Fachverband Teilchenphysik (T)

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Übersicht der Hauptvorträge und Fachsitzungen

(Hörsäle H01 – H04, H06 – H11, S01 – S03, S05 – S07, S09 – S16,
ST 1 – ST 4, ST 7 und ST 8; Poster C.A.R.L. Foyer 1. OG)

Plenarprogramm

PV I	Di	9:00– 9:45	H01	**Particle Physics in the light of the LHC Run 2** — •Klaus Mönig
PV II	Di	19:30–21:00	H01	**Auf der Suche nach Dunkler Materie und Antimaterie im Weltraum - Das AMS Experiment auf der Internationalen Raumstation** — •Stefan Schael
PV III	Mi	9:00– 9:45	H01	**"Die Batterie entscheidet, wie viel Strom sie gibt" - Schülervorstellungen und Physikunterricht** — •Horst Schecker

Mittagsvorträge

AKjDPG/AIW 1.1	Di	13:00–13:30	H11	**Kann man Karriere planen? Als Physiker in der Unternehmensberatung** — •Rolf Loschek
AKjDPG/AIW 2.1	Mi	13:00–13:30	H11	**Physik ist der Schlüssel! Einsatzfeld Finanzbranche** — •Erik Bartel, •Henning Sedello
AKjDPG/AIW 3.1	Do	13:00–13:30	H11	**Als Physiker an der Schnittstelle zwischen Forschung und Politik** — •Stefan Mengel

Hauptvorträge

T 23.1	Di	9:45–10:30	H01	**Neuer Schwung für alten Kandidaten: Die Suche nach dunkle Materie Axionen und ALPs** — •Béla Majorovits
T 24.1	Di	11:00–11:45	H01	**Direkte Suchen nach neuer Physik – Zwischenbilanz LHC Run2** — •Andreas Hinzmann
T 24.2	Di	11:45–12:30	H01	**Neutrinos from Distant Galaxies** — •Christopher Wiebusch
T 47.1	Mi	9:45–10:30	H01	**ATLAS and CMS detector status and upgrades** — •Benedikt Vormwald
T 48.1	Mi	11:00–11:45	H01	**The Quest for the Nature of Dark Matter: Direct Searches** — •Uwe G. Oberlack
T 48.2	Mi	11:45–12:30	H01	**Progress in QCD calculations and applications to LHC physics** — •Giulia Zanderighi
T 72.1	Do	9:00– 9:45	H01	**Next generation high energy e+e- colliders** — •Jorg Wenninger
T 72.2	Do	9:45–10:30	H01	**Flavour anomalies** — •Johannes Albrecht
T 73.1	Do	11:00–11:45	H01	**Timing detectors** — •Lucia Masetti
T 73.2	Do	11:45–12:30	H01	**Getting to know the Higgs boson** — •Sarah Heim
T 98.1	Fr	9:00– 9:45	H01	**Recent developments in low energy neutrino physics: chances and challenges** — •Werner Maneschg
T 98.2	Fr	9:45–10:30	H01	**Gauge/gravity duality and particle physics: New approaches to strongly coupled sectors** — •Johanna Erdmenger
T 99.1	Fr	11:00–11:45	H01	**The Standard Model and the top quark at the LHC** — •Ian Brock
T 99.2	Fr	11:45–12:30	H01	**Don't be a WIMP - new ideas for light dark matter** — •Felix Kahlhöfer

Fachsitzungen

T 1.1–1.1	Mo	14:45–15:30	H01	**Preisträgervortrag Teilchenphysik**
T 2.1–2.10	Mo	16:00–18:30	H02	**Halbleiterdetektoren I**
T 3.1–3.10	Mo	16:00–18:30	H04	**Higgs: Produktion und Zerfälle**
T 4.1–4.10	Mo	16:00–18:30	H06	**Deep Learning I**
T 5.1–5.10	Mo	16:00–18:35	H07	**Suche nach Neuen Teilchen I**
T 6.1–6.8	Mo	16:00–18:00	H08	**Andere Gebiete der Theorie und Post-Deadline-Vorträge**
T 7.1–7.9	Mo	16:00–18:20	H09	**Direkte Suche nach Dunkler Materie I**
T 8.1–8.8	Mo	16:00–18:20	S06	**Neutrinophysik I**
T 9.1–9.10	Mo	16:00–18:30	S07	**Higgs: Erweiterte Modelle**
T 10.1–10.9	Mo	16:00–18:15	S09	**Dunkle Materie und Kollider I**
T 11.1–11.10	Mo	16:00–18:30	S10	**Neutrino-Astronomie I**
T 12.1–12.10	Mo	16:00–18:30	S12	**Astroteilchenphysik: Methoden I**
T 13.1–13.9	Mo	16:00–18:20	S13	**Kosmische Strahlung I**
T 14.1–14.10	Mo	16:00–18:35	S14	**Elektroschwache Wechselwirkung**
T 15.1–15.10	Mo	16:00–18:35	S15	**CP-Verletzung und Mischung**
T 16.1–16.7	Mo	16:00–17:45	S16	**Theorie: Beyond the Standard Model und Quantenfeldtheorie**
T 17.1–17.10	Mo	16:00–18:30	ST 1	**Kalorimeter**
T 18.1–18.10	Mo	16:00–18:35	ST 2	**DAQ und Trigger I**
T 19.1–19.10	Mo	16:00–18:35	ST 3	**Myondetektoren**
T 20.1–20.10	Mo	16:00–18:30	ST 4	**Detektorsysteme I**
T 21.1–21.10	Mo	16:00–18:30	ST 7	**Kosmische Strahlung, Propagation**
T 22.1–22.12	Mo	16:00–18:30	C.A.R.L. Foyer 1. OG	**Poster**
T 23.1–23.1	Di	9:45–10:30	H01	**Hauptvorträge I**
T 24.1–24.2	Di	11:00–12:30	H01	**Hauptvorträge II**
T 25.1–25.3	Di	14:00–15:30	H02	**Eingeladene Vorträge I**
T 26.1–26.3	Di	14:00–15:30	H03	**Eingeladene Vorträge II**
T 27.1–27.10	Di	16:00–18:30	H03	**Halbleiterdetektoren II**
T 28.1–28.10	Di	16:00–18:35	H04	**Higgs-Zerfälle in Fermionen I**
T 29.1–29.10	Di	16:00–18:30	H06	**Deep Learning II**
T 30.1–30.10	Di	16:00–18:30	H07	**Suche nach Neuen Teilchen II**
T 31.1–31.9	Di	16:00–18:15	H09	**Direkte Suche nach Dunkler Materie II**
T 32.1–32.9	Di	16:00–18:35	S06	**Neutrinophysik II**
T 33.1–33.10	Di	16:00–18:30	S07	**Neutrino-Detektoren I**
T 34.1–34.7	Di	16:00–17:45	S09	**Axionen I**
T 35.1–35.9	Di	16:00–18:15	S10	**Top-Physik I**
T 36.1–36.10	Di	16:00–18:30	S11	**Supersymmetrie I**
T 37.1–37.10	Di	16:00–18:30	S12	**Astroteilchenphysik: Methoden II**
T 38.1–38.10	Di	16:00–18:30	S13	**Kosmische Strahlung II**
T 39.1–39.9	Di	16:00–18:25	S14	**Gamma-Astronomie I**
T 40.1–40.10	Di	16:00–18:30	S15	**Flavorphysik I**
T 41.1–41.9	Di	16:00–18:15	S16	**Theorie: Beyond the Standard Model**
T 42.1–42.10	Di	16:00–18:35	ST 1	**Experimentelle Methoden I**
T 43.1–43.10	Di	16:00–18:30	ST 2	**DAQ und Trigger II**
T 44.1–44.10	Di	16:00–18:35	ST 3	**Gasgefüllte Detektoren**
T 45.1–45.9	Di	16:00–18:15	ST 4	**Detektorsysteme II**
T 46.1–46.10	Di	16:00–18:30	ST 8	**Theorie: QCD**
T 47.1–47.1	Mi	9:45–10:30	H01	**Hauptvorträge III**
T 48.1–48.2	Mi	11:00–12:30	H01	**Hauptvorträge IV**
T 49.1–49.3	Mi	14:00–15:30	H02	**Eingeladene Vorträge III**
T 50.1–50.3	Mi	14:00–15:30	H03	**Eingeladene Vorträge IV**
T 51.1–51.9	Mi	16:00–18:15	H03	**Halbleiterdetektoren III**
T 52.1–52.9	Mi	16:00–18:15	H04	**Higgs-Zerfälle in Fermionen II**
T 53.1–53.10	Mi	16:00–18:30	H07	**Suche nach Neuen Teilchen III**
T 54.1–54.9	Mi	16:00–18:25	H09	**Direkte Suche nach Dunkler Materie III**
T 55.1–55.9	Mi	16:00–18:30	S06	**Neutrinophysik III**
T 56.1–56.10	Mi	16:00–18:30	S07	**Neutrino-Detektoren II**
T 57.1–57.7	Mi	16:00–17:50	S09	**Axionen II**

T 58.1–58.7	Mi	16:00–17:45	S10	**Top-Physik II**
T 59.1–59.9	Mi	16:00–18:15	S11	**Grid-Computing und Software**
T 60.1–60.9	Mi	16:00–18:15	S12	**Astroteilchenphysik: Methoden III**
T 61.1–61.9	Mi	16:00–18:25	S13	**Kosmische Strahlung III**
T 62.1–62.10	Mi	16:00–18:35	S14	**Neutrino-Astronomie II**
T 63.1–63.10	Mi	16:00–18:30	S15	**Flavorphysik II**
T 64.1–64.9	Mi	16:00–18:15	S16	**Theorie: Dunkle Materie**
T 65.1–65.10	Mi	16:00–18:30	S01	**Experimentelle Methoden II**
T 66.1–66.10	Mi	16:00–18:30	S02	**DAQ und Trigger III**
T 67.1–67.10	Mi	16:00–18:30	S03	**Detektorsysteme III**
T 68.1–68.9	Mi	16:00–18:15	H08	**Detektorsysteme IV**
T 69	Mi	16:00–18:00	S05	**KET Meeting**
T 70.1–70.7	Mi	16:00–17:45	H10	**QCD (Experiment)**
T 71.1–71.10	Mi	16:00–18:30	H11	**Theorie: Flavorphysik**
T 72.1–72.2	Do	9:00–10:30	H01	**Hauptvorträge V**
T 73.1–73.2	Do	11:00–12:30	H01	**Hauptvorträge VI**
T 74.1–74.3	Do	14:00–15:30	H02	**Eingeladene Vorträge V**
T 75.1–75.3	Do	14:00–15:30	H03	**Eingeladene Vorträge VI**
T 76.1–76.10	Do	16:00–18:30	H04	**Higgs-Zerfälle in Bosonen**
T 77.1–77.9	Do	16:00–18:15	H06	**Deep Learning III**
T 78.1–78.7	Do	16:00–17:50	H07	**Suche nach Neuen Teilchen IV**
T 79.1–79.10	Do	16:00–18:30	H09	**Dunkle Materie und Kollider II**
T 80.1–80.9	Do	16:00–18:20	S06	**Neutrinophysik IV**
T 81.1–81.10	Do	16:00–18:30	S07	**Supersymmetrie II**
T 82.1–82.10	Do	16:00–18:30	S09	**B-Tagging**
T 83.1–83.8	Do	16:00–18:00	S10	**Top-Physik III**
T 84.1–84.8	Do	16:00–18:05	S11	**Outreach-Methoden**
T 85.1–85.7	Do	16:00–17:45	S12	**Astroteilchenphysik: Methoden IV**
T 86.1–86.10	Do	16:00–18:30	S13	**Multi-Messenger**
T 87.1–87.10	Do	16:00–18:35	S14	**Gamma-Astronomie II**
T 88.1–88.10	Do	16:00–18:35	S15	**Flavorphysik III**
T 89.1–89.9	Do	16:00–18:15	S16	**Theorie: Higgs**
T 90.1–90.10	Do	16:00–18:30	S01	**Experimentelle Methoden III**
T 91.1–91.10	Do	16:00–18:30	S02	**Elektronik**
T 92.1–92.10	Do	16:00–18:35	S03	**Detektorsysteme V**
T 93.1–93.10	Do	16:00–18:30	H08	**Detektorsysteme VI**
T 94.1–94.9	Do	16:00–18:15	H10	**Detektorsysteme VII**
T 95.1–95.10	Do	16:00–18:35	H11	**Neutrinos: Myon-Rekonstruktion**
T 96	Do	16:00–18:00	S05	**KAT meeting**
T 97	Do	19:00–20:30	H03	**Mitgliederversammlung Fachverband Teilchenphysik**
T 98.1–98.2	Fr	9:00–10:30	H01	**Hauptvorträge VII**
T 99.1–99.2	Fr	11:00–12:30	H01	**Hauptvorträge VIII**

Mitgliederversammlung Fachverband Teilchenphysik

Donnerstag 19:00–20:30 H03

Vorläufige Tagesordnung:

- Berichte
- Diskussion zu „Deutsch oder Englisch“
- Wahl Vorsitz Fachverband Teilchenphysik
- Verschiedenes

T 1: Preisträgervortrag Teilchenphysik

Zeit: Montag 14:45–15:30 Raum: H01

Preisträgervortrag T 1.1 Mo 14:45 H01

Quantum gravity predictions for particle physics — •Christof Wetterich — ITP, Heidelberg University — Träger des Gentner-Kastler-Preises 2019

Contrary to general belief, quantum gravity can have important consequences for observations in present day experiments. It can predict parameters of the standard model. Functional renormalisation permits the computation of fluctuation effects of the metric. Quantum gravity can be formulated as a non-perturbatively renormalisable quantum field theory, in close analogy to the other fundamental interactions. The scale symmetry associated to the ultraviolet fixed point has far reaching implications for particle physics and cosmology. Quantum fluctuations of the metric determine important parameters of the Higgs-potential at an energy scale close to the Planck mass. Extrapolating the running couplings to the electroweak scale, the mass of the Higgs boson has been predicted in the range found later by experiment. I discuss further possible predictions for particle physics, in particular the gauge hierarchy between the Planck scale and the Fermi scale.

T 2: Halbleiterdetektoren I

Zeit: Montag 16:00–18:30 Raum: H02

T 2.1 Mo 16:00 H02

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

In the development process of a new pixel detector for the phase 2 upgrade of CMS, several variants of new n^+p, planar pixel sensors with pixel sizes of $50 \times 50\ \mu m^2$ and $100 \times 25\ \mu m^2$ and an active thickness of 150 μm have been designed and bump bonded to ROC4SENS read-out chips. 18 weeks of beam tests with sensors, irradiated up to fluences of $8{\times}10^{15}$ neutrons/cm^2 have been completed at the DESY test beam facility. The edge-on method is used to measure the charge collection as a function of depth for different operating conditions and possibly trapping effects due to irradiation as the track passes the pixel cells at varying depths. The depth performance of the sensors as a function of fluence and bias voltage is then compared to simulations with Pixelav. In this talk, edge-on measurements are presented as a function of the applied bias voltage, for irradiated and non-irradiated sensors.

T 2.2 Mo 16:15 H02

Study of the radiation damage of SiPMs by neutrons — •Sara Cerioli, Erika Garutti, Robert Klanner, Stephan Martens, and Joern Schwandt — University of Hamburg, Luruper Chaussee 149, 22761 Hamburg

Thanks to the excellent performance and the robustness of Silicon Photomultipliers (SiPMs), many experiments from high luminosity colliders to medical physics are choosing them as photodetectors. One of the major limitations for the application at hadron colliders is radiation damage. The major issue concerning the radiation damage caused by hadrons on SiPMs is the increase of Dark Count Rate (DCR), which already at the level of relatively low fluences such as $\Phi_{eq} \sim 10^{12}$ cm^{-2}, prevents the separation of the single photo-electron from noise and affects the pixel occupancy, leading to a loss in the Photo-Detection Efficiency (PDE). Since peaks in the charge spectra corresponding to different number of Geiger discharges cannot be resolved anymore, the standard characterization methods cannot be applied to determine parameters like gain, mean number of Geiger discharges and DCR. In this talk, I will present methods developed by our group in order to extract some of the main characteristics of a SiPM after radiation damage, starting from parameters which can be obtained from current-voltage measurements. The SiPMs used for this work are KETEK $15 \times 15\ \mu m^2$ pixel size, irradiated by neutrons in the TRIGA reactor to six fluences up to $\Phi_{eq} = 5 \times 10^{14}$ cm^{-2} (1 MeV equivalent neutrons).

T 2.3 Mo 16:30 H02

Finale Auswahl des Sensormaterials für den äußeren CMS-Spurendetektor im Zuge des Phase-2 Upgrades — Felix Bögelsbacher, Alexander Dierlamm, Jan-Ole Gosewisch, •Marius Metzler, Thomas Müller und Pia Steck — ETP (KIT), Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen

Mitte der 2020er Jahre soll das Phase-II-Upgrade des Large Hadron Collider (LHC) und damit auch des Compact Muon Solenoid Detektors (CMS) umgesetzt werden. Die Erhöhung der Luminosität erfordert strahlenharte Materialien. Die erwarteten Fluenzen für den äußeren Spurdetektor liegen nach 10 Jahren geplanter Laufzeit zwischen $1 \cdot 10^{14}\,n_{eq}cm^{-2}$ und $1 \cdot 10^{15}\,n_{eq}cm^{-2}$. Sensoren müssen bei diesen Fluenzen geringe Leckströme und eine Effizienz von mindestens 95% aufweisen. Dazu müssen die erzeugten Signale deutlich über dem Rauschen der Ausleseelektronik liegen. Nach mehreren Qualifizierungskampagnien, in denen verschiedene Hersteller und Materialien untersucht wurden, fällt die finale Entscheidung nun auf einen von zwei Kandidaten: FZ290 oder thFZ240. Die unterschiedliche Dicke der Materialien ist hierbei der entscheidende Parameter, der Ladungssammlung, Leckstrom, sowie Depletionsspannung und Preis maßgeblich beeinflusst. Die Ergebnisse der Bestrahlungsstudien beider Materialien werden in diesem Vortrag zusammengefasst.

T 2.4 Mo 16:45 H02

Temperature dependent low frequency CV measurements of highly irradiated ATLAS strip detectors and diodes for impedance spectroscopy — •Sven Mägdefessel, Riccardo Mori, and Ulrich Parzefall — Uni Freiburg

The defects in silicon caused by radiation damage affect CV measurements to a level where the well known method for deriving the doping level and the depletion voltage is not aplicable anymore. The electrically active defects contribute to the measured capacitance and interfere with the geometrical effect. To exploit the temperature dependent capture constant of the defects, we perform CV measurements at low frequencies and different temperatures at strip detectors and diodes and use impedance spectroscopy to analyse the effects that can be seen for unirradiated sensors as well as for different radiation levels.

T 2.5 Mo 17:00 H02

Studie zur Strahlenhärte von n-in-p Siliziumstreifensensoren ohne spezifische Zwischenstreifenisolationsstruktur — Thomas Müller, Alexander Dierlamm, Marius Metzler, •Jan-Ole Gosewisch, Hans-Jürgen Simonis, Pia Steck und Felix Bögelspacher — Institut für Experimentelle Teilchenphysik, Karlsruher Institut für Technologie

Der Gebrauch von n-in-p Siliziumstreifensensoren erfordert eine spezifische Zwischenstreifenisolation. Ohne diese kommt es insbesondere nach Bestrahlung durch Oberflächenschäden 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 $10^{15}n_{eq}/cm^2$ 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 der Zwischenstreifenwiderstände für unterschiedlichen Bestrahlungszusammensetzungen gezeigt und bewertet.

T 2.6 Mo 17:15 H02

Messungen bestrahlter Silizium Detektoren für das NitroStrip Projekt — •Jan Cedric Hönig, Leena Diehl, Marc Hauser, Franziska Moos, Riccardo Mori, Ulrich Parzefall und Liv Wiik-Fuchs — Albert-Ludwigs-Universität Freiburg

Die Leistungsfähigkeit von Siliziumdetektoren in der Teilchenphysik ist

limitiert durch ihre Fähigkeit radioaktiver Strahlung zu widerstehen. Strahlenschäden bewirken einen erhöhten Leckstrom, eine verschlechterte Ladungssammlung und verändern die Feldkonfiguration im Sensor. Daher ist Forschung zur Verbesserung der Strahlenhärte von zentraler Bedeutung in der Entwicklung neuartiger Siliziumdetektoren. Ein Ansatz die Strahlenhärte von Silizium zu verbessern ist das gezielte einbringen von Fremdatomen. Im Rahmen des NitroStrip Projekts wird die Strahlenhärte von Streifensensoren, die mit Stickstoff angereichert wurden, untersucht. Es stehen Vergleichsgruppen von Sensoren zur Verfügung die mit unterschiedlichen Verfahren beziehungsweise unter Anreicherung mit Sauerstoff hergestellt wurden. In diesem Vortrag werden neben Ergebnisse aus Messungen mit dem EdgeTCT System, vergleichende Messungen von bestrahlen Sensoren aus dem NitroStrip Projekt vorgestellt.

T 2.7 Mo 17:30 H02

Measurement of E_{eff} for Irradiated and Annealed Diodes — •Felix Wizemann, Kevin Kröninger, and Jens Weingarten — TU Dortmund, Experimentelle Physik IV

The leakage current of silicon sensors and diodes depends on temperature. To compare measurements obtained at different temperatures, it is necessary to understand the dependence of the bulk current on the temperature.

This dependence is usually described with the help of the effective bandgap energy E_{eff} under the assumption of a fully depleted bulk. This talk investigates the applicability of this model for highly irradiated sensors and its dependence on the applied electric field.

Bulk current measurements are used to obtain E_{eff} values for irradiated n^+-in-n diodes during different stages of annealing. Self heating leads to deviations between measured and actual device temperature. Therefore a power limit is used to exclude measurements with significant self heating.

T 2.8 Mo 17:45 H02

Untersuchung von Ladungsvervielfachung in p-Typ Silizium-Streifendetektoren nach langen Annealingzeiten — •Leena Diehl, Riccardo Mori, Marc Hauser, Ulrich Parzefall und Liv Wiik-Fuchs — Albert-Ludwigs-Universität Freiburg

Hochenergetische Teilchen verursachen Schäden in Siliziumdetektoren, was zu Defektbildung und dadurch zu einer steigenden effektiven Dotierungskonzentration in p-Typ Detektoren führt. Die entstandenen Gitterdefekte sind beweglich und die effektive Dotierungskonzentration steigt nach kurzer Abnahme mit der Zeit weiter an. Wenn sie hoch genug ist, kann der Effekt der Ladungsvervielfachung auftreten. Bei der Untersuchung dieses Phänomens in lang annealten p-Typ Streifendetektoren wurden starke Veränderungen im gemessenen Signal festgestellt: vervielfachte Löcher tragen einen signifikanten und langsamen Teil zum Signal bei, der auch auf den sogenannten Plasma-Effekt hinweist. Das heißt, dass Driftzeiten der Ladungen durch einen Abschirmungseffekt vom bestehenden elektrischen Feld innerhalb einer Gruppe freier Ladungsträger verlängert wurden. Die zugrundeliegende Messkampagne sowie die veränderten Signalpulse in Sensoren, die mit einer Fluenz höher als $1 \cdot 10^{15}$ $n_{\text{eq}}/\text{cm}^2$ bestrahlt und bei unterschiedlichen Temperaturen Langzeit-annealed wurden, werden in diesem Vortrag präsentiert.

T 2.9 Mo 18:00 H02

Development of a novel proton irradiation site at the HISKP isochronous cyclotron Bonn — •Pascal Wolf[1], Dieter Eversheim[2], David-Leon Pohl[1], Martin Urban[2], and Norbert Wermes[1] — [1]Physikalisches Institut, Universität Bonn — [2]Helmholtz Institut für Strahlen- und Kernphysik (HISKP), Universität Bonn

A novel proton irradiation site for silicon detectors is currently being developed at Bonn University. The site is located at the isochronous cyclotron of the Helmholtz Institut für Strahlen- und Kernphysik (HISKP). The cyclotron provides protons with up to 14 MeV kinetic energy with beam currents between a few nA and 1 μA. Light ions, such as deuterons, alphas up to ^{12}C, can also be produced with kinetic energies from 7 to 14 MeV per nucleon. The beam spot at extraction can be adjusted from a few mm to approximately 2 cm in diameter. An electron-cyclotron-resonance (ECR) source with low source-noise enables a stable beam over time. Dedicated secondary-electron monitors with custom readout electronics have been developed for on-line beam-current and position monitoring. The intrinsic resolution of the readout electronics allows to measure the secondary-electron current with a precision of 1%. The goal is to measure the primary beam current with comparable precision in order to reduce the uncertainty on the proton fluence at the device. GEANT4 simulations of energy distributions along the beam line up to the setup conclude a proton hardness factor of $\kappa \approx 3$, allowing to irradiate up to $10^{16} \frac{\text{n.e.q}}{\text{cm}^2}$ in 60 minutes.

T 2.10 Mo 18:15 H02

Stress testing the optical readout of CMS 2S modules — •Christian Dziwok[1], Lutz Feld[2], Katja Klein[2], Alexander Pauls[2], Oliver Pooth[1], Marius Preuten[2], Max Rauch[2], Nick Thamm[1], and Tim Ziemons[1] — [1]III. Physikalisches Institut B, RWTH Aachen University, D-52056 Aachen — [2]I. Physikalisches Institut B, RWTH Aachen University

For the upcoming CMS Phase-2 Outer Tracker upgrade, new detector modules will be installed. There are two general types of modules, one consisting of two co-planar silicon strip sensors (2S) and one of a macro pixel and a strip sensor (PS). The communication and the auxiliary support are supplied by a so called SErvice Hybrid (SEH) in case of a 2S module. The RWTH Aachen University the SEHs are qualified regarding power and communication stability. This talk presents the data link test for SEH production.

T 3: Higgs: Produktion und Zerfälle

Zeit: Montag 16:00–18:30 Raum: H04

T 3.1 Mo 16:00 H04

Search for Higgs boson production in association with a single top quark at the CMS experiment — Thorsten Chwalek, Nils Faltermann, •Kevin Flöh, and Thomas Müller — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

Higgs boson production in association with a single top quark (tH) is a very rare process with a production cross section of about one tenth of the production cross section of the associated production of a top quark pair and a Higgs boson ($t\bar{t}H$). In contrast to $t\bar{t}H$ production, it is sensitive not only to the amplitude but also to the relative sign of the top-Higgs and W-Higgs couplings. This presentation will focus on the channel with the Higgs boson decaying into a pair of bottom quarks ($b\bar{b}$). In order to obtain event specific object variables, a jet-quark assignment is implemented under two signal and one background hypothesis. Jointly with global variables, the object variables are used to discriminate between signal and background events using boosted decision trees (BDT). Additionally, a control region dominated by dileptonic top quark pair production events is used to constrain uncertainties on the flavor composition of additional jets. Finally, the BDT outputs of the dileptonic and the signal regions of the $b\bar{b}$ channel are fitted collectively with the multilepton and diphoton decay channels to obtain limits on several coupling scenarios and tH production. Furthermore, a simultaneous fit for tH and $t\bar{t}H$ signal strength is performed.

T 3.2 Mo 16:15 H04

Fake-Rate Determination for the ttH Coupling Measurement with a Signature of Two Same Electric Charge Light Leptons Associated with a Tau Using the ATLAS Detector at the LHC — •Andre Sopczak[1], Babar Ali[1], Simonetta Gentile[2], Andres Melo[1], Santu Mondal[1], and Antonio Policicchio[2] — [1]Czech Technical University in Prague — [2]Universita di Roma Sapienza

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 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 3.3 Mo 16:30 H04

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 decay semi-leptonically, producing an electron or a muon. In the single-lepton channel, the so-called boosted topology, targets events containing a Higgs boson and the hadronically decaying top quark 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 and the reconstruction of the Higgs boson becomes a complicated task. The ultimate goal is to constrain the background events of the boosted channel in order to maximise the statistical 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.

T 3.4 Mo 16:45 H04

Untersuchung multivariater Analysemethoden für die $t\bar{t}H(b\bar{b})$-Analyse am CMS-Experiment — •Jan van der Linden, Karim El Morabit, Ulrich Husemann, Philip Keicher, Jörg Schindler, Matthias Schröder und Michael Wassmer — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

Die Stärke der Top-Higgs-Yukawa-Kopplung kann durch eine Messung der assoziierten $t\bar{t}$+H-Produktion direkt bestimmt werden und ist daher von besonderem Interesse bei der Untersuchung der Higgs-Boson-Eigenschaften. Aufgrund des kleinen Wirkungsquerschnitts ist vor allem der Zerfall des Higgs-Bosons in ein $b\bar{b}$-Paar durch sein hohes Verzweigungsverhältnis interessant. Die nötige Sensitivität wird in dieser Suche nur durch die Verwendung multivariater Analysemethoden erreicht. Eine große Herausforderung stellt hierbei die Separation von Signal ($t\bar{t}$+H) und einer Klasse von $t\bar{t}$-assoziierten Untergrundereignissen ($t\bar{t}$+X) dar.
In diesem Vortrag werden verschiedene multivariate Analysemethoden, unter anderem Convolutional Neural Networks, vorgestellt, die im Rahmen der $t\bar{t}H(b\bar{b})$-Analyse im semileptonischen Zerfallskanal studiert werden.

T 3.5 Mo 17:00 H04

Studies on systematic uncertainties for the ttHbb ATLAS analysis at 13 TeV — •Filip Nechansky — DESY Zeuthen

The discovery of the Higgs boson in 2012 marked an important point in modern science, confirming more than 50 years old theoretical prediction. All measurements so far suggest that the properties of the new found boson are in agreement with the Standard model prediction. Since it is known that SM is not a complete theory, a hunt is on to find any deviation which could point to a new theory and the untouched ground around the Higgs boson is a promising area to find it. Therefore, it is important to probe all its properties as precisely as possible.

Due to its mass, the coupling of the top quark to Higgs boson is the strongest. Since top is too heavy to be produced by a Higgs decay, the most direct way to study its coupling is in a production of a top quark pair where the top radiates a Higgs boson. Analysis of such process at ATLAS is divided based on the decay products of the top quarks and the Higgs. This talk will report on a signature where the Higgs boson decays into two b-quarks, a channel which is not well established because of a difficult background modelling. The measurement was done with Run 2 data at 13 TeV proton collisions. Specifically, sensitivity to different systematic uncertainties will be discussed.

T 3.6 Mo 17:15 H04

Suche nach Produktion von Top-Quark-Antiquark-Paaren in Assoziation mit Higgs-Bosonen bei CMS — Karim El Morabit, Ulrich Husemann, •Philip Keicher, Jörg Schindler, Matthias Schröder, Jan van der Linden und Michael Wassmer — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

Die assoziierte Produktion des Higgs-Bosons mit der Top-Quark-Antiquark-Paarproduktion ermöglicht eine modellunabhängige Messung der Top-Higgs-Yukawa-Kopplung. Diese ist von großer Bedeutung für die theoretische Beschreibung des Standardmodells und daher von besonderem physikalischen Interesse.

Präsentiert wird eine multivariate Analyse im semileptonischen Zerfallskanal des Top-Quark-Antiquark-Systems 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 3.7 Mo 17:30 H04

Differenzielle ttH-Wirkungsquerschnittsmessungen am HL-LHC — •Florian Henkes, Ulrich Husemann, Matthias Schröder und Philip Keicher — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

Eine Messung des Wirkungsquerschnittes für die Higgs-Boson-Produktion in Assoziation mit einem Top-Quark-Antiquark-Paar (ttH) ermöglicht eine direkte Bestimmung der Stärke der Top-Higgs-Yukawa-Kopplung. Die ttH-Produktion wurde im vergangenen Jahr erstmalig am LHC beobachtet. Die Sensitivität der Messung wird sich mit weiteren Daten, wie sie im zukünftigen LHC Run 3 und am High-Luminosity LHC produziert werden, weiter erhöhen und somit insbesondere auch differenzielle Messungen ermöglichen. Diese Möglichkeiten werden in diesem Vortrag genauer untersucht. Zur Planung der Analysen des High-Luminosity LHC ist die Verwendung von Simulationen unabdingbar. Hierbei stellt der große Rechenaufwand bei der Simulation der Detektoren eine große Herausforderung dar, weshalb man sich vereinfachter Simulationen bedient. Diese können mit dem Programm Delphes erzeugt werden.

In diesem Vortrag werden mit Delphes durchgeführte Studien zur Analyse des differentiellen Wirkungsquerschnitts der tt-H Produktion vorgestellt.

T 3.8 Mo 17:45 H04

Efficiency measurement of hadronic $\tau\tau$ triggers and their application in the SM $H \to \tau\tau$ analysis of CMS — •Maximilian Burkart, Artur Gottmann, Günter Quast, and Roger Wolf — Karlsruher Institut für Technologie, Karlsruhe, Deutschland

The most promising decay channel to measure the coupling of the Higgs boson to fermions is the decay into two tau leptons where the vector-boson-fusion (VBF) production mechanism constitutes a high share of the analysis' sensitivity. To increase the available amount of signal events a dedicated trigger targeting specifically the VBF production channel of the Higgs boson in the decay into two subsequently hadronically decaying tau leptons has recently been developed by the CMS Collaboration.

This talk covers the efficiency measurement of triggers for hadronically decaying tau leptons using the tag-and-probe method in $Z \to \tau_\mu \tau_h$ events. The main focus of the talk lies on the application of the measured trigger efficiencies in the SM $H \to \tau\tau$ analysis and the sensitivity gains from the usage of the VBF trigger especially.

T 3.9 Mo 18:00 H04

Study Towards Analysing the Higgs Self-Coupling in the $gg \to hh \to 4\tau$ Channel at the ATLAS Detector — •Henrik Junkerkalefeld, Klaus Desch, Christian Grefe, and Philip Bechtle — Physikalisches Institut, Bonn, Germany

The Higgs boson discovery at the LHC in 2012 completes the predicted particle content of the Standard Model (SM) leaving not much space for BSM physics in the accessibly TeV scale. This heralds the precision measurement era of SM parameters of which the Higgs self-coupling is one of the last unmeasured ones. Its high sensitivity to new physics scenarios further increases its relevance. Due to the very small cross sections, the power of the LHC to measure the self-coupling is estimated to be limited, which motivates the investigation of this process in as many channels as possible.

Apart of more intensively studied decay channels, the $hh \to 4\tau$

channel shapes up as a very promising additional decay because a very limited amount of other processes is expected to produce four truth taus. However, a large background containing several sources of QCD jets can fake hadronically decaying tau leptons and has to be fought.

This work studies the conspicuity of dihiggs production within multi-tau events. To that effort, a novel method to increase the efficiency of detecting events with many truth taus and separating them from fake taus is developed. Moreover, the dominating background is studied and first attempts to separate the very similar process $ZZ \to 4\tau$ from the background are made.

T 3.10 Mo 18:15 H04

Measurements of Simplified Template Cross Sections in the H→ $\tau\tau$ decay channel — •Fabian Becherer, Kathrin Becker, David Hohn, and Markus Schumacher — Albert-Ludwigs-Universität Freiburg

One goal of the LHC is to investigate the observed Higgs boson as precisely as possible by being as model independent as possible. The Simplified Template Cross Sections (STXS) method provides finely-grained measurements of cross sections in well-defined phase space regions. These regions are defined to minimize the dependence on theoretical uncertainties, to isolate possible beyond the SM effects and to maximize experimental sensitivity. The common definiton of the STXS across the Higgs boson decay channels allows a simple combination of the individual measurements, so that the STXS will benefit from a global combination of them.
This talk presents the first results for the STXS in the H→ $\tau\tau$ decay channel published by ATLAS in November 2018 and early studies with the full proton-proton data set recorded from 2015 until 2018. It will point out the most sensitive phase space regions in the published H→ $\tau\tau$ analysis and summarize possible optimisation of the analysis strategy, to increase the sensitivity in these regions and to expand the measured phase space. To this end the definition of the signal event selection as well as the number of measured cross sections are studied.

T 4: Deep Learning I

Zeit: Montag 16:00–18:30 Raum: H06

T 4.1 Mo 16:00 H06

Physics inspired feature engineering with Lorentz Boost Networks — •Yannik Rath, Martin Erdmann, Erik Geiser, and Marcel Rieger — III. Physikalisches Institut A, RWTH Aachen University

A large part of the success of deep learning in computer science can be attributed to the introduction of dedicated architectures exploiting the underlying structure of a given task. As deep learning methods are adopted for high energy physics, increasing attention is thus directed towards the development of new models incorporating physical knowledge.

In this talk, we present a network architecture that utilizes our knowledge of particle combinations and directly integrates Lorentz boosting to learn relevant physical features from basic four vectors. We explore two example applications, namely the discrimination of hadronic top-quark decays from light quark and gluon jets, and the separation of top-quark pair associated Higgs boson events from a $t\bar{t}$ background. We also investigate the learned combinations and boosts to gain insights into what the network is learning.

T 4.2 Mo 16:15 H06

Further development of the ATLAS Deep Learning flavour tagging algorithm — •Manuel Guth — Albert-Ludwigs Universität, Freiburg, DE

The development of machine learning techniques is making a lot of progress in the last few years. Already now, machine learning is deeply embedded in our daily life. Especially deep neural networks require a large amount of statistics for a robust training procedure in order to find yet unknown dependencies in data. The large amount of simulated data available in particle physics allows to use these new sophisticated techniques to improve the physics analyses. The identification of heavy flavour jets (tagging) plays an important role in almost all physics analyses at the ATLAS experiment. It is an essential tool for precision measurements as well as for searches for new physics phenomena. One of the frameworks within ATLAS for b-tagging is the Deep Learning tagger (DL1). It uses deep neural networks based on TensorFlow and Keras to distinguish b-, c- and light flavour jets using the information of several baseline b-taggers. A first introduction of the DL1 tagger is given, followed by detailed studies to improve the deep learning network architecture.

T 4.3 Mo 16:30 H06

Application of Deep Learning to Heavy Flavour Jet Identification with the CMS Experiment — Xavier Coubez[1,2], Luca Mastrolorenzo[1], •Spandan Mondal[1], Andrzej Novak[1], Andrey Pozdnyakov[1], and Alexander Schmidt[1] — [1]RWTH Aachen University, Germany — [2]Brown University, USA

Many physics analyses within the CMS experiment rely on the efficient identification of heavy flavour jets. Over the past few years, several algorithms have been developed to exploit the distinctive features of jets arising from heavy flavour quarks to distinguish them from those arising from light quarks. The CMS collaboration has recently shown that Deep Neural Networks (DNNs) can be used to achieve significantly higher efficiencies while tagging heavy flavour jets, compared to traditional Machine Learning approaches. In addition to standard b-tagging and c-tagging algorithms, Deep Learning has been implemented to develop flavour tagging algorithms specialized for boosted topologies, to aid physics analyses that focus on boosted regimes and heavy exotic particles. This talk focuses on new advances in the application of Deep Learning in heavy flavour jet identification at CMS as well as the performance measurements of tagging algorithms on CMS data.

T 4.4 Mo 16:45 H06

Validation of a Deep Neural Network Based Flavor Tagging Algorithm at Belle and Belle II — •Jochen Gemmler, Florian Bernlochner, Michael Feindt, and Pablo Goldenzweig for the Belle 2-Collaboration — ETP, KIT, Karlsruhe

Measurements of time dependent CP violation will be one of the key tasks of the Belle II experiment, which is located at the SuperKEKB collider in Tsukuba, Japan. Via electron-positron collisions, neutral B mesons are produced in an entangled state. For CP violation measurements, it is crucial to infer the flavor of the accompanying B_{tag} meson from its final states, exploiting the flavor specific decay topologies. This process is referred to as flavor tagging and the presented approach utilizes a Deep Neural Network (DNN) for this classification.

This talk shows current results of the validation of the DNN based approach on the full Belle dataset, which contains 772 Million B-Meson pairs, using the software framework of Belle II.

T 4.5 Mo 17:00 H06

Adversarial Neural Network-based data-simulation corrections for jet-tagging at CMS — Martin Erdmann, •Benjamin Fischer, Dennis Noll, Yannik Rath, Marcel Rieger, and David Schmidt — III. Physikalisches Institut A, RWTH Aachen University

Variable-dependent scale factors are commonly used in HEP to improve shape agreement of data and simulation. The choice of the underlying model 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 scale factors using an adversarial neural network. This method is investigated in the context of the bottom-quark jet-tagging algorithms within the CMS experiment. The primary network uses the jet variables as inputs to derive the scale factor for a single jet. It is trained through the use of a second network, the adversary, which aims to differentiate between the data and rescaled simulation.

T 4.6 Mo 17:15 H06

Hyperparameter optimization of Adversarial Neural Networks in the tW dilepton channel using the ATLAS detector — •Christian Kirfel, Ian Brock, and Rui Zhang — Physikalisches Institut, Bonn, Deutschland

Neural networks are widely used for signal to background separation in high energy collider physics. Neural networks trained on Monte Carlo simulations can be highly sensitive to systematic uncertainties. A proposed technique to diminish this sensitivity is an adversarial neural network consisting of two networks that are trained against each other. In our case, the first network tries to separate between signal and background, while the second network tries to separate between a nominal signal sample and a signal sample with different settings. We are using a Minimax decision rule to achieve a good signal to background separation for the first network and a poor nominal to systematics separation for the second network. In this talk an adversarial neural network trained on tW dilepton channel Monte Carlo simulations with $t\bar{t}$ background using the ATLAS detector is introduced. Testing and tuning of the hyperparameters is presented for both networks as well as a comparison to a single neural network approach. Lastly the dependence for both approaches on systematic uncertainties is investigated.

T 4.7 Mo 17:30 H06

Adversarial Neural Networks zur Reduzierung des Einflusses von systematischen Unsicherheiten am Beispiel einer $t\bar{t}H$ -Analyse — •Jörg Schindler, Karim El Morabit, Ulrich Husemann, Philip Keicher, Matthias Schröder, Jan van der Linden und Michael Wassmer — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

Die Messung des Wirkungsquerschnitts für Higgs-Boson-Produktion in Assoziation mit einem Top-Quark-Antiquark-Paar ($t\bar{t}H$) ermöglicht eine direkte Messung der Top-Higgs-Yukawa-Kopplung. Aufgrund des kleinen Wirkungsquerschnitts wird der Zerfall mit dem größten Verzweigungsverhältnis untersucht, der Zerfall in ein Bottom-Quark-Antiquark-Paar ($b\bar{b}$). Dabei werden multivariate Analysemethoden verwendet, um Signal von Untergrund zu trennen.

Ein entscheidender Untergrund hierbei ist die $t\bar{t}$-Produktion mit einem assozierten $b\bar{b}$-Paar. Die verfügbaren Vorhersagen für diesen Prozess sind mit großen Unsicherheiten behaftet und weisen Unterschiede auf. Durch die Verwendung von Adversarial Neural Networks können die neuronalen Netze robust gegenüber diesen Unterschieden konstruiert werden.

In diesem Vortrag wird die Anwendung von Adversarial Neural Networks am Beispiel einer $t\bar{t}H$ -Analyse im semileptonischen Kanal untersucht.

T 4.8 Mo 17:45 H06

Precise simulation of electromagnetic calorimeter showers using a Wasserstein Generative Adversarial Network — Martin Erdmann[1], Jonas Glombitza[1], and •Thorben Quast[1,2] — [1]Physikalisches Institut 3A, RWTH Aachen — [2]EP-LCD, CERN

The increased instantaneous luminosity at the High Luminosity LHC will raise the computing requirements for event reconstruction and analysis for current LHC-based experiments, hence limiting the available resources for the simulation of particles traversing matter. Developments on the performance of state-of-the-art simulation frameworks such as Geant4 are proceeding but are unlikely to fully compensate for this trend. Generative adversarial neural networks (GANs) have been shown to provide promising fast simulation models. Wasserstein GANs (WGANs) are a variant of this method. They employ a more robust metric for the adversarial training of the generator network. In this talk, we show our adaptation of the WGAN concept for the generation of electromagnetic showers inside a realistic setup of a multi-layer sampling calorimeter. In addition, conditioning on the energy of the incident particle and on its impact position is integrated through two auxiliary regression networks. Overall, the quality of these fast shower simulations with the WGAN reaches the level of showers generated with the GEANT4 program in most aspects. At the same time, the computational speed-up compared to traditional sequential simulations amounts to several orders of magnitudes.

T 4.9 Mo 18:00 H06

Parton showers with Generative Adversarial Networks — •Christof Sauer — Physikalisches Institut, Heidelberg, Deutschland

The prediction of physical processes are usually based on simulations – one example being parton showers. At present, the simulation of hadronic final states is done by dedicated software, such as Pythia, Herwig. This presentation intends to demonstrate a potential application of Generative Adversarial Networks (GANs) within the context of parton shower generation. Such machine learning techniques can be used to produce parton showers which are independent of any current shower model. It would allow to circumvent inherent problems in the simulation of parton showers. This method could be a applied in analyses that are too sensitive to parton shower effects in the modeling of the background and hence rely on an accurate background estimate.

As a first step, a network is trained on multijet events generated with Pythia, whereby the focus lies on training the network to produce realistic and consistent parton showers. The Monte Carlo samples serve as a surrogate to examine the applicability of this method under well controlled conditions before, subsequently, proceeding to use real data instead.

T 4.10 Mo 18:15 H06

Reinforced Sorting Networks for Particle Physics Analyses — Martin Erdmann, Benjamin Fischer, •Dennis Noll, Yannik Alexander Rath, Marcel Rieger, David Josef Schmidt, and Marcus Wirtz — III. Physikalisches Institut A, RWTH Aachen University

Deep learning architectures in particle physics are often strongly dependent on the order of their input variables. We present a two-stage deep learning architecture consisting of a network for sorting input objects and a subsequent network for data analysis. The sorting network (agent) is trained through reinforcement learning using feedback from the analysis network (environment). A tree search algorithm is used to examine the large space of different possible orders.

The optimal order depends on the environment and is learned by the agent in an unsupervised approach. Thus, the 2-stage system can choose an optimal solution which is not know to the physicist in advance.

We present the new approach and its application to various classification tasks.

T 5: Suche nach Neuen Teilchen I

Zeit: Montag 16:00–18:35 Raum: H07

Gruppenbericht T 5.1 Mo 16:00 H07

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

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 36.1 fb^{-1} of proton-proton data collected at 13TeV by the ATLAS experiment, as well as a new search aiming to expand upon these results.

The initial search focused exclusively on a 1-lepton final state, while the new search aims to improve on this by the addition of a 0-lepton final state, the use of approximately 140 fb^{-1} of data, as well as by the addition of Machine Learning based discriminants and taggers.

T 5.2 Mo 16:20 H07

First search for single production of vector-like B quarks in the $B \to bH(\to \gamma\gamma)$ decay channel with the ATLAS detector at $\sqrt{s} = 13$ TeV — •Björn Wendland[1], Frederic Schröder[2], Isabel Nitsche[1], Diane Cinca[1], Elizabeth Brost[3], Johannes Erdmann[1], Jahred Adelman[3], and Kevin Kröninger[1] — [1]TU Dortmund, Experimentelle Physik IV — [2]Bergische Universität Wuppertal — [3]Northern Illinois University

The first search for the single production of vector-like B quarks decaying into a b quark and a Higgs boson where the Higgs boson decays into a pair of photons is presented.
The analysis strategy is based on the characteristic B quark event topology, which consists of two high-momentum photons, a high-momentum b-jet and a more forwardly produced jet. The B quark is reconstructed from its decay products and its reconstructed mass is used as final discriminant against background contributions. The

dominant background contribution arises from non-resonant diphoton processes with additional jets in the final-state, where the photons arise either from Standard Model (SM) diphoton production or from jets mis-identified as photons. Additional small background contributions arise from SM Higgs boson production processes where the Higgs boson decays into a pair of photons.
No significant excess over the background-only hypothesis is observed. Assuming the (B, Y) doublet model and a generalized coupling $\kappa_B = 0.5$ of the B quark to SM quarks, B quark masses below 1210 GeV are excluded at 95 % confidence level.

T 5.3 Mo 16:35 H07

Search for single production of vector-like quarks using boosted techniques with the ATLAS detector — •Anjishnu Bandyopadhyay[1], Ian Brock[1], Janet Dietrich[2], Heiko Lacker[2], and Ferdinand Schenck[2] — [1]University of Bonn — [2]Humboldt University Berlin

Vector-like quarks are hypothetical spin 1/2 fermions predicted by various Beyond the Standard Model (BSM) theories. A search for $Y^{4/3}$ and $T^{2/3}$ is performed. The search is conducted in the Wb decay mode. In addition to the semi-leptonic final state, a search in the fully hadronic final state is also performed using the full Run 2 dataset (140 fb^{-1}) collected by the ATLAS detector. This talk will focus on boosted techniques, one of them being boosted taggers, used in analysing the hadronic final state of $pp \to Y/T \to Wb$.

T 5.4 Mo 16:50 H07

Additional studies in the search for the single production of vector-like quarks decaying to a Wb final state. — •Michel Smola — Humboldt Universität zu Berlin

Vector-like quarks (VLQs) are hypothetical spin-1/2 fermions suggested by various BSM models. Based on a 36.1 fb^{-1} data set, an ATLAS analysis has searched for singly produced VLQs decaying to Wb final states using one-lepton final states. The analysis is now extended to the complete LHC Run 2 data set. This talk reports on studies for the new analysis: 1) background suppression by identifying jets in the forward detector region $|\eta| > 2.5$, 2) evaluation and comparisons of methods to estimate multijet background.

T 5.5 Mo 17:05 H07

Suche nach vektorartigen Top-Quarks in Endzuständen mit einem Lepton, Jets und fehlendem transversalem Impuls bei $\sqrt{s}$ = 13 TeV 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 für die Analyse der ATLAS pp Daten bei $\sqrt{s}$ = 13 TeV wird diskutiert.

T 5.6 Mo 17:20 H07

Studies for the search for pair produced leptoquarks decaying into top quarks and electrons or muons in final states with $\geq$ 3 leptons — Johannes Erdmann, •Abdulkärim Frempong, Elena Freundlich, and Kevin Kröninger — TU Dortmund, Lehrstuhl für Experimentelle Physik IV

Recent flavour physics results from the LHCb collaboration of R_{K^*}, the ratio of the branching fractions $B \to K^* \mu\mu$ and $B \to K^* ee$, was found to deviate 2.5σ from Standard Model predictions. One explanation for a possible lepton non-universality are leptoquarks with cross-generation couplings to Standard Model fermions, meaning that the new introduced particle couples to quark and leptons from different generations with a different coupling for each quark-lepton combination. For the search for pair produced leptoquarks decaying into electrons and muons in final states with $\geq$ 3 leptons using the full run 2 dataset collected by the ATLAS detector, optimisation studies of an event selection using Monte Carlo events are presented. Expected limits on the signal strength, calculated by considering only statistical uncertainties, were calculated for different additional selection criteria, leading to the proposal of an optimised event selection.

T 5.7 Mo 17:35 H07

Searches for pair production of leptoquarks decaying into top quarks and muons at the CMS experiment — •Nino Ehlers, Johannes Haller, Roman Kogler, and Arne Christoph Reimers — Universität Hamburg, Institut für Experimentalphysik

In this talk we present a search for pair-produced leptoquarks in pp-collisions at a center-of-mass energy of $\sqrt{s}$ = 13 TeV. The data have been collected in 2016, 2017 and 2018. In this analysis the production of leptoquark pairs decaying into a top quark an a muon is studied.
The search is carried out in the final state with at least two isolated muons and at least two jets. In events with at least three charged leptons the leptoquark mass is reconstructed. The event selection is optimized for a wide range of leptoquark masses. The dominating standard model backgrounds of $t\bar{t}$ and Drell-Yan + jets are estimated by selecting control regions and extrapolating the data, using additional shape and normalization information from simulated events. The expected sensitivity and expected exclusion limits are derived and compared to the public result, based on 2016 data only.

T 5.8 Mo 17:50 H07

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, the status of a search for pair-produced up-type ($q = +2/3\,\text{e}$) and down-type ($q = -1/3\,\text{e}$) LQs decaying into quarks of the third and leptons of the first or second generation is presented.
For this analysis, the final state of interest is $LQ_u LQ_u \to t\,\nu + b\,e/\mu$ and $LQ_d LQ_d \to t\,e/\mu + b\,\nu$. With a high momentum lepton and large missing transverse energy, this channel provides good separation between signal and background processes.
An overview of the analysis strategy, including the definition of signal and control regions, is given. The studies shown are based on pp-collision data at a centre-of-mass energy of $\sqrt{s} = 13\,\text{TeV}$ measured by the ATLAS experiment at the LHC between 2015 and 2018.

T 5.9 Mo 18:05 H07

Sensitivity Study on Single Leptoquark Production at CMS — •Henrik Jabusch, Paolo Gunnellini, Roman Kogler, and Johannes Haller — Institut für Experimentalphysik, Universität Hamburg

In this talk we present a sensitivity study of a specific leptoquark model recently proposed to explain the measured B-anomalies. We focus on single and pair production of scalar leptoquarks and the final state with two leptons plus hadronic jets.

Our study is performed at generator level and at detector level using a DELPHES simulation of the CMS detector. We show limits on this leptoquark production model and compare them to an analysis of CMS data.

T 5.10 Mo 18:20 H07

Search for singly produced Lepto-Quarks decaying into a Quark and charged Leptons of the first and second generation with ATLAS — •Holger Herr and Stefan Tapprogge — Johannes-Gutenberg Universität Mainz

The most significant deviations from the Standard Model observed in recent years are flavour anomalies. Introducing new particles which carry lepton and baryon number - the so called Lepto-Quarks - to the Standard Model can explain the deviations measured in a convenient way. Since 2015 the LHC collides protons at a center of mass energy of 13 TeV at the interaction point of the ATLAS experiment. This inelastic scattering data at the highest energies ever reached in an earth based collider experiment gives great opportunity to search for these new particles at the high energy frontier. The single production channel allows to probe a higher mass range at cost of introducing some

model dependency. For simplicity reasons only the decay into a quark and charged leptons of the first and second generations are considered for now. In this talk results of the search using the full Run 2 dataset recorded in proton-proton collisions by ATLAS will be presented. This includes the definition of control and validation regions to ensure good background modelling in our simulation.

T 6: Andere Gebiete der Theorie und Post-Deadline-Vorträge

Zeit: Montag 16:00–18:00 Raum: H08

T 6.1 Mo 16:00 H08

The Elementary Particle of Dark Matter — •Hans-Otto Carmesin — Universität Bremen, Fachb. 1, Pf. 330440, 28334 Bremen — Studienseminar Stade, Bahnhofstr. 5, 21682 Stade — Gymnasium Athenaeum, Harsefelder Str. 40, 21680 Stade

An equivalence principle is elaborated and founded. With it a third development of H.-O. Carmesins theory of quantum gravity is presented. The theory combines quantum physics with general relativity and is based on three numerical inputs only: the constants G, c and h (Carmesin, H.-O. (2017): Vom Big Bang bis heute mit Gravitation, Model for the Dynamics of Space. Berlin: Verlag Dr. Köster. Carmesin, H.-O. (2018): A Model for the Dynamics of Space - Expedition to the Early Universe. PhyDid B, p. 1-9. Carmesin, H.-O. (May 2018): Entstehung dunkler Materie durch Gravitation, Model for the Dynamics of Space and the Emergence of Dark Matter. Berlin: Verlag Dr. Köster. Carmesin, H.-O. (November 2018): Entstehung der Raumzeit durch Quantengravitation, Theory for the Emergence of Space, Dark Matter, Dark Energy and Space-Time. Berlin: Verlag Dr. Köster.). In particular the most stable local solution of that theory is elaborated. It is an elementary particle forming by the gravitationally self-stabilizing enclosure of radiation. The transition rates are calculated and show that the formed mass is in accurate accordance with the observed total mass of dark matter in the universe, whereby the difference is 0.23 % only. I interpret this coincidence as a strong evidence for the thesis that the obtained solution presents the elementary particle of dark matter.

T 6.2 Mo 16:15 H08

Wie viel QM brauchen wir für das Verständnis von Teilchen, speziell seiner Masse? — •Albrecht Giese — Taxusweg 15, 22605 Hamburg

Nach dem heutigen Physikverständnis können Elementarteilchen nur auf der Basis der Quantenmechanik beschrieben werden.

Physiker haben Probleme mit der QM. Die meisten Prozesse sind der Intuition nicht zugänglich, weil die Resultate eine Überlagerung unverträglicher Zustände sind. Zudem liefert die QM nur statistische Resultate. Außerdem sind Messungen im Konflikt mit der Theorie wie z.B. die Diskrepanz zwischen der Vakuum-Polarisation, d.h. der Energie von virtuellen Teilchen, und der gemessenen Energie des Universums. Hier ist die Diskrepanz 10^{120} ("Vakuum-Katastrophe"). Ein ähnliches Problem besteht beim Higgs-Feld mit einer Diskrepanz von 10^{57}. - Diese Probleme werden eingeräumt, aber nicht ernsthaft diskutiert.

Historisch folgte die Notwendigkeit für QM aus Ansichten über Teilchen (z.B. das Elektron als unstrukturiertes Objekt), welche in der Anfangszeit der QM bestanden und welche von ad-hoc Annahmen herrührten. Diese wurden aber so weit akzeptiert, dass andere Lösungen nicht ernsthaft angegangen wurden.

Wir werden am Beispiel des Elektrons zeigen, dass bei einem Ersatz der frühen Annahmen durch heute bekannte Tatsachen die meisten Eigenschaften des Teilchens klassisch erklärbar sind - mit hoher Genauigkeit. Das betrifft vor allem die Funktionsweise seiner Trägheit.

Weitere Info: www.ag-physics.org/rmass

T 6.3 Mo 16:30 H08

The Elementary Oscillation of Dark Energy — •Paul Brüning[1] and Hans-Otto Carmesin[1,2,3] — [1]Gymnasium Athenaeum, Harsefelder Straße 40, 21680 Stade — [2]Universität Bremen, Fachb. 1, Pf. 330440, 28334 Bremen — [3]Studienseminar Stade, Bahnhofstraße 5, 21682 Stade

An equivalence principle is elaborated and founded. With it a third development of H.-O. Carmesins theory of quantum gravity is presented. The theory combines quantum physics with general relativity and is based on three numerical inputs only: the constants G, c and h (Carmesin, H.-O. (2018): A Model for the Dynamics of Space - Expedition to the Early Universe. PhyDid B, p. 1-9. Carmesin, H.-O. (July 2018): Entstehung dunkler Energie durch Quantengravitation, Universal Model for the Dynamics of Space, Dark Matter and Dark Energy. Carmesin, H.-O. (November 2018): Entstehung der Raumzeit durch Quantengravitation, Theory for the Emergence of Space, Dark Matter, Dark Energy and Space-Time. Berlin: Verlag Dr. Köster.). In particular the zero - point oscillations of the gravitational field are elaborated. Its energy is in accurate accordance with the observed dark energy, whereby the difference is 0.073 % only. We interpret this as a strong evidence for the thesis that these elementary oscillations present the dark energy. These elementary oscillations emerge at various wavelengths. The resulting polychromatic vacuum explains the difference of the measured Hubble constants with an accuracy of 1 %.

T 6.4 Mo 16:45 H08

The Elementary Particle of Dark Matter forming the Gosset Lattice — •Ole Rademacker[1] and Hans-Otto Carmesin[1,2,3] — [1]Gymnasium Athenaeum, Harsefelder Straße 40, 21680 Stade — [2]Universität Bremen, Fachb. 1, Pf. 330440, 28334 Bremen — [3]Studienseminar Stade, Bahnhofstraße 5, 21682 Stade

An equivalence principle is elaborated and founded. With it a third development of H.-O. Carmesins theory of quantum gravity is presented. The theory combines quantum physics with general relativity and is based on three numerical inputs only: the constants G, c and h (Carmesin, H.-O. (2018): A Model for the Dynamics of Space - Expedition to the Early Universe. PhyDid B, p. 1-9. Carmesin, H.-O. (May 2018): Entstehung dunkler Materie durch Gravitation, Model for the Dynamics of Space and the Emergence of Dark Matter. Berlin: Verlag Dr. Köster. Carmesin, H.-O. (July 2018): Entstehung dunkler Energie durch Quantengravitation, Universal Model for the Dynamics of Space, Dark Matter and Dark Energy. Carmesin, H.-O. (November 2018): Entstehung der Raumzeit durch Quantengravitation, Theory for the Emergence of Space, Dark Matter, Dark Energy and Space-Time. Berlin: Verlag Dr. Köster.). The most stable local solution of that theory is elaborated and identified with the elementary particle of dark matter. It forms the Gosset lattice or E8 lattice at the ground state. Corresponding phonons can in principle be observed with gravitational waves. The total amount of mass formed by the novel elementary particle is in accurate accordance with the observed total mass of dark matter in the universe, whereby the difference is 0.23 % only.

T 6.5 Mo 17:00 H08

Kombination von Suchen nach unsichtbaren Zerfällen des Higgs-Bosons mit dem ATLAS Detektor — •Sascha Dreyer — Kirchhoff-Institut für Physik, Heidelberg

Das Standardmodell (SM) sagt unsichtbare Zerfälle des Higgs-Bosons über den H->ZZ*->4nu Kanal mit einem Verzweigungsverhältnis von ~10^-3 voraus – zu klein, um es am Großen Hadronenbeschleuiger (LHC) zu testen. Mehrere Erweiterungen des SM sagen indes unsichtbare Zerfälle des Higgs in dunkle Materie Teilchen voraus. Nach solchen Zerfällen wird am ATLAS Detektor in den Vektor-Boson-Fusions- (VBF) und Higgstrahlungstopologien (ZH, WH) gesucht. Präsentiert wird eine statistische Kombination der Suchen in VBF, Z(->Leptonen)H und V(->Hadronen)H Topologien mit 36 fb^-1 von Proton-Proton Kollisionsdaten aus dem zweiten Lauf des LHC, sowie die Kombination mit den Ergebnissen des ersten LHC Laufs. Besonderes Augenmerk erhalten dabei die Korrelationsannahmen zwischen den Unsicherheitsparametern der verschiedenen Suchen. In der Gesamtkombination wird eine Ausschlussgrenze auf das unsichtbare Verzweigungsverhältnis des Higgs-Bosons von 26% (17%+7%-5%) auf einem Konfidenzniveau von 95% beobachtet (erwartet).

T 6.6 Mo 17:15 H08

Probing the cosmic-ray e+/- spectrum at TeV energies with MAGIC very large zenith data — •Yating Chai for the MAGIC-Collaboration — Max-Planck institute for physics, Foehringer Ring 6, 80805 Munich

Detecting TeV electrons at Earth may reveal interesting acceleration

and propagation mechanisms from local (below the distance of one kiloparsec) sources, or they may hint to new physics, such as annihilation or decay of TeV dark matter particles. In turn, confirming a cut-off of the cosmic-ray electron spectrum at TeV energies provides constraints on cosmic-ray and dark matter physics. MAGIC is a stereoscopic system of two Atmospheric Cherenkov telescopes on the Canary Island of La Palma mainly for gamma-ray astronomy, but also records data from cosmic-ray electrons. By performing very large zenith observations, we increase the effective area of the instrument at the highest energies and enlarge the potential to probe the cosmic-ray e+/- spectrum at energies up to tens of TeV. In this talk, we present the current process of our work and the plans for the future.

T 6.7 Mo 17:30 H08

Testing ctapipe on measured FACT data — •Noah Biederbeck — TU Dortmund, Germany

The upcoming Cherenkov Telescope Array (CTA) will be the most sensitive Imaging Atmospheric Cherenkov Telescope in the coming years.

CTA will eventually consist of more than 100 telescopes build at two sites, on La Palma covering the northern sky and in Chile covering the southern sky. The first telescope, the 23m Large Size Telescope 1, was finished in November 2018.

The low-level analysis software ctapipe is currently in the developement stage and mainly tested on simulated data of the CTA telescopes.

To verify the software, data analysis is performed on data of the First G-APD Cherenkov Telescope. An IACT operating since 2011 next to the LST site at the Roque de los Muchachos on La Palma.

T 6.8 Mo 17:45 H08

Analyse von $B \to X_u \ell\nu$-Zerfällen in Abhängigkeit der Endzustandmultiplizität — •Alexander Ermakov — Universität Bonn

Der große Datensatz an B-Mesonen mit einer integrierten Luminosität von 711 fb^{-1} aus e^+e^--Kollisionen des Belle-Experimentes erlaubt die Untersuchung von charmlosen semileptonischen B-Mesonzerfällen. Diese Zerfälle sind interessant, da sie zusammen mit Theorievorhersagen hadronischer Formfaktoren eine Bestimmung des Betrages des CKM-Matrixelementes V_{ub} erlauben. Inklusive und exklusive Messungen dieser Zerfälle liefern bisher verschiedene Ergebnisse für $|V_{ub}|$ (3σ Diskrepanz).

Eine große Unsicherheit in der Messung inklusiver $B \to X_u \ell\nu$-Zerfälle liegt in der Modellierung der Zerfälle. Da die Rekonstruktions- und Selektionseffizienzen von den Endzustandsmultiplizitäten abhängen, kann die damit verbundene Unsicherheit der $|V_{ub}|$-Bestimmung reduziert werden, indem die Analyse abhängig von der Endzustandsmultiplizität durchgeführt wird.

Dadurch können in derselben Analysen die resonant und nichtresonanten Signalanteile simultan studiert werden. Der Vortrag beschreibt die Selektion von $B \to X_u \ell\nu$-Zerfällen, die Untersuchung von Variablen zur Untergrundunterdrückung und Signalextraktion, die Analyse der verschiedenen Signalkomponenten mit unterschiedlichen Hadronmultiplizitäten und die Bestimmung von $|V_{ub}|$ mit einer verbesserten systematischen Unsicherheit.

T 7: Direkte Suche nach Dunkler Materie I

Zeit: Montag 16:00–18:20 Raum: H09

Gruppenbericht T 7.1 Mo 16:00 H09

DARWIN: the ultimate dark matter detector — •Darryl Masson — Universität Freiburg

As dark matter detection experiments continue to push to ever-greater sensitivities, new experiments are devised to glimpse the elusive first signal. The DARWIN project, featuring a 40 tonne liquid xenon target, will attempt to measure WIMP-nucleon scattering cross sections down to $\sim 10^{-49}\,\mathrm{cm}^2$. Additionally, DARWIN should be able to probe the neutrino mass hierarchy via measurements of the half-life of ^{136}Xe $0\nu\beta\beta$-decay. Other potential science channels include measurements of galactic axions and axion-like particles coupling to electrons and some neutrino interaction channels, such as solar neutrinos via elastic scattering on electrons and galactic supernovae neutrinos via coherent neutrino-nucleus scattering. The current status of the DARWIN project will be presented along with sensitivity projections for a variety of science channels.

T 7.2 Mo 16:20 H09

Towards a hermetic TPC for the DARWIN experiment — •Julia Dierle — Hermann-Herder-Straße 3, 79104 Freiburg

With its ambitious sensitivity to rare WIMP-nucleus interaction, the DARWIN experiment has to significantly exceed the already very low target-intrinsic background rates achieved by the currently leading experiments. These are dominated by radon which is constantly emanated from all detector surfaces. The concept of a hermetic TPC could complement approaches like radon distillation, material selection and surface treatment and contribute towards the goal of a radon-induced background rate of $0.1\,\mu$Bq/kg. The hermetic TPC minimizes the surface being in direct contact with the active volume which must thus be enclosed in an (almost) liquid- and gas-tight shell. A small residual xenon flow from the purified target to the outside volume is expected. We report on the status and upcoming milestones towards construction and operation of such a hermetic TPC.

T 7.3 Mo 16:35 H09

Electromagnetic field and VUV light tracking simulations for the DARWIN field cage — •Sebastian Stern, Tobias Kleiner, Jonas Kellerer, Ferenc Glueck, and Guido Drexlin — Institut für Experimentelle Teilchenphysik, Karlsruher Institut für Technologie, Deutschland

The goal of the DARWIN experiment is to design and construct the ultimate dark matter detector, using a multi-ton target of liquid xenon for the direct detection of particle dark matter in a sensitive time projection chamber (TPC). Together with achieving very low radioactivity conditions and the required xenon purity, one of the most challenging aspects is the ability to have a very homogeneous drift field inside the TPC with ideally no radial electrical field. It is therefor of particular importance to gain a detailed understanding of the electrical field with high precision simulation algorithms.

In this work we present detailed calculations of the large-scale drift field of the DARWIN TPC with the aim to maximize the field homogeneity, using the KEMField and COMSOL codes. We also investigate the impact of surface charge on the PTFE-LXe interface and the local field of small Cu-pins, which are proposed as countermeasure against surface charges. We show that the impact of pins on the local drift field is well under control. In addition, we present simulations of the effect of the Cu-pins on the propagation of VUV light.

T 7.4 Mo 16:50 H09

Cu-pins as a novel tool to counteract PTFE surface charges in DARWIN — •Tobias Kleiner — KIT (IKP), Karlsruhe, Germany

The goal of the DARWIN experiment is to design and construct the ultimate dark matter detector, using a multi-ton target of liquid xenon for the direct detection of particle dark matter in a sensitive time projection chamber. Together with achieving very low radioactivity conditions and the required xenon purity, one of the most challenging aspects is the ability to have a very homogeneous drift field inside the TPC with ideally no radial electrical field. It is therefore crucial to investigate surface charge-up effects of the reflection enhancing PTFE wall observed in preceding experiments like LUX, as well as identifying a method to reduce its influence on the electric field. We experimentally investigate the novel ansatz to collect PTFE surface charges by Cu-pins. Surface charges are generated by an electron gun as well as by UV light with and without Cu-pins, and the resulting electric field is measured by a movable electrostatic voltmeter.

T 7.5 Mo 17:05 H09

Beyond Dark Matter with the XENONnT Experiment — •Arianna Rocchetti — Uni-Freiburg

The XENON project seeks to directly detect dark matter in the form of Weakly Interacting Massive Particles (WIMPs) and it is now entering a new exciting phase: XENONnT, which will feature almost triple the target mass of xenon as well as decreased backgrounds. This will give XENONnT not only an unprecedented sensitivity to the WIMP-nucleon interaction cross section but also it will open the possibility to probe several other rare physics processes. Among these, the search for the neutrino-less double beta decay of ^{136}Xe, which has a isotopic

abundance of 8.49% in natural xenon. This decay channel has a Q-value of (2457.83 ± 0.37) keV, which is orders of magnitude greater than the expected dark matter signature, for which the detector is primarily optimized. We will present studies to improve the sensibility in the high energy region together with the modifications done in the data acquisition system in order to have a separate readout chain dedicated to these more energetic signals.

T 7.6 Mo 17:20 H09

The Gd-loaded water Cherenkov neutron veto of the XENONnT experiment — •Daniel Wenz for the XENON-Collaboration — Institut für Physik & Exzellenzcluster PRISMA, J. Gutenberg-Universität Mainz, 55099 Mainz, Germany

The XENON1T experiment searching for direct detection of Dark Matter at the Laboratori Nazionali del Gran Sasso in Italy has set in 2018 the world-leading limit on the spin-independent cross-section between nucleon and the Dark Matter candidate Weakly Interacting Massive Particle (WIMP), and is now undergoing an upgrade with a larger dual-phase xenon Time Projection Chamber, XENONnT. The new detector will employ more 8 tonnes of xenon, improving by one order of magnitude the sensitivity to the WIMP-nucleon spin-independent cross-section to $\sim 2 \times 10^{-48}$ cm^2. In addition, the current water Cherenkov Muon Veto system surrounding the XENONnT cryostat will be integrated with a new neutron veto system, based on the use of gadolinium-loaded water. In this talk we describe the implementation of the new neutron veto detector and the plans for its calibration, and we show its beneficial impact on the residual neutron background that could otherwise affect the XENONnT goal sensitivity.

T 7.7 Mo 17:35 H09

Characterization of the Heidelberg Xenon (HeXe) TPC — •Florian Jörg, Guillaume Eurin, Natascha Rupp, Dominick Cichon, and Teresa Marrodán-Undagoitia — Max-Planck-Institut für Kernphysik Heidelberg

Dual phase liquid xenon time projection chambers (TPCs) are among the most sensitive detector technologies used for rare event searches, such as for example direct dark matter detection. To ensure the optimal response of the detector, it is crucial to maintain the chemical purity of the xenon at a high level. New techniques aimed at the background reduction for these experiments, employ chemicals to improve the surface properties of different materials, which are used for the construction of such detectors. In order to guarantee the compatibility of these techniques with the high xenon purity demand of a dual phase TPC, it is mandatory to test these techniques under the operational conditions of such a detector. The Heidelberg Xenon (HeXe) dual phase liquid xenon TPC is dedicated to investigate the possible effects of different surface treatment techniques onto the liquid xenon purity. In this talk, the measuring system and its performance will be described. Results from a first characterization of the charge and light response of the system at different drift fields using a ^{83m}Kr source will be presented. Uncertainties in the drift field were evaluated with a three dimensional FEM simulation using COMSOL Multiphysics.

T 7.8 Mo 17:50 H09

Radon removal for the XENONnT dark matter experiment — •Michael Murra for the XENON-Collaboration — Institut für Kernphysik, Münster

The next-generation dark matter experiment XENONnT utilizes about 8.4 tonnes of liquid xenon for the direct search of Weakly Interacting Massive Particles (WIMPS). Intrinsic radioactive contaminants in the liquid xenon such as Kr-85 and Rn-222 will be the main source of background. Both noble gas species can be removed by cryogenic distillation, employing the differences in vapor pressure between krypton and radon with respect to xenon. While krypton can be reduced once before the start of the dark matter search with the existing krypton distillation column of XENON1T, radon is continously emanating from the detector components. Therefore, a new high-flux radon removal system is under developement for XENONnT. Besides the separation performance, the main challenge is an efficient thermodynamic design.

This talk will present the design along with first measurements with a prototype setup.

The project is funded by BMBF under contract 05A17PM2.

T 7.9 Mo 18:05 H09

Optical simulations of the XENONnT experiment — •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) for a direct search for weakly interacting massive particles (WIMPs). The next operation phase, XENONnT, is currently under construction at Laboratori Nazionali del Gran Sasso (LNGS).

Therefore, a new TPC was developed to maximize the active detector volume while keeping most of the infrastructure of XENON1T. This kind of detector is built to detect low intensity light signals, generated either directly by the recoil produced by the scattering processes of incoming particles (S1) or through proportional scintillation (S2). The light collection efficiency (LCE) of these signals depends on the position of interactions in the active volume and on optical properties of the detector materials. During operation and analysis of XENON1T, several aspects of the design revealed opportunities of further improvements, such as the geometrical arrangement of the PTFE components in the electroluminescence region.

A recap of the design choices for XENON1T and XENONnT regarding optical properties as well as preliminary optical simulations of XENONnT will be shown.

This work is supported by BMBF under contract 05A17PM2.

T 8: Neutrinophysik I

Zeit: Montag 16:00–18:20 Raum: S06

Gruppenbericht T 8.1 Mo 16:00 S06

Towards a neutrino mass measurement with the KATRIN experiment — •Stephanie Hickford for the KATRIN-Collaboration — Karlsruher Institut für Technologie

The *KArlsruhe TRItium Neutrino* (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. High statistics are obtained from a high intensity gaseous tritium source and an $\mathcal{O}(1\ eV)$ energy resolution near the endpoint of molecular tritium at 18575 eV is obtained using a MAC-E filter spectrometer with high angular acceptance.

Two measurement phases took place in 2018, both of which are major milestones on the path to neutrino mass measurements. "First Tritium" took place during May and June, in which trace amounts of tritium at the sub-percent level mixed with deuterium were injected into the source. Commissioning phase III took place during September, in which systematic effects were studied using electrons from a precision photoelectron source and conversion electrons from ^{83m}Kr. The results from these measurement phases, as well as final steps towards neutrino mass measurements beginning in 2019, will be presented in this talk.

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).

Gruppenbericht T 8.2 Mo 16:20 S06

The Electron Capture in ^{163}Ho experiment — •Federica Mantegazzini for the ECHo-Collaboration — Kirchhoff-Institute for Physics, Heidelberg University, Germany

The goal of the Electron Capture in ^{163}Ho (ECHo) experiment is the determination of the electron neutrino mass by the analysis of the electron capture spectrum of ^{163}Ho. The detector technology is based on metallic magnetic calorimeters operated at low temperature in a reduced background environment. During the first phase of the experiment, ECHo-1k, the detector production has been optimised and the implantation process of high purity ^{163}Ho source in large detector arrays has been developed. The implanted detectors have been successfully operated and characterised at low temperatures, reaching energy resolution below 5 eV. High statistics and high resolution ^{163}Ho

spectra have been acquired and analysed at the light of the new 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. In particular, we focus on the production of large arrays with ^{163}Ho embedded in the absorbers and on the multiplexed readout.

Gruppenbericht T 8.3 Mo 16:40 S06

The search for eV sterile neutrinos with the STEREO experiment — •Christian Roca, Helena Almazán, Christian Buck, Manfred Lindner, and Stefan Schoppmann — Max-Planck-Institut für Kernphysik Heidelberg

In the last recent years, two unsolved anomalies have appeared during the study of the reactor neutrinos: one related to the neutrino spectral shape, and another to the absolute neutrino flux. The last one, known as the Reactor Antineutrino Anomaly (RAA), presents a deficit in the observed flux compared to the expected one. This anomaly could point to the existence of a light sterile neutrino participating in the oscillation phenomena.
The study of the nuclear reactor flux at very short baselines is a key to prove these hypothesis. The **STEREO** experiment observes neutrinos emitted from the compact, highly ^{235}U enriched fuel element of the research reactor of the Institut Laue Langevin (Grenoble, France). The detector target is placed at only 10 meters of the reactor core, and in order to have an independent measurement of the neutrino spectrum, it is segmented in six independent cells providing a multiple baseline analysis. The recorded data during 113 (138) days of reactor turned on (off) analyzed and presented last year, are compatible with the null oscillation hypothesis and reject the original best-fit of the RAA at 98 % C.L. These results, and the most recent improvements of the second phase of data taking will be presented in this talk, providing a crucial input in the search of sterile neutrinos.

Gruppenbericht T 8.4 Mo 17:00 S06

New Results from the Double Chooz Experiment — •Philipp Soldin for the Double Chooz-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

Double Chooz is a reactor neutrino disappearance experiment that has been operating between 2011 until 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 measuring the signature of the inverse beta decay (IBD), which consists of a prompt positron- and a delayed neutron capture signal. The double detector setup with an essential iso flux configuration under consideration of all neutrino rates, energy spectral shapes and all relevant backgrounds allows a fit to obtain the neutrino mixing angle θ_{13}. Statistical uncertainties are further reduces by adding the delayed signal of the Hydrogen neutron capture in addition to the Gadolinium, which yields an increase of more than a factor two in statistics. Unique techniques for the selection of antineutrino events and background discrimination and the development of a multivariate, highly parallel fit to the prediction are shown, and the observed spectral distortions are discussed in this talk.

T 8.5 Mo 17:20 S06

Sterile Neutrino Search with the Double Chooz Experiment — •Denise Hellwig, Philipp Soldin, Achim Stahl, and Christopher Wiebusch — III. Physikalisches Institut B, RWTH Aachen

The Double Chooz experiment is a reactor neutrino disappearance experiment located at the Chooz nuclear power plant, France. It measures the electron-antineutrino flux of the two nuclear reactors with two detectors of identical design: A far detector at a distance of about 1 km and a near detector at a distance of about 400 m. The detectors have been operating from 2011 (far) and 2014 (near) till end of 2017. The combination of the two detectors offers sensitivity to sterile neutrino mixing parameters. Sterile neutrinos are neutrino mass states not taking part in weak interactions, but may mix with known neutrino states. This induces additional mixing angles and mass differences where Double Chooz is sensitive to the new mixing angle θ_{14}. This talk describes the search for sterile neutrinos and its results.

T 8.6 Mo 17:35 S06

Analysis of First Tritium Data of the KATRIN Experiment — •Christian Karl for the KATRIN-Collaboration — Max-Planck Institut für Physik

The **Kar**lsruhe **Tri**tium **N**eutrino (KATRIN) experiment is designed to determine the effective electron anti-neutrino mass with a sensitivity of $m_\nu = 0.2\,\mathrm{eV/c^2}$ (90 % C.L.) using electrons from tritium β-decay.

First Tritium data was taken in May and June 2018 with the goal of commissioning the full KATRIN system with 1 % nominal activity and demonstrating a global system stability on the 0.1 % level. In addition, this data provides the opportunity to investigate the β-spectrum for systematic effects and test the analysis tools and strategies.

This talk gives an overview of the results from the high-level analysis of First Tritium measurements with a focus on the different analysis strategies as well as a full analysis including systematic effects.

T 8.7 Mo 17:50 S06

Search for the Detection of the Proton Decay $p \to \bar{\nu}K^+$ in JUNO — •Konstantin Schweizer and Lothar Oberauer — Technische Universität München, Physik-Department, James-Franck-Str. 1, 85748 Garching

The organic liquid scintillator based JUNO experiment (Jiangmen Underground Neutrino Observatory) has the aim to determine the neutrino mass hierarchy. JUNO can also serve for the search for proton decay due to its large target mass of 20 kton. The decay branch $p \to \bar{\nu}K^+$ is favoured in SUSY models. The K^+ emitted in this decay is invisible in water Cherenkov detectors like SuperKamiokande but can be observed in JUNO.
We discuss the prospects of JUNO of reaching a high detection efficiency for this specific decay mode and the capability of JUNO to identify background events. Finally, open questions and problems will be addressed.

T 8.8 Mo 18:05 S06

Determining the neutrino mass with Project8: Improving track reconstruction — •Michael Gödel, Christine Claessens, and Sebastian Böser — Johannes Gutenberg Universität Mainz, Institut für Physik, Deutschland

Project 8 aims to measure the absolute neutrino mass scale from the end point distortion of the tritium beta decay spectrum by using Cyclotron Radiation Emission Spectroscopy (CRES). In this approach the electrons are trapped in a magnetic field causing them to emit cyclotron radiation. By recording the frequency of the resulting radio frequency signal in which electrons will appear as lines in a spectrogram, the electron's energy can be reconstructed. The electron signatures can be extracted by applying image processing techniques. In this contribution a short introduction into the experiment is given. A comparison of different event reconstruction methods is presented by taking a look at their characteristic properties and performances.

T 9: Higgs: Erweiterte Modelle

Zeit: Montag 16:00–18:30 Raum: S07

T 9.1 Mo 16:00 S07

An effective scanning method of the NMSSM parameter space — •Conny Beskidt[1], Wim de Boer[1], and Dmitri Kazakov[1,2] — [1]Karlsruhe Institute of Technology (IETP) — [2]JINR, ITEP, Moscow, Russia

The next-to minimal supersymmetric standard model (NMSSM) naturally provides a 125 GeV Higgs boson and a dark matter sector with electroweak scale neutralinos consistent with all experimental data, like relic density and non-observation of direct or indirect DM signals. However, more free parameters are introduced, which are strongly correlated especially if all radiative corrections from the GUT scale are considered. A simple parameter scan without knowing the correlation matrix is not efficient and missing out significant regions of the pa-

rameter space is at risk. We introduce a new technique to sample the NMSSM parameter space, which allows an efficient sampling with complete coverage. For this we reduce the 7D NMSSM parameter space to a 3D Higgs boson mass parameter space, which allows a detailed sampling of the Higgs mass space and therefore a complete study of the NMSSM Higgs sector including predictions of branching ratios and cross sections.

T 9.2 Mo 16:15 S07

Performance studies of advanced $X \to b\bar{b}$ tagging methods for searches of resonant di-Higgs boson production in the $b\bar{b}WW^*$ decay channel. — •Joshua Beirer, Kira Abeling, Jason Veatch, and Stan Lai — Georg-August-Universität Göttingen

The discovery of the Higgs boson in 2012 paved the way for the Higgs precision era at the LHC. With more data now available, it is increasingly important to search for extremely rare processes such as di-Higgs boson production, which would allow for a direct test of the Higgs mechanism. Furthermore, several beyond the Standard Model theories predict heavy resonances that can decay into two Higgs bosons and would enhance the di-Higgs boson production cross section. For resonant masses in the TeV mass range, the decay products are highly-boosted and appear very close to each other in the detector such that they cannot be resolved individually. Instead, hadronic decay products are collected in large R-jets such that the constituents can be studied using substructure information.

In order to exploit the large $H \to b\bar{b}$ branching ratio, sophisticated methods for boosted $b\bar{b}$ tagging are crucial. For this purpose, the Higgs boson is reconstructed as a large R-jet and associated small R-jets are used to identify the individual b-hadrons. In this talk, the performance of several new subjet tagging techniques in the $X \to HH \to b\bar{b}WW^*$ channel is presented, which are aimed to considerably improve the tagging in boosted topologies.

T 9.3 Mo 16:30 S07

Search for charged Higgs bosons of a Type I 2HDM in the final state with one lepton and four b jets — •David Brunner, Isabell Melzer-Pellmann, and Arathi Ramesh — DESY, Hamburg

The discovery of the Higgs boson at the LHC and various measurements of its coupling to SM particles confirms the predictions of the theoretical frame work of the Higgs mechanism. While in the SM the introduction of one complex scalar doublet is postulated, in more general theories two or more complex scalar doublets are introduced.

In the Two Higgs Doublet Model (2HDM) two complex scalar doublets are postulated, leading to two CP-even scalar Higgs bosons h and H, one CP-odd Higgs boson A and two charged Higgs bosons $H^{\pm}$. Four different types of the model can be studied depending on the coupling of the Higgs doublets to the SM fermions.

This search focuses on a Type I 2HDM model with an inverted scenario, where the H boson is defined as the SM Higgs boson. We investigate a scenario where the decay of the $H^{\pm}$ to the h boson 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 bjets and the $W^{\pm}$ decays leptonically.

The search uses 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.

T 9.4 Mo 16:45 S07

Combination of di-Higgs searches using 13 TeV data collected by the ATLAS detector — •Florian Beisiegel, Alessandra Betti, Jochen Dingfelder, Tatjana Lenz, Alexander Melzer, and Norbert Wermes — University of 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).

By combining di-Higgs searches with different final states the upper limits on the di-Higgs production cross section can be further improved. This talk presents a combination of six different di-Higgs final states ($HH \to 4b$, $bb\tau\tau$, $bb\gamma\gamma$, $bbWW$, $WW\gamma\gamma$, $4W$) using $36.1\,\mathrm{fb}^{-1}$ of data collected at $\sqrt{s} = 13\,\mathrm{TeV}$ with the ATLAS detector. In addition to results on the resonant and non-resonant production modes, constraints on the Higgs self-coupling and interpretations in different BSM models will be shown.

T 9.5 Mo 17:00 S07

Double Higgs boson production and Higgs self-coupling at CLIC — Philipp Roloff[1], •Ulrike Schnoor[1], Rosa Simoniello[1,2], and Boruo Xu[3] — [1]CERN, Geneva, Switzerland — [2]Johannes-Gutenberg-Universität Mainz, Germany — [3]University of Cambridge, UK

The trilinear Higgs self-coupling has a central role in the understanding of electroweak symmetry breaking as it determines the shape of the Higgs potential. Its investigation is a crucial component of physics at future colliders. CLIC, the Compact Linear Collider, is a high-energy electron-positron accelerator being studied as an option for the post-LHC era. Its high-energy stages at $\sqrt{s} = 1.5$ and 3 TeV give direct access to Higgs boson pair production, from which the Higgs self-coupling can be extracted. This talk covers the full-simulation analysis of the expected sensitivity of the high-energy stages of CLIC to double Higgs production. The cross-section measurement of double Higgsstrahlung and differential observables in W-fusion Higgs-pair production are combined to give the expected sensitivity of CLIC to the trilinear Higgs self-coupling.

T 9.6 Mo 17:15 S07

Search for additional Higgs bosons decaying into W+W- with CMS using full Run 2 data — Jordy Degens, Günter Flügge, Olena Hlushchenko, Wolfgang Lohmann, Thomas Müller, •Dennis Roy, Hale Sert, Achim Stahl, and Alexander Zotz — III. Physikalisches Institut B, RWTH Aachen University

After the successful Run 2 data-taking period of the LHC, analyses on the full Run 2 data have been started. With an integrated luminosity of 137 fb^{-1} as measured by CMS, it can be hoped to find new particles, such as those expected from the minimal supersymmetric extension of the standard model (MSSM).
The high mass $H \to WW$ analysis aims to search for resonances at higher masses, which may originate from a heavier Higgs boson, as well as to provide limits on 2HDM and MSSM scenarios. This is achieved by studying the di-leptonic channel, in which each W boson decays into either an electron or a muon. The status and future plans of this analysis on the full Run 2 dataset are presented in this talk.

T 9.7 Mo 17:30 S07

Suche nach unsichtbaren Zerfällen des Higgs-Bosons mit dem ATLAS-Detektor — •Johannes Balz, Katharina Bierwagen, Volker Büscher, Andreas Reiss und Christian Schmitt — 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.

In diesem Vortrag geht es um die Suche nach direkten, unsichtbaren Zerfällen des Higgs-Bosons, die nur mit Modellen jenseits des Standardmodells beschrieben werden können. Bei ATLAS wurde dies bisher nur in den Higgs-Produktionskanälen Vektor-Bosonen-Fusion und Assoziierte Produktion untersucht. In dem am LHC dominanten Produktionskanal Gluon-Fusion werden unsichtbare Higgs-Boson-Zerfälle nur sichtbar, wenn im Anfangszustand zusätzliche Abstrahlungen stattfinden. Diese unterscheiden sich von den Abstrahlungen im dominanten Untergrundprozess $Z \to \nu\nu$ durch unterschiedliche Quark- und Gluonjetanteile. Dadurch ist eine Untergrundunterdrückung mithilfe von Quark-Gluon-Tagging möglich.

Im Vortrag wird der aktuelle Stand der Analyse bei einer Schwerpunktsenergie von $\sqrt{s}$=13 TeV vorgestellt.

T 9.8 Mo 17:45 S07

Possible NMSSM deviations from the SM-like signal strengths of the 125 GeV Higgs boson — •Conny Beskidt[1], Wim de Boer[1], and Dmitri Kazakov[1,2] — [1]Karlsruhe Institute of Technology (IETP) — [2]JINR, ITEP, Moscow, Russia

In the next-to minimal supersymmetric standard model (NMSSM) seven Higgs bosons are predicted: 3 scalar, 2 pseudo-scalar and 2 charged Higgs bosons. In the decoupling limit where the heavier Higgs bosons are well above the Z-boson mass limit and the mixing of the

Higgs singlet and doublets is small, the NMSSM prefers SM-like couplings for one of the light Higgs bosons. The signal strengths are defined as the ratio of the production cross sections times branching ratios divided by the SM predictions. We investigate the regions of parameter space where the signal strength of the observed 125 GeV Higgs boson can deviate from one and if deviations would be observed, the correlation between the deviations for signal strengths to vector bosons and fermions.

T 9.9 Mo 18:00 S07

Search for CP-violation in gluon fusion production of the Higgs boson in $H \to \tau_{lep}\tau_{had}$ decay at $\sqrt{s} = 13$ TeV with the ATLAS detector — •Daariimaa Battulga, Kathrin Becker, and Markus Schumacher — Physikalisches Institut, Universität Freiburg

CP-violation is one of the necessary Sakharov conditions to explain the observed asymmetry between matter and anti-matter in the universe. The magnitude of the observed CP-violation in the neutral meson sector, as described by the CKM matrix in the Standard Model, is insufficient to explain the observed asymmetry. Hence it is important to search for new sources of CP-violation e.g., in the Higgs boson sector. A test of CP-invariance of Higgs boson production in gluon fusion in association with two jets is performed exploiting the decay $H \to \tau_{lep}\tau_{had}$ based on proton-proton collision data corresponding to 140 fb^{-1} collected by the ATLAS experiment. The presentation will discuss the analysis strategy using CP-odd optimal observables and in particular the event selection to isolate the signal from background contributions.

T 9.10 Mo 18:15 S07

Search for neutral Higgs Bosons Production in Final States with b-quarks in the semi-leptonic channel — •Antonio Vagnerini — DESY Hamburg

The LHC discovery of a Standard-Model-like Higgs particle in 2012 could be a portal to an extended Higgs sector predicted by several models, such as the Minimal-Supersymmetric Extension of the SM (MSSM) and the more general Two-Higgs-Doublet Model (2HDM). The additional Higgs states predicted by such extended models can have enhanced coupling to b-quarks in several scenarios, such as the 2HDM Type-II and -IV. This analysis is the search for neutral Higgs bosons decaying into a b-quark pair and produced in association with at least one additional b-quark. In the final state, we require a muon, stemming from b-hadron decays, to lie within any of the two b-jets emitted in the Higgs decay. This type of selection allows us to probe Higgs bosons with low masses. Detailed studies of the analysis strategy and its sensitivity are presented together with parameters of extended models for several mass hypotheses.

T 10: Dunkle Materie und Kollider I

Zeit: Montag 16:00–18:15 Raum: S09

T 10.1 Mo 16:00 S09

Hunting the Dark Higgs at CMS — •Samuel Baxter[1,2], Alexander Grohsjean[1], Christian Schwanenberger[1], and Oliver Buchmüller[2] — [1]Deutsches Elektronen-Synchrotron DESY, Hamburg, Deutschland — [2]Imperial College London, London, England

The dark Higgs model is an extension of the Standard Model (SM) that describes the phenomenology of dark matter while respecting the SM gauge symmetries.
Besides adding a fermionic dark matter candidate to the SM, it introduces a new vector boson (Z') along with a new scalar, the dark Higgs particle.
This new approach opens regions of parameter space that are not covered by searches with simpler models of dark matter.
The result of a search using 36fb^{-1} of proton-proton data recorded in 2016 by the CMS experiment, which is part of the LHC at CERN, will be presented.

T 10.2 Mo 16:15 S09

Suche nach Dunkler Materie im Mono-Higgs-Kanal mit dem ATLAS-Detektor bei einer Schwerpunktenergie von 13 TeV — •Rainer Röhrig, Philipp Gadow, Sandra Kortner, Hubert Kroha und Patrick Rieck — Max-Planck-Institut für Physik, München, Deutschland

Dunkle Materie dominiert die Materie im Universum und ist einer der wichtigsten Hinweise auf Physik jenseits des Standardmodells. Die Teilchennatur der Dunklen Materie ist bisher unbekannt, jedoch wird vermutet, dass sie aus sogenannten WIMPs bestehen könnte. Solche Teilchen könnten am LHC erzeugt und im ATLAS-Detektor in Ereignissen mit hohem fehlenden Transversalimpuls beobachtet werden. Die Paarproduktion von Teilchen der Dunklen Materie zusammen mit dem entdeckten Higgs-Boson, der sogenannte Mono-Higgs-Kanal, liefert eine neue Signatur für Dunkle Materie. Am vielversprechendsten ist dabei die Suche im Endzustand mit Higgs-Bosonzerfällen in $b\bar{b}$-Paare. Die Higgs-Bosonen werden hier mit hohen Impulsen erzeugt, was zu einer starken Kollimation der beiden b-Quarks im Endzustand führt, die daher als ein gemeinsamer Hadron-Jet mit großem Radiusparameter rekonstruiert werden. Für die Suche nach Mono-Higgs-Ereignissen wurden die bisherigen Ergebnisse, die auf Daten der Jahre 2015 und 2016 und einer integrierten Luminosität von 36 fb^{-1} basieren, in Rahmen von zwei neuen Signalmodellen reinterpretiert

T 10.3 Mo 16:30 S09

Search for Dark Matter in the Mono-Higgs Channel with the ATLAS Detector — •Andrea Matic and Jeanette Lorenz — Ludwig-Maximilians-Universität München

From astrophysical observations it is known that a large fraction of the mass-energy density in the universe consists 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. The 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 small-radius jets, while for high momenta they are collimated into one large-radius jet.

In this talk the search strategy will be presented with emphasis on expected improvements of the analysis, which relate to the treatment of the $b\bar{b}$-system and modifications to the fitting procedure for signal and background.

T 10.4 Mo 16:45 S09

Scouting trigger and search for dark photon in dimuon channel in CMS — Thomas Hebbeker and •Swagata Mukherjee — III. Physikalisches Institut A, RWTH Aachen University, Aachen

After several years of running of the LHC, new physics has not been found yet. It is high time to focus on the difficult corners of the phase space. Data scouting is one such attempt. This special data flow, based on event-size reduction rather than event filtering, will be reviewed in this talk. Scouting data is useful to perform searches for low mass resonances, where nominal triggers have reduced or zero sensitivity. A new search for dark-photons in the dimuon channel has been designed 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 small couplings to standard model particles via kinetic mixing with the ordinary photon. This new search will be discussed in this talk.

T 10.5 Mo 17:00 S09

Search for Dark Matter produced in association with a Dark Higgs (s) with the ATLAS experiment at 13 TeV — •Fabrizio Napolitano[1] and Oleg Brandt[2] — [1]Kirchhoff-Institute for Physics Im Neuenheimer Feld 227 D-69120 Heidelberg — [2]Kirchhoff-Institute for Physics Im Neuenheimer Feld 227 D-69120 Heidelberg

The Dark Higgs model extends the spin-1 simplified model by introducing a spontaneously broken *U(1)'* gauge group with a Majorana

Dark Matter (DM) particle and two mediators: a real scalar s (Dark Higgs boson) and a massive vector boson Z'. Any Dark Sector state or the Z' mediator can radiate off a Dark Higgs boson, leading to a new production mechanism of DM at the LHC that may not be accessible with current DM searches. We discuss a search for the Dark Higgs with the ATLAS experiment, considering its resonant signature in association with missing transverse momentum. As the mass of the scalar is a free parameter of the model, we show how this affects the phenomenology and the search strategy.

T 10.6 Mo 17:15 S09

Suche nach Dunkler Materie in Ereignissen mit fehlender transversaler Energie und Jets beim ATLAS Experiment — •Andreas Reiss, Katharina Bierwagen und Volker Büscher — Johannes Gutenberg-Universität, Mainz, Deutschland

Astrophysikalische Beobachtungen legen die Existenz von Dunkler Materie im Universum nahe, deren Natur nicht genau bekannt ist. Durch die Datennahme mit dem Large Hadron Collider von 2015 bis 2018 bei einer Schwerpunktsenergie von 13 TeV werden neue Suchen nach Dunkler Materie in Proton-Proton-Kollisionen ermöglicht, die komplementär zu den indirekten und direkten Suchen sind.

Dieser Vortrag befasst sich mit der Suche nach Dunkler Materie und weiteren neuen Phänomenen in Ereignissen mit Abstrahlung von Jets im Anfangszustand und fehlender transversaler Energie. Dabei wird eine sehr genaue Untergrundabschätzung mit einer Genauigkeit von einigen Prozent benötigt. Hierbei ist es eine große Herausforderung, die datenbasierte Bestimmung der Untergründe und die Extrapolation in die Signalregion mit minimalen Theorieunsicherheiten durchzuführen.

T 10.7 Mo 17:30 S09

Prospects for a Mono-Z search for new invisible particles with CMS at the HL-LHC — •Andreas Albert, Thomas Hebbeker, and Arnd Meyer — III. Physikalisches Institut A, RWTH Aachen University

Over the last decade, the experiments at the CERN Large Hadron Collider (LHC) have established a wide range of searches for collider production of dark matter (DM) particles. In run 2 of the LHC, these searches have profited from the unprecedented center-of-mass energy of 13 TeV, which allowed to directly probe previously inaccessible mass ranges. Even so, no evidence has yet been found for the production of DM particles at the LHC. As we approach the era of the upgraded high-luminosity LHC (HL-LHC), which is scheduled to provide a dataset corresponding to 3 ab^{-1} of proton-proton collisions over the next two decades, it is imperative to understand how the DM search program will profit from this gigantic dataset.

In this talk, I will present a study of the HL-LHC sensitivity of a search for new invisible particles, such as DM candidates, in events with a Z boson and missing transverse momentum ("mono-Z") with the Compact Muon Solenoid detector (CMS). I will discuss the expected experimental conditions and the challenges they pose, present the projected sensitivity estimates, and comment on the complementarity of the mono-Z and other topologies.

T 10.8 Mo 17:45 S09

Hintergrundabschätzung durch Linearkombinationen von theoretischen Berechnungen des Dijet Spektrums für die Dijet Trigger-Level Analyse des ATLAS Experimentes — •Stella Katharina Wermuth — Kirchhoff-Institut für Physik, Heidelberg, Deutschland

Für Mediatorteilchen zwischen dem Standardmodell und einem möglichen Dunkler Materie Sektor sind geringe Massen ein großer unausgeschlossener Bereich. Jedoch ist im Standardbetrieb des ATLAS Experimentes die Sensitivität für Resonanzen in dieser Region statistisch durch die Datenspeicherrate begrenzt. Die Dijet Trigger-Level Analyse (TLA) des ATLAS Experimentes nutzt nur die Eventinformationen, die dem High-Level-Trigger zur Verfügung stehen. Dadurch wird die Eventrate erhöht und die statistische Sensitivität bei kleinen Massen ausgeweitet. Der bevorstehende statistische Anstieg der Daten ermöglicht eine Erhöhung der statistischen Präzision. Gleichzeitig wird für diesen Anstieg eine neue Methode der Hintergrundabschätzung notwendig. Die neue Methode nutzt Linearkombinationen von theoretischen Berechnungen des Dijet Spektrums. In diesem Vortrag werden die Methode dieser Hintergrundabschätzung im Allgemeinen sowie die Ergebnisse mit den TLA Daten von 2016 präsentiert.

T 10.9 Mo 18:00 S09

Trennung von Monojet und Multijet - Hintergrundabschätzung für Suchen nach Dunkler Materie mit dem ATLAS Detektor — •Sebastian Mario Weber — Kirchhoff-Institut für Physik, Heidelberg, Deutschland

Die Suche nach Dunkler Materie (DM) ist ein wichtiger Teil des Phyiskprogramms des ATLAS Detektors am LHC. Eine typische Signatur für die Produktion von DM an Hadronenbeschleunigern ist die hohe fehlende Transversalenergie (MET), durch nicht im Detektor wechselwirkende DM Teilchen, zusammen mit einem oder mehreren hochenergetischen Jets.

Ein bedeutender Hintergrund in dieser Suche entsteht durch Messungenauigkeiten des Detektors bei Multijet Ereignissen. Wird die Energie eines oder mehrerer Jets inkorrekt gemessen, führt dies zu einem Energieungleichgewicht in der transversalen Ebene und damit zu künstlicher MET. Eine Abschätzung dieses Effekts in Monte Carlo Simulationen ist aufgrund ungenügender Modellierung der Multijet Ereignisse nicht möglich.

In diesem Vortrag wird ein datengestützter Ansatz vorgestellt, der eine Abschätzung des Multijet Hintergrundes erlaubt. Dieser basiert auf dem vielfachen Schmieren gut gemessener Jets mit der Detektorantwort. Weiterhin wird die Objektbasierte Metsignifikanz als neue Variable eingeführt, die es ermöglicht, den Hintergrund weiter zu reduzieren.

