Particle Physics Division
Fachverband Teilchenphysik (T)

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Overview of Invited Talks and Sessions

(Lecture halls H-Aula, H-HS I-VI, H-HS VIII-XVII, H-ÜR 1, H-1.002, H-1.003, H-1.004, L-2.004, L-2.017, L-3.001, L-3.002, L-3.015, L-3.016, L-4.001; Poster Grotte)

Prize Talk of the Laureate of the Hertha Sponer Prize 2020

T 67.1	Thu	13:15–13:45	H-Aula	**Dark Matter searches at the LHC** — •Priscilla Pani

Hauptvorträge (Invited Talks)

T 2.1	Mon	11:15–11:55	H-Aula	**Physics Beyond Colliders** — •Joerg Jaeckel, Physics Beyond Colliders Study Group
T 2.2	Mon	11:55–12:35	H-Aula	**Going the extra mile to push the frontier** — •Alexander Mann
T 2.3	Mon	12:35–13:15	H-Aula	**Cosmic Nucleosynthesis as a Multi-Messenger Challenge** — •Roland Diehl
T 22.1	Tue	11:00–11:45	H-Aula	**Flavor directions beyond the standard model** — •Gudrun Hiller
T 22.2	Tue	11:45–12:30	H-Aula	**Highlights from the LHCb experiment** — •Michel De Cian
T 66.1	Thu	11:00–11:45	H-Aula	**No Time to Die? Scrutinising the SM and other Top Stories** — •Reinhild Yvonne Peters
T 66.2	Thu	11:45–12:30	H-Aula	**The Higgs boson at the LHC: a glimpse under the peak** — •Matthias Schröder
T 90.1	Fri	9:00– 9:45	H-Aula	**Probing the neutrino mass scale - first results of the KATRIN experiment** — •Kathrin Valerius
T 90.2	Fri	9:45–10:30	H-Aula	**The European Strategy in Particle Physics** — •Ursula Bassler

Eingeladende Vorträge (Invited Topical Talks)

T 44.1	Wed	14:00–14:30	H-Aula	**Cosmic Particles at Extreme Energies** — •Michael Unger
T 44.2	Wed	14:30–15:00	H-Aula	**IceCube Upgrade - The next level in precision neutrino physics at the South Pole** — •Lew Classen
T 44.3	Wed	15:00–15:30	H-Aula	**Exploring coherent neutrino-nucleus scattering with the NUCLEUS experiment** — •Raimund Strauss
T 44.4	Wed	15:30–16:00	H-Aula	**Can beam-dump experiments uncover the hidden sector?** — •Markus Cristinziani
T 45.1	Wed	14:00–14:30	H-HS X	**A large Scintillating Fibre Tracker for the LHCb Upgrade** — •Xiaoxue Han
T 45.2	Wed	14:30–15:00	H-HS X	**The CMS pixel detector: ready for the future?** — •Jory Sonneveld
T 45.3	Wed	15:00–15:30	H-HS X	**Full event interpretation at Belle II** — •William Sutcliffe
T 45.4	Wed	15:30–16:00	H-HS X	**The Physics Potential of CLIC** — •Ulrike Schnoor
T 68.1	Thu	14:00–14:30	H-Aula	**Assembling the flavour jigsaw (2020 edition)** — •Oscar Cata
T 68.2	Thu	14:30–15:00	H-Aula	**Precise predictions for vector-boson scattering at the LHC** — •Mathieu Pellen
T 68.3	Thu	15:00–15:30	H-Aula	**Hunting dark matter on earth and in the sky** — •Kai Schmidt-Hoberg

T 68.4	Thu	15:30–16:00	H-Aula	**Probing cosmic magnetism and fundamental physics with γ-ray propagation** — •Manuel Meyer
T 69.1	Thu	14:00–14:30	H-HS X	**Boosting jets in Run 2: highlights from Standard Model measurements and searches for new physics in ATLAS** — •Chris Malena Delitzsch
T 69.2	Thu	14:30–15:00	H-HS X	**The decay of Higgs bosons to a pair of tau leptons in the CMS experiment** — •Hale Sert
T 69.3	Thu	15:00–15:30	H-HS X	**Searches for electroweak supersymmetry: highlights, coverage and limitations** — •Jeanette Lorenz
T 69.4	Thu	15:30–16:00	H-HS X	**To the top and beyond: top quarks as a probe of new interactions at the LHC** — •Katharina Behr

Invited talks of the joint symposium "SMuK Dissertation Prize 2020" (SYMD)

See SYMD for the full program of the symposium.

SYMD 1.1	Mon	14:30–15:00	H-Aula/HS I/HS X	***N*-Particle Scattering and Asymptotic Completeness in Wedge-Local Quantum Field Theories** — •Maximilian Duell
SYMD 1.2	Mon	15:00–15:30	H-Aula/HS I/HS X	**First observation of double electron capture in Xe-124 with the dark matter detector XENON1T** — •Alexander Fieguth
SYMD 1.3	Mon	15:30–16:00	H-Aula/HS I/HS X	**Anisotropic Transport of Galactic Cosmic Rays based on Stochastic Differential Equations** — •Lukas Merten

Invited talks of the joint symposium "Dark Matter" (SYDM)

See SYDM for the full program of the symposium.

SYDM 1.1	Wed	10:30–11:15	H-Aula	**Producing the missing matter of the Universe on Earth** — •Alexander Grohsjean
SYDM 1.2	Wed	11:15–12:00	H-Aula	**Searching for physics beyond the Standard Model in nuclei** — •Martin Hoferichter
SYDM 1.3	Wed	12:00–12:45	H-Aula	**Detecting on Earth the missing matter of the Universe** — •Federica Petricca

Sessions

T 1.1–1.2	Sun	16:00–17:45	P-HS 1	**Tutorial: Dark Matter (joint session AKjDPG/T/GR)**
T 2.1–2.3	Mon	11:15–13:15	H-Aula	**Hauptvorträge (Invited Talks) I**
T 3.1–3.3	Mon	16:30–17:15	H-HS I	**Other theory topics**
T 4.1–4.6	Mon	16:30–18:00	H-HS II	**Dark matter: theory**
T 5.1–5.6	Mon	16:30–18:00	H-HS III	**Machine Learning: QCD and electromagnetic showers**
T 6.1–6.6	Mon	16:30–18:00	H-HS IV	**Neutrino physics without accelerators I**
T 7.1–7.6	Mon	16:30–18:05	H-HS V	**Neutrino physics without accelerators II**
T 8.1–8.6	Mon	16:30–18:05	H-HS VI	**Neutrino astronomy I**
T 9.1–9.6	Mon	16:30–18:00	H-HS X	**Flavor physics: Lepton universality tests I**
T 10.1–10.6	Mon	16:30–18:00	H-HS XI	**Top quarks: pair production and tagging**
T 11.1–11.6	Mon	16:30–18:00	H-HS XII	**Higgs: bosonic decays and quantum numbers**
T 12.1–12.6	Mon	16:30–18:05	H-HS XIII	**Detector systems I**
T 13.1–13.6	Mon	16:30–18:00	H-HS XIV	**Pixel detectors I**
T 14.1–14.6	Mon	16:30–18:05	H-HS XV	**Experimental methods I**
T 15.1–15.6	Mon	16:30–18:00	H-HS XVI	**Search for new particles I**
T 16.1–16.6	Mon	16:30–18:00	H-ÜR 1	**QCD theory I**
T 17.1–17.6	Mon	16:30–18:00	H-HS XVII	**Methods of astroparticle physics I**
T 18.1–18.6	Mon	16:30–18:00	L-3.001	**Flavor physics: algorithms**
T 19.1–19.4	Mon	16:30–17:30	L-3.002	**Various topics in astroparticle physics**
T 20.1–20.5	Mon	16:30–17:50	L-3.015	**DAQ, trigger and electronics I**
T 21.1–21.6	Mon	16:30–18:00	L-3.016	**Electroweak physics I**
T 22.1–22.2	Tue	11:00–12:30	H-Aula	**Hauptvorträge (Invited Talks) II**

T 23.1–23.6	Tue	17:00–18:40	H-HS I	**Dark Matter I**
T 24.1–24.6	Tue	17:00–18:35	H-HS II	**Detector systems II**
T 25.1–25.6	Tue	17:00–18:30	H-HS V	**Grid Computing**
T 26.1–26.5	Tue	17:00–18:20	H-HS VI	**Outreach methods I (joint session T/HK)**
T 27.1–27.6	Tue	17:00–18:30	H-HS X	**Higgs: Decay into fermions I**
T 28.1–28.6	Tue	17:00–18:30	H-HS XI	**Top quarks: mass and jets**
T 29.1–29.6	Tue	17:00–18:30	H-HS XII	**Cosmic rays I**
T 30.1–30.6	Tue	17:00–18:30	H-HS XIII	**Flavor physics: Lepton universality tests II**
T 31.1–31.6	Tue	17:00–18:35	H-HS XIV	**Pixel detectors II**
T 32.1–32.6	Tue	17:00–18:30	H-HS XV	**Neutrino physics with accelerators**
T 33.1–33.6	Tue	17:00–18:30	H-HS XVI	**Search for new particles II**
T 34.1–34.6	Tue	17:00–18:30	H-ÜR 1	**QCD theory II**
T 35.1–35.6	Tue	17:00–18:30	H-HS XVII	**Gamma astronomy I**
T 36.1–36.6	Tue	17:00–18:30	L-2.004	**Neutrino physics without accelerators III**
T 37.1–37.6	Tue	17:00–18:30	L-2.017	**Neutrino physics without accelerators IV**
T 38.1–38.6	Tue	17:00–18:30	L-3.001	**Methods of astroparticle physics II**
T 39.1–39.6	Tue	17:00–18:30	L-3.002	**Methods of astroparticle physics III**
T 40.1–40.6	Tue	17:00–18:30	L-3.015	**DAQ, trigger and electronics II**
T 41.1–41.5	Tue	17:00–18:15	L-3.016	**Electroweak physics II**
T 42.1–42.5	Tue	17:00–18:15	L-4.001	**Experimental methods II**
T 43.1–43.15	Tue	17:00–18:30	Grotte	**Poster session Particle Physics**
T 44.1–44.4	Wed	14:00–16:00	H-Aula	**Eingeladene Vorträge (Invited Topical Talks) I**
T 45.1–45.4	Wed	14:00–16:00	H-HS X	**Eingeladene Vorträge (Invited Topical Talks) II**
T 46.1–46.9	Wed	16:30–18:50	H-HS II	**Detector systems III**
T 47.1–47.10	Wed	16:30–19:00	H-HS IV	**Neural networks and systematic uncertainties**
T 48.1–48.8	Wed	16:30–18:30	H-HS V	**Pixel detectors III**
T 49.1–49.9	Wed	16:30–18:45	H-HS VI	**Outreach methods II (joint session T/HK)**
T 50.1–50.4	Wed	16:30–18:30	H-HS X	**Combined detector session (joint session HK/T/ST/EP)**
T 51.1–51.10	Wed	16:30–19:00	H-HS XI	**Flavor physics: CKM I**
T 52.1–52.9	Wed	16:30–18:45	H-HS XIII	**Neutrino physics without accelerators V**
T 53.1–53.10	Wed	16:30–19:00	H-HS XIV	**Dark Matter II**
T 54.1–54.10	Wed	16:30–19:00	H-HS XV	**Axion like particles I**
T 55.1–55.10	Wed	16:30–19:00	H-HS XVI	**Search for new particles III**
T 56.1–56.9	Wed	16:30–18:45	H-ÜR 1	**Experimental methods III**
T 57.1–57.7	Wed	16:30–18:15	H-HS XVII	**Silicon strip detectors**
T 58.1–58.10	Wed	16:30–19:00	H-1.002	**Higgs: associated production**
T 59.1–59.10	Wed	16:30–19:00	L-2.004	**Neutrino astronomy II**
T 60.1–60.9	Wed	16:30–18:45	L-2.017	**Various topics in elementary particle physics**
T 61.1–61.9	Wed	16:30–18:45	L-3.001	**Methods of astroparticle physics IV**
T 62.1–62.10	Wed	16:30–19:05	L-3.002	**Cosmic rays II**
T 63.1–63.8	Wed	16:30–18:30	L-3.015	**DAQ, trigger and electronics III**
T 64.1–64.6	Wed	16:30–18:00	L-3.016	**Gaseous detectors I**
T 65.1–65.10	Wed	16:30–19:00	H-HS VIII	**Top quarks: differential cross sections**
T 66.1–66.2	Thu	11:00–12:30	H-Aula	**Hauptvorträge (Invited Talks) III**
T 67.1–67.1	Thu	13:15–13:45	H-Aula	**Hertha-Sponer Prize Talk**
T 68.1–68.4	Thu	14:00–16:00	H-Aula	**Eingeladene Vorträge (Invited Topical Talks) III**
T 69.1–69.4	Thu	14:00–16:00	H-HS X	**Eingeladene Vorträge (Invited Topical Talks) IV**
T 70.1–70.10	Thu	16:30–19:00	H-HS I	**Higgs: Decay into fermions II**
T 71.1–71.10	Thu	16:30–19:00	H-HS VI	**Supersymmetry: Theory and searches**
T 72.1–72.9	Thu	16:30–18:45	H-HS IX	**Semiconductor detectors**
T 73.1–73.10	Thu	16:30–19:00	H-HS X	**Multi-messenger astronomy**
T 74.1–74.10	Thu	16:30–19:00	H-HS XI	**Flavor physics: CKM II**
T 75.1–75.10	Thu	16:30–19:05	H-HS XIII	**Neutrino physics without accelerators VI**
T 76.1–76.10	Thu	16:30–19:00	H-HS XIV	**Dark Matter III**
T 77.1–77.9	Thu	16:30–18:50	H-HS XV	**Axion like particles II**
T 78.1–78.9	Thu	16:30–18:45	H-HS XVI	**Higgs: Extended models**
T 79.1–79.7	Thu	16:30–18:15	H-ÜR 1	**Experimental methods IV**
T 80.1–80.9	Thu	16:30–18:50	H-1.003	**Calorimeters**
T 81.1–81.10	Thu	16:30–19:00	H-1.004	**Neutrino astronomy III**
T 82.1–82.9	Thu	16:30–18:45	L-2.004	**Pixel detectors IV**
T 83.1–83.10	Thu	16:30–19:00	L-2.017	**Search for new particles IV**

T 84.1–84.10	Thu	16:30–19:00	L-3.001	**Methods of astroparticle physics V**
T 85.1–85.10	Thu	16:30–19:00	L-3.002	**Cosmic rays III**
T 86.1–86.8	Thu	16:30–18:30	L-3.015	**DAQ, trigger and electronics IV**
T 87.1–87.9	Thu	16:30–18:45	L-3.016	**Gaseous detectors II**
T 88.1–88.10	Thu	16:30–19:00	L-4.001	**Top quarks: associated production**
T 89	Thu	19:00–20:30	H-HS I	**General assembly - Particle Physics Division (for DPG members)**
T 90.1–90.2	Fri	9:00–10:30	H-Aula	**Hauptvorträge (Invited Talks) IV**
T 91.1–91.8	Fri	11:00–13:00	H-HS I	**Machine Learning: Event and jet reconstruction**
T 92.1–92.7	Fri	11:00–12:45	H-HS II	**Neutrino physics without accelerators VIII**
T 93.1–93.8	Fri	11:00–13:00	H-HS IV	**Search for new particles V**
T 94.1–94.8	Fri	11:00–13:00	H-HS V	**Supersymmetry: Searches**
T 95.1–95.7	Fri	11:00–12:45	H-HS VI	**Experimental methods V**
T 96.1–96.8	Fri	11:00–13:00	H-HS X	**Higgs: Decay into fermions III**
T 97.1–97.8	Fri	11:00–13:00	H-HS XI	**Drell-Yan and jet production**
T 98.1–98.8	Fri	11:00–13:00	H-HS XII	**Topics in flavor physics**
T 99.1–99.8	Fri	11:00–13:00	H-HS XIV	**Dark Matter IV**
T 100.1–100.8	Fri	11:00–13:05	H-HS XVI	**Gamma astronomy II**
T 101.1–101.7	Fri	11:00–12:45	H-ÜR 1	**Neutrino physics without accelerators VII**
T 102.1–102.8	Fri	11:00–13:00	L-3.001	**Cosmic rays V**
T 103.1–103.8	Fri	11:00–13:00	L-3.002	**Cosmic rays IV**
T 104.1–104.6	Fri	11:00–12:30	L-3.015	**DAQ, trigger and electronics V**
T 105.1–105.8	Fri	11:00–13:05	L-3.016	**Muon detectors**
T 106.1–106.8	Fri	11:00–13:00	L-4.001	**Top quarks: Single top production**
T 107.1–107.8	Fri	11:00–13:00	J-HS C	**Combined instrumentation session I: Gaseous detectors (joint session HK/T)**
T 108.1–108.8	Fri	11:00–13:00	H-HS XIII	**Combined instrumentation session II: Silicon strip detectors (joint session HK/T)**
T 109.1–109.7	Fri	11:00–12:45	J-HS K	**Combined instrumentation session III: Silicon pixel detectors (joint session HK/T)**
T 110.1–110.8	Fri	11:00–13:00	H-HS XV	**Combined instrumentation session IV: Semiconductor detectors (joint session HK/T)**

Annual General Assembly of the Particle Physics Division (for DPG members)

Thursday 19:00–20:30 H-HS I

- Reports
- Meeting venues
- Decisions in section Materie und Kosmos (SMuK)
- AOB

T 1: Tutorial: Dark Matter (joint session AKjDPG/T/GR)

Time: Sunday 16:00–17:45 Location: P-HS 1

Tutorial T 1.1 Sun 16:00 P-HS 1

Tutorial: dark energy, dark matter and dark statistics — •Bjoern Malte Schäfer — Zentrum fuer Astronomie der Universitaet Heidelberg

I will give an overview why cosmology is an interesting branch of theoretical physics and the physics of gravity, the key observations that led to the construction of the cosmological standard model, the fundamental concepts of gravity and of particle physics that are being tested by cosmological observations, and an outlook over the coming decade in new observational techniques.

15 min. break

Tutorial T 1.2 Sun 17:00 P-HS 1

Search for Dark Matter — •Christian Weinheimer — Institut für Kernphysik, Universität Münster

There is multiple and clear evidence from astrophysics and cosmology that exist more matter than we see in the universe. This dark matter should be mainly exotic, i.e. not made out of particles from the Standard Model of particle physics. There are quite a variety of candidates for dark matter, which reqire different search methods.

In my talk I will present various experimental direct and indirect methods to look for candidates for dark matter at underground laboratories, at collider experiments and by astroparticle physics telescopes. At some characteristic examples I will explain detectors and experimental techniques.

T 2: Hauptvorträge (Invited Talks) I

Time: Monday 11:15–13:15 Location: H-Aula

Invited Talk T 2.1 Mon 11:15 H-Aula

Physics Beyond Colliders — •Joerg Jaeckel[1] and Physics Beyond Colliders Study Group[2] — [1]ITP Heidelberg, Philosophenweg 16, 69120 Heidelberg — [2]CERN

Physics Beyond Collider is a study mandated by CERN management to explore the options for future experiments complementary to those at colliders. In this talk we will consider the experiments discussed in this context over the last few years with a particular focus on the fundamental physics questions that they could explore and hopefully answer.

Invited Talk T 2.2 Mon 11:55 H-Aula

Going the extra mile to push the frontier — •Alexander Mann — Ludwig-Maximilians-Universität München

With the completion of the Run-2 dataset, a major checkpoint in the LHC physics program has been reached. For several years, this dataset will be the largest ever taken at the high-energy frontier and enable searches for physics beyond the Standard Model to explore new regions of phase space.

With more data comes more sensitivity, but the more important boost typically arises from new and refined analysis techniques that allow to tackle more challenging scenarios with low cross sections, small acceptance or requiring dedicated reconstruction. The Run-2 dataset allows a wealth of interesting models to be studied — in this presentation, we will look at the overall status and at some selected recent results from the LHC searches in detail.

Invited Talk T 2.3 Mon 12:35 H-Aula

Cosmic Nucleosynthesis as a Multi-Messenger Challenge — •Roland Diehl — Max Planck Institut für extraterrestrische Physik, 85748 Garching, Germany

The origin of cosmic elements and isotopes is among the fundamental challenges of astrophysics. Identifying the origins of specific elements in supernova explosions, or most-recently in binary neutron star collisions, therefore promise breakthrough insights. In this talk, we review the astronomical messengers towards an understanding of cosmic nucleosynthesis in its diversity. Nuclear fusion reactions in cosmic sites produce new isotopes and elements. Observations of such cosmic nucleosynthesis can be direct, or circumstantial/indirect. The decay of unstable isotopes provides a unique and direct trace of a specific event and its nucleosynthesis; stardust or cosmic ray compositions within the solar system can be analysed, but are are less direct, offset in time and space. Indirectly, the effects of violent energy release in such an event, e.g. gravitational waves or a cooling envelope that re-radiates radioactive energy input in a supernova, also reflect aspects of the nuclear-reaction astrophysics. The characteristic evolutionary changes over cosmic times in abundances of cosmic-gas components, as they can be observed in stars that formed from an evolving seed composition, are commonly best known as observables of cosmic nucleosynthesis, as they had led to recognition of the cosmic compositional evolution. We will discuss how these multiple messengers of cosmic nucleosynthesis complement each other, starting from the kilonova/gravitational-wave event GW170817.

T 3: Other theory topics

Time: Monday 16:30–17:15 Location: H-HS I

T 3.1 Mon 16:30 H-HS I

Teilchenmodel basierend auf minimaler Quantentheorie. — •Albrecht Giese — Taxusweg 15, 22605 Hamburg

Wir werden ein Teilchenmodell vorstellen, welches die Eigenschaften von Elementarteilchen mit fast ausschließlich klassischen Ansätzen erklärt. Es basiert im Wesentlichen auf dem Teilchenansatz von Louis de Broglie und der Relativitätstheorie nach Hendrik Lorentz.

In diesem Modell kreisen zwei masselose Unterteilchen mit c umeinander. Das Bindungsfeld hält sie auf Abstand. Die Bindung basiert auf der starken WW. Die Trägheit (Masse) des Teilchens wird verursacht vom Bindungsfeld der starken WW. Setzt man deren bekannte Feldgröße ein, ergibt sich die Masse z.B. des Elektrons mit einer Genauigkeit von 2*10**-6 folgend aus der Teilchengröße (im Kontrast zum Higgs-Ergebnis, welches kaum die Größenordnung angibt); das magnetische Moment mit gleicher Präzision. Andere Tatsachen folgen ebenfalls klassisch aus dem Modell wie die Konstanz des Spin und das Pauli-Prinzip. Ferner die relativistische Massezunahme und die Masse-Frequenz-Relation.

Wir werden auch auf die Aspekte und Vorgänge hinweisen, die weiterhin der QM zuzuordnen sind.

Zur Einführung: www.ag-physics.org/rmass und www.ag-physics.org/electron

T 3.2 Mon 16:45 H-HS I

The Actual Controversy of the Hubble - Constant: Comparison of Observations with Theory — •Ole Rademacker[1] and Hans-Otto Carmesin[1,2,3] — [1]Gymnasium Athenaeum, Harsefelder Straße 40, 21680 Stade — [2]Bahnhofstraße — [3]Universität Bremen, Fachbereich 1, Postfach 330440, 28334 Bremen

First, we evaluate observations in order to show that the Hubble-constant is a function of the redshift. Secondly, we discuss the significance of that finding for the standard model of cosmology. Thirdly, we compare our results with a fundamental theory of quantum gravity. (Carmesin, H.-O. (2019): Die Grundschwingungen des Universums - The Cosmic Unification - With 8 Fundamental Solutions based on G, c and h - With Answers to 42 Frequently Asked Questions. Berlin: Verlag Dr. Köster.).

T 3.3 Mon 17:00 H-HS I

Density Limit of the Evolution of Space and Comparison with 'Cosmic Inflation' — •Laurie Heeren[1], Hans-Otto Carmesin[1,2,3], and Paul Sawitzki[1] — [1]Gymnasium Athenaeum, Harsefelder Straße 40, 21680 Stade — [2]Bahnhofstraße — [3]5

No density can be larger than the Planck density $\rho_P = 5,155 \cdot 10^{96} \frac{\text{kg}}{\text{m}^3}$. The time evolution of the actual light horizon should be traced back until the Planck length $L_P = 1.616 \cdot 10^{-35}$m is reached. However there arises a problem, as in the framework of general relativity theory, GRT, that length L_P is only reached at the density $\rho = 6 \cdot 10^{214} \frac{\text{kg}}{\text{m}^3}$.

We investigate the Planck scale, the evolution of space according to the Friedmann Lemaitre equation and the resulting density limit. Additionally we derive a corresponding time limit. We outline a possible solution of both problems and we compare with 'cosmic inflation' (Carmesin, H.-O. (2019): Die Grundschwingungen des Universums - The Cosmic Unification - With 8 Fundamental Solutions based on G, c and h - With Answers to 42 Frequently Asked Questions. Berlin: Verlag Dr. Köster.).

T 4: Dark matter: theory

Time: Monday 16:30–18:00 Location: H-HS II

T 4.1 Mon 16:30 H-HS II

Impact of SUSY parameters on dark matter prediction — •Marten Berger and Gudrid Moortgat-Pick — II. Institute of Theoretical Physics, University of Hamburg, 22761 Hamburg, Germany

The Minimal Supersymmetric Standard Model (MSSM) is one of the best motivated extensions of the Standard Model (SM): it is of high predictive power and can explain the main open questions of the SM. For instance, if offers a well-motivated cold dark matter candidate. A crucial question is therefore whether this model can explain the correct amount of relic density with its cold dark matter candidate. For calculations of the relic density within the MSSM information about the mass of the lightest supersymmetric particle (LSP) as well as the mass of other particles which play a key role in the dominant mechanisms of annihilation are needed. Since the mixing character can rapidly change depending on the actual parameter point and consequently has immediate influence on the relic density contribution it is necessary to include one-loop corrections in the calculations of the dark matter observables. In this talk the determination of the fundamental SUSY parameter determinations from chargino production at a linear collider will be discussed with the focus on its impact on the contribution on the corresponding relic density.

T 4.2 Mon 16:45 H-HS II

Compatibility of Naturalness with Dark Matter constraints in a recent pMSSM scan — Samuel Bein[1], •Malte Mrowietz[1], Harrison Prosper[2], Peter Schleper[1], and Bogdan Wiederspan[1] — [1]Universität Hamburg, Hamburg, Deutschland — [2]Florida State University, Tallahassee, USA

The viability of weak-scale supersymmetry is studied in the context of a pMSSM scan. The tension of supersymmetric models with LHC results, low-energy constraints, flavor anomalies, dark matter relic density and naturalness are studied. It is exemplified that supersymmetric parameter regions can simultaneously accommodate some, though not all, of the considered observations.

T 4.3 Mon 17:00 H-HS II

One-loop EW corrections to Direct Detection in the Vector Dark Matter Model — Seraina Glaus[1], Margarete Mühlleitner[1], •Jonas Müller[1], Shruti Patel[1], and Rui Santos[2,3,4] — [1]Karlsruher Institut für Technologie, ITP, Karlsruhe, Deutschland — [2]Instituto Politécnico de Lisboa, ISEL, Portugal — [3]Centro de Física Teórica e Computacional, Faculdade de Ciências, Portugal — [4]LIP, Departamento de Física, Universidade do Minho, Portugal

Recent dark matter (DM) direct searches place very stringent constraints on possible DM candidates proposed in extensions of the Standard Model (SM). Driven by the steadily increasing precision in DM direct detection searches, we present the one-loop electroweak corrections to the spin-independent DM scattering cross-section with nucleons in the simplified vector DM model (VDM). The VDM extends the SM with an additional complex singlet and a dark gauged $U(1)_X$ yielding a vector-like DM particle which is stabilised by a Z_2 symmetry. The loop corrections are essential to discuss the sensitivities of the direct detection experiments for the model prediction and might allow for reopening parameter space which is excluded by tree-level analyses.

T 4.4 Mon 17:15 H-HS II

Higher-Order Electroweak Corrections to Dark Matter Direct Detection in the Dark Complex Extension of the Standard Model — Seraina Glaus[1,2], Margarete Mühlleitner[1], Jonas Müller[1], Shruti Patel[1,2], •Tizian Römer[1], and Rui Santos[3,4] — [1]Institute for Theoretical Physics, Karlsruhe Institute of Technology, 76128 Karlsruhe, Germany — [2]Institute for Nuclear Physics, Karlsruhe Institute of Technology, 76344 Karlsruhe, Germany — [3]Centro de Física Téorica e Computacional, Faculdade de Ciências, Universidade de Lisboa, Campo Grande, Edifício C8 1749-016 Lisboa, Portugal — [4]ISEL - Instituto Superior de Engenharia de Lisboa, Instituto Politécnico de Lisboa 1959-007 Lisboa, Portugal

While there is evidence for the existence of Dark Matter, its nature remains unknown. Assuming Dark Matter being constituted of weakly interacting particles, we investigate a minimal extension of the Standard Model, the Dark Complex extension of the Standard Model (DCxSM). In the DCxSM, an additional complex scalar field with a softly broken U(1) symmetry gives rise to a massive pseudo Nambu-Goldstone boson, which is the Dark Matter candidate. We compute the electroweak corrections for the spin-independent direct detection process of this Dark Matter candidate. Since the leading-order cross section of this process vanishes in the non-relativistic limit, the electroweak corrections are essential to discuss the sensitivity of the experimental results of Xenon-1T. We will present the phenomenological implications of the electroweak corrections for the direct detection limits.

T 4.5 Mon 17:30 H-HS II

MeV neutrino dark matter: Relic density, lepton flavour violation and electron recoil — Juri Fiaschi[1], Michael Klasen[1], Miguel Vargas[2], Christian Weinheimer[2], and •Sybrand Zeinstra[1] — [1]Institut für Theoretische Physik, WWU Münster — [2]Institut für Kernphysik, WWU Münster

Right-handed neutrinos with MeV to GeV mass are very promising candidates for dark matter (DM). Not only can they solve the missing satellite puzzle, the cusp-core problem of inner DM density profiles, and the too-big-to fail problem, but they can also account for the Standard Model (SM) neutrino masses at one loop. We perform a comprehensive study of the right-handed neutrino parameter space and impose the correct observed relic density and SM neutrino mass differences and mixings. We find that the DM masses are in agreement with bounds from big-bang nucleosynthesis, but that these constraints induce sizeable DM couplings to the charged SM leptons. We then point out that previously overlooked limits from current and future lepton flavour violation experiments such as MEG and SINDRUM heavily constrain the allowed parameter space. Since the DM is leptophilic, we also investigate electron recoil as a possible direct detection signal, in particular in the XENON1T experiment. We find that despite the large coupling and low backgrounds, the energy thresholds are still too high and the predicted cross sections too low due to the heavy charged mediator, whose mass is constrained by LEP limits. - This work was funded by the Deutsche Forschungsgemeinschaft (GRK 2149).

T 4.6 Mon 17:45 H-HS II

Finding Hints of New Physics in Tritium Molecular Spectra — Wolfgang G. Hollik[1,2], •Matthias Linster[1], Ulrich Nierste[1], Sonia Rani[3], Aman Sardwal[3], and Mustafa Tabet[1] — [1]Institut für Theoretische Teilchenphysik (TTP), Karlsruher Institut für Technologie (KIT) — [2]Institut für Kernphysik (IKP), Karlsruher Institut für Technologie (KIT) — [3]Indian Institute of Technology Bombay (IITB)

Strong limits on the coupling of new light particles can be obtained indirectly from astrophysical observations. Complementary and more

direct searches for keV scale particles are given through molecular spectroscopy, which is—in contrast to astrophysics—in a controlled laboratory environment. In this talk, we present details on the calculation of the effects of different types of new particles on the rovibrational modes of hydrogen-like molecules, especially in the light of a current discrepancy between the best theory prediction and the most precise measurement of Tritium molecular spectra.

T 5: Machine Learning: QCD and electromagnetic showers

Time: Monday 16:30–18:00 Location: H-HS III

T 5.1 Mon 16:30 H-HS III

Deep Learning-based Air-Shower Reconstruction at the Pierre Auger Observatory — Martin Erdmann, •Jonas Glombitza, and Alexander Temme for the Pierre Auger-Collaboration — III. Institut A, RWTH AACHEN UNIVERSITY

Ultra-high energy cosmic rays are the most energetic particles found in nature and originate from extragalactic sources. When propagating within the Earth's atmosphere these particles induce extensive air showers which can be measured by cosmic-ray observatories.

The hybrid design of the Pierre Auger Observatory features a large array of surface-detector stations which is overlooked by fluorescence telescopes. The reconstruction of event-by-event information sensitive to the cosmic-ray mass is a challenging task and so far, mainly based on the fluorescence detector observations with their duty cycle of about 15%.

Recently, deep learning-based algorithms have shown to be extraordinary successful across many domains in computer vision, engineering and science. Applying these algorithms to surface-detector data opens up possibilities for improved reconstructions. In particular it allows for an event-by-event estimation of the cosmic-ray mass, exploiting the 100% duty cycle of the surface detector.

In this contribution we present our deep network, based on recurrent layers and hexagonal convolutions. We show the performance of our method and discuss solutions to systematic biases. Finally, we evaluate the performance by comparing the deep learning-based reconstruction to measurements of the fluorescence detector using Auger hybrid data.

T 5.2 Mon 16:45 H-HS III

Simulation of Extensive Air Showers with Deep Neural Networks — Steffen Hahn, •Marcel Köpke, and Markus Roth — Karlsruhe Institute of Technology, Institute for Nuclear Physics

The Pierre Auger Observatory uses CORSIKA to simulate extensive air showers. With growing incident particle energy it becomes computationally difficult to run the simulations due to increasing time complexity. Deep neural networks possess the ability to recognize patterns in an automatic way and are able to run on specialized, fast hardware like GPUs. Hence they are a good candidate to address run time issues while also offering the possibility to go beyond CORSIKA features like conditioning on meta parameters.

T 5.3 Mon 17:00 H-HS III

Generative Models for Fast Shower Simulation — •Sascha Diefenbacher[1], Erik Buhmann[1], Engin Eren[2], Frank Gaede[2], and Gregor Kasieczka[1] — [1]Universität Hamburg, Institute for Experimental Physics — [2]Deutsches Elektronen-Synchrotron DESY

In high energy physics, simulations of particle collisions play a vital role in most analysis. A significant portion of the time required for these simulations has to be allocated to modeling how highly energetic particles interact with detectors. These simulation times are bound to increase even further, as increased collider luminosities call for more generated samples and advances in detector technology require these samples to have an increasingly fine resolution. One solution is the use of so called generative machine learning models. These models can learn the properties of a calorimeter shower from a relatively small dataset, and are then able to provide new shower samples orders of magnitude faster than a state of the art, full simulation like Geant4 could. We show results of using the two main generative architectures, Generative Adversarial Networks and Variational AutoEncoders, to generate particle showers in a high granular, 5d calorimeter as proposed by the ILD project.

T 5.4 Mon 17:15 H-HS III

Understanding Generative Neural Networks for Fast Simulation of High-Granular Calorimeters — •Erik Buhmann[1], Gregor Kasieczka[1], Sascha Diefenbacher[1], Engin Eren[2], and Frank Gaede[2] — [1]Universität Hamburg, Institut für Experimentalphysik — [2]Deutsches Elektronen-Synchrotron DESY

High-granular calorimeters are necessary for the application of particle flow algorithms in detectors for future collider projects, such as the ILD calorimeters or the CMS-HGCAL. Accurate Monte Carlo (MC) simulations of such calorimeter events demand significant computing resources. An alternative to MC is fast simulation based on generative neural networks that allow event production orders of magnitude faster than traditional MC. We are using generative adverserial network (GAN) and variational autoencoder (VAE) architectures for generating electromagnetic and hadronic calorimeter events.

Determining when the training weights converge to an optimal physics representation of the generated sampels poses a challenge when training generative models. Additionally, increasing our confidence into the accuracy of the sample generation can to be achieved by understanding the latence space represenation of physics observables. In this talk we discuss both challenges and introduce methods on how to interprete the VAE latence space in view of our physics understanding of the underlying training sample distributions.

T 5.5 Mon 17:30 H-HS III

Studies on using Generative Adversarial Networks to simulate parton showers — Johannes Erdmann, •Alexander Froch, and Olaf Nackenhorst — TU Dortmund, Lehrstuhl für Experimentelle Physik IV

Monte Carlo (MC) simulations are one of the basic instruments in data analysis of high energy physics experiments. The three main parts that need to be simulated are the hard scattering process, the parton shower + hadronisation and the detector simulation. Although MC simulations bring great benefits for the data analysis of high energy physics experiments, the costs and time needed to produce them are significantly high. Generative Adversarial Networks (GANs) can be trained with samples from MC simulations to be used for fast MC simulations due to their characteristic as a much less computing-intensive model. It has been shown that GANs are capable to simulate the hard scattering process or imitate even the whole MC simulation process. They were also used as a fast detector simulation trained on samples generated with the GEANT4 detector simulation. Significantly reduced computing times for the event generation were accomplished in comparison to the GEANT4 detector simulation. Motivated by these results we examine the feasibility of generating key features of the parton shower with GANs. In this presentation the latest status of our studies is shown.

T 5.6 Mon 17:45 H-HS III

Towards a Data-Driven Simulation of QCD Radiation with Generative Models — André Schöning, •Christof Sauer, and Danilo Enoque Ferreira de Lima — Physikalisches Institut, Heidelberg, Germany

Recent developments in the field of machine learning open a new window on the simulation of events in high-energy particle physics through Generative Adversarial Networks (GANs) inspired by the pioneering work of Goodfellow *et al* in 2015. This presentation shows a potential application of GANs in terms of solely data-driven event generation with a focus on parton shower simulation. The method could be applied in analyses that are sensitive to the parton shower modelling of the background and hence rely on an accurate background estimate.

The results shown in this talk have been generated using state-of-the-art (conditional) Wasserstein GANs based on the Earth Mover's metric. Furthermore, a comparison is made with (Gaussian) Variational Auto-Encoders (VAEs) – another avenue to generative models –, whereby the latter one shows a significantly worse performance compared to the adversarial approach. All networks presented were trained on dijet samples and W jets obtained from $t\bar{t}$ events produced with MadGraph5_aMC@NLO at LO and further processed by Pythia8.2, which serve as a surrogate to examine the applicability of the methods under well-controlled conditions. The transition to real data would be a possible next step.

T 6: Neutrino physics without accelerators I

Time: Monday 16:30–18:00 Location: H-HS IV

T 6.1 Mon 16:30 H-HS IV

Characterization of the TRISTAN prototype detectors with electrons — •Daniel Siegmann for the KATRIN-Collaboration — Max Planck Institut for Physics

The TRISTAN (TRitium Invetigations of STerile to Active Neutrino mixing) project aims to search for the signature of a keV sterile neutrino in the tritium beta decay spectra. Therefore, the detector system of the KATRIN experiment will be upgraded after its neutrino mass survey.

To reach a high sensitivity to the sterile neutrino mixing angle the strong activity of the KATRIN tritium source is required. The resulting high electron rate is one of the greatest challenges for the TRISTAN project. It will be approached by distributing the rate among 3500 pixels, resulting in count rates of 100 kcps per pixel. To resolve the kink-like signature of the keV sterile neutrino signal the detector needs to maintain an excellent energy resolution of 300 eV (FWHM) at 20 keV and a low energy threshold.

To fulfill these requirements the first two generations of the TRISTAN silicon drift detector prototypes have been characterized with photons and electrons. The overall performance with regard to energy resolution, detection threshold and the thickness of the entrance window are presented in this talk. Additionally the detector response for electrons is modeled and discussed.

This work is supported by the Max Planck society and the TU Munich ("Chair for Dark Matter, Susanne Mertens").

T 6.2 Mon 16:45 H-HS IV

Analysis based on the covariance matrix approach of the first neutrino mass measurement data with KATRIN — •Lisa Schlüter for the KATRIN-Collaboration — Max Planck Institute for Physics, Munich, Germany

The KArlsruhe TRItium Neutrino (KATRIN) experiment is designed to determine the effective mass of the electron-antineutrino with an sensitivity of 200 meV/c^2 (90% C.L.) in a direct and model-independent way. The neutrino mass can be inferred from the shape of the endpoint region of the tritium β-decay spectrum, which is measured using a MAC-E filter and a Windowless Gaseous Tritium Source (WGTS).
KATRIN started its first neutrino mass measurement campaign in March 2019. Considering statistical and systematic uncertainties, we find a central value of the effective electron anti-neutrino mass of $m_\nu^2 = \left(-1.0\,^{+0.9}_{-1.0}\right)\,\mathrm{eV}^2$. Following the method of Lokhov and Tkachov, we derive an upper limit of $m_\nu < 1.1\,\mathrm{eV}$ at 90 % C.L..
This talk presents an analysis of the first neutrino mass measurement data with KATRIN, including systematic effects based on the covariance matrix approach, using the Samak simulation analysis package.

T 6.3 Mon 17:00 H-HS IV

Calibrating the KATRIN main spectrometer with condensed ^{83m}Kr films — •Alexander Fulst for the KATRIN-Collaboration — Institut für Kernphysik, WWU Münster

The *Karlsruhe Tritium Neutrino* (KATRIN) experiment is a direct measurement of the neutrino mass from the kinematics of the tritium β-decay aiming for a sensitivity of 0.2 eV/c^2 (90% C.L.) after five years of operation. It uses an electrostatic spectrometer working in MAC-E-filter mode to analyze energies of beta-electrons generated in the *windowless gaseous tritium source* (WGTS). The experiment recently published the results of its first science run, establishing a new upper limit of $m_\nu < 1.1\,\mathrm{eV/c^2}$ (90% C.L.). Several sources are used for absolute energy calibration, monitoring and precise determination of the spectrometer's transmission function. One of them is the *Condensed Krypton Source* (CKrS) developed in Münster, which utilizes nearly monoenergetic conversion electrons from a ^{83m}Kr film. Measuring the transmission properties is especially necessary in the *shifted analysis plane* (SAP) configuration which reduces the volume between the detector and the analysis plane in the spectrometer. The SAP setting presents a new way to reduce the volume dependent Rydberg background of the spectrometer but can lead to less homogeneous electric potentials and magnetic fields, requiring a precise calibration in order to perform an accurate neutrino mass analysis.

A short overview over the system is given and calibration measurements of the SAP are presented and compared to simulations. This work is supported under BMBF contract number 05A17PM3.

T 6.4 Mon 17:15 H-HS IV

Determination of the tritium Q-value with KATRIN — •Rudolf Sack for the KATRIN-Collaboration — WWU Münster

The **Ka**rlsruhe **Tri**tium **N**eutrino experiment (KATRIN) is a next generation tritium beta decay experiment. It allows a model independent investigation of the absolute neutrino mass scale with an estimated sensitivity of 0.2 eV/c^2 (90% C.L.).
The KATRIN experiment is sensitive to the absolute energy scale of the T_2 beta-decay and can determine the Q-value of tritium beta-decay with sub eV precision. This measured value can be compared to the mass difference of ^{3}He- and T-atoms in Penning traps. This comparison is very important to check the systematic effects of the KATRIN experiment. For the first KATRIN neutrino mass measurement the Q-value determination is still limited by experimental uncertainties, such as work functions and the plasma potential of the source. The talk presents the Q-value of tritium beta decay which was obtained from a measurement phase in 2019, and discusses the dominant systematic effects and uncertainties in detail.
This work is funded by BMBF (05A17PM3) and by DFG (GRK-2149).

T 6.5 Mon 17:30 H-HS IV

Column Density Determination in KATRIN with the Photo-Electron Source — •Christoph Köhler[1], Fabian Block[2], and Alexander Marsteller[2] for the KATRIN-Collaboration — [1]Technical University of Munich/Max Planck Institue for Physics — [2]Karlsruhe Institute of Technology

The Karlsruhe Tritium Neutrino (KATRIN) experiment is designed to measure the effective electron antineutrino mass with a sensitivity of 200 meV (90 % C.L.) using the direct method of investigating the spetral shape of the tritium beta spectrum near the endpoint. To achieve this goal the column density of the windowless gaseous tritium source (WGTS) has to be known with a precision of 0.2 %.

The experimental setup of KATRIN includes an angular resolved electron gun in the rear-end of the beamline. Electrons produced by this source traverse the full length of the WGTS before they are selected according to their energy in the spectrometer and counted by the detector. Analyzing the measured e-gun data with a model of the KATRIN response function for the e-gun electrons allows the determination of the column density with high precision. The implementation of the model reponse function in the analysis software Fitrium and the successful application of this method in the first neutrino mass science run of KATRIN is presented in this talk.

This work is supported by the Technical University of Munich and the Max Planck Society.

T 6.6 Mon 17:45 H-HS IV

Monitoring High Voltage fluctuations in KATRIN using an independent MAC-E filter. — •Vikas Gupta for the KATRIN-Collaboration — Max-Planck Institute for Physics, Munich

KATRIN (Karlsruhe Tritium Neutrino) experiment is measuring electron energy near the endpoint of tritium beta decay (about 18.6 keV) in order to measure the neutrino mass. The final sensitivity goal on the effective mass of the electron anti-neutrino is 0.2 eV at 90% CL. To achieve such a stringent limit, the high voltage of the main spectrometer, which acts as an electrostatic filter, has to be stable at the ppm-level.
The HV in KATRIN is measured using a voltmeter associated with a voltage divider. The Monitor Spectrometer is a stand-alone MAC-E filter coupled to the Main Spectrometer and built to independently assess the HV stability. To do so, a radioactive source of ^{83}Rb is used as a calibration standard. In this talk, the results of the Monitor Spectrometer during the first neutrino mass campaign will be presented. Further, detector upgrades in the Monitor Spectrometer using a novel Silicon Drift detector will be discussed.

T 7: Neutrino physics without accelerators II

Time: Monday 16:30–18:05 Location: H-HS V

Group Report T 7.1 Mon 16:30 H-HS V

Prospects, Design and Status of JUNO — •Hans Theodor Josef Steiger — Technische Universität München (TUM), Physik-Department, James-Franck-Straße 1, 85748 Garching bei München

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kton multi-purpose liquid scintillator detector currently being built in a dedicated underground laboratory in Jiangmen (PR China). Data taking is expected to start in 2021. JUNO's main physics goal is the determination of the neutrino mass ordering using electron anti-neutrinos from two nuclear power plants at a baseline of about 53 km. JUNO aims for an unprecedented energy resolution of 3% at 1 MeV for the central detector, to be able to determine the mass ordering with 3 - 4 σ significance within six years of operation. Besides this fundamental aim, JUNO will have a very rich physics program. It includes the measurement (at a sub-percent level) of the solar neutrino oscillation parameters, the detection of low-energy neutrinos coming from galactic core-collapse supernovae, the first measurement of the diffuse supernova neutrino background, the detection of neutrinos coming from the Sun, the Earth and the Earth's atmosphere. Moreover, JUNO will be sensitive to searches for nucleon decays and neutrinos resulting from dark matter annihilation in the Sun.
In this talk JUNO's design, physics prospects as well as the status of its construction will be presented, together with a short excursion into its rich R&D program.

T 7.2 Mon 16:50 H-HS V

JUNO Sensitivity in The Search for Proton Decay — •Yuhang Guo[1,2], Christoph Genster[2], Wanlei Guo[3], Alexandre Göttel[2,4], Philipp Kampmann[2,4], Runxuan Liu[2,4], Livia Ludhova[2,4], Giulio Settanta[2], and Yu Xu[2,4] — [1]School of Nuclear Science and Technology, Xi'an Jiaotong University, Xi'an, China — [2]IKP-2, Forschungszentrum Jülich, Jülich, Germany — [3]The Institute of High Energy Physics, Chinese Academy of Sciences, Beijing, China — [4]III. Physikalisches Institut B, RWTH Aachen University, Aachen, Germany

Many Grand Unified Theories have predicted that the Baryon number is unconservative, which is beyond the Standard Model physics. As a result, proton decay would be an obvious consequence and would become an explanation to the asymmetry of matter and anti-matter in the Universe. Many experiments have been designed and built in order to search for this key sign of a new physics. Among them, the SuperK has obtained the currently best lower limit to the proton life time, in spite of a low detection efficiency. Jiangmen Underground Neutrino Observatory (JUNO), which is a 20 kton liquid scintillator detector under construction in China, has a large sensitivity in these terms. This is, in addition to the detector's large mass, also thanks to a detection efficiency expected to be larger than in SuperK. The results of a preliminary study concerning JUNO potential in the search for proton decay will be presented.

T 7.3 Mon 17:05 H-HS V

Radon Monitoring in gaseous Nitrogen used for the Filling of the Central Detector of JUNO and OSIRIS — •Hans Theodor Josef Steiger, Lothar Oberauer, and Matthias Raphael Stock — Technische Universität München (TUM), Physik-Department, James-Franck-Straße 1, 85748 Garching bei München

The planned JUNO (Jiangmen Underground Neutrino Observatory) Detector will use 20 kt of liquid scintillator (LS) based on LAB (Linear AlkylBenzene) as neutrino target within an acrylic sphere with a diameter of 35.4 m. For the filling of this sphere as well as for the filling of OSIRIS (Online Scintillator Internal Radioactivity Investigation System) with LS pressurized nitrogen will be used. To avoid a contamination of the LS withradon, its content in the nitrogen gas will be monitored. In this talk the status of a prototype radon monitoring system based on a large volume (50 l) proportional chamber operated in pure nitrogen will be presented as well as pulse shape analysis techniques applied for efficient background reduction. This work is supported by the DFG Research Unit JUNO and the Maier-Leibnitz-Laboratorium (MLL).

T 7.4 Mon 17:20 H-HS V

Towards a Measurement of the CNO cycle in the Sun with Borexino — •Ömer Penek[1,2], Zara Bagdasarian[1], Alexandre Goettel[1,2], Sindhujha Kumaran[1,2], Livia Ludhova[1,2], Mariia Redchuk[1,2], Giulio Settanta[1], and Apeksha Singhal[1,2] for the Borexino-Collaboration — [1]Institut für Kernphysik, Forschungszentrum Jülich — [2]III. Physikalisches Institut B, RWTH Aachen University

The Borexino detector, located at the Laboratori Nazionali del Gran Sasso in Italy, is a liquid scintillator detector with a primary goal to measure solar neutrinos. The *pp* fusion chain has been measured in Borexino with an outstanding precision through the detection of *pp*, *pep*, ^{7}Be, and ^{8}B neutrinos. It is well motivated by standard solar models that less than 1% of the solar energy is fueled by the so-called Carbon-Nitrogen-Oxygen (CNO) cycle which is assumed to be the main energy production mechanism in heavier stars. However, a direct measurement of solar neutrinos from the CNO cycle is difficult due to the high correlation with the ^{210}Bi isotope present in the liquid scintillator. In the so-called Borexino Phase 3, namely the data-taking period after July 2016, the upper limit on the ^{210}Bi rate can be inferred through the α-decay of its decay daughter ^{210}Po. In this talk the Borexino strategy towards the first observation of the CNO neutrinos will be presented. This group report is presented in the name of the Borexino Collaboration.

T 7.5 Mon 17:35 H-HS V

Experimental Comparison of Empirical Ionization-Quenching Models for Plastic Scintillators — •Thomas Pöschl, Martin J. Losekamm, Daniel Greenwald, and Stephan Paul — Technische Universität München

Plastic scintillators have a long tradition as radiation detectors in high-energy physics and are widely used in calorimetry. For high-ionizing radiation, however, their light output is not linearly dependent on the particle's energy deposition. To correctly reconstruct the deposited energy, the scintillator's response including this saturation effect—commonly called ionization quenching—must be known. Several empirical models have been developed in the last decades, each giving a different functional form to the ionization-density dependence of the magnitude of quenching — the so-called quenching function.

We measured the response of two commonly used plastic scintillators to protons and validated the compliance of several quenching models with our data using a Bayesian approach. We calculated the evidences of the models and compared them using Bayes factors. The required posterior-probability distribution for each model was evaluated using a Markov-Chain Monte-Carlo algorithm. To further examine the functional form of the quenching function, we performed a model-independent fit to the data for both scintillators. We found that none of the investigated empirical models can describe the functional form of the quenching function for both scintillators within the explored range of ionization densities.

T 7.6 Mon 17:50 H-HS V

Event Discrimination with Topological 3D Reconstruction at MeV Energies in the JUNO Experiment — •Henning Rebber, Malte Stender, David Meyhöfer, Björn Wonsak, and Caren Hagner — Universität Hamburg

The JUNO experiment will use an unsegmented tank filled with 20 kton liquid scintillator to detect neutrinos and antineutrinos, starting from 2021. An important goal is to answer the open question of neutrino mass ordering by measuring electron-antineutrinos from two nuclear power plants in $\sim$ 53 km distance. A further goal is to measure solar ^{7}Be and ^{8}B neutrinos at high rates. The reactor antineutrinos are identified by means of inverse beta decay (IBD) which leads to a prompt positron and a delayed neutron signal. However, β^{-}-decays of cosmogenic ^{8}He and ^{9}Li can be accompanied by neutron emission and thus mimic the IBD signature. Solar neutrinos are detected via elastic scattering off electrons. The cosmogenic β^{+}-emitters ^{10}C and ^{11}C are a major background here. In any case, a discrimination between electron and positron events would mean a background reduction.

The event discrimination is based on topological differences between the energy deposition of MeV electrons and positrons. The electron events are more point-like than positron events due to the latter emitting two annihilation gammas. A topological 3D reconstruction was applied to Geant4-simulated data in order to visualise the resulting

fine differences in the time spectrum of PMT hits. The potential towards a discrimination between electrons and positrons, gammas, and ^{10}C decays, respectively, will be presented.

T 8: Neutrino astronomy I

Time: Monday 16:30–18:05 Location: H-HS VI

Group Report T 8.1 Mon 16:30 H-HS VI

KM3NeT: Physikziele und erste Daten — •Matthias Bissinger für die KM3NeT-Kollaboration — Erlangen Centre for Astroparticle Physics, Erwin-Rommel-Str. 1, 91058 Erlangen, Germany

Die im Bau befindliche Forschungsinfrastruktur KM3NeT vor den Küsten Frankreichs und Siziliens wird sowohl fundamentale Aspekte der Neutrinophysik erforschen als auch Quellen kosmischer Neutrinos. Dabei kommen zwei Detektoren zum Einsatz, ORCA und ARCA, die aus technisch identischen Wasser-Cherenkov-Modulen bestehen. Aus den Daten von KM3NeT/ORCA lassen sich die Oszillationswahrscheinlichkeiten von Neutrinos, die in der Erdatmosphäre entstehen, ableiten. Dadurch soll es gelingen, die Neutrino-Massenhierarchie zu bestimmen. KM3NeT/ARCA, welcher mit einem Kubikkilometer ein wesentlich größeres Detektorvolumen aufweist als ORCA, wird nicht nur das Gesichtsfeld des IceCube-Neutrinoeleskops am Südpol auf die gesamte Himmelskugel erweitern, sondern strebt insbesondere auch den Nachweis von Neutrinos aus Quellen in unserer Galaxis an. Die Inbetriebnahme erster Detektoreinheiten von KM3NeT/ORCA und ARCA ist erfolgt und der Vortrag wird neben den wissenschaftlichen Zielen von KM3NeT einen Überblick zur Aufbauphase und zu den ersten Messergebnissen geben.

T 8.2 Mon 16:50 H-HS VI

Studies of systematic uncertainty effects on IceCube's real-time angular uncertainty — •Cristina Lagunas Gualda for the IceCube-Collaboration — DESY Zeuthen

Sources of astrophysical neutrinos can be potentially discovered through the detection of neutrinos in coincidence with electromagnetic or gravitational waves. Real-time alerts generated by IceCube play an important role in this search since they act as a trigger for follow-up observations with more sensitive instruments.

Once a high-energy event is detected by the IceCube real-time program, an automatic GCN notice is generated within the first tens of second using a fast and crude reconstruction method. Then a more sophisticated and time-consuming method is run in order to calculate a more accurate localization and uncertainty estimate including an estimate on systematic uncertainties. There is a discrepancy between the spatial uncertainty contours from the two methods with the latter once being significantly larger.

To investigate this discrepancy and especially the effect of systematic uncertainties, we focus on individual high-energy events and simulate similar events in direction and energy for different ice model realizations. This makes use of a novel simulation tool, which allows the treatment of systematic uncertainties with multiple and continuously varied nuisance parameters.

T 8.3 Mon 17:05 H-HS VI

Up-going simulations of neutrino induced Extensive Air Showers with the Fluorescence Detector of the Pierre Auger Observatory* — •Ioana Caracas for the Pierre Auger-Collaboration — Bergische University Wuppertal, Germany

The Pierre Auger Observatory is performing a follow-up of the recent ANITA observations of up-going cosmic ray-like showers with energies around 0.1-1 EeV. These anomalous events could be seen within the Fluorescence Detector (FD) of the observatory. As the exposure of the FD for 14 years of data taking is exceeding the exposure of ANITA by a factor of at least 100, it is strongly believed the current research will be able to either confirm or infirm the recent observations.

Simulations of up-going extensive air showers with elevation of more than $\approx$ 20 degrees below the horizon represent the first step in this search. The extensive air showers are simulated using CORSIKA with primary energies in the range of 10^{17} - $10^{18.5}$ eV; three different primaries are simulated: protons, electrons and tauons, as the main candidates resulted from a neutrino charged current (CC) interaction. The detector response is simulated using the Offline software of the collaboration. These simulations will be used to estimate the sensitivity of the FD to these evens, to optimize the selection of events in real data and reduce the chance of false positives, as well as to provide insight into the nature of these events. Preliminary results of these simulations and estimated exposures will be presented and discussed.

*Gefördert durch die BMBF Verbundforschung Astroteilchenphysik (Vorhaben 05A17PX1)

T 8.4 Mon 17:20 H-HS VI

Cosmic ray detection efficiency and implications for in-ice radio detectors for high-energy neutrinos — •Lilly Pyras for the RNO-G-Collaboration — Humboldt-Universität zu Berlin — DESY Zeuthen

A promising technique to measure neutrinos above 10 PeV is the detection of the radio signals generated by the Askaryan effect. The effect is caused by neutrino-induced particle cascades in dense media i.e. ice. Starting in 2020 a new detector using this technique and containing in-ice detector strings will be deployed in Greenland. One of the main challenges of the data analysis will be distinguishing between a cosmic ray muon and a real neutrino event. By building the detector with surface antennas we can use the established method of radio detection of air showers to identify incoming muons and use these signals as a veto mechanism in the neutrino detection. The data is analysed utilizing a Python based software tool, NuRadioReco, a general reconstruction software used for both neutrino and air shower radio arrays. An efficient veto trigger will lend higher confidence in identifying neutrinos and prevent the false positive neutrino detections caused by muons. This report presents the development of this mechanism and analyses its performance.

T 8.5 Mon 17:35 H-HS VI

Latest results of the ANTARES deep-sea neutrino telescope — •Sara Rebecca Gozzini for the ANTARES-KM3NeT-Erlangen-Collaboration — ECAP / Universität Erlangen-Nürnberg

ANTARES is the largest undersea neutrino detector, installed in the Mediterranean Sea, and is primarily sensitive to neutrinos in the TeV-PeV energy range. Data taking with the telescope has been continous since 2008. In a multitude of analyses ANTARES investigates the southern sky for neutrino signals from possible steady point sources, transient and extended neutrino emitters. A special focus is set on work towards an independent confirmation of the diffuse cosmic neutrino flux discovered by IceCube. ANTARES also contributes actively to multi-messenger and multi-instrument analyses. Sensitive searches for dark matter and exotic particle states, as well as results on neutrino oscillations in the conventional three-flavour picture and beyond complement the ANTARES research program. The contribution gives a selected overview of the latest results.

T 8.6 Mon 17:50 H-HS VI

Study of double cascade sensitivity in IceCube-Gen2 — •Fuyudi Zhang for the IceCube-Collaboration — DESY, Zeuthen

The IceCube Neutrino Observatory is a cubic kilometer in-ice Cherenkov detector located at the South Pole. At high energies, the neutrino flux of $\nu_e : \nu_\mu : \nu_\tau$ is expected to be observed in the ratio of 1 : 1 : 1 on Earth. A ternary particle identification technique on the basis of three event topologies, single cascades, double cascades, and tracks, has been developed. While tracks arise mainly from charged-current muon neutrino interactions, single cascades from neutral-current interactions of all neutrino flavors and many charge-current interactions of ν_e. Double cascades arise from ν_τ charged-current interactions and subsequent non-muonic decay of the taus if the decay length is large enough to be resolved ($E > \sim 100$ TeV). Such double cascades are unique to tau neutrinos and can be used to identify them. The next-generation neutrino observatory, IceCube-Gen2 will have an instrumented volume nearly 10 times greater than IceCube and a different geometry with larger string spacing. In this work I will present a study to estimate the double cascade identification efficiency in IceCube-Gen2, by analyzing the IceCube high-energy starting event sample but only using a subset of the optical sensors that is similar in layout to the future IceCube-Gen2 geometry.

T 9: Flavor physics: Lepton universality tests I

Time: Monday 16:30–18:00 Location: H-HS X

T 9.1 Mon 16:30 H-HS X

Rare baryonic decays and lepton universality tests at LHCb — •Vitalii Lisovskyi and Johannes Albrecht — Experimentelle Physik 5, TU Dortmund

Flavour-changing neutral-current $b \to s\ell^+\ell^-$ transitions are forbidden at tree level in the Standard Model (SM), and can only occur at loop level. Therefore, they are sensitive to potential New Physics (NP) effects. In the SM, the transitions $b \to se^+e^-$ and $b \to s\mu^+\mu^-$ have the same probability to happen, this property is called lepton universality (LU). Probing LU in b-hadron decays is considered as a promising area for NP searches. In particular, tensions at the level of about 2.5 standard deviations with respect to the SM predictions have been observed in rare $B \to K^{(*)}\ell^+\ell^-$ decays.

This talk presents a first test of the LU in rare decays of b baryons, namely $\Lambda_b^0 \to pK\ell^+\ell^-$, using the data collected by the LHCb experiment. The decay $\Lambda_b^0 \to pKe^+e^-$ is observed for the first time, which allows to test LU with about 15% precision. The analysis approach, its main challenges and potential future improvements are discussed.

Furthermore, prospects for studies of rare decays of the Λ_b^0 and heavier b baryons at the LHCb experiment are discussed.

T 9.2 Mon 16:45 H-HS X

Measurement of the ratios $\mathcal{R}(\mathrm{D}^{(*)})$ at Belle using the Belle II software — Florian Bernlochner[2], Michael Feindt[1], Pablo Goldenzweig[1], •Felix Metzner[1], and Maximilian Welsch[2] — [1]Karlsruher Institut für Technologie — [2]Rheinische Friedrich-Wilhelms-Universität Bonn

The discrepancy observed for the ratios $\mathcal{R}(\mathrm{D}^{(*)})$ of the decays $\mathrm{B} \to \mathrm{D}^{(*)}\tau\nu$ relative to the normalisation modes $\mathrm{B} \to \mathrm{D}^{(*)}\ell\nu$ ($\ell = \mathrm{e}, \mu$) between the experimental results and the Standard Model (SM) prediction is one of a few longstanding tensions of the SM. The new Belle II software framework and the therein included conversion tool B2BII allows to reevaluate the Belle data set of 772 million $\mathrm{B\bar{B}}$ pairs recorded from 1999 until 2010 using the improved algorithms of the modern framework. With this approach a new measurement of the ratios $\mathcal{R}(\mathrm{D}^{(*)})$ with an improved hadronic tagging algorithm — the Full Event Interpretation (FEI) — is carried out. Profiting from a higher reconstruction efficiency, due to the new tagging algorithm, this analysis aims to provide new insights into these semileptonic B decays. In this talk, the procedure and the current status of the analysis will be presented.

T 9.3 Mon 17:00 H-HS X

Semitauonic B-decays at Belle II with a hadronic tagging — Florian Bernlochner[1], Jochen Dingfelder[1], •Michael Eliachevitch[1], Felix Metzner[2], and Maximillian Welsch[1] for the Belle II-Collaboration — [1]Rheinische Friedrich-Wilhelms-Universität Bonn — [2]Karlsruher Institut für Technologie

One of the prominent candidates in the search for new physics at the precision frontier is the ratio $\mathcal{R}(\mathrm{D}^{(*)})$ of $\bar{\mathrm{B}} \to \mathrm{D}^{(*)}\tau\nu_\tau$ to $\bar{\mathrm{B}} \to \mathrm{D}^{(*)}\ell\nu_\ell$ decays, where $\ell = \mathrm{e}, \mu$. Combined measurements from the B factories and LHCb reveal an excess of the semitauonic decays with respect to Standard Model predictions. The Belle II experiment in Tsukuba, Japan, will enable new insights into this anomaly.

This talk presents the procedure, status, and plans for an analysis using the hadronic tag side reconstructed with the Full Event Interpretation, a tagging algorithm developed for the Belle II experiment.

T 9.4 Mon 17:15 H-HS X

Signal extraction of $B^0 \to \pi^-\tau^+\nu_\tau$ at Belle and Belle II — Jochen Dingfelder, Peter Lewis, and •Lu Xu for the Belle II-Collaboration — Physikalisches Institut, Universität Bonn, Bonn, Germany

The decay $B^0 \to \pi^-\tau^+\nu_\tau$ is sensitive to new physics beyond the Standard Model, such as contributions from charged Higgs bosons or leptoquarks. The world's best limit was established by the Belle experiment using its full dataset, measuring $\mathcal{B}(B^0 \to \pi^-\tau^+\nu_\tau) < 2.5 \times 10^{-4}$ at 90% confidence level. We present the current status of an ongoing measurement of $\mathcal{B}(B^0 \to \pi^-\tau^+\nu_\tau)$ with improved hadronic tagging in leptonic and hadronic τ decay modes. The study aims to extract the ratio $R(\pi) = \mathcal{B}(B^0 \to \pi^-\tau^+\nu_\tau)/\mathcal{B}(B^0 \to \pi^-\ell^+\nu_\ell)$ with ℓ denoting either an electron or muon. A MVA based on a boosted decision tree is employed to separate light lepton and τ contributions from each other.

T 9.5 Mon 17:30 H-HS X

Measurement of the ratio $R_{K\pi\pi}$ with the LHCb experiment — Christoph Langenbruch, •Johannes Heuel, and Stefan Schael — I. Physikalisches Institut B, RWTH Aachen University

In the Standard Model (SM) of particle physics, the coupling of electroweak gauge bosons to all leptons is universal. Stringent tests of this Lepton Flavour Universality (LFU) are possible by measuring ratios of rare $b \to s\ell\ell$ decays with different leptons in the final state. These decays are loop-suppressed in the SM and therefore sensitive to new heavy particles beyond the SM.

The LHCb experiment is ideally suited for the study of rare b hadron decays due to its large acceptance, the high trigger efficiencies and the excellent tracking and particle identification. Recent measurements of $b \to s\ell\ell$ ratios published by the LHCb Collaboration show tensions with the SM predictions of up to 2.5 standard deviations. Therefore, further studies of LFU tests using other rare B decay channels are crucial.

The current status of the ongoing measurement of the ratio $R_{K\pi\pi}$ of the branching fractions of the decays $B^+ \to K^+\pi^+\pi^-\mu^+\mu^-$ and $B^+ \to K^+\pi^+\pi^-e^+e^-$ is presented. The measurement is experimentally challenging as the hadronic system is measured inclusively.

T 9.6 Mon 17:45 H-HS X

Measurement of the ratio $R_{K^{*0}}$ using Run 1 + 2 data of the LHCb experiment — •Stephan Escher, Christoph Langenbruch, Simon Nieswand, Stefan Schael, and Eluned Smith — RWTH Aachen, Germany

In the Standard Model (SM) of particle physics flavour-changing neutral-current processes are forbidden at tree-level and can only occur in electroweak loop diagrams. Therefore, $b \to s$ transitions are rare and sensitive to heavy particles beyond the SM. In the SM the coupling of gauge bosons to leptons are independent of their flavour, which is known as lepton flavour universality (LFU). Thus, the $R_{K^{*0}}$ ratio, defined as $R_{K^{*0}} = \mathcal{B}(B^0 \to K^{*0}\mu^+\mu^-)/\mathcal{B}(B^0 \to K^{*0}e^+e^-)$, is predicted to be unity in the SM (neglecting lepton mass effects). The existence of new particles, that couple differently to electrons and muons, could influence the $R_{K^{*0}}$ ratio significantly and lead to deviations from unity.

To this date, the most precise measurement of $R_{K^{*0}}$ is performed by the LHCb collaboration using Run 1 data showing a deviation of $2.4 - 2.5$ standard deviations (σ) from the SM expectations.

This talk will present the strategy of the analysis using the combined Run 1 and 2 LHCb data sample, which will allow for a more precise determination of $R_{K^{*0}}$. Particular emphasis will be on the study of backgrounds as well as on the validation of fit yields and efficiencies of the control channel.

T 10: Top quarks: pair production and tagging

Time: Monday 16:30–18:00 Location: H-HS XI

T 10.1 Mon 16:30 H-HS XI

Measurement of the $t\bar{t}$ production cross-section in the lepton+jets channel at $\sqrt{s} = 13$ TeV with the ATLAS experiment — Baida Achkar[1], Tomas Dado[1,2], Kevin Moor[1], •Marcel Niemeyer[1], Arnulf Quadt[1], and Elizaveta Shabalina[1] — [1]II. Physikalisches Institut, Georg-August-Universität Göttingen — [2]Institute of Physics, Comenius University Bratislava

The top quark, as it is the heaviest of all quarks, plays a special role in the Standard Model (SM). Measuring its production cross-section provides an important test of QCD calculations and for SM predic-

tions. A previous measurement of the $t\bar{t}$ production cross-section in the lepton+jets channel with ATLAS was based on a small dataset of 28 pb^{-1}. This talk will present the latest measurement of the $t\bar{t}$ production cross-section at $\sqrt{s} = 13$ TeV in the lepton+jets channel with the ATLAS experiment based on the full Run II dataset corresponding to 139 fb^{-1}. A profile likelihood fit is used to determine the cross-section in three signal regions simultaneously and constrain the uncertainties significantly.

T 10.2 Mon 16:45 H-HS XI

Studies of $t\bar{t}$ production with additional heavy flavour jets in p-p collision with the ATLAS detector — •Lucas Klein, Mahsana Haleem, and Raimund Ströhmer — Universität Würzburg

The production of $t\bar{t}$-pairs with additional jets provides a strong test of quantum chromodynamics (QCD) predictions at high orders. Furthermore, this represents as a significant background to rare SM processes (e.g. $t\bar{t}H$, $t\bar{t}t\bar{t}$), as well as to processes beyond the standard model. The additional jets consisting of b-quarks originating from gluon splitting are particularly interesting in constraining uncertainties in the prediction of the process.

In this talk, we will show studies of $t\bar{t}$-pair production with additional b-jets in the dileptonic top decay channel using full Run 2 ATLAS data from proton-proton collision at $\sqrt{s} = 13$ TeV. Events are chosen by requiring an oppositely-charged $e\mu$-pair and at least two b-jets in the final state. In order to differentiate the b-jets coming directly from *top*-quark decays to those emerging from the gluon splitting, an algorithm is developed. This algorithm assigns the b-jets to *top*-quarks based on the kinematics of the final state objects, such as distributions of angular distances between objects and invariant masses. The performance of this algorithm as well as the distributions of additional jet-multiplicity and kinematics of various objects will be presented.

T 10.3 Mon 17:00 H-HS XI

Jet activity measurement in top pair production in dilepton channel with the ATLAS experiment — •Matthieu Robin for the ATLAS-Collaboration — DESY, Zeuthen

Following previous studies on $t\bar{t} + jets$ published in 2017 and on $t\bar{t}b\bar{b}$ published in early 2019, this study aims to use the full LHC run II dataset of 139 fb^{-1} to improve the results in statistically limited regions as well as methods to better estimate our signal background such as fake background and pile-up jets.

This study plays a major role for other analyses regarding the understanding of their QCD background (e.g.: $t\bar{t}Hb\bar{b}$), and is also important by itself to improve our understanding of additional jet radiation properties and provide tests of the QCD and SM predictions. This should further help to improve the modelling of $t\bar{t}+jets$ in the MC generators.

In this talk will be shown updated data/MC comparisons with some unfolded results and systematics studies that I performed with the help of the $t\bar{t} + jets$ analysis team of ATLAS.

T 10.4 Mon 17:15 H-HS XI

Measurement and EFT interpretation of the $t\bar{t}$ cross section in the boosted lepton+jets channel with the ATLAS detector at $\sqrt{s} = 13$ TeV — •Kevin Sedlaczek, Johannes Erdmann, and Kevin Kröninger — TU Dortmund, Experimentelle Physik IV

Physics beyond the Standard Model (SM) can, in absence of resonances, be investigated in a model-independent way by using effective field theory (EFT) approaches. Without assumption of the underlying theory, effects of potential new particles can be quantified by higher dimension expansions of the SM Lagrangian at a higher energy scale.

At the LHC, physics in the top sector is entering a phase of precision measurements combined with very accurate predictions. Meanwhile, many theories beyond the SM predict deviations in the top couplings or new interactions coupling to the top quark. These aspects combined make model-independent measurements in the top sector a very attractive way to test the SM for deviations arising from new physics at higher energy scales.

In this talk, studies on a differential $t\bar{t}$ cross-section measurement in variables including properties of additional jets are shown. The analysis is performed in the boosted lepton + jets channel on the full 139 fb^{-1} Run 2 dataset taken with the ATLAS detector at a centre-of-mass energy of $\sqrt{s} = 13$ TeV. In order to derive bounds on the contributions of new physics within the EFT framework, the choice of variables for the unfolded differential distributions is investigated for sensitivity to the EFT operators.

T 10.5 Mon 17:30 H-HS XI

Measurement of top tagging efficiencies in CMS — Johannes Haller, Roman Kogler, and •Dennis Schwarz — Institut für Experimentalphysik, Universität Hamburg

Top quarks with high transverse momenta are abundantly produced at the LHC. In this kinematic regime the products of hadronic top quark decays ($t \to bW \to bq\bar{q}'$) are highly collimated and cannot be reconstructed in three separate jets but merge into a single large radius jet. In order to identify these decays, top tagging algorithms make use of the jet substructure. These are crucial for both, searches for heavy new particles as well as precision measurements of top quark production at high transverse momenta.

This talk presents a measurement of top tagging efficiencies in simulation and data recorded with the CMS detector at $\sqrt{s} = 13$ TeV corresponding to an integrated luminosity of 137 fb^{-1}. Correction factors are derived for the application of these algorithms in physics analyses.

T 10.6 Mon 17:45 H-HS XI

Performance studies of the Heavy Object Tagger with Variable R (HOTVR) — •Anna Albrecht, Ksenia de Leo, Johannes Haller, Roman Kogler, and Christopher Matthies — Institut für Experimentalphysik, Universität Hamburg

The Heavy Object Tagger with Variable R (HOTVR) is an algorithm for the clustering and identification of boosted, hadronically decaying, heavy particles at the LHC. The central feature of the HOTVR algorithm is a variable distance parameter R that decreases with increasing transverse momentum p_{T} of the jet. It combines jet clustering, subjet finding and rejection of soft radiation. In its original version, soft and wide-angle radiation is rejected by a mass jump criterion. This study presents first results using the soft drop algorithm instead, comparing the performance between both grooming options.

T 11: Higgs: bosonic decays and quantum numbers

Time: Monday 16:30–18:00 Location: H-HS XII

T 11.1 Mon 16:30 H-HS XII

Search for Di-Higgs production in the $bb\gamma\gamma$ final state with the ATLAS detector — •Florian Beisiegel, Jochen Dingfelder, Tatjana Lenz, and Norbert Wermes — Physikalisches Institut, Uni Bonn

The discovery of the Higgs boson in 2012 was a great success of modern particle physics since it served as a proof of the Higgs mechanism introduced in 1964. One focus of the current particle physics experiments at the LHC is the measurement of the Higgs properties, such as its coupling strengths to fundamental particles. In addition to the coupling of the Higgs boson to fermions and gauge bosons, the Higgs mechanism also predicts a Higgs self-coupling. The triple-Higgs self-coupling can be measured in the di-Higgs production channel (non-resonant production).

Di-Higgs analyses also facilitate the search for new heavy particles that decay to two Higgs bosons (resonant production).

This talk presents a search for Di-Higgs production in the $bb\gamma\gamma$ final state using 139 fb^{-1} of proton-proton collisions at 13 TeV recorded with the ATLAS detector. The analysis aims to measure the non-resonant SM HH production cross section and the Higgs boson self-coupling strength as well as searching for resonant Di-Higgs production.

T 11.2 Mon 16:45 H-HS XII

A method to search for the non-resonant di-Higgs production cross-section in the dileptonic HH→bbWW final state — Martin Erdmann, •Peter Fackeldey, Benjamin Fischer, and Dennis Noll — III. Physikalisches Institut A, RWTH Aachen University

The measurement of the di-Higgs boson production is a direct test of the electroweak symmetry breaking in the standard model of parti-

cle physics (SM). The coupling strength between three Higgs bosons (self-coupling) determines the shape of the Higgs potential and thus the vacuum stability of the universe. The cross section of the di-Higgs boson production is about a factor of thousand smaller in comparison to a single SM Higgs boson, making it a highly statistically challenging search.
The expected sensitivity for the HH→bbWW($l\nu l\nu$) final state is shown corresponding to Run II data.

T 11.3 Mon 17:00 H-HS XII

Background modeling in the measurements of differential Higgs boson cross sections in the diphoton channel with the ATLAS detector — •Nils Gillwald — DESY, Hamburg, Germany

Since the discovery of the Higgs boson in July 2012, efforts have been underway to measure its properties as precisely as possible. An important part of these efforts is the differential measurements of the $H \to \gamma\gamma$ cross section. Such measurements of different spectra of kinematic and event observables offer access to e.g. properties of perturbative QCD, the spin and CP nature of the Higgs boson, bottom and charm Yukawa couplings and new heavy particles coupling to the Higgs boson. The dominating uncertainty for the latest full LHC Run 2 results in the measurement of $H \to \gamma\gamma$ differential cross sections is the estimation of the spurious signal, i.e. the potential bias on the measurement due to the background modeling. Improving the estimate on the spurious signal, and thus the background modeling, is therefore of utmost importance for a precise measurement. In this talk, I present the work in progress on the improvements of the background modeling. This includes a discussion on shortcomings as well as potential further improvements for Run 2 and beyond.

T 11.4 Mon 17:15 H-HS XII

Investigation of the CP properties of VBF Higgs production in the $H \to \tau_{\text{had}}\tau_{\text{had}}$ channel with the ATLAS detector — •Serhat Ördek and Stan Lai — Georg-August-Universität Göttingen

Recent studies at the LHC have led to the observation of the Higgs boson decay to tau leptons with a rate compatible with the Standard Model expectation. This observation opens the possibility of a more in-depth investigation of the properties of the production and decay of a Higgs boson into tau leptons, including whether or not the Higgs boson couplings involved violate CP conservation. The analysis presented in this talk focuses on events where Higgs bosons are produced via vector boson fusion in order to investigate the tensor structure of their coupling to electroweak gauge bosons. For this, a profile likelihood fit using a matrix-element observable method is employed in the decay to tau leptons to test whether a CP-odd component and hence CP violation is present in the coupling. Emphasis will be placed on the fully hadronic final state.

T 11.5 Mon 17:30 H-HS XII

Measurement of the Higgs boson CP quantum number in tau-tau decays with the CMS experiment — •Oleg Filatov, Elisabetta Gallo, Alexei Raspereza, Andrea Cardini, and Merijn van de Klundert — Deutsches Elektronen-Synchrotron (DESY)

The Standard Model (SM) predicts the existence of a CP-even Higgs boson. Measuring the CP quantum number of the Higgs boson is therefore useful to confirm the prediction of the SM and search for evidences pointing to new physics. The study of bosonic decays of the Higgs boson has already excluded a CP-odd Higgs, however direct measurement of a mixing angle between a CP-even and a CP-odd state has not been performed yet. The H->tautau decay at tree level is sensitive to the CP parity of the Higgs boson and offers a possible measurement of the CP mixing angle. The decay planes of the two tau leptons are reconstructed using the decay products in the mutau channel and the angle between them is used to estimate the CP mixing angle. The Run 2 data collected by the CMS experiment in proton-proton collisions at the LHC are used to estimate the sensitivity of the CP measurement.

T 11.6 Mon 17:45 H-HS XII

Test of CP invariance in vector-boson fusion production of the Higgs boson using $H \to \tau\tau$ decays at $\sqrt{s} = 13$ TeV with the ATLAS detector — Kathrin Becker[1,2], •David Hohn[1], Alena Lösle[1], Dirk Sammel[1], and Markus Schumacher[1] — [1]Albert-Ludwigs-Universität Freiburg — [2]University of Warwick

Violation of CP invariance is one of the Sakharov conditions to explain the observed baryon asymmetry in our universe. While CP violation is already realised in the Standard Model via the CKM matrix, it is not sufficient to explain the amount of observed baryon asymmetry. Hence, it is interesting to search for new sources of CP violation in the Higgs sector. The vector-boson fusion production allows to investigate the CP structure of the Higgs-boson coupling to electroweak gauge bosons HVV and to test its CP invariance.

The analysis discussed in this talk is performed in the $H \to \tau\tau$ decay channel and uses the CP-odd *Optimal Observable* to search for additional CP-odd contributions to the SM HVV coupling structure. The result is based on data taken by the ATLAS detector in 2015 and 2016 at $\sqrt{s} = 13$ TeV corresponding to an integrated luminosity of 36.1 fb^{-1}. This talk focuses on the $\tau_{\text{lep}}\tau_{\text{lep}}$ and $\tau_{\text{lep}}\tau_{\text{had}}$ analysis categories and the combined result.

T 12: Detector systems I

Time: Monday 16:30–18:05 Location: H-HS XIII

Group Report T 12.1 Mon 16:30 H-HS XIII

Status of the Mu3e experiment — •Sebastian Dittmeier for the Mu3e-Collaboration — Physikalisches Institut, Universität Heidelberg

The Mu3e experiment will search for the charged lepton flavour violating decay $\mu^+ \to e^+e^-e^+$ with a targeted branching ratio sensitivity of $10^{-15}(10^{-16})$ in Phase I (II). The sensitivity goal drives the experimental design: To distinguish the neutrino-less signal decay from background processes, excellent momentum, vertex and time resolutions of the detector system are required. An ultra-thin silicon pixel tracking detector will be constructed, complemented by a scintillating fibre and a scintillating tile detector which add precise time information to the tracks. To conduct the experiment within a reasonable time, the detector will have to cope with electrons and positrons originating from muon decays at rates up to $10^8(10^9)$ per second. The current status of the design and construction of the Mu3e experiment is presented. Plans for commissioning of first detector module prototypes are outlined.

T 12.2 Mon 16:50 H-HS XIII

Mu3e Tile Detector Prototype — •Tiancheng Zhong, Yonathan Munwes, Hannah Klingenmeyer, Wei Shen, and Hans-Christian Schultz-Coulon for the Mu3e-Collaboration — Kirchhoff-Institut für Physik, Universität Heidelberg, Heidelberg 69120, Germanny

The Mu3e experiment is designed to search for the charged Lepton Flavour Violation (cLFV) decay $\mu^+ \to e^+e^+e^-$ with detector sensitivity of 10^{-16}. The observation of this decay would be a clear signal for new physics beyond the Standard Model (SM). To suppress both accidental and physics background in the experiment, a precise measurement of the vertex position, the decay time and the particle momenta is required. The tile detector, which employs scintillation tiles, SiPMs and dedicated readout ASICs, aims at a timing resolution of better than 100 ps.

At the Kirchhoff-Institut für Physik (KIP), Universität Heidelberg, which is responsible for the tile detector research and development, four 16-channel technical prototypes have been assembled and tested at the DESY electron test beam in Hamburg in December 2019. The preliminary results show a single channel timing resolution below 50 ps, which clearly fulfills the requirement of 100 ps.

T 12.3 Mon 17:05 H-HS XIII

CLAWS: Monitoring Injection Backgrounds at SuperKEKB — •Hendrik Windel for the Belle II-Collaboration — Max-Planck-Insitut für Physik, München

The electron-positron collider SuperKEKB uses continuous injections at a rate of 50 Hz to achieve the highest possible luminosities. These injections result in periods of higher beam backgrounds which may impose constraints on the operation of the Belle II detector. To monitor the level and time structure of the injection backgrounds, CLAWS, a

system based on plastic scintillator tiles read out with silicon photomultipliers connected to a readout system providing continuous readout over several thousand revolutions of the accelerator with subnanosecond time resolution, was installed as part of the inner commissioning detector of Belle II for the second phase of commissioning from February to July 2018. A modified version of the CLAWS detector system is now a permanent part of the beam background monitoring for the Belle II experiment and began regular physics operation in March 2019. This contribution will discuss the hardware installations of the second phase of commissioning and show results from background measurements during the second comissioning phase and physics phase of SuperKEKB.

T 12.4 Mon 17:20 H-HS XIII

A Scintillator Based Background and Beam Abort System for SuperKEKB — •Ivan Popov for the Belle II-Collaboration — Max Planck Institut für Physik, München, Deutschland

The asymmetric-energy collider SuperKEKB started its physics operation in March 2019. The usage of a nano-beam scheme will enable collisions of electrons and positrons at record-breaking luminosities, but requires continuous particle injections at a rate of 50 Hz. These injections result in periods of high backgrounds, which can negatively affect the operation of Belle II subdetectors. In order to monitor and mitigate such backgrounds, the CLAWS detector system, consisting of scintillator tiles read out by silicon photomultipliers, is in operation in various forms since 2016. Beginning with the first physics run in 2019, 32 sensor modules have been distributed along the final focusing magnets. The advantageous locations of these sensors make the CLAWS system ideal for rapid detection of disturbances in the particle beam. The joint usage of fast read out electronics and a smart trigger logic enables the generation of a beam abort trigger within a few 100 ns after the occurrence of excessive background, thus ensuring the safe operation of the experiment. In this report, the development of CLAWS system for its secondary use as a beam abort system is discussed.

T 12.5 Mon 17:35 H-HS XIII

Test Beam Results from ATLAS ITk Strip End-Cap modules — •Arturo Rodriguez Rodriguez, Marc Hauser, Ulrich Parzefall, Frederik Ruehr, Dennis Sperlich, and Liv Wiik-Fuchs — Universität Freiburg - Physikalisches Institut, Hermann-Herder Str. 3a, 79104 Freiburg, Germany

To cope with the occupancy and radiation doses expected at the High-Luminosity LHC accelerator, the ATLAS experiment will replace its Inner Detector with an all-silicon Inner Tracker (ITk), consisting of pixel and strip subsystems. The strip subsystem will be built from modules consisting of n+-in-p silicon strip sensors, and PCB hybrids containing the front-end electronics glued directly to the sensor. A powerboard, including an HV switch, a monitoring and control ASIC, and a DC-DC converter, is also glued to the sensor. In the last year, two prototype strip modules have been tested using beams of high energy electrons produced at the DESY II test beam facility. The modules tested are built from the annular R0 sensor, which will be used in the forward End-Cap region. For the first time, the final production version of the readout electronics, known as ABCstar, has been used. One of the R0 modules has been tested after irradiation to 50% beyond the expected end-of-lifetime fluence. The data allow for thorough tests of the module performance, noise occupancy, detection efficiency, and tracking performance. Moreover, the excellent tracking resolution allows for detailed studies of various strip sensor features. The results give confidence that the ITk strip detector will meet the requirements of the ATLAS experiment.

T 12.6 Mon 17:50 H-HS XIII

Diamond sensors for the LHCb Beam Condition Monitor — •Martin Bieker, Lars Funke, and Dirk Wiedner — Experimentelle Physik 5, TU Dortmund

The LHCb experiment is a single-arm forward spectrometer at the LHC and it focuses on measurements in the b and c quark sector. Due to its unique geometry, featuring a sensitive tracking system located close to the LHC beam, the detector is at risk of adverse beam conditions. For this reason LHCb employs 16 diamond sensors that monitor the particle flux near the beam pipe at two locations close to the interaction point.

The so called Beam Conditions Monitor (BCM) successfully protected the LHCb defector during Run I and Run II of the LHC. However at the end of Run 2 in 2018 indications for possible ageing effect of the diamond sensors were observed. Therefore, the system is overhauled and will receive new diamond sensors and a new back end electronic matching the LHCb upgrade standards.

This talk will give an overview of the activities linked to the upgrade. Special emphasis is put on the characterization of diamond sensors and their use in the new BCM system.

T 13: Pixel detectors I

Time: Monday 16:30–18:00 Location: H-HS XIV

T 13.1 Mon 16:30 H-HS XIV

Quality Control Measurements of RD53A on Wafer- and Module Level — •Michael Daas, Markus Frohne, Tomasz Hemperek, Florian Hinterkeuser, Fabian Hügging, Hans Krüger, David-Leon Pohl, Mark Standke, Marco Vogt, Norbert Wermes, and Jochen Dingfelder — Physikalisches Institut der Universität Bonn

The Large Hadron Collider (LHC) at CERN will be upgraded for higher luminosities in 2025. The increased luminosity poses new demanding requirements for its detectors.

This talk gives an overview over preparations for quality control measurements based on the RD53A readout ASIC, developed by the RD53 collaboration. It features a small pixel pitch of $50 \times 50\,\mu m^2$ to mitigate single-pixel pile-up, higher data rate capabilities and high radiation tolerance. This enables the chip to cope with the high occupancy of up to $3 \cdot 10^9$ hits $\cdot$ cm$^{-2} \cdot$ s^{-1}, that is expected in some areas of the ATLAS tracking detector of the upgraded LHC.

After an extensive characterization phase in the last years, first module assemblies based on RD53A are now used to develop QC procedures for ATLAS ITk module production. This talk covers the development of a wafer probing setup for quality control of bare readout ASICS on wafer level, as well as the first preparations for a module test setup. Since the University of Bonn is one of the largest module production sites within the ATLAS collaboration, many of the about 10000 modules for the ATLAS ITk Pixel Detector will be assembled and tested here.

T 13.2 Mon 16:45 H-HS XIV

Characterization of RD53A modules using x-ray fluorescence — •Sascha Dungs[1,2], Kevin Kröninger[2], Susanne Kühn[1], Lingxin Meng[1], and Heinz Pernegger[1] — [1]CERN — [2]TU Dortmund, Experimental Physics IV

As part of the Phase-II upgrade of the ATLAS detector, the current tracking detector will be replaced by an all-silicon detector, the Inner Tracker (ITk). For this, a new generation of silicon hybrid pixel modules are currently being developed. There are different techniques to investigate the properties of these modules. X-ray fluorescence can be used for energy calibration. An x-ray source is pointing on a target material, which leads to emission of photons with monochromatic energy. By using various target materials a wide energy range can be evaluated.

In this talk, results of x-ray fluorescence measurements of unirradiated and irradiated planar pixel modules with RD53A readout chips will be presented.

T 13.3 Mon 17:00 H-HS XIV

Charge Calibration and Crosstalk Measurements with RD53A Assemblies — •Georgios Giakoustidis — Physikalisches Institut, Universität Bonn, Nussallee 12, 53115 Bonn, Germany

The RD53 collaboration designed a new prototype hybrid pixel readout chip using the 65 nm CMOS technology for the High-Luminosity LHC upgrade. Thinner silicon sensors chosen to cope with the prospective high radiation levels in ATLAS require lower threshold of the readout electronics making the tunings more challenging. Thus, calibration of the charge injection circuitry of RD53A assemblies with different sensor geometries was conducted using the precise TDC method. At low thresholds crosstalk becomes more perceptible and should be consid-

ered for the final sensor design selection. Therefore RD53A assemblies with sensors of different pixel structure and geometries were tested by injecting artificial charge to neighbouring pixels in various patterns. Events of cluster size one and two are analysed, leading to a transfer function with slope of (10.37 ± 0.10) e/DAC and offset of (180 ± 60) e. Calibration results for different thresholds showed no significant difference. Assemblies with the same pixel geometry between the sensor and the readout chip exhibited crosstalk of about 1%, whereas 7% to 16% crosstalk was observed for assemblies with geometry mismatch. Since no significant differences observed between charge calibration of different RD53A assemblies and thresholds, the final transfer function is of global use. A sensor with a non-matching pixel geometry to the readout chip is not ideal for the RD53A. Sensors with smaller implants reduce the crosstalk levels by 30%.

T 13.4 Mon 17:15 H-HS XIV

Characterization of a depleted monolithic active pixel sensor in 180 nm TowerJazz technology — Ivan Berdalovic[2], •Christian Bespin[1], Ivan Caicedo Sierra[1], Leyre Flores Sanz De Acedo[2], Tomasz Hemperek[1], Toko Hirono[1], Fabian Hügging[1], Hans Krüger[1], Thanusan Kugathasan[2], Cesar Augusto Marin Tobon[2], Konstantinos Moustakas[1], Heinz Pernegger[2], Walter Snoeys[2], Tianyang Wang[1], Norbert Wermes[1], and Jochen Dingfelder[1] — [1]Physikalisches Institut, Universität Bonn — [2]CERN, Genf

The planned upgrade of LHC leading to the High-Luminosity Large Hadron Collider (HL-LHC) imposes new requirements on the detectors. With the availability of highly resistive silicon in commercial CMOS processes, there have been efforts to build depleted monolithic active pixel sensors (DMAPS) for high energy particle detectors. TJ-MonoPix is a prototype of such a pixel sensor in 180 nm TowerJazz technology. It is designed for usage in high radiation environments such as the HL-LHC. The pixels with a small collection electrode design and pixel pitch of 36 μm × 40 μm are read out using a FE-I3-like column drain readout architecture. Different flavors allow for a study of minor modifications in the pixel design.

In this talk, results from radioactive sources and X-ray irradiations will be presented. Furthermore, an overview of ongoing work towards a future chip in this CMOS technology will be shown.

T 13.5 Mon 17:30 H-HS XIV

Characterization of Planar Pixel Sensors for the CMS Phase 2 Upgrade — •Finn Feindt[1], Aliakbar Ebrahimi[1], Erika Garutti[1], Caroline Niemeyer[1], Daniel Pitzl[2], Georg Steinbrück[1], Jörn Schwandt[1], and Irene Zoi[1] — [1]Institute for Experimental Physics, Hamburg University, Luruper Chaussee 149, D-22761 Hamburg, Germany — [2]Deutsches Elektronen-Synchrotron, Notkestraße 85, D-22607 Hamburg, Germany

The CMS Pixel Detector for the Phase 2 Upgrade of the CMS Experiment will have to withstand a 1 MeV neutron equivalent fluences ϕ_{eq} of up to 2×10^{16} cm^{-2} at 2.8 cm distance from the beam and enable tracking in a high track multiplicity environment caused by up to 200 proton collisions per bunch crossing.

To meet these requirements, planar pixel sensors with pixel sizes of 50×50 μm^2 or 100×25 μm^2 and an active thickness of 150 μm were designed, produced and characterized after proton or neutron irradiation to ϕ_{eq} above 5×10^{15} cm^{-2}, corresponding to the fluence expected in the second layer of the CMS Pixel Detector. The sensors differ in the design of implantation, metalization and biasing scheme and the pixel isolation technology.

The presented results show that the irradiated planar pixel sensors fulfill the requirement of efficiency $\epsilon = 0.99$ at operation voltages below 800 V. In addition, the characterization and comparison of the different sensor designs provide valuable input for the final choice of the sensor design.

T 13.6 Mon 17:45 H-HS XIV

Capacitance measurements on silicon pixel sensors for ATLAS ITk — •Evelyn Kimmerle, Hans Krüger, and Norbert Wermes — Physikalisches Institut, Universität Bonn, Nussallee 12, 53115 Bonn, Deutschland

The pixel capacitance is a sensitive parameter when it comes to pixel sensors and signal processing. It has influence on noise performance, time resolution and power consumption so its precise knowledge is important.

For this purpose, a dedicated integrated circuit was developed. The so-called PixCap65 chip provides a powerful tool for pixel sensor capacitance measurement with unprecedented sub-femtofarad precision.

The PixCap65 chip is compatible with the next generation of pixel sensors with small 50μm x 50μm pixels that are deployed in the future hybrid pixel detectors of the ATLAS and CMS experiments.

In this presentation, the functional principle of the PixCap65 chip and measurement results of various sensor pixel geometries are discussed.

T 14: Experimental methods I

Time: Monday 16:30–18:05 Location: H-HS XV

Group Report T 14.1 Mon 16:30 H-HS XV

Track reconstruction for the Mu3e experiment — •Alexandr Kozlinskiy for the Mu3e-Collaboration — Institut für Kernphysik Johannes Gutenberg-Universität Mainz

The *Mu3e* experiment will search for the lepton flavour violating decay $\mu^+ \to e^+e^-e^+$ with the aim to reach a branching ratio sensitivity of 10^{-16}. The first phase the experiment will be performed at an existing beam line providing 10^8 muons per second at the Paul-Scherrer Institute (Switzerland) which will allow to reach a sensitivity for the branching fraction of 10^{-15}. The muons will stop on a target and decay at rest. The decay products (positrons and electrons) with energies below 53 MeV are measured by a tracking detector consisting of two double layers of 50 μm thin High-Voltage Monolithic Active Pixel Sensors (HV-MAPS). The high granularity of the pixel detector with a pixel size of 80 × 80 μm allows for a precise track reconstruction in the high occupancy environment of the *Mu3e* experiment. The *Mu3e* track reconstruction uses a novel fit algorithm that in the simplest case takes into account only the uncertainty due to multiple scattering, which allows fast online tracking on a GPU based filter farm. The implementation of the 3-dimensional multiple scattering fit based on hit triplets is described. An extension of the fit that takes into account energy losses and pixel size is used for offline track reconstruction. The algorithm and performance of the offline track reconstruction based on a full Geant4 simulation of the *Mu3e* detector are presented.

T 14.2 Mon 16:50 H-HS XV

ATLAS track reconstruction developments for LHC Run 3 and 4 — •Fabian Klimpel[1,2], Andreas Salzburger[2], and Stefan Kluth[3] for the ATLAS-Collaboration — [1]Technische Universität München — [2]CERN — [3]Max Planck Institut für Physik

Reconstructing trajectories of particles in high-energy physics experiments require the dominant amount of hardware resources used for the total reconstruction. With the start of the high luminosity LHC the combinatorial complexity of this task will increase. In order to handle future track reconstruction challenges the ATLAS collaboration put much effort into the revision of existing code and the development of new software. In this context an optimisation of the current track reconstruction chain has been performed. An overview over the results and this study will be presented within this talk. In addition to the code changes and optimisations in the reconstructions algorithms ATLAS is deploying a new multi-threaded AthenaMT framework in order to improve the memory/thread scaling. This change requires a thread-safe implementation of the track reconstruction components. Since it represents a major conceptual change compared to a single-core optimised software as used in LHC Run 1 and 2 the ATLAS project ACTS was created. The track reconstruction project is by design thread-safe and serves as detector independent R&D project for future improvements in track reconstruction algorithms. We will present the improvements and prospects of the ATLAS track reconstruction for Run 3 and 4 and give an overview of the status of the ACTS project.

T 14.3 Mon 17:05 H-HS XV

Combinatorial Kalman Filter for the Belle II Experiment — Florian Bernlochner[1], Jochen Dingfelder[1], Alexander

Glazov[2], Simon Kurz[2], and •Christian Wessel[1] for the Belle II-Collaboration — [1]Physikalisches Institut, Rheinische Friedrich-Wilhelms-Universität Bonn — [2]Deutsches Elektronen-Synchrotron DESY

Kalman filters are a widely used tool in HEP to identify charged particle trajectories with a high efficiency and purity. The Belle II Combinatorial Kalman Filter (CKF) implementation is instrumental in achieving the physics goals of the experiment and is successfully being used in first emerging physics measurements. In this talk, I will summarize the key elements of the CKF implementation, show first results with data and give an outlook on future optimizations and extensions we have been working on.

T 14.4 Mon 17:20 H-HS XV

Reconstruction of B mesons using machine learning methods — Florian Bernlochner[2], •Tobias Böckh[1], Jochen Gemmler[1], Pablo Goldenzweig[1], and James Kahn[1] for the Belle II-Collaboration — [1]Karlsruher Institut für Technologie — [2]Rheinische Friedrich-Wilhelms-Universität Bonn

The Belle II experiment records events of two B mesons decaying, via intermediate resonances, into final state particles. This work presents a deep learning approach to reconstruct a B meson. For this purpose, a network is trained to predict for each final state particle from which B meson it originated. Subsequently, particles from a common mother are combined to predict properties of the B meson.

T 14.5 Mon 17:35 H-HS XV

Demonstrating learned particle decay reconstruction with graph neural networks at Belle II — •Ilias Tsaklidis[1], James Kahn[2], Tobias Boeckh[2], and Pablo Goldenzweig[2] for the Belle II-Collaboration — [1]Institut Pluridisciplinaire Hubert CURIEN (IPHC), Strasbourg, France — [2]Karlsruher Institut für Technologie, Germany

The clean environment within Belle II, with decay processes originating from an electron-positron pair without the presence of partons, allows for the reconstruction of the entire collision event. This is a unique advantage to the Belle II experiment in that it allows for direct measurements of decay processes involving neutrinos or few detectable particles in the final state. This does, however, require a catch-all reconstruction algorithm which is able to reconstruct those particles not associated with the signal process being investigated. The current Full Event Interpretation algorithm at Belle II requires the reconstructed sub-decay processes to be hard-coded. This both restricts the total branching fraction coverage of the algorithm and relies on intuition to decide which decay processes to reconstruct. In this work we introduce a method for learning which processes to reconstruct and how to reconstruct them from example using graph neural networks.

T 14.6 Mon 17:50 H-HS XV

Track reconstruction with ACTS — Florian Bernlochner, Jochen Dingfelder, and •Ralf Farkas for the Belle II-Collaboration — University of Bonn

The reconstruction of trajectories of charged particles is a crucial task for most HEP experiments. The ACTS (A Common Tracking Software) aims to be a generic, framework- and experiment-independent toolkit for track reconstruction, initially started from the ATLAS tracking software. My talk will summarise recent developments of a combinatorial Kalman filter for the ACTS project and the possibilities of integrating ACTS into the Belle II track reconstruction.

T 15: Search for new particles I

Time: Monday 16:30–18:00 Location: H-HS XVI

T 15.1 Mon 16:30 H-HS XVI

Search for new physics at BESIII — •Riccardo Aliberti — Insitut für Kernphysik, Johannes Gutenberg-Universität, Mainz

The Standard Model of particle physics (SM) is a very successful theory providing an elegant, precise, and consistent mathematical description of the nature at the elementary particles level. However, the experimental observations of neutrinos oscillations, dark matter and dark energy as well as the tension between measurement and prediction of the anomalous magnetic momentum of the muon, pointed out that the SM is incomplete and new physics processes are still waiting to be uncovered.
The BESIII experiment, located on the Beijing Electron–Positron Collider (BEPCII), provides an ideal environment for the search of particles beyond the standard model in the MeV to few GeV mass region. The search for new particles is carried out for production channels directly associated to e^+e^- collisions as well as for those involving particle decays (J/Ψ, ω, Φ, ...). In this talk, the latest results and prospects for the search of dark photon and Z' in visible and invisible final state at BESIII will be presented.

T 15.2 Mon 16:45 H-HS XVI

Searching for Dark Sector Particles in Muon Pair Production at BESIII — •Daniela Becker, Achim Denig, and Christoph Florian Redmer for the BESIII-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Germany

Discrepancies between the Standard Model prediction and the results of precision measurements, such as the Muon (g-2)-anomaly, may hint at the limits of the otherwise successful theory. Models proposed to compensate the observed discrepancies suggest a so-called Dark Sector of new fundamental particles and interactions with a suppressed coupling to the Standard Model.

The BESIII experiment at the BEPCII electron-positron collider in Beijing, China, has collected large samples within the τ-charm region, providing excellent requirements for the study of muonic final states. The talk will report on such a study on the search for the massive Dark Photon (Z'), postulated to couple to the heavy Standard Model leptons and thus might be identified as a narrow resonance in the invariant mass spectrum of muon pairs. — Supported by DFG SFB1044.

T 15.3 Mon 17:00 H-HS XVI

Searches for long-lived particles produced in Higgs decays with b-quark like signature — •Melanie Eich, Lisa Benato, Gregor Kasieczka, Karla Pena, and Jörg Schindler — Institut für Experimentalphysik, Universität Hamburg

Beyond Standard Model (BSM) theories including neutral, long-lived particles (LLP) can solve the hierarchy problem. In these theories, a mirror version of all or some SM gauge group exists alongside additional fermions. The particles of SM and mirror group are connected via a discrete symmetry. In our analysis the Higgs boson is assumed to be the mediator between the two groups, because it mixes with its mirror partner. It is expected that the Higgs boson decays into a pair of long- lived scalars π_ν.

We show results for the case that each π_ν decays into two b-quarks, while the lifetime of the π_ν is in the order of a few millimetres. Such a lifetime results in a displaced vertex (DV), mimicking a b-quark like signature. The search for such π_ν requires new analysis techniques to distinguish between decay products coming from DV and background events. We present a comparison of different reconstruction techniques including machine learning methods and show the achievable sensitivity to twin Higgs production as a function of the mass and lifetime of the π_ν. In this talk an overview of the analysis and its current status and results will be presented, using data recorded with the CMS detector in Run2.

T 15.4 Mon 17:15 H-HS XVI

Observation of an excess at 30 GeV in the opposite sign di-muon spectra of $Z \to b\bar{b} + X$ events recorded by the ALEPH experiment at LEP — •Arno Heister — privat

The re-analysis of the archived data recorded at the Z^0 resonance by the ALEPH experiment at LEP during the years 1992-1995 shows an excess in the opposite sign di-muon mass spectra at 30.40 ± 0.46 GeV in events containing b quarks. The excess has a natural width of 1.78 ± 1.14 GeV.

The di-muon excess has a local significance around $5\,\sigma$ (Z_{asym}), depending on the background model used. The significances for background models based on a kernel density approximation stay close to $3\,\sigma$ ($Z_{\mathrm{freq,\,lee}}$), when including a look elsewhere effect. Another method to obtain a significance value results in at least $2.6\,\sigma$ (Z_{Bi}). A com-

patible, but smaller excess is visible in the opposite di-electron mass spectrum as well.

Several experiments have data samples that include the di-lepton mass region discussed here. The excess described in the paper arXiv:1610.06536 may be present in data of other experiments at LEP, the Tevatron and the LHC. Former members of the L3 collaboration as well as the ATLAS and CMS collaborations have published the result of their searches for this excess. The L3 data and the CMS data shows a noteworthy excess. The ATLAS experiment did not find anything in its data, yet.

T 15.5 Mon 17:30 H-HS XVI

Results of the muon flux and spectrum measurement from a target replica for the SHiP experiment — •Stefan Bieschke, Daniel Bick, Caren Hagner, and Walter Schmidt-Parzefall — Universität Hamburg, Institut für Experimentalphysik, Luruper Chaussee 149, 22761 Hamburg

SHiP is a proposed, general purpose beam dump experiment using CERN's SPS 400 GeV proton beam dedicated to the Search for Hidden Particles. A high intensity proton beam which is stopped in a massive target produces a large number of particles, possibly including particles from the dark sector, which have evaded detection so far. Among these, a huge amount of muons is produced. For SHiP, a low background environment is necessary and muons will be diverted utilizing an active magnetic shield. For the optimization of this shield, knowledge about the muon flux and spectrum is crucial. Therefore in summer 2018 an experiment at the CERN SPS was performed measuring the muon flux and spectrum from a target replica of the SHiP target at the H4 beam line. During the three week experiment $\mathcal{O}(5 \times 10^{11})$ p.o.t were collected. The results of the analysis will be presented.

T 15.6 Mon 17:45 H-HS XVI

Search for long lived particles produced in Higgs decays with lifetimes up to the muon system — •Jörg Schindler, Lisa Benato, Melanie Eich, Gregor Kasieczka, and Karla Peña — Institut für Experimentalphysik, Universität Hamburg

Traditionally, searches for new physics at the LHC focused on already established objects, like photons, leptons, jets or missing energy. A different approach is to look for signatures in the detector which up until now were not considered. One such signatures are long lived particles, which have a macroscopic lifetime ranging from a few micrometers up to several kilometers. Such particles are for example predicted by twin Higgs models, where a dark sector mirroring the SM particles is introduced. The Higgs boson mixes with its dark partner, acting as a mediator between the SM and dark sector and therefore can decay into non-SM particles. These non-SM particles are the long-lived neutral scalars π_ν, which later decay back into SM particles, predominantly b quarks.

In this talk the search for long lived particles which decay after the tracker is presented. These signatures can be observed with close to no background, but require the development of new reconstruction and analysis tools.

The status of the current search for LLPs with long lifetimes is shown, using data collected by the CMS detector in run 2.

T 16: QCD theory I

Time: Monday 16:30–18:00 Location: H-ÜR 1

T 16.1 Mon 16:30 H-ÜR 1

Mixed QCD-QED corrections to Drell-Yan — •Maximilian Delto[1], Matthieu Jaquier[1], Kirill Melnikov[1], and Raoul Roentsch[2] — [1]Karlsruher Institut fuer Technologie — [2]CERN

We present a fully-differential description of mixed QCD-QED corrections to the production of on-shell Z and W bosons in hadronic collisions. These corrections are of phenomenological interest for the precision era of the LHC, e.g. for an improved determination of the W boson mass. We regulate infrared and collinear singularities present in real emission contributions using the nested soft-collinear subtraction scheme.

T 16.2 Mon 16:45 H-ÜR 1

Automating the calculation of jet functions in SCET — •Kevin Brune and Guido Bell — Universität Siegen

In pertubative QCD large logarithms can arise in the computation of collider observables. These logarithms can be resummed via factorization theorems within Soft-Collinear Effective Theory(SCET). The factorization theorems contain jet functions, which describe collinear interactions. In this talk I present a systematic framework for the computation of jet functions for generic observables. For this purpose we introduce a phase space parametrization which allows the factorization of universal singularities of jet functions. We have implemented this framework for different observables, by using the public code "pySecDec" to compute the next-to-leading order and part of the next-to-next-to-leading order jet function.

T 16.3 Mon 17:00 H-ÜR 1

Zero-jettiness beam function at NNLO — •Daniel Baranowski — TTP, KIT, Karlsruhe

Currently there is a push in developing techniques for N3LO fully-differential QCD computations for the most basic 2 to 1 processes, such as the production of the Higgs boson in gluon fusion or the Drell-Yan process. One way to handle IR and collinear singularities is slicing of the phase space along a suitable variable. This talk focuses on one of the ingredients of the slicing technique, the zero-jettiness beam function at NNLO.

T 16.4 Mon 17:15 H-ÜR 1

Parton shower based on TMD parton distributions — •Melanie Schmitz[1], Hannes Jung[1], Sara Taheri Monfared[1], and Francesco Hautmann[2,3] — [1]Deutsches Elektronen-Synchrotron (DESY) — [2]University of Antwerp — [3]University of Oxford

Transverse Momentum Dependent (TMD) parton distributions include the dependence on the transverse momentum kT of the partons. TMDs play an important role for calculations with parton showers, which represent higher-order corrections to the hard subprocess.

