Hadron and Nuclear Physics Division
Fachverband Physik der Hadronen und Kerne (HK)

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Overview of Invited Talks and Sessions

(Lecture halls H-HS X, H-HS XIII, H-HS XVI, J-HS A-H, J-HS K-M; Poster Zelt and Grotte)

Plenary Talks

PV I	Mon	9:15–10:00	H-Aula/HS I/HS X	**Highlights from the LHC** — •Gregor Herten
PV II	Mon	10:00–10:45	H-Aula/HS I/HS X	**Superheavy Element Research at GSI** — •Michael Bock
PV IV	Tue	9:00– 9:45	H-Aula/HS I/HS X	**The Making of High-Precision Gravitational Waves** — •Alessandra Buonanno
PV V	Tue	9:45–10:30	H-Aula/HS I/HS X	**Local measurements of quantum fields** — •Christopher Fewster
PV IX	Wed	8:30–10:00	H-Aula/HS I/HS X	**Physik und Bildung** — •Harald Lesch
PV XII	Thu	9:00– 9:45	H-Aula/HS I/HS X	**Physics-Informed AI for Image Reconstruction in PET** — •Andrew Reader
PV XIII	Thu	9:45–10:30	H-Aula/HS I/HS X	**Geophysics in Elysium Planitia - First Year Results from the InSight Mars Mission** — •Matthias Grott, Bruce Banerdt, Suzanne Smrekar, Tilman Spohn, Philippe Lognonne, Christopher Russel, Catherine Johnson, Don Banfield, Justin Maki, Matt Golombek, Domeniko Giradini, William Pike, Anna Mittelholz, Yanan Yu, Attilio Rivoldini

Prize Talk of the Laureate of the Robert Wichard Pohl Prize 2020

HK 1.1	Mon	11:15–11:45	H-HS X	**50 Years of Online Optical Spectroscopy and Mass Spectrometry** — •H.-Jürgen Kluge

Invited Talks

HK 1.2	Mon	11:45–12:15	H-HS X	**Precision laser spectroscopy studies on exotic tin isotopes.** — •Liss Vazquez Rodriguez
HK 1.3	Mon	12:15–12:45	H-HS X	**Pushing the frontiers in mass measurements of short-lived exotic nuclei** — •Timo Dickel
HK 11.1	Tue	11:00–11:30	H-HS X	**Experimental Nuclear Astrophysics Underground: The LUNA and LUNA-MV experiments** — •Rosanna Depalo
HK 11.2	Tue	11:30–12:00	H-HS X	**Ten years after: Highlights from ALICE and future perspectives** — •Harald Appelshäuser
HK 11.3	Tue	12:00–12:30	H-HS X	**Constraining the nuclear equation of state from nuclear forces and neutron star observations** — •Svenja Greif
HK 32.1	Wed	16:30–17:00	H-HS X	**Detectors for Measuring Space Radiation** — •Robert F. Wimmer-Schweingruber, and the Kiel Extraterrrestrial Physics Team
HK 32.2	Wed	17:00–17:30	H-HS X	**Modern Timing Detectors in HEP** — •Jörn Lange
HK 32.3	Wed	17:30–18:00	H-HS X	**Experimental time resolution limits of modern SiPMs and TOF-PET detectors** — •Stefan Gundacker
HK 32.4	Wed	18:00–18:30	H-HS X	**260 megavoxel camera with continuous readout - the upgraded ALICE TPC** — •Laura Fabbietti

HK 41.1	Thu	11:00–11:30	H-HS X	**Highlights from the COMPASS Experiment and the COMPASS++/AMBER Proposal** — •Boris Grube
HK 41.2	Thu	11:30–12:00	H-HS X	**The charm of exotic bound states of the strong interaction** — •Frank Nerling
HK 41.3	Thu	12:00–12:30	H-HS X	**Characterizing baryon dominated matter with HADES measurements** — •Szymon Harabasz
HK 54.1	Fri	9:00– 9:30	H-HS X	**The Compressed Baryonic Matter experiment at FAIR** — •Alberica Toia
HK 54.2	Fri	9:30–10:00	H-HS X	**Short-Ramge-Correlations in neutron-rich nuclei** — •Meytal Duer
HK 54.3	Fri	10:00–10:30	H-HS X	**Das Physikprogramm des MESA-Beschleunigers** — •Harald Merkel
HK 66.1	Fri	14:30–15:00	H-HS X	**Baryon Spectroscopy with the CBELSA/TAPS experiment at ELSA** — •Annika Thiel
HK 66.2	Fri	15:00–15:30	H-HS X	**The BGOOD experiment at ELSA - exotic structures in the light quark sector?** — •Thomas Jude
HK 66.3	Fri	15:30–16:00	H-HS X	**Double parton scattering and double parton distributions** — •Peter Plössl

Invited talks of the joint symposium SYMD: Dissertation Prize 2020

See SYMD for the full program of the symposium.

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

Invited talks of the joint symposium SYDM: Dark Matter Symposium

See SYDM for the full program of the symposium.

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

Public Evening Talk

PV VIII	Tue	18:30–19:30	H-Aula/HS I/HS X	**Lise Meitner Lecture: Quantum-based Materials Modeling and Artificial Intelligence for Tackling Societal Challenges** — •Claudia Draxl
PV XI	Wed	20:00–21:00	H-Aula/HS I/HS X	**Wie entstand unser Sonnensystem?** — •Harald Lesch
PV XV	Thu	20:00–21:00	H-Aula/HS I/HS X	**Max von Laue Lecture: What physicists can do to improve international security?** — •Steve Fetter

Lunch Talks

PV III	Mon	13:30–14:00	H-HS IX	**Als Physikerin im Wissenschaftsverlag** — •Maike Pfalz
PV VI	Tue	13:00–13:30	H-HS IX	**Als PhysikerIn zum BSI – Mit Sicherheit** — •Vivien Thiel, •Patrick Grete
PV X	Wed	13:00–13:30	H-HS IV	**Vom Laborbuch zur Akte: Als Physiker im Forschungsministerium** — •Peter Schroth
PV XIV	Thu	13:00–13:30	H-HS IX	**Wie kommt der Satellit in die Rakete? Wissenschaft ganz weit oben** — •Anke Pagels-Kerp

Sessions

HK 1.1–1.3	Mon	11:15–12:45	H-HS X	**Invited Talks I**
HK 2.1–2.4	Mon	16:30–17:45	J-HS A	**Hadron Structure and Spectroscopy I**
HK 3.1–3.3	Mon	16:30–17:30	J-HS M	**Hadron Structure and Spectroscopy II**
HK 4.1–4.5	Mon	16:30–18:00	J-HS F	**Heavy-Ion Collisions and QCD Phases I**
HK 5.1–5.5	Mon	16:30–18:00	J-HS G	**Heavy-Ion Collisions and QCD Phases II**
HK 6.1–6.5	Mon	16:30–18:00	J-HS E	**Structure and Dynamics of Nuclei I**
HK 7.1–7.5	Mon	16:30–18:00	J-HS H	**Structure and Dynamics of Nuclei II**
HK 8.1–8.4	Mon	16:30–17:45	J-HS B	**Fundamental Symmetries I**
HK 9.1–9.6	Mon	16:30–18:00	J-HS C	**Instrumentation I**
HK 10.1–10.6	Mon	16:30–18:00	J-HS D	**Instrumentation II**
HK 11.1–11.3	Tue	11:00–12:30	H-HS X	**Invited Talks II**
HK 12.1–12.5	Tue	17:00–18:20	H-HS VI	**Outreach methods I (joint session T/HK)**
HK 13.1–13.4	Tue	17:00–18:15	J-HS A	**Hadron Structure and Spectroscopy III**
HK 14.1–14.5	Tue	17:00–18:30	J-HS M	**Hadron Structure and Spectroscopy IV**
HK 15.1–15.5	Tue	17:00–18:30	J-HS F	**Heavy-Ion Collisions and QCD Phases III**
HK 16.1–16.4	Tue	17:00–18:15	J-HS G	**Heavy-Ion Collisions and QCD Phases IV**
HK 17.1–17.7	Tue	17:00–19:00	J-HS E	**Structure and Dynamics of Nuclei III**
HK 18.1–18.7	Tue	17:00–19:00	J-HS H	**Structure and Dynamics of Nuclei IV**
HK 19.1–19.4	Tue	17:00–18:30	J-HS B	**Fundamental Symmetries II**
HK 20.1–20.6	Tue	17:00–18:30	J-HS C	**Instrumentation III**
HK 21.1–21.5	Tue	17:00–18:30	J-HS D	**Instrumentation IV**
HK 22.1–22.7	Wed	14:00–16:00	J-HS A	**Hadron Structure and Spectroscopy V**
HK 23.1–23.5	Wed	14:00–15:45	J-HS M	**Hadron Structure and Spectroscopy VI**
HK 24.1–24.7	Wed	14:00–16:00	J-HS F	**Heavy-Ion Collisions and QCD Phases V**
HK 25.1–25.8	Wed	14:00–16:00	J-HS G	**Heavy-Ion Collisions and QCD Phases VI**
HK 26.1–26.7	Wed	14:00–16:00	J-HS E	**Structure and Dynamics of Nuclei V**
HK 27.1–27.7	Wed	14:00–16:00	J-HS H	**Structure and Dynamics of Nuclei VI**
HK 28.1–28.6	Wed	14:00–15:45	J-HS B	**Astroparticle Physics I**
HK 29.1–29.7	Wed	14:00–16:00	J-HS C	**Instrumentation V**
HK 30.1–30.7	Wed	14:00–16:00	J-HS D	**Instrumentation VI**
HK 31.1–31.9	Wed	16:30–18:45	H-HS VI	**Outreach methods II (joint session T/HK)**
HK 32.1–32.4	Wed	16:30–18:30	H-HS X	**Combined detector session (joint session HK/T/ST/EP)**
HK 33.1–33.7	Wed	16:30–18:30	J-HS A	**Hadron Structure and Spectroscopy VII**
HK 34.1–34.7	Wed	16:30–18:30	J-HS F	**Heavy-Ion Collisions and QCD Phases VII**
HK 35.1–35.7	Wed	16:30–18:30	J-HS G	**Heavy-Ion Collisions and QCD Phases VIII**
HK 36.1–36.8	Wed	16:30–18:45	J-HS H	**Heavy-Ion Collisions and QCD Phases IX**
HK 37.1–37.7	Wed	16:30–18:30	J-HS E	**Structure and Dynamics of Nuclei VII**
HK 38.1–38.9	Wed	16:30–19:00	J-HS C	**Instrumentation VII**
HK 39.1–39.5	Wed	16:30–19:00	J-HS D	**Instrumentation VIII**
HK 40.1–40.9	Wed	16:30–19:15	J-HS K	**Instrumentation IX**
HK 41.1–41.3	Thu	11:00–12:30	H-HS X	**Invited Talks III**
HK 42.1–42.5	Thu	14:00–15:45	J-HS A	**Hadron Structure and Spectroscopy VIII**
HK 43.1–43.6	Thu	14:00–15:45	J-HS F	**Heavy-Ion Collisions and QCD Phases X**
HK 44.1–44.6	Thu	14:00–15:45	J-HS G	**Heavy-Ion Collisions and QCD Phases XI**
HK 45.1–45.7	Thu	14:00–16:00	J-HS E	**Structure and Dynamics of Nuclei VIII**
HK 46.1–46.7	Thu	14:00–16:00	J-HS H	**Structure and Dynamics of Nuclei IX**
HK 47.1–47.6	Thu	14:00–15:45	J-HS B	**Nuclear Astrophysics I**
HK 48.1–48.5	Thu	14:00–16:00	J-HS C	**Instrumentation X**
HK 49.1–49.5	Thu	14:00–16:00	J-HS D	**Instrumentation XI**
HK 50.1–50.6	Thu	14:00–15:45	J-HS K	**Instrumentation XII**
HK 51.1–51.37	Thu	16:30–18:30	Zelt	**Poster (a)**
HK 52.1–52.18	Thu	16:30–18:30	Grotte	**Poster (b)**
HK 53	Thu	19:00–20:00	H-HS X	**Annual General Meeting of the Hadron and Nuclear Physics Division**
HK 54.1–54.3	Fri	9:00–10:30	H-HS X	**Invited Talks IV**
HK 55.1–55.5	Fri	11:00–12:30	J-HS A	**Hadron Structure and Spectroscopy IX**
HK 56.1–56.7	Fri	11:00–13:00	J-HS F	**Heavy-Ion Collisions and QCD Phases XII**
HK 57.1–57.4	Fri	11:00–12:15	J-HS G	**Heavy-Ion Collisions and QCD Phases XIII**
HK 58.1–58.6	Fri	11:00–12:45	J-HS B	**Nuclear Astrophysics II**
HK 59.1–59.7	Fri	11:00–13:00	J-HS E	**Structure and Dynamics of Nuclei X**

HK 60.1–60.6	Fri	11:00–13:00	J-HS H	**Structure and Dynamics of Nuclei XI**
HK 61.1–61.5	Fri	11:00–12:30	J-HS L	**Astroparticle Physics II**
HK 62.1–62.8	Fri	11:00–13:00	H-HS XIII	**Combined Instrumentation Session: Silicon Strip Detectors (joint session HK/T)**
HK 63.1–63.8	Fri	11:00–13:00	H-HS XV	**Combined Instrumentation Session: Semiconductor Detectors (joint session HK/T)**
HK 64.1–64.8	Fri	11:00–13:00	J-HS C	**Combined Instrumentation Session: Gaseous Detectors (joint session HK/T)**
HK 65.1–65.7	Fri	11:00–12:45	J-HS K	**Combined Instrumentation Session: Silicon Pixel Detectors (joint session HK/T)**
HK 66.1–66.3	Fri	14:30–16:00	H-HS X	**Invited Talks V**

Annual General Meeting of the Hadron and Nuclear Physics Division

Thursday 18:00–19:00 H-HS X

HK 1: Invited Talks I

Time: Monday 11:15–12:45 Location: H-HS X

Prize Talk HK 1.1 Mon 11:15 H-HS X

50 Years of Online Optical Spectroscopy and Mass Spectrometry — •H.-Jürgen Kluge — GSI, Darmstadt — University of Heidelberg — Laureate of the Robert Wichard Pohl Prize 2020

Inspired by the observation of the parity violation in the fifties of the last century, Ernst Otten proposed and performed in 1970 at ISOLDE/CERN the very first online optical spectroscopy of short-lived isotopes at an accelerator facility. Neutron-deficient mercury isotopes were polarized by optical pumping by use of a spectral lamp. Its circular-polarized light was made tunable via the Zeeman effect by applying a magnetic field to the Hg discharge lamp. The resulting beta-asymmetry allowed to determine spin, moments, shape, and size. This led to the first observation of nuclear shape coexistence.