T 11: Neutrino-Astronomie I

Zeit: Montag 16:00–18:30 Raum: S10

T 11.1 Mo 16:00 S10

STRAW: strings for absorption length in water — •Andreas Gärtner for the STRAW-Collaboration — Technische Universität München

Neutrino astronomy uses large volume detectors to search for astrophysical neutrinos. Detectors such as IceCube at the Geographic South Pole and the Gigaton Volume Detector (GVD) at Lake Baikal instrument up to a cubic kilometer of water or ice for measuring Cherenkov radiation created in neutrino-matter interactions. In the past the utilization of the clear water of the deep sea as Cherenkov medium has had severe difficulties in deploying and maintaining the offshore infrastructure.

Ocean Networks Canada (ONC), an initiative of the University of Victoria, has been creating and maintaining a deep sea infrastructure for scientific instruments off the coast of Canada. One of their network nodes, located on the Pacific abyssal plain of Cascadia Basin, could be an ideal site for a future neutrino telescope.

The Strings for Absorption Length in Water (STRAW) were developed at the Technical University of Munich (TUM) in collaboration with ONC and the University of Alberta. Two strings with optical modules have been deployed at Cascadia Basin in order to measure the optical properties of the water and study the feasibility of a larger installation. We will give a brief overview of the STRAW setup and present first results on the absorption length and background radiation at Cascadia Basin.

T 11.2 Mo 16:15 S10

SkyLLH - A new experiment-independent framework for celestial log-likelihood analyses in multi-messenger astronomy — •Tomas Kontrimas and Martin Wolf for the IceCube-Collaboration — Technische Universität München, Physik-Department, James-Franck-Str. 1, 85748 Garching

Common analysis techniques in multi-messenger astronomy involve hypothesis tests with unbined log-likelihood (LLH) functions using recorded celestial data to identify sources of high-energy cosmic particles in the Universe. We present the new general Python tool "SkyLLH", which provides an experiment-independent framework for constructing log-likelihood functions to perform data analyses with recorded multi-messenger astronomy data. Such data could be data

sets from different detectors, e.g. neutrino or gamma-ray event data sets from the IceCube Neutrino Observatory, or the Fermi-LAT, respectively. We highlight the current design goals of SkyLLH, which focus on time-integrated and time-optimized LLH analyses of IceCube data. However, possible future implementations of LLH functions for the Fermi-LAT within the SkyLLH framework will be discussed as well. In addition, we point out future prospects to target SkyLLH as a common analysis tool for the community of multi-messenger astronomy.

T 11.3 Mo 16:30 S10

Geometry calibration of the KM3NeT neutrino telescope using atmospheric muons — •Daniel Guderian and Alexander Kappes — Institut für Kernphysik, Westfälische-Wilhelms-Universität, Münster

The KM3NeT neutrino telescope consists of a network of large volume Cherenkov detectors at the bottom of the Mediterranean Sea destined to look for neutrino interactions in the water. With its two different sites, ORCA and ARCA, currently under construction, specializing in lower and higher neutrino energies, respectively, it aims at studying physics spanning from the determination of the neutrino mass hierarchy to detection of neutrinos from astrophysical objects. With the ongoing deployment of sensors, calibration becomes a highly important task to perform in order to provide the precision necessary for data analysis.

In this talk studies on a method using atmospheric muons for calibration are presented in which the reconstructed muon tracks are used to evaluate the detector geometry. In particular, position and time offset determinations of the photosensors can be achieved applying this technique.

T 11.4 Mo 16:45 S10

Trilateration-based geometry calibration of the IceCube detector — •Frederic Jonske, Christian Haack, Lilly Peters, Shefali Shefali, Martin Rongen, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

The IceCube Neutrino Observatory detects charged particles by measuring their Cherenkov light using photomultipliers. These photomultipliers have been inserted into the clear antarctic ice at depths between 1450 and 2450 meters. Reconstruction relies on arrival times of light at the position of these sensors. However, their position is currently only known to within a few meters based on deployment data and calibration with light sources. Trilateration of the arrival times of light emitted from LEDs within the sensor modules and received by neighboring sensors can be used to determine the relative sensor positions. In this talk, we discuss an improved determination of the detector geometry using trilateration and recent models of light propagation in ice.

T 11.5 Mo 17:00 S10

Development of acoustic receivers for the IceCube-Upgrade mDOM — •Roxanne Turcotte, Dirk Heinen, Frederic Jonske, Martin Rongen, Shefali Shefali, Christopher Wiebusch, and Simon Zierke for the IceCube-Collaboration — Physikalisches Institut IIIb, RWTH Aachen, Aachen, Germany

The IceCube Neutrino Observatory is a cubic kilometer scale neutrino detector, capable of detecting neutrinos of energies ranging from a few GeV to PeV and above. IceCube-Gen2 is a planned large-scale upgrade to enhance the sensitivity for the highest energy neutrinos. As a first step, the IceCube-Upgrade is being prepared. It involves inclusion of additional sensor strings and calibration devices in the central detector region. IceCube-Gen2 will entail larger spacing of optical sensor modules, for which the current calibration scheme of the geometry by means of trilateration by light becomes challenging. As a promising alternative method, trilateration by acoustic signals is being developed. This system will consist of acoustic receivers incorporated inside the optical sensor modules (mDOM), and stand-alone acoustic emitters. Furthermore, interactions of extremely high energy (EHE) neutrinos, with energies above 1 EeV, are expected to generate a transient acoustic signal strong enough to be detected. We will present the concept, design and tests of the first iteration of the acoustic receivers.

T 11.6 Mo 17:15 S10

Development of an Emitter for the Acoustic Geometry Calibration of the upcoming IceCube-Upgrade — •Shefali Shefali, Dirk Heinen, Frederic Jonske, Martin Rongen, Roxanne Turcotte, Christopher Wiebusch, and Simon Zierke for the IceCube-Collaboration — Physics Institute 3B, RWTH Aachen University, NRW, Germany

The IceCube Neutrino Observatory is a cubic kilometer scale neutrino detector, capable of detecting neutrinos of energies ranging from a few GeV to PeV and above. IceCube-Gen2 is a planned large-scale upgrade to enhance the sensitivity for the highest energy neutrinos. As a first step, the IceCube-Upgrade is being prepared. It involves inclusion of additional sensor strings and calibration devices in the central detector region. IceCube-Gen2 will entail larger spacing of optical sensor modules, for which the current calibration scheme of the geometry by means of trilateration by light becomes challenging. As a promising alternative method, trilateration by acoustic signals is being developed. This system will consist of acoustic receivers incorporated inside the optical sensor modules, and stand-alone acoustic emitters. The working principle of the acoustic system will be verified and optimized at shorter distances in agreement with the optical signals during the IceCube-Upgrade. In this talk, we will discuss the concept and design of the acoustic emitters.

T 11.7 Mo 17:30 S10

Improving the IceCube-DeepCore event classification — •Leander Fischer for the IceCube-Collaboration — DESY, Zeuthen, Germany

The IceCube Neutrino Observatory is a cubic kilometer in-ice Cherenkov detector located at the Geographic South Pole. DeepCore is a denser sub-array of IceCube that reaches an energy detection threshold of less than 10 GeV and provides data for some of the most precise neutrino oscillation measurements using atmospheric neutrinos. In current studies, muon neutrinos are identified by separating the measured data into two channels: track- and cascade-like events. A possible way to improve the current sensitivity is to split the data into further classes that might result in better reconstruction performance and better control over the systematic uncertainties. An approach for splitting the data using decision tree-based multivariate machine learning algorithms will be presented in this talk.

T 11.8 Mo 17:45 S10

Topological Track Reconstruction in Liquid Scintillator Neutrino Detectors for GeV Events — Caren Hagner, •David Meyhöfer, Henning Rebber, and Björn Wonsak for the JUNO-Collaboration — Institut für Experimentalphysik, Uni Hamburg

In the current era of neutrino physics, detectors tend to be demanding for more target volume and higher energy resolution. The greater volume and more readout channels make event reconstruction and background rejection challenging. An example for this development is JUNO, which is currently being constructed in China. The Topological Track Reconstruction is being tested and enhanced with simulations from said detector. It is able to provide a 3D light emission density distribution, based on isotropically emitted, unscattered scintillation photons. Hence one will obtain the differential energy loss (dE/dx), which can be used for background rejection.

For high energy events in the range of GeV this yields tremendous potential. Especially the impact of decay product signals from ^{9}Li and ^{8}He can be tackled. By determining the differential energy loss (dE/dx) the volume potentially containing background signals can be minimized. This reduces the dead time of the detector. The talk will primary focus on the differential energy loss (dE/dx) algorithm with the Topological Track Reconstruction in the high energy regime.

T 11.9 Mo 18:00 S10

Improving IceCube low energy event reconstruction — •Elisa Lohfink[1], Maicon Hieronymus[1], Sebastian Böser[1], and Elmar Schömer[2] for the IceCube-Collaboration — [1]Institut für Physik, JGU Mainz, Deutschland — [2]Institut für Informatik, JGU Mainz, Deutschland

Within the IceCube Neutrino Observatory and its low-energy extension (DeepCore), neutrinos with energies down to the GeV range can be reconstructed individually. The reconstruction is based on minimizing a six-dimensional likelihood space. Causality induced steep borders in the time-dimension make this likelihood space particularly difficult to evaluate, especially at reconstructed times later than the true event time. Currently, this challenge is overcome using MultiNest, a computationally expensive global nested sampling algorithm. In the new approach investigated here, directed likelihood sampling in the time-dimension is used to circumvent the issues induced by causality borders. This opens the possibility to use different, less costly minimiza-

tion techniques and thus to significant speed-up of the reconstruction.

T 11.10 Mo 18:15 S10

Simulation of Light Propagation Through Hole Ice for the IceCube Experiment — •Sebastian Fiedlschuster for the IceCube-Collaboration — Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP, Erwin-Rommel-Str. 1, 91058 Erlangen

IceCube is a neutrino observatory at Earth's South Pole that uses glacial ice as detector medium where particles from neutrino interactions produce Cherenkov light as they move through the ice, which then is detected by an array of photo detectors deployed within the ice. *Hole ice* is the refrozen water in the drill holes that were needed to deploy the detector modules.

Aiming to improve the detector calibration for the current IceCube detector as well as for the upcoming upgrade, a new method to simulate the propagation of light through the hole ice has been introduced. The new method allows a ray-tracing simulation of light through ice volumes of different optical properties, such as one or several hole-ice cylinders with specific positions, sizes, scattering lengths and absorption lengths. The effect of shadowing cables can be studied by modeling cables as opaque volumes. This talk will outline the simulation method and present current results.

T 12: Astroteilchenphysik: Methoden I

Zeit: Montag 16:00–18:30 Raum: S12

T 12.1 Mo 16:00 S12

Surface scans of inverted coaxial HPGe detctors for the LEGEND collaboration — •Andreas Zschocke for the LEGEND-Collaboration — Physikalisches Institut, Universität Tübingen

The LEGEND collaboration plans to search for the neutrinoless double beta decay ($0\nu\beta\beta$) with up to 200 kg of enriched germanium detectors. The sensitivity of this experiment relies strongly on the suppression and discrimination of background events. Inverted coaxial high purity Germanium detectors provide excellent pulse shape discrimination (PSD) properties and large masses, which make them a promising candidate for $0\nu\beta\beta$ searches. However, events originating near the passivated surface of these detectors can induce background at the region of interest which are not distinguishable with standard PSD methods. Therefore a detailed understanding of the shape of background events near the surfaces is crucial. This talk will present results of dedicated surface scans of an inverted coaxial detector with a collimated alpha source and focus on the pulse shape discrimination of those surface events.

This work has been supported by the German Federal Ministry for Education and Research (BMBF)

T 12.2 Mo 16:15 S12

Superconductive cryogenic detectors for rare event searches — •Elizabeth Mondragón[1], Stephan Gepräggs[3], Luca M. Pattavina[1], Federica Petricca[2], Stefan Schönert[1,2], Raimund Strauss[1], Andreas Erhart[1], Angelina Kinast[1], Alexander Langenkämper[1], Tobias Ortmann[1], and Walter Potzel[1] — [1]Physik-Department, Technische Universität München, Garching — [2]Max-Planck-Institut für Physik, München — [3]Walther-Meißner-Institut für Tieftemperaturforschung, Garching

We present first results obtained with novel cryogenic detectors coated with a thin Nb superconductive film. The smaller band gap of superconductors (meV) allows an improved light collection and enlarges the light absorption to the infrared. The detectors are equipped with transition edge sensors made from a superconducting W film operated in the steep transition to normal conduction. Detectors of this type are particularly suited as cryogenic light detectors for rare event searches that use phonon-light event-by-event particle discrimination, such as for the CRESST direct dark matter experiment. Further, we discuss the potential of superconducting bulk detectors. Such devices offer the possibility to discriminate particle interactions by the different decay times of phonons and quasiparticles down to low energies (below 100 eV). This technology is highly suited for direct dark matter searches like CRESST and for detecting coherent neutrino nucleus scattering like in the nuCLEUS experiment. This work has been supported in part by the German Federal Ministry for Education and Research (BMBF) and the German Research Foundation (DFG) via the SFB1258.

T 12.3 Mo 16:30 S12

Preparing the FAMOUS telescope for the observation of fluorescence light from extensive air-showers — •Adrianna García[1], Thomas Bretz[1], Paulo Ferreira[1], Thomas Hebbeker[1], Julian Kemp[1], Tobias Pan[1], Christine Peters[1], Merlin Schaufel[2], and Johannes Schumacher[1] — [1]III. Physikalisches Institut A, RWTH Aachen University — [2]III. Physikalisches Institut B, RWTH Aachen University

The First Auger Multi-pixel photon counter camera for the Observation of Ultra-high energy cosmic-ray air-showers (FAMOUS) is a telescope developed at the RWTH Aachen University. Its main goal is to measure photons produced in Extensive Air Showers generated from the interaction of Cosmic Rays (CRs) with the Earth's atmosphere.

The Data Acquisition system (DAQ) currently used by FAMOUS is suitable to measure Cherenkov photons. Now we evaluate its capability to detect also fluorescence light which will give information about the energy and the arrival direction of the primary CRs.

Experiments and analysis techniques have been developed in order to study the possibility of detecting both Cherenkov and fluorescence light with the current DAQ.

T 12.4 Mo 16:45 S12

Production and Testing of Scintillator Surface Detectors for the Pierre Auger Observatory in Aachen — •Julian Kemp, Thomas Bretz, Paulo Ferreira, Adrianna García, Thomas Hebbeker, Tobias Pan, and Christine Peters — III. Physikalisches Institut A, RWTH Aachen University

The Pierre Auger Observatory, located in the Argentinean Pampa, is a hybrid cosmic-ray detector measuring ultrahigh energy cosmic-ray air-showers. It consists of a surface array made up by 1660 water Cherenkov detectors which is overlooked by 27 fluorescence telescopes.

The Pierre Auger Observatory is currently undergoing a major upgrade, AugerPrime, to improve its performance. One main contribution is the installation of an additional scintillator detector on top of each surface detector station. It will allow for a more precise determination of air-shower characteristics, especially its number of muons.

The III. Physikalisches Institut A of the RWTH Aachen University is manufacturing and testing 135 of these Scintillator Surface Detectors. A procedure was developed to validate the performance of each detector individually before shipment.

T 12.5 Mo 17:00 S12

mDOM - a multi-PMT optical module for future IceCube-Extension — •Lew Classen and Alexander Kappes for the IceCube-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, Münster

Located in the deep glacial ice of Antarctica IceCube is the World's largest neutrino telescope. Originally designed for the investigation of the neutrino sky on the TeV to PeV energy scale and beyond, the lower energy threshold of its sensitivity range was expanded to $\sim 10\,\mathrm{GeV}$ by the DeepCore extension. Now plans for an upgrade of the detector are maturing that will further enhance IceCube's potential both at low and high energies. Novel optical sensors will have a key role in this. Among the new designs is the so-called mDOM, a multi-PMT Digital Optical Module. Optical modules based on this concept feature an array of several small photomultipliers (PMTs) housed inside a transparent pressure vessel, resulting in several advantages with respect to the conventional single-PMT design, such as a larger sensitive area, a uniform solid angle coverage as well as enhanced intrinsic directional sensitivity. The contribution will introduce the sensor concept and give an overview of the current status of development of the device.

T 12.6 Mo 17:15 S12

A GPU-Based Photon Tracker for the Wavelength shifting Optical Module (WOM) — •Florian Thomas[1], John Rack-Helleis[1], Sebastian Böser[1], and Elmar Schömer[2] for the IceCube-Collaboration — [1]Institute of Physics, Mainz — [2]Institute of Computer Science, Mainz

The Wavelength shifting Optical Module consists of a cylindrical tube coated with wavelength shifting paint and read out by a photomultiplier tube (PMT) optically attached at each end. Light striking the surface of the tube is absorbed, shifted towards longer wavelengths and guided to the PMT by total internal reflection within the walls of the tube.

This talk presents the current status of a high performance photon tracking simulation for the WOM which runs on CUDA-enabled GPUs. A prototype of this simulation processes photons approximately 240 times faster than commercial software, and we have identified opportunities for additional optimization.

T 12.7 Mo 17:30 S12

Simulation of the Optics of the Imaging Air Cherenkov Telescopes IceAct with Geant4 — •Maurice Günder[1], Jan Auffenberg[1], Pascal Backes[1], Thomas Bretz[2], Erik Ganster[1], Merlin Schaufel[1], and Christopher Wiebusch[1] for the IceCube-Collaboration — [1]III. Physikalisches Institut B, RWTH Aachen — [2]III. Physikalisches Institut A, RWTH Aachen

The Imaging Air Cherenkov Telescopes IceAct are proposed to be deployed on the surface above the IceCube Neutrino Observatory at the South Pole. With an SiPM based camera and a field of view of 12°, IceAct is capable to observe Cherenkov light from cosmic ray air showers in order to veto atmospheric muons and neutrinos which are background sources in cosmic neutrino searches of IceCube. Furthermore, IceAct can be used to measure the composition of cosmic rays and improve the calibration of IceCube and IceTop. For these purposes a detailed wavelength dependent simulation of the optics is needed to parametrize the telescopes' response. This simulation is done by Geant4, a general-purpose Monte Carlo simulation platform for the passage of particles through matter. We will present the results of the simulations with respect to detection efficiency, optical effects, and aberrations. The resulting optical response is parametrized in form of lookup tables that allow the efficient simulation of the signal of air showers.

T 12.8 Mo 17:45 S12

Effectivity analysis of a new lightguide design for SiPM pixel in MAGIC — •Alina Nasr Esfahani for the MAGIC-Collaboration — TU Dortmund, LS E5b, Otto-Hahn-Strasse 4a, 44227 Dortmund

MAGIC is a stereocopic system of two Imaging Air Cherenkov Telescopes on La Palma. At the edges of the camera, which uses Photomultiplier Tubes (PMTs), test clusters of silicon photomultipliers (SiPMs) have been installed.

To maximize the surface area of PMTs and SiPMs, collimators are placed on the pixels to guide the cherenkov light produced in particle showers to the sensor surface. Besides the currently used Winston Cones as lightguides for the SIPM Cluster, different lightguide designs have been installed which are cheaper in the production, while retaining the desired performance. In this talk, the performance of the different collimators are compared. Also, a comparison of the arrival times of lightpulses in SiPM und PMT pixels is shown.

T 12.9 Mo 18:00 S12

Comparison and optimization of scintillation detector DAQ systems for the large surface array of IceCube-Gen2 — •Marie Oehler[1], Andreas Haungs[1], Bernd Hoffmann[1], Thomas Huber[1,2], Timo Karg[2], Matt Kauer[3], Marko Kossatz[2], Max Renschler[1], Harald Schieler[1], Karl-Heinz Sulanke[2], Delia Tosi[3], Andreas Weindl[1], and Chris Wendt[3] for the IceCube-Collaboration — [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 amount of detected extragalactic neutrinos the upgrade IceCube-Gen2 is under development. Among others, a large surface scintillation detector array is proposed.

Two prototype stations, consisting of seven detectors each, have been installed in the Antarctic Season 2017/2018. These detectors use scintillators, wavelength shifting optical fibers and silicon photomultipliers (SiPM). The stations use different data acquisition (DAQ) systems: The μDAQ system researched, developed and built by UW-Madison and the TAXI system researched, developed and built by KIT and DESY. μDAQ transfers the digitized integrated signals only to minimize the amount of transmitted data. TAXI can transmit the waveforms of the signals additionally and build local triggers for further detectors like radio antennas. In this contribution these two DAQ systems will be compared and an optimized setting for the DAQ system will be presented.

T 12.10 Mo 18:15 S12

Development of a hybrid particle and radio detector DAQ for the IceCube experiment — •Peter Steinmüller[1], Michele Caselle[1], Andreas Haungs[1], Bernd Hoffmann[1], Thomas Huber[1,2], Timo Karg[2], Marko Kossatz[2], Max Renschler[1], Michael Schleicher[1], Frank G. Schröder[1,3], Karl-Heinz Sulanke[2], and Andreas Weindl[1] for the IceCube-Collaboration — [1]Karlsruhe Institute of Technology, Karlsruhe, Germany — [2]DESY, Zeuthen, Germany — [3]University of Delaware,Newark, USA

Complementing the in-ice neutrino detector, IceCube features a surface array for the detection of cosmic-ray air showers. A new hybrid detector consisting of particle and radio detectors is at the moment under development as an option to extend the IceCube surface array. While prototypes of the particle detectors are already deployed and operating at the South Pole, the deployment of two prototype radio antennas is scheduled for January 2019. These two antennas will be included in the existing particle detector array and its DAQ. To be able to process radio detector signals with the existing DAQ system (IceTAXI), additional components have to be added to the existing particle DAQ. Special care has been taken since the reconstruction of cosmic-ray properties using the radio signal highly depends on the accuracy of the recorded radio waveform. In this presentation, the hybrid DAQ system will be described in detail focusing on the radio detector electronics. In addition, first results regarding the characterization of the radio electronics as well as first tests with the full setup will be shown.

T 13: Kosmische Strahlung I

Zeit: Montag 16:00–18:20 Raum: S13

Gruppenbericht T 13.1 Mo 16:00 S13

Recent developments from the Auger Engineering Radio Array (AERA) * — •Marvin Gottowik — Bergische Universität Wuppertal, Gaußstraße 20, 42119 Wuppertal

The Auger Engineering Radio Array (AERA) is designed to measure the radio emission of extensive air showers initiated by cosmic rays above an energy of 10^{17} eV. AERA is an extension of the Pierre Auger Observatory located in Mendoza, Argentina. It is operated n coincidence with the other detectors of the observatory. The 153 autonomous radio antenna stations are distributed over an area of 17 km^2 on a grid with a spacing ranging from 150 - 750 m. Each antenna station comprises two dipole antennas sensitive to frequencies of 30 - 80 MHz. Data taking started in 2011.

Special emphasis is put on the detection of inclined air showers, where the radio emission footprint extends over several square kilometers. This motivates the upcoming radio extension of the Pierre Auger Observatory with a radio antenna mounted to each station of the surface detector array. With an optimized radio event reconstruction dedicated to inclined air showers and a possible combination of radio and particle data an independent mass scale and an absolute energy calibration from first principles can be achieved. In this talk an overview of the current status of the experiment and the latest scientific results is given.

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

T 13.2 Mo 16:20 S13

Reconstruction of inclined Extensive Air Showers from transient radio pulses at the Pierre Auger Observatory — •Felix Schlüter — Karlsruhe Institute of Technology - Institut for Nuclear Physics (IKP)

The detection of transient radio pulses provides information on the

electromagnetic component of Extensive Air Showers, e.g., information on the calorimetric energy deposit and longitudinal shower development in the earth's atmosphere. This has been demonstrated for vertical showers in the last decade by next-generation digital radio detectors such as the Auger Engineering Radio Array (AERA). For inclined air showers, radio detection can be combined with complementary measurements of the muonic shower component in hybrid observations to determine the mass composition of cosmic rays at the highest energies. The Radio Upgrade of the Pierre Auger Observatory will be dedicated to exploit these showers with 1660 hybrid detector stations. A reconstruction of the radio signal from inclined air showers has to account for asymmetries in the lateral distribution arising from geometrical effects as well as from the superposition of different emission mechanisms. One proposed model corrects for all asymmetries and describes the radio signal at ground with a rotationally symmetric lateral distribution function. In this talk, this model will be further refined using a greater understanding of the emission processes. With this model shower quantities such as the shower core or electromagnetic energy will be reconstructed for AERA observations.

T 13.3 Mo 16:35 S13

A Simulation study for the Radio Upgrade of the Pierre Auger Observatory — •Tobias Wiegert — Karlsruhe Institut für Technologie, Germany

The study of air showers in our atmosphere provides information about the highest energy particles in our universe, as well as the highest energy accelerators in and out of our galaxy. In recent years, the detection of radio pulses from air showers is becoming increasingly important. Radio antennas measure radio pulses from a large part of the sky 24 hours a day, and are particularly suitable for measuring inclined air showers. As the shower inclines, the area illuminated by radio signals increases. In order to reconstruct such showers well enough, radio antennas must be distributed over a large area. The antenna signals provide information about the electromagnetic component of the shower which can be used in conjunction with the data of surface particle detectors to further characterize the shower and its composition. In view of this, the Pierre Auger Observatory will be extended with additional radio antennas on top of each of the 1660 surface detectors, resulting in a coverage of 3000 km2 and allowing the collaboration to determine the mass composition of cosmic rays arriving at high angles of inclination. This presentation provides an overview of the performance of the planned radio upgrade with antennas on a 1500 m grid, with special regard to the detection of (highly) inclined air showers. Particular focus is put on the minimum energy of the shower at which a detection with the antennas is possible, and its dependence on the zenith angle.

T 13.4 Mo 16:50 S13

Measurements of radio emission induced by Ultra-high energy Cosmic rays with energies above 1 EeV with AERA — •Florian Briechle and Martin Erdmann — RWTH Aachen University, III. Physikalisches Institut A

Ultra-high energy cosmic rays induce extensive air showers emitting radiation in the radio regime which can be used to reconstruct their properties. The radio array AERA of the Pierre Auger Observatory is due to its large size of 17 km**2 able to achieve large event statistics. Incoming cosmic rays at high zenith angles are particularly interesting due to their large footprint on ground which can be measured in many stations. However, their reconstruction is challenging. In this talk a lateral distribution function for fitting the energy fluence on ground of these showers is presented with an emphasis on the energy reconstruction. This allows an energy estimation of the primary cosmic ray using only the information gathered from the radio emission.

T 13.5 Mo 17:05 S13

Development of cosmic-ray radio detectors for the IceCube experiment — •Max Renschler[1], Aswathi Balagopal[1], Andreas Haungs[1], Bernd Hoffmann[1], Thomas Huber[1,2], Timo Karg[2], Marko Kossatz[2], Harald Schieler[1], Frank G. Schröder[1,3], Peter Steinmüller[1], Karl-Heinz Sulanke[2], and Andreas Weindl[1] for the IceCube-Collaboration — [1]Karlsruher Institut für Technologie — [2]DESY Zeuthen — [3]University of Delaware

A new hybrid particle and radio detector is currently under development to upgrade the IceTop array of the IceCube experiment facing IceCube-Gen2. Instrumenting the IceTop surface array with radio detectors in combination with conventional particle detectors improves the accuracy of the measurement of Extensive Air Showers (EAS) induced by cosmic rays. Especially the radio technique enables the measurement of highly inclined EAS throughout all the year. This gives rise to the search for PeV gamma rays coming from the galactic center which is visible from the IceCube site all over the year at an inclination of 61°. In addition, we can study in which way a radio array can improve the ability to veto inclined air showers for the purpose of neutrino detection in the ice. The deployment of the first two prototype antennas extending a station of scintillation detectors at IceTop has been scheduled for January 2019. These antennas serve as a test setup for a future deployment of 74 radio antennas inside the IceTop footprint. During this presentation, the proposed IceTop radio array as well as the first deployed prototype antennas will be introduced in detail and first measurement results will be shown.

T 13.6 Mo 17:20 S13

Analyse der Permittivitätsdaten des Pierre-Auger-Observatorium * — •Jannis Pawlowsky — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal

Mit dem Auger-Engineering-Radio-Array des Pierre-Auger-Observatoriums wird die von Teilchenschauern ausgehende elektromagnetische Strahlung im Frequenzbereich von 30-80 MHz vermessen. Die emittierten Radiowellen werden dabei nicht nur direkt empfangen, sondern auch das vom Boden reflektierte Signal wird von Antennen registriert. Bei der Reflektion spielen die Bodeneigenschaften eine wichtige Rolle. Neben der Erdzusammensetzung sind Umweltfaktoren wie Temperatur oder Feuchtigkeit entscheidend. Diese beeinflussen die relative Permittivität und somit den Transmissions- und Reflektionskoeffizienten des Bodens. In diesem Vortrag werden die am Pierre-Auger-Observatorium gemessenen Permittivitätsdaten analysiert. Dabei steht insbesondere die Qualität der Datensätze im Vordergrund. Ebenso wird die Verteilung der Werte und die zeitliche Variation angesprochen, wodurch die Korrelation mit Wettereinflüssen aufgezeigt werden kann. Der Effekt auf das gemessene Radiosignal wird diskutiert.

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

T 13.7 Mo 17:35 S13

Reconstruction of cosmic ray energies using a single ARIANNA station — •Christoph Welling for the ARIANNA Collaboration — DESY Zeuthen, Zeuthen, Germany

The ARIANNA (Antarctic Ross Ice-Shelf ANtenna Neutrino Array) detector is a pilot-stage antenna array for the detection of ultra-high energy neutrinos using radio signals. Since air showers caused by cosmic rays produce radio emissions similar to those from neutrino-induced showers inside the ice, they present a test case to demonstrate the ability to reconstruct particle shower properties from their radio signals.

An important property of an air shower is its energy. It is usually measured by reconstructing the signal distribution as a function of distance to the shower axis. Since the ARIANNA geometry is optimized fo neutrinos and therefore very sparse, an air shower is only ever detected by a single ARIANNA station, which does not allow us to use methods based on the air shower footprint. We present a novel method that allows us to reconstruct the shower energy based on a single station's measurement. This is achieved by taking the signal's frequency spectrum into account, which is measured in a relatively broad band from 100-500 MHz in ARIANNA.

T 13.8 Mo 17:50 S13

Reconstruction of the electric field using a single ARIANNA station — •Ilse Plaisier — DESY, Zeuthen, Germany

The ARIANNA detector is a pilot detector at the Ross Ice Shelf, for the detection of the radio signals produced after the interactions of high energetic neutrinos in the ice. In order to precisely reconstruct the arrival direction of a neutrino, three ingredients are needed: the arrival direction of the radio signal, the polarization of the signal and the frequency spectrum of the signal. This contribution discusses a fitting method to reconstruct the electric field of the the emitted radio pulses, which then delivers the relevant quantities. So far, the array is not big enough to detect neutrinos. We therefore discuss the application of the fitting procedure to cosmic ray data obtained with ARIANNA. The radio emission caused by cosmic-ray induced air showers is similar to neutrino-induced showers, but with a well-known signal polarization, making it a perfect test case.

T 13.9 Mo 18:05 S13

Seven years of Tunka-Rex operation — •Pavel Bezyazeekov

for the Tunka-Rex-Collaboration — Applied Physics Institute, Irkutsk State University

The Tunka Radio Extension (Tunka-Rex) is an antenna array located in the Tunka Valley in Siberia. It measures the radio emission of cosmic-ray air showers with energies up to EeV. It is triggered by the Tunka-133 air-Cherenkov timing array (during nights) and by the Tunka-Grande array of particle detectors (remaining time). The configuration of Tunka-Rex changed over its runtime from 18 to 57 antennas in an area of 1 km^2 and up to 6 satellite antennas extending the total area to 3 km^2. During its lifecycle Tunka-Rex has demonstrated that a cost-effective and full duty-cycle radio detector can reconstruct the energy and shower maximum with a precision comparable to optical detectors. Moreover, it was shown that cosmic-ray setups, which use different detection techniques and are placed in different locations, can be cross-calibrated via their radio extensions. These results are showing the prospects of application of the radio technique for future large-scale experiments for cosmic-ray and neutrino detection. For the time being Tunka-Rex is switching from active measurements to the data analysis and publication of corresponding software and data in the open-access data center with online analysis features. In this report we present the current status of the array and give an overview of the results achieved during these years.

T 14: Elektroschwache Wechselwirkung

Zeit: Montag 16:00–18:35 Raum: S14

Gruppenbericht T 14.1 Mo 16:00 S14

Evidence for electroweak triboson production with the ATLAS detector at LHC — Carlo A. Gottardo, Sebastian Heer, Vadim Kostyukhin, Ö. Oğul Öncel, Keshava Prasad, Andrea Sciandra, and •Markus Cristinziani — Physikalisches Institut, Universität Bonn

A search for the production of three massive vector bosons is performed using proton–proton collision data recorded with the ATLAS detector at the Large Hadron Collider at $\sqrt{s} = 13$ TeV in the years 2015–2017, corresponding to an integrated luminosity of 79.8 fb^{-1}. Events with two, three or four reconstructed leptons (electrons or muons) are selected. Boosted decision tree classifiers are employed to distinguish the triboson signal from the background. An expected sensitivity of 3.1 standard deviations for the combination of the WWW, WWZ and WZZ channels is attained.

T 14.2 Mo 16:20 S14

Testing the lepton universality in the W-boson decay with the ATLAS detector — Philip Bechtle[1], Klaus Desch[1], Andreas Düdder[2], •Philipp König[1], and Matthias Schott[2] — [1]Rheinische Friedrich-Wilhelms-Universität Bonn — [2]Johannes Gutenberg Universität Mainz

Lepton universality is preserved by the electroweak interaction in the Standard Model (SM). The Higgs mechanism breaks this universality, and thus many new physics models yield small deviations in the predictions for precision tests on lepton universality. A measured deviation of the branching fraction $BR(W \to \tau\nu)$ from the SM prediction would therefore 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 fractions of the tau lepton decay compared to the decay to the lighter leptons. The analysis presented here goes one step further and measures $BR(W \to \tau\nu_\tau \to \mu\nu_\mu\nu_\tau\nu_\tau)/BR(W \to \mu\nu_\mu)$. This allows to cancel many systematic uncertainties by using the same final state. 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 14.3 Mo 16:35 S14

Observations of massive gauge boson scattering in the like-charged WWjj final state and the WZjj final state with the ATLAS detector at the LHC — •Tim Herrmann, Carsten Bittrich, Stefanie Todt, Franziska Iltzsche, Abhishek Nag, Joany Manjarres, and Michael Kobel — TU Dresden, Germany

Scattering of massive gauge bosons (VBS) is predicted by the Standard Model but was not observed by independent experiments before. There are new observations from the ATLAS experiment at LHC of VBS in the WZjj ($5.35\,\sigma$) and WWjj ($6.9\,\sigma$) same sign final state. It is the first observation of VBS in the WZjj final state.

VBS gives insights into and probes the electroweak symmetry breaking of the SM. It is sensitive to quartic and triple gauge couplings and s- and t-channel gauge boson exchanges. The measured differential cross sections are sensitive to the strengths of these contributions.

Data taken in 2015 and 2016 at a center of mass energy of $\sqrt{s} = 13\,\text{TeV}$ at the ATLAS detector at the LHC with a total luminosity of $36.1\,\text{fb}^{-1}$ are analyzed.

For the WZjj final state multivariate methods (BDT) together with a template fit to the BDT shape are used to separate signal from backgrounds and to determine the significance.

The WWjj same sign final state has the best signal to background ratio. A cut-based selection involving data driven background estimation methods for non-prompt leptons and charge flips is applied to establish the signal. The significance is determined with a template fit involving seven control regions and 25 bins in the signal region.

T 14.4 Mo 16:50 S14

Observation and measurement of the electroweak $W^\pm W^\pm jj$ process with the ATLAS detector — •Giulia Gonella and Karsten Köneke — Albert-Ludwigs-Universität Freiburg

Measurements of the electroweak sector of the Standard Model (SM) are a way to probe the mechanism of electroweak symmetry breaking at the LHC, and to detect small deviations from the SM predictions, through which the effect of new physics could manifest itself. In this context the scattering of vector bosons (VBS) is a key process. In particular the production of W bosons pairs is a vital test of the mechanism, since its scattering amplitude would increase at high energies violating unitarity, without cancellations of divergences due to exchange involving Z or Higgs bosons.

This talk will present an overview of the measurement of the electroweak production of two W bosons with the same electric charge in the signature of two leptons, missing transverse energy and two jets using data recorded by the ATLAS experiment during proton-proton collisionsat $\sqrt{s} = 13$ TeV at the LHC corresponding to an integrated luminosity of 36.1 fb^{-1}. The main analysis techniques will be shown, with a focus on the estimation of the background due to the contributions from opposite-charge di-lepton production processes, where the charge of one electron is wrongly reconstructed. An overview of the optimisation procedure will be presented, together with the fit technique that led to the observation of the $W^\pm W^\pm jj$ electroweak process and the measurement of its fiducial cross-section.

T 14.5 Mo 17:05 S14

Measurement of the τ Lepton Polarisation in $Z \to \tau\tau$ events with CMS — Jordy Degens[1], Günter Flügge[1], Olena Hlushchenko[1], Wolfgang Lohmann[1], Johannes Merz[1], •Thomas Müller[1], Dennis Roy[1], Hale Sert[1], Achim Stahl[1], Alexander Zotz[1], and Vladimir Cherepanov[2] — [1]RWTH Aachen University — [2]IPHC Strasbourg

In this talk a measurement of the τ lepton polarisation in $Z \to \tau\tau$ events is presented. Data corresponding to an integrated luminosity of $35.9\,\text{fb}^{-1}$ taken at $\sqrt{s} = 13\,\text{TeV}$ by the CMS detector in 2016 is analysed. From the τ lepton polarisation the ratio of the neutral-current vector to axial-vector couplings of the τ lepton and the weak mixing angle, $\sin\theta_W^{\text{eff}}$, is determined. This measurement allows for internal consistency checks of the Standard Model as well as for the indirect search for BSM effects in the electroweak sector.

T 14.6 Mo 17:20 S14

Approaching the Schwinger Critical Field with the LUXE experiment — •Marius Hoffmann[1] and Beate Heinemann[1,2] — [1]DESY, Hamburg, Germany — [2]University of Freiburg, Germany

The theory of quantum electro dynamics (QED) is one the most pre-

cise theories mankind has ever developed. It has however not yet been tested in the regime above the so called Schwinger critical field, which is theoretically predicted to be $1.32 \times 10^{18}\, V\, m^{-1}$.

The LUXE experiment which is currently developed, aims to test the QED in the regime of the Schwinger critical field and even determine the value of the Schwinger critical field at a linear electron accelerator such as the European XFEL with a 17.5 GeV electron beam. LUXE is a two-scenario experiment aiming to use a high intensity laser system whose pulses are collided nearly head-on with the electron beam of the XFEL (scenario 1) or a beam of bremsstrahlung gamma rays produced by the electron beam in a foil before the interaction (scenario 2). The production rate of the e^+/e^- pairs in this interactions for various laser intensities is sensitive to the Schwinger critical field.

The talk will feature detector design studies outlining possible layouts of the experiment for a location at European XFEL, as well as simulation studies showing the sensitivity of the experiment on the Schwinger critical field.

T 14.7 Mo 17:35 S14

Probing anomalous quartic gauge couplings at the International Linear Collider — •Jakob Beyer[1,2], Michael Kobel[3], and Jenny List[1] — [1]DESY Hamburg — [2]Universität Hamburg — [3]Technische Universität Dresden

Precision measurements of the electroweak sector are sensitive probes for physics beyond the Standard Model. With the future International Linear Collider (ILC) such measurements can be performed in the low-background environment of e^+e^- collisions at center-of-mass energies up to 1 TeV. At these high-energy collisions the process of vector boson scattering can tested for signs of anomalous quartic gauge couplings. The potential of this measurement has been recently studied in an updated EFT framework on theory level. Such results assume detector and analysis performances which must be validated using detector simulations.

A study of the reconstruction of the fully hadronic $\nu\bar{\nu} + 4$jets final state is performed to investigate the challenges to this analysis. Data sets from a full, GEANT4-based simulation of the International Large Detector at the 1 TeV ILC are used to accurately predict its measurement capability.

T 14.8 Mo 17:50 S14

Study of anomalous gauge couplings using WZ channel in ATLAS — •Lilly Wuest — IKTP; TU Dresden, Germany

Studies of anomalous quartic gauge couplings assuming an insignificant impact of triple gauge couplings in the sensitive phase space of aQGC. To study aQGC without calculations of aTGC it's needed to test the sensitivity of this couplings in the VBS phase space.

The triple and quartic gauge couplings are part of the standard model. A direct test of the standard model and an indirect search of new physics is given by studies of gauge couplings. The expansion of the standard model with an effective field theory would describe deviations in the cross section and kinematic distributions of gauge couplings. Samples of aTGC α_W^4, aTGC α_W^6 and aQGC are simulated. Simulations and data taken in 2015/16 at a center of mass energy of $\sqrt{s} = 13\, TeV$ at the ATLAS detector at the LHC with a total luminosity of $36.1\, fb^{-1}$ for the WZ channel are analyzed. The limits of aTGC are extracted in the inclusive WZ phase space. The sensitivity of aTGC in it's limits is tested in the VBS phase space. And it is investigated if the impact of aTGC is significant for the calculation of the limits of aQGC in the VBS phase space.

T 14.9 Mo 18:05 S14

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 above the peak is measured for the first time. The cross-section will be measured differentially in the transverse mass m_T^W and 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.
The analysis strategy and status of the measurement will be presented. The data has been taken at the ATLAS experiment based on pp-collisions at a center-of-mass energy of $\sqrt{s} = 13$ TeV at the LHC.

T 14.10 Mo 18:20 S14

Towards detecting new physics with photon-photon collisions with the ATLAS Forward Proton (AFP) detector — Vlasios Petousis and •André Sopczak — Institute of Experimental and Applied Physics, Czech Technical University in Prague

The quantum-mechanical process Light-by-Light (LbyL) scattering ($\gamma\gamma \to \gamma\gamma$) is forbidden in the classical theory of electrodynamics. In the Standard Model of particle physics, the virtual particles that mediate the LbyL coupling are electrically charged fermions or W bosons. This reaction is accessible at the Large Hadron Collider (LHC) owing to the large electromagnetic field strengths generated by ultra-relativistic proton-proton reactions in elastic interactions. A novel detector (AFP) was installed ±200 m from the central interaction point (IP) which took successfully data in 2017 and 2018 to tag deflected protons from the elastic interactions. While determining the rate of the produced exclusive photon pairs in the IP in coincidence with the detected protons and comparison with the Standard Model expectation, any excess would be an indication of new physics beyond the Standard Model. At the LHC, the photon-photon interactions achieve an energy never achieved before. First, a performance study with $\gamma\gamma \to \mu\mu$ which has a higher rate than LbyL, was performed to demonstrate the functionality of the AFP detector and the analysis method.

T 15: CP-Verletzung und Mischung

Zeit: Montag 16:00–18:35 Raum: S15

Gruppenbericht T 15.1 Mo 16:00 S15

Towards a Storage Ring Electric Dipole Moment Measurement — •Jörg Pretz for the JEDI-Collaboration — Forschungszentrum Jülich — RWTH Aachen Univsersity

The Electric Dipole Moment (EDM) of elementary particles, including hadrons, is considered as one of the most powerful tools to study CP-violation beyond the Standard Model. Such CP-violating mechanisms are searched for to explain the dominance of matter over anti-matter in our universe.

Up to now EDM experiments concentrated on neutral systems, namely neutron, atoms and molecules. Storage rings offer the possibility to measure EDMs of charged particles by observing the influence of the EDM on the spin motion.

A step-wise approach starting with a proof-of-principle experiment at the existing storage ring Cooler Synchrotron COSY at Forschungszentrum Jülich, followed by an electrostatic prototype ring allowing for a simultaneous operation of counter circulating beams in order to cancel systematic effects, to the design of a dedicated 500 m circumference storage ring will be presented.

T 15.2 Mo 16:20 S15

Searches for proton EDM in electrostatic storage rings — •Artem Saleev for the JEDI-Collaboration — IKP FZJ, Jülich, Deutschland

Studies of high precision spin dynamics at the COoler SYnchrotron COSY in Jülich suggest that electric dipole moment (EDM) signal could be resolved in the frequency domain. We propose a new concept for the measurement of the proton EDM in a pure electrostatic storage rings based on the measurement of the spin tune frequency. Wien filter, matched to maintain zero Lorenz force with oscillating B-field at the beam revolution frequency and constant E-field, produces a static spin kick in horizontal direction, simultaneously the beams are circulating clockwise and counterclockwise in the meantime. Such spin rotations

commute with the EDM spin rotation in the ring which leads to an EDM-related spin tune shift. If the beams have the same closed orbit, EDM signal is proportional to a spin tune difference of the two beams and unwanted effects of magnetic dipole moment spin rotations are cancelling. The present model-dependent EDM limit for protons that amounts to $7.9 \cdot 10^{-25} e{\cdot}\text{cm}$ can be confirmed in direct EDM measurements, if the new technique is applied at a prototype EDM storage ring proposed by the JEDI collaboration.

T 15.3 Mo 16:35 S15

Progress toward the first measurement of the deuteron Electric Dipole Moment at COSY — •Vera Shmakova for the JEDI-Collaboration — Institut für Kernphysik, Forschungszentrum Jülich, Germany — JINR, Dubna, Russia

One of the major problems of modern particle physics is the inability of the Standard Model (SM) to explain the matter-antimatter asymmetry of the Universe. Permanent electric dipole moments (EDMs) of particles violate both time reversal (T) and parity (P) invariance, and are via the CPT-theorem also CP-violating. Therefore, measurements of EDMs of fundamental particles probe new sources of CP-violation, and finding an EDM would be a strong indication for physics beyond the SM.
Up to now, EDM searches mostly focused on neutral systems (neutrons, atoms, and molecules). Storage rings, however, offer the possibility to measure EDMs of charged particles by observing the influence of the EDM on the spin motion in the ring. Direct searches of proton and deuteron EDMs using a storage ring thus bear the potential to reach sensitivities beyond 10^{-29} e·cm. In this talk I will discuss recent results of a "percursor" deuteron EDM experiment, presently being carried out at the Cooler Synchrotron COSY at Forschungszentrum Jülich.

T 15.4 Mo 16:50 S15

Suche nach CP Verletzung in $\Lambda_b \to D^0\Lambda$ — •Nis Meinert — LHCb (Uni. Rostock)

Bisher wurden für Analysen der CP Verletzung zumeist Meson- und nur wenige Baryon-Zerfälle verwendet. Letztere lieferten bis jetzt lediglich Asymmetriewerte zwischen Teilchen und Antiteilchen und wurden nicht zur Berechnung von CKM-Phasen benutzt.

In unserer Analyse suchen wir daher nach dem Baryonen-Zerfall $\Lambda_b \to \Lambda D^0/\overline{D}^0$. Die Analyse der Subzerfälle $D^0 \to K\pi$ und $D^0 \to KK/\pi\pi$ erlaubt die Anwendung der ADS- und GLW-Methoden, welche jeweils Zugang zu der CKM-Phase γ gewähren.

Die Rekonstruktion dieser Zerfälle ist auf Grund der langlebigen Λ-Teilchen, der starken Unterdrückung ($\propto \lambda^3$ in der Wolfenstein-Parametrisierung) und dominanten Untergründe (Reflexionen) wie z.B. $B_s \to D^0 K_S$ ($\propto \lambda^2$) herausfordernd. Die einzigartige Produktionsrate von Λ_b-Baryonen und die besonders effiziente Λ_b-Rekonstruktion am LHCb-Experiment kompensieren diese Nachteile jedoch teilweise.

Präsentiert wird der aktuellen Stand der Analyse mit Daten aus Run 1 und Teilen von Run 2. Insbesondere werden Eigenschaften von Reflexionen im Allgemeinen und die Unterdrückung von $B_s \to D^0 K_S$ Zerfällen im Speziellen diskutiert.

T 15.5 Mo 17:05 S15

CP violation and lifetime measurements in the decay $B_s^0 \to J/\psi K^- K^+$ with the LHCb experiment — Stephanie Hansmann-Menzemer and •Simon Stemmle — Physikalisches Institut Heidelberg

Within the Standard Model (SM) the CP violating phase ϕ_s of the decay $B_s^0 \to J/\psi K^- K^+$ can be precisely constrained from indirect measurements. This makes the direct measurement of ϕ_s a sensitive test of the SM. A flavor tagged, time dependent angular analysis of $B_s^0 \to J/\psi K^- K^+$ and $\bar{B}_s^0 \to J/\psi K^- K^+$ decays is presented, using $2\,\text{fb}^{-1}$ of proton-proton collision data, recorded by the LHCb experiment in 2015 and 2016. Besides the CP violating phase, also the lifetime splitting $\Delta\Gamma_s$ in the B_s^0 meson system and the decay width difference, $\Gamma_s - \Gamma_d$, between B_s^0 and B^0 mesons is precisely measured. The results are combined with the corresponding LHCb Run I analysis.

T 15.6 Mo 17:20 S15

Measurement of the weak mixing phase ϕ_s in $B_s^0 \to D_s^+ D_s^-$ decays with the LHCb experiment — •Louis Gerken, Philipp Ibis, Antje Mödden, and Margarete Schellenberg — Experimentelle Physik 5, TU Dortmund

One research priority of the LHCb experiment is testing the Standard Model by the precise measurement of CP-violating parameters. In B_s^0-meson decays with $b \to c\bar{c}s$ transitions, the weak mixing phase ϕ_s can be measured in the interference between the decay with and without B_s^0-$\overline{B_s^0}$ mixing. Since ϕ_s is predicted to be small in the Standard Model, a significant deviation to this prediction could be evidence of New Physics.

In this talk the current status of the $B_s^0 \to D_s^+ D_s^-$ analysis will be presented. The analysis aims to measure ϕ_s by using data corresponding to an integrated luminosity of $6\,\text{fb}^{-1}$ collected by the LHCb detector during 2015 to 2018 at a centre-of-mass energy of 13 TeV.

T 15.7 Mo 17:35 S15

Measurement of CP violation in $B^0 \to J/\psi K_S^0$ decays with the LHCb detector using Run II data — •Vukan Jevtic and Patrick Mackowiak — 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 in the interference of mixing and the decay in the $B^0 \to J/\psi K_S^0$ channel at LHCb reached a sensitivity for $\sin(2\beta)$ that is comparable to measurements of Belle I and BaBar. Due to the higher centre-of-mass energy of $\sqrt{s} = 13\,\text{TeV}$ at the LHC in Run II, more data was taken at higher rates, which helps to increase the statistical significances of analyses. At the same time, this poses new 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 measurement of the CP-violation parameters in $B^0 \to J/\psi(\to \mu\mu) K_S^0(\to \pi^+\pi^-)$ decays will be presented and new reconstruction possibilities of K_S^0 mesons will be discussed.

T 15.8 Mo 17:50 S15

Measurement of the decay-time-dependent CP asymmetry in $B^0 \to D^{*+} D^-$ 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 precision measurements. Among these are decay-time-dependent measurements of CP violation in decays of neutral B mesons.

In $B^0 \to D^{*+} D^-$ decays, CP is violated 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 determinaion of the CP asymmetry and give access to the CKM angle β. As this decay entails a Cabibbo-suppressed $b \to c\bar{c}d$ transition, loop-level Feynman graphs are not additionally suppressed compared to tree-level transitions. Thus, a measurement of CP violation in this channel complements measurements in $B^0 \to J/\psi K_S^0$ decays, which involve non-suppressed $b \to c\bar{c}s$ transitions.

The current status of the analysis is presented using the full LHCb dataset corresponding to an integrated luminosity of $9\,\text{fb}^{-1}$.

T 15.9 Mo 18:05 S15

Measurement of the B_s^0 oscillation frequency Δm_s with $B_s^0 \to D_s^- \pi^+$ decays at the LHCb experiment — Robin Eichhorn and •Kevin Heinicke — Experimentelle Physik 5, TU Dortmund

One way to uncover hiding places for New Physics are precise measurements of the CP parameters in the Standard Model. To extract the currently least known CKM-angle γ with the latest LHCb dataset of $B_s^0 \to D_s^\mp K^\pm$ decays, the B_s^0-$\overline{B}_s^0$ oscillation frequency Δm_s is needed as an external input.

At the LHCb experiment, the parameter Δm_s has so far only been measured using data of $B_s^0 \to D_s^- \pi^+$ decays, recorded in 2011, corresponding to an integrated luminosity of $\mathcal{L}_{\text{int}} = 1.0\,\text{fb}^{-1}$. The uncertainty of this measurment is one of the leading systematic uncertainties of the current measurement of γ with the LHCb experiment. In this talk, the current status of an updated measurement of Δm_s is presented. The analysis is using an extended dataset, recorded with the LHCb experiment between 2015 and 2017, corresponding to an integrated luminosity of $\mathcal{L}_{\text{int}} = 3.6\,\text{fb}^{-1}$.

T 15.10 Mo 18:20 S15

Determination of the resolution function of the B0 anti-B0 decay time difference — •Ketevan Parlagashvili, Vladimir Chekelian, Christian Kiesling, Luigi Li Gioi, and Hans-Günther Moser for the Belle 2-Collaboration — Max-Planck-

Institut für Physik, Munich, Germany

One of the goals of the Belle II experiment at SuperKEKB is the study of the CP asymmetries in the time evolution of the neutral B mesons. A clean laboratory to study the two-state system of B0 and anti-B0 mesons is provided by the $\Upsilon(4S)$ resonance which can be produced in e+ e- annihilation at the center of mass energy of 10.58 GeV. Belle II is equipped with an entirely new tracking system, in particular with a low material budget pixel vertex detector, only 14 mm away from the interaction region. In contrast to its predecessor KEKB, SuperKEKB is exhibiting a very small collision spot for the production of a B meson pair. This may have a strong impact on the analysis methods used so far for the determination of the decay time difference between a B meson in a chosen CP eigenstate and its flavor-determining companion. The goal is to determine the experimental resolution function of the distance (translated to the difference of the decay times) between the vertices of the two B mesons as a function of the different decay vertex qualities and vertex detector running conditions.

T 16: Theorie: Beyond the Standard Model und Quantenfeldtheorie

Zeit: Montag 16:00–17:45 Raum: S16

T 16.1 Mo 16:00 S16

Cosmological Aspects of Multifield NMSSM Higgs Inflation — •Michael Matlis[1,2], Gudrid Moortgat-Pick[1,2], and Alexander Westphal[2] — [1]University of Hamburg, Germany — [2]DESY Theory Group, Hamburg, Germany

The inflationary NMSSM model(Next-to-Supersymmetric Standard Model) is considered to be the simplest extension to the Standard Model circumventing the mu-problem of the MSSM and thus being capable of giving inflation. As the MSSM model, it consists of two Higgs doublets and is augmented by one Higgs Singlet which is stabilized in Kähler moduli space. Research to date has focused on an effective single field description which in turn limits the range of possibilities for cosmological Observables and particle phenomenology. We have discovered that the previously assumed effective single field model can be described by an effective two-field model. The analysis has shown, that a clear distinction between single- and multi-field model can be made based on cosmological Observables that are constrained by Planck data leading to richer phenomenology.

T 16.2 Mo 16:15 S16

CosmoBit: Towards global fits of particle physics and cosmology for dark matter — •Patrick Stoecker — Institute for Theoretical Particle Physics and Cosmology, RWTH Aachen, Germany

The absence of a conclusive dark matter signal casts doubts on the conventional WIMP scenario. Alternative production mechanisms as well as models with an extended self interacting dark sector may explain the absence of a signal in these searches while opening up a new window of strong signals in cosmological observables like the primordial element abundances, the spectrum of the Cosmic Microwave Background as well as large scale structures.

In order to explore the parameter space of such models, it is therefore necessary to combine cosmological information with the constraints from traditional searches for particle dark matter. I will present the recent efforts to perform such a combination in the context of global fits within CosmoBit, a future part within the framework of GAMBIT (Global and Modular Beyond-the-Standard-Model Inference Tool).

T 16.3 Mo 16:30 S16

Testing post-inflation Axion Dark Matter using CMB Observations — •Andreas Pargner[1], Martin Feix[1,2], Johann Frank[1], Robert Reischke[1,2], Bjoern Malte Schaefer[2], and Thomas Schwetz[1] — [1]Institut für Kernphysik, Kalsruhe Institute of Technology, Karlsruhe, Germany — [2]Zentrum für Astronomie der Universität Heidelberg, Astronomisches Recheninstitut, Heidelberg, Germany

We present a novel way of testing axion dark matter using cosmological observables in scenarios where Peccei-Quinn symmetry breaking happens after inflation. It is known that in these scenarios large isocurvature fluctuations in the axion energy density occur. For typical QCD axions, the scale of these fluctuations is too small to be cosmologically relevant and they are usually studied in the context of axion minicluster formation. However, we argue that for extremely light axions, also known as fuzzy dark matter, the isocurvature fluctuations can be quite sizable and have effects in large-scale observables. Relating the scale of the density fluctuations to the axion mass, we use CMB observations from the Planck mission to show that in certain scenarios fuzzy DM in the mass range $10^{-24}\text{eV} < m_a < 10^{-16}$ eV can already be ruled out. We also estimate the sensitivity of upcoming CMB Stage IV experiments and 21cm observations on the axion isocurvature fluctuations.

T 16.4 Mo 16:45 S16

Super-WIMP meets freeze-in — •Jan Heisig[1] and Mathias Garny[2] — [1]Université catholique de Louvain — [2]Technische Universität München

Non-thermalized dark matter is a cosmologically valid alternative to the paradigm of weakly interacting massive particles. For dark matter belonging to a Z_2-odd sector that contains in addition a thermalized mediator particle, dark matter production proceeds in general via both the freeze- in and super-WIMP mechanism. We highlight their interplay and emphasize the connection to long-lived particles at colliders. For the explicit example of a colored t-channel mediator model we map out the entire accessible parameter space, cornered by bounds from the LHC, big bang nucleosynthesis and Lyman-alpha forest observations, respectively. We discuss prospects for the HL- and HE-LHC.

T 16.5 Mo 17:00 S16

Neutrino Portal Dark Matter via Freeze-In — •Mathias Becker — TU Dortmund

Models of Neutrino Portal Dark Matter (NPDM) utilize a right handed neutrino to couple the standard model to a dark sector. We discuss the parametrics of the relic density in the freeze-in regime of NPDM as well as constraints from dark matter stability and direct detection experiments.

T 16.6 Mo 17:15 S16

BSMPT - A Tool for the Electroweak Phase Transition in Extended Higgs Sectors — •Philipp Basler and Margarete Mühlleitner — Karlsruher Institut für Technologie, ITP, Karlsruhe, Deutschland

A first order electroweak phase transition (EWPT) is crucial for electroweak baryogenesis. Since all parameters determining the EWPT are at the electroweak scale, the collider phenomenology can be linked with the cosmological constraints. In this talk we present the code BSMPT. BSMPT can calculate the strength of the EWPT by considering the effective potential approach for a general extended Higgs sector. Further, it can calculate the global minimum of the potential at 1-loop order allowing to test the vacuum stability. Finally, BSMPT is able to determine the triple Higgs self-couplings at 1-loop order playing an important role in the search for new physics.

T 16.7 Mo 17:30 S16

On the High-Energy Behavior of Strong-Field QED in an Intense Plane Wave — •Tobias Podszus and Antonino Di Piazza — Max Planck Institute for Nuclear Physics, Heidelberg, Germany

We study the mass and the polarization operator in an external plane-wave field for different parametric situations. Starting from the one-loop order contributions to the mass and to the polarization operator in a plane wave, we calculate analytically their leading order terms in the limit of different parametric situations (constant crossed field, high-energy and high intensity) [1]. We found that both operators show very different behaviors in the different parameter regions and we also compare the results with the corresponding vacuum expressions. We show that the presence of the plane wave changes the asymptotic behaviors of the radiative corrections and that some of the asymptotical limits do not commute.

[1] T. Podszus and A. Di Piazza, to be submitted.

T 17: Kalorimeter

Zeit: Montag 16:00–18:30 Raum: ST 1

T 17.1 Mo 16:00 ST 1

Analyse von Elektronenschauern in einem hadronischen Kalorimeter-Prototypen für einen zukünftigen Linearbeschleuniger — •Anna Rosmanitz für die CALICE-D-Kollaboration — Johannes Gutenberg-Universität Mainz

Die CALICE-Kollaboration entwickelt Kalorimeter für zukünftige e^+-e^- Linearbeschleuniger wie den ILC. Diese Kalorimeter sollen eine Energieauflösung von $30\%/\sqrt{E[GeV]}$ erreichen. Hierfür kommen Particle Flow Algorithmen zum Einsatz, die die Rekonstruktion von Jets durch die Identifikation einzelner Teilchen verbessern. Um sie anwenden zu können, müssen die Kalorimeter hochgranular sein. Die Zeitstruktur des Strahls am ILC (1 ms Strahl, 199 ms Pause) ermöglicht die Anwendung des sogenannte Power Pulsings, bei dem das Auslesesystem nicht durchgängig betrieben, sondern nur aktiviert wird, wenn ein Teilchenpaket ankommt. Dadurch reduziert sich der Energieverbrauch und die Notwendigkeit von Kühlsystemen. Ein von CALICE entwickelter und in einer Massenfertigung hergestellter hadronischer Kalorimeterprototyp, mit Szintillatoren-Kacheln ausgelesen von Silizium-Photomultipliern, wurde in mehreren Teststrahlkampagnen 2018 am CERN-SPS mit Elektronen, Muonen und Pionen getestet. In diesem Vortrag wird die Analyse der Elektronendaten mit besonderem Augenmerk auf die Schauerform und den Vergeich mit Simulationen vorgestellt.

T 17.2 Mo 16:15 ST 1

Study of High Resolution, DOI-Capable Gamma Detectors — •Federica Demattè, Thomas Dey, Pierre Gebhardt, Nicolas Gross-Weege, Florian Müller, David Schug, Björn Weissler, Laiyin Yin, and Volkmar Schulz — Department of Physics of Molecular Imaging Systems, Institute of Experimental Molecular Imaging, RWTH Aachen University, Aachen, Germany

In gamma detectors, high spatial resolution can be achieved using pixelated scintillators. A specific segmentation of the scintillator on both the x- and y-axis allows the three dimensional reconstruction of the light emission point in the crystal. Thus, the position of the incoming gamma can be estimated precisely. The prerequisite for this reconstruction is the precise alignment of the detector components. Without a careful match between a Silicon Photomultiplier (SiPM) array and the crystal, it is not possible to reconstruct the Depth Of Interaction information needed for a sub-millimeter spatial resolution.

This talk will introduce a compact pixelated gamma calorimeter formed by a PDPC DPC-3200 sensor tile, a pixelated scintillator and a lightguide, as e.g. used in the European Hypmed project. Furthermore, the alignment tool used for the high precision mounting of the detector components will be presented.

T 17.3 Mo 16:30 ST 1

Evaluation of Scintillator Tiles and SiPMs for highly granular Calorimeters — •Malinda de Silva, Frank Simon, and Marco Szalay — Max-Planck-Institut für Physik, Föhringer Ring 6, 80805 München

Plastic scintillator tiles and Silicon photomultipliers (SiPMs) 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 light yield of the combination of the scintillator and the SiPM, 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 different scintillator tile geometries and other scintillator elements, performed with a uniformity scanning setup based on a radioactive source, as well as the observed light yield of tiles obtained with standard and with high dynamic range Hamamatsu MPPCs.

T 17.4 Mo 16:45 ST 1

Muon simulation studies of the CALICE AHCAL 2018 Technological Prototype test beam data — •Saiva Huck for the CALICE-D-Collaboration — Universität Hamburg, Institut für Experimentalphysik, Luruper Chaussee 149, 22761 Hamburg

The Analog Hadron Calorimeter (AHCAL) is a highly granular hadron calorimeter with 8 million single channels designed by the collaboration Calorimeter for Linear Collider Experiment (CALICE) to be used in a future high precision Particle Flow collider experiment. One single channel is made up of one $30\times30\times3\,\mathrm{mm}^3$ plastic scintillator tile which is read out via one Silicon Photomultiplier (SiPM).
A technological prototype of the AHCAL consisting of 38 active layers alternating with 1.7 cm thick steel absorber plates has been constructed and taken to test beam at the CERN SPS in 2018.
This study focuses on the comparison of characteristics of muon runs used for MIP calibration in both test beam data and the corresponding digitized Geant 4 simulation. Various properties including hit energies and number of hits per event are compared.
Overall, the distributions for the muons in data and simulation are in good agreement which validates the digitization procedure for low deposited energies.

T 17.5 Mo 17:00 ST 1

Energy Calibration and First Results of the CERN 2018 Test Beams of the Large AHCAL Technological Prototype — •Daniel Heuchel for the CALICE-D-Collaboration — Deutsches Elektronen-Synchrotron (DESY), Hamburg, Deutschland

The Analog Hadronic Calorimeter (AHCAL) is a highly granular calorimeter developed by the CALICE collaboration for a future e^+e^- linear collider. Driven by the Particle Flow approach the achievement of jet energy resolutions of 3-4% for jet energies between 40-500 GeV is desired. The detector concept is based on 3x3 cm^2 scintillating tiles combined with a read-out by Silicon Photomultipliers (SiPM). In total 21888 channels on 38 active layers, alternating with steel absorber plates, build up the latest generation of the AHCAL technological prototype. This prototype features fully integrated readout electronics, scalable to a full collider detector, operable in power pulsing mode to reduce power consumption. In 2018 three beam test periods at the CERN SPS have been performed with muon, electron and pion beams for the validation of the calibration of the detector and to study hadronic showers.

In this contribution, we will present first results of this beam test periods with the focus on the energy calibration of the detector with muon data and the comparison to simulation. Furthermore, comparative studies of calibration quantities will be discussed in terms of uniformity and stability during the different beam test periods and for different detector operation modes.

T 17.6 Mo 17:15 ST 1

Particle identification methods for the CALICE highly granular SiPM-on tile calorimeter. — •Vladimir Bocharnikov for the CALICE-D-Collaboration — Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — NRNU "MEPhI", Moscow, Russia

The Analog Hadronic Calorimeter AHCAL is a highly granular sampling calorimeter developed by the CALICE collaboration for the future International Linear Collider (ILC). It is designed in accordance with the requirements of the Particle Flow Algorithm to achieve a good jet energy resolution. The AHCAL engineering prototype consists of $\sim$ 22000 channels equipped with $3 \times 3\ cm^2$ scintillator tiles with individual readout by silicon photomultipliers. The prototype was tested with muon, electron and pion beams at the CERN SPS facilities. To classify events according to the initial particle type, we apply cut-based and multivariable analysis methods using topological parameters of events. Monte-Carlo simulations are used for tuning and testing the classification methods. In this contribution we will demonstrate the performance of AHCAL technological prototype for particle identification using different methods.

T 17.7 Mo 17:30 ST 1

Advanced Hadronic Energy Reconstruction in the CALICE AHCAL Technological Prototype — •Christian Graf for the CALICE-D-Collaboration — Max-Planck-Institut für Physik, München, Deutschland

The CALICE collaboration is developing concepts for highly granular calorimeters for future e^+e^--colliders, such as ILC or CLIC. One of them, the analog hadronic calorimeter (AHCAL), is a sampling calorimeter using 3x3 cm^2 scintillator tiles as active material, read out by silicon photomultipliers (SiPMs) and steel or tungsten plates as absorbers. A series of test-beam campaigns was carried out with a technological prototype in order to prove the feasibility of the technology for such a device. The technological prototype is constructed with

front-end chips integrated in the active layers and the design is scalable to a full detector. A new feature compared to previous prototypes is the capability to provide hit time information for each calorimeter cell.

The high granularity of the prototype allows for advanced energy reconstruction methods. This contribution will discuss wether the hit time information can be used to enhance the energy reconstruction using simulated data. Additionally, methods will be explored in order to further improve the energy reconstruction incorporating several event variables in the energy reconstruction.

T 17.8 Mo 17:45 ST 1

Gain Calibration and SiPM Saturation studies with the CALICE AHCAL — •Olin Lyod Pinto for the CALICE-D-Collaboration — Deutsches Elektronen-Synchrotron (DESY), Notkestraße 85, 22607 Hamburg Hamburg — Universität Hamburg, Mittelweg 177, 20148 Hamburg

ABSTRACT: An analog hadron calorimeter (AHCAL) prototype of $\sim$ 4 nuclear interaction length thickness has been developed and constructed by members of the CALICE Collaboration. The prototype consists of a 38-layer sampling structure of steel absorber plates and highly segmented active layers consisting of $21,888$ channels of $30 \times 30 \times 3$ mm^3 scintillator tiles read out by Silicon Photomultipliers (SiPM). The prototype is equipped with a LED system capable of determining SiPM quantities. The LED signals are used to determine the gain of the SiPMs. With the gain measurements, the homogeneity of the detector is studied, the stability and temperature dependence during the testbeam periods are monitored. The amplitudes measured in physics events need to be corrected for the non-linear behavior of the SiPMs due to their limited number of pixels. This saturation effect is studied compared to the data. The study is performed using data collected with the AHCAL at CERN SPS test beams 2018.

T 17.9 Mo 18:00 ST 1

Tile assembly and calibration of CALICE AHCAL technological prototype and tests of Megatile prototypes — •Phi Chau and Sebastian Ritter for the CALICE-D-Collaboration — Johannes Gutenberg-Universität Mainz, Institut für Physik

Several calorimeter concepts are under development by the CALICE collaboration, each of them is optimized for Particle Flow Algorithm. The design of the Analog Hadronic CALorimeter (AHCAL), a sampling calorimeter for a future electron-positron collider, is realized with around 8,000,000 scintillator tiles each wrapped in reflector foil and read out by a silicon photomultiplier (SiPM). Because of these large numbers of channels, an optimization of construction, assembly and calibration is necessary. In 2017/18 the AHCAL-groups have constructed a technological prototype with around 22,000 channels. The tile assembly has been realized with an automated gluing and placing procedure and a light yield calibration with cosmics has been performed as part of a quality check. Also, an alternative scintillator concept, the Megatile, was developed at the University of Mainz for further simplification of the assembly. A full-scale prototype plate with 12 x 12 channels, each separated with tilted reflective TiO_2 trenches, was produced and tested. Results of this and previous prototypes show comparable light yields to those of the individually wrapped scintillator tiles and an adequate low channel to channel crosstalk.

T 17.10 Mo 18:15 ST 1

Energy resolution of the AHCAL and comparison of electron data with simulation. — •Amine Elkhalii for the CALICE-D-Collaboration — Bergische Universität Wuppertal

The CALICE Collaboration develops calorimeters for a future e^+e^- linear collider. Theses calorimeters have a high granularity in order to allow Particle Flow Analysis and to achieve high jet energy resolutions of $3-4\%$. One of these concepts is the Analog Hadronic Calorimeter (AHCAL), which is based on $3*3cm^2$ scintillator tiles with individual Silicon Photomultiplier readout. A large technological prototype of 38 layers with $1.7cm$ steel absorber ($\sim 4\lambda$) has been constructed and commissioned by several institutes. The prototype has been installed in H2 beam line at the CERN SPS, where the test beam has been performed during two periods May and June 2018. Around 8 to 10 $*10^7$ events from muon, electron and pion has been collected with different energy ranges. Comparing the longitudinal electron shower profiles data with simulation is one of the important study for the calibration and performance of the detector. This talk will focus on energy resolution of the AHCAL and comparison of electron data with simulation.

T 18: DAQ und Trigger I

Zeit: Montag 16:00–18:35 Raum: ST 2

Gruppenbericht T 18.1 Mo 16:00 ST 2

FTK system and online monitoring — •Marta Czurylo and André Schöning — Physikalisches Institut, Universität Heidelberg, Germany

The FTK system is currently being commissioned at ATLAS and its main goal is to add the capability of obtaining the full tracking information at the High Level Trigger which will allow to select events with interesting kinematic properties and will help to further reduce the event rate. This will be beneficial during the LHC Run III while during Run II only the tracking information obtained in the Regions of Interest (around trigger objects) was available. An overview of the FTK system is given in the first part of the talk. In order to quickly and efficiently recognise errors occurring in the system, the functioning of hardware and software needs to be monitored. In this talk, the currently developed central online application is presented.

T 18.2 Mo 16:20 ST 2

Adapting the ATLAS Fast Tracker track fit constants to new detector conditions — •Emily Thompson — DESY

During the Run 3 of the LHC, the number of simultaneous proton-proton collisions is expected to rise to an average of 80 events per bunch crossing. This poses a significant challenge for the trigger system of ATLAS, which aims to select interesting signal events with high purity at a rate of only 1 kHz.

The ATLAS Fast Tracker (FTK) is a hardware based track finding system which is designed to provide full tracking information at an early stage of the ATLAS trigger system. The FTK is a highly parallelized system which performs pattern matching between hits in the silicon trackers and one billion simulated patterns stored in ASIC Associative Memory chips, allowing to exploit tracking information in the ATLAS trigger system.

Once a track is found, track parameters are estimated using a linear approximation with pre-calculated constants. The generation of these fit constants is a time consuming process which utilizes 300 million single muon tracks. This presentation addresses the current progress for developing strategies to quickly adapt the FTK fit constants to changing module positions and orientations in the tracking detectors.

T 18.3 Mo 16:35 ST 2

Rückblick auf den ATLAS Level-1 Kalorimeter-Trigger in Run-2 des LHC — •Martin Klassen — Kirchhoff-Institut für Physik, Heidelberg, Deutschland

Run-2 war bisher die mit Abstand erfolgreichste Periode der Datennahme am LHC mit 158 fb^{-1} gelieferten Daten, von denen der ATLAS Detektor bei stetig steigender Effizienz 149 fb^{-1} aufgezeichnet hat. Wichtig dafür war die zuverlässige Funktion des Triggers, insbesondere des Level-1 Triggers, welcher während des langen LHC Betriebsstopps (LS1) verschiedensten Upgrades unterzogen wurde, um dies auch bei einer höheren Anzahl an gleichzeitig stattfinden Interaktionen gewährleisten zu können.
Ein wesentlicher Bestandteil des Level-1 Triggers ist der Kalorimeter-Trigger, in dem einzelne Kalorimeterzellen zu sogenannten Triggertowern zusammengefasst werden. Die so analog summierten Signale werden im PreProcessor in transversale Energien umgewandelt, um in Echtzeit Elektron-, Photon-, Tau- und Jetkandidaten als auch globale Ereigniseigenschaften wie fehlende transversale Energie zu identifizieren. Ereignisse werden akzeptiert, wenn diese Objekte bestimmte Schwellen in transversaler Energie überschreiten. Dazu sind beispielsweise eine gute Energiekalibrierung oder die Bestimmung der korrekten Strahlkreuzung in der Gegenwart von signifikanter Hintergrundaktivität von besonderer Bedeutung. In diesem Vortrag werden die wichtigsten Änderungen im Level-1 Kalorimeter-Trigger und dessen Leistungsfähigkeit während Run-2 vorgestellt.

T 18.4 Mo 16:50 ST 2

A control system for the Mu3e DAQ — •Martin Müller for the Mu3e-Collaboration — Institute for Nuclear Physics, JGU Mainz, Germany

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 thin layers of silicon pixel sensors will be used to track electrons and positrons. 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 control system for the first two DAQ layers and their connections to the Maximum Integrated Data Acquisition System (MIDAS) as well as the clock and reset distribution system.

T 18.5 Mo 17:05 ST 2

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

The Mu3e experiment at the Paul Scherrer Institute searches for the decay $\mu^+ \to e^+e^+e^-$. This decay violates the lepton flavour conservation - so 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 of about 1 TB/s cannot be saved to disk, a trigger-less on line readout system needs to be 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 Field Programmable Gate Array (FPGA) based system which is used to preprocess, sort and transport the data from the detector to the filter farm.

T 18.6 Mo 17:20 ST 2

Mu3e electrical readout chain — •Lars Olivier Sebastian Noehte for the Mu3e-Collaboration — Physikalisches Institut, Heidelberg

The Mu3e experiment is going to search for the charged lepton-flavour violating decay $\mu^+ \to e^+e^-e^+$ with a sensitivity of 1 in 10^{16} decays in phase II. The pixel tracker is based on HV-MAPS and creates an untriggered continuous data stream with a total data rate of approximately 1 Tbit/s. The tracker is read out via 3060 differential links running at 1.25 Gbit/s. To minimise multiple Coulomb scattering ultra-thin tracking layers, consisting of monolithic pixel sensors with a thickness of 50 μm and high density interconnects made out of aluminum and polyimide are used. The tracking layers are designed to have a total radiation length of about $X/X_0 = 0.115\,\%$ per layer.
This talk focuses on the Mu3e electrical readout chain between the sensor chips and FPGA-frontend boards. It is going to cover high density interconnects being aluminum polyimide flexprints as well as micro twisted pair cables and high-speed interposer arrays. Results of the commissioning tests are presented and discussed.

T 18.7 Mo 17:35 ST 2

Status der lokalen DAQ des Belle II Pixel Detektors — •Florian Lütticke, Jochen Dingfelder, Norbert Wermes, Carlos Marinas und Botho Paschen für die Belle 2-Kollaboration — Physikalisches Institut, Universität Bonn

Der Super-KEKB Beschleuniger am KEK Forschungszentrum in Tsukuba, Japan wurde bis zum Jahr 2017 aufgerüstet, um zukünftig eine instantane Luminosität von 8×10^{35} cm^{-2}s^{-1} zu liefern, 40 mal mehr als der Vorgänger KEKB. Um die dadurch erzeugte höhere Datenrate ausnutzen zu können, wird der Belle Detektor zu Belle II aufgerüstet. Dabei werden die innersten beiden Lagen des neuen Vertexdetektors aus DEPFET Pixelsensoren bestehen, die näher an den Interaktionspunkt verschoben, um eine höhere Vertexauflösung zu erreichen. Daten dieser Sensoen werden über zwei FPGA Systeme (DHE und DHC) ausgelesen.

In diesem Vortrag wird die lokalen Datenaquisition (DAQ) des Pixeldetektors vorgestellt und die Erfahrungen mit der DAQ während der Kommisionierung von Belle II präsentiert.

T 18.8 Mo 17:50 ST 2

Online Datenreduktion für das Belle II-Experiment mit dem FPGA-basierten DATCON System — •Christian Wessel, Bruno Deschamps und Jochen Dingfelder für die Belle 2-Kollaboration — Universität Bonn, Physikalisches Institut

Das Belle II-Experiment in Japan ist für eine instantane Luminosität von $8 \cdot 10^{35}$cm^{-2}s^{-1} ausgelegt. Für präzise Messungen von zeitabhängigen Effekten ist Belle II mit einem Pixel Detektor (PXD) mit 8 Millionen Pixeln auf DEPFET-Basis ausgestattet. Durch die Kollisionsrate von 509 MHz wird im PXD eine hohe Datenrate erzeugt, die zu großen Teilen aus Strahluntergründen besteht, welche online aus dem Datenstrom entfernt werden müssen, um so die Datenmenge zu reduzieren. Diese Online-Datenreduktion soll mit dem FPGA-basierten „Data Acquisition Tracking Concentrator Online Node“ (DATCON) System bewerkstelligt werden. Der DATCON sucht im den PXD umgebenden Streifendetektor nach Spursegmenten. Diese werden in den PXD extrapoliert, um dort „Regions of Interest“ (ROI) zu definieren. Nur die Daten der Pixel innerhalb einer ROI werden offline gespeichert. Auf diesem Weg soll eine Reduktion der Daten des PXD um einen Faktor von 10 erfolgen. In vorläufigen Simulationsstudien mit $\Upsilon(4S)$-Ereignissen und Strahluntergründen liegen sowohl die Spurrekonstruktionseffizienz als auch die Effizienz der ROI-Berechnung bei über 96%.

In diesem Vortrag werde ich den aktuellen Status der Entwicklung des DATCON darlegen mit Fokus auf die Simulationsergebnisse.

T 18.9 Mo 18:05 ST 2

Online data reduction with FPGA-based track reconstruction for the Belle II DEPFET Pixel Detector — •Bruno Deschamps, Christian Wessel, Jochen Dingfelder, and Carlos Marinas for the Belle 2-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 48 optical fibers, the track reconstruction and the definition of the ROIs will 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 PHASE2 results as well as the plans for the upcoming PHASE3 are presented.

T 18.10 Mo 18:20 ST 2

Arduino-based Readout Electronics for Particle Detectors — •Markus Köhli[1,2], Jannis Weimar[1], Fabian Allmendinger[1], Fabian Schmidt[2], Klaus Desch[2], and Ulrich Schmidt[1] — [1]Physikalisches Institut, Universität Heidelberg,Heidelberg, Deutschland — [2]Physikalisches Institut, Universität Bonn, Bonn, Deutschland

With the Arduino open source electronics platform microcontrollers have become a comparably easy-to-use tool for rapid prototyping and implementing creative solutions. Yet, running at 16 MHz, the capabilities can be extended to data taking and signal analysis at decent rates. Such devices in combination with dedicated frontend electronics can offer low cost alternatives for student projects and independently operating small scale instrumentation. We present two projects, which cover the readout of helium-3 and boron-10 proportional counters and of scintillators or wavelength shifting fibers with Silicon Photomultipliers. With the SiPMTrigger we have realized a small-scale design for triggering or vetoing in combination with a photon counter. It consists of a custom mixed signal frontend board featuring signal amplification, discrimination and a coincidence unit for rates up to 200 kHz. The nCatcher board transforms an Aruino Nano to a proportional counter readout with pulse shape analysis - time over threshold measurement and a 10-bit analog to digital converter for pulse heights. This makes the device suitable for low to medium rate environments, where a good signal to noise ratio is a crucial.

T 19: Myondetektoren

Zeit: Montag 16:00–18:35 Raum: ST 3

Gruppenbericht T 19.1 Mo 16:00 ST 3

Overview of future muon upgrades for HL-LHC era and drift velocity monitoring system for barrel muon chambers of the CMS — •Archana Sharma, Hans Reithler, Kerstin Hoepfner, Markus Merschmeyer, and Thomas Hebbeker — III. Phys. Institute A, RWTH Aachen

Before being closed for LS2 (December 2018), the CMS detector performed efficiently during the whole LHC Run-I and Run-II data-taking periods and recorded 150.53 fb-1 of good quality 13 TeV proton-proton collisions data. During the HL-LHC era, the integrated luminosity will increase tenfold with respect to original design values, to be foreseen after LS3. To maintain its current excellent performance, the CMS muon detector system, besides other sub-detector systems, will undergo significant upgrades which are crucial to extend the sensitivity of the experiment towards precision measurements and new physics searches. This presentation gives an overview of the planned CMS muon detector system upgrades for LS2 and LS3 periods. Also, the drift velocity monitoring chambers developed at RWTH Aachen and being used in the CMS detector for DT chambers will be discussed.

T 19.2 Mo 16:20 ST 3

Surface commissioning of the BIS-78 sMDT chambers for the upgrade of the ATLAS muon spectrometer — •Šejla Hadžić, Oliver Kortner, Hubert Kroha, and Patrick Rieck — Max-Planck-Insitut für Physik

16 new so-called "BIS-78" sMDT chambers will be installed together with new thin-gap RPC chambers in the inner barrel layer of the ATLAS muon spectrometer in the transition region to the endcaps during the 2019/20 shutdown of the LHC in order to improve the rejection of fake muon triggers. The chambers have been constructed in 2018 and beginning of 2019. All chambers undergo extensive functionality tests with cosmic rays both before and after shipment to CERN. The noise rate and the efficiency of each drift tube are measured as well as the spatial resolution of the chamber. The presentation summarizes the results of these tests.

T 19.3 Mo 16:35 ST 3

Production and quality control of GEM chambers for the CMS Muon System — •Henning Keller, Thomas Hebbeker, Carsten Heidemann, Kerstin Hoepfner, Giovanni Mocellin, and Moritz Seidel — III. Physikalisches Institut A, RWTH Aachen University

In the next years, the LHC will experience a series of upgrades leading to an increased instantaneous luminosity of up to 5×10^{34} cm^{-2}s^{-1}. Along with the LHC, the CMS detector needs to be upgraded, where, in particular, the forward region will be subject to higher background rates and larger radiation doses.

The installation of GE1/1 detectors during Long Shutdown 2 marks the first major upgrade of the CMS Muon System. The endcaps will be complemented by 144 Gas Electron Multiplier (GEM) chambers representing a key component for the muon trigger and tracking performance at high luminosity.

Production sites in seven different countries around the world have been setup to assemble and test the required amount of detectors. GEM detectors with large dimensions of the order of 1 m^2 are built. Before installation, several quality control tests (QCs) are performed. Individual components of the chamber, such as the GEM foils and the gaps between the foils as well as outer frames and PCBs are tested (QC1-2). QC3 and QC4 cover checks of gas tightness and high voltage integrity. QC5 is dedicated to measure the gas gain uniformity.

The mass production of the CMS GEM detectors and the outcome of the quality control tests are discussed in this talk.

T 19.4 Mo 16:50 ST 3

Validation of the CMS GEM Chambers with cosmic rays — •Giovanni Mocellin, Thomas Hebbeker, Kerstin Hoepfner, Henning Keller, Carsten Heidemann, and Moritz Seidel — III. Physikalisches Institut A, RWTH Aachen University

With the increase of the instantaneous luminosity delivered to the experiments by the LHC accelerator, reaching a value of 5×10^{34} cm^{-2}s^{-1} after the Long Shutdown 3, the detectors have to be upgraded to improve the performance and to sustain higher particle fluxes. The forward regions, corresponding to the endcaps of the detectors, are the most affected parts. 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 Muon Endcaps. For the first time, such detectors will have large sizes of the order of 1 m^2, thus high requirements on the consistency of the performance across the detector are needed. Triple-GEM chambers will complement the existing Cathode Strip Chambers, leading to a better identification of the muon tracks and a reduction of the trigger rate due to the suppression of fake candidates. In addition, the forward coverage will be further extended. Before the final installation in the CMS detector, the GEM chambers undergo a quality control test with cosmic rays to check their integrity, quality and performance. The main parameters under study are the efficiency, the noise level and the tracking capabilities. This talk gives an introduction to GEM detectors and presents the status and the initial results of the cosmic rays test.

T 19.5 Mo 17:05 ST 3

Investigation of a high rate capable readout chip for Micromegas detectors — •Maximilian Rinnagel, Otmar Biebel, Bernhard Flierl, Maximilian Herrmann, Ralf Hertenberger, Christoph Jagfeld, Felix Klitzner, Philipp Lösel, Ralph Müller, and Chrysostomos Valderanis — LMU München

The VMM readout chip is designed to be a high rate capable readout chip specifically designed for charge information in gaseous detectors. It samples 64 input channels providing for each channel digital data on pulse height and timing of the pulse maximum. The features and performance of the VMM chip on Micromegas detectors is compared to the APV chip which was originally designed for silicon detector readout but which was adapted for Micromegas. Studies were performed with VMM chips attached on a square meter sized four layered Micromegas detector and small sized Micromegas detectors. These include efficiency studies, position and angular resolution using a muon and pion beam with straight and inclined tracks. The small sized detector has been investigated in a proton beam with the possibility to compare its performance to the APV readout systems.

T 19.6 Mo 17:20 ST 3

Test under high irradiation of new ASD chips for Phase II upgrade of the ATLAS muon spectrometer for the HL-LHC — •Catriona Bruce[1], Oliver Kortner[1], Hubert Kroha[1], Robert Richter[1], Korbinian Schmidt-Sommerfeld[1], and Chrysostomos Valderanis[2] — [1]Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), Munich — [2]Ludwig-Maximilians-Universität, Munich

The muon spectrometer of the ATLAS detector selects muons originating from weak interactions ($p_T > 20$ GeV/c). The comparatively huge background of low-p_T muons should be rejected by an efficient trigger system based on the muon trajectory. When the LHC begins high luminosity operation in 2026, it will be necessary to switch to a more selective first level muon trigger based on fast track reconstruction, requiring continuous readout of the MDT precision tracking chambers. The front-end electronics have been redesigned with new amplifier-shaper-discriminator (ASD) and TDC chips for compatibility with the new trigger scheme and the 10 times higher first-level trigger rates.

The new ASD chip in 130 nm GF CMOS technology has been characterized in the laboratory and tested on a muon chamber in a muon beam under a high gamma radiation background in CERN's Gamma Irradiation Facility. The irradiation affects the drift tube occupancy and the pulse shape of the muon signals and therefore the efficiency and intrinsic spatial resolution. Tests were performed with a range of background fluxes, up to ten times the peak expected value at the HL-LHC.

T 19.7 Mo 17:35 ST 3

Effects of humidity on the gas gain in MicroMegas detectors — •Thorwald Klapdor-Kleingrothaus — Universität Freiburg

The Micro-Mesh-Gaseous Detectors (MicroMegas) are planar and high-rate capable detectors with a high spatial resolution of $\sim 100\mu$m. In the recent years, the MM technology was intensively studied to replace the innermost station of the ATLAS endcap muon spectrometer. The new detector assembly is known as the New Small Wheel Upgrade

and will be installed in the next few years. The NSW will use the MicroMegas and sTGC detectors for triggering and track reconstruction. The performance and response of the MicroMegas detectors can be influenced by variations in the pressure or the gas mixture, like the admixing of humidity, of the operation gas. In addition, there is a further influence by the operation voltage, as the detectors are operated in proportional mode. In this context, MicroMegas prototypes (10x10cm^2) were used to study their performance and their behavior with respect to the mentioned influences. These effects are studied with an experimental setup and according simulations. A potential compensation by the adjustment of the applied operation voltage is investigated. The obtained results affect the design of detector-slow-control system at the New Small Wheel in ATLAS. The measurements, corresponding simulation studies and the detector-slow-control system will be presented.

T 19.8 Mo 17:50 ST 3

Testbeam Studies of a Large Micromegas Quadruplet for the ATLAS New Small Wheel Project — •Patrick Scholer, Ulrich Landgraf, and Stephanie Zimmermann — Physikalische Institut, Universität Freiburg

During the current shutdown of the LHC 2019/20, the innermost end cap of the Muon Spectrometer of the ATLAS detector will be replaced by the so called New Small Wheel (NSW). It will use 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 of 20 kHz/cm^2.

One of the first Micromegas detector modules of the NSW series production in combination with the final read-out electronics was studied in a test-beam campaign at the SPS accelerator at CERN last summer. In this talk, results of this test-beam campaign will be presented. The focus will be set on the reconstruction performance of inclined tracks. Different reconstruction methods, e.g. the so called uTPC method that uses the drift gap of the Micromegas detector as time projection chamber, and their application to the obtained data will be presented.

T 19.9 Mo 18:05 ST 3

Characterisation of 2 m^2 sized 4 layered Micromegas Modules with Cosmic Muons — •Maximilian Herrmann, Otmar Biebel, Bernhard Flierl, Ralf Hertenberger, Christoph Jagfeld, Felix Klitzner, Philipp Lösel, Ralph Müller, Maximilian Rinnagel, and Chrysostomos Valderanis — Ludwig-Maximilians Universität München

Micropattern gaseous detectors are ideal for track reconstruction of muons in high flux environments. They are high rate capable and have a spatial resolution below 100 μm. In high energy physics experiments large areas have to covered with such precision trackers. Therefore Micromegas modules with areas of 2 m^2 and with four active layers have been developed. The investigation of these modules is done in the Cosmic Ray Facility near Munich. Tracks of cosmic muons are used for the comparison between the performance of reference system and module. The active area of a Micromegas module is investigated with respect to homogeneity in pulse height, efficiency and resolution. Also deviations to the nominal design can be uncovered down to the order of 10 μm. We present results for these investigations with several modules and studies done for different gas mixtures.

T 19.10 Mo 18:20 ST 3

Investigation of a multiplexed readout for Micromegas detectors — •Christoph Jagfeld, Otmar Biebel, Bernhard Flierl, Maximilian Herrmann, Ralf Hertenberger, Felix Klitzner, Philipp Lösel, Ralph Müller, Maximilian Rinnagel, and Chrysostomos Valderanis — LMU, Munich

In Micromegas detectors (Micro-MEsh GAseous Structures), a modern form of micro-pattern gaseous detectors, every single micro strip is read out by a single electronic channel. For large scale Micromegas detectors this results in a huge number of electronic readout channels and corresponding electronics, leading to high power consumption and heat dissipation. To reduce the number of electronic readout channels by a factor of two a multiplexed readout scheme has been developed and investigated.
Tests at the tandem accelerator in Munich with 20MeV protons at an angle of incidence of 20° have been performed to observe the impacts of the multiplexed readout on the angular resolution and signal pulse height.
To observe the impacts on the efficiency and spacial resolution studies with cosmic muons have been done.
These tests, which will be presented show the usability of the multiplexed readout for the Micromegas detector.

T 20: Detektorsysteme I

Zeit: Montag 16:00–18:30 Raum: ST 4

T 20.1 Mo 16:00 ST 4

FANGS: Beam background monitoring during the commissioning phase of the Belle II detector — •Patrick Ahlburg, Jochen Dingfelder, Jens Janssen, Hans Krüger, Carlos Marinas, David-Leon Pohl, and Norbert Wermes — University of Bonn

The FANGS (FE-I4 ATLAS Near Gamma Sensors) detector is one of the components of the BEAST II (Beam Exorcisms for A Stable Experiment) experiment, a pre-experiment of Belle II at the SuperKEKB accelerator in Japan. BEAST II was a dedicated detector system used to study the machine-induced background during the commissioning phase of the SuperKEKB accelerator before the installation of the Belle II inner detector (silicon vertex detectors). The FANGS detector is based on hybrid pixel detector modules used in the ATLAS IBL pixel detector (FE-I4) which are sensitive to low-keV X-rays and can cope with high particle rates. In this presentation, the development and construction of the FANGS detector, the installation in BEAST II at the end of 2017 and the first results from background studies, such as energy distributions of the background, are presented.

T 20.2 Mo 16:15 ST 4

CLAWS: Monitoring Injection Backgrounds at SuperKEKB — •Hendrik Windel for the Belle 2-Collaboration — Max-Planck-Institut 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, an array of plastic scintillator tiles read out with silicon photomultipliers connected to a readout system providing continuous readout over several thousand revolutions of the accelerator with sub-nanosecond 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 becoming a permanent part of the beam background monitoring for the Belle II experiment, scheduled to begin regular physics operation in March 2019. This contribution will discuss results from background measurements during the second phase of commissioning, and present the technological evolution of the CLAWS system towards a permanent background monitoring detector.

T 20.3 Mo 16:30 ST 4

Belle II Pixel Detector - Performance of Final Modules — Jochen Dingfelder, Tomasz Hemperek, Hans Krüger, Florian Lütticke, Carlos Marinas, •Botho Paschen, and Norbert Wermes for the Belle 2-Collaboration — University of Bonn, Germany

In spring 2018 the SuperKEKB accelerator in Tsukuba, Japan, provided first e^+e^--collisions to the upgraded Belle II experiment. During this commissioning phase the volume of the innermost vertex detector was equipped with dedicated detectors for measuring the radiation environment as well as one sector of the final Belle II silicon strip (SVD) and pixel (PXD) detectors.

The PXD is the sub-detector closest to the interaction point. It is made from all-silicon modules integrating support structure and sensor. The sensors are pixel matrices of DEpleted P-channel Field Effect Transistors (DEPFET) which are steered and read out by 14 ASICs bump-bonded to each module.

Four of the first available PXD modules of the final iteration were

set up in the commissioning PXD detector. They were operated with close-to-final services and their data used to help evaluate accelerator operation. Final PXD modules were also characterized in the laboratory and at beam tests at DESY. This talk will present results of these performance measurements and the long term tests during accelerator commissioning.

T 20.4 Mo 16:45 ST 4

Production tests and commissioning of the Pixel Vertex Detector for Belle II — •Philipp Leitl[1], Hans-Günther Moser[1], Felix Müller[1], Markus Reif[1], Oskar Tittel[1], Florian Lütticke[2], Botho Paschen[2], Harrison Schreeck[3], Philipp Wieduwilt[3], Varghese Babu[4], Felix Müller[4], and Hua Ye[4] — [1]Max Planck Institute for Physics — [2]University Bonn — [3]Georg-August-University Göttingen — [4]DESY

The Pixel Vertex Detector (PXD) is the inner most tracking detector of the Belle II experiment at the electron positron collider SuperKEKB in Tsukuba, Japan. It was designed to consist out of 40 monolithic Depleted P-channel Field Effect Transistor (DEPFET) modules arranged in two layers around the interaction point.

During 2018 the production of the PXD modules was completed. In a collaborative effort all modules went to a standardized testing procedure for optimization and characterization. As a last mechanical step the modules were glued to ladders. The used procedure turned out to be unsuited for the sensitive detector modules and had to be modified.

Finally, the inner layer was completed and integrated into the inner tracking system together with the Silicon Vertex Detector (SVD). The PXD was commissioned in Japan and cosmic ray measurements were taken before and after the insertion into the Belle II detector.

An overview of the results from the module characterization, from the inspection after module gluing and from the commissioning will be presented.

T 20.5 Mo 17:00 ST 4

Performance studies of Belle II DEPFET Pixel Half-Ladders in Test Beams — •Julian Soltau, Philipp Wieduwilt, Harrison Schreeck, Benjamin Schwenker, and Ariane Frey — Georg-August-Universität Göttingen

In the momentary ongoing upgrade of the Japanese Flavor Factory (KEKB) to SuperKEKB for the Belle II experiment the luminosity targets a luminosity increase to $8 \cdot 10^{35}$ cm^{-2} s^{-1}, which is 40 times higher than the previous luminosity of the Belle experiment. In order to handle the increased data rate, a new detector design is mandatory. This was realized by adding an additional pixel detector to the vertex detector, based on DEPFET technology. The DEPFET pixels have a completely depleted silicon bulk and combine signal detection and amplification in a single chip. As part of a beam test campaign at DESY the influence on the the efficiency of different bulk bisasing settings was tested on different half-ladders. The half-ladders used were final PXD modules with pixel sizes in the range of $(55 - 85) \times 55\mu$m^2. The results from the beam test will be presented in this talk.

T 20.6 Mo 17:15 ST 4

Optimization of Belle II DEPFET Pixel Sensor Biasing — •Philipp Wieduwilt, Harrison Schreeck, Julian Soltau, Benjamin Schwenker, and Ariane Frey — Georg-August-Universität Göttingen

The Belle II experiment at the Japanese B-Factory SuperKEKB will start taking data in early 2019. The SuperKEKB e^+e^- collider runs at a very high peak luminosity of $8 \cdot 10^{35}$cm^{-2}s^{-1} at the $\Upsilon(4S)$ resonance, producing B mesons. In order to reconstruct the decay vertices of the B mesons in this harsh environment, the Belle II detector will be equipped with a DEPFET based silicon pixel detector (PXD). The silicon bulk, on which the field-effect transistors form the individual pixels, is biased by different voltages enabling bulk depletion, charge collection and charge removal.

The base constituents of the PXD are half-ladders of a 768×256 sensitive DEPFET pixel matrix and front-end read-out ASICs. The PXD design consists of two layers (12 ladders in the outer layer, 8 ladders in the inner layer) with four different pixel pitches of $55 \times 50\,\mu$m^2 to $85 \times 50, \mu$m^2. This talk will present observations on characterization of the final PXD half-ladders, as well as studies for finding the optimal sensor biasing scheme.

T 20.7 Mo 17:30 ST 4

Optimization procedure of the PXD modules for Phase 3 — •Markus Reif für die Belle 2-Kollaboration — Max Planck Institute for Physics

The Pixel Vertex Detector (PXD) is part of the new Belle II detector at the electron positron collider SuperKEKB in Tsukuba, 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.

Phase 3 starts in the beginning of 2019. For this phase the 'full' Belle II detector containing all subdetectors will be installed as well as the complete SuperKEKB collider. This then allows for the first time to take data with the full system.

To optimize the PXD modules for data taking, several tests are performed. The software framework had to be adapted from the lab setups, where only single modules were operated, to the final detector setup in Japan.

The tests which are performed and the results from the currently installed PXD modules are presented.

T 20.8 Mo 17:45 ST 4

Noise threshold optimization of SCT strips of the ATLAS detector — •Frank Sauerburger and Karsten Köneke — Albert-Ludwigs-Universität, Freiburg, Deutschland

An optimization study to reduce the effect of noisy strips in the SemiConductor Tracker (SCT) of the ATLAS detector is presented. Currently, strips are marked as "noisy" in the 48-hour calibration loop if their average occupancy is above $p = 1.5\%$. Hits in masked strips are not considered during reconstruction. The current threshold has been determined for the configuration of Run 1. Due to an increase in the number of pile-up events and a higher center-of-mass energy in Run 2, it is expected that the current masking algorithm is not optimal for Run 2. The masking criterion is studied from the point of view of tracking performance. The barrel residual and the number of tracks are used as figures of merit to assess the tracking performance. Furthermore, an alternative treatment of masked strips is tested. Instead of removing the hit information before reconstruction, the strips are marked as "dead" in order to reduce the number of holes introduced by the masking of noisy strips.

T 20.9 Mo 18:00 ST 4

The beam induced background in the ATLAS semiconductor tracker — •Edoardo Rossi[1], Christian Sander[1], and Saverio D'Auria[2] — [1]DESY — [2]University of Milan

The Beam Induced Background (BIB) is composed of particles generated by the interaction of the LHC beam with the environment, for example gas molecules in the beam pipe. Studying the characteristics of the BIB is crucial to estimate and reject this background, which plays a signicant role, for example, in mono-jet analyses and in searches for rare events, where even the smallest backgrounds needs to be estimated accurately.

In this presentation, results from the analysis of the BIB in the Semiconductor Tracker (SCT) of the ATLAS experiment are shown. To disentagle the effect of the BIB from collision fragments, events with unpaired proton bunches are exploited. A signicant signature of the BIB particles arises from the timing of their hits, which has the effect of creating an asymmetric hit distribution in the two SCT end caps. Using this signature, it is possible to further select events with a large BIB component.

In this talk, the hit density and distribution of the BIB measured in the SCT are discussed.

T 20.10 Mo 18:15 ST 4

Measurement and optimization of the soft-error-recovery rates in the phase 1 pixel detector — •Torben Lange[1], Peter Schleper[1], Benedikt Vormwald[1], Jory Sonneveld[1], Klaas Padeken[2], Abhisek Datta[3], and Atanu Modak[4] — [1]Univeristät Hamburg, Germany — [2]Vanderbilt University, US — [3]Cornell University, US — [4]Kansas State University, US

While constructed in a radiation hard way to operate in the high radiation environment at the center of the CMS experiment, single-event upsets or SEU that cause different parts of the silicon-pixel-tracking detector to stop sending data are unavoidable in a system this close to the interaction point. The soft-error recovery is an automated procedure to recover those detector parts that stop sending data after radiation induced SEUs during operation. This talk gives an overview

of trigger- and recovery rates for the soft-error recovery and discusses based on this if and how the trigger thresholds for the soft-error recovery could be adjusted for the RUN-3 of LHC data taking.