In this talk, TMD parton distributions are determined from different standard parton showers. A parton shower based on TMD parton distributions obtained with the Parton Branching method, which allows to solve evolution equations for collinear and TMD parton distributions numerically in an iterative procedure, is presented. It is investigated how well the TMD parton shower reproduces the TMD parton distributions. Applications of the TMD parton shower to LHC processes will be presented.

T 16.5 Mon 17:30 H-ÜR 1

Nested soft-collinear subtractions in NNLO QCD computations — •Konstantin Asteriadis — TTP, KIT, Karlsruhe

Currently important progress is being made in next-to-next-to-leading order (NNLO) QCD calculations. As a result, many processes at hadron colliders have been computed to NNLO QCD precision. Despite these developments, the search for the optimal subtraction scheme that allows us to handle IR and collinear singularities in an efficient and general way is still ongoing. In this talk I will introduce the nested soft-collinear subtraction scheme that possesses many desired features; for example, it is analytic, fully local and highly modular.

T 16.6 Mon 17:45 H-ÜR 1

Matching coefficients in nonrelativistic QCD to two-loop accuracy — •Marvin Gerlach[1], Go Mishima[2], and Matthias Steinhauser[1] — [1]Institut für Theoretische Teilchenphysik, Karlsruhe Institute of Technology (KIT), Wolfgang-Gaede Straße 1, 76128 Karlsruhe, Germany — [2]Institut für Kernphysik, Karlsruhe Institute of Technology (KIT), Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany

Nonrelativistic QCD (NRQCD) describes the system of two heavy quarks with mass m_Q in the limit of small relative velocity, v. It is constructed by a double expansion in α_s and v (of $1/m_Q$). In this talk we present results for various two-loop matching coefficients for operators which contribute at order $1/m_Q^2$. The results are building blocks for next-to-next-to-next-to-leading logarithmic and next-to-next-to-next-to-next-to-leading order corrections to the threshold production of top quark pairs and the decay of heavy quarkonia.

T 17: Methods of astroparticle physics I

Time: Monday 16:30–18:00 Location: H-HS XVII

T 17.1 Mon 16:30 H-HS XVII

A multi-PMT Optical Module for the IceCube Upgrade — •Alexander Kappes for the IceCube-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, Münster

The IceCube Upgrade will add about 700 new advanced optical sensors to the current detector, thereby expanding its capabilities both at low and high neutrino energies. A large fraction of the upgrade modules will be multi-PMT Digital Optical Modules, mDOMs, each featuring 24 three-inch class photomultiplier tubes (PMTs) pointing uniformly in all directions. Together, the 24 PMTs provide an effective photosensitive area more than twice than that of the current IceCube optical module. The main mDOM design challenges arise from the constraints on the module size and power needed for the 24-channel high-voltage and readout systems, as well as the extreme environmental conditions in the deep ice at South Pole. This contribution presents an overview of the module design and the current development status.

T 17.2 Mon 16:45 H-HS XVII

Design and commissioning of a PMT testing facility for the IceCube Upgrade mDOM PMTs — •Lasse Halve, Robert Joppe, Martin Rongen, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

The IceCube Upgrade will extend the current IceCube Neutrino Observatory with seven additional strings of instrumentation. More than 400 multiple-PMT Digital Optical Modules [mDOM], with 24 3" Photomultiplier Tubes [PMT] each, will be deployed. All 10.000 new PMTs need to be tested for compliance with manufacturer requirements and calibrated before integration into the final modules. We present the design and commissioning of a modular test facility that allows testing ~100 PMTs at once at polar temperatures.

T 17.3 Mon 17:00 H-HS XVII

Design and commissioning of a test bench for the quality control of photomultipliers for the IceCube-Upgrade — •Robert Joppe, Lasse Halve, Martin Rongen, and Christopher Wiebusch — III. Physikalisches Institut RWTH Aachen University

A new light sensor [mDOM] housing 24 photomulipliers is developed for the IceCube Upgrade. A total of ~10.000 PMTs has to be tested and characterized prior to assembly of the modules. We construct a test bench to identify defective units, calibrate gain, transit time, noise rates, photon detection efficiency and reject PMTs which emit light from the dynode system or the base. Design challenges are the large number of PMTs to be tested simultaneously, within a tight schedule, at Antarctic temperatures and over a wide wavelength range.

T 17.4 Mon 17:15 H-HS XVII

Determination of the influence of magnetic fields on 3-inch PMTs — •Ken Ueberholz, Lew Classen, and Alexander Kappes for the IceCube-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, Münster

The neutrino telescope IceCube uses Cherenkov light of secondary charged particles to detect neutrino interactions with the molecules of the ice. This light is detected by Digital Optical Modules (DOMs) each consisting of one large 10-inch photomultiplier tube (PMT) inside a glass pressure vessel. Magnetic fields have been found to have an impact on PMT properties such a timing precision and gain, therefore the PMTs are shielded by means of a *mu-metal* caging.

The upcoming IceCube Upgrade will introduce the mDOM to IceCube, a multi Digital Optical Module using 24 smaller 3-inch PMTs. For PMTs as small as 3-inch the influence of the Earth magnetic field was found to be weaker, so the mDOM is not foreseen to feature magnetic shielding.

In this work we investigated in more detail the impact of magnetic fields on PMT and output signal parameters as a function of orientation and strength of the field.

T 17.5 Mon 17:30 H-HS XVII

Development of a Harness for the IceCube mDOM — •Jelena Petereit for the IceCube-Collaboration — Bergische Universität Wuppertal

The primary scientific goals of the planned upgrade of the IceCube Neutrino Observatory are to investigate neutrino oscillations at low energies and to further increase the sensitivity of the existing detector. This upgrade will include new photon detectors called mDOMs. They will have a different shape than the previously used DOMs in order to increase the photo-sensitive area by housing multiple PMTs. In order to preserve a maximum photon detection efficiency, a harness needs to be developed which integrates the mDOM modules mechanically onto strings. Different harness designs, which include different ways of attaching the mDOMs to the harness, have been tested and the results will be presented.

T 17.6 Mon 17:45 H-HS XVII

Determination of scintillation parameters of the mDOM glass pressure vessel for background simulations — •Markus Dittmer, Martin Unland, Lew Classen, and Alexander Kappes for the IceCube-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, Münster

The IceCube neutrino observatory is the world's largest neutrino telescope instrumenting 1 km^3 of Antarctic glacial ice. When charged particles traverse the transparent detector medium, Cherenkov light is produced which is detected by optical modules consisting of PMTs housed in glass pressure vessels. The investigated Vitrovex glass vessels will be used for the mDOM within the IceCube Upgrade. The glass contains trace amounts of radioactive isotopes, such as ^{40}K. The respective decays cause background signals by scintillation and Cherenkov photons. Since the optical activity of the deep glacier ice is very low, the light produced by the modules themselves represents the dominant background source. In order to fully characterize the background expected for mDOMs and its influence on the signal processing of real events, scintillation parameters have to be investigated thoroughly. This contribution presents results from measurements and Geant4 simulations of the scintillation yield for γ and α-particles.

T 18: Flavor physics: algorithms

Time: Monday 16:30–18:00 Location: L-3.001

T 18.1 Mon 16:30 L-3.001

Automating a historic code base for a high precision B_s^0 oscillation frequency measurement with LHCb data — Quentin Führing and •Kevin Heinicke — Experimentelle Physik 5, TU Dortmund

The upcoming, third data taking period of the Large Hadron Collider will provide a significantly increased dataset, required to continue the systematic search for physics beyond the Standard Model.

Many measurements using the already existing LHC dataset will be repeated, facing new challenges due to the increased statistics. In this talk, a brief overview of the ongoing, updated measurement of the B_s^0-meson oscillation frequency Δm_s using a sample of $B_s^0 \to D_s^- \pi^+$ decays, recorded by LHCb between 2015 and 2018 at $\sqrt{s} = 13$TeV is given. The tool stack to automate large parts of the analysis pipeline is presented, combining up-to-date python packages with existing, historically grown `C++` code and showcasing possible best practices to speed up upcoming, similar analyses.

T 18.2 Mon 16:45 L-3.001

HAMMER: a tool for new physics searches in semileptonic decays at Belle II and LHCb — Florian Bernlochner[1], Jochen Dingfelder[1], •Stephan Duell[1], Zoltan Ligeti[2], Michele Papucci[2], and Dean Robinson[2] — [1]Rheinische Friedrich-Wilhelms-Universität Bonn — [2]Lawrence Berkeley National Laboratory

The search for new physics involving semileptonic b-hadron decays requires large, dedicated Monte Carlo data sets, in order to accurately

model acceptance and selection efficiencies. We present the HAMMER reweighting tool, developed for and in conjunction with the LHCb and Belle II experiments, that makes use of an efficient event and histogram reweighting strategy, permitting computationally inexpensive exploration of new physics effects in the fully differential phase space. The HAMMER approach also permits to study the effects of different choices for hadronic form-factor parametrizations describing the semileptonic b-hadron decays, which are crucial for the measurement of the CKM elements $|V_{cb}|$ and $|V_{ub}|$. In this talk we present various example applications of this tool, both for new physics and CKM matrix studies, and summarize the features of the released version 1.0.

T 18.3 Mon 17:00 L-3.001

Flavour tagging developments at LHCb — •Quentin Führing, Kevin Heinicke, and Vukan Jevtic — Experimentelle Physik 5, TU Dortmund

The LHCb experiment at the Large Hadron Collider performs precise measurements of *CP* violation in the B meson sector. For such measurements knowledge of the B meson flavour at production is necessary.

At LHCb the production flavour of B mesons is determined by various flavour tagging algorithms. All of these algorithms exploit hadronisation processes in the B meson production, where various particles are produced in correlation to the initial B flavour.

A new approach in the LHCb flavour tagging is an inclusive flavour tagging algorithm, which evaluates near all tracks of an event by using a recurrent neural network. The current state of the inclusive flavour tagging algorithm development will be presented.

T 18.4 Mon 17:15 L-3.001

Calibration of Belle II hadronic tagging on Belle data — Florian Bernlocher[4], Thomas Kuhr[3], •Kilian Lieret[1,2], Felix Metzner[1,2], Markus Prim[3], and Maximilian Welsch[4] — [1]Ludwig Maximilian Universität — [2]Excellence Cluster Origins — [3]Karlsruhe Institute of Technology — [4]Rheinische Friedrich-Wilhelms-Universität Bonn

The Belle II experiment at the SuperKEKB accelerator produces pairs of B mesons. As the center of mass energy is known, the kinematics of one B meson (the signal B) are determined if the other B meson (the tag B) is fully reconstructed.

The tag B meson can be reconstructed in different channels and using different techniques. This analysis considers hadronic B decays reconstructed with the FEI (Full Event Interpretation), an algorithm relying heavily on machine learning techniques.

Because imperfections in the MC simulation may result in a different tag B reconstruction efficiency than in real data, the FEI must be calibrated. By considering a well known decay mode on signal side (here inclusive $B \longrightarrow X\ell\nu_\ell$), calibration weights can be calculated.

The calibration is performed for the full Belle dataset of $710\,\mathrm{fb}^{-1}$, which has been converted in order to be analyzed with the Belle II software framework. The results of the calibration will be first used for an update of Belle results for $B \longrightarrow D^{(*)}\ell\nu_\ell$ decays that profit from the improved Belle II reconstruction software.

T 18.5 Mon 17:30 L-3.001

Extending the Full Event Interpretation to the Y(5S) system — •Moritz Bauer and Pablo Goldenzweig for the Belle II-Collaboration — KIT Karlsruhe

The Belle experiment has, in addition to the data collected at the $\Upsilon(4S)$ resonance, also collected 121 fb^{-1} of data at the $\Upsilon(5S)$ resonance. The decay products of this resonance include B_s mesons which present interesting channels to test the standard model. Until now, it has not been possible to apply Belle II's new B meson tagging algorithm, the Full Event Interpretation (FEI), to the $\Upsilon(5S)$ dataset. This multivariate exclusive tagging algorithm uses O(10k) decay channels to recombine final-state particles to B mesons which increases the tagging-efficiency significantly compared to cut-based methods.

This talk presents the development and validation of the FEI at the $\Upsilon(5S)$ resonance.

T 18.6 Mon 17:45 L-3.001

Studies for the measurement of $|V_{ts}|$ in top quark decays — Johannes Erdmann, Kevin Kröninger, and •Sonja Zeissner — TU Dortmund, Experimentelle Physik IV

The full Run-2 dataset collected by the ATLAS Detector at the LHC allows for the search of decay processes that were so far unobservable. In this talk, we look at steps towards measuring the CKM matrix element $|V_{ts}|$ in top quark decays. The focus will be on the calibration of a deep neural network s-tagging algorithm and its application to the measurement.

T 19: Various topics in astroparticle physics

Time: Monday 16:30–17:30 Location: L-3.002

T 19.1 Mon 16:30 L-3.002

Multi-wavelength observations of Mrk421 and Mrk501 — •Lea Heckmann and David Paneque for the MAGIC-Collaboration — Max Planck Institute for Physics, Munich, Germany

Blazars, together with other active galactic nuclei, are the most luminous persistent sources in our universe; and therefore a prime candidate for very-high-energy gamma-ray observations. For the two MAGIC telescopes, the Mrk421 and Mrk501 galaxies are amongst the brightest observed objects due to their proximity. Hence, besides single detections during flaring periods, as it is the case for most blazars, also detailed studies of low emission states can be accomplished. Even though blazars have been observed for decades, their jet structures, particle populations and emission mechanism are still intensely discussed, and extensive monitoring campaigns covering the whole electromagnetic spectrum are organised to collect data that will help us understand these extreme objects. Spectral, variability and correlation studies and their evolution over many years are crucial techniques to put constraints on the existing theoretical models that describe the broadband emission and the blazar environments. This talk aims to give an insight into some of the efforts made for the described purpose using data collected on Mrk421 and Mrk501.

T 19.2 Mon 16:45 L-3.002

Time-Dependent AMS-02 Electron-Positron Fluxes in an Extended Force-Field Model — •Marco Kuhlen and Philipp Mertsch — Institute for Theoretical Particle Physics and Cosmology (TTK), RWTH Aachen University, Aachen, Germany

The magnetized solar wind modulates the Galactic cosmic ray flux in the heliosphere up to rigidities as high as 40 GeV. We present a new and straightforward extension of the popular but limited force-field model, thus providing a fast and robust method for phenomenological studies of Galactic cosmic rays. Our semianalytical approach takes into account charge-sign dependent modulation due to drifts in the heliospheric magnetic field and has been validated via comparison to a fully numerical code. Our model nicely reproduces the time-dependent AMS-02 measurements and we find the strength of diffusion and drifts to be strongly correlated with the heliospheric tilt angle and magnitude of the magnetic field. We are able to predict the electron and positron fluxes beyond the range for which measurements by AMS-02 have been presented. We have made an example script for the semianalytical model publicly available and we urge the community to adopt this approach for phenomenological studies.

T 19.3 Mon 17:00 L-3.002

Spatially resolved parameters of photomultipliers for the multi-PMT Digital Optical Module of the IceCube-Upgrade — •Martin Antonio Unland Elorrieta, Lew Classen, and Alexander Kappes for the IceCube-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, Münster

IceCube located at the South Pole is the largest Neutrino Observatory and is going to be expanded in the season 2022/2023 with seven new strings. For this project, the IceCube-Upgrade, new sensors are being developed, which are expected to increase the detector sensitivity. Over half of the modules foreseen for deployment are multi-PMT Digital Optical Modules (mDOMs) which feature 24 photomultipliers (PMTs) inside a pressure vessel pointing in all directions. Since the PMTs are the main detection device of the module, a good understanding of their performance is essential. Several key parameters of the PMTs were spatially resolved across the sensitive area. This talk

will present current results and measurement techniques.

T 19.4 Mon 17:15 L-3.002

Studies on the hole ice characterization with mDOM flashers in IceCube Upgrade — •Cristian Jesus Lozano Mariscal and Alexander Kappes for the IceCube-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, Münster

For the planned upgrade of the IceCube neutrino telescope, seven additional strings equipped with new optical modules will be installed in the center of DeepCore, the current low energy IceCube extension. The upgrade does not only aim at enhancing IceCube's low-energy neutrino detection capabilities, but also to improve the calibration of the existing IceCube detector by installing calibration devices in the new optical modules. One of these devices consists of LEDs which produce ns-long flashes of light. One goal is to characterize the dust column which formes when the ice re-freezes after module deployment, and which poses one of the current biggest sources of uncertainty in IceCube. The talk presents initial studies on the dust column characterization using the LEDs in the mDOM module.

T 20: DAQ, trigger and electronics I

Time: Monday 16:30–17:50 Location: L-3.015

Group Report T 20.1 Mon 16:30 L-3.015

The Phase-II upgrade of the first-level muon trigger for the ATLAS experiment at the HL-LHC — •Davide Cieri, Sergey Abovyan, Varuzhan Danielyan, Markus Fras, Oliver Kortner, Sandra Kortner, Hubert Kroha, Sebastian Nowak, and Robert Richter for the ATLAS-Collaboration — Max-Planck-Institut fuer Physik, Munich, Germany

The first-level muon trigger of the ATLAS experiment will be upgraded to operate at the High-Luminosity LHC. The selectivity of the current system is limited by the moderate spatial resolution of RPC and TGC trigger chambers. The Monitored Drift Tube (MDT) chambers currently used for the precision tracking will be therefore included to improve the transverse momentum resolution and the redundancy.

In the upgraded muon trigger system, the MDT trigger processors will receive MDT hits from the detectors and match them to the trigger candidates from the RPC and TGC trigger systems. These seeds provide a Region-of-Interest and the bunch-crossing timing which is used for calculating the MDT drift time. Matching MDT hits are used by the MDT trigger algorithm to improve the momentum resolution, by forming track segments and combining them for the determination of the transverse momentum.

An FPGA-based hardware demonstrator of the MDT trigger processor is currently under production. A description of the proposed track finding algorithm is presented, together with the obtained performance and its FPGA implementation.

T 20.2 Mon 16:50 L-3.015

Synchronisation of the Mu3e DAQ System — •Martin Müller for the Mu3e-Collaboration — Institute for Nuclear Physics, JGU Mainz

The Mu3e experiment will search for the lepton flavour violating decay $\mu^+ \to e^+e^-e^+$ and is aiming for a sensitivity of one in 10^{16} muon decays. Since this decay is highly suppressed in the Standard Model to a branching ratio of below $\mathcal{O}(10^{-54})$, an observation would be a clear sign for new physics.

In the Mu3e detector, four layers of silicon pixel sensors will be used to track electrons and positrons and a time resolution of $\mathcal{O}(100$ ps) will be provided by scintillating tile and fibre detectors. The overall detector is expected to produce a data rate from 80 Gbit/s (Phase I) to 1 Tbit/s (Phase II), which will be processed in a three-layer, triggerless DAQ system using FPGAs and a GPU filter farm for online event selection.

The talk will focus on the synchronisation of the different detector parts and the firmware implementation of the clock and reset distribution in the Mu3e DAQ system.

T 20.3 Mon 17:05 L-3.015

The XENONnT Data Acquisition System — •Alexey Elykov for the XENON-Collaboration — University of Freiburg

The XENONnT experiment at the Laboratori Nazionali del Gran Sasso, is a liquid xenon-based multi-ton-scale dark matter detector which will be operational from early 2020. It will allow us to probe new parameter spaces of potential dark matter candidates and search for long sought-after decay processes. The scintillation and photoionisation signals that will occur in the detector due to particle interactions will be detected by 494 PMTs, amplified, digitised and recorded by a Data Acquisition (DAQ) system. This system is predominantly based on commercially available hardware and accompanied by custom-developed firmware and software. In combination with a novel data processing framework, it can operate with high efficiency both during the acquisition of low rate dark matter search data and throughout high rate calibration efforts. In this talk, an overview of the XENONnT DAQ system will be presented.

T 20.4 Mon 17:20 L-3.015

Status and plans of upgrade activities for the CMS DT system — •Dmitry Eliseev, Thomas Hebbeker, Archie Sharma, Markus Merschmeyer, and Jonas Roemer — III. Physikalisches Institut A, RWTH Aachen University

The Drift Tube (DT) system of the Compact Muon Solenoid (CMS) experiment consists of about 172 thousand oblong gas detector cells (DT cells). By design of the DT system multiple DT cells are grouped in separate DT chambers, located in the barrel region of CMS. One of the LHC's High-Luminosity upgrade activities is the replacement of the read-out chain of the DT chambers with a more advanced version. The upgraded DT read-out will provide a higher acquisition rate and flexible trigger settings for the DT system. The upgrade involves replacing particular components of the read-out chain, as well as an essential change in this chain's structure. This talk will present an overview of the new read-out chain structure and an overview of the design and operation of the involved components. Special focus will be given to the design of the On-Board DT (OBDT) electronic. Each OBDT board is situated directly on the DT chamber and handles the multiple outputs of the DT cells front-end circuitry. In this way the OBDTs provide the origin for the streams of the muon hit-data. The current upgrade status, functional tests, hard- and software verification tests of the new DT read-out will be discussed in the talk as well.

T 20.5 Mon 17:35 L-3.015

Data flow in the Mu3e filter farm — •Marius Köppel for the Mu3e-Collaboration — Institute for Nuclear Physics, Johannes Gutenberg University Mainz

The Mu3e experiment at the Paul Scherrer Institute searches for the decay $\mu^+ \to e^+e^+e^-$. This decay violates lepton flavour conservation - so an observation would be a clear indication for Physics Beyond the Standard Model. The Mu3e experiment aims for an ultimate sensitivity of one in 10^{16} μ decays. To this end, more than one billion μ tracks per second need to be detected and reconstructed.

Since the corresponding data rate of about 1 TB/s cannot be saved to disk, a trigger-less on line readout system was designed which is able to analyze the data while running. A farm with PCs equipped with powerful graphics processing units (GPUs) will perform the data reduction. The talk presents the ongoing integration of the sub detectors into the Field Programmable Gate Array (FPGA) based readout system which is used to preprocess, sort and transport the data to the filter farm.

T 21: Electroweak physics I

Time: Monday 16:30–18:00 Location: L-3.016

T 21.1 Mon 16:30 L-3.016

Determination of the weak mixing angle using angular coefficients of Z boson production at ATLAS — •Julian Fischer and Stefan Tapprogge — Institut für Physik, Johannes Gutenberg-Universität, Mainz

The weak mixing angle θ_W is one of the fundamental parameters in the electroweak sector of the Standard Model. A measurement of this parameter serves as a fundamental test of this theory and could thus also provide a gateway to physics beyond the Standard Model. Different approaches can be taken to determine this parameter experimentally. In this contribution the focus is on the extraction of the weak mixing angle using angular coefficients that are used to describe the differential cross section of the Z boson production and subsequent decay into leptons in the 'Collins-Soper-frame'. Recent results from ATLAS are reviewed and strategies for a full Run 2 measurement using an integrated luminosity of $L \approx 147\,\mathrm{fb}^{-1}$ at $\sqrt{s} = 13\,\mathrm{TeV}$ are discussed. Expectations on the accuracy will be formulated and challenges will be addressed based on the experience from the 8 TeV measurement.

T 21.2 Mon 16:45 L-3.016

Electroweak precision fits at future electron positron colliders — •Jakob Beyer[1,2] and Jenny List[1] — [1]DESY Hamburg — [2]Universität Hamburg

A precise determination of electroweak parameters is an essential part of future high-$\sqrt{s}$ e^+e^- collider programs. The collider parameters most relevant for the physics case of such a machine are its energy, luminosity and the availability of beam polarisation. All three can be used to maximize the expected signal of interest. In addition, beam polarisation is expected to disentangle systematic uncertainties from fundamental physics. How the extraction of electroweak parameters is affected by the collider parameters must be well understood. This can be investigated through a realistic analysis of electroweak processes at such a collider setup. In this study, charged triple gauge couplings and chiral cross sections are extracted from differential distribution of two- and four-fermion final states. A χ^2-fit to toy measurements is performed for varying initial collision conditions. Selection efficiencies and purities are adapted from full detector simulation analyses. Systematic uncertainties are parameterised and included in the fit. Sensitivities to each fit parameter are extracted from this fit. The importance of the collider parameters for this analysis is seen from their influence on the uncertainties. In particular, the effectiveness of beam polarisation as a tool to suppress systematic uncertainties is assessed. Other analyses at e^+e^- colliders may experience qualitatively similar behaviour of systematic uncertainties. Future collider efforts can use this knowledge in their design studies to maximize their physics potential.

T 21.3 Mon 17:00 L-3.016

Measurement of the differential $W \to \mu + \nu$ cross section at high transverse masses at $\sqrt{s} = 13\,\mathrm{TeV}$ with the ATLAS detector. — •Johanna Wanda Kraus, Frederic Schröder, and Frank Ellinghaus — Bergische Universität Wuppertal

The cross section of the charged-current Drell-Yan process in the decay $W \to \mu + \nu$ is measured with data taken with the ATLAS detector from pp-collisions at a center-of-mass energy of $\sqrt{s} = 13\,\mathrm{TeV}$.
While the inclusive cross-section is well-known, a differential measurement at very high transverse masses is done for the first time. The cross-section will also be measured double-differentially in the transverse mass of the W-boson m_T^W and the pseudorapidity of the lepton. This measurement is important since it can be used to constrain the parton distribution function of the proton as well as electroweak parameters.
An overview over the analysis strategy and progress will be given.

T 21.4 Mon 17:15 L-3.016

Measuring the lepton universality, the mass and the width in the W-boson decay with the ATLAS detector — Lennart Adam[2], Nassim Ainouz[1], Philip Bechtle[1], Klaus Desch[1], Jakub Kremer[2], •Philipp König[1], and Matthias Schott[2] — [1]Rheinische Friedrich-Wilhelms-Universität Bonn — [2]Johannes Gutenberg-Universität Mainz

The ATLAS collaboration measured the W-boson mass based on data taken with 7 TeV in 2017 in the most precise single measurement with a precision of 19 MeV. The analysis presented goes one step further and tries to improving the fitting methods and by measuring also the width of the W-boson. These quantities and the test of the lepton universality in the decay of the W-boson are an excellent precision test of the Standard Model (SM).

A measured deviation of the branching fraction $BR(W \to \tau\nu)$ from the SM prediction would be an indicator for new physics, which is expected to couple predominantly to heavier particles. Experimentally, it is preferable to measure the ratio of the branching ratios of the tau lepton decay into light leptons compared to the direct W decay into light leptons. However, it implies that enumerator and denominator only differ in kinematic distributions from which the result is extracted in a fit. Characteristic observables being important for the fitting procedure will be introduced as well as possibilities to further increase the sensitivity of the measurement. Finally, it is investigated how competitive the obtained sensitivity is compared to previous measurements by other experiments.

T 21.5 Mon 17:30 L-3.016

Using impact parameter information for leptonic tau lepton decays in the measurement of the $W \to \tau\nu$ decay — •Nassim Ainouz[1], Philipp König[1], Matthias Schott[2], Lennart Adam[2], Jakub Kremer[2], Philip Bechtle[1], and Klaus Desch[1] — [1]Rheinische Friedrich-Wilhelms-Universität Bonn — [2]Johannes Gutenberg Universität Mainz

The measurement of the mass of the W-Boson from the ATLAS experiment has been a highly acknowledged result in the past year. It's the most precise single measurement of the W-mass which has been studied in leptonic final states. The SM predicts an equal coupling of the W-Boson to the different lepton flavours, leading to only a small difference in the branching ratios due to the different masses. The presented analysis follows a new approach to look at lepton universality by considering the ratio $BR(W \to \tau\nu_\tau \to \mu\nu_\mu\nu_\tau\nu_\tau)/BR(W \to \mu\nu_\mu)$ as many systematic uncertainties cancel. Any deviation from the SM value could hint at new physics.

To further increase the sensitivity, we aim to make use of the life time of the tau lepton resulting in a given decay length. The measurement of the impact parameter and its correct calibration in Z->ll events is a crucial task to use it in the final measurement.

T 21.6 Mon 17:45 L-3.016

Measurement of $W + \gamma$ production via electroweak vector boson scattering in pp collisions at $\sqrt{s} = 13\,\mathrm{TeV}$ at ATLAS — •Burkhard Böhm, Gia Khoriauli, and Raimund Ströhmer — Universität Würzburg

Electro-weak vector boson scattering (VBS) processes provide a way to search for deviations from the Standard Model (SM) electroweak theory predictions by measuring the triple and quartic couplings between gauge bosons. The cross sections of the VBS processes are predicted to be relatively small in the SM and most of them are not yet measured by the ATLAS experiment in proton-proton collisions with $\sqrt{s} = 13$ TeV. Thus, studying the VBS processes can yield interesting new results.

This work presents an on-going test of the SM by measuring the VBS process when two initial vector bosons radiate from the colliding quarks inside protons and result to a production of $W + \gamma$ and two hadronic jets with large separation in pseudo-rapidity as a final state. The W boson further decays into a muon and a neutrino. ATLAS data from 2018 collected at $\sqrt{s} = 13$ TeV of proton-proton collisions and the corresponding Monte-Carlo simulation samples are used in the study. The goal of the study is to contribute to the ATLAS full analysis of the $W + \gamma$ production via the electroweak vector boson scattering.

T 22: Hauptvorträge (Invited Talks) II

Time: Tuesday 11:00–12:30 Location: H-Aula

Invited Talk T 22.1 Tue 11:00 H-Aula
Flavor directions beyond the standard model — •Gudrun Hiller — TU Dortmund, Dortmund, Germany

The standard model has passed an enormous amount of tests. We report on present challenges posed by flavor for physics in and beyond the Standard model, and discuss directions to go ahead: Improving the precision frontier and understanding of the standard model background, multi-observables methods and fits, new directions in model building, and joint efforts from theory, phenomenology and experimental communities. We highlight the progress and persistent puzzles from the flavor sector.

Invited Talk T 22.2 Tue 11:45 H-Aula
Highlights from the LHCb experiment — •Michel De Cian — EPFL, Lausanne, Switzerland

In the last years, the LHCb experiment observed intriguing deviations from Standard Model predictions in charged-current and neutral-current b hadron decays, commonly known as "flavour anomalies". They might hint to physics beyond the Standard Model. In this talk I will review the state of these anomalies, present the latest results and also highlight other key results by the LHCb collaboration of the last months.

T 23: Dark Matter I

Time: Tuesday 17:00–18:40 Location: H-HS I

Group Report T 23.1 Tue 17:00 H-HS I
The XENONnT Dark Matter Search Experiment — •Sebastian Lindemann for the XENON-Collaboration — University of Freiburg, Germany

XENON1T, the largest and most sensitive dark matter direct detection experiment, has set the most stringent upper limit on the spin-independent WIMP-nucleon cross section, with a minimum of 4.1×10^{-47} cm^2 for a 30 GeV/c^2 WIMP. The next step in the XENON program, XENONnT, is now under construction at LNGS. With this upgrade, the XENON collaboration aims to probe spin-independent WIMP-nucleon cross sections as low as 2×10^{-48} cm^2 with a 20 tonne-year exposure. This talk gives an overview of the experiments and presents the latest results.

T 23.2 Tue 17:20 H-HS I
Neutron background simulations for the DARWIN experiment — •Julia Dierle — Albert-Ludwigs-Universität Freiburg

The DARWIN (DARk matter WImp search with liquid xenoN) detector, a liquid xenon time projection chamber with a 40t target, will probe any signal from dark matter WIMPs above the irreducible neutrino floor for masses $> 5\,\mathrm{GeV/c^2}$. Detailed background simulations are required to estimate DARWIN's sensitivity to WIMPs and other rare events. The investigation of nuclear recoil background events is particularly important since WIMPs are also expected to scatter elastically off xenon nuclei. We report on recent results on the simulations of radiogenic neutrons which are produced in (α,n) and spontaneous fission processes in the detector materials.

T 23.3 Tue 17:35 H-HS I
Update of XENONnT's Gd-loaded water Cherenkov neutron veto — •Daniel Wenz for the XENON-Collaboration — Institut für Physik & Exzellenzcluster PRISMA, J. Gutenberg-Universität Mainz, 55099 Mainz, Germany

In 2018 the XENON1T experiment set the most stringent limits for the WIMP-Nucleon coupling for masses above 6 GeV/c2 utilizing a liquid xenon time projection chamber. Following this success a new and larger liquid xenon time projection chamber called XENONnT is currently constructed at the Laboratori Nazionali del Gran Sasso in Italy. Its sensitivity will be increased by more than an order of magnitude.

To achieve this ambitious goal the detector intrinsic neutron background must be reduced as well. Neutrons are capable to mimic WIMP signal by performing single scatter interactions and escaping the detectors volume. To counter this, XENONnT will be equipped with a new neutron veto that is based on a gadolinium-loaded water Cherenkov detector with a neutron tagging efficiency up to 84 %.

In this talk we present the current status of the neutron veto including the Gd-procurement and the measurement of the Gd-loaded water transparency, as well as discussing novel techniques for the calibration of the neutron-tagging efficiency and background discrimination strategies.

T 23.4 Tue 17:50 H-HS I
Study of muon-induced neutron signatures for DARWIN observatory — •Jose Cuenca Garcia — Karlsruher Institut für Technologie, Karlsruhe, Deutschland, DARWIN collaboration

The goal of the DARWIN observatory is to become the most powerful dark matter detector using liquid Xenon as a target inside a sensitive time projection chamber (TPC). Although DM search experiments are underground, many background sources have to be understood and controlled. We present here some Geant4 simulations of a more detailed muon flux and how the interaction of the muons with the components of the detector can contribute to the background of the DM search.

Group Report T 23.5 Tue 18:05 H-HS I
Low-mass Dark Matter Search with CRESST-III — •Margarita Kaznacheeva for the CRESST-Collaboration — Physik-Department E15, Technische Universität München, D-85747 Garching, Germany

The CRESST-III (Cryogenic Rare Event Search with Superconducting Thermometers) experiment is dedicated to one of the most exciting open questions in modern astroparticle physics - revealing the nature of dark matter (DM). It uses scintillating single crystals operated as cryogenic calorimeters at mK temperatures and is equipped with transition-edge-sensors. In order to achieve the required ultra-low backgrounds, the detectors are surrounded by layers of radiopure shielding materials and installed at the deep underground facility of the Laboratori Nazionali del Gran Sasso. The light produced by particle interactions in scintillating crystals is measured by a separate cryogenic light detector, which enables particle discrimination between nuclear recoils (signal) and electron recoils (dominant background) on an event-by-event basis. With a new generation of CRESST detectors an ultra-low energy threshold of 30 eV has been achieved, which makes CRESST the leading experiment in sub-GeV DM searches. In this talk, I will give an overview of the experiment and present the latest DM data, which improved the sensitivity to spin-independent DM scattering down to masses of 160 MeV. Moreover, I will give an update on recent R&D efforts and conclude with the future perspectives of CRESST.

T 23.6 Tue 18:25 H-HS I
Super Cryogenic Dark Matter Search at SNOLAB — •Alexander Zaytsev for the SuperCDMS-Collaboration — Universität Hamburg, Hamburg, Germany

Convincing astrophysical observations point to the abundant existence of dark matter in the Universe. Many experiments have been using different techniques to detect dark matter directly. However, despite their efforts, dark matter particles remain to be observed to this day. The Super Cryogenic Dark Matter Search experiment (SuperCDMS) is making use of the low-background environment at the SNOLAB underground laboratory (Canada) to detect dark matter interactions with silicon and germanium crystal detectors operated at temperatures as low as 15 mK. The most popular particle dark matter candidates include Weakly Interacting Massive Particles (WIMPs) which recoil from crystal nuclei, producing a phonon signal in the detector. Moreover, the SuperCDMS experiment is capable of detecting electron recoil signals, which could be induced, for example, by Light Dark Matter, dark photons and Axion-Like Particles. SuperCDMS uses two types of

detectors: iZIP detectors which measure both phonon and ionization signals and provide electron and nuclear recoil discrimination, and HV detectors which provide an extremely low energy threshold due to a very strong amplification of the ionization signal. The purpose of this talk is to provide an overview of the SuperCDMS experiment, discuss the detection mechanisms and the projected sensitivity to different dark matter channels.

T 24: Detector systems II

Time: Tuesday 17:00–18:35 Location: H-HS II

Group Report T 24.1 Tue 17:00 H-HS II

The Mu2e experiment at Fermilab — •Stefan E. Müller and Anna Ferrari for the Mu2e-Collaboration — Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

The Mu2e experiment, currently under construction at the Fermi National Accelerator Laboratory near Chicago, will search for the neutrinoless conversion of muons to electrons in the field of an aluminum nucleus. In the Standard Model, this process, which violates charged lepton flavor, is highly suppressed and therefore undetectable. However, scenarios for physics beyond the Standard Model predict small but observable rates. The Mu2e experiment aims for a sensitivity four orders of magnitude better than existing experiments. This is achieved by a rigorous control of all backgrounds that could mimic the monoenergetic conversion electron.

At the Helmholtz-Zentrum Dresden-Rossendorf, we use the ELBE radiation facility to study radiation hardness and performance of components for the Mu2e calorimeter and the detector that will monitor the rate of stopped muons in the aluminum target. Additionally, Monte Carlo simulations are performed for both the pion production target and the muon stopping target.

In the presentation, the design and status of the Mu2e experiment and its detectors will be presented, and results from the ELBE beamtimes and the simulation studies will be given.

T 24.2 Tue 17:20 H-HS II

Commissioning of the LHCb Scintillating Fibre Tracker — Sebastian Bachmann, Daniel Berninghoff, Xiaoxue Han, Blake Leverington, Uli Uwer, and •Lukas Witola — Physikalisches Institut, Heidelberg, Deutschland

The LHCb detector is currently undergoing a major upgrade. The modifications will enable the detector to operate at an increased instantaneous luminosity and to read out data at the LHC bunch crossing rate of 40 MHz. The new operating conditions require the replacement of the complete tracking system. The main tracking stations will be replaced by the SciFi Tracker, a large, high granular scintillating fibre tracker readout by arrays of silicon photomultipliers (SiPMs). A custom ASIC is used to digitise the SiPM signals at 40 MHz. Further digital electronics perform clustering and data-compression before the data is sent via optical links to the DAQ system.
The detector modules together with the readout electronics and all services are mounted on so-called C-Frames. After a first prototype has been build and tested, the serial assembly of frames has started in March 2019. The talk will give an overview of the detector and present experiences from the serial production and the latest commissioning results.

T 24.3 Tue 17:35 H-HS II

Hochratentests an der CMS Binary Chip Auslesekette — Felix Bögelspacher, Alexander Dierlamm, Ulrich Husemann, •Stefan Maier und Thomas Müller — Institut für Experimentelle Teilchenphysik, Karlsruher Institut für Technologie

Für den äußeren Bereich des zukünftigen CMS-Spurdetektors werden im Rahmen des Phase-2-Upgrades Siliziumsensormodule eingesetzt. Diese Module bestehen aus zwei dicht übereinander liegenden Sensoren und sind damit in der Lage Teilchen mit hohem Transversalimpuls bereits im Auslesechip, dem CMS Binary Chip (CBC), zu identifizieren. Dies ist Startpunkt für einen neuartigen spurbasierten Trigger, mit dem interessante Ereignisse angereichert werden können.

Der Vortrag stellt den KARATE-Aufbau (KArlsruhe high RAte TEst) vor. Um einen Siliziumsensor zu emulieren werden auf 48 Kanälen des CBCs in hohen Raten Pulsmuster injiziert. Es können beliebige Muster mit unterschiedlichen Pulshöhen, Clustergrößen, Positionen und Triggerraten erzeugt werden. Somit werden Okkupanz und mittlere Ausleseraten in verschiedensten Variationen auf dem Chip und der nachfolgenden Auslesekette für den späteren Betrieb nachgestellt. Der Vortrag gibt Einblick in die Signalerzeugung und stellt eine Auswahl an Hochratenergebnissen vor.

T 24.4 Tue 17:50 H-HS II

Characterization of Power Hybrids for CMS Outer Tracker PS modules — •Alexander Bogner[1], Christian Dziwok[2], Lutz Feld[1], Katja Klein[1], Martin Lipinski[1], Alexander Pauls[1], Oliver Pooth[2], Nicolas Röwert[1], and Tim Ziemons[2] — [1]I. Physikalisches Institut B, RWTH Aachen University — [2]III. Physikalisches Institut B, RWTH Aachen University

For the Phase-2 Upgrade of the CMS Outer Tracker the CMS Collaboration is developing modules with two strip sensors (2S module) and modules with a strip and macro-pixel sensor (PS module). The upgrade will allow CMS to utilize the high luminosity provided by the future HL-LHC. The powering of an entire PS module will be driven by a so-called Power Hybrid (POH) featuring three DC-DC converters.

At RWTH Aachen University the POHs have been developed and were qualified regarding power stability, noise radiation and temperature profiles. In this talk the results and experience gained is presented.

T 24.5 Tue 18:05 H-HS II

Electron Identification Studies of Belle II — •Justin Skorupa for the Belle II-Collaboration — Max Planck Institute for Physics, Muenchen, Bayern

The Belle II experiment at the SuperKEKB e+ e- accelerator in Tsukuba, Japan, aims to precisly measure parameters of the Standard Model (SM) and to discover physics beyond the SM via high precision measurements of rare processes. Physics procceses studied by the experiment are for example B-Mesons or tau decays. Many of those decays contain leptons in the final state. The experiment is therefore required to provide a reliable lepton identification method, and the performance of this method must be precisely determined. A study of the electron Identification (eID) and detector performance, using non-radiative Bhabha events as a control channel, is presented. Bhabha-like candidates are selected and a tag and probe approach is then used to asses the performance of the eID. This study shows that the Belle II eID provides a significant reduction of mis-identified tracks, while retaining electrons with a very high efficiency.

T 24.6 Tue 18:20 H-HS II

Tracking performance and interaction point properties at the Belle II experiment — •Cyrille Praz for the Belle II-Collaboration — DESY, Hamburg, Germany

The Belle II experiment, located in Tsukuba, Japan along the SuperKEKB e^+e^- collider, is aiming to reach in the years to come an instantaneous luminosity of $8 \times 10^{35}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$, a value $\sim$ 40 times larger than the instantaneous luminosity delivered for the previous experiment (Belle). Compared to Belle, the Belle II experiment offers also a better impact parameter resolution, thanks to an improved vertex detector. This presentation gives a brief overview of the Belle II tracking system and shows a measurement of the impact parameter resolution and of several properties of the interaction point using a selection of $e^+e^- \to e^+e^-$ and $e^+e^- \to \mu^+\mu^-$ events collected in 2019 at a centre-of-mass energy of 10.6 GeV.

T 25: Grid Computing

Time: Tuesday 17:00–18:30 Location: H-HS V

T 25.1 Tue 17:00 H-HS V

Simulating distributed caching for end user analyses — René Caspart, R. Florian von Cube, •Tabea Fessenbecker, Max Fischer, Manuel Giffels, Christoph Heidecker, Maximilian Horzela, Eileen Kühn, Günter Quast, and Matthias Schnepf — Karlsruhe Institute of Technology

With the start of the High-Luminosity LHC era in the near future, the massive amount of data processed in HEP user analyses results in challenges for network and storage infrastructures. In order to face these challenges developing concepts to use existing computing infrastructures more efficiently becomes essential.
Bringing data close to the computing resources is a promising approach to overcome throughput limitations and improve the overall performance. One way to achieve this is the placement of caches close to the computing resource. In order to efficiently use caches in a heterogeneous, distributed computing infrastructure an adapted operation concept needs to be developed.
Our goal at KIT is to develop a concept for facilities focused on end-user analysis. Therefore, we monitor our system and create a simulation to study the effects of different caching concepts. This allows to investigate the possibilities that distributed caching offers to computing facilities designed for end-user analysis.
In this contribution, we give an overview of the simulation tool and discuss different cache operation concepts of distributed caching.

T 25.2 Tue 17:15 H-HS V

XCache for ATLAS production — •Nikolai Hartmann, Günter Duckeck, Rodney Walker, and Christoph Anton Mitterer — Ludwig-Maximilians-Universität München

High-level caching provides a promising and lightweight storage solution that can replace or complement permanent storage clusters. The XRootD project includes a proxy caching server (XCache). Integration with the ATLAS data management system Rucio is added through a plugin.

We have setup such an XCache server at the LRZ-LMU Tier-2 and tested several ATLAS workflows. In particular, we ran an ATLAS production queue that processes all input via the XCache server. In our initial setup several problems showed up when operated longer-term under heavy load in production conditions. The latest XCache version proved to be more stable. We also evaluated different hardware configurations of the caching server, comparing the performance of individual disks and RAID 6.

T 25.3 Tue 17:30 H-HS V

Performancesteigerung in HEP Arbeitsabläufen durch koordinierte Caches — Rene Caspart, R. Florian von Cube, Tabea Fessenbecker, Max Fischer, Manuel Giffels, Christoph Heidecker, •Maximilian Horzela, Eileen Kühn, Günter Quast und Matthias Schnepf — Karlsruhe Institute of Technology

Der stetig steigende Bedarf an IT-Ressourcen durch eine explosiv wachsende Menge an Daten und die zur Analyse benötigten Simulationen insbesondere in Hinblick auf den High Luminosity LHC ist nur mit neuartigen Computing-Konzepten zu decken.

Ein vielversprechender Ansatz um dem Ressourcenbedarf nachzukommen, bietet neben der Bereitstellung zusätzlicher Ressourcen, eine Effizienzsteigerung in den Arbeitsabläufen. Die Effizienz der Arbeitsabläufe in der Hochenergiephysik ist oft durch den Datentransfer limitiert. Um dennoch die volle Rechenleistung auszunutzen sind für verteilte Rechensysteme optimierte Caching-Lösungen, bei der das Workflow Management mit dem Batchsystem koordiniert wird, ein wichtiger Beitrag zur Effizienzoptimierung.

Dieser Beitrag umreißt grundlegende Konzepte für koordinierte Caching-Lösungen.

T 25.4 Tue 17:45 H-HS V

Benchmarking of GRID resources and infrastructure using the HammerCloud service — •David Hohn, Benoît Roland, Benjamin Rottler, and Markus Schumacher — Albert-Ludwigs-Universität Freiburg

The high luminosity LHC is a major upgrade to the current accelerator and will provide an order of magnitude more high energy physics data in the coming decades than exists now. To enable the analysis of this wealth of data the computing resources need to follow suit and be upgraded as well, both in storage and processing capabilities.

Reliable performance information is the foundation for planning of upgrade efforts as well as efficient operation of the complex computing systems. To this end, benchmarks provide essential insight. This talk will present fast benchmarks of CPUs which can enable prompt matching between available and required resources, as is mandatory to incorporate opportunistic and heterogenous resources. Furthermore, benchmarks of remote storage access via several different protocols, e.g. WebDAV via Dynafed, direct WebDAV and Xrootd, will be presented. Dynafed could allow for aggregation and more efficient usage of storage resources.

Both sets of benchmarks are performed by the HammerCloud service within the ATLAS GRID computing network. This constitutes an extension of the HammerCloud use cases from functional to additional performance testing.

T 25.5 Tue 18:00 H-HS V

Scheduling heterogeneous resources for federated usage — René Caspart, •R. Florian von Cube, Tabea Fessenbecker, Max Fischer, Manuel Giffels, Christoph Heidecker, Maximilian Horzela, Eileen Kühn, Günter Quast, and Matthias Schnepf — Karlsruhe Institute of Technology

To overcome shortcomings in computing resources, the opportunistic usage of additional resources, not specifically dedicated to HEP, can help. Such resources might be HPC centers, or commercial and institutional cloud providers. An overlay batch system is used to provide a single point of entry to this plethora of resources and enables transparent usage for the user.

A novel on-demand resource management system COBalD/TARDIS has been developed and extensively tested at KIT to allocate and integrate such resources. Small computing centers are enabled to contribute computing resources to the grid in a very light-weight manner using those services. Such resources can be connected, allowing for jobs to move freely between different batch system instances.

In this contribution we present the latest software developments and the progress made in applications in terms of federating resource pools.

T 25.6 Tue 18:15 H-HS V

Performance monitoring of opportunistic resources at ATLAS-BFG — Anton J. Gamel, •Stefan Kroboth, Benjamin Rottler, and Markus Schumacher — Albert-Ludwigs-Universität Freiburg

The workload of computing clusters is typically unpredictable and tends to alternate between over- and under-utilization of the available resources. Tools such as COBalD/TARDIS provide an easy way to opportunistically make under-utilized resources of one site available to other sites. Fine-tuning of the involved software in order to optimize efficiency and user experience needs to be performed in a production environment and is therefore difficult without continuous monitoring of logs and meaningful metrics. In this work we present the current situation at Freiburg University where resources of the NEMO cluster are used to extend the ATLAS-BFG cluster in an opportunistic fashion using COBalD/TARDIS. The talk covers the tools involved in the collection and analysis of logs and metrics acquired from different sources within the local and opportunistic resources. Examples of how the aggregation of logs and the monitoring of metrics aids decision-making are shown. Besides fine-tuning of the involved tools, this setup can also be used to detect problems and anomalies early on.

T 26: Outreach methods I (joint session T/HK)

Time: Tuesday 17:00–18:20 Location: H-HS VI

Group Report T 26.1 Tue 17:00 H-HS VI

Netzwerk Teilchenwelt als Plattform für Outreach in der Teilchenphysik, Astroteilchenphysik sowie Hadronen- und Kernphysik — •Uta Bilow und Michael Kobel für die Netzwerk Teilchenwelt-Kollaboration — Institut für Kern- und Teilchenphysik, Technische Universität Dresden

WissenschaftlerInnen sind heute verstärkt gefordert, Einblick in ihre Arbeit zu geben und den Dialog mit der fachfremden Öffentlichkeit zu führen. Für die "Physik der kleinsten Teilchen" existiert mit dem Netzwerk Teilchenwelt eine einzigartige Struktur, in der sich bundesweit Forschungsgruppen aus 30 Instituten zusammengeschlossen haben, um ihre wissenschaftliche Arbeit einem breiten Publikum zugänglich zu machen. Netzwerk Teilchenwelt stellt etablierte Programme und Strukturen bereit, mit denen Jugendliche bei Projekttagen die faszinierende Forschung an Beschleunigern kennenlernen oder eigene Messungen mit Detektoren durchführen. Gleichzeitig werden junge ForscherInnen zur Wissenschaftskommunikation motiviert und befähigt. Die Aktivitäten werden derzeit durch das Projekt KONTAKT gefördert und ausgebaut. Über ein mobiles Modul, das durch Deutschland touren wird, werden weniger wissenschaftsaffine Zielgruppen angesprochen. Mit Inhalten aus der Hadronen- und Kernphysik greift KONTAKT zusätzliche Themen auf und bindet weitere Arbeitsgruppen ein, etwa aus der Belle II Kollaboration. Mit dem Programm "Forschung trifft Schule" bietet Netzwerk Teilchenwelt zudem Lehrerfortbildungen zur Teilchenphysik. Der Vortrag stellt die Angebote sowie Beteiligungsmöglichkeiten für interessierte WissenschaftlerInnen vor.

T 26.2 Tue 17:20 H-HS VI

Weiterentwicklung der SchulTPC — •Malthe Koch, Klaus Desch, Jochen Kaminski und Maximilian Meiss — Physikalisches Institut der Universität Bonn

In vielen aktuellen Experimenten der Teilchenphysik, wie z. B. dem ALICE-Experiment am CERN, kommt eine Zeitprojektionskammer zum Einsatz, um geladene Teilchen nachzuweisen und zu vermessen. Die SchulTPC ist eine Zeitprojektionskammer im kleinen Maßstab. Sie ist dafür entwickelt worden, um bei Veranstaltungen für die breite Öffentlichkeit aktuelle Detektortechnologie zu präsentieren. Auch Schüler*innen sollen mit auf diesem Aufbau basierenden Experimenten moderne Detektoren kennenlernen. In diesem Vortrag wird der Entwicklungsstand der SchulTPC vorgestellt. Insbesondere geht der Vortrag auf die Konzeption und den Bau des Netzteils ein. Dieses ist eigens entwickelt worden, um einen Betrieb unabhängig von teuren Komponenten zu ermöglichen. Gleichzeitig muss das Netzteil aber auch die Anforderungen, die für einen Gasdetektor notwendig sind, erfüllen.

T 26.3 Tue 17:35 H-HS VI

Erprobung und Evaluierung des Vorbereitungskurses für die Teilchenphysik-Masterclass von Netzwerk Teilchenwelt — •Inga Woeste, Philip Bechtle und Barbara Valeriani-Kaminski für die Netzwerk Teilchenwelt-Kollaboration — Physikalisches Institut der Universität Bonn, Deutschland

Das Netzwerk Teilchenwelt setzt sich deutschlandweit für die Vermittlung der Teilchenphysik ein und will Jugendliche für die Grundlagenforschung begeistern. Im Rahmen der Teilchenphysik-Masterclass bekommen die Schüler*innen einen Tag lang einen Einblick in die Forschung am CERN und erhalten die Möglichkeit, Originaldaten von LHC-Experimenten eigenständig auszuwerten. Außerdem erfahren sie durch die Einbindung der Promovierenden als sogenannte Vermittler*innen, wie der Alltag eines/r Teilchenphysikers/in aussieht. Um die Schüler*innen inhaltlich auf die Masterclass vorzubereiten, wurde ein Online-Vorbereitungskurs entwickelt, durch den im Vorhinein die Grundlagen im Bereich der Teilchenphysik, teilweise auch interaktiv, vermittelt werden sollen.

In diesem Beitrag wird zunächst der Online-Vorbereitungskurs kurz vorgestellt. Danach werden die Ergebnisse der Kursevaluation, auf der Grundlage einer mehrmaligen Erprobung dieses Konzeptes mit Schulklassen, präsentiert. Hierbei wird auf folgende Fragen eingegangen: Ist der Online-Vorbereitungskurs mit Schulklassen durchführbar? Sind die Kursinhalte für die Schüler*innen verständlich? Ist der Vorbereitungskurs effektiv und beim Verständnis der Masterclass hilfreich?

T 26.4 Tue 17:50 H-HS VI

Entwicklung einer Masterclass zur Suche nach neuer Physik am LHC — •Johanna Rätz, Philip Bechtle und Barbara Valeriani-Kaminski für die Netzwerk Teilchenwelt-Kollaboration — Physikalisches Institut der Universität Bonn, Germany

Das Netzwerk Teilchenwelt ermöglicht Schüler*innen einen Einblick in die Welt der Teilchenphysik. Eines der Angebote in diesem Rahmen sind die Masterclasses, bei denen die Schüler*innen zunächst eine Einführung in das Standardmodell und die Experimente am CERN erhalten, bevor sie dann selber Daten vom CERN in Form einer Messung von Teilcheneigenschaften auswerten. Dabei werden auch die Grenzen des Standardmodells angesprochen. Allerdings wird bislang nicht weiter verfolgt, wie die Teilchenphysik zusätzlich nach neuen, noch unbekannten Phänomenen sucht. Die neu entwickelte Masterclass greift an dieser Stelle an und versucht dies den Schüler*innen anhand einer entsprechenden Suche nach Supersymmetrie zu vermitteln. Nach einer Einführung in die Thematik implementieren die Schüler*innen entsprechende Schnitte und werten die Histogramme der Kontroll- und Signalregionen aus. Daran anschließend werden die Ergebnisse statistisch betrachtet und ausgewertet. Die zwei bisherigen Praxistests haben gezeigt, dass auch das komplexe Thema Supersymmetrie und die anspruchsvolle Datenanalyse gemeinsam mit Schüler*innen erarbeitet werden können.

T 26.5 Tue 18:05 H-HS VI

The International Summer Student Program at GSI-FAIR — Jörn Knoll[1], •Ralf Averbeck[1], Gerhard Burau[1,2], Yvonne Leifels[1], and Haik Simon[1] — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Planckstr. 1, 64291 Darmstadt — [2]Frankfurt Institute for Advanced Studies (FIAS), Ruth-Moufang-Str. 1, 60438 Frankfurt am Main

GSI, the German research center for heavy-ion physics, is one of the leading accelerator laboratories for basic research with accelerated ions. In cooperation with an international research community, the existing accelerator complex will be significantly extended by a new Facility for Antiproton and Ion Research (FAIR). The center provides unique research opportunities for investigations in the fields of hadronic and nuclear physics, nuclear astrophysics, atomic, laser, and plasma physics, materials science, and biophysics with applications to cancer therapy, new accelerator developments and radiation safety.

The 40th International Summer Student Program will take place in the summer months of 2020. It is organized under the leadership of GSI in close cooperation with HGS-HIRe - the Graduate Program of GSI-FAIR with its partner universities. The program is open for advanced undergraduate students in physics or related natural sciences. Each participant joins one of the GSI-FAIR research groups and works on a small project during the program. In addition, a dedicated lecture series is held introducing the various research fields and applications at GSI-FAIR. The program is complemented by introductory soft skills tutorials. An overview of the program will be presented.

T 27: Higgs: Decay into fermions I

Time: Tuesday 17:00–18:30 Location: H-HS X

T 27.1 Tue 17:00 H-HS X

Charm tagging and search for $ZH \to llc\bar{c}$ decay with ATLAS data — •Supriya Sinha[1], Tatjana Lenz[2], and Jochen Dingfelder[3] — [1]DESY-Zeuthen — [2]Uni Bonn — [3]Uni Bonn

The discovery of Higgs boson in 2012 opened the gates to many new analyses with the aim to understand its properties. Analyses have been performed to study various Higgs boson decay channels. Boldly, it decays to a pair of fermions or bosons. From theoretical under-

standing, Higgs is more likely to couple to a pair of heavier fermions as compared to the lighter ones, which is the reason its decay to third generation fermions have been studied rigorously. More interestingly, Higgs also couples to second generation fermions, but no such decays could be established up to now. Additionally, the small decay fraction into charm quarks makes it susceptible to BSM modifications, if they exist. A measurement of this charm decay fraction would either unfold new physics or help in constraining BSM scenarios.

To detect the Higgs decay to charm quarks, one has to develop a method to identify charm jets. A direct method of the so-called "charm tagging" utilises common b-tagging algorithms trained on charm jets. Instead of using multivariate analysis techniques, one can identify them using the reconstruction of charm meson decay: $D^{*+} \rightarrow D^0(\rightarrow K^-\pi^+)\pi^+$. This talk will focus on the description of D^*-based identification method. In addition, both charm identification methods are used to evaluate limits on the $ZH(H \rightarrow c\bar{c}, Z \rightarrow ll)$ cross section. The analysis is performed on 2017 data with a centre of mass energy of 13 TeV and a luminosity of 43.6 fb^{-1}.

T 27.2 Tue 17:15 H-HS X

Search for a SM Higgs boson decaying to a pair of muons in associated production with a gauge boson — •Tobias Kramer, Torben Lange, Oliver Rieger, and Peter Schleper — Universität Hamburg

Studies on developing a search for Higgs decays into muons in VH associated production are presented. The full Run 2 data collected at the CMS experiment from 2016-2018 at a center of mass energy of 13 TeV are used. Events with at least two oppositely charged muons as well as at least one additional lepton, identified as originating from the gauge boson, are selected. These requirements efficiently select signal events and reduce the initially dominant Drell-Yan background events, which typically do not contain a prompt third lepton. The search strategy, including multivariate prompt lepton identification, BDT optimization, and categorization is presented. Estimates of the sensitivity, derived using a data driven background estimation, are given.

T 27.3 Tue 17:30 H-HS X

Fake-Rate Determination for the ttH and ttW Production with a Signature of Two Same Electric Charge Light Leptons Associated with a Tau Using the ATLAS Detector at the LHC — •Santu Mondal[1], Babar Ali[1], Simonetta Gentile[2], Nazim Huseynov[3], Antonio Policicchio[2], and Andre Sopczak[1] — [1]IEAP CTU in Prague — [2]Universita di Roma Sapienza — [3]JINR Dubna

After the discovery of a Higgs boson, the measurements of its properties are at the forefront of research. The determination of the associated production of a Higgs boson and a pair of top quarks is of particular importance as the ttH Yukawa coupling is large and can probe for physics beyond the Standard Model. The analysis is based on data taken by the ATLAS experiment recorded from 13 TeV proton-proton collisions. The ttH and ttW production was analysed in various final states. The focus of this presentation is on the fake rate determination in the final state with two light leptons of same electric charge and one hadronically decaying tau lepton.

T 27.4 Tue 17:45 H-HS X

Mass reconstruction with neural networks for a lepton-flavour violating Higgs boson with the ATLAS experiment at $\sqrt{s}$=13 TeV — •Emanuel Dorbath, Valerie Lang, Katharina Schleicher, and Markus Schumacher — Albert-Ludwigs-Universität Freiburg

The discovery of the Higgs boson allows to search for lepton-flavour violating (LFV) processes in the Higgs-boson sector. Many extensions of the standard model predict this violation, for instance supersymmetric extensions. The general existence of LFV processes in nature has been demonstrated with the observation of neutrino oscillations.

At the ATLAS experiment, interesting LFV Higgs decays are $H \rightarrow e\tau$ and $H \rightarrow \mu\tau$. Leptonic tau-lepton decays are considered yielding the final state $e\mu 2\nu$. Both neutrinos leave the ATLAS detector without detection, making the reconstruction of the Higgs-boson mass challenging. Non-detected particles broaden the mass resolution and thus complicate the separation of the LFV signal from standard model background processes. Improving the resolution of the mass reconstruction will therefore increase the sensitivity to small branching ratios for LFV decays.

A deep neuronal network is trained in order to reconstruct the mass of a spin 0 boson decaying to $\tau e \rightarrow e\mu 2\nu$. The talk describes the optimization of the network architecture and training process. The results in terms of bias and resolution will be compared to standard methods for mass reconstruction.

T 27.5 Tue 18:00 H-HS X

Search for lepton-flavour violating decays of the Higgs boson using the symmetry method for background estimation with the ATLAS experiment at $\sqrt{s} = 13$ TeV — •Katharina Schleicher[1], Kathrin Becker[1,2], Valerie Lang[1], and Markus Schumacher[1] — [1]University of Freiburg — [2]University of Warwick

The discovery of the Higgs boson opened the window to a variety of interesting probes to physics beyond the standard model (SM), including searches for lepton-flavour violating (LFV) Higgs-boson decays. These are predicted in several models, including supersymmetric extensions of the SM and general two-higgs-dublet models. In nature, LFV was already observed in form of neutrino oscillations. In this analysis the decays of $H \rightarrow e\tau$ and $H \rightarrow \mu\tau$ with leptonic τ-decays leading to $e\mu + X$ final states are considered. A central part of the analysis is the precise estimation of the SM backgrounds. Therefore, a data-driven method is used - the so-called symmetry method. It exploits two principles: First, SM backgrounds with prompt leptons are symmetric w.r.t. electrons and muons. And second, this symmetry is broken if the branching ratios of the two LFV decays are of different magnitude. The first principle implicates the challenge of restoring this symmetry since electrons and muons are experimentally different. The second principle is well motivated by the upper limit on $\mu \rightarrow e\gamma$. To obtain the best possible sensitivity, a dedicated statistical model was developed and a neural network for classification is deployed. The analysis is performed using the full LHC Run-2 dataset recorded with the ATLAS detector in proton-proton collisions at $\sqrt{s} = 13$ TeV.

T 27.6 Tue 18:15 H-HS X

Search for pair production of Higgs bosons decaying to $b\bar{b}\tau^+\tau^-$ with the ATLAS detector — •Christopher Deutsch, Jochen Dingfelder, and Tatjana Lenz for the ATLAS-Collaboration — Physikalisches Institut, Bonn

The discovery of the Higgs boson and the measurement of its properties confirming the Standard Model (SM) is a major step towards the understanding of electroweak symmetry breaking. As a result, the potential of the Higgs field, and therefore the trilinear self-coupling of the Higgs boson, is precisely predicted in the SM. It can be probed by measuring the cross section of Higgs boson pair production, offering an additional test of the SM. In the SM such measurements are difficult due to the destructive interference of processes containing the self-coupling and processes with Yukawa couplings to top quarks, leading to a small production cross section at the Large Hadron Collider (LHC). An enhancement would indicate the presence of physics beyond the Standard Model (BSM), since heavy resonances decaying into pairs of Higgs bosons are predicted by several BSM models.

A search for non-resonant and resonant Higgs boson pair production in the $b\bar{b}\tau^+\tau^-$ channel is presented. This channel is one of the most sensitive for probing the Higgs self-coupling. The talk will focus on the subchannel with two hadronically decaying tau leptons. New developments towards the analysis of the $\sim 139\,\text{fb}^{-1}$ dataset collected by the ATLAS experiment in Run 2 of the LHC are presented. These include improvements in object selection with new particle identification algorithms and using multivariate methods for signal selection.

T 28: Top quarks: mass and jets

Time: Tuesday 17:00–18:30 Location: H-HS XI

T 28.1 Tue 17:00 H-HS XI

Investigation of the top-quark mass precision using machine-learning techniques at the ATLAS experiment — •Steffen Ludwig, Andrea Knue, and Gregor Herten — University of Freiburg, Institute of Physics

The top quark is the heaviest known elementary particle in the Standard Model (SM) and its mass is a fundamental parameter. Its value is close to the scale of electroweak symmetry breaking and hence the top quark might serve as a window to physics beyond the SM.

Due to the high collision rate of the LHC, the ATLAS collaboration was able to measure the top-quark mass at subpercent level at $\sqrt{s} = 8$ TeV. Removing badly reconstructed events has shown to reduce the dominant signal modelling uncertainties using $t\bar{t}$ events in the lepton + jets channel.

Exploring this decay channel using pp collision data at $\sqrt{s} = 13$ TeV, the talk focuses on the influence of deep neural networks for event reconstruction in comparison to a likelihood-based reconstruction algorithm (KLFitter) on the event reconstruction efficiency and purity, while studying the impact on the systematic uncertainties on the top-quark mass measurement.

T 28.2 Tue 17:15 H-HS XI

Measurement of the top quark pole mass using $t\bar{t}$+1 jet events with the CMS experiment — Matteo Defranchis, Katerina Lipka, and •Sebastian Wuchterl — DESY, Hamburg

The top quark is the most massive elementary particle known. Its mass, m_t, is a fundamental parameter of the Standard Model (SM), and its value needs to be determined experimentally. Therefore, a precision measurement of m_t, together with the masses of the W and Higgs bosons, allows for stringent tests of self-consistency of the SM. Furthermore, the value and the uncertainty of m_t are driving predictions for the energy dependence of the Higgs quartic coupling, which determines the stability of the electroweak vacuum. In proton-proton collisions at the LHC, top quark-antiquark ($t\bar{t}$) pair production can be used to extract m_t in different renormalization schemes.

In this work, the pole mass of the top quark is measured using events in which the $t\bar{t}$ pair is produced in association with one additional jet. This analysis is performed using proton-proton collision data collected by the CMS experiment at the LHC in 2016-2018 with $\sqrt{s} = 13$ TeV, corresponding to a total integrated luminosity of 137 fb^{-1}. Events with two opposite sign leptons in the final state are analyzed to measure the normalized differential cross section as a function of the inverse of the invariant mass of the $t\bar{t}$+1 jet system. This observable has been chosen due to strongest sensitivity to m_t at the threshold of the $t\bar{t}$ pair production.

T 28.3 Tue 17:30 H-HS XI

A nuisance parameter fit for the top quark mass measurement — •Christoph Garbers, Johannes Lange, Peter Schleper, David Spataro und Hartmut Stadie — Universität Hamburg, Hamburg, Germany

The top quark is the heaviest known particle in the standard model. It plays a crucial role in consistency checks of the Standard Model and in search for new physics.
In the $t\bar{t}$ to lepton+jets channel a top quark mass of 172.25±0.63 GeV was measured. With the 35.9fb^{-1} data recorded by CMS in 2016 this measurement was limited by systematic uncertainties, especially the correction of jet energies and the description of color reconnection in simulation.
A method to improve this measurement by inserting systematic uncertainties as nuisance parameters into a profiled likelihood fit will be presented.

T 28.4 Tue 17:45 H-HS XI

Determination of the jet energy scale and jet momentum resolution at the CMS experiment using Z+jet events — Tabea Fessenbecker, •Christoph Heidecker, Günter Quast, Klaus Rabbertz, and Daniel Savoiu — Karlsruhe Institute of Technology

Accurately measured jets are mandatory for precision measurements of the Standard Model of particle physics as well as for searches for new physics. The increased instantaneous luminosity and center-of-mass energy at LHC Run 2 poses challenges for pileup mitigation and for the measurement of jet characteristics.

At CMS, jets are calibrated using a multi-stage approach in order to correct for effects of pileup, uniformity of the detector response, and residual differences between data and simulation.

A well-established calibration approach to extract residual corrections is based on balancing a jet against a precisely reconstructed Z boson. In this contribution we summarize how Z($\rightarrow \mu\mu$/ee)+jets events are used in CMS to derive data-based corrections to the jet energy scale. Furthermore, we demonstrate that the same Z+jet balancing approach can also be used to adjust the jet momentum resolution in simulation to that in data.

T 28.5 Tue 18:00 H-HS XI

Pileup mitigation in jets with CMS — Anna Benecke, •Ksenia de Leo, Johannes Haller, Andreas Hinzmann, and Roman Kogler — Institut für Experimentalphysik, Universität Hamburg

The high instantaneous luminosity reached by the LHC during Run 2 has led to a large amount of data to analyse, at the cost of an increased number of additional collisions at each bunch crossing (pileup). An important challenge is the separation of particles produced in the interaction of interest from those resulting from pileup interactions.

This talk will present studies of the Pile Up Per Particle Identification (PUPPI) technique to mitigate effects from pileup on hadronic jets. The algorithm will be described together with challenges in its application. In addition, the latest tuning and validation studies will be presented in detail.

T 28.6 Tue 18:15 H-HS XI

Using CWoLa on all-jets final state at $\sqrt{s} = 13$ TeV for top quark mass measurements — Christoph Garbers, Johannes Lange, Peter Schleper, •David Spataro, and Hartmut Stadie — Institut für Experimentalphysik, Universität Hamburg

Top quarks are copiously produced in pairs in the CMS experiment at the LHC. The most likely decay channel results in all-jet final states. The selection of these final states is a challenge due to the huge amount of QCD multi-jet events and Inaccuracies of the simulation in modeling this background.

The CWoLa method (**C**lassification **W**ith**o**ut **La**bels) bypasses this difficulty by using only not labeled data events to train a Neural Network. The received binary classifier separates $t\bar{t}$ from QCD and is compared to a classifier, which was trained on MC simulated labeled $t\bar{t}$ and QCD events. The application of the CWoLa classifier on data is discussed.

T 29: Cosmic rays I

Time: Tuesday 17:00–18:30 Location: H-HS XII

T 29.1 Tue 17:00 H-HS XII

Towards joint analysis of KASCADE and Tunka-133 data — •Victoria Tokareva[1], Andreas Haungs[1], and Dmitriy Kostunin[2] — [1]Institute for Nuclear Physics, Karlsruhe Institute of Technology, DE-76021, Karlsruhe, Germany — [2]Deutsches Elektronen-Synchrotron, DE-15738, Zeuthen, Germany

Ultra-high-energy cosmic rays ($10^{14} - 10^{18}$ eV) that are produced in extreme astrophysical processes can provide us with possible hints about the physical nature of these processes. In particular, one could be highly interested in studying neutral particles like primary gamma rays, which are not deflected by galactic magnetic fields and thus can be associated with the particular source that produced them.

The flux of ultra-high-energy gamma events registered by modern experiments (HAWC, Tibet, Carpet-2, etc.) is quite low, so the chal-

lenge of increasing the statistics of the events in question, as well as multicomponent air-showers investigation, are highly relevant.

The talk is going to consider a possible joint analysis of data from two observatories, KASCADE (Germany) and Tunka-133 (Russia). The data mapping for two observatories is going to be discussed as well as the current status of the data processing.

T 29.2 Tue 17:15 H-HS XII

Interstellar electron and positron spectra from MeV to TeV energies — •Andrea Vittino[1], Philipp Mertsch[1], Henning Gast[2], and Stefan Schael[2] — [1]Institute for Theoretical Particle Physics and Cosmology (TTK), RWTH Aachen University, Germany — [2]I. Physics Institute and JARA-FAME, RWTH Aachen University, Germany

Electrons and positrons play a special role among cosmic ray (CR) species. Most strikingly, their strong energy losses in the Galactic magnetic and radiation fields severely limit their propagation distances. Therefore electrons and positrons offer invaluable insights into the local properties of CR acceleration and propagation. In this talk we present our model for their interstellar spectra over a wide energy range extending from the MeV to the TeV domain. We illustrate how the underlying parameters can be efficiently constrained by exploiting different experimental observations, including both direct observations of the spectra (at Earth and at the heliopause) and measurements of the diffuse synchrotron emission generated by CR leptons as they propagate through the magnetic field of the Galaxy. We then consider recent time-dependent observations at GeV energies by AMS and estimate heliospheric modulation in an extension of the force-field model. What emerges is a complex picture of the interstellar electron and positron spectra that must be shaped by a number of transport processes beyond the simplest models.

T 29.3 Tue 17:30 H-HS XII

Comparing the Cosmic-Ray Sun Shadow in Seven Years of IceCube Data with the Solar Cycle and Solar Magnetic Field Models — Frederik Tenholt, Julia Becker Tjus, and •Johan Wulff for the IceCube-Collaboration — Theoretische Physik IV, Ruhr-Universität Bochum, 44780 Bochum

Measuring the temporal variation of the cosmic-ray Sun shadow has been shown to be a useful tool for assessing different solar magnetic field models.

In this talk, seven years of IceCube data are compared to solar activity and solar magnetic field models. For the first time, such models have been compared quantitatively to IceCube data on the event rate level. Moreover, the energy-dependence of the Sun shadow in IceCube has been studied for the first time and is compared to recent predictions.

Using the sunspot number as an indicator of solar activity, an anticorrelation between Sun shadow strength and solar activity is found to be likely. By modeling cosmic-ray propagation in the solar magnetic field and comparing the predicted Sun shadow to the measured one, two different models of the coronal magnetic field are tested. In agreement with the data, both models predict a weakening of the shadow in times of high solar activity. Assuming only statistical uncertainties, however, tensions on the order of $3\,\sigma$ remain. In times of high solar activity, there is a small indication that the shadowing effect increases with increasing cosmic-ray energy, which is in agreement with a recent prediction.

T 29.4 Tue 17:45 H-HS XII

The cosmic-ray shadow of the Sun and its temporal variation - lessons learned from simulations — •Julia Becker Tjus[1], Paolo Desiati[2], Niklas Döpper[1], Horst Fichtner[1], Jens Kleimann[1], and Frederik Tenholt[1] — [1]Theoretische Physik IV, Ruhr-Universität Bochum, 44780 Bochum — [2]UW Madison, Wisconsin, USA

While cosmic rays show a high level of isotropy when they arrive at Earth, two sinks have been identified by different observatories: the Moon and the Sun. Moon shadow measurements, on the one hand, are typically used for pointing calibrations and angular resolution estimates of the instruments. The Sun shadow, on the other hand, has been shown to change with time, revealing a correlation with the 22-year cycle of the solar magnetic activity and, in turn, the solar magnetic field.

In this contribution, we present simulations of the cosmic-ray Sun shadow for which we apply a back-tracking approach for the particle propagation around the Sun. We show how the shadow projected at Earth changes with time. In addition, we investigate the energy dependence of the depth of the shadow. We show that it changes significantly when comparing years of low solar activity to those of high solar activity. We discuss the implications for future measurements with cosmic-ray detectors and the physics to be learned from such measurements.

T 29.5 Tue 18:00 H-HS XII

High Energy Antiproton Analysis with the AMS-02 Experiment — •Sichen Li — RWTH I. Physikalisches Institut B

The Alpha Magnetic Spectrometer (AMS-02) is a high precision cosmic rays detector installed on the International Space Station in May 2011. It has collected more than 145 billion events until now. Surprisingly, the ratio of antiprotons to protons appears to be energy independent above 60 GeV.

The most important background in the high energy range consists in protons with mis-reconstructed charge sign. In this analysis, we train a deep neural network based on Monte Carlo simulation, using the Keras framework, to separate antiprotons from charge-confused protons. With this method, we have a good potential to extend the energy range for the antiproton to proton flux ratio, which will help us clarify the origin of antiprotons.

T 29.6 Tue 18:15 H-HS XII

Large Acceptance Analysis of Time-Dependent Electron Fluxes with AMS-02 — •Fabian Machate — 1. Physikalisches Institut B, RWTH Aachen

The Alpha Magnetic Spectrometer (AMS-02) on the International Space Station performs precision measurements of cosmic rays in the GeV to TeV energy range. The published analyses of the electron and positron fluxes rely on the electromagnetic calorimeter (ECAL) for energy measurements and background rejection. The geometrical acceptance for the conventional analyses is restricted by the weight limitations for the calorimeter.

A new analysis method based on the Transition Radiation Detector (TRD) and Tracker will be presented. This analysis has a significantly larger geometrical acceptance and can increase the statistics by a factor of up to ~ 4 at the cost of larger systematic uncertainties. These improvements are of particular importance for the time-dependent electron fluxes, which are dominated by statistical uncertainties.

T 30: Flavor physics: Lepton universality tests II

Time: Tuesday 17:00–18:30 Location: H-HS XIII

T 30.1 Tue 17:00 H-HS XIII

Search for the lepton flavour violating decay $B^0 \to K^{*0} e^\pm \mu^\mp$ with the LHCb detector — •Andreas Güth, Jan-Marc Basels, Christoph Langenbruch, and Stefan Schael — I. Physikalisches Institut B, RWTH Aachen University

The conservation of the individual lepton flavour quantum numbers in interactions involving charged leptons is an important prediction of the Standard Model (SM) of particle physics, making searches for lepton flavour violation (LFV) a promising probe for physics beyond the SM. With its ability for the precise study of the decays of B-mesons, that are copiously produced in proton-proton collisions at the Large Hadron Collider (LHC), the LHCb detector is a powerful tool to search for LFV in $b \to s\ell^\pm\ell'^\mp$ transitions. An additional motivation for such searches arises from recent tensions in tests of lepton universality in rare $b \to s\ell^+\ell^-$ decays, as lepton non-universality generally implies the existence of lepton flavour violating decays.

In this talk, the status of a search for the LFV decay $B^0 \to K^{*0} e^\pm \mu^\mp$ with the LHCb detector is presented, including the analysis strategy, signal selection, and the study of background processes affecting this search.

T 30.2 Tue 17:15 H-HS XIII

Search for the Lepton Flavour Violating decay $B_s^0 \to \phi\mu^\pm e^\mp$ — •Jan-Marc Basels, Andreas Güth, Christoph Langenbruch, and Stefan Schael — I. Physikalisches Institut B, RWTH Aachen

In the Standard Model (SM) of particle physics the conservation of the lepton flavour quantum numbers in interactions involving charged leptons is a fundamental principle. Thus, every discovery of lepton flavour violation (LFV) would simultaneously be a discovery of new physics.
Designed to study heavy flavour decays, the LHCb detector at the LHC at CERN allows for the search of LFV in the decays of B hadrons with unprecedented sensitivity. An additional motivation to explore LFV signatures is given by recent tests of lepton flavour universality (LFU) in B decays, which have shown individual tensions with the SM prediction. These tests studied the branching fraction ratios R_h of rare semi-leptonic B decays, defined as $R_h = \mathcal{B}(B \to h\mu^+\mu^-)/\mathcal{B}(B \to he^+e^-) \overset{\text{SM}}{=} 1$. The flavour-changing neutral-current processes are forbidden at tree-level and can only occur in electroweak loop diagrams, making $b \to s\ell^+\ell^-$ transitions sensitive to contributions from heavy particles beyond the SM. Lepton flavour non-universality would generally imply lepton flavour violation.
This talk presents the status of a search for the lepton flavour violating decay $B_s^0 \to \phi\mu^\pm e^\mp$, based on data taken with the LHCb detector. Particular focus is placed on the study and control of backgrounds, as well as on efficiency estimations from Monte Carlo simulations.

T 30.3 Tue 17:30 H-HS XIII

Search for the rare decays $B_{(s)} \to e^+e^-$ with the LHCb experiment — Johannes Albrecht, •Alexander Battig, Titus Mombächer, and Stefanie Reichert — Experimentelle Physik 5, TU Dortmund

The search for decays of the type $B^0_{(s)} \to l^+l^-$, which are strongly suppressed in the Standard Model, provide an ideal environment for searches for New Physics. Tests of lepton flavour universality ($\mathcal{R}_K$, $\mathcal{R}_{K^*}$) hint at a difference in the bahaviour of muons and electrons. In addition to the measurement of the branching ratio of the decay $B_s^0 \to \mu^+\mu^-$, which has been measured to be compatible with the Standard Model, the decay $B^0_{(s)} \to e^+e^-$ provides an additional stringent test for the Standard Model.

In this talk the search for $B^0_{(s)} \to e^+e^-$ with the LHCb experiment is presented. The analysed data set has been recorded during Run 1 and Run 2 of the LHC and corresponds to an integrated luminosity of $5\,\text{fb}^{-1}$.

T 30.4 Tue 17:45 H-HS XIII

Sensitivity of the analysis of the decays $B^0_{(s)} \to \mu^+\mu^-$ with the full dataset of the LHCb experiment — Johannes Albrecht, Maik Becker, and •Titus Mombächer — Experimentelle Phyik 5, TU Dortmund

The successful observation of the decay $B_s^0 \to \mu^+\mu^-$ by a single experiment was achieved by the LHCb collaboration using a dataset corresponding to 4.4fb^{-1}. It confirmed once more the predictions of the Standard Model and strongly constrained models for mechanisms beyond the Standard Model. However, the measurement is still statistically limited with a precision of 22 %. Also the decay $B_d^0 \to \mu^+\mu^-$ could not be measured yet.

This talk presents studies for the sensitivity to measure the decays $B_s^0 \to \mu^+\mu^-$ and $B_d^0 \to \mu^+\mu^-$ on the full Run 1 and Run 2 dataset recorded by the LHCb experiment corresponding to $9\,\text{fb}^{-1}$.

T 30.5 Tue 18:00 H-HS XIII

Analysis of $B^0_{s,d} \to \mu^+\mu^-$ decays with the full LHCb dataset — Johannes Albrecht, •Maik Becker, and Titus Mombächer — Experimentelle Physik 5, TU Dortmund

The first observation of the decay $B_s^0 \to \mu^+\mu^-$ with a single experiment was reported by the LHCb collaboration in 2017 with a significance of 7.8σ using data corresponding to 4.4 fb^{-1} of integrated luminosity. The measurement demonstrated the excellent sensitivity of the LHCb experiment in this channel, but no deviations from the Standard Model predictions were found, introducing strong constraints to New Physics models. Since the uncertainty on the result is driven by statistical limitations, an analysis with a larger dataset and improved methods is performed, which may also allow for the first observation of the decay $B_d^0 \to \mu^+\mu^-$.

In this talk the ongoing measurement of $B^0_{s,d} \to \mu^+\mu^-$ with the full LHCb dataset corresponding to 9 fb^{-1} will be presented. A focus is set on efficiencies and data-based validations.

T 30.6 Tue 18:15 H-HS XIII

Search for $B^+ \to K^+\nu\bar{\nu}$ at Belle and Belle II. — •Filippo Dattola for the Belle II-Collaboration — DESY, Hamburg, Germany

We present the status of our analysis on the rare exclusive decay $B^+ \to K^+\nu\bar{\nu}$, performed on the full Belle dataset and on the Belle II data so far collected.
Prohibited at the tree level in the Standard Model, and suffering only from hadronic form factors uncertainties, the channel is theoretically clean, and stands as an optimal probe to test possible contributions of new mediators.
The specific conditions of the experiment, such as a clean environment and a well defined initial state, strongly support the search for such decay with missing energy in its final state. Previous experimental studies by Belle and BaBar, both adopting a specific tagging for the accompanying B meson, did not led to signal evidence but only managed to put upper limits on the branching fraction. In our analysis, we use an alternative technique based on inclusive tagging aimed at improving what achieved so far.

T 31: Pixel detectors II

Time: Tuesday 17:00–18:35 Location: H-HS XIV

Group Report T 31.1 Tue 17:00 H-HS XIV

Overview of depleted monolithic active pixel sensors in the LFoundry 150 nm and TowerJazz 180 nm CMOS technologies — •Tianyang Wang and Konstantinos Moustakas — Physikalisches Institut, University of Bonn, Germany

CMOS pixel sensors utilizing commercial processes have already been used in high energy particle physics experiments for high precision charged particle tracking. They integrate sensing elements and electronics on the same silicon substrate and can offer lower material budget, lower cost and easier module assembly as compared to the hybrid pixels where the sensing and electronic parts are different entities mated with the cost intensive bump-bonding technology. However, the existing mature CMOS devices cannot withstand the high particle rate and high radiation environments encountered, for example, at the future HL-LHC, with the main limiting factor being the predominant diffusion movement for charge collection. We have been developing CMOS pixels with greatly enhanced radiation tolerance and timing precision for many years. The key ingredient for such sensors is a fully depleted sensing volume that allows for fast charge collection in a strong drift field. We have focused recently on two development lines, pursuing two different sensor design concepts in the LFoundry 150 nm and TowerJazz 180 nm CMOS technologies respectively. Large-scale demonstrator chips incorporating a fast readout architecture have been designed and characterized in both technologies. In this contribution, an overview of R&D activities for CMOS pixels in the aforementioned technologies will be presented.

T 31.2 Tue 17:20 H-HS XIV

Improving Spatial Resolution of Silicon Pixel Detectors through Sub-pixel Cross-coupling — •Sinuo Zhang, David-Leon Pohl, Tomasz Hemperek, and Jochen Dingfelder — Physikalisches Institute, University of Bonn, Nussallee 12, 53115 Bonn

We present a concept to improve the spatial resolution of silicon pixel-detectors via the implementation of position dependent inter-pixel cross-coupling. By segmenting the readout implantations and AC-coupling the sub-pixels, a part of the pixel charge is shared with neighboring pixels. For example, such a sensor can be realized in radiation tolerant high-voltage CMOS processes facilitating its application in modern particle colliders. Simulations to study the impact of different coupling capacitances on the spatial resolution are presented and an improvement of the spatial resolution by approximately 40% is demonstrated.

T 31.3 Tue 17:35 H-HS XIV

Active pixel sensor with small pixel size designed for capacitive readout with RD53 ASIC — •Hui Zhang — Karlsruher Institut für Technologie

We are designing HVCMOS sensors for several particle physics experiments. These sensors are simple and low cost alternative to classical hybrid detectors. HVCMOS sensor can either contain readout circuits on chip (monolithic sensors) or they can be readout by an external readout ASIC by means of capacitive signal transmission (capacitively coupled hybrid particle detector - CCPD). Both approaches have certain advantages. The detector chip for a CCPD has been implemented in an 180nm HVCMOS process. Depleted high voltage n-well/p-substrate diodes are used as sensors. Every pixel has a size of 25μm x 50μm and contains a charge sensitive amplifier and a simple comparator. The outputs of two pixel comparators are connected to a transmitting electrode (pitch 50μm x 50μm) implemented in the top metal layer of the sensor chip. A process modification has been done specially for this chip – deep p allows implementation of comparators in pixel. The readout chip and the sensor chip can be mechanically connected either by glue (standard option) or as a novel approach with a small number of large bump bonds. The output signals of the sensor chip are transmitted capacitively to the input pads of the readout chip which are connected to the signal receivers. The sensor chip has been produced and tested. Parameters such as amplitude, pulse width, rise time and signal noise ratio have been measured. In this talk, the sensor design and the measurement results will be presented.

T 31.4 Tue 17:50 H-HS XIV

Monolithic Pixel Sensors with sub-nanosecond time resolution in BiCMOS — Heiko Augustin[1], Ivan Peric[2], André Schöning[1], and •Benjamin Weinläder[1] — [1]Physikalisches Institut, Heidelberg, Germany — [2]Karlsruher Institut für Technologie, Germany

In recent years, the development of High Voltage Monolithic Active Pixel Sensors (HV-MAPS) has been strongly driven forward. As an example of the latest successes, the MuPix8 can be mentioned, which reached a time resolution of $\sigma_t = 6.8 \pm 0.2\,\mathrm{ns}$.

The combination of HV-MAPS with a BiCMOS technology opens up further possibilities, especially for the improvement of the time resolution. At the University of Geneva a time resolution of $\sigma_t = 46 \pm 2\,\mathrm{ps}$ has been achieved for a small prototype sensor based on BiCMOS.

According to this concept and based on the experience from the MuPix development a new R&D project was started , with the ambition to achieve a time resolution below 1 ns over a large pixel matrix. For this project the BiCMOS technology SG13S from IHP is used, which offers great advantages for high-frequency circuits. Therefore, the analogue circuits inside the pixel will be redesigned, making use of the bipolar technology. The concept here is to use a plain bipolar amplifier in order to decrease the noise from various components and the rise time of the signal edge. Simulations with Cadence Virtuoso® are done to investigate the performance of BiCMOS technology and to make a prediction about the time resolution of the new read-out tree.

T 31.5 Tue 18:05 H-HS XIV

Development of the next generation of high speed hybrid pixel detectors for the European Center of Nuclear Research (HL-LHC) — •Mark Standke, Michael Daas, Yannick Dieter, Piotr Rymaszewski, Markus Frohne, Tomasz Hemperek, Hans Krüger, David-Leon Pohl, Marco Vogt, Norbert Wermes, and Jochen Dingfelder — Physikalisches Institut der Universität Bonn

The European Center for Nuclear research (CERN) in Geneva Switzerland is increasing the luminosity of its Large Hadron Collider in 2026 (HL-LHC). Higher Luminosity leads to new challenges regarding spacial resolution, readout speed and radiation hardness for the tracking detectors at the HL-LHC. Especially detectors in the vicinity to the particle interaction point face significantly higher particle intensities. For this challenging task ATLAS and CMS have joined forces to develop a new, high resolution, high speed, and high radiation resistant readout chip for their hybrid pixel detectors. This talk will give an overview of past, present and future developments of this next generation of hybrid pixel detector readout chips and focus on the development status of their most recent chip iteration called RD53B.

T 31.6 Tue 18:20 H-HS XIV

Bump bond stress tests with ITk-Pixel-style daisy-chain and FE-I4-modules through thermal cycling — •Steffen Korn, Jörn Grosse-Knetter, Jörn Lange, and Arnulf Quadt — II. Physikalisches Institut, Georg-August-Universität Göttingen

Early module prototypes for the new ATLAS Inner Tracker Pixel Detector (ITk) highlighted bump bond connections as a possible point of failure in future ITk Pixel modules when exposed to thermally induced stress. In order to investigate this issue, daisy chain modules with realistic bump bond pitch and modules with read-out-chips were tested before, during, and after exposure to thermal stress through cycling in a thermal shock chamber in Goettingen. The results of these tests using different modules with different assembly options are presented in this talk.

T 32: Neutrino physics with accelerators

Time: Tuesday 17:00–18:30 Location: H-HS XV

T 32.1 Tue 17:00 H-HS XV

SHiP - The Surround Background Tagger and Liquid Scintillator Development — •Patrick Deucher, Annika Hollnagel, and Michael Wurm — Johannes Gutenberg Universität, ETAP, Mainz

SHiP is a proposed, general-purpose fixed target experiment at the SPS accelerator of the CERN Facility. Data collection is aimed for to start in 2027 focusing on the identification of Hidden Sector Particles, such as Heavy Neutral Leptons and light dark matter, and further investigation concerning tau neutrinos. When the high-intensity 400 GeV/c proton beam impinges on the hybrid target, heavy mesons and other weakly interacting particles of masses below 10 GeV/c* are created which can potentially decay into the particles of interest. After a hadron absorber and an active muon shield, the beam traverses through a vacuum vessel, where the particles are expected to decay. The products are then detected by a magnetic spectrometer and a calorimeter. To discriminate against external particle interactions, the vessel is enveloped by the Surround Background Tagger (SBT). The SBT is divided into segments and utilizes liquid scintillator and Wavelength Shifting Optical Modules (WOM) connected to SiPMs to identify throughgoing particles. In 2018/19, we have performed test beam measurements with a prototype detector cell at CERN PS and DESY. This contribution reports on the SBT in general and provides an overview on scintillator development.

T 32.2 Tue 17:15 H-HS XV

Status of the ESSνSB Target Station Design — •Tamer Tolba — Institut für Experimentalphysik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

In the quest of the CP-violation in the leptonic sector, a crucial information obtained recently from reactor and accelerator experiments; demonstrating that the value of the third neutrino-mixing angle, θ_{13}, is higher than its previously defined standard value. In the light of this new finding, an urgent need raised to improve the detection sensitivity of the current long-baseline detectors, with a key modification to place the far detectors at the second, rather than the first, oscillation maximum. The European Spallation Source Neutrino Super Beam (ESSνSB) aims at searching for CP-violation in the leptonic sector, at 5σ significance level in more than 60% of the leptonic Dirac CP violating phase range, and measure the CP phase angle with high precision by setting the neutrino source-to-detector distance at the second oscillation maximum. Several technological challenges must be precisely studied and simulated before addressing the design of the ESSνSB detector. Among these, the finite element and physics simulations of the target station and the neutrino beam considered highest priority at this phase of the ESSνSB project. Here I will shed light on the current target station design physics and FEA simulation efforts of the ESSνSB WP4 group.

T 32.3 Tue 17:30 H-HS XV

Application of the Topological Track Reconstruction to an idealised water-based liquid scintillator detector as study for Theia — Felix Benckwitz, Caren Hagner, David Meyhöfer, Henning Rebber, •Malte Stender, and Björn Wonsak — Universität Hamburg, Institut für Experimentalphysik

The Topological Track Reconstruction (TTR) was developed for unsegmented liquid scintillator detectors like JUNO and performs well in reconstructing track and point-like events in pure liquid scintillator. A next step is the application of the TTR to water-Cherenkov detectors like ANNIE and, in view of Theia, also to water-based liquid scintillator to exploit the advantages of both scintillation and Cherenkov light. Scintillation yields a high number of photons for determining the dE/dx, whereas Cherenkov light gives a handle for the particle identification via its event signature and a more precise event topology due to better time information. Furthermore, a high potential lies in the usage of newly developed photodetectors to max out the reconstruction's performance. The Large Area Picosecond Photodetectors (LAPPDs) feature a good spatial resolution of ~ 1 mm and an excellent time resolution of ~ 0.1 ns compared to the few nanoseconds PMTs typically achieve.
This contribution introduces the basic principles of the TTR and the application of the TTR to an idealised detector, which features a maximum coverage with LAPPDs and an active volume of water-based liquid scintillator. Therefore, also the detector simulation and the first results of the TTR are shown. This work is supported by the BMBF.

T 32.4 Tue 17:45 H-HS XV

Event Classification in the ANNIE experiment — •Michael Nieslony, Michael Wurm, and David Maksimovic for the ANNIE-Collaboration — Johannes Gutenberg-Universität, Mainz, Deutschland

The Accelerator Neutrino Neutron Interaction Experiment (ANNIE) is a 26 t Gadolinium-loaded Water Cherenkov detector on the Booster Neutrino Beam at Fermi National Accelerator Laboratory designed to measure the neutron multiplicity of neutrino nucleus interactions as well as the CC-inclusive neutrino cross-section on oxygen. Besides its physics goals, ANNIE will serve as a testbed for the new photosensor technology of Large Area Picosecond Photodetectors (LAPPDs) that achieve time resolutions below 100 ps and improve the vertex reconstruction capabilities of ANNIE.

The measurements of the neutron multiplicity and the cross-section on oxygen require a pure muon neutrino event sample and hence a need for electron/muon discrimination and multi ring event rejection capabilities. The following talk presents the current status of such classifiers for particle identification and multi-ring event rejection in ANNIE based on Machine Learning algorithms.

T 32.5 Tue 18:00 H-HS XV

Event reconstruction in a water-based liquid scintillator test cell for Theia — •Nils Brast, Daniele Guffanti, and Michael Wurm — Institut für Physik, Johannes Gutenberg-Universität Mainz, Germany

Water-based liquid scintillator (WbLS) permits to combine the benefits of Cherenkov detectors (high transparency, directionality) with the ones of Liquid Scintillator experiments (low energy threshold, good energy resolution). WbLS is considered as target medium for the ANNIE experiment at Fermilab and next-generation neutrino experiments such as Theia. Currently, a test cell for the characterization of WbLS is set up in Mainz to study the discrimination of Cherenkov and Scintillation signals. The setup will exploit the different time and spatial signatures of Cherenkov and Scintillation photons emitted by through-going cosmic muons. Accurate timing is achieved by a system of fast PMTs and offline analysis of digitized waveforms that will allow to resolve the prompt Cherenkov signal from delayed Scintillation photons. The characteristic ring-shaped hit pattern of Cherenkov photons provides another feature for separation. In this contribution we present the methods for event reconstruction developed in Monte-Carlo studies to optimize the design of the cell.

T 32.6 Tue 18:15 H-HS XV

On the road to Theia: the new Mainz WbLS test cell — •Daniele Guffanti, Michael Wurm, and Nils Brast — Institute of Physics and Excellence Cluster PRISMA, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany

One of the most promising developments in the field of neutrino detectors is the recent progress in the production of Water-based Liquid Scintillators (WbLS). This innovative detection medium is being considered by a new generation of neutrino experiments (THEIA, Watchman) for the possibility to combine the advantages of Water Cherenkov and Liquid Scintillators detectors, which opens the way to a broad physics program ranging from long baseline oscillation study to the measurement of low-energy solar neutrinos.

We present in this contribution the status of the development of a small test cell of approx. 10 l volume to be used to characterize different scintillating cocktails and probe the separation of Cherenkov and scintillation signals thanks to a fast PMT readout. Insights on the optical and scintillation properties of WbLS as well as future development and characterization of complementary ultra-fast photodetection systems (SiPM array, LAAPD) will be extremely valuable in view of the THEIA project and for the forthcoming upgrade of the ANNIE experiment.

T 33: Search for new particles II

Time: Tuesday 17:00–18:30 Location: H-HS XVI

T 33.1 Tue 17:00 H-HS XVI

Searching for the single production of vector-like quarks in the Wb final state with the ATLAS detector at 13 TeV — •Ferdinand Schenck[1], Anjishnu Bandyopadhyay[2], Heiko Lacker[1], Janet Dietrich[1], Maxx Rahman[2], Michel Smola[1], and Ian Brock[2] — [1]Humboldt-Universität zu Berlin — [2]Rheinische Friedrich-Wilhelms-Universität Bonn

Vector-Like quarks are hypothetical particles which are consistent with several BSM models, and are promising cadidates for a window into new physics.

This talk will cover the results from an ATLAS search for the single production vector-like $T^{2/3}$ or $Y^{-4/3}$ quarks decaying to a Wb final state using 139 fb^{-1} of proton-proton data collected at 13 TeV by the ATLAS experiment.

Previous searches focused exclusively on the 1-lepton channel, while the new search improves on this by combing the results with a 0-lepton channel for added sensitivity, as well as by the addition of Machine Learning based discriminants and taggers.

T 33.2 Tue 17:15 H-HS XVI

Search for third generation scalar and vector leptoquarks in the context of a stop search at LHC — ferdinand krieter, •kyeong ro lee, and alexander mann — Ludwig-Maximilians-Universität München

Leptoquarks (LQs) are hypothetical bosons coupling both to quarks and leptons. Leptoquarks are interesting since they might provide an explanation for similarities between the quark and lepton sector and lepton-universality violation observed in B-anomalies. Assuming there exist leptoquarks coupling to third-generation fermions (i.e. top and bottom quarks, tau leptons and neutrinos), the direct decay products of LQ pairs produced in pp collisions will be similar to final states of stop (SUSY partner of top quark) pairs. Thus a similar strategy applies to the LQ search and the stop search with corresponding optimizations. Currently, there are open possiblities for both scalar ($s = 0$) and vector ($s = 1$) LQs, so an additional goal is to extend the LQ search to vector LQ.

T 33.3 Tue 17:30 H-HS XVI

Search for a singly-produced vector-like quark in the lepton+jets final state with the CMS experiment — •Anna Benecke, Andreas Hinzmann, Roman Kogler, and Arne Reimers — Universität Hamburg

Many models of physics beyond the Standard Model predict new heavy top partners, the vector-like quarks (T). Considering decay modes $T \to tH, TZ$ and Wb, vector-like quarks are excluded up to a mass of around 1.3 TeV by pair production searches. If other de-

cays are considered, for example to new scalar degrees of freedom, this bound is considerably weaker. The analysis presented here targets the $T \to tH$ decay mode in the lepton+jets final state. The $H \to b\bar{b}$ and $t \to Wb \to l\nu b$ result in a final state with three b jets, which are used to increase the sensitivity of the search. Special emphasis is given to T masses between 600 and 700 GeV, where an analysis in the all-hadronic final state reported an excess above the background expectation of about three standard deviations. Results using pp collision data collected by the CMS experiment in the years 2016 – 2018 at $\sqrt{s} = 13$ TeV, corresponding to an integrated luminosity of 137 fb^{-1}, are presented.

T 33.4 Tue 17:45 H-HS XVI

Search for pair-produced leptoquarks decaying into quarks of the third and leptons of the first or second generation with the ATLAS experiment at $\sqrt{s} = 13$ TeV — •Volker Austrup and Frank Ellinghaus — Bergische Universität Wuppertal

Motivated by similarities between the quark and lepton sectors in the Standard Model, leptoquarks (LQs) are hypothetical bosons that are assumed to couple to quarks and leptons at the same time. First proposed in the 1980s, the initial model includes couplings only within one generation. However, hints at flavor anomalies recently observed by various experiments such as LHCb, BaBar, and Belle have sparked interest in extended models with LQs coupling to quarks and leptons of different generations.
In this talk, a search for up- ($q = 2/3\,\mathrm{e}$) and down-type ($q = -1/3\,\mathrm{e}$) LQs decaying into quarks of the third and leptons of the first or second generation is presented. The focus of this analysis is on final states with exactly one lepton and large amounts of missing transverse energy. Neural networks (NNs) are applied to ensure good separation between signal and background processes over a wide range of the parameter space. The NN output is subsequently used as the discriminating variable in a profile-likelihood fit in control and signal regions. Expected upper limits on the signal mass are obtained from the fit results as a function of the LQ branching ratio into charged and uncharged leptons. The analysis shown is based on pp-collision data at a centre-of-mass energy of $\sqrt{s} = 13\,\mathrm{TeV}$ measured by the ATLAS experiment at the LHC between 2015 and 2018.

T 33.5 Tue 18:00 H-HS XVI

Leptoquark single production in a τ charm final state at the ATLAS detector — •Patrick Bauer for the ATLAS-Collaboration — Physikalisches Institut Bonn

At B-factories, anomalies were observed in decays of the B-hadrons into $D^{(*)}$ and $K^{(*)}$, which are consistent with the hypothesis of contributions from Leptoquarks in the high GeV to low TeV range. Therefore, the direct search for leptoquarks (LQ) got once again in focus at high energy collider experiments. So far most searches aimed at the pair-production via strong interaction, as it is enables a almost model independent approach and is for LQ-masses below 1 TeV expected to be dominating.
However for LQ masses well above 1 TeV the single production mode becomes more relevant. The analysis presented this talk, offers the most direct approach for a search of LQ signature related to the $B \to D^{(*)}\tau\nu$ anomaly, as it incorporates essentially the same couplings. Furthermore the process to be investigated could be mediated by a U_1-vector LQ, which is presently widely discussed among theorists, as preferred solution to B-anomalies.It could explain the two observed anomalies within one model. The talk will motivate the analysis and present first monte-carlo studies.

T 33.6 Tue 18:15 H-HS XVI

Suche nach vektorartigen Top-Quarks in Endzuständen mit einem Lepton, Jets und fehlendem transversalem Impuls am ATLAS Experiment — Frank Ellinghaus und •Jens Roggel — Bergische Universität Wuppertal

Verschiedene Modelle für Physik jenseits des Standardmodells sagen vektorartige Top-Quarks voraus, d.h. schwere Partnerteilchen des Top-Quarks, deren rechts- und links-händige Komponenten gleichartig unter der schwachen Wechselwirkung transformieren.

Die Analyse fokussiert sich auf die Suche nach vektorartigen Top-Quarks aus Paarproduktion mit einem Zerfall in Top-Quark und Z-Boson, wobei das Z-Boson in Neutrinos zerfällt. Die betrachteten Ereignisse werden durch ein Lepton, Jets und einen hohen fehlenden transversalen Impuls im Endzustand gekennzeichnet. Weiter führen die hohen Massen der vektorartigen Top-Quarks zu einem starken Boost der Zerfallsprodukte, was zu einer kollimierten Zerfallstopologie führt. Die Strategie und der Status der Analyse der ATLAS pp Daten bei $\sqrt{s} = 13$ TeV werden präsentiert.

T 34: QCD theory II

Time: Tuesday 17:00–18:30 Location: H-ÜR 1

T 34.1 Tue 17:00 H-ÜR 1

Electroweak Corrections for W^+W^- Scattering — •Robert Franken — JMU Würzburg

Vector boson scattering (VBS) processes are a very good testing ground for the validity of the Standard Model (SM) and electroweak symmetry breaking in general. Over the last few years, Atlas and LHC have been able to measure the cross sections of VBS. To search for deviations, it is important to have precise predictions for VBS processes within the SM. Whilst only the QCD NLO predictions were available for some time, recently electroweak corrections have become available for the scattering of like-sign W bosons and W and Z bosons and turned out to be at the level of 15% for fiducial cross sections. In this talk we report on our efforts to calculate the NLO EW corrections to opposite sign WW scattering and the complete NLO corrections to the process $pp \to e^+\mu^-\nu_e\bar{\nu}_\mu jj$.

T 34.2 Tue 17:15 H-ÜR 1

Vector boson scattering - concrete model realization versus EFT — •Jannis Lang, Stefan Liebler, Heiko Schäfer-Siebert, and Dieter Zeppenfeld — Institute for Theoretical Physics, Karlsruhe Institute of Technology, 76128 Karlsruhe, Germany

We consider a concrete UV complete model with additional fermions and scalars being multiplets under $SU(2)_L$ in the $SU(2)_L$ limit of the Standard Model. We derive its impact on vector boson scattering, both in the full model as well as in terms of an effective field theory (EFT). The validity of the plain EFT and unitarized versions in comparison to the full model is examined, and the impact for experimental analyses bounding EFT operators is pointed out.

T 34.3 Tue 17:30 H-ÜR 1

Vector boson fusion searches for dark matter: Probing the Higgs funnel — •Jan Heisig[1], Michael Krämer[2], Eric Magde[3], and Alexander Mück[2] — [1]Centre for Cosmology, Particle Physics and Phenomenology - CP3 Université catholique de Louvain — [2]Institute for Theoretical Particle Physics and Cosmology, RWTH Aachen University — [3]PRISMA+ Cluster of Excellence and Mainz Institute for Theoretical Physics

We constrain the Higgs-portal model employing the vector-boson fusion channel at the LHC. In particular, we include the phenomenologically interesting parameter region of the Higgs funnel in which the Higgs-boson mass is close to the threshold for dark- matter production and a running-width prescription has to be employed for the Higgs-boson propagator. Limits for the Higgs portal coupling as a function of the dark-matter mass are derived from the CMS search for invisible Higgs-boson decays in vector-boson fusion at 13 TeV. Furthermore, we perform projections for the 14 TeV HL-LHC and the 27 TeV HE- LHC taking into account a realistic estimate of the systematic uncertainties. The respective upper limits on the invisible branching ratio of the Higgs reach down to 2 % and constrain perturbative Higgs-portal couplings up to DM masses of 110 GeV.

T 34.4 Tue 17:45 H-ÜR 1

Soft Gluon Resummation for the Associated Single Top and Higgs Production at the LHC — •Laura Moreno Valero, Anna Kulesza, and Daniel Schwartländer — Institut für Theoretische Physik, Westfälische Wilhelms Universität Münster, Deutschland

Processes involving the Higgs boson and the top quark are of high interest in searches for BSM physics as a way to directly access the top Yukawa coupling. Although it has a relatively small cross sec-

tion, the single top and Higgs production process $pp \to Htj$ is particularly sensitive to new physics, calling for precise theoretical predictions. A reduction of theoretical uncertainties can be achieved by means of resummation techniques, accounting for large logarithmic corrections which originate from soft gluon emissions. In this talk we discuss extending the precision with which theoretical predictions for this process are known from NLO (next-to-leading order) to NLO+NLL (next-to-leading logarithmic matched to NLO) accuracy.

T 34.5 Tue 18:00 H-ÜR 1

Top Quark Mass Effects in Next-To-Next-To-Next-To-Leading Order Higgs Boson Production: Virtual Corrections — Joshua Davies, •Florian Herren, and Matthias Steinhauser — TTP, KIT, Karlsruhe

We discuss the computation of finite top quark mass corrections to the four-loop Higgs boson gluon vertex and briefly recapitulate the computational methods involved.

T 34.6 Tue 18:15 H-ÜR 1

NLO calculations of Higgs decays in various extended Higgs sectors — Shinya Kanemura[1], Mariko Kikuchi[2], Kentarou Mawatari[3], •Kodai Sakurai[4], and Kei Yagyu[1] — [1]Osaka University, Osaka, Japan — [2]Kitakyushu College, Kitakyushu, Japan — [3]Iwate University, Iwate, Japan — [4]Karlsruhe Insitute of Technology, Karlsruhe, Germany

Precise measurements of the discovered Higgs boson is one of important ways to explore the shape of the Higgs sector. We calculated decay branching ratios of the Higgs boson with full next-to-leading-order (NLO) EW and NNLO QCD corrections in various extended Higgs models, such as the singlet extension of the standard model, 4 types of two Higgs doublet models and the inert doublet model. Then, we implemented the analytic results into H-COUP, which is a computation program for the Higgs boson developed by us. In this talk, we will describe the impact of loop contributions of additional Higgs bosons for the decay branching ratios. We will also discuss whether or not above extended Higgs models are discriminated by precise measurements of the branching ratios at future lepton colliders.

T 35: Gamma astronomy I

Time: Tuesday 17:00–18:30 Location: H-HS XVII

T 35.1 Tue 17:00 H-HS XVII

Event classification in Compton-Pair telescopes using Convolutional Networks — •Jan Peter Lommler and Uwe Oberlack — Johannes Gutenberg-Universität Mainz

Low to medium energy gamma rays are shielded by the Earth's atmosphere and can only be measured from space (or near-space environment). Imaging is based on the dominant interaction processes of photons with matter in this energy range, Compton scattering at lower and pair creation at higher energies. Among the biggest challenges are the low signal to background ratio in the low-energy range and high event rates even in a moderate environment like equatorial Low Earth Orbits. An efficient event tagging reduces signal losses by preventing type-mismatching applications of reconstruction algorithms (e.g. performing a Compton reconstruction on a pair event) and signal pollution (distinguishing events originating from background sources). We explore the feasibility of Deep Convolutional Neural Nets in the context of event classification for Compton-pair telescopes on the example of the e-ASTROGAM design proposal.

T 35.2 Tue 17:15 H-HS XVII

Stereo Reconstruction for the early days of CTA — •Lukas Nickel, Richard Wiemann, and Maximilian Nöthe for the CTA-Collaboration — TU Dortmund

The Cherenkov Telescope Array(CTA) aims to increase sensitivity for gamma-ray astronomy compared to the currently operating experiments H.E.S.S, MAGIC and VERITAS while operating as an open observatory. Low-level analysis will be performed with the framework 'ctapipe' that is currently in active development.

The two arrays are planned to consist of 19 (La Palma) and 99 (Chile) telescopes. With these huge numbers of telescopes geometric reconstruction methods for the source position become far superior over traditional disp-based methods.