Before 1985, the binding energies or masses of radionuclides had been determined via observation of nuclear decays or reactions with often rather large uncertainties and were sometimes simply wrong. In 1985, ISOLTRAP was installed at ISOLDE, the very first online Penning trap facility for determining the masses of short-lived isotopes. Since then the atomic masses of over 400 radionuclides could be determined by ISOLTRAP with a relative uncertainty of 10-7 or better.

With the invention of tunable lasers by T. Hänsch in 1971 and the further development of ion traps, lasers, and spectroscopic methods, these atomic-physics methods have become workhorses for investigating nuclear ground state properties far from stability at accelerators world-wide.

Invited Talk HK 1.2 Mon 11:45 H-HS X

Precision laser spectroscopy studies on exotic tin isotopes. — •Liss Vazquez Rodriguez — Max-Planck-Institut für Kernphysik, D-69117 Heidelberg, Germany

The atomic nucleus is a complex many-body quantum system that possesses fundamental properties, such as spin and electromagnetic moments considered as valuable inputs for the determination and testing of nuclear models. The systematic investigation of these observables along an isotopic (isotonic) chain reveals progressive changes in structure with respect to the number of valence nucleons. The tin (Z=50) isotopes form the longest known isotopic chain in the nuclear landscape accessible to current experimental studies with the highest number of stable isotopes (ten). Therefore, they are in the center stage of this powerful line of inquiry.

High-resolution laser spectroscopy has been performed on a long sequence of tin species, spanning from N=58 to the very neutron-rich isotope ^{134}Sn, using the COLLAPS instrumentation at ISOLDE- CERN. From the perturbation and splitting of the electronic energy levels by the nucleus, nuclear spin and electromagnetic moments have been extracted for 38 nuclei including 11 isomers. The quadrupole moments, determined with higher precision than former measurements, show regularities that will be discussed in the framework of *"simple structure in complex nuclei"*. Special attention will be paid to the ^{133}Sn nucleus, one of the eight nuclei observed so far which has a single neutron outside a doubly-magic core, as a key for the investigation of single-particle characters away from stability.

Invited Talk HK 1.3 Mon 12:15 H-HS X

Pushing the frontiers in mass measurements of short-lived exotic nuclei — •Timo Dickel — Justus-Liebig-Universität Gießen — GSI Helmholtzzentrum für Schwerionenforschung

Recently, high-performance multiple-reflection time-of-flight mass spectrometers (MR-TOF-MS) have been developed at Justus Liebig University Gießen for the mass measurement of exotic nuclei. They have been used to perform experiments at the FRS Ion Catcher experiment at the in-flight fragment separator FRS at GSI and at the TITAN experiment at the ISOL facility of TRIUMF, Canada. Unprecedented sensitivity and mass resolving powers (up to one million) have been reached. Very exotic and short-lived ground and isomeric states (half-lives down to less than 2 ms) over a large range of elements have been measured. The experiments provide important information for nuclear structure and nuclear astrophysics. In addition, the use of these MR-TOF-MS goes even beyond these applications, e.g. they can be employed to unambiguously identify and analyze ions independent of their decay properties. This enables novel and universal approaches to measure reaction cross-sections, fission yields, half-lives, and branching ratios. Recent highlights and perspectives from both experiments at GSI and TRIUMF will be presented.

HK 2: Hadron Structure and Spectroscopy I

Time: Monday 16:30–17:45 Location: J-HS A

Group Report HK 2.1 Mon 16:30 J-HS A

Exploring the 3D nucleon structure with CLAS and CLAS12 at JLAB — •Stefan Diehl for the CLAS-Collaboration — Justus Liebig Universität Gießen, 35390 Gießen, Germany — University of Connecticut, Storrs, CT 06269, USA

Exploring the 3-dimensional structure of the nucleon can help to understand several fundamental questions of nature, such as the origin of the nucleon spin and the charge and density distributions inside the nucleon. In QCD, the 3-dimensional structure of the nucleon is described by Wigner functions. However, experimentally momentum and coordinate space have to be accessed independently. The momentum distribution can be accessed by transverse momentum dependent distribution functions (TMDs) measured in semi-inclusive deep inelastic scattering (SIDIS) or Drell-Yan processes, while the distribution in coordinate space is described by generalized parton distributions (GPDs), which can be accessed by deeply virtual Compton scattering (DVCS) and hard exclusive meson production (DVMP). Based on the high quality data of CLAS and the recently upgraded CLAS12 detector at Jefferson Laboratory (JLAB), a detailed study of these distribution functions can be performed. The talk will present the results of recent SIDIS and DVMP studies with CLAS and CLAS12 and their impact on the understanding of the 3D nucleon structure.

HK 2.2 Mon 17:00 J-HS A

SIDIS Kaon Beam Spin Asymmetry Measurements with CLAS12 — •Áron Kripkó[1], Stefan Diehl[1,2], and Kai-Thomas Brinkmann[1] for the CLAS-Collaboration — [1]Justus Liebig Universität Gießen, 35390 Gießen, Germany — [2]University of Connecticut, Storrs, CT 06269, USA

In 2018 the CLAS12 detector started data taking with a polarized 10.6 GeV electron beam at Jefferson Laboratory (JLab). One of the quantities which can be extracted from the data is the moment $A_{LU}^{\sin(\phi)}$ corresponding to the polarized electron beam spin asymmetry in semi-inclusive deep inelastic scattering.

$A_{LU}^{\sin(\phi)}$ is a twist-3 quantity that provides information about the quark gluon correlations. It was studied with a 10.6 GeV longitudinally polarized electron beam and an unpolarized liquid hydrogen target.

The talk will present a simultaneous analysis of two kaon channels (K^+ and K^-) over a large kinematic range with virtualities Q^2 ranging from 1 GeV^2 to 8 GeV^2. The measurement in a large range of z, x_B, p_T and Q^2, including not yet measured kinematic regions, will allow a comparison with different reaction models.

Áron Kripkó is supported by HIC for FAIR.

HK 2.3 Mon 17:15 J-HS A

Analysis of COMPASS data on DVCS — •Johannes Giarra — on behalf of the COMPASS collaboration - Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Johann-Joachim-Becher-Weg 45, 55099 Mainz

In 2016 and 2017 a measurement of the Deeply Virtual Compton Scattering (DVCS) was performed at the M2 beamline of the CERN SPS using 160 GeV positive and negative charged muon beams scattering off a liquid hydrogen target. The scattered muons and the produced real photons were detected by the COMPASS spectrometer, which was supplemented by an additional electromagnetic calorimeter for the de-

tection of large angle photons. The recoil protons were detected by the CAMERA detector, which consists of two barrels of scintillators surrounding the 2.5 m long target. The time of flight (TOF) measurement performed by the detector is used to identify the protons.
The talk will summerize the current status of the analysis of the COMPASS data taking in 2016 on the DVCS cross section.

HK 2.4 Mon 17:30 J-HS A

New study of the two-photon exchange amplitude from polarized electron scatering — D. Balaguer Ríos[1], S. Baunack[1,3], L. Capozza[1], J. Diefenbach[1,2], B. Gläser[1,2], •B. Gou[2], Y. Imai[1,2], E.-M. Kabuss[1], J.H. Lee[1], F. Maas[1,2,3], M. C. Mora Espí[1,2], E. Schilling[1], D. von Harrach[1], and C. Weinrich[1] for the A4-Collaboration — [1]Institut für Kernphysik, Johannes Gutenberg-Universität Mainz — [2]Helmholtz-Institut Mainz — [3]PRISMA Cluster of Excellence, Johannes Gutenberg-Universität Mainz

The study of the two-photon exchange amplitude in lepton scattering has drawn significant interest in the past two decades. This is due to the discrepancy between the Rosenbluth separation and polarization transfer data on the proton form factor ratio. In order to extract hadron structure information correctly in electron nucleon scattering, one needs to understand how two-photon exchange may affect various observables. The transverse single spin asymmetry, which arises from the interference of the one- and two-photon exchange amplitude, provides an excellent testing ground for the two-photon exchange mechanism. The A4 collaboration at the MAMI accelerator in Mainz has performed measurements of the transverse beam spin asymmetry at various beam energies between 300 MeV and 1.5 GeV. Results of a recent analysis will be presented in this talk.

HK 3: Hadron Structure and Spectroscopy II

Time: Monday 16:30–17:30 Location: J-HS M

Group Report HK 3.1 Mon 16:30 J-HS M

Study of multiple $D_{(s)}$-resonant states at e^+e^- colliders. — •Elisabetta Prencipe[1], James Ritman[1], Jens Soeren Lange[2], Ashish Thampi[1], Dmytro Meleshko[3], and Taisiia Tysak[3] — [1]Forschungszentrum Juelich, Germany — [2]Justus-Liebig Univ. Giessen, Germany — [3]Taras Schevchenko National Univ. Kyiv, Ukraine

The systematic study of multiple D and D_s resonances with the BaBar and Belle full data sets will be presented. Too little has been done in this field, due to the limited available statistics.

We want to present preliminary results of our study for the $e^+e^- \to D_s^- D_{s0}^*(2317)^+ X$ and $e^+e^- \to DDDX_c$ processes, in the continuum. In the first analysis, the possibility to fix a better upper limit of the $D_{s0}^*(2317)^+$ width is shown, and confirmation of its spin parity; in the second, we are looking for hexaquark states, and -in case of signal - it would be the first time for the X(3872) to be observed in a different production mechanism than B meson decays, only.

HK 3.2 Mon 17:00 J-HS M

Investigation of Excited Ξ Baryon States in $\bar{p}p$ Collisions with $\overline{P}$ANDA — •Jennifer Pütz, Albrecht Gillitzer, James Ritman, and Tobias Stockmanns — Forschungszentrum Jülich, Jülich, Deutschland

Understanding the excitation pattern of baryons is essential for a deeper insight into the mechanisms of QCD in the non-perturbative regime. Up to now, there is an ongoing worldwide effort on studies of the nucleon excitation spectrum, but our knowledge on excited states of double or triple strange baryons is still rather poor. Combining the antiproton-proton initial states and the capabilities of the detector, the $\overline{P}$ANDA experiment is well-suited for a comprehensive baryon spectroscopy program in the multi-strange sector. A large fraction of the inelastic $\bar{p}p$ cross section is associated to final states with a baryon-antibaryon pair together with additional mesons, giving access to excited states both in the baryon and the antibaryon channel. This study focuses on excited Ξ states, in particular the ΛK^- or $\bar{\Lambda} K^+$ decay of these states are investigated. A cross section in the order of μb, corresponding to production rates of $\sim 10^6$/d at a Luminosity $L = 10^{31}\,\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$ (5% of the design value), are expected for final states containing a $\bar{\Xi}^+\Xi^-$ pair. MC studies to identify the $\bar{\Xi}^+\Lambda K^-$ ($\Xi^-\bar{\Lambda}K^+$) final state and resonant $\Xi^-(\bar{\Xi}^+)$ states with the $\overline{P}$ANDA detector and strategies to determine the spin and parity quantum numbers of specific $\Xi^-(\bar{\Xi}^+)$ states will be presented.

HK 3.3 Mon 17:15 J-HS M

Low-energy constants from charmed baryons on QCD lattices — Yonggoo Heo[1], •Xiao-Yu Guo[2], and Matthias F.M. Lutz[2,3] — [1]Suranaree University of Technology, Nakhon Ratchasima, Thailand — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany — [3]Technische Universität Darmstadt, Darmstadt, Germany

We study the light quark-mass dependence of charmed baryon masses as measured by various QCD lattice collaborations. A global fit to such data based on the chiral SU(3) Lagrangian is reported on. All low-energy constants that are relevant at next-to-next-to-next-to-leading order ($\mathrm{N^3LO}$) are determined from the lattice data sets where constraints from sum rules as they follow from large-N_c QCD at subleading order are considered. The expected hierarchy for the low-energy constants in the $1/N_c$ expansion is confirmed by our global fits to the lattice data. With our results the low-energy interaction of the Goldstone bosons with the charmed baryon ground states is well constrained and the path towards realistic coupled-channel computations in this sector of QCD is prepared.

HK 4: Heavy-Ion Collisions and QCD Phases I

Time: Monday 16:30–18:00 Location: J-HS F

Group Report HK 4.1 Mon 16:30 J-HS F

J/ψ production measurements in pp, p-Pb and Pb-Pb collisions at midrapidity with ALICE at the LHC — •Yvonne Pachmayer for the ALICE-Collaboration — Physikalisches Institut der Universität Heidelberg

J/ψ production is a powerful tool to study the properties of the quark-gluon plasma, since its production is strongly affected by the dense and hot medium created in heavy-ion collisions. In nucleus-nucleus interactions at LHC energies, the charmonium states reveal a smaller suppression with respect to the one measured at lower energies. This is a clear sign of a (re)combination process affecting quarkonium production, which is also confirmed by the measurement of a significant elliptic flow, suggesting a strong participation of the charm quarks in the collectivity of the medium. pp collisions serve not only as an important reference, but also allow quarkonium production models to be constrained and multi-parton interactions to be studied. The influence of cold-nuclear-matter effects is studied in p-Pb collisions.
At midrapidity, the ALICE experiment allows J/ψ production to be measured in the dielectron decay channel down to zero transverse momentum and the prompt and non-prompt contributions to be separated. Further, the electron trigger provided by the Transition Radiation Detector in pp and p-Pb collisions allows the measurements to be extended to intermediate and high transverse momenta.
The large wealth of precise data from the ALICE experiment, recently published and new results from pp, p-Pb and Pb-Pb collisions, will be presented, with comparisons with state-of-the-art theoretical models.

HK 4.2 Mon 17:00 J-HS F

Studies on Midrapidity J/ψ Production as a Function of Charged-Particle Multiplicity in different regions of the azimuthal angle with ALICE — •Ailec de la Caridad Bell Hechavarria for the ALICE-Collaboration — Westfaelische Wilhelms-Universitaet Muenster. Institut fuer Theoretische Physik

The study of the J/ψ meson in correlation with the charged-particle multiplicity is a key observable for the separation of the hard and soft scales, governing, respectively, the production and hadronization of the $c\bar{c}$ pair. Experimentally ALICE studies have shown a stronger than linear relative increase of the inclusive J/ψ production at midrapidity as a function of the charged-particle multiplicity in proton-proton collisions. To shed light on the causes for this behavior Monte Carlo simulations were performed with PYTHIA 8 and the studies attributed part of this behavior to autocorrelation effects. In this regard, interesting results were obtained studying the correlation of the J/ψ production with the charged-particle multiplicity in different regions of the azimuthal angle with respect to the flight direction of the J/ψ meson. With data collected at the LHC with ALICE experiment on proton-proton collisions at $\sqrt{s}$=13 TeV, current results at midrapidity (|y|<0.9) of the J/ψ in correlation with the charged-particle multiplicity in three defined regions of the azimuthal angle (toward, transverse and away) will be shown and compared to predictions from the PYTHIA 8 Monte Carlo generator.