T 21: Kosmische Strahlung, Propagation

Zeit: Montag 16:00–18:30 Raum: ST 7

T 21.1 Mo 16:00 ST 7

Physical interpretations of the Fermi gamma-ray excess — •Neeraj Amin, Iris Gebauer, and Wim de Boer — Karlsruhe Institute of Technology, Karlsruhe, Germany

The so-called gamma-ray excess observed by Fermi-LAT has received different physical interpretations: i) Dark Matter annihilation in the Galactic center ii) a population of millisecond pulsars in the Galactic center, and iii) suppressed emission from molecular clouds. The excess may also be partially caused by detector effects originating from the limited angular resolution of the instrument. In this talk we first discuss the impact of detector effects on the signal shape and then discuss physical interpretation of the signal.

T 21.2 Mo 16:15 ST 7

Modeling the magnetic field configuration in the Galactic Center and the cosmic ray propagation — •Mehmet Guenduez and Julia B. Tjus — Ruhr-Universität Bochum, RAPP-Center, Bochum, Deutschland

This work is aimed at modeling a realistic 3D gas, magnetic field and photon field distribution of the inner 250 pc around the Galactic Center (GC) on purpose of reproducing a reliable cosmic-ray (CR) propagation and secondary emission map . We present our method of modeling the ambient conditions in Central Molecular Zone und the results achieved by implementing these models in the CR propagation tool CRPropa. The results are compared with the polarization map of Nishiyama et al. (2010) and can explain most of the artifacts and configurations. Considering the exact gas distribution, the simulation of the CR propagation can even reproduce the structure of the diffuse gamma-ray emission measured by H.E.S.S. (2016) pretty well. However, a single source does not seem to cause the whole diffuse gamma-ray emission.

T 21.3 Mo 16:30 ST 7

Uncertainties of secondary antiproton production in cosmic rays — •Michael Korsmeier — University of Turin, Department of Physics, Turin, Italy

During the last decade, space-based experiments have drastically reduced the measurement uncertainty of cosmic-ray fluxes. Consequently, systematic uncertainties in the description of cosmic rays become more and more relevant. One important example is the production of secondary antiprotons in our Galaxy. I will give an overview about the current status of the production cross section for cosmic-ray antiprotons and its uncertainties. In cosmic-ray fits, these uncertainties are often neglected or described at an effective level by a covariance matrix. I will review this method and present an alternative approach: We perform a global fit which joins cosmic-ray data and measurements of the antiproton production cross section. By simultaneously fitting cosmic-ray propagation parameters and the parametrization of the antiproton production cross section, we marginalize over the cross section uncertainty. I will briefly discuss the impact on the extraction of cosmic-ray propagation parameters and the putative hint for dark matter in the antiproton spectrum.

T 21.4 Mo 16:45 ST 7

Bestimmung des Diffusionstensors für galaktische Propagation — •Patrick Reichherzer[1], Julia Tjus[1], Lukas Merten[1] und Ellen Zweibel[2] — [1]Ruhr Astroparticle and Plasmaphysics Center, Ruhr-Universität Bochum, Theoretische Physik IV, Bochum, Germany — [2]University of Wisconsin-Madison Department of Astronomy, Madison, USA

Die komplexe Entwicklung der kosmischen Teilchenverteilung kann durch einen Diffusionsprozess für lange Trajektorien mathematisch beschrieben werden. Der Übergang von einem ballistischen zu einem diffusiven Energieregime wird anhand numerischer Simulationen veranschaulicht und zur Berechnung von Diffusionskoeffizienten für homogene Magnetfeldlinien B verwendet, die turbulenten Störungen b unterliegen. Die Ergebnisse werden mit theoretischen Herleitungen der Energie- und Magnetfeldabhängigkeiten des parallelen Diffusionskoeffizienten für schwache Turbulenz verglichen. Die vorliegende Arbeit zeigt, dass die bisher angenommene Extrapolation der Energieskalierung hin zu hohen Turbulenzniveaus für den durch die quasi-lineare Näherung vorhergesagten parallelen Diffusionskoeffizienten keine genaue Beschreibung im diffusiven Energieregime liefert. Es wird gezeigt, dass die numerisch berechneten Diffusionskoeffizienten bei niedrigen Teilchenenergien Unsicherheiten aufgrund fehlender resonanter Wechselwirkungsmöglichkeiten der Teilchen mit der Turbulenz unterworfen sind. Es wird eine Übereinstimmung zwischen der Energieskalierung in dieser Arbeit und der aus früheren Studien gefunden, nachdem diese gemäß den in dieser Arbeit gefundenen Bedingungen angepasst wurde.

T 21.5 Mo 17:00 ST 7

Statistical fluctuations of extragalactic cosmic rays in the Galactic magnetic field — •Alex Kääpä — Gaußstr. 20, 42119 Wuppertal

To account for the flux measured in the energy spectrum of cosmic rays between the so-called "knee" and "ankle", where the transition from galactic to extragalactic cosmic rays occurs, additions to existing models of cosmic ray acceleration as well as propagation are required. While some proposals for acceleration and propagation mechanisms exist (i.e. re-acceleration or spallation), understanding the bulk propagation of cosmic rays in the Galaxy is vital, particularly for those of extragalactic origin, where rigidity-dependent statistical fluctuations in arrival directions are still possible. In this talk, CRPropa simulations of said fluctuations, focusing on concentration effects in the Galactic magnetic field, will be presented and the possibility to measure these with cosmic ray observatories will be discussed.

T 21.6 Mo 17:15 ST 7

Solving the cosmic-ray transport equation with stochastic differential equations: CRPropa's module DiffusionSDE — •Lukas Merten — Ruhr-Universität Bochum

An appropriate numerical modelling of Galactic cosmic-ray transport is a major challenge in modern astroparticle physics. Multi-messenger observations of cosmic rays and neutral secondary particles like neutrinos and gamma-rays must be connected with source models. This requires a detailed description of the propagation and interaction of all particles.

Over the years many different approaches to describe the Galactic cosmic-ray transport have been developed. From early semi-analytical simplifications to modern simulations frameworks a lot of progress has been made, e.g. the introduction of three-dimensional diffusion in recent tools. Furthermore, new solver techniques for the transport equation based on stochastic differential equations have become available e.g. in CRPropa.

In this talk the differences compared with conventional grid-based solvers are explained. In addition, it will be shown why this ansatz is especially promising in the shin region between the cosmic-ray knee and ankle.

T 21.7 Mo 17:30 ST 7

Improved photo-meson model for UHECR nuclei interactions — •Leonel Morejon[1], Anatoli Fedynitch[1], Denise Boncioli[2], Daniel Biehl[1], and Walter Winter[1] — [1]DESY Zeuthen, Platanenallee 6, 15738 Zeuthen, Brandenmburg, Germany — [2]GSSI, Via Michele Jacobucci 2, 67100 L'Aquila AQ, Italia

Photon-nucleus interactions are a necessary element in radiation models of sources and transport Ultra-High Energy Cosmic Rays (UHECRs). The UHECRs encounter dense photon fields with energies in the range $\mu\mathrm{eV} - \mathrm{MeV}$ which are boosted to $\mathrm{MeV} - \mathrm{GeV}$ in the nucleus rest frame, prompting pion production and thus connecting cosmic rays, gamma rays and neutrino spectra. Photomeson models are used to simulate these interactions above the photopion threshold, and previous works have introduced simplifications which need improvement.

Here we introduce a new photomeson model based on experimental data which improves on the previous models. Specifically, the new

model includes shadowing by including an energy dependence of the mass scaling of the total nonelastic cross section above 1 GeV; it also includes pion re-absorption in the nuclear medium by appropriately scaling the photopion cross section with the nuclear surface ($\sim A^{2/3}$), and finally the model contains enhanced nuclear breakup by the inclusion of multiple disintegration channels.

The relevance of these improvements is illustrated by showing the impact on the results of simulating two proposed source classes which have been found in recent works suitable as UHECRs sources.

T 21.8 Mo 17:45 ST 7

Improvements in the high-energy lepton propagator PROPOSAL — •Jean-Marco Alameddine — Technische Universität Dortmund

PROPOSAL is a Monte Carlo simulation library used to describe the propagation of high-energy charged leptons. These leptons can be muons induced by atmospheric air showers or particles produced from interactions of astrophysical high-energy neutrinos with matter, observed with experiments such as the IceCube Neutrino Observatory. PROPOSAL precisely describes the interaction of these particles with matter, especially the occurring energy losses through ionization, direct pair production, bremsstrahlung and inelastic nuclear interaction. The knowledge of these effects is essential for an accurate event reconstruction. However, there are still systematic uncertainties arising from the theoretical predictions as well as physical effects that are not included yet. This talk presents the latest enhancements in PROPOSAL made to further improve the precision and to reduce the systematic uncertainties of the propagation.

T 21.9 Mo 18:00 ST 7

Effects of the muon cross section uncertainties in IceCube — •Jan Soedingrekso, Tobias Hoinka, and Mirco Hünnefeld — TU Dortmund, Dortmund, Germany

The IceCube Neutrino Observatory measures astrophysical neutrinos through charged secondary particles emitting Cherenkov light. As the reconstruction of these secondaries, thus also the neutrinos, depend on the cross sections used in the Monte-Carlo Simulation, a systematic study regarding the uncertainties of these cross sections is needed. For high energy muons the energy loss processes are ionization, pair production and bremsstrahlung all with uncertainties of a few percents and inelastic nuclear interaction with an uncertainty of 10 to 20 percent. In this talk, the effects of different muon cross sections on the energy reconstruction are presented.

T 21.10 Mo 18:15 ST 7

Higher-order corrections to the energy-loss cross sections of high-energy muons — •Alexander Sandrock and Jan Soedingrekso — Technische Universität Dortmund

Over a large part of the energy range investigated by very large volume neutrino telescopes such as IceCube, pair production and bremsstrahlung dominate the energy loss of muons. The theoretical uncertainties on the energy loss cross sections influence the experimental results as systematic uncertainties. This contribution presents calculations of higher-order corrections to decrease these uncertainties for pair production and bremsstrahlung.

T 22: Poster

Zeit: Montag 16:00–18:30 Raum: C.A.R.L. Foyer 1. OG

T 22.1 Mo 16:00 C.A.R.L. Foyer 1. OG

What is Dark Matter? — •Albrecht Giese — Taxusweg 15, 22605 Hamburg

Dark matter is one of the great mysteries in today's physics.

There are fundamentally two solutions possible: (1) there may exist a type of presently undetected particles which provides the missing contribution to the gravitational field; (2) the theory of gravity of Newton and of Einstein which related gravitation to mass and energy may be erroneous.

For the second alternative there is a working ansatz. If one extends the Lorentzian interpretation of relativity to the area of general relativity, so to gravitation, there follows a different causality for gravity. Gravity is no longer caused by mass or energy but it is a side effect of other forces. So every elementary particle contributes to the field independently of its mass. And in this case photons and neutrinos are playing a particular role.

If the thoroughly investigated rotating galaxy NGC 3198 is taken as an example for this approach, it can be shown that the result for the amount of the field as well as its spatial distribution fits quite precisely to the measurement. And the recently detected galaxy NGC 1052-DF2, which emits dim light and has only a small amount of Dark Matter, is a good confirmation of this view.

On the other hand, the search for specific particles as an explanation of this phenomenon has up to now not yielded any hints for their existence.

Further Info: www.ag-physics.org/gravity

T 22.2 Mo 16:00 C.A.R.L. Foyer 1. OG

High Resolution Neutron Detection by the (y)TPC method — •Markus Köhli[1,2], Fabian Schmidt[2], Markus Gruber[2], Jochen Kaminski[2], and Klaus Desch[2] — [1]Physikalisches Institut, Universität Heidelberg,Heidelberg, Deutschland — [2]Physikalisches Institut, Universität Bonn, Bonn, Deutschland

The world of detectors used in thermal neutron scattering instrumentation has changed. By alerts on the future Helium-3 supply, critical to perspectives of the large-scale research infrastructures, the run on substitutional technologies started. Most of the solutions could be adapted from developments of particle physics and are comprised of one or more layers of boron-10. The Time Projection Method achieves a very high resolution by projecting ionization tracks onto a readout with dense spatial and time information. The University of Bonn is developing a novel system employing the Timepix - CMOS based chips with 55 micrometer sized pixels operated at clock speeds up to 80 MHz. Each matrix of 256 x 256 pixels is equipped with an InGrid - microstructured aluminum meshes 50 micrometer ontop of the pixels serving as a charge amplifier. In a first prototype with 8 Timepix chips, which are arranged in parallel to a boron layer, the track topology with this unrivaled high resolution has been studied. By reconstructing the origin of the conversion ions a time resolution of $<$50 ns and a spatial resolution of 100 micrometer has been achieved. As this setup now allows the full reconstruction of the conversion tracks down to the electron level we can address the question: what is realistically the resolution limit for boron-lined gas detectors?

T 22.3 Mo 16:00 C.A.R.L. Foyer 1. OG

Eine neue Software zur 3d Simulation von Solid-State-Detektoren — •Lukas Hauertmann, Martin Schuster, Oliver Schulz, Anna Zsigmond und Iris Abt für die LEGEND-Kollaboration — Max-Planck-Institut für Physik

Germanium- und Siliziumdetektoren kommen in einer Vielzahl von Experimenten weltweit zum Einsatz und haben einen festen Platz in zahlreichen Industriefeldern. In der GeDet (Germaniumdetektor Entwicklung) Gruppe am MPI für Physik werden Germaniumdetektoren genau studiert. Dies geschieht unter anderem durch den Vergleich von experimentell aufgenommenen mit simulierten Daten. Dazu wurde eine neue schnelle „Open Source" Simulationssoftware „SolidStateDetectors.jl" entwickelt, mit der das Verhalten aller auf Dioden basierenden Halbleiterdetektoren simuliert werden kann. Das Paket kann zur Berechnung der elektrischen Potentiale und Felder in Abhängigkeit von der angelegten Biasspannung verwendet werden. Es bietet die Möglichkeit der Pulsformsimulation basierend auf der Drift der Ladungsträger und die Möglichkeit, die Einflüsse der Elektronik zu berücksichtigen. Das Einlesen von GEANT4-generierten Ereignissen ist möglich. Die Software ist in der Programmiersprache Julia geschrieben und modular aufgebaut, sodass Benutzer auch leicht ihre eigenen Modelle, wie z.B. unterschiedliche Charge-Drift-Modelle, implementieren können.

T 22.4 Mo 16:00 C.A.R.L. Foyer 1. OG

The tracking system of the TAIGA-IACT telescope — •Dmitriy Zhurov[1,2], Oleg Gress[1], and Ralf Wischnewski[3] for the TAIGA-Collaboration — [1]Irkutsk State University — [2]Irkutsk National Research Technical University — [3]DESY Zeuthen

The TAIGA Observatory is designed for ground based gamma-ray as-

tronomy in the energy range from a few TeV to several PeV, and is located in the Tunka valley (Siberia/Russia). The TAIGA-IACT telescopes are part of the TAIGA complex hybrid detector that is under deployment. Currently we have one IACT telescope in operation and two more telescopes under construction on the TAIGA site. Observation of a gamma-source with IACT telescopes requires long exposure time, accurate pointing and specific tracking modes that are used for this type of telescope. The telescope drive system is equipped with 17-bit shaft encoders and hybrid stepper motors. A CCD-camera located on the telescope dish is intended for telescope calibration and measurements of its absolute direction by the images. Telescope hardware are controlled with software developed using EPICS control system framework. In this report we overview TAIGA-IACT telescope pointing calibration and tracking control software. Also telescope pointing precision for the 2018-2019 observation season is presented.

T 22.5 Mo 16:00 C.A.R.L. Foyer 1. OG

Analysis of the moon shadow in the IceCube detector and it's sensitivity dependence on the angular reconstruction method — •Aakash Bhat, Thorsten Gluesenkamp, and Gisela Anton for the IceCube-Collaboration — Erlangen Centre for Astroparticle Physics, Friedrich-Alexander Universität Erlangen-Nürnberg

The moon shadow is an observed deficit in cosmic-ray muons from the direction of the moon compared to the average muon flux from the same declination. The observation of such a phenomenon by the IceCube detector can be used to confirm the angular resolution of the detector and the robustness of the reconstruction method used. Here we analyze IceCube data taken from detector runs in 2015 and investigate the effect of the angular reconstruction method and exact statistical analysis on the moon sensitivity.

T 22.6 Mo 16:00 C.A.R.L. Foyer 1. OG

Measurement of Nuclear Fragmentation Cross Sections of Carbon on Proton to Boron with NA61/SHINE at the CERN SPS — •Franziska Sutter for the NA61/SHINE-Collaboration — Karlsruher Institut of Technology

A precise knowledge of fragmentation cross sections of intermediate mass nuclei is very important for the understanding of the propagation of cosmic rays in our Galaxy. The main observable to constrain the average integrated mass density traversed by the cosmic rays is the ratio of secondary-to-primary cosmic rays, especially the boron to carbon ratio, B/C, which has been recently measured by AMS with a precision of several percent. On the other hand, the cross section for the most crucial production channel for boron, $C + p \rightarrow B + X$, has a cross section uncertainty of about $15 - 20\,\%$.

In this poster we will present new measurements of carbon fragmentation with the NA61/SHINE facility at the SPS at CERN. One week of data with a fragmented Pb-ion beam at $13 - 13.5\,\mathrm{AGeV/c}$ was taken in December 2018. By using a carbon trigger as well as two different targets made of polyethylene and carbon the cross section measurement at isotope level was performed.

T 22.7 Mo 16:00 C.A.R.L. Foyer 1. OG

Determination of analysis plane magnetic field in the KATRIN main spectrometer — •Fabian Block[1] and Alexander Osipowicz[2] for the KATRIN-Collaboration — [1]Karlsruher Institut für Technologie, Deutschland — [2]Hochschule Fulda, Deutschland

The Karlsruhe Tritium Neutrino (KATRIN) experiment aims to measure the effective electron anti-neutrino mass with a sensitivity of 0.2 eV (90% C.L.) by investigating the endpoint region of the β decay spectrum. The experimental setup of KATRIN consists of a tritium source, from which the decay electrons are magnetically guided through the transport section towards two Mac-E filters (pre- & main spectrometer). The spectrometers act as integrating high pass filters with an energy resolution defined by the magnetic field strength in the spectrometer's center and the Pinch magnet. Only electrons near the energetic endpoint of the decay spectrum are transmitted to the detector.

A precise magnetic field model is of high importance for the neutrino mass analysis, as slight magnetic field deviations can significantly influence the spectrometer's energy resolution. This poster presents a method to precisely determine the magnetic field inside of the main spectrometer based on field values measured outside of the vessel, with KATRIN's radial magnetic monitoring system. The systematic uncertainty of the model is analyzed as a function of the applied magnetic field setting. The results of the study are essential for deciding which magnetic field setting to use in the first neutrino mass measurements.

This work was supported by the GRK 1694, the YIG VH-NG-1055, BMBF (Ø05A17VK2) and the Helmholtz Association.

T 22.8 Mo 16:00 C.A.R.L. Foyer 1. OG

Precision High Voltage at the KATRIN Experiment — •Caroline Rodenbeck[1], Oliver Rest[1], and Thomas Thümmler[2] — [1]Institut für Kernphysik, WWU Münster — [2]Institut für Kernphysik, Karlsruher Institut für Technologie

The Karlsruhe Tritium Neutrino (KATRIN) experiment aims to determine the neutrino mass by measuring the tritium beta spectrum using an integrating spectrometer (MAC-E filter). The sensitivity goal of $0.2\,\mathrm{eV/c^2}$ (90% C.L.) requires the spectometer's energy scale to be stable up to 60 meV. This translates to a stability requirement of 3 ppm for the high voltage system that creates the retarding potential (18.6 kV) inside the spectrometer.

KATRIN's high voltage system meets these requirements with precision power supplies and a high precision monitoring using two custom-built high voltage dividers. The monitoring system is complemented by an independent comparision of the energy scale to a nuclear standard. This is achieved by spectroscopic measurements of mono-energetic conversion electrons from Kr-83m decays utilizing different source formats (implanted, condensed, gaseous).

The poster will give a detailled overview of KATRIN's high voltage system and its performance during recent commissioning measurements. This project is supportet by BMBF under contract number 05A17PM3.

T 22.9 Mo 16:00 C.A.R.L. Foyer 1. OG

Characterization of Germanium crystals using PET — •Lukas Rauscher, Büsra Cebeci, and Josef Jochum for the GERDA-Collaboration — Physikalisches Institut, Auf der Morgenstelle 14, Tübingen, Deutschland

To increase their sensitivity several neutrino experiments want to significantly reduce background contributions by active background-suppression techniques. One of these techniques is the pulse shape analysis of signals induced by the interaction of radiation with the detector. The pulse shapes do not only depend on the energy of the interacting particle, the geometry and the field configuration but also on the location of interaction within the crystal. One possibility to determine the waveform depending on the location of the interaction in the detector is the use of positron-emission-tomography (PET). The main goal of this work is to create a setup which can characterize a detector using a PET. The poster shows a proof of principle and also the ongoing work on the subject. This work is funded by the BMBF.

T 22.10 Mo 16:00 C.A.R.L. Foyer 1. OG

Attenuation Measurements of Fast Neutrons in an Experimental Site at the Chooz Nuclear Power Plant for NU-CLEUS — •Andreas Erhart, Angelina Kinast, Alexander Langenkämper, Elizabeth Mondragón, Tobias Ortmann, Luca Pattavina, Walter Potzel, Stefan Schönert, and Raimund Strauss for the NU-CLEUS-Collaboration — Physikdepartment E15 and Excellence Cluster Universe, Technische Universität München, D-85748 Garching

The NU-CLEUS experiment is aiming for the detection of coherent neutrino-nucleus scattering (CEνNS) using gram-scale cryogenic bolometric detectors with a demonstrated ultra-low energy threshold ($\mathcal{O}(\lesssim 10\,\mathrm{eV})$) and a time response fast enough to be operated in above ground conditions. Nuclear reactors are promising sources to explore this process at low energies since they deliver large fluxes of anti-neutrinos with energies below 10 MeV. For the NU-CLEUS experiment, a new experimental site at the Chooz nuclear power plant in France has been located. Fast neutrons represent a potentially dangerous background for the measurement of coherent neutrino-nucleus scattering as they interact with the detector-material via the same mechanism of nucleus scattering as CEνNS. Therefore, a detailed understanding of the neutron background rate is crucial. Attenuation measurements of fast neutrons in the experimental site at the Chooz nuclear power plant have been performed and first results are presented. This research was supported by the DFG cluster of excellence "Origin and Structure" of the Universe and by the SFB1258.

T 22.11 Mo 16:00 C.A.R.L. Foyer 1. OG

Towards Run Wise Simulations for the HAWC Observatory — •Edna L. Ruiz-Velasco for the HAWC-Collaboration — Max Planck Institute for Nuclear Physics, Heidelberg, Germany

The High-Altitude Water Cherenkov (HAWC) is a wide-field of view

gamma-ray observatory located in Sierra Negra, Mexico. It is dedicated to study astrophysical sources of very-high energy (VHE) gamma rays from 0.1 to 100 TeV. In the most conservative way (and the currently used one) simulations of air-shower detection is made with *idealised* detector conditions. Event reconstruction, gamma/hadron separation, and high-level data analysis rely on optimisation and checks on simulated events. Therefore, a proper description and well modelled detector becomes extremely important to better estimate systematic uncertainties and reliable results. Dedicated work for an improvement on the HAWCs simulation chain will be presented in this contribution. The importance of a well estimated efficiency of each detector unit is addressed by implementing a correction of the individual PMTs light level based on an analysis of muons detected by HAWC. On this we can include the possible efficiency evolution of the detector during the operation time of HAWC (already spanning for almost 4 years). A new method for emulating the HAWC low level data (trigger level) will be also presented. This introduces the possibility of comparing data and Monte Carlo simulations at the trigger level and can be used to better simulate the detector by including the information of the calibration methods used in data.

T 22.12 Mo 16:00 C.A.R.L. Foyer 1. OG

Gamma-Hadron separation using Convolutional Neural Network for the HAWC observatory. — •Edna L. Ruiz-Velasco for the HAWC-Collaboration — Max Planck Institute for Nuclear Physics, Heidelberg, Germany

The High-Altitude Water Cherenkov (HAWC) is a wide-field of view observatory located in Sierra Negra, México. It is dedicated to study astrophysical sources of very-high energy (VHE) gamma rays from ˜0.1 to 100 TeV. The HAWC main array comprises 300 Water Cherenkov Detectors (WCDs) that collect the footprint information of atmospheric air showers at the ground level. The detection of gamma-ray induced air showers poses a big challenge when it comes to the separation from the highly hadronic-dominated background (gamma-hadron separation problem). The standard method for the rejection of hadronic showers in HAWC employs parameters inferred from the reconstruction of these showers and is mostly based on the identification of muon signals. In this contribution we explore the application of Convolutional Neural Networks (CNNs) as a gamma-hadron separation method for HAWC, using the pure topology of the air showers, obtaining with this a high degree of separation power.

T 23: Hauptvorträge I

Zeit: Dienstag 9:45–10:30 Raum: H01

Hauptvortrag T 23.1 Di 9:45 H01

Neuer Schwung für alten Kandidaten: Die Suche nach dunkle Materie Axionen und ALPs — •Béla Majorovits — MPI für Physik, München, Deutschland

Die Beschreibung der Quantenchromodynamik (QCD) enthält intrinsisch einen CP verletzenden Term, der zu einem nicht verschwindenden elektrischen Dipolmoment (EDM) des Neutrons führen sollte. Die Stärke der CP Verletzung wird als Winkel θ beschrieben. Die nicht-Beobachtung eines EDM führt zu dem Schluss, dass der Absolutwert von θ unnatürlich klein ist: $|\theta| < 10^{-10}$, das starke CP Problem. Das Problem kann gelöst werden, indem θ als dynamisches Feld interpretiert wird, dessen Beitrag zur Vakuumenergiedichte für θ=0 minimal ist. Sollte dieser von Peccei und Quinn vorgeschlagene Mechanismus zu dem verschwindenden θ führen, impliziert dies die Existenz eines pseudoskalares Teilchens, das Axion. Praktischerweise könnte solch ein Teilchen auch das dunkle Materie Problem lösen. Unabhängig von der QCD und u.a. durch die Stringtheorie motiviert ist die Existenz anderer axionähnlicher Teilchen (ALPs). In diesem Vortrag soll der Peccei Quinn Mechnismus eingeführt und der Massenbereich für Axionen motiviert werden, der das dunkle Materie Problem lösen könnte. Die Prinzipien der Experimente zur Suche nach dunkle Materie Axionen und ALPs soll erläutert werden und der Status und die Aussichten von aktuellen und geplanten Experimenten soll diskutiert werden.

T 24: Hauptvorträge II

Zeit: Dienstag 11:00–12:30 Raum: H01

Hauptvortrag T 24.1 Di 11:00 H01

Direkte Suchen nach neuer Physik – Zwischenbilanz LHC Run2 — •Andreas Hinzmann — Universität Hamburg, Institut für Experimentalphysik

Mit dem Abschluss der Datennahme des LHC Run 2 bei einer Schwerpunktsenergie von 13 TeV haben die LHC Experimente in den Jahren 2015-2018 wertvolle Datensätze mit bisher unerreichter Sensitivität auf Prozesse neuer Physik aufgezeichnet.

Die Datensätze der Jahre 15/16 erlaubten erstmals basierend auf einem kleinen Bruchteil der LHC Run 2 Daten Phänomene bei niemals zuvor erreichten Skalen zu untersuchen und stringente Ausschlussgrenzen auf Physik jenseits des Standard Modells zu setzen. Der gesamte etwa 4 mal größere Run 2 Datensatz ermöglicht jetzt neue Suchen nach wesentlich selteneren und exotischeren Prozessen in bisher unerforschtem Territorium. Zu dem erlauben neue Analyseansätze und erheblich verbesserte Präzision in der Untergrundbestimmung, erstmals Tests von wesentlich kleineren Wirkungsquerschnitten und höheren Massenskalen.

In diesem Vortrag wird eine Zwischenbilanz der direkten Suche nach neuer Physik gezogen, wobei der Fokus auf aktuellen Ergebnissen liegt, die den größeren Datensatz nutzen und neue Ansätze verfolgen.

Hauptvortrag T 24.2 Di 11:45 H01

Neutrinos from Distant Galaxies — •Christopher Wiebusch — III. Physikalisches Insitut B, RWTH Aachen

Modern astronomy is seen in a multi-messenger context. Neutrinos, charged cosmic rays, and also gravitational waves supplement photons as additional messengers. The universe is transparent to neutrinos at all energies. They maintain their directional information and trace hadronic processes. Therefore since many decades, the observation of high-energy neutrinos has been considered of outstanding importance for the exploration of the high energy universe, e.g. for the search for the sources of cosmic rays. However, the observation of high-energy cosmic neutrinos is challenging because the small flux and small interaction cross section requires huge detection volumes. In 2013, the IceCube Neutrino Observatory reported the first observation of high-energy cosmic neutrinos. Being largely isotropic in their arrival directions, an extragalactic origin is likely but their sources remain unidentified to date. With the help of multi-wavelength photon observations, in 2018 neutrinos have been associated for the first time with a source, the Blazar TXS 0506+056. The talk reviews the detection of high-energy cosmic neutrinos, exciting recent observations and future developments.

T 25: Eingeladene Vorträge I

Zeit: Dienstag 14:00–15:30 Raum: H02

Eingeladener Vortrag T 25.1 Di 14:00 H02
The Higgs Boson at CMS: from Top to Bottom — •Matthias Schröder — KIT

In the Standard Model of particle physics, the Higgs boson is deeply related to the mechanism that creates the masses of the elementary particles. Thus, a precise measurement of the Higgs boson properties offers a unique probe of this mechanism and plays a crucial role in testing the predictions of the Standard Model or revealing potential new physics.

The Higgs boson mass and its couplings to the electroweak gauge bosons have been established early after its discovery during LHC Run 1, but high sensitivity to the couplings to fermions is achieved only now with the large amount of data collected at 13 TeV centre-of-mass energy during LHC Run 2. This led to the recent observations of the Higgs boson couplings to tau leptons and top and bottom quarks, which mark crucial steps in understanding the mechanism of fermion-mass generation.

In this presentation, the latest Higgs boson measurements performed with the CMS experiment will be reviewed, with special focus on the couplings to fermions. Furthermore, prospects for future measurements at the High-Luminosity LHC will be discussed.

Eingeladener Vortrag T 25.2 Di 14:30 H02
Searches for long-lived particles as signs of new physics at the LHC — •Sascha Mehlhase — LMU Munich

Particles beyond the Standard Model (SM) can generally have lifetimes that are long compared to SM particles at the weak scale. When produced at the Large Hadron Collider (LHC), such long-lived particles (LLPs) can decay far from the primary interaction vertex and possibly themselves interact with the detector material, leading to a wide variety of detector signatures. Such LLP signatures are distinctly different from those associated with searches for promptly decaying BSM particles that constitute the bulk of searches for new physics at the LHC, often requiring dedicated analysis and reconstruction techniques. This contribution aims to motivate searches for new long-lived particles, highlight possible signatures and challenges, and summarise the current status of searches for LLPs at the LHC.

Eingeladener Vortrag T 25.3 Di 15:00 H02
New physics inside jets — •Clemens Lange — CERN, Genf, Schweiz

Jet substructure and grooming enables access to extreme regions of phase space to probe the standard model of particle physics and in the search for new physics. This presentation discusses the use and calibration of these techniques in the context of highly energetic boson decays originating from heavy resonances that are proposed by several beyond the standard model theories. Further, highlights of these resonance searches performed by the CMS collaboration are presented.

T 26: Eingeladene Vorträge II

Zeit: Dienstag 14:00–15:30 Raum: H03

Eingeladener Vortrag T 26.1 Di 14:00 H03
The SHiP Experiment - Current Status & Test Beam Results — •Annika Hollnagel — Johannes Gutenberg-Universität Mainz

SHiP has been proposed as a general-purpose fixed-target facility at the CERN SPS North Area, with the start of data taking scheduled for 2026. Consisting of a two-fold detector, it combines the Search for Hidden Particles (SHiP), such as Heavy Neutral Leptons (HNL) and light dark matter, with studies of tau neutrino physics. An additional third detector would enable research on Lepton Flavour Violation.

The impact of the high-intensity 400 GeV/c proton beam on the hybrid target may create HNL via the decay of heavy mesons and other weakly interacting particles of masses $m \lesssim 10\,\mathrm{GeV/c^2}$. After a hadron absorber and an active muon shield, these particles are expected to decay inside a large vacuum vessel which is followed by a magnetic spectrometer and a calorimeter. To discriminate against external particle interactions, the decay vessel will be covered by the Surrounding Background Tagger (SBT).

Currently in the R&D phase, several studies have already been performed at the CERN test beam facilities. These include measurements of muon flux and charm production using a replica SHiP target exposed to the SPS proton beam, as well as performance tests of prototype segments for the Liquid Scintillator SBT wrt. particles of various type and energy.

Eingeladener Vortrag T 26.2 Di 14:30 H03
Frontier silicon detectors for particle physics and industrial applications — •Hendrik Jansen — DESY, Hamburg

In this contribution, I review the challenges and recent developments in the field of silicon-based particle detectors in the light of the high luminosity LHC and possible future colliders, with special emphasis on test beam results. Additionally, I exemplify the usage of such detectors in industrial applications such as non-destructive testing and medical imaging.

Eingeladener Vortrag T 26.3 Di 15:00 H03
Physics beyond the Standard Model with IceCube — •Anna Pollmann — Bergische Universität Wuppertal

The IceCube neutrino observatory is a neutrino telescope situated near the South Pole in Antarctica. A cubic kilometer of ice is instrumented with optical modules containing photomultiplier tubes. When high energetic particles produce light in interactions with the ice, the signature can be recorded and used for reconstruction of the primary particle.

The design of IceCube not only facilitates the detection of astrophysical neutrinos up to PeV energies but also the direct and indirect probe of physics beyond the Standard Model with leading sensitivities. Exotic particles which can penetrate through the ice sheet or even the entire Earth can be measured directly, these include magnetic monopoles or partially charged particles. Dark matter is indirectly searched for by investigating its effect on neutrino spectra as well as arrival directions.

The discovery of astrophysical neutrinos enables the measurement of neutrino interactions at unprecedented energies where new physics might emerge such as Lorentz Invariance Violation. The recent achievements of IceCube in the search for beyond Standard Model physics will be presented.

T 27: Halbleiterdetektoren II

Zeit: Dienstag 16:00–18:30 Raum: H03

T 27.1 Di 16:00 H03
On the path to module integration with the HV-MAPS prototype MuPix9 — •Heiko Augustin[1], Alena Larissa Weber[1,2], and Ivan Perić[2] for the Mu3e-Collaboration — [1]Physikalisches Institut Heidelberg — [2]Karlsruher Institut für Technologie

The Mu3e experiment is dedicated to the search for the charged lepton flavour violating decay $\mu^+ \to e^+e^-e^+$ with an unprecedented sensitivity of one in 10^{16} decays. In the Standard Model this decay is suppressed to a branching ratio below 10^{-54}. Thus, any observation of a signal is a clear sign for New Physics. To reach the sensitivity goal a pixel tracker with low material budget and high rate capability is required. The technology of choice are High Voltage Monolithic Active Pixel Sensors (HV-MAPS) produced in the AMS aH18 180 nm

HV-CMOS process, which allows to build fast pixel detectors thinned to 50 μm.

In this talk the architecture and test structures of the MuPix9 prototype are presented. It houses a shunt regulator and a fully monolithic pixel sensor engineered for the use within a serial powering chain. Further it contains a synthesized slow control statemachine aiming to reduce the slow control complexity in the view of module integration.

First results on the MuPix9 performance are presented and the road map for the module integration is depicted.

T 27.2 Di 16:15 H03

The MuPix10 - the current state of design — •Alena Weber for the Mu3e-Collaboration — Physikalisches Institut Heidelberg — Karlsruher Institut für Technologie

The Mu3e experiment is searching for the charged lepton flavor 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) will be used in four tracking layers.

In the last years, several prototypes of different size have been designed and tested. In 2017, a first large prototype (MuPix8) with a size of 1 x 2 cm^2 was submitted and successfully tested. Another small prototype, the MuPix9, has been developed to test several small circuits. The next important design step is MuPix10, which has a full recticle size (about 2 x 2 cm^2). The design should fulfill all Mu3e requirements and be close to the final version to be installed in the experiment. Several design blocks undergo a redesign for a better energy and time resolution and for a more uniform voltage supply inside the chip. Furthermore, the design has to be ported to a new fabrication process (TSI 180 nm HVCMOS).

In this talk, the current state of the MuPix10 design will be presented.

T 27.3 Di 16:30 H03

Qualification of a pixel sensor prototype produced by TSI — •Christoph Blattgerste for the Mu3e-Collaboration — Physikalisches Institut, Universität Heidelberg

High Voltage Monolithic Active Pixel Sensors (HV-MAPS) are suitable for particle physics experiments because they allow for high rate capability at low material budget and costs. HV-MAPS are fully integrated, can therefore be thinned to 50 μm and thus multiple Coulomb scattering is reduced. The strong electric field in the depletion zone allows for fast charge collection via drift and a good time resolution.

The MuPix7, the first fully integrated HV-MAPS prototype, has been produced in the commercial 180 nm HV-CMOS process by the foundries AMS and TSI.

The relevant parameters of the two sensors are compared.

T 27.4 Di 16:45 H03

Measurement Results on Monolithic LFoundry HVCMOS Sensors — •Rudolf Schimassek and Ivan Perić — Karlsruher Institut für Technologie (KIT), Karlsruhe, Deutschland

HVCMOS pixel sensors are depleted active pixel sensors produced in commercial standard CMOS processes. Fast signal generation as well as radiation hardness make them an option for particle physics. Monolithic HVCMOS sensors also have a low material budget.

Typically, time resolution is limited by the power consumption of the pixel amplifiers. To overcome this limitation, signal to noise ratio has to be increased or innovative compensation means have to be implemented.

In LFoundry LF15A (150nm) HVCMOS process, two sensors were produced for process evaluation and development of features for future detectors. One evaluation feature is pixel trimming equalising the pixel characteristics enabling lower thresholds. Features for future detectors are parallel pixel to buffer (PPtB) readout for high rate environments and in-pixel sampling of the signal for improved time resolution.

In this contribution, test results of the detector chips will be presented.

T 27.5 Di 17:00 H03

Characterisation of a depleted monolithic active pixel sensor in 180 nm TowerJazz CMOS technology — Ivan Berdalovic[2], •Christian Bespin[1], Ivan Caicedo[1], 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], Piotr Rymaszewski[1], Walter Snoeys[2], Tianyang Wang[1], Norbert Wermes[1], and Jochen Dingfelder[1] — [1]Physikalisches Institut, Universität Bonn, Bonn, Deutschland — [2]CERN, Genf, Schweiz

Monolithic active silicon pixel sensors using commercial CMOS processes are currently under investigation for the upgrade of the ATLAS pixel detector at the upcoming HL-LHC. The TJ-MonoPix chip is a depleted monolithic active pixel sensor fabricated in 180 nm TowerJazz technology using a small fill factor design. The pixel pitch is 36 μm x 40 μm and the hit information is read out using a FE-I3-like column drain architecture.

Results are presented for unirradiated and irradiated sensors from measurements with radioactive sources and testbeams with 2.5 GeV electrons.

T 27.6 Di 17:15 H03

Active pixel sensor with small pixel size designed for capacitive readout with RD53 ASIC — •Hui Zhang and Ivan Peric — 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. 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 27.7 Di 17:30 H03

Design of HVCMOS pixel sensor chips for ATLAS ITk upgrade — •Mridula Prathapan — Karlsruhe Institute of Technology, Karlsruhe, Germany

The high voltage CMOS (HVCMOS) pixel sensors are designed to meet the specifications for the outer pixel layers ATLAS ITk. The HVCMOS prototypes are large fill factor designs in 180nm process on high resistivity substrates. The readout architecture is crucial for achieving high detection efficiencies for high particle hit rates such as 2 MHz/mm^2 in the outer layers of the ITk pixel tracker. The first generation (0.33 cm × 1.3 cm) HVCMOS prototype ATLASpix1_M2 featured a triggered readout scheme with parallel hit transfer from pixels to hit buffers (pptB) and Content Addressable Buffer readout (CAB). Various laboratory tests and irradiation studies have been conducted on ATLASpix1_M2 and is proven to be working. ATLASpix2 is a (3.7 mm × 4.2 mm) MPW run which is optimized for better time resolution and faster readout than its predecessor ATLASpix1_M2. Three novel design concepts namely, programmable sorted readout, hit neighbour logic and smart pixel grouping are introduced in ATLASpix2. Several design improvements are made for ATLASpix3, which is 2×2 cm^2. ATLASpix3 will be used for construction of the HVCMOS demonstrator quad module. This work presents the design evolution of ATLASpix chips in detail together with some measurement results.

T 27.8 Di 17:45 H03

Performance and outlook of a large fill-factor DMAPS in a 150nm CMOS process for the ATLAS HL-LHC upgrade — •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 under consideration for the upgrade of the outer pixel layers of the ATLAS experiment at the LHC. In this upgrade, the area of the pixel modules will be increased tenfold and the so-called HL-LHC is expected to reach a luminosity of $7.5x10^{34}cm^{-2}s^{-1}$. The high collision rate will result in NIEL and TID radiation damage levels of $10^{15}n_{eq}/cm^2$ and 80 Mrad in the outermost pixel region of the inner

tracker by the end of operation. Manufacturing DMAPS in a CMOS process reduces the costs and time for large volume production. Thanks to technology add-ons and careful design the sensor collects charge through drift, which improves its efficiency after irradiation.

This talk will summarize the performance of LF-MONOPIX01: a large fill-factor DMAPS designed in a 150nm CMOS process on a highly resistive substrate. The chip was successfully read out by a fast synchronous architecture and back-side processed after thinning down to 200μm. It showed a small noise increase and hit detection efficiency of $\sim 99\%$ after irradiation up to the dose levels expected in the HL-LHC. At the end of the presentation, the plans for future design efforts based on the encouraging results will be introduced.

T 27.9 Di 18:00 H03

Lab characterization of the ATLASPix1 — •David Maximilian Immig for the ATLAS AMS/TSI-CMOS-Pixel-Collaboration — Physikalisches Institut, Universität Heidelberg

For the operation at the High Luminosity Large Hadron Collider (HL-LHC) the ATLAS Inner Tracker (ITk) will by fully replaced. The increase of the instantaneous luminosity to 5-7 times the nominal value of LHC sets new challenges for the pixel modules regarding radiation tolerance and readout capability. For the outermost pixel layer alternatives to the hybrid detector baseline technology are considered. Their feasibility with respect to the previous mentioned requirements has to be proven. A promising prototype is the ATLASPix1, a High Voltage Monolithic Active Pixel Sensor (HV-MAPS) produced in the aH18 process by AMS. This technology combines fast charge collection via drift of an active pixel matrix with a full readout in a monolithic architecture.
This talk covers the latest results from lab measurements for the characterization of ATLASPix1.

T 27.10 Di 18:15 H03

Annealing and Characterization of Irradiated Low Gain Avalanche Detectors — •Moritz Wiehe[1,2], Marcos Fernández García[1,3], Michael Moll[1], Sofia Otero Ugobono[1,4], Ulrich Parzefall[2], and Ana Ventura Barroso[5] — [1]CERN — [2]Albert-Ludwigs Universität Freiburg — [3]Universidad de Cantabria — [4]Universidad de Santiago de Compostela — [5]Universitat de Barcelona

Irradiated Low Gain Avalanche Detectors (LGADs) are investigated using the Transient Current Technique (TCT) and IV/CV measurements. The sensors are irradiated to a fluence of 1e14 neq/cm2. For different annealing times (at 60°C), the collected charge, the gain and the electric field profile is measured.

T 28: Higgs-Zerfälle in Fermionen I

Zeit: Dienstag 16:00–18:35 Raum: H04

Gruppenbericht T 28.1 Di 16:00 H04

Higgs physics in the $\tau\tau$ final state — Janek Bechtel, Sebastian Brommer, Maximilian Burkart, Artur Gottmann, Guenter Quast, Roger Wolf, •Sebastian Wozniewski, and Stefan Wunsch — Karlsruhe Institute of Technology, Karlsruhe, Germany

The $\tau\tau$ final state allows for highly relevant investigations the Higgs sector in the context of the standard model (SM) and models beyond the SM, like the MSSM. This talk summarizes recent milestones on the way to an LHC Run II legacy result in Higgs to $\tau\tau$ analyses of CMS, both in the SM and MSSM context. The focus is on the ongoing SM analysis based on a machine-learning approach, published developments of the τ-embedding technique and the ongoing efforts in searches for additional heavy Higgs bosons in the MSSM and general 2HDMs.

T 28.2 Di 16:20 H04

Search for pair production of Higgs bosons decaying to $b\bar{b}\tau^+\tau^-$ with the ATLAS detector — •Christopher Deutsch, Alessandra Betti, Tatjana Lenz, Norbert Wermes, and Jochen Dingfelder — 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 $\sim 140\,\mathrm{fb}^{-1}$ 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 28.3 Di 16:35 H04

Observation of $H \to b\bar{b}$ decay with the CMS experiment — •Luca Mastrolorenzo and Alexander Schmidt — RWTH Aachen University - III. Physikalisches Institut A

The first observation of the Higgs boson decay into a bottom and anti-bottom quarks by the ATLAS and CMS Collaboration in summer 2018 represents a discovery of major importance towards the characterization of the Yukawa couplings. Even though this decay channel is the one with the highest predicted branching fraction, the detection of such events is extremely challenging at a hadron collider environment because the overwhelming production of hadronic jets from QCD events. In order to maximise the sensitivity to the $H \to b\bar{b}$ signal, sophisticated analysis techniques have been deployed relying on the exploitation of Deep Neural Networks along the whole analysis chain. In this talk, the CMS observation of the $H \to b\bar{b}$ decay will be presented focussing on the analysis of the data collected by the experiment during the 2017 Run of the LHC and targeting the identification of events where a Higgs boson is produced in association with a vector boson.

T 28.4 Di 16:50 H04

Search for Higgs-boson pair production in the $bb\tau_{\mathrm{lep}}\tau_{\mathrm{lep}}$ decay channel with the ATLAS detector — •Benjamin Rottler, Kathrin Becker, 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 using the full Run-2 dataset corresponding to an integrated luminosity of $\sim 140\,\mathrm{fb}^{-1}$ at $\sqrt{s} = 13\,\mathrm{TeV}$. This is done via the $HH \to bb\tau\tau$ process, which combines the high branching ratio of the $H \to bb$ decay and the good trigger efficiency of the $H \to \tau\tau$ decay. Our focus is the study of the $HH \to bb(\tau\tau \to 2\ell 4\nu)$ decay channel, which has not been investigated so far. We expect this decay channel to give a sizeable contribution to the sensitivity of the measurement due to the highly efficient lepton triggers and the different topologies of the signal and background processes. Our plan is to incorporate modern machine learning technologies like deep neural networks (DNNs) in the analysis.

T 28.5 Di 17:05 H04

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

A search for the Standard Model Higgs boson decaying to a pair of muons is presented. The focus of this analysis is on Higgs production in association with W and Z bosons. The full Run 2 data collected at the CMS experiment from 2016-2018 at a center of mass energy of

$\sqrt{s} = 13\,\text{TeV}$ are used. Events with at least two oppositely charged muons as well as at least one additional lepton, supposedly originating from the gauge boson, are selected. This selection reduces the dominant Drell Yan background events as they do not contain a prompt third lepton. Because of the low signal yields in these Higgs decay channels, it is important to achieve a high signal efficiency while suppressing background contributions. Studies to this end are presented, including final state radiation photon recovery and multivariate prompt lepton identification.

T 28.6 Di 17:20 H04

Constraints on the Higgs self-coupling from searches for Higgs boson pairs in the $b\bar{b}\tau^+\tau^-$ final state with the ATLAS detector and prospects at the High-Luminosity LHC — •Petar Bokan[1,2], Stan Lai[1], Arnaud Ferrari[2], and Jason Veatch[1] — [1]University of Göttingen — [2]Uppsala University

After the discovery of the Higgs boson, the ultimate test of the electroweak symmetry breaking is to establish Higgs self-coupling by searching for pairs of Higgs bosons.

A search for non-resonant Higgs boson pair production in the $b\bar{b}\tau^+\tau^-$ channel is presented for 36.1 fb^{-1} of $\sqrt{s} = 13$ TeV data recorded at the ATLAS experiment at the Large Hadron Collider (LHC). The analysis considers the semi-leptonic and fully hadronic di-τ final states. The observed (expected) upper limit on the non-resonant Higgs boson pair production cross-section times branching ratio corresponds to 12.7 (14.8) times the predicted Standard Model cross-section. The ratio of the Higgs boson self-coupling to its Standard Model expectation, κ_λ, is observed (expected) to be constrained at 95% confidence level to $-7.3 < \kappa_\lambda < 15.7$ ($-8.8 < \kappa_\lambda < 16.7$).

Furthermore the sensitivity is extrapolated to a 14 TeV center-of-mass energy and 3000 fb^{-1}, which is the target integrated luminosity of the High-Luminosity LHC. Various extrapolation assumptions are presented in this talk.

T 28.7 Di 17:35 H04

Search for lepton-flavour violating decays of the Higgs-boson using the asymmetry method with the ATLAS experiment at $\sqrt{s} = 13$ TeV — •Katharina Schleicher, Kathrin Becker, and Markus Schumacher — Albert-Ludwigs-Universität Freiburg

After the discovery of the Higgs boson the search for lepton-flavour violating (LFV) couplings is an interesting topic. These are predicted in several models, including supersymmetric extensions of the standard model (SM) and in general two-higgs-dublet models. In nature, LFV was already observed in form of neutrino oscillations.

Possible LFV decays in the Higgs-sector are $H \to e\mu$, $H \to \tau e$ and $H \to \tau\mu$. In this analysis only the decays of $H \to \tau e$ and $H \to \tau\mu$ with leptonic τ-decays leading to $e\mu + X$ final states are considered. For background estimation the asymmetry method is utilized. It exploits two principles: First, SM backgrounds with prompt leptons are symmetric with respect to a replacement of electrons with muons and vice versa. And second, this symmetry is broken when assuming that the branching ratios of the two considered LFV decays are of different magnitude.

One challenge of the analysis is to maintain this symmetry despite the experimental differences of electrons and muons. Another challenge is to enhance the sensitivity. Therefore, a dedicated statistical model and a multivariate analysis are developed.

The analysis is performed on data recorded in proton-proton collisions with the ATLAS detector at $\sqrt{s} = 13$ TeV.

T 28.8 Di 17:50 H04

Constraining Higgs CP properties using $H \to \tau\tau$ decays — •Alina Manthei, Peter Wagner, Maike Hansen, Christian Grefe, Philip Bechtle, and Klaus Desch — Physikalisches Institut Universität Bonn

In 2012, the discovery of a resonance featuring properties consistent with those of the Higgs boson affirmed the theory of the Higgs mechanism, an essential component of the Standard Model of Particle Physics. The latter predicts the Higgs boson to be CP even. Although measurements revealed that the Higgs cannot be fully CP odd, the existence of a CP-mixed Higgs cannot be ruled out, which can be considered as an indication of physics beyond the Standard Model. Only in the case of the coupling to fermions, it is possible to define a model-independent observable that allows to distinguish between the different CP scenarios. Due to the large QCD background in the channel $H \to b\bar{b}$, this analysis makes use of the decay to τ leptons, the next to heaviest fermionic decay products of the Higgs boson. Due to the short lifetime of the τ, it immediately decays further so that only its decay products can be detected. By examining the decay of the τ lepton to only one charged prong, an angle between the two decay planes of the τs can be defined, an observable that serves to determine the CP phase in the coupling of the Higgs to the two τs. Via the measurement of this angle, the transverse spin correlations can be studied and a mixing angle between the CP even and CP odd states can be extracted. The state of the measurement descibed above will be presented and an outlook towards further steps will be given.

T 28.9 Di 18:05 H04

Test of CP invariance in vector-boson fusion production of the Higgs boson using $H \to \tau_{lep}\tau_{lep}$ decays at $\sqrt{s} = 13\,\text{TeV}$ with the ATLAS detector — Kathrin Becker, •Alena Lösle, and Markus Schumacher — Physikalisches Institut, Universität Freiburg

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 and to test CP invariance in this interaction.
The analysis discussed in this talk is performed in the $H \to \tau_{lep}\tau_{lep}$ decay channel and uses the CP-odd *Optimal Observable*. First combined results with the semi-leptonic and fully-hadronic finally state based on data taken by the ATLAS detector at $\sqrt{s} = 13\,\text{TeV}$ corresponding to an integrated luminosity of 36.1 fb^{-1} are presented.

T 28.10 Di 18:20 H04

Measurement of $H \to \tau_{\text{had}}\tau_{\text{had}}$ at $\sqrt{s} = 13\,\text{TeV}$ with the ATLAS Experiment — •Timo Dreyer, Stan Lai, and Michel Janus — Georg-August-Universität Göttingen

The $H \to \tau\tau$ process is currently the only observed leptonic decay channel of the Higgs boson at the LHC. The ATLAS experiment performed a cut based analysis in this decay channel on 36.1 fb^{-1} of data collected in 2015 and 2016 at $\sqrt{s} = 13\,\text{TeV}$, measuring the cross section times branching ratio for $pp \to H \to \tau\tau$.

The process is divided in sub-channels according to the decay of the τ-leptons into lighter leptons or hadrons. The Higgs production cross sections for the gluon gluon fusion and vector boson fusion production modes are extracted from a maximum likelihood fit to data on the distribution of the reconstructed mass $m_{\tau\tau}$ from the two τ-leptons.

This talk will discuss the recently published ATLAS results with a focus on the di-hadronic sub-channel and give an outlook for the analysis on the full 13 TeV dataset

T 29: Deep Learning II

Zeit: Dienstag 16:00–18:30 Raum: H06

T 29.1 Di 16:00 H06

Reconstruction of Muons with Recurrent Neural Networks for the IceCube Experiment — •Gerrit Wrede, Gisela Anton, and Thorsten Glüsenkamp for the IceCube-Collaboration — Erlangen Centre for Astroparticle Physics, Erlangen, Germany

The IceCube neutrino observatory is searching for point sources in the astrophysical neutrino flux. Relativistic muons created by muon neutrinos offer a good angular resolution and are thus an ideal channel for the detection of point sources. Recurrent neural networks are a class of artificial neural networks designed to handle time series data, such as the signatures created by muons traveling through the IceCube detector. In this talk, I will present an approach to use recurrent neural networks for muon reconstruction in IceCube.

T 29.2 Di 16:15 H06

Antiproton to proton ratio determination using deep neural networks with AMS-02 — •Sichen Li — I. Physikalisches Institut B, RWTH Aachen, Germany

AMS-02 is a high precision detector for charged cosmic rays installed on the International Space Station. A discrepancy occurs between the current observation for antiproton to proton ratio and the prediction from collisions of ordinary cosmic rays, which could be explained by dark matter annihilation or other astrophysical phenomena. To test models precisely, an antiproton to proton ratio in a larger energy range is required.

Charge confusion occurs when a proton is mis-reconstructed as an antiproton. The reasons for this are interactions with AMS materials and detector resolution. To extend the energy range of the measurement, a rejection power against charge-confused protons in excess of 1 in 1 million is needed, due to the tiny fraction of antiprotons in cosmic rays.

We build a deep neural network to improve the separation for charge confusion from interactions. With this approach, we have a good potential to extend energy range for antiproton to proton ratio.

T 29.3 Di 16:30 H06

Particle Identification using Deep Learning at AMS — •Robin Sonnabend — RWTH Aachen, Aachen, Germany

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

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

T 29.4 Di 16:45 H06

Particle Discrimination via Deep Learning with JUNO — •Thilo Birkenfeld, Achim Stahl, and Christopher Wiebusch — III. Physikalisches Institut B, RWTH Aachen University

The JUNO detector is going to be a 20kt liquid scintillator neutrino observatory, currently under construction near Kaiping, China, with a baseline of about 50km to two nuclear reactor plants. With its excellent energy resolution and large fiducial volume, it will be able to determine the neutrino mass hierarchy from their energy spectrum. The neutrinos are detected by measuring the signature of the inverse beta decay (IBD), which consists of a prompt positron- and a delayed neutron capture signal. Although this coincidence is well recognizable, there are still some background events left. Most of these backgrounds have of an electron component instead of a positron. Electron and positron signals are very similar in a liquid scintillator. The only difference is the missing annihilation for electrons. New developments in deep learning techniques give the possibility to distinguish the different event shapes. This talk focuses on a method to discriminate positrons and electrons via a neural network.

T 29.5 Di 17:00 H06

Search for Ultra High Energy Photons with the Pierre Auger Observatory using Deep Learning Techniques — •Tobias Pan, Thomas Bretz, Paulo Ferreira, Adrianna García, Thomas Hebbeker, Julian Kemp, and Christine Peters — III. Physikalisches Institut A, RWTH Aachen University

The Pierre Auger Observatory in Argentina measures extensive air showers induced by ultra high energy cosmic rays using a surface array of 1660 water Cherenkov detectors and 27 fluorescence telescopes. Besides the detailed measurement of the hadronic cosmic ray flux at the highest energies above 1 EeV, the Pierre Auger Observatory is also able to search for a flux of ultra high energy photons.

Until now, no ultra high energy photons have been discovered. Due to the high flux of hadronic cosmic rays, a good separation between photon and hadron induced air showers is crucial. A method has been developed to separate photon induced extensive air shower events from the hadronic events detected by the Pierre Auger Observatory. Deep learning methods are applied for this purpose. Trained on simulated air showers, the deep neural network will then be able to separate events in measured data.

T 29.6 Di 17:15 H06

Signal-background discrimination with Deep Learning in the EXO-200 experiment — •Tobias Ziegler[1], Mike Jewell[2], Johannes Link[1], Federico Bontempo[1], Gisela Anton[1], and Thilo Michel[1] — [1]Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP — [2]Stanford University, California, USA

The EXO-200 experiment searches for the neutrinoless double beta ($0\nu\beta\beta$) decay in ^{136}Xe with an ultra-low background single-phase time projection chamber (TPC) filled with 175 kg isotopically enriched liquid xenon (LXe). The detector has demonstrated good energy resolution and background rejection capabilities by simultaneously collecting scintillation light and ionization charge from the LXe and by a multi-parameter analysis. Advances in computational performance in recent years have made novel Deep Learning techniques applicable to the physics community. This contribution presents the concept of the detector and summarizes the work on applying Deep Learning methods for signal-background discrimination in the EXO-200 experiment.

T 29.7 Di 17:30 H06

Event Reconstruction with Machine Learning methods in JUNO — •Yu Xu[1,2], Yaping Cheng[1,2], Christoph Genster[1,2], Alexandre Göttel[1,2], Livia Ludhova[1,2], Philipp Kampmann[1,2], Michaela Schever[1,2], Achim Stahl[1,2], and Christopher Wiebusch[1] — [1]IKP-2, Forschungszentrum Jülich — [2]III Physikalisches Institut, RWTH Aachen University

Jiangmen Underground Neutrino Observatory (JUNO) experiment aims to determine the unknown neutrino mass ordering at a 3-4 sigma significance with 6 year*s data, which requires 3

T 29.8 Di 17:45 H06

Application of Deep Neural Networks to Event Type Classification in IceCube — •Maximilian Kronmüller and Theo Glauch for the IceCube-Collaboration — Technical University of Munich

The IceCube Neutrino Telescope is able to measure an all-flavor neutrino flux in an energy range between 100 GeV and several PeV. Due to the different features of the neutrino interactions and the geometry of the detector all high-level analyses require a selection of suitable events as a first step. However, up to today, no algorithm exists that gives a generic prediction of an event's topology. One possible solution to this is the usage of deep neural networks, i.e. classification networks similar to the ones used in image recognition. The classifier that we present here is based on a modern InceptionResNet architecture and includes multi-task learning in order to broaden the field of application and increase the overall accuracy of the result. Despite a detailed discussion of the network's architecture we will also examine the performance and speed of the classifier for various tasks and possible applications in IceCube.

T 29.9 Di 18:00 H06

Deep Learning based Air Shower Reconstruction at the Pierre Auger Observatory — •Jonas Glombitza, Martin Erdmann, Maximilian Vieweg, and Michael Dohmen — III. Physikalisches Institut A, RWTH Aachen

The surface detector of the Pierre Auger Observatory measures the footprint of ultra-high energy cosmic ray induced air showers on ground level. Furthermore, fluorescence telescopes allow hybrid detection of air showers and hence, for an independent crosscheck. Reconstructing observables sensitive to the cosmic ray mass, is a challenging task and mainly based on the fluorescence detector which, however, has a small duty cycle. Recently, great progress has been made in multiple fields of machine learning by using deep neural networks and associated techniques. Applying these new techniques on air shower physics provides a new and independent reconstruction.

In this talk, we present AixNet, a deep convolutional neural network for the reconstruction of ultra-high energy cosmic rays properties [1]. First, we assess the performance on CORSIKA based air showers, discuss the performance limit and compare the performance achieved on data by cross-calibrating with the fluorescence detector. Furthermore, we visualize the multidimensional differences between data and simulation using deep neural networks to understand differences in the reconstruction and prepare the simulation for refinement studies [2].

[1] DOI: 10.1016/j.astropartphys.2017.10.006
[2] DOI: 10.1007/s41781-018-0008-x

T 29.10 Di 18:15 H06

Image Recognition with Deep Neural Networks for IceAct

Air-Cherenkov Telescopes — •Matthias Thiesmeyer, Jan Auffenberg, Pascal Backes, Thomas Bretz, Erik Ganster, Maurice Günder, Merlin Schaufel, Jöran Stettner, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen

Deep Neural Networks (DNNs) have brought new possibilities to image analysis. We use these for particle identification in IceAct, which is an array of SiPM-based Imaging Air Cherenkov Telescopes, planned as a surface component of IceCube. One Goal of IceAct is improving composition and gamma ray measurements of the IceCube Neutrino Observatory by the hybrid measurement of air showers. Within the hybrid measurement by the surface detector IceTop, the in-ice detector IceCube, and IceAct, IceTop provides the direction and energy of the shower, IceCube a measurement of the high-energy muon component, and IceAct images the shower development in the atmosphere. We present first results from DNNs trained on simulations of air showers with CORSIKA to separate gamma rays from protons in the energy range from 10-100 TeV.

T 30: Suche nach Neuen Teilchen II

Zeit: Dienstag 16:00–18:30 Raum: H07

T 30.1 Di 16:00 H07

Model Unspecific Search in CMS (MUSiC) - Introduction — •Arnd Meyer, Saranya Ghosh, Thomas Hebbeker, and Tobias Pook — III. Physikalisches Institut A, RWTH Aachen

The "Model unspecific search in CMS" (MUSiC) is a long-term project aiming to discover significant deviations from the standard model (SM) expectation in LHC data. Hundreds of final states are evaluated in 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 30.2 Di 16:15 H07

Model Unspecific Search in CMS (MUSiC) - Results with 2016 Data — Arnd Meyer, Saranya Ghosh, Thomas Hebbeker, and •Tobias Pook — III. Physikalisches Institut A, RWTH Aachen

The CMS Detector recorded a dataset of about $36 fb^{-1}$ during 2016 at a center of mass energy of 13 TeV. This dataset presents a unique opportunity to find new 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 results from an automated search for deviations in significant parts of the complete 2016 dataset.

The observed distribution of deviations is compared to a standard model only expectation estimated from pseudo experiments. The overall agreement between current CMS data and simulations is evaluated and most significant deviations are discussed.

T 30.3 Di 16:30 H07

Search for high-mass resonances decaying to $\tau\nu$ in pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector. — •Christos Vergis and Jochen Christian Dingfelder — 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 of the $W' \to \tau\nu$ decays. Although searches for W' decays to electrons or muons and their neutrinos are more sensitive than $W' \to \tau\nu$ for models with universal couplings to leptons, decays to tau lepton are well suited for models in which the W' couples preferentially to the third-gerneration 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 2015-2017 pp collisions at $\sqrt{s} = 13$ TeV by the ATLAS detector at the LHC. Recent updates to the signal modelling, background estimation and analysis strategy will be discussed. Preliminary expected exclusion limits to the W' masses in the Sequential Standard Model (as benchmark model) will be shown. Due to the increase in luminosity, as well as the upgrades in the tau reconstruction algorithms and analysis strategy, the reach of the search is significantly improved compared to the first ATLAS results.

T 30.4 Di 16:45 H07

Search for new physics in the τ+MET final state with CMS. — •Christoph Schuler, Kerstin Hoepfner, Swagata Mukherjee, and Thomas Hebbeker — 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 2016 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'. In addition, results of a high-luminosity LHC upgrade study in this channel are presented.

T 30.5 Di 17:00 H07

Recent results on the search for heavy neutral resonances decaying into di-tau final states at the ATLAS detector — •Max Maerker, Dirk Duschinger, Wolfgang Mader, and Arno Straessner — IKTP, TU-Dresden

Searches for new heavy resonances decaying to tau-lepton pairs are both theoretically and experimentally well motivated. Extensions of the Standard Model often include additional particles, such as the Minimal Supersymmetric Standard Model (MSSM) introducing new heavy neutral Higgs bosons A and H. Since the couplings of the heavy neutral Higgs bosons to up-type fermions are strongly enhanced at large values of $\tan(\beta)$, their decay into tau lepton pairs is particularly interesting to search for these particles.

In this talk a analysis of the full Run 2 dataset taken with the ATLAS detector in the search for heavy, neutral Higgs bosons in the fully hadronic di-tau final state is presented. Further improvements are investigated by optimizing the event selection and by splitting the signal region into multiple subregions based on the identification quality and the charge multiplicity of the decay products of the subleading tau candidate. Preliminary results of these studies will be shown.

T 30.6 Di 17:15 H07

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 30.7 Di 17:30 H07

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

We present a search for singly produced excited bottom quarks (b*) in pp-collisions at $\sqrt{s} = 13$ TeV recorded with the CMS experiment.

The search is performed in the tW decay channel with a lepton and hadronic jets in the final state, where the top quark is assumed to decay hadronically, while the W boson decays into a lepton and a neutrino.

The reconstruction and identification of the top quark is performed using the Heavy Object Tagger with Variable R (HOTVR). The stable performance of this algorithm 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 30.8 Di 17:45 H07

Eine Suche nach exotischen Resonanzen im Zwei-Boson-Zerfallskanal mit vollhadronischem Endzustand mit dem CMS-Experiment — Matthias Mozer, 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 30.9 Di 18:00 H07

Search for heavy resonances decaying into $t\bar{t}$ in the fully hadronic final state with the ATLAS full Run-2 dataset — Katharina Behr, •Yu-Heng Chen, and Klaus Mönig — Deutsches Elektronen-Synchrotron, Hamburg and Zeuthen, Germany

Heavy resonances decaying into a top-antitop quark pair ($t\bar{t}$), such as a heavy gauge boson Z', are predicted by many extensions of the Standard Model.

We analyse the full dataset recorded by the ATLAS experiment during the second run of the LHC to search for resonances at the high-mass frontier that decay to $t\bar{t}$. In this kinematic region, the decay products of each top quark are highly collinear and form a single hadronic jet with a characteristic substructure.

Top-tagging using machine learning techniques as well as b-tagging in a very busy environment are studied and further optimised to better suppress the challenging multijets background while retaining reasonably good signal efficiency. In addition, for the first time in this final state, the background spectrum is estimated using data-driven techniques by a functional form fit to data in order to reduce the impact of limited Monte Carlo (MC) statistics in the high $t\bar{t}$ mass region. Several ways for signal interpolation are also introduced to obtain a finer signal grid to reduce the need for computing-time intensive Monte Carlo simulations.

T 30.10 Di 18:15 H07

Search for heavy resonances decaying to top quark pairs with the CMS experiment — Johannes Haller, Anastasia Karavdina, Roman Kogler, and •Arne Christoph Reimers — Institut für Experimentalphysik, Universität Hamburg

We present a search for new heavy resonances decaying to pairs of top quarks ($\mathrm{t\bar{t}}$) in data of pp-collisions at $\sqrt{s} = 13\,\mathrm{TeV}$ recorded by the CMS experiment in 2017.

The search is carried out in the final state with exactly one muon and jets. Highly boosted top quarks decaying to the all-jets final state are identified using a top-tagging technique, maximizing the expected sensitivity to large resonance masses.

The invariant mass of the $\mathrm{t\bar{t}}$ system is reconstructed from the muon, missing transverse momentum, and jets, where the hadronically decaying top quark is identified either by a top-tagged large-radius jet or a combination of jets with smaller radius. Its distribution is used to set expected exclusion limits on the production cross section of new heavy resonances decaying to top quarks in different benchmark models. The expected limits are compared to the public result obtained with the 2016 dataset. Different approaches to improve the overall sensitivity of the analysis are discussed.

T 31: Direkte Suche nach Dunkler Materie II

Zeit: Dienstag 16:00–18:15 Raum: H09

T 31.1 Di 16:00 H09

The XENONnT Time Projection Chamber — •Francesco Toschi for the XENON-Collaboration — Albert-Ludwigs-Universität Freiburg

The XENONnT experiment is the next phase of the XENON project and aims at the direct detection of dark matter via WIMP-nucleus scattering. The core of the instrument is the double-phase Time Projection Chamber (TPC) filled with 5.9 t of liquid xenon, allowing position reconstruction and interaction-type discrimination. The talk focuses on the challenges to design a multi-ton double-phase TPC and how they are overcome thanks to the experience coming from the previous phases of the project, dedicated finite elements analyses and extensive mechanical tests in various laboratories.

T 31.2 Di 16:15 H09

Electric field simulations for XENONnT — •Nikolina Sarcevic — Physikalisches Institut, Albert-Ludwigs-Universität Freiburg

The XENONnT is the next generation WIMP (Weakly-Interacting Massive Particle) dark matter detector with a 5.9 t liquid xenon (LXe) target. The electric field inside its TPC has to meet certain requirements as important parameters depend on the quality of the field: energy and position resolution, signal reconstruction, particle identification. Electric field simulations provide crucial input for the TPC design. In this talk, I will present the outcome of field simulations which led to the final design of XENONnT TPC field cage. Focus will be on the field shaping elements and how their geometrical and electrostatic characteristics shape the overall field, as well as on the influence of other TPC components.

T 31.3 Di 16:30 H09

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 31.4 Di 16:45 H09

Background modelling for ^{124}Xe double electron capture search with XENON1T — •Christian Wittweg for the XENON-Collaboration — Institut für Kernphysik, WWU Münster

XENON1T located at Laboratori Nazionali del Gran Sasso is the most sensitive WIMP dark matter detector to date. It uses a dual phase time projection chamber with a sensitive liquid xenon volume of ~ 2 tons for detection. The low background and large target mass also make it suitable for investigating other rare phenomena such as double beta decays and alternative dark matter candidates. Analyses in these physics

channels require a detailed understanding of the electronic recoil background spectrum at higher energies than for the standard WIMP search. This talk will outline relevant background components, neutron activation studies, as well as the background modelling up to the 100 keV range. In addition, the application in a search for ^{124}Xe two-neutrino double electron capture with XENON1T will be presented. This work is supported by DFG through GRK 2149: Strong and Weak Interactions – from Hadrons to Dark Matter.

T 31.5 Di 17:00 H09

The Münster Dual Phase Time Projection Chamber — •Henning Schulze Eissing — Institut für Kernphysik, WWU Münster

The XENON Dark Matter Project utilizes a dual phase time projection chamber (TPC) to directly search for Weakly Interacting Massive Particles (WIMPs).

A smaller TPC was built in Münster to perform different investigations which include studies on electron lifetime, a measure of the xenon purity, as well as studies on different calibration sources. Additionally, the detector was conceived for teaching purposes.

The Münster TPC uses a cylindrical detector filled with up to 2.6 kg liquid and gaseous xenon as active volume monitored by 14 photomultipliers. The raw data are processed by PAX, the processor for analyzing XENON, which was developed for the XENON1T experiment and adapted for the use with the Münster TPC.

The working principle of the detector will be outlined and different measurements will be shown.

The TPC was built from funds by DFG Großgeräte.

T 31.6 Di 17:15 H09

Construction of a Radon Emanation Chamber — •Daniel Baur — Hermann-Herder-Straße 3

Liquid xenon-based experiments are currently leading the search for WIMP dark matter. Their dominant electronic recoil background in the energy region of interest are naked beta decays of ^{214}Pb, a daughter from ^{222}Rn. Consequently, the precise monitoring of the surface emanation of ^{222}Rn is required for the successful development of next-generation dark matter experiments with a multi-ton xenon target such as DARWIN. The emanation can be measured in 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. The status of the construction of such a detector in Freiburg is presented as well as first measurement results.

T 31.7 Di 17:30 H09

Monte Carlo Simulations for DARWIN R&D — •Alexander Bismark — Physikalisches Institut, University of Freiburg, Hermann-Herder-Str. 3, D-79104 Freiburg

The DARWIN project plans to use a 40t liquid xenon (LXe) time projection chamber to fully probe the experimentally accessible parameter space for the direct detection of WIMP dark matter. This space will be eventually limited by coherent neutrino interactions with atomic nuclei. New LXe detector technologies with a potential application in DARWIN are developed using the R&D platform XEBRA (XEnon Based Research Apparatus) at the University of Freiburg. We will introduce the fully functional baseline detector consisting of a small dual phase TPC following the well-established detection scheme of the XENON experiments which will provide a benchmark for comparison with the novel technological approaches and will be used for measurements of LXe parameters as well. We will focus on the current status of the Geant4 Monte Carlo simulation of the setup and will show first results.

T 31.8 Di 17:45 H09

Proportional Scintillation in liquid xenon — •Patrick Meinhardt — Physikalisches Institut, Hermann-Herder-Straße 3, 79104, Freiburg

Time Projection Chambers (TPCs) filled with liquid xenon are currently leading direct search for WIMP dark matter. The experiments detect a scintillation signal (S1) produced instantaneously by the interacting particle and a time-delayed charge signal (S2). In the commonly used dual-phase TPC, the charge signal is amplified by extracting the ionization electrons into the gas phase above the liquid target where they create a secondary scintillation signal which is proportional to the charge. Scaling this concept to the scale of the ultimate dark matter detector DARWIN leads to challenges regarding mechanics and operation which could be overcome by a paradigm shift towards a single-phase TPC. Here, the proportional scintillation signal S2 is produced in the liquid phase, in the strong electric field around very thin wires. Changing the amplification mechanism also provides the opportunity to reduce detector artefacts observed in dual-phase TPCs and could potentially improve the ER/NR discrimination power. We report on our studies to generate S2 signals in liquid xenon using the XEBRA test platform in Freiburg.

T 31.9 Di 18:00 H09

Surface cleaning for background reduction and its influence on liquid xenon TPC performance — •Natascha Rupp, Dominick Cichon, Guillaume Eurin, Florian Joerg, and Teresa Marrodan Undagoitia — Max-Planck-Institut fuer Kernphysik, Heidelberg

One main challenge in the direct detection of dark matter particles with liquid xenon TPCs (Time Projection Chambers) is the background reduction to a minimal rate. The plate-out of Rn222 daughters on the surfaces in contact with the liquid xenon can cause background events. We investigated different cleaning procedures that mitigate this background source. In order to apply them in future TPCs like DARWIN it has to be verified that they don't affect the xenon purity which strongly influences the signal production and hence the discrimination power of signal and background. This talk presents different cleaning procedures for PTFE and shows first results of the xenon purity evolution after applying them in a TPC.

T 32: Neutrinophysik II

Zeit: Dienstag 16:00–18:35 Raum: S06

Gruppenbericht T 32.1 Di 16:00 S06

Status and Physics of the SNO+ Experiment — •Mikko Meyer for the SNOplus-Collaboration — TU Dresden, Institut für Kern- und Teilchenphysik, Dresden, Deutschland

SNO+ is a large liquid scintillator based experiment located in the SNOLAB underground laboratory in Sudbury, Canada. The SNO+ experiment reuses the 12 m diameter acrylic vessel as well as the PMT array of the SNO detector. The main physics goal of SNO+ is the search for the neutrinoless double-beta decay with 130Te. During the initial double-beta phase, the liquid scintillator will be loaded with 0.5% natural tellurium, corresponding to 1330 kg of 130Te. SNO+ sensitivity to the effective Majorana neutrino mass will begin to explore the parameter space in the inverted hierarchy region. Higher Te loading are being developed and a SNO+ Phase II would extend sensitivity to the entire inverted hierarchy region. Designed as a general purpose neutrino experiment, the low background levels and the low thresholds will allow to additionally measure the reactor neutrino oscillations, geo-neutrinos in a geologically-interesting location, watch for supernova neutrinos, and measure the low energy solar neutrinos, like low energy 8B and possibly pep and CNO. This talk will focus on the current status of the SNO+ experiment and recent results.

Gruppenbericht T 32.2 Di 16:20 S06

The COBRA Double Beta Decay Experiment — •Robert Temminghoff for the COBRA-Collaboration — TU Dortmund, Lehrstuhl für Experimentelle Physik IV, Otto-Hahn-Straße 4, 44227 Dortmund

The aim of the COBRA collaboration is to search for neutrinoless double beta-decay ($0\nu\beta\beta$-decay) with CdZnTe semiconductor detectors. This long-sought lepton number violating process is predicted by many Beyond-Standard-Model theories. Advantages of CdZnTe detectors are their commercial availability and ability to work at room-temperature, allowing for easy instrumentation and operation.

COBRA is currently operating two different sets of detectors in a low-background setup at the LNGS in Italy, placed in two distinct arrays, but sharing the same shielding and infrastructure. The *demon-*

strator array consists of 64 1 cm^3 detectors and has now been in operation for several years. It has been used not only to search for various $0\nu\beta\beta$-decays, but also to perform an analysis of the spectral shape of the fourfold-forbidden β^--decay of ^{113}Cd in a low-threshold run.

In 2018, nine additional detectors with a size of 6 cm^3 were installed forming the *extended demonstrator (XDEM)*. Besides being much larger, thus having a higher detection efficiency, these detectors were designed with a novel electrode structure, which helps to suppress the dominating surface related backgrounds found in the *demonstrator*.

In this talk, the current status of the experiment will be presented, including recent results from the spectral shape-investigation and first operational experiences of the *XDEM*.

Gruppenbericht T 32.3 Di 16:40 S06

Exploring CEνNS with nuCLEUS at the Chooz Nuclear Power Plant — •Victoria Wagner for the NU-CLEUS-Collaboration — IRFU, CEA, Université Paris Saclay, F-91191 Gif-sur-Yvette, France

Coherent elastic neutrino-nucleus scattering (CEνNS) offers a unique way to study neutrino properties and to search for new physics beyond the Standard Model. The nuCLEUS experiment offers a new approach to explore this process at unprecedented low energies.
nuCLEUS will be located at the Very-Near-Site (VNS), a new experimental hall at the Chooz nuclear power plant in France. The novel gram-scale fiducial-volume cryogenic detectors feature an ultra-low energy threshold of ≤ 20 eV in nuclear recoil, and a fast rise time of about 100 μs which allows the operation above ground. The fiducialization of the detector provides an effective discrimination of γ-, neutron and surface backgrounds. Furthermore, the use of multiple target nuclei allows to extract the CEνNS signature against possibly challenging backgrounds.

Gruppenbericht T 32.4 Di 17:00 S06

Search for neutrinoless double beta decay with GERDA: status and results — •Anna Julia Zsigmond for the GERDA-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, as well as constrain the neutrino mass hierarchy and scale. In 2018, the Gerda experiment reached an important milestone in the search for $0\nu\beta\beta$ decay with ^{76}Ge by achieving a half-life sensitivity of 10^{26} years. This is made possible by the background-free conditions in Gerda and by a factor of two increase in exposure since the data release in 2017. The details of the background reduction techniques and the latest results will be presented. In 2018, the Gerda setup has been upgraded with germanium detectors of a new design and improved instrumentation of the liquid argon to veto background events. The first results on the performance of the upgraded experimental setup will be also discussed.

T 32.5 Di 17:20 S06

Investigation of EC/β^+-decays with the COBRA experiment — •Juliane Volkmer for the COBRA-Collaboration — TU Dresden, Institut für Kern- und Teilchenphysik, Germany

Besides the very commonly investigated $\beta^-\beta^-$-decay also $\beta^+\beta^+$-decay modes can be of great interest. However, they are more difficult to observe than their $\beta^-\beta^-$-counterpart – only the EC/EC of ^{78}Kr has been managed to be observed, yet. Of the three $\beta^+\beta^+$-decay modes also the EC/β^+-decay is promising to be detected, though. It has a lower half-life than the $\beta^+\beta^+$-decay and creates a more characteristic signature in the detector array than the EC/EC. Measuring the half-life of 2νEC/β^+-events would help to probe models used to calculate nuclear matrix elements, while 0νEC/β^+-events are especially sensitive to the involvement of right-handed currents in the decay mechanism, thus, could help to gain a deeper understanding of the general physics involved.

The COBRA demonstrator, consisting of $4 \times 4 \times 4$ CdZnTe semiconductor detectors, provides three different isotopes capable of EC/β^+-decays. Additionally, the experiment's granularity greatly improves the probability to recognize the events' characteristic decay structures.

This talk's topic will be the investigation of double beta-decay modes with the COBRA experiment and focus on EC/β^+-decays. First investigations of the prospects and feasibility of the EC/β^+-decays' investigation in general as well as with the COBRA experiment in particular and the current status of the data analysis will be discussed.

T 32.6 Di 17:35 S06

Double beta decay of Ge-76 into excited states of Se-76 in Gerda — •Birgit Schneider and Thomas Wester for the GERDA-Collaboration — TU Dresden, Institut für Kern- und Teilchenphysik

Gerda is an experiment searching for the neutrinoless double beta ($0\nu\beta\beta$) decay of ^{76}Ge. The observation of such a decay would prove the Majorana character of the neutrino, i.e. that it is its own antiparticle. This could shed light upon the neutrino mass ordering realized in nature as well as the effective Majorana neutrino mass.

The half life of the neutrino accompanied double beta ($2\nu\beta\beta$) decay from the 0^+ ground state of ^{76}Ge into the 0^+ ground state of ^{76}Se has been measured by Gerda with unprecedented precision. Furthermore, ^{76}Ge can decay into excited states of ^{76}Se, though these transitions are phase space suppressed. Theoretical calculations predict the half lives of these decays, but the results vary by several orders of magnitude due to different nuclear models and their internal parameters. The observation of the $2\nu\beta\beta$ decay of ^{76}Ge into excited states could constrain these models and decrease their uncertainties. Moreover, models of the $0\nu\beta\beta$ decay, that rely on similar assumptions, would be improved.

The excited states analysis of the Gerda data is performed by counting coincident events within the Germanium detector array and optimized with the help of Monte Carlo simulations. The talk will present the analysis technique and preliminary results of the current Gerda Phase II data.

This project is partially funded by BMBF.

T 32.7 Di 17:50 S06

Investigation of Detector Settings for JUNO wih respect to Supernova Neutrinos — •Sivaram Yogathasan, Thilo Birkenfeld, Shivani Ramachandran, Achim Stahl, and Christopher Wiebusch — III. Physikalisches Institut B, RWTH Aachen University

The Jiangmen Underground Neutrino Observatory (JUNO), a 20 kt liquid scintillator reactor neutrino observatory, will be located near Kaiping in the province Guangdong, China. The main goal is the determination of the neutrino mass hierarchy. The large target mass with a low energy threshold and the energy resolution of $3\%/\sqrt{(E(MeV))}$ makes it possible to yield high statistics of measured neutrinos. Supernovae are powerful cosmic sources of neutrinos in the MeV range. They are rare in close proximity and current theories have yet a high uncertainty. The expected high number of detected neutrinos from a galactic supernova, yields the possibility to constrain various supernovae models. An investigation of detector settings for supernova events, based on the simulated detector response for different supernova models is presented in this talk.

T 32.8 Di 18:05 S06

Investigation of Supernova neutrinos in the JUNO detector — •Shivani Ramachandran, Thilo Birkenfeld, Achim Stahl, Christopher Wiebusch, and Sivaram Yogathasan — III. Physikalisches Institut B, RWTH Aachen University

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kt liquid scintillator reactor neutrino experiment, currently under construction in China. Its main physics goal is the determination of the neutrino mass hierarchy with a large fiducial volume and an energy resolution of $3\%/\sqrt{\text{MeV}}$. Multiple channels, such as the inverse beta decay (IBD), neutrino-proton elastic scattering (pES), neutrino-electron elastic scattering (eES) as well as neutrino charged current (CC) and neutral current (NC) interactions on carbon will contribute to the measurement of neutrinos. The detector response to various supernova explosion models is studied via the JUNO detector simulation. Trigger settings are investigated for the future discovery of such supernova events.

T 32.9 Di 18:20 S06

Sensitivity of multi-PMT optical modules to the energy spectrum of MeV supernova neutrinos — •Lozano Mariscal Cristian Jesús, Sprenger Florian, and Kappes Alexander for the IceCube-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, Münster

Within the upgrade of the IceCube neutrino detector new optical modules like the multi-PMT optical module (mDOM) are being developed, which are expected to significantly boost IceCube's performance in its main energy range from GeV to PeV and above. On the other hand, Neutrinos from core-collapse supernovae with energies as low as few MeVs can reveal a detailed picture of the events that accompany the

collapse of the core and verify and enhance our picture of these powerful explosions. With its unique features like local coincidences and information on the arrival direction of detected photons, the mDOM may enable the event-by-event detection of MeV neutrinos with a single module while at the same time keeping the background sufficiently low. The talk presents studies on the energy sensitivity for SNe neutrinos by using coincidences within and between mDOMs.

T 33: Neutrino-Detektoren I

Zeit: Dienstag 16:00–18:30 Raum: S07

T 33.1 Di 16:00 S07

Development of an on-line attenuation length monitor for JUNO — •Heike Enzmann and Michael Wurm for the JUNO-Collaboration — Johannes Gutenberg-Universität, Mainz, Germany

The future neutrino experiment JUNO (Jiangmen Underground Neutrino Observatory) will determine the neutrino mass hierarchy by observing reactor neutrinos in liquid scintillator. To reach the required energy resolution of 3 % @ 1MeV, a very good LS transparency (attenuation length $a \leq$ b 20 m @ 430 nm) is required. There are several purification processes for the LS during the liquid handling in Juno Before filling, the quality of the LS will be monitored by measuring the attenuation length. This talk covers the development and testing of an on-line attenuation length monitor for LS quality control. In a relative measurement over two scintillator samples, potential changes in the attenuation length will be monitored. This work is supported by DFG research unit "JUNO".

T 33.2 Di 16:15 S07

Radon Monitoring in gaseous Nitrogen used for the Filling of the Central Detector of JUNO and OSIRIS — •Hans Theodor Josef Steiger, Alexander Gardanow, Philipp Landgraf, and Lothar Oberauer for the JUNO-Collaboration — Physik Department der Technischen Universität München, 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 with ^{222}Rn, it's content in the nitrogen gas will be monitored. In this talk the status of a prototype radon monitoring system based on a 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 Cluster of Excellence "Origin and Structure of the Universe", the DFG research unit "JUNO" and the Maier-Leibnitz-Laboratorium.

T 33.3 Di 16:30 S07

Attenuation length measurement of liquid scintillators with CELLPALS — •Tobias Heinz, Axel Müller, David Blum, Alexander Tietzsch, Tobias Sterr, Marc Breisch, and Tobias Lachenmaier — Eberhard Karls Universität Tübingen

In large liquid scintillator detectors like the JUNO detector a high optical transparency for the scintillation light is one of the key requirements. To quantify the optical transparency, a measurement of the attenuation length is crucial. The measurement of attenuation lengths of several tens of meters is difficult due to the necessity of a sufficient long light path through the sample to lead to a measurable decrease of the light intensity.

This talk will present the newly developed CELLPALS technique to measure the attenuation length of liquid scintillators using an optical cavity to extend the effective light path through the medium and therefore providing a more precise measurement of the attenuation length. The current status of the experimental setup and first results will be presented.

This work is supported by the Deutsche Forschungsgemeinschaft.

T 33.4 Di 16:45 S07

Status update on AURORA — •Wilfried Depnering and Michael Wurm for the JUNO-Collaboration — Johannes Gutenberg - Universität, Institut für Physik, Staudingerweg 7, 55122 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 LS (attenuation length $\geq$ 20 m @ 430 nm) has to be sufficiently high and stable during the whole operation time. One device for *in-situ* monitoring of the optical LS quality is AURORA (**A U**nit for **R**esearching **O**n-line the LSc t**RA**nsparency) inside the central detector of JUNO. It allows to detect potential aging effects of the liquid and a gradient in its refractive index. The latter can be caused by a temperature gradient and would lead to curved light propagation, which would need to be taken into account during the event reconstruction. This talk presents the current status of AURORA. The development is funded by the DFG Research Unit "JUNO".

T 33.5 Di 17:00 S07

Status of the Ho-163 Source Preparation, Purification and Characterization for the ECHo Neutrino Mass Measurement — •Klaus Wendt, Holger Dorrer, Christoph Düllmann, and Tom Kieck for the ECHo-Collaboration — Johannes Gutenberg-Universität Mainz

The ECHo collaboration addresses the determination of the electron neutrino mass by recording the spectrum following electron capture of Ho-163. After production from enriched Er-162 in the ILL high flux nuclear reactor the Ho-163 is separated and purified before implantation into the tiny 0.18 mm x 0.18 mm Au-absorbers of the metallic magnetic calorimeters of the ECHo detector array. Highly efficient laser resonance ionization and high transmission mass spectrometric selection is carried out at the 30 kV RISIKO magnetic sector field mass separator. This step ensures elemental and isotopic selectivity for ultra-pure Ho-163 ion implantation with sub-millimeter beam spot size and minimum losses of the precious radioisotopic material. In-situ deposition of Au onto the implantation area of the absorbers using pulsed laser deposition is performed in parallel with the ion implantation, ensuring homogeneous Ho-163/Au-layer formation and reducing disturbing erosion from the sputtering process during implantation. The purity of the ECHo source material during the whole preparation process is monitored by a variety of analytical techniques, including gamma spectrometry, neutron activation, and different mass spectrometric approaches, i.e. ICP-MS, AMS and RIMS. Specifications achieved are discussed in comparison to the needs for the ECHo experiment.

T 33.6 Di 17:15 S07

Results of the commissioning of the gaseous Kr-83m calibration source of KATRIN — •Hendrik Seitz-Moskaliuk for the KATRIN-Collaboration — Karlsruher Institut für Technologie, Institut für Experimentelle Teilchenphysik, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen

The metastable isotope Kr-83m de-excites via internal conversion and offers several intense conversion electron lines in the range from 7-32 keV with natural line widths of 1-2 eV. This makes it an ideal nuclear standard for the calibration of high-precision spectroscopic experiments like KATRIN. KATRIN will measure the electron antineutrino mass with an unprecedented precision of 0.2 eV/c^2 and utilizes three different kinds of Kr-83m sources for calibration and monitoring purposes. The first commissioning measurements of the gaseous Kr-83m source were performed in summer 2017. This talk summarizes the results. Important benchmarks for future calibration measurements are set and the outstanding capabilities for high-resolution spectroscopy with KATRIN are demonstrated. This work is supported by BMBF (05A14VK2) and the Helmholtz Association.

T 33.7 Di 17:30 S07

Atomic Tritium Source Design for Project 8 — •Alec Lindman, Sebastian Böser, and Peter Peiffer — PRISMA+ Cluster of Excellence, Johannes Gutenberg Universität Mainz

Project 8 is a phased approach to measuring the absolute neutrino mass with Cyclotron Radiation Emission Spectroscopy of tritium β

decay electrons. All existing tritium β decay m_ν measurements use molecular T_2, which has a relatively broad final state spectrum. An atomic T source and a ~ 10 m^3 fiducial trap volume will enable the design sensitivity. This talk will discuss the motivations for an atomic T source in light of engineering feasibility and the design sensitivity, including recent results from a hydrogen test stand. Parallel technology development efforts in Project 8 aim to deliver a trap with magnetic field uniformity of 10^{-7}, filled with T having a T_2 contamination less than 10^{-6} and instrumented with a spatially resolving antenna array to measure the femtowatt CRES signals. In such a trap, one year of runtime with 10^{18} T atoms should provide 40 meV sensitivity to the neutrino mass.

T 33.8 Di 17:45 S07

Development of MMC based combined photon and phonon detector for rare event searches — •Freerik Forndran[1], Felix Ahrens[1], Christian Enss[1], Andreas Fleischmann[1], Loredana Gastaldo[1], Sebastian Kempf[1], Yong-Hamb Kim[2], Daniel Unger[1], and Clemens Velte[1] — [1]Kirchhoff Institute for Physics, Heidelberg University, Germany — [2]IBS Center for Underground Physics, Daejeon, Rep. of Korea.

In the search for rare events, a simultaneous measurement of photons and phonons produced after an event in a scintillating crystal operated at mK temperatures enables an efficient background rejection. This is due to the fact that the light yield depends on the mass, allowing for particle discrimination. This approach can be used for an investigation of the neutrinoless double beta decay as well as for a direct detection of dark matter. We present the design of a combined photon and phonon detector based on metallic magnetic calorimeters (MMCs). Simulations predict an energy resolution of $\Delta E_{\mathrm{FWHM}} < 10\,\mathrm{eV}$, a signal rise time of $\tau_0 < 50\,\mu\mathrm{s}$ and a signal decay time of $\tau_1 < 10\,\mathrm{ms}$ for the photon detector and $\Delta E_{\mathrm{FWHM}} < 100\,\mathrm{eV}$, $\tau_0 < 200\,\mu\mathrm{s}$ and $\tau_1 < 10\,\mathrm{ms}$ for the phonon detectors. The combined photon and phonon detector design will be described with emphasis on the tower design of the detector setup able to host several crystals. The challenges of the fabrication steps will be discussed. In conclusion we will present the characterization of first prototypes of photon and phonon detectors.

T 33.9 Di 18:00 S07

Effects of Holmium ions embedded in absorbers of ECHo detector arrays — •Andreas Reifenberger, Matthew Herbst, Clemens Velte, Federica Mantegazzini, Andreas Reiser, Andreas Fleischmann, Loredana Gastaldo, Sebastian Kempf, and Christian Enss for the ECHo-Collaboration — Kirchhoff Institute for Physics, Heidelberg University

We investigate dilute alloys of holmium in gold and silver in order to determine the impact of their specific heat on the performance of the microcalorimeters in the neutrino mass experiment ECHo. In particular, we focus on alloys with atomic concentrations of $x_{\mathrm{Ho}} = 0.01\,\% - 1\,\%$ at temperatures between 10 mK and 800 mK. Due to the large total angular momentum $J = 8$ and nuclear spin $I = 7/2$ of holmium, the specific heat of Ag:Ho and Au:Ho depends on the detailed interplay of various interactions. This makes it unfeasible to accurately determine the specific heat of these materials numerically. Instead, we acquire the desired information through experiment, using three different experimental set-ups. The results from measurements on five holmium alloys show that the specific heat of these materials is dominated by a large Schottky anomaly with its maximum at $T \approx 250\,\mathrm{mK}$, which we attribute to hyperfine splitting and crystal field interactions. RKKY and dipole-dipole interactions between the holmium atoms cause additional, concentration-dependent effects. We discuss differences between Ag:Ho and Au:Ho, and conclude that alloys with $x_{\mathrm{Ho}} \approx 1\%$ are suitable for ECHo, where detectors are operated at $T \leq 30\,\mathrm{mK}$.

T 33.10 Di 18:15 S07

Ionisation of Pb-210 induced Rydberg atoms in the KATRIN experiment — •Dominic Hinz for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT), ETP, Postfach 3640, 76021 Karlsruhe

The **Ka**rlsruhe **Tri**tium **N**eutrino (KATRIN) experiment aims to measure the effective neutrino mass of electron anti neutrinos in a model-independent way by precise determination of the beta-spectrum of molecular tritium. Dedicated commissioning measurements showed that the sensitivity is affected by background electrons which are correlated to radioactive decays of a ^{210}Pb contamination of the inner spectrometer surfaces. To achieve the sensitivity of $m_\nu = 0.2\,\mathrm{eV/c^2}$ (90% C.L.) on the effective neutrino mass, knowledge of statistical and systematic uncertainties as well as the background processes is essential. The sensitivity of the KATRIN experiment is currently limited by a higher than anticipated background. Therefore, an understanding of the remaining background processes induced by radioactivity is of high relevance. The background model presented in this talk describes the generation of background electrons by ionisation of atoms in excited states which are sputtered from the main spectrometer vessel by alpha decays of ^{210}Po, a daughter nuclei of long-living ^{210}Pb.

This work was supported by BMBF (05A17VK2) and the HGF.

T 34: Axionen I

Zeit: Dienstag 16:00–17:45 Raum: S09

T 34.1 Di 16:00 S09

KWISP - Hunting Chameleons with the CAST Experiment at CERN — •Justin Baier, Horst Fischer, and Marc Schumann for the CAST-Collaboration — University of Freiburg

The KWISP (Kinetic Weakly Interacting Slim Particle) detector is part of the CAST experiment at CERN exploring the dark sector. It utilizes an ultrasensitive opto-mechanical force sensor for the search for solar chameleons. A chameleon is a hypothetical scalar particle postulated as dark energy candidate, which has a direct coupling to matter depending on the local density. Considering this characteristic 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 Fabry-Pérot cavity utilizing an active electrooptical feedback system to keep the laser frequency-locked. In this talk, the principle and the setup of the KWISP detector will be explained and first results will be presented.

T 34.2 Di 16:15 S09

Hunting Axion Dark Matter with MADMAX - Idea and First Proof of Principle Results — •Stefan Knirck for the MADMAX-Collaboration — Max-Planck-Institute for Physics, Munich, Germany

While the QCD axion was introduced to explain CP conservation in strong the interaction, it is also an excellent dark matter candidate. Axions could be detected using their conversion to photons at boundaries between materials of different dielectric constants in a strong magnetic field. Combining many such surfaces, one can enhance this conversion significantly using constructive interference and resonances. The proposed "Magnetized Disk and Mirror Axion eXperiment" (MADMAX) containing approximately 80 high dielectric disks with 1m diameter in a 10 T magnetic field could probe the well-motivated mass range of $(40 - 400)\mu$eV, a range which is at present inaccessible by existing cavity searches. After explaining the foundations of this approach, we present results from first proof of principle measurements. By comparing a 5 Sapphire disk setup with simulations, we demonstrate the needed disk positioning accuracy and show that the predicted electromagnetic properties are reproduced. We study systematic effects from antenna reflection, beam shape, tilts and others and conclude with an outlook for the final MADMAX setup.

T 34.3 Di 16:30 S09

Current status of the ALPS II detector — •Rikhav Shah for the ALPS-Collaboration — Johannes Gutenberg-Universität Mainz — DESY Deutsches Elektronen-Synchrotron

The Any Light Particle Search II (ALPS II) is an experiment that utilizes the concept of resonance enhancement to improve on the sensitivity of traditional light shining through a wall style experiments. These experiments attempt to detect photons passing through an opaque wall by converting to relativistic weakly interacting sub-eV particles and then reconverting back to photons. The detection of these photons requires a detector capable of observing the extremely small rates, of the order of $10^{-5}\,\mathrm{s}^{-1}$. Thus the detector must have a low dark count rate

as well as a high detection efficiency. This is achieved with a transition edge sensor (TES), i.e. a cryogenic calorimeter, which exploits the drastic dependence of a material's electrical resistance on the temperature at the superconducting edge. One major experimental challenge is the suppression of background dominated by blackbody radiation to a sufficiently low level. The setup of the TES at ALPS II will be presented. We discuss the current status as well as the first measurements of the detector preparing for data taking starting in 2020.

T 34.4 Di 16:45 S09

Status of ALPS IIa and lessons learned for ALPS II — •Richard Smith for the ALPS-Collaboration — DESY, Hamburg

ALPS IIa is a smaller-scale testbed of the 2 x 100m long ALPS II experiment. ALPS IIa uses two 10 m long optical cavities to develop and test the length and alignment sensing and control schemes needed for ALPS II. The experience gained is currently used to guide the design of ALPS II. This talk will provide an update on the status of ALPS IIa, some examples of solutions to challenges encountered, and the projected performance of ALPS II.

T 34.5 Di 17:00 S09

Preparation of a GridPix detector for solar axion search at IAXO — •Hendrik Schmick, Klaus Desch, Jochen Kaminski, Sebastian Schmidt, and Tobias Schiffer for the CAST-Collaboration — Physikalisches Institut, Universität Bonn

The International Axion Observatory (IAXO) is an experiment, currently in development, to search for solar axions. The inverse Primakoff effect is utilized to reconvert the particles into X-rays in a magnetic field.

To test and optimize detectors for IAXO we use the CERN Axion Solar Telescope (CAST). The current gaseous X-ray detector consists of 7 GridPixes, a Timepix ASIC and an integrated MicroMegas stage on top. Additionally the analogue signals induced on the grid of the central GridPix are decoupled and recorded with an FADC. Moreover, two veto scintillators are installed for further background rejection.

Primary object of the talk will be auxiliary detector components (FADC + scintillators). The connection between the FADC, the central GridPix and the scintillator signals will be explained and the ways to use this information to improve background rejection will be presented.

The results presented wil be based on the 2017/18 data taking period at CAST.

T 34.6 Di 17:15 S09

Search for hidden-photon dark matter with FUNK — •Arnaud Andrianavalomahefa[1], Kai Daumiller[1], Ralph Engel[1], Hermann-Josef Mathes[1], Markus Roth[1], Christoph M. Schäfer[1], Thomas Schwetz-Mangold[1], Ralf Ulrich[1], Darko Veberic[1], Babette Döbrich[2], Joerg Jaeckel[3], Axel Lindner[4], Marek Kowalski[4,5], and Javier Redondo[6] — [1]Institute for Nuclear Physics, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany — [2]Physics Department, CERN, Geneva, Switzerland — [3]Institute for Theoretical Physics, Heidelberg University, Germany — [4]Deutsches Elektronen Synchrotron (DESY), Zeuthen, Germany — [5]Department of Physics, Humboldt University, Berlin, Germany — [6]Department of Theoretical Physics, University of Zaragoza, Spain

The FUNK experiment was built to search for hidden and light U(1) gauge force carriers, named hidden photons, which are suitable candidates for cold dark matter. At low energies, these photons with small mass couple dominantly with regular photons via a weak kinetic mixing. As an immediate consequence, when propagating across two different dielectric media a certain probability exists that the dark-matter field emits a faint but measurable ordinary electric field. The FUNK experiment uses a large spherical mirror to capture this conversion. A photomultiplier tube is installed at the radius point where the signal is expected. We scanned the whole optical range of frequencies extended to far-UV and looked for hidden photons with masses from 2 to 8 eV. In this region we found no significant evidence of hidden-photon dark-matter but set an upper bound on the mixing parameter to 10^{-12}.