However, these methods require a certain amount of telescopes to perform well and it is going to take several years to build the complete array. This contribution aims to show that the disp-based approach using the 'aict-tools' works for mono CTA-analysis and the resulting stereoskopic results outperform the geometric approach for low multiplicity events.

T 35.3 Tue 17:30 H-HS XVII

Novel Methods for Particle Energy Reconstruction with the MAGIC Experiment — •Lukas Lütke-Lengerich, Simone Mender, and Dominik Baack for the MAGIC-Collaboration — TU Dortmund, Germany

The MAGIC telescopes, two Imaging Air Cherenkov Telescopes at La Palma, are sensitive in the energy regime from the GeV to the TeV range and are extremely capable instruments for studying gamma*ray sources in the Universe. With a ratio of photons to hadrons up to 1:10000 for the detected showers, it is crucial to understand the properties of all the particles for an improved background rejection and diverse scientific studies. In this talk, two novel methods for the energy regression are presented and compared, applicable to improve the characterization of all species of primary particles. While the first method uses look-up tables to estimate the particles* energy, the second approach is based on a random forest algorithm.

T 35.4 Tue 17:45 H-HS XVII

Analysis of Coincident MAGIC - FACT Events — •Noah Biederbeck and Maximilian Nöthe for the FACT-Collaboration — Experimentelle Physik Vb, Technische Universität Dortmund, Otto-Hahn-Str. 4a, 44227 Dortmund

MAGIC is a system of two 17m-diameter Imaging Air Cherenkov telescopes at the Roque de los Muchachos observatory on La Palma, operating as stereo system since 2009. FACT, a 4m telescope, is operating in close vicinity since October 2011.

The two projects regularly observe the same sources at the same time. Although there is no common hardware trigger, it is possible to identify events recorded by both experiments. These coincident events get processed by the respective standard analyses to compare image features and reconstructed event properties.

This three-telescope system of unlike siblings is similar to the situation with the upcoming Cherenkov Telescope Array (CTA), where also telescopes of very different sizes will operate together. CTApipe, the low-level analysis framework currently under development for CTA, is used to do a stereoscopic three-telescope reconstruction of the origin of the particles.

T 35.5 Tue 18:00 H-HS XVII

Colibri - The Coincidence library for real-time inquiry — •Patrick Reichherzer[1,2,3], Anke Yusafzai[1,2,3], Fabian Schüssler[3], Julia Tjus[1,2], and Lenka Tomankova[4] — [1]Ruhr-University Bochum, Theoretical Physics IV — [2]Ruhr Astroparticle and Plasma Physics (RAPP) Center — [3]Irfu,CEA Paris-Saclay — [4]ECAP, Friedrich-Alexander-Universität Erlangen-Nürnberg

Colibri can support the interpretation of astronomical data. The sensitivity of the next generation high-energy gamma-ray observatory, the Cherenkov Telescope Array (CTA), will surpass current instruments by about an order of magnitude. It will thus provide unique opportunities for the study of transient phenomena at high energies.

Flares of known stable astronomical sources and transient sources can occur on different timescales. The discovery potential of both serendipitous observations and multi-messenger and multi-wavelength follow-up observations could be maximized with a tool which allows for quickly acquiring an overview over both stable sources and transient events in the relevant phase space. We here present Colibri, a prototype for such a tool. It is based on notices forwarded by NASAs Gamma-ray Coordinates Network (GCN) and various catalogues of known sources, and yields a graphical representation with a summary of the relevant data to allow for the fast identification of changes in observed sky regions, and for analyses of those.

In this contribution, the key features of the graphical interface are

presented. Details about the used data resources are explained. Current and possible future implementations of Colibri will be discussed.

T 35.6 Tue 18:15 H-HS XVII

Evaluation of Unfolding Methods On IACT Data with irreducible Background — •Lars Poppe and Maximilian Nöthe — Technische Universität Dortmund Exp. Physik 5, Otto-Hahn-Str. 4a, 44227 Dortmund

Especially in astroparticle physics, quantities of interest like the energy spectra of cosmic gamma-ray sources are not directly observable due to the measurement process. The reconstruction of the relevant quantity is called unfolding. In the case of IACT data (Imaging Atmospheric Cherenkov Telescope), Cherenkov light which is produced by high-energy gamma particles is observed along with a background from charged cosmic rays, which cannot be fully removed. The methodical investigation of the unfolding of these energy spectra is part of this work. Different unfolding methods are evaluated and compared on the basis of Monte-Carlo simulations. In particular, the influence of irreducible background on the unfolded spectra and on the unfolding procedures is investigated. In addition, methods for the estimation of uncertainties are presented.

T 36: Neutrino physics without accelerators III

Time: Tuesday 17:00–18:30 Location: L-2.004

T 36.1 Tue 17:00 L-2.004

The OSIRIS-Prototype — Michael Wurm and •Oliver Pilarczyk — Institut für Physik, Johannes Gutenberg-Universität Mainz

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kt liquid scintillator detector currently under construction near Kaiping in the province Guangdong in southern China. To be able to fulfill the radiopurity requirements of the liquid scintillator there are several purification subsystems installed in the filling line of the JUNO main detector. The last in row of these subsystems is the OSIRIS detector, which will monitor scintillator samples for approximately one day in search of the decays of radioactive impurities. For this, warmed-up scintillator will be continuously filled from the top into a 3m x 3m cylindrical acrylics tank and drained from the bottom. Intermixing of new warm and old cooling scintillator is to be prevented by a temperature stratification inside the tank. Currently, a 1:10 prototype is being set up in Mainz in order to test the filling procedure and to optimize the geometries of the inlet and outlet diffusors to support stratification. This talk will report the current status of the prototype.

T 36.2 Tue 17:15 L-2.004

Reduction of the ^{14}C-background in the JUNO experiment — •Philipp Kampmann[1,2], Christoph Genster[1], Alexandre Göttel[1,2], Yuhang Guo[1,3], Ruquan Liu[1,2], Livia Ludhova[1,2], Giulio Settanta[1], Cornelius Vollbrecht[1,2], and Yu Xu[1,2] — [1]Institut für Kernphysik, Forschungszentrum Jülich — [2]III. Physikalisches Institut B, RWTH Aachen University — [3]School of Nuclear Science and Technology, Xi'an Jiaotong University, Xi'an 710049, China

The Jiangmen Underground Neutrino Observatory (JUNO) is a next-generation neutrino experiment under construction in China expected to complete the construction in late 2021. As the main goal it aims to address the determination of the neutrino mass hierarchy with 3-4 σ significance in 6 years. Therefore, it will measure the oscillated energy spectrum of electron anti-neutrinos from two nuclear power plants at 53 km baseline with an unprecedented energy resolution of 3% at 1 MeV using a 20 kt liquid scintillator detector. Due to the large target size the probability of event pile-up with internal background events such as from ^{14}C decays is high. This can spoil the resolution of the reconstructed neutrino energies, which is a major systematic uncertainty in the mass hierarchy search of JUNO. In this presentation reconstruction techniques to reduce the impact of the ^{14}C pile-up will be presented. These include a Clusterization algorithm as well as an event reconstruction Likelihood-test of the photon hits.

T 36.3 Tue 17:30 L-2.004

Implications of a fine structure in the reactor neutrino spectrum for JUNO — David Blum, Marc Breisch, Jessica Eck, •Tobias Heinz, Tobias Lachenmaier, Neha Lad, Axel Müller, Tobias Sterr, and Alexander Tietzsch — Physikalisches Institut, Eberhard Karls Universität Tübingen

With the main goal to determine the neutrino mass hierarchy, the Jiangmen Underground Neutrino Observatory (JUNO) is currently constructed in the Guangdong province in southern China. To analyze which mass hierarchy is realized in nature, JUNO measures the reactor neutrino spectrum from two nuclear power plants located in a distance of around 53 km. One crucial aspect for a successful measurement is a precise knowledge of the emitted and therefore unoscillated reactor neutrino spectrum. In the last years, new predictions of the spectrum revealed the possible existence of a spectral fine structure which could impede the mass hierarchy determination with JUNO.

This work will present studies on possible implications of the fine structure in the reactor neutrino spectrum for the sensitivity of the mass hierarchy determination with JUNO.

This work is supported by the Deutsche Forschungsgemeinschaft.

T 36.4 Tue 17:45 L-2.004

Search for the two neutrino double beta decay ^{136}Xe to an excited state of ^{136}Ba — •Henning Schulze Eissing for the XENON-Collaboration — Institut für Kernphysik, WWU Münster, Germany

The XENON1T Dark Matter detector used a dual-phase time projection chamber with 2 tonnes of xenon monitored by photomultiplier tubes.

It is possible to reconstruct the energy and position of an interaction in the detector. A good energy resolution and the possibility to reconstruct events at MeV-energies in combination with a very low background rate allows the search for rare decays with XENON1T.

The two neutrino double beta decay of ^{136}Xe to the ground state of ^{136}Ba was measured by multiple experiments with a half life of about 2.16 x 10^{21} years . Beside the decay to the ground state, decays to excited states of ^{136}Ba are possible, but not yet observed experimentally due to long expected half-lifes of about 10^{25} years. With the 1 t x year exposure of XENON1T multiple of these events could be found in the existing data.

This talk will outline steps necessary to search for this decay including a validation of MC simulations and the development of a machine learning discriminator to distinguish signal and background events.

T 36.5 Tue 18:00 L-2.004

Search for new physics with unconventional double beta decay modes in GERDA Phase II — •Elisabetta Bossio for the GERDA-Collaboration — Physik-Department, Technische Universität München, James-Franck- Straße, 85748 Garching

The main goal of the GERmanium Detector Array (GERDA) experiment at the Laboratori Nazionali del Gran Sasso of INFN (Italy) is the discovery of the $0\nu\beta\beta$-decay of ^{76}Ge, which would unambiguously demonstrate lepton number violation. A large variety of beyond the Standard Model physics can also manifest in the $2\nu\beta\beta$ region of the spectrum: models involving Majorons or Lorentz violating physics predict shapes of the measured two-electrons spectrum different from the conventional shape. In GERDA Phase II, the liquid argon veto system allows to have marginal background in this region of the spectrum and makes the search for exotic processes attractive. Possible deformations of the shape due to systematic uncertainties are investigated and a hybrid Bayesian-frequentist approach is used to include them in the results. The analysis of 32.1 kg·yr of ^{76}Ge exposure will be presented. The half-life of $2\nu\beta\beta$-decay of ^{76}Ge is measured with the highest precision to date. Results on unconventional double beta decay modes will also be presented, half-lives of the Majoron involving decays of the order of 10^{23}-10^{24} years are probed and Lorentz invariance violation is tested with a sensitivity of 10^{-6} GeV on the parameter $\dot{a}^{(3)}_{of}$.

This work has been supported in part by the German Federal Min-istry for Education and Research (BMBF) and the German ResearchFoundation (DFG) via the SFB1258.

T 36.6 Tue 18:15 L-2.004

Investigating the background of the GERDA experiment by ^{76}Ge(n,p)^{76}Ga reaction studies — •Marie Pichotta, Konrad Schmidt, Steffen Turkat, Birgit Zatschler, and Kai Zuber —

TU Dresden IKTP, Dresden, Deutschland

The GERmanium Detector Array (GERDA) is located 1400 m underground in the Gran Sasso mountains (Italy) searching for the neutrinoless double beta decay of ^{76}Ge. The discovery of this extremely rare process with an expected Q-value of 2039 keV would prove the Majorana character of neutrinos and consequently physics beyond Standard Model. For an explicit identification of a signal caused by the neutrinoless double beta decay a precise understanding of the background components is crucial.

Previous work indicates gamma rays from the decay of ^{76}Ga in the region of interest (ROI) which can be produced by neutrons via (n,p)-reactions with ^{76}Ge and therefore contribute to the background in the ROI. For the investigation of this potential background an enriched Ge-sample consisting of the same isotopic composition as the GERDA detectors will be activated by neutrons from a DT generator located at the Helmholtz-Zentrum Dresden-Rossendorf (HZDR). Experimental procedure and preliminary works will be presented. This project is supported by BMBF (05A17OD1).

T 37: Neutrino physics without accelerators IV

Time: Tuesday 17:00–18:30 Location: L-2.017

T 37.1 Tue 17:00 L-2.017

^{210}Bi - ^{210}Po studies for the measurement of CNO solar neutrinos with Borexino — •Sindhujha Kumaran[1,2], Zara Bagdasarian[1], Alexandre Göttel[1,2], Livia Ludhova[1,2], Ömer Penek[1,2], Mariia Redchuk[1,2], Giulio Settanta[1], and Apeksha Singhal[1,2] for the Borexino-Collaboration — [1]IKP-2, Forschungszentrum Jülich — [2]III. Physikalisches Institut B, RWTH Aachen University

Borexino is a liquid scintillator detector located at the Laboratori Nazionale del Gran Sasso, Italy with the main goal to measure solar neutrinos. After the successful measurement of all the components of the pp fusion chain, the current focus of the detector is the discovery of neutrinos from the CNO-cycle. In addition to their very low expected rate, a major challenge is posed by the prerequisite to know the rate of internal ^{210}Bi background. This is due to the degeneracy of its spectral shape with that of CNO neutrinos. ^{210}Bi β- decays to ^{210}Po, which then α decays to stable ^{206}Pb. ^{210}Po can be distinguished on an event-by-event basis through pulse shape discrimination techniques. Ideally, ^{210}Bi should be in secular equilibrium with ^{210}Po. Unfortunately, additional ^{210}Po was brought from peripheral sources to the fiducial volume by the convective motions of the scintillator, triggered by seasonal temperature changes. The insulation performed in 2015 has helped to thermally stabilize the detector. This talk will present the strategies to extract the ^{210}Bi rate in Phase 3 through the analysis of ^{210}Po in the cleanest region of the detector.

T 37.2 Tue 17:15 L-2.017

New Analyses of Atmospheric Neutrino Oscillations with IceCube DeepCore — •Alexander Trettin for the IceCube-Collaboration — DESY Zeuthen

The low energy extension to the IceCube Neutrino Observatory, DeepCore, has now been taking data for more than eight years. Analyses previously published have used three years of its data to make competitive measurements of the atmospheric neutrino oscillation parameters. This talk presents a new analysis being developed using eight years of detector live time. An overview is given of the improvements to the event selection that yield a data sample of highly pure atmospheric neutrino events, as well as new reconstruction methods that achieve better resolutions and neutrino flavor separation. Together, these improvements lead to an atmospheric neutrino oscillation analysis with unprecedented sensitivity.

T 37.3 Tue 17:30 L-2.017

Latest advances in the development of a likelihood fit for the Double Chooz experiment — •Philipp Soldin, Christopher Wiebusch, and Achim Stahl — III. Physikalisches Institut B, RWTH Aachen University

Double Chooz is a reactor neutrino disappearance experiment that was operating between 2011 and the end of 2017. Its main purpose has been a precise measurement of the neutrino mixing angle θ_{13}. The experimental setup consisted of two identical liquid scintillator detectors at average baselines of about 400 m and 1 km to two reactor cores at the nuclear power plant in Chooz, France. The neutrinos were detected by the measurement of the inverse beta decay (IBD) signature, which consists of a prompt positron annihilation and a delayed neutron capture signal. The neutrino mixing angle θ_{13} can be obtained by utilising the rate and spectral energy shape of IBD events and all relevant backgrounds in a multivariate likelihood fit. This fit can also be used to observe deviations from the nuclear reactor spectral shape predictions. The latest advancements and applications of such a fit and the development of a new unbinned likelihood fit method are discussed in this talk.

T 37.4 Tue 17:45 L-2.017

Progress in solar neutrino analysis of the Borexino experiment — •Apeksha Singhal[1,2], Zara Bagdasarian[1], Alexandre Göttel[1,2], Sindhujha Kumaran[1,2], Livia Ludhova[1,2], Ömer Penek[1,2], Mariia Redchuk[1,2], and Giulio Settanta[1] for the Borexino-Collaboration — [1]Forschungszentrum Juelich, IKP-2, Juelich, Germany — [2]III B Physikalisches Institut, RWTH Aachen, Aachen, Germany

The Borexino experiment has the most radio-pure scintillator neutrino detector of the world. It is located at the Laboratori Nazionali del Gran Sasso in Italy and has been running since 2007. It has provided important measurements in the MeV scale neutrino physics, including spectroscopy of solar neutrinos from the pp fusion cycle (pp, pep, 7Be, and 8B neutrinos). The next Borexino goal is to observe solar neutrinos from the CNO cycle which has not yet been confirmed experimentally. The talk will discuss important aspects of the current Borexino solar neutrino analysis.

T 37.5 Tue 18:00 L-2.017

Accidental background reduction using artificial neural networks in the Double Chooz experiment — •Markus Bachlechner, Christopher Wiebusch, Achim Stahl, and Philipp Soldin — III. Physikalisches Institut B, RWTH Aachen University

Double Chooz is a reactor anti-neutrino disappearance experiment, which took data from 2011 until the end of 2017. The main purpose is a precise measurement of the neutrino mixing angle θ_{13} with two identical liquid scintillator detectors. Neutrinos are detected via the signature of the inverse beta decay (IBD), which is characterized by a prompt signal from a positron and a delayed signal from neutron capture. A major background is the random association of uncorrelated events that pass the selection criteria individually. The current separation is done in a multivariate analysis, performed by a multi-layer perceptron. In this talk a method to improve the current reduction by deep learning techniques is presented.

T 37.6 Tue 18:15 L-2.017

Evaluation of the Neutron Detection Efficiency in the STEREO Reactor Neutrino Experiment — •Helena Almazan, Aurelie Bonhomme, Christian Buck, Manfred Lindner, Christian Roca, and Stefan Schoppmann — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

The STEREO detector is measuring electron antineutrinos from the research reactor at the Institut Laue-Langevin (Grenoble, France). Located at 10 m from its core and with a segmented neutrino target, STEREO is searching for light sterile neutrino oscillations as a possible explanation for the Reactor Antineutrino Anomaly observed in 2011. An accurate determination of the detection efficiency of the correlated signal created by the electron antineutrino interaction, $\bar{\nu}_e + p \rightarrow e^+ + n$, called inverse beta decay (IBD) is needed to reach that goal. More concretely, a good understanding of the detection efficiency for the IBD neutrons is required, in both data and simulation, since it is one of the dominant systematic uncertainties of the STEREO analysis. An AmBe neutron source has been deployed throughout the different sub-volumes of the detector target, and has been used to study the properties of the neutron detection with high accuracy. This talk is focused on presenting the most relevant properties of the neutron efficiency, and to test the modelisation of the gamma cascade emitted after a neutron capture on gadolinium (nuclei present in the liquid scintillator), providing thus a crucial input in the analysis of the STEREO experiment.

T 38: Methods of astroparticle physics II

Time: Tuesday 17:00–18:30 Location: L-3.001

T 38.1 Tue 17:00 L-3.001

LOM: An optical module for IceCube-Gen2 — •Anna Weatherburn, Lew Classen, and Alexander Kappes for the IceCube-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, Münster

IceCube-Gen2 will further the research done by IceCube and the IceCube Upgrade into cosmic high energy neutrinos. The next generation of IceCube will attempt to identify the sources responsible for these cosmic high energy neutrinos, extend the energy spectrum of measured neutrinos and take measurements of the neutrino flavour ratio. For this high-energy array upgrade, about 10,000 additional optical sensors on 120 strings will be installed, thereby extending its size to about 8 km3. The optical module technology for Gen2 is currently under development, and one of the most promising candidates is the LOM (or Long Optical Module). The LOM design consists of many small photomultipliers (PMTs), similarly to the mDOM (multi-PMT Digital Optical Module) used in the IceCube Upgrade. However the diameter will be reduced in order to substantially reduce the cost and time of drilling to place the optical modules. The particular design of the LOM will be determined through simulations and consideration of the practicalities of design features. An overview of the current status of simulations and optimisation studies of the optical properties of the new module will be given.

T 38.2 Tue 17:15 L-3.001

Development of a Wavelength-shifting Optical Module for STRAW-b — •Maximilian Bubeck, Lucas Sebastian Binn, John Rack-Helleis, Anna Vocke geb. Steuer, Sebastian Böser, Lutz Köpke, and Diego Salgado Llamas — JGU Mainz

The Wavelength-shifting Optical Module (WOM) is a photosensor that detects UV light with a very high signal-to-noise ratio. The WOM consists of a quartz-glass tube coated with a wavelength-shifting paint, which absorbs light in the UV range and re-emits it in the visible spectrum. Two photo-multiplier tubes (PMTs) attached to the ends of the light-guiding tube detect the shifted photons. We are currently assembling a prototype that will soon be deployed in STRAW-b, an experiment in the Cascadia Basin at a depth of 2600 m, to measure the noise rate in a deep sea environment. Designed to withstand extreme pressures, the WOM is surrounded by a pressure housing. To reduce photon losses, the space between the pressure vessel and the inner tube is filled with hydrogel, which offers a similar refractive index as water. The PMTs are optically and mechanically connected to the inner tube using UV-curing adhesive. To fulfill the requirements for a deployment in the deep sea, the final WOM will need to pass multiple vibration and pressure tests.

T 38.3 Tue 17:30 L-3.001

Development of SiPM based light sensors for large neutrino detectors — David Blum, •Marc Breisch, Jessica Eck, Tobias Heinz, Tobias Lachenmaier, Neha Lad, Axel Müller, Tobias Sterr, and Alexander Tietzsch — Physikalisches Institut, Eberhard Karls Universität Tübingen

For future neutrino experiments (like THEIA) the usage of either large photomultiplier tubes (PMTs) or completely new detector technologies like Large Area Picosecond Photodetectors (LAPPDs) are under consideration. To improve the granulation of the detector and thus the reconstruction a new approach based on SiPM and scintillators was investigated. The scintillator in this design has a surface which is larger than the SiPM and acts as an active lightguide to increase the sensitive area. A custom ray-tracing simulation was used to determine the shape and size of the scintillator to optimise its light collection. This talk will present the results of the simulation, the scintillator design and its experimental validation as well as the first test of an array setup. This work is supported by the BMBF (05H18VTRD2).

T 38.4 Tue 17:45 L-3.001

The Efficiency of the Wavelength-shifting Optical Module (WOM) for IceCube — •John Rack-Helleis, Sebastian Böser, Anna Vocke geb. Steuer, Lutz Köpke, Max Bubeck, Florian Thomas, and Lucas Sebastian Binn for the IceCube-Collaboration — JGU Mainz

The Wavelength-shifting Optical Module is a novel photosensor developed for the IceCube neutrino telescope at the South Pole. It combines the technology of light guiding and wavelengthshifting to achieve a large detection area, high sensitivity in the UV range as well as an improved signal-to-noise ratio. The WOM will be deployed and tested in the IceCube Upgrade, scheduled for 2021. Recent results on the modules photon propagation efficiency and its main contributors will be presented. The state of the understanding of theoretical and experimental efficiency is shown.

T 38.5 Tue 18:00 L-3.001

Performance of the UV Calibration Device for the SPICEcore hole — •Jannes Brostean-Kaiser — DESY Zeuthen

IceCube, the biggest neutrino detector in the world, will be upgraded in 2022. For this upgrade and the planned enlarged detector, IceCube-Gen2, new optical modules have been developed. One of these optical modules, the WOM, uses wavelength-shifting and light-guiding techniques to measure Cherenkov photons in the UV-range. To understand the efficiency of this new module the absorption and scattering lengths of UV-light in the South Pole ice have to be measured. The measurement was done in two campaigns (2018/19 and 2019/20) in the SpiceCore hole, a 1751 m deep hole near the IceCube array drilled for glaciology studies and filled with Estisol. To measure the ice properties a calibration device was lowered into the hole and emit UV light. A UV-sensitive detector inside the probe measures the UV photons that are scattered back. From the time distribution of these scattered photons the scattering and absorption lengths can be deduced. The design of the probe will be presented, as well as its performance during the two measurement campaign, and the results from the 2018/19 campaign and preliminary results from the 2019/20 campaign.

T 38.6 Tue 18:15 L-3.001

Ultra-fast ray tracing for the Wavelength-shifting Optical Module — •Florian Thomas, John Rack-Helleis, Sebastian Böser, and Elmar Schömer — Johannes Gutenberg-Universität Mainz

The Wavelength-shifting Optical Module (WOM) is a novel UV-sensitive light sensor for neutrino experiments. It consists of a cylindrical tube coated with wavelength shifting paint, light concentrators and photomultiplier tubes (PMTs). UV light striking the surface of the tube is absorbed, shifted towards longer wavelengths and guided to the PMT by total internal reflection. The simulation models the photon propagation within the tube wall and light concentrator and includes the simulation of photon interactions with the tube material, such as scattering and absorption. The simulation algorithm is based on a ray tracing approach and has been implemented for CUDA-enabled GPUs. It reaches a throughput of several million photons per second, which is three orders of magnitude faster than previous attempts using commercial software. The excellent simulation performance enabled the application in a fit to experimental data.

T 39: Methods of astroparticle physics III

Time: Tuesday 17:00–18:30 Location: L-3.002

T 39.1 Tue 17:00 L-3.002

Particle Identification using Deep Learning with AMS — •Robin Sonnabend — 1. Physikalisches Institut B, RWTH Aachen

The Alpha Magnetic Spectrometer (AMS-02) on the International Space Station performs precision measurements of cosmic rays in the GeV to TeV energy range. One of the challenges of measuring the electron and positron fluxes is rejecting the proton background. The published analyses of these fluxes rely on Multivariate Analyses (MVA)

using shower shape observables from the electromagnetic calorimeter (ECAL) for particle identification and background rejection.

New methods to identify particles with Deep Convolutional Neural Networks using the energy depositions measured by the AMS-02 ECAL directly will be presented.

T 39.2 Tue 17:15 L-3.002

Classification of Cosmic Rays on the basis of raw data of the IceCube Array — •Johannes Bartl, Gerrit Wrede, Thorsten Glüsenkamp, and Gisela Anton — Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, Deutschland

In this paper, a classification of the primary particles of cosmic rays is performed using the measured signal within the IceCube array. This classification is the first separation only based on the detected photons generated by the interaction of the air shower in the ice. The distribution of the photons and thus the measurement signal of the detector depends on the mass and energy of the triggering primary particle. Using simulation data, a neural network was trained to distinguish between hydrogen and iron showers. Subsequently, the predictions of the network were weighted according to reality using a model. It was possible to classify 80% of the air showers correctly and the neural network was able to extract the primary energy and the energy distribution as classification criteria.

T 39.3 Tue 17:30 L-3.002

Supernova interactions in IceCube and reconstruction improvements — •David Kappesser and Lutz Köpke for the IceCube-Collaboration — Johannes Gutenberg-Universität, Mainz

The IceCube Neutrino Observatory is capable of detecting supernova neutrinos with energies around 10 MeV by observing an excess in the overall rate of the detector. This method allows for a particularly precise measurement of the supernova neutrino lightcurve. Due to IceCube's sparse Instrumentation with Digital Optical Modules (DOMs), only in rare cases, more than one Cherenkov photon is detected per supernova neutrino interaction. Still, the number of coincidences is sufficiently large in order to estimate the average neutrino energy by analyzing the energy dependent rate increase of coincidences between neighbouring DOMs. To calibrate and evaluate such a measurement and to carefully study the passage of particles through the ice and the related detector response, a Geant4 based Monte Carlo was developed and tested.

T 39.4 Tue 17:45 L-3.002

Search for hidden Supernovae and frequency space analysis with IceCube — •Alexander Fritz and Lutz Köpke for the IceCube-Collaboration — Institut für Physik, Staudingerweg 7, 55128 Mainz

By measuring a rate excess on top of dark noise in 5160 optical modules, IceCube offers the best resolution of the neutrino light curve for galactic Supernovae. First results on the frequency of optically obscured galactic Supernovae or Supernovae that end up in a black hole are presented for 11 years of IceCube data. For the search for periodic signals in the IceCube rate data in various time bins, Lomb-Scargle and fast Fourier transformations are used.

T 39.5 Tue 18:00 L-3.002

A study of the detectability of the DSNB through high resolution convolutional neural networks for next generation neutrino experiments — •David Maksimovic, Michael Wurm, and Michael Nieslony for the ANNIE-Collaboration — Johannes Gutenberg-Universität, Mainz, Deutschland

The ANNIE experiment (Accelerator Neutrino Neutron Interaction Experiment) at Fermilab is a 26-ton Gadolinium-loaded water Cherenkov detector. Its scientific aim is to study cross-sections and neutron multiplicity from the interactions of GeV neutrinos in the Booster Neutrino Beam. Moreover, ANNIE serves as test bench for new experimental techniques, e.g. the application of Convolutional Neural Networks (CNN) for event classification based on detector hit maps.
Here, we report on the performance of a CNN being developed to distinguish the signals of positrons emitted in Inverse Beta Decays from a background of neutral current interactions induced by GeV neutrinos. The resulting event classifier is of high relevance for the detection of the Diffuse Supernova Neutrino Background (DSNB) in the current Super-Kamiokande+gadolinium phase as well as for future water-based liquid scintillator experiments like THEIA.

T 39.6 Tue 18:15 L-3.002

Reconstruction of Supernova Burst Neutrinos with JUNO — •Thilo Birkenfeld, Max Büsken, Shivani Ramachandran, Achim Stahl, Christopher Wiebusch, and Sivaram Yogathasan — III. Physikalisches Institut B, RWTH Aachen

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20kt liquid scintillator neutrino detector, which is currently under construction in China. It will lead the next generation of liquid scintillator neutrino experiments with its large target mass and total photo coverage of about 77%. A major physics goal is determining the neutrino mass hierarchy from the measurement of reactor electron anti-neutrinos with unprecedented precision. To accomplish this goal it is designed to have an energy resolution of $< 3\%$ at 1MeV and an energy non-linearity better than 1% in the MeV region. Due to its long lifetime JUNO is a promising observatory for measuring the neutrino burst from a galactic supernova explosion. High statistics and the excellent energy reconstruction will unravel the details of the neutrino-driven supernova mechanism. As the flux of such a burst comprises all different neutrino flavours, the expected signal consists of different detection channels, which include the inverse beta decay, elastic scattering on protons and electrons and various interactions with carbon. Separating these channels is crucial for a flavour dependent analysis. In this talk a method for distinguishing the different channels and reconstructing the low energy events from elastic scattering is presented.

T 40: DAQ, trigger and electronics II

Time: Tuesday 17:00–18:30 Location: L-3.015

T 40.1 Tue 17:00 L-3.015

Developement of automated quality tests for the RD51 VMM3a Hybrid — •Finn Jaekel, Jochen Kaminski, Michael Lupberger, and Patrick Schwäbig — Physikalisches Institut, Universität Bonn

The Scalable Readout System of the RD51 Collaboration is a diverse readout system, which is used in many areas in the developement of gaseous detectors. It supports different front-end chips like Timepix, VFAT or APV25 and contains the complete readout-chain to transfer data between the detector and the computer. Until recently the APV25 ASIC was frequently used. As nowadays it is not produced anymore, a new front end chip - the VMM ASIC (developed for the ATLAS New Small Wheels upgrade) - was developed and integrated into the scalable readout system.

The project currently is on its way from developement to mass production. There is already strong interest to use the readout system for a wide variety of experiments and research projects. Especially the front-end printed circuit board with the VMM chip, called hybrid, of which large amounts will be produced, requires automated quality assurance.

In this talk quality criteria, developement of an automated testing procedure, as well as first results of these quality tests will be presented.

T 40.2 Tue 17:15 L-3.015

Development of Calibration Procedures for NSW Micromegas readout electronics — •Vladislavs Plesanovs, Stephanie Zimmerman, and Gregor Herten — Albert-Ludwigs-Universität Freiburg, Freiburg im Breisgau, Germany

During the current LS2 at CERN, ATLAS muon spectrometer will be upgraded by exchanging one of its inner end-caps. The aim is to have an extra input to the L1 muon trigger system to cope with expected event rate and to lower fake-muon trigger rate significantly. For this purpose the New Small Wheel (NSW) will consist of two complementary detector technologies: sTGC (trigger) and MicroMegas (tracking). Data readout from these detectors will be conducted by dedicated front-end electronics.

Before physics data taking, a calibration of the readout electronics and signal conversion from digital units to physical values is required. Calibration procedure sets a global threshold above the noise on the readout chip level and adjusts it individually for each of ≈ 2 million channels. Second part requires a conversion procedure of the input charge from ADC counts to Coulombs and time from bunch crossing clock units to nanoseconds for further data processing.

This presentation will discuss how the developed procedures are integrated with cutting-edge technologies like FELIX, ALTI and present ATLAS TDAQ infrastructure. Also, challenges that were tackled at the development stage together with calibration results of the first commissioned sector of the NSW will be presented.

T 40.3 Tue 17:30 L-3.015

Redevelopment of RawDataAnalysis package for ATLAS pixel detector — •Buddhadeb Mondal[1], Oldrich Kepka[2], Carmen Diez Pardos[1], and Ivor Fleck[1] for the ATLAS-Collaboration — [1]University of Siegen, Siegen, Germany — [2]Institute of Physics, Prague

The RawDataAnalysis package is a part of the ATLAS pixel DAQ (Data Acquisition) infrastructure used for analyzing ATLAS raw data for commissioning the pixel and IBL detectors. The package comprises a decoder and an analysis framework. The decoder takes the raw data as input, decompresses it and it reads pixel and IBL ROB (readout buffer) fragments. Then it decodes the encrypted DAQ logic information from the data and stores it as ROOT object tree. An analysis framework enables access to the decoded ROOT tree and provides common functionality for further analysis.

This tool offers full information about the raw data, low-level validation of DAQ logic and reconstruction chain, ROD (readout driver)/Module error analyses, hit-level occupancy counting, ToT (time over threshold) measurement, timing information at the pixel level, validation of data quality monitoring plots and it can be used for other detector related studies. In this talk development of this package and how this package is used in the ATLAS pixel group will be presented.

T 40.4 Tue 17:45 L-3.015

Firmware development for the Scalable Readout System (SRS) with VMM3a — •Patrick Schwäbig, Finn Jaekel, Jochen Kaminski, and Michael Lupberger — Physikalisches Institut, Universität Bonn

The Scalable Readout System which was developed within the RD51 collaboration is a flexible readout system which can be used with various front-end chips and is scalable from a few channels to many thousand channels.

As a future-oriented technology the VMM front-end chip (ASIC) has been chosen as a successor for the so far mainly used APV25 for innovations in gaseous detector development. Originally developed for the New Small Wheel Upgrade of the ATLAS detector the VMM offers features like continuous readout, which are required to fulfill future demands e.g. for use in the NMX instrument at the European Spallation Source (ESS).

The VMM ASIC has been implemented in recent years in the SRS and was tested in various projects. Additional improvements and enhancements are in ongoing development.

The talk will focus on the progression of the firmware of the FPGA responsible for the VMM readout. Improvements of readout reliability and readout speed as well as future plans will be presented.

T 40.5 Tue 18:00 L-3.015

DC-DC converter for powering the Mu3e detector — •Sophie Gagneur[1], Thomas Rudzki[2], Frederik Wauters[1], and Niklaus Berger[1] for the Mu3e-Collaboration — [1]Institut für Kernphysik Johannes Gutenber-Universität, Mainz — [2]Physikalisches Institut Heidelberg

The Mu3e experiment under construction at the Paul Scherrer Institute, Switzerland, aims to measure the lepton flavour violating decay of a muon into one electron and two positrons with an ultimate sensitivity of one in 10^{16} muon decays.

The detector for the Mu3e experiment consists of High-Voltage Monolithic Active Pixel Sensors (HV-MAPS) combined with scintillating tiles and fibres. The detector ASICs need a supply voltage of around 2 V. This voltage is going to be generated from the 20 V external supply via DC-DC converters. These buck converters must be able to operate within a magnetic field and provide a constant output voltage with a ripple of less than 10 mV to guarantee a proper operation of the pixel sensors and timing detectors. This will be achieved by the use of custom air coils, the implementation of additional output filters and an optimized PCB design. The first version of the converter has been successfully tested with the MuPix8 prototype pixel sensor.

T 40.6 Tue 18:15 L-3.015

Evaluation einer neuen Netzwerk-Technik für die Detektor-Auslese — •Carsten Dülsen, Tobias Flick, Wolfgang Wagner und Marius Wensing — Bergische Universität Wuppertal

Für die Übertragung von Auslesedaten vom FPGA zur Software wird ein Ansatz vorgestellt, bei dem die Daten über ein herkömmliches Netzwerk (UDP/IP) versendet werden. Dabei wird versucht den Datenverlust soweit zu reduzieren, dass die Auslese auch ohne Speicherung und erneutes Versenden der Daten auskommt. Dazu wird eine eXpress Data Path (XDP) genannte Technik untersucht und ihre Eignung im Umfeld des ATLAS ITk Pixel Detektors getestet.

T 41: Electroweak physics II

Time: Tuesday 17:00–18:15 Location: L-3.016

T 41.1 Tue 17:00 L-3.016

Polarization studies in the scattering of two vector bosons with the ATLAS experiment at the LHC — •Jan-Eric Nitschke, Carsten Bittrich, Joany Manjarres, and Michael Kobel — TU Dresden, Germany

In the SM, W and Z bosons acquire their masses through the Higgs mechanism where the Goldstone bosons from the electroweak symmetry breaking (EWSB) are absorbed into the W and Z bosons and become their longitudinal components. This makes the scattering of longitudinal-longitudinal vector boson interactions (V_LV_L) the ideal process to examine the EWSB mechanism and to search for new physics. Without a Higgs boson or an equivalent mechanism the predicted cross section for the scattering of longitudinally polarized bosons violates unitarity at high energies.

A precise measurement of the cross section of this process could eventually help us to understand if the observed Higgs boson behaves like a Standard Model one or might give us hints at new physics beyond the Standard Model.

In order to do such a study at the LHC it is necessary to extract the polarization of the vector bosons from the decay products measured with the ATLAS detector. For this, two methods of generating simulations of polarized bosons in the WZjj finale state are studied.

Determining the fractions of each polarization in the final state requires observables sensitive to these polarizations. Observables sensitive to the polarization of the W- and Z-Boson as well as the combination of both are obtained via template fits.*

T 41.2 Tue 17:15 L-3.016

Estimation of non-prompt lepton background in same-sign WW production at 13 TeV with ATLAS detector. — •Shalu Solomon for the ATLAS-Collaboration — Albet-Ludwigs University of Freiberg, Freiburg, Germany.

The production of same-sign W boson pair via vector boson scattering is one of the pivotal processes to experimentally probe the electroweak symmetry breaking mechanism. The analysis of 2015-2016 ATLAS data at 13 TeV resulted in the observation of the process with the signal significance of 6.5 sigma. With the entire Run 2 data set the signal event yield has increased approximately by a factor of 4, which gives the potential for the first differential cross-section measurement of this process. The final state consisting of two prompt leptons of the same electric charge, two neutrinos and two forward jets is considered. The second-largest background source, non-prompt lepton background, arises due to leptons from heavy-flavour hadron decays and jets misidentified as electrons, passing the lepton selection criteria. A data-driven technique, called fake factor method, is used to estimate

this background. The fake factors are extracted from a jet-enriched sample kinematically close to the signal region. The performance of this background in various validation regions and the estimation in the signal region are presented.

T 41.3 Tue 17:30 L-3.016

Messung des Wirkungsquerschnittes zur Produktion dreier Eichbosonen mit dem Run-2 Datensatz des ATLAS-Detektors — •Philipp Ott — Kirchhoff-Institut für Physik, Heidelberg

Die Produktion dreier Eichbosonen der elektroschwachen Wechselwirkung ist ein Prozess der im Standardmodell der Teilchenphysik vorhergesagt wird. Bislang konnte dieser ausschließlich in einem Produktionskanal ($Z\gamma\gamma$) statistisch signifikant nachgewiesen werden. Aus diesem Grund ist der volle Run-2 Datensatz des ATLAS-Detektors mit einer integrierten Luminosität von 139 fb^{-1} besonders vielversprechend, um nach Produktionsmechanismen zu suchen, die einen verhältnismäßig kleinen Wirkungsquerschnitt aufweisen. In der Überprüfung der Vorhersagen des Standardmodells liefern mögliche Abweichungen Aufschlüsse über Prozesse neuer Physik. Diese können sich beispielsweise in einer anomalen quartischen Eichkopplung manifestieren. Hierbei weist die Kopplung der elektroschwachen Wechselwirkung in der Produktion dreier Eichbosonen eine hohe Sensitivität auf.

Dieser Vortrag stellt eine Analyse zur Bestimmung des Wirkungsquerschnittes der Produktion dreier Eichbosonen der elektroschwachen Wechselwirkung mit dem vollen Run-2 Datensatz des ATLAS-Detektors vor.

T 41.4 Tue 17:45 L-3.016

Measurement of the charged-current Drell-Yan differential cross-section at high transverse masses at $\sqrt{s}$ = 13 TeV with the ATLAS detector — Frank Ellinghaus, •Frederic Schröder, and Christian Zeitnitz — Bergische Universität Wuppertal

The charged-current Drell-Yan (DY) cross-section is measured for the leptonic decay of the W boson $W \to l\nu$ with $l = e, \mu$. While the cross-section at the peak of the W boson mass is known very well, the measurement of the differential cross-section for transverse masses up to $\mathcal{O}(1\,\text{TeV})$ is measured for the first time. In addition, the cross-section will be measured differentially in the pseudorapidity of the lepton.
The charged-current DY can be used to constrain the density function that describes the partonic content of the proton and to measure fundamental parameters of the Standard Model. In particular, the high m_T^W region of the charged-current DY allows probing new physics by constraining effective field theory parameters, because these parameters are sensitive to small deviations in the cross-section with respect to the theory prediction.
Studies for the fake lepton background estimation based on the matrix method as well as an overview of the unfolding procedure will be presented for the electron channel. The data has been taken at the ATLAS experiment based on pp-collisions at a center-of-mass energy of $\sqrt{s} = 13\,\text{TeV}$ at the LHC.

T 41.5 Tue 18:00 L-3.016

Suche nach anomalen Kopplungen in Vektor-Boson-Streuung im hadronischen Zerfallskanal mit dem CMS-Experiment — Steffen Albrecht[1], Thomas Müller[2], •Max Neukum[2] und Daniela Schäfer[2] — [1]Institut für Experimentalphysik, Universität Hamburg — [2]Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Intstitut für Technologie (KIT)

Vektor-Boson-Streuung ist einerseits der am LHC dominierende Prozess, den Vierervertex elektroschwacher Eichbosonen zu untersuchen, und andererseits würde ohne das Higgs-Boson die Streuamplitude für hohe Energien unphysikalisch groß werden. Damit eignet er sich besonders gut dazu, den elektroschwachen Sektor des Standardmodells zu untersuchen.

Abweichungen der Kopplungen im Vierervertex bei hohen Energien werden im Rahmen einer effektiven Feldtheorie formuliert, einem Bottom-Up-Ansatz, der eine Vielzahl expliziter Theorien parametrisiert. Ausschlussgrenzen auf dadurch neu eingeführte Parameter ermöglichen Rückschlüsse auf die Stärke und Energieskala der im Standardmodell nicht beschriebenen Effekte.

Dieser Vortrag beschreibt die Suche nach anomalen Kopplungen im hadronischen Zerfallskanal der Vektor-Boson-Streuung bei einer Schwerpunktsenergie von 13 TeV. Zur Abgrenzung von QCD Ereignissen, werden Jets anhand ihrer Substruktur untersucht.

T 42: Experimental methods II

Time: Tuesday 17:00–18:15 Location: L-4.001

T 42.1 Tue 17:00 L-4.001

Quark gluon tagging in dijet searches using only calorimeter-based event information with the ATLAS experiment — •Lisa Marie Baltes — Kirchhoff-Institute for Physics, University Heidelberg

The analysis of dijet events can give us important information about new possible models beyond the Standard Model such as dark matter. In some models the massive mediator can be observed as an excess in the invariant mass spectrum of the decay product. However, dijet searches at masses below 1 TeV are statistically limited by the bandwidth and storage limitations of the detector. The trigger-object-level analysis (TLA) allows the search for low-mass resonances down to an invariant mass of 450 GeV by recording and analysing only a part of the full event information. In our signal model, the massive mediator decays into two quarks, while the QCD background is dominated by gluon-gluon and quark-gluon final states. Therefore, tagging the flavour of the two final state jets can suppress the background compared to the signal. TLA only uses information about the online reconstructed jets and some jet structure variables based on calorimeter information and therefore no tracking information is available. In this talk, the results from different neural networks are discussed, including ROC curves and background rejection efficiencies.

T 42.2 Tue 17:15 L-4.001

Charm jet identification and discriminator calibration with the CMS experiment — •Spandan Mondal[1], Xavier Coubez[1,2], Luca Mastrolorenzo[1], Andrzej Novak[1], Andrey Pozdnyakov[1], and Alexander Schmidt[1] — [1]Physikalisches Institut III A, RWTH Aachen University — [2]Brown University

Identification of charm-quark-initiated jets at the LHC is especially challenging. Over the past few years, usage of advanced deep learning based algorithms has enabled several CMS analyses to efficiently discriminate charm jets simultaneously from bottom and light jets. The charm probability scores yielded by such charm tagging algorithms can play a powerful role when used as inputs to a machine learning based signal-background discriminating algorithm. However, as jet identification algorithms are trained strictly on simulated jets, a direct usage of charm tagger output values requires calibrating the entire output probability distributions using real jets reconstructed from CMS data. This talk focuses on charm jet identification algorithms in CMS as well as the calibration of their output discriminator values using flavour-enriched selections of jets in data.

T 42.3 Tue 17:30 L-4.001

***b*-tagging efficiency calibration for Variable-R track jets** — •Janik von Ahnen for the ATLAS-Collaboration — DESY, Hamburg, Germany

Many analyses rely on b-tagging algorithms to identify jets containing b-hadrons which are often a distinct feature of interesting processes at the LHC. The b-tagging algorithms are trained using simulation and are calibrated with data-to-simulation scale factors to account for differences coming from mismodeling in the simulation. The method of calculating the data-to-simulation scale factors for anti-k_t Variable-R track jets and the data set collected by ATLAS at $\sqrt{s}$=13 TeV in the years 2015, 2016, 2017 and 2018 ($\mathcal{L}_{int}$ =140 fb^{-1}) is presented. A sample enriched in di-leptonic $t\bar{t}$ and a likelihood-based fitting method are used to extract the b-tagging efficiency in data. In the fit, control regions constructed with variables, which are not related to b-tagging, are implemented to allow for the simultaneous fit of b-tagging efficiency and flavour composition.

T 42.4 Tue 17:45 L-4.001

Multijet Background Estimation with the *Rebalance and Smear* Method — Arthur Linss[1], Xuanhong Lou[1], •Jonas Neundorf[1], Krisztian Peters[1], Matthias Saimpert[2], and Christian Sander[1] — [1]DESY — [2]CERN

In analyses without leptons in the final state, the *multijet* background can become relevant. For this talk, the implementation of the data-driven *Rebalance and Smear* method for multijet background estimation was modified in order to make it usable for different analyses. It is then applied to searches for new physics in the $t\bar{t} + E_{\mathrm{T}}^{\mathrm{miss}}$ channel. The data-driven estimate is shown to agree with the expectation from Monte Carlo simulations and, combined with the Monte Carlo expecations of other background processes, the data yield in the validation regions.

T 42.5 Tue 18:00 L-4.001

Estimation of the multi-jet background using the Rebalance and Smear technique for a dark matter search in ATLAS — •Arthur Linss and Christian Sander for the ATLAS-Collaboration — DESY, Hamburg, Germany

This talk presents an overview of the methodology, advantages and challenges of the Rebalance and Smear (RnS) technique. RnS can be used for the estimation of the multi-jet background for searches for new physics in final states with jets and missing transverse energy. In RnS, unbiased pseudo-data is produced by rebalancing selected events in transverse momentum. After that, to account for jet mismeasurements, a jet smearing is performed. Currently, this method is used or is in the process of implementation for two dark matter searches: 2 jets (VBF) + MET and ttbar + MET, while the focus of this talk is on the former.

T 43: Poster session Particle Physics

Time: Tuesday 17:00–18:30 Location: Grotte

T 43.1 Tue 17:00 Grotte

Quantum Mechanic Analysis of Masses in their Own Gravitational Field: A Model for an Elementary particle? — Hans-Otto Carmesin[1,2,3] and •Maximilian Carmesin[4] — [1]Gymnasium Athenaeum, Harsefelder Straße 40, 21680 Stade — [2]Studienseminar Stade, Bahnhofstr. 5, 21682 Stade — [3]Universität Bremen, Fachbereich 1, Postfach 330440, 28334 Bremen — [4]Arndt Gymnasium, Lindenstraße 52, 47798 Krefeld

The position of masses can be measured and is based on laws describing fundamental interactions among mater. For objects at a very high density, the gravitational force is the most important for describing its interactions. As a result from the Heisenberg uncertainty principle, measurements of complementary properties cannot be exact, examples are position and momentum. Accordingly, such objects have to be investigated in terms of a mass distribution. This is an essential difference to classical mechanics, viewing objects as masses concentrated at a single point. Such a model is not exact, but sufficient in many fields of physics, except quantum physics. This project numerically simulates the gravitational potential of a particle in a 3-dimensional space. Thereby, a mass distribution instead of a concentrated mass is modeled. For this purpose, a computer simulation has been developed. As a result, properties of the gravitational potential and of the wave function of a particle have been examined.

T 43.2 Tue 17:00 Grotte

Measurement of the total cross-section of single top-quark and top-antiquark t-channel production in pp collisions at $\sqrt{s}$ = 13 TeV — Olga Bessidskaia Bylund, Dominic Hirschbuehl, Joshua Aaron Reidelsturz, •Mohsen Reazei Estabragh, and Wolfgang Wagner for the ATLAS-Collaboration — Bergische Universität Wuppertal, Wuppertal, Germany

In leading-order perturbation theory, single top-quark production is described by three sub-processes that are distinguished by the virtuality of the exchanged W boson. In this analysis, t-channel which is the dominant process is the subject of the measurements, using the lepton+jets channel.

Studying the cross-section ratio of top to antitop (R_t) could be helpful for testing different PDF sets from various groups. Calculation of R_t for the newest PDF sets has carried out in the 5-flavour scheme at NLO using the Hathor program. As many systematic uncertainties on R_t are canceled out, we focus on the impact of PDF, α_s and scale uncertainty.

Predictions for the signal process is being compared using different generators, such as POWHEG and aMC@NLO in addition to new predictions from SHERPA and MINLO.

To reduce uncertainty on the jet energy scale (JES), flavour composition and its uncertainty for the signal sample has studied.

T 43.3 Tue 17:00 Grotte

Charakterisierung von unbestrahlten und bestrahlten Silizium-Streifensensoren anhand von Langzeitmessungen — •Jonas Lönker, Andreas Gisen, Kevin Kröninger und Jens Weingarten — TU Dortmund, Experimentelle Physik IV

Für den Einsatz als Spurdetektoren in Experimenten der Hochenergiephysik ist es notwendig, dass Silizium-Sensoren über lange Zeitintervalle zuverlässig betrieben werden können. Zu den Anforderungen zählen unter anderem eine zeitlich stabile Ladungssammlung (Charge Collection Efficiency, CCE) und eine hohe Toleranz gegen Strahlenschäden.

In Labormessungen werden Silizium-Streifensensoren mit einer Fläche von ca. $1\,\mathrm{cm}^2$ anhand von Langzeitmessungen der Interstrip-Kapazität und der CCE während Quellenmessungen mit Sr-90 charakterisiert. Verglichen werden die Ergebnisse von bestrahlten und unbestrahlten Sensoren mit variierenden Designs hinsichtlich Dicke, Pitch, Implantbreite sowie des Bulkmaterials.

T 43.4 Tue 17:00 Grotte

Characterization and quality control methods of petal cores for the ATLAS ITk strip detector end-caps — •Jan-Hendrik Arling — Deutsches Elektronen-Synchrotron DESY, ATLAS group, Hamburg — TU Dortmund, Lehrstuhl für Experimentelle Physik IV, Dortmund

For the high-luminosity LHC, ATLAS will replace its tracking detector by a new, all-silicon tracker, called Inner Tracker (ITk). This is necessary due to the challenging environments in terms of a factor ten higher radiation levels as well as a higher number of proton-proton interactions per bunch crossing (called pile-up). The forward regions of the detector will host the end-caps, structures with disks populated with so-called petals. On the one hand, a petal consists of a core, made of a carbon fiber-based sandwich structure with embedded titanium cooling pipes as well as data and power buses on the surfaces. On the other hand, the silicon modules, assembled out of micro-strip sensors together with readout and power electronics, are directly glued on the core surfaces. The focus of this poster is on the petal core and its requirements in terms of mechanical and thermal properties (e.g. surface flatness and thermal conductance). During production it is necessary to control the quality by dedicated test measurements, but also before in the design phase an extensive verification process took place. The results of the test measurements (e.g. measurement of thermal deformation and cycling) on the recent produced prototype structures shows the ITk requirements fulfilled. The implementation of the tests in the production phase for quality control will be the next step.

T 43.5 Tue 17:00 Grotte

Investigations of systematics on the energy loss measurement of electrons in the KATRIN source — •Lutz Schimpf and Christophe Schwachtgen — ETP, Karlsruhe Institute of Technology (KIT)

The **Ka**rlsruhe **Tri**tium **N**eutrino experiment (KATRIN) is targeted to measure $m(\nu_e)$ with a sensitivity of 200 meV at 90 % confidence level. To determine the neutrino mass, an integrated beta-decay spectrum close to the endpoint is measured and a fit to the data comprising the neutrino mass as a free parameter is performed. A number of systematic effects on the measured spectrum need to be taken into account in the analysis. One of these is the energy loss from inelastic scatterings of beta-electrons with the source gas. A very precise measurement and reliable uncertainty estimate are required for fitting the

beta-decay spectrum. This is achieved by measuring the energy loss of quasi-monoenergetic electrons at 18.6 keV traversing the gaseous Tritium source in both an integral and a differential way. To assess the systematic error budget of the measured energy loss function, the uncertainties arising from various parameters, such as source pressure, rate stability, and background need to be investigated by Monte Carlo error propagation. This contribution presents the resulting error estimate and discusses its impact on the neutrino-mass sensitivity. This work is supported by the Helmholtz Association (HGF), the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), KSETA, and the Helmholtz Young Investigator Group (VH-NG-1055).

T 43.6 Tue 17:00 Grotte

Calibration Measurements with ^{83m}Kr Conversion Electrons at KATRIN — •Matthias Böttcher for the KATRIN-Collaboration — Institut für Kernphysik, WWU Münster

The Karlsruher Tritium Neutrino Experiment (KATRIN) aims at measuring the effective electron neutrino mass with the unprecedented sensitivity of 0.2 eV by measuring the energy spectrum of tritium β-decay electrons. The non-zero neutrino mass established in oscillation experiments introduces a change of the shape of the electron spectrum near the endpoint energy. The first neutrino mass result published recently by the KATRIN experiment gives a new upper limit of 1.1 eV (90 % C.L.). To improve on this limit, a detailed analysis of systematic effects in the tritium source and the main spectrometer is required. One of the tools to assess systematic uncertainties in KATRIN is the use of Krypton-83m as a calibration source, which provides monoenergetic conversion electrons. Gaseous ^{83m}Kr can be injected into KATRIN's windowless gaseous tritium source (WGTS) and can be used, among others, to study the effect of inhomogeneities in the tritium plasma. We describe in this poster the use of ^{83m}Kr for investigating WGTS and spectrometer properties and their influence on systematic uncertainties in the neutrino mass measurements.

This work is supported by BMBF under contract number 05A17PM3.

T 43.7 Tue 17:00 Grotte

Performance of fitting methods for the KATRIN neutrino mass analysis — •Wonqook Choi and Stephanie Hickford for the KATRIN-Collaboration — Institute for Experimental Particle Physics, Karlsruhe Institute of Technology

The KATRIN collaboration aims to determine the neutrino mass with a sensitivity of 0.2 eV/c^2 (90 % CL). This will be achieved by measuring the endpoint region of the tritium β-electron spectrum. The spectrum is fit to obtain several parameters of interest, including the squared neutrino mass and the effective tritium endpoint.

The fit can be done by combining individual tritium spectral scans and averaging slow control parameters, event count rates, and live time of the KATRIN detector pixels. The data combination impacts the balance between computing complexity and the fit result precision. Sophisticated and computationally expensive methods of combining data can be done without averaging of slow control parameters or over detector pixels.

The data combination and fitting methods are compared by investigating the neutrino mass and endpoint results on Monte Carlo datasets using the KaFit package. The performance of the fit methods in terms of computing time and memory will also be presented.

This work is supported by the Helmholtz Association (HGF), the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), and the Helmholtz Young Investigator Group (VH-NG-1055).

T 43.8 Tue 17:00 Grotte

Comparison of column density simulation and measurement in KATRINs windowless gaseous tritium source — •Paul Filip and Fabian Block — Institute of Experimental Particle Physics, Karlsruhe Institute of Technology

The KArlsruhe TRItium Neutrino (KATRIN) experiment aims to measure the effective rest mass of the electron anti-neutrino with a sensitivity of 0.2 $\frac{\mathrm{eV}}{c^2}$ (90 % C.L.). For this purpose, KATRIN utilizes a model-independent approach that relies on a high-accuracy investigation of the endpoint region of the tritium β-decay spectrum.

A key component of KATRIN is the high-luminosity Windowless Gaseous Tritium Source (WGTS) that contains molecular tritium gas. Though the amount of tritium in the WGTS can be controlled precisely, the uncertainty on the absolute calibration of the column density is a dominant systematic factor that impacts the accuracy on the measured neutrino mass.

The comparison between simulated and measured column density during KATRINs second neutrino mass measurement campaign is described in this poster. An improved understanding of gas dynamics inside the WGTS is achieved, which allows for more accurate column density calibrations in future neutrino mass measurement campaigns.

This work is supported by the Helmholtz Association (HGF), the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), and the Helmholtz Young Investigator Group (VH-NG-1055).

T 43.9 Tue 17:00 Grotte

Column density determination in KATRIN's first neutrino mass measurement — •Fabian Block[1], Christoph Köhler[2], and Alexander Marsteller[1] — [1]Karlsruhe Institute of Technology — [2]Technical University of Munich/Max Planck Institute for Physics

The KATRIN experiment aims to probe model-independently the effective electron anti-neutrino mass with a sensitivity of 0.2 eV (90% C.L.) by investigating the endpoint region of the tritium beta decay spectrum. The experimental setup of KATRIN consists of a high-luminosity Windowless Gaseous Tritium Source (WGTS), from which the beta-electrons are magnetically guided to the spectrometer and detector section, which measures the integrated beta decay spectrum.

The neutrino mass analysis requires exact knowledge of the WGTS column density, which is a measure of the gas amount inside the WGTS. The principle of column density measurements and achievements for the precise monitoring of the column density with several monitoring devices during the first neutrino-mass measurement campaign is described. The influence of the column density uncertainty on the neutrino mass is then discussed in light of KATRIN's world-leading direct upper limit on the effective electron anti-neutrino mass.

This work is supported by the Helmholtz Association (HGF), the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), the GRK 1694, and the Helmholtz Young Investigator Group (VH-NG-1055).

T 43.10 Tue 17:00 Grotte

The Radon-induced background in the KATRIN main spectrometer — •Rebekka Kirchgässner for the KATRIN-Collaboration — Karlsruhe Institute of Technology

The Karlsruhe Tritium Neutrino (KATRIN) experiment measures the integral tritium β spectrum with the aim to determine the effective mass of the electron anti neutrino in a model-independent way. To achieve the design sensitivity on the neutrino mass of $m_\nu = 0.2\,\mathrm{eV/c^2}$ (90% C.L.), the study of systematic effects arising from background processes is important.

The background at KATRIN is presently dominated by secondary electrons originating from radioactive decays inside the KATRIN main spectrometer. This poster focuses on the radon-induced background events, their characteristics, and the underlying processes.

This work is supported by the Helmholtz Association (HGF), the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), and the Helmholtz Young Investigator Group (VH-NG-1055).

T 43.11 Tue 17:00 Grotte

Detector upgrade for sterile neutrino search at KATRIN — •Martin Descher for the KATRIN-Collaboration — Karlsruher Institut für Technologie

The KATRIN Experiment is a high precision β-decay experiment which aims to measure the effective electron neutrino mass with a sensitivity of 0.2 eV (90% confidence level). Additionally, the TRISTAN project of the KATRIN experiment aims to search for the signature of keV sterile neutrinos in the β-decay spectrum of tritium. For a three year measurement of the differential β-electron energy spectrum at an event rate of 10^8 counts per second (cps), a sensitivity for sterile mixing angles $\sin^2\theta < 10^{-6}$, within the accessible sterile neutrino mass range, is projected. For this measurement, a detector with improved energy resolution and high rate capabilities is necessary. The development of the envisioned 3500 pixel silicon drift detector, consisting of 21 separate modules, is roughly structured in three stages: Detec-

tor prototyping, first module development, and assembly of the full detector. Detectors from the first two development stages are being integrated into the KATRIN beamline for testing purposes while simultaneously serving as upgrades for existing components. A detector from the prototyping stage is already integrated as a radioactive source monitoring device (Forward Beam Monitor), and the first module is planned to replace the current detector of the monitor spectrometer in 2020. Meanwhile, the planning for the final detector assembly with regard to vacuum requirements, electromagnetic field design, and data acquisition is advancing.

T 43.12 Tue 17:00 Grotte

The Dark Matter confusion — •Albrecht Giese — Taxusweg 15, 22605 Hamburg

The Dark Matter problem is known since more than 90 years. As an explanation there are in principle two causes possible for the underlying observations, which means essentially the high rotation speed of certain galaxies.

1) The possible existence of undetected particles

2) An altered understanding of the mechanism of gravitational attraction.

The search for new particles is going on with a lot of effort since long time. But not the faintest indication of such particles was seen. The other way however, a fundamentally reworked theory of gravitation, is missing. Gravity is still seen to be based on the mass (and energy) of gravitating objects; the original approach of Isaac Newton was never questioned but is causing general logical problems in the view of present physics.

As just one example, the fact that the gravitational acceleration is independent of the accelerated mass is explained by an equivalence of inertial and gravitational mass. But this equivalence is not covered by the current Higgs theory of inertia.

We will show that an altered understanding of the role of mass in gravitation will yield a quantitatively working solution for the Dark Matter problem.

For further information: www.ag-physics.org/gravity

T 43.13 Tue 17:00 Grotte

A cryogenic heat pump for the radon removal system of XENONnT — •Philipp Schulte, Christian Huhmann, Michael Murra, Denny Schulte, and Christian Weinheimer for the XENON-Collaboration — Institut für Kernphysik, WWU Münster

In order to lower intrinsic radioactive contaminants in xenon a new radon removal system is being developed and built for the XENONnT Dark Matter detector. The high-flux radon removal system makes use of crygenic distillation based on the difference in vapor pressure between radon and xenon. In order to have a thermodynamically efficient system, a custom-made heat exchanger will be used with xenon as the working gas. As liquefaction of xenon is envisioned, a cryogenic heat pump with high throughput is needed. This is realized as a radon-free, ultra-clean compressor with the absence of oil-based lubrication.

This poster will show the basic concept of the XENONnT radon removal system focussing on the heat pump concept.

The project is funded by BMBF under contract 05A17PM2.

T 43.14 Tue 17:00 Grotte

A new Detector for Beta Spectroscopy with PERKEO III — •Karina Bernert, Matthias Antony, Max Lamparth, Martin Losekamm, Christoph Roick, Heiko Saul, and Bastian Märkisch — Physik Department, Technische Universität München, 85748 Garching b. München, Germany

Neutron beta decay provides an excellent toolkit for the investigation of the structure of the weak interaction and potential deviations from the predictions of the Standard Model of particle physics. Several times, the spectrometer PERKEO III has been used to perform measurements of neutron decay observables at the PF1B beamline at the Institut Laue-Langevin, Grenoble, most recently to measure the Fierz interference b. This term, which is zero within the Standard Model, offers a direct probe for scalar and tensor interactions. To reach the precision required for an improved limit, we developed a new Scintillation detector, which has nearly double the light output of that of previous detectors. The gain of the Photomultiplier tubes is monitored with light pulses from a Kapustinsky flasher, whose intensity is controlled with a Silicon Photomultiplier.

T 43.15 Tue 17:00 Grotte

Exploration of cosmic rays using stratospheric balloons with students — •Jonas Zumkeller[1], Patrick Pohland[1], Marc Hansen[1], Friederike Schattke[1], Lisa Romaneehsen[1], Stephan Böttcher[1], Matti Heise[2], Bernd Heber[1], and Robert Wimmer-Schweingruber[1] — [1]Christian-Albrechts-Universität zu Kiel, Institut für Experimentelle und Angewandte Physik, Abteilung Extraterrestrische Physik, Deutschland — [2]Ricarda-Huch-Schule Kiel, Deutschland

The Earth is continuously exposed to high energy charged particles from galactic cosmic rays. Due to galactic cosmic rays interacting with atmospheric particles, secondary neutrons are generated. The main objective of the Thermal Atmospheric Neutron Observation System (TANOS) is to measure the flux of thermal neutrons in the stratosphere. To characterize the height dependency of the radiation field, TANOS also measures the flux of charged particles. In order to validate the principle of measurement a prototype - TANOS Junior - was built. TANOS Junior was flown twice on a weather balloon from Kiel. A collaboration between the Ricarda-Huch Schule Kiel and the Department of Extraterrestrial Physics of the University of Kiel allowed several senior pupils to participate in the project. With the experience gained, it was even possible to initiate a school project to which also younger students could contribute. The primary goal of this launch was to measure housekeeping data like pressure, temperature, humidity and particulate matter.

T 44: Eingeladene Vorträge (Invited Topical Talks) I

Time: Wednesday 14:00–16:00 Location: H-Aula

Invited Topical Talk T 44.1 Wed 14:00 H-Aula

Cosmic Particles at Extreme Energies — •Michael Unger — KIT, Karlsruhe, Germany

Cosmic rays are the highest energy messengers of astrophysical phenomena in the Universe. The sources of these particles are unknown and it is one of the great puzzles of modern astrophysics how they are accelerated to macroscopic energies of >10^20 eV. In this talk I will highlight recent experimental results on ultrahigh-energy cosmic rays and discuss their implications on our understanding of the physics and astrophysics at extreme energies.

Invited Topical Talk T 44.2 Wed 14:30 H-Aula

IceCube Upgrade - The next level in precision neutrino physics at the South Pole — •Lew Classen for the IceCube-Collaboration — Institut für Kernphysik, WWU Münster, Münster, Germany

Following the discovery of cosmic high energy neutrinos, a competitive measurement of neutrino oscillation parameters and a strong indiction for the first neutrino point source, plans for extensions of the IceCube neutrino telescope have matured. IceCube Upgrade, a next-generation low-energy neutrino detector, will be installed in the 2022/23 Antarctic summer season and consist of about 700 novel optical sensors as well as state-of-the-art calibration devices distributed along seven strings located in the central region of the existing array. This upgrade will significantly enhance IceCube's capabilities to measure oscillation parameters. In particular, it will allow for measuring tau neutrino appearance in the atmospheric neutrino flux to unprecedented precision. Providing a test for the unitarity of the neutrino mixing matrix, this result will be a sensitive probe for physics beyond the standard model. The enhanced understanding of the detection medium and sensor response will also reduce IceCube's systematic uncertainties, allowing to revisit more than ten years of archival data with an improved directional and spatial resolution. In addition to its compelling science case, IceCube Upgrade will also pave the path towards IceCube-Gen2, the upcoming next-generation high-energy neutrino telescope at the

South Pole. The presentation will address the R&D activities towards the Upgrade as well as the resulting physics potential.

Invited Topical Talk T 44.3 Wed 15:00 H-Aula
Exploring coherent neutrino-nucleus scattering with the NUCLEUS experiment — •Raimund Strauss — Technische Universität München

The detection of coherent-neutrino nucleus scattering (CEvNS) opens a new window to study the fundamental properties of neutrinos and to probe physics beyond the Standard Model of Particle Physics. NUCLEUS is a novel cryogenic neutrino experiment at a nuclear power reactor which allows for precision measurements of CEvNS at unprecedentedly low energies. It is based on recently demonstrated ultra-low threshold cryogenic detectors with nuclear-recoil energy thresholds in the 10eV regime. Accessing these energies enables to fully exploit the strongly enhanced cross section of CEvNS which leads to a miniaturization of neutrino detectors. NUCLEUS is fully funded and will be installed at a new experimental site in between the two 4GW reactor cores of the CHOOZ nuclear power plant in France. In this talk I will present recent results from a prototype detector and discuss the experimental strategy as well as the extensive physics program of NUCLEUS.

Invited Topical Talk T 44.4 Wed 15:30 H-Aula
Can beam-dump experiments uncover the hidden sector? — •Markus Cristinziani — Physikalisches Institut, Nussallee 12, Universität Bonn

More than ten years after the first collisions no clear sign for new physics beyond the Standard Model has been revealed at the LHC. However, there are convincing astrophysical and cosmological arguments for the existence of an additional hidden sector, possibly not yet found in laboratory experiments because of their feeble interaction. A promising class of future experiments to probe new particles in the MeV–GeV range are those at beam dumps, characterized by high-intensity beams and long decay lengths, using either protons (such as SHiP at the CERN BDF, NA62 in beam-dump mode and MiniBooNE-DM) or electrons (such as NA64 and BDX). In this talk I will discuss the features, the physics reach and the current status of the planned beam-dump facilities and proposed experiments.

T 45: Eingeladene Vorträge (Invited Topical Talks) II

Time: Wednesday 14:00–16:00 Location: H-HS X

Invited Topical Talk T 45.1 Wed 14:00 H-HS X
A large Scintillating Fibre Tracker for the LHCb Upgrade — •Xiaoxue Han — Physikalisches Institut, Universität Heidelberg,Germany

The LHCb detector at the Large Hadron Collider (LHC) is undergoing a major upgrade during the long shutdown 2019/2020 in order to collect data at an instantaneous luminosity of up to 2*1033 cm-2s-1. The higher detector occupancy and higher radiation level require the replacement of the current downstream tracking stations by a Scintillating Fibre (SciFi) Tracker. The SciFi Tracker comprises plastic scintillating fibres, read out by state-of-the-art multi-channel Silicon Photomultiplier (SiPM) arrays. The detector design,studies of the radiation hardness of scintillating fibres and the SiPM arrays, the customized PACIFIC ASIC, the front-end electronics, the testbeam performance of the detector slice and the current detector assembly and commissioning status are described.

Invited Topical Talk T 45.2 Wed 14:30 H-HS X
The CMS pixel detector: ready for the future? — •Jory Sonneveld — Universität Hamburg, Hamburg, Germany

A new pixel detector has been installed in the heart of the Compact Muon Solenoid (CMS) early 2017 to meet the challenges of the high-pileup and high-luminosity environment from proton-proton collisions at the Large Hadron Collider (LHC). Despite many challenges, the pixel detector's performance was excellent. The innermost pixel layer, which has withstood radiation levels of 8e14 neq/cm2, is currently being replaced for the coming years of data taking.

For the future high luminosity LHC (HL-LHC), CMS will undergo a major upgrade to be able to fully exploit the increased luminosity and the entire tracker will be replaced. At the HL-LHC, the inner tracker will see hit rates up to 3.2 GHz/ cm2 and unprecedented levels of radiation up to 1.2 Grad and 2e16 neq/cm2. This is more than 20 times the fluence seen by the current CMS pixel detector up until today.

This presentation will discuss experience and lessons learned in operating the CMS phase 1 pixel detector, as well as new developments and test beam results from R&D for the phase 2 upgrade of the CMS pixel detector.

Invited Topical Talk T 45.3 Wed 15:00 H-HS X
Full event interpretation at Belle II — •William Sutcliffe for the Belle II-Collaboration — University of Bonn, Bonn, Germany

The Belle II experiment is an e^+e^- collider experiment in Japan, which was designed to record a large number of e^+e^- collisions producing $\Upsilon(4S) \to B\bar{B}$ decays. A wide range of precision tests of the Standard Model and searches for new physics can be performed by studying the subsequent decays of the B mesons. In many cases, these decays will involve missing energy due to weakly interacting particles such as neutrinos, which escape the detector without interacting. Given the challenging nature of reconstructing decays with missing energy an essential technique, known as tag-side reconstruction, is employed in which one B meson is reconstructed in a large number of specific decay modes. This subsequently allows the kinematics and potentially the flavour of the remaining B meson to be constrained. In this talk, first results, which quantify the performance of the Belle II hadronic tag-side reconstruction algorithm, Full Event Interpretation (FEI), are presented using 5.15 fb^{-1} of early Belle II data. Ultimately the FEI will be an integral part of the physics program of Belle II allowing the measurement of several challenging final states such as $b \to s\nu\bar{\nu}$ decays.

Invited Topical Talk T 45.4 Wed 15:30 H-HS X
The Physics Potential of CLIC — •Ulrike Schnoor for the CLICdp-Collaboration — CERN, Geneva, Switzerland

The Compact Linear Collider (CLIC) is a mature option for a future electron-positron collider operating at centre-of-mass energies of up to 3 TeV. The accelerator uses a two-beam acceleration scheme, in which normal-conducting high-gradient accelerating structures are powered via a high-current drive beam. CLIC will be built and operated in a staged approach with three centre-of-mass energy stages currently assumed to be 380 GeV, 1.5 TeV, and 3 TeV. The detector concept matches the physics performance requirements and the CLIC experimental conditions. The initial energy stage of CLIC will focus on precision measurements of Higgs-boson and top-quark properties. The subsequent energy stages enhance the reach of many searches for Beyond Standard Model physics and give access to the Higgs self-coupling with a precision of around 10 %. A selection of results from recent studies will be presented showing that CLIC has excellent sensitivity to many BSM physics scenarios, both through direct observation and precision measurements of SM processes. New particles can be discovered in a model-independent way almost up to the kinematic limit. Compared with hadron colliders, the low background conditions at CLIC provide extended discovery potential, also for non-standard signatures such as charged long-lived particles. In addition to studying new particles directly, BSM models can be probed up to scales of tens of TeV through precision measurements.

T 46: Detector systems III

Time: Wednesday 16:30–18:50 Location: H-HS II

Group Report T 46.1 Wed 16:30 H-HS II

Implementation of a Background Tagger used in SHiP (search of hidden particles) experiments — •Jan Zimmermann — Humboldt Universität Berlin

SHiP is a proposed beam dump experiment at CERN to search for very weakly interacting new particles with a mass between 0.1GeV - 10GeV. Hadrons from proton-proton collisions are absorbed and muons redirected through a magnet system. This leaves only neutrinos and other neutral particles to decay in the 50m long decay volume. This decay volume will be surrounded by scintillating liquid (Surrounding Background Tagger = SBT) to reduce background. The scintillation photons will be detected using wavelength-shifting optical modules coupled to an array of silicon photomultipliers.

This talk will analyse and discuss the detector-response of a new and improved liquid-scintillator detector, tested at the DESY II accelerator in 2019, and compare the results to previous measurements performed in 2018 with an improved fixation and covering setup.

A general introduction to the SBT will be given in a dedicated presentation by P. Deucher.

T 46.2 Wed 16:50 H-HS II

Tracking detector for the P2 experiment — •Carsten Grzesik for the P2-Collaboration — Institut für Kernphysik, Mainz

The upcoming P2 experiment at the Institute for Nuclear Physics in Mainz aims to measure the parity violating asymmetry in elastic electron-proton scattering to determine the weak mixing angle. It will be performed at low momentum transfer Q^2 and with high precision enabled by the new Mainz Energy Recovering Superconducting Accelerator (MESA).

For the measurement of the average Q^2 a tracking detector utilizing High Voltage Monolithic Active Pixel Sensors (HV-MAPS) is installed, while the asymmetry measurement is conducted by integrating Cherenkov detectors. The high particle rate needed to reach the envisaged precision and large area at a low material budget pose challenges to the design of the tracking detector.

In this talk the current design for the tracking layers and testbeam results of HV-MAPS prototypes are presented. It focuses on high rate capabilities of the pixel sensors, the cooling and mechanical setup, as well as the data acquisition system for the P2 tracking detector.

T 46.3 Wed 17:05 H-HS II

A multi-pixel camera for fast neutron radiography — Christoph Günther, •Nina Höflich, and Oliver Pooth — III. Physikalisches Institut B, RWTH Aachen University

The neutron radiography group at the Physics Institute III B, RWTH Aachen University, develops a multi-pixel camera for fast neutron radiography. Fast neutron radiography has the aim to resolve structures in heterogeneous test objects that cannot be well investigated by common gamma or X-ray radiography.

An Americium-Beryllium radioactive source or a neutron generator can be used as a mobile neutron source. For neutron detection, the organic scintillator Stilbene is used, which allows for neutron-gamma signal discrimination on an event-by-event basis.

So far, two prototypes were built: a single-pixel detector and a 16-pixel camera with a scintillator pixel volume of $5 \times 5 \times 25\,\mathrm{mm}^3$. The scintillators are coupled to SiPMs for scintillation light detection. To optimize the detector setup and to study applications, a Geant4 simulation of the whole measurement setup is under development.

The talk will focus on recent results with the 16-pixel camera and simulation results concerning possible detector improvements.

T 46.4 Wed 17:20 H-HS II

Use of poly(ethylene naphthalate) as a self-vetoing structural material for low-background experiments — •Felix Fischer — Max-Planck-Institut für Physik

Poly(ethylene naphthalate), PEN, is a widely used industrial polyester which intrinsically scintillates in the blue wavelength region. This, combined with measurements of a high intrinsic radiopurity, has sparked interest in the material for use in low-background experiments. The entire process from commercially available granulate to an active support-structure for the next generation $0\nu\beta\beta$-search experiment LEGEND is presented. In addition, new measurements on radiopurity are presented as well as first characterisation studies important for the performance in a low-background experiment.

T 46.5 Wed 17:35 H-HS II

Tracking of charged particles using an FE-I4B pixel telescope and moving emulsion films — •Nikolaus Owtscharenko[1], Vadim Kostyukhin[1,2], Matei Climescu[1,3], Fabian Hügging[1], Jens Janssen[1], David-Leon Pohl[1], and Markus Cristinziani[1] — [1]Physikalisches Institut, Universität Bonn — [2]now at Departement of Physics and Astronomy, University of Sheffield — [3]now at Institut für Physik, Universität Mainz

The SHiP collaboration plans a general purpose fixed-target experiment to search for hidden particles at a new beam-dump facility at the CERN SPS.
To estimate the total charm cross-section in the final experiment, which includes hadronic cascade production, a dedicated measurement was performed in summer of 2018. $15 \cdot 10^5$ Protons at 400 GeV from the SPS interact with a thick multilayer target, interleaved with tracking emulsion films.
A 6 plane telescope made of ATLAS IBL double-chip modules was positioned behind this target and complements the high spatial resolution of emulsion with a high timing resolution.
Telescope efficiency, comparison of results to simulation and reconstruction of first events are presented.

T 46.6 Wed 17:50 H-HS II

Designing a quality assurance setup for the production of PEN scintillator tiles — •Isabelle Schilling, Jens Weingarten, and Kevin Kröninger — TU Dortmund, Lehrstuhl für Experimentelle Physik IV, 44227 Dortmund

The commercially available plastic polyethylene naphthalate (PEN) is interesting for applications in a wide variety of fields of physics due to its emission of easily detectable blue scintillation light without the use of wavelength shifters and its high mechanical stability. The production of PEN samples based on injection molding at the TU Dortmund enables the individual manufacture of different sample sizes and shapes, depending on the requirements on the scintillator.
Besides, the produced PEN samples have comparable stability to copper, which pulls them in the focus of interest for experiments like LEGEND. The tiles could be a part of the detector holder that could simultaneously act as an active signal background veto. To validate the production of scintillator tiles by the injection molding process, the scintillation properties of the produced PEN tiles must be investigated. The use of the tiles as a radiation detector can be validated in various measurements. Based on these measurement results, a quality assurance system for monitoring the production is developed and will be presented in this report.

T 46.7 Wed 18:05 H-HS II

Tests for the Demonstrator of the High-Granularity Timing Detector — Peter Bernhard[2], Andrea Brogna[2], Lucia Masetti[1], Marisol Robles[1], •Jens Söngen[1], and Quirin Weitzel[2] — [1]Johannes Gutenberg-Universität, Staudingerweg 7, 55128 Mainz — [2]PRISMA Detector Lab, Staudingerweg 9, 55128 Mainz

The high-luminosity upgrade of the LHC (HL-LHC) is foreseen to start operating in 2026 and will boost the sensitivity of the Standard Model measurements and searches for new particles substantially. However, the increased instantaneous luminosity of up to $7.5 \times 10^{34}\,\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$ also implies rising requirements to the ATLAS detector. In order to guarantee the correct assignment of particles from hard-scattering events, a silicon-based High-Granularity Timing Detector (HGTD) is planned to mitigate the effect of pile-up, in the endcaps. The next major R&D step is the building of a demonstrator, which serves two essential purposes. First, it offers the oppurtunity to study the performance of all detector components (e.g. sensors and electronics) under realistic conditions. Second, it tests the practicability of the production process and helps to optimize it. This talk presents the basic design of the HGTD demonstrator to test mechanical and thermal conditions as well the total detector capability. Furthermore, it reports on the validation of assembly and quality assurance procudures.

T 46.8 Wed 18:20 H-HS II

DIRC Options for SCTF — •Mustafa Schmidt[1], Michael Düren[1], Avetik Hayrapetyan[1], Alexander Yu. Barnyakov[2], and Sergey A. Kononov[2] — [1]II. Physikalisches Institut, Justus Liebig University Giessen — [2]Budker Institute of Nuclear Physics, Novosibirsk

The proposed future e^+e^- collider Super Charm Tau Factory (SCTF) in Novosibirsk is designed to address fundamental questions in the field of particle and hadron physics. In order to guarantee an excellent PID at SCTF, two different types of Cherenkov counters are proposed as one possible design option. Both types, the barrel and the endcap counters use the principle of detection of internally reflected Cherenkov light (DIRC). The main purpose of these DIRCs is to separate charged pions and muons in the momentum range between 0.2 and 1.5 GeV/c by covering the full solid angle.

Two endcap DIRCs are proposed to be installed in the forward and backward regions. They consist of a thin fused silica radiator plate each, of attached focusing optics and sensors for photon detection. The concept of these detectors is based on existing models that have already been developed for the PANDA experiment at FAIR.

This talk will cover the ongoing simulation studies to optimize the performance of these detectors with respect to the Cherenkov angle resolution and timing information and the related readout systems. According to the actual plan, silicon photomultipliers (SiPMs) with a high granularity are going to be used to measure single Cherenkov photons.

T 46.9 Wed 18:35 H-HS II

Decoding of SciFi detector raw data in the Allen GPU-based High Level Trigger for the LHCb Upgrade experiment — •Lars Funke and Holger Stevens — Experimentelle Physik 5, TU Dortmund

In the coming LHC run, the LHCb experiment will take data without a hardware trigger stage, increasing the input rate to the software-based High Level Trigger (HLT) by a factor of 30. Additionally, the number of *pp* interactions per bunch crossing will increase fivefold. Both of those facts pose a challenge to the HLT, as the projected throughput implies the need for a large amount of computing power.

The Allen project implements the first stage of the HLT on Graphics Processing Units (GPUs), which offer a considerable performance-per-price advantage over CPUs, if used with suitable algorithms. A significant time share of the trigger sequence is used by raw data decoding, as for some of the subdetectors, non-trivial transformations are necessary.

In this talk, the algorithms and challenges of the Scintillating Fibre Tracker (SciFi) raw data decoding are outlined.

T 47: Neural networks and systematic uncertainties

Time: Wednesday 16:30–19:00 Location: H-HS IV

T 47.1 Wed 16:30 H-HS IV

VISPA: Platform as a Service (PaaS) for Scientific Data Analysis — Max Beer, Friederike Butt, Niclas Eich, Martin Erdmann, Peter Fackeldey, Benjamin Fischer, •Katharina Hafner, Dennis Noll, Yannik Rath, Erwin Rudi, Alexander Temme, and Maximilian Vieweg — Physikalisches Institut 3A, RWTH Aachen University

The VISPA project delivers a cloud platform that enables scientific data analysis with the convenience of using a web browser. Our goal is to explore how scientific work with data might look like in the future. Through the VISPA web platform, each user is provided with a working environment consisting of pre-installed tools and software. The working environment can be largely customized and expanded according to the users preferences. To enable a jump start into the infrastructure, a large collection of examples, including classical data analysis and deep learning, can be tried out directly. Computing resources like disk space, processors and GPUs are either assigned to individual users or groups of users, such as research teams. As the emerging JupyterLab is an ideal choice for a comprehensive, browser-based, and extensible work environment, it is currently being integrated into the VISPA frontend. Beside the new frontend, users can now have individual access rights to experimental data (public data, experiment data), use Jupyter Notebooks and state-of-the-art visualization tools for data analysis.

T 47.2 Wed 16:45 H-HS IV

New methods for the application of neural networks in the presence of systematic uncertainties — Simon Jörger[1], Günter Quast[1], Roger Wolf[1], and •Stefan Wunsch[1,2] — [1]KIT — [2]CERN

In this talk, we introduce new methods for the application of neural networks in the presence of systematic uncertainties, common in HEP analysis. We discuss a new technique to identify those features of the multi-dimensional input space, which the response of the network is most sensitive to, as a crucial input to the discussion of the propagation of systematic uncertainties onto the neural network output and therefore the measurement. A second method is presented to penalize such propagations of systematic variations controlling the impact of systematic uncertainties on the measurement.

T 47.3 Wed 17:00 H-HS IV

Treating Uncertainties with Bayesian Neural Networks in a $t\bar{t}H$ Measurement — Ulrich Husemann, Philip Keicher, Matthias Schröder, and •Nikita Shadskiy — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

In the Standard Model, fermions couple to the Higgs boson via a Yukawa coupling with a strength proportional to their mass. The top quark is the heaviest known fermion and, therefore, has the strongest coupling to the Higgs boson.
One of the processes to investigate this coupling is the associated $t\bar{t}$+H production where the Higgs boson decays into a $b\bar{b}$ pair. This signal process has a much smaller cross section than the challenging background processes like $t\bar{t}$+jets production. Especially $t\bar{t}$+$b\bar{b}$ events are very signal-like. A common approach to separate this signal from the backgrounds is to use artificial neural networks.
Neural networks normally do not take into account uncertainties of the processes. Bayesian neural networks, however, use whole weight distributions instead of single weight values. In this talk it is investigated how this feature of Bayesian neural networks can be used to treat uncertainties in a $t\bar{t}H$ measurement.

T 47.4 Wed 17:15 H-HS IV

Reduction of systematic uncertainties with adversarial neural networks in scope of the $t\bar{t}H(b\bar{b})$ analysis at CMS — •Simon Ehnle, Ulrich Husemann, Philip Keicher, Matthias Schröder, and Sebastian Wieland — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

The production of top quark-antiquark pairs in association with the Higgs boson allows a direct measurement of the top-Higgs Yukawa coupling. To compensate the small cross section, the Higgs boson decay into a bottom quark-antiquark pair ($t\bar{t}H(b\bar{b})$), which has the largest branching ratio, is investigated. Multivariate analysis methods are used to separate signal from background.

A major background in this channel is the top quark-antiquark pair production in association with a bottom quark-antiquark pair. This process is hard to model and different simulation approaches with different uncertainties exist. The classifying neural networks have the potential to get robust against these differences by using adversarial neural networks, whereby two neural networks compete against each other in a zero-sum game.

In this presentation, the approach of reducing systematic uncertainties with adversarial neural networks is studied in scope of the $t\bar{t}H(b\bar{b})$ analysis in the semileptonic channel at CMS.

T 47.5 Wed 17:30 H-HS IV

Runtime optimisation of Adversarial Neural Networks in the tW dilepton channel using the ATLAS detector — •Nicolas Boeing, Ian C. Brock, and Christian Kirfel — Physikalisches Institut, Bonn, Deutschland

Neural networks have proven effective for signal to background separation in high energy physics. These classifier networks can be highly

sensitive to systematic uncertainties. A possible solution is the use of an adversarial neural network, a technique that pits two networks against each other. The first network has the classic task of separating signal and background, while a second adversarial network attempts to separate nominal from systematic samples, based on the output of the first network. By minimising the separation of the adversarial network, the classifier can be made more robust with respect to systematic uncertainties. This type of network structure has been shown to work for training on Monte Carlo simulated tW dilepton signal events and $t\bar{t}$ background events using the ATLAS detector, but a significant downside of training in this channel has been computation time. In this talk, we introduce methods to reduce training time using GPUs. Based on this improved performance, further improvements to the network are presented.

T 47.6 Wed 17:45 H-HS IV

Evaluation of performance gains in the training of neural networks for HEP analysis applications using GPUs — •Michael Holzbock, Günter Duckeck, and Klaus Dolag — Ludwig-Maximilians-Universität München

It has become more and more popular to tackle typical analysis task in high-energy physics (HEP) with approaches based on machine learning (ML) techniques. The training of such algorithms is computationally demanding but can be accelerated by the usage of GPUs, which architectures are better suited to perform the underlying calculations.

Studies are presented which evaluate the speed-up in case the training of ML algorithms is accelerated by GPUs. Several test cases are considered, that involve ML techniques commonly used in HEP data analysis such as deep and convolutional neural networks. To study whether benefits of GPUs depend on a network's layout, several of its hyperparameters such as the number of neurons were systematically varied. Finally, the results of these to some extend artificial test cases are compared with the acceleration observed for a neural network configuration used in a search for physics beyond the Standard Model.

T 47.7 Wed 18:00 H-HS IV

Use of Deep Learning techniques in the search for the Higgs boson decay to pair of charm quarks at CMS — Andrey Pozdnyakov[1], Xavier Coubez[1,2], Luca Mastrolorenzo[1], Spandal Mondal[1], Andrzej Novak[1], Alexander Schmidt[1], and •Guillermo Rocamora Pérez[1] — [1]RWTH Aachen, Germany — [2]Brown University, Providence, USA

With the increasing amount of data expected from the Large Hadron Collider, the Higgs boson coupling to second generation fermions is becoming accessible to the experiments. Already now machine learning techniques such as Deep Neural Networks (DNNs) are playing a crucial role in many physics analyses. This presentation shows how a DNN is used in improving the sensitivity of the search for the H->cc decay.

T 47.8 Wed 18:15 H-HS IV

Reinforcement learning for sorting jets in top pair associated Higgs boson production — •Dennis Noll, Martin Erdmann, and Benjamin Fischer — III. Physikalisches Institut A, RWTH Aachen University

For physics analyses with identical final state objects, e.g. jets, the correct sorting of input objects often leads to a sizeable performance increase.

We present a new approach in which a sorting network is placed in front of a classification network. The sorting network provides a two-dimensional likelihood that is used to guide the rearrangement of particle four-momenta.

Because the optimal order is generally not known, a reinforcement learning approach is chosen, in which the sorting network is trained with end-to-end feedback from the analysis. In this way, we enable the system to autonomously find an optimal solution to the sorting problem.

Using the example of top-quark pair associated Higgs boson production, we show an improvement of the signal and background separation in comparison to conventional sorting of jets with respect to their transverse momenta.

T 47.9 Wed 18:30 H-HS IV

Multivariate analysis methods in the analysis of single top-quark production in association with a heavy boson at ATLAS — •Christian Kirfel, Ian Brock, Richard Baumann, and Piet Nogga — Physikalisches Institut Bonn

Single top-quark production in association with a heavy boson gives rise to a multitude of interesting analyses including the production of a top quark and a Higgs boson. To separate the signal from background events, multivariate analysis methods are a common choice.

Previous analyses of a top quark associated with a Z boson featured a shallow neural network provided by the NeuroBayes package. Since the long-term support for this program is unclear, efforts are being made to create an algorithm using the open source software Keras to replace NeuroBayes.

A summary of approaches is presented, ranging from a performance comparison between the formerly used NeuroBayes algorithm and a deep neural network built in Keras, to the use of Lorentz-invariant variables. The different approaches are introduced and the results are discussed not only in the context of replacing the NeuroBayes network but also focusing on the general usability of the methods in particle physics analyses.

T 47.10 Wed 18:45 H-HS IV

Confronting EFT with artificial neural networks in the quest for physics beyond the Standard Model — Alexander Grohsjean and •Jonas Rübenach — DESY, Hamburg, Germany

As no sign of physics beyond the Standard Model has emerged at the Large Hadron Collider so far, high precision measurements of particle properties and couplings become increasingly interesting. A commonly used language to interpret these measurements is effective field theory, in which higher-dimensional operators are added to the Standard Model. Traditional approaches most commonly set constraints on anomalous couplings by employing and combining unfolded measurements.

This talk introduces novel neural-network driven analysis methods to be used in conjunction with effective field theory. The neural networks learn from truth information of Monte Carlo simulation in order to directly perform hypothesis testing on measured data. These new methods outperform traditional approaches by providing stronger constraints of at least a factor of 5.

T 48: Pixel detectors III

Time: Wednesday 16:30–18:30 Location: H-HS V

T 48.1 Wed 16:30 H-HS V

Optimization of the new Pixel Vertex Detector for Physics Running in the Belle II Experiment — •Markus Reif for the Belle II-Collaboration — Max Planck Institute for Physics

The Pixel Vertex Detector (PXD) is the innermost subdetector of the new Belle II detector at the asymmetric energy electron positron collider SuperKEKB in Tsubkuba, Japan. For Phase 3, 20 modules were installed, arranged cylindrically around the interaction point. Each module contains 192000 Depleted P-channel Field-Effect Transistor (DEPFET) pixels.

In Phase 3, which started in March 2019, for the first time physical data was taken with the 'full' detector.

To cope with inhomogeneities between pixels of PXD modules a dedicated software calculates a specific current that is added to each pixel to shrink the pedestal distribution. Since the modules suffer radiation damages in physics runs, these offsets have to be recalibrated frequently.

As a preparation step for the offset calibration, the pedestals of the modules have to be shifted to the lower region of the dynamic range, which is currently done by hand.

In this talk a newly developed software, which speeds up and simplifies this preparation step, is presented.

T 48.2 Wed 16:45 H-HS V

Powering studies for the Mu3e tracking detector — •Thomas Theodor Rudzki for the Mu3e-Collaboration — Physikalisches Institut, Universität Heidelberg

The tracking detector for the Mu3e experiment will use 50 μm thin high-voltage monolithic active pixel sensors (HV-MAPS). Facing the construction of first prototype modules the powering of the sensors was examined in detail. The active components for the power supply will be situated up to 1 m away from the sensors inside the 1 T magnetic field provided by a superconducting solenoid. Power is provided by DC-DC converters based on air coils. The converters provide power with an intrinsic ripple of a few 10 mV. The modules consist of sensors mounted on high-density interconnects without any additional filters.

It was tested if MuPix8 is tolerating this ripple in the digital and analog part. Therefore, the MuPix setup was stripped down to operate the sensor with as few as possible filters on the supply inputs. This talk will present lab as well as testbeam measurements on the dependence of this powering scheme on the jitter in the serial links, noise, and efficiency.

T 48.3 Wed 17:00 H-HS V

Development of a Laboratory Readout System for a DEPFET Pixel Detector Module — •Patrick Ahlburg, Florian Bernlochner, Jochen Dingfelder, Tomasz Hemperek, Hans Krüger, Botho Paschen, and Norbert Wermes — University of Bonn

The DEPFET PiXel Detector (PXD) is successfully operated in the innermost layers of the Belle II experiment at the SuperKEKB e^+e^- collider in Japan. The PXD-DAQ is optimized for the requirements of a full scale detector operating in Belle II. In this talk, the development of a laboratory readout system (BDAQ-PXD) for a single PXD module is shown. BDAQ-PXD is intended as an easily accessible lab test system for irradiation- and testbeam setups using a custom designed readout board (BDAQ53). The lab test system will help gather information about the behavior of DEPFET pixel detector modules in dedicated tests which may also go beyond the requirements of the detector in the running Belle II experiment. The implementation of the firmware and first measurements are presented in this talk.

T 48.4 Wed 17:15 H-HS V

Development of a serial data link IC in 65nm CMOS for the RD53B HL-LHC pixel readout chip — Tomasz Hemperek, Hans Krüger, Konstantinos Moustakas, •Piotr Rymaszewski, Marco Vogt, Tianyang Wang, and Norbert Wermes — Physikalisches Institut Universität Bonn, Bonn, Germany

The LHC High Luminosity upgrade will result in a significant change of environment in which particle detectors are going to operate, especially for devices very close to the interaction point like pixel detector electronics. The performance requirement for the pixel readout chip resulting from these changes are very similar for ATLAS and CMS experiments, therefore the groups decided to work together on the design. This collaboration, named RD53, already delivered a first large scale prototype (RD53A) and is now close to finishing the second one (RD53B). This talk presents the I/O interface of RD53B chip, focusing especially on some timing-critical circuit blocks: CDR (Clock Data Recovery), serializer and CML (Current Mode Logic) output driver. The CDR recovers clock from 160 Mbps incoming data stream and produces a 1.28 GHz clock to be used by the serializer. The double data rate serializer combines 20 data streams into a single 1.28 Gbps stream, which is sent off-chip by a CML driver. The talk will include the circuit description, explanation of the main differences between RD53A and RD53B implementations, and measurement results, especially on radiation hardness (TID and SEE) from a small scale I/O prototype chip.

T 48.5 Wed 17:30 H-HS V

Übersicht über Messungen im Rahmen der ATLAS-ITk-Pixel Marktrecherche — Andreas Gisen, •Valerie Hohm, Kevin Kröninger, Mareike Wagner und Jens Weingarten — TU Dortmund, Experimentelle Physik IV

Nach dem Upgrade des LHC zum HL-LHC werden eine höhere Luminosität und ein größerer Teilchenfluss erwartet. Daher muss das Trackingsystem des ATLAS-Experiments eine höhere Okkupanz und Strahlendosis aushalten können. Aus diesem Grund wird während des LS2 das neue Trackingsystem, der Inner Tracker (ITk), im ATLAS-Experiment eingebaut. Dieses wird im äußeren Teil aus einem Streifendetektor und im inneren Teil aus einem Pixeldetektor bestehen. Beide Detektoren werden Sensoren aus Silizium enthalten. Die innerste Lage des Pixeldetektors wird mit 3D-Sensoren ausgestattet, während die anderen Lagen aus planaren Sensoren gebildet werden.

Aufgrund der Vielzahl von benötigten Sensoren wurde eine globale Marktrecherche gestartet, um Hersteller für die Produktion zu gewinnen. Während eines Teils der Marktrecherche werden die Funktionalität und Qualität der gelieferten Sensoren von einer Gruppe von Universitäten getestet. Diese Tests beinhalten sowohl Labor- als auch Testbeam-Messungen. Die Universität Dortmund beteiligt sich an diesen Messungen für planare Silizium-Pixel-Sensoren.

Dieser Vortrag präsentiert einen Überblick über die bisherigen Messungen und den aktuellen Stand und gibt einen Ausblick auf zukünftige Messungen.

T 48.6 Wed 17:45 H-HS V

ITk-Pixel prototype module assembly and testing — Jörn Grosse-Knetter, Jörn Lange, •Silke Möbius, and Arnulf Quadt — II. Physikalisches Institut, Georg-August-Universität Göttingen

For the upgrade of the LHC to the High-Luminosity-LHC, the ATLAS tracking detector will be replaced with a pure silicon detector, the Inner Tracker (ITk), as the higher luminosity asks for radiation hard components that can deal with higher occupancies and radiation. Given the close proximity to the interaction point, the environment is especially challenging for the pixel detector, which features 3D and planar sensors.

A global market survey on the sensors as well as the bonding to the readout chip has been started. Several institutes are involved in sensor testing with laboratory as well as testbeam measurements. Our working group contributes to the planar sensor market survey.

Additionally, a new readout chip is under development, allowing a faster and reliable readout of the sensors. In order to characterize and test ITk-Pixel prototype modules with the RD53A, a prototype chip, up to 200 modules are built and tested at several institutes. At a later stage, modules will be integrated into a demonstrator to test the system. Our working group in Göttingen is involved in the development of the tooling, needed for the assembly of the module and the assembly and testing itself.

This talk will give an overview of the measurements performed so far and focus on the ITk-Pixel module assembly and tests in our group.

T 48.7 Wed 18:00 H-HS V

System Integration of ATLAS ITK Pixel DCS ASICs — •Ahmed Qamesh for the ATLAS-Collaboration — University of Wuppertal

During the LHC phase II shutdown, the entire tracking system of the ATLAS experiment will be replaced by an all-silicon detector called the ITk (Inner Tracker). with a pixel detector as the most inner part. Therefore a new DCS (Detector Control System) is being developed at the University of Wuppertal to fulfill the control and monitoring requirements of the new pixel detector. The new DCS has an on-detector component DCS ASIC to monitor the voltages and temperatures of the sub-detector components. For the communication between the off-detector DCS server and the DCS ASIC a modified CAN (Controller Area Network) bus is used. The powering scheme of the ASICs is supported by direct power lines from the power supplies . In this talk testing results for the proposed communication system (CAN) and Integration plans of the new chip will be presented.

T 48.8 Wed 18:15 H-HS V

ATLASPix3 results from the laboratory — H. Augustin[1], F. Ehrler[2], D.M. Immig[1], D. Kim[1], •L. Mandok[1], L.O.S. Noethe[1], I. Perić[2], M. Prathapan[2], T.T. Rudzki[1], R. Schimassek[2], A. Schöning[1], A. Weber[1,2], and H. Zhangh[2] — [1]Physikalisches Institut der Universität Heidelberg — [2]Karlruher Institut für Technologie

In the context of the High Luminosity upgrade of the LHC, several components of the ATLAS detector will be renewed and improved to keep up with the increasing luminosity. In particular, High-Voltage Monolithic Pixel Sensors (HV-MAPS) are considered an alternative to conventional hybrid silicon pixels for the outer layers of the ATLAS Inner Tracker. HV-MAPS are based on HV-CMOS technology. It allows integrating an active pixel matrix that collects signal charges via drift and the full readout logic in a monolithic architecture.
The ATLASPix3 is the latest prototype of an ATLAS demonstrator chip. It is the first full-size version with an active area of $19.8 \times 18.6\, cm^2$ integrating pixels of size $150 \times 50\, \mu m^2$. It also features time walk correction possibilities using ToA and ToT measurements.
In this talk, the latest results from the laboratory with a special focus on time resolution studies are discussed.

T 49: Outreach methods II (joint session T/HK)

Time: Wednesday 16:30–18:45 Location: H-HS VI

T 49.1 Wed 16:30 H-HS VI

Erste Erfahrungen mit den BELLE II-Daten bei den International Masterclasses 2020 — •Maike Hansen[1], Florian Bernlochner[1], Jochen Dingfelder[1], Thomas Kuhr[2], Kilian Lieret[2], Christoph Schwanda[3], Barbara Valeriani-Kaminski[1], Barbara Wankerl[4] und Christian Wessel[1] für die Netzwerk Teilchenwelt-Kollaboration — [1]Universität Bonn, Germany — [2]LMU München, Germany — [3]HEPHY Wien, Austria — [4]Max-Planck-Institut für Physik München, Germany

Bei den International Masterclasses "hands on particle physics" erhalten jedes Jahr mehr als 13000 Jugendliche weltweit einen Einblick in die Grundlagen und Forschungsmethoden der Teilchenphysik sowie in die Arbeitswelt von Wissenschaftlerinnen und Wissenschaftlern. Zu diesem Zweck stellen immer mehr Experimente auf der ganzen Welt aktuelle Daten zur Verfügung. Gleichzeitig werden Materialien entwickelt, die Schülerinnen und Schülern die Analyse der Daten ermöglichen.

Unter den "Newcomern" bei den International Masterclasses ist das BELLE II-Experiment am Forschungszentrum KEK in Japan. Im Rahmen der International Masterclasses 2020, die zwischen dem 26. Februar und dem 8. April 2020 stattfinden, werden erstmals im deutschsprachigen Raum BELLE II-Masterclasses angeboten. In diesem Vortrag werden die Erfahrungen der Masterclasses in Bonn, München und Wien präsentiert: Wie wurden die Teilnehmer/innen auf ihre Aufgaben vorbereitet und wie kamen sie mit den Daten zurecht? Außerdem werden Schwierigkeiten und positive Überraschungen diskutiert sowie Impulse für zukünftige Veranstaltungen gegeben.

T 49.2 Wed 16:45 H-HS VI

3D und Virtual-Reality-Umgebungen zur Vermittlung von Grundlagenforschung am Beispiel des ALICE-Detektors am CERN-LHC — •Christian Klein-Bösing[1], Philipp Bhatty[2], Stefan Heusler[3] und Reinhard Schulz-Schaeffer[2] — [1]Institut für Kernphysik, WWU Münster, Germany — [2]Department Design, HAW Hamburg, Germany — [3]Institut für Didaktik der Physik, WWU Münster, Germany

Detektoren in der Elementarteilchenphysik, wie der ALICE-Detektor am LHC, können in der Regel der breiten Öffentlichkeit nur an Hand von Bildern oder Filmen präsentiert werden. Die Darstellung in einer Echtzeit-3D-Umgebung, wie einer Virtual-Reality- und Web3D-Applikation, ermöglicht hingegen direkt die Größe des Experimentes erfahrbar zu machen, aber auch neue, virtuelle Handlungsräume und Handlungsoptionen zu erforschen und zielgruppengerecht einzusetzen. Die Entwicklung einer solchen Web3D-Lernumgebung sowie einer VR-Lernapplikation, inklusive der empirischen Bewertung verschiedener Darstellungsoptionen, der Gestaltung von Nutzerinteraktion und interaktiver Lernaufgaben, erfordert eine enge Kooperation zwischen Grundlagenforschung in der Elementarteilchenphysik, der Didaktik der Physik und der Wissenschaftsillustration.

Wir präsentieren den aktuellen Entwicklungsstatus basierend auf einer interaktiven Visualisierung des ALICE-Detektors in VR (Smartphone und VR-Systeme) und Web-3D (Browser).

T 49.3 Wed 17:00 H-HS VI

Das Feynman-Puzzle: Ein spielerischer Ansatz zur Vermittlung von fundamentalen Wechselwirkungen — •Kai Gerschlauer, Philip Bechtle, Johanna Rätz und Barbara Valeriani-Kaminski für die Netzwerk Teilchenwelt-Kollaboration — Physikalisches Institut der Universität Bonn, Deutschland

Das Netzwerk Teilchenwelt hat sich zur Aufgabe gemacht, den Schüler*innen die Faszination der Teilchenphysik zu vermitteln und die Neugier der Jugendlichen für die Grundbausteine unseres Universums zu wecken. Um zu verstehen, was in einem Teilchenbeschleuniger passiert und welche Prozesse bei einer Teilchenkollision stattfinden, bieten Feynman-Diagramme eine anschauliche Übersetzung der komplexen Mathematik. Das Feynman-Puzzle soll genau dort ansetzen und aufbauend auf einem Online-Vorbereitungskurs den Schüler*innen die möglichen Wechselwirkungsprozesse des Standardmodells (SM) und die dazugehörigen Materie- und Austauschteilchen vermitteln. Schritt für Schritt können sich die Schüler*innen sowohl einfache Prozesse, die sie aus der Schule kennen, als auch komplexere Beschreibungen von Signal/Untergrund-Prozessen in Form von Feynman-Diagrammen aneignen. Da die Spielkarten auf den Vertizes des SM beruhen, vermitteln sie direkt ein Verständnis dafür, welche Prozesse von der Eichstruktur des SM erlaubt sind und welche verboten. So können beispielsweise Produktion und Zerfall des Higgs-Bosons erarbeitet und auch ein Verständnis dafür geschaffen werden, welche Prozesse mehr oder weniger wahrscheinlich sind.

T 49.4 Wed 17:15 H-HS VI

Die nächste Generation von CosMO-Detektoren — •Jonathan Schöttke, Carolin Schwerdt, Heike Prokoph, Michael Walter und Dorothee Braun für die Netzwerk Teilchenwelt-Kollaboration — Deutsches Elektronen-Synchrotron DESY, Platanenallee 6, 15738 Zeuthen, Germany

Jugendlichen einen authentischen Einblick in die Detektion der kleinsten uns bekannten Teilchen zu ermöglichen, ist das Ziel des Detektorprojektes von Netzwerk Teilchenwelt. In diesem Zusammenhang wurde auch das Cosmic Muon Observer (CosMO) Experiment entwickelt. CosMO besteht aus einem Szintillationszähler mit Datenauslesekarte und einem Computer mit schülerfreundlichem Analyseprogramm, welches seit über sieben Jahren an vielen kooperierenden Instituten, Forschungseinrichtungen sowie Schulen zum Einsatz kommt. Wegen des anhaltenden Bedarfs an diesem Experiment sollen nun weitere CosMO-Setups gebaut werden. In diesem Beitrag werden Untersuchungen zur Optimierung des Detektorbaus vorgestellt, welche vor allem auf eine vereinfachte Fertigung und Wartung Wert legen und zeitgleich Neuerungen auf dem Gebiet der Silizium-Photomultiplier (SiPMs) in Betracht ziehen. Es wurde untersucht, ob das aufwendige Einkleben der Lichtleitfasern in den Szintillator umgangen werden kann, indem die Fasern lediglich in eine Art Tunnel im Szintillator geschoben werden oder sogar die SiPMs direkt an den Szintillator angebracht werden können. Dafür wurden unterschiedlich große SiPM von verschiedenen Herstellern charakterisiert und zusammen mit dem veränderten Detektor-Setup getestet.

T 49.5 Wed 17:30 H-HS VI

CERN Open Data im Schülerpraktikum — •Artur Monsch und Günter Quast — Karlsruher Institut für Physik

Die Bereitstellung von Messdaten und Simulationen auf dem öffentlich zugänglichen CERN Open Data Portal schafft eine Möglichkeit diese Daten im Bildungsbereich einzusetzen, um das Interesse an der Teilchenphysik zu wecken und ein tieferes Verständnis der Vorgehensweisen und Arbeitsmethoden zu erreichen. Vorgestellt wird ein an unterschiedliche Kompetenzstufen anpassbares Konzept, das anhand dieser Daten die Entdeckung des Higgs-Bosons auf didaktischer Ebene im Rahmen eines Computer-Kurses nachvollziehbar macht. Dazu wird das Spektrum der invarianten Masse im 'goldenen Zerfallskanal' H in 4 Leptonen untersucht. Ausgehend von dem Aufbau und der Funktionsweise eines Detektors werden die Teilnehmer mit den notwendigen Grundkonzepten der Rekonstruktion und Selektion der Daten vertraut gemacht, um anschließend aus der gewonnen Verteilung der invarianten Massen auf die statistische Signifikanz des Signals für ein Higgs-Boson mit der Masse von 125 GeV zu schließen. Die initiale Auslegung auf das Fortgeschrittenenpraktikum im Physikstudium kann durch eine selektive Eingrenzung des Themenumfanges auch im schulischen Umfeld oder in Schülerprogrammen an der Universität zur Anwendung kommen.