HK 4.3 Mon 17:15 J-HS F

Measurements of J/ψ production in p–Pb collisions at $\sqrt{s_{\rm NN}}$ = 8.16 TeV with ALICE — •Minjung Kim for the ALICE-Collaboration — Physikalisches Institut, Universität Heidelberg

Measurements of J/ψ production in p–Pb collisions are a valuable probe to study cold nuclear matter effects as well as final state mechanisms, which can affect its production.
In ALICE (A Large Ion Collider Experiment), J/ψ production is measured at midrapidity via the dielectron decay channel down to zero transverse momentum ($p_{\rm T}$). The contribution of J/ψ from weak decays of beauty hadrons (non-prompt J/ψ) is separately measured based on the long life time of beauty hadrons.
In this presentation, we will show measurements of inclusive and non-prompt J/ψ production in p–Pb collisions at $\sqrt{s_{\rm NN}}$ = 8.16 TeV. Results from minimum bias collisions as well as from an high–$p_{\rm T}$ electron enriched data sample collected using the Transition Radiation Detector (TRD) will be discussed.

HK 4.4 Mon 17:30 J-HS F

Nuclear modification factor of inclusive J/ψ measured with ALICE at midrapidity in Pb–Pb collisions at $\sqrt{s_{\rm NN}}$ = 5.02 TeV — •Alena Gromada for the ALICE-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung, Planckstr. 1, Darmstadt — Physikalisches Institut, Heidelberg University, Im Neuenheimer Feld 226, Heidelberg

Heavy quarks are produced during hard scatterings at the early stage of nucleus-nucleus collisions. Therefore, the J/ψ meson, a bound state of a charm quark and its antiquark, serves as important probe of Quark-Gluon Plasma (QGP) properties. An in-medium modification can be studied via the nuclear modification factor $R_{\rm AA}$ expressing the difference between yields measured in heavy-ion collisions and the J/ψ cross section in pp collisions multiplied by the nuclear overlap function. A strong J/ψ suppression was observed at SPS and RHIC energies in most central collisions. At the LHC, the suppression is reduced compared to these measurements at lower energies due to the (re)generation of J/ψ from the deconfined medium. However, it is not yet well understood whether this (re)generation process takes place during the QGP phase and/or at hadronization.

A high statistics data sample of central and semi-central Pb–Pb collisions was recorded by ALICE in 2018. In this talk, $R_{\rm AA}$ at midrapidity will be presented as a function of centrality and transverse momentum. The measurement will be compared with previous ALICE results and with model calculations.

HK 4.5 Mon 17:45 J-HS F

Blast-wave description of Upsilon elliptic flow at LHC energies — Klaus Reygers[1], Alexander Schmah[1], •Anastasia Berdnikova[2], and Xu Sun[3] — [1]Physikalisches Institut, Ruprecht-Karls-Universit at Heidelberg, Heidelberg, Germany — [2]National Research Nuclear University MEPhI, Moscow, Russian Federation — [3]Georgia State University, Atlanta, Georgia 30303, USA

A simultaneous blast-wave fit to particle yields and elliptic flow (v_2) measured as a function of transverse momentum in Pb–Pb collisions at LHC energies is presented. A compact formula for the calculation of $v_2(p_T)$ for an elliptic freeze-out surface is used which follows from the Cooper-Frye ansatz without further assumptions. Over the full available p_T range, the Υ elliptic flow data is described by the prediction based on the fit to lighter particles. This prediction shows that, due to the large Υ mass, a sizable elliptic flow is only expected at transverse momenta above 10 GeV/c.

HK 5: Heavy-Ion Collisions and QCD Phases II

Time: Monday 16:30–18:00 Location: J-HS G

Group Report HK 5.1 Mon 16:30 J-HS G

Constraining the Equation of State of Nuclear Matter with Heavy Ion Collisions — •Justin Mohs[1,2,3], Markus Mayer[2], and Hannah Elfner[1,2,3] — [1]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt — [2]Institute for Theoretical Physics, Goethe University Frankfurt am Main — [3]Frankfurt Institute for Advanced Studies, Frankfurt am Main

Heavy ion collisions at SIS 18 energies produce nuclear matter at similar temperature and density as present in neutron star mergers. The aim of this work is to constraint the equation of state of dense nuclear matter from collective flow observables. The azimuthal anisotropy is known to be very sensitive to the employed equation of state and is characterized by flow coefficients. For the calculation of flow coefficients a hadronic transport model (SMASH) is employed, where the equation of state enters the calculation in form of nuclear mean field potentials. A Skyrme potential is used with different parameter sets to vary the stiffness of the equation of state. This is a first step towards a more systematic study with a state-of-the-art description of nuclear potentials and Bayesian parameter estimation.

HK 5.2 Mon 17:00 J-HS G

Multi-particle reactions in hadronic transport approaches — •Jan Staudenmaier[2,3] and Hannah Elfner[1,2,3] — [1]GSI Helmholtzzentrum für Schwerionenforschung, Planckstr. 1, 64291 Darmstadt — [2]Institut für Theoretische Physik, Johann Wolfgang Goethe-Universität, Max-von-Laue-Str. 1, 60438 Frankfurt am Main — [3]Frankfurt Institute for Advanced Studies (FIAS), Ruth-Moufang-Straße 1, 60438 Frankfurt am Main

Nucleus-nucleus collisions at intermediate energies are in progress at BES-II and will also be explored by upcoming experiments at FAIR and NICA. Such collisions offer an unique opportunity to study high particle densities. In such conditions multi-particle reactions are expected to become relevant. Hadronic transport approaches, however, usually only treat binary scatterings, which, in addition, also breaks detailed balance for baryon anti-baryon annihilations and decays of resonances with more than two particles in the final state.

In this talk, a stochastic scattering criterion that allows for a straight forward treatment of multi-particle reactions is presented. The hadronic transport approach named SMASH is extended to include this stochastic criterion. Infinite matter calculations are used to study the scattering rate and detailed balance for the treatment in a systematic way. Furthermore, first results for nucleus-nucleus collisions employing the stochastic criterion are shown.

HK 5.3 Mon 17:15 J-HS G

Development of attractor solutions within the kinetic Boltzmann parton cascade — •Benjamin Schüller[1], Gabriel Denicol[2], Kai Gallmeister[1] und Carsten Greiner[1] — [1]Institut für Theoretische Physik, Goethe Universität, Frankfurt/Main — [2]Instituto de Física, Universidade Federal Fluminense

We investigate the longitudinal boost invariant Bjorken expansion of a gluon gas in the transversal plane for different initial particle distributions using either a set of constant cross sections or a set of constant values for the shear viscosity to entropy ratio with the partonic transport casacade BAMPS ("Boltzmann Approach to Multi-Parton Scatterings").

As a first scenario the particle distribution is constant in the transverse plane (0+1D expansion), whereas the second scenario comprises a symmetric transversal Gaussian profile (1+1D expansion). Further-

more, we investigate the influence of different degrees of anisotropy of the momentum space on the evolution of the system. We compute the time evolution of several quantities like π/P and P_L/P_T. In doing so, we observe that irrespective of the degree of anisotropy in momentum space the different observables merge into one another as an attractor in the course of time. Finally, we compare our results to the results of relativistic viscous fluid dynamics and obtain very good agreement for the 0+1D expansion and only fair agreement for the 1+1D expansion.

Supported by BMBF and GSI F&E.

HK 5.4 Mon 17:30 J-HS G

The Shear Viscosity to Entropy Density Ratio of Hagedorn States — •Jan Rais, Kai Gallmeister, and Carsten Greiner — Institut für Theoretische Physik, Goethe Universität, Frankfurt/Main

The fireball concept of Rolf Hagedorn, developed in the 1960's, is an alternative description of hadronic matter. Using a recently derived mass spectrum, we use the transport model GiBUU to calculate the shear viscosity of a gas of such Hagedorn states, applying the Green-Kubo method to Monte-Carlo calculations. Since the entropy density is rising ad infinitum near T_H, this leads to a very low shear viscosity to entropy density ratio near T_H. Further, by comparing our results with analytic expressions, we find a nice extrapolation behaviour, indicating that a gas of Hagedorn states comes close or even below the boundary $1/4\pi$ from AdS-CFT.

HK 5.5 Mon 17:45 J-HS G

A relativistic diffusion model from nonequilibrium-statistical considerations — •Johannes Hölck and Georg Wolschin — Institut für Theoretische Physik der Universität Heidelberg, Philosophenweg 12/16

A derivation of a Fokker–Planck-type relativistic diffusion model (RDM) from nonequilibrium statistics is considered. The model describes the evolution of centrality-dependent (pseudo-)rapidity distributions of produced charged particles and net protons in relativistic heavy-ion collisions, agreeing with experimental data from RHIC and LHC at various center-of-mass energies.

By separating the system into three subsystems – two fragmentation sources and the central fireball – we account for the different physical processes in and the spatial separation of the three corresponding particle production sources. The drift and diffusion coefficient functions are addressed by considering the expected asymptotic distributions which are used to derive the fluctuation–dissipation relations of the subsystems.

HK 6: Structure and Dynamics of Nuclei I

Time: Monday 16:30–18:00 Location: J-HS E

Group Report HK 6.1 Mon 16:30 J-HS E

Constraints on the symmetry energy from dipole excitations and neutron-removal cross-sections — •Andrea Horvat[1,2], Thomas Aumann[1,2], Konstanze Boretzky[2], Ashton Falduto[1,2], Dominic Rossi[1,2], Heiko Scheit[1], Dmytro Symochko[1], Patrick van Beek[1], and Lorenzo Zanetti[1,2] — [1]Technische Universität Darmstadt — [2]GSI Helmholtzzentrum, Darmstadt

The understanding of the equation of state (EOS) of isospin-asymmetric nuclear matter around saturation density is of crucial importance for the description of exotic nuclei and astrophysical processes. The symmetry energy, describing the isospin-dependence of the EOS, is parametrized by its value at saturation (J) and the slope (L), with the latter quantity still poorly constrained. For this purpose, we aim to experimentally determine the values of selected observables exhibiting sensitivity to varying L in calculations within the scope of energy density functional theory. The newly upgraded R^{3}B setup with the R3B-GLAD spectrometer and the NeuLAND neutron detector at GSI provide a unique opportunity to determine the Coulomb excitation and neutron-removal cross sections of heavy neutron-rich nuclei at energies between 400 and 1000 MeV/nucleon. The dipole response of stable nuclei will be investigated using monoenergetic (GACKO, NewSUBARU) and energy-tagged photons (NEPTUN, S-DALINAC) , complementing the approach with rare isotope beams.

Supported by BMBF via project No. 05P15RDFN1, GSI-TU Darmstadt cooperation agreement, DFG through grant No. SFB 1245, and HMWK through the LOEWE centre *Nuclear Photonics*.

HK 6.2 Mon 17:00 J-HS E

Phase-0 Experiments using the R3B CALIFA Calorimeter — •Lukas Ponnath for the R3B-Collaboration — Technische Universität München

According to recent observations neutron-star mergers providing a suitable system for the rapid neutron capture process (r-process) nucleosynthesis and thus for the origin of the heaviest elements in the universe. This process is dominated by nuclei with an extreme proton-to-neutron asymmetry which are guiding the the r-process-path through the nuclear chart far from stability.

The upcoming R3B (Reactions with Relativistic Radioactive Ion Beams) experiment at the research facility FAIR, currently under construction in Darmstadt, will enable kinematic complete measurements to gain a deep insight and understanding of the structure of these exotic nuclei.

One of the key instruments of the R3B experimental setup is the highly segmented CALIFA calorimeter surrounding the R3B reaction target. For the simultaneous in flight detection of gamma-rays and light charged particles CALIFA will provide unique resolution for relativistic beam energies.

We will present first results of the Phase-0 experiment of R3B where we operated the CALIFA demonstrator combined with R3B detectors and the GLAD magnet for the first time.

HK 6.3 Mon 17:15 J-HS E

Lifetime Measurement of the ^{26}O g.s. at SAMURAI — •Sonja Storck[1,3], Thomas Aumann[1,2], Christoph Caesar[2,3], Julian Kahlbow[1,2], and Dominic Rossi[1] for the NeuLAND-SAMURAI-Collaboration — [1]Institut für Kernphysik, TU Darmstadt — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt — [3]RIKEN Nishina Center, Tokyo

The ground state of the neutron unbound nucleus ^{26}O is speculated to have a lifetime in the pico-second regime. In order to determine the decay lifetime of the ^{26}O ground state with high sensitivity and precision, a new method has been applied. The experiment was performed in December 2016 at the Superconducting Analyzer for MUltiparticle from RadioIsotope Beams (SAMURAI) at the Radioactive Isotope Beam Factory (RIBF) at RIKEN. A ^{27}F beam was produced in the fragment separator BigRIPS and impinged on a W/Pt target stack where ^{26}O was produced. According to the lifetime, the decay of ^{26}O happens either in or outside the target. Thus, the velocity difference between the decay neutrons and the fragment ^{24}O delivers a characteristic spectrum from which the lifetime can be extracted. In the report, the experimental setup and method are introduced and the current analysis status is presented.

This work is supported by the DFG through grant no. SFB 1245, the BMBF under contract number 05P15RDFN1 and the GSI-TU Darmstadt cooperation agreement.

HK 6.4 Mon 17:30 J-HS E

Towards Laser Spectroscopy of Boron-8 — •Bernhard Maass[1], Jason Clark[3], Phillip Imgram[1], Kristian König[2], Jörg Krämer[1], Tim Lellinger[1], Peter Müller[3], Tim Ratajczyk[1], Rodolfo Sánchez[4], Guy Savard[3], Felix Sommer[1], and Wilfried Nörtershäuser[1] — [1]IKP, TU Darmstadt, DE — [2]NSCL, East Lansing, MI, USA — [3]ANL, Lemont, IL, USA — [4]GSI, Darmstadt, DE

We report on our progress towards confirming the exotic structure of the proton-halo candidate ^{8}B. So far, only model-dependent experimental evidence exists which suggests a strong increase in nuclear charge radius. This observable can be accessed model-independently by a laser-spectroscopic investigation, benchmarking not only the results of almost three decades of research, but also of nuclear theory approaches to model this exotic nucleus.

A precursor resonance laser ionization mass spectrometry experiment was performed on stable boron isotopes at TU Darmstadt, delivering the difference in mean-squared nuclear charge radius between ^{10}B and ^{11}B. It also proved the disposability of the atomic theory calculations which are necessary to interpret the results. Apart from the

results of this experiment, updates from the ongoing effort to extend it to ^{8}B at Argonne National Laboratory will be presented.