T 34.7 Di 17:30 S09

Search for Axion-Like Particles produced in e^+e^- collision at Belle II — •Michael De Nuccio — DESY, Hamburg, Germany

The Belle II experiment, located at the asymmetric e^+e^- collider SuperKEKB in Tsukuba, Japan, is a second-generation B factory experiment. A first commissioning run took place in Spring 2018. The main physics data taking will begin in early 2019. Thanks to the very clean environment and dedicated triggers, Belle II is suited to perform searches for dark-sector particles.

ALPs are light neutral pseudoscalars interacting predominantly with Standard Model photons, and have been proposed as both candidate dark matter particles or as portal particles to the dark sector. The sensitivity for ALPs produced in association with a recoil photon from e^+e^- collisions, and decaying promptly into two photons, is already competitive using the small commissioning collisions dataset collected at Belle II. This talk will discuss the expected sensitivity and the status of the ongoing analysis for this search.

T 35: Top-Physik I

Zeit: Dienstag 16:00–18:15 Raum: S10

T 35.1 Di 16:00 S10

Measurement of the Single-Top production cross section in the s-channel at $\sqrt{s} = 13\,\text{TeV}$ with the ATLAS detector — •Stephan Kaphle — Humboldt-Universität zu Berlin

The production fo 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 $\sqrt{s} = 13\,\text{TeV}$ to improve the previous result using the higher luminosity of up to $140\,\text{fb}^{-1}$.

T 35.2 Di 16:15 S10

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 zwar theoretisch exakt 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 und 2017 bei einer Schwerpunktsenergie von 13 TeV gemessenen Daten des CMS-Experiments.

T 35.3 Di 16:30 S10

Measurement of the Single Top tW Inclusive Cross-Section in the Single Lepton Final State at 13 TeV with ATLAS — Ian C. Brock and •Federico G. Diaz Capriles — Physikalisches Institut, University of Bonn

Single top-quark production in association with a W boson (known as the tW channel) is measured in the ATLAS detector at the Large Hadron Collider. Single top-quark cross-section measurements allow for a precise test of Standard Model physics and can aid in the discovery of new physics. The tW channel has the second largest cross-section of the three main single top production processes and it is sensitive to different new physics from that of the s- and t-channels.

In this work, tW production is studied in the lepton plus jets channel by selecting events with three jets, one lepton and some amount of missing transverse momentum. Separation of signal and background events is performed by a neural network trained on Monte Carlo samples. This training helps identify the tW signal from its more prominent backgrounds, top-quark pair production and W in association with jets events, which share similar signatures but have much larger cross-sections. Lastly, a likelihood fit is performed to extract the signal cross-section.

T 35.4 Di 16:45 S10

Constraining anomalous Wtb couplings using measurements of top quark polarization vector components in t-channel single top quark events — •David Seith, Thorsten Chwalek, Thomas Müller, Denise Müller, Soureek Mitra, and Nils Faltermann — Institut für Experimentelle Teilchenphysik(ETP), Karlsruher Institut für Technologie (KIT)

Top quarks are produced 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. The high statistics provided by the LHC in Run II allow to measure the polarization of the top quark to yet unrivaled precision and to further constrain any new physics contribution. In this talk the analysis of the top quark polarization with the CMS experiment is presented.

T 35.5 Di 17:00 S10

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 35.6 Di 17:15 S10

Studies on interference effects in processes with flavor-changing neutral currents and tqγ coupling — •Salvatore La Cagnina[1], Maura Barros[2], Gregor Gessner[1], Ana Peixoto[2], Johannes Erdmann[1], Nuno Castro[2], and Kevin Kröninger[1] — [1]TU Dortmund, Lehrstuhl für Experimentelle Physik IV — [2]Universidade do Minho, Laboratório de Instrumentação e Física Experimental de Partículas

In the Standard Model, flavor-changing neutral currents (FCNC) at tree level are forbidden and are highly suppressed by the GIM mechanism at higher orders. Beyond Standard Model theories, however, can allow FCNCs at tree level. One possible process containing an FCNC includes a top quark that interacts with an up-type quark and a photon ($tq\gamma$ coupling with $q = u, c$). 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, are distinguished. In next-to-leading order, both modes interfere. This interference might lead to changes of kinematic properties. The effect of scale variation on the kinematic variables is studied at leading order and is used to determine an estimation of the systematic uncertainty on their distributions. It is shown that the influence of interference effects is negligible compared to the uncertainty caused by such scale variations. This conclusion equally applies for distributions of kinematic variations after detector simulation.

T 35.7 Di 17:30 S10

Search for charged lepton-flavour violation in top-quark decays at the LHC with the ATLAS detector — Carlo A. Gottardo, Sebastian Heer, Vadim Kostyukhin, Ö. Oğul Öncel, Keshava Prasad, Andrea Sciandra, and •Markus Cristinziani — Physikalisches Institut, Universität Bonn

A direct search for charged lepton-flavour violation in top-quark decays is presented. The data analysed correspond to 79.8 fb^{-1} of proton–proton collisions at a centre-of-mass energy of $\sqrt{s} = 13$ TeV delivered by the LHC. The process studied is the production of top-quark pairs, where one top quark decays into a pair of opposite-sign different-flavour charged leptons and an up-type quark, while the other decays semileptonically according to the Standard Model. The signature of the signal is thus characterised by the presence of three charged leptons, a light jet and a b-jet. A multivariate discriminant is deployed and its distribution used as input to extract the signal strength. In the absence of a signal, an upper limit on the branching ratio of BF($t \to \ell\ell' q$) $< 1.86 \cdot 10^{-5}$ is set at 95% confidence level.

T 35.8 Di 17:45 S10

Search for tH production via FCNC in the H->$b\bar{b}$ decay channel — •Arunika Sahu — 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 pair. The 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 35.9 Di 18:00 S10

Search for tqH FCNC couplings at the ATLAS experiment — •Oliver Thielmann, Wolfgang Wagner, Geoffrey Gilles, and Arunika Sahu — Bergische Universität Wuppertal (BUW)

Processes involving flavour-changing neutral currents (FCNC) are highly suppressed in the top-quark sector and an observation of such processes would signal physics beyond the Standard Model. An important example are the ctH and utH FCNC vertices which lead to the production process pp ->tH and the decay t -> c(u) H in t tbar events. Different reconstruction techniques of the associated final states are compared. Neural networks are employed to separate signal and background events in the signal region. A potential signal is searched for by means of a profile likelihood fit to the neural network discriminants. The sensitivity of the search is quantified in terms of upper limits of the ctH and utH couplings in the context of an Effective Field Theory.

T 36: Supersymmetrie I

Zeit: Dienstag 16:00–18:30 Raum: S11

T 36.1 Di 16:00 S11

Suche nach Supersymmetrie mit versetzten Leptonpaaren beim ATLAS-Experiment am LHC — •Dominik Krauss, Zinonas Zinonos und Hubert Kroha — Max-Planck-Institut für Physik, München

Die meisten Suchen nach Supersymmetrie am LHC konzentrieren sich auf den Fall, dass das leichteste supersymmetrische Teilchen stabil und die anderen supersymmetrischen Teilchen kurzlebig sind. Bisher sind diese Suchen jedoch erfolglos geblieben und daher wird es immer wichtiger auch supersymmetrische Modelle zu betrachten, in denen diese Annahmen nicht erfüllt sind. Einige dieser Modelle sagen langlebige supersymmetrische Teilchen voraus, die in geladene Leptonen zerfallen. Liegt deren Lebensdauer im Bereich von Pikosekunden bis Nanosekunden, können deren Zerfälle als sekundäre Vertizes im Innendetektor rekonstruiert werden. Da das Standardmodell solche Zerfälle nicht vorhersagt, gibt es nur einen geringen Untergrund, der es ermöglicht, selbst schwache Signale in den Daten auszumachen. In diesem Vortrag wird eine Suche nach solchen versetzten Vertizes mit geladenen Leptonen am ATLAS-Experiment vorgestellt.

T 36.2 Di 16:15 S11

Combination of Searches for gauge-mediated Supersymmetry in Events with Photons at CMS — Christian Autermann, Lutz Feld, Johannes Schulz, Marius Teroerde, and •Danilo Meuser — I. Physikalisches Insitut B, RWTH Aachen University

Supersymmetry is one of the most popular extensions to the standard model of particle physics, providing possible solutions to problems such as the hierarchy problem or the unification of forces. In the context of gauge-mediated supersymmetry the rate of events with photons in the final state can be enhanced. This motivates searches in events with photons and missing transverse momentum due to the undetected lightest supersymmetric particle.
This analysis combines searches for gauge-mediated supersymmetry in events with at least one photon. The combination is based on proton-proton collision data recorded by CMS in 2016, which corresponds to a center-of-mass energy of 13 TeV and an integrated luminosity of 35.9 fb^{-1}. Four individual analyses, which all focus on signatures with isolated photons and a significant amount of missing transverse momentum, are combined to cover a wide range of different signal scenarios. These signatures are complemented by additional charged leptons, a second photon, or additional requirements on the hadronic activity. Within the analysis, possible overlaps between the different signal regions are removed by an optimized veto strategy. The combination of searches probes the phase space of gauge-mediated scenarios and improves the exclusion limits derived by the individual analyses.

T 36.3 Di 16:30 S11

Search for stau pair production in proton-proton collisions at the LHC with the ATLAS detectors — •Patrick Selle, Zinonas Zinonos, and Hubert Kroha — Max Planck Institut für Physik, München, Deutschland

Supersymmetry (SUSY) provides solutions to many open problems of the Standard Model (SM) such as the hierarchy problem and the mystery of Dark Matter (DM). In certain SUSY models, the supersymmetric partner of the τ-lepton, the stau ($\tilde{\tau}$), is expected to be lighter than other sleptons, such that its mass could be at the electroweak scale. Models involving coannihilation between the stau and the lightest supersymmetric particle (LSP), which can be almost mass-degenerate, can reproduce the relic DM density of the universe as measured by cosmological observations. At the LHC, staus would be pair-produced and decay into their SM counterpart and the LSP. Typical stau events would therefore be characterized by the presence of SM tau leptons and the production of significant missing energy arising from the LSP pair and the neutrinos from the tau decays. This talk presents the strategy for searching for stau-pair production in final states with one hadronically decaying and one leptonically decaying tau lepton. The analysis relies on data using events in the ATLAS detector. Multivariate analysis techniques are applied to achieve the highest possible signal sensitivity.

T 36.4 Di 16:45 S11

Search for top squark pair production in final states with one lepton using 140 fb^{-1} **of** $\sqrt{13}$ TeV **data with the ATLAS experiment** — •David Handl and Jeannine Wagner-Kuhr — LMU München

Natural supersymmetry models favour a relatively light supersymmetric partner of the top quark referred to as the top squark ($\tilde{t}_1$), with a mass predicted up to a few TeV.
A search for top squark pair production in events with exactly one electron or muon, multiple jets and missing transverse momentum is presented. The analysis is performed using data from proton-proton collisions recorded at a center-of-mass energy of $\sqrt{13}$ TeV by the ATLAS experiment corresponding to an integrated luminosity of 140 fb^{-1}. This talk focuses on decay scenarios where the mass difference between the top squark and the neutralino ($\tilde{\chi}_1^0$) is smaller than the top quark ($\Delta m \equiv m_{\tilde{t}_1} - m_{\tilde{\chi}_1^0} < m_t$). In this phase-space, the top squark pair events closely resemble top quark pair processes, which make dedicated searches difficult. However, it will be shown that a substantial discrimination between signal and background processes can be achieved using machine learning techniques. In the following, the analysis strategy based on neural networks is presented, search regions and background estimation are defined and the sensitivity reach is discussed.

T 36.5 Di 17:00 S11

QCD background estimation for the search of top squarks with 1-lepton in the final state with ATLAS — •Arrubarrena Paola, Handl David, and Wagner-Kuhr Jeannine — LMU, Munich, Germany

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 studies on QCD multijet background estimation for the full Run-2 analysis, using *pp* collision data at a center of mass energy of 13 TeV recorded with the ATLAS detector from 2015 to 2018, are presented.

In this analysis, QCD multijet background originates from jets or non-prompt leptons that mimic the isolated lepton criteria and hence are wrongly selected. In particular for signal regions targeting small $\Delta m = (m_{\tilde{t}_1} - m_{\tilde{\chi}_1^0})$, which are characterized by low-energy leptons, the QCD background is expected to be larger and a quantitative evaluation of the QCD background in these regions is essential. In this talk the estimation of the QCD multijet background via a data-driven fake-factor method is presented.

T 36.6 Di 17:15 S11

Search for electroweak production of supersymmetric states in compressed mass spectra in Run 2 with the ATLAS detector — •Michael Holzbock and Alexander Mann — Ludwig-Maximilians-Universität München

Supersymmetry (SUSY) is one of the best studied extensions of the Standard Model. Although there is no sign of physics beyond the Standard Model yet, SUSY could still be hiding in more challenging signatures, like compressed mass spectra. These scenarios involve small mass differences between heavier SUSY particles and the lightest supersymmetric particle leading to the appearance of soft objects in the decay chain.

A search is presented in which the lightest electroweakino states are nearly mass degenerate, leading to final states with two soft leptons, that have transverse momentum typically in the range from 3 to 20 GeV. These events are selected using triggers on missing transverse momentum ($\text{E}_\text{T}^\text{miss}$) that originates from the SUSY system recoiling against a jet from initial state radiation. To avoid any bias due to mismodeling in simulation, the usage of these triggers usually requires a hard cut on $\text{E}_\text{T}^\text{miss}$ at analysis level, which causes a significant loss in signal acceptance. Measuring the trigger efficiencies in data and simulation allows for an analysis selection with less tight requirements on $\text{E}_\text{T}^\text{miss}$ and thus to recover a considerable fraction of the signal events.
This talk comprises studies about the measurement of the trigger efficiencies and how the inclusion of the low $\text{E}_\text{T}^\text{miss}$ phase space enhances the sensitivity of the search in a statistical combination.

T 36.7 Di 17:30 S11

ATLAS sensitivity to higgsinos with a highly compressed mass spectrum at the HL-LHC — •Jorge Andres Sabater[1], Federico Meloni[1], Simone Amoroso[1], Brian Petersen[2], and Peter Tornambe[3] — [1]DESY — [2]CERN — [3]Freiburg University

Supersymmetry (SUSY) is a symmetry that introduces a relation between every Standard Model (SM) fermion and gauge boson with a superpartner state whose spin differs by half a unit. In the Minimal Supersymmetric extention of the SM (MSSM), the fermionic superpartners of the electrically neutral gauge bosons, the bino and the wino, mix with the Higgsinos, to form four neutralinos and two charginos physical mass eigenstates, often referred to as electroweakinos.

The talk will present the exclusion reach and discovery potential for direct electroweakino pair production in models with small mass differences between the lightest SUSY particle (LSP) and the second LSP at the High Luminosity LHC (HL-LHC). The electroweakinos decay via off shell W and Z bosons, resulting in a final state with two charged leptons, jets and missing transverse momenta coming from the undetected LSP. The analysis is done simulating the ATLAS detector performance in the HL-LHC regime where 200 interactions per bunch crossing will be reached and the amount of data collected will be 20 times greater than the present one. The results show a sensitivity improvement with the increased amount of data, leaving some room for possible SUSY discovery, and they also serve as a good complementarity with other future HL-LHC analyses.

T 36.8 Di 17:45 S11

Search for electroweakinos in events with one lepton with the ATLAS detector at the LHC — •Eric Schanet and Jeanette Lorenz — Ludwig-Maximilians-Universität München

Supersymmetry is a promising extension of the Standard Model of Particle Physics (SM) as it provides a solution to some of the 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.

In this talk, a search for the production of charginos and neutralinos, using 140 fb^{-1} of pp collisions recorded from 2015 to 2018 by the ATLAS detector, is presented. In the signal scenario considered, the chargino decays via $\tilde{\chi}_1^{\pm} \to W\tilde{\chi}_1^0$ while the neutralino decays through $\tilde{\chi}_2^0 \to h\tilde{\chi}_1^0$. In many events, the final state of this signal scenario is thus characterised by the presence of exactly one lepton from $W^{\pm} \to \ell^{\pm}\nu$, two b-jets from the Higgs decay and missing transverse momentum, providing high discrimination against SM background processes. In this talk, the analysis strategy in this decay channel as well as the signal regions optimisation and the sensitivity projections will be presented.

T 36.9 Di 18:00 S11

Searches for $\tilde{\tau}$-production with the ATLAS experiment — •Johannes Junggebburth, Hubert Kroha, and Zinonas Zinonos — Max-Planck Institut für Physik, München

The search for Supersymmetry is a broad topic of the ATLAS research programme. Direct $\tilde{\tau}$ pair production is a channel on which the last limits were put at the era of LEP. Once produced, the $\tilde{\tau}$ decays into a τ-lepton and a $\tilde{\chi}_1^0$. The latter is an ideal Dark Matter candidate and if the $\tilde{\tau}$ is light enough, it naturally explains the observed dark-matter abundance. However, τ reconstruction itself is very challenging due to the large QCD background, motivating to exploit the use of machine-learning techniques. This talk presents the search strategy for direct $\tilde{\tau}$ production where one τ decays into hadrons and other one leptonically using machine-learning techniques. The expected sensitivity in the LHC Run-2 dataset comprising 150 fb^{-1} will be discussed and compared to a cut-based approach.

T 36.10 Di 18:15 S11

A data-driven multijet background estimation method for the search for direct pair production of scalar tau leptons with the ATLAS detector — •Ferdinand Krieter, Alexander Mann, and Clara Leitgeb — Ludwig-Maximilians-Universität München

As a proposed fundamental symmetry of nature, Supersymmetry provides elegant solutions to various open questions of the Standard Model by predicting superpartners of known particles, whose spins differ by one half unit. In R-parity-conserving models, these hypothetical particles are produced in pairs and decay ultimately into the stable, lightest supersymmetric particle, a candidate for dark matter. A search for direct production of scalar tau leptons in final states with two hadronically decaying tau leptons and missing transverse momentum is presented. The simplified signal models consider scalar tau leptons decaying exclusively into a tau lepton and a stable neutralino. Such a production mode may dominate if the strongly interacting superpartners and gauginos are heavy and thus beyond the reach of currently probed energy scales. The analysis uses pp collision data at a center-of-mass energy of 13 TeV, recorded with the ATLAS detector from 2015 to 2018. The background for the investigated signature is dominated by multijet production via the strong interaction, where jets fake the detector signature of a hadronically decaying tau lepton. For the estimation of this background a data-driven fake-factor method is presented.

T 37: Astroteilchenphysik: Methoden II

Zeit: Dienstag 16:00–18:30 Raum: S12

T 37.1 Di 16:00 S12

Efficiency determination of the Wavelength shifting Optical Module (WOM) for IceCube — •John Rack-Helleis, Peter Peiffer, Sebastian Böser, and Florian Thomas for the IceCube-Collaboration — Johannes Gutenberg Universität Mainz

The Wavelength shifting Optical Module (WOM) consists of a cylindrical tube coated in wavelength shifting paint with photomultiplier tubes(PMT) optically attached at each end.

Light hitting the surface of the tube is absorbed, shifted towards larger wavelengths and guided to the PMT via total internal reflection within the walls of the tube.

This design ensures a significantly larger photo detection area compared to the PMT alone. At the same time the noise, which scales with the detection area of the given PMT, is not increased. Additionally this detector is sensitive to light in the UV range, making it well suited for the detection of Cherenkov light.

This makes the WOM a very promising candidate for future extensions of the IceCube Neutrino Observatory at the South Pole.

In this talk I will present the current status of modeling and understanding the light propagation and detection efficiency of the WOM.

T 37.2 Di 16:15 S12

The eyes of XENONnT: Qualification tests of 494 photomultiplier tubes — •Luisa Hötzsch and Oliver Wack for the XENON-Collaboration — Max-Planck-Institut für Kernphysik, Heidelberg

The next phase of the XENON dark matter experiments will be the XENONnT detector. Utilizing in total 8.4 tonnes of xenon in a dual-phase liquid xenon time projection chamber, its aim is to increase the sensitivity for direct dark matter detection by one order of magnitude to probe new regions of the parameter space.

The scintillation light induced in liquid or gaseous xenon by particle interactions will be detected with 494 photomultiplier tubes (PMTs). The Hamamatsu R11410 tub has been chosen for its high quantum efficiency and low intrinsic radioactivity to maximize the detector's sensitivity. Applying the knowledge gained during testing and operation of the previous detector, XENON1T, the characteristics and performance of the PMTs for XENONnT have been studied and tested extensively. The general testing procedures and the results of the testing campaign will be presented in this talk.

T 37.3 Di 16:30 S12

Setup of a batch test facility for the characterization of photomultipliers for the AugerPrime Upgrade of the Pierre Auger Observatory* — •Simon Strotmann — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal

With the surface detector upgrade of the Pierre Auger Observatory, the precision of the primary particle mass composition measurement will be further improved by mounting additional 4 m^2 scintillator detectors on top of the existing surface detector stations. A PMT with expected high linearity was chosen in order to meet the requirements measuring the signal of the scintillator within a high dynamic range. The presentation will focus on the development and design of the batch test facility located at the University of Wuppertal built for the characterization of these PMTs. The setup enables the determination of the relevant quantities of the PMT such as gain and linearity in order to meet the required specifications for operation at the observatory.

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

T 37.4 Di 16:45 S12

PMT characterization for the IceCube mDOM — •Jonas Reubelt, Judith Schneider, Daniel Runze, and Martin Majewski for the IceCube-Collaboration — Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP

In context of the planned IceCube Upgrade new kinds of optical modules are developed. One of them is the multi-PMT Digital Optical Module (mDOM) containing 24 three-inch photomultiplier tubes (PMTs). In order to fully utilize the advantages of the multi-PMT concept, the performance of different PMT models is investigated. The results of extensive characterization of the two most promising candidates are presented.

T 37.5 Di 17:00 S12

PMT characterization 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

In the framework of a planned upgrade of the IceCube Neutrino Observatory and a next-generation neutrino telescope at the South Pole, new optical modules are being developed, which are expected to sig-

nificantly increase the detector sensitivity. One such concept is the multi-PMT Digital Optical Module (mDOM) which features 24 photomultipliers (PMTs) inside a pressure vessel pointing in all directions. This design provides o.a. an almost uniform angular acceptance, an increased effective area and the possibility of using local coincidences between PMTs of the same module. Since the PMTs are the main detection device of the module, a good understanding of their performance is essential. We present current results regarding PMT characterization and measurement techniques.

T 37.6 Di 17:15 S12

Development of a test bench for the quality control of photomultipliers for the IceCube-Upgrade — •Robert Joppe, Martin Rongen, Mareike Profe, Lutz Deriks, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen

For the IceCube-Upgrade a new light sensor (mDOM) is developed, which consists of multiple photomultipliers (PMTs). Each PMT 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 37.7 Di 17:30 S12

Characterisation of PMTs for the FlashCam Project — Stefan Eschbach, •Oleg Kalekin, and Johannes Schumann — Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP

The FlashCam project aims to build a camera for the Middle Size Telescopes of the Cherenkov Telescope Array Project. The 1758 pixel camera consists of 1.5-inch Hamamatsu PMTs of type R12992-100. A subset of 400 PMTs was characterised at Erlangen Centre for Astroparticle Physics. Tested parameters were Quantum Efficiency (QE), afterpulsing, gain, transit time spread, rise time and width of single photoelectron pulses. All these parameters are in agreement with specifications. However, for some PMTs a strong inhomogeneity of QE over photocathode was found.

T 37.8 Di 17:45 S12

Evaluierung der Sensitivität von SALLA Prototypantennen für das großflächige Radio Upgrade des Pierre Auger Observatoriums — •Markus Nowak — Institut für Kernphysik, Karlsruher Institut für Technologie

In Luftschauern, verursacht durch ultrahochenergetische kosmische Strahlung, werden neben den erzeugten Teilchen auch Radiopulse emittiert. Wie bereits einige Radioantennenfeld-Experimente gezeigt haben, ist es möglich, mit diesen Pulsen den Radio-Fußabdruck des Schauers am Boden zu rekonstruieren. Dieser Radio-Fußabdruck bietet eine weitere Möglichkeit um Eigenschaften wie die Energie oder die Masse des primären Teilchens zu bestimmen. Von besonderem Interesse sind stark geneigte Luftschauer, da sie einen sehr großen Radio-Fußabdruck hinterlassen, wohingegen die elektromagnetische Teilchenkomponente dieser Schauer verschwindend gering wird.

Für das Pierre Auger Observatorium wird ein großflächiges Radio-Upgrade durchgeführt, um diese stark geneigten Schauer messen zu können. Ziel ist es, die durch das Observatorium durchgeführte Messung der Massenkomposition kosmischer Strahlung, auf große Zenitwinkel auszudehnen. Im bereits erfolgreich arbeitenden Auger Engineering Radio Array (AERA) sind hierfür unter anderem Prototypstationen mit short aperiodic loaded loop (SALLA)-Antennen aufgebaut worden. In dieser Präsentation wird die Eignung dieser Antennen für ein großflächiges Radioantennenfeld im Vergleich zu den anderen Antennentypen in AERA untersucht.

T 37.9 Di 18:00 S12

Towards an improved radio detection technique for the measurement of air showers — •Aswathi Balagopal V., Andreas Haungs, Thomas Huber, Tim Huege, Donghwa Kang, Agnieszka Leszcynska, Marie Oehler, Max Renschler, and Frank G. Schröder for the IceCube-Collaboration — Karlsruhe Institue of Technology, Karlsruhe, Germany

Radio detection of air showers has continually grown and developed since the past few decades. It is already proven to be an effective method for extracting information of air showers and their properties. Existing experiments measuring such air showers mostly operate in the frequency range of 30-80 MHz, and have successfully measured cosmic rays with energies well above 50 PeV. In this talk, I will present the recent results which show how the optimization of the frequency range of operation can enable us to improve the signal-to-noise ratio, and thereby lower the energy threshold of detection. This optimization is universal, and can pave the way for an improved performance of all future radio air-shower arrays.

T 37.10 Di 18:15 S12

GRANDProto300, a pathfinder for autonomous radio detection of UHECRs — •Anne Zilles — Institut d'Astrophysique de Paris, Paris, France

GRANDProto300, acting as a pathfinder for the future Giant Radio Array for Neutrino Detection (GRAND), is planned as an array of 300 antennas deployed over $\sim 300\,\mathrm{km}^2$. Its main goal is to demonstrate the viability of detection principle of GRAND: from radio data alone, to trigger on nearly horizontal air showers, separate the signal from the background, and reconstruct the properties of the primary particles with a precision similar to standard techniques used for cosmic-ray detection. With 10^5 detected CR events above $10^{7.5}$ GeV already in the first year, GRANDProto300 is placed in a privileged position to study the transition between Galactic and extragalactic cosmic rays. With the extension by a ground array of particle detectors, hybrid detection will allow an independent measurement of the electromagnetic and muonic component of the shower. In this contribution we will present the science goals, preliminary design, performance goals and current status of the GRANDProto300 project.

T 38: Kosmische Strahlung II

Zeit: Dienstag 16:00–18:30 Raum: S13

T 38.1 Di 16:00 S13

Scintillator upgrade of IceTop: An extension of the IceCube surface detector array — •Thomas Huber für die IceCube-Kollaboration — KIT, DESY

The IceCube Collaboration foresees to upgrade the present surface array (IceTop) with scintillation detectors. This array will be used to mitigate the impact of snow accumulation on the reconstruction of cosmic-ray showers detected by IceTop. In addition it will increase the veto capabilities for high energy astrophysical and cosmogenic neutrinos of IceCube. Furthermore, it will serve as a R&D program for a possible future large-scale surface array. Two prototype stations with 7 scintillation detectors each showcasing technological advances have been developed and were deployed at the South Pole in January 2018. Each scintillation detector features 1.5 m* of plastic scintillators and wavelength-shifting fibers which are read out by Silicon Photomultipliers. The detector design, the operation status, first measurements compared to IceTop and prospects of the upgrade will be presented in this contribution. In addition, the science case of the array will be discussed.

T 38.2 Di 16:15 S13

Performance of IceTop enhancement with scintillator array — •Agnieszka Leszczyńska[1], Aswathi Balagopal V.[1], Andreas Haungs[1], Donghwa Kang[1], Marie Oehler[1], Max Renschler[1], Thomas Huber[1,2], and Fiona Ellwanger[1] for the IceCube-Collaboration — [1]KIT, Karlsruhe, Germany — [2]DESY, Zeuthen, Germany

One of the proposed upgrade of IceTop, a surface component of IceCube, will comprise of the scintillation detectors arranged within the present IceTop area. The proposed array will enhance the cosmic-ray measurements and provide an improvement in the background discrimination for the astrophysical neutrino detection in the southern hemisphere sky. The scintillation detectors, due to their complementary response to the air-shower components with respect to the Cherenkov

tanks, can boost the current discrimination of the primary cosmic-ray mass.

We conducted a detailed simulation study on the capabilities of the enhanced array in terms of trigger probability and air-shower reconstruction. Moreover an investigation of a possible parameter which is sensitive to the cosmic-ray mass was performed.

T 38.3 Di 16:30 S13

Reconstruction of the cosmic-ray spectrum based on stopping muons in IceCube — •Sebastiano Ninfa — Technische Universität Dortmund

The IceCube-Observatory at the South Pole is primarily intended to detect neutrinos from extra-galactic sources, yet the vast majority of recorded events originates from air showers induced by cosmic rays interacting in the upper atmosphere. While in the context of neutrino astronomy these events have to be considered background, the data from the atmospheric muons can still be used to infer knowledge about the composition and energy spectrum of these cosmic rays.

In this work the cosmic-ray spectrum is reconstructed using a model-independent unfolding approach. The study is conducted on a specific subsample of events, containing only muons which stop inside the detector, since the energy of these events can easily be estimated considering the propagation length from generation to absorption, so that the muon range can be used as a proxy to reconstruct the energy spectrum.

In this talk I will give an overview over the analysis, focusing mainly on the methods employed.

T 38.4 Di 16:45 S13

Up-going high energy showers in the fluorescence detector of the Pierre Auger Observatory — •Ioana Alexandra Caracas — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal

The Pierre Auger Observatory is performing a follow-up search of the recent ANITA observations of up-going cosmic ray like showers with energies around 0.1-1 EeV. Because of the vastly larger exposure of the fluorescence detector (FD) compared to ANITA, it is expected the current research will be able to either confirm or reject the recent observations. The 14 years of FD data are already taken and will be analyzed.

Simulations of up-going extensive air showers with elevation of more than $\approx$ 20 degrees above the horizon represent the first step in this search. These simulations will be used to reject the false positives and provide insight into the nature of these events. The extensive air showers are simulated using CORSIKA with primary energies in the range of 10^{18} - 10^{20} eV. Preliminary results of these simulations, including detector response simulations, will be presented and discussed.

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

T 38.5 Di 17:00 S13

AugerPrime Event Reconstruction and Analysis of Data from First Prototypes — •Alvaro Taboada-Nunez[1,2], David Schmidt[1], Alexander Streich[1,2], Markus Roth[1], and the Pierre Auger Colaboration[3] — [1]Karlsruhe Institute of Technology (KIT) — [2]Universidad Nacional de San Martin (UNSAM) — [3]Malargue, Argentina

The measurement of the different components of extensive air showers is of key importance for reconstructing the mass composition of ultra-high-energy cosmic rays. The main goal of AugerPrime, the upgrade of the Pierre Auger Observatory, is the enhancement of the Surface Detector sensitivity to mass composition by installing a 4 m^2 scintillator detector atop of the 1660 water-Cherenkov detectors. A complementary measurement with the two detectors would allow for the disentanglement of the electromagnetic and muonic shower components. The current analysis methods for shower reconstruction using both the scintillator and the water-Cherenkov detectors are presented here. Furthermore, 12 upgraded Surface Detector stations are operating in the field since late 2016; analysis of the data from these first prototypes is also presented.

T 38.6 Di 17:15 S13

Air shower universality in the context of AugerPrime — •Maximilian Stadelmaier, Markus Roth, and Ralph Engel — Institut für Kernphysik, KIT, Karlsruhe, Deutschland

The mass composition of the ultra-high energy cosmic rays (UHECRs) is an open question in astroparticle physics. The Pierre Auger Observatory, being the largest cosmic ray observatory in the world, is capable to detect extensive air showers induced by UHECRs at the exa electronvolt scale and beyond. Air shower universality is a principle stating that the overall development of an extensive air shower and therefore also the signal at ground solely depend on the mass-sensitive observables $X_{\max}$, N_μ and the energy of the primary particle. Reconstructing these observables in the context of air shower universality with the information obtained from the scintillators, which are currently being deployed within the AugerPrime update, will boost our understanding of extensive air showers and cosmic accelerators. We will present the status of the signal model development and future perspectives for AugerPrime.

T 38.7 Di 17:30 S13

EmCa - Electromagnetic Cascades — •Stephan Meighen-Berger and Matthias Huber — Technische Universität München, München, Deutschland

The Electromagnetic Cascade package (EmCa) is a simulation package for electromagnetic cascades in different materials. It uses one dimensional, discretized, cascade equations to calculate particles fluxes from a few MeV up to PeV scales. EmCa's large range of validity is a result of the inclusion of low and high energy effects, such as ionization- and dieelectric-effects for the former and the Landau*Pomeranchuk*Migdal effect for the latter. Using pre-tabulated interaction rates, average particle fluxes can be calculated in a few seconds. Unlike a Monte-Carlo regime, where the simulations take longer, this allows for systematic studies of the results. Currently EmCa's results agree with experimental and Monte-Carlo data. An upcoming extension will be full 3D simulations, allowing the inclusion of additional effects, such as magnetic and geometry effects. The package is offered as a stand-alone as well as an extension to MCEq, which is a similar package for the calculation of hadronic cascades. This allows the simulation of hadronic and electromagnetic cascades in a single framework. In this talk we will introduce EmCa, the underlying methods therein and future plans to extend the simulation package.

T 38.8 Di 17:45 S13

Status of the new TAIGA hybrid detector — •Andrea Porelli for the TAIGA-Collaboration — DESY, Zeuthe,Germany

The new TAIGA (Tunka Advanced Instrument for cosmic ray physics and Gamma Astronomy) hybrid detector aims to address gamma-ray astronomy at energies from a few TeV to several PeV, as well as cosmic ray physics above 100 TeV. By combining the wide angle (0.6sr) Cherenkov timing detector TAIGA-HiSCORE with the 4-m class Imaging Atmospheric Cherenkov Telescopes TAIGA-IACT (10x10 degrees FoV), it provides a cost effective-way to instrument large areas (>10km^2). The EAS reconstruction provided by TAIGA-HiSCORE (energy, incoming direction and its core position) allows to increase the distance between the IACTs up to 1000-1200 m. In addition to the Cherenkov light detectors, we intend to deploy an array of muon detectors (TAIGA-Muon array) spread over an area of 1 km^2 with a total area of about 2000 m^2. The TAIGA-IACT, together with the TAIGA-Muon array, will be used for selection of gamma-ray induced EAS. At present, the TAIGA first stage has been constructed in Tunka valley, ∼50 km West from the Lake Baikal. The detector consists of 47 TAIGA-HiSCORE Cherenkov stations distributed over an area of 0.5 km^2, and the first IACT of the TAIGA-IACT array. During 2018-2019 we intend to increase number of the TAIGA-HiSCORE stations up to 100-120, covering an area of 1 km^2, and to deploy 1 - 2 additional TAIGA-IACTs. The first experimental results with the TAIGA first stage will be reported.

T 38.9 Di 18:00 S13

Study of Attenuation of Extensive Air Showers — •Martin Schimassek[1], Darko Veberič[1], Ralph Engel[1], and the Pierre Auger Collaboration[2] — [1]Karlsruher Institut für Technologie — [2]Malargüe, Argentina

The understanding of the attenuation of the air showers on their passage through different amounts of atmospheric matter is crucial for the reconstruction of their energy. Using established techniques like the constant-intensity-cut method it is possible to estimate this attenuation function from the gathered data itself. Another approach is the use of Monte-Carlo simulations to estimate the attenuation. The different methods imply different systematic uncertainties: The MC based attenuation suffers from the differences between, and uncertainties of, the used hadronic interaction models, but can naturally incorporate a potential energy dependence of the attenuation functions. Whereas the data-driven method does not depend on any hadronic interaction

model, it suffers from a low statistics when an estimation of the energy dependence is desired.

This contribution highlights the properties of different methods and with the help of extensive Monte-Carlo studies reviews systematic uncertainties of these methods.

T 38.10 Di 18:15 S13

Thinning algorithm for the simulation of large signals in surface detector stations at the Pierre Auger Observatory — •David Schmidt for the Pierre Auger-Collaboration — Karlsruhe Institute of Technology, Karlsruhe, Germany

Extensive air showers induced by ultra-high-energy cosmic rays result in a massive number of particles reaching Earth's surface. Simulations of the surface detector of the Pierre Auger Observatory consist of injecting these particles into virtual volumes containing its water-Cherenkov detector stations. In such simulations, the shower core sometimes lands very close to such a station resulting in the injection of a colossal number of particles and correspondingly large run-times. As the electronics in such stations saturate, disproportionately large amounts of CPU and memory resources are therefore used to simulate signals that will eventually be clipped and discarded. Here, we present a station-level algorithm that greatly reduces run-times in such cases by randomly decimating injection candidates and scaling resulting signals accordingly. The method eliminates outliers in the distribution of simulation run-times and reduces the average run-time by dozens of hours without a significant cost to the quality of simulated signals. Meanwhile, it still allows for the full simulation of station signals up to the point of saturation, which differs from other speed-oriented algorithms relying on parameterizations that often inadequately describe the rare interactions and odd geometries relevant in the case of low statistics.

T 39: Gamma-Astronomie I

Zeit: Dienstag 16:00–18:25 Raum: S14

Gruppenbericht T 39.1 Di 16:00 S14

FACT - Highlights from an Unbiased Monitoring Program — •Thomas Bretz for the FACT Collaboration-Collaboration — RWTH Aachen, III. Physikalisches Institut A, Germany

The First G-APD Cherenkov Telescope (FACT) has been monitoring bright sources at TeV energies since more than seven years, collecting a total of more than 12000 hours of physics data. Thanks to the usage of silicon-based photosensors, the duty cycle of the instrument is maximized and the gaps in the light curves are minimized. Combined with the observing strategy of unbiased monitoring, an unprecedented data sample has been obtained.

This allows not only for systematic studies of the variability of the sources, but also triggers a lot of multi-wavelength observations. Recent results from these studies will be presented.

Gruppenbericht T 39.2 Di 16:20 S14

MAGIC: Highlights and recent developments from the Galactic and extragalactic physics programme — •Dominik Elsässer for the MAGIC-Collaboration — TU Dortmund

The MAGIC telescope system consists of two 17m diameter imaging air Cherenkov telescopes operated at the Canary Island of La Palma. Even after more than 15 years since the inauguration of the first telescope, and several highly successful upgrades of the system, the physics portfolio of MAGIC is still growing in both scope and depth. In this talk, recent highlights from the observational programme will be presented, which include amongst others detailed studies of the VHE spectra of supernova remnants, key contributions to multi wavelength campaigns on AGN, and the detection of VHE emission from a blazar coincident with a high energy neutrino event. The talk will conclude with an outlook on propagating this programme into the era of the Cherenkov Telescope Array.

T 39.3 Di 16:40 S14

FACT - Spectral variability of TeV-blazars — •Marc Klinger, Marvin Beck, Fabian Theissen, and Thomas Bretz for the FACT Collaboration-Collaboration — RWTH Aachen, Germany

Due to it's ability to measure even under extreme conditions such as full moon nights in combination with it's completely automatic data taking system, the First G-APD Air Cherenkov Telescope (FACT) is well suited for the long term observation of gamma-ray sources. Since the first light in 2011, more than seven years of data from several sources has been acquired, in particular also from two of the brightest TeV-blazars Mrk421 and Mrk501. This allows an unprecedented insight into the variability of these objects. Extracting spectra and combining them with other multi-wavelength data allows to compile time-resolved spectral energy distributions challenging most models.

In this context, a recent model will be studied. It is based on particle-in-cell (PIC) simulations of reconnection driven plasmoids forming in a blazar's jet. In contradiction to most used steady state models, it directly provides predictions on the temporal behavior which can be compared with experimental data.

T 39.4 Di 16:55 S14

FACT - Studying Blazar Variability — •Bernd Schleicher for the FACT Collaboration-Collaboration — Universität Würzburg

The First G-APD Cherenkov Telescope (FACT) is monitoring a small sample of high energy gamma-ray sources. Active Galactic Nuclei emit radiation over the whole electromagnetic spectrum up to TeV energies. Blazars are one subtype with their jets pointing towards the observer. One of their typical features is extreme variability on timescales from minutes to years. To quantify the variability of a light curve, often the fractional variability is used. To study blazar variability depending on energy and time, FACT data are combined with public multi-wavelength data from other instruments in various energy ranges. Different detection methods and sensitivities of the instruments result in different cadence and time binning of the data sets. 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 of cadence and time binning are investigated. On the other hand, the fractional variability is studied depending on energy and time.

T 39.5 Di 17:10 S14

Multiwavelength Analysis of NGC 1275/3C 84 using MAGIC, FermiLAT and VLBA Data — •Lena Linhoff and Kevin Schmidt — TU Dortmund

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. Radio images show multiple and variable emission regions within the core of the galaxy moving away from the innermost core component. In the gamma ray regime the source is known to be variable in flux and experienced some flaring activity in 2017. The Radio flux shows a slight but constant increase in radio emission until mid 2016. Since the origin of the gamma ray emission is still unclear, multiwavelength studies are performed to explain the behavoir of the source. This talk presents a multiwavelength analysis using data taken by MAGIC and the VLBA from 2005 until 2018.

T 39.6 Di 17:25 S14

GRB observations with H.E.S.S. II — •Edna L. Ruiz-Velasco for the H.E.S.S-Collaboration — Max Planck Institute for Nuclear Physics, Heidelberg, Germany

Imaging Atmospheric Cherenkov Telescopes (IACTs) present larger effective area than GeV-range gamma-ray satellites like Fermi-LAT at energies above 50 GeV. The later, has proven the existence of non-thermal high energetic gamma-ray emission of many gamma-ray burst (GRBs) up to energy of tenths of GeVs. The High Energy Stereoscopic System (H.E.S.S) is an IACT array composed by four 12 m diameter and one 28 m diameter telescopes, making it the first hybrid array of Cherenkov Telescopes. Its characteristics allows and energy threshold of ~100 GeV and unprecedented sensitivity making it perfectly suitable for studying the very-high energy emission of GRBs. In this contribution we will describe the H.E.S.S. GRBs observation program, the trigger methods and results on several GRBs observed in the previous years. This compilation represents the largest list of GRB triggers

followed up with IACTs and provides numerous inputs for GRB modelling at the very high energies.

T 39.7 Di 17:40 S14

Overview of recent results of 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 and cosmic-ray studies with the MAGIC telescopes. MAGIC is a stereoscopic system of two imaging atmospheric Cherenkov telescopes located on the Canary island of La Palma. Recent efforts of the group comprise hunting for indirect gamma-ray signals from WIMP dark matter in dwarf galaxies and the Perseus cluster of galaxies; probing the Lorentz invariance of gamma-ray signals from the Crab pulsar; and limits on the flux of Earth-skimming PeV τ neutrinos. We will conclude with an outlook on ongoing analyses and current efforts of the group.

T 39.8 Di 17:55 S14

MAGIC Obsevations of Pulsars with the Sum-Trigger-II — •Ceribella Giovanni for the MAGIC-Collaboration — Max-Planck-Institut für Physisk, München, Deutschland

MAGIC is a stereoscopic system of two Imaging Atmospheric Cherenkov Telescopes at 2200 m above see level, on the Spanish Canary Island of La Palma. During the first 15 years of activity, MAGIC gave birth to the observation of VHE pulsars from the ground with the discovery of the emission above 25 GeV of the Crab Pulsar, and continued contributing to the study of this object through multiple observation campaigns.

In the last years a low-energy trigger system, the Sum-Trigger-II, has been put into operation. This made MAGIC a very proficient instrument for the observation of soft gamma-ray emitters such as pulsars. This recently led to the detection of pulsed gamma rays from the Geminga pulsar, which became the third known object of its kind to be observed with IACTs.

In this talk we will review MAGIC results in the field of VHE pulsars with Crab and Geminga data. In addition, we will present technical details on the Sum-Trigger-II.

T 39.9 Di 18:10 S14

Very Large Zenith Angle Observations with the MAGIC Telescopes — •Juliane van Scherpenberg[1], Razmik Mirzoyan[1], Ievgen Vovk[1], Michele Peresano[1], Darko Zaric[2], Jürgen Besenrieder[1], and Masahiro Teshima[1] — [1]Max-Planck Institut für Physik, München, Deutschland — [2]University of Split, Croatia

The MAGIC Telescopes are a system of two Imaging Air Cherenkov Telescopes (IACTs) located at the Roque de los Muchachos Observatory on the Canary Island of La Palma. MAGIC can observe very-high energy (VHE) gamma rays from around 50 GeV to 50 TeV. In the last years, MAGIC performed observations at very large zenith angles (VLZA) to extend the spectra up to the highest gamma-ray energy regime. However, measurements of this kind bear many challenges. The calibration of the atmosphere needs to be well understood as well as more technical restrictions concerning for example the image size of the shower and the azimuthal dependence of the stereo reconstruction quality. I will present the methods we use to account for these difficulties and show the first results of VLZA observations of the Crab Nebula.

T 40: Flavorphysik I

Zeit: Dienstag 16:00–18:30 Raum: S15

T 40.1 Di 16:00 S15

Search for the Rare Decay B $\to \mu\nu$ with the Belle Experiment — •Markus Prim, Florian Bernlochner, Michael Feindt, and Pablo Goldenzweig — ETP, KIT, Karlsruhe

The Belle experiment at the Japanese research facility KEK recorded a data sample of 772 million $B\bar{B}$ decays of the $\Upsilon(4S)$ resonance. Studying rare modes of these B mesons is interesting, because the influence of new physics on the branching ratios can be large. One such rare decay, which is helicity suppressed in the Standard Model, is the leptonic decay $B \to \mu\nu$, with a muon and a muon-neutrino in the final state. We present the result of the search for this decay with an inclusive reconstruction of the tag B, with an emphasis on the calibration of the inclusive tag and an improved background modeling of $B \to X_u l\nu$ processes. In addition, the search for a heavy sterile neutrino with the same final state is presented.

T 40.2 Di 16:15 S15

Search for the rare decays B$^\pm$ -> $l^\pm l^\mp l^\pm \nu$ at the Belle experiment — •Gabriel Seitz, Florian Bernlochner, Pablo Goldenzweig, Moritz Gelb, and Felix Metzner for the Belle 2-Collaboration — ETP, KIT, Karlsruhe

The leptonic B Meson decay with light charged leptons in the final state is strongly helicity suppressed in the Standard Model. This suppression can in principle be lifted if a real or virtual photon is emitted from the quark-lines before the decay, what enhances the branching fraction. The decays B$^\pm$ -> $l^\pm l^\mp l^\pm \nu$, where two of the leptons result from an emitted $\gamma^{(*)}$, presents the opportunity to study this effect of the cancellation of the helicity suppression in detail. The branching fraction itself also depends on the first inverse moment of the light-cone distribution, λ_B, which is a non-perturbative parameter important for QCD factorization. The parameter λ_B cannot be calculated from first principles and a measurement of the branching fraction of B$^\pm$ -> $l^\pm l^\mp l^\pm \nu$ allows its determination. This talk presents the current status of the search for this decay signature using the full Belle dataset of 711 fb^{-1} of integrated luminosity. The simulated and recorded collisions were converted with the B2BII tool to allow the analysis to take place in the Belle II software framework.

T 40.3 Di 16:30 S15

Studies for the measurement of $B^0_{s,d} \to \mu^+\mu^-$ using the full dataset of the LHCb experiment — Johannes Albrecht and •Titus Mombächer — Experimentelle Physik 5, TU Dortmund

The successful observation of the decay $B^0_s \to \mu^+\mu^-$ by a single experiment was achieved by the LHCb collaboration using a dataset corresponding to 5 fb^{-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 $B^0_d \to \mu^+\mu^-$ could not be measured yet.

This talk presents first studies to measure the decays $B^0_{s,d} \to \mu^+\mu^-$ on the full Run 1 and Run 2 dataset recorded by the LHCb experiment corresponding to 9 fb^{-1}.

T 40.4 Di 16:45 S15

Search for the rare decay $B^0_{(s)} \to e^+e^-$ with the LHCb experiment — Johannes Albrecht, •Alexander Battig, Titus Mombächer, and Stefanie Reichert — 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 $B^0_s \to \mu^+\mu^-$, 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 fb^{-1}.

T 40.5 Di 17:00 S15

Measurement of the differential branching fraction of $B^0_s \to \phi\mu^+\mu^-$ using LHCb data — •Sophie Kretzschmar, Christoph Langenbruch, and Eluned Smith — RWTH Aachen

The LHCb detector at CERN is an experiment optimized 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 update will be performed using the additional data collected by the LHCb experiment since 2015. This further analysis will provide more insight on the nature of this discrepancy with the SM.

This talk will give an overview of the analysis strategy used to measure the branching fraction of the decay $B_s^0 \to \phi\mu^+\mu^-$. In addition, the possibility of the first observation of the rare decay $B_s^0 \to f_2'(1525)\mu^+\mu^-$ will be discussed. The current status of the on-going analysis of the combined Run 1 and 2 LHCb data sample will be presented.

T 40.6 Di 17:15 S15

Angular analysis of $B_s^0 \to \phi\mu^+\mu^-$ decays — •Marcel Materok, Christoph Langenbruch, and Eluned Smith — RWTH Aachen

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 $b \to s\ell^+\ell^-$ 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. The focus of this talk will be on the validation of the angular fit.

T 40.7 Di 17:30 S15

Search for rare $B^0 \to (\pi^0, \eta, \eta')l^+l^-$ decays at Belle — •Maryam Salehi and Thomas Kuhr — Ludwig-Maximilians-Universität München,Munich, Germany

The decay $B^0 \to (\pi^0, \eta, \eta')l^+l^-, (l = e, \mu)$ proceeds through the flavor changing neutral current (FCNC) $b \to dl^+l^-$. In the Standard Model (SM), these decays are forbidden at tree level and can only occur in higher orders. Therefore the predicted branching fractions in the SM are of the order of 10^{-8}. The $b \to dl^+l^-$ transition provides a promising avenue to search for New Physics (NP). Amplitudes from these NP contributions can interfere with those from the SM, and significantly enhance the branching fractions from the SM predictions. I will present a search for rare neutral current decays $B^0 \to (\pi^0, \eta, \eta')l^+l^-$, using a sample of $772 \times 10^6 B\overline{B}$ pairs collected with the Belle detector at the e^+e^- asymmetric collider KEKB.

T 40.8 Di 17:45 S15

Search for $B \longrightarrow K\nu\nu$ at Belle II — •Johannes Kainz for the Belle 2-Collaboration — Ludwig-Maximilians-Universität, München

There have been deviations from the standard model expectation observed in $B \longrightarrow K^*l^+l^-$ in experiments such as LHCb. They are in particular present in lepton flavour universality tests. To further investigate this behaviour, the Belle II Collaboration will collect data that allows us to study $B \longrightarrow K\nu\nu$ decays. These processes are challenging to analyze, since the neutrinos are not detected directly. Therefore it is necessary to reconstruct the second B decay in $e^+e^- \longrightarrow Y(4S) \longrightarrow B\bar{B}$ events completely, in order to get hints on the missing momentum due to the neutrinos and to separate signal from background events.

T 40.9 Di 18:00 S15

Messung des inklusiven $B \to X_s\gamma$ Verzweigungsverhältnisses und spektraler Momente mit dem Belle-Datensatz — •Mario Arndt, Luis Pesantez und Jochen Dingfelder für die Belle 2-Kollaboration — Rheinische Friedrich-Wilhelms-Universität Bonn

Mit dem am KEKB, einem asymmetrischen e^+e^--Kollider, gelegenen Belle-Detektor wurden 770 x 106 $B\bar{B}$ Paare bei einer Schwerpunktenergie von 10.58 GeV aufgenommen. Die hier vorgestellte Analyse befasst sich mit der Messung der radiativen B-Zerfälle $B \to X_s\gamma$. Diese Zerfälle sind im Standardmodell unterdrückt und nur durch Prozesse höherer Ordnung möglich, die sensitiv auf Beiträge neuer Physik sind. Das vermessene Verzweigungsverhältnis liefert z.B. Einschränkungen auf Modelle mit geladenen Higgs-Bosonen (2HDM). Es werden die Ergebnisse der Analyse vorgestellt: die Messung des E_γ-Spektrums, der spektralen Momente und der partiellen Verzweigungsverhältnisse, sowie die Extraktion der HQE-Parameter m_b und μ_π^2.

T 40.10 Di 18:15 S15

Amplituden Analyse von $\Lambda_b \to D^0pK$ — •Harald Viemann — Institut für Physik - Uni Rostock, Rostock, Deutschland

Messungen zur CP Verletzung werden aktuell von Mesonen-Zerfällen dominiert. Zerfälle mit baryonischem Beitrag enden im Augenblick mit der Bestimmung der Asymmetrie, weshalb es die Messung der CKM-Phasen bei Baryonen noch nicht gibt und somit äußert interessant wäre. Der Zerfall $\Lambda_b \to D^0pK$ könnte über den Zerfall des D^0 Zugang zu der CKM-Phase Gamma erlauben. Präsentiert wird die Selektion der wichtigen D^0 Moden in $K\pi$, KK und $\pi\pi$ sowie die ersten Schritte zum Verständnis des Dalitz-Plots.

T 41: Theorie: Beyond the Standard Model

Zeit: Dienstag 16:00–18:15 Raum: S16

T 41.1 Di 16:00 S16

Sterile Neutrinos with Altered Dispersion Relations as an Explanation for the MiniBooNE, LSND, Gallium and Reactor Anomalies — •Dominik Döring[1], Philipp Sicking[1], Heinrich Päs[1], and Thomas J. Weiler[2] — [1]Technische Universität Dortmund — [2]Vanderbilt University, Nashville

Recently the MiniBooNE Collaboration has reported an anomalous excess in muon to electron (anti-)neutrino oscillation data. Combined with long-standing results from the LSND experiment this amounts to a 6.1 sigma evidence for new physics beyond the Standard Model. We develop a framework with 3 active and 3 sterile neutrinos with altered dispersion relations that can explain these anomalies without being in conflict with the absence of anomalous neutrino disappearance in other neutrino oscillation experiments.

T 41.2 Di 16:15 S16

Gauge Coupling Unification without Supersymmetry — •Jakob Schwichtenberg — TTP Karlsruhe Institut für Technologie, Karlsruhe, Deutschland

We discuss the prospects to achieve unification of the gauge couplings in models without supersymmetry. We restrict our discussion to $SU(5), SO(10)$ and E_6 models that mimic the structure of the Standard Model as much as possible ("conservative models"). One possible reason for the non-unification of the standard model gauge couplings are threshold corrections which are necessary when the masses of the superheavy fields are not exactly degenerate. We calculate the threshold corrections in conservative models with a Grand Desert between the electroweak and the unification scale. We argue that only in conservative E_6 models the corrections can be sufficiently large to explain the mismatch and, at the same time, yield a long-enough proton lifetime. A second possible reason for the mismatch are particles at an intermediate scale. We therefore also study systematically the impact of additional light scalars, gauge bosons and fermions on the running of the gauge coupling. We argue that for each of these possibilities there is a viable scenario with just one intermediate scale.

T 41.3 Di 16:30 S16

Coupling the SM to its dark side — Joscha Duchscherer, Florian Goertz, and •Matias Hersch — MPI Kernphysik, Heidelberg, Germany

We consider a 5d braneworld scenario in a linear dilaton background, coupling the SM to a (dark) mirror SM, with both living on separate 3-branes positioned at opposite ends of the $S^1/\mathbb{Z}_2$ orbifold. The

branes interact through dilaton fluctuations of the gravitational field and additional bulk fields. Along the potential to naturally suppress couplings to the dark brane, the dilaton geometry exponentially raises the fundamental 5d planck scale to an effective 4d planck scale on the SM brane posing a solution to the hierarchy problem. This talk discusses motivations, phenomenology and model building aspects of the theory.

T 41.4 Di 16:45 S16

Asymptotic safety and flavour phenomenology from an extended Yukawa sector — •Clara Hormigos Feliu — TU Dortmund, Otto-Hahn-Str. 444227 Dortmund, Germany

Recent works have shown that gauge-Yukawa theories can potentially be rendered UV complete by reaching a weakly interacting fixed point at high energies. This behaviour, known as Asymptotic Safety (AS), is a generalisation of the well-known asymptotically free behaviour of the non-abelian gauge couplings of the Standard Model (SM), and requires the presence of additional Yukawa interactions. In this talk, we explore SU(2)xU(1) extensions of the SM and their potential to deliver AS through Yukawa interactions with the lepton sector. Since the requirement of AS is highly predictive of the BSM couplings once matching to the SM is established, this allows us to test our models through phenomenological constraints. Furthermore, we find that certain scenarios can provide contributions to the muon anomalous magnetic moment which relax its long-standing discrepancy with the SM.

T 41.5 Di 17:00 S16

Phenomenology of the gaugino-sector in the muNMSSM — •Steven Paasch — Deutsches Elektronen-Synchrotron

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 μNMSSM model with an additional parameter which can be embedded consistently into inflation models. We studied the mass spectra in the Higgs and gaugino sector and checked wether the discussed scenarios could be accessible by LHC analysis via applying the programm CheckMATE.

T 41.6 Di 17:15 S16

Phenomenology of the Higgs-sector in the μNMSSM — •Cheng Li and Gudrid Moortgat-Pick — II. Institute for Theoretical Physics-University Hamburg, Hamburg, German

The Next-to-Minimal Supersymmetric Standard Model (NMSSM) with an additional singlet of Higgs sector is a well-motivated extension to the Minimal Supersymmetric Standard Model (MSSM). This additional singlet relaxes constraints within the Higgs sector, and also provides several candidates for cold dark matter. In the talk we also discuss the μNMSSM model which in addition can be embedded consistently into inflation models. Within in the μNMSSM, study the mass spectra in the Higgs and check whether the discussed scenarios may be accessible via LHC analysis via applying the program CheckMATE.

T 41.7 Di 17:30 S16

T_u model unitarization in VBS — •Heiko Schäfer-Siebert — KIT, ITP

Vector Boson Scattering (VBS) at the LHC provides a window on possible effects of physics beyond the SM in electroweak symmetry breaking, which can be described in an effective Lagrangian framework. The use of higher dimension operators leads to a UV incomplete theory, however, that breaks unitarity at high energies. In order to handle this unphysical behavior and to study VBS phenomenologically, the T_u model was developed as a numerical unitarization scheme for off-shell weak boson scattering. I will present the T_u unitarization procedure and its application to dimension eight operators that influence the $VV \to VV$ scattering within the full VBS $VVjj$ production processes. The necessary adaptations when going from same sign WW to $WZjj$ and $W\gamma jj$ production are discussed, including the influence of Higgs boson states on the unitarization results.

T 41.8 Di 17:45 S16

Phenomenology of a unified model containing leptoquarks — •Thomas Faber[1], Werner Porod[1], Yang Liu[1], Matěj Hudec[2], Michal Malinský[2], Florian Staub[3], and Helena Kolešová[4] — [1]Julius-Maximilians-Universität, Würzburg, Germany — [2]Charles-University, Prague — [3]Karlsruhe Insitute of Technology, Germany — [4]University of Stavanger, Norway

We investigate a unified model based on the gauge group $G = SU(4) \times SU(2)_L \times U(1)_R$, which contains scalar leptoquarks as well as other new particles like scalar gluons in the TeV range. First, we studied the impact on low enery observables (e. g. meson decays). This allows to constrain the parameter space. We show that there are allowed sets of parameters which can also explain the measured values for R_K/R_{K^*}. The allowed parameter regions impy rather specific decay properties of the leptoquarks and the scalar gluons. We discuss their phenomenology at the LHC and a prospective 100 TeV pp collider.

T 41.9 Di 18:00 S16

Model building in anomaly free U(1)′ extensions — •Rigo Bause and Gudrun Hiller — TU Dortmund

A crucial feature for a consistent quantum field theory is the cancellation of gauge anomalies, which is present in the SM and also needs to hold for any extension thereof constraining charges of B(SM) fermions.

The concept of asymptotic safety can prevent the rise of a Landau pole and allows for fixed points of the renormalisation group flow in a UV completion.

In this talk, U(1)′ extensions with generation-dependent charges that address present flavour anomalies are examined regarding anomaly cancellation. We discuss the selection process of possible models and further use the asymptotic safety approach to avoid Landau poles. We analyse interacting fixed points of models with a small number of degrees of freedom and study how the SM can emerge at lower energies through matching.

T 42: Experimentelle Methoden I

Zeit: Dienstag 16:00–18:35 Raum: ST 1

Gruppenbericht T 42.1 Di 16:00 ST 1

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

The *Mu3e* experiment is designed to search for the lepton flavour violating decay $\mu^+ \to e^+e^-e^+$. The aim of the experiment is to reach a branching ratio sensitivity of 10^{-16}. In a 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 with a momentum of about 28 MeV/c are stopped and decay at rest on a target. 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 silicon pixel sensors. 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 reaching 100 tracks per reconstruction frame of 50 ns in the final phase of experiment. To deal with such a high occupancy and combinatorics the *Mu3e* track reconstruction uses a novel fit algorithm that in the simplest case takes into account only the 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. The 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 42.2 Di 16:20 ST 1

Selective background Monte Carlo simulation at Belle II — •James Kahn and Thomas Kuhr — Ludwig-Maximilians-Universität München

The Belle II experiment, beginning data taking with the full detec-

tor in early 2019, is expected to produce a volume of data fifty times that of its predecessor. With this dramatic increase in data comes the opportunity for studies of rare, previously inaccessible processes. The investigation of such rare processes in a high data volume environment requires 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 presents a significant challenge in terms of computing resource requirements and calls for more intelligent methods of simulation, in particular 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 convolutional neural networks. The results show a robust training that is integrated natively into the existing Belle II analysis software framework.

T 42.3 Di 16:35 ST 1

New formulas to handle uncertainty from limited Monte Carlo statistics — •Thorsten Glüsenkamp for the IceCube-Collaboration — FAU Erlangen-Nürnberg, Erlangen, Bayern

This talk will discuss new probabilistic approaches to handle the statistical uncertainty from Monte Carlo statistics for Poisson likelihoods. First, it will be shown how five approaches from the last 25 years, starting with Barlow/Beeston in 1993, are related to each other. Then, the approaches are compared in a typical Toy MonteCarlo setting representatative of high-energy particle experiments. The results indicate the advantages of the new formulas over the old ones in terms of speed, interpretability, and ability to mitigate the statistical bias.

T 42.4 Di 16:50 ST 1

BAT.jl - A new toolkit for Bayesian analysis — •Cornelius Grunwald, Kevin Kröninger, and Salvatore La Cagnina — TU Dortmund, Experimentelle Physik IV, Deutschland

In all but the simplest cases, performing Bayesian inference can be a computationally challenging task. Performant algorithms and tools are needed to apply Bayesian statistics to the complex problems of modern data analysis. The Bayesian Analysis Toolkit (BAT) is a software package that allows the application of Bayesian inference through the use of Markov Chain Monte Carlo techniques. BAT provides a toolbox of algorithms and statistical methods that facilitate solving user-defined problems in a Bayesian approach. In order to improve its applicability, a complete rewrite of BAT is currently in process. Using the Julia programming language for core development and targeting innovative sampling algorithms, the performance of BAT will be increased and computation times will be reduced. Software dependencies will be minimized and interfaces to commonly used languages and tools are going to be provided. This will enhance the general usability of BAT and allow to extend its applicability to further fields of research. In this talk, the approach for the redevelopment of BAT will be presented and first insights into the current status of the project will be given.

T 42.5 Di 17:05 ST 1

Pileup mitigation with Constituent Subtraction — •Peter Berta and Lucia Masetti — JGU Mainz, Mainz, Germany

The ability to correct jet kinematics and substructure for simultaneous proton-proton interactions (pileup) largely determines the precision of measurements and searches at the Large Hadron Collider. In this talk, the Constituent Subtraction method for pileup mitigation in jets will be presented. This method corrects the jet inputs from the whole event before jet clustering based on the average pileup density in the event. Phenomenological studies showed potential for sizable improvements in performance for small- and large-radius jets compared to the previously used methods. Several improvements are presented, along with performance studies for expected pileup conditions at the LHC Run 2 and Run 3.

T 42.6 Di 17:20 ST 1

What can High Energy Physics Tracking learn from 1990s computer graphics? — •Paul Gessinger[1,2], Andreas Salzburger[2], and Stefan Tapprogge[1] — [1]Johannes Gutenberg-Universität Mainz — [2]CERN

The process of forming particle trajectories from measurements is called track reconstruction. Due to pile-up, this quickly becomes the most resource intensive part of event reconstruction in HEP. In recent runs of the LHC, experiments have successfully used highly optimized software to achieve desirable computational and physics performance. In light of the upcoming increase of luminosity for the HL-LHC, new solutions are being developed. Propagation and navigation of particle trajectories through the detector are particularly CPU intensive tasks. This is essential for fitting tracks, and thus is revisited in the Acts project. In computer graphics, highly performant ray tracing algorithms are used frequently. Using ray-box intersections in hierarchies of boxes, intersections of the assumed direction of a track and the detector geometry can be found efficiently. These algorithms could enable a more robust and flexible alternative to other navigation solutions. The approach could also alleviate some of the sophistication and fine-tuning required in building geometries which can be navigated easily. Different navigation strategies through HEP detector geometries and their interplay with track reconstruction will be covered in this talk. Benefits and pitfalls of the different approaches will be reviewed. The usage of intersection algorithms for fast navigation will be investigated and applicability to real-world tracking scenarios will be evaluated.

T 42.7 Di 17:35 ST 1

3D Track Finding in the Preprocessing of the Belle II L1 Neural Network z-Vertex Trigger — •Sebastian Skambraks, Christian Kiesling, Sara McCarney, and Felix Meggendorfer for the Belle 2-Collaboration — MPI for Physics

Neural networks are going to be used in the pipelined first level trigger of the upgraded flavor physics experiment Belle II at the high luminosity B factory SuperKEKB in Tsukuba, Japan. An instantaneous luminosity of $\mathcal{L} = 8 \times 10^{35} \mathrm{cm}^{-2} \mathrm{s}^{-1}$ is anticipated, 40 times larger than the world record reached with the predecessor KEKB. Background tracks, with vertices displaced along the beamline (z-axis), are expected to be severely increased due to the high luminosity. Using the hit and drift time information from the central drift chamber, the online neural network trigger estimates the 3D track parameters of single tracks found by the track finder. This robust estimation of the z-vertices significantly improves the suppression of displaced background tracks. A machine learning based extension of the conventional 2D Hough track finder to 3D is discussed, which allows to use the stereo sense wire information in the track finding and thus to improve the track finding efficiency. The estimated polar track angle can be used for a further specialization of the following neural networks to phase space sectors.

T 42.8 Di 17:50 ST 1

Highly performant, deep neural networks with sub-microsecond latency for trigger FPGAs — •Noel Nottbeck, Volker Büscher, and Christian Schmitt — Johannes Gutenberg-Universität Mainz

Artificial neural networks are becoming a standard tool for data analysis, but their potential remains yet to be widely used for hardware-level trigger applications. Nowadays, high-end FPGAs, as they are also often used in low-level hardware triggers, offer enough performance to allow for the inclusion of networks of considerable size into these systems for the first time. Nevertheless, in the trigger context, it is necessary to highly optimize the implementation of neural networks to make full use of the FPGA capabilities.

We optimized and implemented the processing and control flow of typical NN layers for use within FPGAs, such that they can run efficiently in a real-time context with e.g. the ATLAS data rate of 40 MHz and latency limits of at most few hundred nanoseconds for entire networks. Significant effort was put especially into the 2D convolutional layers, to achieve a fast implementation with minimal resource usage.

A Python-based toolkit has been developed that makes implementing a neural network into an FPGA as easy as executing a few lines of code on an already trained Keras network. Results are presented, both for individual layers as well as entire networks created by the toolkit.

T 42.9 Di 18:05 ST 1

First Level Neural Network z-Trigger optimization and implementation or the Drift Chamber at the Belle II Experiment — •Sara McCarney, Christian Kiesling, Felix Meggendorf, and Sebastian Skambraks — Max Planck Institute for Physics, Munich, Germany

For the Belle II experiment at the SuperKEKB asymmetric electron-positron collider (KEK, Japan), a z-trigger for Belle II is required to suppress the dominating background of tracks from outside of the collision point. The concept of a first level track trigger, realized by neural networks, is presented. The Multi Layer Perceptron (MLP) Neural Network, using drift times and a traditional Hough-based 2D track finder as input, reconstructs the origin of the tracks along the beam's z-axis. Training and testing on simulated tracks achieve resolutions below 2 cm in the high Pt region, and below 5 cm in the low Pt region, suf-

ficient for efficient background rejection. The importance of various training parameters and drift time inputs on the optimal spatial resolution of the z-trigger is discussed. Background distributions from first data taking with Belle II are analyzed to optimize suitable z-cuts for an efficient background suppression.

T 42.10 Di 18:20 ST 1

Data Quality Monitoring for the Neural Network z-Trigger in the Drift Chamber at the Belle-II Experiment — •Felix Meggendorfer, Sebastian Skambraks, Sara McCarney, and Christian Kiesling for the Belle 2-Collaboration — MPI for Physics

For the drift chamber of the Belle-II experiment located in Tsukuba, Japan, a first level hardware neural network z-trigger is added to the standard 2D track trigger, which is used to identify tracks coming from outside of the interaction region. With this additional condition, a dominating portion of the background is efficiently suppressed and pure 2-track triggers become possible. Since changing background conditions during the first years of SuperKEKB operation are expected, the neural network weightsets will be adapted accordingly. In order to ensure optimal trigger efficiency and background rejection it is important to monitor the performance of the networks over time and retrain and update their weightsets with data from the experiment. An overview of the data quality monitoring system for the neural z-trigger is presented.

T 43: DAQ und Trigger II

Zeit: Dienstag 16:00–18:30 Raum: ST 2

T 43.1 Di 16:00 ST 2

Auslese des ATLAS ITk Pixel Barrel Demonstrators mit RCE GBT — •Eric Buschmann, Jörn Grosse-Knetter und Arnulf Quadt — II. Physikalisches Institut, Georg-August-Universität Göttingen

Die erhöhte Luminosität des Large Hadron Colliders (LHC) nach dem geplanten Upgrade zum High Luminosity LHC (HL-LHC) stellt hohe Anforderungen an die Detektor- und Auslesesysteme. Für den ATLAS Detektor am LHC ist hierfür ein vollständiges Ersetzen des jetzigen Spurdetektors (Inner Detector) durch einen vollständig halbleiterbasierten Inner Tracker (ITk) bestehend aus Pixel- und Streifensensoren geplant. Besonders die Auslese der innersten Pixellagen stellt eine Herausforderung dar und benötigt eine Übertragungsrate von einigen Gb/s pro Modul.

Der ITk Pixel Barrel Demonstrator ist ein Stave-Prototyp im ITk-Layout, aber bestückt mit der momentan verfügbaren Frontend-Generation. Ein Auslesesystem für den Demonstrator basiert auf der RCE (Reconfigurable Cluster Element) Plattform, welche ARM Prozessoren mit FPGAs integriert und als Test- und Entwicklungsplattform für das ATLAS Upgrade Verwendung findet. Mithilfe des GBTx-Chips können bis zu 20 der Frontend-Links mit 160 Mb/s zu einem optischen Link mit 3,2 Gb/s gebündelt werden, vergleichbar mit der Datenrate eines ITk Pixel Moduls. Der aktuelle Stand der Entwicklung und aktuelle Ergebnisse werden vorgestellt.

T 43.2 Di 16:15 ST 2

Entwicklungen zur Parallelisierung der ITk-Auslesesoftware — Carsten Dülsen, Tobias Flick, •Marvin Emin Geyik, Wolfgang Wagner und Marius Wensing — Bergische Universität Wuppertal

Im Rahmen des LHC-High-Luminosity Upgrades wird der ATLAS-Detektor umgebaut, um die Signale bei einer um das zehnfache erhöhten Ereignisrate verarbeiten zu können. Insbesondere wird ein neuer innerer Spurdetektor (Inner Tracker, ITk) eingebaut. Die Software des ITk-Auslesesystems befindet sich gegenwärtig in der Entwicklung. Es werden Arbeiten an dieser Software präsentiert, die eine parallele Verarbeitung der Daten mehrerer Auslesekarten an einem PC ermöglichen.

T 43.3 Di 16:30 ST 2

Erweiterung der FELIX Firmware für den ATLAS ITk Pixel Detektor im Phase II Upgrade — •Carsten Dülsen, Tobias Flick, Wolfgang Wagner und Marius Wensing — Bergische Universität Wuppertal

Im Jahr 2026 wird in den ATLAS Detektor ein neuer innerster Spurdetektor (Inner Tracker, ITk) eingebaut. Die Datenauslese des ITk wird mit dem neuartigen, netzwerkbasierten FELIX System ausgestattet sein, welches die Ereignisdaten vom Detektor ausliest und zur Verarbeitung an eine Serverfarm weiterreicht. Aufgrund der Größe und Komplexität stellt der ITk sehr hohe Anforderungen an dieses. Es sollen das FELIX-Konzept sowie die ersten Implementierungen in der FELIX Firmware für den ITk Pixel Detektor vorgestellt werden.

T 43.4 Di 16:45 ST 2

SoC based ADC readout for an intelligent PMT concept — Feng Gao, Florian Kiel, Tim Kuhlbusch, Achim Stahl, Jochen Steinmann, Christopher Wiebusch, and •Christian Wysotzki — III. Physikalisches Institut B, RWTH Aachen University

Many experiments rely on the use of large photomultiplier to achieve a large instrumented volume. In a novel readout approach, all electronics for the PMT are directly attached to its back. This reduces analog signal cable length and creates a very scalable system. In this talk the PMT readout is covered. A specialized ASIC – VULCAN – is used to amplify and digitize the analog signal. A system-on-a-chip (SoC) – consisting of a FPGA and an ARM processor – receives the data and preprocesses it. The FPGA part of the SoC is responsible for high-speed data analyses like trigger generation and data filtering. High-level analyses of the data – as gain determination on dark counts – and data transmission via Ethernet is done in the processor part of the SoC.

Results from a first prototype board are presented in the talk.

T 43.5 Di 17:00 ST 2

The conventional PMT system for OSIRIS — Feng Gao, Florian Kiel, •Tim Kuhlbusch, Achim Stahl, Jochen Steinmann, Christopher Wiebusch, and Christian Wysotzki — III. Physikalisches Institut B, RWTH Aachen

The 20-ton OSIRIS detector is designed to measure radiopurity and quality of the liquid scintillator for JUNO. This is especially necessary to commission the liquid handling and purification systems. OSIRIS will monitor the scintillator quality during the filling to ensure that JUNO reaches the design sensitivity. After filling of the central detector OSIRIS can be used for detailed studies of scintillator characteristics and monitoring. OSIRIS will harness two PMT systems: One is the novel iPMT system where each PMT is equipped with an intelligent readout electronic at the back. By reusing parts of the trigger system, FADCs, PMTs and Front End Electronics (FEE) from Double Chooz, the conventional PMT system is based on a reliable and well tested system. Due to the needs of OSIRIS the readout scheme is adapted to enable online reconstruction and to integrate the iPMT system.

T 43.6 Di 17:15 ST 2

The XENONnT Data Acquisition System — •Alexey Elykov for the XENON-Collaboration — Physikalisches Institut, Albert-Ludwigs-Universität Freiburg

The XENONnT experiment, currently under construction in the Laboratori Nazionali del Gran Sasso, is a liquid xenon-based multi-ton-scale dark matter detector. It will allow us to probe new parameter spaces of potential dark matter candidates and search for long sought-after processes, like neutrinoless double beta decay. The scintillation and photoionisation signals that will occur in the detector due to particle interactions will be amplified, digitised and recorded by a Data Acquisition (DAQ) system. This system is predominantly based on commercially available electronics, accompanied by custom-developed firmware and software. In combination with a novel data processing and data reduction 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, as well as its status and potential future developments.

T 43.7 Di 17:30 ST 2

Development of serial data link IC in 65nm CMOS for the RD53B HL-LHC pixel readout chip — Tomasz Hemperek, Hans Krüger, Konsantinos 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. Due to similar requirements ATLAS and CMS are working together within RD53 collaboration on a design of a pixel readout chip in 65nm CMOS technology to be used for the LHC Phase-II upgrade. This talk presents the I/O interface of this readout 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 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 send off-chip by a CML driver. Circuit description together with measurement results will be presented including jitter performance, startup reliability and radiation hardness.

T 43.8 Di 17:45 ST 2

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 — 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 3.1 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 43.9 Di 18:00 ST 2

Vergleich verschiedener Test-Auslesesysteme für den ATLAS Pixeldetektor — Carsten Dülsen, Tobias Flick, •Maren Stratmann, Wolfgang Wagner und Marius Wensing — Bergische Universität Wuppertal

Für den Betrieb im HL-LHC (High Luminosity LHC) ab 2026 wird ein neuer ATLAS Detektor entwickelt. In dessen innersten Spurendetektor ITk (Inner Tracker) kommen auch Pixeldetektoren zum Einsatz. Zum Auslesen der Daten aus den einzelnen Pixeln existieren verschiedene Test-Auslesesysteme, welche für den Einsatz im ITk entwickelt und getestet werden. Es werden verschiedene Test-Auslesesysteme (zum Beispiel RCE (Reconfigurable Cluster Element) und YARR (Yet Another Rapid Readout)) vorgestellt und miteinander verglichen.

T 43.10 Di 18:15 ST 2

Effizienzstudien zum Trigger auf fehlenden Transversalimpuls im Phase-II Upgrade des ATLAS-Experiments — •Falk Bartels — Kirchhoff-Insititut für Physik, Heidelberg, Deutschland

Im Rahmen des geplanten Phase-II Upgrade des Large Hadron Colliders wird dessen instantane Luminosität auf $10^{35}\mathrm{cm}^{-2}\mathrm{s}^{-1}$ erhöht, was etwa dem fünffachen des bisher erreichten Maximums entspricht. Durchschnittlich 200 Proton-Proton-Kollisionen werden dadurch zeitgleich als sogenannter Pile-Up im ATLAS-Detektor sichtbar sein.

Die bestehenden Algorithmen des Level-1-Triggers sind sehr empfindlich gegenüber Pile-Up-Effekten – insbesondere der Trigger auf fehlende transversale Energie produziert mit zunehmendem Pile-Up eine überproportional erhöhte Rate an falsch-positiven Entscheidungen. Dieser Vortrag präsentiert neue Rekonstruktionsalgorithmen für die fehlende transversale Energie, die die mittlere Energiedichte aus Pile-Up-Ereignissen berücksichtigen. Sie können die Rate an „fakes“ reduzieren und erlauben damit niedrigere Triggerschwellen bei gleicher Bandbreite.

T 44: Gasgefüllte Detektoren

Zeit: Dienstag 16:00–18:35 Raum: ST 3

Gruppenbericht T 44.1 Di 16:00 ST 3

A Prototype High Pressure Gas Time Projection Chamber for Future Long Baseline Neutrino Experiments — •Philip Hamacher-Baumann for the HPTPC-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

Currently, a High Pressure gas Time Projection Chamber (HPTPC) is included in the baseline design for the near detector in the Deep Underground Neutrino Experiment DUNE and is a candidate for Hyper-Kamiokande long baseline neutrino experiments. Increased pressure results in a likewise increased probability for (neutrino) gas interactions, but retains a low momentum detection threshold for final state particles, compared to liquid or solid detectors. A Prototype HPTPC rated to 5 bar of pressure was built, using a novel readout based on the detection of scintillation light from gas amplification. A beam test was performed at the CERN East Area T10 beamline from August to September 2018 making measurements of proton and pion interactions in the HPTPC together with an upstream and downstream time of flight system. First results of the analysis of the test beam data are presented.

T 44.2 Di 16:20 ST 3

Progress of the Picosec Micromegas concept towards a particle detector with a restive and segmented readout — •Lukas Sohl — IRFU, CEA, Université Paris-Saclay, F-91191 Gif-sur-Yvette, France

Detectors with a time resolution of several 10 ps and robustness under higher particles flux are necessary for an accurate vertex separation in future HEP experiments.

The Picosec detector concept is a Micro-Pattern Gaseous Detector (MPGD) based solution facing this particular problem. The Picosec concept is based on a Micromegas MPGD coupled with a Cherenkov radiator and a photocathode. The feasibility of this concept to reach a time resolution in the order of several 10 ps has been demonstrated with a measured time resolution of up to 24 ps. The next step is to further develop this concept towards a usable device for precise time and position measurements in high flux environments. To archive this goal several prototypes have been build and tested.

Micromegas with restive layers have been tested to operate the detector stable under a high intensity pion beam. With the additional protective layer a time resolution of up to 28 ps has been obtained.

Different types of photocathode materials have been tested in order to find a robust solution against ion back flow bombardment under higher particle flux. Moreover a first prototype has been tested with a hexagonal segmented anode pads. With this detector a combined time resolution of 36 ps for shared signals over multiple pads has been measured.

T 44.3 Di 16:35 ST 3

Fake track studies for the ATLAS TRT in high pileup scenarios — •Patrick Bauer, Klaus Desch, and Christian Grefe — Physikalisches Institut, Nussallee 12, D-53115 Bonn

The Transition Radiation Tracker (TRT) is an integral component of the inner tracking setup of the ATLAS detector at CERN. During Run 3 the increased luminosity provided by the LHC will lead to an $\langle\mu\rangle \geq 75$ compared to $\langle\mu\rangle \approx 25$ in 2016. Therefore it is essential to investigate the detector response and the track reconstruction performance in an high occupancy (up to 80 %) environment with large numbers of pileup tracks.
In order to ensure a optimal tracking it is important to keep the number of fake tracks caused by combining hits from different tracks (including pileup tracks) to a minimum. In this talk studies of the the fake track rates in ATLAS TRT are presented for high pileup scenarios.

T 44.4 Di 16:50 ST 3

Commissioning of a new gas system for the Würzburg cosmic

ray facility — •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 homogenious mixture of Argon and CO_2 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 likely. 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.

This talk will give an overview over the new system and will show first measurements.

T 44.5 Di 17:05 ST 3

Developement of a low background low energy X-ray detector for IAXO — •Tobias Schiffer, Klaus Desch, and Jochen Kaminski — Uni Bonn

Gaseous detectors and especially micropattern gaseous detectors like MicroMegas are commonly used in particle physics. Due to their high granularity they achieve a very high spatial resolution. An appropriate way to maximise this is a pixelised readout chip, like the Timepix3 ASIC, with a perfectly aligned gas amplification stage (InGrid) on top. This GridPix3 (the successor of GridPix) is also able to detect single primary electrons giving a good energy reconstruction for X-rays.

The search for solar axions and chameleons with helioscopes like the International Axion Obeservatory (IAXO) experiment requires detectors with very low background rates and high detector efficiency, since the expected rates are in the order of one per day and cm^2 or less in the region of 2 to 7 keV.

To achieve very low background rates the selection of special radiopure materials is required as well as a veto system for offline suppression of background events is necessary. In addition to gain a high detector efficiency an, in the low energy X-ray regime, highly transparent entrance window is important. This can be achieved by using utra thin (300 nm) vacuum-tight silicon nitride windows.

The challenges of building such a detector and the current developements will be presented.

T 44.6 Di 17:20 ST 3

Setup of a prototype for the SHiP Straw Tracker Spectrometer — •Benedict Kaiser, Caren Hagner, Daniel Bick, Stefan Bieschke, and Walter Schmidt-Parzefall — Universität Hamburg, Institut für Experimentalphysik, Luruper Chaussee 149, 22761 Hamburg

SHiP is a proposed general-purpose fixed-target experiment utilising 400 GeV protons from CERN's SPS accelerator. Its main focus is the search for hidden particles ("SHiP") such as Heavy Neutral Leptons (HNLs) in the intensity frontier. Besides, SHiP will also offer unparalleled measurements with τ-neutrinos and neutrino-induced charm production.

To fulfil this goal SHiP is designed as a bipartite detector consisting of an Emulsion Spectrometer and a Hidden Sector Decay Spectrometer. A crucial component of the latter is the Spectrometer Straw Tracker (SST) consisting of roughly 16000 straw tubes operated horizontally with an unprecedented length of five metres. Its purpose is the reconstruction of the vertices and masses of the hidden particles' trajectories.

Currently, a prototype of the SST consisting of four straw tubes is being built at Hamburg University. The layout of this prototype and first results will be presented in this talk.

T 44.7 Di 17:35 ST 3

Measuring the transverse diffusion with a Gas Monitoring Chamber — Philip Hamacher-Baumann, •Thomas Radermacher, Stefan Roth, and Jochen Steinmann — III. Physikalisches Institut B, RWTH Aachen University

The Gas Monitoring Chambers of the T2K near detector ND280 are originally built to monitor and measure the drift velocity and relative gain, which are used for calibrating the Time Projection Chambers. These GMCs can also be used to measure the transverse diffusion coefficient. The width of an electron cloud can be reconstructed by the distribution of measured charge on two adjacent pad rows. From the charge distributions at two known drift lengths the transverse diffusion coefficient is determined.

T 44.8 Di 17:50 ST 3

Studies on Temperature Effects in GridPix-based Detectors — •Lucian Scharenberg, Klaus Desch, Jochen Kaminski, and Tobias Schiffer — Physikalisches Institut, Universität Bonn

The GridPix technology is a read-out structure of gaseous detectors. It combines a MicroMegas-like gas amplification stage with a pixelised read-out, the Timepix ASIC. Capable of detecting single ionisation electrons, the advantages of the GridPix are a high spatial resolution and a good energy resolution. Thus the GridPix is the ideal detector technology for low background experiments, like the search for solar axions at the CERN Axion Solar Telescope (CAST) or its successor, the International Axion Observatory (IAXO).

During the development of a new detector for CAST a strong thermal influence on the detector operation was observed, which was related to the power consumption of the increased number of Timepix ASICs. It could be solved by installing an active water cooling. Nevertheless, a better understanding of the observed behaviour was pursued, since the development of a new detector for IAXO is considered. There the successor ASIC, the Timepix3, shall be used as read-out ASIC, which consumes about twice as much power as the Timepix.

Within this talk, the efforts to understand and quantify the temperature effects in GridPix-based detectors are presented. The dedicated test set-up, simulations, and results of the measurements are shown.

T 44.9 Di 18:05 ST 3

Study of ionizazion, apmplification and energy resolution in GridPix detectors — Klaus Desch, •Markus Gruber, and Jochen Kaminski — 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) 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 then called "GridPix". Such GridPix detectors can be used for several different applications like tracking in a TPC (for instance ILD TPC) or for detection of X-ray photons (for instance at CAST or IAXO). The advantage of such a setup is its low capacitance and thus low noise which leads to the possibility of single primary electron detection. For improving future GridPix detectors like the IAXO detector it is important to understand and quantify all detection processes.

The detection of single primary electrons was used for studies of the processes in the conversion and in the amplification region of a GridPix X-ray detector with the detection of low energetic X-ray photons. In the talk I will present measurements and results regarding the ionization, the amplification and the energy resolution. Furthermore I will present estimations of the Fano factor and the Penning transfer efficiencies in argon isobutane mixtures based on these measurements and corresponding Garfield++ simulations.

T 44.10 Di 18:20 ST 3

ROPPERI - A TPC readout with GEMs, pads and Timepix — •Ulrich Einhaus — Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg

A novel anode readout structure for time projection chambers is presented. It combines GEM amplification with small pads on a separate PCB (for flexibility) and a pixel chip, the Timepix, as on-board digitization electronics (for high integration). Pad sizes in the order of a few 100 μm allow for the identification of the initial electron clusters which leads to an improvement of particle identification capabilities via dE/dx. This talk summarizes the hardware development, highlighting the challenges of the production, as well as the analysis of noise data of the second-generation boards, showing the principal feasibility of the technology. The adapted MarlinTPC simulation chain, including usage of the astrophysics software 'Source Extractor' for cluster identification, gives performance prospects of a future intermediate or large scale system.

T 45: Detektorsysteme II

Zeit: Dienstag 16:00–18:15 Raum: ST 4

T 45.1 Di 16:00 ST 4

Testbeam Measurements with the RD53A Hybrid Pixel Readout Chip — Michael Daas, •Yannick Dieter, Tomasz Hemperek, Fabian Hügging, Jens Janssen, Hans Krüger, David-Leon Pohl, Mark Standke, Marco Vogt, Norbert Wermes, and Jochen Dingfelder — Physikalisches Institut der Universität Bonn

The high luminosity upgrade of the LHC (HL-LHC) at CERN poses new requirements on its detectors. In order to cope with the high radiation and high hit occupancy resulting from the high luminosity at the HL-LHC, new pixel readout chips need to be developed for the ATLAS and CMS phase 2 upgrades. RD53A is the first large-scale prototype which was developed within the RD53 collaboration, a joint effort of the ATLAS and CMS experiments. This hybrid pixel readout chip is processed in 65 nm CMOS technology with 50 um × 50 um pixel size and features better data rate capabilities and better radiation tolerance.

Besides the characterization of the chip in the lab, testbeam studies using high-energy beams are important as well. For this, a sensor has been bump-bonded to the chip, which can then be tested in a testbeam. Using a high resolution beam telescope facilitates the possibility of in-pixel studies. In this talk testbeam measurements using the RD53A readout chip with a 120 GeV pion beam at SPS (CERN) are presented.

T 45.2 Di 16:15 ST 4

Testbeam-Ergebnisse von bestrahlten Siliziumsensoren mit modifizierten ATLAS-Pixelimplantationen — •Mareike Weers, Silke Altenheiner, Andreas Gisen, Marius Hötting, Valerie Hohm, Kevin Kröninger, Alexander Kroner, Jonas Lönker, Mike Muschak, Jens Weingarten und Felix Wizemann — TU Dortmund, Experimentelle Physik IV

In Dortmund wurden planare n^+-in-n Silizium Pixelsensoren mit modifizierten n^+-Implantationen entwickelt, um das elektrische Feld zu erhöhen und somit die Ladungssammlung und die Effizienz der Teilchendetektion zu verbessern. Grundlage der Pixeldesigns ist das der planaren Pixelsensoren des IBL.

Nach der Bestrahlung mit Protonen oder Neutronen wird das Verhalten von mehreren Sensoren in Testbeam-Messungen untersucht.

Es zeigt sich, dass Sensoren, die mit Neutronen am Sandia ACC-Reaktor bestrahlt wurden, ein signifikant anderes Verhalten aufweisen als Sensoren, die zu derselben Fluenz mit Neutronen am TRIGA-Reaktor in Ljubljana oder mit Protonen am CERN PS bestrahlt wurden.

In diesem Vortrag wird der aktuelle Status unserer Untersuchung präsentiert. Gezeigt werden sowohl In-Pixel-Effizienzen von Sensoren, die in den verschiedenen Einrichtungen zu unterschiedlichen Fluenzen bestrahlt wurden, als auch erste Annealing-Ergebnisse.

T 45.3 Di 16:30 ST 4

Efficiency and Charge Sharing of Planar Pixel Sensors for the CMS Phase 2 Upgrade — •Finn Feindt[1], Aliakbar Ebrahimi[1], Erika Garutti[1], Paolo Gunnellini[1], Caroline Niemeyer[1], Daniel Pitzl[2], Georg Steinbrueck[1], Joern 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

For the high luminosity upgrade of the LHC a new pixel detector will be built to meet new requirements due to higher track multiplicities and an expected 1 MeV neutron equivalent fluence of up to 2.3×10^{16} neq/cm^2 after an integrated luminosity of 3000 fb^{-1}.
To fulfill these requirements new n^+p pixel sensors with pixel sizes of 50×50 μm^2 and 100×25 μm^2, an active thickness of 150 μm and various implantation and metalization geometries, pixel isolation and biasing schemes have been designed, manufactured and tested in a campaign of beam test measurements.
To determine the hit efficiencies of the new pixel sensors, the impact point of the beam electrons was determined using a track reconstruction in the beam telescope with a position resolution at the order of 5 μm. A CMS Phase 1 module was used as a time reference. The sensors irradiated up to fluences of 8×10^{15} neutrons/cm^2 show a hit efficiency above 99 % at bias voltages greater then 300 V.
In addition to results of the efficiency studies, results on charge sharing studies are shown in this talk.

T 45.4 Di 16:45 ST 4

Spatial resolution measurements with planar pixel sensors for the CMS Phase-2 Upgrade — •Irene Zoi[1], Aliakbar Ebrahimi[1], Finn Feindt[1], Erika Garutti[1], Paolo Gunnellini[1], Andreas Hinzmann[1], Caroline Niemeyer[1], Daniel Pitzl[2], Georg Steinbrück[1], and Jörn Schwandt[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

New pixel sensors are being developed for the CMS Phase–2 upgrade, that will operate at HL-LHC, where 200 pile-up events per bunch crossing may be reached. To pursue a high tracking efficiency in this condition, the granularity of the pixel detector will be six time higher than the current one and the sensors are required to be radiation hard.Various n^+p silicon pixel sensor designs are therefore being tested, with pixel sizes of 50×50 μm^2 and 100×25 μm^2 and an active thickness of 150 μm. The hit resolution improves from a reduced pixel size but it may deteriorate with radiation damage. This talk will present spatial resolution studies of non–irradiated and proton irradiated sensors bump bonded to ROC4Sens read-out chips, performed in the DESY test beam facility. Three parallel planes of sensors have been used, therefore not relying on an external reference tracking detector. Measurements have been performed for various sensor designs at different energies of the electron beam as well as incidence angles to investigate all the relevant contributions to the resolution. A resolution of a few μm, also after irradiation, has been achieved.

T 45.5 Di 17:00 ST 4

Testbeam Characterization of the ATLASpix _Simple Pixel Sensor Prototype in View of the Requirements for the CLIC Tracking Detector — •Jens Kröger — Uni Heidelberg & CERN

The ATLASpix_Simple is a Monolithic Active Pixel Sensor prototype produced in a commercial 180nm HV-CMOS process. It contains a self-triggered 25 x 400 pixel array with a pixel size of 130um x 40um. The chip features tunable in-pixel comparators and a digital periphery allowing for on-chip hit digitization. In order to characterize the chip and investigate its performance with respect to efficiency, timing and spatial resolution, testbeam campaigns are carried out in which the prototype is placed in a beam telescope consisting of multiple layers of pixel sensors. The beam telescope provides reference tracks to which the hits on the device-under-test can be compared with a high spatial and time resolution. This talk will introduce the ATLASpix sensor prototype. Furthermore, results from the testbeam performed with the CLICdp Timepix3 Beam Telescope at the H6 beamline of the SPS in November 2018 will be presented in view of the requirements of the CLIC tracking detector.

T 45.6 Di 17:15 ST 4

High rate electron beam tests with MuPix8 sensors at MAMI — •Carsten Grzesik — Institut für Kernphysik, Mainz, Deutschland

The Mainz Microtron (MAMI) is an electron accelerator at the Institute for Nuclear Physics in Mainz, that provides beam energies of up to 1.6 GeV. With its narrow beam profile, quasi continuous stream of particles and beam currents of up to 100 μA it is well suited for diverse test beam applications. One of them is the high rate testing of detector prototypes.

The talk discusses tests that have been conducted with MuPix8 sensor prototypes during a beam time in August 2018. Preliminary results focusing on the dependency of the detection efficiency on the particle rate will be presented. This is especially relevant for the envisaged usage of this sensor type in the P2 parity violating experiment at the new Mainz Energy-recovering Superconducting Accelerator (MESA).

T 45.7 Di 17:30 ST 4

Simulationen zur Optimierung des ATLAS-ITk-Pixel Testbeam-Aufbaus am DESY mit *Allpix Squared* — Andreas Gisen, Valerie Hohm, Kevin Kröninger, •Alexander Kroner, Mareike Weers und Jens Weingarten — TU Dortmund, Experimentelle Physik IV

Für das Upgrade des LHCs zum HL-LHC wird ein neuer Spurdetektor, der Inner Tracker (ITk), im ATLAS-Experiment eingebaut. Dieser soll den Anforderungen größerer Strahlenschäden und höherer Okkupanz gerecht werden, die durch die höhere Luminosität bedingt sind.

Sowohl für bestrahlte als auch für unbestrahlte Prototypen neuer Pixelsensoren wird die Detektionseffizienz in Testbeam-Aufbauten bestimmt. Dafür steht am DESY ein Elektronenstrahl mit einer Teilchenenergie von bis zu 6 GeV zur Verfügung.

Bei dem verwendeten Aufbau ist die Vielfachstreuung der Elektronen nicht vernachlässigbar, deshalb ist es wichtig die Geometrie des Testbeam-Teleskops bezüglich der Spurrekonstruktion zu optimieren. Eine genaue Spurrekonstruktion ist wichtig, um die Effizienz der Sensoren gut beschreiben zu können. Mithilfe des Simulations-Tools *Allpix Squared* wird versucht, sowohl die optimale Geometrie zu ermitteln, als auch die Testbeam-Rekonstruktionskette mit den simulierten Daten zu validieren.

In diesem Vortrag wird die Herangehensweise sowie die Ergebnisse dieser Simulationen vorgestellt.

T 45.8 Di 17:45 ST 4

The LYCORIS Large Area Strip Telescope — Ties Behnke, Ralf Diener, •Uwe Kraemer, Marcel Stanitzki, and Mengqing Wu — DESY, Hamburg, Deutschland

The continued drive to develop high precision detectors puts large demands on the test beam facilities. As part of the AIDA2020 project, the LYCORIS high precision large area silicon telescope is being developed as an upgrade of the DESY II Test Beam Facility.
LYCORIS is made of multiple $9.3 \times 9.3\,\mathrm{cm}^2$ silicon strip sensors based on a hybrid-less design. This design is realized by routing the charge signal gathered in the strips through an extra metal layer to the KPiX readout chip which is bonded directly to the surface of the sensor. This allows the system to achieve a strip pitch of 25 μm and being read out via only a small Kapton flex cable.
The current status of the project will be presented. This includes the hardware itself as well as the latest results from beam tests to determine the system's performance.

T 45.9 Di 18:00 ST 4

PEN als strukturelles szintillierendes Material für Low-Background Experimente — •Felix Fischer[1], Béla Majorovits[1], Connor Hayward[1,2], Erdem Öz[1] und Simon Eck[1] — [1]MPI für Physik, München, Deutschland — [2]Lancaster University, Lancaster, UK

Polyethylennaphthalat (PEN) ist ein im tiefblauen Spektrum szintillierender Kunststoff. Die prinzipielle Möglichkeit PEN mit hoher Reinheit herzustellen, macht es zu einem vielversprechenden Material für Low-Background Experimenten, wie zum Beispiel Suchen nach dem $0\nu\beta\beta$-Zerfall. Eine große Herausforderung dieser Experimente ist die Unterdrückung und Identifizierung des radioaktiven Untergrunds, um die nötige Sensitivität der Experimente zu erreichen. Die Szintillations- und Wellenlängenverschiebungseigenschaften in Kombination mit der mechanischen Stabilität von PEN können genutzt werden, um strukturelle, optisch nicht aktive Materialien durch szintillierende und transparente zu ersetzen.

Die Lichtleistung vieler Szintillatoren verbessert sich wenn sie abgekühlt werden. Es wurde untersucht, ob PEN ein ähnliches Verhalten zeigt. Für die Bestimmung der Lichtausbeute wurden die Teststücke bei Raumtemperatur und in Flüssiggasen zur Szintillation angeregt.

In diesem Vortrag werden die ersten Messungen der Lichtausbeute bei Raumtemperatur und die dazu notwendige Einzelphoton-Kalibrierung der Sensoren mit Hilfe von Pikosekunden-Impulsen eines Lasers vorgestellt. Darüber hinaus wird die aktuell laufende Erforschung von PEN Eigenschaften präsentiert.

T 46: Theorie: QCD

Zeit: Dienstag 16:00–18:30 Raum: ST 8

T 46.1 Di 16:00 ST 8

Resonance-Aware Subtraction in the Dipole Methode — •Sebastian Liebschner[1], Frank Siegert[1], and Stefan Höche[2] — [1]Institut für Kern- und Teilchenphysik, TU Dresden, 01069 Dresden, Germany — [2]SLAC National Accelerator Laboratory, Menlo Park, CA, 94025, USA

NLO-subtraction schemes such as CS-dipole-subtraction are indispensable for MC-Generators to calculate real and virtual corrections efficiently. However, those algorithms suffer from numerical inefficiencies and even cause distortions in physical distributions when interfaced with parton showers, if the process in question comprises potentially resonant particles. In this talk I will elucidate this matter and offer an alternative subtraction-scheme, which makes use of so called pseudo-dipoles. I will show results, which have been calculated with a SHERPA-implementation of this new pseudo-dipole-subtraction and compare them to the ones obtained with ordinary CS-dipole-subtraction.

T 46.2 Di 16:15 ST 8

The Complete $O(\alpha_s^2)$ Pure-Singlet Heavy Flavour Corrections to the Unpolarized and Polarized Deep-Inelastic Structure Functions — Johannes Blümlein[1], Abilio De Freitas[1], Clemens Raab[2], and •Kay Schönwald[1] — [1]DESY, Zeuthen — [2]Johannes Kepler Universität, Linz

We calculate analytically the flavour pure-singlet $\mathrm{O}(\alpha_s^2)$ massive Wilson coefficients for the inclusive structure functions F_2, F_L and g_1 at general virtualities Q^2 in the deep-inelastic region. We discuss their functional representation, illustrate their large-scale factorization and threshold-representation, and present numerical results.

T 46.3 Di 16:30 ST 8

Integrating double-unresolved collinear emissions for NNLO computations — •Maximilian Delto and Kirill Melnikov — Institut für Theoretische Teilchenphysik, Karlsruhe Institute of Technology (KIT)

We will describe an analytic computation of integrals of triple-collinear splitting functions that emerge as counter-terms in the context of the nested soft-collinear subtraction scheme. Analytic results for counterterms are important for demonstrating analytic cancellation of infrared and collinear divergences in fully-differential NNLO description of generic hard scattering processes in hadron collisions.

T 46.4 Di 16:45 ST 8

Dimensional Recurrence and Analyticity in C++ — •Mario Prausa — Albert-Ludwigs-Universität, Freiburg, Germany

Dimensional Recurrence and Analyticity (DRA) is a powerful tool to calculate single-scale multi-loop Feynman integrals to very high precision. Using Tarasov's dimensional shifts and integration-by-parts identities it is straightforward to derive Dimensional Recurrence Relations (DRRs) for a set of master Feynman integrals. The DRRs relate Feynman integrals in d space-time dimensions to the same Feynman integrals in $d+2$ dimensions. In the DRA method these relations are solved using input from the pole structure of the Feynman integrals.

DRA is exceptionally well-suited to be implemented in an object-oriented framework. In this talk I will present an upcoming fully automated `C++` implementation and demonstrate its usability with a non-trivial example.