T 49.6 Wed 17:45 H-HS VI

Physik-Projekt-Tage – Gleichstellung in der Physik an Hand eines Workshops nur für Schülerinnen — •Roman Kogler, Anna Benecke und Melanie Eich — Universität Hamburg

Dass Gleichstellungsarbeit besonders in der Physik ein wichtiges Thema ist, zeigen nicht zuletzt die Einschreibezahlen von Studentinnen in den Physikstudiengängen. In Kiel liegt der Prozentsatz von Frauen bei etwa 15%. Um ein angemessenes Geschlechterverhältnis auf allen Karrierestufen zu erreichen genügt es daher nicht, erst an der Universität mit Gleichstellungsarbeit zu beginnen - es muss bereits in der Schule angesetzt werden. Mit den Physik-Projekt-Tagen (PPT) wurde ein viertägiger Workshop nur für Schülerinnen ins Leben gerufen. Die Teilnehmerinnen haben die Möglichkeit, zu Schuljahresbeginn vier Tage lang in einem Projekt ihrer Wahl zu experimentieren, ihr Interesse an Physik zu steigern und Netzwerke über Schulgrenzen hinweg aufzubauen. Die Projekte umspannen verschiedene Forschungsfelder der Physik und reichen von Teilchenphysik, über Laserphysik und Plasmaphysik

bis hin zu Nanowissenschaften. Zur Qualitätssicherung und Weiterentwicklung dieser Veranstaltung werden die PPT von einer kritischen Evaluation begleitet. Das Konzept der PPT, Inhalte und ausgesuchte Ergebnisse der Evaluation werden vorgestellt. Seit 2015 ist das Projekt im Instrumentenkasten für Gleichstellungsarbeit der DFG.

T 49.7 Wed 18:00 H-HS VI

Entwicklung einer TPC als Demonstrationsexperiment — •Johannes Streun, Klaus Desch und Jochen Kaminski — Physikalisches Institut der Universität Bonn

Die SchulTPC ist eine kompakte, hochauflösende Zeitprojektionskammer. Der Detektor erfasst Spuren ionisierender Strahlung und bietet die Möglichkeit, diese direkt digital auszuwerten und darzustellen. Dadurch eignet er sich als Demonstrationsexperiment in Ausstellungen und Museen. Außerdem wird auch angestrebt, mit dem Detektor Experimente in der Schule aufzubauen, zum Beispiel als Exkurs im Physikunterricht oder als Thema einer Facharbeit. Zu den Besonderheiten des Detektors gehören die kompakten Maße von ca. 10cm x 10cm x 15cm, die Hochspannungsversorgung in der Größe eines Schuhkartons und eine Ausleseeinheit, welche über USB betrieben und ausgewertet werden kann. Ziel ist es, ein Demonstrationsmodell zu schaffen, welches technisch nahe an den tatsächlich in aktueller Forschung eingesetzten Detektoren liegt, jedoch kompakt und somit transportabel ist, sowie eine Bedienung zu schaffen, welche auch für den Laien klar und verständlich ist. Der Vortrag beschäftigt sich vorwiegend mit den anfänglichen Planungen des Detektors und der technischen Realisierung sowie der Konstruktion des Prototypen. In Folge dessen wird auf einzelne technische Details der Zeitprojektionskammer eingegangen und auf die spätere Anwendung bezogen. Im Anschluss wird über erste Erfahrungen mit der SchulTPC als Demonstrationsmodell berichtet u. a. bei den "Highlights der Physik 2019" in Bonn.

T 49.8 Wed 18:15 H-HS VI

Myonteleskop aus modularen Szintillationsdetektoren mit SiPM-Auslese für das physikalische Praktikum — •Anja Schmidt[1], Günter Quast[1], Ralph Engel[1], Joachim Wolf[1], Andreas Haungs[1] und Thomas Huber[1,2] — [1]Karlsruher Institut für Technologie (KIT) — [2]Deutsches Elektronen-Synchrotron (DESY)

Basierend auf dem KIT IceScint Prototyp des Szintillator-Upgrades des IceCube-IceTop Detektors werden neue Szintillationsdetektoren entwickelt, welche zukünftig im Fortgeschrittenenpraktikum im Rahmen des Physikstudiums eingesetzt werden. Diese werden an die Bedingungen und den Messbereich der Praktikumsziele angepasst. Das Detektorprinzip basiert auf Szintillationsdetektoren, durch welche wellenlängenschiebende Fasern gezogen werden. Die Fasern leiten das Licht zu einem SiPM (Silizium-Photomultiplier), welcher dann mithilfe der für IceScint entwickelten Ausleseelektronik ausgelesen wird. Das verstärkte SiPM Signal wird anschließend mit einem PicoScope aufgenommen. Damit wird die neueste Detektortechnologie Studierenden zugänglich gemacht. Außerdem kann diese auch für die Experimente des Netzwerk Teilchenwelt eingesetzt werden.
Im Praktikum werden drei Detektoren als Hodoskop übereinander aufgebaut. Zusammen mit einem Absorber und einem Magneten können mit diesem Aufbau über Koinzidenzmessungen die Lebensdauer und der Lande-Faktors des Myons bestimmt werden.
In diesem Vortrag werden das Detektordesign, Ergebnisse der Charakterisierung der Detektoren und erste Messergebnisse gezeigt.

T 49.9 Wed 18:30 H-HS VI

Mini NM and MT measurements on the German research vessel Polarstern — •Bernd Heber[1], Dennis Galsdorf[1], Konstantin Herbst[1], Vladimir Mares[2], Carolin Schwerdt[3], Du Toit Strauss[4], and Michael Walter[3] — [1]Christian-Albrechts-Universität Kiel — [2]Helmholtz Zentrum München, Neuherberg, Germany — [3]Deutsches Elektronen-Synchrotron DESY Zeuthen, Germany — [4]Center for Space Research, North-West University, Potchefstroom 2520, South Africa

Neutron Monitors (NMs) are ground-based devices to measure the variation of the intensity of the secondary neutrons from Galactic Cosmic Rays (GCRs). Since their measurements are influenced by the variable Earth magnetic field and the atmospheric conditions close to its position a detailed knowledge of the instrument sensitivity with geomagnetic latitude (rigidity), atmospheric pres- sure and the local environment is essential. Portable NMs, constructed by the North West University campus Potchefstroom, South Africa, and Muon Tele- scopes (MTs), constructed by DESY Zeuthen have been installed aboard the German research vessel Polarstern at the Neumeier III in Antarctica at sea level and at the Environmental Research Station Schneefernerhaus (UFS) Zugspitze at altitude of 2660 m a.s.l. Here we present the theoretical background that is utilized to determine the instrument response with respect to the geomagnetic position and the atmospheric pressure. The latter will be shown by investigating the measurements in Antarctica and on the Zugspitze. The dependence with the geomagnetic position is explored by analyzing Polarstern measurements.

T 50: Combined detector session (joint session HK/T/ST/EP)

Time: Wednesday 16:30–18:30 Location: H-HS X

Invited Talk T 50.1 Wed 16:30 H-HS X

Detectors for Measuring Space Radiation — •Robert F. Wimmer-Schweingruber and and the Kiel Extraterrrestrial Physics Team — Christian-Albrechts-Universität zu Kiel, Kiel, Germany

Radiation in the solar system comes from various sources, primarily galactic cosmic radiation (GCR) and solar (cosmic) radiation, as well as particles trapped and/or accelerated in and at planetary magnetospheres and traveling shock waves. While measurements of radiation on Earth and in its atmosphere have been performed for more than a century, measuring space radiation is more complicated, mainly because of the limited resources available on spacecraft. In this talk I will discuss examples of how to measure space radiation on Mars, the Moon, and in the inner solar system, i.e., between the Sun and Earth, thus covering measurements on a body with a (thin) atmosphere, with no atmosphere, and in free space. The examples include the Radiation Assessment Detector (RAD) on NASA*s Mars Science Laboratory (MSL), the Lunar Lander Neutrons and Dosimetry (LND) instrument on China*s Chang*E 4 lander on the far side of the Moon, and the four sensors STEP, EPT, SIS, and HET on ESA*s Solar Orbiter which is scheduled for launch on February 7, 2020, at the time of writing this abstract.

Invited Talk T 50.2 Wed 17:00 H-HS X

Modern Timing Detectors in HEP — •Jörn Lange — II. Physikalisches Institut, Georg-August-Universität Göttingen, Germany

Particle detectors with precise time information are traditionally used in HEP as time-of-flight detectors. A new generation of high granularity and radiation-hard timing detectors with a precision of few tens of picoseconds is being developed for event time measurements at the High-Luminosity upgrades of the LHC experiments. By measuring the arrival time of each particle in the detector, its underlying collision vertex can be identified to suppress the background from event pileup in an environment with up to 200 collisions per proton-proton bunch crossing. This is made possible thanks to the rapid advance of new detector technologies like Silicon Low Gain Avalanche Detectors (LGADs). For the longer term future, 4D tracking detectors are being developed, which combine precise timing with the high granularity and spatial resolution of today's pixel detectors, enabling enhanced pattern recognition in high density track environments. This presentation will motivate and introduce the novel timing detectors and their technologies. New developments such as 4D-tracking and possible other applications will be discussed as well.

Invited Talk T 50.3 Wed 17:30 H-HS X

Experimental time resolution limits of modern SiPMs and TOF-PET detectors — •Stefan Gundacker — CERN, Esplanade de Particules 1, 1211 Meyrin, Switzerland — UniMIB, Piazza dell'Ateneo Nuovo, 1-20126, Milano, Italy

Time Of Flight (TOF) information applied in Positron Emission Tomography (PET) has shown to improve the image quality, shorten scan times and reduces the patient radiation dose. A Coincidence Time Resolution (CTR) in the range of 20 ps FWHM would enable to access image voxels of $3x3x3mm^3$ along the line of response and

is likely to revolutionize clinical PET. Inorganic scintillator-based detectors are able to record the 511 keV annihilation gammas with high sensitivity and have strongly benefited from the appearance of solid-state photodetectors (e.g. the SiPM), new crystal types (e.g. LYSO:Ce codoped with divalent ions) and improved front-end electronic readout. Such developments enabled commercial PET systems to achieve CTRs around 210 ps FWHM (Siemens Biograph vision). Nevertheless, a complete assessment of state-of-the-art scintillators and SiPMs in terms of their currently achievable time resolution limits was still missing and will be given in this paper. That is important, as it helps to define future strategies and directions of research in order to improve the system CTR by at least an order of magnitude. Furthermore, general aspects of the theoretical CTR limits in TOF-PET will be discussed along with some considerations on how to bring promising laboratory results into real world medical applications.

Invited Talk T 50.4 Wed 18:00 H-HS X

260 megavoxel camera with continuous readout - the upgraded ALICE TPC — •Laura Fabbietti for the ALICE-Collaboration — JamesFranckstr. 1

The ALICE Time Projection Chamber (TPC) is the world largest detector of this type. It is the main tracking and PID device of the ALICE detector. It is currently being upgraded with a new readout system, including new GEM-based Readout Chambers and new front-end electronics. The upgraded TPC will operate in continuous mode, recording the full minimum-bias interaction rate of 50 kHz in Pb-Pb offered by the LHC in Run 3 and beyond. This will result in a significant improvement on the sensitivity of rare probes*that are considered key observables to characterise the QCD matter created in such*collisions. In this presentation I will discuss the physics potential of the upgraded TPC and show the status of the TPC upgrade activities during the ongoing LHC Long Shutdown 2. First results of the commisioning tests will be presented.

T 51: Flavor physics: CKM I

Time: Wednesday 16:30–19:00 Location: H-HS XI

T 51.1 Wed 16:30 H-HS XI

Untagged Analysis of $B \to \pi\ell\bar{\nu}_\ell$ using Early Belle II Data — Florian Bernlochner, Jochen Dingfelder, •Svenja Granderath, and Peter Lewis for the Belle II-Collaboration — Rheinische Friedrich-Wilhelms-Universität Bonn

A discrepancy between the results of exclusive and inclusive measurements of the CKM matrix element $|V_{ub}|$ persists. The charmless semileptonic decay $B \to \pi\ell\bar{\nu}_\ell$ is one of the most accessible and powerful channels for determining $|V_{ub}|$ in exclusive modes. Using data from the Belle II experiment, a new precision measurement of $|V_{ub}|$ will become possible. In preparation for this, an untagged measurement method for extracting $B \to \pi\ell\bar{\nu}_\ell$ events is developed using early Belle II data. Lepton and pion candidates are combined to form $B \to \pi\ell\bar{\nu}_\ell$ candidates. In order to increase the purity, a boosted decision tree is employed to suppress continuum and other backgrounds. This talk will discuss the current status of the analysis and present an outlook on the precision of future Belle II $|V_{ub}|$ measurements.

T 51.2 Wed 16:45 H-HS XI

V_{ub} analysis at Belle II — •Yaroslav Kulii and Thomas Kuhr for the Belle II-Collaboration — Ludwig-Maximilians-Universität München

The flavour mixing of quarks, generated by the CKM matrix, has been experimentally confirmed a long time ago and since then has been a subject of various studies.

While the complex phase generates CP-violation, the moduli of the CKM matrix elements define the overall transition rate of quarks between generations. Discrepancies between results coming from inclusive and exclusive determination of the V_{ub} element (i.e. $b \to u$ quark transition rate) have been a matter of dispute.

In this study the data from Belle and Belle II experiments as well as corresponding experimental and theoretical techniques are used for further analysis of $b \to u$ quark transition rate. The studied processes are in particular $B \to \pi^+\ell^-$ decays.

T 51.3 Wed 17:00 H-HS XI

Precision measurement of the CKM matrix element $\mathbf{V_{cb}}$ with the Full Event Interpretation at Belle — •Markus Prim[1], Florian Bernlochner[2], Jochen Dingfelder[2], Pablo Goldenzweig[1], Thomas Kuhr[3], Kilian Lieret[3], Felix Metzner[1], and Maximilian Welsch[2] — [1]Karlsruher Institut für Technologie — [2]Rheinische Friedrich-Wilhelms-Universität Bonn — [3]Ludwig Maximilian Universität

Precision measurements of the CKM matrix element V_{cb} can be done using three established methods: either by studying exclusive $B \to D\ell\nu$ decays, exclusive $B \to D^*\ell\nu$ decays or by studying inclusive $b \to c\ell\nu$ transitions. Exclusive and inclusive determinations show a persistent tension at the 2 - 3 sigma level. In recent measurements the dependence of the used exclusive form factor parametrizations was explored as a possible source of the discrepancy. In this presentation we show the status of re-analyzing the full Belle data set of 711/fb of integrated luminosity using an improved hadronic tagging algorithm called the Full Event Interpretation (FEI). Semileptonic $B \to D\ell\nu$ and $B \to D^*\ell\nu$ decays are reconstructed and simultaneously analyzed to measure form factors and V_{cb}. The fit is carried out in the HAMMER framework, which provides predictions for all relevant form factor parameterizations, and fully differentially in the recoil parameter w and the three D^* decay angles.

T 51.4 Wed 17:15 H-HS XI

Measurement of inclusive differential kinematic distributions for $|V_{cb}|$ — Florian Bernlochner, Lu Cao, Jochen Dingfelder, William Sutcliffe, and •Raynette van Tonder — University of Bonn, Germany

The discrepancy between inclusive and exclusive measurements of the CKM matrix element $|V_{ub}|$ has posed a longstanding puzzle. Since one of the major difficulties involved with the inclusive $|V_{ub}|$ measurement is the determination of the non-perturbative distribution function describing the internal Fermi motion of the b-quark, innovative new analysis strategies aimed toward reducing model uncertainties have been suggested. One of these approaches proposes to measure key kinematic differential distributions of $B \to X_u\ell\bar{\nu}_\ell$ decays and combine them into a global, data-driven fit, which would simultaneously determine $|V_{ub}|$ as well as other useful parameters. This analysis makes use of hadronic tagging and is performed on the full dataset of the Belle experiment comprising 772 million $B\bar{B}$ pairs. In order to test analysis techniques under development for the above-mentioned measurement, the more abundant phase space region of $B \to X_c\ell\bar{\nu}_\ell$ decays is exploited. This talk will show the current analysis status as well as differential kinematic distributions for $B \to X_c\ell\bar{\nu}_\ell$ decays.

T 51.5 Wed 17:30 H-HS XI

Untagged $\overline{B}^0 \to D^{*+}\ell^-\overline{\nu}_\ell$ studies with Belle II — Florian Bernlochner, Lu Cao, Jochen Dingfelder, and •Chaoyi Lyu — The University of Bonn, Bonn, Germany

The precise determination of the CKM matrix element $|V_{cb}|$ and semileptonic form factors in B meson decays are important for carrying out precision tests of the flavour sector of the Standard Model and to search for new physics. The decay of $\overline{B}^0 \to D^{*+}\ell^-\overline{\nu}_\ell$ is particularly well suited to determine $|V_{cb}|$ due to its large branching fraction, small backgrounds and the availability of lattice data to describe the form factors. In this talk I will present the current status of establishing an untagged measurement of the $\overline{B}^0 \to D^{*+}\ell^-\overline{\nu}_\ell$ branching fraction and form factors. In particular, I will show results using first Belle II data and present detailed comparisons between simulated and recorded $\overline{B}^0 \to D^{*+}\ell^-\overline{\nu}_\ell$ decays.

T 51.6 Wed 17:45 H-HS XI

Measurement of the $B_s \to K^0_S K^0_S$ branching fraction at LHCb — Timon Schmelzer, Moritz Demmer, and •Sophie Hollitt — Experimentelle Physik 5, TU Dortmund

Decays of b hadrons to final states containing only long-lived particles, such as K^0_S mesons or Λ^0 baryons, have never been reported in a hadronic production environment. Of these long-lived final states, the decay $B^0_s \to K^0\overline{K}^0$ has a relatively large predicted branching fraction,

and is dominated by $b \to s\bar{d}d$ electroweak penguin transitions.

In this talk, a measurement of the branching ratio of $B_s \to K^0_S K^0_S$ decays is presented, using data collected by the LHCb experiment in 2011–2012 and 2015–2016 corresponding to a total of 5 fb^{-1} of hadronic collision data. This branching ratio is measured relative to the normalisation channel $B^0 \to \phi K^0_S$. As part of the same analysis, evidence for the $B^0 \to K^0_S K^0_S$ decay mode is also presented.

T 51.7 Wed 18:00 H-HS XI

Measurement of the weak mixing phase ϕ_s in $B^0_s \to D^+_s D^-_s$ decays with the LHCb experiment — •Louis Gerken, Philipp Ibis, and Antje Mödden — Experimentelle Physik 5, TU Dortmund

The LHCb experiment performs precision measurements of *CP* violation to test the Standard Model of particle physics. In $B^0_s \to D^+_s D^-_s$ decays, the *CP*-violating parameter ϕ_s can be measured. This weak mixing phase arises in the interference between the direct decay of the B^0_s meson and the decay after mixing.

In this talk, the selection of $B^0_s \to D^+_s D^-_s$ candidates for a measurement of ϕ_s will be presented. A challenging part of the selection is the suppression of hadronic background decays. The analysis uses the full Run II dataset corresponding to an integrated luminosity of 6 fb^{-1} collected during 2015 to 2018 at a centre-of-mass energy of 13 TeV.

T 51.8 Wed 18:15 H-HS XI

Time-dependent measurement of *CP* violation in $B^0_s \to D^+_s D^-_s$ decays with the LHCb experiment — Louis Gerken, Philipp Ibis, and •Antje Mödden — Experimentelle Physik 5, TU Dortmund

The LHCb experiment aims to test the Standard Model of particle physics and searches for New Physics by performing precision measurements, e.g. decay-time-dependent measurements of *CP* violation in decays of neutral B mesons.

In the decay $B^0_s \to D^+_s D^-_s$, the weak mixing phase ϕ_s arises in the interference between the decay with and without $B^0_s - \bar{B}^0_s$ mixing. This phase can be determined in a decay-time-dependent measurement. The analysis uses data collected by the LHCb experiment from 2015 to 2018 at a centre-of-mass energy of 13 TeV corresponding to an integrated luminosity of 6 fb^{-1}.

In this talk, the modelling of the decay-time-dependent efficiency, the calibration of the decay-time resolution and the calibration of the Flavour Tagging is presented.

T 51.9 Wed 18:30 H-HS XI

Studies of $B^0_{(s)} \to D^{(*)+} D^-$ decays with the LHCb experiment — •Philipp Ibis, Antje Mödden, and Margarete Schellenberg — Experimentelle Physik 5, TU Dortmund

The LHCb experiment searches for physics beyond the Standard Model by performing high precision tests of beauty and charm hadrons. Among these are decay-time-dependent measurements of *CP* violation of neutral meson.

In $B^0 \to D^{(*)+} D^-$ decays, *CP* violation occurs in the interference of direct decays and decays after mixing of the B^0 mesons. Time-dependent measurements of decays of initial B^0 and $\bar{B}^0$ mesons allow the determination of the *CP* asymmetry and give access to the CKM angle β.

Analyses of *CP* violation in $B^0 \to D^+ D^-$ and $B^0 \to D^{*+} D^-$ decays are presented using the full LHCb dataset. Also, a measurement of the branching ratio of the decay $B^0_s \to D^{*+} D^-$ relative to $B^0 \to D^{*+} D^-$ is presented.

T 51.10 Wed 18:45 H-HS XI

Search for the decay $B^0_s \to D^{*+} D^{*-}$ with the LHCb experiment — Philipp Ibis, •Jan Langer, and Antje Mödden — Experimentelle Physik 5, TU Dortmund

At the LHCb experiment precise measurements are performed to search for physics beyond the Standard Model. For this it is important to observe new decays and measure their branching ratio. The aim of this analysis is to observe the decay $B^0_s \to D^{*+} D^{*-}$ and to measure the branching ratio relative to the decay $B^0_d \to D^{*+} D^{*-}$. This cancels dominant, systematic uncertainties in the relative branching ratio. This analysis can also be used to perform an angular analysis and a time-dependent measurement of *CP* violation in the control channel.

The current status of the analysis, in which the full data set of the LHCb experiment corresponding to an integrated luminosity of 9 fb^{-1}, is presented.

T 52: Neutrino physics without accelerators V

Time: Wednesday 16:30–18:45 Location: H-HS XIII

T 52.1 Wed 16:30 H-HS XIII

Project 8: First application of CRES to tritium decay — •Martin Fertl — Johannes Gutenberg-Universität, Mainz

Neutrino flavor oscillation experiments prove that neutrinos do have non-zero masses. Extensions to the Standard Model of Particle Physics have been developed to explain the non-zero masses and can be directly tested by a measurement of the absolute neutrino mass scale. The mass of the electron antineutrino m_ν can be determined from the highest precision measurement of the β^--decay spectrum of tritium around its endpoint region. The current state of the art experiment KATRIN stretches all technological limits to probe the range of m_ν down to 200 meV/c^2. The Project 8 collaboration envisions a completely new path to measure m_ν. The recently demonstrated technique of Cyclotron Radiation Emission Spectroscopy (CRES) allows for a frequency-based measurement of the decay electron energy. This new and staged approach to devise an experiment that combines CRES with an atomic tritium source to achieve a neutrino mass sensitivity of 40 meV/c^2, below the minimum m_ν predicted for the inverted neutrino mass ordering scheme will be presented. Results from the first application of CRES to the continuous decay spectrum of tritium will be discussed. This work is supported by the Cluster of Excellence "Precision Physics, Fundamental Interactions, and Structure of Matter" (PRISMA+ EXC 2118/1) funded by the German Research Foundation (DFG) within the German Excellence Strategy (Project ID 39083149), the US DOE Office of Nuclear Physics, the US NSF and internal investments at all institututions.

T 52.2 Wed 16:45 H-HS XIII

Detection Efficiency in Project 8 — •Christine Claessens for the Project 8-Collaboration — JGU Mainz

The Project 8 collaboration aims to measure the absolute neutrino mass scale from the distortion of the tritium beta decay spectrum near the endpoint. To this end, the collaboration has successfully established Cyclotron Radiation Emission Spectroscopy (CRES), a frequency-based approach to detect electrons and determine their kinetic energy (Phys. Rev. Lett. 114, 162501). As we will extract the neutrino mass from the shape of the tritium spectrum, it is essential to quantify any dependence of the electron detection efficiency on frequency or energy. Incorporating this efficiency in our analysis is crucial for an accurate measurement of the endpoint and the extraction of the neutrino mass. In this contribution, I will demonstrate the influence of the detection efficiency and its integration in our analysis with the example of the first-ever tritium CRES spectrum.

T 52.3 Wed 17:00 H-HS XIII

A new muon fitter for the SNO+ experiment — •Johann Dittmer, Mikko Meyer, and Kai Zuber for the SNOplus-Collaboration — TU Dresden, Institut für Kern– und Teilchenphysik

The SNO+ experiment is a liquid scintillator based neutrino detector looking for the neutrinoless double beta decay of ^{130}Te. The experiment is the successor of the Nobel Prize winning SNO experiment and is located at the same location as SNO (at SNOLAB with 2 km rock overburden).

The goal of track reconstruction algorithms is to identify sub–volumes, where muon–induced nuclides (^{8}He, ^{9}Li, ^{11}C etc.) are produced, and – connected to that – to reduce the detector dead time. Both goals are important for the analysis of solar *pep*– and CNO–neutrinos. In addition, a precise knowledge of the muon track may also take part in other analyses.

In this talk, an algorithm to reconstruct the muon track is presented. First results of the quantitative analysis will be presented as well.

This work is supported by the DFG.

T 52.4 Wed 17:15 H-HS XIII

LEGEND: The future of neutrinoless double-beta decay search with germanium detectors — •Anna Julia Zsigmond for the LEGEND-Collaboration — Max-Planck-Institut für Physik

The observation of neutrinoless double beta ($0\nu\beta\beta$) decay would establish both the violation of lepton number conservation and the Majorana nature of the neutrino. It will also constrain the neutrino mass hierarchy and scale in the light-neutrino exchange mechanism. The current experiments using ^{76}Ge for $0\nu\beta\beta$ decay search, the Majorana Demonstrator and Gerda, lead the field in both the ultra-low background and the energy resolution achieved. Building on their success, the LEGEND experiment will conduct an improved search with the goal of reaching a half-life sensitivity beyond 10^{28} years. In order to achieve this goal, the enriched Ge detector mass has to be increased up to tonne-scale and the backgrounds further reduced. LEGEND will pursue a phased approach with the first phase expected to start in 2021 with about 200 kg of ^{76}Ge-enriched detectors operating at LNGS of INFN in Italy. The plans and physics reach of LEGEND together with the various ongoing R&D activities will be presented.

T 52.5 Wed 17:30 H-HS XIII

Sensitivity of the DARWIN observatory to the neutrinoless double beta decay of 136Xe — •Fabian Kuger for the DARWIN-Collaboration — Albert-Ludwigs-Universität Freiburg, Deutschland

The DARWIN observatory is a proposed next-generation experiment to search for particle dark matter and other rare processes. It will operate 40t of natural xenon in a time projection chamber, thus containing about 3.6t of ^{136}Xe. This renders DARWIN well suited to search for the neutrinoless double beta decay of ^{136}Xe, with a science reach compatible to dedicated double beta decay experiments. We show that DARWIN will reach a half-life sensitivity limit of $T^{0\nu}_{1/2} = 2.4 \times 10^{27}$ yr assuming a rather conservative radio-purity and performance scenario. The impact of more progressive assumptions on the sensitivity limit is discussed. We conclude that after 10 years of operation DARWIN will cover the Majorana mass range corresponding to the inverted hierarchy.

T 52.6 Wed 17:45 H-HS XIII

Signal and background event topologies in the $0\nu\beta\beta$ decay search in DARWIN — •Andrii Terliuk for the DARWIN-Collaboration — Physikalisches Institut, Universität Heidelberg, INF 226, 69120 Heidelberg — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg

The DARWIN observatory is a future Dark Matter detector with 40 tons of liquid xenon in a sensitive volume of a dual-phase TPC. Natural xenon contains approximately 8.9% of ^{136}Xe isotope, which is currently considered as one of the possible candidates to undergo a neutrino-less double beta decay. The large mass, excellent radiopurity and good energy resolution makes DARWIN an ideal device to search for such a rare decay. In DARWIN, separation of signal from background relies on identification of events with single and multiple scatterings in the detector. This contribution discusses event topologies created by signal and background, as well as an impact of different $0\nu\beta\beta$ decay models on the signal selection efficiency.

T 52.7 Wed 18:00 H-HS XIII

Status and Prospects of the COBRA Experiment — •Juliane Volkmer for the COBRA-Collaboration — TU Dresden, Institut für Kern- und Teilchenphysik, Germany

As many Beyond-Standard-Model theories predict the existence of the neutrinoless double beta decay ($0\nu\beta\beta$), this lepton-flavor-violating nuclear reaction is one of today's most examined processes in fundamental physics. Its observation could help to solve important questions as for the neutrino's mass or whether it is a Majorana particle, and thus shed light on physics beyond the Standard Model.
In 2011 the COBRA demonstrator was built with the objective of investigating the practicability of using CdZnTe semiconductor crystals for the decay's investigation. The CdZnTe crystals contain nine isotopes capable of different $0\nu\beta\beta$ decay modes, can be operated at room temperature and are commercially available. Additionally, the versatile detector material offers the possibility of investigating physics besides the $0\nu\beta\beta$ decay, like a potential quenching of g_A in nuclear processes – by measuring the spectrum shape of the strongly forbidden ^{113}Cd β decay – and exotic $\beta^+\beta^+$ decay modes.
Last year the demonstrator setup of $4\times4\times4$ 1 cm^3 CdZnTe crystals was upgraded based on the knowledge gained from the many years of operation. With nine additional larger detector crystals, higher exposure rates as well as strongly reduced background levels can be achieved.
This talk shall give an overview of the status, plans and most recent experimental results of the COBRA collaboration.

T 52.8 Wed 18:15 H-HS XIII

Search for double beta decay to excited states with COBRA XDEM — •Yingjie Chu for the COBRA-Collaboration — TU Dresden, Institut für Kern- und Teilchenphysik, Germany

The COBRA experiment uses CdZnTe semiconductor detectors to search for the neutrinoless double beta decay with the "source=detector" method. Several isotopes of Cadmium, Zinc, and Tellurium, which are known candidates for different double beta decay modes, are contained in the detector material. A new experimental phase has started by upgrading the experiment to the COBRA extended demonstrator (XDEM). The novel detector configuration technology is benefcial for the determination of multiple energy depositions within the same detector and the coincidences analysis between different detectors. This is a key concept to search for the phase space suppressed excited state transitions of double beta decay, which are accompanied by the emission of characteristic gamma lines. This talk will give an overview of the COBRA XDEM detector approach as well as first insights on how to identify the expected signal in the detector array based on Monte-Carlo simulations.

T 52.9 Wed 18:30 H-HS XIII

Characterization of surface events of a p-type point contact germanium detector — •Frank Edzards for the LEGEND-Collaboration — Max-Planck-Institut für Physik, Föhringer Ring 6, 80805 München

LEGEND is a future ton-scale experimental program to search for neutrinoless double beta decay ($0\nu\beta\beta$) in the isotope ^{76}Ge using high-purity germanium detectors. Its observation would establish lepton number violation and provide information on the neutrino mass.

In LEGEND-200, various detector types will be deployed in liquid argon (LAr). Among them are p-type point contact (PPC) germanium detectors that are currently operated in the Majorana Demonstrator experiment. Due to their large passivated surface, PPC detectors are particularly susceptible to surface effects. Therefore, their surface event response with respect to alpha and beta radiation in LAr has to be studied in detail. This talk focuses on the results of surface characterization measurements of a PPC detector carried out in a vacuum cryostat test facility. It is demonstrated that the passivated surface can accumulate charges resulting in a radial degradation of the event energy.

This work is supported by the Max Planck society and the German Academic Scholarship Foundation.

T 53: Dark Matter II

Time: Wednesday 16:30–19:00 Location: H-HS XIV

T 53.1 Wed 16:30 H-HS XIV

Hardware R&D Towards DARWIN: Construction of a Radon Emanation Chamber — •Daniel Baur — Albert-Ludwigs-Universität, Freiburg, Germany

Liquid xenon-based experiments are currently leading the search for WIMP dark matter. Their electronic recoil background in the energy region of interest is dominated by the "naked" (i.e. not accompanied by the coincident emission of a gamma-ray) beta decays of ^{214}Pb, a progeny of ^{222}Rn which is emanated from all material surfaces. Consequently, the reduction of ^{222}Rn emanation is mandatory for the success of next-generation dark matter experiments with multi-ton xenon targets such as DARWIN.
The ^{222}Rn surface emanation can be measured directly with a radon

emanation chamber, where the daughters of ^{222}Rn are collected electrostatically on a silicon PIN diode and the subsequent alpha decays are detected. We present a new radon emanation chamber which is being constructed in Freiburg and show first results.

T 53.2 Wed 16:45 H-HS XIV

First results of a fully functional single-phase TPC — •Patrick Meinhardt — Physikalisches Insitut, Freiburg, Germany

Liquid-xenon dual-phase Time Projection Chambers (TPCs) are leading the field of direct dark matter search for WIMP masses above a few GeV/c^2. As an alternative approach to overcome several challenges appearing when scaling up the dual-phase concept up to the size of the future DARWIN detector we investigate proportional scintillation in liquid xenon. In such single-phase TPC the charge signal is generated in the liquid phase by proportional scintillation close to very thin wires. The XeBRA (Xenon Based Research Apparatus) platform provides the possibility to run a small-scale TPC either in dual- or single-phase mode. First comparative results of the two individual detection concepts will be presented in this talk.

T 53.3 Wed 17:00 H-HS XIV

The xenon gas system for the DARWIN demonstrator — •Julia Müller — Physikalisches Institut, Albert-Ludwigs Universität Freiburg, Germany

DARWIN will be the ultimate liquid xenon-based dark matter detector with a sensitivity covering the entire accessible WIMP parameter space. With linear scales of about 2.6m its central low-background time projection chamber (TPC) and its technical realization will be challenging. We are currently setting up a large-scale demonstrator platform at the University of Freiburg which will feature a 2.8m diameter, flat (0.25m) cryostat for R&D in a liquid/gas xenon environment. Its maximal xenon content will be around 400 kg. This talk will present the xenon gas system required for xenon filling, purification, recuperation and long-term storage.

T 53.4 Wed 17:15 H-HS XIV

The LEGEND Liquid Argon Monitoring Apparatus (LLAMA) — •Mario Schwarz, Patrick Krause, Laszlo Papp, and Stefan Schönert — Physik-Department, Technische Universität München, Garching, Germany

Large volume liquid argon (LAr) detectors require a precise assessment of optical key parameters for both modeling and interpreting the data. Looking at neutrinoless double beta decay experiments, both the state-of-the-art GERDA experiment as well as the next-generation LEGEND detector employ the LAr technology as part of their active veto system. Therefore, modeling the LAr veto efficiency requires knowledge of the optical parameters in LAr, which depend on the actual impurity concentration in the liquid. To this end, a dedicated setup has been designed for in-situ measurements of the light yield, the triplet lifetime and the attenuation length of the 128 nm primary emission wavelength. The setup uses a triggered LAr scintillation light source and will be used both to measure the LAr properties of GERDA as well as a monitor for the LAr in LEGEND, where it will reside permanently. Hence, it is referred to as the LEGEND Liquid Argon Monitoring Apparatus (LLAMA).

An overview of LLAMA, as well as results of the characterization and testing campaign carried out at TUM will be shown.

The work has been supported in part by the German Federal Ministry for Education and Research (BMBF) Verbundforschung.

T 53.5 Wed 17:30 H-HS XIV

Optimization of separation columns for Kr-in-Xe assays — Hardy Simgen, Veronica Pizzella, and •Daniel Winkler — Max-Planck-Institut für Kernphysik Heidelberg

Liquid-xenon time projection chambers are among the most sensitive detectors in search for Weakly Interacting Massive Particles as dark matter. Due to the expected very low event rate, ultra-low background conditions are required. One of the most serious intrinsic backgrounds is the radioactive isotope ^{85}Kr, present in commercially available xenon. To achieve ultra-low concentrations, krypton traces are successfully reduced down to the ppq level e.g. by cryogenic distillation as for the XENONnT experiment.
The analytics of the remaining concentration can be performed off-line with a rare gas mass spectrometer (RGMS). Measuring ultra-low trace contaminations, a pre-separation of krypton in xenon by cryogenic gaschromatography is necessary. The RGMS at the Max-Planck-Institut für Kernphysik in Heidelberg uses a homemade system with miniaturized packed adsorbent columns and UHV-tight all-metal valves well suited for high purity demands.
I present a dedicated set-up for column testing, separation and performance optimization as well as signal shape examination. First results of the set-up will be shown and an outlook for further optimization will be given.

T 53.6 Wed 17:45 H-HS XIV

Slowcontrol systems for mid-scale LXe platforms — •Jaron Grigat — Albert-Ludwigs-Universitaet Freiburg

Slowcontrol systems play a crucial role in liquid xenon experiments. Their tasks are to ensure a stable environment for data collection, to prevent damage to sensitive electronics and to avoid the loss of expensive xenon. Additionally a slowcontrol system should achieve close to 100% of up-time while the experiment is running. Widely used open-source software solutions for data processing can be used to build powerful, scalable and reliable slowcontrol systems. These possibilities will be discussed based on the newly developed system for the Freiburg R&D platform with the purpose of gaining major insight into the development challenges and opportunities of the DARWIN experiment.

T 53.7 Wed 18:00 H-HS XIV

Transition Edge Sensor Production for Rare-Event Searches — •Tobias Ortmann[1], Margarita Kaznacheeva[1], Angelina Kinast[1], Alexander Langenkämper[1], Elizabeth Mondragón[1], Luca Pattavina[1], Walter Potzel[1], Johann Riesch[2], Stefan Schönert[1], Raimund Strauss[1], and Victoria Wagner[1] — [1]Technische Universität München, Physik Department, Lehrstuhl E15, James-Franck-Str. 1, D-85748 Garching — [2]Max-Planck-Institut für Plasmaphysik, Boltzmannstraße 2, D-85748 Garching

The CRESST and the NUCLEUS experiments are aiming for the detection of low-energetic nuclear recoil events (<100eV) induced by elastic scattering of dark matter particles or reactor antineutrinos, respectively. In both cases the detectors are operated as cryogenic calorimeters at mK temperatures and the phonon signals are read out by W thin-film transition edge sensors. For future large scale production, to simplify the production cycles and to improve sensitivity, the application of magnetron sputtering is investigated in terms of film quality and reproducibility. Using X-ray diffractometry we established a preselection procedure of films for cryogenic measurements. First results from a prototype TES produced at the Max Planck Institute for Plasma Physics with a transition temperature of 35 mK are presented. This work was supported by the DFG Excellenzclusters UNIVERSE and ORIGINS, the SFB 1258, the ERC StG-2018 "NU-CLEUS" and the Maier-Leibnitz-Laboratory (Garching).

T 53.8 Wed 18:15 H-HS XIV

High-Purity CaWO4 Crystals for the CRESST Dark Matter Search — •Angelina Kinast[1], Andreas Erb[1,2], Margarita Kaznacheeva[1], Alexander Langenkämper[1], Elizabeth Mondragon[1], Tobias Ortmann[1], Luca Pattavina[1], Walter Potzel[1], Stefan Schönert[1], Raimund Strauss[1], and Victoria Wagner[1] — [1]Physik Department E15, Technische Universität München, D-85748 Garching — [2]Walther-Meißner-Institut für Tieftemperaturforschung, D-85748 Garching

The direct dark matter search experiment CRESST uses scintillating CaWO4 single crystals as a target for potential recoils of dark matter particles. For several years, CaWO4 crystals have been produced in-house at TUM via Czochralski growth from the raw materials CaCO3 and WO3. In order to achieve the future background goals of CRESST, extensive powder purification procedures, e.g. by using the precipitation method, have been developed and applied. Recently the first crystal from this purified material was grown and has been installed as a cryogenic detector in the CRESST setup at the Gran Sasso underground laboratory. Moreover, I will present the status of a dedicated cryogenic alpha screening facility at the TUM shallow underground laboratory (UGL), which will be an important tool to characterize the intrinsic radio purity of single crystals. This research was supported by the DFG cluster of excellence Origins, by the BMBF Verbundprojekt 05A2017 CRESST-XENON and by the SFB1258.

T 53.9 Wed 18:30 H-HS XIV

Characterization of germanium detectors using positron emission tomography — •Lukas Rauscher, Josef Jochum, Katharina Kilgus, Ann-Kathrin Schütz, and Andreas

Zschocke for the GERDA-Collaboration — Physikalisches Institut Tübingen, Auf der Morgenstelle 14, Tübingen, Deutschland

Pulse shape discrimination (PSD) in germanium detectors is an integral part of background reduction in several 0vbb experiments such as GERDA. The efficiency of the PSD can be cross-checked using positron emission tomography (PET), which is used for medical imaging. A PET detector is a segemented, cylindrical detector for photons originating from the annihilation of electron positron pairs. From the intensity distribution of the coincident photons the spatial distribution of the b+ emitter can be reconstructed. To characterize a germanium detector, it is irradiated with a collimated Ta-208 source generating electron positron pairs in the germanium detector. The free electron generates a pulse in the germanium detector and the positron annihilates with an electron of the bulk material generating a signal in two different pixels of the PET detector. Due to the short mean free path of the positron compared to the spatial resolution of the PET detector, the point of interaction can be fixed as the intersection of the incoming gamma beam with the connecting line of the two pixels. The pulse in the germanium detector can be mapped to the spatial position of its origin inside the germanium detector. In this talk the principle of the technique as well as first measurements regarding the functionality of the PET will be presented. This work is funded by the BMBF.

T 53.10 Wed 18:45 H-HS XIV

Charge-carrier collective effects in Ge detectors and the impact for Legend — •Tommaso Comellato, Matteo Agostini, and Stefan Schönert for the LEGEND-Collaboration — Technical University of Munich, München, Deutschland

The state-of-the-art technology in germanium crystals allows the production of detector blanks with lengths and diameters of 10cm, and a level of impurities in the range of 10^{10} atoms/cm^3. With these values, such crystals can be converted into High Purity Germanium (HPGe) detectors. In such devices, the time structure of the signal can be used to discriminate the topology of the energy deposition. This is exploited in the search for neutrinoless double beta ($0\nu\beta\beta$) decay of ^{76}Ge, where HPGe detectors enriched in ^{76}Ge are used simultaneously as source and detector (Gerda, Legend). In the effort to enlarge the detector dimensions, new geometries such as the Inverted Coaxial have been recently developed[1][2]. In this new type of detectors the time needed to collect electrons and holes is much larger than the detectors used in the current $0\nu\beta\beta$ experiments. Longer collection times lead to the observation of subleading effects in the signal formation due to the self-interaction of the electron and hole clusters during their migration. In this talk I will present the impacts that such effects have on signal shape and on pulse shape discrimination performance. This work has been supported in part by the German Federal Ministry for Education and Research (BMBF) Verbundforschung 05A17W02.

[1] R. J. Cooper et al., Nucl. Instrum. Meth. A665 (2011) 25
[2] A. Domula et al., Nucl. Instrum. Meth. A891 (2018) 106

T 54: Axion like particles I

Time: Wednesday 16:30–19:00 Location: H-HS XV

T 54.1 Wed 16:30 H-HS XV

Power boost optimisation for the MADMAX dielectric haloscope — •Lolian Shtembari for the MADMAX-Collaboration — Max Planck Institute for Physics, Munich, Germany

The MADMAX experiment is aimed to directly detect dark matter axions with masses between 40μeV and 400μeV by means of a dielectric haloscope.

Such a setup promotes the conversion of axions to photons at boundaries between materials of different dielectric constants under a strong magnetic field in order to produce an electromagnetic signal.

Combining many such surfaces, the conversion and the power of the emitted signal can be significantly enhanced using constructive interference and resonances.

In the highly dimensional phase space defined by the relative position of such surfaces with respect to each other, we investigate the distribution of the power boost and we look for the largest possible enhancement by means of global optimisation algorithms.

T 54.2 Wed 16:45 H-HS XV

Development of components for the MADMAX prototype booster system — •Christoph Krieger for the MADMAX-Collaboration — Universität Hamburg

The axion, a low-mass particle arising from an elegant solution to the strong CP problem, is a viable and natural candidate for (cold) dark matter. Due to a linear relation between the axion mass and its coupling, for low axion masses, detection becomes non-trivial.

Especially, the range of 40 to 400 μeV, favored in one of the well motivated scenarios, cannot be accessed with the standard haloscope approach. Therefore, for the **MA**gentized **D**isc and **M**irror **A**xion e**X**periment the dielectric haloscope approach will be used, utilizing the axion photon conversion at dielectric surfaces in a strong magnetic field. By combining many surfaces, the conversion can be boosted significantly using constructive interference and resonances.

To prototype the MADMAX booster system a small booster with twenty dielectric discs of 300 mm diameter is foreseen which have to be (re-)positioned in situ with micrometer precision inside a large magnetic field and a cryogenic environment. The prototype system will be commissioned in a dedicated cryostat at the University of Hamburg and later, possibly, operated at CERN in the MORPURGO magnet for a first axion search with a dielectric haloscope.

In this presentation, the concept of the MADMAX prototype and especially the development of the booster will be presented, showing the recent status of the production of tiled discs as well as studies on the drive system.

T 54.3 Wed 17:00 H-HS XV

Search for Axion-Like Particles at BESIII — •Julian Walter, Achim Denig, and Christoph Florian Redmer for the BESIII-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland

Axions or axion-like particles (ALPs) are hypothetical elementary particles proposed by theoretical approaches to extend the Standard Model of particle physics. While initially postulated as a solution to the strong CP problem of Quantum Chromodynamics, the existence of such a particle a could contribute to our understanding of other unsolved problems of modern particle physics. One such example is the anomalous magnetic moment of the muon a_μ, where the experimentally measured value deviates from the theoretical prediction by $3-4\sigma$. Furthermore, ALPs are considered promising candidates for cold Dark Matter.

The BESIII experiment at the BEPCII e^+e^- collider in Beijing, China, offers a great opportunity to investigate the possible production of ALPs in two-photon fusion reactions, assuming a subsequent decay $a \to \gamma\gamma$. This contribution will present a feasibility study of such investigations — Supported by DFG SFB 1044.

T 54.4 Wed 17:15 H-HS XV

Search for Axion-Like Particles in early Belle II data — •Michael De Nuccio for the Belle II-Collaboration — DESY, Hamburg, Germany

The Belle II experiment, located at the asymmetric e^+e^- collider SuperKEKB in Tsukuba, Japan, is a second-generation B factory. A first commissioning run took place in Spring 2018. The main physics data taking began in early 2019. Thanks to the very clean environment and dedicated triggers, Belle II is suited to perform searches for dark-sector particles.

Axion-Like Particles (ALPs) are light, neutral pseudoscalars interacting predominantly with Standard Model photons, and have been proposed both as candidate dark matter particles or as portal particles to the dark sector. The Belle II sensitivity to ALPs produced in association with a recoil photon from e^+e^- collisions, and decaying promptly into two photons, is competitive with the small commissioning collisions dataset collected in 2018. This talk will present the results of this search, and will show the new limits that the Belle II experiment is able to set for this process.

T 54.5 Wed 17:30 H-HS XV

A Ray Tracer for Axions at CAST — Klaus Desch[1], •Johanna von Oy[1], Jochen Kaminski[1], Sebastian Schmidt[1], To-

bias Schiffer[1], and Arshia Ruina[2] — [1]Physikalisches Institut, Uni Bonn — [2]DPNC, Université de Genève, CH-1211 Genève 4, Switzerland

The CAST (CERN Axion Solar Telescope) experiment has primarily been searching for solar axions and other dark matter candidates since 2003. In 2017 and 2018 data has been taken at CAST with an InGrid detector (a MicroMegas like gaseous detector) behind a purpose-built X-ray telescope. To calculate the expected flux arriving at the detector, a ray tracer has been developed.

In this case, the ray tracer tracks the path of thousands of axions from the sun, through the CAST magnet, where they are converted to X-ray photons. Those are then traced through the X-ray telescope to the detector.

It takes into account the production probability of axions for each radius of the sun and for each energy of the axion, which is calculated after choosing an axion model as well as a solar model. Following this, the path of the axion - and after conversion in the magnet, the photon - is constricted by the dimensions of the setup. Especially the Wolter I X-ray telescope is looked upon precisely as the reflection needs to be calculated and its transmission probability depends on the incoming angle and the energy of the X-ray.

The ray tracing of solar axions at CAST will be presented step by step.

T 54.6 Wed 17:45 H-HS XV

KWISP - Hunting Chameleons at the CAST Experiment at CERN — •Justin Baier, Horst Fischer, and Marc Schumann — Albert-Ludwigs-Universität Freiburg

The KWISP (Kinetic Weakly Interacting Slim Particle) detector is part of the CAST experiment at CERN exploring the dark sector. It utilizes an ultra-sensitive opto-mechanical force sensor for the search for solar chameleons. Chameleons are hypothetical scalar particles postulated as dark energy candidates, which have a direct coupling to matter depending on the local density. Considering these characteristics a flux of solar chameleons hitting a solid surface at grazing incidence will, under certain conditions, reflect and exert the equivalent of a radiation pressure. To exploit this trait the KWISP sensor consists of a thin and rigid dielectric membrane placed inside a resonant optical cavity. First results have been published and will be presented in this talk. Meanwhile, various detector upgrades have been implemented, which will be discussed as well.

T 54.7 Wed 18:00 H-HS XV

Method to search for axion-like particles (ALPs) in storage rings, demonstrated at COSY — •Swathi Karanth — Institute of Physics, Jagiellonian University, Cracow, Poland

The axion was originally proposed to explain the small size of CP violation in quantum chromodynamics. It would be light in weight and weakly coupled to nucleons. If sufficiently abundant, it might be a candidate for dark-matter in the universe. Axions or axion-like particles (ALPs), when coupled with gluons, induce an oscillating Electric Dipole Moment (EDM) along the nucleon's spin direction. This can be used in an experiment to search for axions or ALPs using charged particles in a storage ring.

In spring of 2019, at the Cooler Synchrotron (COSY) in Jülich, we performed a first test experiment to search for ALPs using an in-plane polarized deuteron beam with a momentum of 0.97 GeV/c. If the EDM oscillation due to ALPs is in resonance with the spin precession frequency of the beam, then there is an accumulation of vertical polarization. The experiment involved the development of a beam with four bunches, each with different polarization direction and a long polarization lifetime. This allows the ALP to be detected despite ignorance about the oscillating EDM phase. We scanned a frequency window of 1kHz around the spin precession frequency of 121 kHz. I will talk about the experiment and present the preliminary results.

T 54.8 Wed 18:15 H-HS XV

A Two-Higgs-Doublet Variant of the Standard*Model*Axion *Seesaw*Higgs-Portal-Inflation Model — •Michael Matlis and Andreas Ringwald — Deutsches Elektronen-Synchrotron DESY, Theory Group, D-22603 Hamburg, Germany

The Standard Model (SM) suffers from five shortcomings: Dark Matter, Neutrino masses and mixing, Baryon asymmetry, Strong CP-Problem and Inflation. The latter is regarded as the seeds for structure formation. In this contribution, we introduce the 2hdSMASH (Two-Higgs-Doublet SM*Axion*Seesaw*Higgs-Portal-Inflation) model which aims at giving a complete and unified picture of the universe evolution from the inflationary epoch to today.

T 54.9 Wed 18:30 H-HS XV

The search for axion-like particles within A2 — •Daniel Maurer, Achim Denig, and Lena Heijkenskjöld for the A2-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland

A special type of hypothetical pseudo-scalar particles has been postulated in Standard Model extensions to solve the strong CP problem, the so-called axion-like particle (ALP). Additionally, they might be a solution for the puzzle of the anomalous magnetic moment of the muon, as well as a candidate for cold dark matter. By considering ALPs to be dominantly coupling to photons, they can be produced in Primakoff production off a nuclear target, in t-channel photon exchange, and can be searched for in two photon final states.

In this presentation, we discuss a feasibility study of the possibility to detect ALPs within the CB/TAPS setup of the A2 collaboration at MAMI. The experiment uses a Bremstrahlung distributed photon beam with $E_{max} = 1492$ MeV impinging on a fixed target, along with a system of detectors that nearly covers the full solid angle for high precision nuclear experiments. A simulation of the fixed-target particle interaction $\gamma p \to ap \to \gamma\gamma p$ is performed, accounting for a Bremsstrahlung distribution of the incident photon beam together with the Primakoff doubly-differential cross section. The resulting kinematical distributions of the final state particles are investigated to determine the acceptance of the CB/TAPS detector system.

—Supported by DFG SFB1044.

T 54.10 Wed 18:45 H-HS XV

Searching for ALPs in light-by-light scattering in pp collisions using AFP proton tagging with the ATLAS detector — •Patrick Odagiu[1] and André Sopczak[2] — [1]EPFL Lausanne — [2]IEAP CTU in Prague

The search for an Axion-Like-Particle (ALP) is being performed using about $20\,\mathrm{fb}^{-1}$ data recorded with the ATLAS experiment and the ATLAS Forward Proton (AFP) detector in 2017. The AFP detector is positioned symmetrically at approximately 220 m about the interaction point near the beam pipe and is used to measure the kinematics of surviving protons. The high-mass diphoton spectrum is studied for the search for an ALP mediated by light-by-light scattering. At the current stage of the analysis, the focus is on a 1 TeV ALP with coupling $g = 0.001\,\mathrm{GeV}^{-1}$. Data containing photon information and AFP containers were prepared. The blinding strategy was established, along with the next steps in this search.

T 55: Search for new particles III

Time: Wednesday 16:30–19:00 Location: H-HS XVI

T 55.1 Wed 16:30 H-HS XVI

Search for high mass lepton flavour violating processes with CMS — •Sebastian Wiedenbeck, Thomas Hebbeker, Arnd Meyer, and Swagata Mukherjee — III. Physikalisches Institut A, RWTH Aachen University

Lepton flavour is a conserved quantity in the standard model of particle physics, but it does not follow from an underlying symmetry. Neutrino oscillations imply that lepton flavour is not conserved in the neutral sector. Lepton flavour violating processes are common in several models of physics beyond the standard model (e.g. supersymmetry with R-parity violation, black hole production, and leptoquarks). Some models predict objects at the TeV mass scale that can decay into two standard model leptons of different flavours: electron + muon, muon + tau, or electron + tau. The challenges in a search for such phenomena are to achieve a high mass resolution, good rejection of standard model backgrounds, and efficient lepton identification at the same time. The

status of the analysis is presented, based on the latest CMS data taken in Run 2.

T 55.2 Wed 16:45 H-HS XVI

Search for new Physics in Boosted $HH \to bb\tau\tau$ Decays — •David Kirchmeier, Wolfgang Mader, and Arno Straessner for the ATLAS-Collaboration — TU Dresden

The resonant and non-resonant production of two Higgs bosons play an important role in the investigation of the Higgs self-coupling and in searches for physics beyond the Standard Model. Due to the relatively high Higgs mass and its narrow width, decays into two Higgs bosons are ideal e.g. in searches for heavy Higgs bosons. Furthermore the $HH \to bb\tau\tau$ decay channel is promising as the Higgs decay into a pair of b quarks has the highest branching ratio, while the decay into $\tau\tau$ final states has still a moderately high branching ratio and allows good separation against multi-jet background.

In particular the regime of very high mass resonances above 1 TeV is experimentally challenging. The high boost of the two b quarks and the two τ leptons lead to signatures with close-by pairs of b jets and τ decays in the ATLAS detector and requires dedicated experimental techniques to tag those topologies. This talk presents how the search for new physics in the $bb\tau\tau$ final state is extended to the regime of high mass resonances above 1 TeV. For that purpose the latest developments in the identification of highly boosted τ pairs in the fully hadronic decay channel are presented. It will be shown how these new techniques are applied in a search for new physics in the $bb\tau\tau$ final state. The latest results using the full Run-2 dataset of 139 fb^{-1} will be shown.

T 55.3 Wed 17:00 H-HS XVI

A multi-dimensional search for new heavy resonances decaying to boosted WW, WZ, ZZ, WH or ZH boson pairs in the dijet final state at 13 TeV — •Irene Zoi[1], Anna Benecke[1], Andreas Hinzmann[1], Robin Aggleton[1], and Daniela Schaefer[2] — [1]University of Hamburg — [2]KIT

The standard model, the best to date description of elementary particles and their interactions, still has open questions, such as the hierarchy problem. In the attempt to solve this issue, extensions of the standard model predict the existence of new massive resonances. Here a search for such new resonances decaying to two bosons (WW, WZ, ZZ, WH or ZH), where the vector bosons decay hadronically and the Higgs boson decays into pairs of bottom quarks is presented. Multiple resonance production modes are investigated, for the first time also vector-boson fusion is considered with this final state. The analysis is performed on data corresponding to an integrated luminosity of 137.2 fb^{-1} recorded with the CMS experiment at the LHC at a centre-of-mass energy of 13 TeV. The signal extraction method is based on a three-dimensional maximum likelihood fit of the dijet invariant mass and the mass of both jets. This approach has proven to increase the sensitivity and to be applicable to a diverse set of final states. As the search is focused on heavy resonances, where the decay products of each boson are expected to be collimated into one single jet, substructure techniques are exploited to significantly reduce the standard model background. Improvements in boson tagging techniques and sensitivity estimates with the full dataset will be presented.

T 55.4 Wed 17:15 H-HS XVI

Search for a long-lived particle in $b \to s$ transitions at Belle II — •Sascha Dreyer for the Belle II-Collaboration — DESY Hamburg

The Belle II experiment at the asymmetric e+ e- SuperKEKB collider in Tsukuba, Japan can be used for B-physics studies as well as searches for dark sectors. A hypothetical new long-lived scalar particle that mixes with the Standard Model Higgs boson could serve as a mediator to dark sectors. This scalar particle could be produced in $b \to s$ transitions and decay to a pair of charged Standard Model particles with a vertex displaced from the interaction point. Photons interacting with the detector material and converting to an e+ e- pair before reaching the calorimeter feature a similar topology. Studying this process is important to understand possible backgrounds as well as reconstruction efficiencies for this search. This talk gives an overview of the search for a new long-lived scalar particle at Belle II including a study of photon conversions.

T 55.5 Wed 17:30 H-HS XVI

Sensitivity studies for the search for heavy neutral leptons in decays of W bosons produced in 13 TeV pp collisions using displaced signatures with the ATLAS detector — •Christian Appelt and Heiko Lacker for the ATLAS-Collaboration — Humboldt University, Berlin, Germany

The existence of right-handed neutrinos with Majorana masses below the electroweak energy scale can address ongoing problems of neutrino masses, matter-antimatter asymmetry of the universe and dark matter. In this work, we present a sensitivity study in the search of heavy neutral leptons (HNLs) in the mass range of 4.5-10 GeV. The HNLs are produced in leptonic decays of on-shell W bosons formed in 13 TeV pp collisions at the Large Hadron Collider. We are focusing on unique displaced signatures captured by the ATLAS detector. The displaced signatures are characterized by a prompt muon originating from the W boson decay and a secondary vertex displaced in the radial direction by 4-300mm from the beam line. The displaced HNL search considers data with an integrated luminosity of up to 139/fb and results are given as exclusion contours in the HNL coupling strength versus mass plane.

T 55.6 Wed 17:45 H-HS XVI

Search for Excited Leptons in the 2-Lepton + 2-Jet Final State with CMS — •Jonas Roemer, Thomas Hebbeker, and Kerstin Hoepfner — III. Physikalisches Institut A, RWTH Aachen University

This talk presents a new search for excited leptons using data collected by the CMS detector. The theory is based on compositeness models and allows the production of excited leptons via contact interactions in conjunction with a Standard Model lepton. It would provide an explanation for the observed hierarchy of three generations of fermions. This search features a new decay mode of the excited leptons into one lepton and two jets via a contact interaction.

We present limits based on the full 2016 and 2017 proton-proton dataset corresponding to a luminosity of 77.4 fb^{-1} at a center of mass energy of $\sqrt{s} = 13$ TeV and compare if with recent search results in other channels.

T 55.7 Wed 18:00 H-HS XVI

Search for heavy Vh resonances with the ATLAS detector in the final state with boosted $h \to b\bar{b}$ decays — •Andreas Hönle, Dominik Duda, Sandra Kortner, Hubert Kroha, and Stefan Maschek — Max-Planck-Institut für Physik

Many extensions of the Standard Model (SM) predict the existence of heavy resonances that decay into boson pairs. A process with promising search prospects is the decay of a heavy particle into a SM vector boson V ($\equiv W, Z$) and the SM Higgs boson h with a subsequent leptonic V decay and a Higgs boson decay into a pair of b quarks.

With the final Run 2 ATLAS dataset of 139 fb^{-1}, recorded at $\sqrt{s} = 13$ TeV, this process can be probed in new regions of phase space which were not accessible before.

This talk presents most recent results from the search for Vh resonances in the semileptonic decay channel based on the full Run 2 ATLAS dataset.

T 55.8 Wed 18:15 H-HS XVI

Resonanz-Suchen im Zwei-Boson-Zerfallskanal mit vollhadronischem Endzustand mit dem CMS-Experiment — Thomas Müller und •Daniela Schäfer — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Intstitut für Technologie (KIT)

Viele Erweiterungen des Standardmodells sagen die Existenz neuer Teilchen mit Massen im TeV-Bereich voraus, die zum Beispiel über ihren resonanten Zerfall in zwei Vektor-Bosonen nachgewiesen werden könnten. Die hier präsentierte Suche benutzt bei einer Schwerpunktsenergie von 13 TeV mit dem CMS-Detektor aufgenommene Daten, um im vollhadronischen Endzustand nach exotischen Zwei-Boson-Resonanzen zu suchen. Aufgrund der großen Masse der gesuchten Resonanzen sind ihre Zerfallsprodukte stark geboostet. Ein solches geboostetes Vektor-Boson kann nicht mehr über zwei einzelne Jets rekonstruiert werden, sondern seine Zerfallsprodukte werden stattdessen in einen einzigen "fetten" Jet geclustert. Um zwischen solchen Jets, die von stark geboosteten Vektor-Bosonen stammen, und Untergrund-Jets zu unterscheiden, werden Methoden basierend auf der Substruktur der Jets verwendet (*V-tagging*). Eine weitere Herausforderung ist die Modellierung des von QCD-Multijet Ereignissen dominierten Untergrundes. Hierfür wird eine neue Strategie verwendet, die auf einem multidimensionalen Fit im Zwei-Jet-Massenspektrum m_{jj} und den zwei Jet-Massen m_{jet1} und m_{jet2} beruht.

T 55.9 Wed 18:30 H-HS XVI

Search for Diboson Resonances ($X \longrightarrow Zh, Wh$) produced via Vector Boson Fusion with the ATLAS Detector. — •Stefan Maschek, Dominik Duda, Andreas Hönle, Sandra Kortner und Hubert Kroha für die ATLAS-Kollaboration — Max-Planck-Institut für Physik, München

The heavy vector triplet (HVT) model summarizes several extensions of the Standard Model into one phenomenological Lagrangian and predicts heavy vector bosons Z' and W', which can decay into the Standard Model Higgs boson h and SM vector boson Z or W. In some regions of the model parameter space, the couplings to fermions are forbidden such that the production of these new hypothetical particles via the fusion of two vector bosons (VBF) becomes the dominant production process.

In this production mode, the two quarks that each irradiate a vector boson, will form hadron showers in opposite hemispheres in the forward region of the ATLAS detector, resulting in a large gap in the pseudorapidity of those two jets.

This talk will present the results of a search for the Vh ($V = W, Z$) resonances produced via the vector boson fusion. The studies in this final state are performend for the first time in ATLAS.

T 55.10 Wed 18:45 H-HS XVI

Search for FCNC coupling between the top quark and the Higgs boson in the H→ $b\bar{b}$ decay channel — •Arunika Sahu for the ATLAS-Collaboration — Bergische Universitaet Wuppertal

Processes involving flavour-changing neutral currents (FCNC) are highly suppressed in the top-quark sector. Any observations of such processes would therefore be a signal for physics beyond the Standard Model. The FCNC contributions in pp→tH process comes from qtH and qtg interactions at leading order. We assume the qtg coupling contributions to be negligible and consider only qtH coupling contributions. In the presented analysis, we search for the pp→tH process, involving ctH and utH FCNC vertices. Final states are considered in which the top quark decays semi-leptonically and the Higgs boson decays into a $b\bar{b}$ pair. A serious background to $tH(H \to b\bar{b})$ are events featuring two b-jets from top decays and one or two heavy flavour jets from gluon splitting. $t\bar{t}$ with 3 b-tagged jets are expected to be underestimated. We develop a data-driven approach to correct this $t\bar{t}$+ Heavy Flavor underestimation in our signal regions. This challenging $t\bar{t}+b\bar{b}(c\bar{c})$ background is estimated via dedicated control regions. Neural networks are employed to separate signal and background events in the signal region.

T 56: Experimental methods III

Time: Wednesday 16:30–18:45 Location: H-ÜR 1

T 56.1 Wed 16:30 H-ÜR 1

Background reduction in KATRIN by induced de-excitation of Rydberg atoms with terahertz radiation — •Enrico Ellinger for the KATRIN-Collaboration — Bergische Universität Wuppertal

A major background in the neutrino mass experiment KATRIN is supposed to originate from the ionization of Rydberg atoms within the main spectrometer (MS) volume. In Rydberg atoms one or more electrons have a high principal quantum number n resulting in a large orbital radius and long decay periods in the ms range. Once produced in radioactive processes in the surface of the MS vessel wall the neutral Rydberg atoms can travel through the whole MS before they get ionized by thermal radiation and finally accelerated towards the main detector producing the background. Terahertz radiation can be used to stimulate Δn= $\pm$ 1 transitions to states from where spontaneous de-excitation to ground state is faster (μs range). This approach was pioneered by the anti-hydrogen community at CERN. However, due to the very different environment in comparison to atomic trap experiments the feasibility at KATRIN must be examined. This study is presented as well as the first draft of an experimental set-up for testing this new method.

T 56.2 Wed 16:45 H-ÜR 1

Pile-up in the Borexino experiment — •Alexandre Göttel[1,2], Zara Bagdasarian[1], Mariia Redchuk[1,2], Sindhuja Kumaran[1,2], Livia Ludhova[1,2], Ömer Penek[1,2], Giulio Settanta[1], and Apeksha Singhal[1,2] — [1]IKP-2, FzJ — [2]RWTH Aachen University

In particle physics, pile-up refers to recorded physics events in which two or more uncorrelated physical processes occur so close in time that the detector is unable to correctly distinguish between them. The Borexino Detector is a liquid scintillator detector located at the Laboratori Nazionali del Gran Sasso (LNGS) in Italy. It was built with the primary goal of detecting solar neutrinos, with an unprecedented sensitivity below 2 MeV. Because of similarities in the rate and spectral shape of pile-up events and low-energy solar neutrino events, pile-up is one of the most crucial backgrounds in the energy range of Borexino's solar neutrinos measurement (e.g. neutrinos from the pp-chain, and from the CNO-chain). Therefore it is extremely important to tightly constrain the spectral shape and rate of pile-up events for different energy estimators. In this talk the methods used to estimate pile-up in Borexino will be presented, and the results will be discussed alongside the different sources of statistical and systematic uncertainty.

T 56.3 Wed 17:00 H-ÜR 1

Data-driven Continuum Monte Carlo Corrections for Belle and Belle II — •Lena Feld[1], Florian Bernlochner[2], Pablo Goldenzweig[1], and Markus Prim[1] for the Belle II-Collaboration — [1]Karlsruher Institut für Technologie — [2]Rheinische Friedrich-Wilhelms-Universität Bonn

The Belle and Belle II experiments record BB decays at the Y(4S) resonance. For background determination, continuum data without B meson decays is recorded 60 MeV below the resonance. We present a method to improve the simulation of the continuum in a data-driven way. For this purpose, a multivariate classifier is trained to distinguish the Monte Carlo prediction from the continuum data. The classification is used to reweight the individual events of the Monte Carlo prediction. We present early studies on the improvability of the continuum Monte Carlo sample.

T 56.4 Wed 17:15 H-ÜR 1

Bias mitigation in Selective Background Monte Carlo Simulation at Belle II — •Yannick Bross[1], Thomas Kuhr[1], Andreas Lindner[1], and James Kahn[2] for the Belle II-Collaboration — [1]Ludwig-Maximilians-Universität München — [2]Karlsruhe Institute of Technology

The Belle II experiment is expected to collect a total of 50 ab^{-1} in its lifetime. Considering the focus of measurements on rare processes with a small branching fraction, a strong statistical understanding of the background is required. However, a significant portion of the simulated data is discarded trivially in the first stage of analysis, warranting a better method of simulation to keep up with the amount of data. For this purpose a neural network is implemented to select the relevant data after the Monte Carlo event generation and then only simulate selected events. Existing methods have shown great success with graph neural networks, but lack a good understanding and control of any biases they introduce during selection. Therefore carefully controlling any biases that arise is an important task to improve the network. In this work we introduce methods of checking and further mitigating potential biases.

T 56.5 Wed 17:30 H-ÜR 1

Selective background simulation using graph neural networks at Belle II — •James Kahn[1], Andreas Lindner[2], Emilio Dorigatti[2], and Thomas Kuhr[2] for the Belle II-Collaboration — [1]Karlsruher Institut für Technologie — [2]Ludwig-Maximilians-Universität München

The large volume of data expected to be produced by the Belle II experiment presents the opportunity for studies of rare, previously inaccessible processes. Investigating such rare processes in a high data volume environment necessitates a correspondingly high volume of Monte Carlo simulations to prepare analyses and gain a deep understanding of the contributing physics processes to each individual study. This resulting challenge, in terms of computing resource requirements, calls for more intelligent methods of simulation, in particular for background processes with very high rejection rates. This work presents a method

of predicting in the early stages of the simulation process the likelihood of relevancy of an individual event to the target study using graph neural networks. The results show a robust training that is integrated natively into the existing Belle II analysis software framework.

T 56.6 Wed 17:45 H-ÜR 1

Pixel Detector Background Generation using Generative Adversarial Networks at Belle II — Matej Srebre, Thomas Kuhr, •Hosein Hashemi, and Martin Ritter for the Belle II-Collaboration — Ludwig-Maximilians-Universität München

The pixel detector (PXD) is an essential part of the Belle II detector recording particle positions. Data from the PXD and other detectors allow us to reconstruct particle tracks and decay vertices. The effect of background noise on track reconstruction for measured data is emulated for simulated data by a mixture of measured background noise and easily-simulated particle decays. This model requires a large set of statistically independent PXD background noise samples in order to avoid the systematic bias of reconstructed tracks. However, data from the fine-grained PXD requires a substantial amount of storage. As an efficient way of producing background noise, we explore the idea of an on-demand PXD background generator using Generative Adversarial Networks (GANs).

T 56.7 Wed 18:00 H-ÜR 1

Accuracy and performance of Geant4 in background simulations for rare event searches — •Holger Kluck[1,2], Robert Breier[3], Alexander Fuss[1,2], Valentyna Mokina[2], Veronika Palušová[3], and Pavel Povinec[3] — [1]Atominstitut, Technische Universität Wien, A-1020 Wien, Austria — [2]Institut für Hochenergiephysik der Österreichischen Akademie der Wissenschaften, A-1050 Wien, Austria — [3]Comenius University, Faculty of Mathematics, Physics and Informatics, 84248 Bratislava, Slovakia

Searches for rare events depend crucially on an accurate prediction of the background. Depending on the type of search, the energies of interest go from the MeV regime, e.g. for neutrinoless double-beta ($0\nu2\beta$) decay, down to the sub-keV regime, e.g. for coherent elastic neutrino-nucleus scattering (CEνNS) and dark matter-nucleus scattering. A widespread Monte Carlo code to model the background is Geant4. It gives its users great freedom of configuration, i.a. by choosing the actual model for the particle interactions, the so-called physics list, and by setting the production threshold for secondary particles.

In this contribution, we assess the dependency of the obtained background spectra on the chosen Geant4 configuration for radioactive decays in Ge and $CaWO_4$ targets. First, a potential most accurate reference configuration is infered based on literature research. Afterwards we systematically scan the configuration space and compare the simulated spectra with the reference both in the MeV and in the sub-keV regime. Lastly, for configurations with a similar accuracy as the reference, we identify the one with the highest performance.

T 56.8 Wed 18:15 H-ÜR 1

Background rejection with the Liquid Argon Veto System of LEGEND-200 — •Patrick Krause[1], Maria Fomina[2], Konstantin Gusev[1,2], Jozsef Janicsko-Csathy[3], Oskar Moras[1], Stefan Schönert[1], Mario Schwarz[1], Egor Shevchik[2], and Christoph Wiesinger[1] — [1]Technische Universität München, Garching, Germany — [2]Joint Institute for Nuclear Research, Dubna, Russia — [3]Leibniz-Institut für Kristallzüchtung, Berlin, Germany

A discovery that neutrinos are Majorana fermions would have profound implications for particle physics and cosmology. The Majorana character of neutrinos would make possible the neutrinoless double-beta (0nbb) decay, a matter-creating process without the balancing emission of antimatter. The LEGEND Collaboration aims to develop a phased, ^{76}Ge-based double-beta decay experimental program with discovery potential at a half-life beyond 10^{28} years. The first Phase, LEGEND-200, aims for a discovery potential of 10^{27} years and a background index of 0.6 cts/(ROI t yr). Based on the success in GERDA a liquid argon veto system will be deployed in LEGEND-200 to actively suppress background events. It utilizes the property of liquid argon to scintillate upon the interaction with ionizing radiation. The emitted vacuum ultraviolet light is shifted to the optical spectrum and read out by silicon photomultipliers mounted to the end of optical fibers. This talk will give an insight into the design considerations of the LEGEND-200 liquid argon veto system, driven by the performance of the GERDA liquid argon veto system. This work has been supported in part by the German Federal Ministry for Education and Research.

T 56.9 Wed 18:30 H-ÜR 1

An embedding technique to determine genuine $\tau\tau$ backgrounds from CMS data — Janek Bechtel, •Sebastian Brommer, Artur Gottmann, Oliver Kuntze, Günter Quast, and Roger Wolf — Karlsruhe Institut für Technologie, Karslruhe, Deutschland

The τ-embedding technique is a data-driven method, where dimuon events are selected from data, and the muons are replaced by simulated τ lepton decays. In this way, a hybrid event is created, which only relies on the simulation for the well understood τ lepton decay. The remainder of the event, by construction, provides a better description of the data than full simulation, especially for challenging simulation tasks, such as the underlying event or multijet production.

The τ-embedding technique is actively used by CMS to estimate standard model backgrounds that contain genuine τ decays.

The current status of the technique, as well as studies on polarization effects in embedded events are presented.

T 57: Silicon strip detectors

Time: Wednesday 16:30–18:15 Location: H-HS XVII

T 57.1 Wed 16:30 H-HS XVII

Design of a test system for Service Hybrids for CMS silicon strip modules — Alexander Bogner[1], Christian Dziwok[2], Lutz Feld[1], Waclaw Karpinski[1], Katja Klein[1], Martin Lipinski[1], •Alexander Pauls[1], Oliver Pooth[2], Marius Preuten[1], Max Rauch[1], Michael Wlochal[1], and Tim Ziemons[2] — [1]1. Physikalisches Institut B, RWTH Aachen — [2]3. Physikalisches Institut B, RWTH Aachen

The CMS Collaboration is developing two-sided silicon strip modules for the second phase of the CMS tracker upgrade. This upgrade will enable the CMS experiment to utilize the high luminosity provided by the future HL-LHC. The modules' Service Hybrids are responsible for the high and low voltage distribution on the module and the data transmission via optical links to the back-end electronics. During the production a test system for roughly 20,000 Service Hybrids will be needed.

A design for a standalone Service Hybrid test board, which has been produced for prototype qualification and active thermal cycling is presented. The choices in design are compared to a test card, which is compatible with a common infrastructure for CMS hybrid qualification during series production. Measurement results of Service Hybrid prototypes are also presented.

T 57.2 Wed 16:45 H-HS XVII

Qualifizierung von Silizium-Streifensensormodulen für das CMS-Experiment am HL-LHC — Tobias Barvich, •Justus Braach, Alexander Dierlamm, Ulrich Husemann, Roland Koppenhöfer, Stefan Maier, Thomas Müller, Andreas Nürnberg, Hans Jürgen Simonis und Pia Steck — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

Zur Vorbereitung auf den HL-LHC wird im Rahmen des Phase-2-Upgrades des CMS-Experiments der gesamte Spurdetektor ausgetauscht.
Der Bereich bei Radien größer 60 cm wird mit Silizium-Streifensensormodulen bestückt, den sogenannten 2S-Modulen. 2S-Module bestehen aus zwei parallel übereinander angeordneten Streifensensoren, zwei Auslese-Hybriden und einem Service-Hybrid, auf welchem Stromversorgung und optische Auslese des Moduls integriert sind.
Im November 2019 wurde am ETP ein neuer 2S-Modul-Prototyp gebaut, welcher zum ersten Mal eine optische Kommunikation mit den Auslesechips ermöglicht, die auch der späteren Verwendung des Moduls im Detektor entspricht. Dieser Modulprototyp wird hinsichtlich der Herausforderungen des Betriebs bei CMS sowohl im Labor als auch bei Teststrahlmessungen am DESY intensiv getestet.

Der Vortrag gibt einen Einblick in das am ETP bestehende Programm zur Qualifikation von Silizium-Streifensensormodulen und diskutiert die Ergebnisse von Messungen mit dem Prototyp des 2S-Moduls.

T 57.3 Wed 17:00 H-HS XVII

Assembly of functional 2S-modules for the Phase-2 Upgrade of the CMS-Tracker — Christian Dziwok[2], Lutz Feld[1], Katja Klein[1], Oliver Pooth[2], •Nicolas Röwert[1], Tim Ziemons[2], and Michael Wlochal[1] — [1]I. Physikalisches Institut B, RWTH Aachen University — [2]III. Physikalisches Institut B, RWTH Aachen University

In the course of the Long Shutdown 3 the LHC will be upgraded to the High Luminosity LHC (CERN) with a planned increased instantaneous luminosity of $5 \cdot 10^{34}$ cm^{-2}s^{-1}. For this purpose the current strip tracker of the CMS experiment will be replaced by innovative modules that are equipped with two vertically stacked silicon sensors each. In this sensor sandwich a measurable difference in the hit position is generated as the 3.8 T magnetic field inside the detector bends the particle tracks. This enables the selection of high transverse momentum tracks for the L1 trigger on a module basis.
The RWTH Aachen University as one of the assembly centers is responsible for manufacturing around 1000 of the so called 2S modules. A special assembly process is required to meet the high precision demands with simple-to-use tools to facilitate mass production. This talk presents the current progress and selected challenges of the procedure that appeared during the assembly of first functional modules.

T 57.4 Wed 17:15 H-HS XVII

Beam test of 2S module prototypes for the Phase-2 CMS Outer Tracker — Christian Dziwok[2], Lutz Feld[1], Katja Klein[1], Martin Lipinski[1], Alexander Pauls[1], Oliver Pooth[2], Max Rauch[1], Nicolas Röwert[1], and •Tim Ziemons[2] — [1]I. Physikalisches Institut B, RWTH Aachen University — [2]III. Physikalisches Institut B, RWTH Aachen University

The CMS detector will be upgraded in the Phase-2 Upgrade for the operation at the HL-LHC. Among others, the silicon tracking system will be completely replaced by a new system providing an extended acceptance, an improved granularity and the feature to include tracking information into the level-1 trigger. The new Outer Tracker will consist of 2S modules with two strip sensors and PS modules with a macro-pixel sensor and a strip sensor, specialized detector modules with onboard p_T discrimination.

The functionality of current generation prototype 2S modules has been tested at the test beam facility at DESY Hamburg. With a 4 GeV electron beam, various studies are performed like efficiency scans at different positions of the module or at varying inclination angles to mimic different p_T particles. In this talk, module related preparations for the test beam are presented and first results are shown.

T 57.5 Wed 17:30 H-HS XVII

Effizienzstudien von n-in-p Silizium-Makropixelsensoren für das Phase-2-Upgrade des CMS-Experiments — Tobias Barvich, Alexander Dierlamm, Alexander Droll, Ulrich Husemann, Thomas Müller, Jan-Ole Müller-Gosewisch, Andreas Nürnberg, Hans-Jürgen Simonis und •Florian Wittig — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

Im Rahmen des Phase-2-Upgrades des CMS-Experiments wird der äußere Spurdetektor komplett ausgetauscht. Es kommt ein neuer Modultyp zum Einsatz, der in der Lage ist Teilchen mit hohen Transversalimpulsen auf Modulebene zu identifizieren. Dies ermöglicht einen direkten Beitrag des Spurdetektors zur ersten Triggerstufe des CMS-Experiments (Level-1-Trigger).
Für eine Variante, dem PS-Modul, kommen siliziumbasierte n-in-p Streifen- und Makropixelsensoren zum Einsatz. Letztere bilden mit ihrer Streifenlänge von etwa 1,5 mm einen Kompromiss zwischen Pixel- und Streifensensoren und weisen somit eine verbesserte Ortsauflösung als reine Streifensensoren auf.
In diesem Vortrag werden Ergebnisse aus Teststrahlmessungen am Deutschen Elektronen-Synchrotron (DESY) in Hamburg mit Prototypen der Makropixelsensoren gezeigt und diskutiert.

T 57.6 Wed 17:45 H-HS XVII

Performance of the Lycoris large area strip telescope — •Uwe Kraemer, Marcel Stanitzki, Mengqing Wu, Ralf Diener, and Ties Behnke — DESY, Hamburg, Germany

The Lycoris high precision large area silicon telescope was designed and commissioned for the DESY II Test Beam Facility as part of the AIDA2020 project.
The telescope consists of six $9.35 \times 9.35\,\mathrm{cm}^2$ hybrid-less silicon microstrip sensors with a pitch of 25 μm. This strip pitch is made possible by routing all signals via extra metallization layers to the top surface where it is read out via an integrated pitch adapter and digital readout in the form of the KPiX readout ASIC as opposed to a more classical approach where each strip is read out via a wire bond at the end. The full system was tested in multiple test beam campaigns and first results of the sensor performance, including the achievable signal over noise ratio, hit efficiency, as well as the achievable single point resolution of the system will be presented.

T 57.7 Wed 18:00 H-HS XVII

Loading of strip silicon modules for the ATLAS ITk upgrade phase-II — •Alessia Renardi, Sergio Diez Cornell, and Othmane Rifki for the ATLAS-Collaboration — DESY

The upgrade of the central tracking system of the ATLAS experiment is required for the operation at the High Luminosity LHC (HL-LHC) starting in the middle of 2027. It needs to be completely replaced for the Phase II upgrade due to increased radiation environment, detector occupancy and trigger rate, as well as aging and radiation damage of the existing inner detector. The most basic unit, a module, of the new Inner Tracker (ITk) strip detector consists of a single silicon sensor, one or two flex hybrid circuit boards where the read-out chips are located, and a power-board. For the ATLAS ITk strip End-cap six flavors of modules have been designed, different in shape and structure. All of them are glued on both sides of a low-mass carbon-fibre support structures with embedded CO2 cooling, so-called petal core. A semi-electrical petal is going to be built at DESY-Hamburg: semi-electrical modules have been produced in different institutes of the ITk strip collaboration and are going to be glued on a petal core using an automatized procedure. The glue is dispensed on the local support structure and the pattern has to be investigated in order to aim for a good glue coverage as well as the required thickness and sensor flatness. The whole procedure will be shown explaining how the robot is able to pick and place every single module and glue it on the petal core.

T 58: Higgs: associated production

Time: Wednesday 16:30–19:00 Location: H-1.002

T 58.1 Wed 16:30 H-1.002

Optimisation of a deep neural network flavour-tagging algorithm to improve the definition of signal and control regions in the $t\bar{t}H$ ($H \to b\bar{b}$) search. — •Thea Engler, Manuel Guth, Andrea Knue, and Gregor Herten — University of Freiburg, Institute of Physics

The search for the $t\bar{t}H$ ($H \to b\bar{b}$) signal provides direct access to the top-Higgs Yukawa coupling. This channel has four b-jets in the final state and is suffering from large physics background, which makes b-tagging a crucial tool for this analysis. The dominant and most challenging background process is $t\bar{t} + b\bar{b}$. This process also contains four jets however, wherefore a simple b-tagger will not help to discriminate between signal and background. Nonetheless, the two b-jets from the $g \to b\bar{b}$ splitting can be so close that they are identified as one jet. Identification of these gluon splittings would allow to reject the $t\bar{t} + b\bar{b}$ background more efficiently. In this talk, a deep neural network is presented in which the nominal DL1 tagger used by the ATLAS experiment is extended by the $g \to b\bar{b}$ category, and first optimisation studies are shown.

T 58.2 Wed 16:45 H-1.002

Application of Deep Neural Networks to Combinatorial Assignment of Jets in a $t\bar{t}H(b\bar{b})$ Analysis in CMS — •Tobias

Lösche — Institut für Experimentalphysik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg

A precise determination of the interactions of the Higgs boson with other SM particles is a crucial part of the LHC physics program. When determining the top Yukawa coupling in $t\bar{t}H(b\bar{b})$ events, deep learning plays an integral role. In the single-lepton channel, multivariate approaches using deep neural networks (DNNs) achieve state-of-the-art performance in signal/background classification.

A particular challenge of this analysis is the discrimination of $t\bar{t}H(b\bar{b})$ events from the irreducible $t\bar{t}$ + $b\bar{b}$ background. Considering the combinatorial assignment of jets offers a possible means to deal with this problem and thus further improve performance. To achieve this, multiple DNN architectures were analyzed: An attention-based classifier, able to focus on the different combinations of objects in the event and a graph-based network, inferring relations between objects by learning a meaningful measure of distance between their respective nodes. The results of these analyses will be presented in this talk.

T 58.3 Wed 17:00 H-1.002

Measurement of the $t\bar{t}H$ production cross-section with $H \to b\bar{b}$ in the boosted topology with the ATLAS detector — •Eftychia Tzovara, Peter Berta, Lucia Masetti, and Alexander Basan — Institute of Physics, JGU Mainz, Germany

Studying the coupling of the Higgs boson to the top quark (the heaviest particle in the SM) is of particular interest, since it could be very sensitive to effects of physics beyond the SM (BSM). The most favorable production mode for a direct measurement of the Higgs-top Yukawa coupling is the Higgs production in association with a pair of top quarks, $t\bar{t}H$. The newly observed decay to two bottom quarks ($H \to b\bar{b}$) has the largest branching fraction of about 58%. This analysis aims at events in which one of the top quarks decays semileptonically, producing an electron or a muon. In the single-lepton channel, the so-called boosted topology, targets events containing a Higgs boson produced at high transverse momentum.

Due to the highly complex final state and the large Standard Model backgrounds, measuring the signal strength in this process is very challenging. The ultimate goal is to precisely estimate the amount of background events in order to maximise the significance of the measurement. For this purpose, multivariate techniques are used to discriminate between signal and background events, in particular from $t\bar{t}$ + jets production. In this talk, the challenges of this decay channel and the suppression of the background processes will be discussed. Finally, the measurement of the $t\bar{t}H(b\bar{b})$ cross-section, using the full LHC run-2 data collected by the ATLAS detector, will be presented.

T 58.4 Wed 17:15 H-1.002

Assoziierte Produktion eines Top Quarks und eines Higgs-Bosons am CMS-Experiment — Thorsten Chwalek, Nils Faltermann, Kevin Flöh, •Marco Link und Thomas Müller — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

Die assoziierte Produktion eines Top-Quarks und eines Higgs-Bosons (tH) ist ein noch nicht beobachteter Standardmodell Prozess mit einem Produktionswirkungsquerschnitt von etwa einem Zehntel des Produktionswirkungsquerschnitts der kürzlich entdeckten Produktion eines Top-Quarkpaars und eines Higgs-Bosons ($t\bar{t}$H). Im Gegensatz zu $t\bar{t}$H ist tH durch Interferenz sensitiv auf das Vorzeichen der Top-Higgs Kopplung.

Dieser Vortrag konzentriert sich auf die Rekonstruktion von tHq-, tHW-, $t\bar{t}$- und $t\bar{t}$H-Ereignissen im semileptonischen Kanal mit Zerfall des Higgs-Bosons in zwei Bottom-Quarks für die kombinierte Analyse von tH und $t\bar{t}$H auf den kompletten Run 2 Daten des CMS-Experiments. Die Rekonstruktion verwendet Boosted Decision Trees (BDTs) um die Jets den Quarks zuzuordnen. Zum Schluss werden erste Limits auf den tH-Produktionswirkungsquerschnitt, die Top-Higgs Kopplungskonstante und CP-Verletzung gezeigt.

T 58.5 Wed 17:30 H-1.002

Search for the $t\bar{t}H(H \to b\bar{b})$ process utilising improvements in Deep-Neural-Network-based b-tagging in ATLAS — •Manuel Guth and Andrea Knue — Uni Freiburg, Freiburg

ATLAS and CMS recently discovered the $t\bar{t}H$ production channel using LHC Run 2 data. However the $t\bar{t}H(H \to b\bar{b})$ process is not yet discovered due to its irreducible $t\bar{t}$+$b\bar{b}$ background and corresponding systematic uncertainties. The process allows a direct measurement of the Top-Yukawa coupling which is the strongest fermion-Higgs coupling in the Standard Model and plays therefore an important role in Higgs physics.

The challenging final state with at least 4 b-jets requires an advanced analysis strategy as well as sophisticated b-tagging algorithms.

The data collected during Run 2 with the ATLAS experiment allows to explore Higgs boson properties in the $t\bar{t}H(H \to b\bar{b})$ channel for the first time. Since this channel allows a reconstruction of the Higgs transverse momentum, a simplified cross-section measurement in bins of different Higgs p_{T} is possible. A first study of this measurement will be presented, followed by an outlook to planned improvements based on new b-tagging developments.

T 58.6 Wed 17:45 H-1.002

Improvements of the MVA classifiers for the ttH(bb) analysis in the dilepton channel with full Run2 data in the CMS experiment — Maria Aldaya, •Angela Giraldi, and Marino Missiroli — Deutsches Elektronen Synchrotron (DESY)

In the Standard Model (SM), the Higgs boson couples to fermions with a Yukawa-type interaction and a strength proportional to the fermion mass. The associated production of a Higgs boson with a top-quark pair ($t\bar{t}H$) is therefore the best direct probe of the top-Higgs Yukawa coupling, a vital element to verify the SM nature of the Higgs boson. In the SM, the Higgs boson decays into b-quark-antiquark pair with the largest branching fraction, and is thus experimentally attractive as a final state. The dominant background contributions arise from $t\bar{t}$+jets production, and in particular the $t\bar{t}b\bar{b}$ background is irreducible with respect to $t\bar{t}H$,$H \to b\bar{b}$. To better enhance the sensitivity, the signal is extracted exploiting multivariate analysis (MVA) techniques.

This talk focuses on the analysis of the $t\bar{t}H$,$H \to b\bar{b}$ process in final states with two leptons using proton-proton data collected by the CMS experiment at the LHC during 2016-2018 at $\sqrt{s} = 13$ TeV. The possibility to critically increase the sensitivity to the $t\bar{t}H$ signal is investigated using machine learning approaches. Detailed studies on the optimization and performance of MVA discriminants trained using Artificial Neural Networks are presented for the first time in this final state.

T 58.7 Wed 18:00 H-1.002

Towards a measurement of single top-quark production in association with a Higgs boson (tH) in the ditau channel at ATLAS — •Tanja Holm and Ian C. Brock — Physikalisches Institut Universität Bonn, Bonn, Germany

Single top-quark production in association with a Higgs boson sometimes is referred to as the "golden channel" of single top-quark processes due to the opportunities it gives in studying the couplings of the Higgs boson. Especially interesting is the sign of $\frac{C_F}{C_V}$ which results in the cross-section changing by almost one order of magnitude, as the pair production channel (ttH) is not sensitive to it.
The production of a top-quark in association with a Z boson has been discovered at ATLAS and CMS in the trilepton channel, considering the top-quark and the Z boson to decay leptonically. Because of this a promising channel for the tH search is the multilepton channel where the Higgs decays into two τ. Given that each τ has a 64.6% probability to decay hadronically we search for events containing two hadronic τ decays and events containing one hadronic τ decay.
This talk will discuss the search for the tH production in the hadronic τ channels in ATLAS using the Run 2 data of the LHC.

T 58.8 Wed 18:15 H-1.002

Simplified Template Cross Section measurement in the $t\bar{t}$H($\mathrm{H}\to b\bar{b}$) channel — Ulrich Husemann, Karim El Morabit, •Peter Krämer, and Matthias Schröder — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

Recently, $t\bar{t}$H-production has been observed for the first time and the CMS collaboration has established evidence for $t\bar{t}$H in the $\mathrm{H}\to b\bar{b}$ decay channel. An exciting next step is the exploration of more differential information using the larger datasets available by now.
Simplified Template Cross Sections (STXS) provide a framework designed as a next step of interpreting LHC Higgs data beyond the κ-framework. It defines mutually exclusive regions of phase space for each production mode. For each of these STXS bins, one can build a template based on the Standard Model prediction and fit them to data simultaneously, resulting in a differential measurement of the observable.
Within the recent update of the STXS framework, a binning is defined for $t\bar{t}$H-production for the first time.

In this talk, I will give an overview of STXS in $t\bar{t}H$-production and show studies towards a first STXS measurement of $t\bar{t}H$ in the $H\to b\bar{b}$ channel with the CMS detector.

T 58.9 Wed 18:30 H-1.002

Improvement of the jet-parton assignment in $t\bar{t}H(b\bar{b})$ events using machine-learning techniques — •Felicia Volle, Andrea Knue, and Gregor Herten — Albert-Ludwigs-Universität Freiburg, Deutschland

The associated production of a Higgs boson and a top-antitop-quark pair allows to directly measure the Higgs-top Yukawa coupling, which can be sensitive to Beyond Standard Model physics. In the studies presented, a final state with the Higgs boson decaying into two b-quarks and the $t\bar{t}$ pair decaying into the lepton+jets channel is investigated. This decay channel suffers from irreducible $t\bar{t}$+$b\bar{b}$ background. In order to discriminate signal from background, a good reconstruction of the signal event is of utmost importance.

In the targeted decay channel, at least six jets are expected to be present in the final state. Four of these jets are expected to originate from a b-hadron. Having that many jets in the final state, the correct assignment of the measured jets to their corresponding parton-level object proves difficult. A Boosted Decision Tree has been used in the past in order to identify the correct permutation. The performance of this Boosted Decision Tree is presented and first studies towards using a deep neural network for the assignment will be shown.

T 58.10 Wed 18:45 H-1.002

Measurement of top-quark-antiquark pair production in association with a Higgs boson at CMS — Ulrich Husemann, Philip Keicher, Matthias Schröder, Jan van der Linden, and •Sebastian Wieland — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

The top quark-antiquark pair production in association with a Higgs boson offers a model-independent measurement of the top-Higgs Yukawa coupling. This is of great interest in order to test precisely the couplings of the Higgs boson to fermions predicted by the standard model.

In this talk a multivariate analysis in the semileptonic decay channel of the top quark-antiquark pair and the decay of the Higgs boson into a bottom quark-antiquark pair is presented.

A major challenge to this analysis are the backgrounds. Particularly, top quark-antiquark pair production with additional b quarks provide a final state almost indistinguishable from the signal process. Since this process is also theoretically challenging, different ways of modelling this background will be compared. The focus will be on the comparison of observables sensitive to differences in the background modelling.

T 59: Neutrino astronomy II

Time: Wednesday 16:30–19:00 Location: L-2.004

T 59.1 Wed 16:30 L-2.004

Search for high-energetic neutrino sources — •Martina Karl[1,2], Anna Schubert[2], Theo Glauch[2,3], Paolo Giommi[3,4,5], Elisa Resconi[1,2], Paolo Padovani[6,7], Andrea Turcati[2], and Yu-Ling Chang[5,8] — [1]Max-Planck-Institut für Physik, München, Germany — [2]Technische Universität München, Germany — [3]Institute for Advanced Study, Technische Universität München, Germany — [4]Associated to Agenzia Spaziale Italiana, Roma, Italy — [5]ICRANet, Pescara, Italy — [6]European Southern Observatory, Garching, Germany — [7]Associated to INAF - Osservatorio Astronomico di Roma, Monteporzio Catone, Italy — [8]Tsung-Dao Lee Institute, Shanghai, China

IceCube is a cubic-kilometer scale neutrino detector instrumenting a gigaton of ice at the geographic South Pole in Antarctica. On average, 8 track-like high energetic neutrino events with a high probability of being of astrophysical origin are detected per year. The bright appearance of these events in the detector allows for a good pointing to their origin. We present several searches for the production sites of these cosmic neutrinos. The first analysis uses IceCube's high-statistics, neutrino-induced through-going muon samples to search for sources specifically in the vicinity of the arrival directions of the single most high-energetic events. Complementary, we also present a multi-wavelength search for the counterparts of the high-energy tracks. As a result we find that there is a 3 sigma over-fluctuation of HBL/IBL Blazars. Which makes them one of the most promising candidates for a fraction of the astrophysical neutrino flux.

T 59.2 Wed 16:45 L-2.004

Real-time identification of transient neutrino sources — •Richard Naab for the IceCube-Collaboration — Deutsches Elektronen-Synchrotron DESY, Platanenallee 6, D-15738, Zeuthen

The identification of the sources of astrophysical neutrinos is one of the main motivations behind the IceCube real-time follow-up programs. A high duty cycle and all sky coverage make the neutrino observatory at the South Pole an effective trigger for follow-up searches aiming at finding electromagnetic counterparts. Telescopes used for this usually have a limited sky coverage due to their small field of view and thus depend on trigger input.

There are two approaches to distinguish astrophysical neutrinos from atmospheric background. The first is to select single high-energy neutrinos assuming that the signal neutrino spectrum is harder compared to the background. The second is to search for neutrino events clustering in time and space. The latter approach is used by IceCube's optical follow-up programs, which aims to probe gamma-ray bursts and choked-jet supernovae as possible neutrino source candidates. In my talk I will outline the performance and prospects of improvement in sensitivity to transients, which flare on a timescale of 100 seconds.

T 59.3 Wed 17:00 L-2.004

Stacking Point Source Search for a Neutrino Contribution at 27 Track-Like EHE Positions using Six Years of IceCube Data — •Johannes Kollek[1], Jan Soedingrekso[1], and Alexander Sandrock[1,2] for the IceCube-Collaboration — [1]TU Dortmund, Dortmund, Germany — [2]Now at National Research Nuclear University MEPhI, 115409 Moscow, Russia

Neutrino point source searches could help understanding cosmic ray acceleration. With past all-sky searches not revealing any point sources so far, a higher sensitivity can be achieved with time-dependent stacking searches on predefined source positions. A previous analysis on high energy starting events (HESE) positions with 21 different non-overlapping time windows issued no significant lower-energy excess. The analysis is repeated using the positions of extremely high energy events (EHE) and extended to test also overlapping time windows. In this talk, the methods of the analysis and the progress on the sensitivity for the EHE case is presented.

T 59.4 Wed 17:15 L-2.004

Neutrinos from Choked-Jet Supernovae — •Jannis Necker for the IceCube-Collaboration — DESY, Zeuthen, Germany

The past two decades have seen a revolution in astronomy as for the first time it became possible to gain information about astrophysical processes not only from (low energy) photons but also from other messengers such as gravitational waves and neutrinos. The IceCube observatory is a cubic kilometre neutrino detector array in the antarctic ice, looking for astrophysical, high-energy neutrinos. The collected data reveal a diffuse flux of these neutrinos over the whole sky, indicating an extragalactic origin. A possible contribution to this diffuse flux could stem from choked-jet core collapse supernovae, which occur when the jet emanating from a massive star's collapsing core gets stuck in the star's envelope. In this talk I will present preliminary results on a search for IceCube neutrinos from choked-jet supernovae candidates. The neutrino emission is expected during the supernova explosion time, which I estimate from optical light curves recorded by the Zwicky Transient Facility (ZTF), a large field-of-view optical observatory.

T 59.5 Wed 17:30 L-2.004

A new and improved IceCube point-source analysis — •Chiara Bellenghi, Hans Niederhausen, Martin Wolf, Theo Glauch, and Tomas Kontrimas — James-Franck-Straße 1, 85748 Garching bei München

The IceCube Neutrino Observatory is a one cubic kilometer neutrino telescope deployed deep in the Antarctic ice at the South Pole. The general aim of IceCube is to investigate high energy astrophysical phenomena by studying the corresponding high energy neutrino signal. One of the main goals is to identify the sources of the diffuse astrophysical neutrino flux, that IceCube discovered in 2012. We present a new method to search for neutrino point-sources that improves the accuracy of the likelihood function in the low energy regime, where the usual gaussian approximation of IceCube's point spread function breaks down. The new method includes multidimensional KDE based probability density functions, angular error estimates using a BDT as well as a new DNN energy estimator. We will present the performance of the updated analysis including sensitivity and discovery potential for point-like sources in the sky.

T 59.6 Wed 17:45 L-2.004

Event Reconstruction for the Cascade Real-Time Alert Stream in IceCube — •Mirco Hünnefeld and Jan Soedingrekso for the IceCube-Collaboration — TU Dortmund, Germany

IceCube is a neutrino detector located at the geographic South Pole, instrumenting a cubic kilometer of glacial ice. A major goal of IceCube is the detection of astrophysical neutrino sources. Therefore, a real-time alert system was implemented to enable multi-messenger astronomy. Events that pass certain selection criteria are reconstructed in real-time on-site at the South Pole. If these events meet the requirements, they are sent out as alerts to telescopes around the world, enabling follow-up observations. Precise and fast reconstruction methods are necessary to abide the harsh resource constraints given on-site. The inclusion of cascade-like events harbors further challenges due to their inherently difficult angular reconstruction. In this talk, a deep learning-based reconstruction method is presented, which enables the accurate and fast reconstruction of cascade-like events and thus the implementation of a cascade alert stream.

T 59.7 Wed 18:00 L-2.004

Perspectives of a Global Fit of IceCubes Diffuse Neutrino Flux — •Erik Ganster, Christian Haack, Jöran Stettner, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

The IceCube Neutrino Observatory has first observed a flux of high-energy astrophysical neutrinos in 2013. Since then, this observation has been confirmed in multiple analyses based on different event selections and topologies such as: high-energy starting events (HESE), cascades and throughgoing muon-tracks. This diffuse flux is typically modelled by a power-law energy spectrum. However, the measured flux properties differ between these complementary analyses. We will report on the status of a combined analysis of all high-energy neutrino data from IceCube which is currently being prepared. First studies on the sensitivity of this 'global fit' to improve the measurement of the flux properties will be shown.

T 59.8 Wed 18:15 L-2.004

Towards a Global Fit of the Diffuse Neutrino Flux with IceCube: Novel Simulation Techniques — Jöran Stettner, Erik Ganster, and •Christian Haack for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen

The IceCube Neutrino Observatory at the South Pole discovered a flux of astrophysical neutrinos at TeV − −PeV energies and started the era of neutrino astronomy. However, the energy spectrum of the observed diffuse flux is not yet fully understood: The measured fluxes differ between multiple detection channels such as high-energy starting events (HESE), cascades and through-going muons from the Northern Hemisphere. Here, we present the status of a combined analysis of all high-energy event samples which is currently being prepared. One important ingredient is a joint Monte-Carlo (MC) simulation that enables a consistent treatment of systematic uncertainties throughout the different event topologies. We present novel ideas how to efficiently produce large-scale MC-simulations covering a wide range of systematic uncertainties and how to apply it in likelihood analyses.

T 59.9 Wed 18:30 L-2.004

The Radio Neutrino Observatory in Greenland — •Zachary Meyers for the RNO-G-Collaboration — DESY, Zeuthen, Germany — Erlangen Center for Astroparticle Physics, Friederich-Alexander-Universitat Erlangen-Nurnberg, Erlangen, Germany

Ultra high energy (UHE) neutrinos play a vital role in the new age of multi-messenger astronomy. While light can be bent or absorbed by intervening dust and cosmic rays can be significantly deflected by magnetic fields, UHE neutrinos make their journey to us nearly unimpeded, revealing a direct line to their source and providing insight into the mechanisms of their creation. With projects including IceCube, ARA, ANITA and ARIANNA, neutrino astronomy has made great strides in the past decade. However, energies beyond 100 PeV cannot cost efficiently be targeted with with optical sensors due to the relatively short attenuation length of light. Radio arrays searching for Askayran emission can cover a much larger effective area for a fraction of the price. The Radio Neutrino Observatory in Greenland (RNO-G) will be capable of detecting these cosmogenic neutrinos with a view of the northern sky, acting as a pathfinder for the radio component of IceCube Gen-2. We explore the inspiration, design, and rollout of this new observatory, which will deploy 35 stations over the next 3 years.

T 59.10 Wed 18:45 L-2.004

Reconstructing Neutrino-induced Particle Showers in Ice from their Radio Emission — •Christoph Welling for the RNO-G-Collaboration — DESY, Platanenallee 6, Zeuthen

For the detection of astrophysical neutrinos with energies beyond 10 PeV, a detection volume of several cubic kilometers is required. One solution to overcome this challenge is the detection of radio emission from neutrino-induced particle cascades in glacial ice. Starting in summer 2020 a first discovery-scale radio detector will be deployed in the Greenland ice sheet. In this talk, we present how the detector will be used to detect neutrinos and how their properties can be reconstructed from the data obtained.

T 60: Various topics in elementary particle physics

Time: Wednesday 16:30–18:45 Location: L-2.017

T 60.1 Wed 16:30 L-2.017

Test of isospin symmetry bz measuring $\Upsilon(4S) \to B^0\overline{B^0}$ at *Belle* — •Pascal Schmolz and Thomas Kuhr for the Belle II-Collaboration — Ludwig-Maximilians-Universität München

In contrast to hadron colliders, B-factories allow for the determination of absolute branching fractions. The *Belle* experiment as well as its successor, *Belle II*, examine decays of $\Upsilon(4S)$ to pairs of either neutral or charged B mesons.
The calculation of the production rate for B mesons is often based on the assumption of strong isospin symmetry, i.e. charged and neutral pairs would be produced with the same probability. Quark masses and electromagnetic interaction, however, are responsible for slightly breaking isospin symmetry. In most of the previous measurements of $f_{00} = Br(\Upsilon(4S) \to B^0\overline{B^0})$ isospin is assumed. We present an analysis that bypasses this bias with a sophisticated method, first applied by the *BABAR* collaboration for such a measurement, that avoids any assumption on isospin.

T 60.2 Wed 16:45 L-2.017

Inclusive b-jet measurement at 13 TeV with 2016 CMS data and prospects for BBar jets measurement — •Luis Ignacio Estevez Banos and Patrick Connor — DESY

An inclusive b-jet measurement in pp collisions at a center-of-mass energy of 13 TeV will be presented. The analyzed dataset was recorded with the CMS detector during 2016 corresponding to an integrated luminosity of about 36 fb-1. The inclusive b-jet fraction is measured double differentially, and we compare the results with MC predictions at NLO matched with Parton Showers (PS), including Parton Branching (PB) TMDs (Transverse Momentum Dependent PDFs). In this talk I will also introduce the new measurement of BBar jets and associated jets production in CMS at 13 TeV, and will show some phenomenological studies and MC predictions at NLO interfaced with Parton Showers (PS) and also with PBTMDs.

T 60.3 Wed 17:00 L-2.017

Reconstruction of tau lepton decay planes for analysing the Higgs CP at CMS — Mate Farkas, Olena Hlushchenko, Wolfgang Lohmann, Dennis Roy, Hale Sert, Sebastian Siebert, Achim Stahl, •Lucas Wiens, and Alexander Zotz — III. Physikalisches Institut B, RWTH Aachen University, Germany

One of the three Sakharov conditions states that CP violation is needed to explain the matter-antimatter asymmetry in our universe. In order to find more occurances of CP violation, the Higgs Boson is now being investigated, so one can find out whether or not it is the CP-even Higgs Boson of the Standard Model or if it is in a mixed state of CP-even and CP-odd and a gateway to new physics.

By reconstructing the decay planes of tau leptons, one can perform the measurement of the CP mixing angle. This requires the use of impact parameters and thus it is vital for the analysis to properly determine and select well reconstructed impact parameters.

T 60.4 Wed 17:15 L-2.017

Search for decays of boosted Higgs bosons to pairs of charm quarks with the CMS Experiment — •Andrzej Novak, Xavier Coubez, Luca Mastrolorenzo, Spandan Mondal, Andrey Pozdnyakov, and Alexander Schmidt — RWTH Aachen

The Higgs boson decay into charm quarks has the highest branching fraction of the yet unobserved decays. Moreover, it is predicted to be the strongest coupling to the second generation of fermions which as of now remains unconfirmed. This talk presents a search for the Higgs boson in the gluon fusion production mode with high Lorentz boosts, decaying to a pair of charm quarks. The analysis is modeled on a previous analysis of decays to pairs of bottom quarks and is enabled by recent developments in deep learning based tools for jet identification in such topologies. Probing this channel is not only important for completeness, but it could also be sensitive to potential beyond Standard Model corrections.

T 60.5 Wed 17:30 L-2.017

Identification of boosted Higgs bosons decaying into a pair of b-quarks using multivariate analysis techniques with the ATLAS detector at $\sqrt{s} = 13$ TeV — Jochen Dingfelder, Tatjana Lenz, and •Christian Nass — PI Universität Bonn, Bonn, Germany

Studying properties of the Higgs Boson is crucial for testing the Higgs-mechaism. Prerequisite is the identification of Higgs Boson candidates. High transverse momentum Higgs Bosons are of special interest, as those may arise from new heavy resonances. The final state looked at is the decay into a pair of b-quarks ($H \to b\bar{b}$), since it has the largest Standard Model branching ratio. The main backgrounds are QCD-events and hadronic t-decays. Large-$R = 1.0$ calorimeter-jets are used to reconstruct the collimated Higgs Boson candidate decay products. The ATLAS default Higgs Boson identification algorithm (Higgs-tagger) uses the jet mass and the number of $R = 0.2$ track-jets associated to the large-R jet and identified as b-jets in order to identity Higgs boson candidates.

A new multivariate algorithm is developed based on b-jet identification, jet kinematic and jet substructure informations. An increase in performance by a factor of 1.5 - 2.5 and 2 - 5 for QCD and hadronic t-events, respectively, is achieved over the whole signal efficiency range compared to the default ATLAS analysis. The Higgs-taggers are calibrated in 15.4/fb of 2016 data $g \to b\bar{b}$. The extrapolation to $H \to b\bar{b}$ is done using Monte Carlo simulations. This talk presents the new Higgs-tagger and its calibration.

T 60.6 Wed 17:45 L-2.017

Messung der Top-Higgs-Kopplung im H → bb̄-Endzustand bei CMS — Ulrich Husemann, •Philip Keicher, Matthias Schröder, Jan van der Linden und Sebastian Wieland — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

Die Kopplung des Higgs-Bosons an Fermionen ist von großer theoretischer Bedeutung, da ihre Messung ein guter Test des Standardmodells ist und Aufschluss über den Mechanismus zur Generierung der Fermionmassen geben kann. Dabei ermöglicht die assoziierte Produktion des Higgs-Bosons mit einem Top-Quark-Antiquark-Paar oder die Produktion eines einzelnen Top-Quarks in Assoziation mit einem Higgs-Boson eine direkte Messung der Top-Higgs-Kopplung.

Präsentiert wird eine multivariate Analyse mit Fokus auf den Endzustand mit einem Lepton und dem Zerfall des Higgs-Bosons in ein Bottom-Quark-Antiquark-Paar. Dabei werden die Analysestrategie, die wichtigsten Untergrundprozesse und Systematiken und eine multivariate Klassifikation mit beispielsweise neuronalen Netzen zur Trennung von Signal und Untergrund vorgestellt. Abschließend werden aktuelle Ergebnisse und ein Ausblick auf mögliche zukünftige Messungen präsentiert.