This work is supported by the U.S. DOE, Office of Science, Office of Nuclear Physics, under contract DE-AC02-06CH11357, and by the Deutsche Forschungsgemeinschaft through Grant SFB 1245.

HK 6.5 Mon 17:45 J-HS E

Collinear and anti-collinear laser spectroscopy measurements on He-like ^{11}B and ^{10}B — •A. Buss[1], Z. Andelkovic[2], V. M. Hannen[1], P. Imgram[3], K. Mohr[3], R. Sánchez[2], W. Nörtershäuser[3], C. Weinheimer[1], B. Maass[3], K. König[4], J. Krämer[3], and S. Rausch[3] — [1]IKP, WWU Münster — [2]GSI, Darmstadt — [3]IKP, TU Darmstadt — [4]NSCL, MSU

We present preliminary results of hyperfine spectroscopy measurements on He-like boron atoms. In particular, experimental results for ^{11}B and previously unobserved HFS transitions in ^{10}B are presented.

The measurements have been performed at the HITRAP facility, using a local ion source and a beam line leading to the SPECTRAP experiment. A downscaled version of the CRYRING fluorescence detector was installed on top of the SPECTRAP magnet. The detector was built as a general purpose detector for collinear and anti-collinear laser spectroscopy experiments and is able to detect fluorescence photons in a wavelength range from 250 nm to 900 nm. Together with a frequency doubled continous wave laser system, the setup enables high precision measurements of the hyperfine transitions $1s2s\,^3S_1 \rightarrow 1s2p\,^3P_{0,1,2}$. The metastable $^3S_1$ state in ^{11}B and ^{10}B is populated in an up to now unknown fraction of the ions produced in the local electron beam ion source (EBIS). Uncertainties in the ions' acceleration voltage can be eliminated by combining collinear and anti-collinear measurements of the same transition and therefore allow a precise determination of the transition wavelengths. This work is supported by BMBF under contract numbers 05P19PMFA1 and 05P19RDFAA.

HK 7: Structure and Dynamics of Nuclei II

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

Group Report HK 7.1 Mon 16:30 J-HS H

Investigation of the low-lying dipole response in photon-scattering experiments — •Miriam Müscher[1], Johann Isaak[2], Deniz Savran[3], Ronald Schwengner[4], Werner Tornow[5], Julius Wilhelmy[1], and Andreas Zilges[1] — [1]Institute for Nuclear Physics, University of Cologne — [2]Institute for Nuclear Physics, TU Darmstadt — [3]GSI, Darmstadt — [4]Helmholtz-Zentrum Dresden-Rossendorf — [5]Department of Physics, Duke University

The photoabsorption cross sections of atomic nuclei have great impact on reaction rates in nucleosynthesis processes. For instance, the occurrence of additional dipole strength below and around the particle separation threshold, often denoted by Pygmy Dipole Resonance [1], enhances the reaction rates in the rapid neutron-capture process [2].

Photon-scattering experiments are well-suited to selectively study dipole excited states [3]. Photoabsorption cross sections as well as spin and parity quantum numbers can be extracted in a model-independent way. Recent results of complementary (γ,γ') experiments with "white" bremsstrahlung beams (at DHIPS [4] and γELBE [5]) and with quasi-monoenergetic photons (at HIγS [6]) will be presented.

This work is supported by the BMBF (05P18PKEN9).

[1] D. Savran *et al.*, Prog. Part. Nucl. Phys. **70** (2013) 210
[2] S. Goriely, Phys. Lett. B **436** (1998) 10
[3] U. Kneissl *et al.*, Prog. Part. Nucl. Phys. **37** (1996) 349
[4] K. Sonnabend *et al.*, Nucl. Instr. and Meth. A **640** (2011) 6
[5] R. Schwengner *et al.*, Nucl. Instr. and Meth. A **555** (2005) 211
[6] H.R. Weller *et al.*, Prog. Part. Nucl. Phys. **62** (2009) 257

HK 7.2 Mon 17:00 J-HS H

Test of photon strength functions for the well-deformed ^{164}Dy — •O. Papst[1], V. Werner[1,2], N. Pietralla[1], T. Beck[1], C. Bernards[2], N. Cooper[2], B.P. Crider[3,4], U. Friman-Gayer[1], J. Isaak[1], J. Kleemann[1], FNU Krishichayan[5], B. Löher[6], F. Naqvi[2,7], E.E. Peters[3], F.M. Prados-Estevez[3], R.S. Ilieva[2,8], T.J. Ross[3], D. Savran[6], M. Scheck[1,9], W. Tornow[5], and J.R. Vanhoy[10] — [1]IKP, TU Darmstadt — [2]WNSL, Yale U., New Haven, CT, USA — [3]UKY, Lexington, KY, USA — [4]MSU, East Lansing, MI, USA — [5]Duke U. & TUNL, Durham, NC, USA — [6]GSI, Darmstadt — [7]U. Delhi, India — [8]UNIS, Guildford, UK — [9]UWS, Paisley & SUPA, Glasgow, UK — [10]USNA, Annapolis, MD, USA

For heavy nulei, low-lying E1 strength referred to as Pygmy Dipole Resonance is often related to a semi-collective oscillation of a neutron skin. A sensitivity to the nucleus' symmetry axes can be expected, resulting in a separation into two parts (K-splitting) for axially deformed nuclei. Data is sparse for such nuclei. In nuclear resonance fluorescence experiments performed at the High Intensity γ-ray Source (HIγS), the dipole strength of the deformed ^{164}Dy was probed using a polarized, quasi-monochromatic γ-ray beam.

Above 4 MeV, a dominance of E1 strength is observed. Due to high level densities, only mean properties such as the average decay behavior are accessible above 5 MeV. The results are compared to experiments using complementary probes and statistical model simulations.

* Supported by the DFG under grant SFB1245 and by the State of Hesse under grant "Nuclear Photonics" within the LOEWE program.

HK 7.3 Mon 17:15 J-HS H

Isovector-$E2$ strength of the scissors mode of ^{152}Sm — •K.E. Ide[1], T. Beck[1], M. Berger[1], S. Finch[2], U. Friman-Gayer[1], J. Kleemann[1], FNU Krishichayan[2], B. Löher[1], O. Papst[1], N. Pietralla[1], D. Savran[3], W. Tornow[2], M. Weinert[4], V. Werner[1], and J. Wiederhold[1] — [1]IKP, TU Darmstadt — [2]TUNL, Duke University, Durham NC, USA — [3]GSI, Darmstadt — [4]IKP, Universität zu Köln

The nucleus ^{152}Sm is well known to be located at the $N = 90$ quantum shape-phase transition (QSPT) boundary, mainly set by the residual forces between valence protons and neutrons. Since the scissors mode (SM) is a collective, isovector excitation, its decay characteristics are highly dependent on these forces and sensitive to the QSPT. The SM is known for its $M1$-excitation strength, however, data on isovector $E2$ properties are sparse [1]. The SM of ^{152}Sm was investigated in a nuclear resonance fluorescence experiment performed at the High-Intensity γ-Ray Source with a quasi-monoenergetic, polarized photon beam with an energy of 2.99(5) MeV. Emitted photons were detected by four high-purity germanium detectors positioned at angles sensitive to the multipolarities of the decay radiation of 1^π states. The isovector $E2$ transition of the SM of ^{152}Sm to its first 2^+ state has been deduced from the $E2/M1$ multipole mixing ratio of the $1^+_{sc} \rightarrow 2^+_1$ transition. Experimental results are compared to predictions of the interacting boson model 2, yielding proton and neutron effective boson charges.

*Supported by the DFG under grant No. SFB 1245

[1] T.Beck *et al.*, Phys. Rev. Lett. **118** (2017) 212502

HK 7.4 Mon 17:30 J-HS H

Constraining $0\nu\beta\beta$-decay nuclear matrix elements with NRF* — •J. Kleemann[1], T. Beck[1], U. Friman-Gayer[1], N. Pietralla[1], V. Werner[1], S. Finch[2], J. Kotila[3], FNU Krishichayan[2], B. Löher[1], H. Pai[1,4], O. Papst[1], W. Tornow[2], M. Weinert[5], and A. Zilges[5] — [1]IKP, TU Darmstadt — [2]TUNL, Duke University, Durham NC, USA — [3]University of Jyväskylä, Finland — [4]SINP, Kolkata, India — [5]IKP, Universität zu Köln

The search for neutrinoless double beta ($0\nu\beta\beta$) decay, a process only allowed if the neutrino is a Majorana particle, recently gained much attention with numerous experiments being dedicated to it. While the neutrino mass could be determined from its decay rate, to do so a nuclear matrix element (NME) is required, which has to be calculated using nuclear structure models. To constrain such calculations for the $0\nu\beta\beta$-decay of ^{150}Nd to ^{150}Sm new data on the decay characteristics of the scissors mode of these nuclei was recently taken in nuclear resonance fluorescence (NRF) experiments performed at the High Intensity γ-ray Source at Duke University. The decay characteristics of the scissors mode are sensitive to the nuclear deformation and allow inducing constraints on model parameters, especially the Majorana parameters of the Interacting Boson Model 2 (IBM-2), in turn resulting in a more reliable prediction of the $0\nu\beta\beta$-NME [1]. The experimental results and updated IBM-2 calculations will be presented and discussed.

[1] J. Beller *et al.* Phys. Rev. Lett. **111**, 172501 (2013)

*Supported by the DFG through the research grant SFB 1245 and by the State of Hesse under the LOEWE grant Nuclear Photonics.

HK 7.5 Mon 17:45 J-HS H

Sudden regime of laser-nucleus interaction with neutron evaporation — •Sergei Kobzak, Hans Weidenmüller, and Adriana Pálffy — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

At the Extreme Light Infrastructure facility under construction in Romania or at the Gamma Factory envisaged at the LHC, intense and partially coherent photon beams with energies ranging up to several MeV should soon become available. Novel experiments employing a laser beam with photon energies comparable to typical nuclear excitation energies will shed light on a number of questions and will open new unexplored avenues for nuclear physics [1,2].

In this work we investigate theoretically the interaction of such intense MeV gamma-ray pulses with medium-weight nuclei. The time-dependent interplay between the rates of average photon absorption, statistical equilibration and neutron evaporation is studied with the help of the master equation [2]. The sudden regime of laser-nucleus interaction refers to the case when photon absorption occurs faster than the complete nuclear equilibration of the nucleus. Consequently, multiple photon absorptions lead to neutron evaporation. We investigate the time scales of compound nucleus equilibration, as well as lifetimes of state classes with different particle-hole numbers and refer them to the spreading width of the giant dipole resonance.

[1] A. Pálffy and H. A. Weidenmüller, PRL 112, 192502 (2014).
[2] A. Pálffy, O. Buss, A. Hoefer and H. A. Weidenmüller, PRC 92, 044619 (2015).

HK 8: Fundamental Symmetries I

Time: Monday 16:30–17:45 Location: J-HS B

Group Report HK 8.1 Mon 16:30 J-HS B

Inputs to the Hadronic Contributions to $(g-2)_\mu$ from BESIII — •Christoph Florian Redmer and Achim Denig — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, 55128 Mainz, Germany

The Standard Model prediction of the anomalous magnetic moment of the muon $a_\mu = (g-2)_\mu/2$ is limited by its hadronic contributions, due to the non-perturbative nature of the strong interaction at the relevant energy scales. In order to establish the significance of the long standing discrepancy between the direct measurement and the prediction of currently three to four σ, both, experiment and theory, need to be improved. Recently developed data driven approaches allow to make use of related information obtained in precision measurements to reduce the uncertainties of the Standard Model prediction of a_μ.

The BESIII collaboration embarked on a dedicated experimental program of hadronic cross section and transition form factor measurements to provide inputs to the calculations. The large data samples acquired at center of mass energies at and above the $\psi(3770)$ peak allow to determine exclusive hadronic cross sections with high accuracy at energies below 2 GeV using the technique of initial state radiation. The single-tagged investigation of two-photon processes allows to measure transition form factors of light pseudoscalar mesons and meson systems in the range of momentum transfers, which is most relevant to the a_μ calculations.

In this presentation we discuss recent results, ongoing projects, and the prospects of the efforts at BESIII — Supported by DFG SFB1044.

HK 8.2 Mon 17:00 J-HS B

A new measurement of the electric dipole moment of the neutron — •Dieter Ries — Institut für Kernchemie, Johannes-Gutenberg-Universität, Mainz

A non-zero electric dipole moment of the neutron (nEDM) would violate CP symmetry, and thus would be an indication for a new source of CP violation, which might help to explain the matter to antimatter asymmetry in our universe.

The nEDM collaboration has taken data at the Paul Scherrer Institute in 2015 and 2016 in order to improve on the previous limit $d_n < 3 \times 10^{-26} e \cdot cm$ at 90% C.L. [1].

In total more than 54000 individual measurement cycles were recorded using Ramsey's method of separated oscillating fields to measure the precession frequency of ultracold neutrons in electric and magnetic fields. The analysis of this dataset has been carried out in a blind fashion.

The collaboration has un-blinded their result at the end of November 2019.

The new result will be presented together with a detailed description of the experiment.

[1]: J.M. Pendlebury et al. PRD 92, 092003 (2015)

HK 8.3 Mon 17:15 J-HS B

Status of the neutron lifetime experiment τSPECT — •Kim Ulrike Ross[1], Peter Blümler[2], Martin Fertl[2], Werner Heil[2], Jan Kahlenberg[2], Simon Kaufmann[1], Dieter Ries[1], and Christian Schmidt[2] — [1]Institute of Nuclear Chemistry, Johannes Gutenberg University Mainz, Germany — [2]Institute of Physics, Johannes Gutenberg University Mainz, Germany

The τSPECT experiment aims to measure the neutron lifetime τ_n using a 3D magnetic storage technique. Due to the neutron's magnetic moment, very low-energetic neutrons (ultracold neutrons, UCN) with a maximum energy of ≈ 50 neV can be stored in the magnetic trap with a volume of ≈ 8 litres. τSPECT is designed to determine τ_n using two independent measurement methods. In phase I, surviving UCN in the storage volume after varying storage times are counted. Phase II involves the in-situ detection of decay protons. A proof-of-principle measurement using the magnetic field of the former aSPECT spectrometer (double hump structure) for longitudinal confinement and a fused silica tube for radial storage has been performed in July 2015. Since then, besides the successful upgrade of the UCN D source at the pulsed research reactor Mainz, the 3D magnetic trap using a magnetic octupole for the radial confinement has been installed and commissioned. Other relevant components are a movable neutron guide system with an adiabatic fast passage (AFP) spin flipper as well as a custom-designed UCN detector (boron-coated ZnS:Ag scintillator). We will present the current status of the experiment and the progress of the initial commissioning runs.