T 46.5 Di 17:00 ST 8

The gradient flow at higher orders in perturbation theory — Johannes Artz[1], Robert V. Harlander[1], Yannick Kluth[2], •Fabian Lange[1], Tobias Neumann[3,4], and Mario Prausa[5] — [1]RWTH Aachen University, Aachen, Germany — [2]University of Sussex, Brighton, UK — [3]Illinois Institute of Technology, Chicago, USA — [4]Fermilab, Batavia, USA — [5]Albert-Ludwigs-Universität, Freiburg, Germany

The gradient or Wilson flow has proven to be a useful tool in lattice QCD calculations in the last years. It also offers promising possibilities of cross-fertilization of lattice and perturbative calculations. Up to now, perturbative calculations in the gradient-flow formalism have mostly been carried out to next-to-leading order. Experience shows that the step to next-to-next-to-leading order (NNLO) typically leads to a significant improvement of the perturbative accuracy.

We apply well-known techniques for multi-loop calculations to the gradient-flow formalism in order to systematically compute higher or-

ders. After describing our general setup, we show NNLO results of central observables like the gluon action density, which may offer a possibility to extract α_s from lattice results. We also present a lattice formulation of the energy-momentum tensor in the gradient-flow formalism through NNLO.

T 46.6 Di 17:15 ST 8

Laporta algorithm with finite fields — •Jonas Klappert and Fabian Lange — RWTH Aachen University

The implementation of rational functions from their numerical values over a field has been actively studied in computer science and mathematics over the last few decades. Recently, its application to calculations in High Energy Physics has become of interest since in a purely numerical framework no large intermediate expressions occur. The latter often lead, due to a limitation of hardware, to the failure of purely analytic calculations. In this talk, we present efficient algorithms to solve these interpolation problems and their implementation in the publicly available `C++` library `FireFly`. To demonstrate their capability, we apply them to the reduction of multi-scale Feynman integrals with the Laporta algorithm.

T 46.7 Di 17:30 ST 8

Automatizing the calculation of the N-jettiness soft function — •Tobias Mohrmann — Universität Siegen

Whenever a QCD-scattering process is restricted to its soft region, soft functions emerge. They are essential ingrediants of factorization theorems within Soft-Collinear Effective Theory (SCET). In this talk I present a systematic framework for the calculation of soft functions which are defined in terms of $N \geq 2$ light-like Wilson lines for generic observables. For this purpose we introduce a phase space parametrization which allows the factorization of universal singularities for soft functions. The formalism is an extension of a method that some of my collaborators developed earlier for the calculation of dijet soft functions. We have implemented this framework using the public code "pySecDec" to compute 1-jettiness and 2-jettiness soft function numerically.

T 46.8 Di 17:45 ST 8

Recursion Relations for Massive Scattering Amplitudes — •Robert Franken — Julius-Maximilians-Universität, Würzburg

In this talk I will show that scattering amplitudes with massive or massless particles of spin $s \leq 1$ in renormalisable theories can be constructed recursively out of amplitudes with a lesser number of external legs. The basic idea is to deform the momenta of the external particles by shifting them into the complex plane in such a manner that on-shellness and overall momentum conservation are preserved. The precise shifting procedure depends on the kind of the involved particles and their spin projected along a reference axis.

Using Cauchy's residue theorem leads to connect the physical amplitude to emerging poles in the complex plane and a contour integral which is forced to vanish by deforming enough external momenta.

It turns out that shifting 5 external legs is always sufficient, shifting 3 external legs is sufficient except all external particles are scalars or longitudinally polarised vector bosons.

Furthermore the introduction of special reference frames to guarantee a good behaviour of the contour integral and hence recursive constructibility involves some subtleties. Especially the reference frames for individual particles are different. To overcome these problems a formalism to convert a posteriori between different reference frames is introduced, leading to a description in a common frame.

Together with construction rules, that forbid certain helicity combinations in the 3-point amplitudes, a set of selection and suppression rules can be derived.

T 46.9 Di 18:00 ST 8

Parton-shower effects in electroweak W^+Zjj production at the next-to-leading order of QCD — Barbara Jäger[1], Alexander Karlberg[2], and •Johannes Scheller[1] — [1]Institute for Theoretical Physics, University of Tübingen, Auf der Morgenstelle 14, 72076 Tübingen, Germany — [2]Physics Institute, University of Zürich, Winterthurerstrasse 190, 8057 Zürich, Switzerland

We present an implementation of W^+Zjj production via vector-boson fusion in the `POWHEG BOX`, a public tool for the matching of next-to-leading order QCD calculations with multi-purpose parton-shower generators. We provide phenomenological results for electroweak W^+Zjj production with fully leptonic decays at the LHC in realistic setups and discuss theoretical uncertainties associated with the simulation. We find that beyond the leading-order approximation the dependence on the unphysical factorization and renormalization scales is mild. The two tagging jets are furthermore very stable against parton-shower effects. However, considerable sensitivities to the shower Monte-Carlo program used are observed for central-jet veto observables.

T 46.10 Di 18:15 ST 8

Automated production and evaluation of interpolation grids for cross sections at next-to-next-to-leading order — Günter Quast, Klaus Rabbertz, and •Miguel Santos Correa — ETP, KIT Karlsruhe

The recent availability of calculations in perturbative QCD at next-to-next-to-leading order (NNLO) offers another significant increase in precision for comparisons between theory and experimental data e.g. from collisions at the LHC. To avoid repetitions of these CPU intensive computations for variations of input parameters, the interpolation grid technique as implemented in APPLgrid and fastNLO is used together with the original theory code in the form of the NNLOJET package. Up to now many manual steps are required for setup, quality checks, parallelised production on thousands of compute nodes, harvesting, and combination of subgrids to the final product.

We present as an example calculation the triple-differential Z+jet cross section, suitable for precision comparisons to LHC data, and demonstrate the implementation of an automated pipeline based on the software packages Luigi and LAW for the creation of such high precision interpolation grids at NNLO.

T 47: Hauptvorträge III

Zeit: Mittwoch 9:45–10:30 Raum: H01

Hauptvortrag T 47.1 Mi 9:45 H01

ATLAS and CMS detector status and upgrades — •Benedikt Vormwald — Universität Hamburg, Hamburg, Deutschland

2018 was a record-setting year at CERN's large hadron collider (LHC). In just one year, LHC delivered an integrated luminosity of more than 65 fb^{-1}, which is more than 40% of the integrated luminosity of the entire LHC run-2. However, not only the LHC was performing extraordinarily well, but also the two big experiments, ATLAS and CMS, achieved the highest data taking efficiency in their history amounting to more than 94%.

In the 2-year long shutdown of the LHC ahead of us, the ATLAS and CMS detectors will undergo a very dense maintenance and upgrade program. Some of these activities lay already now the foundations for the high-luminosity program of the LHC starting foreseeably in 2026.

In this talk, the status of ATLAS and CMS at the end of LHC run-2 will be described and the various detector upgrades will be outlined.

T 48: Hauptvorträge IV

Zeit: Mittwoch 11:00–12:30 Raum: H01

Hauptvortrag T 48.1 Mi 11:00 H01
The Quest for the Nature of Dark Matter: Direct Searches — •Uwe G. Oberlack — Institute of Physics & PRISMA$^+$ Excellence Cluster, Johannes Gutenberg University Mainz

Non-baryonic Dark Matter is five to six times more abundant than "regular" baryonic matter in the universe. Evidence to this conclusion is multi-facetted and solid, ranging in scale from galaxies to the observable universe. Dark Matter is key to the formation of cosmic structure from an early smooth stage as witnessed by the Cosmic Microwave Background to the rich structures observed with galaxy surveys today. Yet, the nature of Dark Matter remains unknown.

Interpreted as a new type of particle, Dark Matter constitutes one of our most direct evidences for physics beyond the Standard Model. Weakly Interacting Massive Particles (WIMPs) describe a broad class of well-motivated Dark Matter candidates, left over as a thermal relic from the early hot universe. Bound by the galactic gravitational potential, WIMPs carry velocities around 10^{-3} c and are expected to scatter off of atomic nuclei. Direct search experiments are searching for the minute signals from these nuclear recoils with low-background detectors underground. The range of WIMP masses being tested through their keV-size spectra extends from the sub-GeV to the $\sim$ 10 TeV scale. This talk focuses on recent progress and future perspectives in the field.

Hauptvortrag T 48.2 Mi 11:45 H01
Progress in QCD calculations and applications to LHC physics — •Giulia Zanderighi — Max-Planck-Institut für Physik, Föhringer Ring 6, 80805 München

This talk reviews the exciting progress achieved in recent years in the context of precision calculations for the LHC, and the impact of this progress for the upcoming Run III and High Luminosity program.

T 49: Eingeladene Vorträge III

Zeit: Mittwoch 14:00–15:30 Raum: H02

Eingeladener Vortrag T 49.1 Mi 14:00 H02
Higgs Boson Properties as a Window to New Physics — •Kathrin Becker — Albert-Ludwigs-Universität Freiburg

So far, direct searches at the LHC have not observed any hints for physics beyond the Standard Model. New physics outside the reach of direct searches can affect the properties of Standard Model particles at LHC energies. These deviations can be described using general approaches like effective field theories.

One of the most promising particles to look for these deviations is the Higgs boson. Additional couplings can affect kinematic distributions, like the transverse momentum of the Higgs boson or the angular difference of the two leading jets, or properties like its CP symmetry. In my presentation I will discuss different measurement approaches like differential and simplified template cross sections. Their aim is to maximise our knowledge about the Higgs boson with the currently available dataset and make interpretations in effective field theories and specific extensions of the Standard Model possible. Recent results from the ATLAS experiment are presented and discussed.

Eingeladener Vortrag T 49.2 Mi 14:30 H02
Precise QCD predictions for the LHC — •Alexander Huss — Theoretical Physics Department, CERN, 1211 Geneva 23, Switzerland

The LHC offers the widest range of physics opportunities: Among the highest priorities is the understanding of the Higgs boson and the search for physics beyond the SM. In view of the absence of striking new-physics signals to date, BSM physics is likely hiding in small and subtle effects. Revealing such phenomena though precision studies critically relies on our ability to predict both signal and background processes with high precision.

I will review some state-of-the art QCD predictions for hadron colliders and their impact on the interpretation of LHC measurements. A focus will be put on perturbative calculations for Higgs- and gauge-boson processes and the underlying subtraction procedures. Current limitations will be addressed with an outlook on future developments relevant for precision phenomenology.

Eingeladener Vortrag T 49.3 Mi 15:00 H02
Vector Boson Scattering: a new toolkit to probe the standard model and beyond — •Joany Manjarres — Technische Universität Dresden

The discovery of the Higgs boson at the Large Hadron Collider (LHC) has invigorated the study of electroweak symmetry breaking (EWSB) and confirmed once again that the Standard Model (SM) is a reliable model, at least as a first approximation. However fundamental questions remain unanswered by the SM. Some hints for our New Physics quest may be found at the heart of the SM, in the breaking of the electroweak symmetry. With the EWSB mechanism vector bosons acquire mass through their coupling to the Higgs field. At the same time, EWSB rules the scattering of vector bosons (VBS, vector boson scattering), avoiding its divergence at high energy. The rate of occurrence of VBS processes is predicted by the SM to be very low due to cancellations of different contributions. Processes related to new physics can disturb this delicate balance and lead to potentially large enhancements of the VBS rate, making it the ideal process for a model-independent test-bench of new physics at an energy scale never investigated before. The door for measuring VBS has just open. We will scrutinize the first experimental results obtained by ATLAS with a partial dataset. We will also explore the potential VBS analysis have with the upcoming LHC data to ultimately test the SM at high precision or possibly hinting at new physics.

T 50: Eingeladene Vorträge IV

Zeit: Mittwoch 14:00–15:30 Raum: H03

Eingeladener Vortrag T 50.1 Mi 14:00 H03
Electroweak penguins and the search for new physics — •Eluned Smith — RWTH Aachen

Electroweak penguin (EWP) decays are Flavour Changing Neutral Currents mediated via loop or box diagrams. As such, they are suppressed in the Standard Model (SM) and sensitive to effects from new heavy particles (New Physics).

There has been increasing interest in EWP decays of b-hadrons, due to the emergence of several intriguing tensions between measured observables and SM predictions. Of particular interest are measurements of decay rates and angular observables, as well as lepton flavour universality tests, where clean SM predictions are available. The tensions in this area, which are at the level of 2-3 standard deviations (σ), constitute part of the so-called *flavour anomalies*.

This talk will give an overview of the recent most relevant analyses of EWP b-hadron decays, with focus on results from the LHCb experiment. Possible theoretical interpretations of the anomalies will also briefly be discussed.

Eingeladener Vortrag T 50.2 Mi 14:30 H03
B mesons as a Telescope for New Physics — •Keri Vos — Siegen University, Germany

Flavour physics forms a crucial part in the search for physics beyond the Standard Model (SM) of particle physics. The B factories and LHCb are dedicated to the study of rare B meson decays and they have gathered an incredible amount of data which probes the SM with

an unprecedented precision. The effect of new heavy physics would show as (tiny) deviations from the SM predictions, therefore flavour physics can probe energy scales far beyond the reach of the LHC. In this talk, I will give a theoretical overview addressing the challenges in this quest focusing on the search for new CP-violating physics.

Eingeladener Vortrag T 50.3 Mi 15:00 H03
Analysis algorithms for Belle II and first results — •Pablo Goldenzweig — KIT

High precision measurements of B meson decays offer powerful tests of the Standard Model paradigm. With the imminent start of the full physics program of the Belle II experiment, we are poised to enter a new era of precision flavor physics at the intensity frontier. In this talk, I will describe the Belle II algorithm for hierarchical tag-side B meson recombination, and the B meson flavor tagging and continuum background suppression algorithms with Deep Neural Networks. First results on Belle II data will also be presented.

T 51: Halbleiterdetektoren III

Zeit: Mittwoch 16:00–18:15 Raum: H03

T 51.1 Mi 16:00 H03
Testbeam results of a high voltage monolithic active pixel sensor prototype for the ATLAS experiment — •Adrian Herkert for the ATLAS AMS/TSI-CMOS-Pixel-Collaboration — Physikalisches Institut Heidelberg

In the context of the High-Luminosity LHC the ATLAS Inner Tracker will be fully replaced. While the baseline design for the new pixel layers foresees hybrid detectors there are different approaches to monolithic pixel sensors that could be valid alternatives. Using monolithic pixel sensors for the outermost pixel barrel could lead to a significant reduction of production cost and time. Beyond that, these novel technologies have great potential with regard to future large scale pixel detectors. ATLASPix1 is a high voltage monolithic active pixel sensor (HV-MAPS) prototype produced in the commercial aH18 process by AMS. This talk will cover results from testbeam campaigns with unirradiated as well as neutron and proton irradiated ATLASPix1 samples.

T 51.2 Mi 16:15 H03
Total ionizing dose effects on the perfomance of RD53A — Michael Daas, Jochen Dingfelder, Tomasz Hemperek, Hans Krüger, •Marco Vogt, Norbert Wermes, Piotr Rymaszewski, Ahmed Qamesh, and Yannick Dieter — Physikalisches Institut der Universität Bonn

The phase-2 upgrade of the LHC will substantially increase the instantaneous luminosity. Especially for the pixel detector, which sits close to the interaction point, this requires novel pixel readout chips with highly complex digital architectures, which deliver hit information at drastically increased data rates and unprecedented radiation tolerance.

The large-scale prototype chip RD53A has been designed and manufactured by the RD53 collaboration in a 65 nm CMOS process, suitable for the innermost layers of both the ATLAS and the CMS experiment.

In order to verify the radiation hardness design goal of 500 Mrad, RD53A has been irradiated to a total ionizing dose of 600 Mrad using X-rays. The radiation effects on the performance of the data link, PLL, reset circuit and the analog front-ends have been investigated and will be presented in this talk.

T 51.3 Mi 16:30 H03
TCAD Simulation of High-Voltage Monolithic Active Pixel Sensors — •Annie Meneses Gonzalez, Heiko Augustin, and Andre Schoning — Physikalisches Institut, Universitat Heidelberg

The requirements for precision physics and the experimental conditions of several Particle Physics experiments lead to tight constraints for its tracker detectors. High-Voltage Monolithic Active Pixel Sensors (HV-MAPS) implemented in a commercial 180-nm High-Voltage CMOS process are under study as the technology for the Mu3e Pixel Tracker and as a candidate for other future detector applications like the ATLAS outermost pixel layer.

Laboratory measurements and beam test with prototypes are complemented by Technology Computer Aided Design (TCAD) simulations aiming for a comprehensive understanding of the sensor behavior and charge collection process. In this work TCAD simulation results of HV-MAPS prototype sensors will be presented. These include electric field distribution, breakdown voltage, leakage current, interpixel capacitance, and transient response to minimum

T 51.4 Mi 16:45 H03
Time Resolution of the Mupix8, a large HV-MAPS prototype — •Jan Hammerich for the Mu3e-Collaboration — Physikalisches Institut, Universität Heidelberg

The Mu3e experiment is searching for the charged lepton flavor violating (cLFV) decay $\mu \rightarrow eee$ with a planned sensitivity of 2 in 10^{15} decays for phase I. To achieve such a sensitivity, a fast, high resolution tracking detector is required which has a material budget of 0.1 % per tracking layer to reduce multiple Coulomb scattering.
A suitable technology for these requirements is the High Voltage Monolithic Active Pixel Sensor (HV-MAPS) concept. It combines fast charge collection via drift with a fully monolithic architecture of sensor and readout in one chip which can be thinned to 50 μm.
The MuPix8 is the first large scale HV-MAPS prototype for Mu3e with a size of 1×2 cm^2. It features circuitry to measure charge information which is used to correct for time walk. The time resolution of the system using time walk correction is presented.

T 51.5 Mi 17:00 H03
Characterization of RD53A, a readout ASIC prototype for the Phase-II upgrades of ATLAS and CMS — •Michael Daas, Jochen Dingfelder, Tomasz Hemperek, Florian Hinterkeuser, Fabian Hügging, Hans Krüger, David-Leon Pohl, Mark Standke, Marco Vogt, and Norbert Wermes — Physikalisches Institut der Universität Bonn, Bonn, Deutschland

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 a comprehensive overview over front-end characterization measurements on the RD53A pixel detector readout chip. It was developed by the RD53 collaboration, a joint research and development initiative of the ATLAS and CMS experiments. The RD53A readout chip features a smaller 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 very high occupancy, that is expected close to the interaction points of the upgraded LHC due to the higher luminosity.

The chip was characterized with regard to the performance of the three different analog front-end implementations in order to conclude the front-end R&D phase and decide which flavor will be used in the final production chip for the pixel tracking detectors of ATLAS and CMS. Measurement results comparing all three front-end flavors will be presented in this talk.

T 51.6 Mi 17:15 H03
Development of a small collection electrode monolithic pixel sensor in a novel 180 nm process for the ATLAS ITk upgrade — •Konstantinos Moustakas[1], Ivan Berdalovic[2], Christian Bespin[1], Ivan Caicedo[1], Tomasz Hemperek[1], Toko Hirono[1], Hans Krüger[1], Thanusan Kugathasan[2], Cesar Augusto Marin Tobon[2], Heinz Pernegger[2], Walter Snoeys[2], Tianyang Wang[1], Sinuo Zhang[1], and Norbert Wermes[1] — [1]Physikalisches Institut, University of Bonn, Germany — [2]CERN, Geneva, Switzerland

Monolithic pixel sensors are currently in consideration for the outer layers of the ATLAS ITk. Implementations that are based on a small collection electrode are advantageous in terms of power consumption and timing performance but can be sensitive to bulk radiation damage effects. A large-scale demonstrator chip, called TJ-Monopix01 has been developed in a modified 180 nm process that employs an implanted n-layer to achieve full depletion and enhanced radiation tolerance. It consists of $36x40\,\mu m^2$ pixels arranged in a 224x448 matrix and features sensor capacitance $\leq 3\,fF$, a synchronous "column-drain" readout architecture and total power consumption of $120\,mW/cm^2$. Laboratory measurements demonstrate the high signal to noise ratio by means of $ENC \approx 10\,e^-$ and fast timing response. These promising results en-

couraged the ongoing design of TJ-Monopix02, which addresses the challenges of a full-scale matrix ($2x2\,cm^2$) and will include further optimization of the process modification and improvements in the front end and pixel design to withstand radiation dose up to $1 \cdot 10^{15}\ n_{eq}/cm^2$ towards an ATLAS ITk compatible monolithic sensor.

T 51.7 Mi 17:30 H03

Charge Collection Efficiency Simulation of a Small Fill-Factor 180 nm Monolithic Pixel Detector — •Sinuo Zhang, Christian Bespin, Ivan Caicedo, Tomasz Hemperek, Toko Hirono, Fabian Hügging, Hans Krüger, Konstantinos Moustakas, David-Leon Pohl, Piotr Rymaszewski, Tianyang Wang, Jochen Dingfelder, and Norbert Wermes — Physikalisches Institut, University of Bonn, Nussallee 12, Bonn, Germany

For the ATLAS experiment at the HL-LHC, the innermost pixel tracking detector will be upgraded. As a potential replacement of the hybrid pixel detector, monolithic CMOS pixel detectors in 180 nm technology are developed. Such monolithic pixel detectors placed at the outer barrel layer suffer from silicon bulk damage after irradiation with the expected dose of 10^{15} neq/cm^2 that significantly enhances charge carrier trapping through impurity energy levels in the band gap. This causes a degradation in charge collection efficiencies which has been simulated with Synopsis Sentaurus TCAD by assuming effective defect levels according to the Perugia model. The obtained results revealed that enhancements of charge collection performance can be achieved by modifications of the electric field by changing biasing condition and implantation profile. The simulation results will be presented by comparing different biasing conditions, pixel geometries, and irradiation doses.

T 51.8 Mi 17:45 H03

Analysis of the behavior of the poly-crystalline diamond sensors of the BCM1F detector and luminosity measurement at the CMS Experiment — •Valerie Scheurer, Moritz Guthoff, and Andreas Meyer — DESY, Hamburg

For determination of the cross sections of physical processes, it is essential to measure the luminosity as accurately as possible. This is done by measuring the event rate. From the visible cross section of a so-called luminometer the total luminosity can be extrapolated. The visible cross section is determined in calibration measurements (Van der Meer scans). If the visible cross section is known for a luminometer, the instantaneous luminosity can be measured in real-time.

Several luminometers are used in the CMS experiment. One of these detectors is the Fast Beam Condition Monitor (BCM1F). The BCM1F detector is located directly at the beam pipe, on both sides at a distance of 1.8 m from the interaction point. However, the efficiency of these sensors shows a dependency on the absolute event rate. For its calibration the per bunch luminosity changing during a fill of the collider has to be considered. Also the total Luminosity, which for example depends on the number of bunches in a fill, has an influence on the efficiency of the sensors.

In the talk the luminosity measurement at the CMS experiment as well as the calibration of BCM1F are presented.

T 51.9 Mi 18:00 H03

Timepix3 (TPX3) Luminosity Determination of 13 TeV Proton-Proton Collisions at the ATLAS Experiment — •Andre Sopczak[1], Cyprien Beaufort[1], Benedikt Bergmann[1], Thomas Billoud[2], Bartholomej Biskup[1], Jan Broulim[1,3], Pavel Broulim[3], Petr Burian[1,3], Davide Caforio[1], Erik Heijne[1], Petr Fiedler[1], Claude Leroy[2], Catalina Lesmes Ramierez[1], Stanislav Pospisil[1], Thomas Seidler[1], and Michael Suk[1] — [1]Czech Technical University in Prague — [2]University of Montreal — [3]University of West Bohemia in Pilsen

Medipix and Timepix devices, installed in the ATLAS cavern at LHC, have proved to provide valuable complementary luminosity information. Results are presented from a new measurement network, based on the latest Timepix3 chip. In contrast to previously employed frame-based data acquisition, the TPX3 detector remains active continuously, sending information on pixel hits as they occur. Hit- and cluster-counting methods were used for the luminosity determination of the LHC proton-proton collisions. By counting the number of clusters, instead of just pixel hits, the precision of the luminosity determination could be improved. The LHC luminosity versus time is determined using these two methods, and fitted to a simple model incorporating luminosity reduction from single bunch and beam-beam interactions. The internal precision and long-term time stability of the TPX3 luminosity measurement were determined. The TPX3, owing to its precise time resolution, is able to resolve the time structure of the luminosity due to the collisions of individual LHC proton bunches.

T 52: Higgs-Zerfälle in Fermionen II

Zeit: Mittwoch 16:00–18:15 Raum: H04

T 52.1 Mi 16:00 H04

Kombinierte Messung der Higgs-Boson-Produktionsmechanismen und -Zerfälle mit dem ATLAS Detektor — •Théo Megy und Karsten Köneke — Albert-Ludwigs-Universität Freiburg

Seit der Entdeckung des Higgs-Bosons im Jahr 2012 werden dessen Eigenschaften durch mehrere Analysen erforscht. Beim ATLAS Experiment werden diese Eigenschaften sowohl in bosonischen ($H \to ZZ^*, \gamma\gamma, WW^*$) als auch in fermionischen ($H \to \tau\tau, b\bar{b}$) Kanälen vermessen.
Die Kombination dieser Analysen erlaubt eine erhöhte Präzision der Messungen und ermöglicht eine unabhängige Bestimmung der Wirkungsquerschnitte der Produktionsmechanismen und der Verzweigungverhältnisse der Zerfallkanäle. Deswegen erlaubt sie ein genaueres Prüfen der Natur des Higgs-Bosons, insbesondere durch den sogenannten Simplified-Template-Cross-Sections-Formalismus (STXS) oder durch eine Reinterpretation im Rahmen des κ-Frameworks.
In diesem Vortrag wird das Kombinierungsverfahren der Higgs-Boson-Analysen in ATLAS diskutiert werden, mit einem Schwerpunkt auf der Messung der Wirkungsquerschnitte und Verzweigungverhältnisse. Die Behandlung der Ergebnisse der einzelnen Analysen sowie die Parametrisierungen für die verschiedenen Messungen werden erläutert werden. Darüberhinaus werden die STXS und κ-Framework Formalismen diskutiert werden.

T 52.2 Mi 16:15 H04

Search for boosted Higgs decays to pairs of heavy quarks with the CMS Experiment — •Andrzej Novak, Xavier Coubez, Luca Mastrolorenzo, Spandan Mondal, and Alexander Schmidt — RWTH Aachen, Aachen, Germany

The Higgs boson decay into bottom quarks has the highest branching fraction of all decay modes. Among the not yet observed decays, the branching fraction to charm quarks is the second highest. This talk presents a search for the Higgs boson in the gluon fusion production mode with high Lorentz boosts, decaying to a pair of bottom quarks. The analysis has been published in 2018 and was sensitive enough to observe the boosted Z boson decay into b quarks for the first time. Given the recently developed deep learning based tools for identification of bottom and charm flavor jets in such topologies, the natural next step is an analogous search for the decay to a pair of charm quarks. Probing this channel is not only important for completeness and studying the Higgs couplings to the second generation of fermions, but it could also be sensitive to potential beyond Standard Model corrections.

T 52.3 Mi 16:30 H04

Search for Higgs boson pair production and constraints on Higgs couplings in the $b\bar{b}\tau^+\tau^-$ final state with 36.1 fb^{-1} of pp collisions data at $\sqrt{s} = 13$ TeV with the ATLAS detector — •Alessandra Betti, Florian Beisiegel, Christopher Deutsch, Tatjana Lenz, Alexander Melzer, and Norbert Wermes — Physikalisches Institut, Universität Bonn

In the SM Higgs boson pairs can be produced via gluon-gluon fusion through top-quark loops and the Higgs triple self-interaction. The study of this process can therefore allow to probe the structure of the Higgs potential by measuring the Higgs self-coupling λ_{HHH}. Although the SM cross-section for Higgs pair production is very small, modifications to the top-quark Yukawa coupling or to the Higgs self-coupling, could enhance the di-Higgs production rate and show hints of possible new physics in this process. It is therefore interesting to set constraints

on these couplings with the 2015+2016 dataset collected by ATLAS even without yet having the sensitivity to observe the SM process. Moreover, many BSM theories predict heavy resonances that could decay into a pair of Higgs bosons, such as a neutral scalar heavy Higgs in two-Higgs doublet models or spin-2 Kaluza-Klein excitations of the graviton in the bulk Randall-Sundrum model. In the assumption of SM Higgs bosons with m=125 GeV, the $b\bar{b}\tau^+\tau^-$ channel of the di-Higgs decay has the third largest branching fraction (7.4%). The results of the search for Higgs boson pair production in the $b\bar{b}\tau^+\tau^-$ final state obtained with 36.1 fb^{-1} of pp collisions data at $\sqrt{s} = 13$ TeV with the ATLAS detector will be presented in this talk.

T 52.4 Mi 16:45 H04

Modelling of the W+jets background in the 1-lepton channel for the VH, H → bb analysis — •Simona Gargiulo, Stephen Jiggins, and Christian Weiser — Albert-Ludwigs-Universität Freiburg

The observation 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 79.8 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 $Z \to \nu\nu$, $W \to l\nu$ and $Z \to l^+l^-$.

The W+jets process is one of the leading backgrounds in the 1-lepton channel and its uncertainty contributes significantly to the overall systematic uncertainty on the signal strength. The focus of this talk will be on the estimation of the systematic uncertainties of the theoretical prediction of the W+jets background in the 1-lepton channel. This estimation relies on generator studies with varied settings and on the comparison between different generators.

Furthermore, new techniques are explored to reduce the W+jets systematic on the vector boson transverse momentum, by making use of control regions that allow a better determination of kinematic properties in these events.

T 52.5 Mi 17:00 H04

Studies towards improving the Missing Mass Calculator at the ATLAS experiment — •Michael Hübner, Philip Bechtle, Klaus Desch, Christian Grefe, Lara Schildgen, Peter Wagner, and Martin Werres — Universität Bonn

The Missing Mass Calculator (MMC) is a well-established likelihood-based tool that is used in a variety of analyses studying particles decaying into two tau leptons, such as the $H \to \tau\tau$ coupling measurement. It reconstructs the invariant mass of the ditau system which can then be used to distinguish signal and background processes.

Developments in the tau reconstruction over the last years, e.g. the new possibility of hadronic tau decay mode classification, have been targeted to be propagated to the MMC. I will introduce the concepts behind this tool and what I have done in order to incorporate the aforementioned improvements in the tau reconstruction.

T 52.6 Mi 17:15 H04

An embedding technique to determine genuine $\tau\tau$ backgrounds from CMS data — Janek Bechtel, •Sebastian Brommer, Artur Gottmann, Guenter Quast, and Roger Wolf — Karlsruhe Institute of Technology, Karlsruhe, Germany

The τ-embedding technique is a data-driven method, where $\mu\mu$ events are selected from data, and the muons are replaced by simulated τ decays. In this way a hybrid event is created, which only relies on the simulation for the well understood τ 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, recent developments and improvements of the technique are presented.

T 52.7 Mi 17:30 H04

Suche nach der Produktion von Higgs-Paaren über Vektor-Boson-Fusion im 4b-Endzustand — Goetz Gaycken, Vadim Kostyukhin, Tatjana Lenz, •Alexander Melzer, Eckhard von Törne und Norbert Wermes — Rheinische Friedrich-Wilhelms-Universität Bonn

Mit der Entdeckung des Higgs-Bosons wurde 2012 das letzte vom Standard Modell vorhergesagte Teilchen gefunden. Seither werden auf der Suche nach Abweichungen vom Standrad Modell die Eigenschaften des Teilchens und seine Interaktionen mit andern Teilchen studiert. Der VBF Kanal ermöglicht es zum ersten Mal auf die Kopplung von zwei Vektorbosonen zu zwei Higgs-Bosonen (c2V) im nicht-resonanten Kanal ein Limit zu setzten. Der resonante Kanal bietet zusätzlich eine Möglichkeit für die Suche nach Teilchen jenseits des Standrad Modells. Begünstigt durch das das hohe Verzweigungsverhältnis des Higgs-Bosons zu b-Quark-Paaren wurde die Analyse im 4b-Endzustand durchgeführt. Für die Analyse wurde der vollständige ATLAS Run-2 Datensetzen mit 149 inversen femtobarn bei 13TeV Schwerpunktsenergie verwendet.

T 52.8 Mi 17:45 H04

Search for Higgs boson decay to a pair of charm quarks at CMS. — •Andrey Pozdnyakov, Luca Mastrolorenzo, Xavier Coubez, and Alexander Schmidt — RWTH, Aachen, Germany

With more data accumulated by the CMS experiment in Run-2 it became possible to determine Higgs boson coupling to a bottom quark. With more data at High Luminosity LHC one can hope to be sensitive to Higgs boson coupling to charm quarks, or at least to put the most stringent limit on this coupling. This would require not only an increase in the integrated luminosity, but also a development of the advanced analysis techniques to control the background processes and efficiently tag c-quark flavored jets.

In this talk the first analysis of the H->cc search by CMS experiment is presented using 36/fb of data recorded in 2016. It shows the current sensitivity of the H->cc measurement and paves the way for the future advancements in this search.

T 52.9 Mi 18:00 H04

Search for a very light pseudoscalar boson produced in decays of the 125 GeV Higgs boson in final state with two muons and two tau leptons in pp collisions at $\sqrt{s} = 13$ TeV — Somnath Choudhury[4], •Sandra Consuegra Rodríguez[1], Elisabetta Gallo[2], Alexis Kalogeropoulos[3], Danyer Pérez Adán[1], Alexei Raspereza[1], and Prabhat Solanki[4] — [1]DESY, Germany — [2]DESY and University of Hamburg, Germany — [3]Princeton University, USA — [4]Indian Institute of Science, India

The results of the study of the H(125) boson properties allow the branching fraction of H(125) into non-SM particles to be as high as 34%. A vast set of models containing two Higgs doublets plus one additional Higgs singlet complex field (2HD+1S) are consistent with SM measurements, constraints from additional Higgs bosons and searches for supersymmetry, as well as with the measured properties of the H(125) boson. The Higgs sector of the 2HD+1S models features seven physical states: three CP-even, two CP-odd and two charged bosons. The lightest pseudoscalar boson a_1 is potentially accessible in the H(125)→ a_1a_1 decay, with sufficiently high rate to be detected at the LHC. A new search for a very light pseudoscalar higgs boson will be presented, investigating final states where one a_1 boson decays into a pair of muons and the other into a pair of tau leptons. The search is based on a dataset corresponding to an integrated luminosity of 35.9 fb^{-1}, collected with the CMS detector at $\sqrt{s}$=13 TeV, probing low mass a_1 region between 3.6 and 19 GeV.

T 53: Suche nach Neuen Teilchen III

Zeit: Mittwoch 16:00–18:30 Raum: H07

T 53.1 Mi 16:00 H07

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.

T 53.2 Mi 16:15 H07

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, München, Deutschland

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.

The final Run 2 ATLAS dataset of approximately 140 fb^{-1}, recorded at $\sqrt{s} = 13$ TeV, allows for probing regions of the process' phase space that were not accessible before. Consequently, new analysis strategies are being implemented, aiming to maximise the sensitivity in those regions.

This talk presents the strategy to search for Vh resonances in the semileptonic decay channel based on the Run 2 ATLAS dataset. It will highlight differences to the previously published search which was based on a subset of the Run 2 data recorded in 2015 and 2016.

T 53.3 Mi 16:30 H07

Search for new Physics in Boosted $hh \to bb\tau\tau$ Decays — •David Kirchmeier, Fabian Petsch, Arno Straessner, and Wolfgang Mader — IKTP, TU Dresden, Germany

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 or heavy Kaluza-Klein gravitons. 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 QCD 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 can be 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 apply to the $bb\tau\tau$ final state and how the main background coming from multi-jet events can be estimated. The reconstruction and identification of boosted τ pairs is furthermore verified in boosted Z boson decays.

T 53.4 Mi 16:45 H07

Identifizierung geboosteter $H \to b\bar{b}$ - Zerfälle mit dem ATLAS-Detektor — •Stefan Maschek, Dominik Duda, Andreas Hönle, Sandra Kortner und Hubert Kroha — Max-Planck-Institut für Physik, München

Das Heavy Vector Triplet (HVT)-Modell fasst mehrere Erweiterungen des Standardmodells zusammen und sagt neue, schwere Vektorbosonen Z' und W' voraus, die für geeignete Modelparameter in das Higgs-Boson und ein Z- oder W-Boson zerfallen. Beim Zerfall eines neuen HVT-Teilchens, das viel schwerer als das Higgs-Boson ist, erhält das Higgs-Boson einen hohen Transversalimpuls. Im dominantem Higgs-Zerfallskanal in zwei b-Quarks führt dies zu kollimierten b-Quarkjets. Um eine solche geboostete Topologie identifizieren zu können, werden Jets mit einem großen Radiusparameter rekonstruiert, welche die Zerfallsprodukte beider b-Hadronen umfassen. In diesem Vortrag werden die jüngsten Entwicklungen bei der Identifizierung geboosteter H→bb-Zerfälle und deren Anwendung bei der Suche nach den oben genannten Resonanzen vorgestellt. Die H→bb-Jets müssen effizient vom Untergrund getrennt werden. Hierfür werden die Standardalgorithmen zur b-Jetidentifizierung in ATLAS verwendet, ergänzt durch Anforderungen an die Jetsubstruktur, charakterisiert durch die Jetmasse und die Anzahl der Jetkonstituenten. Diese etablierte Methode wird neuen Algorythmen gegenüber gestellt, welche multivariate Verfahren oder Reclustering verwenden.

T 53.5 Mi 17:00 H07

Search for a light CP-odd Higgs boson decaying into a pair of taus — •Paul Moder, Arno Straessner, and Wolfgang Mader — 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 in the 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 60 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 potential new search is discussed based on Monte Carlo simulations, assuming 36.1 fb^{-1} of data collected by the ATLAS experiment at 13 TeV. The sensitivity of the analysis is then presented in terms of discovery significance and expected exclusion limits for the coupling to up type quarks in this scenario.

T 53.6 Mi 17:15 H07

Reconstruction techniques for displaced particle decays in the CMS calorimeter — Gregor Kasieczka and •Zhiyuan He — Institut für Experimentalphysik, Universität Hamburg, Deutschland

We present how deep neural networks (DNN) can be exploited to improve searches for beyond Standard Model (SM) physics, peformed with the CMS detector. One of the SM issues, the hierarchy problem, can be addressed by introducing a so-called "dark sector", that interacts with SM particles via the Higgs boson. The Higgs boson is expected to decay into a pair of new scalar long lived particles (LLPs), that in turn decay predominantly into SM b quark pairs, expected to be "displaced" with regards to the interaction point. If the new scalar particles have decay lengths of approximately the radius of the CMS calorimeter radius, high-level jet variables, as well as low-level quantities calculated from jet components, can be used to discriminate the b-jet decay products of the LLPs from SM b-jets. These attributes, extracted from Monte Carlo simulations of the new exotic process and of SM processes, are used to train a DNN algorithm. We focus on optimizing the search strategy for masses of the LLP ranging from 15 to 60 GeV, and decay lengths from 100 mm up to several meters.

T 53.7 Mi 17:30 H07

Search for long-lived particle decays in the CMS tracking system — Lisa Benato, Melanie Eich, Zhiyuan He, Gregor Kasieczka, and •Karla Pena — Institut für Experimentalphysik, Universität Hamburg

Twin Higgs models propose the existence of a dark sector, neutral under all 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 to non-SM particles. 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 SM background. However, as conventional track reconstruction and vertex finding algorithms are optimized for prompt decays, these signatures are very challenging to find and advanced tracking reconstruction techniques are required. A benchmark analysis is performed, where information from reconstructed tracks is used to tag jets whose origin is significantly displaced with respect to the primary vertex.

The status of a search for LLPs decaying in the CMS tracker is presented, using data collected by the CMS detector in 2016 pp collisions at $\sqrt{s} = 13$ GeV.

T 53.8 Mi 17:45 H07

Search for Highly Ionizing Particles with the Pixel Detector in the Belle II Experiment — Soeren Lange, Klemens Lautenbach, Leonard Koch, Dennis Getzkow, Simon Reiter, and •Katharina Dort — Justus Liebig University Giessen, Giessen, Germany

The Belle II experiment, located at the SuperKEKB collider at the high-energy research facility KEK in Tsukuba, Japan, started operation in 2018. Compared to the predecessor experiment Belle, Belle II plans to increase the peak luminosity by a factor of 40, by employing nano-beam technology in the interaction region.

In particular the new, innermost sub-detector of Belle II - the Pixel Vertex Detector (PXD) - is in close proximity to the interaction point. This allows for the detection of particles, which do not leave a signal in the outer sub-detectors. Among these, Highly Ionizing Particles (HIPs) possess a characteristically severe energy loss limiting their penetration depth into the detector.

Magnetic monopoles, stable tetraquarks and anti-deuterons as possible HIPs are considered. Without a signal in the outer sub-detectors, no trigger is issued resulting in a loss of information about them. In this talk the possibility of identifying HIPs solely with information provided by the PXD is presented, by using neural network algorithms operating in a multi-dimensional parameter space of e.g. PXD cluster data. Most notably, the application of unsupervised learning in the form of Self-Organizing Maps (SOM) is presented.

T 53.9 Mi 18:00 H07

Search for long-lived particles decaying in the CMS calorimeters — •Lisa Benato, Melanie Eich, Zhiyuan He, Gregor Kasieczka, and Karla Peña — Institut für Experimentalphysik, Universität Hamburg

A search for long lived exotic particles, performed with 2016 data collected by the CMS detector, is presented. Many models of new physics aim at solving the hierarchy problem of the Standard Model by extending the SM gauge group to a dark QCD sector, that interacts with SM particles via the Higgs boson. The Higgs boson is predicted to decay with sizeable branching fraction into a pair of dark mesons, that are long lived (with decay lengths from ˜50 cm up to ˜10 meters), and that each sequentially decay into pairs of b-quarks. Given the lifetimes considered, b-quarks are expected to shower mainly in the CMS calorimeters, producing only few hits in the tracker: as a consequence, they are reconstructed as displaced or trackless jets, with peculiar features in terms of their compositions when compared to the overwhelming multi-jet background. The SM predictions are calculated using control regions in data. Results are presented as function of the mass and lifetime of the exotic particles.

T 53.10 Mi 18:15 H07

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

Beyond Standard Model (BSM) theories including electrically 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 seen as a 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 $\pi\nu$.

In this analysis each $\pi\nu$ is expected to decay into two b-quarks, while the lifetime of the $\pi\nu$ is in the order of a few millimeters. Such a lifetime result in a displaced vertex (DV), mimicking a b-quark like signature. The search for such $\pi\nu$ requires new analysis techniques to distinguish between decay products coming from DV and background events. In this talk an overview of the reconstruction techniques and the current analysis status is presented, using data recorded with the CMS detector in 2016.

T 54: Direkte Suche nach Dunkler Materie III

Zeit: Mittwoch 16:00–18:25 Raum: H09

Gruppenbericht T 54.1 Mi 16:00 H09

Direct Dark Matter Search with the CRESST-III Experiment — •Alexander Langenkämper for the CRESST-Collaboration — Physik-Department E15, Technische Universität München, D-85747 Garching, Germany

The detection of dark matter (DM) is one of the biggest challenges in modern astroparticle physics. The CRESST-III (Cryogenic Rare Event Search with Superconducting Thermometers) experiment aims at the direct detection of DM particles via their elastic scattering off nuclei. Each detector consists of a ∼25 g scintillating $CaWO_4$ single crystal operated as cryogenic detector at millikelvin temperatures. An interaction in the $CaWO_4$ target crystal leads to a phonon and a light signal which is detected by a separated cryogenic light detector. The read-out of phonon and light signals allows an event-by-event particle discrimination which is used for background suppression. The latest run of the experiment (CRESST-III Phase 1) started data taking in August 2016 and was successfully finished in 2018, reaching nuclear recoil thresholds of well below 100 eV. In this talk the latest results will be presented. Requirements and perspectives for the upcoming CRESST-III phase will be discussed.

Gruppenbericht T 54.2 Mi 16:20 H09

NaI-based direct search for dark matter with the COSINUS experiment — •Martin Stahlberg for the COSINUS-Collaboration — Institut für Hochenergiephysik der ÖAW, A-1050 Wien - Austria — Atominstitut, Technical University Vienna, A-1020 Wien - Austria

Presently, the search for dark matter is one of the most prominent fields in physics. Although the claim of an observation of a dark matter modulation signal has been made by the DAMA/LIBRA collaboration several years ago, this result is in tension with null results from several other experiments. As none of these experiments use sodium iodide (NaI), a target material dependency remains as one possible explanation of the signal. COSINUS (Cryogenic Observatory for Signals seen in Next-generation Underground Searches) employs scintillating cryogenic calorimeters operated at temperatures of a few mK to directly detect interactions of dark matter particles in a target NaI crystal. This well-tested detection technique comprises two readout channels, a phonon and a light channel, and thereby allows for discrimination of signal and background on an event-by-event basis, with the additional advantage of a low detection threshold for nuclear recoils in the order of several keV. Through the use of NaI as target, a model-independent direct comparison with the DAMA/LIBRA results will be possible. We will report the status of the COSINUS project, as well as first results obtained with prototypes. Finally, an outlook on the planned setup of the experiment will be given.

T 54.3 Mi 16:40 H09

Development of the First Prototype of an MMC-Based Detector for Light Dark Matter Direct Detection — •Arnulf Barth[1], Klaus Eitel[2], Christian Enss[1], Andreas Fleischmann[1], Loredana Gastaldo[1], Sebastian Kempf[1], Bernhard Siebenborn[2], and Marc Weber[2] — [1]Kirchhoff Institute for Physics, Heidelberg University. — [2]Institute for Nuclear Physics, Karlsruhe Institute of Technology.

The use of low temperature detectors in the search for the direct interaction of dark matter (DM) particles in a suitable target has opened the possibility to reach high sensitivities even at masses well below $1\,\mathrm{GeV}/c^2$. We present the design for a low-threshold detector optimized for the search of light DM particles based on metallic magnetic calorimeters (MMCs) with a germanium (Ge) crystal as a scattering target. The interaction of a DM particle in the Ge crystal would create two different kinds of excitations: phonons and electron-hole pairs. We discuss the design of a 3-fold MMC system for the measurement of the temperature increase of the Ge crystal, and how the temperature signal can be amplified via the Neganov-Trofimov-Luke effect to ensure a high sensitivity. A first detector prototype has already been developed. We describe the fabrication steps and a first characterization of the performance.

T 54.4 Mi 16:55 H09

Modelling backgrounds for the CRESST experiment — •Holger Kluck for the CRESST-Collaboration — Institut für Hochenergiephysik der Österreichischen Akademie der Wissenschaften, 1050 Wien, Österreich — Atominstitut, Technische Universität Wien, 1020 Wien, Österreich

CRESST searches directly for dark matter (DM) with $CaWO_4$ crystals operated as cryogenic calorimeters. It established leading limits for the spin-independent DM-nucleon scattering cross-section down to DM-particle masses of $350\,\mathrm{MeV/c^2}$. At this mass regime, the rejection power against electromagnetic background starts to degrade. The background in the region of interest is mainly caused by β and γ decays of radioactive contaminations in the $CaWO_4$ crystals and their Cu surrounding. To gain a reliable understanding of these background components a detailed Geant4 simulation code was developed.

In this contribution we present the final model of electromagnetic backgrounds for CRESST-II phase 2. We discuss ongoing modifications to adapt this model for the current CRESST-III phase 1 and to improve its accuracy. Finally, we show preliminary simulations of the cosmic activation of $CaWO_4$.

T 54.5 Mi 17:10 H09

DELight: A new detection concept to search for light Dark Matter — •Klaus Eitel[1], Arnulf Barth[2], Christian Enss[2], Andreas Fleischmann[2], Loredana Gastaldo[2], Sebastian Kempf[2], Bernhard Siebenborn[1], and Marc Weber[3] — [1]Karlsruher Institut für Technologie, Institut für Kernphysik — [2]Kirchhoff-Institut für Physik, Universität Heidelberg — [3]Karlsruher Institut für Technologie, Institut für Prozessdatenverarbeitung und Elektronik

Recently, there has been increased interest in investigating Dark Matter particle candidates in the MeV mass range. Such light DM particles could be detected via DM-electron scattering with energy transfers in the eV range. An excellent target material is Ge with an efficient band gap of only 3eV. Amplifying the phonon signal in a mK-cold Ge crystal via the Neganov-Luke effect and reading out this signal via a metallic magnetic calorimeter (MMC) has the potential to detect single electron-hole pairs and thus test a yet unexplored parameter range for DM.

We present the physical motivation, the general detection scheme and first R&D tests performed in the last months.

T 54.6 Mi 17:25 H09

Investigation of Production Techniques for Sputtered Tungsten Thin Films — •Tobias Ortmann, Angelina Kinast, Alexander Langenkämper, Elizabeth Mondragon, Andrea Münster, Luca Pattavina, Walter Potzel, Stefan Schönert, Raimund Strauss, and Michael Willers for the CRESST-Collaboration — Technische Universität München, Physik Department, Lehrstuhl E15, James-Franck-Str. 1, D-85748 Garching

The CRESST experiment (Cryogenic Rare Event Search with Superconducting Thermometers) searches for nuclear recoils events induced by elastic scattering of dark matter particles off the target nuclei within CaWO4 target crystals. The detectors are operated at a temperature of (10 mK) and consist of the target crystal and a separate cryogenic detector. Both heat (phonon) and light signals are read out via a tungsten TES (Transition Edge Sensor) utilizing the superconducting phase transition of tungsten to measure the energy deposited in the absorbers. Until now the TES are produced via electron beam physical vapor deposition. For future large scale production the application of magnetron sputtering is investigated in terms of film quality and reproducibility. Several sputtering techniques were examined and the results are presented. This work was supported by the DFG Excellenzcluster Origin and Structure of the Universe, the SFB 1258 and the Maier-Leibnitz- Laboratory (Garching).

T 54.7 Mi 17:40 H09

Production and investigation of radiopure $CaWO_4$ crystals for the CRESST experiment — •Angelina Kinast[1], Andreas Erb[1,2], Andreas Erhart[1], Alexander Langenkämper[1], Elizabeth Mondragón[1], Andrea Münster[1], Tobias Ortmann[1], Luca Pattavina[1], Walter Potzel[1], Stefan Schönert[1], Raimund Strauss[1], and Michael Willers[1] — [1]Physik-Department E15, Technische Universität München, D-85747 Garching, Germany — [2]Walther-Meißner-Institut für Tieftemperaturforschung, D-85748 Garching, Germany

The direct dark matter search experiment CRESST (Cryogenic Rare Event Search with Superconducting Thermometers) uses scintillating $CaWO_4$ single crystals as targets for potential recoils of dark matter particles. For several years these $CaWO_4$ crystals have been produced in-house at Technische Universität München (TUM) via Czochralski growth from the raw materials $CaCO_3$ and WO_3. Thereby, extensive powder purification procedures have been applied. In a next step, TUM aims for minimizing the internal stresses of the $CaWO_4$ crystals. For this a COMSOL-simulation of the growth process was developed. In this talk the results of this simulation will be presented. In addition, the status of the alpha screening measurements planned at TUM, which are an important tool for characterization of TUM-grown crystals, will be presented. This research was supported by the DFG cluster of excellence "Origin and Structure of the Universe", by the BMBF Verbundprojekt 05A2017 CRESST-XENON and by the SFB1258.

T 54.8 Mi 17:55 H09

Erster Vergleich von Oberflächenereignissen eines Germaniumdetektors mit einer neuen 3d Simulationssoftware — •Lukas Hauertmann für die LEGEND-Kollaboration — Max-Planck-Institut für Physik

Germaniumdetektoren kommen in Experimenten mit niedrigem Untergrund zum Einsatz. So, z.B. in den beiden Experimenten GERDA und MAJORANA, die nach neutrinolosem doppelten Betazerfall suchen. In der nächsten Generation dieser Experimente soll die Anzahl der Detektoren erhöht und der Untergrund noch weiter reduziert werden. Um dazu beizutragen, wurde in der GeDet (Germaniumdetektor Entwicklung) Gruppe am MPI für Physik eine neue Software, „SolidStateDetectors.jl“, zur 3d Simulation solcher Detektoren entwickelt. Diese hilft Germaniumdetektoren besser zu verstehen und mehr Untergrundereignisse als solche zu identifizieren. Die GeDet Gruppe besitzt auch mehrere Teststände um Germaniumdetektoren experimentell zu untersuchen. Einer davon ist der Teststand GALATEA, der besonders geeignet ist um die Oberflächeneffekte bei Germaniumdetektoren mit Alpha- und Beta-Teilchen zu studieren. In diesem Vortrag werden erste Vergleiche zwischen mittels der neuen Software simulierten und in GALATEA experimentell aufgenommenen Pulsformen gezeigt.

T 54.9 Mi 18:10 H09

Eine neue Software zur 3d Simulation von Solid-State Detektoren — •Martin Schuster für die LEGEND-Kollaboration — Max-Planck Institut für Physik, München

Germanium- und Siliziumdetektoren kommen in einer Vielzahl von Experimenten weltweit zum Einsatz und haben einen festen Platz in zahlreichen Industriefeldern. In der GeDet (Ger- maniumDetektor Entwicklung) Gruppe am MPI für Physik werden Germaniumdetektoren genau untersucht. Dabei spielt der Vergleich von im Experiment aufgenommenen und simulierten Daten eine entscheidende Rolle. In der Gruppe wurde eine neue schnelle "Open Source" Software in der jungen Programmiersprache Julia geschrieben, mit der das Verhal- ten aller auf Dioden basierenden Halbleiterdetektoren simuliert werden kann. Das Paket dient der Berechnung der elektrischen Potentiale und Felder und bietet die Möglichkeit der Pulsformsimulation basierend auf der Drift der Ladungsträger. Das Einlesen von GEANT4-generierten Ereignissen ist möglich. In diesem Vortrag wird die Funktionsweise der Software Schritt für Schritt erläutert. Als Beispiel dient ein vierfach segmentierter n-Typ Punktkontakt - Germaniumdetektor.

T 55: Neutrinophysik III

Zeit: Mittwoch 16:00–18:30 Raum: S06

Gruppenbericht T 55.1 Mi 16:00 S06

KM3NeT/ORCA: status and perspectives — •Jannik Hofestädt for the KM3NeT-ECAP-Collaboration — Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP

ORCA is the low-energy part of KM3NeT, the next-generation underwater Cherenkov neutrino detector currently under construction in the Mediterranean Sea. The ORCA detector features a dense configuration of optical modules, optimised for measuring the oscillation of atmospheric neutrinos with energies down to a few GeV. ORCA's primary goal is to resolve the neutrino mass hierarchy. With the same data, ORCA is also sensitive to the appearance of tau neutrinos and a variety of possible new physics phenomena.

In this talk, the status of the ORCA detector construction and the performance of the first detector elements in the deep sea will be reported. Different activities of the ORCA group at ECAP will be presented. An overview is given on the deep-learning-based event classification and regression developments for the analysis of ORCA data. Furthermore, the sensitivity of ORCA to possible quantum decoherence effects will be discussed.

Gruppenbericht T 55.2 Mi 16:20 S06

The Jiangmen Underground Neutrino Observatory — •Michaela Schever for the JUNO-Collaboration — IKP-2, Forschungszentrum Jülich — III. Physikalisches Institut, RWTH Aachen University

The Jiangmen Underground Neutrino Observatory (JUNO) is a next generation multi-purpose antineutrino detector currently under construction in Jiangmen, China. The central detector contains 20 kton of liquid scintillator and is equipped with 18,000 20 inch and 25,000 3 inch PMTs. The surrounding water pool serves as Cherenkov veto detector allowing muon track reconstruction for a partial volume veto of the central detector. Measuring reactor antineutrinos of two powerplants at a baseline of 53 km, the unprecedented design energy resolution is 3% at 1 MeV. The main physics goal is to determine the neutrino mass hierarchy within six years of run time with a significance of 3-4 sigma. Additional physics goals are the precise measurement of the solar neutrinos, geo-neutrinos, supernova burst neutrinos, the diffuse supernova neutrino background as well as the search for proton decays. Data taking is expected to start in 2021. This talk reviews the current status of the project and the physics goals. Furthermore, the contributions of the German collaboration groups are summarized.

Gruppenbericht T 55.3 Mi 16:40 S06

Borexino's guide into the solar core and neutrinos — •Zara Bagdasarian[1], Sale-Iti Kroon[1,2], Sindhujha Kumaran[1,2], Livia Ludhova[1,2], Ömer Penek[1,2], and Mariia Redchuk[1,2] for the Borexino-Collaboration — [1]IKP-2, Forschungszentrum Jülich — [2]III Physikalisches Institut, RWTH Aachen University

The Borexino experiment is located at the Laboratori Nazionali del Gran Sasso in Italy with the primary goal of detecting solar neutrinos, particularly those below 2 MeV, with unprecedentedly high sensitivity. The Borexino collaboration has recently published the comprehensive measurement of solar neutrinos produced along the pp-chain, a sequence of nuclear reactions responsible for about 99 percent of solar energy. The solar neutrinos produced in different fusion reactions are affected to a different extent (due to their different energies) by the so-called Mikheyev, Smirnov, and Wolfenstein effect. As neutrinos propagate from the core of Sun to the photosphere, the oscillation parameters acquire effective values in an energy-dependent fashion. As a result, by measuring the solar neutrinos at different energies, Borexino probes the neutrino flavor-transition phenomena simultaneously both in a vacuum and matter-dominated regimes. The neutrino fluxes also provide a direct determination of the relative intensity of the two primary terminations of the pp-chain (pp-I and pp-II) and an indication that the temperature profile in the Sun is more compatible with solar models that assume high surface metallicity. In short, we explore the solar neutrinos measurements in Borexino as a unique probe of both the Sun's internal working, as well as fundamental physics.

T 55.4 Mi 17:00 S06

Analysis of first KM3NeT/ORCA data — •Johannes Schumann for the KM3NeT-ECAP-Collaboration — Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP

The KM3NeT neutrino detectors are currently being built in the deep Mediterranean Sea. KM3NeT/ORCA is the low energy branch of KM3NeT and the ORCA detector is designed for the investigation of oscillations of atmospheric neutrinos. The first detection elements have been deployed and the corresponding data has been analysed. Even with the first detection elements of the detector, the reconstruction of muon tracks is already possible.

In this talk, the analysis of the track reconstruction data and the identification of first neutrino candidates is presented.

T 55.5 Mi 17:15 S06

Updated Geoneutrino Measurement with the Borexino Detector — •Sindhujha Kumaran[1,2], Zara Bagdasarian[1], Sale-Iti Kroon[1,2], Livia Ludhova[1,2], Ömer Penek[1,2], and Mariia Redchuk[1,2] for the Borexino-Collaboration — [1]IKP-2, Forschungszentrum Jülich — [2]III B Physikalisches Institut, RWTH Aachen University

Geoneutrinos are electron antineutrinos and neutrinos emitted in the radioactive decays of heat producing elements such as ^{238}U, ^{235}U, ^{232}Th and ^{40}K from the Earth's interior. The main goal of neutrino geophysics is to use the obtained geoneutrino signals in estimating the abundance and distribution of these elements. So far, only two detectors, namely KamLAND and Borexino, have measured geoneutrinos.

The Borexino Detector is a liquid scintillator detector located at the Laboratori Nazionali del Gran Sasso (LNGS). The latest geoneutrino measurement included a 5.9σ evidence of geoneutrinos and the rejection of the null hypothesis of the mantle signal at a 98% C.L. The uncertainty in the latest published result is 26.2%. This work concentrates on the further improvement of the geoneutrino measurement. The increased statistics and the optimised selection cuts used for the analysis have made it possible to reduce the uncertainty to 20.6%. An uncertainty of less than 20% can be achieved by the further optimisation of the selection cuts and needs more investigation.

T 55.6 Mi 17:30 S06

Detection of the Diffuse Supernova Neutrino Background (DSNB) in JUNO: Challenges and Prospects — •Julia Sawatzki and Lothar Oberauer — Technical University of Munich, Chair for Experimental Astroparticle Physics E15, James- Franck-Str. 1, 85748 Garching b. München

The planned 20kt liquid scintillator detector JUNO (Jiangmen Underground Neutrino Observatory) will offer the possibility of a diffuse supernova neutrino background (DSNB) measurement. Although the cosmic background of neutrinos generated by core collapse supernova explosions throughout the universe is present in all flavors, the study will focus on the measurement of electron antineutrinos via the inverse beta decay, as this coincidence reaction provide powerful background suppression. This is of particular importance, as the relic neutrino signal rate in JUNO is, with few events per year, quite low. Therefore good background knowledge as well as powerful background suppression techniques are required. Neutrinos produced in nuclear reactors, the atmosphere, and cosmic muons, which can induce cosmogenic isotopes or fast neutrons, are the main background sources.

T 55.7 Mi 17:45 S06

Measuring the atmospheric neutrino to antineutrino flux ratio with IceCube DeepCore — •Lasse Halve, Marvin Beck, Christian Haack, Martin Leuermann, Saskia Philippen, Jöran Stettner, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen

The IceCube Neutrino Observatory, located at the geographic South Pole, measures neutrinos and antineutrinos produced in cosmic-ray showers in the atmosphere. Neutrinos and antineutrinos cannot be distinguished on an event-to-event basis within IceCube, but follow different distributions of the inelasticity parameter y in deep inelastic scattering. We present first results from a novel analysis, based on a new reconstruction of y with machine-learning methods, which measures the energy dependent $\nu\bar{\nu}$ flux ratio between 50 GeV and 300 GeV.

T 55.8 Mi 18:00 S06

ORCA sensitivity to ν_τ appearance — •Lukas Maderer for

the KM3NeT-ECAP-Collaboration — ECAP / Universität Erlangen-Nürnberg

The deep-sea neutrino detector KM3NeT/ORCA is optimized to study oscillations of atmospheric neutrinos in the few-GeV energy range. Apart from the primary science goal of ORCA - to resolve the neutrino mass hierarchy - the detector will be sensitive to the ν_τ flux developing from oscillations from a purely ν_μ and ν_e atmospheric flux along its passage through the Earth. Precise measurements of the ν_τ flux normalization facilitate the investigation of deviations from the expected unitarity of the PMNS matrix.

The upcoming installation of its first detector strings (about 5% of full detector with 115 strings) will already provide considerable atmospheric neutrino statistics with about 450 detected ν_τ events per year. This talk will present performance studies of a 7-string ORCA array and its sensitivity to exclude ν_τ non-appearance within the first months of operation.

T 55.9 Mi 18:15 S06

Effect of different host material for implantation of ^{163}Ho in metallic magnetic calorimeters — •Martin Neidig, Benjamin Raach, Christian Enss, Andreas Fleischmann, Loredana Gastaldo, Sebastian Kempf, Federica Mantegazzini, and Clemens Velte for the ECHo-Collaboration — Kirchhoff Institute for Physics, Heidelberg University

The ECHo experiment has been designed for determining the value of the effective electron neutrino mass by the analysis of the endpoint region of the ^{163}Ho spectrum. The measurement of the ^{163}Ho spectrum is performed using low temperature metallic magnetic calorimeters (MMCs) with ^{163}Ho enclosed in the absorber. To achieve high sensitivity, detector performance as energy and time resolution are fundamental. In the process of optimizing MMCs for ECHo we have tested different materials for hosting ^{163}Ho: gold, silver and aluminum. For that, high purity ^{163}Ho has been implanted at Mainz University in three different MMC arrays having different implantation layers.
We discuss the signal shape obtained with the different detectors as function of temperature as well as the energy resolution at the operating temperature of about 20 mK. In addition, we have also investigated if different host material could influence the decay mode for the electron capture in ^{163}Ho. We present the comparison of ^{163}Ho spectra acquired with the different detectors and discuss the results at the light of available theories.

T 56: Neutrino-Detektoren II

Zeit: Mittwoch 16:00–18:30 Raum: S07

T 56.1 Mi 16:00 S07

Improved approach of monitoring the effective quantum efficiency of Borexino photomultipliers — •Mariia Redchuk[1,2], Zara Bagdasarian[1], Sale-Iti Kroon[1,2], Sindhujha Kumaran[1,2], Livia Ludhova[1,2], and Ömer Penek[1,2] for the Borexino-Collaboration — [1]IKP-2, Forschungszentrum Jülich — [2]III B Physikalisches Institut, RWTH Aachen University

Borexino is a liquid scintillator detector located in Laboratori Nazionali del Gran Sasso in the mountains of central Italy. It is equipped with nominally 2212 inward-facing photomultipliers (PMTs) that are used to detect events producing scintillation light.

The effective quantum efficiency (EQE) represents the amount of incident light detected by the PMT. It may vary in time due to various factors like light yield change or the PMT aging. Therefore, in order to accurately represent the detector in terms of light collection, we need to account for these changes.

We calculate the EQE of each PMT and monitor its changes using the low-energy ^{14}C (Q = 156 keV) events, for which the single-photoelectron mode on each PMT dominates. However, this calculation is sensitive to the position and energy of the selected events as well as to the set of PMTs active in the detector in a given time period. We developed a new more stable method of selecting ^{14}C events and improved the accuracy of the EQE calculation. The highlights of the new approach will be summarized in this talk.

T 56.2 Mi 16:15 S07

Investigation of g_A quenching using the COBRA demonstrator to study the β-spectrum shape of ^{113}Cd — •Stefan Zatschler for the COBRA-Collaboration — TU Dresden, Institut für Kern- und Teilchenphysik

The COBRA experiment is dedicated to the search for the hypothesized neutrinoless double β-decay using CdZnTe semiconductor detectors. Located at the underground facility LNGS in Italy it is shielded from cosmic rays which allows for the investigation of ultra-rare nuclear decays. Besides the examination of naturally present $\beta\beta$-isotopes it also allows for the study of the fourfold forbidden non-unique β-decay of ^{113}Cd.

Nuclear model calculations predict that the spectral shape of the electron momentum distribution of highly forbidden β-decays, such as ^{113}Cd with a Q-value of about 320 keV and a half-life of $8{\cdot}10^{15}$ yrs, is sensitive to the effective value of the axial-vector coupling strength g_A involved in nuclear processes. In order to confirm a quenching of g_A, which is proposed to reproduce half-life measurements with the help of nuclear models, the COBRA demonstrator was optimized for a dedicated ^{113}Cd low-threshold run.

This talk will cover the optimization of the COBRA demonstrator, an overview of the data-taking as well as the statistical analysis to extract effective values of g_A for several considered theory frameworks.

COBRA is funded by the German Research Foundation DFG.

T 56.3 Mi 16:30 S07

α/β discrimination techniques in Borexino — •Sale-Iti Kroon, Zara Bagdasarian, Sindhujha Kumaran, Livia Ludhova, Ömer Penek, Mariia Redchuk, and Yu Xu — Forschungszentrum Jülich, Jülich, Germany

Borexino is a liquid scintillator detector located in the Laboratori Nazionali del Gran Sasso, Italy whose main goal is the measurement of low-energy solar neutrinos. The first complete measurement of all the components of the pp-chain was performed with Borexino detector. In contrast, neutrinos from the CNO fusion cycle, expected to contribute less than 1% to the total solar power, have not been observed yet.

The observation of CNO solar neutrinos even in an ultra-pure liquid scintillator detector is challenging because of the similar spectral shapes of the signal due to CNO neutrinos and the 210Bi background. 210Bi from the 238U chain undergoes β- decay to 210Po and 210Po undergoes α-decay into stable 206Pb. As a part of the 238U decay chain, ideally, 210Bi would be in secular equilibrium with its daughter, 210Po. Unfortunately, due to convective motions inside the detector, 210Po can be introduced into the fiducial volume from peripheral sources. To prevent this, in 2015 the detector has been thermally insulated from its surroundings. Moreover, a large effort is dedicated towards linking the "easy-to-determine" 210Po alpha-decay activity to that of 210Bi. This can be achieved using different alpha/beta discrimination techniques. This study concentrates on testing and evaluation of several pulse-shape variables developed in Borexino analysis.

T 56.4 Mi 16:45 S07

Investigation of detector effects for a sterile neutrino search at KATRIN — •Marc Korzeczek for the KATRIN-Collaboration — Karlsruhe Institut für Technologie, Karlsruhe, Deutschland

The KATRIN (KArsrluhe TRItium Neutrino Experiment) investigates the energy endpoint of the tritium beta-decay to determine the effective mass of the electron anti-neutrino with a precision of 200 meV (@90CL) after an effective data taking time of three years. A possible future extension of KATRIN is the search for a sterile neutrino signature in the tritium beta-decay. Such a search requires measuring the whole energy spectrum of tritium beta-decay and thus requires a redesign of the detector section, as the total rate at the detector is increased by several orders of magnitude. Moreover systematic effects, such as detector backscattering, charge sharing and the detector deadlayer, which lead to drastic modifications of the measured energy spectrum, have to be measured and modeled in order to achieve high sterile neutrino sensitivities. This talk discusses the impact of such systematics and compares measurements to current modeling approaches.

T 56.5 Mi 17:00 S07

Measurement of KATRINs energy loss function using a time

of flight method — •Rudolf Sack and Caroline Rodenbeck for the KATRIN-Collaboration — WWU Münster

The **Ka**rlsruhe **Tri**tium **N**eutrino experiment (KATRIN) is a next generation tritium beta decay experiment improving the sensitivity on direct neutrino mass measurements by one order of magnitude over the predecessor experiments. It allows a model independent investigation of the absolute neutrino mass scale with an estimated sensitivity of $0.2\,\mathrm{eV/c^2}$ (90% C.L.)

Understanding energy losses of electrons inside the windowless gaseous tritium source (WGTS) of KATRIN is essential for measuring the tritium beta decay spectrum with the required precision. The electrons can scatter elastically and inelastically off tritium molecules in the WGTS loosing energy in the process and resulting in a modification of the spectrum.

The talk presents a high resolution measurement of the shape of this energy loss function, which was obtained using a time of flight method with monoenergetic electrons from a photoelectron source at the endpoint energy of the tritium beta spectrum of 18.6 keV.

This work is funded by DFG through the Research Training Group 2149 and by BMBF under contract number 05A17PM3.

T 56.6 Mi 17:15 S07

Calibration of the KATRIN high-voltage monitoring system with ^{83m}Kr conversion electrons — •Oliver Rest for the KATRIN-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster

The KATRIN experiment will measure the endpoint region of the tritium-β-decay spectrum to determine the neutrino mass with a sensitivity of 0.2 $\mathrm{eV/c^2}$. To achieve this sub-eV sensitivity the energy of the decay electrons will be analyzed using a MAC-E-filter type spectrometer. The retarding potential of the MAC-E-filter of -18.6 kV has to be monitored with a relative precision of 3 ppm over a measurement period of two month. For this purpose the potential will be measured directly via two custom made ppm-precise high-voltage (HV) dividers. In order to determine the absolute values and the stability of their scale factors, regular calibration measurements with ppm precision are required.

Among other things, the HV will be compared to a natural standard given by mono-energetic conversion electrons from the decay of ^{83m}Kr. This has been done in 2017 with gaseous krypton, which can be injected into the KATRIN source section. With conversion electrons emitted by gaseous ^{83m}Kr not only relative changes but also an absolute calibration of the HV system can be performed, since their kinetic energy is well known. The talk will give an overview of the HV calibration at KATRIN with a gaseous ^{83m}Kr source.

This project is supported by BMBF under contract number 05A14PMA and 05A17PM3.

T 56.7 Mi 17:30 S07

Mechanical Construction and Liquid Handling System of the OSIRIS (Online Scintillator Internal Radioactivity Investigation System) Predetector Facility — •Hans Theodor Josef Steiger[1], Lothar Oberauer[1], Rainer Othegraven[2], Mathias Walter[1], and Michael Wurm[2] for the JUNO-Collaboration — [1]Physik Department der Technischen Universität München, James-Franck Straße 1, 85748 Garching bei München — [2]Institut für Physik, Experimentelle Teilchen und Astroteilchenphysik, Johannes Gutenberg Universität Mainz, Staudinger Weg 7, 55128 Mainz

To ensure the liquid scintillator (LS) quality, necessary for a successful operation of the JUNO (Jiangmen Underground Neutrino Observatory) detector the OSIRIS system is currently designed. This 20 t detector serves as online monitor for the radiopurity of the scintillator produced during the commissioning and production phase of the LS purification plants. After the filling of the JUNO detector detailed studies of the LS characteristics are foreseen. This talk is focused on the mechanical design of the OSIRIS detector and the liquid handling system necessary for the screening of a significant fraction of the 6000l/h of LS produced in the purification plants. This work is supported by the DFG Clusters of Excellence "Universe" and "PRISMA", the DFG Research Unit "JUNO" and the Maier-Leibnitz-Laboratorium.

T 56.8 Mi 17:45 S07

Development of the OSIRIS detector simulation and its sensitivity study — •Christoph Genster[1,2], Yaping Cheng[1,2], Alexandre Göttel[1,2], Livia Ludhova[1,2], Philipp Kampmann[1,2], Michaela Schever[1,2], Achim Stahl[1,2], Yu Xu[1,2], Sebastian Lorenz[3], Paul Hackspacher[3], and Michael Wurm[3] — [1]IKP-2, Forschungszentrum Jülich — [2]III. Physikalisches Institut, RWTH Aachen University — [3]Institute for Physics, Johannes Gutenberg-Universität Mainz

The OSIRIS detector is designed to monitor the radio-purity of the liquid scintillator (LS) during the filling of JUNO detector. It will be located between the LS-purification plant and the JUNO Central Detector and measure the purified LS either in a continuous flow or in batches. Its acrylic vessel can hold 18 tons of LS and it will feature an energy resolution of better than 10% @ 1 MeV. In the filling process of JUNO, OSIRIS will act as an early warning system to prevent contamination of the Central Detector in case of a failure of the purification plant. Beyond this purpose it can further aid JUNO with long-time measurements of the scintillator. This talk will give an overview of the detector simulation and sensitivity studies for OSIRIS.

T 56.9 Mi 18:00 S07

Data reduction and analysis of the ^{163}Ho spectrum for the ECHo experiment — •Clemens Velte[1], Arnulf Barth[1], Martin Brass[3], Sergey Eliseev[4], Loredana Gastaldo[1], Federica Mantegazzini[1], Benjamin Raach[1], Andreas Reifenberger[1], and Alexander Ziegenbein[2] for the ECHo-Collaboration — [1]Kirchhoff Institute for Physics, Heidelberg University — [2]Physikalisches Institut, Tuebingen University — [3]Institute for theoretical physics, Heidelberg University — [4]MPI for Nuclear physics, Heidelberg University

The ECHo experiment has been conceived for the determination of the effective electron neutrino mass. High statistics and high energy resolution spectra will be acquired using large arrays with in total about 10000 metallic magnetic calorimeters with enclosed high purity ^{163}Ho source. The reliability of the high statistics ^{163}Ho spectrum resides in an accurate analysis protocol to be applied to single pixel data sets. This analysis protocol has been first tested for the reduction of acquired data obtained by reading out 24 pixels over 3 weeks. We describe the quality check and calibration each file needs to pass for adding the corresponding data to the final spectrum. This is based on the analysis of key parameters, as energy resolution and background level. Furthermore we present the analysis structure for the high statistics spectrum to extract spectral shape parameters, background contributions, Q_{EC}-value and determine the effective electron neutrino mass evidence. Preliminary results obtained with the analysis of a selected data set will be discussed.

T 56.10 Mi 18:15 S07

Data aquisition systematic effects for sterile neutrino search at KATRIN — •Martin Descher for the KATRIN-Collaboration — Karlsruhe Institut für Technologie, Germany

The KATRIN Experiment (Karlsruhe Tritium Neutrino Experiment) aims to measure the effective electron neutrino mass down to 0.2 eV @90% CL. Using KATRIN's highly active tritium source, it is also possible to search for the signature of a keV sterile neutrino in the differential beta decay spectrum. To reach sensitivity for sterile mixing angles down to $\sin^2\theta = 10^{-6}$, a large statistical sample is necessary. For this, the detector and readout system must be capable of handling extremely high rates of $\approx 10^8$ electron counts per second. The new detector and readout system TRISTAN is designed to live up to this task, but systematic effects from its data aquisition system in respect to high rates still need to be investigated.

T 57: Axionen II

Zeit: Mittwoch 16:00–17:50 Raum: S09

Gruppenbericht T 57.1 Mi 16:00 S09

The ALPS II experiment — •Jan H. Põld[1] and Aaron D. Spector[2] for the ALPS-Collaboration — [1]AEI Hannover — [2]DESY Hamburg

ALPS II is a light-shining-through-a-wall experiment searching for undiscovered sub-eV elementary particles motivated by astrophysics and cosmology. These particles are not accessible with accelerator based experiments. ALPS II is located at DESY in Hamburg. In its final version it will use 20 superconducting HERA dipole magnets, ultra-stable lasers and two long-baseline cavities that are housed in a 200m long vacuum system. The installation and commissioning of the experiment will start next year and first data are expected in 2020. This talk will discuss the physics case for ALPS II and the sensitivity of the experiment. An explanation of the light-shining-through-a-wall approach will be provided as well as an overview of the ALPS II experiment.

T 57.2 Mi 16:20 S09

Control and Alignment of the Optical Systems in the ALPS II Experiment — •Todd Kozlowski and Aaron Spector for the ALPS-Collaboration — DESY, Hamburg, Germany

The Any Light Particle Search (ALPS) IIc is a light-shining-through-a-wall experiment that aims to detect laboratory-generated axions and axion-like-particles (ALPs) via axion-photon coupling. In order to improve detection sensitivity, the experiment requires two optical cavities to maintain simultaneous resonance with the generated axion field. One of the resonators, the production cavity (PC), increases the laser field amplitude on one side of a light-tight barrier by a factor of 70 (5000 in power) which improves the amplitude of the generated axion field. The second resonator, the regeneration cavity (RC), on the other side of the light-tight barrier builds up the regenerated laser field by a factor of 200 (40000 in power) which can then either be detected as the modulation of a reference field or counted by a photon counter. I will discuss the envisioned length and alignment sensing and control scheme of ALPS.

T 57.3 Mi 16:35 S09

Heterodyne detection in the ALPS II experiment — •Giuseppe Messineo for the ALPS-Collaboration — University of Florida, Gainesville FL (USA)

The Any Light Particle Search (ALPS) II is an experiment designed to search for weakly interacting sub-eV particles that couple to photons in the presence of a magnetic field. In order to detect the extremely weak photon fields associated with the existence of such hypothetical particles, the detector employed needs to be sensitive to power levels equivalent to a few photons per week. The ALPS group at the University of Florida has developed a detection method based on heterodyne interferometry that takes advantage of the coherent nature of the expected signal field. This technique relies on the ability to precisely track the signal phase, with a precision better than 0.1 cycles, over measurement times of several weeks. We use optical techniques similar to those found in modern day gravitational wave experiments to appropriately track and record phase information to achieve the required precision. I will report on the design and tests of the heterodyne optical setup and its associated shot-noise-limited detector.

T 57.4 Mi 16:50 S09

MADMAX - Towards a Dielectric Axion Haloscope — •Christoph Krieger for the MADMAX-Collaboration — Universität Hamburg, Institut für Experimentalphysik, Luruper Chaussee 149, 22761 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. Its major coupling to ordinary matter is realized as a coupling to two photons allowing for axion photon conversion inside strong electromagnetic fields. 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.

For MADMAX a booster consisting of 80 dielectric discs with 1 m^2 size inside a magnetic field in the order of 10 T are envisioned. The relative positions of these discs has to be adjustable in the range of a few to tens of millimeter with micrometer precision.

In this presentation, developments and first results towards a (technical) prototype, including production of tiled large area discs and characterization measurements, will be shown along prospects for the final experiment to be build at DESY in Hamburg.

T 57.5 Mi 17:05 S09

Simulation of axion-electrodynamics for the MADMAX experiment — •Jan Schütte-Engel for the MADMAX-Collaboration — University of Hamburg, Hamburg, Germany

Axions are hypothetical particles introduced to solve the strong CP problem of the Standard Model. In addition axions can resolve the dark matter mystery. Axions with masses in the range of a few μeV up to a few hundreds of μeV are furthermore motivated by the scenario in which the Peccei-Quinn symmetry is broken after inflation. These motivate the search for axions in direct detection experiments on Earth, and the development of new techniques to become sensitive to this specific axion mass region. The presence of axions modifies the Maxwell equations, which many direct axion search experiments on Earth exploit. In this talk we will discuss the simulation of axion-electrodynamics. The developed formalism is applied to the MADMAX direct detection axion experiment, where diffraction and near field effects can be important loss mechanism.

T 57.6 Mi 17:20 S09

Development of GridPix detectors for IAXO at CAST — •Sebastian Schmidt, Klaus Desch, Jochen Kaminski, Tobias Schiffer, and Hendrik Schmick for the CAST-Collaboration — Physikalisches Institut, 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, are deployed at CAST to develop an ultra low background detector for IAXO.

The talk focuses on an overview of the data analysis framework for this detector, written in Nim. The likelihood based analysis for the GridPix data will be discussed and preliminary results of the achieved background rate with the 2017/18 data will be presented.

T 57.7 Mi 17:35 S09

Low Temperature MMC Detector Arrays for the IAXO — •Daniel Unger, Christian Enss, Andreas Fleischmann, Lisa Gamer, Loredana Gastaldo, Daniel Hengstler, Sebastian Kempf, and Dennis Schulz for the iaxo collaboration — Kirchhoff Institute for Physics, Heidelberg University

The International Axion Observatory (IAXO) is searching for axions or axion-like particles generated in the Sun. A large magnetic field is used to convert solar axions to photons via the Primakoff effect. The major part of the expected spectrum considering only axion-photon coupling covers an energy range up to 10 keV with its maximum at about 3 keV. X-ray detectors with high efficiency in this energy range and low intrinsic background are required. Low temperature metallic magnetic calorimeters (MMCs) fulfil these requirements and can reach very low thresholds below 100 eV.

We present the design of a new detector system for the IAXO experiment with the possibility to operate two different kinds of two-dimensional MMC arrays. The setup is designed to host a large MMC array with moderate energy resolution aiming to discover events related to axions. If axions were discovered the focus would move to study the spectral shape. In this case a smaller MMC array featuring a higher energy resolution would replace the initial array using the same setup.

We show the current status of the platform and discuss methods to recognize background events based on pulse shape analysis and event coincidence in several pixels.

T 58: Top-Physik II

Zeit: Mittwoch 16:00–17:45 Raum: S10

T 58.1 Mi 16:00 S10

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 for processes that were so far unobservable. In this talk, we look at first steps towards measuring the CKM matrix element $|V_{ts}|$ in top quark decays. One focus will be the differentiation between jets from strange quarks and jets from other light quark flavors using neural network techniques.

T 58.2 Mi 16:15 S10

Suchen nach der Produktion von 4 Top-Quarks mit dem ATLAS Detektor — Clara Nellist, Thomas Peiffer, Arnulf Quadt, Paolo Sabatini, Elizaveta Shabalina und •Fabian Sohns — II. Physikalisches Institut, Georg-August-Universität Göttingen

Die vom ATLAS-Experiment gemessene Datenmenge von ca. 140 fb^{-1} im RUN-2 des Large Hadron Colliders (LHC) ermöglicht Präzisionsstudien und die Untersuchung von seltenen Prozessen, insbesondere im Bereich der Physik des Top-Quarks.
Die Produktion von $t\bar{t}t\bar{t}$ ist ein noch nicht beobachteter Prozess mit einem Wirkungsquerschnitt von $\sigma_{t\bar{t}t\bar{t}} \approx 10\,\mathrm{fb}$. Er wird vom Standardmodell vorhersagt und ist sensitiv auf viele Modelle jenseits des Standardmodells. In diesem Vortrag wird eine Übersicht des einfachleptonischen und des zweifach-leptonischen Kanals mit ungleicher Ladung gegeben. Die beiden Kanäle haben die gemeinsame Herausforderung, ein sehr kleines Signal in einem Bereich nachzuweisen, in welchem der $t\bar{t}$-Prozess den Untergrund dominiert. Somit ist es wichtig, sehr genau zwischen dem geringem Signal und dem großen Untergrund zu unterscheiden und systematische Unsicherheiten genauestens zu analysieren. Zu diesem Zweck werden verschiedene Methoden getestet, die von datengetriebenen Abschätzungen des $t\bar{t}t\bar{t}$-Untergrundes bis hin zu multivariaten Analysen zur Rekonstruktion der Ereignisse sowie zur Differenzierung von Signal und Untergrund reichen. Weiterhin ist es notwendig, Abweichungen zwischen der theoretischen Vorhersage und den gemessenen Daten mithilfe einer Umgewichtung zu korrigieren.

T 58.3 Mi 16:30 S10

Studies of background processes for the search of the simultaneous production of four top quarks at the ATLAS detector — •Lennart Rustige and Romain Madar — LPC, Clermont-Ferrand, Frankreich

The search for the simultaneous production of four top quarks has so far been dominated by searches for physics beyond the standard model. Using the full dataset of the LHC Run II recorded at the ATLAS detector, corresponding to an integrated luminosity of almost $\mathcal{L} = 150\,\mathrm{fb}^{-1}$, the observation of this process as predicted by the standard model (SM) may finally come within reach.

This process is fairly rare under the SM assumption, with a next-to-leading order prediction for the production cross-section of $\sigma_{tttt} = 11.97^{+18\%}_{-21\%}$ fb [arXiv:1711.02116] at a centre-of-mass energy of $\sqrt{s} = 13\,\mathrm{TeV}$. Therefore, detailed studies of the background processes play an important role for the search of this process. This contribution discusses some of these studies, where the final state signature contains either a lepton pair with the same electric charge, three leptons or four leptons.

T 58.4 Mi 16:45 S10

Ein Vergleich des $t\bar{t}+b\bar{b}$-Prozesses in verschiedenen Simulationen — •Maximilian Horzela, Ulrich Husemann, Philip Keicher und Matthias Schröder — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

In der Analyse der mit einem Top-Quark-Antiquark-Paar ($t\bar{t}$) assoziierten Higgs-Boson-Produktion mit einem Zerfall des Higgs-Bosons in ein Bottom-Quark-Antiquark-Paar ($b\bar{b}$) ($t\bar{t}H(b\bar{b})$) begrenzt die Unsicherheit auf den dominanten Untergrundprozess $t\bar{t}+b\bar{b}$ die Sensitivität der Analyse.

Die Komplexität des $t\bar{t}+b\bar{b}$-Prozesses in Monte-Carlo(MC)-Simulationen hat zur Folge, dass einige Beiträge mit zum Teil unterschiedlichen Ansätzen existieren. Ein Beispiel für diese ist die Wahl zwischen 4- und 5-Flavor-Schema (4FS und 5FS). Diese unterschiedlichen Methodiken führen zu teils deutlichen Diskrepanzen in den MC-Vorhersagen. In Kombination mit dem Mangel an Referenzdaten aus Messungen führt dies zu relativ hohen Unsicherheiten in der Beschreibung.

Dieser Vortrag soll die Schwierigkeiten in der Beschreibung und Interpretation von $t\bar{t}+b\bar{b}$-Ereignissen umreißen und zeigt diesbezüglich einen Vergleich unterschiedlicher MC-Vorhersagen des $t\bar{t}+b\bar{b}$-Prozesses mit möglichen Anwendungen im Rahmen der $t\bar{t}H(b\bar{b})$-Analyse.

T 58.5 Mi 17:00 S10

Reconstruction-studies of $t\bar{t}Z$ events in the $t\bar{t}$-allhadronic channel with $Z \to ll$ at the ATLAS experiment — Otmar Biebel, Florian Fischer, Jeannine Wagner-Kuhr, and •Nina Wenke — Ludwig-Maximilians-Universiät München

The process of the associated production of $t\bar{t}$ pairs with Z-bosons has just been discovered in 2015 and is regarded as an important process in top-quark physics ever since. It is sensitive to the tZ-coupling, thus the measurement of the $t\bar{t}Z$ cross-section is a direct probe of the weak coupling of the top-quark. The latter might be modified in the presence of physics beyond the standard model, so a precise measurement of this coupling is essential. On top of that, the $t\bar{t}Z$ process is also an important background in the measurement of the $t\bar{t}$H process in the multi-lepton final state.

The studies presented in this talk are based on Monte Carlo simulated data and are conducted in the context of the full Run-2 ($140 fb^{-1}$) analysis. They consider $t\bar{t}Z$ systems in which the top and the antitop quark decay hadronically and the Z-boson decays either in an electron-positron or muon-antimuon pair. The presented studies focus on the reconstruction of those kind of events. First, the standard χ^2_{min} reconstruction technique is used and its weaknesses are studied. As an additional approach, a multivariate reconstruction method is developed and studied.

T 58.6 Mi 17:15 S10

Studies on the measurement of the $t\bar{t}Z$ production cross section in the multilepton channel — Otmar Biebel[1], •Florian Fischer[1], Thomas McCarthy[2], and Jeannine Wagner-Kuhr[1] — [1]Ludwig-Maximilians-Universität, München — [2]Max-Planck-Institut für Physik, München

The measurement of the production cross section of top-antitop quark pairs in association with a Z boson is sensitive to the coupling between top quarks and Z bosons. In the Standard Model, this coupling is precisely predicted via the weak interaction and therefore any deviation from the Standard Model value is an indicator for new physics. Although, with four leptons in the final state, the tetralepton decay channel is the most rare leptonic decay channel of $t\bar{t}Z$, it has the highest signal purity of all.

In this talk, studies for an analysis with the full Run-2 dataset taken by the ATLAS experiment in the years 2015 to 2018, corresponding to an integrated luminosity of 140 fb^{-1}, are performed. In order to increase the signal efficiency and to reconstruct not only the Z boson but also $t\bar{t}$ and thus the whole $t\bar{t}Z$ system with four leptons in the final state, a neutrino weighting method has been applied. For the differential cross section measurement kinematic variables of the $t\bar{t}Z$ system and its decay products are tested for differences between several Monte Carlo generators. In addition, the benefits of jets reconstructed with a particle-flow algorithm will be studied in the context of this analysis.

T 58.7 Mi 17:30 S10

Iterative Bayes Unfolding for $t\bar{t}\gamma$ production using full Run2 pp collisions with the ATLAS detector — •John Meshreki and Ivor Fleck — Universität Siegen

The top-quark has a unique position in the Standard Model of elemen-

tary particle physics. Due to its large mass, it has a very short lifetime, which allows it to decay to a W boson and b-quark almost 100% of the time and pass its spin information on to its decay products. This permits to test the validity of the SM as well as unraveling hints of theories beyond the Standard Model.

This talk presents the Iterative Bayes Unfolding (IBS) for the differential cross-section measurement of the top-quark pair production associated with a photon using full Run2 proton-proton collisions data collected by the ATLAS detector. The IBS estimates the initial distribution needed by Bayes' theorem through an iterative approach. It gives stable results with respect to variations of the initial probabilities and of the smoothing procedures. The IBS method is performed in the electron-muon channel to remove experimental distortions, due to the detector's limitations, for observed detector-level observables allowing to estimate their "truth-level" spectra. Such truth-level distribution will be used in measuring the differential cross-section as a function of the observable.

T 59: Grid-Computing und Software

Zeit: Mittwoch 16:00–18:15 Raum: S11

T 59.1 Mi 16:00 S11

Analysis software for the Belle II experiment. — •Sam Cunliffe — DESY

The Belle II experiment at SuperKEKB will benefit from an approximate factor 40 increase in the instantaneous luminosity with respect to Belle / KEKB. This, together with a longer data-taking plan will result in a factor 50 increase in the recorded data.

In order to cope with the challenges of such large data samples, a new software framework has been developed for Belle II including candidate-based high-level analysis tools. This talk will describe the key analysis tools, their integration into the framework, and the analysis model in general.

T 59.2 Mi 16:15 S11

Tuning ROOT parameters to optimize ATLAS Analysis Object Data — •Martin Errenst[1,2] and Attila Krasznahorkay[1] — [1]Bergische Universität Wuppertal — [2]Cern

In ATLAS, reconstructed physics objects are stored in the centrally managed xAOD format. xAOD is based on ROOTs file format and therefore offers a range of configuration settings. In a study where typical file access patterns in ATLAS analyses and other workflows are emulated, these settings are reviewed to optimize for small file sizes and good reading speeds.

The results of this study will be used to find optimal storage configurations for datasets used in different stages of ATLAS analyses. Finding good middle grounds between file size and file reading speed for different requirements of the final stage analyses and that of central data processing, is becoming even more important as ATLAS is preparing for LHC's Run3.

As a cross check to the analysis emulation, similar computing performance studies are done in an ongoing SUSY analysis, which is searching for R-parity violating decays in final states with one lepton and many (>8) jets of which 0 or >3 are b-tagged.

T 59.3 Mi 16:30 S11

Speeding Up Reconstruction of Low Energy Neutrino Events in IceCube with GPUs — •Maicon Hieronymus, Sebastian Böser, Bertil Schmidt, and Elisa Lohfink for the IceCube-Collaboration — Johannes Gutenberg-Universität, Mainz, Deutschland

The IceCube Neutrino Observatory can reconstruct neutrinos with just a few GeV of energy, even though only few hits per event are detected. The multi-dimensional parameter space where each event has an energy deposit at the vertex, potentially an energy and direction of the emerging muon track as well as the usual position and time parameters makes this a non-trivial problem. In addition, the light diffusion process can not be calculated ab-initio but has to be taken from simulation stored in so called photosplines as look-up tables. A maximum likelihood approach is used for the reconstruction. The vertex and the direction are optimized using MultiNest, a multi modal nested sampling algorithm that handles degenerated likelihoods. Track length and energy are determined separately. The likelihood is constructed from hit probabilities stored in spline tables. The overall process takes on average 10 mins per event on a CPU. The lookups in the spline tables are the bottleneck of the reconstruction. In this talk I present approaches using a CUDA-enabled GPU to significantly speed up the reconstruction. The focus lies on balanced workload, coalesced memory access and overlapping computation and communication, which might result in a speed-up of 15-20 over the CPU implementation for $O(10^4)$ likelihood evaluations.

T 59.4 Mi 16:45 S11

Grid Computing at Belle II — •Tobias Jenegger and Thomas Kuhr — Ludwig-Maximilians-Universität München

Over the last decades not just the setup of physics experiments and the measurement instruments have become considerably more sophisticated and complex but also the amount of retrieved data has exceeded what humans can interpret directly. The data can only be handled using large computing systems.

Belle II, a particle physics experiment in Japan designed to study the properties of B mesons, involves over 100 institutes in 25 countries and employs a large grid computing system that allows about 800 scientists to analyse the obtained data and to produce data sets of simulated events. Instead of working with one supercomputer a distributed grid computing system equipped with the most current software technology allows to exploit the computing resources of the individual research institutes in the most efficient way.

This talk will give an overview of the grid computing model at Belle II and present work in progress on developments of an improved user interface.

T 59.5 Mi 17:00 S11

Concept of federating German CMS Tier 3 Resources — •R. Florian von Cube, Manuel Giffels, Christoph Heidecker, Günter Quast, Martin Sauter, and Matthias J. Schnepf — Karlsruher Institut für Technologie

Computing resources located at the different institutes of the German CMS community (DCMS) provide a large infrastructure for end user analyses. Some groups also have access to HPC centers and cloud resources, not dedicated to HEP. Though, all of these resources are mostly only shared within the local group. The community, however, profits from making resources such as HPC centers and cloud resources available to all DCMS users for shared, efficient usage.

In this contribution we present a concept, how an overlay submission infrastructure based on HTCondor's routing and flocking mechanism can be used to connect different resource pools available to the DCMS community in order to allow a transparent and more efficient utilization of all resources. Beside integrating static resources, also dynamically allocated ones can be considered as well, provided that site specific access and usage policies are taken into account and implemented. Virtualization and container technologies such as virtual machines, Docker, and Singularity are key components to assure well-defined software environments on opportunistic resources, no matter where computing jobs are run.

We present the concept, and the current status of the proof-of-concept setup.

T 59.6 Mi 17:15 S11

Integrating Dynafed into the ATLAS workflow — •Benjamin Rottler[1], Frank Berghaus[2], Felix Bührer[1], and Markus Schumacher[1] — [1]Albert-Ludwigs-Universität Freiburg — [2]University of Victoria

In the current ATLAS grid computing model analysis jobs are sent to the grid site where the corresponding data is available. With the ever increasing amout of measured and simulated data this is not feasible anymore in the future. Furthermore, there are plans that smaller grid sides can only provide computing ressources, but not storage.

Dynafed allows to aggregate different storage endpoints where data access is possible via the WebDAV protocol. It supports traditional grid storage solutions like dCache and DPM as well as object stores such as Amazon S3 or Microsoft Azure. Dynafed allows to redirect the

user request to the nearest storage endpoint where the data is available.

Our goal is to incorporate Dynafed into the ATLAS grid workflow. For this we need to evalute the performance of Dynafed and WebDAV based access. We present results of those benchmarks and compare Dynafed with traditional access methods. Additionally, we compare the performance of grid storage and object store endoints.

T 59.7 Mi 17:30 S11

HEP Analyses in a Cloud — •Matthias J. Schnepf, R. Florian von Cube, Manuel Giffels, Christoph Heidecker, Günter Quast, and Martin Sauter — Karlsruhe Institute für Technologie

Many user analyses in High Energy Physics (HEP) have a huge demand for computing resources. This demand is unpredictable due to peak loads, which makes it challenging to use the resources efficiently.

Additional computing resources that are not dedicated to HEP usage, so-called opportunistic resources, help to cover the resource demand. We allocate these resources from HPC centers or cloud providers on demand and integrate them transparently into our institute batch system. This results in a flexible cloud-like system with a huge number of heterogeneous resources and a single point of entry.

To improve the utilization of these resources, we developed COBalD (Opportunistic Balancing Daemon), a framework that makes decisions using feedback loops. This allows for reacting dynamically on the current demand of resources while adjusting the amount of resources based on their utilization. For the integration of resources from different resource providers, we combined CoBalD with a multi-agent resource manager called TARDIS (Transparent Adaptive Resource Dynamic Integration System) in order to interact with various providers. TARDIS enables reacting on the current demand in a higher granularity which results in a higher resource utilization.

In this contribution, we give an overview of our developments as well as the experiences with our system.

T 59.8 Mi 17:45 S11

Testing XCache for ATLAS workflows — •Guenter Duckeck, Nikolai Hartmann, and Thomas Maier — Ludwig-Maximilians-Universität München

Caching servers are a promising and lightweight alternative or complement to permanent storage clusters. XCache is a service developed by XRootd team which acts as a proxy cache for remote storage. It is integrated into the ATLAS data management system Rucio and provides transparent access to the globally distributed ATLAS data. We have setup such an XCache server at the LRZ-LMU Tier-2, we tested several ATLAS workflows and will discuss possible use cases.

T 59.9 Mi 18:00 S11

Boosting data-intensive HEP analyses by coordinating distributed caches — •Christoph Heidecker, Martin Sauter, Matthias J. Schnepf, Max Fischer, Manuel Giffels, Eileen Kühn, R. Florian von Cube, and Günter Quast — Karlsruhe Institute of Technology

The ever-growing amounts of data processed by HEP user analyses results in challenges for the network and storage infrastructure, which can be tackled by introducing local caches for recurrently accessed data.

Efficient utilization of conventional caches placed within a distributed infrastructure requires both, coordination of data placement and sending work-flows to the most suitable host in terms of data locality. The coordinated and distributed caching approach thereby reduces redundantly stored data and improves the overall processing efficiency.

Thus, the KIT developed the NaviX coordination service, which connects an XRootD caching proxy infrastructure with an HTCondor batch system. The performance improvements of our concept are currently evaluated on opportunistic compute resources as well as on the Throughput-Optimized Analysis-System (TOPAS) cluster dedicated for data-intensive HEP user analyses, which is currently commissioned at KIT.

In this contribution, we give an overview of the coordinated and distributed caching concept, performance benchmark results and experiences gained.

T 60: Astroteilchenphysik: Methoden III

Zeit: Mittwoch 16:00–18:15 Raum: S12

T 60.1 Mi 16:00 S12

IceAct, SiPM based Imaging Air Cherenkov Telescopes for IceCube — •Jan Auffenberg, Pascal Backes, Thomas Bretz, Erik Ganster, Maurice Günder, Merlin Schaufel, Johannes Schumacher, and Aatif Waza for the IceCube-Collaboration — RWTH Aachen University

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 the prospects of the upcoming data taking season during the antarctic winter.

T 60.2 Mi 16:15 S12

Primary Particle Identification for IceAct Cherenkov Telescopes — •Lenka Tomankova[1,2,4], Jan Auffenberg[3], Pascal Backes[3], Lasse Ebener[1,2], Erik Ganster[3], Merlin Schaufel[3], and Julia Tjus[1,2] for the IceCube-Collaboration — [1]Ruhr-Universität Bochum, Theoretische Physik IV — [2]Ruhr Astroparticle and Plasma Physics (RAPP) Center — [3]RWTH Aachen University, III. Physikalisches Institut — [4]Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen-Nürnberg

IceAct, a planned array of compact, SiPM-based Imaging Air Cherenkov Telescopes at the IceCube Neutrino Observatory, was designed to fulfill manyfold functions, including a cosmic-ray veto to open the southern sky for astrophysical neutrino detection and an enhancement of composition and gamma-ray measurements at the South Pole. An essential part of the latter is an effective separation of gamma- and hadron-induced showers, which we approach with multi-variate tools, in particular with boosted decision trees. In this contribution we present the first results of a study performed on a CORSIKA-simulated data set spanning the energy range from 10 to 100 TeV. Special focus is placed on pushing the energy threshold for an effective gamma/hadron separation to lower energies.

T 60.3 Mi 16:30 S12

Large-Size Composite SiPM Pixel Tests in the Imaging Camera of the MAGIC IACT — •Alexander Hahn[1], Antonios Dettlaff[1], David Fink[1], Daniel Mazin[1,2], Razmik Mirzoyan[1], and Masahiro Teshima[1,2] — [1]Max-Planck-Institut für Physik, München, Deutschland — [2]Institute for Cosmic Ray Research, the University of Tokyo, Tokyo, Japan

Silicon photomultipliers (SiPMs) are becoming increasingly popular as light detectors in Imaging Atmospheric Cherenkov Telescopes (IACTs). Yet, an in-situ performance comparison of SiPMs and photomultiplier tubes (PMTs) is missing. At the Max Planck Institute for Physics we built three prototype detector modules based on composite SiPM pixels. These modules are installed to one of the Major Atmospheric Gamma Imaging Cherenkov (MAGIC) telescopes. The MAGIC camera structure allows the installation and parallel operation of up to six prototype detector modules at the rim of the existing PMT imaging camera. This outer rim is not part of the trigger, so to minimize the systematic effects on our performance comparison we installed one SiPM based prototype into the camera centre for a single night.

The collected data consist of artificial light pulses from a light flasher as well as real Cherenkov light from extensive air showers in the atmosphere.

In this talk, we will present a comparison of our SiPM-based prototype light detector modules to the existing modules of the PMT imaging MAGIC camera.