T 60.7 Wed 18:00 L-2.017

Software Compensation in a Highly Granular Calorimeter using Principal Component Analysis — •Jack Rolph[1] and Erika Garutti[1,2] for the CALICE-D-Collaboration — [1]Institute for Experimental Physics, Hamburg University, Luruper Chaussee 149, D-22761 Hamburg, Germany — [2]Deutsches Elektronen-Synchrotron, Notkestraße 85, D-22607 Hamburg, Germany

Hadronic calorimeters are insensitive to 'invisible energy' (neutrons, binding energy). Large event-by-event fluctuations thereby worsen energy resolution. This effect may be corrected for by weighting events offline. This procedure is known as software compensation.

In this analysis, Principal Component Analysis (PCA) was used to study correlations between observables measurable by the CALICE Analogue Hadronic Calorimeter (AHCAL) steel prototype on both a cell-wise and calorimeter-wise basis using simulation. This was performed to assess the usefulness of these observables with respect to estimating the 'invisible energy' content of hadronic showers.

A weighting method was devised using PCA projections to measure the differences between a purely cell-wise method, independent of total measured energy and the state of the art for simulated 10 to 80 GeV negative pion showers. Relative to the control, the method was found to improve compensation by a maximum of 8.0 ± 0.9% and degrade compensation at by a maximum of 9.9 ± 1.2% at energies above and below 35 GeV respectively. Most significantly, edge effects observed in the state of the art due to limited statistics were found to be strongly suppressed by the use of purely local compensation.

T 60.8 Wed 18:15 L-2.017

Energy Deposition due to Synchrotron Radiation and Secondary Particles in Undulator Wall at ILC-250 GeV — •Khaled Alharbi[1,3,4], Sabine Riemann[3], Gudrid Moortgat-Pick[1,2], and Andriy Ushakov[1] — [1]University of Hamburg — [2]Desy, Hamburg — [3]Desy, Zeuthen — [4]KACST, Saudi Arabia

The positron source of the International Linear Collider (ILC) is based on a superconducting helical undulator passed by the high-energy electron beam to generate photons which hit a conversion target. Since the photons are circularly polarized the resulting positron beam is longitudinally polarized. At a center-of-mass energy of 250 GeV (ILC-250), the undulator with 231 m magnet length is needed to produce the required number of positrons. The power deposition in the undulator walls should be below the acceptable limit of 1W/m since it is a superconducting undulator and also to fulfill the vacuum requirements. The power deposition of the photon beam in undulator walls was studied and shown that the peak power deposition in the undulator walls is above 20 W/m. To keep the power deposition below the acceptable limit, 23 photon masks must be inserted in the undulator line. In this paper the design of photon masks for an ideal and non-ideal helical undulator is presented and the power deposition in the undulator walls is discussed.

T 60.9 Wed 18:30 L-2.017

Polarization of Photon Beam Generated in Helical Undulator at ILC-250GeV — •Khaled Alharbi[1,3,4], Sabine Riemann[3], Gudrid Moortgat-Pick[1,2], and Andriy Ushakov[1] — [1]University of Hamburg — [2]Desy, Hamburg — [3]Desy, Zeuthen — [4]KACST, Saudi Arabia

The positron source of the ILC is based on a superconducting undulator passed by the high-energy electron beam to generate polarized photons which hit a target to create electron-positron pairs. These pairs will inherit the photon polarization so that a polarized positron beam is generated. The degree of polarization depends on the photon energy and emission angle. Considering an ideal undulator, the collimation of the photon beam increases the polarization. In a real undulator, the parameters as K value and period vary within margin defined be the fabrication process. The resulting effective polarization differs from that expected by an ideal helical undulator. The photon spectra from non-ideal undulator can be simulated by the HUSR code by introducing errors in the helical undulator magnetic field map. This study presents a comparison of the ideal and realistic polarization distribution of the photon beam expected for ILC250. Further, 23 masks are inserted to protect the undulator wall along the 320m undulator line from power deposition by the photon beam. These masks colli-

mate slightly the photon beam and modify the polarization. Also this effect is evaluated in the study.

T 61: Methods of astroparticle physics IV

Time: Wednesday 16:30–18:45 Location: L-3.001

T 61.1 Wed 16:30 L-3.001

The characterization of PMTs for the AugerPrime Upgrade of the Pierre Auger Observatory* — •Simon Strotmann and Julian Rautenberg for the Pierre Auger-Collaboration — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal

The Surface Detector (SD) of the Pierre Auger Observatory will be upgraded through the addition of a 4 m^2 scintillator detector on top of each station to further improve the sensitivity of the surface array. A PMT with expected high linearity was chosen in order to meet the requirements of measuring the scintillator's signals over a high dynamic range.
A batch test facility, built to verify that the gain and linearity requirements for operation in the field are met by each PMT, will be presented. The validation of the test facility on the first 80 PMTs recieved as well as the progress on the characterization of the remaining PMTs for the upgrade as well as additional measurements of the spectral and spatial quantum efficiency of selected PMTs will be shown.
** Gefördert durch die BMBF Verbundforschung Astroteilchenphysik (Vorhaben 05A17PX1).*

T 61.2 Wed 16:45 L-3.001

Measurement of luminescence in South Pole ice — •Anna Pollmann for the IceCube-Collaboration — Universität Wuppertal

The IceCube neutrino observatory uses 1km3 of the natural Antarctic ice near the geographic South Pole as optical detection medium. When charged particles, such as particles produced in neutrino interactions, pass through the ice with relativistic speed, Cherenkov light is emitted. This is detected by IceCube's optical modules and from all these signals a particle signature is reconstructed. A new kind of signature can be detected using light emission from luminescence. This detection channel enables searches for exotic particles (states) which do not emit Cherenkov light and currently cannot be probed by neutrino detectors. For the measurements at IceCube, a 1.7km deep hole was used which vertically overlaps with the glacial ice layers found in the IceCube volume over a range of 350 m. The experiment as well as the measurement results are presented. The impact of the results, which enable new kind of searches for new physics with neutrino telescopes, are discussed.

T 61.3 Wed 17:00 L-3.001

Absolute calibration of the light source for the end-to-end calibration of the Fluorescence Detector of the Pierre Auger Observatory — •Tobias Heibges for the Pierre Auger-Collaboration — Bergische Universität Wuppertal, Gaußstraße 20 42119, Wuppertal, Deutschland

One of the crucial parts of the hybrid detection method used at the Pierre Auger Observatory is the absolute calibration of the fluorescence telescopes. Since it determines the energy range of the Observatory, high accuracy is required. The previous calibration method was carried out infrequently, due to its difficulty and high demand of manpower. To address this, the new XY-Scanner calibration system has been developed. It consists of a small lambertian light source, which is scanned spatially across the front of the telescope and emits short light pulses at several known locations.
To calibrate the telescope based on these light pulses an exact measurement of the number of photons emitted in each pulse is needed. For this purpose, a calibration test bench was designed, which combines the measurements of a calibrated photodiode and a PMT was designed. The setup and operation of this bench will be the main subject of this talk. Using it, an uncertainty of less than 4% could be achieved with potential for further reductions in the near future.
** Gefördert durch die BMBF Verbundforschung Astroteilchenphysik (Vorhaben 05A17PX1).*

T 61.4 Wed 17:15 L-3.001

Characterizing the response of a liquid xenon time projection chamber to α-particles — •Dominick Cichon, Guillaume Eurin, Florian Jörg, Teresa Marrodán Undagoitia, and Natascha Rupp — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

Liquid xenon (LXe) time projection chambers (TPCs) are at the forefront of the search for new physics, especially regarding the hunt for particle dark matter. In such detectors, ^{222}Rn and its daughters often belong to the major sources of background encountered. The α-decays of the chain provide a way to both estimate rates of radon-related background and to study its distribution within the detector. However, at the time of writing, only a scarce amount of data on certain important α-particle response parameters, such as signal yields in LXe, is available.

In this talk, measurements of α-particle light and charge yields at different electric field strengths are presented. They complement the currently available data and were made with a small-scale LXe TPC. It was necessary to attenuate the scintillation light seen by the TPC's photosensors, as they would saturate otherwise. For this purpose, auxilliary measurements of the transmittance of polytetrafluoroethylene (PTFE), a common material in xenon TPCs, for LXe scintillation light (175 nm) were conducted and are also presented here. They make the construction of attenuators with well-defined reduction factors possible and also help future detectors, such as DARWIN, with optimizing TPC design in terms of PTFE material budget.

T 61.5 Wed 17:30 L-3.001

Construction and commissioning of new IACT telescopes for IceAct/IceCube — •Yuriy Popovych[1], Jan Audehm[2], Thomas Bretz[2], Giang Do[2], Adrianna García[2], Florian Rehbein[2], Merlin Schaufel[1], and Christopher Wiebusch[1] for the IceCube-Collaboration — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]III. Physikalisches Institut A, RWTH Aachen University

The IceAct Imaging Air Cherenkov Telescopes (IACTs) are used to observe cosmic-ray air-showers and work hereby as a veto detector for the IceCube Neutrino Observatory. The hybrid observation with IceCube allows cross-calibrating the energy-threshold and energy-scale of the surface detector IceTop as well as the directional reconstruction of the in-ice detector. In January 2019, two telescopes were installed at the South Pole and successfully integrated into IceCube data-taking. As an upgrade for these existing telescopes, new telescopes will be produced. To ensure high instrument reliability, each of the telescopes has to be tested individually simulating the harsh conditions at the South Pole. This talk will report on the status and testing results of the production of the new telescopes.

T 61.6 Wed 17:45 L-3.001

Results of SiPM Pixel Tests in the MAGIC IACT Camera — •Alexander Hahn[1,2], Antonios Dettlaff[1], David Fink[1], Daniel Mazin[1,3], Razmik Mirzoyan[1], and Masahiro Teshima[1,3] — [1]Max-Planck-Institut für Physik, München, Deutschland — [2]Physik-Department, Technische Universität München, München, Deutschland — [3]Institute for Cosmic Ray Research, the University of Tokyo, Tokyo, Japan

Large size Imaging Atmospheric Cherenkov Telescopes (IACTs), such as MAGIC, H.E.S.S. or VERITAS, currently in operation or such as LST of CTA in commissioning, are relying on photomultiplier tubes (PMTs) as their primary light detectors. Smaller IACTs (such as FACT or ASTRI) have shown that they can operate with Silicon photomultipliers (SiPMs) instead. However, there is no conclusive study yet whether SiPMs might be also suitable light detectors for large size IACTs. Our group at the Max Planck Institute for Physics built several SiPM based prototype detector modules and installed them to one of the MAGIC telescopes. We operated them since a couple of years in parallel with the existing scientific PMT based camera allowing for a multi-year in-situ comparison of SiPMs and PMTs inside an operational telescope. Here we present a direct performance comparison between SiPM-based and existing PMT-based detector modules being operated in parallel inside the MAGIC imaging camera.

T 61.7 Wed 18:00 L-3.001

Status of the Imaging Air-Cherenkov Telescopes HAWC's Eye at the HAWC Gamma-Ray Observatory — •Giang

Do[1], Jan Audehm[1], Thomas Bretz[1], Florian Rehbein[1], Merlin Schaufel[2], and Adrianna García[1] — [1]III. Physics Institute 3A, RWTH Aachen, Germany — [2]III. Physics Institute 3B, RWTH Aachen, Germany

The imaging air-Cherenkov telescope HAWC's Eye has been developed in order to improve the energy and angular resolution of extensive air shower arrays. Hybrid observations can improve the reconstruction of the air shower by combining the ground-based detectors and the air-Cherenkov telescopes. The combination of both techniques allows to measure not only the fraction of the shower at ground level but also the shower development. In summer 2017, the first telescope prototype featuring a 50 cm Fresnel lens and a camera with 61 silicon photomultipliers (SiPMs) was commissioned at the site of the High-Altitude Water Cherenkov Gamma-Ray Observatory (HAWC) located in the state of Puebla, Mexico. For the first time, hybrid data was recorded. By using the shower reconstruction of HAWC, the telescope was characterized and calibrated without simulations. In October 2019, two telescopes with upgraded hexagonal light collectors and a new type of SiPMs were successfully installed and operated in stereo mode, promising a better performance. Based on first measurements, the performance of the improved telescopes is evaluated.

T 61.8 Wed 18:15 L-3.001

Parameterisation of the angular acceptance of KM3NeT PMTs — •Johannes Schumann for the ANTARES-KM3NeT-Erlangen-Collaboration — Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP

The KM3NeT neutrino telescope is currently being built in the depths of the Mediterranean Sea. The detector consists of a three-dimensional array of digital optical modules, housing 31 photomultiplier tubes (PMT) each. A detailed simulation of the experiment is required in order to perform precision measurements of neutrino interactions. The PMT properties are substantial input for the detector response model. In this talk, the in-situ measurement of the angular acceptance based on Cherenkov light emitted by Potassium-40 decays in the sea water is discussed. A comparison of this measurement and the corresponding simulations, as well as a parameterisation for the PMT angular acceptance will be presented.

T 61.9 Wed 18:30 L-3.001

Status Update from the PMT Mass Testing Container System for JUNO — •Alexander Tietzsch[1], David Blum[1], Marc Breisch[1], Jessica Eck[1], Caren Hagner[2], Tobias Heinz[1], Tobias Lachenmaier[1], Neha Lad[1], David Meyhöfer[2], Axel Müller[1], Henning Rebber[2], Tobias Sterr[1], and Björn Wonsak[2] — [1]Physikalisches Institut, Eberhard Karls Universität Tübingen — [2]Institut für Experimentalphysik, Universität Hamburg

The Jiangmen Underground Neutrino Observatory (JUNO) experiment will be one of the coming neutrino oscillation experiments starting in the next years. To reach its main goal of determining the neutrino mass hierarchy from the oscillation pattern, a high energy resolution of 3% @ 1 MeV is required, for whose realization up to 20'000 20-inch photomultiplier tubes (PMTs) are intended to be used in JUNO. All of these PMTs have to fulfil dedicated quality requirements for several key characteristics (dark rate, PDE, peak-to-valley ratio etc.), for which a PMT mass testing facility using commercial shipping containers has been developed and is running successfully for more than 2 years now. With this system, so far more than 12'000 PMTs have been tested and characterized. This talk will give an update on the system, the progress in PMT testing and data analysis of tested PMTs and will discuss current statistics and questions related to the PMT characterization for JUNO. This work is supported by the Deutsche Forschungsgemeinschaft.

T 62: Cosmic rays II

Time: Wednesday 16:30–19:05 Location: L-3.002

Group Report T 62.1 Wed 16:30 L-3.002

The Pierre Auger Observatory – Status, Results, Prospects — •Michael Schimp for the Pierre Auger-Collaboration — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal

The Pierre Auger Observatory is the world's largest cosmic ray observatory. The surface detector (SD) covers an area of 3000 km^2 instrumented with 1660 stations. Surrounding the SD, 27 telescopes at 4 sites comprise the fluorescence detector (FD). The SD stations sample the lateral particle distributions of extensive air showers (EASs) on the ground while the FD measures the longitudinal profile of the EASs. Combined, SD and FD allow for 100 % duty cycle calorimetric EAS detection.

Recent results show that the energy spectrum of UHECRs has more features than known before, and that the UHECR mass composition is best described as mixed with overall increasing primary particle masses towards the highest energies. Additionally, several significant large and medium scale anisotropies have been revealed. Searches for neutrinos and photons have lead to the most significant constraints on their fluxes in a substantial energy and directional range.

An upgrade of the Pierre Auger Observatory, called AugerPrime, is underway. It will add scintillation and radio detectors together with improved electronics to the SD stations. AugerPrime will allow for improved particle identification and therefore enhance the overall UHECR mass composition sensitivity for the full-duty-cycle SD.

T 62.2 Wed 16:50 L-3.002

Scintillation and Radio Detectors for an Enhancement of the IceTop Air-Shower Array — •Frank G. Schröder for the IceCube-Collaboration — Institut für Kernphysik (IKP), Karlsruher Institut für Technologie (KIT) — Bartol Research Institute, Department of Physics and Astronomy, University of Delaware

IceTop is the 1 km^2 surface array of the IceCube neutrino observatory. IceTop detects cosmic-ray air showers in the PeV to EeV energy range, but is losing sensitivity due to snow coverage. A planned enhancement by scintillation and radio detectors on the surface will solve this problem and increase the measurement accuracy for the energy and mass of the primary particles initiating the air showers. In addition to providing a veto and calibration tool for in-ice detectors, the more accurate measurement of the cosmic-ray mass composition and absolute flux will help us to better understand atmospheric muon and neutrino fluxes, which are important backgrounds for IceCube's astrophysical neutrino measurements. Moreover, the increase in accuracy and sky coverage compared to the current IceTop will enable new science goals: The improved classification of the primary particle will help to determine the transition from Galactic to extragalactic sources expected at energies between 100 PeV to a few EeV, and the search for PeV photons provides direct discovery potential for the - yet unknown - most energetic Galactic sources. This talk will provide an overview about the prototype detectors existing at the South Pole, and the plans for the upgrade of the full IceTop arrays in the next years.

T 62.3 Wed 17:05 L-3.002

Event Reconstruction with the Surface Scintillator Detectors of AugerPrime — Markus Roth[1], •David Schmidt[1], Alexander Streich[1,2], Alvaro Taboada[1,2], and Darko Veberic[1] for the Pierre Auger-Collaboration — [1]Karlsruher Institut für Technologie (KIT) — [2]Universidad Nacional de San Martin (UNSAM)

Reconstructing the mass of ultra-high-energy cosmic rays from measurements performed at ground hinges on disentanglement of the electromagnetic and muonic components of extensive air showers. The AugerPrime upgrade to the Pierre Auger Observatory will do exactly this by equipping each of the existing water-Cherenkov detector stations in its surface detector array with a 4 m^2 Scintillator Surface Detector, which is more sensitive to the electromagnetic component of showers. As part of the deployment plan, 77 detectors were switched on in March of 2019, and thousands of events have been collected since. We present the calibration of measurements performed by the upgraded stations as well as the first event reconstructions enhanced with information from the new detectors here.

T 62.4 Wed 17:20 L-3.002

IceScint: The Scintillator Upgrade of IceTop - Performance of the Prototype Array — •Thomas Huber for the IceCube-Collaboration — Institut für Kernphysik (IKP), Karlsruher Institut für Technologie (KIT) and Deutsches Elektronen-Synchrotron (DESY)

The IceCube Collaboration foresees to upgrade IceTop, the present surface array, with scintillation detectors augmented by radio antennas. As one of several goals the detectors will be used to measure and mitigate the effects of snow accumulation on the IceTop tanks: The increasing energy threshold and efficiency loss are nowadays the sources of the largest systematic uncertainties in shower reconstruction and mass composition analysis. In addition, the upgrade will provide useful experience for the development of next generation neutrino detectors proposed for the South Pole.
Beginning of 2018 two full prototype stations were installed near the center of the IceTop array. Each station features custom-designed electronics and consists of seven detectors, each having an active area of 1.5 m^2 plastic scintillator and wavelength shifting fibers read out by a Silicon Photomultiplier (SiPM).
In this talk the DAQ and detector R&D decicions, the calibrations methods and the performance are reviewed and results from more than one year of operation of the prototype station are shown. During that year several thousand air-shower events have been measured in coincidence with IceTop. In addition, the future plans for instrumenting the whole IceTop surface with scintillation detectors and radio antennas will be presented.

T 62.5 Wed 17:35 L-3.002

Composition Measurements with AugerPrime using Deep Learning* — •Sonja Schröder for the Pierre Auger-Collaboration — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal

The AugerPrime upgrade of the Pierre Auger Observatory in Argentina enhances the precision of primary particle composition measurements made by the surface detector. This is achieved using the different responses of the Water-Cherenkov-Detector (WCD) and the Surface-Scintilator-Detector (SSD) on top, to the electromagnetic and muonic component of the extensive air shower. While the upgrade is still in progress, the cosmic ray composition sensitivity of AugerPrime can already be probed using current machine learning techniques, such as deep neural networks, on simulations.

In this presentation a deep learning approach is shown to be able to reconstruct the depth of shower maximum X_{max}, a mass sensitive observable, on an event-by-event basis. A combination of deep convolutional neural networks is used to process information from both WCD and SSD signals. These signals are extracted from full AugerPrime detector simulations containing a mixed composition of protons, helium, nitrogen and iron. The sensitivity of the reconstruction will be shown, as well as its estimated bias and resolution.
* *Gefördert durch die BMBF Verbundforschung Astroteilchenphysik (Vorhaben 05A17PX1).*

T 62.6 Wed 17:50 L-3.002

Design and preliminary results of the radio antennas array of the first complete prototype station inside IceTop footprint — •Roxanne Turcotte for the IceCube-Collaboration — Institut für Kernphysik (IKP), Karlsruher Institut für Technologie (KIT)

The IceTop array, located at the surface of the IceCube Neutrino Observatory, is currently used as a veto for the in-ice neutrino detection as well as a cosmic ray detector. Snow accumulated on the tanks which reduces the detector sensitivity and resolution. In order to improve those, an enhancement of IceTop is planned in the next few years which consists of an array of scintillator panels and radio antennas. Upgrading IceTop with radio antennas will improve the measurement accuracy and the field-of-view for the detection of cosmic rays, which will lead to a better estimation of the mass composition as well as a better mitigation of the atmospheric neutrino background for the in-ice neutrino. In January 2019, the first two antennas were deployed alongside seven scintillators. As a follow-up, a refurbished station with three antennas and eight scintillators, in the station layout planned for the full array, will be deployed in January 2020. This talk will focus on this prototype station. I will present the radio front-end electronics, the antenna structure and give an overview of the first data recorded by the surface antennas at the South Pole.

T 62.7 Wed 18:05 L-3.002

Paving the way to an event-by-event level estimation of the masses of UHECRs with AugerPrime and Air Shower Universality — •Maximilian Stadelmaier[1], Markus Roth[1], Ralph Engel[1], and Federico Sanchez[2] for the Pierre Auger-Collaboration — [1]KIT, Karlsruhe, Germany — [2]ITeDA, Buenos Aires, Argentina

Reconstructing the primary masses of ultra high-energetic cosmic rays (UHECRs) on event level can give insight into a manifold of open questions in astrophysics, for instance identifying individual sources or source regions. A reconstruction based on Air Shower Universality allows the determination of the relative muon content, R_μ, and the atmospheric depth of the shower maximum, $X_{\max}$, of an extensive air shower with data collected only from a surface detector. Both these observables can be linked to the mass of the cosmic ray. The upgraded surface detector of the Pierre Auger Observatory, *AugerPrime*, will allow an accurate reconstruction of these mass sensitive observables on an event level. We present the principles of Air Shower Universality as well as first results based on simulations to reconstruct the relative muon content of extensive air showers produced by ultra high-energetic cosmic rays using AugerPrime.

T 62.8 Wed 18:20 L-3.002

Characterisation of the radio background at the future IceTop upgrade site — •Hrvoje Dujmovic for the IceCube-Collaboration — Institut für Kernphysik, Karlsruher Institut für Technologie (KIT)

IceTop, the surface array of the IceCube Neutrino Observatory, currently consists of 162 ice Cherenkov tanks and is used for the detection of air showers, besides being used as a veto and calibration device for the in-ice neutrino detector. The analyses of the IceTop data have led to many important results in cosmic ray physics. The science case of IceTop can be further enhanced by complementing the existing detector with an array of radio antennas and scintillator panels. Due to the unique location at the geographic South Pole and the radio-quite environment, the radio antennas are expected to provide an excellent characterisation of the electromagnetic shower component. This will help us identify primary particle mass and give us a good sensitivity to inclined air showers, in particular interesting for those arriving from the direction of the Galactic Centre. As a test for the deployment of the full array, a first prototype station with scintillator panels and two radio antennas has been deployed at the Pole in January 2019. The data collected from this station has been crucial for giving us a better understanding of the radio background at the IceTop site, giving us a more realistic estimate of the future array performance and helping us with design decision for the final array hardware. In this talk, I will show the background measurements obtained from the prototype station and give a summary of the analysis results.

T 62.9 Wed 18:35 L-3.002

Signal processing aspects of the AERA absolute energy scale analysis — •Vladimir Lenok for the Pierre Auger Collaboration — Karlsruhe Institute of Technology, Institute for Nuclear Physics, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen

Determination of the absolute energy scale of cosmic-ray measurements is one of the present goals of great importance for astroparticle physics. Recently, significant progress towards this direction has been achieved by the Auger Radio Engineering Array (AERA), a digital detector of air-shower radio emission within the Pierre Auger Observatory. AERA pioneered the use of well physically motivated values in the analysis of radio emission of air showers such as energy fluence, and in application of the axially asymmetrical radio-emission footprint models for sparse arrays. For the time being, AERA is approaching a new milestone — validation of the absolute energy scale of cosmic-ray observations with radio measurements. This analysis consists of several steps on different levels. The proper signal processing is the foundation of all higher level steps for a correct estimation of the energy scale. In the talk I will present a comprehensive evaluation of the signal processing pipeline of AERA from the perspective of a consistent estimation of the energy fluence.

T 62.10 Wed 18:50 L-3.002

Development of a scintillation and radio hybrid detector station at the South Pole — •Marie Oehler[1], Tim Bendfelt[3], Hrvoje Dujmovic[1], Andreas Haungs[1], Bernd Hoffmann[1], Thomas Huber[1], Timo Karg[2], Matt Kauer[3], John Kelley[3], Marko Kossatz[2], Max Renschler[1], Frank Schröder[1], Karl-Heinz Sulanke[2], Delia Tosi[3], Roxanne Turcotte-Tardif[1], Andreas Weindl[1], and Chris Wendt[3] — [1]KIT, Karlsruhe, Germany — [2]DESY, Zeuthen, Germany — [3]UW, Madison, USA

The IceCube Observatory is a cubic-kilometer neutrino detector installed in the ice at the geographic South Pole. To increase the efficiency of detecting astrophysical neutrinos the upgrade IceCube-Gen2 is under development. To also boost the sensitivity of the surface array, IceTop, an enhancement consisting of a hybrid scintillation-detector

and radio-antenna array is planned.

An optimized prototype station, consisting of eight scintillation detectors and three radio antennas, was deployed in January 2020. Both, scintillation detectors and radio antennas, are read out by a central hybrid data acquisition system (DAQ), researched, developed and built by a cooperation of DESY, UW-Madison and KIT. The scintillation detectors transfer digitized integrated signals to the DAQ to minimize the amount of transmitted data and trigger the radio antennas. The radio waveforms are transferred as analog signals to the central DAQ and are digitized and read out, when triggered by the scintillation detectors. In this contribution the enhanced prototype station and its DAQ will be presented and first measurement results will be shown.

T 63: DAQ, trigger and electronics III

Time: Wednesday 16:30–18:30 Location: L-3.015

T 63.1 Wed 16:30 L-3.015

Der Level-1 topologische Prozessor bei ATLAS: Triggerperformance und zukünftiger Ausbau — Volker Büscher, •Johannes Damp, Christian Kahra und Ulrich Schäfer — Johannes Gutenberg-Universität Mainz

Das ATLAS-Triggersystem reduziert die hohe LHC *pp*-Kollisionsrate von 40 MHz auf eine Rate von 1 kHZ zur Datenspeicherung. Die erste Stufe dieses Triggersystems ist der hardwarebasierte Level-1 Trigger mit einer Ausgangsrate von 100 kHz und einer Latenz von 2.5 μs. Bei Erhöhung der Luminosität und Energie müssen die Triggerschwellen wichtiger Physiktrigger erhöht werden, um die Datenrate konstant zu halten, was allerdings mit einem Verlust interessanter Ereignisse verbunden ist. Um dieses Problem zu lösen, wurde der Level-1 topologische Prozessor (L1Topo) in die erste Triggerstufe eingeführt. L1Topo erhält sämtliche Objekte jedes Ereignisses von den Kalorimetern und vom Myonsystem, und verarbeitet diese Informationen um Triggerentscheidungen basierend auf topologischen Größen durchzuführen. Dies ermöglicht eine verbesserte Untergrundunterdrückung und eine Verbesserung der Signifikanz vieler ATLAS Physikmessungen, während gleichzeitig eine Reduktion der Raten erzielt werden kann.

In diesem Vortrag wird einen Überblick über die Triggerperformance von L1Topo in den LHC-Runs in 2017 und 2018 gegeben. Zudem wird ein Überblick über den aktuellen Status des Ausbaus von L1Topo für den in 2021 startenden Run-3 des LHC gegeben.

T 63.2 Wed 16:45 L-3.015

Particle selection and combinatorics in LHCb's Upgrade trigger — •Niklas Nolte[1,2], Sascha Stahl[1], and Oliver Lupton[1] — [1]CERN — [2]TU Dortmund

LHCb is undergoing a significant upgrade for Run 3 of the LHC, where one of the main changes is the transition to a full software trigger solution. Processing events at a 30-fold increased rate and a five-fold increase in instantaneous luminosity with respect to Run 2 is a challenging task. We expect O(1000) selections that have to be processed for each event in the second trigger stage, which will operate at 1 MHz event rate. Each of these selections filter particles based on their properties and reconstruct their entire decay chain with different mass hypotheses. To meet the tight performance requirements of these tasks, we introduce a new trigger event model and optimized algorithms to perform these selections.

T 63.3 Wed 17:00 L-3.015

First level EM trigger algorithms in the ATLAS forward region — •Julian Fischer and Stefan Tapprogge — Institut für Physik, Johannes Gutenberg-Universität, Mainz

The HL-LHC at CERN is a planned upgrade of the Large Hadron Collider (LHC) that will increase its instantaneous luminosity of up to a factor of five in *pp*-collisions. In order to exploit the full potential of the HL-LHC the first level trigger of the ATLAS experiment will have to efficiently find electromagnetic objects in the forward region. A dedicated 'forward Feature EXtractor' (fFEX) is in development for Run 4 to trigger jet and electromagnetic objects in the the ATLAS forward region making use of the full granularity of the calorimeters in pseudorapidity ranges of $|\eta| > 2.5$. Two hardware modules are to be developed to cover both forward directions of the detector. This contribution will highlight the development of candidate algorithms that are designed to trigger electromagnetic objects on the fFEX modules. Performance studies will be shown and different concepts investigated to tackle the challenging geometries in this particular detector region while considering the restrictions imposed by the firmware implementation.

T 63.4 Wed 17:15 L-3.015

Design of a Flexible Printed Circuit prototype for the High Granularity Timing Detector at ATLAS — •Maria Soledad Robles Manzano[1], Andrea Brogna[2], Peter Bernhard[2], Fabian Greiner[1], Lucia Masetti[1], Paul Plattner[1], Quirin Weitzel[2], and Atila Kurt[2] — [1]Institut für Physik, Johannes-Gütenberg Universität Mainz — [2]PRISMA Detector Lab, Johannes-Gütenberg Universität Mainz

The ATLAS detector at CERN is being upgraded to face the new HL-LHC challenges. In order to improve the physics performance of the ATLAS detector a High-Granularity Timing Detector (HGTD) is proposed. It will help to mitigate the pile-up contribution in the forward region by providing a timing resolution below 30 ps per track. 2×4 cm^2 sensors are bump-bonded two ASICs in the detector basic unit, the so-called bare module. The active area, consisting of 2 double-sided disks per end-cap, populated by about 8000 modules in total, is surrounded by the Peripheral Electronics Boards (PEB). In this scenario, custom electronics is required to transmit the signals (1.28 Gbps) from the active area to the PEB as well as to bias the sensor (800 V) and deliver power (1.2 V at 1 A) to the ASICs. A 220 μm thick Flexible Printed Circuit (FLEX cable) was selected as the optimal candidate for such purpose. The baseline of the FLEX cable as well as the most recent prototype design are presented.

T 63.5 Wed 17:30 L-3.015

High Density Interconnects for the Mu3e experiment — •Lars Noehte for the Mu3e-Collaboration — Physikalisches Institut, Heidelberg, Germany

The Mu3e experiment is going to search for the charged lepton-flavor violating decay $\mu^+ \to e^+e^-e^+$ with a sensitivity of one in 10^{16} events in phase II. Since the tracking of the decay electrons (positrons) is dominated by multiple scattering, the detector material thickness has to be minimized. The tracking layers of the detector deploy the HV-MAPS pixel sensor MuPix, which can be thinned down to 50 μm. Achieving a thickness of $X/X_0 = 0.115\%$ radiation lengths per layer requires an ultra-thin readout structure, capable of transmitting 1.25Gb/s of data reliably over a high density interconnect. This talk focuses on design studies and characterizations of edge-coupled micro strips on 12 μm thick aluminum layers.

T 63.6 Wed 17:45 L-3.015

VMM3 Readout Chips Calibration and Performance Response to Pressure in Micromegas Detectors — •Ksenia Solovieva[1], Thorwald Klapdor-Kleingrothaus[2], Patrick Scholer[2], Vladislavs Plesanovs[2], and Ulrich Landgraf[2] — [1]Imperial College London, London, UK — [2]Albert-Ludwigs University, Freiburg, Germany

During the ongoing LHC Long Shutdown, the ATLAS detector upgrade includes the implementation of the New Small Wheels as part of the Muon Spectrometer. One of its detector technologies is the MicroMesh Gaseous Detector (MicroMegas) used for improved tracking and triggering in a higher particle rate environment.

For the purpose of investigating the MicroMegas detector readout, prototype detectors were set up and read out with dedicated Front End Boards containing VMM3 ASICs. Two logic chains for triggering were successfully implemented, one for cosmic muons and one including the ion signal of the micromesh in the detector. This presentation discusses the developed procedures and presents the results of calibration and gain studies.

T 63.7 Wed 18:00 L-3.015

Tests results of a Flexible Printed Circuit prototype for the High Granularity Timing Detector at ATLAS — •Paul Plattner[1], Andrea Brogna[2], Peter Bernhard[2], Fabian Greiner[1], Atila Kurt[2], Lucia Masetti[1], Maria Soledad Robles

Manzano[1], and Quirin Weitzel[2] — [1]Institut für Physik, Johannes-Gütenberg Universität Mainz — [2]PRISMA Detector Lab, Johannes-Gütenberg Universität Mainz

A prototype of a Flexible Printed Circuit for the ATLAS High Granularity Timing detector (HGTD) has been designed and manufactured. A specific testing plan, based on both the mechanical and electrical specifications as well as the operational conditions of the HGTD, is required in order to check its performance. The signal transmission tests at 1.25 Gbps data rate additionally to the impedance measurements with the Time Domain Reflectrometry technique provide valuable information in terms of signal integrity. Power integrity simulations and measurements of the plane resistance with different methods are compared. Tests on high voltage insulation are also required to quantify its influence on the rest of planes and lines. Results of the tests of the prototype are presented.

T 63.8 Wed 18:15 L-3.015

Efficiency Study of the Neural Network z-Vertex Trigger in the Belle II Experiment — •Felix Meggendorfer[1,2], Sebastian Skambraks[1,3], Christian Kiesling[1,3], Steffen Baehr[4], and Kai Unger[4] for the Belle II-Collaboration — [1]MPI für Physik, München — [2]Technische Universität München — [3]Ludwig-Maximilians-Universität München — [4]Karlsruher Institut für Technologie

For the drift chamber of the Belle-II experiment located in Tsukuba, Japan, a first level hardware neural network trigger is used to identify tracks coming from outside of the interaction region. The neural trigger makes it possible to efficiently suppress the dominating portion of background tracks not coming from the interaction vertex and makes it possible to launch pure 2-track triggers without additional conditions. After a short introduction into the hardware design of the trigger system, the efficiency of the neural "z-vertex" trigger will be presented.

T 64: Gaseous detectors I

Time: Wednesday 16:30–18:00 Location: L-3.016

T 64.1 Wed 16:30 L-3.016

Bau einer Funkenkammer als mobiler Demonstrator — •Martin Serfling, Andreas Glatte und Arno Straessner — TU Dresden, Dresden, Deutschland

Historisch waren Funkenkammern beliebte Teilchendetektoren, welche in simplen bis komplexen Aufbauten den Nachweis elektromagnetischer Teilchen sowie deren Interaktion beleuchten. Unser Ziel ist die Konstruktion einer mobilen Funkenkammer, welche als Demonstrator im Rahmen der Wissenschaftsvermittlung für physikalische Vorträge, Ausstellungen oder den Lehrbetrieb genutzt werden kann und einen visuellen Nachweis atmosphärischer Myonen gibt. Diese einfache Erkenntnis bietet einen Einstieg zu teilchenphysikalischen Phänomenen sowie Überlegungen zur speziellen Relativitätstheorie. Somit baut die Kammer eine Brücke von simplen Beobachtungen hin zu komplexen physikalischen Zusammenhängen und soll auf die allgegenwärtigen Prozesse, welche unbemerkt stattfinden, hinweisen.

In dem Vortrag soll außerdem auf Probleme, Designentscheidungen sowie entscheidende Parameter eingegangen werden, welche unsere Konstruktion beeinflusst haben und für den generellen Nachbau einer solchen Kammer entscheidend sind, da dies erklärtes Ziel des Projekts ist.

T 64.2 Wed 16:45 L-3.016

Commissioning of a prototype for the SHiP Spectrometer Straw Tracker — •Morten Henken, Felix Bergholz, Daniel Bick, Stefan Bieschke, Caren Hagner, and Walter Schmidt-Parzefall — Institut für Experimentalphysik, Luruper Chaussee 149, 22761 Hamburg

The SHiP (Search for Hidden Particles) experiment is a proposed general purpose beam-dump experiment to be located at the CERN SPS North Area. It is designed to search for hidden particles at the intensity frontier as well as to study tau neutrino physics, utilizing the SPS's 400 GeV proton beam.

The SHiP hidden sector detector is designed to detect the decay products of hidden particles decaying inside it's ∼50 m long vacuum decay vessel. A crucial part is the determination of the trajectory and the momentum of charged particles produced in these decays. This is the purpose of the Spectrometer Straw Tracker (SST), consisting of roughly 16000 straw tubes, each one 5 m long and 2 cm in diameter.

A prototype, consisting of four straw tubes, has recently been set up at Hamburg University. The status of the commissioning and first results will be presented.

T 64.3 Wed 17:00 L-3.016

Concept of an inverted Ring Imaging Cherenkov detector — •Maximilian Rinnagel, Otmar Biebel, Bernhard Flierl, Maximilian Herrmann, Christoph Jagfeld, Felix Klitzner, Katrin Penski, Sebastian Trost, Chrysostomos Valderanis, Fabian Vogel, and Ralf Hertenberger — LMU München

The concept of this Ring Imaging Cherenkov detector consists of a lead glass volume inside which Cherenkov light is created by traversing particles. Afterwards Cherenkov photons are converted to electrons by a CsI photocathode. The created photoelectrons enter the drift gap of a Micro Pattern Gaseous Detector. Signals on the readout strips of the detector allow for the reconstruction of the momentum of a known particle by the size of ellipses illuminated by the Cherenkov light. Simulations for the efficiency of particle yield and their respective energy have been performed for cosmic muons to investigate the feasibility of this detector design. Furthermore studies of the detector components e.g. the photon spectrum of the lead glass are presented.

T 64.4 Wed 17:15 L-3.016

Development of a GridPix X-ray polarimeter — Klaus Desch, •Markus Gruber, Jochen Kaminski, and Leonie Richarz — Physikalisches Institut, Universität Bonn, Nußallee 12, 53115 Bonn

In our group there are several gaseous detectors in development based on a highly granular pixel ASIC (Timepix / Timepix3) and a MicroMegas gas amplification stage (InGrid). The MicroMegas is produced by photolithographic postprocessing techniques and can be aligned with the pixel structure so that one grid hole is directly above one pixel. The combination of the Timepix ASIC and the InGrid amplification stage is called "GridPix". The advantage of a GridPix is its high granularity combined with low noise which gives the possibility of high resolution tracking and single primary electron detection.

To build an X-ray polarimeter based on a GridPix one uses the correlation of the polarisation plane and the emission angle of photoelectrons. By tracking the photoelectrons with the GridPix with its high resolution one can identify the start and endpoints as well as the direction of the photoelectrons. It is also possible to resolve multiple scattering within the photoelectron track. By reconstruction of the emission angle one can reconstruct the polarisation plane of the incoming photons.

In this talk I will present the working principle of a GridPix X-ray polarimeter as well as measurements from recent testbeams at PETRA III and KARA. Furthermore I will give an outlook on our future plans for the development of such a detector.

T 64.5 Wed 17:30 L-3.016

Gaseous Detector Studies with the VMM3a ASIC — •Lucian Scharenberg[1,2], Klaus Desch[2], Hans Muller[1], Eraldo Oliveri[1], Dorothea Pfeiffer[3,1], and Leszek Ropelewski[1] — [1]CERN, Geneva, Switzerland — [2]Physikalisches Institut, University of Bonn, Germany — [3]ESS, Lund, Sweden

The VMM3a is a 64-channel Application-Specific Integrated Circuit (ASIC), which was specifically developed for the electronic read-out of Micro-Pattern Gaseous Detectors (MPGDs). It offers various features, like for example a high-rate (up to 4 MHz per channel) continuous read-out, a nanosecond time resolution, a 10-bit Analogue-to-Digital-Converter (ADC) for the charge signals, an integrated zero-suppression or a neighbouring-logic.

Recently this ASIC has been implemented into RD51's Scalable Readout System (SRS), enabling the usage of the VMM3a for small R&D laboratory set-ups to mid-scale experiments. In order to demonstrate the capabilities of this system for future applications, characterisation and test measurements are conducted, using a $10 \times 10\,\mathrm{cm}^2$

active area triple-GEM detector.

In this talk a short overview of the experimental set-up and the VMM3a/SRS structure is given, followed by the presentation of one example of the test measurements, exploiting several of the available features. It is shown that the rare case of fluorescence X-rays, also known as 'escape photons', interacting in the gas volume can be resolved. Furthermore these resolved X-rays are used to introduce a new method to determine the drift velocity in a gaseous detector.

T 64.6 Wed 17:45 L-3.016

Development of a testing system for the new ASD chips for the PhaseII upgrade of the ATLAS Muon Spectrometer — •Chrysostomos Valderanis, Otmar Biebel, Bernhard Flierl, Christoph Jagfeld, Maximilian Herrmann, Ralf Hertenberger, Felix Klitzner, Katrin Penski, Maximilian Rinnagel, Sebastian Trost, and Fabian Vogel — LMU München

The ATLAS Monitored Drift Tubes (MDT) muon barrel chambers will cope with higher background conditions in the next High Luminocity (HL) LHC program. An efficient trigger system is being designed for this purpose, taking into account the muon trajectory. This system will require the replacement of the MDT's front end electronics. The production prototypes for the Amplifier Shaper Discriminator (ASD) chip build in 130 nm GF CMOS technology are already available.

We report on the fully automated testing system developed to test the full production of the ASD chips. The performance characteristics of the tester and the first tests and their result are being presented.

T 65: Top quarks: differential cross sections

Time: Wednesday 16:30–19:00 Location: H-HS VIII

T 65.1 Wed 16:30 H-HS VIII

Top-antitop energy asymmetry in jet-associated top-quark pair production at ATLAS — •Alexander Basan, Peter Berta, Lucia Masetti, and Eftychia Tzovara — Johannes Gutenberg University Mainz

The top quark is particularly well suited to probe the standard model (SM) and many extensions thereof at the electroweak symmetry-breaking scale and beyond.

At hadron colliders, the $t\bar{t}$ production is symmetric at leading order perturbation theory under the exchange of the top- and anti-top-quark, while interferences at higher orders create an asymmetry. This charge asymmetry can provide sensitive probes for many models beyond the standard model like massive color-octet states, extra dimensions, flavor violating gauge bosons and axigluons. Within the framework of effective field theories (EFT), the charge asymmetry is especially sensitive to four-quark operators and one operator that modifies the top-gluon interaction.

In inclusive jet-associated top-quark pair production the asymmetry arises already at leading order in quark-gluon interactions. Furthermore, the $t\bar{t}j$ final states allow the definition of a new observable, the energy asymmetry, expressed in terms of the distribution of the energy difference $E_t - E_{\bar{t}}$.

This talk presents the measurement strategy in lepton+jets events with a high p_T hadronically decaying top quark at ATLAS with a center of mass energy of $\sqrt{s} = 13\,\text{TeV}$ as well as expected sensitivities to the Wilson coefficients.

T 65.2 Wed 16:45 H-HS VIII

Bestimmung der Energie-Asymmetrie im Top-Quark-Paarsystem mit einem zusätzlichen Jet mit dem CMS-Experiment — Darius Bühler, Thorsten Chwalek, Nils Faltermann, Thomas Müller, •Johann Rauser und Simon Weisser — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

Mit dem aufgenommenen Datensatz von Run 2 eröffnet sich am LHC die Möglichkeit, die Eigenschaften des Top-Quarks mit noch höherer Präzision zu vermessen. Von besonderem Interesse sind hierbei Asymmetrien im Top-Quark-Paarsystem, da Abweichungen von der Theorie-Erwartung ein Indiz auf Physik jenseits des Standardmodells sein können. Bisherige Analysen am Tevatron und am LHC mit den Daten von Run 1 fokussierten sich auf Rapiditäts-Asymmetrien; ein Effekt, der sich mit steigender Schwerpunktsenergie verringert.

Die Energie-Asymmetrie ist eine speziell auf den LHC zugeschnittene Observable im Kanal der Top-Quark-Paarproduktion mit einem zusätzlichen Jet. Diese verspricht bei einer Schwerpunktsenergie von $\sqrt{s} = 13\,\text{TeV}$ einen signifikant messbaren Effekt. Im Vortrag wird die Messung der Energie-Asymmetrie am CMS-Experiment vorgestellt.

T 65.3 Wed 17:00 H-HS VIII

Measurements of observables sensitive to color reconnection in $t\bar{t}$ dilepton events — •Shayma Wahdan[1], Dominic Hirschbühl[1], Wolfgang Wagner[1], Thorsten Kuhl[2], Andrea Knue[3], Frederic Deliot[4], Tetiana Moskalets[4], and Clement Helsens[5] — [1]Wuppertal — [2]DESY — [3]Freiburg — [4]Saclay CEA — [5]CERN

The color reconnection (CR) modelling uncertainty could become one of the dominant sources of systematic uncertainties in the top mass determination. Ongoing top-quark mass analyses use the PYTHIA 8 MC generator for parton showering and hadronization. PYTHIA 8 comes with several alternative CR models which should be explored to estimate the CR modelling uncertainty. At the same time, the models should be confronted with collision data to test their validity. Only models which are in agreement with data in general are suitable to define the corresponding modelling uncertainty. An investigation to find the most discriminating observable between these models has been done in $t\bar{t}$ dilepton events. The sensitive observables use tracks associated to the vertex of the hard scattering (primary vertex). The selected tracks are still diluted with pile-up tracks and tracks of secondary particles. Therefore, a pile-up model is developed to subtract the pile-up contribution. The observables are then unfolded to the particle level.

T 65.4 Wed 17:15 H-HS VIII

Regressionsbasierte Rekonstruktion der Top-Quark-Kinematik bei Top-Quark-Paarproduktion für das CMS-Experiment. — •Darius Bühler, Thorsten Chwalek, Nils Faltermann, Thomas Müller, Johann Rauser und Simon Weisser — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

Im Laufe des Run 2 am LHC wurde eine hohe Zahl von Top-Quark-Paaren erzeugt, weshalb sich dieser Produktionsmechanismus für Präzisionsmessungen der Eigenschaften des Top-Quarks eignet. Mögliche Abweichungen dieser Eigenschaften von den Vorhersagen des Standardmodells könnten wichtige Hinweise auf neue Physik liefern. Für die Vermessung verschiedener Eigenschaften – beispielsweise von Asymmetrien im Top-Quark-Paarsystem – ist eine möglichst genaue Kenntnis der Kinematik von Top-Quark und Top-Antiquark erforderlich.

Klassische Rekonstruktionsansätze basieren auf der Zuordnung von im Detektor gemessenen Objekten, in diesem Fall Leptonen und Jets, zu den nach dem Zerfall des Top-Quark-Paares erwarteten Teilchen. Die rekonstruierte Kinematik der Top-Quarks ergibt sich durch Addition der Vierervektoren der entsprechenden Detektorobjekte.

Im Vortrag werden Studien zu einem anderen Ansatz am CMS-Experiment vorgestellt, der auf der Regression von Top-Quark- und Top-Antiquark-Kinematik mittels neuronaler Netze aufbaut. Dabei wird die Geometrie herkömmlicher neuronaler Netze durch spezielle Strukturen erweitert, die auch in modernen Verfahren der Bildanalyse Anwendung finden.

T 65.5 Wed 17:30 H-HS VIII

Measurements of differential cross sections for $t\bar{t}$ production at $\sqrt{s} = 13$ TeV with the CMS experiment — Maria Aldaya, Olaf Behnke, •Henriette Petersen, Mykola Savitskyi, Rafael Sosa, and Sebastian Wuchterl — Deutsches Elektronen Synchrotron (DESY)

Precision tests of the Standard Model are of utmost importance in particle physics, not only in terms of testing existing theories but also in probing the realm of new physics. The top quark is of particular interest in this context as its heavy mass can link it to production- and decay-modes of new processes at higher energy scales. In this talk measurements of differential cross sections for $t\bar{t}$ production at $\sqrt{s} = 13$ TeV will be presented. The analysis is based on data ob-

tained with the CMS experiment during 2016, 2017 and 2018 in Run 2 of the LHC which corresponds to an integrated luminosity of 137 fb^{-1}. In this period of time more than 100 million $t\bar{t}$ events have occurred and as such this facilitates unprecedented precision in measurements of kinematic spectra and topologies in these events. The analysis is performed using the dileptonic decay channel. We perform differential measurements of the $t\bar{t}$ production cross section in bins of kinematic properties of the visible decay products, $t\bar{t}$ system and top quark.

In this talk the general analysis strategy will be presented. This constitutes an overview of the event selection, kinematic reconstruction of the $t\bar{t}$ system, cross section unfolding procedure and the first results for full Run 2 differential cross sections compared to MC predictions based on NLO QCD models matched to parton showers.

T 65.6 Wed 17:45 H-HS VIII

Measurement of multi-differential cross sections for the production of top quark pairs plus additional jets in pp collisions at sqrt(s)=13TeV. — Maria Aldaya, Olaf Behnke, Henriette Petersen, Mykola Savitskyi, •Rafael E. Sosa Ricardo, and Sebastian Wuchterl — Deutsches Elektronen-Synchrotron DESY.

Measurements of multi-differential cross sections for top quark pair ($t\bar{t}$) production in pp collisions at a centre-of-mass energy of 13 TeV using events containing two opposite-sign leptons will be presented. The analyzed dataset was recorded with the CMS detector during the years 2016, 2017 and 2018, corresponding to an integrated luminosity of 137fb^{-1}. The $t\bar{t}$ cross sections are measured double and triple-differentially as a function of the $t\bar{t}$ system kinematics, the top quark and of additional jets in the event.

This talk comprises an overview of the analysis starting with the event selection, kinematic reconstruction of the $t\bar{t}$ system and the cross section unfolding procedure. First cross section results will be compared to MC predictions based on NLO QCD matched to parton showers.

T 65.7 Wed 18:00 H-HS VIII

Measurement of the dileptonic $t\bar{t}$ differential cross section in a BSM phase space at CMS — Lutz Feld, •Danilo Meuser, Johannes Schulz, and Marius Teroerde — I. Physikalisches Institut B, RWTH Aachen University

Measurements of the $t\bar{t}$ production cross section yield important precision tests of the Standard Model (SM), while also probing scenarios for physics beyond the SM (BSM). Although the dileptonic channel has the lowest branching ratio of all $t\bar{t}$ decay channels, its sensitivity is large due to small contributions from other SM processes, making this channel a great candidate for precision measurements of the $t\bar{t}$ process.

This analysis aims to measure the $t\bar{t}$ cross section in a phase space where additional contributions from BSM scenarios could be present. It is based on the data set recorded by CMS in the years 2016 to 2018 at a center-of-mass energy of 13 TeV, corresponding to an integrated luminosity of 137.2 fb^{-1}. The BSM scenarios considered include supersymmetric and dark matter models, where, similarly to the dileptonic $t\bar{t}$ channel, two leptons, b jets and undetected particles are produced. Unlike previous measurements, where the differential cross sections were mainly measured as a function of kinematic variables of the leptons or top quarks, this analysis focuses on observables related to the neutrinos, like the missing transverse momentum, to separate BSM from SM $t\bar{t}$ events.

T 65.8 Wed 18:15 H-HS VIII

Differential Measurement of the Associated Production of a Single Top Quark and a Z Boson at the CMS Experiment — •David Walter — DESY, Hamburg, Germany

The top quark is the heaviest particle of the standard model (SM) and can be produced through strong interactions in top quark-antiquark pairs, or polarised as a single top quark (or antiquark) via the electroweak interaction. The associated production of a single top quark and a Z boson (pp → tZq) includes the tZ coupling as well as the coupling of three vector bosons (WWZ) and is therefore a unique process to study the couplings of heavy particles in the SM. As early as 2018, the CMS Collaboration observed the SM production of tZq in its final state with three leptons. It was found to be in agreement with the SM prediction. In an ongoing analysis, a differential cross section measurement is being pursued. This can give more detailed insight into the modeling of the process in the SM while some of the distributions are also sensitive to beyond SM effects.

In this presentation, the analysis strategy is outlined. This includes the reconstruction of the leptons and jets as well as of the composite objects from the Z boson and the top quark. Furthermore, a multiclass neural network to isolate the signal from various background processes is shown. Based on this, first results of the signal extraction are presented. A maximum likelihood unfolding procedure is discussed to obtain results that are corrected for detector effects and effects of the hadronization process.

T 65.9 Wed 18:30 H-HS VIII

Differential cross-section measurement of the tZq process with the ATLAS detector — •Nilima Akolkar, Chris Boever, and Ian Brock — Physikalisches Institut, University of Bonn

The associated production of a single top quark with a Z boson (tZq) is a rare process confirmed by the ATLAS Collaboration in 2019. This process is of special interest, as it allows one to probe the couplings of the Z boson to the quark sector and to W bosons simultaneously.

This talk will focus on the differential cross-section measurement of the tZq process, analyzed in the trilepton decay channel. The data used was collected with the ATLAS detector during Run 2 of the LHC, corresponding to an integrated luminosity of 139 fb^{-1}. The tZq differential cross-section is measured using two different methods of unfolding and the preliminary results will be presented in the talk.

T 65.10 Wed 18:45 H-HS VIII

Measurement of the jet mass distribution in boosted top quark decays at CMS — Johannes Haller, Roman Kogler, •Alexander Paasch, and Dennis Schwarz — Institut für Experimentalphysik, Universität Hamburg

The top quark plays an essential role in particle physics and precision measurements of its mass allow consistency tests of the standard model. While most measurements of the top quark mass rely on the reconstruction of its decay products as distinct objects, this analysis targets the boosted regime where the decay products are reconstructed in a single large jet, using the exclusive cone (XCone) algorithm. The differential $t\bar{t}$ cross section is measured as a function of the jet mass for transverse momenta larger than 400 GeV. The distribution is sensitive to the value of the top quark mass, enabling a measurement in the boosted regime. Studies are presented for a measurement in the lepton+jets channel, using data recorded by the CMS experiment in 2016, 2017 and 2018 at a center of mass energy of 13 TeV.

T 66: Hauptvorträge (Invited Talks) III

Time: Thursday 11:00–12:30 Location: H-Aula

Invited Talk T 66.1 Thu 11:00 H-Aula

No Time to Die? Scrutinising the SM and other Top Stories — •Reinhild Yvonne Peters — The University of Manchester, Manchester, UK

Technically, the standard model of particle physics has been completed with the discovery of the Higgs boson in 2012. However, the success of the standard model can not hide the fact that new physics beyond the standard model must exist. With the ever-increasing data sample provided by the LHC, precision studies of the standard model are used to challenge its predictions. In my talk, a selection of results from the LHC experiments are presented, in which the standard model is strutinised. This includes measurements of the strong and electroweak forces, as well as property measurements of the heaviest known elementary particle, the top quark.

Invited Talk T 66.2 Thu 11:45 H-Aula

The Higgs boson at the LHC: a glimpse under the peak — •Matthias Schröder — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

In the Standard Model (SM) of particle physics, the Higgs boson is deeply related to the mechanism that creates the masses of elementary particles and, as such, has very characteristic properties, which are dif-

ferent from any other known particle. The large data samples collected during the LHC Run 2 from 2015 to 2018, together with new analysis techniques, allow measurements of Higgs boson production and properties at unprecedented precision. These cover various production and decay channels and include more and more differential measurements. The results play a crucial role in probing the SM and provide a unique window to discover new physics.

In this presentation, I will review the status of Higgs boson measurements by the ATLAS and CMS collaborations and discuss their interpretation within and beyond the SM. Furthermore, I will outline prospects for future measurements at the LHC and the High-Luminosity LHC.

T 67: Hertha-Sponer Prize Talk

Time: Thursday 13:15–13:45 Location: H-Aula

Prize Talk T 67.1 Thu 13:15 H-Aula
Dark Matter searches at the LHC — •Priscilla Pani — Deutsches Elektronen-Synchrotron DESY, Hamburg and Zeuthen, Germany — Laureate of the Hertha Sponer Prize 2020

Astrophysical observations have provided compelling evidence for the existence of a non-luminous component of the universe: Dark Matter. If Dark Matter is a particle, characterised by weak-scale interactions with the Standard Model, it can be recreated in the high-energy proton-proton collision at the Large Hadron Collider (LHC) at CERN. The LHC experiments have a vast and diversified experimental programme, designed in collaboration with the theoretical community, which aims to discover and precisely measure dark matter. In this talk I will provide an overview of this programme, outlining both the fundamental assumptions and the experimental challenges of this effort. Finally, I will briefly detail one specific aspect of these searches, which focus on the particularly interesting possibility that the interaction between ordinary matter and Dark Matter is mediated by new scalar particles that extend the Higgs sector.

T 68: Eingeladene Vorträge (Invited Topical Talks) III

Time: Thursday 14:00–16:00 Location: H-Aula

Invited Topical Talk T 68.1 Thu 14:00 H-Aula
Assembling the flavour jigsaw (2020 edition) — •Oscar Cata — Theoretische Physik 1, Universität Siegen, Walter-Flex-Str. 3, D-57068 Siegen

I will discuss the different flavour puzzles that we are currently facing in the bottom, charm and strange sectors, in the light of recent experimental data. I will also report on the most recent theoretical ideas to tackle them. Interestingly, the revival of low-TeV leptoquarks in the last years suggests a stronger link between the flavour puzzles in the quark and lepton sectors. These broader theoretical frameworks suggest new directions for future experimental searches, and indicate that new insights on the flavour problems might be just around the corner.

Invited Topical Talk T 68.2 Thu 14:30 H-Aula
Precise predictions for vector-boson scattering at the LHC — •Mathieu Pellen — Cavendish Laboratory, University of Cambridge, United Kingdom

Vector-boson scattering (VBS) processes have just started to be measured at the Large Hadron Collider (LHC). This is particularly exciting because this class of processes has been thought to be a possible window to new physics. But VBS is also interesting in its own right because it probes the Standard Model in extreme phase-space regions at high energy. The measurement of such processes is particularly challenging due to their low rates and large background. In this talk, I review necessary theoretical inputs to perform such measurements.

Invited Topical Talk T 68.3 Thu 15:00 H-Aula
Hunting dark matter on earth and in the sky — •Kai Schmidt-Hoberg — DESY, Hamburg

I will discuss recent developments in dark matter research with a particlar focus on light dark matter. After a quick overview I will concentrate on complementary search strategies including astrophysical as well as collider based experiments with a particular focus on the complementarity between different searches.

Invited Topical Talk T 68.4 Thu 15:30 H-Aula
Probing cosmic magnetism and fundamental physics with γ-ray propagation — •Manuel Meyer — ECAP, University of Erlangen-Nuremberg, Erlangen, Germany

The observation of high-energy γ rays produced in distant galaxies offers the unique opportunity to search for an intergalactic magnetic field (IGMF) and dark-matter particle candidates. During their propagation, γ rays interact with background radiation fields and produce e^+e^- pairs. These pairs in turn up-scatter photons of the cosmic microwave background to γ-ray energies, initiating a cascade. The morphology of this cascade signal will depend on the IGMF since it deflects the e^+e^- pairs. On the other hand, γ rays could oscillate into axion-like particles (ALPs), leaving distinct features in γ-ray energy spectra. I will review the latest results in the search for an IGMF and ALPs and give an outlook over the capabilities of future γ-ray telescopes.

T 69: Eingeladene Vorträge (Invited Topical Talks) IV

Time: Thursday 14:00–16:00 Location: H-HS X

Invited Topical Talk T 69.1 Thu 14:00 H-HS X
Boosting jets in Run 2: highlights from Standard Model measurements and searches for new physics in ATLAS — •Chris Malena Delitzsch — University of Arizona, Tucson, USA

The unprecedented center-of-mass energy of the proton-proton collisions at the Large Hadron Collider enables the production of hadronically decaying particles such as W/Z/H bosons and top quarks with a transverse momentum much larger than their rest mass, resulting in the collimation of their decay products. To enhance the sensitivity to new physics, a variety of jet substructure techniques have been developed in the last decade that take advantage of the different radiation patterns within the large-radius jet depending on the initiating particle. The usage of jet substructure techniques is however not just limited to the identification of the origin of jets but also allows for the precise measurement of jet properties to probe and constrain the Standard Model in extreme regions of phase space.

This talk describes the state of the art substructure and tagging techniques and discusses highlights from Standard Model measurements and searches for new physics in ATLAS using these versatile techniques.

Invited Topical Talk T 69.2 Thu 14:30 H-HS X
The decay of Higgs bosons to a pair of tau leptons in the CMS experiment — •Hale Sert — RWTH Aachen University, Experimental Physics Institute 3B, Aachen, Germany

Studies of Higgs bosons decaying into a tau lepton pair play a crucial role not only in understanding the standard model of particle physics (SM) but also in searching for physics beyond the SM. Since the tau

leptons couple directly to the Higgs boson, the measurement of the coupling strength of the Higgs boson to tau leptons helps to prove the generation of fermion masses and to understand if the observed Higgs boson is the SM Higgs boson.

The $H \to \tau\tau$ process was first observed in combination of the CMS and ATLAS experiments with 5 fb^{-1} data collected in 2011 at $\sqrt{s}$ =7 TeV and 20 fb^{-1} data collected in 2012 at $\sqrt{s}$ =8 TeV. The first significant observation only by the CMS experiment was achieved after inclusion of the 2016 data, corresponding to an integrated luminosity of 35.9 fb^{-1} at a centre-of-mass energy of 13 TeV. The analysis strategies have been improved during Run 2 data-taking for example by estimating most of the background processes from data, by moving to a new tau identification method using deep neural networks and alternatively by using a new method based on neural networks classification to differentiate the individual signal and background processes.

In this talk, these improvements will be discussed and the results for the full Run 2 data corresponding an integrated luminosity of 137 fb^{-1} collected at a centre-of-mass energy of 13 TeV will be presented.

Invited Topical Talk T 69.3 Thu 15:00 H-HS X

Searches for electroweak supersymmetry: highlights, coverage and limitations — •Jeanette Lorenz — LMU Munich, Germany

Supersymmetry is an appealing extension beyond the Standard Model, which could provide e.g. a particle candidate for Dark Matter. Both the ATLAS and the CMS experiments at the Large Hadron Collider (LHC), CERN, carry out a comprehensive search program, addressing several complementary signatures of supersymmetric particles. Searches for the supersymmetric partners of the electroweak gauge bosons (charginos and neutralinos) and leptons (sleptons) are particularly challenging due to low cross sections and possibly low-energetic decay products. The increasing data statistics as well as improvements in the technical methods allow some of these searches to be done for the first time at the LHC. Recent highlights of these searches will be presented along with the assumptions made in the interpretation of the results. Although these searches have not resulted in a discovery yet, there are several ways how supersymmetry could hide, which guide us to new directions in future searches.

Invited Topical Talk T 69.4 Thu 15:30 H-HS X

To the top and beyond: top quarks as a probe of new interactions at the LHC — •Katharina Behr — DESY

As the heaviest known elementary particle with a close to unity Yukawa coupling to the Higgs field, the top quark plays a special role in the Standard Model and in searches for new particles and interactions, which are often predicted to couple preferentially to the third quark generation. Searches targeting the complex detector signatures of single or multiple top quarks aim, for example, to shed light on dark matter or probe the existence of additional Higgs bosons.

I will review the strategies of searches involving top quarks or hypothetical top partner on the latest LHC data from proton-proton collisions at $\sqrt{s} = 13$ TeV, highlighting new analysis and reconstruction techniques.

T 70: Higgs: Decay into fermions II

Time: Thursday 16:30–19:00 Location: H-HS I

T 70.1 Thu 16:30 H-HS I

Tau decay mode splitting in the semi-leptonic final state of the $H \to \tau\tau$ coupling measurement at ATLAS — •Lara Katharina Schildgen, Philip Bechtle, Klaus Desch, Christian Grefe, Michael Hübner, and Peter Wagner for the ATLAS-Collaboration — University of Bonn

The Higgs decay to fermions plays an important role to gain a deeper understanding of the coupling properties of the Higgs. Due to its relatively high branching ratio and its distinct signatures, the decay of the Higgs boson to a tau lepton pair is a unique channel to access the Higgs-Yukawa coupling to fermions and is the first fermionic channel which has been observed by ATLAS and CMS with a significance exceeding 5σ.

Because of its short lifetime, the tau lepton decays before reaching the detectors and is therefore reconstructed by its decay products. The reconstruction algorithm for hadronically decaying taus used in ATLAS for Run-2 benefits from an improved tau decay mode classification and higher energy resolution.

The presentation outlines the main effects of tau decay mode splitting in the $H \to \tau\tau$ coupling measurement in the semi-leptonic final state using the full Run-2 dataset collected at a centre-of-mass energy of 13 TeV.

T 70.2 Thu 16:45 H-HS I

Optimizing the Machine Learning techniques used in the CMS Higgs→ $\tau\tau$ analysis — •Maryam Bayat Makou, Elisabetta Gallo, Teresa Lenz, Mareike Meyer, and Alexei Raspereza — Deutsches Elektronen-Synchrotron DESY, Hamburg,Germany

One of the main goals of LHC experiments is the precise measurement of the Higgs boson's production properties in order to clarify its coupling structure. In Standard Model physics the coupling of the Higgs boson to fermions are introduced as Yukawa couplings. Due to the high branching ratio of the Higgs boson decay into tau leptons and the lower background contribution compared to H→ $b\bar{b}$, the Higgs→ $\tau\tau$ channel is an interesting channel to probe the Higgs coupling to fermions.

The presented measurement is performed using data collected by the CMS experiment at a center-of-mass energy of 13 TeV in 2018 corresponding to an integrated luminosity of 59.7 fb^{-1}. The analysis is based on a multi-class neural network, which classifies the events into two signal classes (gluon-gluon and vector boson fusion production) and several background classes.The eμ final state of the tau lepton pair is studied. The main challenge in the analysis is the differentiation between the signal events produced via gluon-gluon fusion and the irreducible background process where a Z boson decays into tau lepton pair. In this talk, studies aiming to improve the separation power of the neural network between these processes will be presented.

T 70.3 Thu 17:00 H-HS I

Track and SecondaryVertex Reconstruction of Tau Leptons in ATLAS — •Kevin Bass, Peter Wagner, Michael Huebner, Klaus Desch, and Philip Bechtle — Universitaet Bonn

The Higgs boson decay into two tau leptons offers a unique way to test the Standard Model. Techniques to better characterize this decay in data collected from LHC runs are being improved. The Missing Mass Calculator (MMC) is used to estimate the di-tau mass and is an important discriminator between signal and background processes. I will introduce the concepts behind tau vertex reconstruction both in regards to and independently of the MMC and show how it can help to improve the predicted Higgs boson mass.

T 70.4 Thu 17:15 H-HS I

Standard Model H→ $\tau\tau$ analysis with a neural network trained on a mix of simulation and data samples — Günter Quast, •Moritz Scham, and Roger Wolf — Karlsruhe Institut für Technologie, Karslruhe, Deutschland

At the LHC, best access to the coupling of the observed Higgs boson to fermions is provided by the decay into τ leptons. For the measurement of simplified template cross sections in this decay channel CMS uses a multi-classification neural network to distinguish signal from background classes. In this talk a training of the neural network is presented, where the most important backgrounds from genuine di-τ events and from jets misidentified as τ leptons are obtained from data. In this way up to 90% of the background events are estimated from data, independent from the simulation.

T 70.5 Thu 17:30 H-HS I

Measurement of the Higgs boson coupling to τ leptons using a multi-class neural network — •Frank Sauerburger, Spyridon Argyropoulos, Shigeki Hirose, Karsten Koeneke, and Christian Weiser — Albert-Ludwigs-Universität Freiburg, Freiburg, Deutschland

A multivariate analysis using a multi-class neural network to measure the standard model coupling of the Higgs boson to τ leptons ($H \to \tau\tau$)

is presented. The analysis focuses on the signal region enriched in vector-boson fusion (VBF) events. The background is estimated with a combination of Monte Carlo simulation and data-driven methods. A neural network is trained on multiple event categories of the background and signal model and employed to select VBF-like events. The rejection of background events and signal events originating from the gluon-fusion Higgs production mechanism increases the sensitivity of the analysis by increasing the signal to background ratio and reducing the systematic uncertainties of the theoretical prediction. The analysis is performed using the full Run 2 dataset of proton-proton collisions at a center-of-mass energy $\sqrt{s} = 13\,\text{TeV}$ corresponding to an integrated luminosity of $139\,\text{fb}^{-1}$ recorded with ATLAS detector at the LHC between 2015 and 2018.

T 70.6 Thu 17:45 H-HS I

CP Violation in Higgs Boson Decays into two Tau Leptons with the CMS Experiment — Mate Farkas, Olena Hlushchenko, Wolfgang Lohmann, Dennis Roy, Hale Sert, Sebastian Siebert, Achim Stahl, Lucas Wiens, and •Alexander Zotz — III. Physikalisches Institut B, RWTH Aachen University, Germany

Ever since the observation of the Higgs boson decay into a pair of tau leptons in 2016 by ATLAS and CMS, measurements of the structure of fermionic couplings have been made possible. Many of the Higgs boson's quantum numbers have been determined already, yet the full picture of its CP nature is unclear. The angle between the decay planes of the tau lepton decay products in the $H \to \tau\tau$ decay is a suitable observable to differentiate between different CP hypotheses including an admixture of odd and even states giving rise to CP violation.

In this talk, an analysis is presented to measure a CP mixing angle in fermionic Higgs boson decays via two tau leptons with the CMS experiment and in addition an estimation of the expected sensitivity for the data of Run 2 of the LHC is given.

T 70.7 Thu 18:00 H-HS I

Making a Higgs to tau leptons coupling analysis at ATLAS: Behind the Scenes — •Michael Hübner, Philip Bechtle, Klaus Desch, Christian Grefe, Lara Schildgen, and Peter Wagner — Universität Bonn

What are necessary ingredients to an analysis at ATLAS? Taking the previous instalment of the measurement of the $H \to \tau\tau$ rate from ATLAS [https://arxiv.org/abs/1811.08856], a very complex analysis can be described on only 29 pages. The experimental uncertainties are presented in less than one page. But what needs to happen behind the scenes to derive all these results?

This talk will cover some key aspects of the $H \to \tau\tau$ measurement that require a lot of work but which are not obvious at first glance:
How is the key observable for this analysis defined and what has to be done to use it?
How to estimate experimental uncertainties and how to improve those estimates?
What kind of technical infrastructure and code frameworks are needed to arrive at the final result?

T 70.8 Thu 18:15 H-HS I

Analysis of CMS $\tau\tau$ events in SM and BSM interpretations — •Artur Gottmann, Günter Quast, and Roger Wolf — Karlsruhe Institute of Technology, Wolfgang-Gaede-Str. 1, 76131 Karlsruhe, Germany

In the past, $\tau\tau$ analyses distinguished between the measurement of the properties of the observed Higgs boson at 125 GeV and the search for additional heavy resonances from theories beyond the Standard Model (BSM).
Analyses of the observed Higgs boson were optimized on its kinematic properties from gluon fusion and vector boson fusion production with a sophisticated event categorisation, whereas the BSM searches were based on more inclusive event selections optimized for heavy resonances from gluon fusion and b-associated production.
However, a BSM motivated analysis of $\tau\tau$ events in predefined benchmark scenarios can profit from a comprehensive measurement that consistently includes all possible constraints from the observed Higgs boson and the search for additional heavy resonances. In this talk, such an approach will be proposed for future BSM interpretations of $\tau\tau$ analyses.

T 70.9 Thu 18:30 H-HS I

Standard model Higgs physics in the $\tau\tau$ final state — Janek Bechtel, Sebastian Brommer, Maximilian Burkart, Artur Gottmann, Simon Jörger, Günter Quast, Moritz Scham, Roger Wolf, Stefan Wunsch, and •Sebastian Wozniewski — Karlsruhe Institute of Technology, Karlsruhe, Germany

The $\tau\tau$ final state allows for highly relevant investigations of the Higgs sector in the context of couplings to fermions. With the data of the full LHC Run II, the sensitivity in this channel is large enough to aim for fiducial cross sections that are differential in the phase space of the Higgs boson production, known as simplified template cross section (STXS) measurements. This talk summarizes recent milestones on the way to a Run II legacy analysis of CMS in the context of the SM Higgs boson in the named decay channel. The machine learning approach that was presented earlier in a preliminary result has been further developed and tailored to this STXS measurement. Tau embedding and the extrapolation of background with jets misidentified as hadronic taus are used for both the training and the statistical inference, which makes this analysis data driven to a large extent and less dependent on the simulation of the underlying physics or detector and beam conditions.

T 70.10 Thu 18:45 H-HS I

Measurements of Simplified Template Cross Sections in the H→ $\tau\tau$ decay channel at the ATLAS experiment — •Fabian Becherer, David Hohn, and Markus Schumacher — Albert-Ludwigs-Universität Freiburg

The measurement of Simplified Template Cross Sections (STXS) is a strategy to study the Higgs boson at the LHC. The measurements of the signal strength μ and coupling modifiers κ used in Run 1 make use of assumptions, such as the Standard Model kinematics or extrapolating from the measured phase space to the global phase space. These assumptions introduce theoretical uncertainties on the determined results and dependencies on the underlying physics model.
The STXS technique allows the reduction of theory dependencies in a systematic way, which are directly folded into the measurements. It provides more finely-grained measurements of cross sections in well-defined phase space regions. These measurements will benefit from the global combination of the measurements in all decay channels and the higher cross section for the Higgs boson production at $\sqrt{s}$=13 TeV in Run 2. Furthermore, the common definition used by the ATLAS and CMS experiments will allow a combination across them.
This talk will focus on the optimization of the H→ $\tau\tau$ decay channel analysis strategy of the ATLAS experiment for the full Run 2 data set. These measurements form an important input to combined STXS results, in particular for vector boson fusion and high transverse momentum topologies.

T 71: Supersymmetry: Theory and searches

Time: Thursday 16:30–19:00 Location: H-HS VI

T 71.1 Thu 16:30 H-HS VI

Study of thesensitivity of the ATLAS experiment to the phenomenological MSSM afterRun 2 — •Christoph Ames and Alexander Mann — Ludwig-Maximilians-Universität, Munich

Supersymmetry (SUSY) is a framework that can be used to solve many problems that cannot be explained with the Standard Model, such as the hierarchy problem or the existence of dark matter. SUSY can be implemented in many different models, one of which is the phenomenological Minimal Supersymmetric Model (pMSSM), a simplified version of the MSSM. In this model, it is assumed that all parameters are real, which eliminates the possibility of CP violation through SUSY. Flavour-changing neutral currents are excluded and the first and second generations of supersymmetric fermions are considered to be degenerate. Also, the Yukawa couplings for the first two generations are assumed small and negligible. Therefore, the pMSSM can be described with only 19 parameters and it is feasible to run scans over the phase space to learn more about the behaviour of supersymmetric particles.

We evaluate ATLAS analyses that use the Run 2 data of the LHC by performing such scans. With this information, regions of phase space to which current analyses are not sensitive can be identified. The final goal is a statement about the combined sensitivity of ATLAS analyses in the pMSSM.

T 71.2 Thu 16:45 H-HS VI

Phenomenology in the μNMSSM — •Steven Paasch[1], Li Cheng[1], Gudrid Moortgat-Pick[2], and Wolfgang Hollik[1,3,4] — [1]Deutsches Elektronen-Synchrotron — [2]Deutsches Elektronen-Synchrotron, Universität Hamburg — [3]IKP — [4]TTP

The Next-to-Minimal Supersymmetric Standard Model (NMSSM) with an additional singlet in the Higgs sector is a well motivated extension to the Minimal Supersymmetric Standard Model (MSSM). The additional singlet in the Higgs sector relaxes constraints within the Higgs sector. It also provides several candidates for cold dark matter. We will discuss the so-called μNMSSM model that can be embedded consistently into inflation models. Compared to the NMSSM it offers an additional parameter that originates from a non-minimal coupling to gravity. We performed a phenomenological study for the LHC and a future linear collider and analyzed in detail scenarios that are in accordance with current experimental constraints. In particular, we focussed on developing strategies for distinguishing the models in experiment and performed a multi-parameter scan in these models.

T 71.3 Thu 17:00 H-HS VI

Phenomenology of inflation-inspired supersymmetric models — •Cheng Li[1], Steven Paasch[1], Wolfgang Hollik[2], and Gudrid Moortgat-Pick[3] — [1]DESY, Hamburg, Germany — [2]KIT, Karlsruhe, Germany — [3]University Hamburg, Hamburg, Germany

The Next-to-Minimal Supersymmetric Standard Model (NMSSM) with an additional singlet of Higgs sector is a well-motivated extension of the Minimal Supersymmetric Standard Model (MSSM). This additional singlet relaxes constraints within the Higgs sector and enlarges the parameter space. In the talk we discuss the μNMSSM model which in addition can be embedded consistently into inflation models. Within in the μNMSSM, we study the scenarios which are intrinsically different from the normal NMSSM. After that we try to replace some input parameters for adapting `NMSSMTools` to μNMSSM model, and compute the whole spectrum including particles masses, decay widths and mixing matices for specific μNMSSM scenarios. By using the Monte Carlo simulation we check whether the discussed scenarios may be excluded by the experimental limit with `CheckMATE`. For the allowed scenarios, we focus on the process of the light singlet-like Higgs production, and predict the cross sections with different center-of-mass energy and polarization of initial state at the future electron-positron colliders.

T 71.4 Thu 17:15 H-HS VI

An application of neural networks in the phenomenological minimal supersymmetric standard model — Bein Samuel[1], Mrowietz Malte[1], Schleper Peter[1], Prosper Harrison[2], and •Wiederspan Bogdan[1] — [1]University Hamburg, Germany — [2]Florida State University, United States of America

The simplified model approach to interpreting searches for supersymmetry (SUSY) has been extensively used so far in both CMS and ATLAS. In recent times, interpretation have also been done in terms of full models, like the phenomenological minimal supersymmetric standard model (pMSSM). The pMSSM offers the advantages of interpretations in full models, while it contains a manageable number of just 19 degrees of freedom, in contrast to e.g. the over 100 degrees of freedom in the minimal supersymmetric standard model. Neural networks in particle physics have shown their usefulness in the recent past, especially in higher-dimensional problems, where it is hard to detect patterns. A feasibility study for using a neural network to regress on the acceptance of a complex SUSY search is presented.

T 71.5 Thu 17:30 H-HS VI

Search for new physics in final states with hadronically decaying tau leptons in association with *b*-jets — •Ferdinand Krieter and Alexander Mann — Ludwig-Maximilians-Universität München

While the predictions given by the Standard Model (SM) of particle physics show an exceptionally good agreement with experimental data, there are still several questions left unanswered. A search for new physics involving final states with tau leptons, *b*-jets and missing transverse momentum is presented. Such signatures can emerge in multiple extensions of the SM, which try to provide solutions to some of the open questions. The search uses data of *pp* collision events at a center-of-mass energy of 13 TeV, recorded with the ATLAS detector from 2015 to 2018.

One proposed extension is given by Supersymmetry (SUSY), which predicts superpartners of known SM particles, whose spins differ by one half unit. In many SUSY models the mass of the top squark, the superpartner of the SM top quark, is expected to be low enough to not only be within the reach of the LHC but also to provide an elegant solution to the hierarchy problem.

Besides a search for top squark pair production, another SM extension, leptoquarks, is discussed in this talk. These hypothetical particles are potential candidates to explain the similarities between the quark and lepton sector of the SM as well as the anomalies observed in B-meson decays. Pair-produced leptoquarks of the third generation yield a final state that can be covered by this analysis as well.

T 71.6 Thu 17:45 H-HS VI

Search for Direct Pair Production of Staus with Two Hadronically Decaying Taus in the Final State at the ATLAS Detector in Run 2 — •Clara Leitgeb and Alexander Mann — Ludwig-Maximilians-Universität, München

Supersymmetry is a popular extension of the Standard Model of particle physics. In particular, the search for direct pair production of the supersymmetric partners of left- and right-handed taus (staus) is an important goal of the ATLAS physics program.

Using the full dataset that was taken during Run 2 of the LHC at a center-of-mass energy of 13 TeV, a cut-and-count based analysis of events containing two hadronically decaying taus and missing transverse energy was performed. Despite the low stau production cross section it was possible to exclude degenerate stau masses up to 390 GeV and neutralino masses up to 140 GeV at 95% confidence level. Furthermore, separate exclusion limits for the supersymmetric partners of left-handed taus could be derived.

The analysis will be presented in this talk together with possible improvements of these limits by using machine-learning techniques and studying compressed scenarios.

T 71.7 Thu 18:00 H-HS VI

Search for direct stau production in events with one hadronically and one leptonically decaying tau lepton with the ATLAS detector — •Anna Bertolini and Alexander Mann — Ludwig-Maximilians-Universität, Munich

Supersymmetry (SUSY) provides a solution to many open questions of the Standard Model (SM). It postulates the existence of supersymmetric partners of the elementary particles of the SM. In many SUSY models the mass order of the supersymmetric leptons (sleptons) is reversed compared to the SM, making the supersymmetric tau (stau) the lightest slepton and therefore possibly accessible at the LHC.
Direct stau production has been studied with the ATLAS detector, assuming that both staus decay into a tau lepton and a stable neutralino. An analysis considering only hadronically decaying taus (Had-Had Channel) found no significant excess over the expected SM background.
The presented study looks at a final state with one tau decaying hadronically and one leptonically (LepHad Channel). The advantage of this channel is the possibility to trigger on a light lepton with lower offline thresholds than required for the tau triggers. Therefore, it is possible to search for direct stau production covering a phase-space region to which the HadHad-channel is not sensitive.

T 71.8 Thu 18:15 H-HS VI

Search for disappearing tracks with the CMS experiment at $\sqrt{s}$ = 13 TeV — •Viktor Kutzner[1], Samuel Bein[1], Seh Wok Lee[3], Isabell Melzer-Pellmann[2], Sang-Il Pak[3], Peter Schleper[1], Sezen Sekmen[3], Akshansh Singh[2], and Alexandra Tews[1] — [1]Institut für Experimentalphysik, Universität Hamburg — [2]DESY — [3]Kyungpook National University

Long-lived particles are often predicted in theories with a small mass splitting between the two lightest particles, for example a chargino and a neutralino. Given a sufficiently small mass splitting in the range of $m_\pi \lesssim \Delta m \lesssim 200$ MeV, the chargino is expected to decay in the CMS tracker volume into soft non-reconstructed leptons or hadrons and a lightest supersymmetric particle, leaving a disappearing track. This signature is characterized by missing hits in the outer layers of the tracker with little or no energy deposited in the calorimeter. In addi-

tion to events with one or more disappearings tracks, events with an additional lepton are considered as well to account for a second long-lived chargino, which decays outside the tracker volume. For both topologies events with additional b-quark jets are investigated to account for gluino-/squark-associated chargino production. Data-driven methods are used to determine the dominant backgrounds arising from prompt leptons and fake tracks. Results are presented using proton-proton collision data with $\sqrt{s} = 13$ TeV collected with the CMS experiment during Run-2.

T 71.9 Thu 18:30 H-HS VI

Soft and displaced tracks in searches for compressed Higgsinos at the CMS experiment — Samuel Bein, Viktor Kutzner, Yuval Nissan, Peter Schleper, Alexandra Tews, and •Moritz Wolf — Universität Hamburg

Many supersymmetric extensions to the Standard Model predict the three lightest electroweakinos, χ_2^0, $\chi_1^\pm$ and χ_1^0, to be Higgsino-like with similar masses around the electroweak scale. The lightest chargino and the second-lightest neutralino can be pair-produced and decay to the lightest neutralino. To search for these particles, the best strategy depends on the differences between their masses. For $\Delta m(\chi_2^0, \chi_1^0) > \mathcal{O}(1)\,\text{GeV}$ lepton pairs from the decay of the second-lightest neutralino leave an experimentally distinct signature, whereas $\Delta m(\chi_1^\pm, \chi_1^0) < 0.3\,\text{GeV}$ leads to the chargino in some cases giving rise to a disappearing track or a soft displaced pion. However, mass splittings in the range of $\Delta m(\chi_1^\pm, \chi_1^0) = 0.3 - 1\,\text{GeV}$ are still unexplored by either of those methods.

This study describes how a mono-jet analysis can be made more sensitive to Higgsinos with mass splittings in this range by requiring a soft and displaced track in the event corresponding to the pion originating from the chargino decay.

T 71.10 Thu 18:45 H-HS VI

Search for compressed mass-spectrum long-lived particles using short disappearing tracks with the ATLAS experiment — •Paul Gessinger[1,2] and Stefan Tapprogge[2] — [1]CERN — [2]Johannes Gutenberg-Universität Mainz

In certain Supersymmetry scenarios, the lightest neutalino $\tilde{\chi}_1^0$ and charginos $\tilde{\chi}_1^\pm$ can become nearly degenerate in mass. At mass splittings as low as $\Delta m(\tilde{\chi}_1^\pm, \tilde{\chi}_1^0) \approx 100$ MeV, the chargino obtains lifetimes of $\mathcal{O}(10$ ps), which causes it to reach sensitive parts of the ATLAS experiment, before decaying mostly to a neutralino leaving the detector without interacting, and a low momentum charged pion that is difficult to detect. This causes the chargino track to *disappear*.

The tracking systems and reconstruction algorithms of the ATLAS detector are designed to efficiently detect and reconstruct charged particles crossing all sensor layers. Using specialized reconstruction techniques, it is possible to reconstruct short *tracklets*, which arise only from hits in the Pixel detector. Previous ATLAS analyses used tracklets consisting of 4 Pixel hits and no hits in the silicon strip detector as disappearing track signatures to search for the aforementioned scenarios in LHC *pp*-collisions at 13 TeV.

Building on efforts to reconstruct even shorter tracklets with only 3 Pixel hits and to reconstruct the soft charged pion, this talk will present the strategy and report on progress towards a dedicated pure-higgsino search, using established analysis techniques and new developments.

T 72: Semiconductor detectors

Time: Thursday 16:30–18:45 Location: H-HS IX

T 72.1 Thu 16:30 H-HS IX

Transient Current Technique (TCT) using alpha particles and red laser on irradiated silicon detectors — •Mohammadtaghi Hajheidari, Erika Garutti, Georg Steinbrueck, Joern Schwandt, and Robert Klanner — Institute for Experimental Physics, Hamburg University, Luruper Chaussee 149, D-22761 Hamburg, Germany

The luminosity of CMS Phase 2 will increase to $7.5\times10^{32} cm^{-2} s^{-1}$.The inner layer of the tracker detector will experience a fluence up to $2.6 \times 10^{16} neq/cm^2$. This will induce a radiation damage to the silicon sensors and change their performance. One of the important radiation effects on silicon detectors is the introduction of trapping centers which reduces the Charge Collection Efficiency (CCE).

Transient Current Technique (TCT) is an experimental tool to study the trapping probabilities of charge carriers inside an irradiated sensor. The transient pulses induced by front-side/ back-side illumination with red light laser (wavelength of 660 nm) or alpha particles (energy of 5 MeV) are dominated by holes and electrons, respectively. Literature has reported contradicting trapping times of e/h using alpha and laser TCT. Therefore, it is necessary to have a systematic comparison between the two modalities.

This work presents the results of the alpha- and red laser-TCT measurements on two irradiated pad diodes with fluences of 2×10^{15} and $4 \times 10^{15} neq/cm^2$. By measuring the CCE values, the trapping times of e/h are calculated.

T 72.2 Thu 16:45 H-HS IX

TPA-TCT – Two Photon Absorption - Transient Current Technique — •Moritz Wiehe[1,2], Marcos Fernandez Garcia[1,5], Isidre Mateu[1], Michael Moll[1], Raúl Montero Santos[3], Rogelio Palomo Pinto[4], and Ivan Vila Alvarez[5] — [1]CERN — [2]Universität Freiburg — [3]Universidad del Pais Vasco (UPV-EHU) — [4]Universidad de Sevilla (US) — [5]Instituto de Fisica de Cantabria (CSIC-UC)

The Transient Current Technique (TCT) has become a very important tool for characterization of unirradiated and irradiated silicon detectors. In recent years a novel method, the Two Photon Absorption - Transient Current Technique (TPA-TCT), based on the charge carrier generation by absorption of two photons, was developed. TPA-TCT proved to be very useful in 3D characterization of silicon devices with unprecedented spatial resolution. Currently the first compact TPA-TCT setup is under development at CERN. The current status of the setup and first measurements are presented.

T 72.3 Thu 17:00 H-HS IX

Improvement of a Transient Current Technique (TCT) setup and first results obtained with silicon diodes — •Falko Barth, Kevin Kröninger, Jonas Lönker, Mareike Wagner, and Jens Weingarten — TU Dortmund, Lehrstuhl für Experimentelle Teilchenphysik IV

The Transient Current Technique (TCT) can be used for characterisation of semiconductor detectors. Charge is deposited in the (silicon) diodes using red to infrared lasers. For red lasers (672 nm) th charges are created close to the surface which is illuminated, leading to one kind of charge carriers being absorbed very quickly, leaving only the other kind of charge carriers to generate a signal while drifting in the electric field in the sensor. The induced signal is amplified and read out using a high-bandwidth oscilloscope. Analysis of the signal yields information on the electric field in the sensor bulk and the collected charge. This talk will present TCT results using different wavelength lasers as well as sensor materials and thicknesses.

T 72.4 Thu 17:15 H-HS IX

NitroStrip: Stickstoff angereichertes Silizium für Teilchendetektoren — •Jan Cedric Hönig, Leena Diehl, Franzsika Moos, Riccardo Mori, Ulrich Parzefall und Liv Wiik-Fuchs — Albert-Ludwigs-Universität Freiburg

Ein Ansatz die Strahlenhärte von Silizium zu verbessern ist das gezielte einbringen von Fremdatomen. Im Rahmen des NitroStrip Projekts wurde die Strahlenhärte von mit Stickstoff angereicherten Streifensensoren untersucht. Es wurde erwartet, dass eine Vielzahl von Defekten, vor allem Leerstellen, mit geringerer Konzentration auftreten. Zu diesem Zweck standen Vergleichsgruppen unterschiedlicher Silizium Sensoren, mit identischer Architektur aber unterschiedlichem Grundmaterial zur Verfügung. In diesem Vortrag wird das Nitrostrip Projekt der RD50 Kollaboration vorgestellt, welches kurz vor seinem Abschluss steht. Es werden Ergebnisse aus dem Projekt gezeigt und diskutiert. Besonderer Fokus wird auf Messungen mit der "edge transient current technique" gelegt.

T 72.5 Thu 17:30 H-HS IX

Effekte von Trapping auf die gemessenen Signale von auf-

einander folgenden Laserpulsen in bestrahlten Siliziumsensoren — •Leena Diehl[1], Riccardo Mori[1], Marc Hauser[1], Karl Jakobs[1], Gregor Kramberger[2], Ulrich Parzefall[1] und Liv Wiik[1] — [1]Universtität Freiburg, Germany — [2]Jozef Stefane Institute, Ljubljana, Slovenia

Während Untersuchungen zur Signalzusammensetzung in bestrahlten und annealten Silizium-Streifensensoren, die Ladungsvervielfachung zeigten, wurde beobachtet, dass zuvor kreierte freie Ladungsträger Auswirkungen auf den Sensor haben. Es wurde daraus gefolgert, dass die erzeugten freien Ladungsträger die vorhandene elektrische Feldverteilung verändern.

Der Einfluss von aufeinander folgenden Laserpulse mit bis zu 20μs Abstand wurde daraufhin mithilfe von Edge- und Top- Transient Current Technique untersucht. Dabei wurde eine signifikante Abnahme der gemessenen Ladung beobachtet, ebenso wie Veränderungen in der Form der Signale. Abnahme und Veränderungen zeigten verschiedene Abhängigkeiten, unter anderem von der Laserintensität, des zeitlichen Abstands der Laserpulse und der Messtemperatur.

Die Ergebnisse zeigen, dass die Trappingprozesse das elektrische Feld verändern. Dieses Phänomen ist als Polarisationseffekt bekannt und wurde in anderen Materialien oder in Silizium bei sehr niedrigen Temperaturen bereits beobachtet. In dieser Arbeit werden die Auswirkungen dieses Effekts auf die gemessenen Signale bei Betriebstemperaturen gezeigt.

T 72.6 Thu 17:45 H-HS IX

Vergleich der Signale von Alpha Teilchen auf unterschiedliche Metallisierungen eines p-Kontaktes eines Germaniumdetektors — •Lukas Hauertmann für die GeDet-Kollaboration — Max-Planck-Institut für Physik

Germanium Detektoren werden unter anderem in speziellen Experimenten mit geringem Untergrund verwendet. So z.B. im LEGEND Experiment, das zur Suche nach dem neutrinolosem doppeleten Beta-Zerfall aufgebaut wird. Entscheidend in solchen Experimenten ist es, den Untergrund als solchen zu erkennen. Radioaktive Zerfälle auf der Detektoroberfläche sind eine besonders schwierig zu kontrollierende Quelle für Untergrund. Daher gibt es am Max-Plack-Institut für Physik in München einen Teststand, GALATEA, der das Studium von Oberflächenereignissen ermöglicht. In diesem Vortrag werden Messungen an eines segmentierten n-type koaxialen Detektors vorgestellt welcher mit kollimierter Alpha- und Beta-Strahlung bestrahlt wurde um den Einfluss von Metallisierung zu untersuchen.

T 72.7 Thu 18:00 H-HS IX

Tote Zonen in BEGe Detektoren — •Martin Schuster für die GeDet-Kollaboration — Max-Planck-Institut für Physik, München

Germaniumdetektoren kommen in einer Vielzahl von Experimenten weltweit zum Einsatz. Beispielsweise werden Broad Energy Germanium (BEGe) Detektoren bei der Suche nach neutrinolosen Doppelbetazerfällen genutzt. Ein genaues Verständnis der Detektoren ist dabei von großer Bedeutung. In der GeDet (Germanium Detektor Entwicklung) Gruppe am MPI für Physik werden Germaniumdetektoren genau untersucht. Tote Zonen im Detektor reduzieren das effektiv nutzbare Volumen und können die gemessenen Energien verfälschen da erzeugte Ladungsträger gar nicht oder nur teilweise von den Elektroden eingesammelt werden. Die Dicke und Ausbreitung von toten Zonen und deren Temperaturabhängigkeit, insbesondere nahe passivierter Oberflächen, wurden untersucht und die Ergebnisse werden vorgestellt. Dazu wurde ein vierfach segmentierter n-Typ BEGe Detektor in mehreren Scans mit einer kollimierten ^{133}Barium-Quelle bestrahlt. Die Temperatur konnte mittels eines elektrisch gekühlten Kryostaten kontrolliert und konstant gehalten werden. Die Daten werden zudem mit Simulationen verglichen.

T 72.8 Thu 18:15 H-HS IX

Ein LGAD Time-of-Flight System zur Anwendung in der Protonentherapie — Valerie Hohm, Kevin Kröninger, •Sebastian Pape und Jens Weingarten — TU Dortmund, Experimentelle Physik IV

Low Gain Avalanche Detektoren (LGADs) sind n-in-p Siliziumsensoren, die sich durch eine hochdotierte Zone nahe der Ausleseelektrode auszeichnen, welche die deponierte Ladung um einen Faktor von ca. 10 bis 20 verstärkt. Dadurch können die Sensoren ionisierende Teilchen mit einer Zeitauflösung von bis zu 30 ps detektieren, was LGADs zu sehr guten Kandidaten für halbleiter-basierte Time-of-Flight Systeme macht. Mit ihrer hohen Strahlenhärte (bis etwa $\Phi = 3.7{\cdot}10^{15}\,\mathrm{n_{eq}/cm^2}$) sind sie ideal für den Einsatz an medizinischen Beschleunigeranlagen geeignet, wo sie für die Vermessung des Energiespektrums des Primärstrahls verwendet werden können. Der Vortrag führt in das Thema der hochpräzisen Zeitvermessung ein und beleuchtet erste Charakterisierungsmessungen von LGADs. Darüber hinaus wird ein mögliches Time-of-Flight System mit LGADs für den Einsatz an medizinischen Beschleunigern vorgestellt und diskutiert.

T 72.9 Thu 18:30 H-HS IX

A Proton Irradiation Site for Silicon Detectors at Bonn University — •Pascal Wolf[1], David-Leon Pohl[1], Jochen Dingfelder[1], Paul-Dieter Eversheim[2], and Norbert Wermes[1] — [1]Physikalisches Institut, Universität Bonn — [2]Helmholtz Institut für Strahlen- und Kernphysik, Universität Bonn

A proton irradiation site has been developed at Bonn University. The site is located at the Bonn Isochronous Cyclotron of Helmholtz Institut für Strahlen- und Kernphysik (HISKP) which provides protons with 14 MeV kinetic energy and beam currents of a few nA up to 1 μA. Dedicated beam diagnostics have been developed for online beam-current and position monitoring at extraction, allowing the determination of the proton fluence ϕ_p at the device with an accuracy at the percent level. Evaluation of irradiated silicon structures yield a proton hardness factor which allows to irradiate up to $10^{16}\ \frac{neq}{cm^2}$ in approximately one hour. Typical irradiation parameters, characteristics of the beam diagnostics as well as proton hardness factor measurements and comparisons with various irradiation facilities are presented.

T 73: Multi-messenger astronomy

Time: Thursday 16:30–19:00 Location: H-HS X

T 73.1 Thu 16:30 H-HS X

Investigation of the Neutrino Emission from Supermassive Black Hole Mergers and Starburst Galaxies — •Ilja Jaroschewski[1], Julia Tjus[1], and Peter L. Biermann[2,3,4,5] — [1]Theoretische Physik IV, Ruhr-Universität Bochum, Bochum — [2]MPI for Radioastr., Bonn — [3]Dept. of Phys., Karlsruhe Inst. for Tech., Karlsruhe — [4]Dept. of Phys.& Astron., U. Alabama, Tuscaloosa, AL, USA — [5]Dept. of Phys. & Astron., Univ. Bonn, Bonn

The first detection of non-terrestrial, high-energy neutrinos by IceCube in 2013 as well as the high-probability association of such a neutrino to the blazar TXS 0506+056 are fundamental achievements in neutrino Astronomy. Along with the successful detection of gravitational waves in September 2015 by LIGO and the clear identification of the neutrino merger GW170817, these detections opened both new branches in multi-messenger Astrophysics. With 10 binary black hole mergers already documented and more to come there are strong indications that supermassive black holes in galaxy centers also merge and had at least one merger in their lifetime.

Such a merger is almost always accompanied by a change of the jet direction leading to interactions of the jet with molecular clouds and therefore neutrino productions.

In this work, a connection between the radiated gravitational wave energy of supermassive black hole mergers and the high-energy neutrino flux is suggested. It is estimated, whether these mergers could contribute to the diffuse astrophysical neutrino flux that is measured by IceCube, with the rest contributed by starburst galaxies.

T 73.2 Thu 16:45 H-HS X

Bestimmung der zeitlichen Korrelation zwischen Gravitationswellen- und Neutrino-Emission durch das Spin-Flip Phänomen in supermassiven binären Schwarzen Löchern — •Oliver de Bruijn[1], Julia Tjus[1] und Imre Bartos[2] — [1]Theoretische Physik IV, Ruhr-Universität Bochum, 44780 Bochum, Germany — [2]Department of Physics, University of Florida, P.O. Box 118440, Gainesville, Forida 32611-8440, USA

Die hier vorgestellte Masterarbeit zielt darauf ab, die zeitliche Korrela-

tion von Gravitationswellen- und Neutrino-Emission von supermassiven binären Schwarzen Löchern (SMBSL) zu bestimmen. Zur Bestimmung des Zeitpunktes des zu erwartenden Neutrino Signals dient das Spin-Flip Phänomen, als physikalische Grundlage. Dabei wird angenommen, dass während des Inspirals eines SMBSL der Jet des massiveren Schwarzen Lochs um den Gesamtdrehimpuls präzediert und sich der Richtung des Gesamtdrehimpulses annähert. Die Beschreibung dieses Prozesses erfolgt mittels der Post-Newtonischen Approximation, mit der ebenfalls das emittierte Gravitationswellen Signal berechnet wird. Es ist geplant das Modell auf transiente Objekte anzuwenden, wie z.B. den Blazar TXS 0506+056. Das Ziel dabei ist es eventuelle Kandidaten für eine Detektion durch LISA zu finden.

Das vorgestellte Modell ist in der Lage die Periodizität von AGKs zu erklären. Darüber hinaus könnte die Analyse von korrelierten Neutrino- und Gravitationswellendaten uns die Möglichkeit geben, Theorien der Quantengravitation zu testen.

T 73.3 Thu 17:00 H-HS X

Search for ultra-high energy neutrinos from binary black hole mergers* — •Michael Schimp — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal

The SD of the Pierre Auger Observatory is able to distinguish extensive air showers (EAS) induced by ultra-high energy neutrinos (UHE neutrinos; $E_\nu > 0.1$ EeV) from those induced by atomic nuclei, provided that they are highly inclined ($60° < \theta < 95°$ with zenith angle θ). While its sensitivity to a diffuse UHE neutrino flux is comparable to IceCube's, the dependences on arrival direction and flavor are very different. For instance, the Pierre Auger Observatory is the only operational instrument sensitive to UHE neutrinos from the Northern Hemisphere. Close to the horizon, the effective area is much enhanced, leading to unrivaled UHE neutrino sensitivities for searches following up transient sources in this part of the sky.

Binary black hole (BBH) mergers are among the most recently discovered classes of astrophysical objects but have not yet been successfully observed by any other means than gravitational waves. Using the sky localization probability distributions of the BBH mergers known so far, their most probable distances, and the assumption of a universal time-dependent luminosity per source, a combined search for UHE neutrinos emitted by the BBH mergers is performed. We present constraints on the time-dependent luminosity for the exemplary hypothesis of an emission lasting for 24 hours after each merger.

*Gefördert durch die BMBF Verbundforschung Astroteilchenphysik (Vorhaben 05A17PX1)

T 73.4 Thu 17:15 H-HS X

Neutrino flux estimates for hadronic AGN models — •Felix Spanier[1,2] and Stephan Richter[2] — [1]Institut für Theoretische Astrophysik, Universität Heidelberg — [2]Centre for Space Research, North-West University, Potchefstroom, South Africa

Recent reports of possible correlations between high energy neutrinos observed by IceCube and Active Galactic Nuclei (AGN) activity sparked a burst of publications that attempt to predict the neutrino flux of these sources. However, often rather crude estimates are used to derive the neutrino rate from the observed photon spectra. In this work neutrino fluxes were computed in a wide parameter space. The starting point of the model was a representation of the full spectral energy density (SED) of 3C 279. The time-dependent hybrid model that was used for this study takes into account the full pγ reaction chain as well as proton synchrotron, electron-positron-pair cascades and the full SSC scheme. We compare our results to estimates frequently used in the literature. This allows to identify regions in the parameter space for which such estimates are still valid and those in which they can produce significant errors. Furthermore, if estimates for the Doppler factor, magnetic field, proton and electron densities of a source exist, the expected IceCube detection rate is readily available. An outlook on applications to TXS 0506+056 is given.

T 73.5 Thu 17:30 H-HS X

On the relative importance of hadronic emission processes along the jet axis of Active Galactic Nuclei — •Mario Hoerbe[1,2], Paul Morris[2,3], Garret Cotter[2], and Julia Becker Tjus[1] — [1]Ruhr-Universität Bochum, Germany — [2]University of Oxford, United Kingdom — [3]DESY, Zeuthen, Germany

We present a space and time-resolved model of the high-energy particle emission of a plasmoid assumed to travel along the axis of an AGN jet at relativistic speed. This was achieved by modifying the publicly available CRPropa (version 3.1) propagation framework which in our work is capable of being applied to sub-kpc scales. The propagation of a population of primary protons is modelled in a purely turbulent magnetic field and we take into account $p\gamma$-interactions of these protons either with photons scattered from the accretion disc or with synchrotron radiation emitted by ambient relativistic electrons. The significance of inelastic pp-collisions among primaries and energetically less significant hadronic matter is evaluated.

Our model produces a PeV-neutrino flare which is caused mainly by photo-hadronic interactions of primaries with the accretion disc field. A relative deficit of secondary high-energy gamma-rays to neutrinos is observed due to $\gamma\gamma$-pair-attenuation with the ambient photon fields whose combined optical depths achieve their minimal opacity for photons in the TeV-range. We warmly thank the Studienstiftung des deutschen Volkes (German Academic Scholarship Foundation) for the funding of this work.

T 73.6 Thu 17:45 H-HS X

3D-modeling of the Galactic Center explaining the diffuse gamma-ray emission — •Mehmet Guenduez[1], Julia Becker Tjus[1], and Dominik J. Bomans[2] — [1]Ruhr-Universität Bochum, Fakultät für Physik and Astronomie, RAPP Center, TP IV, 44780 Bochum, Deutschland — [2]Ruhr-Universität Bochum, Fakultät für Physik and Astronomie, RAPP Center, AIRUB, 44780 Bochum, Germany

The origin of high energy cosmic rays has not yet been entirely solved. Due to their accessibility, Galactic sources allow us to study the ambient conditions. The Galactic Center, on the one hand, shows a peculiar non-thermal emission. On the other hand, the crowded and emissively active vicinity makes modeling more challenging. Previous works discussed the origin of the diffuse gamma-ray emission detected by H.E.S.S. without considering the magnetic field, although the magnetic field has a significant impact on the CR spatial profile. In this work, we use for the first time recently developed 3D models of the ambient condition, including the magnetic field configuration, mass distribution, and the photon field. In doing so and using the propagation tool CRPropa, we can involve all relevant interaction processes in the TeV- PeV regimes such as hadronic pion production, inverse Compton scattering, and gamma-ray attenuation by electromagnetic pair production. In order to identify the real source, we further present five different source set-ups based on observational hints. Hereafter, we compare our results with the measured spatial as well as energy spectra.

T 73.7 Thu 18:00 H-HS X

On the origin of the diffuse Gamma-Ray Excess from the Galactic Center — •Joanna Berteaud, Iris Gebauer, and Wim de Boer — KIT, Karlsruhe, Germany

The Fermi-LAT has observed an excess in the diffuse emission from the Galactic center around a few GeV. Several interpretations of this excess exist, including the annihilation of dark matter, an undetected population of millisecond pulsars or the interactions of cosmic rays with molecular clouds. We have previously found a correlation of the GeV excess with the distribution of molecular clouds, traced by the CO emission line. However, what is called diffuse emission is subject to uncertainties originating from detector effects, such as the instrument response function and model uncertainties, such as the point source models. We have developed a novel technique to correct the Fermi-LAT data for the instrument response function. We have also studied the uncertainties originating from the point source model. We find that the GeV excess cannot be explained by these effects. After taking into account these uncertainties, we confirm the correlation between the GeV excess and the CO emission line.

T 73.8 Thu 18:15 H-HS X

Multiwavelength Analysis of NGC1275/3C84 — •Lena Linhoff and Simone Mender — TU Dortmund

Multiwavelength Analysis of NGC1275/3C84

The radio galaxy 3C 84 is a well studied source of radio emission and was detected as misaligned blazar NGC 1275 also in the very high-energy regime by gamma-ray detectors like MAGIC and FermiLAT. Unless the innermost structure of 3C 84 can be resolved with radio observations at 43 GHz, the mechanisms producing gamma-ray emission are still not fully understood. A necessary step to understand the production of high-energy photons, is to localize the emission region of gamma-rays in the central region of the source. For this aim, we use photo absorption and calculations of the optical depth within the broad line region to constrain the origin of the gamma-ray emission.

In this talk we place our results in the context of theoretical models and other multiwavelength analysis results.

T 73.9 Thu 18:30 H-HS X

FACT-Variability of Blazar Light Curves — •Bernd Schleicher and Daniela Dorner for the FACT-Collaboration — University of Würzburg, Institute for Theoretical Physics and Astrophysics, Germany

Blazars are a subtype of Active Galactic Nuclei, where the relativistic jet is pointing towards the observer. They emit radiation over the whole electromagnetic spectrum up to TeV energies and their flux can be extremely variable on timescales from minutes to years. To investigate the variability characteristics bright TeV blazars like for example Mrk 421 and Mrk 501 are used. These sources are monitored in the complete electromagnetc spectrum with instruments like FACT, Fermi-LAT, SWIFT, OVRO and several optical telescopes like KVA, BOSS and the Hans-Haffner-Sternwarte. This gives a chance to study the light curve variability over the complete electromagnetc spectrum. To quantify the variability of a light curve, often the fractional variability is used. The different detection methods, sensitivities and observation strategies of the instruments influence the properties of the light curve for every instrument. The effect of these differences on the fractional variability needs to be studied and taken into account for the physics interpretation. On the one hand, systematic effects like cadence, binning and the completeness of the light curve and on the other hand, the fractional variability of the two sources depending on energy, time and flux is studied.

T 73.10 Thu 18:45 H-HS X

Long term variability study for the radio galaxy IC 310 with MAGIC — •Simone Mender and Lena Linhoff for the MAGIC-Collaboration — TU Dortmund, Otto-Hahn Str. 4a, 44227 Dortmund

The very-high-energy gamma-ray sky is dominated by jetted active galactic nuclei with a small viewing angle to the jet axis, where the gamma rays are doppler bosted towards Earth. So far, known VHE gamma-ray sources with a larger viewing angle are very rare as only six TeV gamma-ray emitting radio galaxies are detected up to now.

One of these TeV-gamma-ray emitting radio galaxies is the active galaxy IC 310 which was detected in 2010 by the MAGIC telescopes. In November 2012, an exceptionally bright flare from IC 310 was detected by MAGIC on timescales of minutes. To investigate the variability of IC 310 on large time scales, the long term variability study for the radio galaxy IC 310 with MAGIC will be presented in this talk.