HK 8.4 Mon 17:30 J-HS B

Investigation of helicity correlated false asymmetries at the P2 experiment — Sebastian Baunack[1], Dominik Becker[1], Kathrin Imai[1], Rahima Krini[1], Frank Maas[1,2,3], David Rodriguez Pineiro[2], and •Malte Wilfert[1] for the P2-Collaboration — [1]Institut für Kernphysik, Johannes Gutenberg-Universität Mainz — [2]Helmholtz-Institut Mainz, Johannes Gutenberg-Universität Mainz — [3]PRISMA Cluster of Excellence, Johannes Gutenberg-Universität Mainz

The weak mixing angle $\sin^2\theta_W$ can be measured in parity violating elastic electron-proton scattering. The aim of the P2 experiment is a very precise measurement of the weak mixing angle with a precision of 0.15% at a low four-momentum transfer of $Q^2 = 4.5 \cdot 10^{-3}\,\mathrm{GeV}^2$. This precision is comparable to existing measurements at the Z pole. The experiment will be built at the future MESA accelerator in Mainz.

The achievable precision in the measurement of the parity violating asymmetry depends not only on the statistical uncertainty, it also depends on various systematic effects. One of them are helicity correlated differences in beam parameters like energy, position and angle. The false asymmetry induced by such fluctuations is described in this talk.

HK 9: Instrumentation I

Time: Monday 16:30–18:00 Location: J-HS C

HK 9.1 Mon 16:30 J-HS C

Energy Resolution of a Compton Camera Absorber Detector with SiPM Readout for up to 6.13 MeV — •Tim Binder[1,2], Katia Parodi[1], Florian Schneider[2], and Peter G. Thirolf[1] — [1]Ludwig-Maximilians Universität, Munich, Germany — [2]KETEK GmbH, Munich, Germany

The capability of spatially resolved γ detection is required in many applications in modern physics. A Compton camera (CC) allows to spatially resolve the γ-ray origin while still providing an acceptable efficiency compared to other detection setups. In medical physics a CC can be used to detect prompt γrays to verify the range of a hadron beam in the body during a patient's tumor treatment or to detect a higher energetic γ ($\sim$1.5 MeV) which is coincidently emitted by a β^+ emitter (e.g. ^{44}Sr) in a so-called Gamma-PET scanner. The γ origin is obtained, by using the kinematics of Compton scattering, where the energy and interaction position of the primary and the scattered γ is of major interest. Consequently, the energy resolution of the CC, consisting of a scatter and an absorber detector, is a key parameter.In this work, the energy resolution over a wide energy range (100 - 6130 keV) of a monolithic (50 x 50 x 30 mm^3) $LaBr_3$:Ce and a $CeBr_3$ scintillator, respectively, with KETEK SiPM array readout and the PETsys TOFPET2 ASIC data acquisition system will be presented. Furthermore, a comparison study between SiPM with 25 μm and 50 μm microcell sizes will be shown and compared to a PMT readout. This work was supported by the DFG Cluster of Excellence MAP (Munich-Centre for Advanced Photonics) and the Bayerische Forschungsstiftung.

HK 9.2 Mon 16:45 J-HS C

The multi-detector array ELIADE at the Extreme Light Infrastructure ELI-NP — •Julius Wilhelmy[1], Calin Alexandru Ur[2], Andreas Zilges[1], Norbert Pietralla[3], Tobias Beck[3], Anukul Dhal[2], Bastian Löher[4], Miriam Müscher[1], Alfio Pappalardo[2], George Pascovici[2], Cristian Petcu[2], Deniz Savran[4], Gabriel Suliman[2], and Volker Werner[3] — [1]Institute for Nuclear Physics, University of Cologne — [2]ELI-NP, Bucharest — [3]Institute for Nuclear Physics, TU Darmstadt — [4]GSI, Darmstadt

The new γ-beam system at the ELI-NP (Extreme Light Infrastructure - Nuclear Physics) facility will provide highly brilliant and almost monoenergetic γ-ray beams with unprecedented intensities at very narrow bandwidths. Via the Nuclear Resonance Fluorescence (NRF) technique, many experimental quantities can be deduced in a model-independent way, such as level energies and widths, γ-decay branching ratios, and spin and parity quantum numbers.

This contribution will present an overview and the current status of ELIADE, a multi-detector array comprised of HPGe detectors and large-volume $LaBr_3$ detectors.

Supported by the Project Extreme Light Infrastructure - Nuclear Physics (ELI-NP) - co-financed by the Romanian Government, the European Union through the European Regional Development Fund and the BMBF (05P18PKEN9 and 05P18RDEN9).

HK 9.3 Mon 17:00 J-HS C

A new digital data acquisition system for AGATA at IKP Cologne — •Rouven Hirsch[1], Robert Hetzenegger[1], Dino Bazzacco[2], Jürgen Eberth[1], Herbert Hess[1], Lars Lewandowski[1], and Peter Reiter[1] — [1]IKP Universität zu Köln, Cologne, Germany — [2]INFN - LNL, Padua, Italy

An AGATA triple cryostat (ATC) consists of three 36-fold segmented encapsulated large volume High Purity Germanium (HPGe) detectors. As part of any assembly or maintenance cycle the performance of the detector system has to be characterized. In the past multiple measurements with analog and digital electronics were needed to measure the required performance values. The existing setup was replaced with a new digital data aquisition system at the IKP Cologne. It is based on the latest AGATA phase 1 digital electronics and allows the simultaneous readout of all 111 high resolution spectroscopic channels of one ATC system. The main performance values such as the energy resolution, crosstalk, position resolution after pulse shape analysis (PSA) and γ-ray tracking of a complete ATC detector system were measured efficiently. Results obtained with the new data acquisition system demonstrate superior energy resolution and count rate capabilities. PSA and γ-ray tracking were performed in a time efficient way with high accuracy.

HK 9.4 Mon 17:15 J-HS C

SORCERER: A novel particle-detection system for transfer-reaction experiments at ROSPHERE — •Tobias Beck[1], Cristian Costache[2], Razvan Lică[2], Nicolae M. Mărginean[2], Constantin Mihai[2], Radu E. Mihai[2], Oliver Papst[1], Sorin Pascu[2], Norbert Pietralla[1], Christophe Sotty[2], Lucian Stan[2], Andrei E. Turturică[2], Volker Werner[1], Johannes Wiederhold[1], and Waldemar Witt[1] — [1]IKP, TU Darmstadt — [2]IFIN-HH, Bucharest, Romania

Transfer-reactions have proven to be suitable for the population of low-abundant or unstable nuclei close to the valley of stability though they usually suffer from excessive background due to fusion-evaporation (FE) reactions. SORCERER [1] is a customizable and cost-efficient particle-detection system for such transfer experiments to be studied with the ROSPHERE detector array [2] at the Bucharest Tandem accelerator. It allows for an efficient suppression of contributions from FE reactions and an improvement of the peak-to-background ratio by about one order of magnitude. The construction, characteristics, and performance in a ^{94}Zr(^{18}O,^{16}O)^{96}Zr experiment are presented and further developments are outlined.

[1] T. Beck *et al.*, Nucl. Inst. Meth. Phys. A **951** (2020) 163090
[2] D. Bucurescu *et al.*, Nucl. Inst. Meth. Phys. A **837** (2016) 1

HK 9.5 Mon 17:30 J-HS C

Status report on NEPTUN upgrade and first data analysis results — •Patrick van Beek[1], Thomas Aumann[1,2], Martin Baumann[1], Alexander Fuchs[1], Daniel Körper[1,2], Yevhen Kozymka[1], Heiko Scheit[1], and Dmytro Symochko[1] — [1]TU Darmstadt — [2]GSI Helmholtzzentrum

The low-energy photon tagging facility NEPTUN at the superconducting Darmstadt linear accelerator (S-DALINAC) can be used to study the photoabsorption cross section of nuclei in the energy regions of Pygmy Dipole and Giant Dipole Resonances. The electric dipole polarizability can be deduced from the photo nuclear response, which can be used to further constrain the symmetry energy in the equation of state.
After a major upgrade, the setup allows photoabsorption cross section measurements from 5 MeV – 35 MeV within a single spectrometer setting, effectively covering energies well below and far above particle separation threshold. It was furthermore extended by the target positioning system PROTEUS, which ensures a precise and rapid target exchange.
Commissioning data on ^{27}Al has been taken. The current setup and the status of data analysis will be presented.
Supported by DFG (SFB 1245).

HK 9.6 Mon 17:45 J-HS C

New Two-Photon Decay Experiments - Status and First Results — •Martin Baumann[1], Thomas Aumann[1,2], Michael Beckstein[1], Patrick van Beek[1], Daniel Körper[2], Bastian Löher[2], Heiko Scheit[1], and Dmytro Symochko[1] — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]GSI Helmholtzzentrum, Darmstadt, Germany

The 4π NaI detector array Heidelberg-Darmstadt Crystal Ball has been modified to host up to 18 LaBr3 detectors. In combination with a new compton suppression system called BACCHUS this makes new experimental studies of the competitive two-photon nuclear decay possible, significantly reducing measurement time in comparison to previous experiments. Also the angular distribution between the two emitted photons can be now probed for a larger set of angles. The new setup and first results for the $\frac{11}{2}^-$ state of 137-Ba will be presented.
Supported by DFG (SFB 1245)

HK 10: Instrumentation II

Time: Monday 16:30–18:00 Location: J-HS D

HK 10.1 Mon 16:30 J-HS D

Einsatz des Optimierungsframeworks Geneva in der Physik — •Jannis Geuppert[1], Kilian Schwarz[1], Jan Knedlik[1], Denis Bertini[1], Matthias Lutz[1] und Rüdiger Berlich[2] — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Planckstraße 1, 64291 Darmstadt — [2]Gemfony scientific UG, Hauptstraße 2, 76344 Eggenstein-Leopoldshafen

Das Optimierungsframework Geneva wird nach mehreren Jahren weiterhin bei GSI erfolgreich zur parametrischen Optimierung technischer und wissenschaftlicher Fragestellungen auf Clustern sowie lokalen parallelen Recheneinheiten eingesetzt. Im Vortrag wird ein Überblick über die Funktionen und Anwendungsbereiche von Geneva gegeben, bereits mit Geneva durchgeführte Projekte werden präsentiert sowie wichtige vollzogene Änderungen diskutiert. Dies beinhaltet die Implementierung einer generischen Schnittstelle zu Geneva über welche Nutzer ihre Funktionen optimieren lassen können als auch erste Ansätze wie sich Fehlerrechnungen mit Hilfe von Geneva durchführen lassen. Darüber hinaus wurde ein Lizenzwechsel hin zu der Apache-Lizenz 2.0 sowie ein Github-Release vollzogen.

HK 10.2 Mon 16:45 J-HS D

Debugging as addition to Monitoring of Compute Clusters — •Alexander Adler and Udo Kebschull — Goethe-Universität Frankfurt

Monitoring is an indispensible tool for the operation of any large installment of grid or cluster computing. Usually, monitoring is configured to collect a small amount of data, just enough to enable detection of abnormal conditions. Once detected, the abnormal condition is handled by gathering all information from the affected components. This data is processed by querying it in a manner similar to a database. This contribution shows how the metaphor of a debugger (for software applications) can be transferred to a compute cluster. The concepts of variables, assertions and breakpoints known from software debugging can be applied to monitoring by defining variables as the quantities recorded by monitoring and breakpoints as invariants formulated through these variables. It is found that embedding fragments of a data extracting and reporting tool such as the UNIX tool awk facilitates very concise notations for commonly used variables since tools like AWK are designed to process large event streams (in textual representations) with bounded memory. Additionally, it is found that a functional notation similar to both the pipe notation used in the UNIX shell and the pointfree style used in functional programming facilitates concise combinations of variables that commonly occur when formulating breakpoints.

HK 10.3 Mon 17:00 J-HS D

Vorstellung eines Data-Lake-Konzepts für FAIR — •Paul-Niklas Kramp — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Deutschland

Im Rahmen dieses Vortrags wird ein Konzept eines Data Lakes vorgestellt, welches den zukünftigen Ansprüchen des FAIR-Experimentes hinsichtlich der geforderten Funktionalität entspricht und auch als Anregung für die anderen, vor ähnlichen Problemen stehenden Bereiche der Wissenschaft dienen kann.
Konkreter wird ein Konzept einer verteilten Datenspeicherinfrastruktur vorgestellt, welche benutzbar, sicher, heterogen, modular und skalierbar sein soll.
Das Konzept wurde bereits zu signifikanten Teilen in einer prototypischen Implementierung umgesetzt. Diese beinhaltet eine verteilte, reproduzierbare Infrastruktur, die zum Aufbau des Data Lake dient. Die Reproduzierbarkeit ist ein wichtiger Punkt dieser Implementierung, da durch Ansible-Playbooks, bei denen auf einfache Konfigurierbarkeit Wert gelegt wurde, ein schnelles Aufsetzen der Data-Lake-Komponenten bei weiteren Teilnehmern ermöglicht wird. Der vorliegende, nach dem Discovery-Prinzip arbeitende Data Lake verzichtet auf einen zentralen Filekatalog. Durch das Zusammenspiel von Dynafed und einer Hash-Table-Verteilung ist ein performantes Hybrid-System entwickelt worden. Performanz-Tests zeigen, dass noch Optimierungsbedarf bei Schreibzugriffen besteht. Lesende Zugriffe sind allerdings als performant aufgezeigt worden, und primär von der zur Verfügung stehenden Bandbreite der Infrastruktur abhängig.

HK 10.4 Mon 17:15 J-HS D

ALICE Tier 2 Centre and ALICE Analysis Facility prototype at GSI — •Sören Fleischer, Raffaele Grosso, Jan Knedlik, Paul-Niklas Kramp, and Kilian Schwarz — GSI Helmholtzzentrum für Schwerionenforschung, Planckstr. 1, 64291 Darmstadt

Since 2004 GSI has been operating a Tier 2 Center for the ALICE experiment on the local shared computing cluster, currently located in the Green IT Cube.

In this contribution we describe the current status of the center as well as our experience gained from recent changes. Those include using policy routing for ALICE-related traffic without XrootD proxy servers, improved monitoring of ALICE jobs using Grafana, as well as the migration to CentOS on the worker nodes and running the ALICE workload in Singularity containers. The build process of the latter has been implemented in a Gitlab Continuous Integration Pipeline, triggering a rebuild on every pushed commit to the definition file. The resulting container file is then run against a list of tests for known issues to reduce the chance of deploying a dysfunctional container.