T 60.4 Mi 16:45 S12

IACTs for IceAct and HAWCs Eye - A versatile and cost effective design — •Merlin Schaufel[1], Jan Audehm[2], Jan Auffenberg[1], Pascal Backes[1], Thomas Bretz[2], Johannes Buscher[1], Erik Ganster[1], Adrianna García[2], Maurice Günder[1], Martin Rongen[1], Johannes Schumacher[2], and Christopher Wiebusch[2] — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]III. Physikalisches Institut A, RWTH Aachen University

The development of cost effective, compact and wide field-of-view imaging air-Cherenkov telescopes (IACTs) enables a broad range of applications for the detection of extensive air showers. Combining the IACT technology with ground based detectors like IceCube/IceTop (IceAct) or HAWC (HAWCs Eye) improves and cross calibrates the direction and energy reconstruction. The complementary shower information shows promising discrimination power for primary particle determination. We present the updated design of a SiPM based 61-pixel telescope featuring a sealed Fresnel optic and a versatile DAQ and slow control concept for the IceAct and the HAWCs Eye project.

T 60.5 Mi 17:00 S12

Hybrid measurements with the HAWCs Eye telescope and the HAWC detector — •Jan Audehm[1], Jan Auffenberg[2], Thomas Bretz[1], Adrianna García[1], and Merlin Schaufel[2] — [1]III. Physikalisches Institut A, RWTH Aachen University — [2]III. Physikalisches Institut B, RWTH Aachen University

The High Altitude Water-Cherenkov Observatory (HAWC) is designed for the observation of gamma rays as well as cosmic rays in the TeV energy range. Located near Puebla in Mexico, it is surveying the northern sky for sources of these particles using 300 water tanks equipped with photomultipliers. Hybrid measurements merging the detection principles of air shower arrays and Air-Cherenkov telescopes give the opportunity to improve the reconstruction of primary particle properties such as energy or arrival direction. The compact imaging Air-Cherenkov telescope HAWCs Eye with its 64 SIPM pixel camera is well suited as an expansion of the HAWC detector providing additional shower information. An installation of multiple HAWCs Eye telescopes at the HAWC Observatory offers the opportunity to investigate possible improvements by taking stereoscopic hybrid data.

T 60.6 Mi 17:15 S12

Improving the Direction Reconstruction for CTA — •Konstantin Pfrang — Deutsches Elektronen-Synchrotron Zeuthen

The Cherenkov Telescope Array (CTA) will be the next generation Imaging Air Cherenkov Telescope array (IACT) for gamma-ray astronomy, with more than 100 telescopes located at two sites in the southern and northern hemispheres. The accurate reconstruction of the initial gamma-ray direction is a crucial factor for the IACT performance. In the CTA calibration and low-level data analysis framework *ctapipe* a geometrical direction reconstruction based on the Hillas parameterization of the images is applied. CTA will be the first IACT using such a large number of telescopes and consequently it will record many images of the same air shower. However, their quality is not uniform and giving more importance to appropriate images will improve the performance of the reconstruction.
In this work, the importance of the individual images for the direction reconstruction for simulations of CTA south in *ctapipe* is investigated and the weighting is reviewed. The influence is estimated using look-up tables for the distance of closest approach between the semi-major axis of the parameterized image to the true direction in the camera. This weighting of the images improves the reconstruction for point source and diffuse simulations over the default weights calculated from an analytic expression.

T 60.7 Mi 17:30 S12

Identification of Cherenkov Signal in Shower Images Recorded by CTA — •Johan Wulff[1,2], Jonas Hackfeld[1,2], Julia Tjus[1,2], and Lenka Tomankova[1,2,3] for the CTA-Collaboration — [1]Ruhr-Universität Bochum, Theoretische Physik IV — [2]Ruhr Astroparticle and Plasma Physics (RAPP) Center — [3]Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen-Nürnberg

The Cherenkov Telescope Array (CTA) is the next-generation ground-based gamma-ray observatory surpassing current instruments by roughly an order of magnitude in sensitivity. This unprecedented sensitivity bears new challenges for the on-site analysis and brings about the necessity to reduce the recorded data stream by about two orders of magnitude to allow for efficient handling and off-site transfer. This process will take place on-the-fly and must not significantly deteriorate physics performance.

We present a data reduction approach based on identifying camera pixels containing Cherenkov signal and suppressing those containing only noise. The procedure is applied to individual air shower images, both gamma- and hadron-induced. We employ deep learning (DL) methods, in particular convolutional neural networks (CNNs), which show great pattern recognition in image analysis tasks. Following the introduction of the method itself, we discuss its application to and performance in data reduction for CTA, including a comparison with non-DL methods.

T 60.8 Mi 17:45 S12

Ein GCN-basiertes Tool zur Optimierung der Detektion von transienten Ereignissen mit CTA — •Anke Yusafzai[1,2,4], Fabian Schüssler[4], Julia Tjus[1,2] und Lenka Tomankova[1,2,3] für die CTA-Kollaboration — [1]Ruhr-Universität Bochum, Theoretische Physik IV — [2]Ruhr Astroparticle and Plasma Physics (RAPP) Center — [3]ECAP, Friedrich-Alexander-Universität Erlangen-Nürnberg — [4]Irfu, CEA Paris-Saclay

Mit CTA (Cherenkov Telescope Array), dem terrestrischen Gamma-Observatorium der nächsten Generation, sollen weit mehr hochenergetische Gammaquellen als bisher beobachtet werden. Flares von bekannten Quellen und unerwartete transiente Erscheinungen können auf verschiedenen, teilweise wenige Sekunden kurzen Zeitskalen ablaufen, was eine besondere Herausforderung an die Echtzeitanalyse der Teleskopdaten darstellt. Zur Optimierung der Echtzeitanalyse und Maximierung des Entdeckungspotentials soll ein Übersichts-Tool entwickelt werden, das eine schnelle Identifikation von Veränderungen in beobachteten Himmelsregionen erleichtert und eine umfassende Analyse fördert. Als Basis dafür dient eine auszuführende Analyse des GCN der NASA, aus der eine graphische Darstellung und Zusammenfassung der interessanten Eckdaten resultieren wird. Es wird schnell eine Übersicht der bekannten Quellen in der relevanten Himmelsregion und die dort in bestimmten Zeitfenstern registrierten Ereignisse liefern. In Abhängigkeit des zu beobachtenden Ereignisses sind physikalisch sinnvolle Zeitskalen und Energiebereiche zu wählen. In diesem Vortrag wird ein erstes Konzept zur Ausarbeitung dieses Tools vorgestellt.

T 60.9 Mi 18:00 S12

Status of CORSIKA 8 — Maximilian Reininghaus[1], Felix Riehn[2], and •Ralf Ulrich[1] — [1]Institut für Kernphysik, Karlsruher Institut für Technologie (KIT), Karlsruhe, Deutschland — [2]Laboratório de Instrumentação e Física Experimental de Partículas, Lissabon, Portugal

Current and future challenges in astroparticle physics require novel simulation tools to achieve higher accuracy and more flexibility. For the last three decades the FORTRAN version of the Monte Carlo air shower simulation package CORSIKA served the community in an excellent way. However, the effort to maintain and further develop this complex package has become increasingly difficult. To overcome existing limitations we are developing CORSIKA 8 in modern C++, designed as a modular framework and open platform useful for all particle cascade simulations in astroparticle physics. In this contribution, we give a status report on the project and show first simulations of hadronic showers.

T 61: Kosmische Strahlung III

Zeit: Mittwoch 16:00–18:25 Raum: S13

Gruppenbericht T 61.1 Mi 16:00 S13

Recent Results from the KASCADE-Grande Data Analysis — •Donghwa Kang for the KASCADE-Grande-Collaboration — Karlsruher Institut für Technologie, Karlsruhe, Germany

KASCADE and its extension KASCADE-Grande finished data taking in 2013 to measure individual air showers of cosmic rays with energies from 100 TeV up to 1 EeV. The experiment was completely dismantled in 2013 though, the data analysis is still in progress. Recently, we investigated the validity of the new hadronic interaction model SIBYLL 2.3c. We also published a new result of a search for large-scale anisotropies performed with the KASCADE-Grande data. Investigation of the attenuation length of the muon content of very-high energy air showers in the atmosphere is also updated with the predictions of the SIBYLL 2.3 interaction model. We investigated, in addition, the muon content of EAS and compared them to all post-LHC interaction models. In this contribution, these recent results from KASCADE-Grande will be discussed. An update of the internet-based data center of KCDC offering the original scientific data from KASCADE-Grande to the public will be briefly discussed as well.

Gruppenbericht T 61.2 Mi 16:20 S13

The Pierre Auger Observatory - Recent Results and Perspectives — •Thomas Bretz — RWTH Aachen, III. Physikalisches Institut A, Germany

The Pierre Auger Observatory covering an area of 3000 km^2 in Argentina is the world largest surface detector for the observation of extensive air-showers. It comprises 1660 individual water-Cherenkov detectors and is complemented by 27 telescopes recording fluorescence light emitted in the atmosphere.

Sensitive to energies >300 PeV at the ankle and cut-off region, significant discoveries to today's knowledge about ultra-high energy cosmic-rays were made: a precise measurement of the spectrum, the measurement of the chemical composition, results on fundamental shower physics, and the detection of a large-scale anisotropy above 4 EeV. Upper limits have been provided for the contribution from gamma-rays, the flux from the direction of the first gravitational wave events, the search for magnetic monopols and the search for EeV neutrinos.

Exciting future discovery potential on the hunt for the origin of cosmic rays lays in the observed evidence for a correlation between the recorded arrival direction above 40 EeV with starburst galaxies examined by Fermi-LAT.

With the successfull radio detection for extended air showers and the applicability of SiPMs in scintillator detectors, important technological development have been made. With AugerPrime, the on-going upgrade of the detector, a new era in the sensitivity for ultra-high energy cosmic-rays will start soon.

T 61.3 Mi 16:40 S13

Updates on AugerPrime Engineering Array Analyses * — •Sonja Schröder — Bergische Universität Wuppertal, Gaußstraße 20, 42119 Wuppertal

The AugerPrime upgrade of the Pierre Auger Observatory in Argentina will enhance the precision of composition measurements of the primary particles that create extensive air showers. This is achieved by separating the electromagnetic and muonic components of the particle shower with the help of Surface Scintillator Detectors (SSD) placed on top of the already existing Surface Detector (SD) stations. This talk concerns the analysis of the data quality for the SSD Engineering Array stations. The long-term stability of the data, as well as parameters such as timing resolution, signal amplitudes and temperature effects of the detectors will be discussed. A focus point will be the data from a triplet of stations in immediate vicinity of each other, which are located in a more densely instrumented region of the array, where the spacing of SD stations is reduced from 1500 m to 433 m. This lowers the energy threshold to $\approx 10^{16.5}$ eV, yielding 10 times higher statistics as compared to the regular array.

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

T 61.4 Mi 16:55 S13

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, Tobias Pan, and Christine Peters — III. Physikalisches Institut A, RWTH Aachen University

The Pierre Auger Observatory, located in the Argentinian Pampa, is the world's largest experiment for the detection of ultra-high energy extensive air showers. For such, it uses a surface array of 1660 water Cherenkov detectors and 27 fluorescence telescopes. Among other studies, it has been used to search for photon-induced showers at energies above 1 EeV. Analyzing the photon flux is crucial to understand the flux suppression of cosmic rays above 50 EeV. Until now, no photon-induced shower has been confirmed by the Pierre Auger Collaboration. Even if these studies allow for the best upper limits for the photon flux at the ultra-high energy, they are limited by the current discrimination power between photon and hadron induced showers. As part of the recent upgrade of the Pierre Auger Observatory, called AugerPrime, an additional scintillator detector will be installed on top of each water Cherenkov station. Thereby, a more precise measurement of the number of muons is aimed at, which will increase the sensitivity to photons significantly. As such, this analysis focus on studying the increase in discrimination power that will be reached with AugerPrime.

T 61.5 Mi 17:10 S13

A new end-to-end calibration of the Fluorescence Detector of the Pierre Auger Observatory — Jan Berens[1], Kai Daumiller[2], Joachim Debatin[2], Hermann-Josef Mathes[2], •Eric Mayotte[1], Alexander Menshikov[2], and Julian Rautenberg[1] — [1]Bergische Universität Wuppertal, Gaußstraße 20, 42119 Wuppertal* — [2]Karlsruher Institut für Technologie, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen

The Fluorescence Telescopes are crucial to the science goals of the Pierre Auger Observatory. Currently, to ensure the accuracy of their measurements, a relative calibration of each telescope is performed nightly. To improve upon this established calibration, as well as to improve the time-dependent end-to-end calibration of each telescope's optics and camera, a new absolute calibration process has been developed. The core of the technique consists of scanning a calibrated UV Lambertian light source across the aperture of each telescope and reading out the response of the PMT camera. The camera response is then compared to the simulated end-to-end optical performance of the instrumentation given the known source properties in order to provide an absolute calibration of each telescope. This talk will give a brief overview of the method and its status as well as progress on the absolute calibration of the light source. Preliminary results including fluorescence telescope response and light source characteristics will also be presented. *Gefördert durch die BMBF Verbundforschung Astroteilchenphysik(Vorhaben 05A17PX1/05A17VK1).

T 61.6 Mi 17:25 S13

Observation of air showers with the IceAct 7 pixel demonstrator in coincidence with IceCube and IceTop — •Erik Ganster, Jan Auffenberg, Pascal Backes, Thomas Bretz, Johannes Buscher, Maurice Günder, Martin Rongen, Merlin Schaufel, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut, RWTH Aachen University

The IceAct Imaging Air Cherenkov Telescopes are proposed surface detectors extending the IceCube Neutrino Observatory. By observing Cherenkov light in the atmosphere with an SiPM based camera, IceAct is capable of detecting cosmic ray air showers in coincidence with IceCube and its surface detector IceTop. These observations can improve the measurement of the composition of cosmic rays, they allow for the calibration of the angular resolution and efficiency of IceCube and IceTop, and potentially can be used to to veto atmospheric muons and neutrinos, which are a background in cosmic neutrino searches. In December 2015, a 7-pixel demonstrator telescope was installed at the South Pole and had been operated in coincidence with IceCube during the years 2016 and 2017. We present results of the analysis of air-showers measured coincidentally with IceAct, IceCube, and IceTop.

T 61.7 Mi 17:40 S13

Cosmic Ray Composition With Combined Particle and Radio Measurements * — •Marvin Gottowik — Bergische Universität

Wuppertal, Gaußstraße 20, 42119 Wuppertal

A hybrid detection of extensive air showers by the associated radio emission and particle density at ground shows significant potential for mass composition measurements. The radio signal is sensitive only to the electromagnetic component of the air shower, while the particle detector at zenith angles larger than 60° performs an almost pure measurement of the muonic component as the electromagnetic shower dies out in the atmosphere. The combination of both types of data is sensitive to mass composition and may be even superior to the classical depth of shower maximum approach.

Within the next years the surface detector stations of the Pierre Auger Observatory will be equipped with an additional radio antenna to detect the radio emission of extensive air showers together with the direct measurement of the particles. The horizontal exposure of the radio upgrade will be complementary to the vertical scintillator upgrade and increase the exposure for composition analyses.

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

T 61.8 Mi 17:55 S13

Contracting Alignment Patterns in the arrival directions of Ultra High Energy Cosmic Rays induced in the Galactic Magnetic Field — •Marcus Wirtz, Martin Erdmann, Lukas Geiger, David Schmidt, and Martin Urban — III. Physikalisches Institut A, RWTH Aachen University, Deutschland

We present a novel approach to search for origins of ultra-high energy cosmic rays. In a simultaneous fit to all observed cosmic rays we use a data driven galactic magnetic field model as a mass spectrometer and adapt the nuclear charges such that their extragalactic arrival directions are concentrated in as few directions as possible. During the fit the nuclear charges are constraint by the individual energy and shower depth measurements. We show in a simulated astrophysical scenario that source directions can be reconstructed even within a substantial isotropic background and without exact knowledge of the galactic magnetic field.

T 61.9 Mi 18:10 S13

Large Acceptance Analysis of Electrons and Positrons with AMS-02 — •Fabian Machate — 1. Physikalisches Institut B, RWTH Aachen University

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 using information from the Transition Radiation Detector (TRD) and Tracker will be presented, with particular emphasis on background rejection with the TRD. This analysis has a significantly larger geometrical acceptance and can increase the statistics by a factor of up to ~ 4.

T 62: Neutrino-Astronomie II

Zeit: Mittwoch 16:00–18:35 Raum: S14

Gruppenbericht T 62.1 Mi 16:00 S14

High-energy neutrino astronomy with IceCube: recent results and new perspectives — •Kai Krings for the IceCube-Collaboration — Technische Universität München, Physik-Department, James-Franck-Str. 1, 85748 Garching

Building a neutrino telescope at the Geographic South Pole was envisioned in the end of the 80s. After the first in-ice detection of neutrinos from the Earth's atmosphere with its predecessor AMANDA in the year 2000, the IceCube Neutrino Observatory was completed in 2011. IceCube is a one cubic kilometer sized deep in-ice Cherenkov telescope. It is composed by 5160 digital optical modules that record the Cherenkov light emitted along secondary charged particles, which are produced in neutrino interactions with the Antarctic ice. First high-energy neutrino events of astrophysical origin were discovered in 2013. A new phase of neutrino astronomy in Antarctica was initiated with the first evidence for a non-stellar neutrino point source in 2018: a high-energy neutrino-induced muon track was observed from the direction of the blazar TXS0506+056 and in coincidence with very high-energy gamma rays from the same direction. Moreover, a follow-up search found in the archival IceCube data evidence for a neutrino flare from the direction of TXS0506+056. In this group talk, we will report on recent IceCube results connected to high-energy neutrino astronomy and introduce a possible path towards the future of this new field.

T 62.2 Mi 16:20 S14

Self-triggered point source search with IceCube — •Martina Karl for the IceCube-Collaboration — Max-Planck-Institut für Physik, München, Deutschland — Technische Universität München, Deutschland

IceCube is a cubic-kilometer scale neutrino detector instrumenting a gigaton of ice at the geographic South Pole in Antarctica. On average, about 6-8 track-like high energetic neutrino events with energies ranging from 70 TeV to few PeV are detected per year. These muon tracks allow for a pointing to the origin of the muon neutrino in the sky as precise as 0.2°. This work presents a search for cosmic neutrino sources by looking for an excess of neutrino events with energies >= 100 GeV at the source positions of these track-like events. The analysis is applicable to both, a continuous neutrino flux from the source position, meaning a time integrated search over the entire live time of IceCube; as well as to neutrino flares from that source position, comprising an analysis of a time-dependent source. This search will be applied to all presently measured track-like events and additionally will be implemented as an automatic procedure that will be started as soon as a new track-like high energy event is detected.

T 62.3 Mi 16:35 S14

Improving the description of the astrophysical muon-neutrino spectrum with 9 years of IceCube data — •Joeran Stettner, Christian Haack, René Reimann, and Christopher Wiebusch for the IceCube-Collaboration — Otto-Blumenthal Strasse, 52074 Aachen

The IceCube Neutrino Observatory has observed a flux of high-energy astrophysical neutrinos, typically modeled as unbroken powerlaw energy spectrum. This observation has been confirmed in independent channels, i.e. different event selections and event topologies. However, the best-fitting description of the astrophysical astrophysical component differs between these analyses and it is an unsolved question where the difference comes from. Here, we present an update of the analysis of through-going muon-neutrinos from the Northern Hemisphere. It was extended to nine years of data and models beyond the unbroken powerlaw are explored to describe the astrophysical component. Additionally, an approach is presented to extract the flux-normalization in bins of true neutrino energy to enable an easy comparison to other measurements and theoretical predictions.

T 62.4 Mi 16:50 S14

Studying the temporal variation of the cosmic-ray Sun shadow – comparison of IceCube data with theoretical models of the solar magnetic field — •Frederik Tenholt and Julia Becker Tjus for the IceCube-Collaboration — Ruhr-Universität Bochum

The shadowing effect of the Moon and Sun in TeV cosmic rays has been measured with high statistical significance by several experiments. Unlike particles from directions close to the Moon, however, charged particles passing the Sun are deflected not only by the geomagnetic but also by the solar magnetic field. Since the latter undergoes a well-known 11-year cycle – during which it can become highly disordered – changes in the cosmic-ray Sun shadow measured at Earth are expected over time. We present a comparison of simulations that were developed in order to predict the cosmic-ray shadows of Moon and Sun and seven years of data taken with the IceCube Neutrino Observatory. While the results for the Moon shadow verify a stable detector, the results for the Sun shadow exhibit a clear variation. The observed variation in the data is used to compare two potential field models of the coronal magnetic field.

T 62.5 Mi 17:05 S14

First Double Cascade Tau Neutrino Candidates in IceCube — •Juliana Stachurska for the IceCube-Collaboration — DESY Zeuthen

The IceCube Neutrino Observatory at the South Pole detects Cherenkov light from charged particles produced in neutrino interactions. At the highest energies, the neutrino flux is of cosmic origin, with an expected flavor ratio of ν_e:ν_μ:ν_τ of about 1:1:1. A measurement of the flavor ratio on Earth can provide important information to constrain sources and production mechanisms. We have performed a flavor composition measurement of astrophysical neutrinos using 7.5 years of HESE data, distinguishing between three topologies: single cascades, double cascades and tracks. In IceCube, ν_τ -CC interactions above ~ 100 TeV can produce resolvable double cascades, breaking the degeneracy between ν_e and ν_τ present at lower energies. I will present IceCube's first two identified double cascades and discuss these two ν_τ candidates.

T 62.6 Mi 17:20 S14

Observation of the cosmic-ray moon shadow using the IceCube Neutrino Observatory — •Saskia Philippen, Christian Haack, René Reimann, Marius Wallraff, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, Physikzentrum RWTH Aachen, Otto-Blumenthal-Straße, 52074 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. By combining multiple years of observation a high-statistics data sample is obtained. In addition to the verification of existing reconstruction methods, the contrast of the shadow will be employed to optimize the reconstructions.

T 62.7 Mi 17:35 S14

Seasonal variations of the atmospheric neutrino flux — •Marit Zöcklein, Pascal Backes, Jakob Böttcher, Philipp Fürst, Christian Haack, Patrick Heix, Jöran Stettner, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

Most neutrinos detected by the IceCube Neutrino Observatory emanate from pion and kaon decays in the Earth's atmosphere. Their flux correlates with the density of the atmosphere and thus with its temperature. Consequently, variations of the atmospheric neutrino flux caused by seasonal temperature variations are observable. The measured correlation can be used to test hadronic interaction models of air shower simulations and improve modeling of the atmospheric neutrino background for the search of cosmic neutrinos. This talk will present a measurement of these seasonal variations. Furthermore, it focuses on the development of a generalized analysis method of the neutrino rate correlation with the atmospheric temperature.

T 62.8 Mi 17:50 S14

Light diffusion in birefringent polycrystals and the IceCube ice anisotropy — •Martin Rongen for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

The IceCube Neutrino Observatory instruments about $1\,\mathrm{km}^3$ of deep, glacial ice at the geographic South Pole with 5160 photomultipliers to detect Cherenkov light of charged relativistic particles. The experiment pursues a wide range of scientific questions ranging from particle physics such as neutrino oscillations to astronomy with the search for sources of astrophysical neutrinos. Most of these efforts rely heavily on an ever more precise understanding of the optical properties of the instrumented ice. A largely unexplained light propagation effect is an anisotropic attenuation, which is aligned with the local flow of the ice. In this talk, the micro-structure of ice as a birefringent polycrystal is explored as the cause for this anisotropy.

T 62.9 Mi 18:05 S14

Study of seasonal variations of the atmospheric neutrino flux with MCEq — •Patrick Heix, Pascal Backes, Jakob Böttcher, Philipp Fürst, Christian Haack, Jöran Stettner, Christopher Wiebusch, and Marit Zöcklein for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen

Atmospheric muon neutrinos originate mostly from the decay of pions and kaons in atmospheric showers initiated by cosmic rays. The production rate of these neutrinos depends on the profiles of density and temperature of the atmosphere. Using the Matrix Cascade Equation (MCEq) code, we calculate the neutrino flux for different atmospheric profiles, varying hadronic interaction and cosmic ray models. In particular we study the impact of these parameters on the seasonal variation of the atmospheric neutrino flux.

T 62.10 Mi 18:20 S14

Predictions for the flux of high-energy cosmogenic neutrinos* — •David Wittkowski and Karl-Heinz Kampert — Bergische Universität Wuppertal, Gaußstraße 20, 42119 Wuppertal

The origin and properties of the sources of ultra-high energy cosmic rays (UHECR, charged nuclei with energies $E > 1\,\mathrm{EeV}$) are still among the most important issues in astroparticle physics. A promising way to solve these issues is offered by multi-messenger approaches. When they propagate through the universe, UHECR interact with cosmic background photons generating the so-called „cosmogenic neutrinos". Since they are not affected by cosmic magnetic fields or energy losses due to interactions with the cosmic background photons, cosmogenic neutrinos can provide additional and independent information about the sources of UHECR. In this talk, we present predictions for the so far unmeasured flux of high-energy cosmogenic neutrinos. These predictions are consistent with recent upper limits for the neutrino flux from large-scale cosmic-ray experiments and based on four-dimensional simulations that take the extragalactic magnetic field into account. The corresponding simulation results for the flux of UHECR are in good agreement with data from the Pierre Auger Observatory. Our predictions are important for the design of future neutrino observatories, since they allow to assess what detector volume and detection time are needed to measure the flux of high-energy cosmogenic neutrinos.

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

T 63: Flavorphysik II

Zeit: Mittwoch 16:00–18:30 Raum: S15

T 63.1 Mi 16:00 S15

Measurement of the ratio $R_{K^{*0}}$ using Run 1 + 2 data of the LHCb experiment — •Stephan Escher, Sarah Beranek, Christoph Langenbruch, 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 this theory 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 and control of backgrounds.

T 63.2 Mi 16:15 S15

Probing lepton flavour universality with $R_{K\pi\pi}$: Studies of the decay $B^+ \to K^+\pi^+\pi^-e^+e^-$ with the LHCb experiment

— Johannes Albrecht, •Maik Becker, Stefanie Reichert, and Tobias Tekampe — Experimentelle Physik 5, TU Dortmund

The Standard Model of particle physics predicts universal couplings of gauge bosons to leptons, which can be tested by measuring the ratio of branching fractions of $b \to s\ell^+\ell^-$ decays with equal hadronic and different leptonic components in the final state. Results of recent measurements of this kind like R_K or R_{K^*} show tensions with the Standard Model predictions.

The observable $R_{K\pi\pi}$, defined as the ratio of the branching fractions of the decays $B^+ \to K^+\pi^+\pi^- e^+e^-$ and $B^+ \to K^+\pi^+\pi^-\mu^+\mu^-$, is explored as a similar but fully independent probe.

In this talk the ongoing measurement of $R_{K\pi\pi}$ will be presented. A focus is set on studies of the final state with electrons.

T 63.3 Mi 16:30 S15

Test of lepton flavour universality using the branching fraction ratio R_ϕ — •Simon Nieswand, Sarah Beranek, Christoph Langenbruch, Stefan Schael, and Eluned Smith — I. Physikalisches Institut, RWTH Aachen University

The LHCb detector at the LHC is designed for the search for New Physics (NP) beyond the Standard Model (SM) in heavy flavour decays. Particularly interesting are rare decays of b-hadrons that proceed via $b \to s$ transitions. In the SM, these flavour changing neutral currents are forbidden at tree-level. They can only occur at loop-level and can be influenced by heavy non-SM particles. Therefore, the branching fractions of decays like $B_s^0 \to \phi\ell^+\ell^-$ are sensitive probes for NP.

Especially clean theory predictions are available for the ratios of rare semileptonic $b \to s$ decays with muons and electrons in the final state. Due to lepton universality, these ratios should be close to unity in the SM. The LHCb collaboration observed interesting tensions with the SM predictions for the ratios R_{K^*} and R_K corresponding to $2.4 - 2.5$ and 2.6 standard deviations (σ), respectively. Therefore, it is interesting to study further rare B decays for a similar behavior.

In this talk the analysis strategy to measure the branching fraction ratio $R_\phi = \mathcal{B}\left(B_s^0 \to \phi\mu^+\mu^-\right)/\mathcal{B}\left(B_s^0 \to \phi e^+e^-\right)$ and the current status of the on-going analysis of the combined Run 1 and Run 2 LHCb data sample will be presented.

T 63.4 Mi 16:45 S15

Measurement of the branching fraction of $B \to D^{**}(D^{(*)}\pi^0)\ell\nu$ in the context of a $R(D^{(*)})$ analysis at the Belle experiment — Florian Bernlochner, Pablo Goldenzweig, Felix Metzner, and •Maximilian Welsch — ETP, KIT, Karslruhe

The observed ratios of semi-tauonic decays involving D and D^* mesons, $R(D^{(*)})$, are in strong tension with the Standard Model expectation. Recent measurements point to a deviation of about four standard deviations. One of the main backgrounds in the experimental determination are processes from $B \to D^{**}(D^{(*)}\pi^0)\ell\nu$, where D^{**} denotes one of the four 1P excited D meson states. In this work, a direct measurement of these channels is carried out and this talk presents the current status of measuring $\mathcal{B}(B \to D^{**}(D^{(*)}\pi^0)\ell\nu)$ using the full Belle dataset of 772 million $B\bar{B}$ pairs and a novel hadronic tagging method.

T 63.5 Mi 17:00 S15

Measurement of $\mathrm{B} \to \mathrm{D}^{(*)}\tau\nu$ via the ratios $R(\mathrm{D}^{(*)})$ at Belle and under utilisation of the Belle II software — Florian Bernlochner, Michael Feindt, Pablo Goldenzweig, •Felix Metzner, and Maximilian Welsch — ETP, KIT, Karslruhe

The discrepancy observed for the ratios $R(\mathrm{D}^{(*)})$ of the decays $\mathrm{B} \to \mathrm{D}^{(*)}\tau\nu$ relative to the light lepton modes $\mathrm{B} \to \mathrm{D}^{(*)}\ell\nu$ ($\ell = e, \mu$) between the experimental results and the Standard Model predictions is one of the persistent flavour anomalies with a significance of four standard deviations. 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 $R(\mathrm{D}^{(*)})$ with an improved hadronic tagging algorithm — the Full Event Interpretation — is carried out. Profiting from the 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 63.6 Mi 17:15 S15

Search for $B_s^0 \to \psi(2S)K_S^0$ decays at the LHCb experiment — Vukan Jevtic, •Jasper Lammering, and Patrick Mackowiak — Experimentelle Physik 5, TU Dortmund

The decay $B_s^0 \to \psi(2S)K_S^0$ has not been observed yet but is predicted by the Standard Model. In a previous analysis, where *CP*-violation was measured in $B^0 \to \psi(2S)K_S^0$, performed by LHCb using the Run I dataset, a hint for the B_s decay has been seen. Therefore the observation is expected by analyzing more data and developing a specialized selection for such decays. In order to cancel systematic uncertainties, the ratio of branching fractions $\mathcal{B}(B_s^0 \to \psi(2S)K_S^0)/\mathcal{B}(B^0 \to \psi(2S)K_S^0)$ is measured. In this talk, the current status of the analysis using the complete LHCb dataset corresponding to an integrated luminosity of 9 fb^{-1} is presented.

T 63.7 Mi 17:30 S15

Measurement of the ratio of branching fractions of the decays $\Lambda_b^0 \to \psi(2S)\Lambda^0$ and $\Lambda_b^0 \to J/\psi\Lambda^0$ at LHCb — •Patrick Mackowiak — Experimentelle Physik 5, TU Dortmund

The aim of this analysis is the measurement of the ratio of branching fractions $\mathrm{Br}(\Lambda_b^0 \to \psi(2S)\Lambda^0)/\mathrm{Br}(\Lambda_b^0 \to J/\psi\Lambda^0)$, where the decay of the Λ_b^0 is reconstructed through the decays of $\psi(2S) \to \mu\mu$ or $J/\psi \to \mu\mu$ and $\Lambda^0 \to p\pi$. A measurement of the ATLAS collaboration of this ratio shows a deviation to a theory prediction and similar ratios from the b meson sector. Using data from the LHCb experiment, a more sensitive result is expected. By measuring the ratio of branching fractions, systematic uncertainties, uncertainties from the measured luminosity, and from fragmentation effects cancel.
The talk will cover the current status of the analysis using the Run I dataset of the LHCb experiment, which corresponds to an integrated luminosity of 3 fb^{-1}.

T 63.8 Mi 17:45 S15

Search for the decay $B_s^0 \to D^{*+}D^{*-}$ with the LHCb experiment — Kevin Heinicke, Philipp Ibis, •Jan Langer, Antje Mödden, and Margarete Schellenberg — Experimentelle Physik 5, TU Dortmund

The LHCb experiment is dedicated to search for New Physics beyond the Standard Model through precision measurements of B-meson decays. This analysis aims to observe the decay $B_s^0 \to D^{*+}D^{*-}$ and measure its branching fraction. In order to reduce systematic uncertainties, the branching fraction is measured relative to the decay $B^0 \to D^{*+}D^{*-}$. A next step of the analysis could be a measurement of the time dependent *CP* violation in $B^0 \to D^{*+}D^{*-}$ decays. As this decay involves a pseudoscalar meson decaying into two vector mesons, an angular analysis is planned.

In this talk the current status of the analysis will be presented, using the full dataset of the LHCb experiment corresponding to an integrated luminosity of 9 fb^{-1}.

T 63.9 Mi 18:00 S15

Erste Studien von inklusiven $\mathrm{B} \to \mathrm{X}\ell\nu_\ell$ Zerfällen mit dem Belle II Experiment — •Stephan Duell[1], Jochen Dingfelder[1], Florian Bernlochner[2] und Peter Lewis[1] — [1]Rheinische Friedrich-Wilhelms-Universität Bonn — [2]Karlsruher Institut für Technologie

In diesem Vortrag wird eine Analyse von inklusiven semileptonischen B-Zerfällen mit den ersten Kollisionsdaten des neuen SuperKEKB Beschleunigers vorgestellt, in der das inklusive semileptonische Verzweigungsverhältnis $\mathcal{B}(B \to X\ell\nu_\ell)$ gemessen und die Leistungsfähigkeit des Belle II Detektors mit ersten Daten charakterisiert werden soll. Zur Unterscheidung zwischen $\Upsilon(4S) \to B\bar{B}$ Ereignissen und Untergrundereignissen wird ein zweites Lepton mit hohem Impuls in jedem Ereignis rekonstruiert. Anschließend können Ladungs- und Winkelabhängigkeiten zwischen den beiden Leptonen ausgenutzt werden, um semileptonische B-Zerfälle von anderen Zerfällen zu unterscheiden. Die Analyse basiert auf einem frühen Datensatz ($500\mathrm{pb}^{-1}$), den das Belle II Experiment im Sommer 2018 mit dem SuperKEKB Beschleuniger in Japan aufgezeichnet hat. Der aktuelle Status der Messung wird präsentiert.

T 63.10 Mi 18:15 S15

Measurement of inclusive differential kinematic distributions for $|V_{ub}|$ — Florian Bernlochner, Lu Cao, William Sutcliffe, and •Raynette van Tonder — Karlsruhe Institute of Technology, 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 $B \to X_u l\nu$ 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 $B \to X_c l\nu$ decays is exploited. This talk will show the current analysis status as well as differential kinematic distributions for B $\to X_c l\nu$ decays.

T 64: Theorie: Dunkle Materie

Zeit: Mittwoch 16:00–18:15 Raum: S16

T 64.1 Mi 16:00 S16

Dijet + Missing Energy in Extended Dark Matter Effective Theory — Florian Goertz, •Karla Tame-Narvaez, and Valentin Tenorth — Max-Planck-Institut für Kernphysik, Heidelberg,Germany

A search for dijet plus missing energy is discussed in the framework of an extended dark matter EFT. This signature offers a unique opportunity to probe the peculiar SS$\chi\chi$ operator, present in the setup. Prospects to extract its coefficient will be presented both for the High-Luminosity LHC and a future electron-proton collider, such as the FCC-eh, taking into account the major backgrounds.

T 64.2 Mi 16:15 S16

CP-Violating Scalar Dark Matter in the N2HDM — •Shruti Patel[1], Duarte Azevedo[2], Pedro Ferreira[3], Margarete Muhlleitner[4], Rui Santos[5], and Jonas Wittbrodt[6] — [1]ITP and IKP, Karlsruhe Institute of Technology, Germany — [2]Universidade de Lisboa, Portugal — [3]Universidade de Lisboa, Portugal — [4]ITP, Karlsruhe Institute of Technology, Germany — [5]Universidade de Lisboa, Portugal — [6]DESY, Hamburg Germany

Several extensions of the Standard Model (SM) containing an additional Higgs doublet and/or singlet provide viable dark matter (DM) candidates or beyond the SM sources of CP violation. However, singlet-doublet models which contain both a DM candidate as well as extra sources of CP violation are rare. In this talk we study such a model containing two scalar doublets and a scalar singlet with a discrete Z2 symmetry. Electroweak symmetry breaking in this model yields SM-like phenomenology, in addition to a hidden scalar sector containing a viable DM candidate. We show that a complex phase in the Lagrangian gives rise to CP violation exclusively in the hidden sector, and consider possible experimental signatures of CP violation. In particular, we study contributions to anomalous gauge couplings from the hidden scalars in the model.

T 64.3 Mi 16:30 S16

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 64.4 Mi 16:45 S16

Dark matter in supersymmetrical Inverse-Seesaw models — •Yang Liu — Institute fuer Theoretische Physik und Astrophysik, Universitaet Wuerzburg, Deutschland

We consider two supersymmetrical models, where the neutrino masses and mixings can be explained by the additional sterile neutrinos. The first model is based on the Seesaw-I mechanism where the structure of the Yukawa coupling is the one of an Inverse-seesaw. In this model, the dark matter consists of two components: the lightest right-handed neutrino with a mass in keV range and the lightest sneutrino. We show that this model has two problems: (i) The results from *NuSTAR* collaboration constrain the mixing between the active and sterile neutrinos and therefore excludes this part of the parameterspace. (ii) The contribution from the sneutrino part is in this scenario too large.

The sneutrino contribution of the dark matter can be reduced through the resonance in the annhilation processes. Therefore we considered the former model as the effective model of a theory with expaned $U(1)_{B-L}$ gauge group. This model contains an additional lightest Higgs boson with a relative large coupling to the right-handed sneutrinos. We show that with help of a "Higgs-Funnel", the observed dark matter density can be explained while respecting the constraints from collider experiments.

T 64.5 Mi 17:00 S16

Triplet scalar and singlet–doublet fermion dark matter in a radiative model of neutrino masses — Juri Fiaschi[1], Michael Klasen[1], and •Simon May[1,2] — [1]Westfälische Wilhelms-Universität Münster — [2]Max-Planck-Institut für Astrophysik

We present a detailed study of a combined triplet scalar and singlet–doublet fermion model for dark matter. These models have only been studied separately in the past. Together, they form a simple extension of the Standard Model that can account for dark matter and explain the existence of neutrino masses, which are generated radiatively. However, this also implies the existence of lepton flavor-violating (LFV) processes. In addition, this particular model allows for gauge coupling unification. The new fields are odd under a new $\mathbb{Z}_2$ symmetry to stabilize the dark matter candidate.

We analyze the dark matter, neutrino mass and LFV aspects both separately and in conjunction, exploring the model's viable parameter space. This is done using numerical random scans imposing the relic density, neutrino mass and Higgs mass constraints. We discover differing properties of the scalar and fermion dark matter candidates in this model and discuss this model's features in contrast with earlier studies of its separate components and of similar radiative neutrino mass models.

T 64.6 Mi 17:15 S16

MadDM v.3.0: Towards a Comprehensive Tool for Dark Matter Studies — •Jan Heisig[1], Federico Ambrogi[2], Chiara Arina[1], Mihailo Backovic[1], Fabio Maltoni[1], Luca Mantani[1], Olivier Mattelaer[1], and Gopolang Mohlabeng[3] — [1]Universite catholique de Louvain — [2]University of Vienna — [3]Brookhaven National Laboratory

We present MadDM v.3.0, a numerical tool to compute particle dark matter observables. The new version features a comprehensive and automated framework for dark matter searches at the interface of collider physics, astrophysics and cosmology and is deployed as a plugin of the MadGraph5_aMC@NLO platform, inheriting most of its features. With respect to the previous version, MadDM v.3.0 now provides predictions for indirect dark matter signatures in astrophysical environments, such as the annihilation cross section at present time and the energy spectra of prompt photons, cosmic rays and neutrinos resulting from dark matter annihilation. MadDM indirect detection features support both $2 \to 2$ and $2 \to n$ dark matter annihilation processes. In addition, the ability to compare theoretical predictions with experimental constraints is extended by including the Fermi-LAT likelihood for gamma-ray constraints from dwarf spheroidal galaxies.

T 64.7 Mi 17:30 S16

Resummed photon spectrum from dark matter annihilation for intermediate energy resolution — Martin Beneke[1], Alessandro Broggio[2,3], Caspar Hasner[1], •Kai Urban[1], and Martin Vollmann[1] — [1]Physik-Department T31 ,TU München, Germany — [2]University of Milano-Bicocca, Italy — [3]INFN Milano, Italy

The annihilation cross section for TeV-scale weakly interacting massive particles χ_0 into photons is affected by large quantum corrections such as Sudakov logarithms and the Sommerfeld effect. In previous work the effective field theory setup and resummation of Sudakov logarithms of the semi-inclusive photon energy spectrum in $\chi_0\chi_0 \to \gamma + X$ was calculated for narrow resolutions $E^\gamma_{\rm res} \sim m_W^2/m_\chi$ with NLL' accuracy. In this talk, I will discuss the extension to intermediate resolutions of order m_W. I will show the matching of the two effective field theory descriptions for the wino dark matter model in an overlap region, thereby providing an accurate description of the energy spectrum for γ-ray telescopes for energy resolutions of about 300 GeV from the endpoint.

T 64.8 Mi 17:45 S16

Majoron Dark Matter and Constraints on the Majoron-Neutrino Coupling — •Tim Brune and Heinrich Päs — Otto-Hahn Straße 4, 44227 Dortmund

We revisit a singlet Majoron model in which neutrino masses arise from the spontaneous violation of lepton number. If the Majoron obtains a mass of order MeV, it can play the role of dark matter. We discuss constraints on the couplings of the massive Majoron to neutrinos from supernova data and from neutrinoless double beta decay with Majoron emission. The combination of both constraints excludes a large range of Majoron-Neutrino couplings in the mass range of intererest for Majoron dark matter.

T 64.9 Mi 18:00 S16

Impact of SUSY parameters on dark matter prediction — •Marten Berger — 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 65: Experimentelle Methoden II

Zeit: Mittwoch 16:00–18:30 Raum: S01

T 65.1 Mi 16:00 S01

Performance of the ATLAS- Muon spectrometer in Run-II — •Johannes Junggeburth[1], Hubert Kroha[1], Nicolas Koehler[1] und Maximilian Goblirsch-Kolb[2] — [1]Max-Planck Institut für Physik, München — [2]Brandeis University, USA

The large LHC Run-2 dataset comprising 150 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 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/ψ resonances. This talk presents the latest developments in the $Z \to \mu\mu$ muon efficiency measurement allowing to reach a precision below 0.1%. The evolution of the ATLAS Muon spectrometer performance during the Run-2 data-taking is discussed in addition.

T 65.2 Mi 16:15 S01

Tau Trigger Efficiency Measurements using $Z \to \tau\tau$ Events at ATLAS — •Kieran Amos, Serhat Ördek, Michel Janus, and Stan Lai — II. Physikalisches Institut, Georg-August-Universität Göttingen

Experiments with the ATLAS detector involving tau leptons in the final state use the tau trigger system for the online selection. This trigger system must accommodate the high instantaneous luminosity achieved during the LHC's run in 2018. In this talk, the $Z \to \tau\tau$ tag and probe analysis used to determine the tau trigger efficiency will be dicussed. For each event a single muon (tag) is required, and the tau trigger efficiency is then calculated from the fraction of events where the accompanying hadronic tau decay candidate (probe) passes the trigger. The dependency of the efficiency on the transverse momentum and the pseudorapidity of the tau candidate as well as the average number of interactions per bunch-crossing is presented. The talk discusses the challenges involved in implementing the method as well as possible future improvements.

T 65.3 Mi 16:30 S01

Particle Flow jets in the $H \to ZZ^* \to 4\ell$ analysis at ATLAS for optimizing kinematical reconstructio — •Tobias Klingl, Philip Bechtle, and Klaus Desch — Universität Bonn

In the LHC Run-II, the Higgs simplified template cross sections (STXS) framework was developed to provide signal strength measurements in kinematical distributions of Higgs Boson production and decay. About 2.5 % of Higgs Bosons with a mass of $m_H = 125\,\text{GeV}$ produced at the LHC decay into a real and virtual Z boson. The further decay into two lepton pairs provides a clear final state with high reconstruction efficiency and good access to the underlying Higgs Boson kinematics. On top of the four final state leptons an event can contain additional jets. New physics at high energy scales might influence the properties of the extra jets, therefore their precise reconstruction is of high importance. These jets were typically reconstructed using topological cell clustering. In this study we aim to optimize the STXS bins by switching to particle flow jets which have demonstrated superior momentum and spatial resolutions, especially at low energies.

T 65.4 Mi 16:45 S01

Identification of hadronically decaying tau leptons in CMS and determination of their energy corrections — Jordy Degens, Günter Flügge, •Olena Hlushchenko, Wolfgang Lohmann, Thomas Müller, Dennis Roy, Hale Sert, Achim Stahl, and Alexander Zots — III. Physikalisches Institut B, RWTH Aachen University

In this talk, the identification of tau leptons decaying into hadrons in the CMS experiment will be explained and the performance of the latest multivariate discriminators will be presented. To calculate the mass of a particle decaying into tau leptons, any bias in the energy measurement or reconstruction of the tau lepton decay products must be determined and corrected for. The energy scales are determined to treat the charged and neutral components of the tau separately and are compared to the energy scale obtained without this separation. The dedicated energy scale measurement for the electrons faking tau leptons are discussed as well in the context of $H \to \tau\tau$ analysis.

T 65.5 Mi 17:00 S01

Calibration of the measured $p_{\mathrm{T}}^{\mathrm{miss}}$ recoil of CMS using MVA regression techniques — Artur Gottmann[1], Tanja Kopf[1], Günter Quast[1], Roger Wolf[1], and •Stefan Wunsch[1,2] — [1]Karlsruhe Institute of Technology — [2]CERN

The measured $p_{\mathrm{T}}^{\mathrm{miss}}$ is a sum of genuine $p_{\mathrm{T}}^{\mathrm{miss}}$, carried e.g. by neutrinos, emerging from a high energy physics collision and miss measurements of the $p_{\mathrm{T}}^{\mathrm{miss}}$ recoil in the detector. A calibration method of the $p_{\mathrm{T}}^{\mathrm{miss}}$ recoil is performed to minimize the resolution of the measured $p_{\mathrm{T}}^{\mathrm{miss}}$. This calibration is formulated as an MVA regression task. It is obtained from $Z \to \mu\mu$ events in data which can be assumed to be free of genuine $p_{\mathrm{T}}^{\mathrm{miss}}$. The calibrated recoil in turn can be used as an esti-

mator of the genuine $p_{\mathrm{T}^{\mathrm{miss}}}$ for events with resonances, where a recoil can be defined. The application on W+Jets events will be presented.

T 65.6 Mi 17:15 S01

Bremsstrahlung finding at Belle II — Florian Bernlochner[1], Nils Braun[1], •Patrick Ecker[1], Torben Ferber[2], and Thomas Hauth[1] — [1]ETP, KIT, Karlsruhe — [2]DESY, Hamburg

For the physics studies that will be performed at the Belle II experiment in Tsukuba, Japan, a precise reconstruction of charged particle trajectories is of the utmost importance. Electron tracks are highly relevant here, as such are used in many new physics analyses or Standard Model parameter measurements. The quality of the reconstruction of electron tracks is however affected by energy losses due to bremsstrahlung processes. Therefore a new algorithm for identifying bremsstrahlung photons during the reconstruction, using the combined information from the track reconstruction and the electromagnetic calorimeter of the Belle II detector, was developed and tested. This talk presents the concept of the algorithm along with first results to what extent the resolution of the extracted parameters of the electron tracks can be improved.

T 65.7 Mi 17:30 S01

Track propagation for different detector and magnetic field setups in Acts — •Fabian Klimpel[1,2], Andreas Salzburger[2], and Stefan Kluth[3] — [1]TU München — [2]CERN — [3]MPI für Physik

Track finding and fitting are amongst the most complex part of event reconstruction in high-energy physics, and dominates usually the computing time in high luminosity (HL) environment. A central part of track reconstruction is the transport of a given track parameterisation (i.e. the parameter estimation and associated covariances) through the detector, respecting the magnetic field setup and the traversed material. While a track propagation in a sparse environment (e.g. a tracking detector) can be sufficiently good approximated by considering discrete interactions, the propagation in a material dense environment (e.g. calorimeters) is better served by a continuous application of material effects. Recently, a common Tracking software project (Acts) born initially from the Common Tracking code of the ATLAS experiment has been developed in order to preserve the algorithmic concepts from the LHC start-up era and prepare them for the HL era of the LHC and beyond. The software is designed in an abstract, detector independent way and prepared to allow highly parallelised execution of all involved software modules. Therefore the propagation algorithm needs to be as flexible and adjustable which will be the main focus of this talk. The implemented solution for using a fourth order Runge-Kutta-Nystrom integration and its extension with continuous material integration and eventual time propagation is presented, such as the navigation through different geometry setups involving different environments are shown.

T 65.8 Mi 17:45 S01

Measuring the Jet Energy Resolution with the Bisector Method in ATLAS — •Tanja Holm and Ian C. Brock — Physikalisches Institut Universität Bonn, Bonn, Germany

Jets play an important role in many physics processes at the LHC. Therefore a precise knowledge of its jet energy resolution (JER) is important. It is defined as the width of the energy distribution of a reconstructed jet with respect to its true energy.
The bisector method is one way of estimating the JER. It is a geometric approach to separate particle-level from detector-level contributions to the transverse momentum imbalance in dijet events. Additionally out-of-cone mis-measurements of the jet energy due to the jet reconstruction algorithm are subtracted. Particle-level imbalances mostly originate from initial-state radiation and therefore are expected to be isotropic in the transverse plane. Detector-level imbalances only occur in the direction of the jets. For this reason the imbalance vector is decomposed into a perpendicular and a parallel component with respect to the average direction of the jets ("jet axis"). The resolution effects perpendicular to the jet axis (particle level) are removed from the resolution effects parallel to the jet axis (particle + out-of-cone effects + detector level). The resolution of the out-of-cone effects gets evaluated in Monte Carlo samples and is subtracted quadratically, remaining therefore with the resolution originating from the detector. This talk will discuss the bisector method, its implementation and improvements for Run 2 of the LHC at ATLAS.

T 65.9 Mi 18:00 S01

Studies for the calibration of a strange tagger in ATLAS using full Run-2 data — Johannes Erdmann, •Egor Evsenin-Gutschank, Kevin Kröninger, and Sonja Zeissner — TU Dortmund, Lehrstuhl für Experimentelle Physik IV

Up to date, the measurement of the CKM matrix element $|V_{ts}|$ relies on indirect methods. A major obstacle for the development of a direct measurement method is the absence of a reliable way to distinguish between jets originating from strange quarks and jets from other light quarks. Studies to discriminate between strange and up/down jets using multivariate methods are ongoing. This talk presents studies for calibrating such a strange tagging algorithm, which is still under development. Full ATLAS Run-2 data were used for studies to measure the efficiency of the tagging algorithm.

T 65.10 Mi 18:15 S01

Reconstruction of heavy flavour jets for Higgs physics at future e^+e^- colliders — •Yasser Radkhorrami[1,2] and Jenny List[1] — [1]DESY, Hamburg, Germany — [2]University of Hamburg, Hamburg, Germany

The reconstruction of heavy flavour jets plays an important role in precision measurements of the Higgs boson. $H \to b\bar{b}$ is the most frequently occuring decay mode of the Higgs boson. Furthermore, measuring the $H \to c\bar{c}$ decay mode will be possible for the first time at an e^+e^- collider. The International Large Detector proposed for the International Linear Collider is designed for particle flow reconstruction and optimised to achieve a jet energy resolution of 3-4% for light-flavour jets. Due to harder fragmentation functions and presence of semi-leptonic decays, heavy-flavour jets are expected to behave differently. In this study, b- and c-jets are for the first time included in the evaluation of the jet reconstruction performance. Different strategies for correcting the b- and c-jet energy based on the identification of leptons in the jets will be presented and their impact on the jet energy resolution will be evaluated.

T 66: DAQ und Trigger III

Zeit: Mittwoch 16:00–18:30 Raum: S02

T 66.1 Mi 16:00 S02

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 die ersten Hochratenergebnisse vor.

T 66.2 Mi 16:15 S02

Einen Auslesesystem der nächsten Generation für generische Detektorentwicklung und Instrumentierung: Integration des VMM front-end chips in das Scalable Readout System — •Michael Lupberger — CERN

Das Scalable Readout System (SRS) der RD51 Kollaboration mit dem APV25 Application Specific Integrated Circuit (ASIC) treibt die Innovation auf dem Gebiet der gasgefüllten Detektoren. Da der APV25

nicht weiter produziert wird und zukünftige Anwendungen mehr Flexibilität z. B. bei der Detektorkapazität oder Ausleserate benötigen, soll der ASIC ersetzt werden. Die Kollaboration hat sich für den VMM ASIC entschieden, der für das ATLAS New Small Wheel upgrade entwickelt wurde.

Dieser Chip wurde in den letzten Jahren in das SRS implementiert. Das Prototypsystem hat bereits für verschiedene Projekte in Strahlzeitmessungen als Auslesesystem gedient. Die einzelnen Komponenten sind im letzten Schritt der Überarbeitung und die Massenproduktion wird auf den Weg gebracht. Mehr als zwölf Gruppen, sowohl aus der Entwicklung, als auch aus geplanten Experimenten, wollen dieses System verwenden.

Die Auslesekette des Systems und die Art und Weise der Implementierung, sowie dessen Anwendung und Pläne für die weitere Entwicklung werden vorgestellt.

T 66.3 Mi 16:30 S02

A Compact First-Level Muon Track Trigger for the Phase-II ATLAS experiment at the HL-LHC — •Davide Cieri, Markus Fras, Oliver Kortner, Sandra Kortner, Hubert Kroha, and Sebastian Nowak — Max-Planck-Institut für Physik, Munich, Germany

Single muon triggers will still be crucial for the physics programme of the experiments at the High Luminosity LHC. To keep the rates of these triggers at an acceptable level, the ATLAS collaboration will significantly upgrade the muon spectrometer in LS3 to be ready for Phase-II. The new L0 trigger will integrate data from the Monitored Drift Tube (MDT) chambers to reduce the accidental trigger rates and sharp the trigger turn-on curves.

The future L0 trigger system will use data from the fast Resistive Plate Chambers (RPC) and Thin Gap Chambers (TGC) to identify the bunch crossing in which the muon was created. This information will be then passed to the downstream L0 MDT trigger, where matched MDT hits will be used to precisely measure the muon trajectory, and hence, the transverse momentum.

A fast compact muon track finding algorithm is presented, where muon track candidates are reconstructed using a binning algorithm based on a 1D Hough Transform. The algorithm has been designed and implemented with a hardware demonstration system using Xilinx Evaluation ZC706 and proFPGA duo boards. The system is meant to prove the concept towards the realisation of an official ATLAS MDT trigger processor prototype.

T 66.4 Mi 16:45 S02

Der Level-1 topologische Prozessor bei ATLAS: Triggerperformance und zukünftiger Ausbau — Katharina Bierwagen, Volker Büscher, •Johannes Damp, Christian Kahra, Ulrich Schäfer und Rosa Simoniello — 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 jedoch mit einem Verlust interessanter Ereignisse verbunden ist. Um dieses Problem zu lösen, wurde der Level-1 topologische Prozessor (L1Topo) in das Level-1 Triggersystem 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 Erhöhung der Raten vermieden werden kann.

Dieser Vortrag präsentiert einen Überblick über die Firmware als auch die Triggerperformance in den LHC-Runs in 2017 und 2018, in denen L1Topo routinemäßig eingesetzt wurde. Zudem wird ein Überblick über den aktuellen Status des Ausbaus von L1Topo für den in 2021 startenden Run-3 des LHC gegeben.

T 66.5 Mi 17:00 S02

Trigger-Effizienzstudien für das Phase-II Upgrade des ATLAS-Tile-Kalorimeters — •Philipp Ott — Kirchhoff-Institut für Physik, Heidelberg, Deutschland

Der HL-LHC, welcher die nominelle instantane Luminosität von $10^{34}\mathrm{cm}^{-2}\mathrm{s}^{-1}$ um nahezu eine Größenordnung anheben wird, stellt den Level-1 Trigger des ATLAS-Detektors vor enorme Herausforderungen. Die Algorithmen des Level-1 Triggers, die auf die Suche nach Elektron- und Photonsignaturen spezialisiert sind, verwenden ein hadronisches Veto zur Unterdrückung sogenannter „fake“ Elektronen. Dieses wird aus der im ATLAS-Tile-Kalorimeter deponierten Energie bestimmt. Bislang bildet das elektronische Rauschen einen der limitierenden Faktoren für dieses Veto. Dank des Phase-II Upgrades, welches den ATLAS-Detektor auf den HL-LHC vorbereitet, wird dieses auf ein Minimum reduziert. Weiterhin werden die Algorithmen des Level-1 Triggers auf Objekte höherer Granularität zugreifen können. Das erlaubt eine differenziertere Definition des hadronischen Vetos. Dieser Vortrag stellt Studien zur Neudefinition des hadronischen Vetos vor und analysiert, inwiefern die Effizienz entsprechender Level-1 Trigger verbessert werden kann.

T 66.6 Mi 17:15 S02

Commissioning of Fast TracKer Online Monitoring during Run II — •Anjali Krishnan and Andre Schoning — Physikalisches Institut, University of Heidelberg

The Fast TracKer (FTK) is a hardware-based system in the ATLAS experiment designed for fast and efficient track finding. To understand the data flow and check the quality of the data taken, it is highly helpful to perform online monitoring of the system. Several levels of online monitoring have been designed for the FTK, in order to achieve such goal. The low-level monitoring analyses the independent board dataflow, while the high-level monitoring considers the whole system's performance. The high-level monitoring performs a constant monitoring of the data quality of the output provided by FTK, that is, by scrutinizing the different track parameters in each geometrical slices and providing histograms of relevant observables.

This talk focuses on the low-level monitoring implemented for one particular board in FTK, the way all the information is published and the results of data quality studies done for FTK output data in the 2018 data-taking.

T 66.7 Mi 17:30 S02

PreProzessor Erweiterung für das Triggersystem des ATLAS Detektors — •Dieter Liebert — Kirchhoff-Institut für Physik, Heidelberg

Während der Run-3 Datennahme übermittelt das ATLAS Liquid-Argon Kalorimeter Daten in höherer Granularität direkt optisch an den ATLAS "Level-1 Kalorimetertrigger" (L1Calo), wogegen das Tile Kalorimeter weiterhin analoge Signale sendet. Der L1Calo PreProzessor digitalisiert die Signale, um die zugehörigen Transversalenergien und Strahlkreuzungen zu bestimmen. Die Ergebnisse werden optisch an drei neue "Feature-Extractor" (FEX) Systemerweiterungen des L1Calo und simultan elektrisch an die entsprechenden Altsysteme übertragen, um die Funktionalität des Triggers während der Inbetriebnahme der neuen FEX Prozessoren zu garantieren.

Dafür werden neue "Tile Rear Extension" (TREX) Module als Erweiterung des PreProzessors benötigt, die mit modernsten FPGAs und optischen Hochgeschwindigkeitssendern für Datenübertragungsraten bis zu 14 Gbit/s ausgestattet sind. Außerdem werden die TREX Module Ereignisdaten sowie gemessene Temperaturen und Betriebsspannungen an die ATLAS DAQ und DCS Systeme weiterleiten.

Drei TREX Prototyp Module wurden gefertigt und ausgiebig am KIP Heidelberg getestet. Unter anderem wurde die optische Hochgeschwindigkeitsübertragung zu den FEX Systemen sowohl mit einer Loopback-Schnittstelle als auch gemeinsam mit einem Jet FEX (jFEX) Prototyen untersucht. Ergebnisse der Prototypentests und das nächste TREX Hardwaredesign werden vorgestellt.

T 66.8 Mi 17:45 S02

Triplet Track Trigger for Future Hadron Collider Experiments — •Tamasi Kar, André Schöning, and Jike Wang — Physikalisches Institut, Universität Heidelberg, Germany

A very large number of pileup events and the reduction of the huge data rate whilst keeping high signal efficiencies are some of the major challenges that future high rate experiments such as the High Energy LHC or the Future Circular hadron Collider (FCC-hh) have to tackle. This requires smart triggering concepts that not only allow for a significant reduction of pileup but also provide high signal acceptance and purity.

In this talk, the concept of triplet track trigger using High Voltage Monolithic Active Pixel Sensors (HV-MAPS) is introduced for a generic detector geometry. It is demonstrated that the triplet pixel layer design i.e. three closely stacked pixel layers at sufficiently large radius, allows a very simple and fast track reconstruction, providing

excellent track reconstruction efficiencies and very high purity at the same time. Tracking performance studies are exemplarily presented for the ATLAS detector using a full Geant4 simulation. It is shown that the triplet track trigger can be used to trigger efficiently multi-jet signals using track-jets. A significant pileup, and thus data rate reduction is achieved by reconstructing the z-vertex positions of the jet constituents already at the very first trigger level.

T 66.9 Mi 18:00 S02

Readout Electronics of the LHCb SciFi Tracker — Sebastian Bachmann, •Daniel Berninghoff, Albert Comerma, Michal Dziewiecki, Xiaoxue Han, Blake Leverington, Hanna Malygina, Ulrich Uwer, and Lukas Witola — Physikalisches Institut, Heidelberg, Germany

The LHCb Scintillating Fibre (SciFi) Tracker is designed to replace the current downstream tracking detectors in the LHCb Upgrade during the shutdown 2019 to 2020. It is based on 2.5 m long and 0.250 mm diameter scintillating fibres as the active medium. Silicon photomultiplier arrays with 128 channels and 0.25 mm channel width are used for readout. The front-end electronics are based on a custom ASIC chip, the PACIFIC, and an FPGA for the hit clustering with a readout rate of 40 MHz.

The assembly and commissioning of the SciFi Tracker is underway. Milestones and challenges in operating and monitoring the detector together with latest performance results will be presented.

T 66.10 Mi 18:15 S02

Online track reconstruction for the LHCb Upgrade using machine learning — •Dennis Hnida — Experimentelle Physik 5, TU Dortmund

The LHCb experiment records events at a rate of up to 40 MHz. Before being recorded to disk a multi-level trigger system reduces this data rate to several kHz. Up until 2018 the first trigger was based on hardware, while the trigger system for future runs will be purely software based. With the removal of the hardware trigger, efficient algorithms have to perform a first trigger decision on a very short timescale. This trigger decision depends on e.g. track reconstruction and vertex position determinations. The current first High Level Trigger can process events at a rate of 3.5 MHz. This process needs to be speed up by a factor of 10.

The raw LHCb data is comparable to images, therefore recent years success of neural networks for pattern recognition could be transferred to the trigger system. Furthermore, the inference complexity of neural networks is constant and can be easily parallelised, which could fulfill the requirements. The current status of studies on track reconstruction using neural networks will be presented in this talk.

T 67: Detektorsysteme III

Zeit: Mittwoch 16:00–18:30 Raum: S03

T 67.1 Mi 16:00 S03

Tracking efficiencies for the track selections in the track-counting luminosity measurement in ATLAS. — •Surabhi Sharma — DESY, Hamburg

Particle production at the Large Hadron Collider (LHC) is driven by two important parameters: the center of mass energy and the luminosity. The luminosity is a measure of how many collisions happen in an accelerator per second and area. An accurate measurement of the luminosity at the LHC is an important objective for the ATLAS experiment and high precision of the luminosity measurement is essential to fulfill the ATLAS physics goals. The luminosity measurement with the track-counting method requires high and stable efficiencies for the selection of tracks in the Inner Detector of ATLAS. The reconstructed and selected charged particle tracks use mainly information from the silicon pixel and strips detectors in ATLAS.

In this context, the tracking efficiencies for the track selections used in the track counting luminosity measurement using Z ->mumu events are calculated. The techniques used to calculate the tracking efficiencies and the first look at the ATLAS data from 2018 will be shown in this presentation.

T 67.2 Mi 16:15 S03

Cross detector stability and linearity uncertainty for the integrated luminosity measurement in 2015 and 2016 in the CMS detector. — Olaf Behnke, Joscha Knolle, Andreas Meyer, and •Rafael Sosa — CMS - DESY Hamburg

The integrated luminosity recorded and measured by the CMS Experiment establishes the reference for cross section measurements of physics processes and the sensitivity reach of searches for new physics. The stability and linearity of the detectors used to measure the luminosity play an important role in the uncertainty estimation for the integrated luminosity value.

During the 2015 and 2016 data taking period, the Pixel Cluster Counting (PCC) was the primary offline luminometer, but also other detectors like the Drift Tubes (DT) and the HF (Forward Hadronic Calorimeter) provided luminosity measurements that can be used either for comparison or even to replace the PCC as the reference in some cases. The procedure and results on the cross detector stability and linearity between these detectors will be presented as well as the impact on the integrated luminosity uncertainty.

T 67.3 Mi 16:30 S03

Simulating Defects in the ITk Pixel Detector — •Kira Abeling, Timo Dreyer, Jason Veatch, and Stan Lai — Georg-August-Universität Göttingen

Around 2026, the current ATLAS Inner Detector will be replaced by the Inner tracker (ITk) in preparation for the coming higher luminosity of the HL-LHC but also with the higher radiation which can degrade silicon detector performance or disable readout electronics.

This talk presents how defects in the ITk pixel detector are simulated and how these defects affect track reconstruction. Different scenarios are simulated, including malfunctioning modules due to random failure or due to radiation problems, all of which are crucial to investigate in order to quantify failure and risk scenarios of the ITk before it is built.

T 67.4 Mi 16:45 S03

Long Term Studies of the Tracking Efficiency for the LHCb SciFi-Tracker — •Holger Stevens and Martin Bieker — Experimentelle Physik 5, TU Dortmund

The LHCb-Detector is upgraded in the ongoing shutdown of the Large Hadron Collider. Among other things the tracking stations will be replaced by the so called SciFi-Tracker. This tracker is made of scintillating fibres.

The light output of the fibres decreses during the life time of the detector, which is caused by two major factors. On the one hand the irradiation of the fibres caused by the operation of the LHC. On the other hand natural aging of the material.

This talk will show possibilities to simulate these effects and estimate the tracking efficiency of the Scifi-Tracker during the planed data taking period of 10 years.

T 67.5 Mi 17:00 S03

Momentum transfer reconstruction for the P2 Experiment — •Alexey Tyukin — Institute for Nuclear Physics, Johannes Gutenberg University, Mainz

The P2 experiment at the future MESA accelerator in Mainz will determine the weak mixing angle, a core parameter of the Standard Model. The high precision of this measurement stems from the use of elastic electron-proton scattering, which has a 39 ppb cross-section asymmetry between the two electron helicity states. This asymmetry depends on the momentum transfer Q^2 of the scattering process. The experiment will be performed by injecting a high intesity electron beam into a liquid hydrogen target and measuring the outgoing particles.

The P2 detector will consist of a solenoid magnet surrounding the target and two main detector systems: a ring of fused silica crystals as an integrating cherenkov detector and four tracking planes consisting of thin high voltage monolithic active pixel sensors (HV-MAPS). The trajectories of electrons hitting all four tracking planes will be reconstructed to give an estimate on the Q^2.

A Geant4 simulation is used to produce realistic detector hit distributions to test the Q^2 recontruction performance. The average Q^2 value of $0.006\,\mathrm{GeV}^2/c^2$ can be reconstructed with about 4% uncertainty for a single event, leading to a high overall precision due to

large electron rates of the experiment.

T 67.6 Mi 17:15 S03

Tracking of charged particles using an FE-I4B pixel tracker and moving emulsion films — Matei Climescu, Fabian Hügging, Jens Janssen, Vadim Kostyukhin, •Nikolaus Owtscharenko, David-Leon Pohl, and Markus Cristinziani — Physikalisches Institut, Universität Bonn

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, including hadronic cascade production, in the final experiment, a dedicated measurement was performed. 400 GeV protons from the SPS interacted with a thick target, events were then recorded by a dedicated spectrometer consisting of emulsion plates, a pixel tracker, a magnetic field, scintillating fibers, drift tubes and RPCs.
The pixel tracker was composed of 12 ATLAS IBL double chip modules, arranged in 6 planes, complementing the high spatial resolution of the emulsion detector with a high timing resolution.
Setup and first results of this testbeam are presented.

T 67.7 Mi 17:30 S03

Implementation of a pixel tracker into simulation and comparison with data in a charm cross-section measuring testbeam. — •Matei Climescu, Fabian Hügging, Jens Janssen, Vadim Kostyukhin, Nikolaus Owtscharenko, David-Leon Pohl, and Markus Cristinziani — Physikalisches Institut, Universität Bonn

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The resulting data is compared to the simulation and will be used to tune it.

T 67.8 Mi 17:45 S03

A Multivariate Track Quality Estimation for the Belle II Experiment — Florian Bernlochner, Nils Braun, •Michael Eliachevitch, and Felix Metzner for the Belle 2-Collaboration — ETP, KIT, Karlsruhe

Starting from April 2018 The Belle II experiment at the SuperKEKb accelerator facility in Tsukuba, Japan, has successfully recorded first collisions data for calibration and testing purposes, to prepare the physics data taking in early 2019. Many analyses rely on the ability of the Belle II detector and software to correctly reconstruct all tracks originating from a $B\bar{B}$ decay event. Depending on their sensitivity to falsely reconstructed tracks and the rarity of their signal processes, different analyses can profit from a varying trade-off between the tracking efficiency and purity. In this talk, I present a method for a quality estimation of tracks in the Belle II Analysis Software Framework, which combines information from the different subdetectors and their respective tracking algorithms by employing multivariate analysis techniques. It provides a track quality indicator that can be used to choose and an optimal working point on the efficiency vs. purity receiver operating curve at analysis level.

T 67.9 Mi 18:00 S03

Time-dependence in CMS tracker alignment — •Henriette Petersen — DESY, Hamburg, Germany

The Compact Muon Solenoid (CMS) is a general-purpose detector located at the Large Hadron Collider (LHC) at CERN. The high granularity silicon tracker of CMS with 1856 pixel and 15148 strip modules provide accurate track reconstruction. To achieve high precision, corrections for the position, rotation and curvature of these modules must be found; such a procedure is known as tracker alignment. Magnet cycles, temperature variations and ageing of modules cause significant time variations that affect the track reconstruction and therefore necessitate continuous alignment throughout the operation of the LHC machine. In 2017 and 2018 the LHC generated the highest instantaneous luminosity to date leading to fast changes in the pixel detector due to the proximity to the interaction region. This talk will elucidate the strategy to include a time dependence of the alignment.

T 67.10 Mi 18:15 S03

Systematic studies of track-based alignment of the CMS tracker — •Josry Metwally — DESY, Hamburg, Germany

The CMS (Compact Muon Solenoid) tracker is the largest silicon tracker in the world, consisting of a large number of pixel (1856) and strip (15148) modules to ensure a precise reconstruction of tracks and vertices. In order to fully exploit the precision of the local reconstruction of the silicon modules, we use a track-based approach to align the modules. The number of alignment parameters is of the order of 100k and its determination is achieved by the means of the linear least-squares method (χ^2), while residuals between the hits and the reconstructed track are minimised. Continuous transformations called weak modes corresponding to transformations to which the χ^2 fit is not very sensitive are one of the major challenges of track-based alignment. In this talk, systematic studies to control weak modes are presented.

T 68: Detektorsysteme IV

Zeit: Mittwoch 16:00–18:15 Raum: H08

T 68.1 Mi 16:00 H08

Current status of the Dortmund Low Background Facility — •Marcel Gerhardt, Kevin Kröninger, and Christian Nitsch — TU Dortmund, Lehrstuhl für Experimentelle Physik IV, Otto-Hahn-Straße 4a, 44227 Dortmund

The Dortmund Low Background Facility (DLB) is a low-background gamma-ray spectrometry system built above ground. With an outer shielding, consisting of barite concrete and cast iron, an artificial overburden of about 10 meters of water equivalent is achieved. This outer shielding houses a multi-layer lead castle, which features borated polyethylene as a neutron moderator and absorber. Additionally, an active muon veto detector is installed in order to reduce cosmic muons contributing to the background spectrum. The DLB's high-purity germanium detector with a relative efficiency of 60% is set up within this shielding. Therefore, the background-level is remarkably lowered and allows measurements with sensitivities well below the 1 Bq/kg-level, which is comparable to laboratories situated at shallow depths.

In this talk a brief description of the current status of the DLB with the recently completed active muon veto detector, which results into an improved background-level, is given. Also, developments in the digitization of the data acquisition system and ongoing measurements are presented.

T 68.2 Mi 16:15 H08

Entwicklung und Test eines auf szintillierenden Fasern basierenden Spurdetektors für das LHCb-Experiment — •Jan-Niklas Siekmann, Hannah Erpenbeck, Damian Iwanicki, Simon Nieswand, Waclaw Karpinski, Thomas Kirn, Stefan Schael, Georg Schwering und Michael Wlochal — I. Physikalisches Intitut, RWTH Aachen University

Am Large Hadron Collider am CERN untersuchen Wissenschaftler mithilfe komplexer Detektorsysteme die Vorhersagen des Standardmodells und suchen nach Anzeichen neuer physikalischer Phänomene. Eines dieser Systeme ist das LHCb-Experiment, welches gezielt für die Untersuchung seltener Zerfälle in der B-Physik konzipiert wurde.

Aufgrund der Erhöhung der Strahlenergie und der Luminositt des LHCs nach dem Long Shutdown 2 in 2018/19, müssen Teile des Detektors ausgetauscht und verbessert werden. Zu diesem Zweck wird derzeit ein neues, modulares Tracking-System entwickelt, welches auf szintillierenden Fasern(250 um) basiert, die durch Silizium-Photomultiplier ausgelesen werden. Insgesamt wurden für das Tracking-System 1024

sechslagige Fasermatten an mehreren Standorten produziert. Für zukünftige Verbesserungen des LHCb-Detektors ist ein mögliches Konzept die Instrumentalisierung des LHCb-Magnetbereiches mit szintillierenden Fasern, welche an klare Fasern gekoppelt werden.

In diesem Vortrag werden die Ergebnisse der Serienproduktion von Fasermatten vorgestellt. Es werden weiterhin Studien zur optischen Ankopplung an klare Fasern und zum Einsatz bei tiefen Temperaturen präsentiert.

T 68.3 Mi 16:30 H08

Characterization of the KATRIN detector wafers with the Iron Bird test setup — •Sebastian Schmid for the KATRIN-Collaboration — Institute of Experimental Particle Physics, Karlsruhe Institute of Technology (KIT)

The KArlsruhe TRItium Neutrino experiment (KATRIN) aims to determine the effective mass of the electron anti-neutrino by measuring the β-spectrum of molecular tritium. To reach the intended sensitivity of 0.2 eV/c^2 the energy spectrum close to the kinematic endpoint is determined precisely. To do so the experiment combines a high-luminosity windowless gaseous tritium source followed by a differential and cryogenic pump section for reduction of the tritium flow with a high resolution MAC-E filter spectrometer system. At the downstream end of the setup the transmitted electrons are detected by a focal plane detector system containing a 148-pixel silicon p-i-n-diode wafer.

A test stand, called Iron Bird, was established in order to examine the characteristics of the KATRIN wafers. Of particular importance is to determine the energy resolution of individual pixels with a ^{241}Am source and to check for electrical shorts between pixels. The Iron Bird utilizes readout electronics and data acquisition system equivalent to the KATRIN main detector. This talk will cover the hardware setup, commissioning and the characterization of the wafers using the Iron Bird.

This work was supported by the U.S. Department of Energy under award numbers DE-FG02-97ER41020, DE-FG02-97ER41041, DE-FG02-97ER41033, BMBF (05A17VK2), and the HGF.

T 68.4 Mi 16:45 H08

Qualifikation eines Messstands für Sensoren für den neuen ATLAS-Pixeldetektor — Jörn Grosse-Knetter, Jörn Lange, •Silke Möbius und Arnulf Quadt — II. Physikalisches Institut, Georg-August-Universität Göttingen

Für das Upgrade zum High-Luminosity-LHC wird ebenso der ATLAS Detektor überarbeitet, wobei insbesondere der Spurdetektor komplett durch einen reinen Siliziumdetektor ersetzt werden soll. Die erhöhte Luminosität erfordert sowohl strahlenhärtere Komponenten, als auch ein neues Design der Sensoren (insbes. der Segmentgröße), um mit den höheren Okkupanzen umzugehen. Durch die Nähe zum Interaktionspunkt sind diese Anforderungen besonders für den Pixeldetektor eine Herausforderung. Um Prototyp-Sensoren für das Upgrade zu charakterisieren und zu testen, werden Labormessungen an den beteiligten Instituten durchgeführt.

Der Vortrag wird auf die Qualifizierung des Spitzenmessplatzes und metrologischer Messungen in Göttingen für solche Sensorcharakterisierungen eingehen. Ziel ist, möglichst automatisiert Strom-Spannungs- sowie Kapazitäts-Spannungs-Kennlinien aufnehmen zu können sowie mechanische Eigenschaften der Sensoren wie Verbiegung mittels eines Messmikroskops festlegen zu können. Ergebnisse von Messungen mit Prototypen von Sensoren für den Upgrade des ATLAS-Pixeldetektors werden gezeigt.

T 68.5 Mi 17:00 H08

Test System for Service Hybrids of CMS Silicon Strip Modules — Christian Dziwok[2], Lutz Feld[1], Waclaw Karpinski[1], Katja Klein[1], Martin Lipinski[1], Franz Josef Neus[1], •Alexander Pauls[1], Gerhard Pierschel[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 outer 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 connection via optical links to the back-end electronics. During the production a test system for the roughly 20,000 Service Hybrids will be needed. It is designed to test all functions of the Service Hybrids during active thermal cycling. The design is centred around a dedicated test board PCB, which hosts a Raspberry Pi miniature computer, serializer/deserializer ASICs to mimic the readout hybrids' data stream, and components to test the slow control and power distribution features. The design of the system, the test software, and recent measurements with fully functional Service Hybrid prototypes are presented.

T 68.6 Mi 17:15 H08

Building a burn-in crate for the end-cap hybrids of the ATLAS ITk silicon strip detector: developping a cooling system and DCS monitoring — •Marianna Liberatore, Ben Brüers, Ingo Bloch, and Priscilla Pani — DESY, Zeuthen, Germany

The current silicon strip tracking detector (SCT) of the ATLAS experiment at CERN, Switzerland, is not suited to handle the track density and radiation levels that will be present at the high lumi phase of the LHC. Hence, ATLAS is currently preparing for the production of a new tracking detector, called the Inner Tracker (ITk). It will consist of a pixel and a strip part. The strip detector will be composed of barrel and end-cap (EC) modules. Modules consist of the strip sensors and several printed circuit flex boards (Hybrids or power-boards) which host the read-out, control and monitoring chips. To reduce the risk of hybrid failure in the finalized ITk detector due to infant mortality, specific tests, burn-in tests, are performed before assembly of the silicon strip modules. In this talk, the design of a burn-in crate for EC hybrids will be presented. In particular, the focus will be brought on the development of a cooling infrastructure for preliminary tests, as well as a first setup for Low Voltage (LV) and temperature monitoring.

T 68.7 Mi 17:30 H08

Design and commissioning of a temperature-controlled readout station for CMS 2S modules — Christian Dziwok[1], Lutz Feld[2], Katja Klein[2], Alexander Pauls[2], Oliver Pooth[1], Marius Preuten[2], Max Rauch[2], •Nick Thamm[1], and Tim Ziemons[1] — [1]III. Physikalisches Institut B, D-52056 Aachen — [2]I. Physikalisches Institut B, RWTH Aachen University

During the high luminosity upgrade of the LHC starting in 2024, the CMS experiment gets partly replaced in the Phase-2 Upgrade. Part of this upgrade is the Outer Tracker, which gets exchanged to contribute to the L1-trigger system. The new detector consists of 2S, featuring two strip sensors, and PS silicon modules, which feature one strip and one macro-pixel sensor. These modules get cooled by CO_2 phase-change cooling loops to approximately -30°C to ensure operation while being irradiated. All one thousand modules build by the RWTH Aachen University will be quality controlled, including functionality tests under nominal conditions.

This talk focuses on the design and commissioning of a readout station, which is used to test single modules at operational temperature during prototyping.

T 68.8 Mi 17:45 H08

DAQ and constructional aspects of a burn-in crate for the ATLAS ITk strips end-cap — •Ben Brüers — DESY Zeuthen

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 will consist of cylindrical layers in the centre (barrel) and concentric discs on either side of the barrel (end-caps). Large parts (a surface area of 162 m^2) of the ITk will be populated with silicon strip sensors. Read-out chips (ABCStar, HCCStar and AMAC) and some other components will be hosted on printed circuit flex boards (hybrids and power-boards). To reduce the risk of hybrid failure in the finalised ITk detector due to infant mortality, all hybrids are tested intensively for 100 hours at 40°C after production. Only hybrids fulfilling certain quality criteria are installed in ATLAS later. This procedure, called burn-in, will be performed in crates allowing to reach the designed production rates. This talk will summarise the progress of the development of an end-cap hybrid burn-in crate, focussing on DAQ and constructional aspects.

T 68.9 Mi 18:00 H08

Qualifizierung einer temperaturstabilisierten Teststation zur elektrischen Charakterisierung von Siliziumsensormodulen für das CMS-Experiment — Tobias Barvich, Felix Bögelspacher, Alexander Dierlamm, Ulrich Husemann, •Roland Koppenhöfer, Stefan Maier und Thomas Müller — Institut für Experimentelle Teilchenphysik, Karlsruher Institut für Technologie

Im Rahmen des Phase-2-Upgrades des CMS-Experiments wird der

gesamte CMS-Spurdetektor ausgetauscht. Der neue äußere CMS-Spurdetektor wird aus zwei verschiedenartigen Siliziumsensormodulen bestehen (PS- und 2S-Module). Um einen stabilen Betrieb der Module zu gewährleisten, werden die Sensoren mittels eines Kühlsystems bei einer Temperatur von ca. −20°C betrieben. Am Ende des Herstellungsprozesses der Detektormodule in den Produktionszentren muss die Funktionalität der Module unter den späteren Betriebsbedingungen im CMS-Detektor überprüft werden. Das Institut für Experimentelle Teilchenphysik am Karlsruher Institut für Technologie ist eines der Produktionszentren für 2S-Module und hat für die elektrische Charakterisierung der Module eine temperaturstabilisierte Teststation entwickelt. Der Vortrag stellt den Funktionsumfang der entwickelten Station und die Ergebnisse von Messungen mit einem Prototyp eines 2S-Moduls vor.

T 69: KET Meeting

Zeit: Mittwoch 16:00–18:00 Raum: S05

KET meeting (nur für KET-Mitglieder)

T 70: QCD (Experiment)

Zeit: Mittwoch 16:00–17:45 Raum: H10

T 70.1 Mi 16:00 H10

Prospects for a precise determination of PDFs from measurements of the dijet cross section at $\sqrt{s} = 13$ TeV with the CMS detector — Günter Quast, Klaus Rabbertz, and •Daniel Savoiu — Institut für Experimentelle Teilchenphysik, Karlsruher Institut für Technologie (KIT)

Precision studies at hadron colliders play an increasingly important role in the search for new or rare physics phenomena. An essential prerequisite for these studies is the precise knowledge of the Parton Distribution Functions (PDFs) of the proton, which are not predicted by theory and must therefore be determined experimentally.

Dijet production is particularly well-suited for this purpose. Not only are pairs of jets produced in abundance at the LHC, maximizing the statistical precision, but the different topologies of dijet events can be exploited in a triple-differential cross section measurement for a more precise determination of PDFs.

In the presented analysis of data taken with the CMS detector at an energy of 13 TeV, the dijet phase space is divided in terms of the boost of the dijet system, the rapidity separation of the two jets, and the average jet transverse momentum.

T 70.2 Mi 16:15 H10

Measurements of the total charm cross section with the CMS detector — •Nur Zulaiha Jomhari and Achim Geiser — DESY, Hamburg, Germany

The main objective of this project is to measure the total cross section for inclusive charm production at different proton-proton center of mass energies (0.9, 2.7, 5, 7, 8, and 13 TeV). The measurement of charmed meson production is one of the ways to verify the corresponding Standard Model prediction. In previous LHC analyses, the CMS, ATLAS and ALICE experiments covered only small fractions of the available phase space while the LHCb experiment fully covered the forward region, $0 < p_T < 15$ GeV and $2.0 < y < 4.5$.

For this project, we measure the charm cross section through the decays $D^* \to D^0\pi_s$ and $D^0 \to K^-\pi^+$ in the full rapidity range not covered by LHCb and down to $p_T \sim 1$ GeV. The challenge is the acceptance of the D mesons at this low p_T. Combining with the LHCb measurements, essentially the full phase space will be covered. In this talk, the ongoing analysis on this project will be presented.

T 70.3 Mi 16:30 H10

Measurement of the triple differential inclusive Z ($\to \mu\mu$) + 1 jet cross section at $\sqrt{s} = 13$ TeV with the CMS detector and constraints on the proton structure — •Thomas Berger, Klaus Rabbertz, and Günter Quast — Karlsruher Institut für Technologie

This talk presents a measurement of the triple differential inclusive Z($\to \mu\mu$) + 1 jet cross section in proton-proton collisions at the LHC at $\sqrt{s} = 13$ TeV. The data represent an integrated luminosity of 35.8 fb^{-1} collected with the CMS detector in 2016. The cross section is measured as a function of the Z boson's transverse momentum p_T^Z, the rapidity separation y^* of the Z boson and the leading jet, and the boost y_b of their center-of-mass system. The analysis is performed simultaneously with a variable Φ_η^* determined from muon angular information. Cross section predictions have been derived at next-to-next-to-leading order. The measured cross sections are corrected for detector effects and compared with the predictions to obtain constraints on the parton distribution functions of the proton.

T 70.4 Mi 16:45 H10

Amplitude analysis of the $\Lambda_b^0 \to \Lambda_c^+ \overline{D}^0 K^-$ decay at the LHCb experiment — •Alessio Piucci, Stephanie Hansmann-Menzemer, Sebastian Neubert, Marian Stahl, and Nicola Skidmore — Physikalisches Institut, Heidelberg, Germany

Pentaquark-like candidates have been observed in 2015 by the LHCb experiment in the $\Lambda_b^0 \to J/\psi p K^-$ decay. Since then a variety of theoretical models and predictions have been proposed to describe their nature. One of the most prevalent ones interprets the two pentaquark states as $\overline{D}\Sigma_c^*$ and $\overline{D}^*\Sigma_c$ hadronic molecules, predominantly decaying into $\overline{D}^{0*}\Lambda_c^+$. This talk will focus on the amplitude analysis of the $\Lambda_b^0 \to \Lambda_c^+ \overline{D}^0 K^-$ decay using the full LHCb dataset; this decay is a golden channel for testing the validity of the above-mentioned molecular model. In addition to the two already-observed pentaquark candidates, possible extra hidden-charm pentaquark states are predicted to lie in the mass range investigated by the analysis.

T 70.5 Mi 17:00 H10

Tuning studies of the `Pythia8` generator using LEP and LHC data — •Thea Engler, Andrea Knue, and Gregor Herten — University of Freiburg, Institute of Physics

For the simulation of particle physics processes in high energy physics, Monte Carlo (MC) generators are heavily used. The different parton shower and hadronisation models have parameters which cannot be deduced from first principles, but which can be varied in a well-defined range in order to find the best values to describe the data distributions well (MC tuning). The tuning step is done by varying several parameters, performing an interpolation for each bin of the distribution and comparing the simulated distributions to data. This is done with the `Professor` framework. In this talk a tune of the `Pythia8` generator using data from both the LEP and the LHC experiments is presented. The focus lies on the tuning of the hadronisation model.

T 70.6 Mi 17:15 H10

Pileup mitigation in CMS with PileUp Per Particle Identification (PUPPI) — •Anna Benecke and Andreas Hinzmann — Universität Hamburg

Every bunch crossing at the LHC has not only one proton-proton interaction but several. These additional proton-proton interactions are called pileup interactions. With the increasing luminosity of the LHC also the number of pileup interactions per bunch crossing increased in the past years and it will reach up to 140 pileup interaction during high-luminosity LHC operation. Removing the pileup from an event is essential, because pileup does not only affect the jet energy but also other event observables as for example the missing transverse energy, the jet substructure, jet counting and the lepton isolation. To account for these pileup effects various techniques like charged hadron subtraction, pileup jet ID, delta-beta correction for lepton isolation are used within CMS, but meanwhile a new technique, PUPPI, has been introduced and extensively tested on 2016 data. This talk will explain the algorithm behind PUPPI and shows the first Data to MC comparison

plots of the variables of PUPPI.

T 70.7 Mi 17:30 H10

ρ^0 Photoproduktion in HERA — •Arthur Bolz — Physikalisches Institut, Heidelberg

Exklusive Photoproduktion von ρ^0 Mesonen in HERA wird mit dem H1 Detektor studiert. Ein Datensatz mit c.a. 700000 $\rho^0 \to \pi^+\pi^-$ Zerfällen wird verwendet, um Wirkungsquerschnitte als Funktion der invarianten Dipion-Masse $m_{\pi^+\pi^-}$, der Photon-Proton Kollisionsenergie $W_{\gamma p}$ und des quadratischen Impulsübertrags am Proton-Vertex t zu messen. Der zugängliche Phasenraum ist $0.4 < m_{\pi^+\pi^-}$ [GeV] < 2.2, $20 < W_{\gamma p}$ [GeV] < 80 und $-1.5 < t$ [GeV^2] < 0. Ereignisse mit elastisch gestreuten Protonen werden statistisch von solchen getrennt, in denen das Proton in ein hadronisches System mit kleiner invarianter Masse dissoziiert. Die gemessenen Wirkungsquerschnitte und kinematischen Abhängigkeiten werden mittels Fits parametrisiert und mit phänomenologischen Modellen verglichen. Der Datensatz wurde in den Jahren 2006-2007 mit dem H1 Fast Track Trigger aufgezeichnet. Er entspricht einer integrierten Luminosität von 1.3 pb^{-1}.

T 71: Theorie: Flavorphysik

Zeit: Mittwoch 16:00–18:30 Raum: H11

T 71.1 Mi 16:00 H11

$B \to \pi, K, \bar{D}$ and $B \to \rho, K^*, \bar{D}^*$ Form Factors from B-Meson Light-Cone Sum Rules — •Nico Gubernari, Danny Van Dyk, and Ahmet Kokulu — Technische Universität München, München, Germany

Our understanding of semileptonic B decays depends on accurate estimates of hadronic matrix elements. The latter are usually expressed in terms of form factors, which are functions of the momentum transfer. We calculate the $B \to \pi, K, \bar{D}$ and $B \to \rho, K^*, \bar{D}^*$ form factors in the framework of QCD Light-Cone Sum Rules (LCSRs) with B-meson distribution amplitudes. Our calculation improves upon previous studies by including higher twist contributions and the full set of the three-particle distribution amplitudes. Our LCSR results are complementary to present and future Lattice QCD studies. Finally, we discuss selected phenomenological implications of our results, giving predictions for the Lepon-Flavour Universality ratios $R(D)$ and $R(D^*)$.

T 71.2 Mi 16:15 H11

Angular analysis of $B^+ \to K^{+*}\mu\mu$ decays at LHCb — •Renata Kopečná, David Gerick, Martino Borsato, and Stephanie Hansmann-Menzemer — Physikalisches Institut, Heidelberg, Germany

Flavor-changing neutral current $b \to s$ quark transitions are in the Standard Model forbidden at tree level and occur at the lowest order as so-called box or penguin processes. Angular observables of such transitions probe the underlying Lorentz structure of the Standard Model. These observables are of particular interest and suitable for theory comparison since the predictions are only little affected by form-factor uncertainties.

LHCb reported on several $b \to s$ quark flavor-changing neutral current transitions including $B^0 \to K^{0*}\mu\mu$ decays with various $K^*(\to K\pi)$ decay modes. These studies revealed tensions with the Standard Model predictions of an angular observable (P_5'), hinting to a potential contribution from physics beyond the Standard Model.

We present the first angular analysis of $B^+ \to K^{+*}\mu\mu$ decays at LHCb. This channel is experimentally challenging due to neutral particles present in the final state. The analysis is however an important complement to the $B^0 \to K^{0*}\mu\mu$ measurements and will significantly contribute to understanding of the observed tensions.

T 71.3 Mi 16:30 H11

D-Wave Contributions in B_{l4} Decays — •Stephan Kürten[1] and Bastian Kubis[2] — [1]Physik Department, Technische Universität München, James-Franck-Straße 1, D-85748 Garching, Germany — [2]HISKP, Universität Bonn, Nussallee 14-16, D-53115 Bonn, Germany

Semileptonic $b \to u$ transitions are used to further refine the Cabbibo-Kobayashi-Maskawa matrix element $|V_{ub}|$. Previously, extractions of $|V_{ub}|$ from $B \to \rho(\to \pi\pi)l\nu$ only assumed P-wave dominance of the decay distribution. For precision determinations, we need to understand the composition of the $\pi\pi$ partial waves at a precision level, which includes S-wave and D-wave contributions. This talk focuses on the methods and the actual comparison between the $\rho(770)$ and $f_2(1270)$ as first resonances in their respective partial waves.

T 71.4 Mi 16:45 H11

V_{cb} from inclusive $b \to c\ell\nu$ decays: an alternative method — •Matteo Fael, Thomas Mannel, and Keri Vos — Universität Siegen, Siegen, Germany

The standard method to extract V_{cb} from inclusive semileptonic B decays relies on the precise calculation of the inclusive rate as well as of spectral moments (i.e. moments of the charged lepton energy and the hadronic mass spectra) performed in the Heavy Quark Expansion (HQE). The HQE allows us to predict physical observables as a series in $\Lambda_{\rm QCD}/m_b$ and to write them in terms of HQE parameters, the non-perturbative inputs that can be determined on the lattice or fitted from data.

Their extraction from data is possible only up to $1/m_b^3$; up to this order there are only four independent parameters. However starting at order $1/m_b^4$, their proliferation prevents their extraction from data.

In this talk I will discuss how reparametrization invariance, a symmetry within the HQE reflecting Lorentz invariance of the underlying QCD, reduces the number of independent HQE parameters. Specific observables, in particular the total rates and the q^2 moments (the moments of the leptonic invariant mass spectrum), indeed depend on a smaller set of non-perturbative inputs. I will propose an alternative extraction of V_{cb} based on the q^2-moment measurement that could push the V_{cb} determination up to order $1/m_b^4$ without making use of models for the HQE parameters, i.e. to have a fully data-driven analysis up to this order

T 71.5 Mi 17:00 H11

Combining theory inputs for $\bar{B} \to D^{(*)}\ell\bar{n}u$ and extracting $|V_{cb}|$ — Marzia Bordone[1,2], Martin Jung[3], and •Danny van Dyk[4] — [1]Physik-Institut, Universität Zürich, Winterthurer Strasse 190, 8057 Zürich, Switzerland — [2]Theoretische Physik 1, Universität Siegen, Walter-Flex-Straße 3, D-57068 Siegen, Germany — [3]Excellence Cluster Universe, Technische Universität München, Boltzmannstr. 2, D-85748 Garching, Germany — [4]Physik Department, TU München, James-Franck-Straße 1, D-85748 Garching, Germany

Recent theory results for the full set of hadronic matrix elements arising in $\bar{B} \to D^{(*)}\ell\bar{\nu}$ decays have triggered our interest. We investigate if and how various pieces of theory information on these hadronic matrix elements fit together. As a consequence, we obtain precise theory predictions for the full angular distribution of these decays in the SM and beyond. Finally, we challenge the experimental data available from the BaBar and Belle collaborations. We discuss the compatibility between our results for $|V_{cb}|$ and the inclusive determination.

T 71.6 Mi 17:15 H11

Clustering of B Decay Kinematic Distributions — •Kilian Lieret[1,3], Thomas Kuhr[1,3], and Jason Aebischer[2,3] — [1]Ludwig-Maximilians-Universität München — [2]Technische Universität München — [3]Excellence Cluster Universe

The phenomenology of New Physics models typically depends on a number of free parameters, sometimes strongly influencing the shape of kinematic distributions. Besides being an obvious challenge when presenting exclusion limits on such models, this also is an issue for analyses that need to make assumptions on kinematic distributions in order to extract features of interest, but still want to publish their results in a very general way.

By clustering the New Physics parameter space based on a metric that quantifies the similarity of the resulting kinematic distributions, a small number of New Physics benchmark points can be chosen in such a way that they can together represent the whole parameter space. Experiments can then report exclusion limits and measurements for these benchmark points without sacrificing generality.

In this talk, such a clustering procedure is carried out with kinematic distributions relevant to semileptonic B decays, in particular in

light of the recent flavor anomalies.

T 71.7 Mi 17:30 H11

New new physics probes with $\Lambda_b \to \Lambda_c(\to \pi\Lambda)\ell\bar{\nu}$ — •Ahmet Kokulu, Danny van Dyk, and Philipp Böer — Technische Universität München, James-Franck-Straße 1, D-85748 Garching, Germany

We calculate the four-differential decay rate for the cascade $\Lambda_b \to \Lambda_c(\to \Lambda\pi)\ell\nu$ for the full set of $b \to c\ell\nu$ operators up to dimension six. Our work extends earlier studies in this respect. We find the cascade to provide complimentary constraints compared to those arising in $B \to D(*)$, $B_c \to \ell\nu$.

T 71.8 Mi 17:45 H11

Testing the standard model with the photon polarization in radiative charm decays — •Nico Adolph, Gudrun Hiller, and Andrey Tayduganov — TU Dortmund, Deutschland

We study the photon polarization in radiative charm decays with an up-down asymmetry in the decays $D^+_{(s)} \to K^+_1(\to K\pi\pi)\gamma$. Angular distributions of the three body decay are used to determine the polarization of the K^+_1 which is correlated to the photon polarization. While the D^+ decay is SM like, the D_s decay is sensitive to BSM physics in the $c \to u\gamma$ coupling, which induces differences in the up-down asymmetries between these two decays, as a signature of new physics.

T 71.9 Mi 18:00 H11

Flavor physics meets Asymptotic Safety — •Marcel Golz and Gudrun Hiller — TU Dortmund, Theoretische Physik IV

Most common explanations of the recent B-anomalies involve additional massive gauge bosons. In order to assess those models from the theoretical point of view, consistency checks such as anomaly cancellation conditions and perturbativity checks are available but less widely applied.

Asymptotic safety is a concept that was originally developed for quantum gravity in the 1970s and recently put forward for gauge-Yukawa theories, and in the context of the Standard Model and extensions thereof. In such a scenario the energy dependent couplings of a model are running into a non-vanishing fixed point, so that an ultraviolet complete model is achieved.

We consider a fully-fledged model (Alonso et al., **1704.08158**) involving a gauged $SU(3)_{\rm H} \otimes U(1)_{\rm B\text{-}L}$ flavor symmetry, which adresses the current B-anomalies. We point out UV-inconsistencies due to Landau poles below the GUT-scale and show how this can be fixed within asymptotic safety.

We confront this extended model to B-anomaly data.

T 71.10 Mi 18:15 H11

A Realistic $U(2)$ Model of Flavor — •Matthias Linster[1] and Robert Ziegler[2] — [1]Institut für Theoretische Teilchenphysik, Karlsruher Institut für Technologie — [2]Theoretical Physics Department, CERN

We propose a simple model based on a $U(2)$ flavor symmetry which is able to describe all mixings in quarks, charged leptons and neutrinos by powers of two small parameters. Comparing with experimental data we obtain predictions for the yet unknown neutrino mass scale. Moreover, we discuss a variant of this model based on a $D_6 \times U(1)$ flavor symmetry that leads to large mixings in the lepton sector due to the small mixings in the quark sector.

T 72: Hauptvorträge V

Zeit: Donnerstag 9:00–10:30 Raum: H01

Hauptvortrag T 72.1 Do 9:00 H01

Next generation high energy e+e- colliders — •Jorg Wenninger — CERN, Geneva, Switzerland

Following the shutdown of the Large Electron Position collider (LEP) at CERN in 2000, design activities for high energy colliders were initially focused on linear colliders with a centre-of-mass energy reach of up to 3 TeV. Two projects, the International Linear Collider (ILC) and CLIC, proceeded with detailed conceptual and technical designs. Since a few years two high energy circular collider projects have emerged, the China Electron Position Collider (CEPC) and the e+e- collider variant of the Future Circular Collider (FCC-ee) at CERN. Both circular colliders have converged on circumferences around 100 km and top centre-of-mass energies ranging between 250 and 360 GeV to reach Higgs boson and top quark pair production thresholds. FCC-ee also focuses on high precision and high statistics measurements of the Z boson resonance. After an introduction to the different projects, this presentation will outline the status and challenges of the circular high energy colliders.

Hauptvortrag T 72.2 Do 9:45 H01

Flavour anomalies — •Johannes Albrecht — Otto-Hahn-Str. 4, 44227 Dortmund

Precision measurements of decays of heavy mesons offer a unique lab to test the Standard Model of particle physics. Heavy, virtual particles in loop processes lead to quantum corrections that are measurable in the precision tests of flavour physics. Using this strategy, hints for postulated new particles can be found. The energy range tested here extends the range reachable in direct searches by about one order of magnitude. Historically, many discoveries in particle physics have first been seen in precision measurements.

The talk will give a status of the current measurements in flavour physics with measurements of the B-factories Babar and Belle and of the LHC experiments ATLAS, CMS and LHCb. A focus of the talk will be on tensions that are currently seen in the LHCb data with respect to the Standard Model and the perspectives to clarify these in the near future.

T 73: Hauptvorträge VI

Zeit: Donnerstag 11:00–12:30 Raum: H01

Hauptvortrag T 73.1 Do 11:00 H01

Timing detectors — •Lucia Masetti — PRISMA+ Cluster of Excellence and Institute for Physics, Johannes Gutenberg University, Mainz, Germany

Traditionally, precise time measurements have been used in particle physics in Time Of Flight (TOF) detectors for particle identification. For the upcoming upgrade of the LHC to high luminosity in 2026, new technologies are being developed to exploit the time information in the assignment of detector signals to the hard scattering process. A very challenging precision of few tenths of picoseconds is needed for this task together with high spatial resolution. On the long term four dimensional tracking and five dimensional calorimetry can be envisaged by adding the time information to each single hit in the detector. In this talk the newest timing detector developments will be presented focusing mostly on the high luminosity LHC, but including also future colliders, as well as applications in medical and astroparticle physics.