T 74: Flavor physics: CKM II

Time: Thursday 16:30–19:00 Location: H-HS XI

T 74.1 Thu 16:30 H-HS XI

Angular analysis of $B^0 \to K^{*0}e^+e^-$ at the LHCb experiment — Martino Borsato, Stephanie Hansmann-Menzemer, and •Jiangqiao Hu — Physikalisches Institut, Heidelberg, Germany

The rare decay $B^0 \to K^{*0}e^+e^-$ is a flavor-changing neutral current process that occurs at loop level and is forbidden at tree level in the Standard Model. The rarity of the decay means that the modifications by contributions from new physics could be comparable with the Standard Model predictions. In particular, the study of the angular distribution of its final state particles offers an theoretically clean probe to search for new physics.

The momentum resolution of electrons is inferior than that of muons at LHCb due to the large amount of energy emitted through bremsstrahlung before the spectrometer. For this reason, the previous analysis of $B^0 \to K^{*0}e^+e^-$ at LHCb has been limited to the low dielectron mass squared (q^2) region while the angular analysis of $B^0 \to K^{*0}\mu^+\mu^-$ was carried out in the full q^2 range. However the higher q^2 region is very interesting for testing lepton flavor universality paradigm which has been recently challenged by several LHCb branching ratio measurements. In this talk, we will present the early studies in the high q^2 region for the angular analysis of $B_0 \to K^{*0}e^+e^-$ at the LHCb experiment.

T 74.2 Thu 16:45 H-HS XI

Branching fraction measurement of $B_s^0 \to \phi\mu^+\mu^-$ and search for $B_s^0 \to f_2'(1525)\mu^+\mu^-$ using LHCb data — •Sophie Kretzschmar, Christoph Langenbruch, and Eluned Smith — I. Physikalisches Institut B, RWTH, Aachen

The LHCb detector at CERN is an experiment optimised to study b-quarks, which are produced copiously in the proton-proton collisions at the Large Hadron Collider (LHC). The flavour-changing neutral current (FCNC) process $b \to s\ell^+\ell^-$ is of particular interest since it occurs only via higher order loop corrections in the Standard Model (SM), and thus can be significantly affected by new heavy particles beyond the SM.

The rare decay $B_s^0 \to \phi\mu^+\mu^-$ has been previously analysed by the LHCb collaboration using data taken in 2011 and 2012 during Run 1. The $B_s^0 \to \phi\mu^+\mu^-$ branching fraction was measured to be more than $3\,\sigma$ below the SM expectation. An updated measurement is performed including the data taken by the LHCb experiment during the LHC Run 2, which will provide more insight on the nature of this discrepancy with the SM.

A similar decay that incorporates a b- to s-quark transition is $B_s^0 \to f_2'(1525)\mu^+\mu^-$. This decay has not been observed yet, but will be accessible with the combined Run 1 and Run 2 dataset.

This talk will give an overview of the on-going analysis of the combined Run 1 and Run 2 LHCb data sample that is used to measure the branching fractions of the decay $B_s^0 \to \phi\mu^+\mu^-$ and search for $B_s^0 \to f_2'(1525)\mu^+\mu^-$.

T 74.3 Thu 17:00 H-HS XI

Angular analysis of $B_s^0 \to \phi\mu^+\mu^-$ decays — •Marcel Materok, Christoph Langenbruch, and Eluned Smith — I. Physikalisches Institut B, RWTH Aachen University

The LHCb experiment at the LHC is dedicated to the search for new phenomena beyond the Standard Model (SM) through precision measurements of heavy flavour decays. Rare semileptonic $b \to s\mu^+\mu^-$ decays are particularly interesting as they constitute flavour changing neutral currents that are forbidden at tree-level in the SM and are only allowed at loop-level. Theses processes are thus rare and the theoretically clean angular observables are sensitive to the effects of new, heavy particles beyond the SM.

The rare decay $B_s^0 \to \phi\mu^+\mu^-$ has been previously analysed by the LHCb collaboration using data taken in 2011 and 2012, during Run 1 of the LHC. Further studies of this mode are particularly motivated by recent tensions with SM predictions seen in other rare $b \to s\ell\ell$ processes.

This talk will show the progress of the measurement of the angular observables in the $B_s^0 \to \phi\mu^+\mu^-$ decay using Run 1 and 2 LHCb data samples.

T 74.4 Thu 17:15 H-HS XI

Measurement of $\mathcal{A}_{CP}$ in $B^0 \to K^{*0}\mu^+\mu^-$ and $B^+ \to K^+\mu^+\mu^-$ decays with LHCb — •Hendrik Jage, Christoph Langenbruch, and Eluned Smith — I. Physikalisches Institut B, RWTH Aachen University

The LHCb detector at CERN is an experiment dedicated to the study of heavy flavour quarks, which are abundantly produced in the proton-proton collisions at the Large Hadron Collider (LHC). Flavour-changing neutral currents (FCNC), like the $b \to s\ell^+\ell^-$ transitions common to both analysed decay modes, are forbidden in the Standard Model (SM) at tree-level and could thus be significantly affected by new heavy particles beyond the SM.

The direct CP asymmetry ($\mathcal{A}_{CP}$) in $B^0 \to K^{*0}\mu^+\mu^-$ and $B^+ \to K^+\mu^+\mu^-$ decays has been previously measured by the LHCb collaboration using data taken in 2011 and 2012 during the LHC Run 1. While no significant deviations from the SM predictions have been observed, the measurement is still statistically limited. An update will be performed aiming to include the additional data collected by the LHCb experiment during the LHC Run 2.

In this talk the status of the updated measurement of $\mathcal{A}_{CP}$ in $B^0 \to K^{*0}\mu^+\mu^-$ and $B^+ \to K^+\mu^+\mu^-$ decays will be presented.

T 74.5 Thu 17:30 H-HS XI

Towards completion of the four-body contributions to $\bar{B} \to$

$X_s\gamma$ at NLO — •Lars-Thorben Moos and Tobias Huber — Universität Siegen

The inlusive radiative $\bar{B} \to X_s\gamma$ decay constitutes an important pillar in the indirect search for new physics and allows to constrain the parameter space of many models.

In this talk we present the ongoing efforts in the computation of four-body contributions to the process $\bar{B} \to X_s\gamma$, namely those of $b \to s\bar{q}q\gamma$ at NLO in the strong coupling and the necessary complementing 5-particle cuts of the gluon-bremsstrahlung $b \to s\bar{q}q\gamma + g$.

Although these corrections are expected to be small, this computation formally completes the NLO contributions to $\bar{B} \to X_s\gamma$.

Since the anomalous dimensions are already computed to a sufficient order, the main tasks are the systematic generation of the 1-loop amplitude, the automation of the phase space integration, the infrared-regularization and finally the renormalization of the diagrams including the operator mixing.

The results obtained so far are shown and the further structure of the calculation is outlined.

T 74.6 Thu 17:45 H-HS XI

Measurement of CP Violation in $B_s^0 \to J/\psi K_S^0$ at LHCb — Vukan Jevtic, •Patrick Mackowiak, and Gerwin Meier — Experimentelle Physik 5, TU Dortmund

With larger datasets collected by the LHCb Experiment and the start of Belle II, future measurements of $\sin(2\beta)$ in the golden mode $B^0 \to J/\psi K_S^0$ will be systematically limited by the uncertainty from penguin contributions. One ingredient to constrain these contributions is the measurement of CP violation in $B_s^0 \to J/\psi K_S^0$, where the tree level contribution is Cabibbo suppressed. The larger oscillation frequency of B_s^0 compared to B_d^0 and the lower branching fraction lead to further challenges in the analysis. The talk will present the current status of the analysis in $B_s^0 \to J/\psi K_S^0$ using the full Run II dataset collected by the LHCb Experiment corresponding to an integrated luminosity of 6 fb^{-1}.

T 74.7 Thu 18:00 H-HS XI

Measurement of $\sin(2\beta)$ in the CP violating decays $B^0 \to J/\psi(\to e^\pm e^\mp) K_S^0(\to \pi^\pm\pi^\mp)$ with the LHCb experiment — Vukan Jevtic, Patrick Mackowiak, and •Gerwin Meier — Experimentelle Physik 5, TU Dortmund

High precision measurements of Standard Model parameters can be used to search for New Physics . The golden mode $B^0 \to J/\psi K_S^0$, which is dominated by tree-level amplitudes, provides a clean measurement of the CKM angle β. Combining the measurements of $\sin(2\beta)$ in the decays $B^0 \to J/\psi(\to \ell^\pm\ell^\mp)K_S^0(\to \pi^\pm\pi^\mp)$ with $\ell = e, \mu$ and $B^0 \to \psi(2S)(\to \mu^\pm\mu^\mp)K_S^0(\to \pi^\pm\pi^\mp)$ will lead to the most precise measurement of this quantity.

In this talk the current status of the CP violation measurement in the decays $B^0 \to J/\psi(\to e^\pm e^\mp)K_S^0(\to \pi^\pm\pi^\mp)$ will be presented for the full LHCb Run II dataset, which corresponds to 6 fb^{-1}.

T 74.8 Thu 18:15 H-HS XI

Measurement of *CP* violation in $B^0 \to [c\bar{c}]K_S^0$ decays with the LHCb experiment using Run II data — •Vukan Jevtic, Patrick Mackowiak, and Gerwin Meier — Experimentelle Physik 5, TU Dortmund

The measurement of the CKM angle β is an important precision test of the Standard Model. Previous measurements of *CP*-violation parameters in $B^0 \to J/\psi K_S^0$ decays using the Run I dataset that was taken at centre-of-mass energies of 7 and 8 TeV reached a sensitivity for the parameter $\sin(2\beta)$ comparable to Belle and BaBar. With the full LHCb Run II dataset at $\sqrt{s} = 13$ TeV, the statistical significance of this measurement is expected to increase as more data was collected at higher rates. At the same time, this poses challenges, for example in the reconstruction of particle tracks in datasets with high background contamination and track multiplicities. In this talk, the status of the ongoing measurement of the *CP*-violation parameters will be presented with a focus on the decays $B^0 \to J/\psi(\to \mu\mu)K_S^0(\to \pi^+\pi^-)$ and $B^0 \to \psi(2S)(\to \mu\mu)K_S^0(\to \pi^+\pi^-)$.

T 74.9 Thu 18:30 H-HS XI

B^0-meson mixing rediscovery using hadronic b to c transitions at Belle II — •Sviatoslav Bilokin for the Belle II-Collaboration — Ludwig-Maximilians-Universität München

The Belle II experiment at the SuperKEKB asymmetric energy e^+e^- collider is a substantial upgrade of the B factory facility at the Japanese KEK laboratory. The design luminosity of the machine is 8×10^{35} $\text{cm}^{-2}\text{s}^{-1}$ and the Belle II experiment aims to record 50 ab^{-1} of data, a factor of 50 more than its predecessor. The Belle II collaboration has successfully recorded and processed about 10 fb^{-1} of data at the $\Upsilon(4S)$ resonance in 2019.

This contribution presents the B^0-$\bar{B}^0$ mixing rediscovery in hadronic B-meson decays using the collected Belle II data. This analysis is a first necessary step towards an improvement of unitarity triangle measurements and New Physics searches in radiative penguin decays.

T 74.10 Thu 18:45 H-HS XI

CP-Violation in Multi-Body B Decays — •Kevin Olschewsky[1], Thomas Mannel[1], and Keri Vos[2] — [1]Universität Siegen, Siegen, Germany — [2]TU München, Garching, Germany

Charmless two and three-body B decays are interesting probes of CP violation. In the Standard Model (SM), CP violation is induced by a weak phase described by the CKM matrix. For charged B decays, only direct CP violation occurs, which requires both a weak CP-violating and a strong CP-conserving phase. While the first is given by the CKM-phase in SM, it is extremely challenging to calculate the strong phase in a QCD based framework due to hadronic and rescattering effects.

The current analysis of multi-body B decays is usually done with a resonant 2+1 description, which does not include $D\bar{D}$ threshold effects. These effects can provide an important mechanism in order to generate a non-trivial strong phase that may explain the large CP asymmetries observed at high invariant masses. We propose an addition to current resonance models including such threshold effects.

T 75: Neutrino physics without accelerators VI

Time: Thursday 16:30–19:05 Location: H-HS XIII

Group Report T 75.1 Thu 16:30 H-HS XIII

The Electron Capture in ^{163}Ho Experiment — •Arnulf Barth for the ECHo-Collaboration — Kirchhoff Institute for Physics, Heidelberg University

The goal of the Electron Capture in ^{163}Ho (ECHo) experiment is the determination of the electron neutrino mass by analyzing the electron capture (EC) spectrum of ^{163}Ho. Metallic magnetic calorimeters operated at low temperatures, in which the ^{163}Ho has been implanted, present the best performance to conduct a high resolution and low background calorimetric measurement of the ^{163}Ho EC spectrum. During the first phase of the experiment, ECHo-1k, the detector production and the implantation process of a high purity ^{163}Ho source have been optimized. Additionally, large detector arrays have been developed, reaching an energy resolution below 5 eV and featuring an activity of about 1 Bq per pixel. High statistics and high resolution ^{163}Ho spectra have been acquired and analyzed in light of the newly developed theoretical description of the spectral shape, considering the independently determined value of the energy available to the EC process, Q_{EC}, and a dedicated background model. In this contribution, we present preliminary results obtained in the first phase of ECHo. At the same time, we discuss the necessary upgrades towards the second phase of the experiment, ECHo-100k.

T 75.2 Thu 16:50 H-HS XIII

Room Temperature and mK Characterisation of ECHo-100k MMC Array Chip — •Tom Wickenhäuser for the ECHo-Collaboration — Kirchhoff-Institute of Physics, Heidelberg University, Germany

The ECHo experiment is designed to determine the effective electron neutrino mass by the analysis of high resolution and high statistics ^{163}Ho electron capture spectra. The calorimetric measurement of the ^{163}Ho spectrum is performed using large arrays of low temperature metallic magnetic calorimeters (MMCs) hosting ^{163}Ho in the absorber and operated at mK temperature. For the ECHo-100k phase about

12000 detectors need to be operated. For a succesful integration of single array chips in the experiment we are developing a process to characterize the functionality of each detector without the need of measurements at mK temperatures. The idea is to find a correlation between resistance measurements of individual leads of a chip at room temperature and the performence at 4K and mK. The most important point is to ensure a reliable heat switching to insert a persistent current in the detector array. We discuss the result of the resistance measurements in correlation with the test performed at low temperatures and conclude with giving the reliability of the room temperature measurement for identifying working detectors.

T 75.3 Thu 17:05 H-HS XIII

Results of the First Neutrino Mass Measurement at the KATRIN Experiment — •Martin Slezák for the KATRIN-Collaboration — Max Planck Institute for Physics, Munich, Germany

The **Ka**rlsruhe **Tri**tium **N**eutrino (KATRIN) experiment aims to search for the effective electron antineutrino mass with a sensitivity of $0.2\,\mathrm{eV/c^2}$ (90 % C.L.) from the shape of the tritium β-decay electron energy spectrum.

The first measurement campaign in KATRIN dedicated to the neutrino mass took place in Spring 2019 with about 22 % of the nominal tritium activity. The goal of this pilot measurement was to reach an improved sensitivity compared with the existing results while establishing a robust bias-free analysis and good initial understanding of systematic effects. Different analysis techniques were developed independently to further support the robustness of the result.

This talk presents the high-level analysis of the first neutrino mass data at KATRIN from which an upper limit of $1.1\,\mathrm{eV/c^2}$ (90 % C.L.) was derived. The performance of the apparatus will also be discussed in detail. Besides, an overview of the analysis strategies and experimental systematic effects will be given.

T 75.4 Thu 17:20 H-HS XIII

Analysis of First KATRIN Neutrino Mass Data using Monte Carlo Propagation — •Christian Karl for the KATRIN-Collaboration — Max-Planck-Institut für Physik — Technische Universität München

The KATRIN experiment is designed to measure the effective electron anti-neutrino mass m_ν by investigating the energy spectrum of tritium beta-decay. The first neutrino mass measurement took place in spring 2019. For this first period, the source activity was set to about 22 % of the nominal value and around two million electrons were collected in the region of interest. This corresponds to an effective measurement time of five days at full source activity. Nevertheless, this data was used to improve existing laboratory limits and allowed to advance the analysis tools for forthcoming high-statistics data sets.

This talk presents one of the analysis strategies pursued which is based upon Monte Carlo propagation of uncertainties. A fit to the data including all dominant systematic effects leads to a best-fit value of $m_\nu^2 = -1.0^{+0.9}_{-1.1}\,\mathrm{eV}^2$. From this we derive an upper limit of $m_\nu < 1.1\,\mathrm{eV}$ at 90 % confidence level using the sensitivity limit method of Lokhov and Tkachov.

T 75.5 Thu 17:35 H-HS XIII

ECHo - A ^{163}Ho spectrum and a bit of theory — •Clemens Velte for the ECHo-Collaboration — Kirchhoff Institute for Physics, Heidelberg University

The ECHo experiment belongs to the group of direct neutrino mass experiments and is designed to reach a sub-eV sensitivity via the analysis of the electron capture energy spectrum of ^{163}Ho. This analysis is considered to be model-independent since it only relies on energy and momentum conservation. At the same time the precise description of the expected spectrum goes beyond simple atomic models. In particular many-body electron-electron interactions lead to additional structures besides the main resonances in calorimetrically measured electron capture spectra. A precise description of the ^{163}Ho spectrum is fundamental to gain information on a sub-eV neutrino mass due to a change in the spectral shape. Especially the end point region is here of interest, since there the impact of a finite neutrino mass is the largest. We present a low background and high-energy resolution measurement of the ^{163}Ho spectrum and study the line shape of the main resonances and multiplets with intensities spanning three orders of magnitude. Furthermore we discuss the need to introduce an asymmetric line shape contribution (usually Lorentzian form) to improve the theoretical description of the experimental spectrum. With this, we predict an enhancement of count rate at the endpoint region of about a factor of 2, compared to previous theoretical models. This relaxes the constraints to reach a sub-eV sensitivity on the effective electron neutrino mass.

T 75.6 Thu 17:50 H-HS XIII

Search for eV Sterile Neutrinos - The STEREO Experiment — •Stefan Schoppmann for the STEREO-Collaboration — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

In recent years, major milestones in neutrino physics were accomplished at nuclear reactors: the smallest neutrino mixing angle θ_{13} was determined and the emitted antineutrino spectrum was measured at unprecedented detail. However, two anomalies, the first one related to the absolute flux and the second to the spectral shape, have yet to be solved. The flux anomaly is known as the Reactor Antineutrino Anomaly (RAA) and could be caused by the existence of a light sterile neutrino eigenstate participating in the neutrino oscillation phenomenon. The RAA is best explained by an oscillation with a mass splitting at the eV^2-scale.

The STEREO experiment was built to probe this parameter region. At a short baseline of 10 metres, it measures the antineutrino flux and spectrum emitted by the compact research reactor at ILL Grenoble (France). The segmentation of the detector in six cells allows for independent measurements of the neutrino spectrum at multiple baselines. An active-sterile flavour oscillation could be unambiguously detected, as it distorts the spectral shape of each cell's measurement differently. In 2018, STEREO was able to exclude significant parts of the parameter space with its initial dataset.

In this contribution, updated results on the oscillation analysis as well as the absolute rate and shape of antineutrinos will be presented with the factor 3 increased dataset of 179 (235) days of reactor-on (off).

T 75.7 Thu 18:05 H-HS XIII

Measurement of the Low Energy Electron Capture Spectrum of ^{163}Ho — •Robert Hammann for the ECHo-Collaboration — Kirchhoff-Institute for Physics, Heidelberg University, Germany

The aim of the electron capture in ^{163}Ho experiment (ECHo) is to directly measure the effective electron neutrino mass with sub-eV sensitivity by analysing the weak decay of ^{163}Ho. For this purpose, a high statistics and high energy resolution measurement of the electron capture spectrum is required. This can be achieved using arrays of metallic magnetic calorimeters with ^{163}Ho enclosed in the absorber operated at millikelvin temperatures.
In this contribution we present a calorimetric measurement of the spectrum with the 64 pixel ECHo-1k chip. Three detectors had an outstandingly low readout noise, which allowed for a very low threshold. With these detectors a total of $5.4 \cdot 10^6$ ^{163}Ho decay events were acquired in the energy range from 15 eV to 2800 eV with an energy resolution of 4.5 eV at the NI-line with 411 eV in the final spectrum.
Thanks to the low threshold as well as an improved algorithm used for data reduction, it was possible to resolve the low energy part of the spectrum with unprecedented detail. In particular, the OII-line was observed for the first time with a resonance energy of about 27 eV. Furthermore, features of the OI-line related to higher order atomic transitions similar to those found for the NI-line were observed.
These results are essential for the development of a precise description of the theoretical ^{163}Ho spectrum over the full energy range.

T 75.8 Thu 18:20 H-HS XIII

Development and optimisation of metallic magnetic calorimeter arrays towards ECHo-100k — •Federica Mantegazzini, Arnulf Barth, Christian Enss, Andreas Fleischmann, Loredana Gastaldo, Sebastian Kempf, Clemens Velte, and Tom Wickenhäuser for the ECHo-Collaboration — Kirchhoff-Institute for Physics, Heidelberg University, Germany

The Electron Capture in ^{163}Ho (ECHo) experiment has been designed for the determination of the effective electron neutrino mass exploiting the electron capture spectrum of ^{163}Ho. The detector technology is based on metallic magnetic calorimeters (MMCs) loaded with ^{163}Ho and operated at millikelvin temperature. For the first phase of the experiment, ECHo-1k, MMC arrays consisting of 72 pixels have been microfabricated and implanted with high purity ^{163}Ho source reaching an activity of about 1 Bq per pixel. For the next phase of the experiment, ECHo-100k, the planned activity per pixel is 10 Bq and the required number of pixels simultaneously operated will be 12000. Therefore, a new dedicated chip design has been prepared and microfabricated in order to improve detector performances, ^{163}Ho implantation efficiency and to allow for parallel and multiplexed read-out.

The detector geometry and the ^{163}Ho host material have been studied in order to optimise the detector response and the energy resolution. An energy resolution of 2.9 eV FWHM can be reached under optimal read-out noise conditions. In this contribution we present the new ECHo-100k design and the first results from pulse shape analysis and detector caratherisation obtained with an external ^{55}Fe source.

T 75.9 Thu 18:35 H-HS XIII

The TRISTAN project — •Tim Brunst for the KATRIN-Collaboration — Technische Universität München — Max-Planck-Institut für Physik

The KATRIN (Karlsruhe Tritium Neutrino) experiment investigates the energetic endpoint of the tritium beta-decay spectrum to determine the effective mass of the electron anti-neutrino. The TRISTAN project aims at detecting a keV-sterile neutrino signature by measuring the entire tritium beta-decay spectrum with an upgraded KATRIN system. One of the greatest challenges is to handle the high signal rates generated by the strong activity of the KATRIN tritium source while maintaining a good energy resolution. Therefore, a novel multi-pixel silicon drift detector and read-out system are being designed to handle rates up to 100 Mcps with an energy resolution of 300 eV (FWHM) at 20 keV. In this talk the current status of the project is presented as well as the next steps towards the final detector.

T 75.10 Thu 18:50 H-HS XIII

Status of the ^{163}Ho Source Preparation for the ECHo Neutrino Mass Experiment — •Nina Kneip[1], Holger Dorrer[1], Christoph E. Düllmann[1,2,4], Tom Kieck[1,4], Ulli Köster[3], and Klaus Wendt[1] — [1]Johannes Gutenberg University Mainz, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH Darmstadt, Germany — [3]Institut Laue-Langevin, Grenoble — [4]HIM Johannes Gutenberg University Mainz, Germany

The ECHo collaboration addresses the determination of the electron neutrino mass by recording the deexcitation spectrum following the electron capture of ^{163}Ho. This nuclide is produced by neutron irradiation of enriched ^{162}Er in the ILL high flux reactor. The Ho fraction is then chemically separated. Isotope separation and implantation into the 0.18 mm x 0.18 mm Au-absorbers of the metallic magnetic calorimeters is performed at the RISIKO mass separator at JGU Mainz. This facility consists of a pulsed Ti:sapphire laser system for highly efficient laser resonance ionization, installed at the 30 kV sector field magnet mass separator. The combination of laser ionization and mass spectrometry allows for exceptional elemental and isotopic selectivity leading to a high purity ^{163}Ho beam for ion-implantation process. A submillimeter beam diameter ensures minimal losses of the precious ^{163}Ho source material. In parallel to ion implantation, in-situ deposition of Au onto the implantation area is performed by pulsed laser deposition, counteracting the losses of absorber material by sputtering process during implantation.

T 76: Dark Matter III

Time: Thursday 16:30–19:00 Location: H-HS XIV

T 76.1 Thu 16:30 H-HS XIV

Ultra-low energy calibration of the XENON1T detector with a diluted ^{37}Ar source — •Matteo Alfonsi for the XENON-Collaboration — Institut für Physik & Exzellenzcluster PRISMA, J. Gutenberg-Universität Mainz, 55099 Mainz, Germany

In 2018 the XENON1T experiment set the most stringent constraints on the interaction cross-section between nucleons and Dark Matter in the form of Weakly Interacting Massive Particles. Due to the size of the active volume and the excellent self shielding properties of liquid xenon, the understanding of the detector response relies to a large extent on internal calibrations, based on ^{83m}Kr and ^{220}Rn gaseous isotopes diluted into the liquid xenon and uniformly distributed inside the active volume. In Autumn 2018 we introduced a new low energy calibration source, the ^{37}Ar isotope, with calibration lines at energies of 2.8 keV and 270 eV. The radioisotope was quickly and efficiently removed after two weeks of data-taking by means of cryogenic distillation. In this talk we will show the results of this calibration and the study of the detector response at these ultra low energies. We also compare these results with our Monte Carlo simulation framework of the detector response, to further validate the model used in the Dark Matter search results.

T 76.2 Thu 16:45 H-HS XIV

Dark Matter Constraints from SuperCDMS Single-Charge Sensitive Detectors — •Matthew Wilson for the SuperCDMS-Collaboration — Universität Hamburg

Direct search limits on electron-scattering dark matter and dark absorption limits are examined using prototype phonon-mediated SuperCDMS R&D detectors with sub-electron-hole pair charge resolution (CDMS HVeV, 0.93 gram CDMS Si devices). The first science run with a HVeV device (HVeV R1) achieved a resolution of 0.1 electron-hole pairs and an exposure of 0.49 gram days. The results of HVeV R1 significantly improved the experimental constraints on electron-recoiling dark matter with masses as low as 0.5 MeV/c^2, and demonstrated sensitivity to dark photons competitive with other leading approaches but using substantially less exposure. The second science run with a HVeV device (HVeV R2) achieved roughly 3 times better resolution compared to HVeV R1 with >2.5 times more exposure. The improved HVeV R2 detector design also included a second channel with the goal of fiducializing detector events to reduce backgrounds. The latest HVeV results are shown, demonstrating the scientific potential of phonon-mediated semiconductor detectors sensitive to single electron excitations.

T 76.3 Thu 17:00 H-HS XIV

Direct search for modulated Dark Matter signals with XENON1T — •Lutz Althüser for the XENON-Collaboration — Institut für Kernphysik, WWU Münster

The XENON Dark Matter Project uses a dual-phase xenon time projection chamber (TPC) to directly search for weakly interacting massive particles (WIMPs). Dark Matter particles are expected to scatter off xenon nuclei in the active detector region, leading to nuclear and electronic recoils. Both recoil types can be detected as light signals in the TPC. The measured Dark Matter count rate is expected to modulate with a certain amplitude and phase.

The concept of annual modulation assumes that Dark Matter exists as a spherical and non-rotating halo in which the Earth and Sun are contained. Given the relative movement of the Sun, Earth and galactic center, one would expect a time-dependent WIMP interaction count rate. Using this time dependent signature of the count rate could provide an additional background discrimination, one of the biggest challenges of any direct detection Dark Matter experiment.

The talk will give an introduction to the characteristics of the event rate modulation, assuming the Standard Halo Model, the current status of direct searches in the field and perspectives for the XENON1T experiment.

The work of the author is supported by Deutsche Forschungsgemeinschaft (DFG) through the Research Training Group "GRK 2149: Strong and Weak Interactions - from Hadrons to Dark Matter".

T 76.4 Thu 17:15 H-HS XIV

Optimized triggering and noise mitigation in the SuperCDMS experiment — •Hanno Meyer zu Theenhausen — University of Hamburg

The SuperCDMS SNOLAB experiment is a direct detection search for dark matter using phonon and charge signals in ultra cold Si and Ge crystals. In the search for light dark matter, axion-like particles and dark photons the sub-MeV mass range offers unexplored parameter space which becomes accessible at high exposures and low recoil energies down to 7 eV using high voltage amplified phonon detectors and down to ∼1 eV by prototype ultra-pure single crystal detectors. To reach the desired search thresholds, the experiment requires a challenging event-by-event discrimination between signal-like and noise events. This requirement concerns both the data acquisition and trigger system as well as the offline analysis. This talk reports on a study on the optimized trigger threshold and noise mitigation methods using optimal filters and machine learning techniques for the data acquisition systems and the subsequent analyses.

T 76.5 Thu 17:30 H-HS XIV

Signal corrections with the XENONnT analysis framework

— •Johanna Jakob for the XENON-Collaboration — Institut für Kernphysik, WWU Münster

The upcoming dark matter experiment XENONnT is currently under construction at Laboratori Nazionali del Gran Sasso (LNGS). The detector uses a dual-phase time projection chamber (TPC) filled with liquid and gaseous xenon to detect scattering of WIMPS. The TPC design allows to perform 3D position reconstruction of the recorded events. The XENONnT TPC is designed in a way that most of the XENON1T infrastructure can be reused, featuring a maximized active detector volume. XENONnT has a novel, faster analysis framework called strax(en) which has to be verified with data from the XENON1T experiment.

The talk will focus on using the new XENONnT data analysis framework with calibration data already used for the dark matter search with the XENON1T experiment. Light Collection Efficiency (LCE) maps, used to compensate the position-dependent light yield, are extracted and compared to the former data processor (PAX).

T 76.6 Thu 17:45 H-HS XIV

Radiogenic Background Simulations for XENONnT — •Diego Ramírez García for the XENON-Collaboration — Albert-Ludwigs-Universität Freiburg, Freiburg im Breisgau, Germany

The XENON1T experiment at the Laboratori Nazionali del Gran Sasso has achieved the world-leading sensitivity in the direct search for dark matter in the form of Weakly Interacting Massive Particles (WIMPs). Its upgrade to XENONnT will use a liquid xenon target of 5.9 t, aiming at further improving this sensitivity by an order of magnitude, and will be operative in 2019.

For a multi ton-scale time projection chamber, the background signals induced by radioisotopes from the detector materials will become relevant in the WIMP search region of interest. Using the material-intrinsic levels of radioactivity measured in screening campaigns, Monte Carlo simulations have been performed in order to estimate this contribution. This talk will briefly describe the utilized framework to model the detector response and summarize the result on the predicted radiogenic background.

T 76.7 Thu 18:00 H-HS XIV

Cosmic muon induced neutron measurement with the MINIDEX experiment — •Xiang Liu, Iris Abt, Christopher Gooch, Oliver Schulz, and Raphael Kneissl for the GeDet-Collaboration — Max-Planck-Institut für Physik, Föhringer Ring 6, D-80805 München, Bayern

Cosmic-ray muon induced neutrons are an important source of background in low-background experiments searching for rare phenomena, like neutrinoless double beta decay or dark matter. These neutrons can generate radioactive isotopes in the shielding materials or in the detector itself, creating background which can not be easily removed by a cosmic muon veto, due to the time delay. The Muon-Induced Neutron Indirect Detection EXperiment, MINIDEX, running in the shallow undergound laboratory at the University of Tübingen, measures the production of muon-induced neutrons in a variety of high-Z materials. Recently, the experiment has been upgraded to measure the neutron production not only from through-going muons but also from stopped muons. The design of the experiment and the upgrade are presented as well as selected results.

T 76.8 Thu 18:15 H-HS XIV

A cryogenic distillation system for continuous radon removal at XENONnT — •Denny Schulte for the XENON-Collaboration — Institut für Kernphysik, Westfälische Wilhelms- Universität Münster

The forthcoming XENONnT experiment is a next generation 8 t liquid xenon detector for the direct detection of dark matter in the form of the Weakly Interacting Massive Particle (WIMP). After extensive efforts of material selection and cleaning, the intrinsic contamination of the ultra-pure xenon by Rn-222 will be the main background. This radioactive impurity can be removed by cryogenic distillation making use of the difference in vapor pressure between radon and xenon. Since radon is continuously emanated from detector components, the reduction depends not only on the separation efficiency but also on the recirculation speed. Therefore, a high flux distillation system is under developement.

This talk will focus on the design and the technical challenges of building a removal system with a 20 times larger throughput compared to the previous distillation column used at the XENON1T experiment.

The project is funded by BMBF under contract 05A17PM2.

T 76.9 Thu 18:30 H-HS XIV

Designing the XENONnT electric field — •Francesco Toschi for the XENON-Collaboration — Physikalisches Institut, Universität Freiburg, 79104 Freiburg, Germany

The XENONnT experiment is the next phase of the XENON project and aims at the direct detection of dark matter via WIMP-nucleus scattering. Its dual-phase Time Projection Chamber (TPC) filled with 5.9 ton of liquid Xenon allows position reconstruction and interaction-type discrimination, necessary for WIMP detection. The applied electric field plays a crucial role in its detection capabilities: uniformity in the drift field means homogeneous response in the full active volume, while high intensity fields in the liquid-gas interface are needed for electron extraction. Numerical simulations are used both to optimize the design of the detector and to have a better understanding of the expected signals.

This talk will focus on the field shaping elements of the TPC and how the electric field simulations drove their design.

T 76.10 Thu 18:45 H-HS XIV

Search for dark matter production in association with a top quark and a W boson — •Baishali Dutta, Paul Moder, Priscilla Pani, and Claudia Seitz — DESY, Germany

Searches for dark matter are extensively pursued by the ATLAS experiment based on specific theoretical models of interest and with various experimental signatures. This talk presents a search for dark matter in association with a top quark and a W boson in the final state, a unique signature not covered by the ATLAS experiment so far. The analysis focuses on a two-Higgs-doublet model with an additional pseudo-scalar mediator, which decays to the dark matter candidates (2HDM+a) and utilises the full LHC Run-2 data collected by the ATLAS detector, comprising an integrated luminosity of 139 fb^{-1} at a centre-of-mass energy of $\sqrt{s} = 13$ TeV.

The signal candidate events contain two W bosons, a b-tagged jet and a significant amount of missing transverse momentum due to the dark matter candidates escaping detection. Based on the subsequent decay of the two W bosons, the analysis is optimised individually for one or two leptons in the final state. The two channels are eventually combined to extend the sensitivity of the analysis to cover a large parameter space of the dark matter model considered. In this talk, the analysis strategy and interpretation of the obtained results are presented.

T 77: Axion like particles II

Time: Thursday 16:30–18:50 Location: H-HS XV

Group Report T 77.1 Thu 16:30 H-HS XV

Any Light Particle Search II Overview and Status — •Richard C G Smith for the ALPS-Collaboration — DESY, Hamburg, Germany

The Any Light Particle Search II (ALPS II) is an experiment that will search for hypothesized axion-like particles using a light-shining-through-a-wall approach. These kinds of experiments generate axion-like particles from photons in a strong magnetic field, let the particles pass through a wall which blocks the photons, and then detect the photons regenerated from another strong magnetic field after the wall. The experiment is located at DESY in Hamburg which gives us access to infrastructure used in the HERA accelerator, such as tunnels, magnets, and cryogenics. In order to achieve the novel sensitivities planned we will use two 125 m long cavities housed in a vacuum system: one with 150 kW of circulating optical power to generate the axion-like particles, and one with a power build-up factor of 40,000 to resonantly enhance the probability of regeneration into photons. Both of these cavities will be located in a 5.3 T magnetic field provided by superconducting dipole magnets. ALPS II is currently being installed and we expect data collection to begin in 2021. This talk will

provide the current status of the experiment, an explanation of the light-shining-through-a-wall concept, and a brief discussion of some of the technologies being used.

T 77.2 Thu 16:50 H-HS XV

Low Temperature MMC Detector Arrays for IAXO — •Daniel Unger, Andreas Abeln, Christian Enss, Andreas Fleischmann, Loredana Gastaldo, and Daniel Hengstler — Kirchhoff Institute for Physics, Heidelberg University

The International Axion Observatory (IAXO) is searching for evidence of axions or axion-like particles generated in the Sun. A large magnet inside a helioscope pointing towards the Sun is used to generate the required magnetic field to convert solar axions into photons via the Primakoff effect. The expected photon spectrum considering only axion-photon coupling has a black body shape with its maximum at around 4 keV. Hence, X-ray detectors with high efficiency and low intrinsic background are necessary. Low temperature detectors based on metallic magnetic calorimeters (MMCs) fulfill these requirements.

We present the characterization of the first MMC detector setup developed for IAXO. This system consists of a two dimensional 64 pixel MMC array covering a detection area of 16 mm^2. Together with the SQUIDs necessary for the readout, the detector is mounted on a structure designed to be suitable for even larger MMC arrays. The performance of the detector array was investigated over a period of two months and will be discussed in terms of energy resolution, stability over time and background rate. To cope for different X-ray optics, a larger array covering an area of 1 cm^2 is at present under development.

The results, in particular the achieved low intrinsic background, demonstrate that two dimensional MMC arrays are a promising technology for IAXO.

T 77.3 Thu 17:05 H-HS XV

Heterodyne Detection in ALPS II — •Todd Kozlowski for the ALPS-Collaboration — University of Florida

The Any Light Particle Search II (ALPS II) is a laboratory-based "light-shining-through-a-wall" experiment which aims to detect axion-like particles. This technique requires a detector that is sensitive to signals as weak as a single photon per 10 hours. One of two detection methods to be implemented in ALPS II uses heterodyne interferometry, whereby a strong local oscillator laser is overlapped with the weak signal field to generate a radio frequency optical beat note. Extremely weak signals can be resolved over sufficient time, thanks to the coherence between the signal and local oscillator fields. This coherence is maintained by a series of phase-locked-loops and a stable central optical breadboard, which minimizes relative phase noise between these fields. This talk will provide an overview of the heterodyne interferometry coherent detection technique, as well as its implementation in the ALPS II experiment.

T 77.4 Thu 17:20 H-HS XV

The TES Detector for ALPS II — •Rikhav Shah for the ALPS-Collaboration — JGU Mainz

The Any Light Particle Search II (ALPS II) is an experiment utilizing the concept of resonant enhancement to improve the sensitivity of traditional light shining through a wall style experiments. These experiments attempt to detect photons passing through an opaque wall via conversion to and from weakly interacting (relativistic) sub-eV particles, in the presence of a strong magnetic field. The detection of these photons requires a detector capable of observing the extremely small photon flux, of the order of $10^{-5}\,s^{-1}$. To realize this, the detector must have a low dark count rate and high efficiency. This can be achieved with a transition edge sensor (TES). This is a cryogenic calorimeter which exploits the drastic dependence of a material's electrical resistance on the temperature, while at the superconducting edge. The current, updated setup of the TES at ALPS II will be presented. We discuss recent results from background studies of the TES, plans and challenges for the future as well as the current measurements from the detector in preparation for TES data taking starting in late 2021 or 2022.

T 77.5 Thu 17:35 H-HS XV

Developement of GridPix detectors for IAXO — •Tobias Schiffer, Klaus Desch, Markus Gruber, Jochen Kaminski, and Sebastian Schmidt — Physikalisches Institut, Universität Bonn

In the scope of the search for axions and axion like particles (Alps) with helioscopes, like the International Axion Obeservatory (IAXO) and its precurser BabyIAXO, detectors capable of measuring low energy X-rays down to the 200 eV range are necessary. For this purpose the GridPix detector is an appropriate solution, which has already been used successfully at CAST.

The GridPix is a MicroMegas like readout consisting of a pixelized readout ASIC (Timepix/Timepix3) with a perfectly aligned gas amplification stage, which is photolithographically built on top of the ASIC. Resulting in a very high granularity this detector is capable of detecting single electrons allowing the measurement of low energy X-rays. To convert these X-rays into electrons a small gas volume is built above the readout sealed with an X-ray entrance window.

For the goals of IAXO very low backgrounds need to be achived with the detectors and therefore only a few radiopure materials are contemplable. Also, to get a good signal to noise ratio the X-ray entrance window needs to be as transparent as possible for the low energy X-rays, while still maintaining a barrier between the detector gas and the vacuum system in front. This is achived with an ultra thin silicon nitride membrane.

This talk will present the challenges of the design process and the current status of the detector.

T 77.6 Thu 17:50 H-HS XV

A low-background Silicon Drift Detector system for axion research with IAXO — •Thibaut Houdy[1,2] and Susanne Mertens[1,2] — [1]Max-Planck-Institut für Physik, Föhringer Ring 6, D-80805 München, Germany — [2]Physik-Department, Technische Universität München, D-85747 Garching, Germany

The nature of dark matter is among the most challenging question of modern physics. Axions are invoked to solve the strong CP problem and are dark matter candidates. IAXO is the new generation helioscope, designed to discover solar axions by measuring x-rays induced by axion-photon conversion. The requirement for the detector to reach an extremely low background level below 10 keV is very challenging.

The TRISTAN project is developing a new detection system using silicon drift detector (SDD) for upgrading the KATRIN experiment and search for keV sterile neutrino. We propose to use this unique technology as an x-ray detector for the IAXO experiment. A first prototype detector revealed excellent spectroscopic quality, matching each IAXO requirements however the required background level remains to be demonstrated.

A dedicated test-bench is now being built to assess the detector background. This includes simulations of the external background, design of the shields, determination of the natural radioactivity of detector board and front-end electronics. In this talk, first results of measurements in the Munich shallow underground laboratory will be reported. Secondly, conceptual design studies of the final detector system, meeting the required background level, will be presented.

T 77.7 Thu 18:05 H-HS XV

Preliminary results of a GridPix based IAXO prototype detector — •Sebastian Schmidt, Klaus Desch, Jochen Kaminski, Tobias Schiffer, and Johanna von Oy — Physikalisches Institut der Universität Bonn

The International AXion Observatory (IAXO) is a next generation axion helioscope aiming for an order of magnitude improvement on the axion photon coupling $g_{a\gamma}$ over the current best results by the CERN Axion Solar Telescope (CAST). Such helioscopes utilize the inverse Primakoff effect to reconvert solar axions (and potential other ALPs) into X-rays in their respective magnetic fields.

A gaseous detector based on 7 GridPixes, a combination of a 256×256 pixel Timepix ASIC and an integrated MicroMegas stage on top, together with veto scintillators and an FADC, were deployed at CAST in 2017/18 to develop an ultra low background detector for IAXO.

This talk will present preliminary results of the data taking campaign from 2017/18 and compare it with the current best limit on the axion electron coupling g_{ae}. The focus will be the improvements given by each of the detector features and the importance of ray tracing the axion / X-ray paths from the Sun to the detector.

T 77.8 Thu 18:20 H-HS XV

Large x-ray detector design for Baby-IAXO — •Andreas Abeln, Daniel Unger, Daniel Hengstler, Loredana Gastaldo, Christian Enss, and Andreas Fleischmann — Kirchhoff-Institute for Physics, Heidelberg University

Axions are promising candidates for cold Dark Matter as well as for solving the strong CP problem, their detection could shine light onto

two important open questions in particle physics. The International AXion Observatory (IAXO) is an experiment designed for the validation of the existence of axion or axion-like particles (ALPs) produced in the Sun. IAXO is a fourth generation helioscope and will consist of a 20 m long magnet with field up to 6 T filling eight bores with diameter 60 cm. In this volume axion can be converted back to photons. Solar axions would produce a black body spectrum picking between 4 keV and 6 keV. The photons produced in the conversion volume are then focused onto high resolution and low background x-ray detectors. Metallic magnetic calorimeters (MMCs) have shown extremely good energy resolution and mainly unit quantum efficiency in the energy range of interest. First investigations have shown the possibility to reach very low level of undesired events.
We present the development of a new 2D MMC array characterized by 64 pixels covering an active surface of 1 cm^2. This absorber area perfectly contains the focal area of the x-ray optics foreseen to be used in Baby-IAXO, an intermediate stage of IAXO. The pixels are optimized to have high efficiency up to 10 keV. The expected energy resolution is 12 eV FWHM. We discuss the chip design and expected performance.

T 77.9 Thu 18:35 H-HS XV

Cryogenic Setup for the Operation of Metallic Magnetic Calorimeters in BabyIAXO — •D. Hengstler[1], A. Abeln[1], D. Unger[1], U. Schneekloth[2], A. Fleischmann[1], L. Gastaldo[1], and C. Enss[1] — [1]KIP, Heidelberg University — [2]DESY

The International Axion Observatory (IAXO) aims for the detection of solar axions. This helioscope will feature a 20 m long magnet pointing to the Sun with a magnetic field of up to 6 T in which axions could be converted to X-rays. An X-ray optics will focus the X-rays produced in a bore of 60 cm diameter to a detector positioned in the focal plane.

Towards IAXO a smaller version of the helioscope will be developed to fix the technologies for the final experiment. This project goes under the name babyIAXO and will be located at DESY, Hamburg. For babyIAXO, we propose to use metallic magnetic micro-calorimeters as alternative X-ray detectors. This type of energy-dispersive particle detectors has not only been shown to achieve excellent energy resolutions down to 1,6 eV at 6 keV but also provides a quantum efficiency up to 100 % and a low background level, both being essential for rare-event searches. To reach the necessary operating temperatures of around 20 mK, magnetic micro-calorimeters are typically operated in a dry, pulse-tube cooled $^3He/^4He$ dilution refrigerator.

We discuss the technological challenges that arise from mounting the cryogenic setup at the helioscope and suggest possible solutions to them. In particular, we present a study for operating a dry dilution refrigerator that is tilted with respect to the gravitational field axis and experiences vibrations due to the tracking of the Sun.

T 78: Higgs: Extended models

Time: Thursday 16:30–18:45 Location: H-HS XVI

T 78.1 Thu 16:30 H-HS XVI

Messung der HZZ-Tensor-Kopplung in $pp \to H \to ZZ^* \to 4\ell$ - Zerfällen mit dem ATLAS-Detektor — •Verena Walbrecht, Sandra Kortner, Oliver Kortner und Hubert Kroha — Max-Planck-Institut für Physik, München

Ein wichtiger Zerfallsprozess für die Messung der Eigenschaften des Higgs-Bosons ist der Zerfall in zwei Z-Bosonen, die jeweils in ein e^+e^-- oder $\mu^+\mu^-$-Paar zerfallen, $pp \to H \to ZZ^* \to 4\ell$.
Im Standardmodell wird das Higgs-Boson als Spin-0-Teilchen mit positiver CP-Quantenzahl vorhergesagt. Diese Hypothese wird auch von den Run-1-Daten des LHC bevorzugt. Dabei sind kleine Beimischungen anomaler, möglicherweise auch CP-verletzender Kopplungen mit geänderter Tensorstruktur nicht ausgeschlossen.
Solche Abweichungen vom Standardmodell können unter anderem im Rahmen effektiver Feldtheorien (EFT) beschrieben werden, in denen die Standardmodell-Lagrangedichte durch weitere Operatoren höherer Dimensionen erweitert wird.
In diesem Vortrag werden die Messungen der Produktions- und Zerfallseigenschaften des Higgs-Bosons im Kanal $pp \to H \to ZZ^* \to 4\ell$ vorgestellt und im Rahmen einer effektiven Feldtheorie interpretiert, um die EFT-Parameterwerte einzuschränken. Die Messungen basieren auf dem vollen Run-2-Datensatz des ATLAS-Detektors.

T 78.2 Thu 16:45 H-HS XVI

Analysis of heavy Higgs boson decays into lighter Higgs bosons in the bb+$\tau\tau$ final state — •Janek Bechtel, Günter Quast, and Roger Wolf — Karlsruhe Institute of Technology, Wolfgang-Gaede-Str. 1, 76131 Karlsruhe, Germany

In the Next-to-Minimal-Supersymmetric-Standard-Model (NMSSM), an additional complex Higgs singlet leads to modifications in the Higgs sector resulting in seven Higgs bosons, of which three are scalar, two are pseudoscalar and two are charged. One scalar Higgs boson can be identified with the observed Higgs boson at 125 GeV. The lightest additional boson (h') can be lighter or heavier than 125 GeV, and its coupling to quarks and leptons can be suppressed, such that the dominant production of h' is via the decay of a heavy Higgs boson into the 125 GeV Higgs boson plus this additional boson h'. A promising decay channel to find these states is the decay of one boson into b quarks, and of the other into tau leptons. In the talk, the signal simulation towards this measurement and an analysis strategy in this final state using data collected by the CMS experiment are presented.

T 78.3 Thu 17:00 H-HS XVI

New Analysis Techniques for the search for BSM H $\to \tau\tau$ with the full Run-2 dataset — •Lino Gerlach and Stan Lai for the ATLAS-Collaboration — Georg-August-Universität Göttingen

In 2012, a scalar boson was found at CERN that is consistent with the properties of the Higgs boson predicted by the Standard Model of particle physics. Some theories, in particular supersymmetric models, also predict the existence of additional heavier neutral Higgs bosons. The decays of these heavy Higgs bosons to a pair of τ leptons can be siginificant because of the relatively large mass of the τ lepton and additional effects of two-Higgs-doublet models that can enhance the coupling to down-type fermions.

While efforts are ongoing to quickly publish results of a search with the full Run-2 dataset, detailed investigations on the analysis methods and techniques are being carried out to ensure maximal sensitivity in a legacy result with 139 fb^{-1}.

This talk places special emphasis on these investigations. They include a new method of estimating the background of QCD jets faking hadronic tau decays, a machine learning based approach to identify possible signal signatures, and a Z' scenario signal interpretation.

T 78.4 Thu 17:15 H-HS XVI

Search for additional Higgs bosons decaying to a pair of W bosons in the semi-leptonic final state with the CMS detector using full Run 2 data — Mate Farkas, Olena Hlushchenko, Wolfgang Lohmann, Dennis Roy, Hale Sert, •Sebastian Siebert, Achim Stahl, Lucas Wiens, and Alexander Zotz — III. Physikalisches Institut B, RWTH Aachen University, Germany

During Run 2 of the LHC an integrated luminosity of 137 fb^{-1} at $\sqrt{s} = 13$ TeV was recorded by the CMS detector. Apart from measuring properties of known particles more precisely, it is also expected that new particles might be discovered with such a large dataset. Additional heavy Higgs bosons are suggested by many theories beyond the standard model. The high mass $H \to WW$ analysis studies gluon-gluon fusion and vector-boson fusion as Higgs production mechanisms. The analysis aims to find Higgs-like resonances in the mass region from 115 GeV/c^2 to 5000 GeV/c^2 or set exclusion limits in the context of MSSM and also two-Higgs-doublet scenarios. This talk presents the status and future plans in the semi-leptonic channel.

T 78.5 Thu 17:30 H-HS XVI

Lepton selection in the boosted $HH \to b\bar{b}WW^*$ analysis with $\sqrt{s} = 13$ TeV ATLAS data — •Kira Abeling, Stan Lai, and Jason Veatch — Georg-August-Universität Göttingen

Higgs boson pair production is an important probe for the nature of the Standard Model as it provides a direct measurement of the Higgs potential. Furthermore, many theories predict heavy resonances, X, that can decay into two Higgs bosons which then decay further, in this case, to a b-quark pair and a W boson pair.

Depending on the mass of X, the Higgs bosons are boosted, which results in overlapping decay products that are difficult to resolve. These effects can be counteracted by using larger jet sizes to collect all Higgs decay products in a single object.

In the case that one of the W bosons decays leptonically while the other decays hadronically, it is expected that the lepton will be inside or very close to the jet. To fully exploit this unique topology, the leptonic and hadronic components need to be disentangled. This talk presents studies performed to define an optimal lepton selection in the context of the boosted $X \to HH \to b\bar{b}WW^*$ analysis.

T 78.6 Thu 17:45 H-HS XVI

Search for charged Higgs bosons of a Type I 2HDM in the final state with one lepton and multiple jets — •David Brunner, Isabell Melzer-Pellmann, and Dirk Krücker — Deutsches Elektronen-Synchrotron (DESY)

The search for the direct production of non Standard Model (SM) elementary particles is one of the portals to explain new physics using high energy collider experiments like the Large Hadron Collider (LHC).

This search focuses on a Type I 2-Higgs Doublet Model (2HDM). The heavier neutral CP-even Higgs boson (H) is defined as the SM Higgs boson. In this configuration the decay of the charged Higgs boson ($H^{\pm}$) to the lighter CP-even Higgs boson (h) and a $W^{\pm}$ boson is enhanced, while the h decays predominantly into b quarks and τ leptons. The production mode of the charged Higgs boson in association with one h is studied, where both h bosons each decay into two b quarks and the $W^{\pm}$ decays leptonically.

Two types of machine learning algorithms are used in the analysis. First, a mass-parameterized boosted decision tree (BDT) is trained to optimize the signal significance for each mass point of interest. Second, a deep neural network (DNN) is trained on the substructure of highly boosted jets originating from h bosons and top quarks to differentiate between signal and background jets.

The search will be based on proton-proton collision data recorded by the CMS experiment at the LHC in 2016-18 with a center of mass energy of $\sqrt{s} = 13$ TeV. The results are given as expected limit on the cross section times branching ratio of the $H^{\pm}$ decay.

T 78.7 Thu 18:00 H-HS XVI

Search for additional Higgs bosons decaying into W^+W^- in the di-leptonic final state with CMS using full Run 2 data — Mate Farkas, Olena Hlushchenko, Wolfgang Lohmann, •Dennis Roy, Hale Sert, Sebastian Siebert, Achim Stahl, Lucas Wiens, and Alexander Zotz — III. Physikalisches Institut B, RWTH Aachen University, Germany

After the successful second data-taking period of the LHC, analyses using the full Run 2 data are being performed. With an integrated luminosity of 137 fb^{-1} recorded by CMS, the search for additional Higgs bosons, such as those expected from the minimal supersymmetric standard model (MSSM), is extended to higher masses.
The high mass $H \to WW$ analysis aims to search for resonances at higher masses. Their origin might be a heavier Higgs boson. In case no signal is found, new limits on 2HDM and MSSM scenarios are set. The status of this analysis in the di-leptonic final state is presented in this talk.

T 78.8 Thu 18:15 H-HS XVI

Studies of an Extended Higgs Sectors — •Judith Höfer, Claudia Seitz, Rickard Strom, Priscilla Pani, and Beate Heinemann — Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

The Higgs particle is a vital part of the current Standard Model (SM) of particle physics. Since its discovery, the measurements of its properties have confirmed the SM predictions. However, astrophysical observations hint towards the existence of physics Beyond the Standard Model (BSM) to explain, for example, phenomena like dark matter and baryon asymmetry. An extended Higgs sector is a prominent candidate to provide a connection between this BSM physics and the SM. Since the current measurements of the Higgs boson are limited in precision, they still provide sizeable space for such an extension of the Higgs sector. Here, an extension of the SM Higgs doublet by two additional scalar particles is considered. Depending on the mass of these new particles, processes where the 125 GeV SM Higgs decays into two new scalar particles can occur. In addition, asymmetric decays and successive cascade decays of the new Higgs particles are considered and their novel collider signatures are explored in the context of the ATLAS experiment at the Large Hadron Collider, CERN.

T 78.9 Thu 18:30 H-HS XVI

Suche nach unsichtbaren Zerfällen des Higgs-Bosons in Ereignissen mit einem hadronisch zerfallenden Vektorboson mit dem ATLAS-Detektor — •Johannes Balz, Volker Büscher, Andreas Reiss und Duc Bao Ta — Institut für Physik, Johannes Gutenberg-Universität Mainz

Eines der gegenwärtig größten Ziele für das ATLAS Experiment ist neben der präzisen Vermessung des Standardmodells (SM) die Suche nach Physik jenseits des SM (BSM).

In diesem Vortrag geht es um die Suche nach unsichtbaren Zerfällen des Higgs-Bosons, die nur mit Modellen jenseits des Standardmodells beschrieben werden können. Beim untersuchten Kanal wird das Higgs-Boson über Assoziierte-Produktion erzeugt, wobei das beteiligte Vektorboson hadronisch zerfällt. Daher werden Ereignisse mit hohem fehlendem Transversalimpuls und einem großflächigen Jet selektiert, der als W/Z-Jet klassifiziert ist. Die Quark- und Gluonanteile dieses Jets unterscheidet sich zwischen Signal- und Hauptuntergrundereignissen, wodurch eine Untergrundunterdrückung mithilfe von Quark-Gluon-Tagging möglich ist.

Im Vortrag wird der aktuelle Stand der Analyse bei einer Schwerpunktsenergie von $\sqrt{s}$=13 TeV vorgestellt.

T 79: Experimental methods IV

Time: Thursday 16:30–18:15 Location: H-ÜR 1

T 79.1 Thu 16:30 H-ÜR 1

Fast simulation of Electromagnetic Calorimeter using Variational Autoencoder — •Jubna Irakkathil Jabbar[2], Florian Bernlochner[1], Pablo Goldenzweig[2], and Jochen Gemmler[2] — [1]University of Bonn, Germany — [2]Karlsruhe Institute of Technology, Germany

The simulation of particle showers in electromagnetic calorimeters with high precision is a computationally expensive and time consuming process. Fast simulation of particle showers using generative models have been suggested to significantly save computational resources. In this study, electron showers simulated using the Geant4 simulation toolkit are used to train a variational autoencoder model. The model consists of an encoder, decoder and a latent noise vector. Once the model is trained, the decoder is used to generate particle shower simulations providing noise vectors as input. The generated particle showers are cross-checked with the Geant4 showers using various observables.

T 79.2 Thu 16:45 H-ÜR 1

Probing Non-Perturbative QED with LUXE — •Marius Hoffmann[1] and Beate Heinemann[1,2] — [1]DESY, Hamburg — [2]Albert-Ludwigs-Universität Freiburg

In the presence of very strong fields, quantum electrodynamics can not rely on perturbation theory. Instead, nonlinear effects have to be considered. The LUXE (Laser Und European XFEL) Experiment aims to use the high-quality electron beam of the XFEL accelerator to probe this strong-field regime.

With LUXE, field strengths above the Schwinger critical limit can be achieved in two different experimental setups: Interaction of the electron beam with a high-intensity laser or interaction of a photon beam, produced via bremsstrahlung, and the laser.

The two setups open up the possibility to measure both nonlinear Compton scattering and nonlinear Breit-Wheeler pair production. These processes are relevant for example around heavy astronomic objects or future particle colliders. In preparation for the experiment, physics simulations and design studies are performed for the different physics processes of interest.

After giving an introduction to the experiment and setups, this talk focuses on the simulation results for the Breit-Wheeler process after the laser-beam interaction.

T 79.3 Thu 17:00 H-ÜR 1

Studies on Monte Carlo tuning including correlation of uncertainties — •Salvatore La Cagnina, Johannes Erdmann, and Kevin Kröninger — TU Dortmund, Lehrstuhl für Experimentelle Physik IV

Monte Carlo (MC) simulations are an essential aspect of data analysis at the LHC. One aspect of MC event generation involves hadronisation and parton shower models. Since these models are based on physics approximations, they introduce a number of parameters. These parameters cannot be inferred from first principles. Therefore, their values have to be optimized using numerical tools and experimental data (MC tuning). Generally, MC tuning is performed by choosing observables that are sensitive to the parameters. Afterwards, a fit of the parameters to data using a simplified MC response function derived from fits to MC events is performed. Though out-of-the box solutions to MC tuning exist, uncertainties are usually treated as uncorrelated. In this talk, MC tuning using a Bayesian approach will be discussed. The EFTfitter tool is used for fitting, which enables the implementation of correlations for different sources of uncertainties. First results using this method on a MC tune will be presented.

T 79.4 Thu 17:15 H-ÜR 1

sPlot technique: Comparison of error correction methods in unbinned maximum likelihood fits with sWeighted events — Peter Buchholz, Siddardha Chelluri, Mazuza Ghneimat, •Tim-Philip Hücking, Iskander Ibragimov, and Wolfgang Walkowiak — Universität Siegen, Germany

The *sPlot* technique is used in HEP to e.g. separate signal and background events in control variable distributions on a statistical basis. Extracting *sWeights* from a fit to a discriminating variable distribution, the signal and background distributions of the control variable are constructed by weighting the events with the *sWeights*. If an unbinned maximum likelihood fit is performed on such a distribution, the covariance matrix returned by the minimization package Minuit needs to be corrected, as in the case of fits to weighted events in general. Different methods to correct the uncertainties in this case are discussed based on pseudo experiments, performed in RooFit.

T 79.5 Thu 17:30 H-ÜR 1

Bunch pattern dependency of the track counting luminosity measurement in the ATLAS experiment — •Paul Moder[1,2], Valerie Lang[2], Beate Heinemann[1,2], and Claudia Seitz[1] for the ATLAS-Collaboration — [1]DESY Hamburg — [2]Albert-Ludwigs-Universität Freiburg

The measurement of the integrated luminosity, delivered to the ATLAS experiment by the Large Hadron Collider (LHC) at CERN is a key parameter for every physics analysis. It describes the number of particle collisions over a certain time and area, and combined with the cross section, it can be used to predict the expected production rates for a particular process. The uncertainty in the luminosity measurement therefore plays an important role for the precision of physics analyses in ATLAS.
One of the methods for measuring the luminosity is called *track counting*. For this method, the reconstructed charged particle tracks in the ATLAS Inner Detector are counted where the average over several crossings of proton bunches is proportional to the number of simultaneous interactions μ and therefore the luminosity for a dedicated track selection. One challenge of the method, however, is the dependence on the pattern of proton bunches, which usually consists of trains - a number of consecutive filled bunches - and individual bunches with larger gaps in between. In this presentation, the studies of the dependency of the *track counting* luminosity measurement on the bunch position will be shown.

T 79.6 Thu 17:45 H-ÜR 1

Study of the detector occupancy and track selection efficiencies in $Z \to \mu\mu$ events for the track-counting luminosity measurement in ATLAS — •Surabhi Sharma[1], Valerie Lang[2], and Ingrid-Maria Gregor[1] — [1]DESY, Hamburg, Germany — [2]Albert-Ludwigs-Universität, Freiburg, Germany

Particle production at the Large Hadron Collider (LHC) is driven by two important parameters: the centre-of-mass energy and the luminosity. While the centre-of-mass energy is determined by the LHC accelerator, the luminosity delivered to the ATLAS experiment needs to be measured to very high precision, in order to fulfill the physics goals of the ATLAS. In order to provide an accurate and reliable luminosity measurement, ATLAS uses a variety of methods. One of these method is track-counting. The number of charged particle tracks in the inner detector of the ATLAS experiment is proportional to the number of simultaneous proton-proton collisions, and hence the luminosity. A reliable luminosity measurement using this technique requires high and stable tracking efficiencies for the selection of tracks.

In this work, $Z \to \mu\mu$ events are used to study the efficiencies for different track selections. These efficiencies can be used to correct inefficiencies of the track counting luminosity measurement, assuming if there is variation in track selection efficiencies same would be seen in luminosity measurement. This assumption is studied by establishing a method to directly monitor changes in the track-related occupancy of the detector.

T 79.7 Thu 18:00 H-ÜR 1

Detector-corrected Dark Matter search in topologies with missing energy and jets with the ATLAS detector — •Sebastian Mario Weber for the ATLAS-Collaboration — Kirchhoff-Institut für Physik, Heidelberg, Deutschland

A powerful signature for dark matter production at the Large Hadron Collider is large missing transverse energy (MET) from the dark matter particles in association with one or more energetic jets. A Standard Model (SM) process with identical event topology is the Z boson decaying to neutrinos ($Z \to \nu\nu(+jets)$).

A measurement of this process is performed by selecting events with energetic jets and MET as well as events which are selected to enhance vector-boson fusion processes. To simplify later comparisons of the measurement with models for physics beyond the SM, detector effects are removed from the data using an iterative unfolding procedure. Experimental and theoretical uncertainties are constrained using a set of control regions (CRs). These CRs are based on different boson mediated processes, which ensures a high degree of correlation of the uncertainties between the different regions. A search for deviations from the SM is then performed on the detector-corrected results.

In this talk new results on the background estimation in the signal and control regions are presented.

T 80: Calorimeters

Time: Thursday 16:30–18:50 Location: H-1.003

Group Report T 80.1 Thu 16:30 H-1.003

A Highly Granular Electromagnetic Calorimeter Concept for the DUNE Near Detector — •Lorenz Emberger[1], Eldwan Brianne[2], and Frank Simon[1] — [1]Max-Planck-Institut für Physik — [2]DESY

The near detector (ND) of the Deep Underground Neutrino Experiment (DUNE) will play an important role in the search of CP violation in the neutrino sector. Additionally, as a standalone complex, it will be an excellent laboratory to study a wide range of neutrino interactions. The ND design study consists of three independent subdetectors, placed downstream of the neutrino production target. One of these detectors, a Multi Purpose Detector (MPD), consists of a high pressure gaseous Argon time projection chamber (TPC), surrounded by an electromagnetic calorimeter (ECAL) and a muon system. One key aspect of the ECAL is the reconstruction of neutral particles such as neutral pions and neutrons invisible in the TPC. We present a concept study of the MPD system featuring a highly granular electromagnetic calorimeter inspired by the SiPM-on-Tile technology developed by the CALICE collaboration. First studies of the reconstruction of neutral pions decaying into two photons inside the TPC will be covered. Additionally, we will touch on background studies carried out in the full MPD geometry.

T 80.2 Thu 16:50 H-1.003

Development and performance of Megatile prototypes for the CALICE AHCAL — •Rosmanitz Anna for the CALICE-D-Collaboration — Johannes Gutenberg-Universität Mainz, Institut für

Physik

The CALICE collaboration is developing a highly granular Analog Hadronic Calorimeter (AHCal) for a future e+e- linear collider. At the moment, the detector consists of 3x3 cm^2 scintillating tiles, singularly wrapped in reflective foil, glued to an electronic board, and read out by silicon photomultipliers (SiPM). To simplify and speed up the assembly process, the Megatile was developed at the University of Mainz as an alternative concept. It is built from a single scintillator plate with cut-out trenches that are filled with a TiO2-glue mixture to maintain the same granularity. Several full-scale prototypes have been built and tested with cosmic rays in the lab and with an electron beam. This talk presents the Megatile concept and its performance in particular in terms of light yield and cross talk.

T 80.3 Thu 17:05 H-1.003

Time Measurements with the CALICE Analogue Hadronic Calorimeter Prototype — •Lorenz Emberger for the CALICE-D-Collaboration — Max-Planck-Institut für Physik

One of the main design drivers at future energy-frontier e^+e^- colliders is the precise determination of the energy of particle jets. This is achieved with detector designs optimized for particle flow algorithms.

CALICE is an R&D collaboration focussed on the development of highly granular calorimeters optimized to aid this paradigm by providing high spatial resolution. The Analogue Hadronic Calorimeter (AHCAL) is one of the detector concepts based on scintillating tiles read out by Silicon Photomultipliers. It is a 22000 channel sampling calorimeter with steel absorber. The high spatial granularity and single-cell timing enhances the particle separation and background rejection capability.

This contribution is focussed on the hit time measurement of the AHCAL using data collected in extensive beam test campaigns at CERN in 2018. The calibration procedure and correction of electronic effects will be introduced and the achievable hit time distribution will be reported. It will also touch upon first results of the hit time analysis of hadronic showers in simulation as well as in data.

T 80.4 Thu 17:20 H-1.003

Evaluation of Scintillator Tiles for Highly Granular Calorimeters — •Malinda de Silva, Frank Simon, and Lorenz Emberger — Max-Planck-Institut für Physik, München

Plastic scintillator tiles are key elements of highly granular imaging calorimeters being developed for HL-LHC upgrades and for experiments at future colliders and in neutrino beams. The scintillation light emitted by the tiles are read out by silicon photomultipliers placed underneath the tile. The amount of scintillation light obtained from the combination of the scintillator and the SiPM (light yield), as well as the spatial response uniformity of the scintillator elements, are crucial for the overall performance of the detectors.

In this contribution we discuss detailed studies of the impact of misalignment on the spatial response uniformity of different scintillator tiles of varying shapes, sizes and materials, performed with a uniformity scanning setup based on a radioactive source. Furthermore, a simulation-based on GEANT4 is used to simulate an electromagnetic sampling calorimeter in the context of the DUNE neutrino experiment, using non-uniformity data to evaluate the impact of misalignment on the calorimeter*s overall energy resolution.

T 80.5 Thu 17:35 H-1.003

The new fast calorimeter simulation of the ATLAS detector — •Joshua Beirer[1,2], Michael Duehrssen[1], and Stan Lai[2] — [1]CERN — [2]Georg-August-Universität Göttingen

The simulation of physics processes is one of the most essential tools for all types of measurements and searches at hadron colliders. However, the production of simulated events is a highly CPU intensive task and the limited amount of Monte Carlo (MC) events is already one of the largest sources of systematic uncertainties in many ATLAS physics analyses. The main bottleneck of the simulation is the detailed detector simulation with Geant4, for which most of the simulation time is needed to simulate the calorimeter response. In order to increase the amount of produced MC events, ATLAS has successfully employed a fast calorimeter simulation (FastCaloSim) during Run 1 and 2 of the LHC. FastCaloSim parametrizes the energy response of particles in the calorimeter cells, taking into account the lateral shower profile and the correlation between the energy depositions in the various layers of the calorimeter. In recent years, an improved version of FastCaloSim has been developed, which uses machine learning techniques such as principal component analysis and neural networks, and has been shown to considerably improve the simulation while reducing the required CPU time per simulated event.

In this talk, an overview of the new fast simulation of the ATLAS calorimeter will be given and future possible improvements will be outlined.

T 80.6 Thu 17:50 H-1.003

Detailed studies of electromagnetic and hadronic showers in a SiPM-on-tile highly granular calorimeter — •Olin Lyod Pinto for the CALICE-D-Collaboration — Deutsches Elektronen-Synchrotron, Hamburg, Germany

The analog hadron calorimeter prototype is a highly granular calorimeter based on steel absorbers and SiPM-on-tile readout, developed by the CALICE Collaboration. It has acquired sizeable data sets with precise five-dimensional information on electromagnetic and hadronic showers in two test beam periods at the CERN SPS beam test facility. The unprecedented granularity of the detector provides detailed information about the properties of electromagnetic and hadronic showers, which helps to constrain shower models through comparisons with model calculations. Results on longitudinal and lateral shower profiles compared to GEANT4 shower models will be discussed which were measured for electrons and pions in the energy range 10 - 100GeV. The comparison of longitudinal and lateral shower profiles to simulations with a variety of different hadronic shower models can provide input for further development of these models.

T 80.7 Thu 18:05 H-1.003

Particle identification using boosted decision trees for the CALICE highly granular SiPM-on tile calorimeter. — •Vladimir Bocharnikov for the CALICE-D-Collaboration — DESY, Hamburg, Germany — MEPhI, Moscow, Russia

The Analog Hadron Calorimeter (AHCAL) is a highly granular SiPM-on-tile sampling calorimeter developed by the CALICE collaboration for future e^+e^- colliders such as the International Linear Collider (ILC) or the Compact Linear Collider (CLIC). The AHCAL technological prototype consists of 39 active layers alternating with 1.72 cm steel absorber plates. Each active layer is equipped with 576 3×3 cm^2 scintillator tiles with individual readout by silicon photomultipliers. The prototype was tested with muon, electron and pion beams at the CERN SPS facilities in 2018. The high granularity provides detailed spatial information about energy depositions of particles in the detector material that can be used for the event characterisation. We perform a gradient boosted decision tree method to classify events according to incoming particle type. Monte-Carlo simulations were used to train and test the classification model. In this contribution, the particle identification method, its efficiency in simulations and the results of data purification will be discussed.

T 80.8 Thu 18:20 H-1.003

Pandora Particle Flow Algorithm Studies of the CALICE AHCAL 2018 Technological Prototype Test Beam Data and Simulation — •Daniel Heuchel for the CALICE-D-Collaboration — Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany

The CALICE collaboration is developing highly granular calorimeters for a future e^+e^- collider, like ILC or CLIC. To achieve the desired jet energy resolutions of 3-4% for jet energies between 40-500 GeV in such an experiment the Pandora Particle Flow Algorithm (PandoraPFA) can be used. The basic concept of PandoraPFA is to use the energy measurement of the sub-detector providing the best resolution for each individual particle. This means that charged particles are measured in the tracker, neutral particles in the calorimeters. In this pattern recognition framework high granularity in the calorimeter systems is crucial to correctly assign particle tracks to shower clusters and efficiently separate charged and neutral particles. The current Analog Hadronic Calorimeter (AHCAL) technological prototype features 38 active layers with a total of 21888 channels each consisting of a 3x3cm2 scintillating tile read-out by a Silicon Photomultiplier. Three test beam periods at the SPS CERN have been performed in 2018 to proof the scalability to a full collider detector and record different particles for detailed shower analysis. In this contribution, we will present first results of the application of PandoraPFA to a AHCAL standalone scenario. Focusing on the case of single particle reconstruction and the separation of a neutral hadron in the presence of charged one, we are validating the algorithms performance on test beam data and simulated events.

T 80.9 Thu 18:35 H-1.003

New developments on the residual pile-up subtraction for small R jets in ATLAS — •Pablo Rivadeneira[1], Michaela Queitsch-Maitland[2], and Krisztian Peters[1] for the ATLAS-Collaboration — [1]DESY Hamburg — [2]CERN

In-time and out-of-time pile-up produce energy deposits in the calorimeters generating a dependence of the reconstructed transverse momentum (pT) of jets on the pile-up. In order to correct for this dependence in the ATLAS calibration workflow, first, a correction based on the area of the jet is applied and later a residual correction is needed. The residual calibrations uses the number of primary vertex (NPV) as an estimator of in-time and the mean number of interactions per bunch crossing (mu) as an estimator of out-of-time pile-up. This correction has the limitation that it does not consider any correlation between mu and NPV. Also, the dependence on the pile-up is dependent on the jet pT. This dependence on the pT is set as an uncertainty. A new method that removes the pile-up dependence considering the correlation between mu and NPV, and the dependence on the pT of the jet has been developed and will be part of the new recommendations provided by the JET/ETMiss group to the ATLAS collaboration.

T 81: Neutrino astronomy III

Time: Thursday 16:30–19:00 Location: H-1.004

T 81.1 Thu 16:30 H-1.004

Observations of the Moon Shadow in Cosmic-Ray-Induced Muons with the IceCube Neutrino Observatory — •Saskia Philippen, Johannes Merz, René Reimann, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B RWTH Aachen

Calibrating the directional reconstruction of neutrino-induced muons in IceCube is a challenging task. As no luminous neutrino source exists in the sky, pointing and resolution are often estimated by Monte-Carlo methods. Experimentally, IceCube uses cosmic-ray-induced atmospheric muons for various calibration purposes. Particularly useful is the effect that cosmic rays are absorbed by the moon, resulting in a deficit of cosmic-ray muons from the lunar direction. This "Moon Shadow" finds application in the verification of the angular resolution and pointing of the detector as well as for source analyses. In this talk, the improvements in the directional uncertainty estimation of events and in the background determination are presented. The point source hypothesis is extended to a disc source hypothesis, which allows a scan of the radius of the moon. These improvements are tested against the standard analysis methods using the Moon Shadow. Furthermore, ideas to measure the impact of Earth's magnetic field with the usage of the Moon Shadow analysis are discussed.

T 81.2 Thu 16:45 H-1.004

Improving IceCube low-energy event reconstruction — •Elisa Lohfink, Jan Weldert, and Sebastian Böser for the IceCube-Collaboration — Johannes Gutenberg-Universität Mainz

With the low-energy extension (DeepCore) of the IceCube Neutrino Observatory, neutrinos with energies down to the GeV range can be reconstructed individually. The reconstruction is based on minimizing an eight-dimensional likelihood, using tabulated charge expectation values at each optical module, for the entire range of possible light sources. Due to computational restrictions, this includes spline-interpolating between a finite number of possible sources as well as assuming symmetries of the light behavior in the ice, neglecting for instance the known ice anisotropy. Also, within reconstruction, particle track lengths are quantized and certain characteristics of the light emission are simplified. Motivated by the resolutions an ideal reconstruction would yield and by the improvements this implies for physics results, it is worthwhile to thoroughly understand the individual effects these simplifications have. Consequently, those having the largest impact are identified and the potential of using full available detail is evaluated.

T 81.3 Thu 17:00 H-1.004

Moon analysis to test the directional resolution of a segmented spline algorithm in IceCube — •Sebastian Schindler, Thorsten Glüsenkamp, and Gisela Anton for the IceCube-Collaboration — Erlangen Centre for Astroparticle Physics (ECAP), University Erlangen-Nürnberg, Germany

In IceCube arrival directions of muon neutrinos are determined from resulting muon tracks in the detector. As muons from cosmic rays produce the same signature in the detector they can be used to test reconstruction algorithms. A calibration source of cosmic ray muons is provided by the moon, which produces an easy to observe localized reduction of the mostly uniform cosmic ray flux.

The directional resolution of a new segmented spline algorithm for muon reconstructions is tested by using the abundant flux of cosmic rays in a moon analysis. The current work using both experimental data and Monte Carlo simulations will be presented.

T 81.4 Thu 17:15 H-1.004

Observation of the Shadow of the Moon in Cosmic rays with the IceCube Neutrino Obervatory — •Johannes Merz, Erik Ganster, Christian Haack, Saskia Philippen, René Reimann, Lisa Schumacher, Jöran Stettner, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

When new processes to calculate trajectories of muons passing through the IceCube Observatory are developed, the need for a calibration method arises. Due to the lack of a reliable standard candle, other options are considered, particularly with an all too familiar one rising over the horizon. The moon casts an observable shadow in the muon flux originating from air showers due to cosmic rays. This talk presents advancements in using this moon shadow as a calibration method for IceCube's reconstruction algorithms.

T 81.5 Thu 17:30 H-1.004

Seasonal Variation of the Atmospheric Neutrino Flux measured by IceCube — •Simon Hauser, Jakob Böttcher, Philipp Fürst, Patrick Heix, René Reimann, Jöran Stettner, Christopher Wiebusch, and Marit Zöcklein for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen

Atmospheric muon neutrinos measured by the IceCube Neutrino Observatory originate from charged meson decays in cosmic-ray induced air showers. The meson production and decay depend on the local atmospheric conditions. Therefore, one expects a correlation between the atmospheric temperature and the observed atmospheric neutrino flux. For the analysis of this correlation, almost 10 years of IceCube neutrino data are analyzed in conjuction with atmospheric temperature profiles measured by the Atmospheric Infrared Sounder (AIRS). The observed seasonal variation allows for testing models of hadronic interaction in atmospheric air showers. In this talk, an unbinned likelihood analysis of the correlation will be presented.

T 81.6 Thu 17:45 H-1.004

Seasonal Variations of the unfolded Atmospheric Neutrino Energy Spectrum with IceCube — •Karolin Hymon[1,2], Tim Ruhe[1], and Julia Tjus[2] for the IceCube-Collaboration — [1]TU Dortmund — [2]Ruhr-Universität Bochum

The IceCube Neutrino Observatory is a detector array at the South Pole with the central aim of studying high energy neutrinos of astrophysical origin. The majority of the detected neutrinos, however, are atmospheric neutrinos, caused by cosmic ray interactions in the atmosphere. The rate of atmospheric neutrinos undergoes a seasonal variation with indications that the rate changes with the temperature in the stratosphere. Possible implication of this variation on the shape of the atmospheric neutrino spectrum have not been studied so far. This talk will focus on the investigation of possible shape changes of the atmospheric neutrino spectrum, which will be analyzed using the Dortmund Spectrum Estimation Algorithm (DSEA).

T 81.7 Thu 18:00 H-1.004

Event Selection of Muons with Recurrent Neural Networks in IceCube — •Gerrit Wrede, Thorsten Glüsenkamp, and Gisela Anton for the IceCube-Collaboration — Erlangen Centre for Astroparticle Physics (ECAP), University Erlangen-Nürnberg, Germany

Relativistic muons created by muon neutrinos offer a good angular res-

olution and are thus an ideal channel for the detection of point sources. However, IceCube also measures a major background of muons from cosmic rays. This background can be avoided by selecting upgoing events from the northern hemisphere, where the earth shields cosmic rays. It is essential to reject misreconstructed cosmic-ray events in the upgoing region while preserving as much signal as possible. We trained a recurrent neural network to reconstruct muon tracks with high accuracy. In this talk, the neural-network-based reconstruction will be presented and its ability to reject cosmic-ray muons will be compared with standard reconstructions.

T 81.8 Thu 18:15 H-1.004

Development of the comprehensive analysis tools for the Supernova neutrino detectors — •Vsevolod Orekhov and Michael Wurm — Institute of Physics, Johannes Gutenberg Universität, Mainz

A galactic Supernova explosion is a unique neutrino source: detecting the neutrinos from deep inside the star will help us understand both the physics of the core collapse and properties of the neutrino themselves. If a SN neutrino burst arrived at Earth today, it would be detected by a variety of ton to kiloton scale neutrino detectors based on different technologies and target media. A full understanding of the observed signals can only be obtained by a combined analysis of the different interaction channels. This contribution presents an analysis framework developed to combine and fit the neutrino spectra from different detectors assuming a common flavour-dependent neutrino signal. We start the development from the six channels available on hydrogen, carbon and electrons that are available in large liquid scintillator detectors like JUNO. From there, the framework will be extended to include other detector media.

T 81.9 Thu 18:30 H-1.004

Unfolding of Supernova Neutrino Spectra in JUNO — •Max Büsken, Thilo Birkenfeld, Achim Stahl, Sivaram Yogathasan, and Shivani Ramachandran — III. Physikalisches Institut B, RWTH Aachen University

The Jiangmen Underground Neutrino Observatory (short: JUNO) currently under construction in southern China, is a 20 kt liquid scintillator neutrino detector. Its main physics goal will be to determine the neutrino mass hierarchy by measuring reactor neutrinos from two nuclear power plants at a baseline of 53 km. Apart from that JUNO will also be a great detector for neutrinos emerging from core-collapse supernovae. Recording such a signal would give a lot of insight into the physics of the collapse. Comprehensive simulations allow studying JUNO's potential detector response to the energy spectrum of supernova neutrinos. In this talk such simulations together with an identification of neutrino reaction channels are presented and a first approach to spectrum unfolding is shown.

T 81.10 Thu 18:45 H-1.004

P-ONE and prospects towards a global neutrino telescope network — •Matthias Huber — Technische Universität München, Deutschland

The origin of cosmic rays, the highest-energy particles ever observed is one of the greatest scientific mysteries that captures the interest of scientist for more than 100 years. High energy neutrinos, arriving from the farthest reaches of the cosmos, could hold the key to resolving this cosmic ray riddle. In 2018 first evidence for high-energy neutrino emission from the blazar TXS 0506+056 was announced by the IceCube collaboration as a result of a multi-messenger campaign. Despite this evidence no sources of high-energy neutrinos have been detected yet. The Pacific Ocean Neutrino Explorer (P-ONE) located in Canada at Cascadia Basin is designed to identify the origin of these high-energy neutrinos by covering a detector volume of $3km^3$ at a depth of 2660m after its completion. In order to reach maximal sensitivity to high-energy neutrino sources we furthermore propose a Planetary Neutrino Monitoring System (PLEnuM) realised by the integration of all existing neutrino telescopes in progress (KM3NeT, GVD, P-ONE and IceCube). In the first part of this presentation we will give a brief overview of the idea, the current status and the future plans of P-ONE. In the second part we will concentrate on a sensitivity study showing the enormous potential of the collaborative PLEnuM project in order to observe the sources of high-energy neutrinos.

T 82: Pixel detectors IV

Time: Thursday 16:30–18:45 Location: L-2.004

T 82.1 Thu 16:30 L-2.004

Simulation Studies on the Robustness of the ATLAS Pixel Detector for the HL-LHC — •Timo Dreyer, Stan Lai, and Kira Abeling — Georg-August-Universität Göttingen

Around 2026, the LHC will start its high luminosity phase (HL-LHC), during which more than 3000 fb^{-1} of pp collision data is expected to be delivered. In addition to the physics benefits of the increased amount of data, new technical challenges will arise. These include an increased amount of pileup in the events and exposure of the detector components to larger radiation doses.

To face these challenges, the ATLAS experiment will undergo a major upgrade during the long shutdown 3 that will precede the HL-LHC phase. The current inner detector will be completely replaced by a new silicon based inner tracker (ITk) consisting of an inner pixel detector and an outer silicon strip detector.

This talk presents studies performed to evaluate the robustness of the planned ITk pixel detector under defects of sub-components. The methodology for masking pixel modules and front-ends is introduced and comparisons between the expected performance under different failure modes are presented.

T 82.2 Thu 16:45 L-2.004

Guard Ring investigation of Silicon Sensors with Modified Pixel Implant shapes in the context of the ATLAS experiment — •Serena Di Pede[1], Andreas Gisen[2], Valerie Hohm[2], Kevin Kröninger[2], Jonas Lönker[2], Maximiliano Sioli[1], Mareike Wagner[2], Jens Weingarten[2], and Felix Wizemann[2] — [1]Physics Department Bologna University, Italy — [2]TU Dortmund, Experimentelle Physik IV

Based on the standard design of the planar $n^+ - in - n$ silicon pixel sensors of the innermost part of the tracking detector of the ATLAS experiment, six modified pixel designs were developed in Dortmund in order to increase the average electric field and thus the radiation hardness. The REINER pixel sensors contain these six modified pixel implantation shapes beside structures with the standard pixel design. It is well-known that the high-voltage capability of detector diodes fabricated in the planar process is limited by the electric field generated at the edge of the junction. An approach to reduce the electric field at the junction edges is to use floating guard rings. Each pixel structure of the REINER sensor is provided by 13 guard rings and can be biased and investigated separately. This study investigates the guard ring structure of each of the eight pixel designs as well as the influence among the guard ring structure of the different pixel designs, in order to investigate the strength of the electric field at the edge and the phenomenon of the leakage current creation in the bulk and the surface of each pixel implant.

T 82.3 Thu 17:00 L-2.004

Radiation Damage Measurements of the Hybrid Pixel Readout Chip RD53A — Jochen Dingfelder, Florian Hinterkeuser, Tomasz Hemperek, Fabian Hügging, Hans Krüger, Konstantinos Moustakas, Piotr Rymaszewski, •Marco Vogt, and Norbert Wermes — Physikalisches Institut der Universität Bonn

After the phase-2 upgrade of the LHC at CERN, the instantaneous luminosity will be increased substantially. New detector systems are required which are able to deliver hit information at drastically increased data rates and cope with unprecedented radiation levels. The RD53 collaboration will provide the pixel readout chips for the innermost tracking detector layers of both ATLAS and CMS. The first large-scale prototype chip RD53A was manufactured in a 65 nm CMOS process and is available since 2017.

Accelerated irradiation campaigns indicate that the radiation damage of RD53A is significantly dose rate dependent. It is therefore necessary to improve the radiation models to make better predictions

about the detector performance during its lifetime, prior to the submission of the next prototype chip.

In this contribution, the ongoing low-dose-rate irradiation campaigns and their results will be presented.

T 82.4 Thu 17:15 L-2.004

Radiation hardness of a large electrode DMAPS design in a 150 nm CMOS process — •Ivan Caicedo, Christian Bespin, Jochen Dingfelder, Tomasz Hemperek, Toko Hirono, Fabian Hügging, Hans Krüger, Piotr Rymaszewski, Tianyang Wang, and Norbert Wermes — Physikalisches Institut, Universität Bonn. Bonn, Germany.

Monolithic CMOS active pixel sensors in depleted substrates (DMAPS) are an attractive development for pixel tracker systems in high-rate collider experiments. The radiation tolerance of these devices is enhanced through technology add-ons and careful design, which allow them to be biased with large voltages and collect charge through drift in highly resistive silicon bulks. In addition, the use of monolithic chips in commercial CMOS processes would reduce the current production complexity and costs of large module areas.

LF-Monopix1 is the first DMAPS with a fully functional column-drain read-out architecture. It was designed in a 150 nm CMOS process that made it possible to place and isolate each pixel's front-end circuitry within a charge collection electrode of a size comparable to the pixel area. This presentation will give an overview of the chip performance and then focus on its radiation hardness. Measurements on irradiated samples showed a detection efficiency of $\sim$ 99% after a NIEL dose of $1 \times 10^{15} n_{eq}/cm^2$. Moreover, their gain did not degrade and their noise increased by 25% after a TID dose of 100 MRad from X-rays. In both cases, the chips remained operational and within reasonable values of leakage current and power consumption.

T 82.5 Thu 17:30 L-2.004

Effects of gamma irradiation on DEPFET pixel sensors for the Belle II experiment — Patrick Ahlburg[1], Ladislav Andricek[2], Jochen Dingfelder[1], Ariane Frey[3], Tomasz Hemperek[1], Hans Krüger[1], Carlos Marinas[4], •Botho Paschen[1], Rainer Richter[2], Harrison Schreeck[3], Benjamin Schwenker[3], Philipp Wieduwilt[3], and Norbert Wermes[1] — [1]University of Bonn, Germany — [2]HLL of Max-Planck-Society, Munich, Germany — [3]University of Göttingen, Germany — [4]University of Valencia, CSIC, Spain

For the Belle II experiment at KEK (Tsukuba, Japan) the KEKB accelerator was upgraded to deliver e^+e^- collisions at a center of mass energy of $E_{\mathrm{CM}} = 10.58$ GeV with an instantaneous luminosity of $8 \cdot 10^{35}$ cm^{-2}s^{-1}. As the innermost part of the Belle II detector, the PiXel Detector (PXD), based on DEpleted P-channel Field Effect Transistor (DEPFET) technology, is most exposed to radiation from the accelerator. A module from the final Belle II production batch was irradiated with X-rays to a total dose of 266 kGy corresponding to 7-10 years of Belle II operation. While individual components have been irradiated before, this campaign is the first full system irradiation. The performance of the DEPFET sensors and front-end electronics and efficiency studies of the module from beam tests performed before and after the irradiation will be presented.

T 82.6 Thu 17:45 L-2.004

Irradiation burst study of Belle II PXD module components — Florian Bernlochner[1], Jochen Dingfelder[1], Martin Hensel[3], Matthias Hoek[2], Florian Lüttticke[1], Botho Paschen[1], and •Jannes Schmitz[1] for the Belle II-Collaboration — [1]University of Bonn, Germany — [2]University of Mainz, Germany — [3]HLL of Max-Planck-Society Munich, Germany

The Belle II detector started recording physics collision data in spring 2019 with its full tracking detectors installed. During this years campaign, unexpected irradiation burst events were observed, which exposed the inner detectors and especially the PXD (PiXel Detector) to unwanted levels of prompt irradiation. A dedicated measurement campaign with spare PXD modules was carried out at the Mainz Microtron or brief MAMI, which aimed to reproduce the observed effects of irradiation burst events on the PXD in Belle II. To this end, a focused high intensity (800 nA) pencil beam of 855 MeV electrons was used to irradiate a full system demonstrator in several spatially confined fiducial regions. In this talk, the results of this campaigns will be presented and compared to the observed impact on the PXD modules installed inside Belle II.

T 82.7 Thu 18:00 L-2.004

Testbeam measurements with passive CMOS pixel sensors in 150 nm LFoundry technology bump-bonded to the RD53A readout chip — •Yannick Dieter, Michael Daas, Tomasz Hemperek, Fabian Hügging, Jens Janssen, Hans Krüger, David-Leon Pohl, Mark Standke, Marco Vogt, Tianyang Wang, Norbert Wermes, and Jochen Dingfelder — Physikalisches Institut der Universität Bonn

The Large Hadron Collider at CERN will be upgraded to the High-Luminosity-LHC and will deliver an instantaneous luminosity increased by a factor of 5 - 8 from 2026 on compared to now. In order to cope with the increased radiation level and hit rate, detectors with better radiation tolerance and higher data rate capabilities are demanded. Therefore, the ATLAS experiment develops an all-new pixel detector which will consist of 5 barrel layers and an increased surface of approximately 15m^2.

For the construction of such large scale detectors, commercial CMOS processes, which offer high yield and high throughput at comparatively low costs, are of interest not only for the readout chip but also for the sensor. In order to qualify the suitability of commercial CMOS pixel sensors for the ATLAS pixel detector upgrade, pixel sensors using a 150 nm CMOS technology offered by LFoundry have been designed and produced.

Measurements of the pixel sensor bump-bonded to the RD53A readout chip and test-beam results using a 2.5 GeV electron beam will be presented.

T 82.8 Thu 18:15 L-2.004

Teststrahl- and Laborergebnisse von ATLAS Sensoren mit modifizierten Pixelimplantationen — •Mareike Wagner, Andreas Gisen, Valerie Hohm, Kevin Kröninger, Jens Weingarten und Felix Wizemann — TU Dortmund, Experimentelle Physik IV

Während des ersten Long Shutdowns (LS1) des LHC am CERN wurde der Insertable B-Layer (IBL) in das bestehende ATLAS Experiment eingebaut um das Tracking zu verbessern. Er befindet sich zwischen der innersten Pixellage und einer neuen Strahlröhre. Aufgrund des geringen Abstands zum Interaktionspunkt, sind die planaren und 3D Sensoren des IBL einer hohen Strahlenbelastung ausgesetzt. Die planaren Pixelsensoren sollen einer Fluenz von $5 \cdot 10^{15}$ n$_{\mathrm{eq}}$/cm^2 standhalten. Die Pixel mit einer Größe von 250 μm $\times$ 50 μm sind in einer Matrix aus 80 Spalten und 336 Reihen angeordnet und werden mit dem FE-I4B Auslesechip ausgelesen.

Diese IBL-Sensoren sind die Basis für neue Implantationsformen, die in Dortmund entwickelt wurden. Sie sollen zu Maxima des elektrischen Feldes führen um so die Ladungssammlung zu verbessern. Es könnten höhere Detektionseffizienzen bei niedrigerer Spannung erreicht werden, was besonders bei bestrahlten Modulen erstrebenswert ist.

In dieser Präsentation werden Ergebnisse von bestrahlten Sensoren mit modfizierten Implantationen aus verschiedenen Teststrahlmessungen präsentiert. Außerdem werden Resultate nach verschiedenen Annealing-Schritten gezeigt und mit Messungen der Ladungssammlung, die mit Hilfe eines Lasers im Labor generiert wurden, verglichen.

T 82.9 Thu 18:30 L-2.004

Testbeam results of ATLASPix3 — H. Augustin[1], F. Ehrler[2], D.M. Immig[1], •D. Kim[1], L. Mandok[1], L.O.S. Noehte[1], I. Perić[2], M. Prathapan[2], T.T. Rudzki[1], R. Schimassek[1], A. Schöning[1], A. Weber[1,2], and H. Zhangh[2] — [1]Physikalisches Institut, Uni Heidelberg — [2]Karlruher Institut für Technologie

For the high luminosity upgrade at the Large Hadron Collider (HL-LHC) ATLAS will replace its tracking system with the Inner Tracker fully made of silicon detectors. The instantaneous luminosity, that increases by 5-7 times with respect to the current LHC value, causes challenges in terms of radiation tolerance and readout speed. An alternative to the hybrid detectors of the outer pixel modules are High-Voltage Monolithic Active Pixel Sensors (HV-MAPS).

HV-MAPS combines the fast charge collection via drift of the active pixel matrix with a fully integrated readout structure in one entity. ATLASPix3 is an HV-MAPS prototype based on HV-CMOS 180nm technology and was produced with a substrate resistivity of the wafer of 200 Ωcm. In ATLASPix3, an NMOS comparator is embedded in the pixels. The pixel matrix consists of 132 columns and 372 rows with a pixel size of the ATLASPix3 is a pixel size of 150 x 50 μm^2.

This talks presents first testbeam results of ATLASPix3, including the efficiency and time resolution, as measured with MuPix telescope.

T 83: Search for new particles IV

Time: Thursday 16:30–19:00 Location: L-2.017

T 83.1 Thu 16:30 L-2.017

Background estimate for a dijet resonance search with ATLAS at trigger level — •Falk Bartels — Kirchhoff-Institut für Physik, Heidelberg, Deutschland

Conventional LHC searches for dijet resonances are statistically limited in the sub-TeV range due to the reduced readout rate of lower p_T jet triggers. The ATLAS trigger-level analysis covers this part of the spectrum by recording a strongly reduced set of jet information processed by the High Level Trigger for all events passing the seeding Level-1 Trigger. This allows lowering the minimum measured dijet mass from ≈1 TeV to 450 GeV.

The total of 77 billion dijet events recorded in this way during Run-2 require a novel approach for determining the QCD background. A sliding window fit with an analytic function as performed to 2016 data can be used but reduces the sensitivity to wider resonances. An alternative background estimate based on truth-level theory predictions is presented.

T 83.2 Thu 16:45 L-2.017

Search for long-lived particles decaying in the CMS tracker detector — Lisa Benato, Melanie Eich, Gregor Kasieczka, Stuart Nicholls, •Karla Peña, Philipp Rincke, and Jörg Schindler — Institut für Experimentalphysik, Universität Hamburg

Higgs-portal models propose the existence of a dark sector, neutral under all Standard Model (SM) gauge groups. Interaction between the dark sector and the SM is mediated solely by the Higgs boson, which mixes with its dark partner. As a consequence of this, the Higgs boson is predicted to decay also in the dark sector. Scenarios are considered where the Higgs boson decays into a pair of dark long-lived particles (LLPs), each of which travels a macroscopic distance before decaying back to a pair of SM particles—predominantly b quarks.

Decays occurring within the CMS tracking system result on displaced-vertex signatures, which can be observed with almost no background from the SM. However, as conventional tracking and vertex finding algorithms are optimized for prompt decays, these signatures are challenging to find and advanced reconstruction techniques are required. Studies of machine-learning methods for displaced-vertex reconstruction will be discussed and compared to a benchmark analysis, where information from displaced tracks is used to tag jets resulting from LLP decays. The status of a search for LLPs is presented, using data collected by the CMS detector in pp collisions at $\sqrt{s} = 13$ GeV.

T 83.3 Thu 17:00 L-2.017

Search for a Z' with couplings to top quarks and muons in CMS — •Björn Tiedemann, Alexander Fröhlich, Paolo Gunnellini, Johannes Haller, Roman Kogler, and Arne Reimers — Institut für Experimentalphysik, Universität Hamburg

A search for a heavy gauge boson Z' coupling exclusively to muons and top quarks in proton-proton collisions at $\sqrt{s} = 13$TeV with the CMS experiment is presented. The search is performed assuming that the Z' is produced in association with a top quark pair and decays to two muons, resulting in $t\bar{t}\mu^+\mu^-$ finale state. Studies are presented to suppress background from standard model $t\bar{t}$ production. It is demonstrated how the sensitivity for this signal can be improved compared to inclusive searches in the dimuon mass spectrum.

T 83.4 Thu 17:15 L-2.017

Search for new particles in events with 4 top quarks at the ATLAS detector — •Alicia Wongel for the ATLAS-Collaboration — DESY, Hamburg

A novel search for anomalous production of four-top-quark events is presented. It offers a unique way to probe top-philic resonances (Z') which can only be produced in association with top quarks ($t\bar{t}Z' \to t\bar{t}t\bar{t}$) and thus cannot be accessed in current searches. Full Run 2 data is used in this analysis. It focuses on one-lepton events, that ensure a high signal acceptance while suppressing multijet process events. Furthermore, the particular configuration where the resonance decays fully hadronically is investigated. A potential signal would manifest itself as a bump over the steeply falling mass spectrum of the two hadronically decaying top quarks ($m_{t\bar{t}}$). In this talk, an overview of the analysis strategy is given, including the background estimation techniques and measures taken to improve the mass resolution of the reconstructed resonance.

T 83.5 Thu 17:30 L-2.017

A search for pair production of excited top quarks t^* — •Finn Labe, Paolo Gunnellini, Johannes Haller, Anastasia Karavdina, and Roman Kogler — Institut für Experimentalphysik, Universität Hamburg

A search for pair production of excited top quarks t^* in the decay channels $t^*t^* \to tgtg$ and $t^*t^* \to tgt\gamma$ is presented. The search is performed in the lepton + jets final state using data collected from proton-proton collisions at a center-of-mass energy of 13 TeV by the CMS experiment. Studies are shown using simulated signal events to examine the possibility of reconstructing the mass of the t^*. In addition, first results using data of the CMS detector will be shown. Events are classified by the presence of a reconstructed photon and the best signal hypothesis is chosen based on kinematic constraints from the top quark decays.

T 83.6 Thu 17:45 L-2.017

Search for displaced decays of massive particles in multijet events with the ATLAS detector — •Emily Thompson for the ATLAS-Collaboration — DESY, Hamburg, Germany

Massive, long lived particles (LLPs) are predicted to exist in several theories beyond the Standard Model. For example, models with small couplings, such as R-parity-violating supersymmetry, and models allowing for decays via highly virtual intermediate states, such as Split supersymmetry, can result in LLPs. With lifetimes ranging from picoseconds to nanoseconds, these LLPs could decay to several electrically charged particles in the inner tracking volume of the ATLAS detector, resulting in a displaced secondary vertex that can be reconstructed.

This presentation concerns a search for high-mass displaced vertices reconstructed in the ATLAS inner detector in multijet events with 136 fb^{-1} of data collected at $\sqrt{s} = 13$ TeV. There are no Standard Model particles that give rise to high-mass displaced vertices. Therefore, the backgrounds stem from various instrumental effects and their expected yields are estimated from data. In this talk, a novel method to estimate all sources of background inclusively is discussed.

T 83.7 Thu 18:00 L-2.017

Search for singly produced excited bottom quarks decaying to tW with the CMS experiment — •Alexander Fröhlich, Johannes Haller, and Roman Kogler — Institut für Experimentalphysik, Universität Hamburg

A search is presented for singly produced excited bottom quarks (b*) decaying to a top quark and a W boson in pp collisions at $\sqrt{s} = 13$ TeV using the full Run2 dataset corresponding to 137 fb^{-1} recorded with the CMS detector. The search is performed in the lepton + jets final state, where the top quark decays hadronically, and the W boson decays into a lepton and a neutrino.

The reconstruction and identification of the top quark is done with the Heavy Object Tagger with Variable R (HOTVR). Its stable performance over a large range in transverse momentum allows for a high signal sensitivity over a wide range of b* masses. Data driven methods are used to estimate standard model background contributions from misidentified objects.

T 83.8 Thu 18:15 L-2.017

A data-driven estimate of the ZZ background in the search for high mass Higgs bosons — •fang-ying tsai for the ATLAS-Collaboration — DESY

An additional Higgs boson is predicted by many models such as the two-Higgs-doublet model (2HDM). This talk will mainly focus on a data-driven method used to estimate the dominant ZZ background in the search for X → ZZ → $\ell^+\ \ell^-$+ MET. Currently, the ZZ → $\ell^+\ \ell^-$+ $\nu\nu$ background is estimated from simulated MC samples and it contributes the largest systematic uncertainties to the analysis. The idea of the Zγ methodology is to make use of the similarity of the ZZ and Zγ processes, especially in the regions where the mass difference between the Z and the photon does not matter. The ZZ/Zγ cross-section ratio is calculated in bins of the $\nu\nu$ pt and γ pt and applied to the Zγ events in data, together with a correction of the photon reconstruction effi-

ciency to mimic the production of the ZZ background. The presented studies use the full ATLAS Run 2 data sample (2015-2018) in proton-proton collisions at $\sqrt{s} = 13$ TeV centre-of-mass energy, corresponding to 139 fb^{-1}.

T 83.9 Thu 18:30 L-2.017

Search for high-mass resonances decaying to $\tau\nu$ in pp-colisions at $\sqrt{s}$ =13 TeV with the ATLAS detector — •Christos Vergis and Jochen Christian Dingfelder for the ATLAS-Collaboration — Physikalisches Institut, Bonn, Germany

Many models beyond the Standard Model predict the existence of new heavy charged gauge bosons (W'). In case of leptonic W' decays, the signature in the detector is a high-p_T lepton and large missing energy from the undetected neutrino. Although searches for $W' \to (e/\mu)\nu$ are more sensitive than $W' \to \tau\nu$ for universal coupling to leptons, decays to tau lepton are well suited for models in which the W' couples preferentially to the third-generation of fermions.

This talk will cover the search for heavy resonances decaying to a tau and a neutrino, in events where the tau lepton decays hadronically, using data collected during the 2015-2018 pp-collisions at $\sqrt{s}$ =13 TeV by the ATLAS detector at the LHC. Recent updates to the background estimation and analysis strategy will be discussed. Preliminary expected exclusion limits to the W' masses in the Sequential Standard Model (as benchmark model) and models with preferential couplings to the third generation of fermions will be shown. Following the increase in luminosity as well as upgrades in the tau reconstruction algorithms and analysis strategy, the reach of the search is significantly improved compared to the first ATLAS results.

T 83.10 Thu 18:45 L-2.017

Search fore heavy resonances decaying to VH in the H→WW→4q channel — Paolo Gunnellini, Johannes Haller, Roman Kogler, and •Andrea Malara — Institut für Experimentalphysik, Universität Hamburg

A search for new heavy particles decaying to a Higgs and a Z boson is presented. The analysis is performed on the dataset recorded by the CMS experiment in proton–proton collisions at a centre-of-mass energy of 13 TeV in the year 2016, which corresponds to an integrated luminosity of 35.9 fb^{-1}.

The final state resulting from the H→WW→4q and Z→ $\ell\ell$ is analysed. In order to maximise the sensitivity to a potential signal in highly-energetic processes with collimated final-state objects, deep neural network techniques as well as multiple jet algorithms are used to identify jets characterised by a 4-prong structure. Expected upper exclusion limits on the production cross section of the new resonance are derived.

T 84: Methods of astroparticle physics V

Time: Thursday 16:30–19:00 Location: L-3.001

T 84.1 Thu 16:30 L-3.001

A new end-to-end calibration of the Fluorescence Detector of the Pierre Auger Observatory — •Christoph Schäfer for the Pierre Auger-Collaboration — Institute for Nuclear Physics, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

One of the crucial parts of the Pierre-Auger-Observatory are fluorescence telescopes. In the past, the absolute calibration of these fluorescence telescopes was performed with a large-diameter light-source, which illuminated the whole aperture of the telescope at once, roughly once every three years, while a relative calibration was performed every night. In this contribution a new technique of an absolute end-to-end calibration of the fluorescence telescopes is presented. This new technique employs a calibrated portable Lambertian light-source which is scanned across the aperture of each telescope. The readout of the PMT camera at each position of the light source in front of the aperture provides an absolute calibration of the telescope. This talk will give a brief overview of the method and its status as well as preliminary results from the fluorescence telescope measurements.

T 84.2 Thu 16:45 L-3.001

Thermal drills for rapid deployment of in-ice instrumentation used for ARIANNA — •Simon Zierke, Dirk Heinen, Lars Steffen Weinstock, and Christopher Wiebusch — RWTH Aachen University, III. Physikalisches Institut

In recent years, access to subglacial regions has become increasingly interesting for terrestrial and extraterrestrial research as well as for large-scale astroparticle physics experiments. Most of the current ice-drilling technologies require a large infrastructure or close supervision. In order to enable a simple and rapid deployment of in-ice instrumentation, within the EnEx-RANGE project thermal drills with a diameter of 8 cm and a length of about 1 m were developed, that reached melting velocities up to 8 m/h. One of these thermal drills was used for the installation of dipole radio antennas for ARIANNA at the Ross Ice Shelf at depths of up to 40 m. For this application, the equipment could be handled by one person, and the drilling could be carried out with minimal remote monitoring. As a next step this drilling technology will be improved within the TRIPLE-IceCraft project, to build a larger melting probe for transporting scientific payloads to a depth of several hundred meters. This melting probe will be demonstrated on the Ekström Ice Shelf near Neumayer-Station-III during the 2021/2022 Antarctic season. We will present the melting probe design, its use for ARIANNA and an outlook on the TRIPLE-IceCraft project.

T 84.3 Thu 17:00 L-3.001

Radio reflections on clouds as a potential background for cosmic ray radio detection — •Carina Kanitz[1], Ilse Plaisier[1,2], and Anna Nelles[1,2] — [1]Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP, Erwin-Rommel-Str. 1, 91058 Erlangen — [2]DESY, Platanenallee 6, 15738, Zeuthen, Germany

The successful radio-triggered detection of cosmic air showers with measurements at the Owens Valley Radio Observatory Long Wavelength Array (OVRO-LWA) illustrates again the opportunities for cosmic ray detection with radio telescopes.

While several background sources such as airplanes, stationary sources close to the array like A/C units of the data processing shelter and nearby cities were identified, rejected by triggers, and removed from the data, a strong source of radio signals at an elevation angle of 15° could not be identified, as no known emitting objects lie in this direction. An incorrectly reconstructed arrival direction has been excluded.

We investigate the possibility of this signal being caused by radio signals from nearby towns reflected off clouds into the array. This is studied in radio propagation simulations and in a correlation search of measured radio signals with atmospheric data. We will report on first results.

T 84.4 Thu 17:15 L-3.001

Geometry calibration of the KM3NeT neutrino telescope using atmospheric muons — •Daniel Guderian and Alexander Kappes for the KM3NeT-Collaboration — Institut für Kernphysik, Wilhelm-Klemm-Straße 9, Münster

The KM3NeT neutrino telescope consists of a network of large volume Cherenkov detectors at the bottom of the Mediterranean Sea designed to search for neutrino interactions in the water. With its two sites ORCA (optimized for GeV energies) and ARCA (optimized for TeV-PeV energies) under construction, it will allow to determine the neutrino mass hierarchy and detect neutrinos from powerful astrophysical objects. With continuous deployment of sensors and the recent start of data analysis, detector calibration has become a critical task. This contribution reports on the status of a calibration method which uses reconstructed tracks of atmospheric muons to evaluate the detector geometry and timing. In particular, comparisons to time and position calibration methods using dedicated hardware devices will be shown and the added value of this alternative, purely data-driven approach will be discussed.

T 84.5 Thu 17:30 L-3.001

Performance analysis of new PMTs and light guide systems at the Fluorescence Detector of the Pierre Auger Observatory — •Urs Grosse-Rhode for the Pierre Auger-Collaboration — Bergische Universität Wuppertal, Gaußstraße 20, 42119 Wuppertal, Deutschland

The Fluorescence Telescopes at the Auger Observatory are used to detect the fluorescence light produced by extensive air showers. This is done through the use of photomultiplier tubes(PMTs) which are placed in the telescopes camera. The camera consists of 440 PMTs in the focus plane of a $12m*$ mirror. To study the performance of a new generation of PMTs, one camera has been partially equipped with two new PMT types and an new light guide system. The performance can be estimated with the standard and the new PMT types. The bulk of the analysis uses a reference calibration executed at the camera and laser shots which are fired with low inclination, passing by the camera building. Also the recently launched Aeolus satellite introduced a new opportunity, providing a loser shooting into the Auger Oberservatory from space. An overview of the used methods for the performance analysis as well as results from the analysis will also be presented.
* *Gefördert durch die BMBF Verbundforschung Astroteilchenphysik(Vorhaben 05A17PX1).*

T 84.6 Thu 17:45 L-3.001

The Acoustic Calibration Modules of the IceCube Upgrade — •Max Scharf, Dirk Heinen, Moritz Kellermann, Martin Rongen, Shefali Shefali, Lars Steffen Weinstock, Christopher Wiebusch, and Simon Zierke for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

The IceCube Upgrade will expand the current IceCube Neutrino Observatory with seven additional strings of instrumentation. These will include an acoustic calibration system. This calibration system consists of ten acoustic modules, which are distributed along the new strings and can receive and emit acoustic signals over distances of up to several hundred meters. Using acoustic trilateration these modules are able to determine their positions and improve the overall quality of positioning in IceCube. Furthermore, the system will allow for glaciological measurements and will be an important demonstration of acoustic geometry calibration for the future IceCube Gen2 detector. Within the EnEx-RANGE project autonomous melting probes with acoustic instrumentation for positioning have been developed and successfully demonstrated. Based on this experience, acoustic modules are currently being developed and planned to be ready for production by late 2020. This talk will present the current status of the hardware development and results from test measurements.