HK 10.5 Mon 17:30 J-HS D

Data Pre-Processing on FPGAs with High-Level Synthesis for High-Energy Physics Experiments — •Thomas Janson and Udo Kebschull — IRI, Goethe-Universität Frankfurt am Main, Max-von-Laue-Straße 12, 60438 Frankfurt am Main, Germany

In this talk, we discuss a methodology of implementing massive parallel algorithms using the C++ high-level synthesis. The methodology belongs to the domain of high-performance computing and is discussed from this viewpoint. FPGAs for high-performance computing are becoming increasingly important and manufacturers such as Intel or Xilinx have recently developed their first accelerator cards for this. We show, that the methodology is also applicable for preprocessing in FPGA based readout cards widely used in high-energy physics experiments.

HK 10.6 Mon 17:45 J-HS D

Space point calibration of the ALICE TPC with track residuals — •Marten Ole Schmidt for the ALICE-Collaboration — Physikalisches Institut, University of Heidelberg

In the upcoming LHC Run 3, starting in 2021, the upgraded Time Projection Chamber (TPC) of the ALICE experiment will record minimum bias Pb–Pb collisions in a continuous readout mode at 50 kHz interaction rate. This corresponds to typically 4-5 overlapping collisions in the detector. Despite careful tuning of the new quadruple GEM-based readout chambers, which fulfill the design requirement of an ion back flow below 1%, these conditions will lead to space charge distortions of several centimeter that fluctuate in time. They will be corrected via a calibration procedure that uses the information of the Inner Tracking System (ITS) and the Transition Radiation Detector (TRD). They surround the TPC internally and externally, respectively. Such procedure is capable of restoring the TPCs intrinsic track resolution of a few hundred micrometer.

We present the required online tracking algorithm for the TRD, which is based on a Kalman filter. The procedure matches extrapolated ITS-TPC tracks to TRD space points utilizing GPUs. Subsequently these global tracks are refitted neglecting the TPC information. The residuals of the TPC clusters to the interpolation of the refitted tracks are used to create a map of space charge distortions for intervals of about one minute. First performance results of the tracking algorithm and the space charge distortion maps will be shown.

HK 11: Invited Talks II

Time: Tuesday 11:00–12:30 Location: H-HS X

Invited Talk HK 11.1 Tue 11:00 H-HS X

Experimental Nuclear Astrophysics Underground: The LUNA and LUNA-MV experiments — •Rosanna Depalo for the LUNA-Collaboration — Università degli Studi di Padova and INFN Padova

The cross sections of nuclear reactions relevant for astrophysics are crucial ingredients to understand the energy generation inside stars and the synthesis of the elements. In stars, nuclear reactions take place at energies well below the Coulomb barrier. As a result, their cross sections are often too small to be measured in laboratories on the Earth's surface, where the signal would be overwhelmed by the cosmic-ray induced background. An effective way to suppress the cosmic-ray induced background is to perform experiments in underground laboratories. LUNA is a unique facility located at Gran Sasso National Laboratories (Italy) and devoted to Nuclear Astrophysics. The extremely low background achieved at LUNA allows to measure nuclear cross sections directly at the energies of astrophysical interest.

Over the years, many crucial reactions involved in stellar hydrogen burning as well as Big Bang Nucleosynthesis have been measured at LUNA. The presentation will provide an overview on underground Nuclear Astrophysics and discuss the latest results and future perspectives of the LUNA experiment.

Invited Talk HK 11.2 Tue 11:30 H-HS X

Ten years after: Highlights from ALICE and future perspectives — •Harald Appelshäuser for the ALICE-Collaboration — Goethe-Universität Frankfurt

After ten years of operation at the CERN-LHC, ALICE has accumulated an impressive amount of experimental results from collisions of protons and heavy ions at the energy frontier. They help understanding the QCD phase transition at vanishing net baryon density, and elucidate the properties of the Quark-Gluon Plasma, a state of matter where the confinement of quarks and gluons is lifted and chiral symmetry is restored. Moreover, ALICE results contribute in a unique way to the understanding of extreme matter at high baryonic densities, such as neutron stars, and other related subjects including hyperonic interactions and the properties of hypernuclei.

During the present LHC Long Shutdown 2, ALICE undergoes a substantial detector upgrade to cope with a significant increase of the interaction rate in Pb-Pb to 50 kHz, expected at the LHC in 2021 and beyond. In this presentation, recent highlights from ALICE are presented and the physics perspectives for running with an upgraded ALICE detector in the next decade are discussed.

Invited Talk HK 11.3 Tue 12:00 H-HS X

Constraining the nuclear equation of state from nuclear forces and neutron star observations — •Svenja Greif — Institut für Kernphysik, Technische Universität Darmstadt — ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH

Understanding dense matter and the nuclear equation of state beyond nuclear saturation density is a challenging open problem. We use a general equation of state framework based on chiral effective field theory constraints combined with extensions using piecewise polytopes and a new speed of sound parametrization [1], including also constraints from Fermi liquid theory. In addition, we require that the general equation of state reaches the observed heavy neutron star masses. In this talk, we present first applications provided by the first mass-radius determination obtained by NASA's NICER mission [2,3] and constraints inferred from the gravitational wave event GW170817. Complementary to the determination of the radius is the prospect of a moment of inertia measurement, which we explore for the most likely source PSR J0737 − 3039A.

*Supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Project-ID 279384907 - SFB 1245.

[1] Greif *et al.*, MNRAS 485, 5363 (2019)
[2] Raaijmakers *et al.*, ApJL 887, L22 (2019)
[3] Raaijmakers *et al.*, arXiv:1912.11031 (2019)

HK 12: Outreach methods I (joint session T/HK)

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

Group Report HK 12.1 Tue 17:00 H-HS VI

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

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

HK 12.2 Tue 17:20 H-HS VI

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

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

HK 12.3 Tue 17:35 H-HS VI

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

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

vermittelt werden sollen.

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

HK 12.4 Tue 17:50 H-HS VI

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

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

HK 12.5 Tue 18:05 H-HS VI

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

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

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

HK 13: Hadron Structure and Spectroscopy III

Time: Tuesday 17:00–18:15 Location: J-HS A

Group Report HK 13.1 Tue 17:00 J-HS A

Investigating the scalar meson sector with BESIII — •Nils Hüsken, Johannes Bloms, Anja Brüggemann, Alfons Khoukaz, Sascha Lennartz, and Frederik Weidner — Westfälische Wilhelms-Universität Münster, Germany

The scalar meson sector has long been subject of intense speculation. Lattice QCD calculations predict the lightest glueball to share its quantum numbers with the scalar mesons. From various experiments, five scalars with a mass below 2 GeV/c^2 have been established, the $f_0(500)$, $f_0(980)$, $f_0(1370)$, $f_0(1500)$ and $f_0(1710)$. While it is clear that at least one of these states is supernumerary with respect to naive quark model expectations, there is no consensus on the nature of these scalar mesons yet. With the BESIII experiment, scalar mesons can be studied in different production and decay mechanisms. Using the world-record 10^{10} J/ψ mesons directly produced in e^+e^- annihilation with BESIII, scalar mesons can be studied both in direct decays of the J/ψ, for example in $J/\psi \to \phi K\bar{K}$, as well as in η_c decays like $\eta_c \to \eta' K\bar{K}$. While the former channel gives access to scalar states with a strong $s\bar{s}$ component, η_c decays involving scalar resonances might potentially allow to study $gg - q\bar{q}$ mixing. In addition, the BESIII high statistics datasets at center-of-mass energies between 3.7 GeV and 4.6 GeV dedicated to the search for new, heavy resonances in the charmonium region are used to explore potential couplings of the XYZ states to the light (scalar) meson sector. The current status of these analyses being performed in the Münster BESIII group will be discussed. This project has received funding from the DFG (FOR2359 and GRK2149).

HK 13.2 Tue 17:30 J-HS A

Untersuchung von J/ψ-Zerfällen mit dem BESIII-Experiment — •Orestis Afedulidis — Ruhr-Universität Bochum - Institut für Experimentalphysik I, 44801 Bochum

Das BESIII-Experiment, welches am symmetrischen Elektron-Positron-Speicherring BEPCII am Institute of High Energy Physics (IHEP) in Peking mit Schwerpunktsenergien von $\sqrt{s} = (2-4,6)$ GeV, betrieben wird, hat bis heute etwa 10^{10} J/ψ-Ereignisse aufgezeichnet. Dies ist der zur Zeit größte Datensatz, bei der die J/ψ-Resonanz in Formation erzeugt wurde. Aufgrund der großen Anzahl von Ereignissen kann dieser Datensatz zur präzisen Vermessung von Verzweigungsverhältnissen benutzt werden.

Untersucht wird der Zerfall $J/\psi \to K^+K^-\,\gamma\gamma$ mit den möglichen Zwischenresonanzen π^0, η und η' im $\gamma\gamma$-System. Darüber hinaus können weitere Resonanzen – z.B. angeregte Pseudoskalare – im $\gamma\gamma$-System gesucht werden, um weitere Erkenntnisse über die Struktur dieser Resonanzen zu erhalten. Vorgestellt werden erste Ergebnisse dieser Studie.

Gefördert durch die DFG (FOR 2359)

HK 13.3 Tue 17:45 J-HS A

Observation of the hypertriton in pp collisions with ALICE at the LHC — •Michael Hartung — Institut für Kernphysik, Goethe-Universität, Frankfurt, Germany

The hypertriton lifetime represents one of the open key questions of hypernuclear physics. The separation energy of the Λ inside the hypertriton is only 130 keV and this implies a small modification of the Λ wave function inside the nucleus, hence the lifetime of the hypertriton is expected to be close to that of the free Λ. The average value of the results obtained with different experimental techniques was found to be significantly lower than the theoretical prediction and this disagreement is referred to as the hypertriton lifetime puzzle. Significant hypertriton yields have only been measured in Pb-Pb collisions at the LHC. Due to its weak decay, the hypertriton can be reconstructed from its daughter products, e.g. the charged two-body decay channel ${}^3_\Lambda\mathrm{H} \to {}^3\mathrm{He} + \pi^-$. In order to be able to measure these rare (anti-) nuclei also in pp collisions, it is essential to increase the statistics by employing a dedicated trigger on nuclei. The Transition Radiation Detector of ALICE offers unique trigger capabilities. In combination with the excellent particle identification through the energy-loss measurement in the Time Projection Chamber and the capabilities to separate primary particles from those from secondary decays, provided by the Inner Tracking System, it is possible to identify the hypertriton in pp collisions. In this talk, the first observation of the hypertriton in pp collisions is presented as well as the current status of the lifetime measurement. Supported by BMBF and the Helmholtz Association.

HK 13.4 Tue 18:00 J-HS A

Final fit of the $a_1(1420)$ as a triangle singularity — •Mathias Wagner[1], Mikhail Mikhasenko[2], and Bernhard Ketzer[1] for the COMPASS-Collaboration — [1]Universität Bonn, Helmholtz-Institut

für Strahlen- und Kernphysik, 53115 Bonn, Germany — [2]CERN, Geneva, Switzerland

In the recent past several new particle candidates (e.g. the X, Y, Z states in the charmed sector) were found which do not fit into the simple constituent-quark models for mesons and baryons. Different concepts were introduced in order to find an explanation for these exotic states. One of them is a rescattering effect in the three-particle system. Here, triangle diagrams can produce resonance-like signals.

One prominent example is the $a_1(1420)$ signal, observed by the COMPASS experiment in the $J^{PC} = 1^{++}$ partial wave decaying to $f_0(980)\pi$ in a P-wave.

By coupling the $K\bar{K}\pi$ and the 3π final states we obtain a first order approximation to the Khuri-Treiman equation for the 1^{++} sector. We present the fit results of the finalized model, where we properly include all involved spins via a dispersion integral over a partial wave projection of the $K\bar{K}\pi$ final state onto the 3π final state, using a general πK P-wave amplitude.

Many systematic studies were performed, including a bootstrap analysis and an investigation of other contributions to the decay amplitude. A comparison to a fit with a genuine-resonance model is done for all cases.

Supported by BMBF.

HK 14: Hadron Structure and Spectroscopy IV

Time: Tuesday 17:00–18:30 Location: J-HS M

Group Report HK 14.1 Tue 17:00 J-HS M

Σ^0 production in p(3.5 GeV)p collisions at HADES — •Waleed Esmail and James Ritman for the HADES-Collaboration — Jülich Forschungszentrum, GmbH, IKP1, 52428 Jülich

Studying hyperon production at beam energies of a few GeV is important for many open questions in the field of hadron physics. While there are several experimental results for Λ hyperons in $p+p$ reactions, measurements of Σ^0 production are scarce. This study is a first step to gain access to the hyperon electromagnetic transition form factors with the upgraded HADES detector system. As a first step, existing HADES data taken in 2007 with a proton beam of kinetic energy 3.5 GeV incident on liquid hydrogen target were used to study the production of Σ^0 baryons via the exclusive reaction $pp \to pK^+\Sigma^0$. Σ^0s were identified via the decay $\Sigma^0 \to \Lambda\gamma$ with subsequent decays $\Lambda \to p\pi^-$. Since HADES was not equipped with an electromagnetic calorimeter at that time, photons are identified as a missing mass particle, while other charged particles are identified by their energy loss and time of flight. This talk will present a brief overview of the first results about the electromagnetic decay of the Σ^0.

HK 14.2 Tue 17:30 J-HS M

$K^0_S\Sigma^0$ photoproduction at the BGO-OD experiment — •Katrin Kohl for the BGO-OD-Collaboration — Physikalisches Institut, Nussallee 12, D-53115 Bonn

The BGO-OD experiment at the ELSA accelerator facility uses an energy tagged bremsstrahlung photon beam to investigate the exitation structure of the nucleon in meson photoproduction.

The associated photoproduction of K^0_S and hyperons is essential to understand the role of K^* exchange mechanisms. A cusp-like structure observed in the $\gamma p \to K^0_S\Sigma^+$ reaction at the K^* threshold is described by models including dynamically generated resonances from vector meson-baryon interactions. Such interactions are predicted to give a peak like structure in $K^0_S\Sigma^0$ photoproduction off the neutron.

This talk presents a preliminary analysis of the reaction $\gamma n \to K^0_S\Sigma^0$. First results seem to support the predicted peak like structure.

*Supported by DFG (PN 50165297).

HK 14.3 Tue 17:45 J-HS M

K^+ Σ^- Photoproduction at the BGO-OD Experiment — •Johannes Gross — Physikalisches Institut Universität Bonn

The BGO-OD experiment at the ELSA accelerator facility uses an energy-tagged bremsstrahlung photon beam to investigate the excitation spectra of the nucleon. The setup consists of a highly segmented BGO calorimeter surrounding the target, with a particle tracking magnetic spectrometer at forward angles.

This unique combination is ideal for investigating low momentum transfer processes due to the acceptance and high momentum resolution at forward angles. The K^+ detection in the forward spectrometer is complemented by a technique to identify K^+ mesons in the central calorimeter via the time delayed weak decay, vastly increasing the angular acceptance for final states of open and hidden strangeness.