Hauptvortrag T 73.2 Do 11:45 H01

Getting to know the Higgs boson — •Sarah Heim — DESY, Hamburg

The Higgs boson was discovered in 2012 by the ATLAS and CMS experiments at the Large Hadron Collider. In the last years both experiments have measured its properties more and more precisely, in particular the couplings to other particles. The goal is to search for deviations from the Standard Model predictions that could be explained with other theories.

T 74: Eingeladene Vorträge V

Zeit: Donnerstag 14:00–15:30 Raum: H02

Eingeladener Vortrag T 74.1 Do 14:00 H02
Upgrade of the ATLAS Pixel Detector — •Matthias Hamer — Physikalisches Institut, University of Bonn

In order to meet the requirements at the High-Luminosity LHC, the ATLAS inner detector will be upgraded to an all silicon tracker, the Inner Tracker ITk, until 2025. The ITk will consist of a five layer pixel detector and a four layer strip detector. Due to the harsh environment at the High-Luminosity LHC, the ITk pixel detector will consist of newly developed front-end electronics and sensors, namely the RD53 chip and thin n-in-p sensors. The dense tracking environment requires a higher granularity compared to the currently used pixel detector, significantly higher data transmission rates and low mass global and local supports. An overview on the resulting challenges for the mechanical design and layout, the powering and data transmission schemes, testing and operation will be given, and the current status of the ongoing developments to meet these challenges will be presented.

Eingeladener Vortrag T 74.2 Do 14:30 H02
Model independent search for new physics — •Saranya Samik Ghosh — Physik Institut III. A., RWTH Aachen University, Germany

Several experimental searches dedicated to searching for new physics beyond the standard model (BSM) have been performed in dedicated experiments as well as general collider experiments such as those at the Large Hadron Collider (LHC). These searches are typically developed around specific BSM predictions, with the investigated final states and kinematic selections being chosen and optimised to have sensitivity to a particular model or a few limited models. These search strategies are limited due to constraints on experimental resources and personpower. The limitations on dedicated search analyses, the sizeable number and variety of proposed BSM physics models, and the large datasets collected by several experiments, in particular by collider experiments including those at the LHC, highlight the importance of developing generalised model independent approaches to search for new physics in the large datasets available for analysis. Furthermore, such model independent searches are potentially sensitive to unforeseen physics phenomena that have not been included in any of the currently theorised models and hence likely to be overlooked by model driven search strategies. This talk will discuss the recent approaches and accomplishments of model independent searches for new physics in collider experiments.

Eingeladener Vortrag T 74.3 Do 15:00 H02
The XENON Dark Matter Project: Latest Results and Future Prospects — •Constanze Hasterok — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

Weakly interacting massive particles (WIMPs) are a very popular explanation for the nature of dark matter. The XENON1T experiment aims for the direct detection of WIMP-nucleon interactions using a dual-phase time projection chamber (TPC) with a liquid xenon target of 3.5 tons. With the data acquired in the two science runs of a total of one tonne year exposure, the experiment could impose the most stringent upper limit on spin-independent WIMP-nucleon cross-sections with $4.1 \cdot 10^{-47}\,\mathrm{cm}^2$ at a mass of $30\,\mathrm{GeV/c}^2$. After an overview on the XENON1T experiment, the talk will focus on the latest results of searches beyond the standard WIMP model. Finally, the detector upgrade XENONnT will be presented.

T 75: Eingeladene Vorträge VI

Zeit: Donnerstag 14:00–15:30 Raum: H03

Eingeladener Vortrag T 75.1 Do 14:00 H03
AugerPrime: Pushing the Research Frontier of Ultra-High Energy Cosmic Rays — •Darko Veberic — Karlsruhe Institute of Technology (KIT), Germany — for The Pierre Auger Collaboration

Taking data for more than 15 years and delivering many interesting results, the Pierre Auger Observatory is undergoing a major upgrade. The 1660 water-Cherenkov detectors, composing the 3000 km2 of the surface array, will be instrumented with additional scintillators, radio-detection units, and new faster acquisition electronics, while modifying the fluorescence detector to achieve larger duty cycle. I will present the main features of the design, our (already ongoing) deployment plans, impact of the additional event information on identification of primary cosmic rays, and discuss the goals and potential capabilities of the upgraded Observatory.

Eingeladener Vortrag T 75.2 Do 14:30 H03
Very-high-energy gamma-ray astronomy with the VERITAS observatory — •Elisa Püschel — Deutsches Elektronen-Synchrotron (DESY), Platanenallee 6, D-15738 Zeuthen, Germany

Over the past several decades, very-high-energy gamma rays have proved to be an excellent tool for studying the non-thermal universe, as well as a probe of cosmology and fundamental physics. Recent results will be presented from the VERITAS gamma-ray observatory, an imaging atmospheric-Cherenkov telescope array located in southern Arizona. VERITAS is sensitive to gamma rays from ~85 GeV to several tens of TeV, and has a broad observing program targeting galactic and extragalactic astronomy, multi-messenger and transient observations, and dark matter searches.

Eingeladener Vortrag T 75.3 Do 15:00 H03
Neutrinos from Blazars - what we learned from the TXS0506+056 observations — •Anatoli Fedynitch[1,2], Shan Gao[1], Walter Winter[1], and Martin Pohl[1,3] — [1]DESY, Platanenallee 6, 15738 Zeuthen, Germany — [2]Dept. of Physics, University of Alberta, Edmonton, Alberta, Canada T6G 2E1 — [3]Institute of Physics and Astronomy, University of Potsdam, 14476 Potsdam, Germany

Blazars such as TXS0506+056 are collimated relativistic outflows from active galactic nuclei and among the brightest persistent radiation sources in the universe. The recent detection with the IceCube Observatory of a very-high-energy neutrino from TXS0506+056 in coincidence with a multi-wavelength flare supports the hypothesis that blazars accelerate cosmic rays beyond PeV energies, challenging conventional theoretical models. At the same time, the identification of a neutrino burst from the same source in archival IceCube data challenges most of the existing models and raises concerns about our theoretical understanding of these objects. In this talk I will highlight the relevant blazar models in the context of multi-messenger emission and highlight how the observational cornerstones of the TXS0506+056 discovery constrain their viability and generalization.

T 76: Higgs-Zerfälle in Bosonen

Zeit: Donnerstag 16:00–18:30 Raum: H04

T 76.1 Do 16:00 H04
Projections for Measurements of Higgs Boson Couplings for the High-Luminosity LHC — •Ralf Gugel and Karsten Köneke — Albert-Ludwigs-Universität Freiburg

The European Strategy for Particle Physics Update 2018 - 2020 will shape the future of particle physics not only in Europe, but the world. The sensitivities of the measurements of Higgs boson coupling strengths that are expected to be achieved with the full High-Luminosity LHC program are a vital input to this strategic planning. For this important purpose projections of recent analyses re-

ported by the ATLAS Collaboration using data recorded at $\sqrt{s} = 13$ TeV have been performed estimating the expected sensitivities at $\sqrt{s} = 14$ TeV and an integrated luminosity of 3000 fb^{-1}. In this talk these prospects are shown for combined measurements of Higgs-Boson coupling strengths with an additional focus on the results for the $H \to WW^* \to e\nu\mu\nu$ decay channel.

T 76.2 Do 16:15 H04

Messung des Produktionswirkungsquerschnittes für Higgs-Bosonen in der Vektorbosonfusion im Zerfallskanal $H \to WW^\star$ mit dem ATLAS-Detektor am LHC — Volker Büscher, Frank Fiedler, Sophio Pataria, Christian Schmitt, Natalie Wieseotte und •Marc Geisen — Universität Mainz, Mainz, Deutschland

Die präzise Vermessung aller Kopplungen des Higgs-Bosons ist eine der wichtigsten Aufgaben des Physikprogramms am LHC. Zur Vermessung der Kopplung zwischen Higgs-Boson und schweren Vektorbosonen eignet sich hierbei die Untersuchung von Ereignissen, in denen das Higgs-Boson durch Fusion zweier Vektorbosonen erzeugt wird und in W-Bosonen zerfällt. Wenn leptonische W-Zerfälle betrachtet werden, zeichnet sich der Prozess durch ein gutes Verhältnis von Signal- zu Untergrundereignissen aus. Dies liegt einerseits an Leptonen aus den W-Zerfällen, andererseits an den zwei auftretenden Teilchenjets, die bei der Vektorbosonfusion entstehen.

Die zurückliegende Veröffentlichung des ATLAS-Experiments behandelte einen Datensatz mit einer integrierten Luminosität von 36,1 fb^{-1}. Der gesamte Datensatz der Datennahme von 2015 bis 2018 liefert hingegen circa 150 fb^{-1} bei einer Schwerpunktsenergie von $\sqrt{s} = 13$ TeV und ermöglicht somit eine verbesserte Messung mit bisher unereichter Präzession. Dieser Vortrag wird neue Schwerpunkte der ATLAS-Analyse unter Verwendung einer verbesserten Rekonstruktion des Endzustandes und der über viermal höheren Datenstatistik vorstellen.

T 76.3 Do 16:30 H04

Measurement of the Higgs boson CP quantum number in $\tau\,\tau$ decays — •Andrea Cardini, Elisabetta Gallo, Mareike Meyer, Teresa Lenz, Alexei Raspereza, and Merijn van de Klundert — Deutsches Elektronen-Synchrotron (DESY), Hamburg

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 that analysis is not sensitive to the possibility of a mixing angle between a CP-even and a CP-odd state.

The $H \to \tau\tau$ 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 τ leptons are reconstructed using the decay products in the $\mu\tau_h$ channel and the angle between them is used to estimate the CP mixing angle.

The 2017 data collected by the CMS experiment in proton-proton collisions at the LHC are used to estimate the sensitivity of the CP measurement.

T 76.4 Do 16:45 H04

Messung des Wirkungsquerschnitts der assoziierten Produktion von Higgs-Bosonen mit einem W-Boson im Zerfallskanal $H \to WW \to \ell\nu\ell\nu$ mit dem ATLAS-Detektor — •Natalie Wieseotte, Volker Büscher, Frank Fiedler, Marc Geisen, Sophio Pataraia und Christian Schmitt — Johannes Gutenberg-Universität Mainz

Nach der Entdeckung des Higgs-Bosons am LHC-Beschleuniger konnten Masse und Spin als wesentliche Eigenschaften bereits bestimmt werden. Die nächsten Schritte sind der Nachweis in allen Produktions- und Zerfallskanälen und die Präzisionsmessung der Kopplungen. Eine Messung von Kopplungen des Higgs-Bosons hat das Potential, Erweiterungen des Standardmodells zu testen, und ist deshalb von großem wissenschaftlichen Interesse. Hierfür eignet sich der untersuchte Kanal besonders gut, da das Higgs-Boson sowohl in der Produktion als auch im Zerfall ausschließlich an W-Bosonen koppelt.
Die Signalregion wird nach der Anzahl der Leptonenpaare, die mit einem Z-Boson kompatibel sind, unterteilt. Damit ergeben sich zwei Regionen mit stark unterschiedlicher Untergrundzusammensetzung, in welchen der jeweils dominante Untergrund gezielt unterdrückt werden kann. Dies geschieht unter Anwendung multivariater Methoden, die diese Unterdrückung ohne signifikanten Signalverlust ermöglichen und damit die Sensitivität maximieren.
Der Vortrag stellt die Ergebnisse mit dem bis Ende 2016 bei 13 TeV am ATLAS-Experiment aufgezeichneten Datensatz bei einer integrierten Luminosität von 36.1 fb^{-1} vor.

T 76.5 Do 17:00 H04

Messung der HZZ-Tensor-Kopplung in $pp \to H \to ZZ^* \to 4\ell$ -Zerfällen mit dem ATLAS-Detektor — •Verena Walbrecht, Davide Cieri, 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 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-I-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 Vortag werden die Messungen der Produktions- und Zerfallseigenschaften des Higgs-Bosons im Kanal $pp \to H \to ZZ^* \to 4\ell$ vorgestellt, die im Rahmen einer effektiven Feldtheorie zur Einschränkung der EFT-Parameterwerte sowie zur Suche nach CP-Verletzung im Higgs-Sektor beitragen. Die Messungen basieren auf dem Run-II-Datensatz des ATLAS-Detektors.

T 76.6 Do 17:15 H04

Measurement of CP properties in the gluon fusion production of the Higgs boson with the CMS detector — •Jordy Degens, Günter Flügge, Olena Hlushchenko, Wolfgang Lohmann, Thomas Müller, Dennis Roy, Hale Sert, Achim Stahl, and Alexander Zotz — III. Physikalisches Institut B, RWTH Aachen University

After the discovery of the Higgs boson a measurement of its quantum numbers is of crucial interest. One of the quantum numbers to be measured is the CP state of the Higgs boson. Although recent measurements disfavor a CP odd coupling, a CP odd admixture is not excluded. Measuring a CP odd admixture would result in CP violation in the Higgs sector. In this talk a search for CP odd couplings in the gluon fusion production of the Higgs boson is presented using the correlation of radiated jets. The decay of the Higgs boson into two tau leptons, where the di-tau pair decays semileptonically, is used to select Higgs signal events. A statistical analysis using data collected by the CMS detector in 2017 with an integrated luminosity of 41.5 fb^{-1} is performed.

T 76.7 Do 17:30 H04

Investigation of the CP properties of the Higgs boson in fully hadronic final states of VBF $H \to \tau\tau$ events with the ATLAS detector — •Serhat Ördek, Michel Janus, and Stan Lai — Georg-August-Universität Göttingen

Recent studies at the LHC have confirmed that the Higgs boson couples to τ leptons with a strength compatible with the Standard Model. Based on this, the next step is to measure the properties of its couplings, including whether the Higgs couplings 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 channel $H \to \tau_{\text{had}}\tau_{\text{had}}$ to test whether a CP-odd component is present in the coupling. A measurement of a non-zero value would be an indication of CP-violation in the Higgs sector.

T 76.8 Do 17:45 H04

Background estimation in the context of a Higgs boson CP analysis in the di-tau lepton final state with the CMS experiment — Jordy Degens, Günter Flügge, Olena Hlushchenko, Wolfgang Lohmann, Thomas Müller, Dennis Roy, Hale Sert, Achim Stahl, and •Alexander Zotz — III. Physikalisches Institut B, RWTH Aachen University, D-52056 Aachen

Ever since the observation of the Higgs boson decay to a pair of two 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. Although a pure CP odd Higgs boson is strongly disfavored, a CP violating scenario is still possible. The final state with two tau leptons is one of the best decay channels for this measurement, but the signal events are contaminated by a large amount of irreducible background. Therefore a good understanding of the associated backgrounds and their uncertainties is crucial to obtain the highest sensitivity with the data taken by CMS.
In this talk background estimation methods in the context of a Higgs boson CP analysis with the CMS experiment are presented and their impact on the sensitivity is highlighted.

T 76.9 Do 18:00 H04

Measurement of the $H \to \tau\tau$ coupling exploiting tau lepton decay mode classification in the semi-leptonic final state at ATLAS — •Lara Schildgen, Philip Bechtle, Klaus Desch, Christian Grefe, Michael Hübner, and Peter Wagner — 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 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 recently with a significance exceeding 5σ by ATLAS and CMS.

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 hadronic taus used in ATLAS for Run-2 benefits from an improved tau decay mode classification and higher energy resolution.

The presentation outlines the main aspects of exploiting the tau decay mode classification in the ongoing analysis for 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 76.10 Do 18:15 H04

Search for a pseudoscalar boson produced in decays of the 125 GeV Higgs boson and decaying into τ leptons — Somnath Choudhury[4], Sandra Consuegra Rodríguez[1], Elisabetta Gallo[2], Alexis Kalogeropoulos[3], Teresa Lenz[1], •Danyer Pérez Adán[1], and Alexei Raspereza[1] — [1]DESY, Germany — [2]DESY and University of Hamburg, Germany — [3]Princeton University, USA — [4]Indian Institute of Science, India

Several theories extending the Standard Model (SM) have predicted the existence of additional Higgs bosons. Searches for these extra Higgs bosons have focused primarily on general two Higgs doublet models (2HDM) as well as the minimal supersymmetric standard model, whose Higgs sector corresponds to the 2HDM. However, models where the two Higgs doublets are extended by one additional Higgs singlet complex field (2HD+1S) are consistent with SM measurements and constraints from searches for additional Higgs bosons. The Higgs sector of the 2HD+1S models contains seven physical states, namely three CP-even, two CP-odd and two charged bosons. There exist scenarios where the lightest pseudoscalar boson (a_1) can have a mass in the range $2m_\tau < m_{a_1} < 2m_b$, and this case becomes potentially accessible in the channel $H(125) \to a_1 a_1 \to 4\tau$. This analysis presents a search for pairs of very light pseudoscalar bosons, in the mass range between 4 and 15 GeV, produced in the decay of the 125 GeV Higgs boson, and each decaying to pairs of τ leptons. This search is based on proton-proton collision data collected by the CMS experiment at a centre-of-mass energy of 13 TeV and corresponding to an integrated luminosity of 35.9 fb^{-1}.

T 77: Deep Learning III

Zeit: Donnerstag 16:00–18:15 Raum: H06

T 77.1 Do 16:00 H06

Studies of Energy Reconstruction with Deep Learning at the LHC — •Simon Schnake, Hartmut Stadie, and Peter Schleper — Institut für Experimentalphysik, Uni Hamburg

The higher energies and luminosities in the up coming LHC phases are increasing the requirements on detector and analysis methods. One way to achieve this is to apply deep learning to different areas of the data analysis. The recent developments in the field make it a suitable candidate for exploration. This could significantly increase the accuracy and precision of the experiment. In this talk different approaches of energy reconstruction with deep learning are shown. Also some techniques to tackle distribution problems are presented.

T 77.2 Do 16:15 H06

Deep Learned Calorimetry with the CALICE AHCAL Technological Prototype — •Erik Buhmann and Gregor Kasieczka for the CALICE-D-Collaboration — Universität Hamburg, Institut für Experimentalphysik, Luruper Chaussee 149, 22761 Hamburg

The Analog Hadron Calorimeter (AHCAL) Technological Prototype 2018, developed by the CALICE collaboration for a future linear collider experiment, is a highly granular calorimeter consisting of roughly 22,000 individual scintillator tiles. The prototype underwent test beam in May, June and October 2018 at the SPS. Hit energies and hit times in each individual channel are recorded and can be processed into 3D images of single events. In this study we use Deep Learning algorithms to analyze those images.

Convolutional Neural Nets (CNNs) are used for two separate tasks, for energy reconstruction as well as for particle classification. The training of the neural networks are performed with test beam data as well as using a Monte Carlo simulation. Studies of the energy reconstruction performance with different CNN architectures, preprocessing and data augmentation are presented. A comparison between a cut based approach and the CNN performance for particle classification is discussed.

T 77.3 Do 16:30 H06

A Neural Network Approach to Estimate the Mass of Resonances decaying to $\tau^+\tau^-$ with the ATLAS Detector — •Martin Werres, Philip Bechtle, Klaus Desch, Christian Grefe, Michael Hübner, Lara Schildgen, and Peter Wagner — Physikalisches Institut, Uni Bonn, Deutschland

This study investigates the predictive power of deep neural networks (DNN) in the task of mass reconstruction in ditau events with simulated ATLAS data at the LHC. The ditau mass has a large discriminating power in distinguishing between $Z \to \tau\tau$ and $H \to \tau\tau$ events. A strategy how to design a DNN training environment is presented. The performance is compared to the Missing Mass Calculator tool [arXiv:1012.4686] which is currently used in analyses. The conditions under which a competitive mass reconstruction can be achieved are presented. The influence of the environment of the individual event in the training of the DNN, such as the tau decay mode, the rest of the event, the pileup conditions and other influences on the reconstruction are studied.

T 77.4 Do 16:45 H06

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 in comparison to boosted decision trees on the event reconstruction and selection purity, while studying the impact on the total systematic uncertainty of the top-quark mass.

T 77.5 Do 17:00 H06

A deep learning based search for a heavy CP-even Higgs boson in dileptonic H → WW decays with the CMS experiment — •Peter Fackeldey[1] and Dennis Roy[2] — [1]III. Physikalisches Institut A, RWTH Aachen University — [2]III. Physikalisches Institut B, RWTH Aachen University

A promising model beyond the Standard Model is the Minimal Supersymmetric Standard Model (MSSM), which is commonly parameterized in the Higgs sector by $\tan\beta$ and m_A. As in every 2HDM, five different Higgs bosons are predicted. Especially the decay of the heavy scalar Higgs boson into two W bosons is very sensitive to low values of $\tan\beta$ and m_A. Standard Model background processes are a challenge in this region. These backgrounds are modelled using data driven methods, whose performances heavily rely on the purity of their associated control regions. In the last few years Deep Learning showed remarkable progress and success in high energy physics. We present a multi-class classification strategy with deep neural networks, which increases the purity in the signal regions and in control regions for SM background processes. This strategy minimizes systematic uncertainties and thus improves the limits in an unexplored region of the MSSM parameter space in the search for H → WW.

T 77.6 Do 17:15 H06

ttγ topology training through neural network — •Binish Batool — binish.batool@cern.ch

The study of the process of production of Top Quarks in association with Photon (ttγ) is done as an handle to study the electroweak coupling. It is being studied with full run2 data at the centre of mass of 13 TeV of LHC for higher precision. The usage of advance techniques is being done in this analysis which include the analysis independent approach to distinct the real prompt photon from hadron-fakes and an analysis dependent approach which employs the ttγ topology. This talk will cover the later one. This approach takes the form of neural network (NN) and its architecture is chosen to provide best suppression for signal and background. The ttγ topology for single and the dilepton channel has been implemented in NN in separate mode.

T 77.7 Do 17:30 H06

Trennung von Signal und Untergrund in $t\bar{t}\gamma$-Prozessen durch Nutzung eines neuronalen Netzes in leptonischen Endzuständen bei $\sqrt{s} = 13\,\text{TeV}$ in ATLAS — •Steffen Korn, Thomas Peiffer, Arnulf Quadt, Elizaveta Shabalina, Royer Edson Ticse Torres und Knut Zoch — II Physikalisches Institut, Georg-August-Universität Göttingen

Durch die assoziierte Produktion von Top-Quark-Paaren und Photonen ($t\bar{t}\gamma$) kann die Stärke der elektromagnetischen Kopplung des Top-Quarks an das Photon gemessen werden. Die Messung dieses fundamentalen Parameters des Standard Modells (SM) ermöglicht des Weiteren Einsicht auf Physik jenseits des SM. Evidenz dieses Prozesses wurde zuerst bei CDF am Tevatron mit $\sqrt{s} = 1,96\,\text{TeV}$ erbracht. Die Beobachtung des Prozesses erfolgte am LHC mit $\sqrt{s} = 7$ und $\sqrt{s} = 8\,\text{TeV}$ mit erhöhter Präzision. Aufgrund der ähnlichen Topologie von Untergrund und Signal sowie einem Verhältnis zwischen Untergrund und Signal von ungefähr 1:1 im leptonischen Kanal bieten sich neuronale Netze (NN) zur Separation von Signal und Untergrund an. Die Trennung von Signal und Untergrund im $t\bar{t}\gamma$-Endzustand aus Proton-Proton-Kollisionen aus den Jahren 2015 bis 2018, die mit dem ATLAS-Detektor bei einer Schwerpunktsenergie von 13 TeV gemessen wurden, werden präsentiert. Neuronale Netze werden genutzt, um Signal und Untergrund in unterschiedliche Klassen zu gruppieren. Die Leistungsfähigkeit verschiedener NN-Architekturen und ihr Effekt auf die Ereignisselektion werden vorgestellt.

T 77.8 Do 17:45 H06

A DeepWWTagger for CMS — Paolo Gunnellini, Johannes Haller, Roman Kogler, and •Andrea Malara — Institut für Experimentalphysik, Universität Hamburg

In this talk, we will present an overview for a new tagger that, using deep learning technique and investigating jet-substructure variables as well as sub-particles information, aims for both a high background rejection and a large selection efficiency of boosted Higgs bosons, decaying into two hadronic W bosons. In an environment of increasingly highly-energetic events, and therefore more and more collimated heavy objects, this tagger can help to discriminate jets characterised by a different number of sub-jets.

T 77.9 Do 18:00 H06

Multi-Class Boosted Object Tagger for Reclustered Jets at the ATLAS Experiment — •Elena Freundlich, Olaf Nackenhorst, Johannes Erdmann, and Kevin Kröninger — TU Dortmund, Experimentelle Physik IV

The identification of boosted objects is a key element of many analyses targeting the search for new physics at high energies. At the ATLAS experiment, a multi-class boosted object tagger for reclustered (RC) jets is developed as a novel tool to identify W/Z bosons, H bosons and t quarks unambiguously. A clear advantage of this tagger is the possibility to propagate the systematic uncertainties of small-R jets.

As input, RC jet properties and constituent information are used to train a deep neural network in order to obtain a four-dimensional output and differentiate between boosted objects and multijet events. The performance for each of the three signal classes W/Z, H and t can be adapted according to the needs of an analysis. Different studies about the performance of such a tagger are shown.

T 78: Suche nach Neuen Teilchen IV

Zeit: Donnerstag 16:00–17:50 Raum: H07

Gruppenbericht T 78.1 Do 16:00 H07

Measurement of the muon flux and spectrum for the SHiP experiment — •Stefan Bieschke, Caren Hagner, Daniel Bick, Walter Schmidt-Parzefall, Benedict Kaiser, Joachim Ebert, and Björn Opitz — Universität Hamburg, Institut für Experimentalphysik

SHiP is a proposed general purpose beam dump experiment at CERN's SPS 400 GeV proton beam dedicated to the Search for Hidden Particles. A high intensity proton bunch stopped in a target produces a large number of particles, some of which might have evaded detection due to their very low couplings in prior experiments. Among these, a huge amount of muons is produced, considered background. For SHiP, a low background environment is necessary and an active muon shield is needed. In order to optimize this shield, knowledge of the muon spectrum to expect 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 with a drift tube spectrometer and RPC detector at the H4 beam line. During the three week experiment $\mathcal{O}(5 \times 10^{11})$ p.o.t were collected. The status of the analysis will be presented.

T 78.2 Do 16:20 H07

Statistical methods and issues in sterile neutrino searches — •Birgit Neumair and Matteo Agostini — Technische Universität München, James-Franck-Straße 1, 85748 Garching bei München

In the last years, several neutrino oscillation experiments reported results not compatible within the 3-neutrino model, which hint at the existence of light sterile neutrinos. To test this hypothesis, a large number of short-baseline neutrino oscillation experiments have been constructed, are currently taking data and releasing new results.

In this talk, the statistical issues related to the search for sterile neutrinos are reviewed with focus on short-baseline appearance and disappearance experiments. The sensitivities for limit setting and signal discovery are discussed along with their dependency on the experimental parameters, including the signal rate and the spectral shape. The baseline analysis is built on a profile-likelihood test statistic that extends the unified approach of Feldman and Cousins by introducing nuisance parameters for the signal and background rate. Further, the differences between methods based on a local and global p-value are examined, and the limitations of approaches relying on a Gaussian approximation are explored.

The work is supported by the German Research Foundation (DFG) via the SFB 1258.

T 78.3 Do 16:35 H07

Background estimation for sub-relativistic particle searches

with IceCube — •Jakob Böttcher, Christian Haack, Michael Handt, Timo Stürwald, Christopher Wiebusch, and Simon Zierke for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

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 the usual event duration. 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 for the long time scales that have to be considered. We present an efficient way to generate and parametrize the background by reusing actual data from the detector.

T 78.4 Do 16:50 H07

A Geant4 simulation: The detector response of the SHiP Surrounding Background Tagger — •Eva-Rebecca Dietrich genannt Eisermann for the SHiP LScin SBT-Collaboration — JGU Mainz

The SHiP (Search for Hidden Particles) experiment has been proposed as a general-purpose fixed-target facility for the CERN SPS accelerator in order to look for weakly interacting particles which have a mass below 10 GeV/c^2. It will also be used to search for light dark-matter particles and studies of tau neutrino physics.

400 GeV protons impact on the heavy target which may produce weakly interacting particles that are supposed to decay inside a large vacuum vessel ($\sim$ 50 m). To distinguish between external and internal particle interactions, this vessel will be covered by the Surrounding Background Tagger (SBT).

A prototype module with the same dimensions as a final SBT detector cell was exposed to a test beam at the CERN PS in October 2018. It consisted of a liquid scintillator-filled steel box equipped with Wavelength-shifting Optical Modules and SiPM readout. To study the detector response, the same module was simulated in Geant4, allowing for comparison with the test beam measurements. Furthermore, different geometries can be implemented in the simulation which will be used to optimise the detector design.

This talk will give details on the Geant4 detector simulation and summarise its performance.

T 78.5 Do 17:05 H07

Signatures of sub-relativistic magnetic monopoles in IceCube — •Timo Stürwald, Jakob Böttcher, Christian Haack, Michael Handt, Jöran Stettner, Christopher Wiebusch, and Simon Zierke for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen

The IceCube Neutrino Observatory is a km^3 scale Cherenkov light detector that also searches for signatures of particles beyond the standard model. Sub-relativistic magnetic monopoles may catalyze proton decay via the Rubakov-Callan effect. Icecube can detect the Cherenkov light induced by this process. However, the cross-section for this process is model dependent and ranges over several orders of magnitude. This results in diverse signatures of monopoles, slowly moving through the detector. Thus, it is important to find significant variables that characterize the signal with respect to background. In this talk, we present a new selection method based on machine learning.

T 78.6 Do 17:20 H07

Search for Q-balls with IceCube — •Sarah Pieper for the IceCube-Collaboration — Bergische Universität Wuppertal, Deutschland

Many field theories include nonlinear, nondissipative solutions, which are stabilised by the existence of a Noether charge. These so called non-topological solitons behave like other standard model particles, as they have a finite shape in space and can travel with a constant velocity. Due to their spherical shape, they are also called Q-balls.

All supersymmetric generalisations of the standard model predict the existence of Q-balls. Produced in the early universe, Q-balls are candidates for cold dark matter. Additionally, they could yield an explanation for the baryon asymmetry in the universe.

Since Q-balls, like magnetic monopoles postulated in Grand Unified Theories, can catalyse nucleon decay, they can be detected by neutrino telescopes. Results for flux limits for non-relativistic magnetic monopoles can therefore be reinterpreted as flux limits for Q-balls. A new calculation of flux limits for Q-balls will be performed using IceCube data. The present status of signal simulations for Q-balls in IceCube will be presented.

T 78.7 Do 17:35 H07

Search for low relativistic magnetic monopoles utilizing luminescence light with IceCube* — •Frederik Lauber — Bergische Universität Wuppertal, Gaußstraße 20, 42117 Wuppertal

Magnetic monopoles are hypothetical particles predicted by many Beyond the Standard Model theories. They are carriers of single elementary magnetic charge. This work considers intermediate mass monopoles which have been created shortly after the Big Bang.

While there have been current results in the mild and high relativistic regime ($0.5\,c - 1\,c$), there is no recent search in the low relativistic range ($0.1\,c - 0.5\,c$). This is due to the predominant usage of Cherenkov light as a detection mechanism and the usage of detection media with a Cherenkov threshold above the aforementioned velocity range in current experiments. However, utilizing luminescence light produced by highly ionizing particles such as magnetic monopoles in water and ice, the low relativistic range becomes measurable for current water and ice based neutrino detectors. This has been demonstrated in simulation for IceCube and conservative luminescence light yield.

The current status on the ongoing search in the low relativistic range, utilizing luminescence light as a detection method with IceCube for the first time, is presented. Signal simulation is compared to data and background simulation on different cut levels. Signal and background are separated with a machine learning approach including neural networks and boosted decision trees. ** Gefördert durch die BMBF-Verbundforschung Astroteilchenphysik*

T 79: Dunkle Materie und Kollider II

Zeit: Donnerstag 16:00–18:30 Raum: H09

T 79.1 Do 16:00 H09

Constraining dark matter signal from a combined analysis of VERITAS, MAGIC, HESS, HAWC and Fermi-LAT observations of dwarf spheroidal galaxies — •Chiara Giuri — Deutsches Elektronen-Synchrotron (DESY), D-15738 Zeuthen, Germany

Dwarf spheroidal galaxies (dSphs) are the most dark matter (DM) dominated objects observed so far, indeed they are believed to contain up to $\mathcal{O}(10^3)$ times more mass in dark matter than in visible matter. Moreover, they are very close by (15 - 250 kpc), with an extremely large mass to light ratio and no other known sources of gamma-ray emission. For these reasons, indirect dark matter searches with dSphs as observation targets have been increasingly developed by many different observatories during the past decade. Within the context of the Λ-Cold Dark Matter (ΛCDM) paradigm, a candidate for DM is the so-called weakly interacting massive particle (WIMP), formed in the early Universe, with a mass range between 10 GeV to higher than 10 TeV. Such particles can decay or annihilate into Standard Model particles, including very-high-energy (E>100 GeV) gamma-rays. In this context, we show our progress towards a joint binned likelihood analysis of 11 dwarf spheroidal galaxies by combining VERITAS, MAGIC, HESS, HAWC and Fermi-LAT. Our goal is to improve the limits on the annihiliation cross-section for dark matter particles by combining multiple datasets.

T 79.2 Do 16:15 H09

Auswirkungen der Geschwindigkeits-Modifikation des Dunkle-Materie-Halo-Profils auf die Einfangrate in der Sonne in Bezug auf aktuelle Neutrino-Teleskope — •Leonie Nöthe — TU Dortmund, Deutschland

Eine mögliche Theorie zur Erklärung der Dunklen Materie postuliert WIMPs, für die eine Maxwell-Boltzmann-Verteilung als Geschwindigkeitsverteilung angenommen wird. Kosmologische Simulationen von

numerisch simulierten Halos weisen jedoch auf Abweichungen von dieser Verteilung hin. Um den Effekt zu berücksichtigen, wird die Maxwell-Verteilung mit Hilfe von zusätzlichen Peaks moduliert.

In diesem Vortrag werden die Auswirkungen der Geschwindigkeits-Modifikation auf die Einfangrate der WIMPs in der Sonne und den aus Annihilationen stammenden Neutrinofluss diskutiert. Der auf diese Weise berechnete Neutrinofluss am Standort der Erde kann dann mit den Daten aktueller Neutrino-Teleskope im Hinblick auf eine mögliche Detektion verglichen werden.

T 79.3 Do 16:30 H09

Auswirkung der Geschwindigkeits-Modifikation des Dunkle-Materie-Halo-Profils auf die Einfangrate in der Erde in Bezug auf aktuelle Neutrino Teleskope — •Sophia Suhrcke — TU Dortmund, Deutschland

Die Frage nach der Existenz Dunkler Materie ist bis heute noch ungelöst. Eine Möglichkeit nach Dunkler Materie zu suchen ist dabei die indirekte Detektion von Neutrinos, welche durch Annihilationsprozesse von in der Erde eingefangener Dunkler Materie entstehen.

Der dabei erwartete Neutrinofluss an den Teleskopen ist unter anderem abhängig von der Geschwindigkeitsverteilung des Dunkle-Materie-Halo-Profils, für die mehrere numerische Simulationsexperimente Abweichungen von der allgemeinen Maxwell-Boltzmann-Verteilung berechnet haben. Durch diese Modifikation der Geschwindigkeitsverteilung wird die Einfangrate der Dunkle-Materie-Teilchen in der Erde beeinflusst und somit auch der erwartete Neutrinofluss. In diesem Vortrag wird diskutiert, welchen Einfluss diese Änderungen im Neutrinofluss bei Betrachtung der aktuellen Neutrino Teleskope im Hinblick auf die Möglichkeit der Detektion hervorrufen.

T 79.4 Do 16:45 H09

Halo independent determination of the Dark Matter mass — •Yannick Müller and Thomas Schwetz — Institut für Kernphysik, Karlsruher Institut für Technologie (KIT)

A method for the determination of the mass of dark matter particles independent of any astrophysical parameters is presented. Hypothetical positive signals from two independent direct detection experiments are compared using distribution-free test statistics which neither require distribution fitting, nor data binning. Limitations in case of finite energy resolution as well as additional background sources are discussed. The method can also be generalized to analyze specific models such as the exchange of a light mediator particle.

T 79.5 Do 17:00 H09

Entfaltung in einer Suche nach Dunkler Materie anhand von Mono-Jet-Signaturen am CMS-Detektor — Ulrich Husemann, Michael Wassmer und •Sebastian Wieland — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

Eine große Herausforderung in Suchen nach Dunkler Materie am LHC stellt die Interpretation im Kontext theoretischer Modelle dar. Übliche Suchen werden basierend auf rekonstruierten kinematischen Größen durchgeführt. Aus diesem Grund ist eine präzise Detektorsimulation unerlässlich, wodurch ein direkter Vergleich theoretischer Berechnungen mit gemessenen Daten erschwert wird.

Entfaltung beschreibt eine Methode gemessene Daten um Effekte wie begrenzte Akzeptanz und Effizienz zu korrigieren. Diese Effekte stellen eine besondere Herausforderung dar, da die Anzahl selektierter Ereignisse modifiziert wird. Ein korrekte Handhabung dieser Ereignisse ist daher unerlässlich bei Suchen nach neuer Physik.

In diesem Vortrag wird Entfaltung innerhalb einer Suche nach Dunkler Materie basierend auf einer Mono-Jet-Signatur vorgestellt und direkt in einem theoretischen Model interpretiert.

T 79.6 Do 17:15 H09

Suche nach Dunkler Materie in Assoziation mit einem hochenergetischen Jet unter Verwendung des entfalteten fehlenden Transversalimpulses. — Ulrich Husemann, •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 Jet mit Daten des CMS-Experiments vorgestellt. Diese sogenannte Mono-Jet-Signatur bietet im Vergleich zu anderen Mono-X-Signaturen eine hohe Statistik, enthält jedoch auch große Beiträge durch Untergrundprozesse des Standardmodells. Klassische Analysen nutzen für diese Suche die Verteilung des rekonstruierten fehlenden Transversalimpulses. In dieser Analyse wird, im Gegensatz dazu, die Verteilung des fehlenden Transversalimpulses auf Teilchenebene verwendet. Diese Verteilung wird durch einen Entfaltungsvorgang gewonnen, welcher Akzeptanz- und Effizienzeffekte des Detektors korrigiert. Die Analyse interpretiert die Daten in vereinfachten theoretischen Modellen, welche einen zusätzlichen Mediator und ein zusätzliches Teilchen als Kandidat für Dunkle Materie enthalten. Es werden Ausschlussgrenzen aus der entfaltete Verteilung mit Resultaten der rekonstruierten Verteilung verglichen. Desweiteren wird auf Vorteile der Nutzung entfalteter Verteilungen bei der Kombination mehrerer Analysen in verschiedenen Kanälen oder Experimenten eingegangen.

T 79.7 Do 17:30 H09

Suche nach Dunkler Materie in Mono-Jet Ereignissen mit dem ATLAS-Experiment — •Makoto Teshima, Oliver Kortner, Sandra Kortner, Hubert Kroha und Patrick Rieck — MPI für Physik, München, Deutschland

Astrophysikalische und kosmologische Messungen zeigen die Existenz von nicht-baryonischer Dunkler Materie im Universum. Teilchen der Dunklen Materie könnten in Proton-Proton-Kollisionen am LHC erzeugt werden. Aufgrund von Abstrahlungsprozessen der starken Wechselwirkung werden dabei neben der Dunklen Materie, die nicht mit dem Detektor wechselwirkt, stets auch Hadronen produziert. Dementsprechend werden Ereignisse mit großer fehlender Transversalenergie und mindestens einem Jet mit großem Transversalimpuls untersucht. In dem Vortrag wird die Optimierung der Suche nach Dunkler Materie mit dieser Signatur diskutiert. Dabei wird der vollständige Run-2-Datensatz des ATLAS-Experiments verwendet.

T 79.8 Do 17:45 H09

Suche nach Dunkler Materie in Assoziation mit einem in zwei b-Quarks zerfallendem Higgs-Boson mit den Run-2-Daten des ATLAS-Detektors — •Philipp Gadow, Sandra Kortner, Oliver Kortner, Hubert Kroha, Patrick Rieck und Rainer Röhrig — Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), München

Bei den pp-Kollisionen am Large Hadron Collider können hypothetische Teilchen der Dunklen Materie in Paaren gemeinsam mit Teilchen des Standardmodells erzeugt und so über Signaturen mit fehlendem Transversalimpuls nachgewiesen werden. Dieser Vortrag stellt die Suche nach Dunkler Materie in assoziierter Produktion mit einem in zwei b-Quarks zerfallenden Higgs-Boson vor, basierend auf den Run-2-Daten des ATLAS-Detektors mit einer integrierten Luminosität von $79.8\,\mathrm{fb}^{-1}$. Die Zerfallsprodukte des Higgs-Bosons werden entweder als zwei b-Jets rekonstruiert oder als einzelner Jet mit großem Radiusparameter, der zwei kleinere b-Subjets enthält. Letzteres ist typisch für Ereignisse mit geboostetem Higgs-Boson. Die Herausforderung bei der Rekonstruktion besteht darin, dass in Ereignissen mit stark geboostetem Higgs-Boson die Subjets überlappen, falls diese mit konstantem Radiusparameter rekonstruiert werden. Die in diesem Vortrag vorgestellte Suche verwendet daher die Subjet-Rekonstruktion mit einem impulsabhängigen Radiusparameter, der die räumliche Trennung der Subjets und somit die Sensitivität der Suche wesentlich verbessert. Die Ergebnisse der Suche werden im Rahmen vereinfachter Signalmodelle interpretiert.

T 79.9 Do 18:00 H09

Dark Matter search in association with top quark pair production — •Nicole Stefanov[1,2], Alexander Grohsjean[2], Gerrit Van Onsem[2], Afiq Aizuddin Anuar[1,2], and Christian Schwanenberger[1,2] — [1]Universität Hamburg, Hamburg, Deutschland — [2]DESY, Hamburg, Deutschland

The existence of dark matter (DM) hints to the incompleteness of the standard model (SM). Some models feature an enhanced coupling of DM to heavier SM particles, making searches for its associated production with such particles especially attractive. In this talk a search for DM in association with top quark pair production at the CMS experiment will be presented. Particular attention is given to the kinematic reconstruction of events containing dileptonically decaying top quark pairs. The performance of the correct matching of the b-jets with leptons as well as of the reconstruction of the transverse momentum of the DM mediator will be discussed.

T 79.10 Do 18:15 H09

Estimation of the QCD multi-jet background for a search of Br(H → invisible) in vector boson fusion processes. — •Arthur Linss — DESY, Hamburg, Germany

One of the most important shortcomings of the Standard Model of elementary particle physics is the absence of a Dark Matter (DM) particle candidate. One promising channel for the search for DM at the LHC in context of Higgs portal models provides the Higgs to invisible decay. One of the most sensitive channels is targeting vector boson fusion production, resulting in signatures of missing transverse energy (MET) and two forward jets in different hemispheres of the detector. While the main background for this channel is the decay of a Z boson to two neutrinos, the QCD multi-jet background is also important and must be treated with care. This talk deals with the description and possible improvements of the QCD multi-jet background. The focus will be on the faking of MET by jets via a jet mis-measurement and via a wrong pile-up jet identification.

T 80: Neutrinophysik IV

Zeit: Donnerstag 16:00–18:20 Raum: S06

Gruppenbericht T 80.1 Do 16:00 S06

The Large Enriched Germanium Experiment for Neutrinoless double beta Decay - LEGEND — •Christoph Wiesinger for the LEGEND-Collaboration — Physik-Department, Technische Universität München, James-Franck-Straße, 85748 Garching

Isotopically modified high-purity germanium detectors offer unique properties to search for neutrinoless double beta ($0\nu\beta\beta$) decay. The currently operating ^{76}Ge experiments — GERDA and MAJORANA DEMONSTRATOR — have achieved the lowest background rate in the signal region. The Large Enriched Germanium Experiment for Neutrinoless double beta Decay (LEGEND) is building on these experiences. The combination of an ultra-low background environment with active background rejection techniques will allow an almost background-free exploration of $0\nu\beta\beta$ decay half-lives two orders of magnitude beyond our current reach. In the first phase, 200 kg of ^{76}Ge-enriched germanium will be deployed in the existing GERDA infrastructure at the Laboratori Nazionali del Gran Sasso (LNGS) of INFN. The status of this next-generation $0\nu\beta\beta$ decay project will be presented in the talk.

This work has been supported in part by the German Federal Ministry for Education and Research (BMBF) and the German Research Foundation (DFG) via the SFB1258.

T 80.2 Do 16:20 S06

Status of the TRISTAN project — •Thibaut Houdy for the KATRIN-Collaboration — Max Planck Institute for Physics, Föhringer Ring 6, 80805 München, Germany — Technische Universität München, Arcisstraße 21, 80333 München, Germany

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 with a precision of 200 meV (90% C.L.) after an effective data taking time of three years. It had successfully see Tritium light for the first time in June 2018. The TRISTAN (tritium beta-decay to search for sterile neutrinos) group aims at detecting a 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 keeping a good energy resolution. Therefore, a novel multi-pixel silicon drift detector is being designed which is able to handle rates up to 100 Mcps with an energy resolution of 200 eV (FWHM) at 10 keV. First seven-pixel prototype detectors were successfully characterized and the first 166 pixels is under production. This talk presents the results of these measurement campaigns as well as next steps toward the final detector.

T 80.3 Do 16:35 S06

Analytical Multivariate Studies in the Borexino Solar Neutrino Analysis — Livia Ludhova[1,2], Simone Marcocci[3], •Ömer Penek[1,2], and Alina Vishneva[4] for the Borexino-Collaboration — [1]IKP-2, Forschungszentrum Jülich — [2]III. Physikalisches Institut, RWTH Aachen University — [3]Gran Sasso Science Institute, L'Aquila — [4]Joint Institute for Nuclear Research, Dubna

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 spectral fit of the energy spectrum has been performed for the first time in the whole energy range from 0.19 up to 2.93 MeV. To increase the sensitivity for *pep* and CNO neutrinos, the multivariate fit technique has been developed, which takes into account additional information of the radial and pulse shape distributions of events. The talk shows the analytical multivariate fitting strategy used to obtain the new Borexino results for the ^{7}Be, *pp*, and *pep* rates and the sensitivity of the Borexino detector to measure CNO neutrinos. This talk is presented in the name of the Borexino Collaboration.

T 80.4 Do 16:50 S06

Inner vessel shape reconstruction methods of the Borexino experiment — •Vsevolod Orekhov, Johann Martyn, Michael Nieslony, and Michael Wurm for the Borexino-Collaboration — Institute of Physics, JGU Mainz

Borexino is a large liquid-scintillator experiment located deep underground at the Laboratori Nazionali del Gran Sasso in Italy. The unprecedented levels of radio-purity achieved in Borexino enable the experiment to perform solar neutrino spectroscopy with an energy threshold of ∼0.2 MeV. Borexino has been able to measure all spectral components associated with the solar pp-chain. The active core of the detector consists of about 300 t of pseudocumene doped with 1.5 g per litre of PPO and contained in a spherical nylon inner vessel (R = 4.25m). It is very crucial to know the exact vessel shape of the detector in order to estimate the systematic error of the exposure, check position reconstruction tools for events inside the fiducial volume and perform Monte Carlo simulations. Methods based on ^{210}Bi and ^{14}C events are perfectly matched and are in a very good comparison with the vessel shape obtained after photographing it with CCD cameras. Both of them are presented in this talk.

Borexino is supported by funds of the Deutsche Forschungsgemeinschaft (DFG).

T 80.5 Do 17:05 S06

The OSIRIS pre-detector - A radioactivity monitor for the JUNO liquid scintillator — •Paul Christian Hackspacher and Michael Wurm for the JUNO-Collaboration — Johannes Gutenberg-Universität Mainz

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kt liquid scintillator reactor neutrino experiment currently being built in the Guangdong province in southern China. In order to reliably reconstruct neutrino-induced inverse beta decay events from photomultiplier signals, scintillator purity is imperative. Potential air leaks in the filling and cycling lines or failures of the purification plants are risks that endanger the high radiopurity necessary to obtain clean signals within such a large active target volume. The Online Scintillator Internal Radioactivity Investigation System (OSIRIS) is being developed as a failsafe monitor to assess the quality of the scintillator batches before filling them into the central detector. This presentation will serve as a general introduction to the project concept, design and schedule, with more details on software and hardware shown in their own respective talks. This work is supported by the DFG Research Unit "JUNO".

T 80.6 Do 17:20 S06

Background reduction in the ECHo experiment — •Alexander Göggelmann for the ECHo-Collaboration — Kepler Center for Astro and Particle Physics, Universität Tübingen

The ECHo experiment is designed to determine the effective ν_e-mass by analyzing the endpoint region of the calorimetrically measured ^{163}Ho electron capture spectrum.

To reach sub-eV sensitivity on the effective electron neutrino mass the identification and reduction of background is extremely important.

We consider three main contributions to the background in the ^{163}Ho spectrum: Intrinsic background due to unresolved pile-up events, events due to radioactive contamination in the detector and detector set-up and events induced by cosmic radiation.

In this contribution we present the strategies developed by the ECHo collaboration in order to reduce the background in the experiment.

In particular we discuss the use of an active muon veto which is installed around the ECHo cryostat to discriminate muon induced events.

In conclusion, we will report on the contribution of muon induced and natural radioactivity background.

T 80.7 Do 17:35 S06

Measurement of low energy electron capture spectra to test the impact of high order processes — •Tobias Schmitt[1], Christian Enss[1], Andreas Fleischmann[1], Loredana Gastaldo[1], Sebastian Kempf[1], Ulli Koester[2], Federica Mantegazzini[1], and Clemens Velte[1] for the ECHo-Collaboration — [1]Kirchhoff Institute for Physics, Heidelberg University. — [2]Institut Laue-Langevin, Grenoble.

The neutrino mass can be determined by analyzing the shape of the endpoint region of electron capture spectra. The best candidate for this investigation is ^{163}Ho due to its low Q-value. Recent measurements of high statistic ^{163}Ho spectra, performed by the ECHo collaboration, showed, that available theories can not describe the spectral shape. The deviations are in the order of 5 percent of the total spectrum.
The best description of the ^{163}Ho spectrum is nowadays obtained using methods developed for the calculation of core level spectroscopy. To be able to better understand the excitations in which a ^{163}Dy atom can be left after an EC-process occurred in ^{163}Ho, we decided to study the calorimetrically measured EC spectrum of ^{193}Pt. With its relatively low Q-value of 56 keV and the large atomic number it shares two important properties with ^{163}Ho. The analysis of the ^{193}Pt spectrum will allow for testing theories developed for the description of the ^{163}Ho spectrum both in the same energy range as well as for captures from the second shell. We will give a status report on the detector design, ^{193}Pt enclosure and the completed experimental platform we developed with the goal to measure a ^{193}Pt electron capture spectrum.

T 80.8 Do 17:50 S06

Time-Focusing-Time-of-Flight methods for neutrino mass measurements at KATRIN — •Alexander Fulst for the KATRIN-Collaboration — Institut für Kernphysik, WWU Münster

The KArlsruhe TRItium Neutrino (KATRIN) experiment aims at a direct and model independent determination of the electron antineutrino mass with a sensitivity of $0.2\,\mathrm{eV}/c^2$.

In its design configuration the statistical sensitivity of KATRIN will reach $\sigma_{\mathrm{stat}}(m^2_{\nu_e}) = 0.018\,\mathrm{eV}^2/c^4$ after 3 years of measurement time. Investigations have shown that the sensitivity can be improved by up to a factor of 5 in the ideal case using Time-of-Flight (ToF) methods. This improvement is possible because the flight time of an electron depends on its kinetic energy, enabling the measurement of a differential spectrum compared to the integrated spectrum measured by a MAC-E filter in standard mode. However, this requires a well known start time of the electrons, which is not easy to acquire. Here, a different method is presented, were electrons are accelerated depending on their arrival time at a dedicated Time-Focusing-Time-of-Flight section. The TFTOF concept is introduced and results of an extended Monte-Carlo study are presented.

This work is supported under BMBF contract number 05A17PM3.

T 80.9 Do 18:05 S06

Reduction of the ^{14}C background in the JUNO experiment — •Philipp Kampmann[1,2], Yaping Cheng[1], Christoph Genster[1,2], Alexandre Göttel[1,2], Livia Ludhova[1,2], Michaela Schever[1,2], Achim Stahl[2], Christopher Wiebusch[2], and Yu Xu[1,2] — [1]IKP-2, Forschungszentrum Jülich — [2]III Physikalisches Institut, RWTH Aachen University

The Jiangmen Underground Neutrino Observatory (JUNO) will be a 20 kt liquid scintillator neutrino detector. Its main goal is the determination of the neutrino mass hierarchy from a precise measurement of the energy spectrum of anti-electron-neutrinos 53 km away from the emitting nuclear reactor cores. To precisely measure the oscillation pattern of the reactor spectrum an unpredecent energy resolution for this kind of detector of 3% at 1 MeV is needed. Pile-up events with background from radioactive decays such as those from ^{14}C can spoil the reconstruction of the neutrino energy. In this talk methods for discriminating pile-up events are presented. These methods are in addition to a simple clusterization algorithm, the utilization of spherical harmonics and a Likelihood-test of the photon hit time informations.

T 81: Supersymmetrie II

Zeit: Donnerstag 16:00–18:30 Raum: S07

T 81.1 Do 16:00 S07

Suche nach Supersymmetrie in Endzuständen mit Photonen und einem Z Boson bei CMS — •Sebastian Wuchterl, Lutz Feld und Johannes Schulz — I. Physikalisches Institut B, RWTH Aachen University

Supersymmetrie ist eines der vielversprechendsten Modelle zur Ergänzung des Standardmodells der Teilchenphysik. In Szenarien, in denen die Symmetriebrechung durch Eichbosonen vermittelt wird (GMSB), werden Endzustände mit Photonen (γ) und Gravitinos ($\tilde{\mathrm{G}}$), hier das leichteste supersymmetrische Teilchen, vorhergesagt, die sich aufgrund der Undetektierbarkeit der Gravitinos in fehlendem transversalem Impuls im Detektor ($\mathrm{p}_{\mathrm{T}}^{\mathrm{miss}}$) niederschlagen. Auch andere Bosonen können im Zerfall des zweitleichtesten Teilchens, dem Neutralino (χ_1^0), entstehen, $\chi_1^0 \to \tilde{\mathrm{G}} + \gamma/\mathrm{Z}$.

Es wird eine Suche präsentiert, die Daten untersucht, die 2016 in Proton-Proton Kollisionen bei einer Schwerpunktsenergie von 13 TeV vom CMS-Detektor aufgezeichnet wurden und einer integrierten Luminosität von $36\mathrm{fb}^{-1}$ entsprechen. In der Analyse werden Endzustände mit einem Photon und zwei Leptonen gleicher Familie und unterschiedlicher elektrischer Ladung selektiert. Die Ergebnisse in dem bisher nicht untersuchten Endzustand werden in GMSB und vereinfachten Modellen interpretiert und Ausschlussgrenzen berechnet.

T 81.2 Do 16:15 S07

Signal Optimisation Strategies for Direct Pair Production of Scalar Tau Leptons with the ATLAS Detector in Run 2 — •Clara Leitgeb, Alexander Mann, and Ferdinand Krieter — Ludwig-Maximilians-Universität München

Supersymmetry is a promising extension of the Standard Model of particle physics. The direct pair production of scalar tau leptons (staus) and their subsequent decay into a tau lepton and the lightest neutralino is searched for with the ATLAS detector at the LHC. Because of the very low expected cross section, a search for this process in the first run of the LHC at 8 TeV center-of-mass energy could hardly reach any sensitivity. But the increased center-of-mass energy of 13 TeV in run 2 results in a higher cross section for this process. Together with the large integrated luminosity of $140\,\mathrm{fb}^{-1}$ this significantly improves the prospects for the detection of stau pairs. Furthermore, the identification of tau leptons has been improved in run 2. However, there is also an increase of the cross sections of some Standard Model background processes. In addition, the trigger selection becomes more difficult due to the higher instantaneous luminosity and pile-up.

In this talk, the search for direct stau production with the full dataset recorded by ATLAS at a center-of-mass energy of 13 TeV will be presented. The main focus will be on the design of optimal signal regions, for which a cut-and-count approach is used in two distinct regions of phase space.

T 81.3 Do 16:30 S07

Search for Supersymmetry in final states with opposite-sign same-flavor lepton pairs, $p_T^{\mathbf{miss}}$, and jets using data taken with the CMS experiment from 2016 to 2018 — Lutz Feld and •Marius Teroerde — I. Physikalisches Institut B, RWTH Aachen, Aachen, Germany

Supersymmetry (SUSY) is an extension of the Standard Model (SM) of particle physics with the potential to solve several problems of modern physics by introducing superpartners of 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.

The presented search is performed on data taken by the CMS detector at the Large Hadron Collider at $\sqrt{s} = 13\,\mathrm{TeV}$ in the years 2016 to 2018, amounting to an integrated luminosity of $140\,\mathrm{fb}^{-1}$.

T 81.4 Do 16:45 S07

Suche nach Topsquarkpaarproduktion in Endzuständen mit einem Lepton am ATLAS-Experiment — •Julian Wollrath

und Frederik Rühr — Physikalisches Institut, ALU Freiburg

Mit dem ATLAS-Experiment wurden bei einer Schwerpunktsenergie von $\sqrt{s} = 13\,\text{TeV}$ $140\,\text{fb}^{-1}$ an Daten aufgenommen. Dieser Vortrag berichtet über die Suche nach Topsquarkpaarproduktion in Endzuständen mit einem Lepton in diesem Datensatz, und die zu erwartenden Verbesserungen gegenüber der schon bestehenden Suche mit $36\,\text{fb}^{-1}$ an Daten durch Entwicklung neuer sensitiver Variablen. Dabei wird angenommen, dass ein hundertprozentiges Verzweigungsverhältniss von $\tilde{t}_1 \to t^{(*)}\tilde{\chi}_1^0$ besteht und dass $m(\tilde{t}_1) \approx m(t) + m(\tilde{\chi}_1^0)$ gilt.

T 81.5 Do 17:00 S07

Searches for New Physics at the CMS Experiment Using Advanced Techniques for Lepton Reconstruction — Samuel Bein, Viktor Kutzner, Yuval Nissan, Peter Schleper, and •Alexandra Tews — Universität Hamburg, Deutschland

A variety of supersymmetric extensions of the Standard Model lead to low-mass Higgsinos with compressed mass spectra. Searches for SUSY in events with two low-momentum opposite-sign leptons as well as searches for disappearing tracks are particularly sensitive to such SUSY models.

A new data-driven method to determine lepton track reconstruction efficiencies in CMS is presented. This method is used in searches for disappearing tracks, which target compressed Higgsino models with mass differences among the Higgsinos of order of $1.4 - 10$ GeV.

In addition, we consider the case of the production of Higgsino-like electroweakinos, e.g. $\chi_1^\pm, \chi_2^0$, where 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 if the mass spectrum of the SUSY particles is extremely compressed (nearly degenerate). Progress is reported on new methods for reconstructing low-momentum, displaced lepton pairs, which may be key in targeting the compressed, unexplored regions of the model phase space.

T 81.6 Do 17:15 S07

Fake Background Estimation for the Search for Supersymmetry in Multileptonic Final States with the ATLAS Detector — •Marian Rendel, Zinonas Zinonos, and Hubert Kroha — Max Planck Institut für Physik (Werner-Heisenberg-Institut)

The search for supersymmetry (SUSY) is a major part of the ATLAS physics program. Due to the low Standard Model (SM) background, the search for final states with four or more charged leptons provides excellent sensitivity to various supersymmetric scenarios. Nevertheless, several SM processes lead to signatures resembling SUSY signals with four reconstructed charged leptons, including real and fake lepton contributions. In contrast to real leptons, fake leptons are non-prompt or non-isolated and originate from semileptonic hadron decays or are due to misidentification of particles or jets. Therefore, the background can be classified into two categories: The irreducible background, from processes with four or more real leptons, and the reducible background with at least one fake lepton. In this talk the methods for estimating the reducible background is discussed.

T 81.7 Do 17:30 S07

A run-II CMS pMSSM interpretation — Samuel Bein, •Malte Mrowietz, Peter Schleper, and Jorine Sonneveld — Institut für Experimentalphysik, Universität Hamburg

Constraints on new physics from collider searches are usually presented in terms of so-called simplified models. However, because simplified models only consider a very small number of degrees of freedom of a more complete fundamental extension of the standard model, they are likely to provide an incomplete picture. To evaluate the impact of new physics searches more broadly, interpretations are made in terms of full models like the phenomenological Minimal Supersymmetric Standard Model (pMSSM). An integral part of such an analysis is a scan of the parameter space. In this talk, results from previous pMSSM scans are reviewed and a new parameter scan is presented as the basis of a run II pMSSM interpretation by the CMS experiment.

T 81.8 Do 17:45 S07

Search for squarks and gluinos in final states with jets and missing transverse momentum with the ATLAS detector — •Veronika Magerl — Albert-Ludwigs-Universität Freiburg

Many extensions of the Standard Model (SM) include heavy coloured particles, such as the squarks and gluinos of supersymmetric (SUSY) theories, which could be accessible at the Large Hadron Collider (LHC) and detected by ATLAS. A large number of R-parity-conserving models predict squarks and gluinos produced in pairs and decaying either directly or in cascades to quarks, neutralinos and eventually leptons.

The neutralino $\tilde{\chi}_1^0$ is assumed to be the Lightest Supersymmetric Particle (LSP) which escapes undetected, resulting in large missing transverse momentum which, in addition to the jets originating from the quark fragmentation, form the final states investigated in the 0-Lepton SUSY analysis. In order to distinguish these signatures from the SM background it is crucial to have a good estimation of the SM processes resulting in the same final states.

This talk presents the latest results of the ATLAS 0-Lepton SUSY analysis focusing on the techniques of background estimation.

T 81.9 Do 18:00 S07

Search for Higgsino production in SUSY scenarios with a compressed mass spectrum — •Yuval Nissan[1], Peter Schleper[1], Gudrid Moortgat-Pick[2], and Sam Bein[1] — [1]University of Hamburg — [2]DESY

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 employed in the event- and object-level selection, and their performance is studied.

T 81.10 Do 18:15 S07

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], Alexandra Tews[1], Peter Schleper[1], Sezen Sekmen[3], Akshansh Singh[2], Jory Sonneveld[1], Georg Steinbrück[1], and Benedikt Vormwald[1] — [1]Institut für Experimentalphysik, Universität Hamburg — [2]DESY — [3]Kyungpook National University

Long-lived charginos are predicted in theories with a small mass splitting between the two lightest particles, such as anomaly-mediated supersymmetry breaking (AMSB). Here, the two lightest particles are typically 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. The search includes short disappearing tracks with only a few hits in the tracking detector, as well as events with several jets and disappearing tracks. Events with b-quark jets are investigated as well to account for gluino-/squark-associated chargino production. Disappearing tracks are identified using a boosted decision tree, and 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 82: B-Tagging

Zeit: Donnerstag 16:00–18:30 Raum: S09

T 82.1 Do 16:00 S09

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

A crucial part of the LHCb physics programm is the indirect search for new physics. In this context, precision measurements of *CP* violation in neutral B mesons are performed. For such measurements the initial B flavour has to be known. At LHCb this is estimated by various algorithms in the so called flavour tagging.

The LHCb flavour tagging is challenged by the upcoming running conditions at LHC run III. As the mistag rate increases with a higher number of proton interactions per event, the flavour tagging performance is expected to decrease. One approach to preserve and to improve the flavour tagging performance is the development of new algorithms. In this talk the latest flavour tagging developments, like the development of the SS$K^{*0}(892)$ flavour tagging algorithm, will be presented.

T 82.2 Do 16:15 S09

Overview of b-tagging and its calibration in the ATLAS collaboration — •Matthieu Robin — DESY-Zeuthen, Germany

Flavour tagging is used to discriminate different flavours in jets. So called b-taggers are important tools for the identification of *bottom* quark jets (e.g.: Higgs measurements and SUSY searches).

These algorithms calculate a single discriminating variable based on B-hadron specific properties using a combination of different algorithms. This allows to estimate how likely a jet is to include a b-quark.

Discrepancies are observed between the Monte Carlo simulations and the data due to mismodelling. Therefore a calibration of the b-tagging algorithm is performed applying scale factors on the simulations. This ensures that the b-tagging response in Monte Carlo simulations agrees with the response in data. The algorithm output is used applying a fixed cut or in a binned distribution (5 bins). Several methods are performed for the calibrations of the b-tagging efficiency and the mistag rate of *light* and *charm* jets.

The aim is to present how the calibration scale factors are extracted from template fits to the data and made available for common ATLAS analysers in a dedicated format.

T 82.3 Do 16:30 S09

Multivariate classification of charged particle tracks for an improved b-tagging performance with the ATLAS detector — •Maximilian Klinke, Dominik Duda, Oliver Kortner, and Sandra Kortner — Max Planck Institut für Physik

The identification of jets containing b-hadrons, called b-tagging, is a key element for many precision measurements and searches for new physics. Heavy flavour tagging algorithms used in ATLAS are based on modern machine learning techniques that exploit characteristic features of tracks and displaced (secondary) vertices to distinguish b-hadron jets from c-hadron or light-flavour jets.

In particular, the ability to reconstruct secondary vertices dominates the performance of flavour tagging algorithms. However, for high transverse momenta, above 400 GeV, the efficiency to reconstruct a secondary vertex starts to decline significantly. One of the reasons for this degradation is the increase of track multiplicity inside a jet for high jet energies, leading to a degradation of vertex finding algorithms. It has been previously shown, that multivariate analysis techniques can be used to reduce the amount of tracks that do not carry any information from the b-hadron decay and thus help to recover the performance of the vertex finding at high p_T. The studies presented in this talk aim for an optimisation of these track classification taggers. In addition, the performance of such a technique and its input quantities are compared for various parton shower generators in order to gain a better understanding of model dependencies.

T 82.4 Do 16:45 S09

Track finding algorithm for the BelleII detector — •Thomas Lueck — LMU, Munich, 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, the data taking with the full detector will start in early 2019. It is foreseen to collect a data sample corresponding to 50 ab^{-1} by 2025.

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 82.5 Do 17:00 S09

Jet Residual Correction at CMS with data collected during 2017 — •Christoph Garbers, Anastasia Karavdina, Jens Multhaup, Arne Reinmers, and Peter Schleper — Institut für Experimentalphysik, Universität Hamburg, Hamburg, Germany

For most CMS analysis precise knowledge of the jet energies is of high importance. This is achieved by calibration of the reconstructed jet energies in different detector parts. The calibration is done with simulation as well as with data. In this talk the relative residual correction with di-jet events for the CMS pp-collision data recorded during 2017 is presented. The preparation of data for the analysis and tools introduced for monitoring of residual corrections are discussed in detail.

T 82.6 Do 17:15 S09

Double-b-tagging calibration in $g \to b\bar{b}$ events with the ATLAS experiment — •Ruth Jacobs, Tatjana Lenz, and Norbert Wermes — Physikalisches Institut, Universität Bonn

In 2018, the ATLAS and CMS collaborations announced the discovery of the Higgs boson decay into two b-quarks with the main contribution from the vector boson associated production mode. To access other production modes, such as gluon gluon fusion, in connection with the $H \to b\bar{b}$ decay, it is useful to consider Higgs bosons with a large transverse momentum, as the relative background contribution is reduced in this kinematic regime. In boosted $H \to b\bar{b}$ decays, the b-quark fragmentation products are reconstructed using a single large-R jet. A Higgs boson identification algorithm ("Higgs tagging") can be used to decide whether a jet originated from a Higgs boson decay, based on the large-R jet properties. One of the main ingredients for Higgs tagging is the determination of the flavour content of the candidate large-R jet. This is achieved by the so-called double-b-tagging method where a b-jet identification ("b-tagging") algorithm is used on two small-R sub-jets associated to the large-R jet. Since b-tagging algorithms are optimized on simulated events only, they must be calibrated in data. In order to calibrate double-b-tagging directly, a data sample of close-by b-jet events is needed. One possibility is to use data events of gluons splitting into b-quark pairs, which are produced abundantly at the LHC. In my talk I will present the strategy and results of the first direct double-b-tagging calibration in $g \to b\bar{b}$ events with the ATLAS experiment using data collected at the LHC in 2015 and 2016.

T 82.7 Do 17:30 S09

Kalibration der Jetenergieskala von anti-k_T Jets mit Radiusparametern von $0,2$ oder $0,6$ am ATLAS-Detektor — •Lars Henkelmann und Oleg Brandt — Kirchhoff-Institut für Physik, Ruprecht-Karls-Universität Heidelberg, Heidelberg, Deutschland

Hadronische Jets sind für eine Vielzahl von Standardmodellmessungen und Suchen nach Neuer Physik am Großen Hadronen-Beschleuniger (LHC) von zentraler Bedeutung. Einige der interessantesten Signaturen können an Präzision gewinnen, wenn andere Radiusparameter R zur Jetrekonstruktion verwendet werden als die Standardwerte von $R = 0,4$ und $R = 1,0$. So geben z.B. $R = 0,2$ anti-k_T Jets die Möglichkeit, Jetstrukturobservablen in Ereignissen mit hadronisch zerfallenden W, Z, oder Higgs-Bosonen, top-Quarks oder hypothetischen neuen Resonanzen, welche hadronisch zerfallen könnten, genauer zu messen.

Dieser Vortrag skizziert einen Überblick über das Kalibrationsverfahren für R = 0, 2, und R = 0, 6 anti-k_T Jets. Besonderes Augenmerk liegt auf den Unterschieden zu bestehenden Kalibrationen für R =

0, 4 Jets. Darüber hinaus werden ausgewählte Details der Kalibration angesprochen: die Monte-Carlo basierte Pile-Up-Residuumskorrektur, die statistische Kombination der verschiedenen Beiträge zur finalen Daten-basierten In-Situ Korrektur, sowie eine Studie des Einflusses zusätzlicher Nachbarjets in Regionen mit hoher Hadronendichte auf die Anwendbarkeit der Kalibration.

T 82.8 Do 17:45 S09

Tau Identification Efficiency Scale Factor Measurement using the $Z \to \tau\tau$ Tag & Probe method at ATLAS — •Lino Gerlach, Michel Janus, and Stan Lai — II. Physikalisches Institut, Georg-August-Universität Göttingen

Tau leptons play an important role in many measurements and searches within and beyond the Standard Model at ATLAS. As these analyses use Monte Carlo generated events for both signal and background processes, scale factors should be determined to correct Monte Carlo predictions of the tau identification efficiency.
We present the precision measurement of these scale factors binned in the number of prongs, the transverse momentum, and the working point of the ID applied to the hadronically decaying tau lepton. To obtain a high purity sample of hadronically decaying tau leptons, a muon from a leptonically decaying tau lepton is used to tag $Z \to \tau_{\text{lep}}\tau_{\text{had}}$ events, and the hadronically decaying tau lepton is then used to measure the identification efficiency and determine the corresponding scale factors.

T 82.9 Do 18:00 S09

Energy Reconstruction with Software Compensation Techniques in a highly granular Scintillator - Tungsten Hadronic Calorimeter — •Christian Winter and Frank Simon for the CALICE-D-Collaboration — Max-Planck-Institut für Physik, Föhringer Ring 6, 80805 München

The CALICE Collaboration is developing highly granular calorimeters for future high-energy physics experiments. One of the technologies is the Analog Hadron Calorimeter (AHCAL), based on plastic scintillator tiles with SiPM readout. In the context of the multi-TeV e^+e^- collider CLIC, the performance of the AHCAL was studied with Tungsten absorbers. We study the hadronic energy resolution of this prototype with local software compensation techniques, which apply energy-density dependent weights on local energy deposits to improve the energy reconstruction, primarily by correcting for the difference in response to electromagnetic and purely hadronic components of the particle showers. Preliminary results of a study perfomed on pion data from 10 GeV to 80 GeV recorded at the CERN SPS will be presented.

T 82.10 Do 18:15 S09

The Track Classification Tool and the implementation of a new b-tagging algorithm for ATLAS — Carlo A. Gottardo, Sebastian Heer, Vadim Kostyukhin, •Ö. Oğul Öncel, Keshava Prasad, Andrea Sciandra, and Markus Cristinziani — Physikalisches Institut, Universität Bonn

Correctly identifying b-quark initiated jets (b-tagging) at large transverse momentum ($p_{\text{T}} > 1$ 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. The Track Classification Tool (TCT) is a multi-class multivariate discriminator that classifies tracks into one of the following three categories: heavy flavour, fragmentation or hadronic interactions and pile-up.

A newly developed b-tagging algorithm in ATLAS uses the TCT to classify tracks in a jet and based on this information creates a b-tagging score. 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 implementations will be described and comparative performance studies will be presented.

T 83: Top-Physik III

Zeit: Donnerstag 16:00–18:00 Raum: S10

T 83.1 Do 16:00 S10

Messung des Produktionswirkungsquerschnittes von Top-Quark-Paaren im semileptonischen Zerfallskanal am ATLAS-Detektor bei $\sqrt{s} = 13$ TeV — Baida Achkar[1], Tomas Dado[1,2], •Kevin Moor[1], Clara Nellist[1], Thomas Peiffer[1], Arnulf Quadt[1] und Elizaveta Shabalina[1] — [1]II. Physikalisches Institut, Georg-August-Universität Göttingen — [2]Comenius-Universität Bratislava

Das Top-Quark ist das zurzeit schwerste bekannte Elementarteilchen und wird am LHC in Proton-Proton-Kollisionen, überwiegend in Paaren, in großer Zahl produziert. Eine Analyse von ATLAS-Daten bei einer Schwerpunktsenergie von 13 TeV erlaubt eine präzise Messung des Produktionswirkungsquerschnittes. Studien für eine solche Messung im semileptonischen Zerfallskanal werden vorgestellt. Ereignisse mit einem Lepton, mindestens vier Jets und mindestens einem b-Tag werden studiert und verschiedene Signalregionen definiert. Aufgrund der geplanten Nutzung des vollen Datensatzes wird erwartet, dass die Messung durch systematische Unsicherheiten, u.a. die Modellierung von Top-Quark-Paar-Produktion, limitiert sein wird. Es wird versucht, Variablen mit ausreichend guter Modellierung aber gleichzeitig auch genügend großer Trennkraft zwischen Signal und Untergrund auszuwählen. Diese Variablen werden für das Trainieren eines künstlichen neuronalen Netzwerkes verwendet, dessen Ausgabe in einem Likelihood-Fit für die Extraktion des Wirkungsquerschnittes genutzt werden kann.

T 83.2 Do 16:15 S10

Measurement of the top quark mass in the all-jets final state at $\sqrt{s} = 13$ TeV and combination with the lepton+jets channel — Christoph Garbers, •Johannes Lange, Peter Schleper, and Hartmut Stadie — Institut für Experimentalphysik, Universität Hamburg

The top quark mass m_{t} is measured using $35.9\,\text{fb}^{-1}$ of proton-proton collision data collected with the CMS experiment at the LHC at $\sqrt{s} = 13$ TeV. The $\text{t}\bar{\text{t}}$ all-jets final state is used, i.e., events consisting of at least six jets are selected. The full $\text{t}\bar{\text{t}}$ system is reconstructed using a kinematic fit, allowing to improve the mass resolution and suppress multijet background. An estimation of the remaining background is performed using data events. Using the ideogram method, m_{t} is extracted, simultaneously constraining an additional jet energy scale factor.

In addition, a combined measurement using the all-jets and lepton+jets final states is presented. The likelihoods for both channels are combined and a simultaneous mass extraction is performed.

Differences in the determination of systematic uncertainties with respect to previous results obtained at $\sqrt{s} = 7$ and 8 TeV are discussed.

T 83.3 Do 16:30 S10

Constraining the color reconnection uncertainty in the top-quark mass measurement — Dominic Hirschbühl, •Shayma Wahdan, and Wolfgang Wagner — Bergische Universität Wuppertal

The color reconnection (CR) modelling uncertainty could become one of the dominant sources of systematic uncertainty in the top mass determination. Ongoing top mass analyses in Run 2 of the LHC use the PYTHIA 8 generator for parton showering and hadronization. This new generator comes with several alternative CR models which should be explored to estimate the CR modelling uncertainty, providing a broader basis for the estimate compared to the PYTHIA 6 generator which was used in Run 1 analyses. An investigation to find the most discriminating observable between these models is presented in $t\bar{t}$ dilepton events. The observable is unfolded to the particle level.

T 83.4 Do 16:45 S10

Measurement of the top quark mass in single top events at the CMS Experiment — T. Aziz[2], R. Karnam[2], M. Kumar[2], •S. Mitra[1], G. Mohanty[2], and T. Müller[1] — [1]Institute for Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT), Germany — [2]TIFR, India

The top quark mass is one of the important parameters of the standard model (SM) of particle physics and is directly related to the stability of the electroweak vacuum. It has the largest contribution among the SM particles to the radiative correction of self-coupling of the Higgs boson. A measurement of the mass of the top quark is done using single top events with the data collected by the CMS experiment at a center-of-mass energy of 13 TeV. The analysis is performed in the leptonic decay channels of the top quark. Events are selected by requiring one energetic, isolated lepton and two hadronic jets within the pseudorapidity (η) range defined by $|\eta| \leq 4.7$, one of which is identified to originate from the hadronization of the bottom quark arising from the top quark decay. The other jet stems from the light flavor quark recoiling against the top quark. A boosted decision tree (BDT) is developed to discriminate signal events from backgrounds. In order to select a signal enriched phase space, a cut on the BDT discriminant is optimized. The top quark mass is determined by performing maximum-likelihood fit simultaneously for the muon and electron final states. The masses of the top quark and antiquark are determined separately, depending on the electric charge of the lepton in the final state, along with their difference.

T 83.5 Do 17:00 S10

Bestimmung der Energie-Asymmetrie im Top-Quark-Paar-System mit einem zusätzlichen Jet mit dem CMS-Experiment — Thorsten Chwalek, Thomas Müller und •Johann Rauser — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

Mit dem aufgenommenen Datensatz von Run II 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 I 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 83.6 Do 17:15 S10

Studies on ttbar charge asymmetry in the photon handle with ATLAS experiment — •Amartya Rej and Ivor Fleck — Universität Siegen, Germany

Tevatron measurements show a 2.2σ deviation from the Standard Model(SM) inclusive $t\bar{t}$ forward-backward asymmetry(A_{FB}), whereas measurements of the $t\bar{t}$ charge asymmetry(A_C) at the LHC exhibit a good consistency with the SM expectations. It is speculated to have an excess at the Tevatron and no excess at the LHC if there is a cancellation of some type. The addition of a final state photon in the top pair production changes this: it can increase the fraction of events from quark annihilation, which increases the asymmetry. For example, $A_C(t\bar{t}\gamma)$ at $\sqrt{s} = 14$ TeV can be found to be -0.035 ± 0.010 at LO calculation. To measure it, $t\bar{t}$ production in association with a photon coming from the production processes is studied with the ATLAS detector at $\sqrt{s} = 13$ TeV with the full Run2 dataset. In the presentation, the MC production, top reconstruction and the analysis strategy will be discussed.

T 83.7 Do 17:30 S10

Measurement of the jet mass distribution in boosted top quark decays at CMS — Johannes Haller, Roman Kogler, and •Dennis Schwarz — Institut für Experimentalphysik, Universität Hamburg

The top quark plays a special role in modern particle physics since it is not only heavily involved in searches for new physics but also offers consistency tests of the standard model, especially by measuring its mass with high precision.

While typical top quark mass measurements at hadron colliders rely on the reconstruction of the decay products as separate objects, this analysis is carried out in the boosted regime where the top quark decay can be reconstructed within one single hadronic jet. Using the XCone jet clustering algorithm, the differential cross section as a function of the jet mass can be measured in pp collisions at the LHC. Furthermore, the cross section can be calculated analytically, offering the possibility to extract a well defined top quark mass without relying on the mass parameter in Monte Carlo simulations.

The measurement is performed in the lepton+jets channel of $t\bar{t}$ using data recorded by the CMS detector in 2016 at a center of mass energy of 13 TeV.

T 83.8 Do 17:45 S10

Measurement of substructure variables in boosted top quark decays at CMS — Johannes Haller, Roman Kogler, and •Jan Skottke — Institut für Experimentalphysik, Universität Hamburg

Highly boosted top quarks play an essential role in various searches for new physics. If they carry high transverse momentum, they decay within a single jet. Highly sensitive substructure variables can be used to discriminate those jets from jets of other processes.

In this talk first studies are presented towards a measurement of substructure variables, such as N-subjettiness using data of pp collisions recorded by the CMS experiment in 2016 at a center of mass energy of 13 TeV. We select highly boosted top quarks in the lepton + jets channel of $t\bar{t}$, which guarantees a good background rejection while maintaining high selection efficiency.

T 84: Outreach-Methoden

Zeit: Donnerstag 16:00–18:05 Raum: S11

Gruppenbericht T 84.1 Do 16:00 S11

KONTAKT-Outreach für Teilchenphysik, Astroteilchenphysik, Hadronen- und Kernphysik unter einem Dach — •Uta Bilow und Michael Kobel für die Netzwerk Teilchenwelt-Kollaboration — TU Dresden, IKTP

Am 1.1.2019 startet das bundesweite Projekt KONTAKT, das Jugendlichen und der interessierten Allgemeinheit die Physik der kleinsten Teilchen näherbringt. Das Vorhaben bündelt die Outreach-Aktivitäten in der Teilchen-, Astroteilchen-, Hadronen- und Kernphysik und baut auf dem Programm von Netzwerk Teilchenwelt (www.teilchenwelt.de) auf. Bei mobilen Projekttagen können Jugendliche und Lehrkräfte die faszinierende Forschung mit Beschleunigern und Teilchendetektoren kennenlernen und eigene Messungen durchführen. Bei Vorträgen, Ausstellungen, etc. stellen Wissenschaftler/innen ihre Forschung einer breiten Öffentlichkeit vor. KONTAKT unterstützt die Outreach-Aktivitäten der Institute, stellt den direkten Zugang zur Öffentlichkeit her und fördert so Dialog zwischen Wissenschaft und Gesellschaft. Nachwuchsgewinung und -förderung für die Forschung ist durch das Fellow-Programm integriert. Im Projekt kooperieren Wissenschaftler/innen von 30 Instituten der Teilchen-, Astroteilchen- und neu auch der Hadronen- und Kernphysik. Außerdem wird bei KONTAKT ein mobiles Ausstellungsmodul zur Teilchenphysik entwickelt, das durch Deutschland touren wird.

Der Vortrag stellt die Angebote des Projekts für Institute sowie Beteiligungs- und Weiterbildungsmöglichkeiten für interessierte Wissenschaftler/innen vor.

T 84.2 Do 16:20 S11

The Webinterface Cosmic@Web. Data analysis of different cosmic particle experiments. — Miriam Goldack, Carolin Schwerdt, and •Michael Walter — Deutsches Elektronen Synchrotron DESY, 15738 Zeuthen

The outreach project Cosmic@Web allows high school and university students to analyze data of different cosmic particle experiments even without a contact to research institutes. Introducing texts give background knowledge, describe the experiments, the parameters to be analyzed and the corresponding physical questions. A tutorial leads beginners through the webinterface. The detailed mode gives advanced users a broad range of analysis and presentation possibilities. At present data sets are available for the following experiments: Trigger-Hodoscope, measurement of the angle dependence (CosMO-mill), life time (LiDO) and velocity of muons (CosMO-muv). Muon detectors and mini neutron monitors installed on the research vessel Polarstern and on the

Antarctic station Neumayer III allow to analyze the activity of the Sun, of cosmic weather and of the dependence on the magnetic field of the Earth. The webinterface is available in German and English and was used in 2018 during the "International Cosmic Day" organized by DESY.

T 84.3 Do 16:35 S11

Vorbereitungsmaterialien für Teilchenphysik-Masterclasses — •Philipp Lindenau und Carolin Diesel für die Netzwerk Teilchenwelt-Kollaboration — Technische Universität Dresden

Seit 2010 ermöglicht es Netzwerk Teilchenwelt, Jugendlichen in ganz Deutschland durch Teilchenphysik-Masterclasses einen Einblick in aktuelle teilchenphysikalische Forschung zu gewinnen. Die Schülerinnen und Schüler werden dabei einen Tag lang selbst zu Forschern und setzen authentische Methoden und Tools ein, um zum Beispiel den Aufbau von Protonen zu untersuchen oder sich auf die Suche nach Higgs-Teilchen zu begeben. Dabei analysieren sie Originaldaten von Großexperimenten wie dem ATLAS-Experiment am LHC. Um das Potenzial eines solchen Projekttages besser ausschöpfen zu können, ist eine fachliche Vorbereitung sinnvoll. Zu diesem Zweck stellt Netzwerk Teilchenwelt verschiedene Materialien bereit. Dazu gehören Informationen zum Aufbau von Großdetektoren, Arbeitsblätter zur Identifikation von Teilchen anhand ihrer Signaturen im Eventdisplay des OPAL-Experiments sowie ein Online-Vorbereitungskurs, durch welchen sich die Jugendlichen selbständig über wesentliche Aspekte des Standardmodells der Teilchenphysik informieren können. Diese Vorbereitungsangebote sollen die Menge der vollständig neuen Begriffe und Konzepte, mit denen die Jugendlichen während einer Masterclass konfrontiert werden, reduzieren und somit eine tiefere und nachhaltigere Auseinandersetzung mit den aufgeworfenen Forschungsfragen ermöglichen.

T 84.4 Do 16:50 S11

Physik-Projekt-Tage - Gleichstellung in der Physik an Hand eines Workshop nur für Schülerinnen — •Anna Benecke[1], Jochen Wilms[2], Franko Greiner[2], Dietmar Block[2], Melanie Eich[1], Andreas Hinzmann[1], Gregor Kasieczka[1] und Roman Kogler[1] — [1]Universität Hamburg — [2]Christian-Albrecht Universität zu Kiel

Das Gleichstellungsarbeit besonders in der Physik ein wichtiges Thema ist, zeigt nicht zuletzt die Anzahl von Studentinnen unter den Studienanfängern in den 1- Fach Physikstudiengängen. In Kiel fangen nur etwa 15% Physikstudentinnen an. 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 eine viertägiger Workshop nur für Schülerinnen ins Leben gerufen. Die Teilnehmerinnen haben die Möglichkeit, zu Schuljahresbeginn in einem Projekt ihrer Wahl zu experimentieren, ihr Interesse an Physik zu steigern und Netzwerke über Schulgrenzen hinweg aufzubauen. Zur Qualitätssicherung und Weiterentwicklung dieser Veranstaltung werden die PPT von einer kritischen Evaluation begleitet. Mit einer Basisumfrage an 10 Schulen in Schleswig-Holstein wurde ermittelt, ob und wie die PPT an Schulen für diese Thematik sensibilisieren können. Das Konzept der PPT, Inhalte und ausgesuchte Ergebnisse der Evaluation werden vorgestellt. Die PPT fanden 2018 zum vierten Mal statt in Kiel und zum ersten Mal and der Universität Hamburg. Seit 2015 ist das Projekt im Instrumentenkasten der DFG.

T 84.5 Do 17:05 S11

Entwicklung eines Wasser-Cherenkov-Detektors mit SiPM Auslese für Schülerpraktika — •Katrin Link, David Schwer, Günter Quast, Andreas Haungs, Thomas Huber und Anja Schmidt — Karlsruher Institut für Technologie

Es gibt bereits etablierte Show-Case-Experimente zur Messung kosmischer Muonen mit Thermoskannen welche mit PMTs ausgelesen werden, z.B. die von Netzwerk Teilchenwelt bereit gestellte Kamiokannen. Mit Unterstützung des SENSE Projektes wurde am KIT nun eine neue Auslese für solche Detektoren, basierend auf SiPMs, entwickelt. Die Nutzung von SiPMs hat mehrere Vorteile: Der wichtigste Aspekt für den Umgang mit Schülern ist, das SiPMs im Gegensatz zu PMTs nicht mit Hochspannung betrieben werden müssen. Außerdem sind sie insgesamt deutlich robuster und unempfindlicher. Um das im Wasser entstehende Cherenkov-Licht zum SiPM zu leiten wurden wellenlängenschiebende Fasern verwendet. Diese wurden in verschiedenen Konfigurationen in der Kanne angebracht und getestet. Für diese erste Version der Kanne wurde eine ursprünglich für IceCube entwickelte Ausleseelektronik mit SiPM verwendet. Das verstärkte SiPM Signal wurde dann mit einem Picoscope aufgenommen und mit der picoCosmo-Software verarbeitet. Erste Messungen haben gezeigt, das mit diesem Aufbau kosmische Muonen gemessen werden können. Weitere Untersuchungen, auch um die Elektronik zu vereinfachen, sind in Planung.

T 84.6 Do 17:20 S11

Wie kann man in der Schule die mittlere Lebensdauer des Myons bestimmen? — •Thomas Hildebrand, Ulrich Blum und Barbara Valeriani-Kaminski für die Netzwerk Teilchenwelt-Kollaboration — Physikalisches Institut der Universität Bonn

In diesem Beitrag wird ein alternativer Ansatz zur Messung der mittleren Lebensdauer des Myons in der Schule vorgestellt. Experimentelle Daten aus dem Nachweis von Zerfällen kosmischer Myonen wurden aufgenommen und zusammen mit begleitenden Unterrichtsmaterialien online gestellt, damit an jeder Schule die Bestimmung der mittleren Lebensdauer unabhängig von örtlichen Gegebenheiten durchgeführt werden kann. Für die Datennahme wurde ein an der Universität Bonn entwickeltes Experiment verwendet, das auf dem bekannten Experiment Myonenkanne basiert, aber eine statistische relevante Messung der mittleren Lebensdauer innerhalb eines Tages ermöglicht und Oszilloskopbilder von Myonenzerfällen liefert. Diese neuen Möglichkeiten werden auf der Onlineplattform https://www.cosmics4school.physik.uni-bonn.de/ präsentiert.

T 84.7 Do 17:35 S11

Einsatz von Blasenkammerbildern in der Schule auf grundlegendem Anforderungsniveau — •Rebecca Liebschner für die Netzwerk Teilchenwelt-Kollaboration — Laborschule Dresden

Seit Mitte des 20. Jahrhunderts entwickelt sich das Gebiet der Teilchenphysik zu einem großen Forschungsbereich der modernen Physik. Einen Meilenstein in diesem Fachbereich bildete die Erfindung der Blasenkammer durch Donald A. Glaser im Jahre 1952. Durch die visuelle Auswertung der Blasenkammerbilder können direkt Rückschlüsse auf die Eigenschaften der Teilchen gezogen werden. Im Rahmen einer Masterarbeit sind Unterrichtsmaterialien entstanden, welche die Auswertung solcher Blasenkammeraufnahmen thematisieren. Die Aufnahmen wurden so aufbereitet, dass zum einen digitale Arbeitsblätter in GeoGebra und ergänzend analoge Arbeitsblätter zur Verfügung stehen. Die digitalen Arbeitsblätter bieten eine automatische Feedbackfunktion und stellen eine Hilfefunktion zur Verfügung.

Auf der Grundlage dieser Materialien ist es möglich, den Schülern einen Einblick in den Aufbau, die Funktionsweise und die Auswertung von Aufnahmen einer Blasenkammer zu geben. Durch die Auswertung der Blasenkammeraufnahmen gewinnen die Schülerinnen und Schüler neue Erkenntnisse im Bereich der Teilchenphysik und wenden bekannte Konzepte auf dieses Fachgebiet an. In diesem Vortrag werden die Materialien für den Einsatz von Blasenkammerbildern auf grundlegendem Anforderungsniveau und das zugrunde liegende didaktische Konzept vorgestellt.

T 84.8 Do 17:50 S11

Einsatz von Blasenkammerbildern in der Schule auf erhöhtem Anforderungsniveau — •Floria Naumann für die Netzwerk Teilchenwelt-Kollaboration — Gymnasium Bürgerwiese Dresden

Seit Mitte des 20. Jahrhunderts entwickelt sich das Gebiet der Teilchenphysik zu einem großen Forschungsbereich der modernen Physik. Einen Meilenstein in diesem Fachbereich bildete die Erfindung der Blasenkammer durch Donald A. Glaser im Jahre 1952. Durch die visuelle Auswertung der Blasenkammerbilder können direkt Rückschlüsse auf die Eigenschaften der Teilchen gezogen werden. Im Rahmen einer Masterarbeit sind Unterrichtsmaterialien entstanden, welche die Auswertung solcher Blasenkammeraufnahmen thematisieren. Die Aufnahmen wurden so aufbereitet, dass zum einen digitale Arbeitsblätter in GeoGebra und ergänzend analoge Arbeitsblätter zur Verfügung stehen. Die digitalen Arbeitsblätter bieten eine automatische Feedbackfunktion und stellen eine Hilfefunktion zur Verfügung.

Die Unterrichtsmaterialien sind für den Einsatz im Leistungskurs Physik in der gymnasialen Oberstufe konzipiert und sollen das Wissen der Lernenden im Bereich der Teilchenphysik über die Diskussion der Photonen und Atombausteine (Elektron, Proton und Neutron) hinaus erweitern. Bereits aus anderen Gebieten der Physik bekannte Konzepte werden durch die Nutzung der Materialien angewendet und auf das Gebiet der Teilchenphysik ausgeweitet. In diesem Vortrag werden die Materialien für den Einsatz von Blasenkammerbildern auf erhöhtem Anforderungsniveau und das zugrunde liegende didaktische Konzept vorgestellt.

T 85: Astroteilchenphysik: Methoden IV

Zeit: Donnerstag 16:00–17:45 Raum: S12

T 85.1 Do 16:00 S12

Performance increase due to new optical modules for IceCube Upgrade — •Wing Yan Ma for the IceCube-Collaboration — DESY, Zeuthen, Germany

The IceCube Neutrino Observatory is a cubic-kilometer Cherenkov detector at the South Pole. The planned upgrade to IceCube's neutrino detection capability relies on the deployment of a denser array of Digital Optical Modules (DOMs) inside the current DeepCore volume. The addition instrumentation will rely on a new generation of DOMs with improve detection efficiency as well as directional resolution for Cherenkov photons. In this talk, the IceCube Upgrade project is outlined and the expected performance increase due to the new generation of DOMs are presented.

T 85.2 Do 16:15 S12

Simulation studies on the thermal properties of the mDOM for the IceCube Upgrade — •Judith Schneider, Gisela Anton, Jonas Reubelt, and Gerrit Wrede for the IceCube-Collaboration — Erlangen Centre for Astroparticle Physics, 91058 Erlangen, Germany

In the framework of a planned upgrade of the IceCube Neutrino Observatory and a next-generation neutrino telescope at the South Pole, new optical modules are being developed, which are expected to significantly increase the detector sensitivity. One of such concepts is the multi-PMT Digital Optical Module (mDOM) which features 24 three-inch PMTs inside a pressure vessel resulting in a homogeneous directional sensitivity. We have implemented the construction of a mDOM with its substantial components and their thermal properties in a COMSOL simulation as well as a heat source reproducing the expected heat input of the mDOM electronics. With the assumption that all heat is conducted away via the pressure vessel, the thermal flux is determined. The results are compared to measurements of the thermal behavior of a mDOM in the climate chamber.

T 85.3 Do 16:30 S12

Event selection studies for the IceCube-Upgrade — •Cristian Jesús Lozano Mariscal and Alexander Kappes for the IceCube-Collaboration — Institüt 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 will significantly enhance IceCube's low-energy neutrino detection capabilities with the goal of performing precision measurements in atmospheric neutrino oscillation, and improve the calibration of the existing IceCube detector in particular also for the reconstruction of astrophysical high-energy neutrinos. In order to achieve these goals, a crucial pre-requisite is to accurately distinguish between neutrinos and atmospheric muons. This study presents initial studies on event selection algorithms and their performance.

T 85.4 Do 16:45 S12

In-situ measurement of the luminescence of IceCube ice* — •Anna Pollmann for the IceCube-Collaboration — Bergische Universität Wuppertal

The IceCube neutrino observatory uses $1\,\mathrm{km}^3$ of the clear, natural ice near the geographic South Pole as an optical detection medium. When charged particles, such as neutrino secondaries, pass through the ice, Cherenkov light is emitted. The light is then recorded by embedded optical modules.

However new kind of signatures, produced by exotic particles, could be detected by using light emission from luminescence. It is induced by highly ionizing particles passing through matter causing the excitation of surrounding atoms and molecules which then emit photons as they return to ground state. This process is highly dependent on the ice structure, impurities, pressure and temperature. Therefore a logging devices was build in order to measure these ice properties in-situ.

For the measurements in the recent Antarctic summer season, a 1.7 km deep and 12.5 cm wide hole is used which was recently drilled near the IceCube site. The small diameter of the hole presents a challenge for the construction of the experiment and the design of the read-out electronics inside the pressure vessels. The details of the experiment as well as available measurement results will be presented.

*Gefördert durch die BMBF-Verbundforschung Astroteilchenphysik.

T 85.5 Do 17:00 S12

Ultra-low energy calibration of the XENON1T detector with an internal ^{37}Ar source — •Christopher Hils for the XENON-Collaboration — Institut für Physik & Exzellenzcluster PRISMA, J. Gutenberg-Universität Mainz, 55099 Mainz, Germany

XENON1T is the first ton-scale dual phase xenon Time Projection Chamber aiming at the direct detection of Dark Matter, which in 2018 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 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 distributed over the whole active volume. In this talk we report on the novel internal calibration isotope ^{37}Ar, produced with high purity by neutron capture in the TRIGA research reactor in Mainz, and introduced in XENON1T in October 2018: this isotope provides two (X-rays and Auger electrons) calibration lines at 2.8 keV and 270 eV that allowed an unprecedented study of the ultra-low energy response of the detector and its detection thresholds. After the calibration, the isotope has been efficiently removed by the XENON1T distillation column originally designed for krypton removal, opening the way for the adoption of this calibration technique in the upcoming XENONnT experiment.

T 85.6 Do 17:15 S12

Radar measurements in glacial ice — •Pia Friend, Alexander Kyriacou, Klaus Helbing, and Uwe Naumann — Bergische Universität Wuppertal, Fachbereich Physik

Some of the icy moons in the outer solar system are most promising potential hosts of extraterrestrial life. To access their water reservoirs, and test it for possible signs of life, a melting probe must navigate through their icy crusts. Therefore, as a part of the DLR funded Enceladus Explorer initiative (EnEx), we aim to develop a radar based positioning system working in ice. Essential for this is the knowledge of the permittivity and the attenuation of radio waves in ice. To evaluate these principles, measurements of radio wave propagation will be performed on an alpine glacier in february 2019. We will melt several boreholes up to 15 m in the glacier and will take radar measurements at different depths, at different distances and at frequencies between 500 MHz and 2 GHz. In this way, we can study dependences of the permitivity on the density of the ice and air mixture at different depths within the glacier. Additionally, from the attenuation, we will further evaluate the frequency range to provide optimal range and distance resolution for in-ice radar sounding. First results will be provided.

T 85.7 Do 17:30 S12

Alexander Kyriacou — •Alexander Kyriacou, Pia Friend, Klaus Helbing, and Uwe Naumann — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal

The sub-surface ocean of Saturn's ice-moon Enceladus is considered one of the most promising and accessible environments in the solar system to search for extra-terrestrial life. Enceladus Explorer (EnEx) is a DLR initiative to test the feasibility of sending a lander to Enceladus' south pole, which would deploy an autonomous melting probe or 'IceMole' that travels through the ice to a near-surface aquifer and perform in-situ tests for microbial life. The success of such a mission depends on accurate radar mapping of the ice interior from orbit, the surface and from within the ice.

The feasibility of using frequency modulated radar at ultra-high frequencies, deployed from the lander and IceMole is under investigation. The visibility range of radar in Enceladus' surface ice is uncertain, requiring better knowledge of the local permittivity. The effects of attenuation, refraction, internal reflections, dispersion, refraction and dust scattering are investigated using ray-tracing based simulations. The results of these simulations are to be compared against measurements of radar transmission through an alpine glacier, conducted in February of 2019. The resulting radar modulations, and the measured local permittivity will be used to train the simulations to predict radar

propagation on Enceladus for given permittivity and attenuation profiles. These insights on radio propogation in ice will also assist in the development of neutrino detection using radio waves.

T 86: Multi-Messenger

Zeit: Donnerstag 16:00–18:30 Raum: S13

T 86.1 Do 16:00 S13

Automatic Neutrino Follow-Up Searches with the Pierre Auger Observatory — •Michael Schimp — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal

The Pierre Auger Observatory is sensitive to ultra-high energy neutrinos (UHE neutrinos; $E_\nu > 0.1$ EeV) due to the discriminability of neutrino-induced air showers from nucleus-induced air showers at high inclinations ($60° < \theta < 95°$), and the Observatory's large acceptance. Its sensitivity to a diffuse UHE neutrino flux is competitive to the sensitivity of other neutrino detectors. Additionally, its field of view, spanning the declination region from $-85°$ to $60°$, is changing throughout the day and its exposure is non-uniform in inclination, meaning that it samples different regions of the sky with much enhanced sensitivity for certain fractions of the day. Therefore, it is very sensitive to transient sources that are in its field of view at the time of increased emission. One example demonstrating this was the follow-up search of the source of GW170817, the first ever observed binary neutron star merger. In this search, the sensitivity of the Pierre Auger Observatory to prompt UHE neutrino emission exceeded the sensitivities of the other instruments by at least an order of magnitude. Also, a procedure to automatically follow up the open public alerts of the current observing run (O3) of the LIGO/Virgo gravitational wave observatories will be shown.

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

T 86.2 Do 16:15 S13

Search for correlations of high-energy neutrinos and ultra-high-energy cosmic rays — •Lisa Schumacher, Christian Haack, Philipp Muth, Saskia Philippen, Rene Reimann, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen

The IceCube Neutrino Observatory has recently found compelling evidence for a particular blazar producing high-energy neutrinos and PeV cosmic rays, however the sources of cosmic rays above several EeV remain unidentified. It is believed that the same environments that accelerate ultra-high-energy cosmic rays (UHECRs) also produce high-energy neutrinos via hadronic interactions of lower-energy cosmic rays. Two out of three joint analyses of the IceCube Neutrino Observatory, the Pierre Auger Observatory and the Telescope Array yielded hints for a possible directional correlation of high-energy neutrinos and UHECRs. These hints however became less significant with more data. Recently, an improved analysis with an approach complementary to the other analyses has been developed. This analysis searches for neutrino point sources in the vicinity of UHECRs with search windows estimated from deflections by galactic magnetic fields. We present this new analysis method and its preliminary results for searching common hadronic sources, additionally including neutrino data measured by ANTARES in order to increase the sensitivity to possible correlations in the Southern Hemisphere.

T 86.3 Do 16:30 S13

The impact of the mass composition of ultra-high-energy cosmic rays on the correlation with high-energy neutrinos — •Philipp Muth, Christian Haack, Saskia Philippen, Rene Reimann, Lisa Schumacher, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen

The search for sources of highly energetic cosmic messengers such as ultra-high-energy cosmic rays (UHECRs) with an energy above several EeV and cosmic neutrinos is an active field of research as these sources have remained unidentified to date. UHECRs and neutrinos are suspected to share common sources, which motivates a multi-messenger approach correlating the data from different experiments. UHECRs, unlike neutrinos, are deflected by magnetic fields depending on their rigidity, and this deflection has to be accounted for when searching for these common sources. While no quantitative consensus on the mass composition of UHECRs at the EeV-range has been reached, assumptions on the resulting rigidities need to be assessed. In this talk, the impact of the UHECR mass composition on a correlation analysis of UHECR and neutrino data will be discussed.