T 84.7 Thu 18:00 L-3.001

Entwicklung von Sensoren eines akustischen Kalibrierungssystems für das IceCube Upgrade — •Moritz Kellermann, Dirk Heinen, Martin Rongen, Max Scharf, Shefali Shefali, Lars Steffen Weinstock, Christopher Wiebusch und Simon Zierke für die IceCube-Kollaboration — III. Physikalisches Institut B, RWTH Aachen University

Das IceCube Upgrade wird das derzeitige IceCube Neutrino Observatorium um sieben Kabelstränge mit optischen Modulen und Kalibrierungsgeräten erweitern. Darunter befindet sich ein Kalibrierungssystem mit zehn Modulen, die akustische Signale über mehrere hundert Meter senden und empfangen können. Zusätzlich sollen in einigen optischen Modulen akustische Sensoren integriert werden. Mittels Trilateration akustischer Laufzeiten kann die Position der Module bestimmt und die Qualität bisheriger Positionsbestimmungen verbessert werden. Außerdem ermöglicht das System glaziologische Messungen und ist eine wichtige Demonstration für eine akustische Kalibrierung der Geometrie des zukünftigen IceCube-Gen2 Detektors. Der Vortrag präsentiert das aktuelle Design, sowie die elektronischen und mechanischen Eigenschaften der akustischen Sensoren.

T 84.8 Thu 18:15 L-3.001

The POCAM as self-calibrating light source for the IceCube Upgrade — •Felix Schmuckermaier, Felix Henningsen, and Christian Spannfellner — Technische Universität München, Germany

The IceCube Neutrino Observatory will be upgraded until the South Pole season of 2022/23. This IceCube Upgrade will consist of seven new instrumentation strings containing optical sensors and calibration devices. Besides extending the detector's science capabilities towards lower energies, the goal is to improve the knowledge of the Antarctic ice properties as well as the detector response. In order to achieve these calibration goals, the strings will be equipped with different calibration devices, including 21 Precision Optical Calibration Modules (POCAM). In this talk we present the motivation for the POCAM and its properties as a novel self-calibrating and isotropic light source, emitting light pulses of adjustable intensity and pulse width. The POCAM's primary goals are the improvement of South Pole ice systematic uncertainties down to a few percent as well as the study of detector instrumentation efficiencies and linearities. In the scope of the latter, it will further aim to verify the detector energy scale and its calibrations.

T 84.9 Thu 18:30 L-3.001

PeeEmTee: A python/numpy-based package for analyses of PMT characterisation measurements — •Jonas Reubelt, Tamás Gál, and Johannes Schumann — ECAP, Universität Erlangen-Nürnberg, Erwin-Rommel-Str. 1, 91058 Erlangen

Photomultiplier tubes (PMTs) are frequently used as high-sensitivity light sensors in modern physics detectors. Precision measurements employing PMTs require a detailed understanding of the sensors' behaviour in low light-level environments. The PeeEmTee package (https://github.com/JonasReubelt/PeeEmTee) provides functionalities fundamental for PMT characterisation under such conditions, like a routine for fitting PMT response functions to charge distributions. The physical modelling of PMTs that went into PeeEmTee, as well as the concept and base functionality of the package will be presented.

T 84.10 Thu 18:45 L-3.001

Development of a standard test and calibration procedure for the hardware of the Radio Neutrino Detector RNO-G — •Nora Feigl for the RNO-G-Collaboration — ECAP, Friedrich-Alexander-Universität Erlangen-Nürnberg

The Radio Neutrino Observatory in Greenland (RNO-G) will be able to detect the radio emission of neutrinos with energies above 100 PeV in the Greenland ice. RNO-G will not only observe as the first ultra-high-energy neutrino detector the Northern sky but also works as a pathfinder for the radio component of the next-generation neutrino detector IceCube-Gen2.

Starting summer 2020, 5 of the overall 35 stations of RNO-G will be installed. The hardware of these first stations is tested in spring 2020. On the basis of the experiences of these 5 stations, the second generation of hardware will be improved and IceCube-Gen2 will be designed with the knowledge and experience gained in the RNO-G project.

Reproducible and exact testing and calibration procedures are essential to evaluate the performance of the stations and make RNO-G a success. The same holds for a well-designed calibration database and suitable interfaces to store the calibration data.

In this talk the used methods and the current status of the hardware testing are presented.

T 85: Cosmic rays III

Time: Thursday 16:30–19:00 Location: L-3.002

T 85.1 Thu 16:30 L-3.002

Muon studies with IceTop data — •Donghwa Kang for the IceCube-Collaboration — Karlsruher Institut für Technologie (KIT)

IceTop is the surface component of the IceCube Neutrino Observatory at the geographical South Pole. It is designed to measure the air showers of cosmic ray with energies from PeV up to EeV. In general it is reasonable to assume that the muon signal becomes significant for a large distance from the shower axis, since they are overwhelmed by the signal from electromagnetic components at close to the shower axis. Considering the charge signal distribution, a parameter sensitive to the muon content was defined and estimated, which is the sum of the charge signals divided by the total number of tanks and the area of the tanks at a fixed distance from the shower axis. In this talk the estimated muon parameter based on the charge distribution will be presented. Its dependence of the high-energy hadronic interaction models will be discussed as well.

T 85.2 Thu 16:45 L-3.002

Insight into physical parameters of hadronic interactions — •Isabel Goos[1,2,3], Xavier Bertou[2,4], and Tanguy Pierog[3] for the Pierre Auger-Collaboration — [1]Universidad Nacional de San Martín, Buenos Aires, Argentina — [2]CONICET — [3]Institute for Nuclear Physics, Karlsruhe Institute of Technology, Karlsruhe, Germany — [4]CNEA

The Pierre Auger Observatory is a hybrid detector designed to detect extensive air showers initiated by cosmic rays with energies above 3×10^{17} eV. Monte Carlo simulations are used to study the relationship between properties of the primary cosmic ray and features of the resulting air shower which ultimately provides the observables accessible in the observatory. In these simulations an anti correlation between the number of muons N_μ and the depth X_{max} of maximum development of the air shower was observed. The main explanation is that the more energy is taken by neutral pions, the deeper the shower develops (higher X_{max}) and the less energy is left for charged pions which decay into muons (lower N_μ). However, this anti correlation presents a spread that is still to be understood. It is expected to give insight into physical parameters related to the hadronic interactions at very high energies. Searching for these parameters is particularly interesting since they are not accessible with current accelerator experiments. In this talk we present the current results on the search of the relationship between the X_{max}-N_μ anti correlation and some physical parameters describing aspects of hadronic interactions.

T 85.3 Thu 17:00 L-3.002

Muon deficit in air shower simulations estimated from AGASA muon measurements — •Flavia Gesualdi[1,2], Alberto Daniel Supanitsky[1], and Alberto Etchegoyen[1] — [1]Instituto de Tecnologías en Detección y Astropartículas (CNEA, CONICET, UNSAM), Centro Atómico Constituyentes, San Martín, Buenos Aires, Argentina — [2]Karlsruhe Institute of Technology, Institute for Nuclear Physics (IKP), Germany

Understanding the origin of ultra-high energy cosmic rays is still a challenge. The average composition as a function of primary energy is a key information to elucidate the origin of these very energetic particles. The most sensitive observables to the mass composition are the atmospheric depth of the shower maximum and the muon content of the showers. In this work, direct measurements of the muon density at 1000 m from the shower axis observed by the Akeno Giant Air Shower Array (AGASA) are analysed. The selected events have zenith angles $\theta \leq 36^\circ$ and energies in the range $18.83 \leq \log_{10}(E_R/\mathrm{eV}) \leq 19.46$. These are compared to the predictions corresponding to proton, iron, and mixed composition scenarios obtained by using the high-energy hadronic interaction models EPOS-LHC, Sibyll2.3c, and QGSJetII-04. A muon deficit in air shower simulations is observed: The muon density obtained from AGASA data is greater than the one obtained in the mixed composition scenario by a factor of $1.49\pm0.11\,(\mathrm{stat})\pm0.17\,(\mathrm{syst})$, $1.54\pm0.12\,(\mathrm{stat})\pm0.18\,(\mathrm{syst})$, and $1.66\pm0.13\,(\mathrm{stat})\pm0.20\,(\mathrm{syst})$ for EPOS-LHC, Sibyll2.3c, and QGSJetII-04, respectively.

T 85.4 Thu 17:15 L-3.002

Unfolding of the energy spectrum of stopping muons in IceCube — •Hubertus Kaiser and Jan Soedingrekso for the IceCube-Collaboration — TU Dortmund, Dortmund, Germany

The investigation of neutrinos and their origin is one of the main objectives of IceCube Neutrino Observatory. A classification of measured events into atmospheric muons and neutrinos is essential, as most events are of atmospheric nature and form the background in the search for extragalactic neutrino sources. Therefore an accurate selection of atmospheric muons and a precise determination of their energy spectrum provide the basis for further analysis. This talk gives insights into the selection of single stopping muons using machine learning algorithms and how their energy spectrum can be unfolded.

T 85.5 Thu 17:30 L-3.002

Leading HE Muon Measurements using Machine Learning Techniques — •Johannes Werthebach for the IceCube-Collaboration — TU Dortmund

The prompt component of the cosmic ray flux can be determined by analysing the energy spectrum of single atmospheric muons. A sufficiently pure sample of these muons can be obtained with the IceCube detector. Extracting such a sample is challenging, due to IceCubes geometric restrictions. Using machine learning techniques is one possible solution. This talk presents a machine learning based approach.

T 85.6 Thu 17:45 L-3.002

Analysis of photon-like airshowers measured by the Pierre Auger Observatory — •Jannis Pawlowsky for the Pierre Auger-Collaboration — Bergische Universität Wuppertal

The Pierre Auger Observatory is the largest experiment measuring ultra high energy cosmic rays. It is sensitive to the type of the primary particle because of their different shower development in the atmosphere. This yields the experiment the most sensitive detector for photons and neutrinos at energies above the EeV range.
For this search of photons, the full duty cycle of the Surface Detector is used. The detectors are sensitive to separate the electromagnetic and hadronic shower component by the lateral distribution of the station signals as well as shape of the signals. Based on this, observables are combined in a principal component analysis resulting in a photon-like parameter. In this, the distributions for hadrons and photons are well separated. Using a threshold corresponding to 50% photon detection efficiency photon candidates can be selected. Applied to the full dataset, candidates in the tail of the data-distribution have been found.
Testing a hadron hypothesis, protons with the event-geometry of the candidates have been simulated to study the effect of the shower-to-shower fluctuations. A small fraction of simulated hadronic showers is further studied for their specific properties that are responsible for the photon-like air shower development. First results for the characterization of the photon-like hadronic showers are presented.
*Gefördert durch die BMBF Verbundforschung Astroteilchenphysik (Vorhaben 05A17PX1)

T 85.7 Thu 18:00 L-3.002

Using the Leptonpropagator PROPOSAL for air shower and underground experiments — •Jan Soedingrekso and Mirco Hünnefeld — TU Dortmund

The lepton propagator PROPOSAL is a simulation library to efficiently propagate leptons and high energy photons through large volumes of media. To study the effect of systematic uncertainties of the cross-sections on the propagation, e.g. the muon energy or the secondary distribution, multiple cross-section parametrizations are implemented. PROPOSAL is mainly used and optimized for the muon propagation in the Cherenkov neutrino astronomy experiment IceCube, but is also used in radio neutrino astronomy simulations.

In this talk, the current status of the library and new opportunities for its usage in air shower and underground experiments are shown.

T 85.8 Thu 18:15 L-3.002

Recent developments in CORSIKA 8 — Tanguy Pierog[1], •Maximilian Reininghaus[1,2], Felix Riehn[3], and Ralf Ulrich[1] — [1]Karlsruher Institut für Technologie, Karlsruhe, Deutschland — [2]Instituto de Tecnologías en Detección y Astropartículas, Buenos Aires, Argentinien — [3]Laboratório de Instrumentação e Física Experimental de Partículas, Lissabon, Portugal

CORSIKA 8 is a next-generation framework for Monte Carlo simulations of air showers currently under development. In this contribution we present recent developments of the project, mainly concerning the propagation of the hadronic and muonic components of air showers. Furthermore we compare simulation results obtained from CORSIKA 8 to other codes, including CORSIKA 7, CONEX and MCEq.

T 85.9 Thu 18:30 L-3.002

Extension of the simulation library PROPOSAL to propagate electromagnetic shower components — •Jean-Marco Alameddine, Jan Soedingrekso, and Maximilian Sackel — TU Dortmund, Dortmund, Germany

PROPOSAL is a Monte Carlo simulation library, usable both in C++ and via a python wrapper, used to describe the propagation of highly energetic particles. These particles can, for example, be induced by atmospheric air showers or produced from interactions of astrophysical high-energy neutrinos with matter, observed with experiments such as the IceCube Neutrino Observatory. Previous versions of PROPOSAL focused on a precise description of muon and tau propagation. In a recent update, both photon propagation and a more precise description of electron and positron propagation were implemented as well. This allows PROPOSAL to be used as a propagator for electromagnetic shower particles, for example in the upcoming eight version of the extensive air shower simulation framework CORSIKA. In this talk, the recent update of PROPOSAL is presented with a focus on the physical description of the new processes as well as comparisons with alternative propagation models such as EGS.

T 85.10 Thu 18:45 L-3.002

PROPOSAL as a tool for the calculation of electromagnetic and muonic energy losses — •Maximilian Sackel, Jean-Marco Alameddine, and Jan Soedingrekso — Technische Universität Dortmund, Dortmund, Germany

For cosmic rays experiments, precise simulations of the various components of a particle shower are of high importance. Both the muonic and the electromagnetic component of an air shower can be propagated with the lepton propagator PROPOSAL. The initial concept was to calculate the energy losses of muons in large volume media with constant density. For the propagation of the muonic and electromagnetic shower components through inhomogeneous densities, modifications are needed that preserve the modularity to new interactions and parameterizations. Fast propagation is ensured by the use of interpolation tables, whereby the number of calculated tables is kept as small as possible by parameterizing the density distribution of the media. On the basis of the air shower simulation program CORSIKA a concept is shown how stochastic and continuous interaction points can be calculated with the library PROPOSAL for the use in a custom simulation.

T 86: DAQ, trigger and electronics IV

Time: Thursday 16:30–18:30 Location: L-3.015

T 86.1 Thu 16:30 L-3.015

Design of the Event Builder for the OSIRIS pre-detector of JUNO — •Runxuan Liu[1,2], Christoph Genster[1], Kai Loo[4], Livia Ludhova[1,2], Alexandre Göttel[1,2], Yu Xu[1,2], Yuhang Guo[1,3], Philipp Kampmann[1,2], Giulio Settanta[1], and Cornelius Vollbrecht[1,2] — [1]Institut für Kernphysik, Forschungszentrum Jülich, Jülich 52428, Germany — [2]III. Physikalisches Institut B, RWTH Aachen University — [3]School of Nuclear Science and Technology, Xi'an Jiaotong University, Xi'an 710049, China — [4]Johannes Gutenberg-University Mainz, Institute of Physics, 55128 Mainz, Germany

JUNO is a 20 kt liquid scintillator detector under construction in Jiangmen, China, whose goal will be to determine the neutrino mass hierarchy. In order to meet the stringent requirements on the radiopurity of the liquid scintillator, the OSIRIS pre-detector is being designed to monitor the liquid scintillator during the several months of filling the large volume of JUNO. OSIRIS will contain 20 ton of scintillator and will be equipped with 76 20-inch PMTs. The DAQ system will have no global hardware trigger: instead, each PMT will provide a data-stream composed of the waveforms, each containing a gps time stamp. Based on the latter, dedicated offline trigger software will organize individual waveforms into events. This talk will discuss the optimization of the event builder trigger conditions, considering the expected rates of different backgrounds and the PMTs dark rate and using the OSIRIS simulation software.

T 86.2 Thu 16:45 L-3.015

Development of a tester hardware tool for new read-out electronic cards of the ATLAS muon detector monitored drift tubes for the Phase-II upgrade — •Mathias Modlmayr, Gia Khoriauli, and Raimund Ströhmer — Julius-Maximilians-Universität Würzburg

The ATLAS detector is a experiment at the Large Hadron Collider (LHC) at CERN and collects data from particle collisions with energies in the multi-TeV range. The monitored drift tubes (MDT) are a part of the ATLAS muon spectrometer and are used to identify and measure muon tracks. The MDT are read-out with on-chamber mezzanine cards which are equipped with signal amplifier-shaper-discriminator and time to digital converter chips. For the High Luminosity LHC, this front-end electronics has to be replaced with the new mezzanine cards being developed. We develop a hardware tool to test the functionality of the new mezzanine cards. Hardware and software specifications as well as the status of the development of the tool is presented.

T 86.3 Thu 17:00 L-3.015

Logging and Monitoring Architecture for the High Level Trigger at the Belle II Experiment — •Anselm Baur[1], Markus Prim[1], Takuto Kunigo[2], Pablo Goldenzweig[1], and Florian Bernlochner[3] — [1]Karlsruhe Institute of Technology, Germany — [2]KEK, Tsukuba, Japan — [3]University of Bonn, Germany

The Belle II online software trigger — the so-called High Level Trigger (HLT) — is the second and last trigger stage applied to the detector data before it is written to permanent storage. Its purpose is to select events with interesting physics signatures to reduce the data rate from the Level-1 trigger from 30 kHz to 10 kHz. The HLT design foresees $\mathcal{O}(5000)$ CPU cores distributed to $\mathcal{O}(20)$ hardware nodes. The same Belle II analysis software framework (basf2) used for offline reconstruction is running on the HLT nodes for the online reconstruction.

This architecture has to be monitored to ensure smooth processing. Therefore, all the log outputs of the system and running subsystems are bundled in a central monitoring environment. Such a central monitoring system provides fast error recognition and enables a quick identification of problematic subsystems. Additionally, detecting issues which may lead to future errors and analysing error correlations is a power of such a monitoring approach. In this talk, we present a monitoring system with Elastic Stack for the HLT at the Belle II experiment.

T 86.4 Thu 17:15 L-3.015

Development of a radiation hard ASIC to be used for the monitoring of the ATLAS ITk Pixel detector — •Rizwan Ahmad[1], Susanne Kersten[1], Christian Zeitnitz[1], Peter Kind[1], Ahmed Qamesh[1], Michael Karagounis[2], Alexander Walsemann[2], and Tobias Fröse[2] — [1]University of Wuppertal, Wuppertal, Germany — [2]University of Applied Sciences and Arts, Dortmund, Germany

For the phase II upgrade of ATLAS, a new ITK pixel detector is under development. In this context, the ATLAS pixel detector will get a new DCS (Detector Control System) which is being developed at the University of Wuppertal. The control and monitoring path of the DCS system has two main entities. The DCS computer (Main Control room) and the MoPS (Monitoring of Pixel System) chip.

The MoPS chip monitors temperature and voltages of the different sub-detector parts. The chip communicates to the DCS computer over CAN (Controller Area Network) bus. This chip has a 12-bit ADC to read up to 35 channels and it implements a part of the CANopen standard. The MoPS must be radiation hard up to an ionizing dose of $>$ 500 Mrad and it must also provide great immunity against SEU (Single Event Upsets). This chip implements a non-standard CAN physical layer with a maximum voltage of 1.2 Volt. The first prototype of the chip implements core digital functionality and all the analog components required for the operation of the chip. In this talk functionality, simulation results and status of the chip will be presented.

T 86.5 Thu 17:30 L-3.015

Readout of the Tile Rear Extension Module for the Phase-I upgrade of the ATLAS L1Calo Trigger System — •Tigran Mkrtchyan — Kirchhoff-Institut für Physik, Heidelberg

For Run 3, the ATLAS Level-1 Calorimeter Trigger (L1Calo) system is being upgraded with new subsystems, called feature extractors (FEXes). While the Liquid Argon calorimeter will send fine-granularity digital data to the FEXes, the Tile Calorimeter (TileCal) will continue to send analogue signals to the existing L1Calo Preprocessor (PPr) subsystem. In order to provide the FEXes also with digital results from the TileCal, the L1Calo PPr is being extended with new Tile Rear Extension (TREX) modules. Equipped with advanced FPGAs and high speed optical transmitters, the TREX provides digitized hadronic transverse energy (E_T) results in real-time at the LHC clock frequency to the FEX processors via optical fibers running at 11.2 Gbps and to the legacy L1Calo processors via existing 11 m long electrical cables. Additionally, for verifying the accepted trigger decision, the TREX formats and transfers event data to the DAQ system. The event data transfer is performed via a single optical link running at 9.6 Gbps to the Front-End Link Exchange (FELIX) board. The interface to the legacy readout path to the DAQ is preserved via a single optical link running at 960 Mbps in G-Link transmission mode. In this talk, the status of production, commissioning, test results of the TREX to FELIX readout path and the data formatting analysis

will be presented.

T 86.6 Thu 17:45 L-3.015

The LHCb real-time analysis concept for a purely software-based trigger for Run III of the LHC — •André Günther[1], Stephanie Hansmann-Menzemer[1], Sascha Stahl[2], and Michel De Cian[3] — [1]Physikalisches Institut, Uni Heidelberg — [2]CERN — [3]École polytechnique fédérale de Lausanne

The LHCb experiment in the Run 3 environment of the LHC faces challenging rates of data containing particle decays of interest. In fact, expected signal rates alone are higher than current raw data storage capabilities. Therefore, LHCb is implementing a real-time data processing strategy and a reduced event model allowing triggering on fully reconstructed events and persisting an arbitrary set of reconstructed or raw objects. A crucial part of the real-time data analysis are fast and efficient tracking algorithms. The talk highlights ways to improve the so-called Forward Tracking, which is the algorithm reconstructing the majority of charged particle trajectories used in LHCb analyses.

T 86.7 Thu 18:00 L-3.015

Entwicklung von algorithmischer Firmware für den Ausbau des ATLAS Level-1 Jet/Energiesummen-Triggers — Volker Büscher, Christian Kahra, Ulrich Schäfer, Stefan Tapprogge und •Marcel Weirich für die ATLAS-Kollaboration — Johannes Gutenberg-Universität Mainz

In den kommenden Ausbaustufen des LHC werden immer höhere Luminositäten erreicht. Dadurch werden auch immer größere Herausforderungen an das Triggersystem des ATLAS Detektors gestellt. Zusätzlich zu den steigenden Ereignisraten werden die Daten aus den elektromagnetischen und hadronischen Kalorimetern mit erhöhter Granularität übertragen. Um dies für eine effiziente Selektion von Ereignissen zu nutzen, muss das existierende System ausgebaut werden. Bei einer Datenrate von 40 MHz muss in der ersten Triggerstufe eine Entscheidung innerhalb von 2.5 μs getroffen werden.

Der jet Feature EXtractor, kurz jFEX, bildet eine Neuerung für den Ausbau des ATLAS Level-1 Triggers. Ab 2021 wird jFEX in erster Linie für die Identifikation von Jet-Kandidaten und zur Berechnung von Energiesummen eingesetzt. Pro Modul ist eine Eingangsbreite von bis zu 2.7 Tb/s erforderlich, die sich auf 4 Xilinx UltraScale+ FPGAs verteilt. Für die dort laufenden Algorithmen stehen maximal 125 ns an Berechnungszeit zur Verfügung. Aus diesem Grund müssen diese eine hochparallele Struktur aufweisen.

In diesem Vortrag wird der aktuelle Stand der Algorithmen-Implementierung vorgestellt.

T 86.8 Thu 18:15 L-3.015

Development of Digital Signal Processing for the ATLAS Liquid-Argon Calorimeters with Artificial Neural Networks using Field Programmable Gate Arrays — •Nick Fritzsche, Anne-Sophie Berthold, Rainer Hentges, Philipp Horn, and Arno Straessner — Institut für Kern- und Teilchenphysik, Dresden, Germany

The upgrade plans for the Large Hadron Collider result in more challenging requirements for the data readout of the Liquid-Argon calorimeters of the ATLAS detector. The energy deposits of particles that are formed in high-energy proton-proton collisions create electrical pulses in the detector. These undergo a digital signal processing for selecting and preparing the signals in real-time for data acquisition and trigger. In signal processing artificial neural network algorithms can be used for fast, precise and resource-saving trigger decisions and energy reconstruction. A general implementation for feed-forward networks in FPGA hardware is introduced, which is freely configurable regarding neuron number and network depth. It is capable of processing parallel as well as time-lagged inputs. Applications as optimal filters, dense and time-lagged feed-forward neural networks are presented. A simulation and an implementation for FPGAs is considered optimizing the circuit with respect to resource usage and signal delay. An efficient use of digital signal processors is realized by time division multiplexing in order to use one network for multiple input channels. Results of test runs with a slow control, which allows memory-based data injection and readout under software control, are presented.

T 87: Gaseous detectors II

Time: Thursday 16:30–18:45 Location: L-3.016

T 87.1 Thu 16:30 L-3.016

Belle 2 Central Drift Chamber Wire Monitoring Software Developments — •Henrikas Svidras, Alexander Glazov, and Kerstin Tackmann for the Belle II-Collaboration — Deutsches Elektronen Synchrotron, 22607 Hamburg, Germany

Belle 2 is an experiment at the next-generation B factory SuperKEKB located at KEK in Tsukuba, Japan. It aims to probe heavy flavour physics at a higher precision than its predecessors, namely BaBar and Belle. The goal is to collect 50 ab^{-1} of data during its run: more than 50 times that of Belle. One of the main components used in triggering, tracking and charged particle identification is the Central Drift Chamber (CDC). Thorough understanding and monitoring of the conditions of this subdetector are crucial, as it is a key element in the whole detector performance. In this talk, a newly-developed CDC wire monitoring software tool will be presented. It is used to identify faulty wires and wire groups within the CDC for a given period of data takes. The information from reconstructed tracks is used to look for the closest wires that particles passed but had no hits recorded. Therefore, the wire monitoring tool is able to select the wires and wire sectors that continuously fail to produce hits that contribute to track reconstruction. This has been used to mark and monitor these wires for most recent data takes, with this information now available for tracking and to simulate the detector conditions.

T 87.2 Thu 16:45 L-3.016

Production and Characterisation of square-meter-sized Micromegas Quadruplets — •Maximilian Herrmann, Otmar Biebel, Bernhad Flierl, Ralf Hertenberger, Christoph Jagfeld, Felix Klitzner, Maximilian Rinnagel, Sebastian Trost, Chrysostomos Valderanis, and Fabian Vogel — Ludwig-Maximilians Universität München

The momentum reconstruction of muons in high energy physics experiments requires large, high-rate-capable precision tracking detectors. Resistive strip Micromegas are ideally suited for this application. The highly segmented anode enables hit position reconstruction within one plane of about 0.1 mm resolution. The resistive strips ensures a fast quenching of discharges in the 0.12 mm high amplification gap. Using multiple modules with four layers of Micromegas a large area can be covered.
In this talk the production progress of such modules will be presented. Focus will be placed on the steps to ensure high voltage stability in the amplification gap and on validation measurements. Imperfections and dust in the gap would lead to dark currents which could harm the active area. Therefore an elaborate production scheme was developed to keep these currents below 100 nA. Using the tracks of cosmic muons in a reference facility the quadruplets can be investigated in terms of efficiency homogeneity, reaching values of 97% over two square meter.

T 87.3 Thu 17:00 L-3.016

Noise related studies for large area Micromegas detectors — •Sebastian Trost, Otmar Biebel, Bernhad Flierl, Maximilian Herrmann, Ralf Hertenberger, Christoph Jagfeld, Felix Klitzner, Katrin Penski, Maximilian Rinnagel, Chrysostomos Valderanis, and Fabian Vogel — LMU München

As part of the New Small Wheel upgrade of the ATLAS detector at the LHC, high-rate-capable large-area Micromegas detectors are being constructed and investigated at LMU Munich. These four-layered Micromegas modules are designed for precision track reconstruction in the muon spectrometer. This talk presents the evaluation of cosmic muon tracking performance of the Micromegas detector under high fluxes of MeV neutron background at the MLL tandem accelerator at Garching. Moreover, the influence of small water vapor additions at the ppm level to the Ar:CO2 93:7 vol% detector gas are studied systematically for stability, pulse height and efficiency at the Cosmic Ray Facility in Garching.

T 87.4 Thu 17:15 L-3.016

Particle position reconstruction using a segmented GEM foil in combination with a Micromegas readout — •Christoph Jagfeld, Otmar Biebel, Bernhard Flierl, Maximilian Herrmann, Ralf Hertenberger, Felix Klitzner, Katrin Penski, Maximilian Rinnagel, Sebastian Trost, Chrysostomos Valderanis, and Fabian Vogel — LMU München

In Micromegas (Micro-MEsh GAseous Structures) detectors, a modern form of micro-pattern gaseous detectors, the signal is usually read out via readout strips on the anode. The signal created at the mesh is neglected for the particle position reconstruction. By replacing the mesh with a GEM (Gas Electron Multiplier) foil, which is segmented into 0.5 mm broad readout strips on its side facing the anode, the particle position can be determined on the "mesh" as well. If the strips on the GEM foil are orientated perpendicular to the anode strips, a particle position can be reconstructed in two spatial coordinates without adding a second layer of readout strips on the anode. This talk presents results from simulation studies to investigate the performance of this detector concept. First measurements with the new GEM foil will be presented.

T 87.5 Thu 17:30 L-3.016

Alignment reconstruction of Micromegas quadruplets — •Fabian Vogel, Otmar Biebel, Bernhard Flierl, Maximilian Herrmann, Ralf Hertenberger, Christoph Jagfeld, Felix Klitzner, Katrin Penski, Maximilian Rinnagel, Sebastian Trost, and Chrysostomos Valderanis — LMU Muenchen

For the upcoming New Small Wheel upgrade of the ATLAS detector Micromegas quadruplets will be implemented as muon tracking detectors. These gaseous detectors are optimized for the detection of minimum ionizing particles. They contain a metallic micromesh to divide the gas volume into a drift and an amplification region. The anode on the bottom of the detector contains parallel readout strips on a printed circuit board (PCB) for one dimensional readout. Each of the four detector layers is built from three individual PCBs glued side-by-side on either side of the readout panel. The alignment of a quadruplet made from two readout panels with four layers of PCBs for each individual layer, as well as the alignment of these layers with respect to each other is investigated. Studies of those quadruplets in the cosmic ray facility of the LMU are compared to optical precision inspections using dedicated markers on the PCBs. New measuring techniques have been developed and integrated in the series production of the modules. First results of the comparison will be presented.

T 87.6 Thu 17:45 L-3.016

The Effect of Gas Contaminations on Micromegas Detectors — •Thorben Swirski, Deb Sankar Bhattacharya, and Raimund Ströhmer — Universität Würzburg

The Würzburg cosmic ray facility is used to conduct research on the behavior of Micromegas detectors. A homogeneous mixture of Argon and CO2 can be prepared in desired ratios.

The behavior of the detector changes with any impurities in the gas. Of these impurities, water has been shown to be often present. In addition, oxygen can have a large effect due to its high electronegativity, while making up about 20.95% of the air, making entry in case of a leak possible. A systematic study on such changes of the detector behavior with a controlled infusion of impurities can give us an idea about the detector responses in large experiments like ATLAS, ALICE or ILC.

To be able to produce a gas containing only trace amounts of up to 1% each of oxygen and water, the cosmic ray facility had to be augmented with a new gas system. The system was built at the end of 2018.

Since then, the system has been used to perform measurements on the typical amount of contaminants in the detector gas and their sources, such as plastic tubing. In these measurements, the influence of different materials, and pipe geometries has been evaluated at several different tube lengths. The effect on the detector performance is also being investigated, including changes in gain, the number of primary electrons lost due to attachment, transparency and high voltage stability.

T 87.7 Thu 18:00 L-3.016

Prototype of a Boron-based neutron Time Projection Chamber — •Divya Pal[1], Klaus Desch[1], Jochen Kaminski[1], Markus Köhli[1,2], and Michael Lupberger[1] — [1]Physikalisches Institut, Universität Bonn — [2]Physikalisches Institut, Universität Heidelberg

Thermal neutrons have widespread applications ranging from tests of fundamental physics to neutron tomography, solid-state physics and medical physics. Therefore, the development of improved detectors for thermal neutrons is an important challenge.

Thermal neutrons are traditionally detected with Helium-3 filled proportional counters. Due to the supply shortage of He-3 leading to a rapid rise in its price, alternative detectors are sought. In Bonn, a prototype neutron detector BODELAIRE (Boron detector with light and ionization reconstruction) is being developed with the aim of providing high spatial and time resolution.

BODELAIRE works on the principle of a Time Projection Chamber (TPC) with a GridPix readout which will have Timepix3 as ASIC. The idea is to use Boron-10 as neutron converter, which is coated on the walls. One of the reaction products will yield a track in the gas volume, while the other reaction product will provide a trigger signal in a scintillator.

The current development status of the BODELAIRE detector will be presented.

T 87.8 Thu 18:15 L-3.016

Time Projection Chambers for the T2K Near Detector Upgrade — Philip Hamacher-Baumann, Thomas Radermacher, Stefan Roth, and •Nick Thamm — III. Physikalisches Institut B, RWTH Aachen University

The Tokai to Kamioka (T2K) long baseline neutrino oscillation experiment is entering the next phase (T2K-II) with increased beam power of up to 1.3 MW. To match the reduced statistical uncertainty an upgrade of the near detector (ND280) is planned to increase the detector acceptance and therefore reduce the systematic uncertainties. In the upstream part a 3D fine-grained scintillator target, a time-of-flight system and two time projection chambers (TPCs) will be installed. The new high angle TPCs (HAT) will cover the phase space of neutrino scattering with the final state lepton scattered at a large angle. Improved momentum resolution and particle identification will be achieved by using resistive bulk Micromegas technology. Installation is scheduled for the year 2021 with first data taking starting in 2022. In this talk first tests of a prototype HAT including gas monitoring chambers will be presented.

T 87.9 Thu 18:30 L-3.016

Building and testing a TPC for IAXO and developing reconstruction algorithms — Ivor Fleck, •Jan Joachim Hahn, and Ulrich Werthenbach — Universität Siegen

We present the detection and reconstruction of X-rays in a time projection chamber. A test chamber has been especially designed and build for this purpose for the upcoming Baby IAXO and IAXO experiment. The chamber operates with an Ar:CO_2 mixture at a ratio of 80:20. The readout is done using an InGrid chip. A first reconstruction algorithm has been developed to reconstruct the events and distinguish between photons and background. The used algorithm is a based on the Cambridge-Aachen algorithm with additional discriminators to further supress the background events. The tests are done using ^{55}Fe X-rays as a test signal.

T 88: Top quarks: associated production

Time: Thursday 16:30–19:00 Location: L-4.001

T 88.1 Thu 16:30 L-4.001

$t\bar{t}$+Z production in the Z → $b\bar{b}$ channel at the CMS experiment — Ulrich Husemann, Matthias Schröder, and •Jan van der Linden — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

The production of $t\bar{t}$+Z is a direct probe of the weak coupling of the Z boson to the top quark. Contributions of BSM interactions, changing the coupling of the Z boson to the top quarks, might be identified by studying this process. The $t\bar{t}$+Z process has already been successfully measured in final states with two or more charged leptons. In

these multi-lepton analyses also first effective field theory interpretations have been performed.

A measurement of the $t\bar{t}$+Z process in an additional phase space region targeting the $Z \to b\bar{b}$ decay is performed. This can improve the sensitivity to the coupling of the top quark to the Z boson.

The analysis also builds the ground work for a combined measurement of the $t\bar{t}$+Z and $t\bar{t}$+H processes in the $Z \to b\bar{b}$ and $H \to b\bar{b}$ final states for LHC Run-II data. This is especially interesting, as these two processes share similar kinematic features and production probabilities, and are therefore inherently hard to separate from each other. The analysis strategy devised explicitly aims at distinguishing the $t\bar{t}$+H and $t\bar{t}$+Z contributions in the analyzed region as much as possible.

In this talk an overview of the analysis strategy and methods for an enhanced $t\bar{t}$+H and $t\bar{t}$+Z separation is given.

T 88.2 Thu 16:45 L-4.001

Measurement of ttZ with hadronically decaying Z bosons — •Valerie Scheurer — DESY

In the Standard Model of particle physics the coupling of top quark and Z boson is an important quantity to probe for possible deviations that hint to new physics. This coupling can be measured in the associated production of top quark pairs with a Z boson. This process has been observed with leptonically decaying Z bosons. However in the region of high Z boson p_{T}, where the deviation is expected to be strongest, this measurement is not sensitive. In that region the measurement of ttZ with a hadronically decaying Z boson can provide additional sensitivity due to the large branching ratio of that process. However the background in that region is very high. Signal and background are separated using a dedicated deep neural network. The development and application of this technique is the topic of this talk.

T 88.3 Thu 17:00 L-4.001

Studies on the measurement of the $t\bar{t}Z$ production cross section in the dilepton channel — Otmar Biebel[1], •Florian Fischer[1], and Thomas McCarthy[2] — [1]Ludwig-Maximilians-Universität München — [2]Max-Planck-Institut für Physik, München

In the Standard Model of Particle Physics, the coupling of the Z boson to top quarks is precisely predicted via the weak interaction. As its value is experimentally not yet well constrained, several possible extensions of the Standard Model predicting modifications to this coupling could not be ruled out nor confirmed so far. Therefore a more accurate understanding of electroweak processes could significantly benefit from a precise measurement of this coupling at the LHC.

A process that is particularly sensitive to this coupling is the associated production of top-antitop quark pairs with a Z boson. Analyses targeting final states with three or four leptons offer the benefit of a very high signal purity. However, they suffer from low branching ratios. In contrast, the dileptonic channel currently being considered targets events in which the Z boson decays leptonically but the $t\bar{t}$ system decays to a fully hadronic final state.

Multivariate techniques are employed to improve the discrimination between signal events and the two dominant backgrounds: the production of top-antitop quark pairs, and the associated production of Z bosons with jets. For the studies presented in this talk, LHC Run 2 data collected by the ATLAS detector between 2015 and 2018 at a centre-of-mass energy of 13 TeV, as well as simulated data normalised to an integrated luminosity of 139 fb^{-1}, have been used.

T 88.4 Thu 17:15 L-4.001

Studies on the reconstruction of the Z boson for a measurement of the $t\bar{t}Z$ production cross section at ATLAS — Otmar Biebel, Florian Fischer, and •Maximilian Riepe for the ATLAS-Collaboration — Ludwig-Maximilians-Universität, München

In top quark physics, the production of top-antitop quark pairs in association with a Z boson is of great relevance since measuring this cross section provides direct sensitivity to the coupling between the top quark and the Z boson. The precise determination of this coupling allows testing many models of physics beyond the Standard Model which expect a significantly varied top-Z-coupling.

In this talk, studies on the improvements of the reconstruction of the Z boson will be presented, using LHC Run 2 data recorded by the ATLAS experiment in the years 2015 to 2018 at a centre-of-mass energy of 13 TeV and Monte Carlo simulations normalized to an integrated luminosity of 139 fb^{-1}. Special emphasis will be put on the suppression of combinatorial effects in decay channels with multiple leptons in the final state as this directly impacts the performance of the unfolding technique used in a differential cross section measurement.

T 88.5 Thu 17:30 L-4.001

Separation of Signal and Background in $t\bar{t}\gamma$ Processes using Deep Neural Networks in Single Lepton Final States at $\sqrt{s} = 13$ TeV in ATLAS — •Steffen Korn, Thomas Peiffer, Arnulf Quadt, Elizaveta Shabalina, and Knut Zoch — II. Physikalisches Institut, Georg-August-Universität Göttingen

Through the associated production of the $t\bar{t}\gamma$ process, the strength of the electromagnetic coupling of the top quark and the photon can be measured. The measurement of this fundamental parameter of the Standard Model (SM) also serves as a probe to new physics beyond the SM. First evidence for this process was found by CDF at the Tevatron at $\sqrt{s} = 1.96$ TeV. The process was later observed by ATLAS and CMS at $\sqrt{s} = 7$ and 8 TeV with increased precision. Due to the similar topology between signal and background processes and a signal to background ratio of approximately 1:1 in the single lepton channel, deep neural networks (DNN) are used to improve the separation of signal and background processes. The separation of $t\bar{t}\gamma$ signal processes from background processes in proton-proton collisions data, taken between 2015 and 2018 with the ATLAS detector, is presented. Signal and background processes are hereby grouped into multiple different classes using a deep multi-class neural network. The performance of different DNN architectures based on a one-vs-one and a one-vs-many training approach and their effect on the event selection and the sensitivity of the analysis is presented.

T 88.6 Thu 17:45 L-4.001

Measurement of top quark charge asymmetry in $t\bar{t}\gamma$ production in the ATLAS experiment — •Amartya Rej, Ivor Fleck, and Carmen Diez Pardos for the ATLAS-Collaboration — Universitaet Siegen, Germany

Top quarks pairs ($t\bar{t}$) produced via initial quarks at the LHC are emitted in slightly different directions depending on its charge, referred to as charge asymmetry (A_c). The asymmetry is due to QCD interference contributions at next-to-leading order accuracy and it is very sensitive to New Physics models. Such asymmetry was observed at the Tevatron experiment, where quark anti-quark ($q\bar{q}$) annihilation was the dominant mode of $t\bar{t}$ production. The asymmetry is diluted at the LHC owing to the very large fraction of gluon fusion initiated $t\bar{t}$ production. However, recently its evidence has been found by the ATLAS experiment.

In $t\bar{t}$ production in association with a photon ($t\bar{t}\gamma$), the fraction of top quark pairs produced via $q\bar{q}$ annihilation increases with respect to $t\bar{t}$ production and also leading order QED interference contributes to the charge asymmetry. Hence a larger value of charge asymmetry is expected to be found in this process with higher sensitivity to New Physics models. Still, this process has a tiny cross-section compared to $t\bar{t}$ production, one of the dominant background processes. Thus the background discrimination becomes more challenging. In this presentation, the ongoing effort for the charge asymmetry measurement in $t\bar{t}\gamma$ production in the ATLAS experiment will be presented highlighting the analysis methods and related challenges.

T 88.7 Thu 18:00 L-4.001

Constraining top-quark couplings combining top-quark and B decay observables — Stefan Bissmann, Johannes Erdmann, •Cornelius Grunwald, Gudrun Hiller, and Kevin Kröninger — TU Dortmund, Fakultät Physik, Deutschland

Over the last years the Standard Model Effective Field Theory (SMEFT) gained a lot of popularity in model-independent searches for physics beyond the Standard Model in the top-quark sector. Various efforts are being made to interpret measurements of top-quark production and decay observables in the context of SMEFT, aiming towards a global fit of dimension-six operators affecting the top quark. In this talk, a new approach is presented, combining measurements from top-quark and B physics observables to constrain the Wilson coefficients of dimension-six operators that modify the couplings of the top quark to the gauge bosons. Considering the $t\bar{t}\gamma$ cross section together with the $\bar{B} \to X_s\gamma$ branching fraction, the ingredients required for a consistent combination of observables from different energy scales are discussed and the benefits of this approach for the resulting constraints on the Wilson coefficients are demonstrated.

T 88.8 Thu 18:15 L-4.001

Effective Field Theory for $t\bar{t}\gamma$ at $\sqrt{s} = 13$ TeV

— •Binish Batool[1], Carmen Diez Pardos[2], and Ivor Fleck[3] for the ATLAS-Collaboration — [1]binish.batool@cern.ch — [2]carmen.diez.pardos@cern.ch — [3]fleck@hep.physik.uni-siegen.de

The cross section measurement for the production of top anti-top quark pair in association with a photon ($t\bar{t}\gamma$) probes the electroweak coupling of top quark and photon. The high energy and luminosity of LHC data could provide an opportunity to look for possible deviations from the standard model (SM). These deviations are interpreted by employing model dependent and model independent, such as Effective Field Theory, approaches. This talk is about the later one, where three, dimension-six operators, namely O_{tG}, O_{tB}, O_{tW} are investigated. The sensitivity of the total and differential $t\bar{t}\gamma$ cross sections towards these operators, is investigated and expected limits for the full run2 data at $\sqrt{s} = 13$ TeV, on the operators are given.

T 88.9 Thu 18:30 L-4.001

Search for $t\bar{t}t\bar{t}$ production in same-sign dilepton and multilepton final states at the LHC with the ATLAS detector using the full Run-2 dataset — •Ö. Oğul Öncel, Niklas W. Schwan, and Markus Cristinziani — Universität Bonn

Production of $t\bar{t}t\bar{t}$ in proton–proton collisions is a rare process predicted by the Standard Model with an expected cross section of around 0.01 pb. Many BSM theories, such as Top Compositeness and 2HDM, predict an enhancement of the $t\bar{t}t\bar{t}$ cross section. In addition, $t\bar{t}t\bar{t}$ can also be used to measure the top-quark Yukawa coupling, another important quantity for probing new physics.

A search for this process in the same-sign dilepton and multilepton channels using ATLAS data collected at the LHC during 2015–2018 with 139.4 fb^{-1} integrated luminosity and at a centre-of-mass energy of 13 TeV, is presented. The main challenges are the small cross section, irreducible background contaminations from $t\bar{t}Z$, $t\bar{t}W$, $t\bar{t}H$, as well as sizeable backgrounds due to charge mis-identification and photon conversion. Particular focus is given to the multi-variate techniques used in signal extraction, which has led to significant improvement in the signal sensitivity.

T 88.10 Thu 18:45 L-4.001

Signal extraction with ANNs for $t\bar{t}t\bar{t}$ production in the same–sign dilepton and multilepton channels at the LHC with the ATLAS detector — Ö. Oğul Öncel, •Niklas W. Schwan, and Markus Cristinziani — Universität Bonn

Artificial Neural Networks (ANNs) have become an increasingly popular multivariate method in particle physics. They are used in a wide range of applications such as vertex reconstruction, particle identification, calorimeter energy estimation and jet tagging.
In this talk, ANNs are considered for improving the signal extraction in the $t\bar{t}t\bar{t}$ analysis carried out by the ATLAS collaboration in the same-sign dilepton and multilepton channels; using the data collected during 2015–2018 with 139.4fb^{-1} integrated luminosity and at a centre-of-mass energy of 13 TeV. The $t\bar{t}t\bar{t}$ events are produced in proton–proton collisions at the LHC with a cross section of around 0.01pb. The dominant background processes are the irreducible contributions from $t\bar{t}Z$ and $t\bar{t}H$ production, as well as background stemming from charge misidentification and photon conversion.
The performance of the ANNs will be compared to the Boosted Decision Tree method currently being used in the analysis. Different kinds of architectures are considered such as Feedforward and Recurrent Neural Networks which can take advantage of the high jet and lepton multiplicities of the signal process. Studies on how the Neural Network distinguishes between $t\bar{t}t\bar{t}$ and background events will be presented.

T 89: General assembly - Particle Physics Division (for DPG members)

Time: Thursday 19:00–20:30 Location: H-HS I

General assembly - Mitgliederversammlung

T 90: Hauptvorträge (Invited Talks) IV

Time: Friday 9:00–10:30 Location: H-Aula

Invited Talk T 90.1 Fri 9:00 H-Aula

Probing the neutrino mass scale - first results of the KATRIN experiment — •Kathrin Valerius — Karlsruhe Institute of Technology, Institute for Nuclear Physics, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen

Precision measurements of the kinematics of weak decays offer a direct and nearly model-independent approach to probe the absolute neutrino mass scale. The KArlsruhe TRItium Neutrino experiment (KATRIN) is searching for the minute imprint of the neutrino mass in the endpoint region of the tritium beta-decay spectrum. KATRIN employs a high-intensity gaseous molecular tritium source and a high-resolution electrostatic filter with magnetic adiabatic collimation to target a neutrino-mass sensitivity of $0.2\,\text{eV/c}^2$, thus improving on previous experiments by an order of magnitude, after five years of data-taking.

This talk presents the results of the first science run of KATRIN in which an initial dataset of a few weeks allows to tighten the direct neutrino mass bound by about a factor of 2 already, yielding a new upper limit of $1.1\,\text{eV/c}^2$ (90% CL). The successful first campaign gives promising perspectives on the long-term data harvest to exploit KATRIN's neutrino mass sensitivity goal and to open up further interesting science channels in the search for physics beyond the Standard Model.

Invited Talk T 90.2 Fri 9:45 H-Aula

The European Strategy in Particle Physics — •Ursula Bassler — IN2P3 - CNRS, Paris, France

For the 3rd time, the European Strategy of Particle Physics is updated in 2020, after the strategies established in 2006 and 2013. The challenges are important as for the first-time projects at CERN for the period after the exploitation of the LHC are considered. The Strategy update has been launched in 2018, with the community input being collected and presented at an Open Symposium in Grenada in May 2019 and summarized in the Physics Briefing Book published in September 2019. In January 2020, delegates from all CERN member states and major European Laboratories come together for the drafting session of the strategy in Bad Honnef. The resulting document should be adopted by the CERN Council in May 2020 in Budapest.

The presentation will summarize the outcome of the Strategy and discuss the different options and propositions. Some emphasis will also be given to transvers considerations of the field such as, among others, Education and Public Engagement, Early Careers, Diversity, Sustainability and Technology Transfer.

T 91: Machine Learning: Event and jet reconstruction

Time: Friday 11:00–13:00 Location: H-HS I

T 91.1 Fri 11:00 H-HS I

Event reconstruction for ANTARES using Convolutional Neural Networks — •Nicole Geisselbrecht for the ANTARES-KM3NeT-Erlangen-Collaboration — FAU Erlangen-Nürnberg, ECAP

ANTARES is the largest undersea neutrino detector, installed in the Mediterranean Sea, and is primarily sensitive to neutrinos in the TeV-PeV energy range. Data taking with the telescope has been continous since 2008. One of the central goals of ANTARES, next to searches for neutrino signals from point, transient, and extended sources, is an independent detection and investigation of the diffuse cosmic neutrino flux discovered by IceCube. The suppression of backgrounds, in particular of atmospheric muons, is essential to further increase the sensitivity of the data analysis. The contribution reports on the design and application of deep Convolutional Neural Networks to ANTARES telescope data. Data preprocessing concepts, image generation, and first performance investigations of an event-topology classificator will be presented.

T 91.2 Fri 11:15 H-HS I

Adversarial Neural Network-based shape calibrations of observables for jet-tagging at CMS — Martin Erdmann[1], •Benjamin Fischer[1], Dennis Noll[1], Yannik Alexander Rath[1], Marcel Rieger[2], and David Josef Schmidt[1] — [1]III. Physikalisches Institut A, RWTH Aachen University — [2]CERN

Scale factors are commonly used in HEP to improve shape agreement between distributions of data and simulation. The choice of the underlying model for such corrections is of great importance, but often requires a lot of manual tuning e.g. of bin sizes or fitted functions. This can be alleviated through the use of neural networks and their inherent powerful data modeling capabilities.

We present a novel and generalized method for producing shape changing scale factors using adversarial neural networks. This method is investigated in the context of the bottom-quark jet-tagging algorithms within the CMS experiment. The scale factor of each jet is produced by the primary network using the jet's variables. The second network, the adversary, aims to differentiate between data and rescaled simulation events and facilitates the training of the former. An additional third network is used for normalization preservation with respect to correlated variables.

We present the conceptual design and resulting scale factors in comparison to the previously applied methods.

T 91.3 Fri 11:30 H-HS I

Study on the use of convolutional neural networks for strange-tagging based on jet images from calorimeters — •Nils J. Abicht, Johannes Erdmann, Olaf Nackenhorst, and Sonja Zeissner — TU Dortmund, Lehrstuhl für Experimentelle Physik IV

In addition to already existing algorithms for bottom- and charm-tagging, a technique that identifies jets originating from the hadronisation of strange quarks (strange-tagging) would be useful for various analyses at the LHC. This study focuses on making use of calorimeter information for this identification in the form of *jet images*, i.e. a representation of energy depositions in η and ϕ. Such jet images are built from simulations of jets from strange and down quarks. Convolutional neural networks (CNNs), which are especially geared towards extracting possible patterns in images, are used to learn the distinctive features of the strange and down jet images. During the optimization of the performance of the final CNN, different preprocessing steps as well as CNN layouts are explored in order to create a new method for strange-tagging.

T 91.4 Fri 11:45 H-HS I

Di-tau mass reconstruction in ATLAS using regression-based deep neural networks — •Lena Herrmann, Philip Bechtle, Klaus Desch, Michael Hübner, and Peter Wagner — Physical Institute, University Bonn, Germany

The di-tau decay channel of resonances is important and challenging at the same time. On the one hand, it is essential for the H-analysis, but on the other hand, the unmeasured neutrinos of the tau decays complicate the mass reconstruction. As a consequence, it is hard to distinguish H-events from Z-background.

Common techniques like collinear approximations [1] or the maximum likelihood method of the Missing Mass Calculator (MMC) [2] are applied in order to estimate the invisible components and thus the invariant mass of the resonance. Alternatively, regression-based deep neural networks can be trained for this specific task. By now, the accuracy of the MMC can be approached [3] but there are still important areas of studies. Hence, edge effects, the optimum usage of the true tau-mass in the training process or the effect of tau-spin-correlations on the learning results are investigated. In the following, the optimization of a regression-based deep neural network for the di-tau mass reconstruction in ATLAS regarding the mentioned aspects, will be presented.

[1] ATLAS Collaboration: G. Aad et al., arXiv:0901.0512v4 [hep-ex]
[2] A. Elagin et al., arXiv:1012.4686, Dec 2010
[3] M. Werres, Apr 2019, *Estimating the Mass of Di-Tau Systems in the ATLAS Experiment Using Neural Network Regression*

T 91.5 Fri 12:00 H-HS I

Primary Vertex Reconstruction with ML in ACTS — •Bastian Schlag — CERN / JGU Mainz

The reconstruction of particle trajectories and their associated vertices is an essential task in the event reconstruction of most high energy physics experiments. In order to maintain or even improve upon the current performance of tracking and vertexing algorithms under the upcoming challenges of increasing energies and ever increasing luminosities in the future, major software upgrades are required. Based on the well-tested ATLAS tracking and vertexing software, ACTS (A Common Tracking Software) provides a modern, experiment-independent set of track- and vertex reconstruction software, specifically designed for parallel execution. In addition to thread-safe reimplementations of classical primary vertexing algorithms, ACTS provides a solid code base for evaluating new approaches to primary vertex finding, such as applications of sophisticated deep learning methods. Associating tracks to the correct vertex candidate is a crucial step in vertexing and will become even more important in the high-pileup environments expected for HL-LHC or FCC-hh. Learning a track representation in an embedding space in such a way that tracks emerging from a common vertex are close together while tracks from neighboring vertices are further separated from one another allows for the determination of a similarity score between a pair of tracks. Constructing undirected, edge-weighted graphs from these results allows the subsequent usage of classical graph algorithms or graph neural networks for clustering tracks to vertex candidates.

T 91.6 Fri 12:15 H-HS I

Track finding algorithm for the BelleII detector — •Thomas Lück and Thomas Kuhr for the Belle II-Collaboration — Ludwig-Maximilians-Universität München, München, Germany

BelleII is a multi-purpose detector which will collect data produced at the asymmetric e+e- collider SuperKEKB located in Japan. The goal of BelleII is to test the standard model (SM) of particle physics with measurements of unprecedented high precision. Possible contributions from physics beyond the SM can manifest theirselves as significant discrepancies among the SM predictions and the actual measurements. While BelleII already took data with a partially completed detector in 2018, and started data taking with the full detector in 2019. It is foreseen to collect a data sample corresponding to 50 ab-1 by 2027. To achieve these physics goals it is required to have an efficient and precise track finding which has to cope with the higher background level at BelleII compared to its predecessors. The tracking devices of the BelleII detector consist of, from inner to outer, two layers of pixelated detectors, 4 layers of double sided strip detectors, and a drift chamber. In this contribution I will present the functionality and the performance of the BelleII track finding algorithms which reconstruct the tracks of charged particles in the tracking devices. These are direct input for the physics analyses.

T 91.7 Fri 12:30 H-HS I

Particle identification with the Belle II Calorimeter using Machine Learning — •Abtin Narimani Charan and Torben Ferber — Deutsches Elektronen-Synchrotron (DESY)

The Belle II experiment, located at the asymmetric SuperKEKB $e^+ e^-$

collider in Tsukuba, Japan, plans to perform studies of B-physics and searches for new physics at the luminosity frontier. The Belle II electromagnetic calorimeter is designed to measure the energy deposited by charged and neutral particles. The electromagnetic calorimeter also provides important contributions to the Belle II particle identification system. In particular for lower momentum muons and pions which do not reach the outer muon detector, the electromagnetic calorimeter can be critical for muon vs. pion separation. This is crucial for the study of semi-tauonic and semi-leptonic B decays.

This talk presents an application of a convolutional neural network in order to tackle this challenge. Such a network uses the granularity of the calorimeter crystals to provide 5×5 and 7×7 images of calorimeter clusters that contain information of the spatial location of the crystals' energy deposits from extrapolated tracks. The cluster images of muons and pions are distinguishable since pions undergo hadronic shower in addition to ionization, making the deposited energy more dispersed. In this talk, the performance of the network is investigated with MC samples of muons and pions selected from the Belle II simulation together with data samples which were collected in 2019. Moreover, comparisons will be presented benchmarking against independent approaches to calorimeter-based particle identification.

T 91.8 Fri 12:45 H-HS I

Muon bundle reconstruction with KM3NeT/ORCA using Deep Learning techniques — •Stefan Reck for the ANTARES-KM3NeT-Erlangen-Collaboration — Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP

KM3NeT/ORCA is a water-Cherenkov neutrino detector, currently under construction in the Mediterranean Sea at a sea depth of 2450 meters. The projects main goal is the determination of the neutrino mass hierarchy by measuring the energy- and zenith-angle-resolved oscillation probabilities of atmospheric neutrinos traversing the Earth.

Deep Learning techniques provide promising methods to analyse the signatures induced by the particles traversing the detector. Despite being in an early stage of construction, the data taken so far already provide large statistics to investigate the signatures from atmospheric muons. This talk will cover a deep-learning based approach using convolutional networks to reconstruct atmospheric muon bundles, and results on both simulations and data will be presented. Furthermore, the performances are compared to the ones of classical approaches, showing good agreement.

T 92: Neutrino physics without accelerators VIII

Time: Friday 11:00–12:45 Location: H-HS II

T 92.1 Fri 11:00 H-HS II

Status Update on AURORA — •Wilfried Depnering and Michael Wurm — Johannes Gutenberg-University, Institute of Physics, Staudingerweg 7, 55128 Mainz, Germany

The Jiangmen Underground Neutrino Observatory (JUNO) is a reactor antineutrino experiment which aims to determine the neutrino mass hierarchy with at least 3σ significance. In order to reach that goal, an energy resolution of 3% @ 1 MeV is required. Therefore, the transparency of the liquid scintillator (LSc) has to be sufficiently high (attenuation length $\geq$ 20 m @ 430 nm) and stable during the whole operation time.

One device for in-situ monitoring of the optical LSc quality is AURORA (**A U**nit for **R**esearching **O**n-line the LSc t**RA**nsparency) inside the central detector of JUNO. Tiltable, blue laser beams are used to measure the optical attenuation of the LSc allowing the detection of potential aging effects over time. This talk presents the current status of AURORA. The development is funded by the DFG Research Unit "JUNO".

T 92.2 Fri 11:15 H-HS II

Timing Calibration of the OSIRIS detector — David Blum, Marc Breisch, Jessica Eck, Tobias Heinz, Tobias Lachenmaier, Neha Lad, Axel Müller, •Tobias Sterr, and Alexander Tietzsch — Physikalisches Institut, Eberhard Karls Universität Tübingen

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20kt liquid scintillator (LS) detector currently under construction near Kaiping in southern China. For monitoring the very low background rate from radio impurities of the LS filling the OSIRIS (Online Scintillator Internal Radioactivity Investigation System) pre-detector is introduced. This talk will give an overview on the concept and prototyping of the timing calibration system of OSIRIS, which is based an a pico-second pulsed Laser.

T 92.3 Fri 11:30 H-HS II

Background reduction with the shifted analyzing plane configuration in KATRIN — •Alexey Lokhov — University of Muenster, 48149 Muenster, Germany — Institute for Nuclear Research RAS, 117312, Moscow, Russia

To measure the effective electron antineutrino mass mv with a sensitivity of 0.2 eV/c^2 the KATRIN experiment requires the level of background of about 10 mcps. One of the sources of the background electrons are the Rydberg atoms, created in the decay of Po-210, entering the spectrometer and ionized by thermal radiation. This yields low-energy electrons, almost uniformly distributed over the vessel volume.

We present here a technique to reduce this volume-dependent background of the KATRIN main spectrometer by using a specific configuration of the electromagnetic fields (so called shifted analyzing plane with a reduced fluxtube), that effectively decreases the volume of the fluxtube of electrons while preserving the energy resolution and allowing for the required neutrino mass sensitivity. The dedicated tests, which were performed recently, investigated the background reduction in this configuration and studied the EM fields at the shifted analyzing plane by calibration measurements using the Kr-83m conversion electrons and electron gun as reference sources.

T 92.4 Fri 11:45 H-HS II

Source activity monitoring in the KATRIN experiment — •Karol Debowski for the KATRIN-Collaboration — Bergische Universität Wuppertal, Deutschland

The absolute mass scale of neutrinos is one of the open questions in particle physics and cosmology. The KATRIN experiment is set up to measure this parameter with an unprecedented sensitivity of 0.2 eV.

To improve the currently existing mass limits by a factor of 10, all systematic effects in the experimental setup must be controlled. One of the characteristic properties is the activity of the electron source, which is demanded to be stable on the permille level within the time scale of a few hours. To keep track of changes to the total activity, multiple monitoring devices are installed in the KATRIN setup, such as the Forward Beam Monitor (FBM). Located in front of the spectrometers, the FBM measures the total flux of electrons emitted by the source, and thus can provide important information about changing source parameters. Additionally, it can be moved through the whole cross section of the beam tube and measure the flux tube profile.

The performance of the FBM during the first neutrino mass campaigns is presented as well as an outlook on future activities and investigations.

T 92.5 Fri 12:00 H-HS II

Background at the KATRIN experiment: Investigations of Radon and Rydberg induced events — •Alessandro Schwemmer for the KATRIN-Collaboration — Max-Planck-Institut für Physik

To achieve the design sensitivity of the **Ka**rlsruhe **Tri**tium **N**eutrino (KATRIN) Experiment of $m_\nu = 0.2\,\mathrm{eV\,c^{-2}}$ (90 % CL), a low background rate is essential. The residual background is dominated by two processes: Decays of radon emanated from the getter material and ionization of Rydberg states created by alpha decays in the spectrometer walls. To determine the individual fractions, Monte Carlo simulations are performed with the particle tracking software Kassiopeia (Furse et al. "Kassiopeia: A Modern, Extensible C++ Particle Tracking Package" (2016)) and compared to measurements. This contribution presents first results and gives an outlook on the possibility of discriminating between β-electrons and Rydberg-induced electrons.

T 92.6 Fri 12:15 H-HS II

Measurement of the Energy Loss Spectrum of 18.6 keV Electrons in Tritium at KATRIN — •Caroline Rodenbeck for the

KATRIN-Collaboration — Institut für Kernphysik, WWU Münster

The Karlsruhe Tritium Neutrino experiment (KATRIN) measures the beta decay spectrum of a windowless gaseous tritium source (WGTS) for a model independent investigation of the absolute neutrino mass scale with an estimated sensitivity of $0.2\,\mathrm{eV/c^2}$ (90% C.L.).

Beta decay electrons can scatter elastically and inelastically off tritium molecules inside the WGTS and lose energy in the process. A precise description of the the energy loss shape is provided by measurements with a pulsed photo-electron source, shooting mono-energetic electrons through the WGTS. By applying a time-of-flight cut a differential energy loss spectrum is obtained.

The energy loss and the resulting response function of the experiment are essential for neutrino mass analysis of the beta decay spectrum and are used in the analysis of the recent KATRIN neutrino mass runs. The talk will give an overview on the measurements and the analysis to obtain the energy loss function and an insight on how KATRIN's response function is constructed. This work is funded by BMBF under contract number 05A17PM3.

T 92.7 Fri 12:30 H-HS II

Development of novel Water based Liquid Scintillators for the THEIA Neutrino Experiment — Hans Theodor Josef Steiger[1], Lothar Oberauer[1], •Andreas Steiger[1], Matthias Raphael Stock[1], Daniele Guffanti[2], and Michael Wurm[2] — [1]Technische Universität München (TUM), Physik-Department, James-Franck-Straße 1, 85748 Garching bei München — [2]Institute of Physics and Excellence Cluster PRISMA, Johannes Gutenberg-Universität (JGU) Mainz, 55099 Mainz

New developments in liquid scintillators, high-efficiency, fast photon detectors, and chromatic photon sorting have opened up the possibility for building a large-scale (up to 100 kt) neutrino detector called THEIA that is planned to be able to discriminate between Cherenkov and scintillation signals. Currently Water-based Liquid Scintillator (WbLS) is a potential candidate for this type of detector. By introducing a small amount (typically 1%-10%) of organic liquid scintillator by the use of surfactants into water, the liquid yield can be adjusted to allow detection of particles below Cherenkov threshold while not sacrificing directional capability. Typically, such mixtures can be considered to be cheaper than organic scintillators and to be less hazardous for the environment. In this talk some new WbLS cocktails (developed at TUM and JGU) and the techniques for their production as well as selected properties of the mixtures are discussed. This work is supported by the Bundesministerium für Bildung und Forschung (BMBF) in the frame of the Verbundprojekt 05H2018, the Excellence Cluster PRISMA+ and the Maier-Leibnitz-Laboratorium (MLL).

T 93: Search for new particles V

Time: Friday 11:00–13:00 Location: H-HS IV

T 93.1 Fri 11:00 H-HS IV

Model Unspecific Search in CMS (MUSiC) - Overview — •Saranya Samik Ghosh, Thomas Hebbeker, Arnd Meyer, Tobias Pook, and Lorenzo Vigilante — III. Physikalisches Institut A, RWTH Aachen, 52074 Aachen, Germany

The Model Unspecific Search in CMS (MUSiC) is a long-term project aiming to search for new physics beyond the standard model (BSM) by searching for significant deviations from the standard model (SM) expectation in LHC data. Kinematic distributions of the data are compared with the SM expectation in hundreds of different final states using an automated procedure with a minimum of additional assumptions, and in particular without optimization for specific models beyond the SM. In this presentation, the general method and its current implementation will be discussed, pointing out limitations and applications beyond the original scope, as well as methods used for validation and benchmarking.

T 93.2 Fri 11:15 H-HS IV

Model Unspecific Search in CMS (MUSiC) - Results with 2016 Data — Saranya Samik Ghosh, Arnd Meyer, Tobias Pook, Thomas Hebbeker, and •Lorenzo Vigilante — III. Physikalisches Institut A, RWTH Aachen, 52074 Aachen, Germany

The CMS experiment has been collecting data during proton-proton collisions at a center of mass energy of 13 TeV during Run 2 of the LHC. This presents a unique opportunity to search for new physics phenomena beyond the Standard Model.

The majority of searches for new physics are optimized for an established signal hypothesis in one or few decay channels. These searches cover only a fraction of all observed final states with model dependent analysis strategies. The Model Unspecific Search in CMS (MUSiC) provides a unique procedure to search for new physics at CMS in several hundred final states that are not all covered by dedicated analyses.

This talk extends the previous introductory talk and presents the analysis based on the dataset collected during 2016 by the CMS detector corresponding to about $36fb^{-1}$ using an automated search for significant deviations from the Standard Model expectation. The observed distribution of deviations is compared to a Standard Model only expectation estimated from pseudo experiments. The overall agreement between the CMS data and simulations is evaluated and most significant deviations are studied.

T 93.3 Fri 11:30 H-HS IV

Search for Dark Matter in the Mono-H(bb) Channel — •Andrea Matic and Jeanette Lorenz — Ludwig-Maximilians-Universität München

Astrophysical and cosmological measurements indicate that about 27% of the energy density in the universe consist of Dark Matter (DM). However, the particle nature of DM is unknown. Promising candidates for DM are weakly interacting massive particles (WIMPs). Apart from the gravitational force, these hypothetical particles only interact weakly. WIMPs could be produced in proton-proton collisions at the Large Hadron Collider (LHC). As they would not interact with the detector material, such collision events can be characterized by high missing transverse momentum.

A search for DM with the ATLAS detector at a center-of-mass energy of 13 TeV will be presented. This search is sensitive to the pair production of DM particles in association with a Higgs boson, which decays further into two b-quarks. This decay can have two different signatures in the detector: For low momenta of the Higgs boson the b-quarks hadronize into two well separated jets, while for high momenta they are merged into a single jet.

In this talk the search strategy will be presented as well as the improvements which have been introduced in light of the analysis with the full Run II dataset.

T 93.4 Fri 11:45 H-HS IV

Searching for Dark Matter with the CMS experiment — •Dominic Stafford, Christian Schwanenberger, Alexander Grohsjean, Afiq Anuar, Nicole Stefanov, Samuel Baxter, and Jonas Rübenach — DESY, Hamburg, Germany

Astronomical observations provide strong evidence that a large proportion of the matter in the universe is "Dark Matter" not described in the Standard Model of particle physics. Furthermore, cosmological considerations suggest Dark Matter should couple to the SM on the TeV scale, and hence may be discoverable at the LHC. We present a search for Dark Matter coupling to top quarks via a (pseudo-)scalar mediator in top quark pair production in pp-scattering at 13 TeV. Dark Matter particles would show up as an excess of missing transverse energy. We review the results of a previous search in dilepton final states using 2016 CMS data, and present our current status of the full-Run-2 analysis involving new techniques, such as adding the single top production channel, improvements in Monte Carlo simulations and data-driven modeling of backgrounds, and improvements of machine learning techniques, which may improve sensitivity to these models.

T 93.5 Fri 12:00 H-HS IV

Suche nach Dunkler Materie in Assoziation mit einem hochenergetischen Top-Quark. — Ulrich Husemann, Matthias Schröder, •Michael Wassmer und Sebastian Wieland — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

In diesem Vortrag wird eine Suche nach Dunkler Materie in Assoziation mit einem hochenergetischen Top-Quark in Daten des CMS-

Experiments vorgestellt. Diese sogenannte Mono-Top-Signatur zeichnet sich durch hohe fehlende transversale Energie und den Top-Quark-Zerfall aus, welcher eine klare Signatur besitzt. Im hadronischen Kanal werden Fat-Jets, Jet-Substruktur-Techniken und multivariate Methoden zur Identifizierung von Top-Jets verwendet. Im leptonischen Kanal wird zur Unterscheidung zwischen Untergrund und Signal die transversale W-Boson-Masse genutzt. Die Messergebnisse werden in vereinfachten theoretischen Modellen interpretiert, welche einen zusätzlichen Mediator und ein zusätzliches Teilchen als Kandidat für Dunkle Materie enthalten.

T 93.6 Fri 12:15 H-HS IV

Search for a light CP-odd Higgs boson decaying into a pair of taus — •Tom Kresse, Wolfgang Mader, Max Märker, and Arno Straessner — IKTP, Dresden, Germany

Even though the predictions of the SM have often agreed with experimental observations to an incredible degree, there are still some phenomena it can not explain, for example the anomalous magnetic moment of the muon, which shows significant deviations between prediction and experiment. This deviation could be explained in the context of a 2 Higgs Doublet Model (2HDM), which predicts a second Higgs doublet with one CP-odd Higgs boson. Interesting parameters of the model are the mass of the CP-odd Higgs boson and the couplings to charged leptons and up type quarks.

In this talk, a search for a light CP-odd Higgs boson is presented through a cut based analysis. In the analysis the Higgs boson is produced via gluon fusion and then decays into a pair of two tau leptons, where both tau leptons decay leptonically, one into an electron, one into a muon. The analysed mass range of the CP-odd Higgs boson lies between 40 GeV and 90 GeV, which is a favored part of the parameter space to explain the deviation between SM prediction and experimental results of the magnetic moment of the muon. This promising new search is discussed based on Monte Carlo simulations, assuming 139 fb^{-1} of data collected by the ATLAS experiment at 13 TeV. A refined analysis will be presented and projections of the discovery significance will be given.

T 93.7 Fri 12:30 H-HS IV

Search for new physics ins the τ+MET final state with CMS — •Christoph Schuler, Kerstin Hoepfner, Thomas Hebbeker, and Swagata Mukherjee — III. Physikalisches Institut A, RWTH Aachen University

A search for new physics in the τ +missing transverse energy (MET) channel is presented based on proton-proton collisions measured with the CMS detector at the LHC, using the full Run-II CMS data set recorded at a center of mass energy of 13 TeV. The analysis strategy is discussed and the results are interpreted in the context of the Sequential Standard Model (SSM) which predicts a new heavy charged vector boson W'.

T 93.8 Fri 12:45 H-HS IV

Search for low mass dark photon in dimuon channel using scouting trigger in CMS — •Swagata Mukherjee and Thomas Hebbeker — III. Physikalisches Institut A, RWTH Aachen University

After several years of running of the LHC, new physics has not been found yet. Data scouting is an attempt to search in a rather difficult corner of phase space, which is the low mass region. This special data flow, based on event-size reduction rather than event filtering, will be discussed in this talk. Scouting data is useful to perform searches in regions where nominal triggers have reduced or zero sensitivity. A new search for dark-photons in the dimuon channel has been performed in CMS, which utilises dimuon scouting data for low mass. An intriguing possibility that the dark matter might interact via a new dark force, felt only feebly by standard model particles, has recently motivated a worldwide effort to search for dark forces. A particularly compelling dark-force scenario is that of a dark photon, which has very small couplings to standard model particles via kinetic mixing with the ordinary photon. This new search will be presented in this talk.

T 94: Supersymmetry: Searches

Time: Friday 11:00–13:00 Location: H-HS V

T 94.1 Fri 11:00 H-HS V

Search for the electroweak production of supersymmetric particles decaying to final states with a lepton with the ATLAS detector — •Lars Ferencz and Jeanette Lorenz — LMU,Munich,Germany

Profiting from the large *pp* data statistics available, collected by the ATLAS detector at the LHC during Run 2, some searches for the electroweak production of supersymmetric particles get accessible for the first time. This talk presents a search for chargino and neutralino pair production, where the chargino $\tilde{\chi}_1^{\pm}$ decays to a W boson and the lightest neutralino $\tilde{\chi}_1^0$ (lightest supersymmetric particle, LSP), and the neutralino $\tilde{\chi}_2^0$ to a Z boson and the LSP. The search presented focuses on signatures with an isolated electron or muon, which provides complementary sensitivity to searches in multilepton signatures. Depending on the boost of the W and Z boson emitted, advanced tagging techniques to identify these bosons can be used, leading to different search regions.

T 94.2 Fri 11:15 H-HS V

Search for supersymmetry in final states with opposite-sign same-flavor lepton pairs at the CMS experiment with data taken from 2016 to 2018 — Lutz Feld, Danilo Meuser, Johannes Schulz, and •Marius Teroerde — 1. Physikalisches Institut B, RWTH Aachen

Supersymmetry (SUSY) is an extension of the standard model (SM) of particle physics with the potential to solve open questions in physics like the unification of forces or the nature of dark matter by introducing superpartners to all SM particles. In the presented analysis, the production of opposite-charge same-flavor lepton pairs along with jets and stable, undetected SUSY particles is considered.

Events from top-pair production have a similar event topology and thus are an important background to the analysis. A likelihood variable based on the characteristics of top-pair production suppresses this background. Using the flavor-symmetry of the process, a data-driven background estimation is then employed.

The presented search is performed on data taken by the CMS detector at the Large Hadron Collider at $\sqrt{s} = 13\,\text{TeV}$ in the years 2016 to 2018.

T 94.3 Fri 11:30 H-HS V

Search for Supersymmetry in Multileptonic Final States with the ATLAS Detector — •Marian Rendel, Johannes Junggeburth, Zinonas Zinonos, and Hubert Kroha — Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), München

The search for supersymmetry (SUSY) is a major part of the ATLAS physics program. Due to the low Standard Model (SM) background, multileptonic finalstates provides excellent sensitivity to various supersymmetric scenarios. In this talk a search for events with at least four charged leptons is presented which uses LHC proton-proton collision data collected by the ATLAS detector during 2015 to 2018. The results are interpreted in terms of various supersymmetric models with R-parity conservation and R-parity violation.

T 94.4 Fri 11:45 H-HS V

Search for Higgsino production in SUSY scenarios with a compressed mass spectrum. — •Yuval Nissan[1], Sam Bein[1], Peter Schleper[1], and Gudrid Moortgat-Pick[2] — [1]Institut für Experimentalphysik, Universität Hamburg — [2]Institute of Theoretical Physics, Universität Hamburg

A search for leptonic decays of Higgsino-like neutralinos in the case of a compressed mass spectrum using a track, a reconstructed lepton and missing transverse momentum is presented. We consider the case of a second-lightest neutralino decaying into a dark matter candidate - lightest neutralino - and two leptons via an off-shell Z boson. In the case of a very small mass differences between the neutralinos, the leptons produced are very soft, making it very difficult to reconstruct them at CMS. We consider a case where one of the leptons is reconstructed by a track, and the other as a reconstructed lepton of opposite charge. Signals of different mass splitting are probed and interpreted within a set of simplified models. Multivariate discriminants are em-

ployed in the event- and object-level selection, and their performance is studied.

T 94.5 Fri 12:00 H-HS V

Searches for sleptons with semi-compressed mass spectra using the ATLAS detector at $\sqrt{s}$ = 13 TeV — •Jorge Sabater Iglesias for the ATLAS-Collaboration — DESY, Hamburg

Supersymmetry (SUSY) is a symmetry that introduces a relation between every Standard Model (SM) particle with a superpartner state whose spin differs by half a unit. This provides an elegant solution to, among others, the hierarchy problem, and it has a possible candidate for dark matter. In the Minimal Supersymmetric extension of the SM (MSSM), the bosonic superpartners of the fermions (sfermions) can be classified into scalar leptons (sleptons) and scalar quarks (squarks).
The talk will focus on specific scenarios for the mass spectra of the supersymmetric particles and cover an ongoing search for slepton pair production. These scenarios are of particular interest since they explain the dark matter abundance observed in the universe and the longstanding muon g-2 discrepancy between the measured value and theoretical prediction.
Sleptons are unstable and decay to a lepton and the lightest supersymmetric particle (LSP), resulting in a final state with two same flavour opposite sign (SFOS) leptons and missing transverse momenta coming from the undetected LSP. In this search we exploit the flavour asymmetry of the signal final state (100% same flavour leptons) in order to discriminate signal from background. Sensitivity to a yet unexplored region in the phase-space will be demonstrated.

T 94.6 Fri 12:15 H-HS V

Search for Compressed Higgsinos in events with two oppositely charged soft leptons at the CMS experiment — Samuel Bein, Viktor Kutzner, Yuval Nissan, Peter Schleper, •Alexandra Tews, and Moritz Wolf — Universität Hamburg, Deutschland

A variety of supersymmetric extensions of the Standard Model lead to light Higgsinos with compressed mass spectra.

In case of pair production of Higgsino-like electroweakinos, e.g. $\chi_1^{\pm}, \chi_2^0$, the decay of the second neutralino through an off-shell Z boson can lead to a pair of same-flavor opposite-sign leptons. These leptons can have very low momentum and semi-stable lifetimes if the mass spectrum of the SUSY particles is sufficiently compressed (nearly degenerate).

Searches for SUSY in events with two low-momentum opposite-sign leptons are particularly sensitive to such SUSY models. Scenarios with compressed Higgsinos with a mass splitting below 2 GeV with the CMS experiment are studied. We exploit new reconstruction and vertexing techniques for oppositely charged displaced lepton tracks with very low momenta of order of a few hundred MeV.

T 94.7 Fri 12:30 H-HS V

Search for chargino and neutralino production in final states with one lepton, a Higgs boson and missing transverse momentum with the ATLAS detector. — •Eric Schanet and Jeanette Lorenz — Ludwig-Maximilians-Universität München

Supersymmetry is a popular extension of the Standard Model of Particle Physics (SM), providing a solution to several open questions of the SM. If squarks and gluinos are beyond the reach of the LHC, the production of charginos and neutralinos could be the dominant production mode of supersymmetric particles in $\sqrt{s} = 13$ TeV pp collisions at the LHC.

A search for electroweak production of supersymmetric particles, using 139 fb^{-1} of pp collisions recorded by the ATLAS detector, is presented. In the signal scenario considered, a chargino $\tilde{\chi}_1^{\pm}$ is pair-produced together with a next-to-lightest neutralino $\tilde{\chi}_2^0$. The chargino decays via $\tilde{\chi}_1^{\pm} \to W^{\pm}\tilde{\chi}_1^0$ while the neutralino decays through $\tilde{\chi}_2^0 \to h\tilde{\chi}_1^0$. The final state of this signal scenario is thus in many cases characterised by the presence of two b-jets from the Higgs decay, missing transverse momentum and exactly one lepton from $W^{\pm} \to \ell^{\pm}\nu$, providing high discrimination against SM background.

In this talk, the analysis strategy is introduced. It exploits the different shapes of signal and background distributions in a two-dimensional shape fit, resulting in sensitivity to a broad range of kinematic regimes. Finally, the results of the search are presented and discussed.

T 94.8 Fri 12:45 H-HS V

Search for top squarks with one-lepton final states in $\sqrt{s}$ = 13 TeV pp collisions with the ATLAS detector — •Zulit Paola Arrubarrena Tame and Alexander Mann for the ATLAS-Collaboration — Ludwig-Maximilians-Universität München

Supersymmetry (SUSY) is an extension of the standard model of particle physics which predicts a supersymmetric partner for each particle in the standard model. If R-parity is conserved, then the lightest supersymmetric particle (LSP) is stable and a good dark matter candidate. In many models the LSP is favored to be the lightest neutralino ($\tilde{\chi}_1^0$), and the SUSY partner of the top quark, top squark ($\tilde{t}_1$), is usually assumed to be light and in the reach of the LHC. In this talk a search for top squark pair production in final states with one isolated lepton, jets, and missing transverse momentum using pp collision data recorded by the ATLAS detector over the full Run 2 of the LHC is presented.

The latest results of an analysis targeting a compressed region of the top-squark phase space are shown where the mass difference between the $\tilde{t}_1$ and $\tilde{\chi}_1^0$ is smaller than the W-boson. In this scenario the $\tilde{t}_1$ decays via a 4-body process into a b-quark, two soft fermions and a $\tilde{\chi}_1^0$. A strategy to discriminate the SUSY signal from the dominant top-quark and W+jets background processes is described.

T 95: Experimental methods V

Time: Friday 11:00–12:45 Location: H-HS VI

T 95.1 Fri 11:00 H-HS VI

Plasma lensing: A new idea for focussing Positrons at the source — •Niclas Hamann[1], Manuel Formela[2], Gudrid Moortgat-Pick[3], Klaus Floettmann[4], and Sabine Riemann[5] — [1]Universität Hamburg — [2]Universität Hamburg — [3]Universität Hamburg, DESY Hamburg — [4]DESY Hamburg — [5]DESY Zeuthen

The Capturing and matching of positrons at high-luminosity e+ - e- - Colliders is a challenge. Usually there are involved optic matching devices (OMD) in place. In this talk we want to discuss a promising new idea which could be more efficient and eventually also be more flexible, the Plasma Lense. Since the Plasma Lense uses a different component of the B-Field, the focussing effect is expected to be much higher as in the conventional OMDs. With the code Astra by Klaus Floettmann we simulate potential Plasma Lenses and optimise the expected matching parameters.

T 95.2 Fri 11:15 H-HS VI

Compton Scanner Messungen an Germaniumdetektoren — •Felix Hagemann für die GeDet-Kollaboration — Max-Planck-Institut für Physik, München, Deutschland

Der Einsatz von Germaniumdetektoren bei der Suche nach neutrinolosen Doppelbetazerfällen verlangt das bestmögliche Verständnis ihrer Eigenschaften. Seit Mitte 2019 betreibt die GeDet Gruppe am Max-Planck-Institut für Physik in München einen Compton Scanner zur Untersuchung von Germaniumdetektoren. Dieser vollständig automatisierte Aufbau kann zusätzlich zu den gemessenen Pulsformen Informationen über den Ort der Energiedeposition im Detektor liefern. In der ersten Messreihe wurde ein vierfach segmentierter n-Typ Broad Energy Germaniumdetektor mit einer kollimierten ^{137}Cs-Quelle und einem pixelierten CdZnTe Kristall als Comptonkamera untersucht. Die Rekonstruktionsmethoden werden veranschaulicht und die Ergebnisse werden mit Simulationen verglichen.

T 95.3 Fri 11:30 H-HS VI

A test-setup for an electron-tagger for the neutrino mass experiment KATRIN — •Kevin Gauda, Volker Hannen, Patrick Oelpmann, Hans-Werner Ortjohann, Richard Salomon, and Christian Weinheimer for the KATRIN-Collaboration — Institut für Kernphysik, WWU Münster

KATRIN aims to directly measure the mass of the electron antineutrino. There, a windowless gaseous tritium source and a high-resolution MAC-E filter is used to analyze the endpoint region of the

tritium beta-decay. The sensitivity on m_ν is targeted to reach 0.2 eV/c^2 with 90% C.L. after five years. Recently, a first limit was set to 1.1 eV/c^2 with 90% C.L. (M. Aker et al. (KATRIN Collaboration), Phys. Rev. Lett. 123 (2019) 221802).

The background in KATRIN is currently higher than originally planned, creating demand for new techniques of background reduction. An electron-tagger between pre- and main-spectrometer of KATRIN, which provides a trigger signal when a beta-decay electron passes, would allow to introduce delayed time-coincidence with the focal-plane detector signal and thereby to discard most background events. Developing such a device, which must not alter the electron energy much, is challenging and close to impossible and various low-temperature quantum detectors need to be tested. Such an electron-tagger could further enhance the sensitivity of KATRIN by applying time-of-flight spectroscopy (N. Steinbrink et al., New J. Phys. 15 (2013) 113020). This talk presents a first setup consisting of an electron-gun, a MAC-E-filter and a detector for testing such quantum devices.

T 95.4 Fri 11:45 H-HS VI

Reconstruction performance of low-p_{T} muons with the ATLAS experiment — •Johannes Junggeburth[1], Ferdinand Krieter[2], Davide Cieri[1], and Hubert Kroha[1] — [1]Max-Planck Institut für Physik München — [2]Ludwig-Maximilians-Universität München

The large LHC Run-2 dataset comprising 140 fb^{*1} marks the beginning of an era where precision measurements increasingly become limited by systematic uncertainties. This necessitates improved precision in the understanding of the detector performance in both collision data and simulation. The muon reconstruction efficiency is measured using a so-called tag&probe method exploiting the $Z \to \mu\mu$ and $J/\psi \to \mu\mu$ resonances where the latter is used for low-p_{T} muons. These muons have become more interesting in the recent time since they open the gate to extensions of the Standard Model predicting compressed spectra of new heavy particles, where only little energy is available for the lepton from the heavy particle decay. This talk presents the recent developments to identify low-p_{T} muons down to 3 GeV and to measure their reconstruction efficiency at a precision level of less than 1% with the ATLAS experiment.

T 95.5 Fri 12:00 H-HS VI

Scale factor measurement for the DeepTau tau lepton identification algorithm of CMS — •Maximilian Burkart, Günter Quast, and Roger Wolf — Karlsruhe Institute of Technology, Wolfgang-Gaede-Str. 1, 76131 Karlsruhe, Germany

Analyses of final states involving hadronically decaying tau leptons suffer from large backgrounds stemming from misidentified jets, electrons or muons. A new identification algorithm for hadronically decaying tau leptons exploiting deep learning techniques has been developed by the CMS Collaboration to suppress these backgrounds. This algorithm combines low and high-level variables to simultaneously distinguish hadronic tau lepton decays, quark or gluon jets, electrons and muons.

In the first part of the talk this newly developed identification algorithm will be shortly introduced. The second part of the talk covers the measurement of scale factors correcting for efficiency differences of the algorithm in data and simulation.

T 95.6 Fri 12:15 H-HS VI

Classifying tau lepton decay modes using Deep Neural Networks at the ATLAS Experiment — •Hoang Nguyen, Klaus Desch, Philip Bechtle, Christian Grefe, Peter Wagner, Michael Hübner, and Lara Schildgen — Physialisches Institut, Uni Bonn, Deutschland

The tau lepton as the heaviest lepton in the Standard Model and plays an important role in many studies regarding Higgs physics or physics beyond the Standard Model. Of its decay modes, about two third occur hadronically.

The decay products of the tau lepton are difficult to distinguish from each other and other particles originating from jet and gluon interaction. A better knowledge of this could improve background suppression, help with studies of CP eigenstates and, furthermore, reconstruction accuracy will get better as well.

Latest studies indicate that the use of the predictive power of deep neural networks (DNN) yields better results than current likelihood or BDT based methods. In this presentation, a recurrent neural network with the aim to improve classification of tau decays is presented. Results obtained via this way are compared to https://arxiv.org/pdf/1512.05955.pdf.

T 95.7 Fri 12:30 H-HS VI

Implementation of a new b-tagging algorithm for ATLAS — Vadim Kostyukhin[1], •Ö. Oğul Öncel[2], and Markus Cristinziani[2] — [1]Universität Bonn — [2]now at Sheffield University

Correctly identifying b-quark initiated jets (b-tagging) at large transverse momentum ($p_{\mathrm{T}} > 1$ TeV) will become increasingly important as ATLAS accumulates more data. Currently used b-tagging algorithms distinguish b-jets against light-jets. This approach is effective for low- and medium-p_{T} jets, but results in performance degradation at high p_{T}, where fragmentation dominates.

Instead of distinguishing two sets of tracks, the b-tagging performance can be improved by introducing explicitly the most important track categories and classifying tracks before the b-tagging step itself. A newly developed b-tagging algorithm in ATLAS uses classified tracks in a jet and based on this information creates a b-tagging score. Classification of tracks is accomplished through a multi-class multivariate discriminator that classifies tracks into one of the following three categories: heavy flavour, fragmentation or hadronic interactions and pile-up. It is found to be enhancing the b-tagging performance, particularly in the high-p_{T} regime, in comparison to currently used b-taggers. The implementation will be described and comparative performance studies will be presented.

T 96: Higgs: Decay into fermions III

Time: Friday 11:00–13:00 Location: H-HS X

T 96.1 Fri 11:00 H-HS X

Search for the Higgs boson decay to a pair of charm quarks at CMS — •Andrey Pozdnyakov[1], Xavier Coubez[1,2], Luca Mastrolorenzo[1], Spandan Mondal[1], Andrzej Novak[1], and Alexander Schmidt[1] — [1]RWTH, Aachen, Germany — [2]Brown University, Providence, USA

Coupling of the Higgs boson to top and bottom quarks has been firmly established. It is now time to determine its coupling to second generation fermions. In this talk the coupling of the Higgs boson to charm quarks is probed in a direct search for H -> cc decay, where H boson is produced in association with a W or Z boson. Key feature of the analysis is the ability to tag jets from Higgs boson decay as charm-quark jets and distinguish them from gluon or light-quark initiated jets. This is done using sophisticated jet tagging algorithms employing Deep Neural Network techniques.

T 96.2 Fri 11:15 H-HS X

modelling of the W+jets and $t\bar{t}$ backgrounds for the VH, H $\to$ bb analysis — •Simona Gargiulo, Stephen Jiggins, and Christian Weiser for the ATLAS-Collaboration — Albert-Ludwigs-Universitaet Freiburg

The measurement of the decay of the Higgs boson into a $b\bar{b}$ pair produced in association with a W or Z boson with the ATLAS detector is presented. The analysed dataset corresponds to an integrated luminosity of 139 fb^{-1} collected in proton-proton collisions in Run 2 of the Large Hadron Collider at a centre-of-mass energy of 13 TeV. Final states with 0, 1 and 2 charged leptons are considered targeting the decay channels $Z \to \bar{\nu}\nu$, $W \to l\nu$ and $Z \to l^+l^-$. The $t\bar{t}$ and the W+jets processes are two leading backgrounds and their uncertainties contribute significantly to the overall systematic uncertainty on the signal strength. The focus of this talk will be on the estimation of the systematic uncertainties on the theoretical prediction of these two backgrounds. In this contex, a new technique to derive the shape uncertainties based on an n-dimensional reweighting approach is explored. A Boosted Decision Tree (BDT) is trained to separate the nominal Monte Carlo prediction from the alternative one for both backgrounds. The parametrized ratio between the nominal and the alternative classifier responses is used to map the nominal prediction

to look like the alternative. The potential of this methodology lies in the ability to simultaneously map the two generators into each other in all n-dimensions of the analysis and examples of this will be presented.

T 96.3 Fri 11:30 H-HS X

Improved reconstruction methods for $H \to b\bar{b}/c\bar{c}$ at future e^+e^- colliders — •Yasser Radkhorrami[1,2] and Jenny List[1] — [1]DESY, Hamburg — [2]Hamburg University

The reconstruction of b- and c-jets is essential for the physics program of the future e^+e^- colliders. For instance, $H \to b\bar{b}$ is the most frequently occuring decay mode of the Higgs boson and measuring the $H \to c\bar{c}$ decay mode will be possible for the first time at an e^+e^- collider. The presence of semileptonic decays in b- and c-jets causes missing energy due to the undetectable neutrinos. A correction for the missing neutrino energy based on the presence of a lepton in a jet and the reconstructed decay vertex will be presented. In the case of the International Large Detector (ILD) proposed for the International Linear Collider (ILC), the Time Projection Chamber allows to identify kaons and protons by their specific energy loss. As a new component of the reconstruction, it has been studied to use the correct mass of kaons and protons in the track fit. This improves the impact parameter and p_T resolution considerably. The impact of these improvements on the vertex reconstruction, the neutrino correction, the jet energy resolution as well as the Higgs mass reconstruction will be investigated.

T 96.4 Fri 11:45 H-HS X

Search for Higgs-boson pair production in the $bb\ell\ell + \mathbf{MET}$ decay channel with the ATLAS detector — •Benjamin Rottler, Benoit Roland, and Markus Schumacher — Albert-Ludwigs-Universität Freiburg

The determination of the triple Higgs-boson self-coupling λ is one of the key goals of the physics program at current and future colliders. It will allow to reconstruct the Higgs potential. The self-coupling can be measured via non-resonant Higgs-boson pair production, which can happen at the LHC via the destructively interfering top-loop and Higgs self-interaction diagrams. Furthermore, this process is sensitive to new heavy particles.

The goal of this analysis is to measure the cross-section of the non-resonant Higgs-boson pair production σ_{HH} using the full Run-2 dataset collected by the ATLAS experiment corresponding to an integrated luminosity of $\sim$140 fb^{-1} at $\sqrt{s} = 13$ TeV. This is done via the $bb\ell\ell + \text{MET}$ final state, which combines the high branching ratio of the $H \to bb$ decay and the good trigger efficiency of lepton triggers. Our focus is on a combined search for the $HH \to bb(WW \to 2\ell 2\nu)$, $HH \to bb(\tau\tau \to 2\ell 4\nu)$, and $HH \to bb(ZZ \to 2\ell 2\nu)$ processes.

Modern machine learning (ML) technologies like multi-class deep neural networks will be used to separate background and signal processes. The ML classifier will be trained on top of a loose preselection. The statistical analysis will use the shape information provided by the output distribution of the ML classifier in order to extract the HH cross-section.

T 96.5 Fri 12:00 H-HS X

Simplified template cross section measurement of Higgs bosons produced in association with vector bosons decaying to b quark pairs. — •Aliya Nigamova — University of Hamburg, Hamburg, Germany

Since the discovery of the Higgs boson in 2012 the field of related studies has expanded extraordinarily, with the precision measurements of Higgs production modes gaining more attention. To increase the measurement sensitivity and reduce its dependence on theory the simplified template cross section (STXS) framework has been developed. The most prominent decay mode of Higgs boson, $H \to b\bar{b}$, was observed in 2018 when only part of the Run 2 data was available. Consequent STXS measurement of this channel using full Run 2 with the Higgs boson produced in the most sensitive mode, i.e. in association with vector bosons (VH), will provide an important input for further interpretation in terms of EFT SM operators. This report will focus on the STXS measurement of VH ($H \to b\bar{b}$) process, and the evaluation of related STXS theory uncertainties.

T 96.6 Fri 12:15 H-HS X

Search for additional Higgs bosons produced in association with b quarks and decaying into two b quarks — •Paul Asmuss — DESY Hamburg

A huge breakthrough in particle physics was achieved with the discovery of the Higgs boson in 2012, which was followed by precision measurements of its properties. So far, the discovered particle is found to be in good agreement with the predictions of the Standard Model, but there is still sizable room for theories with extended Higgs sectors, like Supersymmetry or general Two Higgs Doublet Models. Besides additional Higgs bosons, these models may also feature a significant enhancement of the Higgs boson coupling to b quarks. In this analysis, heavy neutral Higgs bosons are targeted which decay into two b quarks and are produced in association with one or two further b quarks, resulting in a fully hadronic final state and focused on masses between 250 GeV and 1.6 TeV. The search is performed with data collected in 2017 and 2018 with the CMS detector at the LHC at a center-of-mass energy of 13 TeV.

T 96.7 Fri 12:30 H-HS X

Development of a jet substructure based multivariate Higgs tagger and its calibration using $g \to b\bar{b}$ events with the ATLAS experiment. — •Shubham Bansal, Tatjana Lenz, and Norbert Wermes — Physikalisches Institut, Universität Bonn

Within the ATLAS collaboration, the most recent algorithm to separate *boosted* $H \to b\bar{b}$ from dominant backgrounds like multijets and jets originating from hadronically decaying top-quarks, employs a cut based approach using jet kinematics, b-tagging and jet substructure. Jet substructure variables in particular, gave an additional multijet background rejection over mass and b-tagging requirement, which are the most powerful variables, in some regions of phase space. This sensitivity from individual jet substructure variables can be seen as a motivation to combine many jet substructure variables in a multivariate discriminant to tag a *boosted* object like Higgs, in order to gain a larger improvement in the performance.

This talk presents a jet substructure based multivariate algorithm which is designed to separate 2-prong jets (two track-jets of $R = 0.2$ associated to a large-$R = 1.0$ jet, e.g. $H \to b\bar{b}$) from 1-prong jets (a single track-jet associated to a large-R jet, e.g. QCD jets). This multivariate Higgs tagger is optimised in multijet simulated events and the modelling of the tagger and its input variables is examined in 15.4 fb^{-1} of data collected in 2016 at $\sqrt{s} = 13$ TeV using $g \to b\bar{b}$ event selection in data. The calibration of the tagger is carried out in both $g \to b\bar{b}$ and $H \to b\bar{b}$ simulated events and a comparison between these two topologies is made.

T 96.8 Fri 12:45 H-HS X

Full Run 2 analysis of Higgs boson decay to b-quarks in CMS — •hessamoddin kaveh — DESY, Hamburg, Germany

After the discovery of the 125 GeV Higgs boson in July 2012, the data collected at the LHC during 2016 and 2017 has lead to the discovery of the Higgs decaying to b-quarks. The focus is now changed to precision measurements in this decay channel. The measurement of the Higgs boson properties in the vector boson associated production mode, with the Higgs boson decaying to a pair of b-quarks using the full pp collision dataset collected by the CMS experiment during Run 2 will be reported. The talk will focus on the statistical and systematic power of the analysis, improving essential analysis methods such as kinematic reconstruction and machine learning approaches, both for the inclusive and simplified template cross-section measurements.

T 97: Drell-Yan and jet production

Time: Friday 11:00–13:00 Location: H-HS XI

T 97.1 Fri 11:00 H-HS XI

Transverse momentum spectrum of Drell Yan pairs — •Heng Yang, Melanie Schmitz, and Hannes Jung — DESY CMS Group, Hamburg, Germany

We apply the Parton Branching method to calculate transverse momentum dependent (TMD) parton densities and fit the free paramters to HERA DIS measurements. These TMD densities are used to calcuate the Drell Yan transverse momentum spectrum for Z bosons at the LHC at next-to-leading order. We apply the same calcualtions to Drell Yan production at lower energies and low mass and estimate the contributin of primordial kt (intrinsic kt).

T 97.2 Fri 11:15 H-HS XI

Low mass Drell-Yan cross section measurement in p-p collision at $\sqrt{s} = 13$ TeV using the ATLAS detector at the LHC — •Alessandro Guida for the ATLAS-Collaboration — DESY, Hamburg, Germany

High energy physics experiments are performed at the Large Hadron Collider at CERN making collide bunches of protons at energies up to 13 TeV. The ATLAS experiment, with its multipurpose detector, studies the products of these collisions and compares the experimental measurements with the predictions of the Standard Model. An input for all the theoretical calculations is the structure of the proton, encoded in the so-called Parton Distribution Functions (PDFs). These can be deduced by experimental observations only. Inputs for the determination of the PDFs come from measurements of particular physical processes. This talk presents a new study of the process $Z/\gamma^* \to \mu\mu$ at low masses of the di-muon system, in the region between 7 GeV and 60 GeV. In particular, the differential cross sections $d\sigma/dm_{\mu\mu}$, $d^2\sigma/dm_{\mu\mu}\, d|y_{\mu\mu}|$ and $d^2\sigma/dm_{\mu\mu}\, dp_T^Z$ for that process are measured in 13 TeV proton-proton collisions at the LHC, using the ATLAS detector. The predictions in the kinematic region explored in the analysis are sensible to resummed theoretical results (predictions valid at each perturbative order, but only in some particular kinematics conditions). These results can be compared with the experimental measurements and later on included in the determination of PDFs.

T 97.3 Fri 11:30 H-HS XI

Measurement of the triple differential inclusive Z ($\to \mu\mu$) + jet cross section at $\sqrt{s} = 13$ TeV using 2016 and 2017 data from the CMS detector — Thomas Berger, Maximilian Horzela, Günter Quast, Klaus Rabbertz, and •Matthias Schnepf — Karlsruhe Institute of Technology

The proton structure, which is not perturbatively calculable, is a limiting uncertainty in many LHC analyses. Therefore, precise experimental measurements to determine the proton structure in the form of the parton distribution functions (PDFs) are primarily important.

The Z($\to \mu\mu$) boson production in association with Jets provides a combination of high event rates and clear signals. We give an overview of a triple differential inclusive Z($\to \mu\mu$)+jet cross section measurement at $\sqrt{s} = 13$ TeV with data taken by the CMS detector in 2016 and 2017. The cross section is measured as a function of the rapidity separation of the Z boson and the leading jet, the boost of their center-of-mass system, and the transverse momentum of the Z boson (p_T^Z). Furthermore, the measurement is alternatively performed with a variable determined from muon angular information instead of p_T^Z. The results are compared with next-to-next-to-leading order calculations.

T 97.4 Fri 11:45 H-HS XI

Triple-differential measurement of the dijet cross section at $\sqrt{s} = 13$ TeV with the CMS detector — Günter Quast, Klaus Rabbertz, and •Daniel Savoiu — Karlsruher Institut für Technologie (KIT)

Jet cross sections are of particular interest for precision studies at proton colliders such as the LHC. They are sensitive to the proton structure and can be used to derive tighter constraints on the parton distribution functions (PDFs) of the proton. Moreover, jet production is among the processes with the highest cross section. As a result, event rates are high enough to enable differential measurements as a function of multiple observables with sufficient statistical precision.

The analysis presented here concerns a triple-differential measurement of the dijet production cross section from data collected by the CMS experiment during Run 2 of the LHC at a center-of-mass energy of 13 TeV. The cross section is measured as a function of the dijet rapidity difference y^*, the total boost of the dijet system y_b, and the average transverse momentum of the jets. An alternative measurement is performed using the dijet invariant mass as the third variable.

T 97.5 Fri 12:00 H-HS XI

Measurement of the angular coefficients in Z-boson production at $\sqrt{s} = 13$ TeV with the ATLAS experiment — •Matthias Kohl and Stefan Tapprogge — Institut für Physik, Johannes-Gutenberg-Universität, Mainz

Angular distributions of the Drell-Yan process can probe the underlying QCD dynamics of Z-boson production and can improve predictions for future analyses at hadron colliders. The related angular coefficients can be measured using final states of charged lepton pairs in the Collins-Soper frame, differentially in the transverse momentum, mass and rapidity of the dilepton system.

A previous measurement by ATLAS of the full set of eight angular coefficients $A_0 - A_7$ was performed at $\sqrt{s} = 8$ TeV. In this talk the current status of the analysis of di-electron and di-muon events at a center-of-mass energy of $\sqrt{s} = 13$ TeV is presented. The data used for the analysis corresponds to 147 fb^{-1} of pp-collisions at the LHC recorded by the ATLAS experiment. The analysis strategy as well as challenges, the understanding of the data and expected uncertainties are discussed.

T 97.6 Fri 12:15 H-HS XI

Cross section ratios of Z+jet over dijet production — Thomas Berger[1], Günter Quast[1], Klaus Rabbertz[1], Daniel Savoiu[1], •Bettina Schillinger[1,2], and Mikko Voutilainen[2] — [1]Karlsruhe Institute of Technology — [2]Helsinki Institute of Physics

In this analysis we investigate a ratio of cross sections, which promises to profit from reduced uncertainties.
As the first cross section we choose the inclusive dijet cross section, because the abundant production of jets at the Large Hadron Collider offers the opportunity to investigate this observable in a wide kinematic range. As the second observable we consider the Z+jet cross section. The production of Z bosons in association with jets provides a clear signal, especially due to the fact that the decay of the Z boson into two muons can be measured precisely with the CMS detector.
Since the partonic production channels differ between dijet and Z+jet production, interesting insights might be obtained when comparing these processes.
The presented measurement is carried out triple-differentially in phase space and it is based on data collected with the CMS detector in 2018.

T 97.7 Fri 12:30 H-HS XI

Jet Mass Calibration — •Steffen Albrecht, Andreas Hinzmann, Roman Kogler, and Dennis Schwarz — Universität Hamburg

In this talk, a technique for calibrating the mass of (fat) jets will be presented. In the analysis of hadronic final states, the resolution and the scale of the jet mass can be an important source for the systematic uncertainties. Therefore an improvement of its measurement will benefit many of these analyses.

Using scales of jet constituents of different categories (e.g. charged hadronic, neutral hadronic) as nuisance parameters in a template fit of the jet mass in several regions to data, one can learn about their influence on the jet mass shape and normalisation.

The presented analysis considers processes with W+jets in the final state, where the boson has a large transverse momentum (high Lorentz boost) and thus produces strongly collimated decay products, which are reconstructed as a single fat jet.

T 97.8 Fri 12:45 H-HS XI

Jet substructure modeling in dijet and Z+jet events — •Julian Zeyn, Robin Aggleton, and Andreas Hinzmann — University of Hamburg

Searches for boosted W-, Z-, H- or top-jets make use of jet substructure observables to reduce the background composed of quark and gluon jets. In particular, gluon jets dominate the QCD multijet background. Therefore, precise background modeling is necessary to gain

sensitivity for such searches.

We use gluon enriched dijet and quark enriched Z+jet samples to measure substructure observables. We then study the modeling of quark and gluon jets in Monte Carlo generators with the goal of finding a tune that well describes the jet substructure of quark and gluon jets while not breaking the modeling of existing measurements.

T 98: Topics in flavor physics

Time: Friday 11:00–13:00 Location: H-HS XII

T 98.1 Fri 11:00 H-HS XII

First Results and Prospects for τ lepton Physics at Belle II — •Thomas Kraetzschmar for the Belle II-Collaboration — Max-Planck-Insitut für Physik (Werner-Heisenberg-Insitut), München, Deutschland

The Belle II experiment at SuperKEKB, an asymmetric e+e- collider, has a rich program of Standard Model and Beyond the Standard Model physics. The collider, a next generation B factory, started operation in 2016 and successfully commissioned with first collisions in April 2018. In 2019 a first physics run with the full Belle II detector has taken place. Ultimatly SuperKEKB will reach a world-record luminosity of 8e35 cm-2 s-1 and aims to record a database of 50 ab-1. In the area of tau physics, this will enable new and/or more precise measurement of Standard Model processes as well as Beyond the Standard Model searches. Because of its well understood electroweak production and decay mechanisms and its high mass of above 1.7 GeV the tau lepton is an excellent probe for physics beyond the standard model, and provides clean samples for studying QCD at the 1 GeV energy level. This contribution will give a compact overview over the tau physics programme at Belle II, with a particular emphasis on first results and decay modes with significant potential in the near future.

T 98.2 Fri 11:15 H-HS XII

Study of tau decay to three charged pions and a neutrino at Belle — •Andrei Rabusov, Daniel Greenwald, and Stephan Paul — Technical University of Munich, Munich, Germany

The COMPASS experiment saw a potential new particle, the a1(1420), that does not fit the quark model. They observed it via its production in pion-proton scattering and subsequent decay to three pions. At Belle, we investigate if this particle appears in tau decays to three pions and a neutrino, using partial wave analysis (PWA). For this technique, it is necessary to know the tau direction. We present data selection criteria for obtaining a clean sample of such tau decays in which knowledge of the tau direction is obtainable upto a two-fold ambiguity.

T 98.3 Fri 11:30 H-HS XII

Measurement of (anti)deuteron production at Belle II — Elio Monaco and •Nathalie Eberlein for the Belle II-Collaboration — LMU München

One of the biggest hurdles in our modern understanding of cosmology comes from dark matter. Indirect searches for dark matter in astrophysical sources rely mainly on the detection of cosmic (anti)deuterons. Production mechanisms for (anti)deuterons are mostly modelled using the coalescence model, which is poorly understood.

Our work aims to measure (anti)deuteron production in e^+e^- collisions and compare its value to theoretical models, as well as the efficiency of particle identification variables, at the Belle II experiment. First, the performance of particle identification variables is investigated with untagged $\Lambda \to p\pi$ for different detector components.

Then, cross-section measurements of inclusive $e^-e^+ \to d(\bar{d}) + X$ processes are performed at the center of mass energy of 10.58 GeV, for both Monte Carlo generated events and real data.

T 98.4 Fri 11:45 H-HS XII

Global analysis of $e^+e^- \to c\bar{c}$ in a K-matrix formalism — •Stephan Kürten — Tu München

A precise description of the spectrum of vector charmonia close to the open charm threshold is of phenomenological relevance to several open questions relating to the physics of heavy mesons. Examples include the search for exotic states, CP-violation in purely hadronic meson decays, and the prediction of $b \to s\mu^+\mu^-$ decays with high-mass dimuons.

At the moment the best determination of the spectral parameters is based on an inclusive measurement by the BES collaboration. Here, I show how to extend the current analysis within the framework of the K-Matrix formalism through a simultaneous description of all the exclusive open charm final states. I will also discuss the effects of two particle thresholds, and the intrinsic probability conservation of the S-Matrix. I will present the results of a fit to all available data for $e^+e^- \to$ open charm, and I will discuss further phenomenological applications of my results.