Preliminary, high statistics cross section and beam asymmetry measurements for the reaction $\gamma n \to K^+\Sigma^-$ will be presented.

HK 14.4 Tue 18:00 J-HS M

Strange-Meson Spectroscopy at COMPASS — •Stefan Wallner — Physik-Department E18, Technische Universität München

COMPASS is a multi-purpose fixed-target experiment at CERN aimed at studying the structure and spectrum of hadrons. The two-stage spectrometer has a large acceptance over a wide kinematic range. Thus, it can be used to investigate a wide range of reactions. Diffractive production of mesons is studied with a negative hadron beam with a momentum of 190 GeV/c. So far, COMPASS has studied mainly isovector resonances of the a_J and π_J families with high precision, using the dominating π^- component of the beam.

Using the smaller K^- component of the beam allows us to investigate also the spectrum of strange mesons in various final states. The flagship channel is the $K^-\pi^-\pi^+$ final state, which in principle gives access to nearly all kaon states, i.e. K_J and K^*_J families. COMPASS has acquired the so far worlds largest data set of about 720 000 exclusive events for this channel. In order to disentangle the produced mesons by their spin-parity quantum numbers, we employ the method of partial-wave analysis. The size of our dataset enables us to perform the analysis in four bins of the squared four-momentum transfer t'. Thus, the t' dependence of the various signals in the data can be studied.

This work was supported by the BMBF, the DFG Cluster of Excellence *Origin and Structure of the Universe* (Exc 153), and the Maier-Leibnitz-Laboratorium der Universität und der Technischen Universität München.

HK 14.5 Tue 18:15 J-HS M

In-beam tests results for the PANDA STT — •Gabriela Perez-Andrade, Peter Wintz, and James Ritman for the PANDA-Collaboration — Institut für Kernphysik, Forschungszentrum Jülich, Germany

At the PANDA experiment, fundamental hadron physics questions will be addressed through $\bar{p}p$ annihilations in a $\bar{p}$ momentum range from 1.5 to 15 GeV/c. The Straw Tube Tracker (STT), in the solenoidal magnetic field of the PANDA target spectrometer, has the tasks of charged particle tracking, momentum reconstruction, and particle identification (PID) based on the energy loss measurement (dE/dx) in the straw gas. The STT will provide PID information for $p/K/\pi$ separation in the low momentum region up to ∼0.8 GeV/c. For a full 3D track reconstruction, the STT consists of axial and stereo straw layers. The technique of self-supporting, close-packed straw layer modules yields a minimal material budget of 1.2% (X/X_0). In-beam measurements with a STT test system have been conducted at COSY (Forschungszentrum Jülich), using proton and deuteron beams in a momentum range of ∼ 0.6 - 2.5 GeV/c. Preliminary results show a 2D track resolution of ∼120 μm ($\sigma_{r\phi}$), which corresponds to 2.5 mm (σ_z) for the stereo layers in the beam direction. Furthermore, a PID method based on time-over-threshold measurement was tested, showing that proton and deuteron separation from minimum ionising particles of 4σ at 0.8 GeV/c is obtained, rising to about 12σ for 0.6 GeV/c deuterons. In this talk, the calibration, tracking and PID methods together with the preliminary test results will be discussed.

HK 15: Heavy-Ion Collisions and QCD Phases III

Time: Tuesday 17:00–18:30 Location: J-HS F

Group Report HK 15.1 Tue 17:00 J-HS F

Measurements of charm-baryon production with ALICE at the LHC — •Andrea Dubla for the ALICE-Collaboration — GSI Helmholtz Center for Heavy Ion Research

Heavy quarks (charm and beauty) are an effective tool to study the properties of the Quark-Gluon Plasma (QGP) formed in heavy-ion collisions at the LHC. Due to their large masses, they are produced during the early stages of the collisions in hard-scattering processes, on a time scale shorter than the QGP formation time. Thus, they experience the whole evolution of the system.

The measurement of charm baryons and mesons allows the baryon-to-meson ratio to be evaluated, probing hadronisation and thermalisation mechanisms of charm quarks in the medium. In particular, the baryon-to-meson ratio is expected to be enhanced if charm quarks hadronise via recombination with the surrounding light quarks in the QGP.

The ALICE detector is well suited to reconstruct charm baryons down to low transverse momentum thanks to the excellent tracking and particle identification capabilities. In this contribution, new ALICE results on charm-meson and baryon production in Pb-Pb and in pp collisions will be shown. In the pp system, the measurement of Λ_c and Ξ_c^0 production will be discussed. In the Pb-Pb system, the measurement of Λ_c production, the nuclear modification factor and the Λ_c/D^0 ratio will be discussed together with the comparison with similar results in smaller collision systems. Moreover, the comparison of the results to theoretical models will be shown.

HK 15.2 Tue 17:30 J-HS F

Charmed hadron production at LHC energies with the statistical hadronisation model — Anton Andronic[1], Peter Braun-Munzinger[2], •Markus K. Köhler[3], Krzysztof Redlich[4], and Johanna Stachel[3] — [1]Westfälische Wilhelms-Universität Münster, Institut für Kernphysik, Münster, Germany — [2]Research Division and ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany — [3]Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Heidelberg, Germany — [4]University of Wrocław, Institute of Theoretical Physics, 50-204 Wrocław, Poland

We present p_{T}-integrated and p_{T}-differential yields of charmonium states and baryon over meson ratios of open charmed hadrons at LHC energies within the framework of the statistical hadronisation model. It is demonstrated that the statistical hadronisation model reproduces available data at LHC energies. Predictions for exotic charmonium states of potential measurements in future LHC runs will be shown.

HK 15.3 Tue 17:45 J-HS F

Particle reconstruction with the KF package to study charmed baryons — •Carolina Reetz for the ALICE-Collaboration — Heidelberg University

The study of charmed baryon production in proton-proton (pp) collisions is a crucial step on the way of understanding charm hadronisation processes in the presence of a Quark-Gluon Plasma (QGP) state, which is expected to be created in heavy-ion collisions.

The hadronic decay of the Ξ_c^0 baryon is the subject of the studies presented in this contribution. The complex decay topology includes the decay hyperons Ξ and Λ: its reconstruction is performed with the help of the KF Particle package, developed in the context of the CBM experiment. The package supports the reconstruction of full particle decay chains, exploiting the use of various constrained fits and including the complete treatment of tracking and vertexing uncertainties. These features are of crucial importance in the search for rare signals.

Different selection criteria related to the reconstruction of the Λ and Ξ decays are investigated. This study provides the validation of the KF Particle package for the reconstruction of decay topologies in ALICE and its implementation in the ALICE software framework.

HK 15.4 Tue 18:00 J-HS F

Ξ_c^0 reconstruction in pp collisions with ALICE — •jianhui zhu for the ALICE-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH

The high collision energies available at the LHC allow for an abundant production of heavy quarks (charm and beauty), which are sensitive probes for investigating the properties of the Quark-Gluon Plasma (QGP) formed in high-energy heavy-ion collisions. Due to their large masses, they are produced in initial hard parton scattering processes on a timescale shorter than the QGP formation time and experience the whole system evolution. There have been extensive researches regarding the production of charm mesons in order to investigate the interactions of charm quarks with the QGP constituents and the transport properties of the medium. The measurement of charm-baryon production, and in particular the baryon-to-meson ratios, provides unique information on hadronisation mechanisms, constraining the role of coalescence and testing the universality of the fragmentation function.

Measurements of charm-baryon production in pp collisions are important to set up a benchmark for Pb-Pb collisions and provide essential tests of pQCD calculations and models of charm hadronisation process. In this presentation, the p_{T} differential cross section times branching ratio of the Ξ_c^0 baryon measured in the decay channel $\Xi_c^0 \to \mathrm{e}\Xi\nu$ and the status of the Ξ_c^0 baryon reconstruction via the hadronic decay channel $\Xi_c^0 \to \pi^+\Xi^-$ (and its charge conjugate) in pp collisions using Kalman Filter (KF) Particle package combined with machine learning technique will be reported.

HK 15.5 Tue 18:15 J-HS F

Reconstruction of Bottom Jets in Proton-Proton Collisions at $\sqrt{s} = 13$ TeV with ALICE — •Katharina Garner for the ALICE-Collaboration — Westfälische Wilhelms-Universität Münster

When traversing the Quark-Gluon Plasma (QGP), partons lose energy via collisional and radiative processes. For both types of processes, the amount of lost energy depends on the particle mass and manifests in a reduced jet multiplicity in heavy-ion collisions with respect to proton-proton collisions, for which no QGP is expected to form. A detailed knowledge about not only the light-flavour but also the charm and bottom jet production in proton-proton collisions is thus inevitable for further investigations on particle energy losses.

Since B mesons have much larger life-times compared to other hadrons, transverse impact parameter spectra, as a measure for the distance between particle tracks and the primary vertex, offer a great opportunity to investigate the bottom jet production. Results of an analysis on the performance of two bottom jet selection algorithms, the Track Counting and the Track Probability Tagger based on impact parameter spectra, will be presented for 13 TeV proton-proton collisions.

HK 16: Heavy-Ion Collisions and QCD Phases IV

Time: Tuesday 17:00–18:15 Location: J-HS G

Group Report HK 16.1 Tue 17:00 J-HS G

Cold, dense quark matter and quark-hadron continuity in neutron stars — •Yifan Song — Physics Department, Technical University of Munich, 85748 Garching b. Munich, James-Franck-Str. 1, Germany

Recent discoveries of record-breaking massive neutron stars indicate their core density could reach up to five times nuclear matter saturation density, where the matter could begin to be properly described by quark matter. State-of-the-art equation of state studies using phenomenological quark models constrained by neutron star observations strongly suggest a continuous, smooth crossover from hadronic matter to quark matter, possibly with no first-order phase transitions. In this talk I show how such quark-hadron continuity can be manifestly realized in several aspects: 1. the continuity of spectrum of low-lying Nambu-Goldstone modes resulting from spontaneous chiral symmetry breaking by coexisting chiral and diquark condensates can be demon-

strated using a schematic Nambu-Jona-Lasinio type model; 2. the explicit mapping between fermion and boson degrees of freedom in hadronic and quark matter can be established by a gauge-invariant description of QCD via field redefinition in the presence of diquark pairing; 3. the massive diquark-dressed gluons could be used to explain the strong vector correlations (implied by equation of state studies) between quarks, potentially bridging the non-perturbative gluon dynamics to phenomenological vector boson exchanges in such models.

This work is supported by the DFG Excellence Cluster "Origins".

HK 16.2 Tue 17:30 J-HS G

Λ hyperon production in collisions of relativistic ions at the CERN SPS and FAIR SIS100 energies — •Hamda CHERIF for the CBM-Collaboration — Goethe University Frankfurt am Main — GSI Helmholtzzentrum für Schwerionenforschung GmbH

For more than 30 years, the production of strangeness has been proposed as a sensitive signal to QGP formation. Strange particles are of particular interest in hadronic collisions since they carry a new quantum number not present in the colliding nuclei. In that respect, the study of the production of Λ hyperons is of particular interest as it allows one to study simultaneously strangeness production and the effect of net baryon density.

The NA61/SHINE experiment at the CERN/SPS and the CBM experiment at the future facility FAIR aim to investigate the QCD phase diagram of strongly interacting matter in the region of moderate temperatures and high net-baryon densities. A systematic study of the energy dependence of Λ production has been performed previously by NA49 for Pb+Pb collisions, and recently by NA61/SHINE in p+p collisions.

In this contribution, the status of the analysis of Λ hyperons with the NA61/SHINE experiment at CERN/SPS will be presented. The study of Λ production in CBM experiment at the future FAIR facility in Darmstadt will be also presented based on simulation of Au+Au collisions at various SIS100 energies.

HK 16.3 Tue 17:45 J-HS G

Inhomogeneous phases in the quark-meson model with explicit chiral-symmetry breaking — •Lennart Kurth and Michael Buballa — Theoriezentrum, IKP, TU Darmstadt

The conjectured existence of a critical endpoint of a first-order chiral phase boundary in the QCD phase diagram has triggered tremendous experimental and theoretical activities. Several QCD-inspired models suggest that instead of a first-order transition between homogeneous phases there is an inhomogeneous phase where the chiral condensate periodically varies in space. While in the chiral limit the existence of the inhomogeneous phase appears to be rather robust under model variations, the situation is less clear when chiral symmetry is explicitly broken.

In this talk we discuss the effect of explicit chiral-symmetry breaking on the existence and size of an inhomogeneous phase in the quark-meson model. To this end we perform a stability analysis of the homogeneous phase with respect to developing inhomogeneities. We find that the inhomogeneous region shrinks with increasing pion mass but still survives at the physical value of m_π. The instability of the homogeneous phase occurs in the scalar channel while pseudoscalar fluctuations or the popular chiral density wave are not favored.

HK 16.4 Tue 18:00 J-HS G

Self-consistent meson spectral functions from analytically continued FRG flow equations — •Jan-Hendrik Otto, Lorenz von Smekal, and Christopher Jung — Justus Liebig Universität Giessen

The Functional Renormalization Group (FRG) can be used to calculate spectral functions from analytically continued (aFRG) flow equations for two-point correlation functions. Of particular relevance for the electromagnetic spectral function and thus for thermal dilepton rates in the resonance region, are the vector and axial-vector meson spectral functions in the hot and dense medium. Because chiral symmetry restoration at finite temperature and/or density is reflected in these spectral functions, this can be exploited to search for experimental signatures, from heavy-ion collisions at HADES energies and later with CBM at FAIR, of a chiral first-order phase transition and the associated critical endpoint (CEP) in the phase diagram of QCD. While present calculations are thermodynamically consistent and symmetry preserving, fully self-consistent solutions are still a challenge. On the other hand, self-consistent calculations are particularly important for possible signatures of a CEP. In this contribution we therefore present a simplified scheme to calculate self-consistent spectral functions from aFRG flow equations, based on self-energy parametrisations inspired by one-loop structures, for π and σ mesons in the O(4)-model.

HK 17: Structure and Dynamics of Nuclei III

Time: Tuesday 17:00–19:00 Location: J-HS E

Group Report HK 17.1 Tue 17:00 J-HS E

Studying the nuclear electric-dipole response in multi-messenger experiments: A holistic view on ^{120,124}Sn — •Michael Weinert[1], Michelle Färber[1], Miriam Müscher[1], Deniz Savran[2], Philipp Scholz[1], Julius Wilhelmy[1], and Andreas Zilges[1] — [1]Institute for Nuclear Physics, University of Cologne — [2]GSI, Darmstadt

Over the past decade, great effort has been put into experiments studying the low-energy electric-dipole response (LEDR) of atomic nuclei. The work horse experiments with bremsstrahlung-photon beams have been complemented by measurements using hadronic probes, following a multi-messenger approach.