T 86.4 Do 16:45 S13

Follow-Up Search for UHE Photons after Gravitational Wave Events with the Pierre Auger Observatory — Philip Ruehl, •Marcus Niechciol, and Markus Risse — Universität Siegen, Department Physik

With the first detection of a gravitational wave event by the Advanced LIGO detectors in September 2015 a new window to multimessenger astronomy has been opened. The origin of this event has later been identified as the merger of a binary black hole system. Since then, multiple gravitational wave events have been observed from different sources. Possibly, these transient objects could be sources of ultra-high-energy (UHE) cosmic rays. This can be tested by multimessenger observations. Unlike charged particles, neutral messengers like neutrinos and photons carry information about the direction and the time of their production site making them ideal tools for multimessenger astronomy. While in classical scenarios photons can interact with the cosmic microwave background such that a measurable UHE photon fraction would only be expected from nearby sources, a UHE photon detection from a distant source could point towards new physics.
To extend the search window of the Pierre Auger Observatory, in addition to the established neutrino follow-up search now also a photon follow-up is being developed. In this contribution, the first approach towards an UHE photon follow-up search using the surface detector of the Pierre Auger Observatory will be presented.

T 86.5 Do 17:00 S13

Neutrinos und Gravitationswellen aus Verschmelzungen binärer super-massiver Schwarzer Löcher — •Ilja Jaroschewski — Ruhr-Universität Bochum, Bochum, Deutschland

Am 14ten September 2015 detektierte das Laser Interferometer Gravitations-Wellen Observatorium (LIGO) das erste Gravitations-Wellen Signal, GW150914, das aus der Verschmelzung eines binären Schwarzen Lochs entstand. Nachfolgeuntersuchungen konnten keine Koinzidenz-Emission von elektromagnetischen Wellen oder Neutrinos detektieren.

Aus der Nicht-Detektion von Neutrinos haben K. D. de Vries et al. in ihrer Arbeit untersucht, wie viele solcher Verschmelzung detektiert werden müssten, um sie als Quellen des, vom IceCube Neutrino Observatorium gemessenen, diffusen astrophysikalischen Neutrino-Flusses ausschließen zu können. Dazu wurde ein Parameter eingeführt und bestimmt, der das Verhältnis von freigesetzter Energie in Form von Neutrinos zu der in Form von Gravitationswellen beschreibt.

In meiner Master-Arbeit übertrage ich diese Untersuchungen auf Verschmelzungen binärer super-massiver Schwarzer Löcher, die Millionen bis Milliarden größere Massen als unsere Sonne besitzen, und teste, ob solche Ereignisse als Quellen des diffusen Neutrino-Flusses in Betracht kommen oder ausgeschlossen werden können.

T 86.6 Do 17:15 S13

Exploring astrophysical counterparts of high energy neutrino events from IceCube — •Pratush Mallik, Rene Reimann, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen

Multi-messenger astronomy incorporates signals from different cosmic messengers to have a deeper understanding of the properties of an object under consideration, and enhancing the potential to discover new sources. The IceCube Neutrino Observatory has detected spectacular high energy neutrino events. We correlate these high energy neutrino events to known sources from various astronomical catalogs from electromagnetic observations. The talk reports the findings of these studies.

T 86.7 Do 17:30 S13

Gamma-ray counterparts of the IceCube track-type high-energy neutrino events — •Simone Garrappa — DESY Zeuthen

The IceCube neutrino observatory sends public alerts in realtime for the most interesting muon-neutrino track events. Observations performed by the Large Area Telescope (LAT) on board of the Fermi Gamma-ray Space Telescope revealed a flaring gamma-ray blazar, TXS 0506+056, in spatial and temporal coincidence with the neutrino event IceCube-170922A. The presented work searches for further coincidences of high-energy neutrinos with Fermi gamma-ray sources. We find another high-energy neutrino in spatial coincidence with the gamma-ray blazar GB6 J1040+0617. We study this source in detail using 9.6 years of Fermi-LAT data in the 100 MeV - 1 TeV energy range and find that the energetics and the multi-wavelength behavior of the source make it a plausible neutrino source candidate.

T 86.8 Do 17:45 S13

The diffuse gamma-ray excess from the galactic center and its correlation with CO emission — •Iris Gebauer[1], Neeraj Amin[1], Wim de Boer[1], and Peter Biermann[2] — [1]Karlsruhe Institute of Technology, Karlsruhe, Germany — [2]Universität Bonn and University of Alabama

The Fermi-LAT has observed an excess in the diffuse emission from the Galactic center around a few GeV. This excess was previously observed by the EGRET instrument onboard CGRT, but the accurate Fermi-LAT data have triggered significant interest in the origin of the excess. Possible interpretations discussed in the literature are the annihilation or the decay of dark matter, a population of milisecond pulsars and emission from molecular clouds. We have found a correlation with the distribution of molecular clouds, traced by the CO emission line. Assuming that the excess emission indeed originates from molecular clouds we determined the spectrum of this component of gamma radiation from the Fermi-LAT data. The derived spectrum is compatible with a depletion of gamma-ray production within molecular clouds.

T 86.9 Do 18:00 S13

Multi-Messenger emission in Gamma-Ray Bursts — •Annika Rudolph, Jonas Heinze, Anatoli Fedynitch, and Walter Winter — Deutsches Elektronen-Synchrotron (DESY)

Due to the large amounts of energy they release, the extremely luminous transients called Gamma-Ray Bursts (GRBs) are of great interest for high energy astroparticle physics. In the fireball internal shock scenario, particle acceleration occurs in collisions between regions of the jet with different Lorentz factors. Usually, the observed prompt emission is attributed to synchrotron emission from accelerated electrons. However, if cosmic rays (baryons and nuclei of high energies) are contained in the outflow, they will be co-accelerated with electrons and might produce signatures in the electromagnetic spectrum. Besides, their interactions with the present photon fields will lead to the production of secondary neutrinos. In this talk, I will discuss the production of multiple astrophysical messengers within the internal shock scenario, focussing on the constraints on cosmic ray production that come from neutrino and gamma-ray observations.

T 86.10 Do 18:15 S13

Testing the Pierre Auger Observatory starburst galaxy correlation aided anisotropy result with CR Propa simulations. — •Wilson Namasaka, Karl - Heinz Kampert, and Eric Mayotte — Bergische Universität 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 recent study, a correlation between the arrival direction of cosmic rays at energies above 39 EeV and the positions of starburst galaxies was reported by the Pierre Auger Collaboration with a 4.0σ statistical significance when the observed gamma-ray Luminocity used as a proxy for cosmic ray Luminocity. In the study, the predicted cosmic-ray excess maps were created using an angular smearing parameter fit to the observed arrival direction distribution via an optimization scan. In this research, we investigate the viability of this angular smearing using CRPropa simulations to test whether the results of the Pierre Auger Observatory study can be reproduced by the deflections expected due to magnetic fields. Preliminarily, we have selected the five strongest gamma-ray sources in both the Fermi-LAT AGN and the SBG catalogs and match our CR arrival intensity to the 1.4 GHz emmissions Luminosity for each of these sources. Simulations of the flux from these sources including extragalactic and galactic fields will be presented in this talk.*Gefördert durch die BMBF Verbundforschung Astroteilchenphysik(Vorhaben 05A17PX1).

T 87: Gamma-Astronomie II

Zeit: Donnerstag 16:00–18:35 Raum: S14

Gruppenbericht T 87.1 Do 16:00 S14

The CTA Large Scale Telescope Prototype in La Palma — •Martin Will for the CTA-Collaboration — Max-Planck-Institut für Physik, München

The Large Scale Telescope (LST), an Imaging Atmospheric Cherenkov Telescope with a reflective surface of 23 meter diameter and a focal length of 28 meters, is the largest of the several sizes of telescopes that will comprise the Cherenkov Telescope Array (CTA). The large reflective surface allows the LST to extend the energy range set by current IACTs below 30 GeV. It is built mainly of carbon fiber and aluminum, the use of such light weight materials is crucial for very fast repositioning and follow-up of transients.

Currently, the LST prototype is being commissioned on the Canary island of La Palma and about to start its first science run. In this report the first data taken with the LST prototype is presented and the future operation and science goals during commissioning and withing the CTA Observatory are presented.

T 87.2 Do 16:20 S14

A Novel Glass Mirror Design for Imaging Atmospheric Cherenkov Telescopes — •Juliane van Scherpenberg[1], Razmik Mirzoyan[1], Martin Will[1], Markus Garczarczyk[2], and Masahiro Teshima[1] — [1]Max-Planck Institut für Physik, München, Deutschland — [2]DESY Zeuthen, Deutschland

The large dimensions of Imaging Atmospheric Cherenkov Telescopes (IACTs) make it practically unfeasible to protect them from environmental influences. Due to this, the mirrors which are installed on the telescopes are affected by corrosion from wind, dust, and rain. In current mirror technologies the reflective material is covered by a thin quartz layer for protection. However, still a significant decrease in reflectivity can be observed over the timescale of a few years. Additionally, current mirrors are impossible to clean from deposited dust and dirt without damaging their delicate surface, leading to an unstable reflectivity over short timescales. I present a novel glass mirror design which is easily cleaned and very resistant to degradation due to environmental influences. This new technology could provide a stable performance over a period comparable to the lifetime of an IACT. Results of tests which were performed on first prototypes in terms of reflectivity, focusing and stability under exposure to the environment will be presented.

T 87.3 Do 16:35 S14

Developing stacked-analysis methods for γ-ray search in air shower arrays — •Victoria Tokareva[1], Andreas Haungs[1], and Dmitriy Kostunin[2] — [1]Institut für Kernphysik, Karlsruher Institut für Technologie, DE-76021 Karlsruhe, Germany — [2]Deutsches Elektronensynchrotron, D-15738 Zeuthen, Germany

In cosmic ray studies, detection of neutral particles like gammas and neutrinos is especially important since they are not deflected by galactic magnetic fields and thus allow to identify the direction to their sources. At the moment, the search for gamma rays at ultra-high energy (10^{14}–10^{18} eV) is of high interest to identify the PeVatrons.

Satellite experiments allow observation of gamma-rays with energies up to hundreds GeV, while higher energies can only be accessed with ground-based setups. Recently, HAWC announced the registration of several sources with an energy of more than 56 TeV. The Carpet-2 experiment performed a stacked analysis of IceCube neutrino events.

One of the recent KASCADE results in gamma-ray studies is putting a limit on the flow of diffuse gammas which is currently the best limit

in its energy range. The programme of gamma-ray investigations is continued where we are developing methods for stacked-analysis using the KASCADE-Grande archival data as well as data from other experiments like Tunka-133. The talk presents the current status of this work.

T 87.4 Do 16:50 S14

Extending ctapipe image reconstruction using FACT methods — •Lukas Nickel and Maximilian Nöthe — TU Dortmund

The Cherenkov Telescope Array 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. The first CTA telescope, the 23m diameter LST-1, was inaugurated in October 2018 on the northern site in La Palma, Spain.

CTA analyses will be performed using the low-level framework ctapipe which is based on the scientific python stack. The framework is still under active development.

In this contribution, the ongoing work of extending ctapipe with image reconstruction techniques that have been developed for the First G-APD Cherenkov Telescope will be presented.

With this we hope to improve future CTA analyses using the experience in monoscopic reconstrucion gained during the seven years of FACT operation, which will be especially important for the first CTA telescopes.

T 87.5 Do 17:05 S14

FACT - Measuring the Evolution of the Optical Point Spread Function using Muon-Rings — •Laurits Tani — ETH Zürich, Switzerland

In ground-based gamma-ray astronomy, muon events have a distinct feature of casting ring-like images on the sensor plane, thus forming a well known signal class for Cherenkov telescopes. These ring-like images can then be used to deduce the optical point spread function (PSF) which is a highly important measure of the optical quality of the system. In this talk the observed width of a muon ring is used as a measure to infer the PSF. However to have a good estimate for this width, the reconstruction of the ring center and ring radius itself needs to be accurate, so different methods of ring feature extraction were studied. To check the accuracy of the ring reconstruction and correlation between the width of the ring and PSF, a simulation is done. Measuring the evolution of the PSF over time allows to adjust the instrument response function postliminary. Furthermore, no dedicated observations are needed and no human activity is required on site. The best found reconstruction method is applied on FACT data and the plots for accuracy of the ring feature extraction and for PSF vs. time will be presented.

T 87.6 Do 17:20 S14

Photon bunching in starlight with optical telescopes — •Peter Deiml[1], Stefan Funk[1], Gisela Anton[1], Adrian Zink[1], Dmitry Mayshev[1], Thilo Michel[1], Andreas Zmija[1], Katja Gumbert[1], Manami Sasaki[2], Uli Heber[2], Jörn Wilms[2], Simon Kreuzer[2], Joachim von Zanthier[3], Stefan Richter[3], and Sebastian Karl[3] — [1]Erlangen Centre for Astroparticle Physics, Universität Erlangen-Nürnberg, 91058 Erlangen — [2]Dr. Karl Remeis Observatory, Universität Erlangen-Nürnberg, Sternwartstraße 7, 96049 Bamberg — [3]Institut für Optik, Information und Photonik, Universität Erlangen-Nürnberg, 91058 Erlangen

Imaging air Cherenkov telescopes provide excellent opportunities for Hanbury Brown-Twiss intensity interferometry with unprecedented angular resolution. For this purpose, new detector electronics were tested and measurements of temporal photon correlations were carried out in the laboratory and using an optical telescope in the observatory of Bamberg. We will present the experimental setup and will discuss the obtained results regarding sensitivity and backgrounds. Finally, observations of Sirius, Arcturus and Vega are discussed and the temporal intensity correlations are highlighted.

T 87.7 Do 17:35 S14

FACT - Improvement of Background Suppression — •Marvin Beck, Marc Klinger, Fabian Theissen, and Thomas Bretz for the FACT Collaboration-Collaboration — RWTH Aachen, Germany

Imaging Air Cherenkov Telescopes (IACTs) observe extended air showers developing in the atmosphere. The First G-APD Cherenkov Telescope (FACT), located on the Canary Island of La Palma, is dedicated to the long-term monitoring of the brightest TeV blazars and has been operational for over seven years.

The measured events are highly dominated by charged particles (protons and other atomic nuclei), leading to the need to discriminate air showers by their incident particle. The large amount of available data taken from the Crab Nebula under many different conditions, e.g. various zenith angles and ambient light levels, allows to study the performance of classical background suppression methods in depth. This study focuses on the optimization of the currently applied background suppression algorithms and the understanding of their evolution as function of observation conditions.

T 87.8 Do 17:50 S14

FACT - Investigations of Long Term Performance — •Fabian Theissen, Marvin Beck, Marc Klinger, and Thomas Bretz for the FACT Collaboration-Collaboration — RWTH Aachen, Germany

The First G-APD Cherenkov Telescope (FACT) has continuously been monitoring a small sample of known TeV gamma-ray sources over the last seven years reaching up to 93% data taking efficiency.

Measurements of imaging air Cherenkov telescopes are dominated by charged cosmic rays. They hit the Earth with a remarkably stable rate. Therefore, they are a precise measurement of performance variations and changes of the atmosphere and can be used to quantify these variations.

The telescope has observed the Crab Nebula for more than 2000 hours. As the Crab Nebula is known as a standard candle in TeV astronomy, correlation studies of the cosmic ray rate with the photon flux of Crab allow for an efficiency correction. A long term understanding of the changes in the performance of the telescope is required for further analyses like periodicity studies. It also allows for a phenomenological correction of data taken under bad weather conditions.

T 87.9 Do 18:05 S14

Modelling of gamma-ray emission from galactic colliding wind binaries — •Ruslan Konno[1], Stefan Ohm[1], and Jim Hinton[2] — [1]DESY, D-15738 Zeuthen, Germany — [2]Max Planck Institut für Kernphysik, Heidelberg D-69029, Germany

Colliding wind binaries (CWBs) are binary stars with strong stellar winds that form shock regions and as it is known from the CWB Eta Carinae, these shocks can accelerate particles up to gamma-ray energies. This work aims to model CWBs as a gamma-ray source class with a radiative dynamical 3D code. Assuming two shocks and a hadronic interaction picture and by balancing acceleration and energy losses of particles, the model delivers flux predictions. Comparing predicted emission with the measurements made with the Large Area Telescope, the primary instrument on the Fermi Gamma-ray Space Telescope, likeliness of source detection will be tested and upper limits in case of non-detection will be placed. In this talk, the results will be presented and discussed.

T 87.10 Do 18:20 S14

Jet Kinematic Analysis of TeV Radio Galaxies using High-Resolution Radio Images — •Kevin Schmidt, Lena Linhoff, and Simone Mender — TU Dortmund, Experimentelle Physik Vb

In the last years, a new class of TeV emitters has been discovered, the so-called TeV radio galaxies. These are observed under larger viewing angles than blazars, which allows a direct view of their jet's morphologies. As they show features of both blazars and radio galaxies, the observed properties provide strong challenges for existing emission models. Expanding the group of TeV radio galaxies is essential to define their characteristics and learn about the acceleration mechanisms of active galactic nuclei (AGN) in general.

A central feature for the classification of AGN is their viewing angle relative to our line of sight. One opportunity to estimate the viewing angle is to study the jet characteristics using high-resolution radio images obtained by VLBI measurements. In this talk, a framework for jet kinematic analysis is presented using the example of 3C 264, the most recently discovered TeV radio galaxy.

T 88: Flavorphysik III

Zeit: Donnerstag 16:00–18:35 Raum: S15

Gruppenbericht T 88.1 Do 16:00 S15

The Tau Physics Program at Belle II — •Thomas Kraetzschmar for the Belle 2-Collaboration — Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), München, Deutschland

The Belle II experiment at the SuperKEKB collider is a next-generation B factory, with a rich program of Standard Model and Beyond the Standard Model physics. The large database to be collected thanks to the world-record luminosity of the machine will allow measurements with unprecedented precision. 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 it's 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 of the tau physics programme at Belle II, with a particular emphasis on decay modes with significant potential already in the upcoming first physics run.

T 88.2 Do 16:20 S15

Search for the lepton flavour violating decay $B^0 \to \tau^\pm l^\mp$ — •Nathalie Eberlein and Thomas Kuhr — Ludwig-Maximilians-Universität München

An observation of $B^0 \to \tau^\pm l^\mp$ decays with ($l = e/\mu$) would be a clear sign for new physics. The search for this decay is experimentally challenging due to the multiple neutrinos in the final state.

At B factories one can identify the decay by fully reconstructing the other B meson in $e^+e^- \to \Upsilon(4S) \to B\bar{B}$ events.

In my talk I will present studies of $B^0 \to \tau^\pm l^\mp$ decays with Belle 2 Monte Carlo data using the Full Event Intrepreation algorithm for the tagged B.

T 88.3 Do 16:35 S15

Search for the lepton flavour violating decays $B^+ \to K^+e^\pm\mu^\mp$ at the LHCb experiment — Johannes Albrecht, •Gerwin Meier, Titus Mombächer, and Stefanie Reichert — Experimentelle Physik 5, TU Dortmund

Lepton flavour number is conserved in the Standard Model, but this conservation was found violated in neutrino oscillations. The current measurements of R_K and $R_{K^{*0}}$ hint at a violation of lepton flavour universality. Most New Physic models, that explain lepton favour universality violation predict also lepton flavour violation. One of the most promising decay channels to observe lepton flavour violation in B-decays is $B^+ \to K^+e^\pm\mu^\mp$.

In this talk the current status of the search for the lepton flavour violating decays $B^+ \to K^+e^\pm\mu^\mp$ with the LHCb Run 1 data corresponding to 3 fb^{-1} will be presented.

T 88.4 Do 16:50 S15

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 charged 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 LFV 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 88.5 Do 17:05 S15

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

In the Standard Model (SM) of particle physics the coupling of gauge bosons to leptons is independent of their flavour, which is known as lepton flavour universality. Thus, the branching fraction ratios R_h of rare semileptonic B decays, defined as $R_h = \mathcal{B}(B \to h\mu^+\mu^-)/\mathcal{B}(B \to he^+e^-)$, are precisely predicted to be unity in the SM. The most precise measurements of the R_h ratios so far are performed by the LHCb experiment showing deviations of up to 2.6 standard deviations (σ) from the SM prediction. Lepton flavour non-universality would generally imply lepton flavour violation, which could be explained by several theories beyond the SM.
This talk will present the analysis strategy of a search for the lepton flavour violating decay $B_s^0 \to \phi e^\pm\mu^\mp$ with particular focus on the study and control of backgrounds.

T 88.6 Do 17:20 S15

Search for heavy Majorana neutrinos in semileptonic B meson decays at the LHCb experiment — •Leon Carus, Eluned Smith, and Christoph Langenbruch — RWTH Aachen

The origin of neutrino masses is still one of the most puzzling unsolved problems of modern particle physics. The Standard Model (SM) assumes neutrinos to be Dirac fermions. Alternative models trying to explain the observation of neutrino oscillations are including neutrinos that are Majorana fermions, meaning that they are their own anti-particles. A striking experimental signature of Majorana neutrinos would be lepton number violating (LNV) processes, which are forbidden in the Standard Model. A search for LNV B meson decays with two same-sign leptons in the final state could be sensitive to new heavy Majorana neutrinos. The LHCb experiment is an ideal environment for these measurements, due to the large $b\bar{b}$ acceptance, and excellent tracking and particle identification capabilities. This talk presents the current status of the search for the LNV decays $B^+ \to \mu^+\mu^+\pi^-$ and $B_c^+ \to \mu^+\mu^+\pi^-$ using Run 1 and 2 data, which probes different Majorana neutrino lifetimes and masses up to 6 GeV.

T 88.7 Do 17:35 S15

Measurement of the branching ratio of $B_s^0 \to D^{*\pm}D^\mp$ with the LHCb experiment — Philipp Ibis, •Antje Mödden, and Margarete Schellenberg — Experimentelle Physik 5, TU Dortmund

Precision measurements testing the Standard Model are performed at the LHCb experiment, two important goals of which are the observation of new decays and measurements of their branching ratios. Although the decay $B_s^0 \to D^{*\pm}D^\mp$ has not yet been experimentally observed, an excess of $B_s^0 \to D^{*\pm}D^\mp$ candidates has been seen in the measurement of CP violation in the $B^0 \to D^{*\pm}D^\mp$ decay. By measuring the branching ratio relative to the decay $B^0 \to D^{*\pm}D^\mp$, most uncertainties cancel due to the similarity of both decay channels.
The talk will cover the current status of the analysis of the branching ratio of the decay $B_s^0 \to D^{*\pm}D^\mp$ using the full dataset of the LHCb experiment corresponding to an integrated luminosity of 9 fb^{-1}.

T 88.8 Do 17:50 S15

Search for the decay $D_{s0}(2317)^\pm \to D_s^{*\pm}\gamma$ — Johannes Albrecht[1], •Lukas Calefice[1], and Ricardo Vázquez Gómez[2] — [1]Experimentelle Physik 5, TU Dortmund — [2]CERN

The surprising discoveries of the $D_{s0}(2317)^\pm$ and $D_{s1}(2460)^\pm$ mesons by the BaBar and CLEO Collaborations in 2003 aroused new interest in the field of heavy-light meson spectroscopy. Their low masses and decay widths allow for decays that are isospin violating or radiative. Although theoretical predictions claim that radiative decays should be sizeable, they have not been seen yet.

The search for the decay $D_{s0}(2317)^\pm \to D_s^{*\pm}\gamma$ is performed by measuring the ratio $\mathcal{B}(D_{s0}(2317)^\pm \to D_s^{*\pm}\gamma)/\mathcal{B}(D_{s0}(2317)^\pm \to D_s^\pm\pi^0)$ on the full Run II data set recorded by the LHCb experiment. The talk will cover the current status of the analysis.

T 88.9 Do 18:05 S15

Test of lepton flavour universality with $b \to s\ell\ell$ decays at the LHCb experiment — Johannes Albrecht und •Alex Seuthe —

Technische Universität Dortmund

Current measurements of the LHCb experiment hint to deviations from Standard Model predictions in tests of lepton flavour universality. An example for this is the measurement of $R_{K^{*0}}$, the ratio of the branching fractions of the decays $B^0 \to K^{*0}\mu^+\mu^-$ and $B^0 \to K^{*0}e^+e^-$. This measurement was performed with the a dataset corresponding to an integrated luminosity of 3/fb. For conclusive results the measurements have to include the extended LHCb dataset. In this talk the updated measurement of $R_{K^{*0}}$, which is currently under preparation, is presented.

T 88.10 Do 18:20 S15

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 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. First measurements of $b \to s\ell\ell$ ratios published by the LHCb collaboration show tensions with the SM predictions of up to 2.6 standard deviations. Therefore, further studies of lepton universality 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 89: Theorie: Higgs

Zeit: Donnerstag 16:00–18:15 Raum: S16

T 89.1 Do 16:00 S16

Probing the Higgs sector within non-linear Effective Field Theory — •Matteo Capozi — MPI for Physics, Munich, Germany

We discuss the effects of anomalous couplings in the Higgs sector arising in a non-linear Effective Field Theory, combined with full NLO QCD corrections.

We analyze how variations of the anomalous couplings can modify the behavior of total and differential cross sections for processes involving the Higgs boson and how they interplay with the NLO corrections.

T 89.2 Do 16:15 S16

Next-to-next-to-leading order real corrections to Higgs boson pair production in the large top mass limit — Joshua Davies, •Florian Herren, Go Mishima, and Matthias Steinhauser — Institut für Theoretische Teilchenphysik, Karlsruhe Institute of Technology (KIT)

Higgs boson pair production allows to probe the trilinear Higgs self-interaction of the scalar potential of the Standard Model. Whereas at next-to-leading order (NLO) exact results are available one has to rely on approximations at NNLO.

In this talk we will present analytic results for NNLO real corrections in the large top quark mass limit and include several $1/m_t$ terms.

T 89.3 Do 16:30 S16

NLO QCD-Korrekturen zur Higgspaarproduktion via Gluonfusion — Julien Baglio[4], Francisco Campanario[1,3], •Seraina Glaus[1], Margarete Mühlleitner[1], Michael Spira[2] und Juraj Streicher[4] — [1]Institute for Theoretical Physics, Karlsruhe Institute of Technology, D-76128 Karlsruhe, German — [2]Theory Group LTP, Paul Scherrer Institut, CH-5232 Villigen PSI, Switzerland — [3]Theory Division, IFIC, University of Valencia-CSIC, E-46980 Paterna, Valencia, Spain — [4]Institute for Theoretical Physics, Eberhard Karls Universitaet Tuebingen, Auf der Morgenstelle 14, D-72076 Tuebingen, Germany

Die gemessenen Eigenschaften des am LHC entdeckten Higgsbosons lassen im Rahmen der Unsicherheiten die Zuordnungen zu anderen erweiterten Modellen zu. Bei der Bestimmung der Eigenschaften dieses Teilchens spielt die Rekonstruktion des Higgspotentials eine zentrale Rolle, um zu prüfen, ob dieses Teilchen die elektroschwache Symmetriebrechung erzeugt. Dafür muss die Selbstwechselwirkungsstärke zwischen Higgsbosonen direkt bestimmt werden, was für die trilineare Kopplung in der Higgspaaarproduktion möglich ist. Der dominante Prozess ist die loop-induzierte Gluonfusion. Die Methodik zur Berechnung der NLO QCD-Korrekturen mit voller Topmassen-Abhängigkeit im Rahmen des Standardmodells und möglichen Erweiterungen wird vorgestellt. Resultate für den differenziellen und totalen Wirkungsquerschnitt werden gezeigt. Insbesondere werden die Unsicherheiten, induziert durch die verbleibende Schemen- und Skalenabhängigkeit, sowie die PDF+α_s-Unsicherheiten präsentiert.

T 89.4 Do 16:45 S16

Double Higgs boson production at NLO in the high-energy limit — Joshua Davies, Go Mishima, Matthias Steinhauser, and •David Wellmann — Karlsruher Institut für Technologie (KIT), Karlsruhe, Deutschland

Double Higgs boson production via gluon fusion is a loop-induced process. Determining the form factors at next-to-leading order requires the evaluation of massive two-loop Feynman diagrams and involves multiple scales. We tackle this problem in the high-energy limit where we obtain analytic results for both planar and non-planar master integrals and therefore also for the form factors. In this talk, the results and the kinematic region in which they are valid, are discussed and compared against numerical calculations.

T 89.5 Do 17:00 S16

Automatised NLO matching between two scalar sectors — •Martin Gabelmann, Margarete Mühlleitner, and Florian Staub — Karlsruher Institut für Technologie

Null results in searches for new physics at the LHC support the possibility that a large separation between the scale of new physics and the electroweak scale exists. Nevertheless, there are still observables in this scenario, in particular the Higgs mass, that are sensitive to the properties of theories beyond the Standard Model. In order to obtain reliable predictions for a model that involves very heavy degrees of freedom, the precise matching to an effective theory is necessary. I present an extension of the Mathematica package SARAH which is able to perform the matching of the scalar sector between two renormalizable gauge theories at the full one-loop level. In addition to comparisons with known results that concern a Standard Model effective theory, I discuss the matching of a singlet extended Minimal Supersymmetric Standard Model onto a low energy theory with an extended scalar and fermion sector.

T 89.6 Do 17:15 S16

Thermal Goldstone bosons and the calculation of the thermal Higgs potential — •Sinan Zeissner — TU-Dortmund

I discuss an intuitive way of deriving a general form of the effective Higgs potential in the presence of matter and focus in particular on the question if thermal contributions of the Goldstone boson modes have to be taken into account for the calculation.

T 89.7 Do 17:30 S16

Wilson coefficients for Higgs boson production to $\mathcal{O}(\alpha_s^4)$ — •Marvin Gerlach, Florian Herren, and Matthias Steinhauser — Institut für Theoretische Teilchenphysik, Karlsruhe Institute of Technology (KIT), Wolfgang-Gaede Straße 1, 76128 Karlsruhe, Germany

The high luminosity phase at the LHC may reveal new insides to the Higgs boson self coupling. Therefore, the importance of theory predictions is obvious. A comprehensive tool to include QCD corrections in Higgs physics is to use Higgs Effective Field Theory (HEFT), in which the top quark mass m_t is sent to infinity. For this theory we compute the effective couplings of one and two Higgs bosons to gluons to N^{3}LO in QCD in a diagrammatic way. The resulting Wilson coefficients are crucial for gluon fusion processes, the most important production channels of Higgs bosons at the LHC.

T 89.8 Do 17:45 S16

Higher-Order Corrections to 2HDM Higgs Decays with 2HDECAY — •Marcel Krause[1], Margarete Mühlleitner[1], and Michael Spira[2] — [1]Institute for Theoretical Physics, Karlsruhe Institute of Technology, Wolfgang-Gaede-Str. 1, 76131 Karlsruhe, Germany — [2]Paul Scherrer Institute, CH-5232 Villigen PSI, Switzerland

Among the simplest extensions of the Standard Model (SM) Higgs sector is the Two-Higgs-Doublet Model (2HDM). In order to discern subtle new physics effects in the Higgs sector from the SM background precise theoretical predictions for Higgs observables are required. We present the program package 2HDECAY which allows for the calculation of branching ratios and partial decay widths of all Higgs bosons of a general CP-conserving 2HDM including higher-order corrections. The tool combines the state-of-the-art quantum chromodynamics (QCD) corrections implemented in HDECAY with the full electroweak one-loop corrections to all non-loop-induced two-body on-shell Higgs decays in the 2HDM. The renormalization of the electroweak sector is performed mostly in an on-shell scheme. Exceptions are the $\overline{\text{MS}}$ renormalized $\mathbb{Z}_2$-symmetry-breaking scale m_{12}^2 and the scalar mixing angles α and β for the CP-even and CP-odd/charged Higgs bosons, for which several different renormalization schemes are implemented. 2HDECAY allows for a consistent comparison of the partial decay widths and branching ratios obtained from the different renormalization schemes of the mixing angles which enables an estimate of the remaining theoretical error due to missing higher-order corrections. 2HDECAY can be obtained from https://github.com/marcel-krause/2HDECAY.

T 89.9 Do 18:00 S16

The light MSSM Higgs mass: merging fixed order and resummation at three loop — Robert V. Harlander, •Jonas Klappert, Lars-Thorben Moos, Daniel Ochoa, and Alexander Voigt — RWTH Aachen University

Results for the light Higgs mass in the MSSM up to three-loop order including the corresponding uncertainties are discussed. Since experimental exclusions push the threshold of masses of potential SUSY partner particles to the TeV scale, it is necessary to resum terms which are enhanced by logarithms of the SUSY scale. In this talk, we present a combined technique based on a diagrammatic fixed-order and an EFT approach to reduce the origin of the individual uncertainties and to obtain a reliable result for the light Higgs mass. All results are publicly available in the Himalaya library.

T 90: Experimentelle Methoden III

Zeit: Donnerstag 16:00–18:30 Raum: S01

T 90.1 Do 16:00 S01

Bau von small-diameter Monitored Drift Tube (sMDT)-Kammern für das ATLAS-Myonspektrometer — •Marian Rendel, Patrick Rieck, Verena Walbrecht, Oliver Kortner und Hubert Kroha — Max Planck Institut für Physik (Werner-Heisenberg-Institut)

Im Rahmen des zweiten Long Shutdown des Large Hadron Colliders, 2019-2020, wird die Hälfte der Monitored Drift Tube (MDT)-Kammern an den Enden der inneren Barrellage durch 16 neue small-diameter Monitored Drift Tube (sMDT)-Kammern mit dem halben Rohrdurchmesser ersetzt, die mit neuen thin-gap RPC-Triggerkammern integriert sind. Wie bei den MDT-Kammern muss auch beim Bau der sMDT-Kammern eine hohe Positioniergenauigkeit der Zähldrähte erreicht werden.

In diesem Vortrag wird über die Driftrohrproduktion und die Montage der Kammern berichtet.

T 90.2 Do 16:15 S01

Vermessung neuer small-diameter Monitored Drift Tube (sMDT)-Kammern für das ATLAS-Myonspektrometer — •Marian Rendel, Patrick Rieck, Verena Walbrecht, Oliver Kortner und Hubert Kroha — Max Planck Institut für Physik (Werner-Heisenberg-Institut), München

Im Rahmen des zweiten Long Shutdown des Large Hadron Colliders, 2019-2020, werden die Monitored Drift Tube (MDT)-Kammern an den Enden der inneren Barrellage durch 16 neue small-diameter Monitored Drift Tube (sMDT)-Kammern mit dem halben Rohrdurchmesser ersetzt, die mit neuen thin-gap RPC-Triggerkammern integriert sind. Um Richtung und Impuls der Myonen präzise messen zu können, müssen die mechanischen und elektrischen Eigenschaften der Kammern möglichst genau bestimmt werden.
In diesem Vortrag wird über die Vermessung der Kammerdeformation, der Positionierung der Alignierungsplattformen und die Messung der Gasleckraten berichtet.

T 90.3 Do 16:30 S01

Electrostatic deflector development — •Kirill Grigoryev and Christian Käseberg for the JEDI-Collaboration — Institut für Kernphysik, Forschungszentrum Jülich, Deutschland

The direct measurement of the proton or deuteron Electric Dipole Moment (EDM) has never been performed before. These experiments can be done at electrostatic storage ring. As a starting point the magnetic storage ring COSY at Forschungszentrum Jülich can be used. It will require implementation of the electrostatic or electromagnetic beam-bending elements. For testing the electrodes material, shape, surface treatment and high voltage, a real size large deflector is developed and will be checked in a magnetic field of a large-gap dipole magnet. The experimental setup and the laboratory test results will be presented.

T 90.4 Do 16:45 S01

Polyimide aging studies for the Mu3e experiment — •Thomas Theodor Rudzki for the Mu3e-Collaboration — Physikalisches Institut, Universität Heidelberg

The Mu3e experiment is searching for the lepton flavour violating decay $\mu^+ \to e^+e^-e^+$ with a sensitivity of 1 event in 10^{16} decays in phase II. Since the momentum resolution is limited by multiple Coulomb scattering low material budget is necessary. Therefore, the pixel tracker of Mu3e will use 50 μm thin sensors glued on thin polyimide foils including all signal and power lines. This results in a radiation length of only $X/X_0 = 0.115\,\%$ per layer. The sensors will be cooled by gaseous helium, a low Z material.

There are indications from aerospace engineering that ionizing radiation in a dry and inert atmosphere gives rise to radiation damage, potentially impacting the mechanical structure. Potential instability of the support structure caused by decomposition of the polyimide foil would be a great danger for the whole experiment. The presence and time scale of the damaging process and its potential effect on the material properties and their relevance for the Mu3e experiment will be discussed in this talk. This includes simulation results of the energy deposited by low-momentum electrons in polyimide.

T 90.5 Do 17:00 S01

Power deposition in the wall of the helical undulator of the ILC positron source — •Khaled Alharbi — Hamburg University, Germany — DESY-Zeuthen, Germany — KACST,Saudi Arabia

The positron source of the International Linear Collider 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 polarized.

At ILC250 (Ecm = 250GeV), the full active length of 231m (320m total length) is needed to produce the required number of positrons. To keep the power deposition in the undulator walls below the acceptable limit of 1W/m, masks must be inserted. The mask design requires a detailed study of the power deposition in the walls. The results of this study will be presented taking into account errors in the undulator magnetic field and period as well as misalignment of the electron beam.

T 90.6 Do 17:15 S01

Microscopic simulation of gaseous detectors — •Moritz Seidel, Thomas Hebbeker, Carsten Heidemann, Kerstin Hoepfner, Henning Keller, and Giovanni Mocellin — Physikalisches Institut III A, RWTH Aachen, Germany

Gaseous detectors are widely used in the field of particle physics research, such as at the main experiments of the LHC. Given the increasing demand of precision and reliability of the detectors for the discovery of new particles, it is essential to better understand the details of the

already existing detectors and those of the next generation.

To achieve this, the generation and propagation of signals inside the detectors are studied on a microscopic scale. Simulations are performed using the Garfield++ package mainly focusing on GEM detectors.

Starting from ionizing particles, the ion-electron pairs are generated in the gas volume. The electrons are propagated towards the regions of high electric field where the electron multiplication takes place. Finally the collection of the signal on the electrodes is simulated.

The studies presented here cover the influence of environmental parameters, detector geometry, high voltage distribution and gas composition.

T 90.7 Do 17:30 S01

Scheduling algorithms in LHCb's upgrade trigger — •Niklas Nolte[1,2], Sascha Stahl[1], and Johannes Albrecht[2] — [1]CERN — [2]Experimentelle Physik 5, TU Dortmund

During the second long shutdown of the LHC, LHCb is undergoing a major upgrade, which involves the removal of the hardware trigger. With the prospect of reconstructing LHC proton bunch crossings at a rate of 30 MHz in LHCb's software trigger from 2021 onwards, an event scheduler must fulfill two important requirements. It needs to have sufficient versatility to handle the control and data flow of up to thousands of reconstruction and selection algorithms per event, while keeping the runtime overhead minimal. An static-order, inter-event parallel scheduler capable of configuring arbitrary dependency graphs via control flow trees is presented.

T 90.8 Do 17:45 S01

Test beam results of the prototype of the LHCb SciFi Tracker — Sebastian Bachmann, Daniel Berninghoff, Albert Comerma, Michal Dziewiecki, Xiaoxue Han, Blake Leverington, Hanna Malygina, Ulrich Uwer, and •Lukas Witola — Physikalisches Institut, Heidelberg, Germany

The LHCb Scintillating Fibre (SciFi) Tracker is designed to replace the current downstream tracking detectors in the LHCb Upgrade during the shutdown 2019 to 2020. It is based on 2.5 m long and 0.250 mm diameter scintillating fibres as the active medium. Silicon photomultiplier arrays with 128 channels and 0.25 mm channel width are used for readout. The front-end electronics are based on a custom ASIC chip, the PACIFIC, and an FPGA for the hit clustering with a readout rate of 40 MHz.

The prototype modules of the SciFi Tracker with the full readout chain have been studied at the CERN SPS test beam area. Performance results of the electronics as well as of the detector will be reported.

T 90.9 Do 18:00 S01

Optimization of a high-intensity positron source — •Manuel Formela[2], Sabine Riemann[1], Gudrid Moortgat-Pick[2], and Andriy Ushakov[2] — [1]DESY — [2]Universität Hamburg

The positron source of a future high-energy e+e- collider is challenging due to the high luminosity requests. Therefore CLIC as well as the International Linear Collider (ILC) have a design for an undulator based positron source, using an helical undulator and producing a high number of circularly polarized photons. However such a high number of photons generate a high termic stress on the target material producing the required high number of positrons.

This talk is about a mathematical study on the radiation behaviour of a helical undulator based on the equation for the radiated synchrotron energy spectral density per solid angle per electron in the relativistic, far field and pointlike charge approximation. From this starting point the resulting following undulator properties were examined: the deposited power in the undulator vessel, which can disrupt the functionality of the undulator*s electromagnets, the protectiv property of a mask on this disturbance and the number of positrons produced by the synchrotron radiation in a Ti-6%Al-4%V target. Those quantities were calculated for various values for parameters like the undulator period, undulator length and the magentic flux.

T 90.10 Do 18:15 S01

Calibrating the OSIRIS pre-detector - A radioactivity monitor for JUNO — •Alexandre Göttel[1,2], Yaping Chen[1], Christoph Genster[1,2], Philipp Kampmann[1,2], Livia Ludhova[1,2], Michaela Schever[1,2], Achim Stahl[1,2], Christopher Wiebusch[1,2], and Yu Xu[1,2] for the JUNO-Collaboration — [1]IKP-2, Forschungszentrum Jülich — [2]III Physikalisches Institut, RWTH Aachen University

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kt liquid scintillator reactor neutrino experiment currently being built in the Guangdong province in southern China. Its energy resolution is designed to go below 3% at 1 MeV in order to reach a statistical significance of at least 3 sigma for the neutrino mass hierarchy. It is therefore imperative to closely monitor the radiopurity of the liquid scintillator. The Online Scintillator Internal Radioactivity Investigation System (OSIRIS) is being developed for this purpose. In order to achieve this goal a rigorous energy calibration of the OSIRIS predetector is necessary. In this talk the methods used for this calibration are discussed, as well as how they were optimized beforehand using a GEANT4-based Monte Carlo simulation.

T 91: Elektronik

Zeit: Donnerstag 16:00–18:30 Raum: S02

T 91.1 Do 16:00 S02

ALTAS New Small Wheel Project - Front-End Board Cooling — •Vladisalvs Plesanovs, Ulrich Landgraf, and Stephanie Zimmermann — Universität Freiburg, Freiburg im Breisgau, Germany

For the New Small Wheel (NSW) project the innermost end-cap of the ATLAS muon spectrometer will be replaced. This part of the muon tracking system will use the sTGC and Micromegas detector technologies. The high density of the readout channels of both detector installations results in a high density of the Front-End readout boards (FEBs). To extend the service time of the FEBs their cooling is necessary.

To achieve this goal, an approach that enables FEB cooling with a combination of custom design aluminium plates and heat conducting gap pad was developed and studied. Furthermore, a method for the heat transfer from the transceivers, which are located on the FEB side opposite to the cooling installations, was developed. Four types of measurements were executed to test applicability of both cooling solutions under the NSW cooling system constraints.

The presentation focuses on the cooling test results of the MMFE-8 production board and L1DDC transceivers. The constraints of each task are described and test results of the implemented solution are discussed.

T 91.2 Do 16:15 S02

Effects of humidity on deformation of PCBs in the ATLAS New Small Wheel — •Yanwen Hong, Ulrich Landgraf, and Stephanie Zimmermann — Universität Freiburg

The New Small Wheel (NSW) will replace the present Small Wheel for the Muon Spectrometer upgrade of the ATLAS experiment during the Long Shutdown 2 in next years. Small-strips Thin Gap Chamber (sTGC) and Micro-Mesh- Gaseous Detectors (Micromegas) technologies will be employed in the NSW. Printed circuit boards (PCBs) are widely used in Micromegas readout boards and the sTGC. Unfortunately the humid environment can cause deformation of the PCBs during the transportation, storage process and assembly of the NSW. This deformation misplaces the readout strip pattern and furthermore has a direct impact on the spatial resolution of the detectors. In this context, a closed chamber which can be flushed with controlled humidity density nitrogen was designed and built and a high precision Coordinate Measurement Machine is used to measure the deformation of the sTGC board and Micromegas panel over the large dimensions up to 2 m. Later on, a 3D reconstruction will be achieved to study the deformation in both Z direction and XY-plane. In this talk, the setup of the measurement system is discussed and first measurement results are presented.

T 91.3 Do 16:30 S02

Optimization of the ATLAS (s)MDT readout electronics for high counting rates — Oliver Kortner, Hubert

Kroha, and •Korbinian Schmidt-Sommerfeld — Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), Föhringer Ring 6, 80805 München

In the ATLAS muon spectrometer, Monitored Drift Tube (MDT) chambers are used for precise muon track measurement. For the high background rates expected at HL-LHC, which are mainly due to neutrons and photons produced by interactions of the proton collision products in the detector and shielding, new small-diameter Muon Drift Tube (sMDT)-chambers with half the drift tube diameter of the MDT-chambers and ten times higher rate capability have been developed. In order to avoid baseline shifts of the shaped signal the standard MDT readout electronics uses bipolar shaping which, however, leads to a deterioration of signal pulses due to preceding background hits at high counting rates, leading to losses in muon efficiency and drift tube spatial resolution. These so-called signal pile-up effects can be mitigated by active baseline restoration (BLR), which can also eliminate the baseline shift in the case of unipolar shaping. Discrete multi-channel prototype electronics of both types have been tested with generated input pulses and in the Gamma Irradiation Facility at CERN under high γ-irradiation rates.

T 91.4 Do 16:45 S02

CMS DT system electronics upgrade and verification — •Dmitry Eliseev, Thomas Hebbeker, Kerstin Hoepfner, Carsten Heidemann, Giovanni Mocellin, Henning Keller, and Archie Sharma — III. Physikalisches Institut A. RWTH Aachen University, Aachen

The Drift Tube (DT) system is the key detector in the region of the CMS barrel dedicated to the measurement of muon tracks. The signals from a huge number of the DT chambers must be acquired fast and synchronously in order to deliver the information about the hits. In the context of increasing the luminosity of the LHC in preparation for the Phase II the DT system is being upgraded. The main focus of this upgrade is the development of a new generation of read out electronics based on the FPGA technology. The new electronics will provide for the DT system higher acquisition rates, radiation resistance and flexibility of the trigger settings. The development of the new generation instrumentation requires numerous verification measurements. For these purposes a cosmic muon test stand is currently being redesigned and improved at RWTH Aachen. This test stand combines different types of detector technologies providing redundancy and therefore turning it to an excellent verification facility for the new generation electronics of the DT system. This talk presents the status of the DT system upgrade with the main focus on the upgrade of the read out electronics and gives the overview of the Aachen cosmic muon test stand.

T 91.5 Do 17:00 S02

Development of a CANopen node used as a DCS Controller in the ATLAS pixel detector — •Rizwan Ahmad[1], Tobias Fröse[2], Michael Karagounis[2], Susanne Kersten[1], Niklaus Lehmann[1], and Christian Zeitnitz[1] — [1]University of Wuppertal, Wuppertal, Germany — [2]University of Applied Sciences and Arts, Dortmund, Germany

A phase-II upgrade is planned for the ATLAS pixel detector. 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 DCS system has three main entities. The DCS Computer (Main Control room), the DCS controller chip and the PSPP (Pixel Serial Powering Protection) Chip. The DCS controller communicates to the DCS computer over CAN (Controller Area Network) bus while the DCS controller communicates to the PSPP chip over SCB (Serial Control Bus), a modified version of the I2C. The DCS controller provides a bridge logic which translates messages between two different communication protocols. It will also implement the CANopen standard in hardwired logic. Additionally, it allows for connecting NTCs to monitor temperature. The DCS controller must be radiation hard up to an ionizing dose of $>$ 500Mrad and it must also provide great immunity against SEU (Single Event Upsets). The first prototype of the chip implements the physical layers for the CAN & SCB and the on-chip voltage regulators. In this talk, the results from the first prototype and the logic implemented on an FPGA will be presented.

T 91.6 Do 17:15 S02

Finaler Prototyp für den Kontroll-Chip des ATLAS Pixel Detektor — •Niklaus Lehmann[1], Rizwan Ahmad[1], Michael Karagounis[2], Susanne Kersten[1] und Christian Zeitnitz[1] — [1]Bergische Universität Wuppertal — [2]Fachhochschule Dortmund

An der Bergischen Universität Wuppertal wird das Detektor-Kontroll-System (DCS) für das Phase II Upgrade des ATLAS Pixeldetektors entwickelt. Dieses beinhaltet zwei ASICs welche die zu überwachenden Messwerte digitalisieren und zum zentralen DCS übertragen. Der Pixel Serial Power Protection (PSPP) Chip ist in der vierten Version vorhanden und ist ein Prototype von einem der beiden ASICs. Der PSPP kann ein einzelnes Modul in einer seriellen Versorgungskette überwachen und bei Bedarf ausschalten. Der Chip wurde entwickelt um parallel zu den Pixel Modulen zu arbeiten. Er kann bis zu 8A an Strom schalten und wird über AC gekoppelte Kommunikationsleitungen angesprochen. Der ganze Chip muss strahlenhart bis zu einer ionisierender Dosis (TID) >500Mrad sein und soll robust gegen strahlungsbedingte Bitfehler (SEU) sein. Basierend auf diesem Prototypen, soll dann ein Produktionschip entwickelt werden, welcher im ATLAS Detektor eingebaut werden kann. Resultate der Belastungstests und Bestrahlungen des PSPPs bezüglich SEU und TID werden in diesem Vortrag präsentiert.

T 91.7 Do 17:30 S02

A silicon-photomultiplier readout integrated circuit for highly granular imaging calorimetry — •Zhenxiong Yuan — Kirchhoff Institute for Physics, 69120 Heidelberg, Germany

The KLauS ASIC is a 36-channel mixed-mode silicon-photomultiplier (SiPM) charge readout integrated circuit dedicated to the application in a highly granular imaging calorimeter at a future linear collider experiment. The high density of readout channels together with the dense structure of the calorimeter system limit the readout electronics power consumption down to 25 μW per channel. This ASIC is designed to read out the SiPM signals with high precision and over a large dynamic range with high linearity. Each channel consists of an analog front-end for charge integration and a 10/12-bit ADC to digitize the pulse height information. The design of the ASIC and results of the characterization measurements will be presented. In addition, the integration of the ASIC into the AHCAL calorimeter prototype of the CALICE collaboration is ongoing and the status will also be reported.

Furthermore, a 200 ps bin-sized TDC has been designed for the next version of the KLauS chip, which is implemented to digitize the timing information for the arriving signals. This will allow to study the time development of hadronic showers in the calorimeter with subnanosecond resolution.

T 91.8 Do 17:45 S02

Remote Configuration of the iPMT ReadOutBoard in OSIRIS — Feng Gao, Florian Kiel, Tim Kuhlbusch, Achim Stahl, •Jochen Steinmann, Christopher Wiebusch, and Christian Wysotzki — III. Physikalisches Institut B, RWTH Aachen University

Within a novel concept for photomultiplier readout, all necessary electronics are mounted at the back of the PMT. This introduces the problem, that there is no direct access to the electronics anymore. Configuration and debugging using standard tools and adapters is not possible.

In order to be able to configure and debug the readout-electronics the Slow Control and Configuration Unit has been developed. This device enables programming and configuration of the used FPGA and ADC. Furthermore it provides access to various interfaces, which can be used to implement the slow control and monitoring of the electronics. The whole data transfer is done via Ethernet. Hence no attention has to be payed to the distances between the control system and the PMT.

T 91.9 Do 18:00 S02

Design of a Flexible PCB prototype for the High Granularity Timing Detector at ATLAS — •Maria Soledad Robles Manzano[1,2], Peter Bernhard[2], Andrea Brogna[2], Atila Kurt[2], Lucia Masetti[1,2], Paul Plattner[1], and Quirin Weitzel[2] — [1]Institut für Physik, Johannes-Gütenberg Universität Mainz — [2]Exzellenzcluster PRISMA, Johannes-Gütenberg Universität Mainz

The High-Granularity Timing Detector (HGTD) is designed to improve the physics performance in the forward region of the ATLAS detector when the new HL-LHC is operative. Based on Low Gain Avalanch Detectors, the HGTD will mitigate the pile-up in the forward region by providing a timing resolution below 30 ps per track. In this scenario, the HGTD requirements for data transmission (1.28 Gb/s), sensor powering (up to 1 kV) as well as the geometrical constraints (thickness below 350 μm) lead to the need of custom designed electronics. A Flexible PCB (FLEX cable) is the best candidate to ful-

fil both the electrical and geometrical requirements. The design of the first prototype is presented.

T 91.10 Do 18:15 S02

Tests of a first prototype of the Flexible PCB for the High Granularity Timing Detector at ATLAS — •Paul Plattner[1], Peter Bernhard[2], Andrea Brogna[2], Atila Kurt[2], Lucia Masetti[1,2], Maria Soledad Robles Manzano[1,2], and Quirin Weitzel[2] — [1]Institut für Physik, Johannes-Gütenberg Universität Mainz — [2]Exzellenzcluster PRISMA, Johannes-Gütenberg Universität Mainz

The High Granularity Timing Detector (HGTD) is proposed for the ATLAS Phase II Upgrade to provide precise timing to tracks in the forward region. Each of its modules will be connected to the peripheral electronics via a flexible PCB. A first prototype of this Flexible PCB has been designed and manufacured. The geometrical constraints (thickness < 350 μm and a maximum length of 750 mm) as well as the electrical requirements (high-speed rate of 1.28 Gb/s and sensor powering up to 1 kV) requires a specific testing plan to check its performance. The Power Integrity (PI) simulation provides the resitance of the dedicated planes for powering and grouding before manufacturing and simulated results are compared to the measured values in the laboratory. The High Voltage insulation of the materials used to fabricate the FLEX cable is also tested. Time Domain Reflectrometry measurements, in order to check the impedance homogeneity of the tracks crucial for Signal Integrity (SI), are performed. Results of the testing of the prototype are presented.

T 92: Detektorsysteme V

Zeit: Donnerstag 16:00–18:35 Raum: S03

Gruppenbericht T 92.1 Do 16:00 S03

The SHiP Liquid Scintillator-Based Surrounding Background Tagger — •Julian Schliwinski for the SHiP LScin SBT-Collaboration — HU Berlin, Berlin, Deutschland

SHiP is a proposed general-purpose beam dump experiment at the CERN SPS North Area. It is desigend to combine the Search for Hidden Particles (SHiP), e.g. Heavy Neutral Leptons (HNL), with the search for light dark-matter particles and studies of tau neutrino physics.

Proton-proton Collisions with the SPS' 400 GeV beam on the fixed target may create very weakly interacting new particles with a mass between 0.1 GeV - 10 GeV. Hadrons from these collisions are absorbed and muons redirected through a magnet system. This leaves only neutrinos as well as other neutral particles to decay in the 50 m long decay volume, which is followed by a magnetic spectrometer and calorimeter. The decay volume will be surrounded by scintillating liquid (Surrounding Background Tagger - SBT) to reduce background. The scintillation photons may be detected using wavelength-shifting optical modules coupled to large-area silicon photomultipliers.

This talk will give an overview of the current design and ongoing R&D on the SBT. Results of test beam measurements with a new and improved liquid-scintillator detector will be presented with a focus on readout electronics and the SiPM photo sensors.

T 92.2 Do 16:20 S03

Simulation of light guidance in scintillating fibres for the LHCb upgrade — •Martin Bieker, Robert Ekelhof, Ole Gerber, and Robin Manderfeld — Experimentelle Physik 5, TU Dortmund

During the current long shutdown of the LHC the LHCb detector will undergo a comprehensive upgrade. An important part of this upgrade is the replacement of the current downstream tracking stations by a detector made of scintillating fibres. These fibres are wound and glued to form mats with a length of 2.5 m. Charged particles crossing the scintillator emit light which is then guided by total internal reflection towards silicon photo multipliers at the end of the mat.

The amount of light observed at the end of the fibre is an important predictor for the performance of the system. This so called light yield is among other things affected by irradiation damage of the fibres. Hence it is important to understand and quantify these effects in order to predict the performance of the tracker during its life time.

In this talk several approaches to the simulation of scintillating fibres are presented. Special emphasis is put on the development of effective models from simulation studies and measurements of single fibres.

T 92.3 Do 16:35 S03

Metal-Loaded Liquid Scintillators for Neutrino Physics — Christian Buck, Benjamin Gramlich, Manfred Lindner, Christian Roca, and •Stefan Schoppmann — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

Liquid scintillators have become a well established detection medium in the context of neutrino experiments. They offer good transparency and light yield while allowing for geometrical flexibility of the fiducial volume at low costs. By loading the scintillators with metal compounds, effectiveness of neutron detection can be highly increased making them suitable for applications e.g. in reactor neutrino physics.

Depending on the respective usage-case, additional scintillator properties such as particle identification and vertex resolution become beneficial. We report the development of scintillator in the context of the STEREO experiment which allows for good particle identification by exploiting light pulse shape discrimination. In addition we present the current status of a LAB-based scintillator aiming for improved spatial resolution.

T 92.4 Do 16:50 S03

Reflectance of vacuum ultraviolet-sensitive silicon photomultipliers in liquid xenon — •Michael Wagenpfeil[1], Tobias Ziegler[1], Denny Schulte[2], Lutz Althueser[2], Thilo Michel[1], and Christian Weinheimer[2] — [1]Universität Erlangen-Nürnberg, ECAP — [2]Universität Münster, Institut für Kernphysik

Silicon Photomultiplier (SiPMs) are pixelated semiconductor photosensors with single photon resolution and a strong candidate for the ultimate low light-level detector due to their compact robust geometry, low power consumption, insensitivity to magnetic fields and easy scalability. Vacuum ultraviolet-sensitive SiPMs are innovative SiPM modifications suitable for detecting scintillation photons from liquid noble gases as used in various astroparticle physics detectors e.g. for neutrinoless double beta decay or dark matter searches.

SiPMs need to be characterised extensively focussing on their optical and electronic behaviour to determine the SiPM operation parameters which influence the energy resolution of such detectors. Many astroparticle groups plan to use SiPM-based photosensor systems directly within the liquid noble gas detector material so SiPM parameters need to be measured within the same environments for reliable results.

We present results from the first reflectance studies with SiPMs in liquid xenon and for vacuum ultraviolet photons. Such reflectance studies are important to determine the angular dependence of the SiPM photon detection efficiency as well as the optical influence of the complex SiPM surface microstructure required for the pixelation of the sensor.

T 92.5 Do 17:05 S03

Geant4 simulation of a detector prototype for neutron radiography — Christoph Günther, •Nina Höflich, Oliver Pooth, Christian Teichrib, and Simon Weingarten — III. Physikalisches Institut B, RWTH Aachen University, D-52056 Aachen

At the Physics Institute III B, a detector for fast neutron radiography measurements is under development. Neutron radiography allows for the discrimination of different materials in heterogeneous probes and is especially sensitive to light elements.

For this purpose, a neutron camera prototype made of 16 stilbene scintillator crystals coupled to a 4×4 pixel SiPM array is constructed. A radioactive AmBe source is used for detector tests with neutrons of energies up to 11 MeV.

In this talk, a Geant4 simulation of the detector prototype is presented. The focus lies on the simulation of the fast neutron interactions and the scintillation process as well as the propagation of the scintillation light inside the detector. Also, the interaction of neutrons with different test materials is simulated.

T 92.6 Do 17:20 S03

Development and test of a fast neutron camera — •Christoph Günther, Nina Höflich, Oliver Pooth, Christian Teichrib, and Simon Weingarten — III. Physikalisches Institut B, RWTH Aachen University, D-52056 Aachen

We are developing a prototype of a scintillator based camera for fast neutron radiography. The camera consists of 4×4 pixels with a size of $5\,\text{mm} \times 5\,\text{mm}$ per pixel. Each pixel consists of a stilbene crystal whose scintillation light is read out by an SiPM. As a neutron source we use an $^{241}\text{Am}/^{9}\text{Be}$ source that emits neutrons with energies up to 11 MeV. So far, optimization studies have been carried out with one pixel in order to achieve a good gamma-neutron discrimination and to maximize the number of detected neutrons.

In this talk the further development of the camera and first measurements with the 4×4 pixel array are presented. To be able to capture images of larger size, measurements with a XY-table will be carried out.

T 92.7 Do 17:35 S03

Detector Response of a Liquid-Scintillator Detector Prototype with WOM and SiPM Readout — •Linus Shihora for the SHiP LScin SBT-Collaboration — HU Berlin, Berlin, Deutschland

SHiP is a proposed beam dump experiment at CERN to search for very weakly interacting new particles with a mass between 0.1 GeV - 10 GeV. 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 CERN PS accelerator in 2018, and compare the results to previous measurements performed in 2017 with a smaller liquid-scintillator detector.

T 92.8 Do 17:50 S03

The intelligent PMTs for OSIRIS — Feng Gao, •Florian Kiel, Tim Kuhlbusch, Achim Stahl, Jochen Steinmann, Christopher Wiebusch, and Christian Wysotzki — III. Physikalisches Institut B, RWTH Aachen University

For the next generation of liquid scintillator detectors, a novel concept for the readout of the Photomultiplier-Tubes has been developed. In the intelligent PMT concept all necessary electronics are mounted at the back of the PMT. The electronics is able to digitize and process the measured signal. Thereby, the high computing power of the FPGA offers the possibility of a low-level waveform reconstruction. Based on the analyzed data, the operational parameters of the PMT, e.g. applied voltage, are regulated autonomously. Since the iPMT will be connected via digital signals only, the performance does not decrease with long cables. The concept can be easily adapted from the laboratory to any size of detector, since the PMTs operate independent. The iPMTs will be deployed in the OSIRIS detector in order to demonstrate the concept as well as testing the performance.

T 92.9 Do 18:05 S03

Dynamic gain optimization for large-area PMTs for OSIRIS — •Feng Gao, Florian Kiel, Tim Kuhlbusch, Achim Stahl, Jochen Steinmann, Christopher Wiebusch, and Christian Wysotzki — III. Physikalisches Institut B, Aachen RWTH

Photomultiplier-Tubes are photodetectors with good single photon resolution. For the optimal photon reconstruction the PMT gain is required to 1E7 e- per electron. The gain of the PMT depends exponentially on the applied high voltage. By regulating the high voltage, the gain can be tuned and stabilized. By using the presented technique it is possible to simply connect all PMTs to the readout system, without characterizing the gain and the correct HV beforehand. By using the charge of dark counts there is no need for a special light source in the detector for implementing this procedure. Potential changes of the PMT gain can be compensated during runtime. This concept will be implemented and tested in the OSIRIS detector.

T 92.10 Do 18:20 S03

Entwicklung eines Messstandes zur Qualitätsprüfung der Szintillationseigenschaften von PEN — •Isabelle Schilling, Jens Weingarten, Kevin Kröninger und Philipp Hellmann — TU Dortmund, Lehrstuhl für Experimentelle Physik IV, 44227 Dortmund

Polyethylennaphtalat (PEN) ist ein thermoplastischer Kunststoff, welcher nach Anregung beim Durchgang energiereicher Teilchen oder Photonen szintilliert und im Zuge dessen sichtbare Strahlung im optimalen Funktionsbereich herkömmlicher Photomultiplier emittiert. Er ist günstig herzustellen, individuell formbar und könnte die Verwendung von Wellenlängenschiebern überflüssig machen. Um PEN beispielsweise in Experimenten als Veto-System einzusetzen, oder als Detektorkomponente zur Qualitätssicherung in der Strahlentherapie, sind detaillierte Kenntnisse über dessen Szintillationseigenschaften unverzichtbar.
Am kalibrierten Messstand werden Emissionsspektren und Rastermessungen bei Bestrahlung der PEN-Proben mit einer ^{207}Bi-Quelle aufgenommen, um Rückschlüsse auf die vom Herstellungsprozess der Probe abhängigen Materialeigenschaften ziehen zu können. Die Selbstabsorption des Szintillationslichtes, sowie die Lichtausbeute sind hierbei von besonderem Interesse.

T 93: Detektorsysteme VI

Zeit: Donnerstag 16:00–18:30 Raum: H08

T 93.1 Do 16:00 H08

Erfahrungen aus dem Einsatz von DC-DC-Konvertern im CMS Phase-1 Pixeldetektor — •Martin Lipinski, Karl-Heinz Dreger, Lutz Feld, Waclaw Karpinski, Katja Klein, Franz Josef Neus, Irfan Ötzen, Alexander Pauls, Gerhard Pierschel, Marius Preuten, Max Rauch, Stefan Schmitz und Michael Wlochal — I. Physikalisches Institut B, RWTH Aachen University

Im Rahmen des Phase-1 Upgrades wurde ein neuer Pixeldetektor in das CMS-Experiment installiert. Für diesen wurde eine neuartige Spannungsversorgung entwickelt, um Verluste auf den Versorgungskabeln deutlich zu verringern. Dabei wird eine Speisespannung von etwa 10 V erst im Detektor mit DC-DC-Konvertern auf die benötigten Spannungen von etwa 3 V transformiert. Dies ist der erste Einsatz von strahlungstoleranten und magnetfeldresistenten DC-DC-Konvertern innerhalb eines Detektors in einem Experiment der Hochenergiephysik.

Nach einigen Betriebsmonaten kam es zu unerwarteten Ausfällen, sodass am Ende des Jahres 2017 etwa 5% der installierten DC-DC-Konverter nicht mehr funktionierten. In diesem Vortrag wird die Problemsuche und die Ursache der Defekte vorgestellt. Alle DC-DC-Konverter wurden vor Beginn der Datennahme im Jahr 2018 ausgetauscht. Seitdem gab es keine neuen Ausfälle.

T 93.2 Do 16:15 H08

Power distribution for the Mu3e experiment — •Frederik Wauters for the Mu3e-Collaboration — Johannes Gutenberg Universität, Mainz

The Mu3e experiment aims to measure the charged flavour violating decay $\mu^+ \to e^- e^+ e^+$ with a single events sensitivity of $2{\cdot}10^{-15}$ in the first data taking phase. For this purpose, a DC muon beam of $10^8 \mu^+/\text{s}$ will be stopped inside a Si pixel tracker constructed from High-Voltage Monolithic Active Pixel Sensors (HV-MAPS), complemented with timing detectors. The entire experiments resides within a superconducting solenoid proving a homogeneous magnetic field of 1 T. All 3136 detector ASICs combined need about 5 kW of power at 1.8 V. In addition, the serial data from the indiviual sensors is processed by front-end FPGAs before being send off via optical links to the outside, adding another 2.7 kW of power needed at voltages of 1.1 to 3.3 V. This requires a power distribution system wich works inside the magnetic field and takes into account to the tight space constrains of the experiment. DC-DC buck converters with custom aircoils will drop down the incoming 20 VDC to the lower voltages. LDO regulators will provide the low noise power lines needed by the electronic. Special care has to be taken distibuting the low voltage power to the electronics and sensors.

T 93.3 Do 16:30 H08

Serial Powering Tests with RD53A — Matthias Hamer[1], •Florian Hinterkeuser[1], Fabian Hügging[1], Dominik Koukola[2], Hans Krüger[1], Susanne Kuehn[2], Stella Orfanelli[2], and Klaus Desch[1] — [1]University of Bonn — [2]CERN

The high luminosity upgrade for the Large Hadron Collider at CERN requires a complete overhaul of the ATLAS detector. The current tracking detector will be replaced by an all-silicon tracking detector, the ITk. It will occupy the same volume as the current ATLAS tracker and will cover a significantly larger phase space. The new Front-End chips for the pixel detector are developed within the RD53 collaboration together with CMS. Due to the increased power consumption and the increased number of modules, a serial powering scheme has to be deployed. While the concept of serial powering has already been proven using FE-I4 readout chips, detector prototypes with the new FE chips are now being built by the ITk collaboration. This talk will present an overview of first serial powering tests with RD53A, the current prototype readout chip for ATLAS and CMS, focusing on on-module current distribution and HV distribution in a serially powered chain.

T 93.4 Do 16:45 H08

Beam Test measurements of silicon-strip modules for the ATLAS Inner Tracker upgrade — Carlos Garcia Argos, Mark Hauser, Ulrich Parzefall, •Arturo Rodriguez Rodriguez, Frederik Ruehr, Dennis Sperlich, and Liv Wiik — Albert-Ludwigs-Universität, Freiburg, Germany

For the high luminosity phase of the LHC, the tracking system of the ATLAS experiment will be replaced with a new all-silicon detector called the Inner Tracker (ITk), to cope with the expected severe conditions in terms of radiation and occupancy. With the production of modules scheduled to begin in 2020, a thorough understanding of the current prototype modules is critical. Beam Tests allow, to some extent, to simulate real experimental conditions and test the module performance. This talk presents the results of beam tests at DESY and CERN. The devices under test are the first ever double-sided R0 module built from non-irradiated silicon sensors and a single R0 module irradiated up to a dose of 1.1×10^{15} n_{eq}/cm^2. The R0 module will occupy the innermost position in the end-cap wheels of the ITk-strip detector system and will face the highest radiation dose. The results presented focus on the detection efficiency and spatial resolution of the modules.

T 93.5 Do 17:00 H08

Testbeam results of irradiated and non-irradiated silicon strip sensors with embedded pitch adapters — Ingo Bloch[2], Javier Fernández-Tejero[1], Celeste Fleta[1], Heiko Lacker[3], •Sam Yanwing Ng[3], Luise Poley[4], Laura Rehnisch[3], Edoardo Rossi[2], Christian Scharf[3], and Miguel Ullán[1] — [1]Centro Nacional de Microelectrónica — [2]Deutsches Elektronen-Synchrotron — [3]Humboldt-Universität zu Berlin — [4]Lawrence Berkeley National Lab

Embedded pitch adapters (EPA) are used to adjust the bond pattern of segmented sensors to that of read-out chips. In this way the sensor geometry can be made independent of the bond pattern of the read-out chips. This can be very useful for challenging sensor geometries used in the trackers of several experiments. However, the EPA may lead to efficiency loss due to coupling to the bulk or the strip metallization.

For the high-luminosity upgrade of the ATLAS inner tracker, silicon strip sensors with EPA structures have been investigated as an approach to mitigate the challenging wire-bonding in the end-cap region. Prototype end-cap silicon strip sensors with various EPA structures have been produced by Centro Nacional de Microelectrónica (IMB-CNM, CSIC), Barcelona, Spain. A non-irradiated sensor and a sensor irradiated to $\Phi_{eq} = 10^{15}\ n_{eq} \cdot cm^{-2}$ with MeV protons were subjected to test beam at DESY using a 4.4 GeV electron beam with a EUDET-type pixel telescope. First results of the tracking efficiency in the region of the EPA compared to the standard sensor region as well as a study of the coupling between the EPA and the bulk will be presented.

T 93.6 Do 17:15 H08

Thermische Messungen mit 2S-Modulen für das Phase-2-Upgrade von CMS — Christian Dziwok[2], Lutz Feld[1], Waclaw Karpinski[1], Katja Klein[1], Martin Lipinski[1], Irfan Özen[1], Alexander Pauls[1], Oliver Pooth[2], Marius Preuten[1], •Max Rauch[1], Nicolas Röwert[1], Nick Thamm[2], Michael Wlochal[1] und Tim Ziemons[2] — [1]1. Physikalisches Institut B, RWTH Aachen — [2]3. Physikalisches Institut B, RWTH Aachen

Im CMS Phase-2 Tracker werden u.A. ca. 8000 Stück neuartige 2S-Siliziumstreifenmodule eingesetzt werden. Ein 2S-Modul besteht aus zwei 10 cm × 10 cm-großen Siliziumstreifensensoren und drei Hybriden zur Spannungsversorgung und Auslese. Die elektrische Modulleistung nach HL-LHC-Bestrahlung wird mit etwa 6 W abgeschätzt, wovon etwa 1 W durch Leckstrom in den Sensoren entsteht. Die 2S-Module werden mit einem zweiphasigen CO_2-System bei einer nominellen CO_2-Temperatur von $-35\,^{\circ}C$ gekühlt. Das thermische Verhalten der 2S-Module wie z.B. der Effekt des „Thermal Runaway“ wird mit FE-Analysen simuliert. In diesem Vortrag werden thermische Messungen mit 2S-Dummy-Modulen vorgestellt. Die in den FE-Analysen gemachten Annahmen wie Klebeschichtdicken, Wärmeleitfähigkeiten etc. werden durch die Messungen überprüft. Ein detailliertes Verständnis und eine gezielte Kontrolle der äußeren Einflüsse erlauben präzise Aussagen über das thermische Verhalten des 2S-Moduls.

T 93.7 Do 17:30 H08

Thermal performance measurements of petals for the ATLAS ITk strip detector upgrade — •Jan-Hendrik Arling — Deutsches Elektronen-Synchrotron DESY, ATLAS group, Hamburg — TU Dortmund, Lehrstuhl für Experimentelle Physik IV, Dortmund

The Inner Tracker (ITk) is the new tracking detector for the phase-II upgrade of the ATLAS experiment, meant to meet the challenges at the high-luminosity LHC. The forward regions (end-caps) will be populated with modules consisting out of silicon micro-strip sensors with readout and power electronics. These modules are directly glued on local support structures (petal core), consisting of carbon fiber-based sandwich structures with embedded titanium cooling pipes as well as data and power buses. This structure has to provide mechanical stability while minimizing material and allows for evaporative CO2 cooling of sensors and electronics. The combination of modules and support structure is a petal.

For the optimization of the petal design, petal core prototypes as well as a thermo-mechanical petal prototype, fully loaded with dummy silicon modules emulating the real heat load, were constructed. A set of measurements has been performed on these objects to validate the petal design. One type of tests is to assess the thermo-mechanical behaviour using dual-phase CO2 cooling by applying infrared thermography on it. In a developed setup experimental results for the prototypes were taken and used to validate FEA simulations.

In this talk, results in terms of thermal performance of the petal as well as properties of the CO2 cooling will be discussed.

T 93.8 Do 17:45 H08

Qualifizierungsmessungen im Rahmen der ATLAS-ITk-Pixel Market-Survey — Andreas Gisen, •Valerie Hohm, Kevin Kröninger, Alexander Kroner, Mareike Weers und Jens Weingarten — TU Dortmund, Experimentelle Physik IV

Der aktuelle Inner Detector des ATLAS-Experiments wird beim Upgrade des LHC zum HL-LHC durch den Inner Tracker (ITk) ausgetauscht. Dies ist durch die zukünftig höhere Luminosität bedingt, die größere Strahlenschäden und eine höhere Okkupanz hervorruft. Der ITk-Pixeldetektor wird zum großen Teil aus planaren Silizium-Pixelsensoren bestehen.

Verschiedene Hersteller können sich für die Produktion dieser Sensoren qualifizieren. Die Qualifizierungsmessungen werden mit einem standardisierten Messverfahren an verschiedenen Instituten durchgeführt. Die Dortmunder Arbeitsgruppe beteiligt sich an diesen Messungen für planare Silizium-Pixelsensoren. In diesem Vortrag werden der Messaufbau und die Messmethoden sowie erste Ergebnisse präsentiert.

T 93.9 Do 18:00 H08

Module building and performance measurements for the ATLAS ITk Pixel Outer Barrel demonstrator — •Sascha Dungs[1,2], Bora Atlay[3], Helge Beck[4], Jörn Grosse-Knetter[4], Matthias Hamer[5], Fabian Hügging[5], Kevin Kröninger[1], Susanne Kühn[2], Jörn Lange[4], Jannicke Pearkes[6], Heinz Pernegger[2], Alexey Petrukhin[3], Arnulf Quadt[4], Steffen Schaepe[2], and Jens Weingarten[1] — [1]TU Dortmund, Experimental Physics IV — [2]CERN — [3]Uni Siegen — [4]Uni Göttingen — [5]Uni Bonn — [6]SLAC

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). The new pixel detector will consist of five central layers and several endcap discs with about 9000 modules. For qualification of system integration aspects, a demonstrator with representative components for the outer barrel layers of the pixel detector is currently

being installed.

In this talk, the production of about 70 hybrid pixel modules with two or four readout chips will be presented. This production was done in different steps at various institutes. Particular focus will be placed on flex attachment and wirebond encapsulation. To qualify these production steps, a careful monitoring of the module performance is essential after each stage. An overview will be given about the testing procedure and the result of the performance measurements of these modules.

T 93.10 Do 18:15 H08

Assembly and test of 2S modules for the Phase-2 CMS Outer Tracker — Christian Dziwok[1], Lutz Feld[2], Katja Klein[2], Martin Lipinski[2], Alexander Pauls[2], Oliver Pooth[1], Marius Preuten[2], Max Rauch[2], Nicolas Röwert[2], Nick Thamm[1], and •Tim Ziemons[1] — [1]III. Physikalisches Institut B, RWTH Aachen University, D-52056 Aachen — [2]I. Physikalisches Institut B, RWTH Aachen University

The CMS detector will be upgraded in the Phase-2 Upgrade for 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.

At RWTH Aachen University about one thousand 2S modules will be assembled. In this talk, the assembly of the first functional module prototypes is presented. Additionally, tests to check mechanical properties as well as electrical tests are shown.

T 94: Detektorsysteme VII

Zeit: Donnerstag 16:00–18:15 Raum: H10

T 94.1 Do 16:00 H10

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 for detectors 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. This calorimeter provides high spatial granularity and single-cell timing in order to enhance the particle separation and background rejection capability.

A 22000 channel technological prototype has been constructed and extensively tested in particle beams at CERN in 2018. This contribution is focussed on the time analysis of the data taken in the course of these test beam campaigns. It will touch upon the correction of electronic effects caused by the read-out chip and report on the achievable hit time resolution.

T 94.2 Do 16:15 H10

Timing performance of the Mu3e tile detector prototype — •Tiancheng Zhong, Yonathan Munwes, Konrad Briggl, Hannah Klingenmeyer, Huangshan Chen, Hans-Christian Schultz-Coulon, and Wei Shen — Kirchhoff Institute for Physics, University of Heidelberg

The Mu3e experiment is designed to search for the charged Lepton Flavour Violation (cLFV) decay $\mu^+ \to e^+e^+e^-$ with a sensitivity of 10^{-16}. The observation of this decay would be a significant 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 timing detector aims at a timing resolution of better than 100ps, and is based on scintillation tiles, SiPMs and a readout ASIC.

A prototype with totally 96 channels was built at the Kirchhoff Institute for Physics. It was tested by exposed to the DESY electron test beam in Hamburg in June 2018. All three submodules with separated ASICs were successfully read out by the same data acquisition (DAQ) system using separated ASICs. The single channel and submodule resolution was measured to be better than 40ps and 60ps, respectively.

T 94.3 Do 16:30 H10

Commissioning and First Image Reconstruction with a new Time-of-Flight PET Prototype — •Ole Brandt[1,2], Yonathan Munwes[3], Erika Garutti[2], and Ties Behnke[1] — [1]Desy, Notkestrasse 85, 22607 Hamburg — [2]Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg — [3]Kirchhoff-Institut für Physik, Universität Heidelberg Im Neuenheimer Feld 227, 69120 Heidelberg

Within the framework of the EndoTOFPET-US project an endoscopic multimodal imaging device combining Ultrasound endoscopy and Time-of-Flight Positron Emission Tomography is developed. The design foresees a miniaturized PET head installed on a commercial ultrasound endoscope and an external detector plate, which will be positioned in close proximity to the patient's body. The prototype system described here consists of the final PET plate and an endoscopic demonstrator, which has a system time of flight resolution of 255 ps FWHM and reaches a spatial resolution of about 1.5 mm in the direction transverse to the line of sight connecting the detectors. The applications of this device are within diagnostic and surgical oncology as well as the development of new biomarkers targeted for prostate cancer. In this talk, results from the commissioning of a full sized prototype, including timing performance, first data acquisition and image reconstruction are presented.

T 94.4 Do 16:45 H10

Development and simulation of the Mu3e tile detector prototype — •Hannah Klingenmeyer — Kirchhoff-Institut für Physik, Universität Heidelberg

The tile detector is a dedicated timing detector system developed for the Mu3e experiment, which is designed to search for the lepton-flavour violating decay $\mu \to eee$ with a target sensitivity of 10^{-16}. In order to determine the vertex of the three decay electrons, precise spatial and timing measurements are necessary, resulting in the requirement of a time resolution below 100 ps for the tile detector.

The tile detector, which is currently under development, employs plastic scintillator tiles and silicon photomultipliers read out by dedicated ASICs. In this talk, the status of the first technical prototype will be presented. Measurements of the prototype in two testbeam campaigns, undertaken at DESY in 2018, show a preliminary time resolution of the order of 40 ps, well below the required 100 ps. In addition, the experience gained from the construction of the prototype provides crucial input for the definition and finalisation of the production and assembly procedures, which are needed for the final detector system.

Furthermore, the prototype design has been implemented in a CAD software with built-in simulation options, which are used to simulate the heat flow and cooling capabilities of the detector. This is of particular importance regarding the integration of the tile detector within the full experimental setup, as constraints on the final detector design can first be tested and verified in simulation studies.

T 94.5 Do 17:00 H10

Zeitauflösung eines Flüssigszintillatordetektors mit WOM- und SiPM-Auslese — •Maximilian Ehlert für die SHiP LScin SBT-Kollaboration — Humboldt-Universität zu Berlin, Institut für Physik

SHiP (Search for Hidden Particles) ist ein Vorschlag, in einem Beamdump-Experiment am CERN SPS-Beschleunigerkomplex nach sehr schwach wechselwirkenden, neutralen Teilchen im Massenbereich von 0,1 GeV - 10 GeV zu suchen. Hadronen aus den Proton-Proton-Kollisionen werden absorbiert und Myonen durch ein Magnetsystem ausgelenkt, so dass neben Neutrinos nur noch andere neutrale Teilchen in einem etwa 50m langen Volumen vorhanden sind und in diesem zerfallen können. Dieses Zerfallsvolumen soll mit Flüssigszintillator umgeben sein (Surrounding Background Tagger = SBT), um Untergrund unterdrücken zu können. Die Szintillationsphotonen sollen mit sogenannten Wavelength-Shifting-Optical-Modules (WOMs), die an Photosensoren angekoppelt werden, nachgewiesen werden. Im

Vortrag wird die Zeitauflösung eines Flüssigszintillatordetektors mit WOM- + SiPM-Auslese, welcher an einem Testrahl am CERN PS-Beschleuniger getestet wurde, analysiert und diskutiert.

T 94.6 Do 17:15 H10

Development of a Detector Control System for the ATLAS High Granularity Timing Detector — •Davide Caforio, Michael Düren, and Hasko Stenzel — II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Heinrich-Buff-Ring 16, 35392 Gießen

The high-luminosity phase of the LHC will require important upgrades of the ATLAS detector. The experimental challenges are related to the high mean number of interactions per bunch crossing ($\mu \approx 200$) and the harsh radiation environment. The High Granularity Timing Detector will be able to mitigate the impact from pile-up by an improved track-to-vertex association using a timing measurement with about 30ps resolution. In order to ensure an efficient and safe operation, a detector control system is designed. All relevant detector parameters are continuously monitored and archived for debugging and performance studies, and a system of alert handles signals of abnormal behavior. Interfaces with DAQ, trigger and the accelerator, with interlock signal in case of critical situations, must also be implemented. The large number of read-out channels, the severe environmental conditions characterized by high radiation levels and magnetic fields, the limited space, and the required fast response time of the system are the main challenges faced by the HGTD DCS system.

T 94.7 Do 17:30 H10

Simulation of a High-Granularity Timing Detector for the ATLAS Phase-II Upgrade — •Alexander Basan[1], Lucia Masetti[1], Dirk Zerwas[2], Eftychia Tzovara[1], and Peter Berta[1] — [1]Johannes Gutenberg University Mainz — [2]Universite de Paris-Sud

The high-luminosity Large Hadron Collider (HL-LHC), scheduled to start in 2026, will deliver an instantaneous luminosity of up to $7.5\times10^{34}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$, which is approximately 5 times larger than the typical luminosities of Run 2. The corresponding increase in the average number of simultaneous *pp* interactions per bunch crossing (pileup) poses a challenge for the tracking detectors to efficiently assign the charged particles to the production vertices. The performance in terms of heavy-flavor tagging, lepton isolation and the identification of pileup jets will deteriorate especially in the forward region where the spatial resolution is much larger than the inverse of the average pileup density.

The High-Granularity Timing Detector (HGTD) enables the use of high-precision timing information in the forward region to distinguish between collisions occurring very close in space but well-separated in time. With an expected time resolution for minimum-ionising particles of approximately 30 ps and a spread of collision times over a bunch crossing of 175 ps, the amount of pileup can be reduced by a factor of $175/30 \approx 6$.

This talk presents the simulation software for the HGTD and studies on the performance for muons.

T 94.8 Do 17:45 H10

Analysis of test beam measurements for the ATLAS High Granularity Timing Detector — •Jens Soengen, Lucia Masetti, and Marisol Robles — Johannes Gutenberg-Universitaet

The high-luminosity upgrade to the LHC(HL-LHC) is foreseen to start operating in 2026 and will boost the potential of discovering new particles substantially. However, the increased instantaneous luminosity of up to $7.5{\cdot}10^{34}\ \mathrm{cm}^{-2}\mathrm{s}^{-1}$ also implies rising requirements to the ATLAS detector. In order to guarantee the correct assignment of particles from hard-scattering events, a High-Granularity Timing Detector(HGTD) is planned to mitigate the effect of pile-up. The most appropriate candidate is a silicon-based avalanche detector with low-gain(LGAD) and reduced thickness in the magnitude of 50 μm, promising an excellent time resolution below 30 ps. Its capabilities are examined under testbeam conditions with a 120 GeV pion beam at the CERN SPS. This talk will outline the central work steps of the analysis process as well its current status. Finally the crucial qualities, such as timing-performance and efficiency are presented for the latest testbeam campaigns in 2018.

T 94.9 Do 18:00 H10

Charakterisierung hoch-zeitauflösender Sensoren (LGAD) — Jörn Grosse-Knetter, Jörn Lange, Arnulf Quadt und •Marike Schwickardi — II. Physikalisches Institut, Georg-August-Universität Göttingen

Im Rahmen des Ausbaus des ATLAS-Detektors werden zeitaufgelöste Messungen angestrebt, welche zur Pile-Up-Unterdrückung am Hochluminositäts-LHC eingesetzt werden können. Dafür wird ein neues Silizium-Detektorkonzept mit geringer interner Verstärkung entwickelt, das als Low Gain Avalanche Detector (LGAD) bekannt ist. Von diesem Detektor wird erwartet, dass er genaue Zeitinformationen für geladene Teilchen mit einer Zeitauflösung von etwa 30 Pikosekunden liefert.

Für diese Art von Sensor gibt es verschiedene Hersteller, welche jeweils die Dotierung der Verstärkungsschicht sowie den Abstand zwischen den Pads variieren, um ein optimales Design zu finden. Dabei werden sowohl einzelne Pads mit $1.3\times1.3\ \mathrm{mm}^2$ Größe als auch Arrays von diesen Pads untersucht, welche zwischen 2×2 und 15×15 Pads beinhalten, also zum ersten Mal Sensoren der angestrebten Größe des Auslesechips von ca. $2\times2\ \mathrm{cm}^2$.

Das Strom-Spannungs (IV)-Verhalten wird mit einer automatischen Probe Station gemessen und liefert zum ersten Mal Ergebnisse für Sensoren in dieser Größenordnung. Darüberhinaus werden die Ladung, Verstärkung und Homogenität der Sensoren, insbesondere auch zwischen den Pads, mit einem ortsaufgelösten Laser-Aufbau (TCT) gemessen.

T 95: Neutrinos: Myon-Rekonstruktion

Zeit: Donnerstag 16:00–18:35 Raum: H11

Gruppenbericht T 95.1 Do 16:00 H11

Overview and status of the Topological Track Reconstruction for large unsegmented liquid scintillator neutrino detectors — Felix Benckwitz[1], Caren Hagner[1], David Meyhöfer[1], Henning Rebber[1], •Malte Stender[1], Björn Wonsak[1], Sebastian Lorenz[2], Johann Dittmer[3], Mikko Meyer[3], and Kai Zuber[3] — [1]Universität Hamburg, Institut für Experimentalphysik — [2]Johannes Gutenberg-Universität Mainz, Institut für Physik — [3]Technische Universität Dresden, Institut für Kern- und Teilchenphysik

In this contribution we present the Topological Track Reconstruction, which works with minimal hypothesis in contrast to other reconstruction methods in liquid scintillator detectors. The reconstruction yields a 3D density distribution of the emitted scintillation photons enabling the localisation of muon events. This also implies information of the dE/dx of the muons and is therefore able to pin down hadronic showers within the track. These showers produce serious background isotopes. This information enhances the rejection and the study of cosmogenic background events.
The discussed reconstruction provides sharp tracks for GeV events, but even low energy events of a few MeV - traditionally thought as point-like - reveal some topological information. This information can then be used for event discrimination. The possibility to apply the reconstruction to different detector geometries and configurations promises a large field of application. This talk will present the advances of the Topological Track Reconstruction and give an overview about its applications.

T 95.2 Do 16:20 H11

Topological Track Reconstruction in Liquid Scintillator Neutrino Detectors for MeV Events — •Henning Rebber, Caren Hagner, Björn Wonsak, David Meyhöfer, Malte Stender, and Felix Benckwitz for the JUNO-Collaboration — Universität Hamburg

Neutrino detectors like the JUNO experiment in China demand for an unprecedented energy resolution while pushing the fiducial mass of liquid scintillator to ever higher dimensions. This complicates the tasks of event reconstruction and background reduction. For widespread events, like e.g. high energy (∼GeV) muons, current developments in the topological track reconstruction provide a 3D light emission density distribution based on isotropically emitted, unscattered scintillation photons. The method gives access to a particle's differential energy loss $\mathrm{d}E/\mathrm{d}x$ and can help in the essential task of background rejection.

But also for low energy events in the signal range (∼MeV) - although

comparatively point-like - the topological features hold valuable information which can be used for particle discrimination. Electron events can partly be separated from positron and gamma events. The current status of this study is presented. This work is supported by the DFG.

T 95.3 Do 16:35 H11

Studies on multi-muon track reconstruction with the JUNO liquid scintillator neutrino detector — •Axel Müller, Alexander Tietzsch, David Blum, Tobias Heinz, Tobias Sterr, Marc Breisch, and Tobias Lachenmaier for the JUNO-Collaboration — Physikalisches Institut, Universität Tübingen

The Jiangmen Underground Neutrino Observatory (JUNO) is a planned 20 kt liquid scintillator detector with the main goal to determine the neutrino mass hierarchy with neutrinos from nuclear power plants at 53 km baseline. With an expected muon rate of 3 per second, fast and reliable muon tracking is necessary to veto a partial volume along the track. Due to the large dimensions of the detector a fraction of the atmospheric muon events consists of two or more muons traversing the detector. These events cannot be reconstructed with conventional one-particle reconstruction algorithms. In order to reconstruct the tracks of these bundle events, a new approach is developed to expand and combine the single-muon reconstruction algorithms. A description of the reconstruction strategy, examples of its application and first results are presented in this talk.

This work is supported by the Deutsche Forschungsgemeinschaft.

T 95.4 Do 16:50 H11

A new muon tracking for the Borexino experiment — •Michael Nieslony, Johann Martyn, Vsevolod Orekhov, and Michael Wurm for the Borexino-Collaboration — Johannes Gutenberg-Universität Mainz

The Borexino experiment is a liquid scintillator detector located at the Laboratori Nazionali del Gran Sasso (LNGS) in Italy with the primary aim of detecting solar neutrinos. The experiment's exceptional radiopurity levels enabled the spectral measurement of almost the whole pp-fusion-cycle of the sun, including ^{7}Be-, *pp*-, and *pep*-neutrinos. Besides the solar program, a multitude of analyses ranging from the detection of geoneutrinos up to setting the most stringent limit on the lifetime of the electron have been performed.

The rejection of background events is a vital factor for the ongoing success of the experiment. One of the major background sources are cosmic muons, which produce unstable nuclei like ^{11}C along their way through the detector through spallation processes. To efficiently reject those events, a precise knowledge of the muon track is necessary. A new muon tracking based on the first hit times of the emitted Cherenkov and scintillation photons was developed and is presented in this talk. The work was supported by funds of the *Deutsche Forschungsgemeinschaft (DFG)*

T 95.5 Do 17:05 H11

Topological Track Reconstruction with the SNO+ experiment — •Johann Dittmer, Mikko Meyer, and Kai Zuber for the SNOplus-Collaboration — TU Dresden, Institut für Kern- und Teilchenphysik, Deutschland

SNO+ is a large liquid scintillator based experiment that reuses the Sudbury Neutrino Observatory (SNO). Located 2 km underground in a mine near Sudbury the detector consists of a 12 m diameter acrylic vessel which is filled with 780 t of liquid scintillator. Main goal of SNO+ is the search for the neutrinoless double beta decay ($0\nu\beta\beta$) of ^{130}Te. The scintillator is loaded with 0.5 % by weight during the search. It is also possible to measure reactor–, geo–, supernova– and solar neutrinos.

This talk deals with the evaluation of expected background for $0\nu\beta\beta$ search coming from solar neutrinos detected via elastic neutrino–electron scattering (ES) and solar neutrino capture (ν–capture).

Furthermore, first results from the so–called topological track reconstruction developed in Hamburg will be presented. This method already demonstrated potential to discriminate background processes and might be an interesting tool for the analysis of solar neutrinos and the $0\nu\beta\beta$ search.

T 95.6 Do 17:20 H11

Potential of the application of the Topological Track Reconstruction to ANNIE — •Felix Benckwitz, Caren Hagner, David Meyhöfer, Henning Rebber, Malte Stender, and Björn Wonsak — Universität Hamburg, Institut für Experimentalphysik

Neutron tagging is an important technique to reduce the background in proton decay searches and precision measurements of neutrino oscillations in water Cherenkov detectors. Therefore, the neutron yield per neutrino energy is a vital input for MC simulations to accurately calculate the background rejection. The measurement of the neutron yield as a function of the transferred momentum for charged current and neutral current neutrino interactions is the goal of the Accelerator Neutrino Neutron Interaction Experiment (ANNIE). In order to achieve this goal, ANNIE deploys a 26 t gadolinium-doped water Cherenkov detector at the Fermilab Booster Neutrino Beam. To meet the vertex reconstruction requirements in a small detector volume, ANNIE, besides conventional PMTs, makes use of Large Area Picosecond Photo Detectors (LAPPDs), which yield a spatial resolution of $\sim$ 1 mm and a time resolution of $\sim$ 50 ps. These characteristics, as well as the instantaneous Cherenkov light make ANNIE a perfect testing field for the Topological Track Reconstruction, which uses the temporarily and spatially detected photon hits to reconstruct the spatial number density of emitted photons. The potential of the Topological Track Reconstruction using Cherenkov light, as well as LAPPDs and its advantages over currently used reconstruction methods are discussed.

T 95.7 Do 17:35 H11

Study of the event reconstruction for the COBRA coplanar grid quad CdZnTe detectors — •Yingjie Chu for the COBRA-Collaboration — TU Dresden, Institut für Kern- und Teilchenphysik, Germany

The COBRA experiment aims to measure neutrino-less double beta decay using CdZnTe detectors with a coplanar grid design. Recently the detector system was upgraded with nine 6/, /*mathrmcm*^{3} coplanar grid quad CdZnTe detectors to the extended demonstrator (XDEM). The XDEM detectors employ four independent coplanar grid electrode pairs on a single crystal surrounded by an instrumented guard-ring electrode. The purpose of this large volume combined with coplanar grid quad design is to improve the detection efficiency as well as maintain the good energy resolution. Signals can be read out from each grid and be processed separately. A reconstruction of the deposited energy based on the sum of the anode signal amplitudes from four grid pairs could be achieved. Furthermore, the spectral performance as a function of the interaction depth could also be measured.

This talk focuses on the event reconstruction method for XDEM detectors. First results of an improved energy reconstruction and interaction depth determination are presented. In order to improve the energy resolution, further corrections due to the contributions of electron trapping and charge sharing effects on the signals are reported.

T 95.8 Do 17:50 H11

An improved muon track reconstruction for IceCube and IceCube-Gen2 — •Federica Bradascio — federica.bradascio@desy.de

IceCube is a cubic-kilometer Cherenkov telescope operating at the South Pole. Its goal is to detect astrophysical neutrinos and identify their sources. High-energy muon neutrinos are identified through the secondary muons produced via charge current interactions with the ice. The muon tracks are reconstructed using a maximum likelihood method which models the arrival times of Cherenkov photons registered by the photomultipliers. This work aims to improve the muon angular resolution of IceCube and its planned extension, IceCube-Gen2, to the sub-degree range. The current muon reconstruction assumes continuous energy loss along the muon track, and does not account for photomultiplier-related effects such as prepulses and afterpulses. In the reconstruction scheme presented here, the expected arrival time distribution has been modified to parameterize the stochastic muon energy losses.

T 95.9 Do 18:05 H11

Improving the Sensitivity of Measurements in IceCube to Neutrino Oscillation Parameters — •Alexander Trettin for the IceCube-Collaboration — DESY, Zeuthen

One of the applications of the IceCube Neutrino Observatory is the measurement of the neutrino mass splittings and mixing angles using atmospheric neutrinos. These measurements use the DeepCore subarray of IceCube, which has an energy threshold of just under 10 GeV. One of the algorithms used for directional reconstruction in neutrino oscillation studies relies on the arrival time pattern of minimally scattered photons. This talk presents a simple yet effective way to minimize the impact of scattering in ice and increase the efficiency of this approach. Discussed improvements are expected to result in about 10% increase of the sensitivity to oscillation parameters in future studies.

T 95.10 Do 18:20 H11

Impact of uncertainties in the detector geometry of IceCube on event reconstruction — •Lilly Peters, Frederic Jonske, Martin Rongen, Jöran Stettner, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen

Neutrinos travel through the universe nearly undisturbed, keep their directional information and provide the possibility to study the unknown sources of high-energy cosmic rays. In 2017, the IceCube Neutrino Observatory has identified, for the first time, a potential astrophysical neutrino source, the Blazar TXS 0506+056. The ability to reliably trace back a neutrino to an astrophysical source requires a precisely reconstructed direction. One source of systematic uncertainties is the actual position of the optical sensors of the detector. Those positions can be estimated from calibration light sources and deployment data taken during the construction of the detector. In this talk, the influence of geometrical uncertainties of the IceCube detector array on directional reconstructions of high-energy neutrinos will be analyzed.

T 96: KAT meeting

Zeit: Donnerstag 16:00–18:00 Raum: S05

KAT meeting (nur für KAT-Mitglieder)

T 97: Mitgliederversammlung Fachverband Teilchenphysik

Zeit: Donnerstag 19:00–20:30 Raum: H03

Mitgliederversammlung Fachverband Teilchenphysik (für Mitglieder)

T 98: Hauptvorträge VII

Zeit: Freitag 9:00–10:30 Raum: H01

Hauptvortrag T 98.1 Fr 9:00 H01

Recent developments in low energy neutrino physics: chances and challenges — •Werner Maneschg — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg

Since their discovery in 1956 neutrinos have been extensively studied and used to reveal neutrino source properties as well as to search for physics beyond the Standard Model. Next to precision measurements of oscillation parameters in the existing standard 3-flavor framework, the key questions addressed nowadays are related to the absolute neutrino mass, the neutrino mass ordering and the existence of a CP violating phase. But also the search for the Majorana character of neutrinos, the existence of sterile neutrinos, of electromagnetic neutrino properties and non-standard quark-neutrino interactions are under investigation. This talk provides an overview about the most recent results in the low energy neutrino sector. A few experiments like Katrin, Borexino, Juno, Gerda, Stereo and Conus will be exemplarily used to demonstrate recent technological challenges and progresses, but also the rich physics program covered with very small to very large sized projects.

Hauptvortrag T 98.2 Fr 9:45 H01

Gauge/gravity duality and particle physics: New approaches to strongly coupled sectors — •Johanna Erdmenger — Institut für Theoretische Physik und Astrophysik, Julius-Maximilians-Universität Würzburg, Am Hubland, 97074 Würzburg

The AdS/CFT correspondence, which may be generalized to gauge/gravity dualities with running couplings, provides an important new map between quantum field theories (QFT) without gravity on the one hand, and gravity theories on the other. This is of intrinsic interest in view of a unified theory of fundamental interactions. In addition, gauge/gravity duality provides a new approach to strongly coupled QFT by mapping them to classical gravity theories. This has been used as a dual approach to confinement and chiral symmetry breaking, including the evaluation of meson and glueball masses and decay constants that compare favourably to lattice gauge theory results. Gauge/gravity duality has also proved very useful in the study of QCD at finite temperature and density. Currently, gauge/gravity duality is used as a road to new physics in the context of composite Higgs models, where the Higgs boson is viewed as an admixture of a pseudo-Goldstone boson and a condensate. Gauge/gravity duality allows to model the underlying strongly coupled gauge dynamics. The spectrum is determined by solving the equations of motion in the dual gravity theory. The talk will provide an overview over the main concepts of gauge/gravity duality and its use for beyond the standard model physics.

T 99: Hauptvorträge VIII

Zeit: Freitag 11:00–12:30 Raum: H01

Hauptvortrag T 99.1 Fr 11:00 H01

The Standard Model and the top quark at the LHC — •Ian Brock — Universität Bonn, Bonn

With the end of Run 2, both ATLAS and CMS have collected around 150 fb^{-1} of data at a centre-of-mass energy of 13 TeV. Standard Model and top-quark processes are backgrounds for most searches for new physics. It is therefore essential that they are understood as well as possible. The talk will present the latest measurements of tests of the Standard Model published by the LHC collaborations, emphasising the measurements with the heaviest elementary particles (with the exception of the Higgs boson): the top quark and W and Z bosons. Top quarks have even been observed in the LHCb experiment recently. The most precise measurements have percent level precision, which usually takes several years to achieve. Differential cross-section measurements allow models to be tested in more detail and provide valuable input for improved simulations.

Hauptvortrag T 99.2 Fr 11:45 H01

Don't be a WIMP - new ideas for light dark matter — •Felix Kahlhöfer — Institute for Theoretical Particle Physics and Cosmology (TTK), RWTH Aachen University, D-52056 Aachen, Germany

In spite of the overwhelming evidence for the existence of dark matter, its properties remain elusive. I will review the global effort to search for dark matter and discuss the implications of the present absence of new signals. A consistent combination of all available information mounts pressure on the idea of Weakly Interacting Massive Particles, which may point to a production mechanism in the Early Universe different from thermal freeze-out. I will review a number of attractive alternatives and discuss their theoretical and experimental implications.