T 98.5 Fri 12:00 H-HS XII

Measurement of time-dependent Charge-Parity asymmetries in neutral charm meson decays — •Daniel Unverzagt[1], Dominik Mitzel[2], Angelo Di Canto[3], and Sascha Stahl[2] — [1]PI Heidelberg — [2]CERN — [3]Brookhaven National Laboratory

The measurement of the decay-time-dependent charge-parity (CP) asymmetry in $D^0 \to \pi^+\pi^-$ and $D^0 \to K^+K^-$ is presented using proton-proton collisions. The data was recorded between 2016 and 2018 at a center-of-mass energy of 13TeV with the LHCb detector at the LHC. Neutral D-mesons which arise from semi-leptonic decays of b-flavoured hadrons are used. The charge of the accompanying muon identifies the flavour of the D-meson at the time of production. The analysis strategy is discussed and final results are shown.

T 98.6 Fri 12:15 H-HS XII

Measuring lepton flavour universality in W boson decays at the ATLAS experiment — •Nicolas Köhler — CERN, Meyrin, Schweiz

The universality of the lepton couplings to electroweak gauge bosons (lepton flavour universality) is one of the fundamental ingredients of the Standard Model (SM) of particle physics. At LEP, the branching fractions of the W boson into charged leptons have been measured with a high precision, however the uncertainty on the ratio of $\mathcal{BR}(W \to \tau\nu)/\mathcal{BR}(W \to \mu\nu)$ still remains at approximately 2.4%. The PDG combined measurement of $\mathcal{BR}(W \to \tau\nu)/\mathcal{BR}(W \to \mu\nu)$ shows a significant deviation from the SM prediction of 2.7σ, thus motivating an independent measurement of this ratio at the LHC. This analysis focusses on leptonic tau decays due to the significantly larger experimental systematic uncertainties for hadronic tau reconstruction. It exploits a Tag&Probe method on $t\bar{t}$ events where the leptonic W decay of one top quark is used to trigger the event, allowing the lepton of the second W decay, which is unbiased in transverse momentum, to be used for the actual measurement. Leptonic tau decays are distinguished from prompt muons by requirements on the unsigned impact parameter, $|d_0(\mu)|$, and the transverse momentum of the muon. This analysis is expected to achieve a 1% precision which will be a significant improvement over the existing LEP results.

T 98.7 Fri 12:30 H-HS XII

Untersuchung des $b \to u$ Beitrages zur V_{cb} Bestimmung — Thomas Mannel und •Muslem Rahimi — Theoretische Physik I, Universität Siegen, Walter-Flex-Strasse 3, 57068 Siegen

Zur Bestimmung von V_{cb} aus inklusiven Zerfällen wird die inklusive Rate $B \to X_c\ell\bar{\nu}$ benötigt. Um diese aus der vollständig inklusiven Rate $B \to X\ell\bar{\nu}$ zu extrahieren, wird in der aktuellen Analyse der Beitrag von $B \to X_u\ell\bar{\nu}$ mittels eines Monte Carlo Generators subtrahiert, der auf einer partonischen Rechnung, verknüpft mit einem Hadronisierungsmodell beruht. Von theoretischer Seite können aber die Beiträge zur totalen Rate und zu den spektralen Momenten des Prozesses $B \to X_u\ell\bar{\nu}$ in einer „Heavy Quark Expansion“ berechnet werden. In dieser Arbeit soll diese Rechnung mit den Ergebnissen des Monte Carlo Generators verglichen werden. Dabei ist das Ziel die systematische Unsicherheit zu reduzieren, die durch die Modellierung des $B \to X_u\ell\bar{\nu}$ Beitrages entsteht.

T 98.8 Fri 12:45 H-HS XII

Study of inclusive $B \to X_u\ell\nu$ decays at the Belle II experiment — Florian Bernlochner, Lu Cao, Jochen Dingfelder, and •Maximilian Welsch — Universität Bonnn

The absolute value of the CKM matrix element $|V_{ub}|$ can be measured from semileptonic B meson decays into either inclusive or exclusive charmless final states. One of the main challenges in studying inclusive $B \to X_u \ell \nu$ decays is the presence of the much more abundant semileptonic B decays involving $b \to c$ transitions. The required phase space cuts to suppress the $b \to c$ background lead to difficulties in the calculation of the partial branching fractions, resulting in significantly larger theoretical uncertainties on $|V_{ub}|$. In this talk, I will present the current status of the measurement of inclusive $B \to X_u \ell \nu$ decays with the Belle II experiment.

T 99: Dark Matter IV

Time: Friday 11:00–13:00 Location: H-HS XIV

T 99.1 Fri 11:00 H-HS XIV

Search for dark matter produced in association with a hypothetical dark Higgs boson with the ATLAS detector — •Philipp Gadow, Sandra Kortner, and Hubert Kroha — Max-Planck-Institut für Physik, München, Deutschland

Searches for particle dark matter produced in association with a hypothetical dark Higgs boson are performed using the Run-2 proton-proton collision data recorded with the ATLAS detector. The presence of such a dark Higgs boson is motivated both by the need of a generation mechanism for the mass of dark matter particles and by the need of relaxing constraints on models of dark matter production due to the observed dark matter relic abundance. The dark Higgs boson mixing with the Standard Model Higgs boson allows to probe visible dark Higgs boson decays to b-quarks or pairs of vector bosons. Dark Higgs candidates are reconstructed as jets of hadronic activity enhanced by tracking information, allowing to exploit precision jet substructure information to identify dark Higgs decays. This contribution discusses constraints on dark Higgs models placed by searches exploring signatures of missing transverse momentum due to the invisible dark matter particles and dark Higgs decays to either b-quarks or pairs of W bosons. The signature of missing transverse momentum and a pair of resonantly produced W bosons is explored for the first time at the Large Hadron Collider.

T 99.2 Fri 11:15 H-HS XIV

Estimation of non-prompt and fake leptons in searches for dark matter associated production with Wt+MET — •Marianna Liberatore — DESY

In regions with multiple leptonic final states, estimating the number of events containing non-prompt (leptons inside a jet) and misidentified (fake) leptons (other particles faking leptons) represents a crucial issue. Given that Monte Carlo simulations of processes with fake leptons are unreliable or computationally expensive, data-driven methods are considered instead. In this talk are presented the first results of fake leptons background estimation using one of these methods, called the matrix method. The estimation is done for a search for dark matter in associated production with a single top quark. The search is focused on final states including one or two leptons and high missing transverse energy. Data collected with the ATLAS experiment at $\sqrt{s}$=13 TeV during LHC Run-2 (2015-2018) are used and correspond to an integrated luminosity of 139 fb^{-1}.

T 99.3 Fri 11:30 H-HS XIV

Sensitivity studies for Dark Matter models — •Martin Habedank, Priscilla Pani, and David Berge — Humboldt-Universität zu Berlin, Deutsches Elektronen-Synchrotron (DESY)

There is overwhelming evidence for the existence of Dark Matter, yet despite all efforts in direct, indirect and collider searches no suitable candidate has been found so far. To advance activities in the right direction in collider searches it is therefore informative to assess the parameter space already excluded for Dark Matter models by the various searches.

This talk will present sensitivity studies conducted in order to constrain existing Dark Matter models like the 2HDM+a model that introduces an extended Higgs sector. The work thereby focusses mainly on LHC results and makes use of the open-source tool Contur that allows straightforward comparisons of the parameter space excluded by different analyses available as Rivet routines.

T 99.4 Fri 11:45 H-HS XIV

Background Estimation for Sub-Relativistic Particles in IceCube — •Jakob Böttcher, Sukeerthi Dharani, Christian Haack, Timo Stürwald, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut, RWTH Aachen

The IceCube Neutrino Observatory is a multi-purpose detector with research programs encompassing neutrinos, muons, and more exotic particles, such as magnetic monopoles. These monopoles are predicted to catalyse proton decays and, depending on their mass, can propagate with sub-relativistic velocities. To find these slow particles, IceCube has a dedicated trigger that is sensitive to time scales a factor 1000 larger than usual event durations. Since the expected rate of such particles is small, if existent, the estimation of background is crucial for such a search. Explicitly, the challenge lies in simulating correlated noise and low energy atmospheric muons for the long time scales that have to be considered. This talk presents an efficient way to generate and parametrize the background with a data-based approach. This method re-shuffles short snips of actual data and adds de-correlated noise back in by appending to existent launches. The disagreements of this background estimation with data are on a percentage scale.

T 99.5 Fri 12:00 H-HS XIV

Search for Sub-Relativistic Magnetic Monopoles in IceCube — •Sukeerthi Dharani, Jakob Böttcher, Christian Haack, Timo Stürwald, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

Grand Unified Theories predict magnetic monopoles as one of the remnants of the very early universe. The IceCube Neutrino Observatory searches for high-energy astrophysical neutrinos as well as exotic particles like magnetic monopoles. A slowly moving (sub-relativistic) magnetic monopole could catalyze nucleon decays in matter via the Rubakov-Callan effect. When passing through the IceCube detector, the decay products of the nucleon produce Cherenkov light along the monopole's track. The experimental signature is a characteristic light pattern which lasts up to milliseconds. In order to separate monopole events from the background, an event selection based on a Boosted Decision Tree has been developed. In this talk, updates on the search for sub-relativistic monopoles are presented.

T 99.6 Fri 12:15 H-HS XIV

Signatures of Q-balls in IceCube* — •Sarah Pieper for the IceCube-Collaboration — Bergische Universität Wuppertal, Deutschland

Supersymmetric generalisations of the Standard Model predict the existence of extended objects that are coherent states of squarks, sleptons and the Higgs fields. Those objects, called Q-balls, are comparable to other Standard Model particles, as they have mass, a finite shape in space and can travel through the universe with a constant velocity. Produced in the early universe, Q-balls are possible dark matter candidates. Additionally, their existence could yield an explanation for the observed baryon asymmetry.

Q-balls can interact with ordinary matter, resulting in the decay of nucleons or the production of luminescence light. Light produced in those processes can be detected by various experiments, including the IceCube Neutrino Observatory.

In order to enable a first search for Q-balls with IceCube, signatures of Q-balls in the detector have been investigated by transfering theoretical models into simulations of event signatures. This has been done for different parameters, including zero and non-zero electric charge. An overview over the analysis, as well as the calculated detector sensitivity will be presented.

** Gefördert durch die BMBF-Verbundforschung Astroteilchenphysik*

T 99.7 Fri 12:30 H-HS XIV

Search for low relativistic magnetic monopoles utilizing luminescence light with IceCube* — •Frederik Lauber for the IceCube-Collaboration — Bergische Universität Wuppertal, Gaußstraße 20, 42119 Wuppertal

Magnetic monopoles are hypothetical particles predicted by many Be-

yond the Standard Model theories. They are carriers of elementary magnetic charge. This work considers intermediate mass monopoles which have been created shortly after the Big Bang.

Due to the predominant usage of Cherenkov light as a detection mechanism and the usage of detection media with a high Cherenkov threshold, in recent years magnetic monopole searches were only conducted in the mild and high relativistic regime ($0.5\,c - 1\,c$) or at non relativistic velocities ($< 0.1\,c$). This work connects these two regimes by utilizing luminescence light in ice to cover the low relativistic range ($0.1\,c - 0.5\,c$). Luminescence becomes the dominant light production mechanism in the low relativistic regime. While the light yield for low charged particles is neglectable in most contexts, highly ionizing particles such as magnetic monopoles have a much higher light yield due to the quadratic nature of the charge dependency of luminescence to the incident particle.

New results on the search for magnetic monopoles in the low relativistic regime utilizing multiple years of IceCube data are presented.

** Gefördert durch die BMBF-Verbundforschung Astroteilchenphysik*

T 99.8 Fri 12:45 H-HS XIV

Constraining minimal Dark Matter models with data from the IceCube Neutrino Observatory — •Raffaela Busse[1], Sybrand Zeinstra[2], and Michael Klasen[2] — [1]Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, Münster — [2]Institut für Theoretische Physik, Westfälische Wilhelms-Universität Münster, Münster

Dark matter is one of the biggest puzzles of modern physics. Since SUSY and other prominent theories remain unconfirmed to this day, alternative models start to shift more into focus, for example so-called minimal dark matter models which extend the Standard Model only by very few new particles. The WIMP dark matter predicted by these models accumulates in the cores of celestial bodies like the Sun, where it annihilates and generates a neutrino flux that might be measurable by means of neutrino telescopes. The IceCube detector with its large instrumented volume and the densely instrumented DeepCore region is well suited to search for neutrinos from the annihilation of dark matter in the GeV to TeV mass range. In this talk, the current status of neutrino flux calculations from minimal models is presented, and an outlook on the analysis of IceCube data is given.

T 100: Gamma astronomy II

Time: Friday 11:00–13:05 Location: H-HS XVI

Group Report T 100.1 Fri 11:00 H-HS XVI

Recent Highlights of MAGIC — •Razmik Mirzoyan for the MAGIC-Collaboration — Max-Planck-Institut für Physik (Werner-Heisenberg-Institut) — Föhringer Ring 6, 80805 München

MAGIC, consisting of two 17m diameter imaging atmospheric Cherenkov telescopes, is a pioneering instrument for doing astrophysics by means of very high energy gamma-rays in the energy range 30 GeV - 100 TeV. The telescopes are located at 2200m a.s.l. in the "Roque de los Muchachos" European Northern Observatory on the Canary island of La Palma. Since 2004 the MAGIC-I stand-alone telescope is taking scientific data. The sensitivity of the detector has been significantly improved by adding the MAGIC-II telescope and operating them in a coincidence (stereo) mode. For boosting the system sensitivity, we upgraded them in 2012. In recent 3-4 years we further boosted the sensitivity of MAGICs at the lowest energies, down to 20-30 GeV, by using the novel SUM-Trigger-2 system and at the very high energies of ~100 TeV, by using the very large zenith angle observation technique. In this report we are going to present the recent highlights of MAGIC, as for example, the gamma-ray observations of Geminga and Crab pulsars at energies above 20 GeV, of Crab Nebula in the range 30 GeV to 100 TeV, measurements of selected AGN, as well as observation of the recent gigantic signal from GRB 190114C, which made a major impact on understanding of the GRB physics.

T 100.2 Fri 11:20 H-HS XVI

FACT - Highlights from an Unbiased Monitoring Program — •Thomas Bretz[1] and Daniela Dorner[2] for the FACT-Collaboration — [1]RWTH Aachen, III. Physikalisches Institut A — [2]Universität Würzburg, Lehrstuhl für Astronomie

The First G-APD Cherenkov Telescope (FACT) has been monitoring bright sources at TeV energies for over eight years, collecting a total of more than 14000 hours of physics data. Using semi conductor photosensors, the duty cycle is maximized and gaps in the light curves minimized. Unbiased monitoring yields an unprecedented data sample and allows for systematic studies of source variability. In addition, a lot of multi-wavelength observations are triggered. One on Mrk 501 in 2014 allowed for a variability studies in gamma rays. In 2016, an unprecedented study of the intermittent extreme blazar 1ES 2344+51.4 was triggered. The long-term sample is studied for multi-wavelength correlations, e.g. a 5.5 year sample of Mrk 421, and periodic oscillations. Recent results from these studies will be presented.

T 100.3 Fri 11:35 H-HS XVI

Performance of the CTA Large Size Telescope — •Martin Will for the CTA-Collaboration — Max-Planck-Institut für Physik, München

The Large Size Telescope (LST) is the largest of the several sizes of telescopes that will comprise the Cherenkov Telescope Array (CTA). With its reflective surface of 23 meter diameter, the LST is optimized to detect gamma rays in the energy range between 20 and 200 GeV. The use of light weight materials to construct the telescope is crucial for very fast repositioning and follow-up of transients. In 2019, operations of the LST prototype in the Canary island of La Palma have started as part of the telescope commissioning. In this presentation, some results on the performance evaluation as well as some preliminary data on the Crab Nebula gamma-ray source will be presented.

T 100.4 Fri 11:50 H-HS XVI

First results from IceAct - SiPM based Imaging Air Cherenkov Telescopes for IceCube — •Merlin Schaufel[1], Jan Audehm[2], Thomas Bretz[2], Johannes Buscher[1], Giang Do[2], Adrianna García[2], Erik Ganster[1], Maurice Günder[1], Yuriy Popovych[1], Florian Rehbein[2], Martin Rongen[1], and Christopher Wiebusch[1] for the IceCube-Collaboration — [1]III. Physikalisches Institut 3B, RWTH Aachen, Deutschland — [2]III. Physikalisches Institut 3A, RWTH Aachen, Deutschland

The development of cost effective and compact Silicon Photomultipliers (SiPM) based Imaging Air Cherenkov Telescopes enables new measurements using a hybrid configuration with ground based detectors. IceAct is a proposed surface array of such telescopes above IceCube. During January 2019, two new versions of IceAct telescope demonstrators featuring 61 SiPM pixels and improved optics were installed in the center of the IceTop surface detector at the geographic South Pole. Combining information from these telescopes and IceCube, it is possible to test the performance in primary particle discrimination, energy calibration, and veto capabilities. We present the status of the project and first results from coincident and stereoscopic data taken during the antarctic winter 2019.

T 100.5 Fri 12:05 H-HS XVI

Performance analysis of the Imaging Air-Cherenkov Telescope HAWC's Eye based on Monte Carlo simulations — •Florian Rehbein[1], Jan Audehm[1], Thomas Bretz[1], Giang Do[1], Adrianna García[1], and Merlin Schaufel[2] — [1]Physics Institute III A, RWTH Aachen, Germany — [2]Physics Institute III B, RWTH Aachen, Germany

The compact imaging air Cherenkov telescope HAWC's Eye was developed to operate with the High-Altitude Water Cherenkov Gamma-Ray Observatory (HAWC), which is an extensive air shower array located in the state of Puebla, Mexico. Hybrid observations allow for improved energy and angular resolution. This approach is very promising not only for the HAWC observatory but also for future experiments such as the Southern Wide-field Gamma-ray Observatory, which will observe the Southern Hemisphere and is foreseen to begin operation by 2026. HAWC's Eye is based on a Fresnel lens focussing the light on a SiPM-based camera. Solid light guides increase the light collection area of the sensors. A full detector simulation has been set up, including the optical components as well as the electronics. Results on energy and angular resolution have been obtained.

T 100.6 Fri 12:20 H-HS XVI

Recent results from the MAGIC astroparticle and fundamental physics programme — •Moritz Hütten for the MAGIC-Collaboration — Max-Planck-Institut für Physik, Föhringer Ring 6, 80805 München

In this report, we present the latest results of searches for signs for new physics in extraterrestrial gamma rays with the MAGIC telescopes. MAGIC is a stereoscopic system of two imaging-atmospheric Cherenkov telescopes located on the Canary island of La Palma. We draw special attention to two recent efforts of the group: Firstly, we present a combined analysis of various dwarf galaxies for indirect gamma-ray signals from WIMP dark matter. Secondly, we show results on probing the Lorentz invariance using the MAGIC data from the first detection of TeV photons from a gamma-ray burst, namely, GRB190114C, and on Mrk421. We will conclude with an outlook on current activities of the group.

T 100.7 Fri 12:35 H-HS XVI

Towards intensity interferometry with Air Cherenkov Telescopes — •Andreas Zmija, Adrian Zink, Dmitry Malyshev, Stefan Funk, Gisela Anton, Naomi Vogel, and Thilo Michel — Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP

Astronomical intensity interferometry - recording correlated intensity fluctuations of starlight in two or more telescopes - is a promising tool of measuring the star's diameters and geometries, first performed by Hanbury Brown and Twiss in the late 1950s. The insensitivity to atmospheric fluctuations and the fact that the photon streams at the telescopes can be recorded independently of each other allows interferometry baselines of several kilometres even in the optical regime resulting in extremely high angular resolution. Therefore Cherenkov telescopes such as the future Cherenkov Telescope Array (CTA) with large baselines and detection areas provide excellent conditions for these measurements. We recall the physics of thermal light intensity correlations that set the conditions on optics and electronics. In this context we show the development of a setup for intensity interferometry with Cherenkov Telescopes and present results of laboratory tests which demonstrate the possibilities and challenges of the project.

T 100.8 Fri 12:50 H-HS XVI

Intensity interferometry setup characterization for possible measurements at the H.E.S.S. telescopes — •Naomi Vogel, Andreas Zmija, Gisela Anton, Stefan Funk, Dmitry Malyshev, Adrian Zink, and Thilo Michel — Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP

Intensity interferometry is a method which can be used to determine the angular diameter of a star by taking the measurements of at least two telescopes with varying baselines into account. An advantage of this technique is that only the measured intensities of a thermal source which are observed by the detectors each at a different position on Earth are of importance for the correlation. Intensity interferometry measurements can be performed at Cherenkov telescopes with additional detector systems, such as photomultiplier tubes (PMTs), which are able to record photon counts continuously. Provided that the collecting area of the Cherenkov telescopes is very large, the expected photon count rate is on the order of hundreds of MHz. In order to prove that our setup can handle such high photon count rates, we characterized the PMTs behaviour and measured intensity correlations at high photon rates in the laboratory. Furthermore, measurements were also carried out at the medium sized telescope prototype of the Cherenkov Telescope Array (CTA) in Berlin Adlershof. In this contribution we will present our laboratory setup and results as well as the results from the measurements at Adlershof. These tests serve as a preparation for measurements with H.E.S.S. Cherenkov telescopes in Namibia.

T 101: Neutrino physics without accelerators VII

Time: Friday 11:00–12:45 Location: H-ÜR 1

T 101.1 Fri 11:00 H-ÜR 1

Indirect dark matter search with JUNO — •David Blum, Marc Breisch, Jessica Eck, Tobias Heinz, Tobias Lachenmaier, Neha Lad, Axel Müller, Tobias Sterr, and Alexander Tietzsch — Eberhard Karls Universität Tübingen, Physikalisches Institut

The Jiangmen Underground Neutrino Observatory (JUNO) is a multi-purpose 20 kt liquid scintillator neutrino detector currently under construction in southern China. Its main goal is the determination of the neutrino mass ordering by measuring reactor antineutrinos at 53 km baseline. Due to the size and the excellent energy resolution (3% @ 1 MeV) of the detector, JUNO is sensitive to a potential neutrino flux produced by dark matter self-annihilation. The expected neutrino signals from dark matter self-annihilation and the relevant backgrounds in the energy range from 10 MeV to 100 MeV are investigated. Results of a sensitivity study on the dark matter self-annihilation cross section based on a Bayesian analysis are presented in this talk. This work is supported by the Deutsche Forschungsgemeinschaft.

T 101.2 Fri 11:15 H-ÜR 1

CONUS - COherent Neutrino nucleUs Scattering with reactor neutrinos — •Thomas Hugle for the CONUS-Collaboration — Max-Planck-Institut für Kernphysik

The measurement of coherent elastic neutrino nucleus scattering (CEνNS) by the COHERENT collaboration served as a first step into this kind of new measurements of the standard model neutrino sector. However, accessing the fully coherent regime at low neutrino energies provided by, e.g., nuclear power plants, is still a challenge due to the strong requirements in terms of a low detection threshold and a reduction of backgrounds. The CONUS experiment at the powerful commercial nuclear power plant in Brokdorf, Germany, with a distance of 17.1 m to the reactor core, employs the latest generation of ultra-low threshold and high-purity Germanium detectors with noise thresholds around 300 eV as well as an advanced shield design to tackle those challenges. Data collection started in April 2018 and is ongoing, while a first rate-only analysis has been done and further analyses are currently studied. The talk will give an overview of the CONUS experiment together with the latest results and developments, like an investigation of reactor-correlated backgrounds.

T 101.3 Fri 11:30 H-ÜR 1

The Design and Status of the DAQ-software for OSIRIS — •Kai Loo[1], Christoph Genster[2], Runxuan Liu[2,3], and Michael Wurm[1] — [1]Johannes Gutenberg-Universität Mainz, Institute for Physics, Staudingerweg 7, 55128 Mainz — [2]Institut für Kernphysik, Forschungszentrum Jülich, 52428 Jülich — [3]III. Physikalisches Institut B, RWTH Aachen University

The Jiangmen Underground Neutrino Observatory (JUNO), under construction in southern China, will determine the neutrino mass hierarchy (MH) by observing neutrinos from nuclear reactors at the distance of 53 km. To reach the desired sensitivity ($> 3\sigma$) for MH, the radiopurity of the different detector components plays a crucial role. To ensure the purity of the 20 kt liquid scintillator (LS) target of JUNO, the Online Scintillator Internal Radioactivity Investigation System (OSIRIS) will be constructed. It will monitor the radiopurity of the LS during its production and the filling phase of the central detector of JUNO. The OSIRIS will utilize the novel concept of intelligent-PMT i.e. the necessary DAQ electronics will be mounted at the back of the PMT. Each iPMT will then act as an individual self-triggering digitizer. Due to the asynchronous data flow from the iPMT system and of the order of 15 kHz dark count rate per PMT, this chosen approach requires a triggering and physical event building in software level. This talk will report the design, progress and status of the DAQ software for OSIRIS. This work is supported by the DFG Research Unit "JUNO"

T 101.4 Fri 11:45 H-ÜR 1

Measurement of the attenuation length and the group velocity of liquid scintillators with the CELLPALS technique — David Blum, Marc Breisch, •Jessica Eck, Tobias Heinz, Tobias Lachenmaier, Neha Lad, Axel Müller, Tobias Sterr, and Alexander Tietzsch — Physikalisches Institut Eberhard Karls Universität Tübingen

To quantify the transparency of liquid scintillators for next-generation neutrino experiments (e.g. JUNO), a measurement of the attenuation

length is crucial to ensure that a sufficient number of scintillation photons reach the surrounding photomultipliers. However, this becomes difficult for attenuation lengths of several tens of meters due to the necessity of a sufficient long light path through the sample.

This talk will present the CELLPALS technique to measure the attenuation length of liquid scintillators using an optical cavity to extend the effective light path. In addition, the CELLPALS method also provides the determination of the group velocity of the sample. The experimental setup and the results for different samples will be presented. This work is supported by the Deutsche Forschungsgemeinschaft.

T 101.5 Fri 12:00 H-ÜR 1

Development of an attenuation length monitor for JUNO — •Heike Enzmann and Michael Wurm — Johannes Gutenberg-Universität, Mainz, Germany

The Jiangmen Underground Neutrino Observatory (JUNO) is currently under construction in China. With its 20 kt liquid scintillator (LS) detector is designed to determine the neutrino mass hierarchy via a precision measurement of the survival probabilities of electron antineutrinos in reactor neutrino oscillations. The filling of the detector with LS will commence in 2021. Excellent transparency of the LS is required to maximize the collection of scintillation light, in order to reach the required measurement precision. Thus, several purity monitors will be installed as part of the filling system to test each batch of LS prior to its insertion into the Central Detector. This talk covers the development and testing of an attenuation length monitor for LS quality control. The monitor will measure the attenuation length using a laser. The measurement will be done over two different lengths of LS to reduce systematic effects. This work is supported by DFG research unit "JUNO".

T 101.6 Fri 12:15 H-ÜR 1

Waveform Reconstruction with Deep Learning method in JUNO — •Yu Xu[1,2], Christoph Christoph Genster[1], Alexandre Göttel[1,2], Yuhang Guo[1,3], Philipp Kampmann[1,2], Runxuan Liu[1,2], Ludhova Livia[1,2], Giulio Settanta[1], and Cornelius Vollbrecht[1,2] — [1]Institut für Kernphysik, Forschungszentrum Jülich — [2]III. Physikalisches Institut B, RWTH Aachen University — [3]School of Nuclear Science and Technology, Xi'an Jiaotong University, Xi'an 710049, China

Jiangmen Underground Neutrino Experiment (JUNO) is a next generation liquid scintillator neutrino experiment. The main goal of JUNO is to measure the neutrino mass ordering, while its 20 kton target mass and excellent energy resolution of 3%@1MeV will allow to study the neutrinos from multiple sources, including solar, geo, supernova, and atmospheric neutrinos. Signal from about 18,000 20-inch photomultiplier tubes will be read by 1 GHz Flash ADCs. Ideally, the precise reconstruction of charge and hit times of incident photons from Flash ADC waveforms would allow us to push the resolutions of energy and spatial reconstructions to their physical limits: a feature helpful to multiple physics purposes. In this talk, we will present the current status of the waveform reconstruction in JUNO, including the new results obtained with dedicated neural network. The details and the possible ways of additional improvement in waveform reconstruction with deep learning methods will be also discussed.

T 101.7 Fri 12:30 H-ÜR 1

Fluorescence Decay-Time Spectroscopy of the JUNO Liquid Scintillator using Gamma Radiation and a Pulsed Neutron Beam — •Matthias Raphael Stock, Hans Theodor Josef Steiger, Lothar Oberauer, Andreas Steiger, Ulrike Fahrendholz, Katharina Bock, and Oliver Dötterl — Technische Universität München, Physik-Department, James-Franck-Straße 1, 85748 Garching bei München

Major science goals of the upcoming Jiangmen Underground Neutrino Observatory (JUNO) in China are the search for the proton decay and the detection of the diffuse supernova neutrino background. Both phenomena will show characteristic signals in the detector. Therefore, we evaluate the pulse shape discrimination performance of liquid scintillators (LSs) using excitation by gamma radiation inducing recoil electrons as well as a pulsed neutron beam inducing recoil protons. We developed an experimental setup to characterize the distribution of light emission in the fluorescence process for different LS mixtures for future neutrino experiments e.g. JUNO and THEIA. We present results such as the fluorescence decay-time constants of the JUNO LS, which we investigated during two beam times at the 14 MV Tandem Van de Graaff Accelerator of the Maier-Leibnitz-Laboratorium (MLL). This work is supported by the DFG Research Unit JUNO and by the Bundesministerium für Bildung und Forschung (BMBF) for THEIA (Verbundprojekt 05H2018: R&D Detectors and Scintillators).

T 102: Cosmic rays V

Time: Friday 11:00–13:00 Location: L-3.001

T 102.1 Fri 11:00 L-3.001

Studies of Lorentz Violation using Air Shower Data — •Fabian Dünkel, Marcus Niechciol, and Markus Risse — Universität Siegen, Siegen, Germany

Due to their extremely high energies, cosmic rays are ideally suited to search for new physics, for example violations of Lorentz invariance. Isotropic, nonbirefringent Lorentz violation is considered in the following, specializing to the case of a photon velocity which is larger than the maximum attainable velocity of standard Dirac fermions. Earth-based bounds on this type of Lorentz violation have been determined before by observations of TeV gamma rays. A novel approach to test Lorentz invariance is based on the measurement of extensive air showers induced by cosmic-ray particles in the Earth's atmosphere. Lorentz-violating processes can have a large impact on the longitudinal shower development of air showers, for example reducing the average atmospheric depth of the shower maximum Xmax. For showers with high primary energies, this change is significantly larger than the average resolution of current air-shower experiments. This can be used to obtain new bounds on this type of Lorentz violation, which can be further improved by taking into account composition constraints.

This work is supported by the Deutsche Forschungsgemeinschaft (DFG).

T 102.2 Fri 11:15 L-3.001

Study of Lithium Isotopic Composition in Cosmic Rays with AMS-02 — •Manbing Li — I. Physikalisches Institut B, RWTH Aachen

AMS-02 is a multi-purpose magnetic spectrometer designed for precise measurements of cosmic ray fluxes above Earth's atmosphere. The isotopic compositions of cosmic ray nuclei are of great interest since they directly reflect processes related to cosmic ray propagation through the Galaxy. In seven years of data taking, AMS has collected the largest available dataset on fluxes of nuclei. The AMS Ring Imaging Cherenkov detector provides particle velocity measurements with a resolution better than 0.1%, and the silicon tracker measures the particle momentum inside the 0.14 Tesla field created by the AMS magnet. With these measurements, the mass of the selected events can be calculated, which allows the measurement of relative isotopic abundances. Here we present the study of lithium isotopic composition in the energy range from about 1 GeV/n to 10 GeV/n where no other precise measurements are currently available.

T 102.3 Fri 11:30 L-3.001

Composition Study of Cosmic Rays using IceCube Experiment — •Paras Koundal for the IceCube-Collaboration — KIT, Karlsruhe

The IceCube Neutrino Observatory is a large-scale physics experiment constructed at the Amundsen-Scott South Pole Station in Antarctica. It consists of more than five thousand sensors located in the Antarctic ice, distributed over a cubic kilometer. Besides its main purpose of neutrino astronomy, IceCube, and in particular its surface component IceTop, is also used for cosmic ray detection and analysis.

The composition studies of cosmic rays are extremely challenging because of the significant dependence of flux and primary-particle estimation, on the hadronic-interaction model one chooses to interpret the air-shower measurements. This talk will be focused on motivating new techniques which can be used for studying the mass composition and energy spectrum of high-energy cosmic rays measured with IceCube. For the mentioned purpose, I will be using the tools of Neu-

ral Networks. This will aim to benefit from the information about the high-energy muons which IceCube provides; in addition to the charged particle component measured at the surface array; hence together acting as a unique three-dimensional cosmic ray detector.

T 102.4 Fri 11:45 L-3.001

Search for ultra-high energy photons with the AugerPrime upgrade of the Pierre Auger Observatory — •Paulo Ferreira, Thomas Bretz, Adrianna García, Thomas Hebbeker, Julian Kemp, and Tobias Pan for the Pierre Auger-Collaboration — III. Physikalisches Institut A, RWTH Aachen University

The Pierre Auger Observatory is the world's largest experiment for the detection of ultra-high energy extensive air showers. It consists of a surface array of 1660 water Cherenkov detectors and 27 fluorescence telescopes, which allows for a hybrid reconstruction of air showers.
An air shower detected by the observatory can have its origin in nuclei, but also in very energetic photons. Analysing the photon flux is crucial to understand the flux suppression of cosmic rays above 50 EeV.
Until now, no photon-induced air shower has been detected by the Pierre Auger Collaboration. Recent studies allowed for better upper limits for the photon flux at the ultra-high energy, but they are constrained by the current discrimination power between different types of primary particles. AugerPrime, an on-going upgrade of the Pierre Auger Observatory, brings, among other improvements, an additional scintillator detector to be installed on top of each water Cherenkov detector station. Thereby, a more precise measurement of the number of muons is aimed at, which will increase the sensitivity to primary photons significantly. As such, new analysis frameworks exploiting the additional information obtained using AugerPrime are being developed. First studies of the performance to be expected will be presented.

T 102.5 Fri 12:00 L-3.001

Estimation of the mass composition of ultra-high energy cosmic rays with the Pierre Auger Observatory — •Olena Tkachenko for the Pierre Auger-Collaboration — Institute for Nuclear Physics, Karlsruhe Institute of Technology, Karlsruhe, Germany

The mass composition of ultra-high energy cosmic rays (UHECRs) is of crucial importance for the understanding their origin. One of the most robust techniques for estimation of the mass composition is based on the depth of atmospheric shower maximum, $X_{\max}$, as measured by the fluorescence detectors of the Pierre Auger Observatory.

In this talk we present a study of the composition of UHECRs from the $X_{\max}$ distributions using the Markov Chain Monte Carlo (MCMC) algorithm. We estimate the fractions of different mass groups as a function of energy and we discuss the corresponding statistical and systematic uncertainties.

T 102.6 Fri 12:15 L-3.001

Studies of the energy resolution and bias in the Pierre Auger Observatory — •Adrianna García, Thomas Bretz, Paulo Ferreira, Thomas Hebbeker, and Julian Kemp for the Pierre Auger-Collaboration — III. Physikalisches Institut A, RWTH Aachen University

The Pierre Auger Observatory is the largest experiment built for the study of cosmic rays (CRs). It consists of a hexagonal array of 1660 water-Cherenkov detector stations and 27 fluorescence telescopes located at five sites around the array to record hybrid signals from the extensive air showers produced by CRs during their interaction with the Earth's atmosphere.

Monte Carlo simulations of primary CRs have been performed using CORSIKA. The resulting showers are processed by the standard simulation and reconstruction framework Offline of the Pierre Auger Observatory, which includes the detector simulations and the data reconstruction algorithm. Two different simulated data sets were generated by applying different cuts taking into account two different detection methods. The first data set contains events that were recorded just by the surface detector, and the second one includes the hybrid events recorded by the surface detectors and, at least, two fluorescence telescopes simultaneously.

The discrepancies in the energy reconstruction of the observatory between the two different detection modes (surface detector only and hybrid mode) have been studied in order to correct for the possible bias in the cosmic ray primary energy. Preliminary results are going to be presented.

T 102.7 Fri 12:30 L-3.001

The science case for the AugerPrime Radio Detector — •Tim Huege for the Pierre Auger-Collaboration — Karlsruher Institut für Technologie — Vrije Universiteit Brussel

Within the AugerPrime upgrade, the Pierre Auger Observatory is currently being equipped with additional detectors and improved readout electronics. In the course of this upgrade, each of the 1660 Water-Cherenkov surface detectors will also be equipped with an integrated radio antenna for measurements in the 30-80 MHz band. These radio antennas will allow us to measure the electromagnetic component of inclined air showers with zenith angles above 65°. Simultaneous measurement of the muon content of inclined air showers by the Water-Cherenkov Detectors then provides mass-composition information complementary to the combined measurements with Water-Cherenkov and Scintillation detectors used at zenith angles below 60°. In this talk, we will discuss the expected performance and scientific potential of this upcoming Radio Detector of the Pierre Auger Observatory.

T 102.8 Fri 12:45 L-3.001

First data from the pre-production stations of the AugerPrime Radio Detector* — •Julian Rautenberg for the Pierre Auger-Collaboration — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal, Germany

The success of the radio detection of inclined air showers with the Auger Engineering Radio Array at the Pierre Auger Observatory proved the feasibility of radio detection at the 1.5 km spacing of the Surface Detector (SD). A first design of a possible radio extension to the SD stations was deployed in May 2019 on one station at the Observatory. With this station, the first successful integration of radio measurements into data acquisition was shown. Consequently, a full design of the antenna with its mounting was completed. In parallel, the front-end board, which samples the amplitudes and feeds them into the digital electronics of the station, was developed. In November 2019, the first 10 antennas were deployed on SD stations. For seven of these stations, the upgraded electronics were available, allowing the installation of the radio front-end boards. We present the first data from these SD stations which were extended with the pre-production version of the radio detectors.

* Gefördert durch die BMBF Verbundforschung Astroteilchenphysik (Vorhaben 05A17PX1).

T 103: Cosmic rays IV

Time: Friday 11:00–13:00 Location: L-3.002

T 103.1 Fri 11:00 L-3.002

Connection between turbulence and diffusive Cosmic Ray transport in the ISM — •Julien Dörner, Patrick Reichherzer, and Julia Tjus — RAPP-Center at Ruhr-University Bochum, Theoretische Physik IV, Bochum, Germany

The propagation of Cosmic Rays can be described by diffusive motion in most astrophysical environments. In the diffusion approach a proper modeling of the diffusion tensor is necessary. It has recently been shown that the energy dependence of the parallel component of the diffusion tensor is a function of the turbulence level, i.e. $\kappa \propto E^{\gamma(\delta B/B)}$. In this talk, we will discuss these insights in the astrophysical context. We focus on the impact of $\delta B/B-$dependent diffusion on the signatures of cosmic-ray propagation in the Galactic Interstellar Medium and the interpretation of recent gamma-ray measurements by Fermi.

T 103.2 Fri 11:15 L-3.002

Propagation in the Galactic magnetic field: Effects on the spectrum, composition and anisotropy of Galactic and extragalactic cosmic rays * — •Alex Kääpä for the Pierre Auger-Collaboration — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal

In the energy range signifying the transition from Galactic to extragalactic cosmic rays (GCRs and EGCRs), current cosmic ray source and propagation models fail to describe the observed flux above PeV energies. This calls for modifications to such models, the nature of which may be found in the study of the Galactic magnetic field (GMF), as it exhibits a range of effects on the propagation of cosmic rays. At the lowest rigidities, near the end of the diffusive regime, GCRs are trapped in, and EGCRs are effectively shielded from the Galaxy. At intermediate rigidities, the EGCRs that reach the Galaxy and GCRs are concentrated in the Galactic plane. At highest rigidities, particles are hardly affected by the GMF.
In this talk, I will present the consequences of these propagation effects on the spectrum, composition and anisotropy of both GCRs and EGCRs with special focus on how this may help elucidate the missing predicted flux in the transition region.

* Gefördert durch die BMBF Verbundforschung Astroteilchenphysik (Vorhaben 05A17PX1).

T 103.3 Fri 11:30 L-3.002

Deepening the understanding of cosmic-ray diffusion — •Patrick Reichherzer[1,2,3], Julia Tjus[1,2], Ellen Zweibel[4], Lukas Merten[5], and M.J. Pueschel[6] — [1]Ruhr-University Bochum, Theoretical Physics IV — [2]Ruhr Astroparticle and Plasma Physics (RAPP) Center — [3]Irfu,CEA Paris-Saclay — [4]Department of Astronomy & Physics, University of Wisconsin-Madison — [5]Institute for Astro-& Particle Physics, University of Innsbruck — [6]Institute for Fusion Studies, University of Texas at Austin

Understanding the transport of energetic cosmic rays belongs to the most challenging topics in astrophysics. The complicated evolution of the cosmic-ray distribution can be modeled mathematically by a diffusive process in the limit of large times. Consequently, diffusion is of fundamental importance in the transport of cosmic rays through turbulence.

We demonstrate the reduction of numerical artifacts for the calculation of the diffusion coefficient D by providing important conditions for physical and numerical input parameters. We characterize the rigidity regimes of D for arbitrary rigidities and guide fields, which we derive as a function of physical and numerical parameters. We show that at turbulence levels b/B above 5% of the total magnetic field, the approximation of an energy dependence E^(1/3) as predicted for a Kolmogorov spectrum within Quasi-Linear Theory does not hold. Consequently, a proper description of cosmic-ray propagation can only be achieved by using a b/B-dependent diffusion coefficient and can contribute to solving the Galactic cosmic-ray gradient problem.

T 103.4 Fri 11:45 L-3.002

Investigation of a Combined Fit Method to Identify a Nearby Cosmic Ray Source — Teresa Bister, Martin Erdmann, •Josina Schulte, and Marcus Wirtz — III. Physikalisches Institut A, RWTH Aachen

The origin of ultra high energy cosmic rays is still unknown and every progress to constrain the physical parameters of the acceleration process at the origin site will help to identify suitable cosmic ray source candidates. The application of a combined fit method to the energy spectrum and shower depth distribution measured by the Pierre Auger Observatory already unveiled information on the spectral index, original elemental composition as well as the maximum cosmic-ray rigidity at the sources. Now, the hypothesis of identical, homogeneously distributed sources is extended by a nearby source with a distance d and a signal fraction f_s using CRPropa 3 simulations to explore the astrophysical scenario in even more detail. In this talk, results of the combined fit method using the extended hypothesis applied on simulated data are presented. In order to develop a reliable analysis, the dependency of the fit results on a wide range of the astrophysical parameters is investigated.

T 103.5 Fri 12:00 L-3.002

Predicting the UHE photon flux from GZK-interactions of hadronic cosmic rays using CRPropa 3 — •Anna Bobrikova, Marcus Niechciol, Markus Risse, and Philip Ruehl for the Pierre Auger-Collaboration — University of Siegen

Measurements of the ultra high energetic cosmic ray (UHECR) spectrum taken by the Pierre Auger Observatory indicate an energy cut-off at about 50 EeV. The origin of this cut-off is still unclear. Possible explanations are the GZK-process (UHE proton interacting with the photons of the cosmic microwave background), photodisintegration interactions of UHE nuclei, or the maximum acceleration energy of the sources themselves. Indirect evidence for the GZK-effect could be provided by the search for UHE photons. Such photons would be produced if hadronic cosmic rays with energies above the cut-off energy interact via the GZK-process. In order to interpret the experimental upper limits on the flux of the UHE photons, theoretical predictions are needed. Predictions of the photon flux above 1 EeV as expected from the GZK-process have been derived in the past. The constantly growing amount of data collected at Auger along with refined analysis methods make it possible to search for photons with energies down to 2×10^{17} eV. For the study presented in this contribution, the CRPropa 3 framework is used to simulate the propagation and interaction of primary hadronic cosmic rays and their secondaries on their way from their sources to the earth to obtain predictions for the UHE photon flux below 1 EeV.
Funded by BMBF Verbundforschung Astroteilchenphysik.

T 103.6 Fri 12:15 L-3.002

Search for Cosmic Ray Sources Using Graph Convolutional Neural Networks — Teresa Bister, Martin Erdmann, Jonas Glombitza, •Niklas Langner, Josina Schulte, and Marcus Wirtz — III. Physikalisches Institut A, RWTH Aachen

Convolutional neural networks (CNNs) are a promising tool in the search for nearby sources of ultra-high energy cosmic rays (UHECRs). Here, CNNs are used to identify patterns in the arrival directions and energies of UHECRs created by their deflection in the Galactic magnetic field. We investigate graph CNNs, which operate on a graph constructed from the UHECR-features, efficiently utilizing both arrival directions and energies of the UHECRs. First, simple toy simulations of single multiplets consisting of a signal pattern on top of an isotropic background are analyzed as a function of the number of injected UHECRs from a source. Second, astrophysical simulations of many sources taking into account the attenuation in photon fields during the propagation in the extragalactic universe are used to evaluate the sensitivity of the graph networks for varying source densities.

T 103.7 Fri 12:30 L-3.002

Testing The Pierre Auger Observatory Starburst Galaxy and Active Galactic Nuclei Correlation Anisotropy Result with CRPropa Simulations — •Wilson Namasaka — Bergische Universtät Wuppertal - Germany, Gaußstr. 20, 42119 Wuppertal

Intermediate scale anisotropies in the distribution of UHECR arrival directions can be associated with two prominent classes of extragalactic gamma-ray sources detected by Fermi-LAT. In a most recent study, a correlation between the arrival direction of cosmic rays at energies above 38 EeV for starburst galaxies (SBG) and 39 EeV for active galactic nuclei (AGN) was reported by the Pierre Auger Collaboration with a significance of 4.5σ and 3.1σ respectively. In the study, the observed gamma-ray Luminosity was used as a proxy for cosmic ray Luminosity. The predicted cosmic ray excess maps were created using an angular smearing parameter to fit the observed arrival direction distribution via an optimization scan. In this research, we investigate the viability of this angular smearing using CRPropa simulation to test whether the results of the Pierre Auger Observatory can be reproduced by the deflections expected due to magnetic fields. We have selected the five strongest gamma-ray sources in both the Fermi-LAT AGN and SBG catalogs, and match our CR arrival intensity to the 1.4 GHz emission Luminosity for each of these sources. Simulations of the flux from these sources including extragalactic and galactic fields will be discussed. Furthermore, the results of search radius from both catalogs will be presented in this talk.

T 103.8 Fri 12:45 L-3.002

Fitting cosmic ray charges to cluster in accordance with an extragalactic source model — •Teresa Bister, Martin Erdmann, and Marcus Wirtz — III. Physikalisches Institut A, RWTH Aachen University

One of the main aims of astroparticle physics nowadays is to identify the sources of ultrahigh energy cosmic rays. This quest is particularly challenging as it requires knowledge of the galactic magnetic field as well as information about each cosmic ray's individual energy and charge. The latter cannot be measured directly at the highest energies by air shower experiments. Therefore this analysis presents a novel approach to fit all individual charges simultaneously by deep learning techniques. The fit uses different origin models as well as measurements of the energy and the shower depth in the atmosphere. The expected sensitivity is evaluated on simulated astrophysical scenarios and it is verified that this technique can differentiate between isotropic scenarios and cosmic rays originating in starburst galaxies.

T 104: DAQ, trigger and electronics V

Time: Friday 11:00–12:30 Location: L-3.015

T 104.1 Fri 11:00 L-3.015

Closing status of the Fast TracKer system — •Marta Czurylo and André Schöning for the ATLAS-Collaboration — Heidelberg Universität, Germany

The Fast TracKer (FTK) system for the ATLAS detector is presented. FTK was a system designed to process hits of the silicon Inner Detector (ID), and to provide full tracking information at the High Level Trigger on events first accepted at the Level-1 trigger. FTK should have allowed to significantly reduce the computing load necessary to perform tracking over the full ID volume compared to the CPU-based tracking.

Progress achieved during the LHC Long Shutdown 2 (LS2) including the hardware and software status of the system at the time of closure as well as the most recent tracking performance analysis based on the collected data from the partially running system will be discussed. Experience from the FTK project provided important input to the design of the new "Hardware Tracking for the Trigger" project, an FTK follow up project for the High-Luminosity LHC.

T 104.2 Fri 11:15 L-3.015

Online data reduction with FPGA-based track reconstruction for the Belle II DEPFET Pixel Detector — •Bruno Deschamps, Christian Weseel, and Jochen Dingfelder for the Belle II-Collaboration — University of Bonn

The innermost two layers of the Belle II vertex detector at the KEK facility in Tsukuba, Japan, will be covered by high-granularity DEPFET pixel sensors (PXD). The large number of pixels leads to a maximum data rate of 256 Gbps, which has to be significantly reduced by the Data Acquisition System. For the data reduction the hit information of the surrounding Silicon strip Vertex Detector (SVD) is utilized to define so-called Regions of Interest (ROI). Only hit information of the pixels located inside these ROIs are saved. The ROIs for the PXD are computed by reconstructing track segments from SVD data and extrapolating them to the PXD. The goal is to achieve a data reduction of up to a factor of 10 with this ROI selection. All the necessary processing stages, the receiving, decoding and multiplexing of SVD data on 52 optical fibers, the track reconstruction and the definition of the ROIs is be performed by the Data Acquisition Tracking and Concentrator Online Node (DATCON). The planned hardware design is based on a distributed set of Advanced Mezzanine Cards (AMC) each equipped with a Field Programmable Gate Array (FPGA). In this talk, the recent PHASE3 results as well as the future plans are presented.

T 104.3 Fri 11:30 L-3.015

Hard- und Firmware Entwicklung für Trigger-Module des ATLAS Level-1 Kalorimeter-Triggers — Volker Büscher, Johannes Damp, •Christian Kahra, Ulrich Schäfer, Ren-Jie Wang und Marcel Weirich — Inst. für Physik, Universität Mainz

Während dem Long Shutdown 2 (LS2) des Large Hadron Colliders (LHC), wird nicht nur der Beschleuniger ausgebaut, sondern zeitgleich auch die Triggersysteme der Experimente modernisiert, um trotz der höheren Ereignisrate weiterhin sensitiv für seltene Prozesse zu sein. Die Universität Mainz ist mit zwei Projekten am Upgrade des ATLAS Level-1 Kalorimeter Trigger beteiligt: dem *jet Feature Extractor* (jFEX) und dem *Level-1 Topologischen Prozessor* (L1Topo). Beide Projekte basieren auf gemeinsamen Hard- und Firmware-Designs, welche in diesem Vortrag vorgestellt werden.

Die Hardware-Module bieten eine Bandbreite von bis zu 3.1 *Tbps* für die Eingangsdaten, welche in Echtzeit von den Prozessor-FPGAs verarbeitet werden. Die Hochgeschwindigkeits-Datenleitungen wie auch der hohe Leistungsbedarf der FPGAs stellten hohe Anforderungen an das Design. Die Entwicklung dieser dichtbestückten Leiterplatinen, deren Simulationen und die Test-Ergebnisse der produzierten Module werden präsentiert.

Die Infrastruktur-Firmware der Prozessor-FPGAs wurde zur Nutzung in beiden Projekten generisch entwickelt. Daher ist sie auch für andere Projekte leicht anpassbar und stellt somit eine allgemein nutzbare Low-Level Abstrahierung für Echtzeit-Datenverarbeitung in FPGAs dar.

T 104.4 Fri 11:45 L-3.015

Software development for the ITk-Pixel module read-out and test system "BDAQ" — •Rafael Gonçalves Gama, Ali Skaf, Jörn Grosse-Knetter, Jörn Lange, and Arnulf Quadt — II. Physikalisches Institut, Georg-August-Universität Göttingen

The Inner Tracker (ITk) is a new all-silicon detector which will replace the current ATLAS tracking system during the Phase II upgrade. The ITk innermost layers are composed by pixel modules, which comprise a new sensor and a new front-end chip, designed to cope with the challenging demands of the HL-LHC environment. This work consists of adding support for the BDAQ hardware platform to the official ITk DAQ system, enabling the use of the said hardware in a centralized environment for the verification of pixel modules during the prototyping and (pre-)production phase of the ATLAS ITk upgrade. The BDAQ hardware is an, affordable yet powerful, FPGA-based electronics board designed by the University of Bonn for the readout of the RD53A front-end and upcoming generation chips. A new software library, based on the original BDAQ software package, was written to allow the new hardware integration into the ITk DAQ software. A summary of the development process, as well as results of the BDAQ hardware integration compared with results from the ITk software running with one of its originally supported hardware platforms, will be presented.

T 104.5 Fri 12:00 L-3.015

Echtzeit-Pfad des Tile Rear Extension (TREX) Moduls — •Damir Rassloff für die ATLAS-Kollaboration — Kirchhoff-Institut für Physik, Heidelberg

Im Zuge des Phase-I Upgrades des Atlas Experimentes steht auch der Atlas Level-1 Kalorimeter Trigger vor einer Reihe von Upgrades. Dabei soll die hohe Effizienz der Triggerentscheidungen beibehalten werden, weshalb drei neue digitale Indentifizierungsprozessoren verwendet werden. Die Prozessoren erhalten aus dem LAr-Kalorimeter digitalisierte Daten bei erhöhter Kalorimetergranularität. Das Tile-Kalorimeter hingegen wird weiterhin analoge Daten an das L1Calo Preprozessor System senden, welche dort digitalisiert werden. Die digitalisierten Daten werden daraufhin mit Hilfe der Tile Rear Extension (TREX) Module formatiert und an die neuen Prozessoren über optische Verbindungen weitergeleitet. Die verwendeten TREX Module sind komplexe PCBs, mit hochmodernen FPGAs und Hochgeschwindigkeitstransceivern.
Zur Zeit befindet sich das neue Atlas Level-1 Kalorimeter Trigger System innerhalb eines selbstständigen Teststandes unter ausführlichen Tests, in denen auch der zuvor beschriebene Echtzeitpfad validiert wird. Das Hauptaugenmerk dieses Vortrages soll auf den Untersuchungen des Echtzeitpfades liegen und dabei vor allem die Kommunikation zwischen der TREX Module und den neuen Indentifizierungsprozessoren betrachten. Zum besseren Verständnis wird zuvor ein Überblick des Atlas Level-1 Kalorimeter Trigger Grundsystems sowie des TREX Moduls gegeben.

T 104.6 Fri 12:15 L-3.015

Prototyping Serial Powering with RD53A — •Florian Hinterkeuser, Matthias Hamer, Hans Krüger, Fabian Hügging, and Klaus Desch for the ATLAS-Collaboration — Universität Bonn

The high luminosity upgrade for the Large Hadron Collider at CERN requires a complete overhaul of the current inner detectors of ATLAS and CMS. These new inner detectors will consist of all-silicon tracking detectors. A serial powering scheme has been chosen as baseline for the pixel detector to cope with the higher number of modules and the higher power consumption of the new front-end chip, spatial constraints and the need to minimalize the tracker's material budget. This new powering scheme provides challenges for the electrical and mechanical design. In order to verify this new powering scheme and its implications on the detector integration, efforts are ongoing to set up a prototype for serial powering using modules based on the RD53A chip, a half-size prototype for the new Pixel front-end chip, developed by the RD53 collaboration. In particular, a serial powering stave consisting of up to 8 RD53A quad chip modules has been set up in Bonn. First results from the ongoing activities with RD53A chips are presented. Emphasis is put on the electrical characterization of a RD53A serial powering chains, using representative services and power supplies. The setup, measurement goals and characterization of the serial powering chain and recent R&D activities focused on serial powering components will be discussed.

T 105: Muon detectors

Time: Friday 11:00–13:05 Location: L-3.016

Group Report T 105.1 Fri 11:00 L-3.016

Inbetriebnahme neuer Myondriftrohrkammern für den ATLAS-Detektor — Šejla Hadžić, Oliver Kortner, Hubert Kroha, Patrick Rieck, Marian Rendel, Daniel Soyk und •Elena Voevodina — MPI für Physik, München, Deutschland

Die Effizienz des Triggersystems des ATLAS-Experiments ist im Pseudorapiditätsbereich $|\eta| < 1,0$ durch Lücken in der Akzeptanz des RPC-Triggersystems begrenzt. Die begrenzte Hochratenfähigkeit der installierten RPC-Kammern würde die Triggereffizienz am HL-LHC weiter verringern. Um beide Schwächen des aktuellen Systems zu beseitigen, ist die Installation neuer hochratenfähiger RPC-Kammern in der innerste Lage des Myonspektrometers für $|\eta| < 1,0$ bis zum Start der HL-LHCs vorgesehen. Um den für diese Kammern benötigten Platz zu schaffen, werden die zur Zeit verwendeten Präzisionmyondriftrohrkammern in der innersten Myonspektrometerlage durch Myondriftrohrkammern mit kleinerem Rohrdurchmesser, sogenannte sMDT-Kammern, ersetzt werden. 2020 während der Betriebspause des LHCs werden im Bereich $|\eta| = 1,0$ werden 16 Pakete aus den neuen RPC- und sMDT-Kammern in den ATLAS-Detektor eingebaut werden. Die 16 sMDT-Kammern wurden am MPI für Physik in München entwickelt und im Jahr 2019 hergestellt. Sie wurden ausgiebig mit Myonen aus der Höhenstrahlung getestet. Die detailierten Teste der Myonnachweiseffizienz und der Myonspurauflösung der sMDT-Kammern wurden nach dem Zusammenbau der sMDT-Kammern mit den RPC-Kammern am CERN wiederholt. Im Vortrag werden die Prüfverfahren und die Testergebnisse vorgestellt.

T 105.2 Fri 11:20 L-3.016

Triple GEM detectors for the CMS Muon Upgrade — •Giovanni Mocellin, Thomas Hebbeker, Kerstin Hoepfner, Henning Keller, and Shawn Zaleski — III. Physikalisches Institut A, RWTH Aachen University

With the increase of the instantaneous luminosity delivered to the experiments during Phase-2 of the LHC planned to start after the Long Shutdown 3, the detectors have to be upgraded to improve the performance and to sustain higher particle fluxes. The detectors in the forward regions are the most affected. In the CMS experiment, to cope with the higher event rates and larger radiation doses, triple-layer Gas Electron Multipliers (GEM) will be installed in the endcaps to complement the existing Cathode Strip Chambers and further extend the coverage. For the first time, such detectors will have large sizes of the order of 1 m^2, thus high requirements on the uniformity across the detector are needed. Chambers are built in production sites spread over 7 countries around the world. To test their integrity, quality and performance, the GEM chambers undergo multiple quality control tests at the sites. After shipment to CERN, a final major test with cosmic rays is performed before installation. The first endcap has been equipped with 144 detectors and is being integrated in CMS. This talk gives an introduction to GEM detectors in CMS, presents their performance in quality control tests, status of installation and initial results during operations in CMS.

T 105.3 Fri 11:35 L-3.016

Gas Electron Multiplier Quality Control Tests and Performance Studies — •Shawn Zaleski, Thomas Hebbeker, Kerstin Hoepfner, Henning Keller, and Giovanni Mocellin — III. Physikalisches Institut A, RWTH Aachen University

The Compact Muon Solenoid (CMS), one of the primary experiments at the CERN LHC, will be upgraded to be able to record the higher event rates as well as deal with the related increased radiation doses expected during the next running of the LHC. The installation of the Gas Electron Multiplier (GEM) GE1/1 detector in the CMS muon station endcaps will be the first in a series of upgrades to better handle these higher rates. The hardware for the GE1/1 detector chambers are produced in seven countries throughout the world. The chambers are then qualified in a series of steps called quality checks (QCs). Several of the QC stages, in particular the tests for gas tightness, high voltage, and gas uniformity will be discussed.

GEMs are being employed in an increasing number of application areas, from university lab experiments to large scale experiments such as CMS. As such, the characteristics of a GEM with 10 cm x 10 cm active gas area has been studied for the purpose of integrating into the particle physics advanced undergraduate laboratory course at RWTH Aachen University. Aspects which can be studied are: chamber performance, impact of HV applied across an individual GEM foil on the gain and gas mixture.

T 105.4 Fri 11:50 L-3.016

Optimierung der Impulsformung in Myondriftrohrkammern für den Betrieb bei hohem Gammastrahlungsuntergrund an zukünftigen Hadroncolliderexperimenten — •Oliver Kortner, Hubert Kroha, Robert Richter und Korbinian Schmidt-Sommerfeld — MPI für Physik, München, Deutschland

Myondriftrohrkammern mit dünnen Rohren, sogenannte sMDT-Kammern, eignen sich zur Instrumentierung großflächiger Myonsysteme von Experimenten an zukünftigen Collidern. Sie zeichnen sich durch hohe Myonnachweiseffizienz und Ortsauflösung bei hohem γ-Strahlungsuntergrund aus, wie er zum Beispiel im ATLAS-Myonspektrometer am HL-LHC oder im Myonsystem des für den FCC-Hadroncollider konzipierten Detektors auftreten werden. Teststrahlmessungen mit sMDT-Kammer an der Gammabestrahlungseinrichtung des CERN zeigten, dass die Ortsauflösung der sMDT-Kammern vor allem durch die Überlagerung von Signalen durch den γ-Strahlung mit darauffolgenden Signalen von Myonspuren beieinträchtigt wird. Simulationen des Verhaltens der sMDT-Rohre unter hohem Strahlungsuntergrund ergaben, dass dieser Effekt durch eine Verstärkerschaltung mit aktiver Wiederherstellung des Impulsbodens der verstärkten Signal weitgehend eliminiert werden kann. Im Vortrag werden diese Simulationsergebnisse und der erfolgreiche Einsatz solcher Verstärkerschaltungen im Testrahl vorgestellt.

T 105.5 Fri 12:05 L-3.016

Position Reconstruction in the ATLAS New Small Wheel — •Patrick Scholer, Ulrich Landgraf, and Stephanie Zimmermann — Albert-Ludwigs-Universität Freiburg

During the current shutdown of the LHC, the innermost end cap of the Muon Spectrometer of the ATLAS detector will be replaced by the so called New Small Wheel (NSW). It uses Micro Mesh Gaseous Detectors (Micromegas) and small-strip Thin Gap Chambers (sTGCs) as its detector technologies; both providing a high spatial resolution at high incidence rates.

This talk will discuss the position reconstruction with the NSW detectors. The focus is set on the Micromegas detectors where the measurement of the drift time of the primary ionization can be used to turn it into a micro time-projection chamber. The performance of different reconstruction algorithms applied on the Monte Carlo simulation of the NSW and on test-beam data will be compared. Furthermore, the impact of different detector imperfections applied in the Monte Carlo simulation will be presented. These imperfections contain e.g. worsening of charge and time resolutions and reduced efficiencies in different detector regions.

T 105.6 Fri 12:20 L-3.016

CMS Drift Tube Chambers : Upgrade activities during LHC Long Shutdown II — •Archana Sharma, Thomas Hebbeker, Kerstin Hoepfner, Hans Reithler, and Saranya Ghosh — III. Physikalisches Institut A, RWTH Aachen University

To sustain and extend its discovery potential, the Large Hadron Collider (LHC) will undergo a major upgrade in the coming years, referred to as High Luminosity LHC (HL-LHC), aimed to increase its instantaneous and integrated luminosity respectively by a factor of five and ten beyond the original design value. After delivering an integrated luminosity of more than 160 fb-1 until the end of Run 2, from the beginning of 2019, LHC is shutdown for two years (LS2) in order to get its accelerator-chain and detectors upgraded for the HL-LHC phase. During this LS2, The CMS experiment aims to upgrade its electronics and detector performance to improve the data taking and a precise reconstruction of all the particles in high pile-up conditions of HL-LHC. Drift Tube (DT) chambers as one of the important part of CMS muon system responsible for identifying, measuring and triggering on muons by the precise measurement of their position. This talk briefly summarizes the ongoing activities/plans related to the electronics upgrades of DT chambers along with some details about the gas monitoring in the DT system using Drift Velocity Chambers (VDC).

T 105.7 Fri 12:35 L-3.016

A Large Scale Cosmic Muon Test Stand — Dmitry Eliseev, Thomas Hebbeker, Markus Merschmeyer, and •Lars Steffen Weinstock — III. Physikalisches Institut A, RWTH Aachen University, Aachen, Germany

The CMS Drift Tubes (DT) system is used to precisely measure the tracks of muons in the barrel region. In order to provide higher acquisition rates, that are required by the phase 2 upgrade, and to add more flexibility to the trigger logic the on-chamber electronics of the DT system are being upgraded. The verification of this new generation of readout electronics requires several test setups using actual DT chambers. For this purpose a large scale cosmic muon test stand is being equipped with new readout electronics and a scintillator based trigger system. The trigger system consists of three layers with plastic scintillator tiles that are read out by silicon photomultipliers (SiPMs) providing fast trigger signals and data for muon track reconstructions. Using this setup several functional tests can be performed on the new DT system.

This talk gives an overview of the cosmic muon test stand and focuses on the trigger system.

T 105.8 Fri 12:50 L-3.016

Production of new small-diameter Monitored Drift Tube (sMDT)-chambers for the ATLAS-Muonspectrometer — •Marian Rendel, Patrick Rieck, Oliver Kortner, and Hubert Kroha — Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), München

Within the second long shutdown of the Large Hadron Collider, 2019-2021, Monitored Drift Tube (MDT)-chambers at the ends of the inner barrel layer will be replaced by 16 new small-diameter Monitored Drift Tube (sMDT)chambers with half the tube diameter, together with new thin-gap RPC trigger chambers. Additionally, 96 more MDT chambers in the inner barrel layer will be replaced for the high-luminosity LHC. In this talk the current status of the production of the sMDT chambers is presented. Furthermore the development for the production of the additional 96 sMDT chambers will be discussed.

T 106: Top quarks: Single top production

Time: Friday 11:00–13:00 Location: L-4.001

T 106.1 Fri 11:00 L-4.001

Measurement of the t-channel single top-quark production cross-section in proton-proton collisions at a centre-of-mass energy of 13 TeV with the ATLAS detector — Olga Bessidskaia Bylund, Dominic Hirschbühl, •Joshua Reidelstürz, Mohsen Rezaei Estabragh, and Wolfgang Wagner for the ATLAS-Collaboration — Bergische Universität Wuppertal, Wuppertal, Germany

The measurement of the single top-quark t-channel production cross sections σ_{tq} and $\sigma_{\bar{t}q}$ and their fraction R_t as well as the total cross section $\sigma_{tq,\bar{t}q}$ is presented. These measurements provide a precise test of the standard model and are sensitive to new-physics phenomena by probing the properties of the Wtb vertex and placing limits on the CKM matrix element $|V_{tb}|$. Data taken at the ATLAS detector from 2016 to 2018 corresponding to an integrated luminosity of $\mathcal{L} = 139\,\mathrm{fb}^{-1}$ at a center of mass energy of 13 TeV is analyzed using corresponding Monte Carlo simulated data. Cuts are applied to the data selecting events with the signature expected for the signal process. Next, to separate signal and background events a neural network is trained using the Monte Carlo simulated data combining several kinematic variables measured with the detector. The neural network output distribution is then used in a binned profile maximum likelihood fit including all systematic uncertainties to determine the cross sections.

T 106.2 Fri 11:15 L-4.001

Suche nach der Einzel-Top-Quark-Produktion im s-Kanal bei einer Schwerpunktsenergie von 13 TeV mit dem CMS-Experiment — Thorsten Chwalek, Nils Faltermann, •Denise Müller und Thomas Müller — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

Die Produktion einzelner Top-Quarks erfolgt, im Gegensatz zur Top-Quark-Paarproduktion, über die elektroschwache Wechselwirkung. Daher ist dieser Prozess sensitiv auf mögliche Abweichungen im elektroschwachen Sektor des Standardmodells. Eine besondere Herausforderung stellt hierbei die Produktion über den s-Kanal dar. Dieser Produktionsmodus ist von allen Einzel-Top-Quark-Produktionsmechanismen theoretisch am präzisesten beschrieben, weist jedoch nur einen geringen Anteil an der gesamten Produktion einzelner Top-Quarks auf. Dies erfordert eine gute Trennung zwischen Signal- und Untergrundereignissen mittels multivariater Analysemethoden.

Dieser Vortrag beschreibt die Suche nach der Einzel-Top-Quark-Produktion im s-Kanal unter Verwendung der 2016 bis 2018 bei einer Schwerpunktsenergie von 13 TeV gemessenen Daten des CMS-Experiments.

T 106.3 Fri 11:30 L-4.001

Measurement of the Single-Top production cross section in the s-channel at $\sqrt{s}$=13 TeV with the ATLAS detector — •Ken Kreul for the ATLAS-Collaboration — Humboldt-Universität zu Berlin

The production of single top-quarks in electroweak processes (Single-Top) is an important part for the study of the Standard Model and possible extensions. Single-Top production is possible in three channels: t-channel, s-channel and via associated production of a W-boson. In proton-proton collisions at the Large Hadron Collider (LHC), the s-channel has the lowest production cross section and is dominated by many background processes. During the LHC run at 8 TeV, the s-channel was already observed with a significance of 3.2σ using the Matrix Element Method. In this method, the matrix elements for the most important signal and background processes are integrated over the available phase space to compute process likelihoods, which can then be combined to a discriminant. The method is now applied to current ATLAS data at $\sqrt{s}$=13 TeV to improve the previous result using the higher luminosity of up to 140 fb^{-1}.

T 106.4 Fri 11:45 L-4.001

Mesurement of top quark polarization in t-channel single top quark events and constraining anomalous Wtb couplings with the CMS-Experiment — •David Seith, Thorsten Chwalek, Thomas Müller, and Nils Faltermann — Institut für Experimentelle Teilchenphysik(ETP), Karlsruher Institut für Technologie (KIT)

Single top quarks are produced via electroweak production and are therefore polarized at the LHC. Their polarization is highly sensitive to anomalous contributions to the Wtb vertex. Deviations in the top quark polarization from the predictions of the Standard Model could therefore hint at new physics. In this talk a measurement of the top quark polarization using the data taken from 2016 to 2018 at a center-of-mass energy of 13 TeV at the CMS-Experiment is presented.

T 106.5 Fri 12:00 L-4.001

Search for FCNC in strong interactions with the ATLAS detector — •Gunnar Jäkel, Wolfgang Wagner, and Dominic Hirschbühl — Bergische Universität Wuppertal

Flavor changing neutral currents (FCNC) are forbidden at tree level and highly suppressed at higher orders in the standard model. In some new physics models leading order contributions could enhance cross sections for FCNC processes by many orders of magnitude. A search for direct top quark production is presented. In this process a u(c)-quark interacts with a gluon and produces a top quark. Different cuts and neural networks are studied to increase the sensitivity of the search.

T 106.6 Fri 12:15 L-4.001

Search for flavour-changing neutral currents in single-top quark processes in association with a photon at $\sqrt{s} = 13$ TeV with the ATLAS experiment — Johannes Erdmann, Gregor Gessner, •Benedikt Gocke, and Olaf Nackenhorst — TU Dortmund, Lehrstuhl für Experimentelle Physik IV

In the Standard Model, flavor-changing neutral currents (FCNC) at tree level are forbidden and are highly suppressed by the GIM mech-

anism at higher orders. However, extensions to the Standard Model predict higher cross sections for processes including FCNCs.
One possible process with an FCNC includes a top quark that interacts with an up-type quark and a photon ($tq\gamma$ coupling with $q = u, c$). A distinction is made between the production mode, in which a single top quark is produced, and the decay mode, in which one of the top quarks of a $t\bar{t}$ system decays through an FCNC interaction.
A search with focus on the production process, which used 81 fb^{-1} of proton-proton collision data, was recently published (Phys. Lett. B 800 (2019) 135082). Now, first studies of the search for both processes, decay and production mode, using the full LHC Run-2 data are presented.

T 106.7 Fri 12:30 L-4.001

Search for single production of top quarks in association with a photon with the ATLAS detector at $\sqrt{s} = 13$ TeV — •Björn Wendland, Johannes Erdmann, and Kevin Kröninger — TU Dortmund, Experimentelle Physik IV

Analyses of top quark production in association with a photon are important tests of the Standard Model as top quark properties with respect to the electroweak interaction such as the structure of the top quark and photon vertex can be probed. Top quark pair production with a photon ($t\bar{t}\gamma$) in leptonic final states was observed and investigated by the ATLAS and CMS collaborations. No significant deviations from the Standard Model expectations were found by now.

With the rich datasets collected by the ATLAS and CMS experiments during Run 2 of the LHC programme, it is feasible to observe the Standard Model single production of top quarks in association with a photon. The CMS collaboration reported evidence corresponding to $4.4\,\sigma$ for this process using a partial Run 2 dataset. Investigations of this process are complementary to the measurement of the $t\bar{t}\gamma$ process.

In this talk, studies of t-channel single production of top quarks with a photon using the full Run 2 dataset collected by the ATLAS detector are presented. The leptonic decay channel of the top quark is targeted in this analysis where the final state consists of either an electron or a muon, a jet containing B hadrons, missing transverse energy, a photon and an additional jet produced in forward direction.

T 106.8 Fri 12:45 L-4.001

Measurement of highly boosted W-associated single top quark production with CMS — •Christopher Matthies, Paolo Gunnellini, Johannes Haller, and Roman Kogler — Institut für Experimentalphysik, Universität Hamburg

A measurement of W-associated single top quark production in the highly boosted regime in proton–proton collisions at $\sqrt{s} = 13$ TeV with the CMS experiment is presented. The measurement focusses on the ℓ+jets final state in which the top quark decays hadronically and the associated W boson leptonically, leading to a distinct event signature with a hadronic and a leptonic hemisphere. The HOTVR jet clustering and tagging algorithm is used to identify the fully merged top quark decay. Deep learning techniques are used to discriminate the tW signal from top quark pair production and other background processes. It is shown that a measurement up to a transverse momentum of about 1 TeV of the top quark is feasible, extending the range of previous measurements considerably.

T 107: Combined instrumentation session I: Gaseous detectors (joint session HK/T)

Time: Friday 11:00–13:00 Location: J-HS C

T 107.1 Fri 11:00 J-HS C

Study of gas gain in GEM detectors — •Henning Keller, Thomas Hebbeker, Kerstin Hoepfner, Giovanni Mocellin, and Shawn Zaleski — III. Physikalisches Institut A, RWTH Aachen University

The Gas Electron Multiplier (GEM) technology is quite popular among the gaseous detector community due to the excellent performance, even in high-rate environments; it has strong resistance to aging as well as a flexible design. The heart of the detector consists of GEM foils with an etched hexagonal pattern of holes. The detection principle relies on electron multiplictation inside the holes, where a high electric field is apparent. GEM detectors are currently being installed in the CMS Muon system at the LHC in preparation for Run-3. New etching techniques have been used for the production of large-size ($\mathcal{O}(1\ \mathrm{m}^2)$) GEM foils needed for CMS. The new techniques result in different hole geometries inside the GEM foil. In order to better understand the gas gain dependance on the hole geometry, several measurements have been performed, and have been complemented by GARFIELD++ simulations. The findings are compared with other recent studies.

T 107.2 Fri 11:15 J-HS C

Studies on a structured cathode to increase the detection efficiency of gaseous detectors — •Katrin Penski, Otmar Biebel, Bernhard Flierl, Maximilian Herrmann, Ralf Hertenberger, Christoph Jagfeld, Felix Klitzner, Maximilian Rinnagel, Sebastian Trost, Chrysostomos Valderanis, and Fabian Vogel — LMU München

Micropattern gaseous detectors show extremely good spatial resolution and high-rate capability. Nevertheless, due to the low density of the gas detector they exhibit only low detection efficiency for neutral particles such as e.g. high energy photons or neutrons. For these particles the detection efficiency can be increased by using a solid converter cathode e.g. of high-Z materials as gold for photons or materials with a large neutron interaction cross section e.g. ^{10}B for neutrons. In order to obtain even higher efficiencies several tilted converter layers can be stacked with large overlap. For photons several studies were performed to optimize the detection efficiency in regard to cathode geometry and detector performance. Especially, measurements of the drift electron movement and investigations of the improvement of the efficiency are presented and compared to results of corresponding simulations. These measurements were performed using a prototype cathode and a GEM detector.

T 107.3 Fri 11:30 J-HS C

Charge transfer properties of a GEM stack – simulations and measurements — •Jan Paschek, Philip Hauer, Jonathan Ottnad, Markus Ball, and Bernhard Ketzer — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

Gas Electron Multipliers (GEM) are a micropatterned structure widely used as an amplification stage in gaseous detectors exposed to a high rate particle flux, e.g. Time Projection Chambers. Typically, a GEM consists of a polyimide foil which is coated with thin copper layers on both sides. Through a photolitographic process large numbers of holes are etched into this structure. In order to obtain the desired amplification a suitable voltage needs to be applied between both metal layers.

Typically, detectors consist of stacks of multiple GEM foils. The performance of a detector is highly influenced by the charge-transfer properties within the stack. To study these effects, a Monte-Carlo program simulating the charge transfer in a GEM stack using the frameworks Garfield++ and Ansys has been written. This program allows us to predict the properties of a GEM stack from the geometry of the GEM-foils and the applied fields. In order to verify the predictions a test detector has been assembled with a configuration corresponding to the quadruple GEM stack of the new readout chambers for the ALICE TPC. The talk will discuss the simulation program and compare the predictions to measurements with this test detector.

Supported by BMBF.

T 107.4 Fri 11:45 J-HS C

The Charge-Up Effect in GEM Detectors – Simulations and Measurements — •Philip Hauer, Karl Flöthner, Dimitri Schaab, Markus Ball, and Bernhard Ketzer — Univ. Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

Gas Electron Multipliers (GEM) are widely used as an amplification stage in gaseous detectors exposed to high rates, e.g. in the Time Projection Chamber of the ALICE (A Large Ion Collider Experiment) experiment after its upgrade. Typically, the GEM consists of a polyimide foil which is coated from both sides with thin layers of copper. Holes are etched into this structure in which electrons can get multiplied.

During the multiplication process, some electrons and ions diffuse to the polyimide part of the GEM and are adsorbed there, which change

the electric field inside the holes. This is known as the *charge-up effect*. Many publications suggest that it is causing a change of the effective gain with time but a quantitative description is often missing.

In this work, the charge-up effect was investigated quantitatively in simulations and measurements. The simulations are based on an iterative approach, where new field maps are calculated with a finite element method and the deposition of charges is simulated with Garfield++. For the measurements, a dedicated test detector was set up with a single (standard) GEM foil as amplification stage. In this talk, the results from both approaches will be shown and compared to each other. A special focus lies on the influence of initial rate, applied voltage and different hole shapes on the charge-up effect.

Supported by BMBF.

T 107.5 Fri 12:00 J-HS C

Propagation of discharges in a double-GEM detector — •Bogdan Blidaru for the ALICE-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

The Large Hadron Collider will provide Pb-Pb collisions at an interaction rate of 50 kHz from 2021 onward.

In order to cope with this, the ALICE Time Projection Chamber is being upgraded. Readout chambers equipped with a stack of four Gas Electron Multiplier (GEM) foils provide a continuous readout. After installation in the ALICE cavern, the GEM chambers will be inaccessible. Thus, long-term stability and reliable readout over a time span of about 10 years is required.

One of the major challenges GEMs must overcome are electrical discharges, which can short-circuit a GEM segment and render it inactive. Some peculiar aspects of the discharge phenomena are surfacing. This talk is focused on the propagating nature of discharges, from one GEM in a stack to another.

A small detector with two 10×10 cm^2 GEM foils is used to study the evolution of the GEM potentials during and after discharges. Particular emphasis is put on understanding and mitigating the appearance of discharges by using decoupling resistors that substantially reduce their propagation probability.

Moreover, some new results showing that photons are not solely responsible for the propagation of discharges are discussed. A considerable number of events where the propagation is delayed by more than 300 ns are observed and studied.

T 107.6 Fri 12:15 J-HS C

Modelling of discharge in parallel-plate-type Micro-Pattern gaseous detectors — •Deb Sankar Bhattacharya, Raimund Ströhmer, and Thomas Trefzger — University of Wüzburg, Physik und ihre Didaktik, Emil-Hilb-Weg 22, 97074, Germany

The Micro-Pattern Gaseous Detectors (MPGD) have been widely adopted in nuclear and particle physics experiments, for their fast response and other excellent characteristics. To achieve the required signal strength and detection efficiency, sometimes they are operated at a high voltage range. This often challenges the limit of high voltage stability of the detector. Discharge in gaseous detectors is a complex process and there are several factors which may directly or indirectly influence. The microscopic geometrical structures of the MPGDs may itself sometimes induce discharges. In this study, we are numerically investigating the discharge phenomena in non-resistive Micromegas. Within the COMSOL framework, a 3-dimensional model is developed to observe the occurrence and the development of discharge in Micromegas. The effect of space charge has been taken into account in the calculation. The model allows to vary the geometrical parameters of the detector as well as to study the effects of gas impurities and a different number of primary charges.

T 107.7 Fri 12:30 J-HS C

Status of MRPC performance for the endcap-time-of-flight upgrade of STAR — •Philipp Weidenkaff for the CBM-Collaboration — Ruprecht-Karls-Universität Heidelberg

As part of the FAIR phase 0 program, CBM-ToF MRPC modules have been installed as endcap-time-of-flight detectors in STAR for the current beam-energy-scan II (BES II) program in 2019 and 2020. These detectors provide a major improvement to the particle identification capability of the experiment in the forward region ($1.0 < \eta < 1.5$), which is especially necessary for the fixed target program. An Analysis of the MRPC performace in terms of time resolution, efficiency and matching to STAR-TPC tracks will be presentent in this talk. The Results are based on the 2019 run as well as first data of the 2020 run.

The project is partially founded by BMBF 05P15VHFC1.

T 107.8 Fri 12:45 J-HS C

Development of a High Pressure Time Projection Chamber — •Philip Hamacher-Baumann, Thomas Radermacher, Stefan Roth, and Nick Thamm — III. Physikalisches Institut B, RWTH Aachen University

Gaseous detectors have long been used by particle physics experiments. Their low momentum threshold has made them interesting as active targets for long baseline neutrino experiments. To increase the statistics of neutrino interactions, but retain a low momentum threshold, pressurized Time Projection Chambers (TPCs) have been proposed. The Deep Underground Neutrino Experiment (DUNE) considers building one as part of its near detector complex.

Gas Monitoring Chambers are mini TPCs that are designed to measure gas properties. Such a system with the capability of testing common and new drift gas mixtures can provide input to the design process of new high pressure TPCs. This talk presents a High Pressure Gas Monitoring Chamber (HPGMC), capable of operating up to 10 bar pressure and a maximum drift field close to 1000 V/cm.

T 108: Combined instrumentation session II: Silicon strip detectors (joint session HK/T)

Time: Friday 11:00–13:00 Location: H-HS XIII

T 108.1 Fri 11:00 H-HS XIII

Investigation of Irradiated silicon strip Sensors using the Trasient Current Technique — •Nicky Potters[1], Christian Scharf[2], Heiko Lacker[2], Ingo Bloch[3], and Johanna Stachel[1] — [1]Ruprecht-Karls-Universität Heidelberg, Heidelberg ,Germany — [2]Humboldt-Universität zu Berlin, Berlin, Germany — [3]Deutsches Elektronen-Synchrotron (DESY), Zeuthen, Germany

A new edge-TCT setup has been built and commissioned at DESY Zeuthen. The setup allows for charge injection at defined depth or at the surface of un-irradiated and irradiated ATLAS17LS silicon strip sensors using red and infrared laser light with 100 ps pulse width and a minimum beam diameter of $w_0 = 7\mu$m. The current induced by the injected carriers is measured with GHz bandwidth electronics in up to four channels and information on the electric field and other quantities can be extracted at defined positions in the sensors. Results of the commissioning of the setup using non-irradiated silicon strip sensors as well as measurements of irradiated strip sensors will be presented. The sensors were irradiated with 70 MeV/c protons to equivalent fluences of $1.0 \cdot 10^{13}$ cm^{-2}, $3.7 \cdot 10^{14}$ cm^{-2}, $1.0 \cdot 10^{15}$ cm^{-2}, $1.3 \cdot 10^{16}$ cm^{-2} and with 1 MeV neutrons to $4.0 \cdot 10^{14}$ cm^{-2}, $1.0 \cdot 10^{14}$ cm^{-2}, $1.3 \cdot 10^{15}$ cm^{-2}, and $5.0 \cdot 10^{16}$ cm^{-2}. The position-dependent electric field has been determined by using a new method of fitting the edge-TCT data. Additionally, strip sensors with different strip metal and strip implant widths have been studied.

T 108.2 Fri 11:15 H-HS XIII

Analysis of 2.7 GeV proton-beam measurements with the STS detector for the CBM experiment — •Patrick Pfistner for the CBM-Collaboration — Karlsruhe Institute of Technology

The Compressed Baryonic Matter (CBM) experiment at the future Facility for Antiproton and Ion Research (FAIR) in Darmstadt, Germany, aims to explore the quantum chromodynamics phase diagram for highest baryon densities. CBM will measure rare probes with high statistics which requires fast and radiation hard detectors combined with free-streaming readout electronics. One of the core detectors of CBM is the Silicon Tracking System (STS). The STS is the key detector for measuring the momentum and tracks of up to 800 charged particles produced in Au+Au collisions happening at interaction rates of up to 10 MHz. In order to evaluate the detector performance, comprehensive tests have been performed with a minimum ionizing particle beam at the COSY accelerator in Jülich in November 2019. During the beamtime, one fully assembled prototype module consisting of a double-sided Silicon microstrip sensor, 32 low-mass aluminum micro-

cables, 16 STS-XYTER 2.1 readout ASICs and two front-end boards (FEB-8), has been exposed to a 2.7 GeV proton beam. We will present the status of the beamtime data analysis and discuss the related detector performance metrics.

T 108.3 Fri 11:30 H-HS XIII

First beam test with the final readout scheme of Phase-2 CMS Outer Tracker 2S prototype modules — •Christian Dziwok[2], Lutz Feld[1], Katja Klein[1], Martin Lipinski[1], Alexander Pauls[1], Oliver Pooth[2], Max Rauch[1], Nicolas Röwert[1], and Tim Ziemons[2] — [1]I. Physikalisches Institut B, RWTH Aachen University — [2]III. Physikalisches Institut B, RWTH Aachen University

For the upcoming Phase-2 Upgrade for the operation of CMS at the HL-LHC a new silicon tracker design will be implemented. With extended acceptance and giving additional input of track p_T to the level-1 trigger, the new Outer Tracker will consist of 2S modules with two coplanar strip sensors and PS modules with a macro-pixel sensor and a strip sensor. Therefore, for these specialized detector modules the p_T information of a track is already available online. Based on cluster size and position in a module's sensors and its sensor spacing, a first p_T trigger information is generated in its front-end ASIC and then constantly streamed to the back end at bunch crossing rate.

The final front-end ASIC CBC 3.1 was used alongside the concentrator ASIC CIC v1 and the serializer- and slow control ASICs GBTx and SCA without additional interface card for the first time. This final readout scheme of 2S modules has been tested with up to 4 modules at once at the test beam facility of DESY Hamburg using a 4 GeV electron beam and the AIDA telescope. This talk will showcase the efficiency of the new p_T discrimination mechanism and the test on synchronicity of modules.

T 108.4 Fri 11:45 H-HS XIII

Abschätzung des Signal- und Leckstromverhaltens im äußeren CMS Phase-2 Spurdetektors — Felix Bögelspacher, Tobias Bravich, Alexander Dierlamm, Umut Elicabuk, Jan-Ole Gosewisch, Ulrich Husemann, •Marius Metzler und Thomas Müller — Institut für Experimentelle Teilchenphysik, Karlsruher Institut für Technologie

Im September 2019 wurde die finale Entscheidung bezüglich des verwendeten Sensormaterials für den äußeren Bereichs des zukünftigen CMS-Spurdetektors gefällt. Der jetzige Spurdetektor wird im Rahmen der Phase-2 Aufrüstung des CMS-Detektors komplett ausgetauscht und durch neuere Komponenten ersetzt. Die verwendeten Streifensensortypen, der 2S und der PS-s, sowie der Makropixelsensor PS-p, werden auf FZ290 Siliziumwafern prozessiert werden. Dabei handelt es sich um float zone Wafer mit einer physikalischen Dicke von 320 μm und einer 30 μm dicken, hochdotierten Rückseitenimplantation, welche die aktive Dicke auf 290 μm reduziert.

Im Zuge des Forschungs- und Entwicklungsprozesses wurden Bestrahlungsstudien mit Signal- und Leckstrommessungen an FZ290 Sensoren für durchgeführt. Der Vortrag zeigt, wie diese Daten verwendet werden können, um die jährliche, optimale Operationsspannungen für verschiedene Bereiche des äußeren CMS Phase-2 Spurdetektors abzuschätzen. Daraus lassen sich dann Leckstrom und die benötigte Kühlleistung ableiten.

T 108.5 Fri 12:00 H-HS XIII

Quality assurance of the CBM Silicon Tracking System sensors — •Evgeny Lavrik for the CBM-Collaboration — Facility for Antiproton and Ion Research, Darmstadt, Germany

The Compressed Baryonic Matter (CBM) experiment at FAIR aims to study the properties of nuclear matter at high net-baryon densities. The Silicon Tracking System is the key detector to reconstruct charged particle tracks created in heavy-ion interactions. In order to assure the quality of more than 1100 silicon sensors including spares, highly efficient and highly automated procedures were developed.

In this contribution we report on the optical and electrical quality assurance procedures for silicon sensors. We describe dedicated hardware setups to perform basics tests and full characterization and their application for the quality assurance of the STS sensors. We present the results of ongoing QA campaign of sensors from mass production which begun in November 2019.

T 108.6 Fri 12:15 H-HS XIII

Silicon strip detector set-up for α-particle detection at MAGIX — •Jennifer Geimer for the MAGIX-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität, Mainz, Germany

The MAGIX experiment will take place at the energy recovering superconducting electron accelerator MESA in Mainz. At MAGIX high-precision electron scattering experiments will be performed. The experimental set-up is currently under development, it comprises a windowless gas target and two identical high-resolution magnetic spectrometers including a GEM-based TPC. Additionally, a silicon strip detector is planned to detect recoil particles in the scattering chamber. Its resolution requirements are derived from simulation studies of the $^{16}O(\gamma^*,\alpha)^{12}C$ reaction, which we will examine to determine the S-factor of the nucleosynthesis reaction of carbon and alpha. The design of this detector system and first performance studies will be presented in this talk.

T 108.7 Fri 12:30 H-HS XIII

Studying magnet-induced wire-bond oscillations for the ATLAS ITk Strip Detector — •Ben Brüers[1], Ruchi Gupta[1], Ksenia Solovieva[2], Dennis Sperlich[3], and Edoardo Rossi[1] — [1]DESY — [2]Imperial College London — [3]Albert-Ludwigs-Universität Freiburg

For the high luminosity phase of the LHC, the ATLAS collaboration plans to upgrade its current tracking detector with a new, all silicon Pixel and Strip Detector, referred to as Inner Tracker (ITk). The ITk Strip Detector modules will contain printed circuit flex boards carrying the read-out and powering chips. All chips will be connected to the printed circuit flex boards using 25 μm thick aluminium wire-bonds. Several of these wire-bonds will carry alternating currents. In the 2 T solenoid magnetic field of ATLAS surrounding the ITk, these wire-bonds can start oscillating. Damage by oscillations have been observed e.g. at the CDF detector, when the trigger frequency (and with that the alternating current frequency) accidentally aligned with the resonance frequency of the wire-bonds. To study the potential danger of resonant wire-bond oscillations for the ITk Strip Detector, a prototype module was exposed to a 1 T magnetic field and triggered at multiple frequencies between 0.1 kHz and 350 kHz. To observe oscillations, an innovative observation setup was employed and several hours of video material collected. While the module was not damaged, the search for wire-bond oscillations in the video material is on-going. This talk will introduce the procedure and show the latest results on assessing the resonant frequencies and sensitivities of the ITk Strip Detector wire-bonds to magnet-induced oscillations.

T 108.8 Fri 12:45 H-HS XIII

characterization and operation of the frontend electronics of the CBM silicon tracking system — •Osnan Maragoto Rodriguez for the CBM-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

The Compressed Baryonic Matter (CBM) experiment is a fixed-target heavy-ion physics experiment at the Facility for Antiproton and Ion Research (FAIR) in Darmstadt, Germany. The CBM physics program aims at exploring the QCD phase diagram at very high baryon densities. For high-statistics measurements of rare probes, CBM is designed to cope with very high interaction rates up to 10 MHz. To achieve this high rate capability, the CBM experiment will be equipped with fast and radiation hard detectors employing free-streaming readout electronics. The Silicon Tracking System (STS) is the essential component for tracking up to 1000 charged particles per event in A+A collision. The experimental conditions pose demanding requirements in terms of channel density and read-out bandwidth. The STS-XYTER is a dedicated ASIC for the readout of the double-sided silicon micro-strip sensors. It is a low power, self-triggering ASIC with 128 channels, 5-bit ADC charge and 14-bit timing information. It needs to be fully integrated into a very confined space and it should perform in a highly irradiated environment with strong magnetic field. Several tests are carried out to check chip functionalities, full detector modules performance and integration aspects. An overview of the frontend electronic, module tests and experimental results, for different data taking scenarios, will be presented.

T 109: Combined instrumentation session III: Silicon pixel detectors (joint session HK/T)

Time: Friday 11:00–12:45 Location: J-HS K

T 109.1 Fri 11:00 J-HS K

ATLASPix3 – A reticle sized HV-CMOS Detector for Construction of Multi-Sensor Modules — •Rudolf Schimassek[1], Felix Ehrler[1], Mridula Prathapan[1], Alena Weber[1,2], Winnie Wong[3], Hui Zhang[1], and Ivan Perić[1] — [1]Karlsruher Institut für Technologie — [2]Universität Heidelberg — [3]Université de Genève

Monolithic High-Voltage CMOS (HV-CMOS) detectors are a sensor type planned to be used for tracking in several particle physics experiments. HV-CMOS Sensors are especially well suited for applications with strict constraints on mass and spatial resolution. In addition, low power and radiation hardness, along with good time resolution are possible. Furthermore, the usage of standard CMOS processes makes the detectors highly available and cheap.

To overcome the mask size limit of HV-CMOS processes, the ATLASPix3 detector is designed to be used in multi-chip modules. It is a 2×2.1 cm^2 three side buttable pixel sensor, designed for the environment of layer 4 of the ATLAS inner tracker upgrade for High-Luminosity LHC. A single data input and a single data output are sufficient to control and read out the detector using protocols that are RD53 compatible. The detector was produced on a high resistivity substrate and the first production shows a good yield. In this contribution, measurements of the detector features and performances will be presented.

T 109.2 Fri 11:15 J-HS K

CMS Phase-1 pixel detector never sleeps: results from the Hamburg group — •Irene Zoi, Finn Feindt, Alexander Froehlich, Erika Garutti, Johannes Haller, Andreas Hinzmann, Viktor Kutzner, Torben Lange, Malte Mrowietz, Yuval Nissan, Peter Schleper, Dennis Schwarz, Jory Sonneveld, Georg Steinbrueck, and Benedikt Vormwald — University of Hamburg

The CMS Phase-1 Pixel detector has already been successfully operated for two years and has collected more than a 100 fb^{-1} of data and consequently radiation. During the ongoing shut down it has been extracted from the experiment and has been kept cold and monitored in a clean environment. The Hamburg group has been involved in all these operations and continues to control the status of the detector, to study the collected data to improve our knowledge of radiation damage and make predictions for future data taking. In this talk a broad overview of the achievements of the group will be offered. The radiation study on data and simulation will be covered. These are based on leakage current and cluster charge. The progress in detector monitoring in clean room and in the on-line monitoring tools and database will be presented. The improvements for the future data acquisition will be also described.

T 109.3 Fri 11:30 J-HS K

First measurements with an ALPIDE MAPS telescope in an 40-Ar test beam at GSI — •Pascal Becht for the ALICE-Collaboration — GSI Helmholzzentrum für Schwerionenforschung, Darmstadt, Germany

In the framework of the ALICE Inner Tracking System (ITS) upgrade during LHC's long shutdown 2, a new silicon sensor chip was developed and produced. This ALICE Pixel Detector (ALPIDE) chip is entirely built up of Monolithic Active Pixel Sensors (MAPS) and can be thinned down to 50 μm. It features a low material budget of only 0.05% X/X_0 as well as a position resolution in the order of 5 μm, which makes it suitable for the use in high-resolution beam telescopes.

In order to investigate the detector performance different beam tests with e. g. proton or pion beams have been performed using an ALPIDE MAPS telescope. To study the performance of such telescopes being irradiated with highly ionising particles, a 7-layer ALPIDE MAPS telescope has been brought to GSI and installed in a test beam area. In this talk, first results of this 50 MeV/u 40-Ar beam test at GSI are discussed.

T 109.4 Fri 11:45 J-HS K

Results from the MIMOSIS-0 CMOS Monolithic Active Pixel Sensor — •Benedict Arnoldi-Meadows for the CBM-MVD-Collaboration — Goethe Universität Frankfurt am Main

The next generation CMOS Monolithic Active Pixel Sensor MIMOSIS is being developed to respond to the challenges imposed by future applications including the CBM Micro Vertex Detector. The project, which is carried out by the PICSEL group of IPHC Strasbourg and the Goethe University Frankfurt, aims for a 50 μm thin and ~ 5 cm^2 sized sensor. This sensor will host 1024×504 pixels with a size of 26.9×30.2 μm^2. The pixels include the amplifier-shaper-discriminator chain known from the ALPIDE chip which was extended to achieve a compatibility with a fully depleted sensing element. Moreover, MIMOSIS will feature a continuous readout suited for a readout time of 5 μs and peak rates of 70 MHz/cm^2.

We show results from measurements performed with the preamplifier of a first prototype called MIMOSIS-0, which indicate that a time resolution well below 1 μs might be within reach. *This work has been supported by BMBF ErUM-FSP C.B.M. (05P19RFFC1), GSI and HIC for FAIR.

T 109.5 Fri 12:00 J-HS K

Experiences with long-term operation of a CBM-MVD prototype module. — •Michal Koziel for the CBM-MVD-Collaboration — Goethe Universität Frankfurt

The Compressed Baryonic Matter Experiment (CBM) is one of the core experiments of the future FAIR facility. It will explore the phase diagram of strongly interacting matter in the regime of high net baryon densities with numerous probes, among them open charm. The Micro Vertex Detector (MVD) will contribute to the secondary vertex determination on a 10 μm scale, reconstruction of weak decays of multi-strange baryons, and low-momentum track reconstruction. The detector comprises four stations placed next to the target in vacuum. The stations will be populated with 50 μm thin, highly granular customized CMOS Monolithic Active Pixel Sensors (MAPS) called MIMOSIS.

The integration of the mechanically fragile MAPS to vacuum compatible detector stations was studied within the PRESTO project. This project aimed for building a quarter of a detector station including the necessary vacuum compatible cooling system and the steering electronics. The study was carried out with elder MIMOSA-26 sensors, which are considered as a representative precursor of the final sensor technology. We report the outcome of this study and the observations made while operating PRESTO for several months under vacuum conditions.

*This work has been supported by BMBF ErUM-FSP C.B.M. (05P19RFFC1), GSI and HIC for FAIR.

T 109.6 Fri 12:15 J-HS K

The MuPix10 - design and status — •Alena Weber for the Mu3e-Collaboration — Physikalisches Institut, Universität Heidelberg — Karlsruher Institut für Technologie

The Mu3e experiment is going to search for the charged lepton flavour violating decay $\mu^+ \to e^+e^-e^+$ with a sensitivity of one in 10^{16} decays (in phase II). High Voltage Monolithic Active Pixel Sensors (HV-MAPS) with a minimal gate length of 180nm will be used for its tracking system which will be the core element of the detector.

In the last years several prototypes of different size for the Mu3e pixel sensors were designed and tested. In 2019 the latest version of the MuPix, the MuPix10, was submitted. MuPix10 is a chip of full reticle size (2.066 x 2.318 cm^2) and contains a pixel matrix with 256 columns each with 250 pixels. The pixel size is 80 um x 80 um. The readout buffer has two different operation modes, one providing ToT measurement and one implementing a two threshold method. Some new elements have been added, for example a delay circuit. The timestamp was extended to 11 bit, the ToT has now 5 bit. The pixels are organized together with the readout buffer and the end of column in a double column architecture.

In this contribution the MuPix10 design and the next steps will be presented.

T 109.7 Fri 12:30 J-HS K

TCAD Simulation of High-Voltage Monolithic Active Pixel Sensors — •Annie Meneses Gonzalez, Heiko Augustin, and Andre Schöning — Physikalisches Institut, Universität Heidelberg

The requirements for precision physics and the experimental conditions of several Particle Physics experiments lead often to challenging tracking detectors. High-Voltage Monolithic Active Pixel Sensors (HV-

MAPS) implemented in a commercial 180 nm High-Voltage CMOS process has been chosen as the baseline for the Mu3e Pixel Tracker and are under study for the application in future detectors like PANDA, P2, CLIC, and LHCb.

A full depletion over the pixel, a fast charge collection, and a high signal-to-noise ratio are essential to achieve highly efficient sensors and good time resolutions.

Technology Computer-Aided Design (TCAD) simulations have been used to develop and optimize HV-MAPS, aiming for a comprehensive understanding of the sensor characteristics. Simulation results of the pixel capacitance for different prototypes and pixel sizes will be presented.

T 110: Combined instrumentation session IV: Semiconductor detectors (joint session HK/T)

Time: Friday 11:00–13:00 Location: H-HS XV

T 110.1 Fri 11:00 H-HS XV

Investigation of light enhanced annealing of irradiated silicon strip detectors and pad diodes — •Mägdefessel Sven, Parzefall Ulrich, and Mori Riccardo — Uni Freiburg, Germany

Thermally induced annealing of irradiated silicon devices has been widely studied. Latest results indicate that charge carriers being generated during the annealing procedure can change charge states of the defect centers and therefore influence the annealing behaviour. Therefore, we irradiated silicon strip detectors and pad diodes during the annealing process with IR and green light to achieve different penetration depths and performed CV based impedance spectroscopy to investigate differences in defect behaviour compared to annealing in the dark.

T 110.2 Fri 11:15 H-HS XV

Temperature Scaling of Leakage Current in Irradiated Silicon Sensors — •Felix Wizemann, Kevin Kröninger, and Jens Weingarten — TU Dortmund, Experimentelle Physik IV

The leakage current of silicon sensors increases with radiation damage, which can be used to monitor fluence. For this, the bulk leakage current needs to be scaled with temperature using the parameter E_{eff}. In previous studies, this parameter was determined to be 1.21 eV for samples irradiated to fluences up to $1 \times 10^{15}\,\mathrm{n_{eq}cm^{-2}}$. Sensors irradiated to higher fluences have shown lower values of E_{eff}.

To investigate this change in scaling behaviour, E_{eff} was determined as a function of the applied bias voltage for irradiated samples with fluences from $1 \times 10^{14}\,\mathrm{n_{eq}cm^{-2}}$ to $3 \times 10^{15}\,\mathrm{n_{eq}cm^{-2}}$. Results of this study are presented in this talk.

T 110.3 Fri 11:30 H-HS XV

Studie zur Auswirkung von Strahlenschäden auf die Zwischenstreifenisolation von n-in-p Siliziumstreifensensoren — Felix Bögelspacher, Alexander Dierlamm, Thomas Müller, •Jan-Ole Müller-Gosewisch, Andreas Nürnberg, Hans Jürgen Simonis und Pia Steck — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

Der Gebrauch von n-in-p Siliziumstreifensensoren erfordert eine spezifische Zwischenstreifenisolation. Ohne diese kommt es insbesondere nach Bestrahlung durch Akkumulation von Ladungsträgern an der Oberfläche zu einem Kurzschluss der Streifen und einer Verringerung der Ortsauflösung. Ein Maß für die Güte der Isolation ist der Zwischenstreifenwiderstand. Entgegen den Erwartungen wurde bei Sensoren ohne spezifische Isolation ein ausreichend hoher Widerstand zwischen den Streifen nach Protonenbestrahlung mit einer Fluenz von $10^{15}\mathrm{n_{eq}/cm^2}$ beobachtet. Für ein genaueres Verständnis der beitragenden Effekte auf die Streifenisolation wurden Sensoren ohne Zwischenstreifenimplantat mit Röntgenstrahlen, Protonen und Neutronen bestrahlt. In diesem Vortrag werden Messungen und Simulationen der Zwischenstreifenwiderstände für unterschiedlichen Bestrahlungszusammensetzungen gezeigt und bewertet.

T 110.4 Fri 11:45 H-HS XV

Study of thermal runaway of hadron-irradiated silicon sensors — Ingo Bloch[1], Heiko Lacker[2], •Felix Riemer[2], and Christian Scharf[2] — [1]Deutsches Elektronen-Synchrotron DESY — [2]Humboldt-Universität zu Berlin

Silicon sensors are widely used in the several parts of the ATLAS detector at the LHC. Low leakage current is desirable since the leakage current generates heat. At the same time the leakage current increases with increasing sensor temperature. Thermal runaway will occur if the heat removed from the sensor is lower than the heat generated by the sensor. During operation the silicon sensors at hadron colliders are exposed to high fluences of highly energetic particles which introduce defects in the crystal lattice strongly increasing the leakage current. The cooling infrastructure of the detector has to be adapted order to prevent thermal runaway during operation until the end-of-life. Therefore, the capacitance and current of irradiated silicon diodes have been measured as a function of the particle fluence, temperature, bias voltage, heating power, and for different pad areas. The diodes were irradiated with 70 MeV/c protons and 1 MeV/c neutrons to equivalent fluences between $1 \cdot 10^{13}$ cm^{-2} and $5 \cdot 10^{16}$ cm^{-2}. The goal of the study is to develop models for the capacity and reverse current of highly irradiated silicon sensors which can be used to estimate the cooling power needed to prevent thermal runaway while fully depleting the sensors after high particle fluences.

T 110.5 Fri 12:00 H-HS XV

R&D for the Cooling Demonstrator of the CBM Silicon Tracking System (STS) — •Kshitij Agarwal for the CBM-Collaboration — Physikalisches Institut der Universität Tübingen

As the core detector of the CBM experiment, the Silicon Tracking System (STS) located in the dipole magnet aims to reconstruct charged-particle tracks & momentum from beam-target interactions.

Due to the expected non-ionising irradiation damage (fluence - 10^{14} $\mathrm{n}_{eq}(1\mathrm{MeV})/\mathrm{cm}^2$), the silicon microstrip sensors will dissipate < 6 mW/cm^2 at -10°C. Thus it is imperative to keep the sensors at or below -10°C at all times to avoid thermal runaway and reverse annealing by forced N_2 cooling. The corresponding electronics connected via ultra-thin microcables are placed outside detector acceptance with a dedicated cooling system used to remove $\sim$ 40kW power dissipated.

To experimentally verify the aforementioned concepts under realistic mechanical constraints, a thermal demonstrator comprising a half-layer of STS is under development. This contribution will describe the electronics cooling system design and respective cooling performance simulations. Experimental proof-of-principle tests/simulations with 3M$^{\mathrm{TM}}$ Novec$^{\mathrm{TM}}$ 649 for electronics cooling and air cooling for silicon sensor cooling will be shown. Lastly, future plans on the demonstrator integration and design will be also presented.

This work is supported by GSI/FAIR.

T 110.6 Fri 12:15 H-HS XV

Ultra Fast Silicon Detectors for timing applications in HADES — •Wilhelm Krueger[1], Nicolo Cartiglia[2], Marco Ferrero[2,3], Tetyana Galatyuk[1,4], Mladen Kis[4], Wolfgang Koenig[4], Michal Koziel[5], Sergey Linev[4], Jan Michel[5], Stefano Moneta[6], Jerzy Pietraszko[4], Adrian Rost[1], Arnaud Schemm[7], Valentina Sola[2], Konrad Sumara[8], Michael Traeger[4], Michael Traxler[4], and Christian Wendisch[4] — [1]TU Darmstadt, Germany — [2]INFN, Sezione di Torino, Italy — [3]Università del Piemonte Orientale, Novara, Italy — [4]GSI, Darmstadt, Germany — [5]Goethe-Universität Frankfurt, Germany — [6]Universita di Pisa, Italy — [7]IMT Atlantique, Campus de Nantes, France — [8]Jagiellonian University in Kraków, Poland

In order to measure a precise time zero (T0) for particle identification produced in nucleon-nucleon or nucleus-nucleus collisions a time precision of 50 ps or better is required. Ultra fast silicon detectors (UFSD) enable such precision. In addition the combination of high spatial resolution, high time precision and high radiation hardness makes them an excellent alternative to the scCVD diamond detectors used so far by HADES for T0 measurements and for beam monitoring.

In this contribution we present the results of test measurements conducted at COSY in Juelich. Particular emphasis is put on achieving the desired precision for MIPs and on comparison of two different discriminator boards, one based on the NINO chip and the other, called

PaDiWa, which is based on discrete components. This work has been supported by BMBF under ErUM -FSP C.B.M. and GSI.

T 110.7 Fri 12:30 H-HS XV

A precision floating, high-voltage picoamperemeter — •Florian Rössing, Tobias Rudolph, Dimitri Schaab, and Bernhard Ketzer — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

Many modern tracking detectors, e.g. the Time Projection Chambers for ALICE and CBELSA, are based on Micropattern Gaseous Detector (MPGD) technology. In the examples given above, Gas Electron Multipliers (GEM) will be used for the amplification of primary charges. The optimization of MPGD often requires current measurements at the level of picoamperes on the high-voltage lines. Therefore, currentmeters with a complete electrical insulation from ground are needed, requiring wireless data transmission and floating power supply. Previous versions of devices custom-made at TU München and further developed at Bonn University showed problems with the overvoltage-protection, a residual non-linearity and a non-negligible temperature dependence. In order to overcome these issues the analog signal processing was completely revised. The shunt resistor configuration in use was replaced by a zero burden transimpedance amplifier, with high input impedance. A precise temperature sensor and a photovoltaic powering were added. In the talk design characteristics and the performance of the devices will be discussed.

T 110.8 Fri 12:45 H-HS XV

Automatized dark current measurement system for irradiated SiPM detectors in COSY — •Anoop Nagesh Koushik for the JEDI-Collaboration — Forschungszentrum Jülich GmbH — III. Physikalisches Institut B, RWTH Aachen University

The JEDI (Jülich Electric Dipole moment Investigations) collaboration performs Electric Dipole Moments (EDM) experiments with deuteron beams at COSY (COoler Synchrotron) accelerator in Forschungszentrum Jülich. The beam is polarized and the determination of the polarization is based on a polarimeter using LYSO scintillators coupled to SiPM (Silicon Photo-Multiplier) modules. SiPM are preferred over traditional PMT's because of absence of high electric fields near the beam which affects the EDM measurements.

SiPMs near the beam pipe were accidentally exposed to intense radiation and were damaged. This radiation damage adds noise to the signal and hence decreases the resolution of the detector. The dark current of the irradiated SiPM was characterized and was found to be orders of magnitude higher.

An automatized system of dark current measurement for different SiPM reverse bias voltages was developed. 8x8 array mapping of the SiPM was designed to analyze the extent of the damage of the irradiated SiPM. Few SiPM arrays were annealed several times at different temperatures and was compared to the previous annealed results to determine the reduction of the damage. Extent of damage, the results of annealing and the comparison between them for the irradiated SiPM will be presented and discussed in the talk.