For the isotopes ^{120,124}Sn, the most complete set of experiments has been performed, investigating the LEDR via real and virtual photon scattering as well as with hadronic probes, such as transfer reactions and proton and α-particle scattering at different incident energies. From earlier results, it is known that the comparison of the nuclear response to these different probes can shed vital light on the underlying nuclear structure [1-3]. This contribution will give an overview on the data sets available today. It will investigate similarities and differences between the measurements and try to anticipate systematic behavior along the tin isotopic chain.

Supported by DFG (ZI 510/7-1).

[1] J. Endres *et al.*, Phys. Rev. Lett. **105** (2010) 212503
[2] L. Pellegri *et al.*, Phys. Lett. B **738** (2014) 519
[3] D. Savran *et al.*, Phys. Lett. B **786** (2018) 16

HK 17.2 Tue 17:30 J-HS E

Measurement of the total Neutron-Removal Cross Section of ^{120} Sn at R^{3}B to determine Constraints on the Equation of State — •Ashton Falduto[1,2], Andrea Horvat[1,2], Dominic Rossi[1], Thomas Aumann[1,2], Carlos A. Bertulani[3,1], and Stefan Typel[1,2] for the R3B-Collaboration — [1]TU Darmstadt — [2]GSI Helmholzzentrum — [3]Texas A&M University- Commerce

The knowledge of the equation of state (EOS) for neutron-rich matter is fundamental for understanding properties of, e.g., neutron stars, core-collapse supernova, and neutron-rich nuclei. Deriving experimental constraints for the EOS is thus of utmost importance. The parameter for the slope of the symmetry energy at saturation (L), in the EOS for asymmetric nuclear matter has not yet been constrained well experimentally so far. If determined accurately, the neutron-skin thickness and the ground-state dipole polarizabilty can potentially provide much better constraints on L. It has been shown that through an accurate measurement of the total neutron-removal cross section, the value of L can be constrained.The R^{3}B setup has been upgraded to now include the neutron detector NeuLAND and the GLAD dipole magnet alongside our tracking setup, which will allow us to take measurements with high momentum resolution and large acceptance. This will allow us to get the accuracy required for constraining L. A first measurement for ^{120}Sn has already been completed using the FAIR phase 0 R^{3}B setup at GSI.

This project was supported by the BMBF project No. 05P15RDFN1 and the GSI-TU Darmstadt cooperation.

HK 17.3 Tue 17:45 J-HS E

Precise determination of the (γ,xn) cross sections for Sn isotopes — •Dmytro Symochko[1], Patrick van Beek[1], Takashi Arizumi[2], Thomas Aumann[1], Martin Baumann[1], Sergey Belyshev[3], Frank Leonel Bello Garrote[4], Tomas K. Eriksen[4], Vetle W.

Ingeberg[4], Ioana Gheorghe[5], Philipp Kuchenbrod[1], Yiu-Wing Lui[6], Shuji Miyamoto[7], Wanja Paulsen[4], Line G. Pedersen[4], Fardous Reaz[4], Heiko Scheit[1], and Hiroaki Utsunomiya[2] — [1]Technische Universität Darmstadt, Germany — [2]Department of Physics, Konan University, Japan — [3]Lomonosov Moscow State University, Skobeltsyn Institute of Nuclear Physics — [4]Department of Physics, University of Oslo, Norway — [5]NP, "Horia Hulubei" National Institute for Physics and Nuclear Engineering (IFIN HH), Romania — [6]Cyclotron Institute, Texas A&M University — [7]Laboratory of Advanced Science and Technology for Industry, University of Hyogo

We performed measurements of the partial photoneutron cross-sections for ^{112,116,120,124}Sn isotopes in the energy range up to 4-neutron thresholds. The experiment utilized a quasi-monochromatic gamma-ray beam produced in the laser Compton back-scattering at the New-Subaru synchrotron radiation facility. A novel flat-efficiency neutron detector based on ^{3}He counters was used to detect the emitted neutrons and allowed the analysis with direct multiplicity sorting.

Details of the experiment and some preliminary results will be presented.

Supported by HMWK (LOEWE centre "Nuclear Photonics") and DFG (SFB1245).

HK 17.4 Tue 18:00 J-HS E

Study of the magnetic dipole respone of ^{58}Ni — •Isabelle Brandherm[1], Johann Isaak[1], Peter von Neumann-Cosel[1], Maximilian Spall[1], Jonny Birkhan[1], Sergej Bassauer[1], Maxim Singer[1], Antonio d'Alessio[1], Hiroaki Matsubara[2], and Atshushi Tamii[2] — [1]Institut für Kernphysik, TU Darmstadt, Darmstadt, Germany — [2]RCNP, Osaka, Japan

A high resolution inelastic proton scattering experiment on ^{58}Ni at extreme forward angles, was performed at RCNP. This method has been proven to be an excellent tool to study the dipole response of nuclei. Measurements performed at afew hundred MeV incident energy and at 0° are particulary suited for the excitation of the isovector spin-flip M1 (IVSM1) resonance. The properties of the IVSM1 are e. g. used in the description of neutral-current neutrino interactions in supernovae. Another interesting phenomena is the so called quenching, which describes a systematically overestimation of the experimentally obtained magnetic dipole strength by microscopic model predictions. In this work first result towards an extraction of the magnetic dipole strength with a multipole decomposition analysis will be shown.

Supported by SFB 1245

HK 17.5 Tue 18:15 J-HS E

Low-energy dipole response of the halo nuclei ^{6,8}He — •Christopher Lehr[1] and Thomas Aumann[1,2] for the NeuLAND-SAMURAI-Collaboration — [1]TU Darmstadt — [2]GSI Helmholtzzentrum

The heaviest bound helium isotopes ^{6}He and ^{8}He are 2- and 4-neutron halo nuclei with a clear alpha plus 2n and 4n structure.

The multi-neutron decay of ^{6}He and ^{8}He after heavy-ion induced electromagnetic excitation reactions has been measured kinematically complete to study the dipole response of these nuclei. The combination of the neutron detectors NEBULA and NeuLAND at the SAMURAI setup and the high beam intensities available at the RIKEN Nishina Center in Japan made this measurement possible for the first time. The experimental method is based on the measurement of the differential cross section via the invariant-mass method, which allows to extract the dipole strength distribution dB(E1)/dE and the photo-absorption cross section.

The analysis of the data is nearly finished and the neutron reconstruction and cross talk analysis for the challenging 4-neutron channel, in which good statistics could still be achieved, has been performed. During the talk preliminary results focusing on the ^{6}He and ^{8}He excitation energy spectra and the dipole strength distributions will be presented and discussed.

This work is supported by the DFG through grant no. SFB 1245, the GSI-TU Darmstadt cooperation and the BMBF project 05P15RDFN1.

HK 17.6 Tue 18:30 J-HS E

Structure of ^{6}He in Halo EFT — •Matthias Göbel[1], Daniel R. Phillips[2], and Hans-Werner Hammer[1,3] — [1]IKP, TU Darmstadt — [2]Department of Physics and Astronomy, Ohio University — [3]EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH

The Borromean two-neutron halo ^{6}He with its scale separations is well suited to a treatment in Halo EFT with the neutrons (n) and the α core as degrees of freedom. The s-wave nn interaction and the $^2P_{3/2}$ αn interaction as well as a three-body force are employed in our leading order analysis.

We study the structure of ^{6}He by calculating the momentum-space probability density by using Faddeev amplitudes. Based on the probability density we compute the nn relative energy distribution observed in α knockout reactions. We discuss the sensitivity to the nn scattering length and compare to model calculations.

This work is supported in part by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Projektnummer 279384907 - SFB 1245 and by the US Department of Energy under contract no. DE-FG02-93ER-40756 (DRP).

HK 17.7 Tue 18:45 J-HS E

Investigation of inelastic proton scattering at 0° for ^{16}O — •Maximilian Spall[1], Isabelle Brandherm[1], Antonio D'Alessio[1], Maxim Singer[1], Sergej Bassauer[1], Jonny Birkhan[1], Johann Isaak[1], Peter von Neumann-Cosel[1], Hitoshi Matsubara[2], and Atsushi Tamii[2] — [1]TU Darmstadt — [2]RCNP, Osaka University

In order to obtain a better understanding of the nuclear structure of ^{16}O, a high energy resolution measurement under extreme forward angles, including 0°, was performed at the Research Center for Nuclear Physics (RCNP) using a 295 MeV proton beam. Angular distributions for seperated excited states and a multipole decomposition of the cross sections are extracted. First results of the deduced monopole and dipole strength distributions will be presented.

This work is supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - SFB 1245.

HK 18: Structure and Dynamics of Nuclei IV

Time: Tuesday 17:00–19:00 Location: J-HS H

Group Report HK 18.1 Tue 17:00 J-HS H

Recent results from the FRS Ion Catcher — •Gabriella Kripkó-Koncz for the FRS Ion Catcher-Collaboration — II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Gießen, Germany

The atomic masses of exotic nuclei provide key information for the understanding of nuclear structure and astrophysics. Combining a cryogenic stopping cell (CSC) and a multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS), the FRS Ion Catcher experiment (FRS-IC) at the Fragment Separator (FRS), GSI enables high precision mass measurements or isobar and isomer separation with thermalized projectile and fission fragments. Incorporating several novel and unique concepts, the system enables the highest performance, such as a mass resolving power up to 1,000,000 and mass accuracies down to $6 \cdot 10^{-8}$.

The first direct mass measurements of seven isotopes close to the double magic nucleus ^{208}Pb allowed to study the evolution of the two-neutron separation energies. Mass measurements of projectile fragments in the vicinity of ^{100}Sn were performed, including the first mass measurement of the ^{101}In ground state. Two new isomeric states were discovered in ^{97}Ag and ^{101}In. A novel technique for measuring half-lives and decay branching ratios was developed and demonstrated experimentally. These results, recent technical upgrades, and approved experiments for FAIR Phase-0 will be presented.

The FRS-IC also serves as a prototype for the future Ion Catcher at the Low-Energy-Branch (LEB) of the Super-FRS at FAIR. Latest results of the next-generation CSC for the LEB will be discussed.

HK 18.2 Tue 17:30 J-HS H

Weak decays within an effective theory — •Catharina Brase[1,2], Eduardo A. Coello Peréz[3], Javier Menéndez[4], and Achim Schwenk[1,2,5] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Lawrence Liv-

ermore National Laboratory, Livermore, CA — [4]Department of Quantum Physics and Astrophysics, University of Barcelona — [5]Max-Planck-Institut für Kernphysik, Heidelberg

We study Gamow-Teller and unique forbidden β decays within an effective theory. In this approach nuclei are described as spherical cores coupled to a neutron and/or proton, depending on the nuclei of interest. We calculate matrix elements for β decays into low-lying states of the daughter nucleus, explore their applications and investigate the associated theoretical uncertainty based on a power counting and Bayesian methods. Our effective theory results are found to be in good agreement with experiment within theoretical uncertainties.

*This work is supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) – Projektnummer 279384907 – SFB 1245.

HK 18.3 Tue 17:45 J-HS H

Lifetime measurements in N=Z nuclei ^{44}Ti and ^{56}Ni — •K. Arnswald[1], P. Petkov[2,1], P. Reiter[1], A. Blazhev[1], T. Braunroth[1], L. Kaya[1], C. Müller-Gatermann[1], and D. Werner[1] — [1]Institut für Kernphysik, Universität zu Köln — [2]*„Horia Hulubei“* National Institute for Physics and Nuclear Engineering, Bucharest-Măgurele, Romania

Reduced transition strengths are sensitive signatures to describe collective excitations of atomic nuclei and the evolution of shell structures. They provide stringent tests of present shell-model interactions in the $0f1p$ shell along the $N = Z$ line. Recently determined B(E2) values showed an enhanced collective behavior for ^{44}Ti, ^{48}Cr, and ^{52}Fe [1]. In ^{44}Ti the collective behavior has been associated with core excitations. However, there is a lack of information on precise values along the negative parity band in this nucleus. These states arise from a strong interplay between *sd*- and *pf*-shell orbitals and allow for refined tests of cross-shell contributions. For the doubly-magic nucleus ^{56}Ni only the $B(\mathrm{E2}, 2_1^+ \rightarrow 0_{\mathrm{g.s.}}^+)$ value is known [2]. Lifetime measurements employing the recoil distance Doppler-shift (RDDS) and the Doppler-shift attenuation method (DSAM) were performed at the FN tandem accelerator at the IKP, Cologne. Excited states in ^{44}Ti and ^{56}Ni were populated via fusion-evaporation reactions. Lifetimes were determined for excited states up to $J^\pi = 6^+$. They will be presented and compared to shell-model calculations.

[1] K. Arnswald *et al.* Phys. Lett. B **772**, 599 (2017)
[2] K.L. Yurkewicz *et al.* Phys. Rev. C **70**, 054319 (2004)

HK 18.4 Tue 18:00 J-HS H

Laser Spectroscopy of Nickel 56 and a new Charge Exchange Cell — •Felix Sommer[1], Nathan Everett[2], David Garand[2], Ruben De Groote[3], Phillip Imgram[1], Colton Kalman[2], Jeremy Lantis[2], Yuan Liu[4], Andrew Klose[5], Paul Mantica[2], Andrew Miller[2], Kei Minamisono[2], Witold Nazarewicz[2], Wilfried Nörtershäuser[1], Robert Powel[2], Paul-Gerhard Reinhard[6], Elisa Romero-Romero[7], Dominic Rossi[1], Achim Schwenk[1], Chandana Sumithrarachchi[2], and Andrea Teigelhöfer[8] — [1]TU Darmstadt, DE — [2]NSCL, US — [3]Oak Ridge Laboratory, US — [4]University of Jyväskylä, FI — [5]Augustana University, US — [6]Universität Erlangen-Nürnberg, DE — [7]University of Tennessee, US — [8]TRIUMF, CA

We present laser spectroscopic measurements of Nickel charge radii at and across the n=28 shell closure. Using the BECOLA experiment at NSCL, we achieved the first laser spectroscopic measurements of Nickel 55 and 56. Values for the difference in rms charge radii have been extracted for these isotopes and showcase the evolution across the shell closure. The results allow a comparison of ab initio calculations for Nickel 56 with those of Nickel 68 at the sub shell closure n=40. The measurements were done on the atomic system using a charge exchange cell, since no suitable transition is available in the ion. To extend future capabilities, we developed a new design that will allow the use of Magnesium vapor instead of the typically used alkalis.

This work was supported in part by NSF grant PHY-15-65546, U.S. DOE grant DE-NA0002924 and DFG grant SFB1245.

HK 18.5 Tue 18:15 J-HS H

Übergangswahrscheinlichkeiten angeregter Zustände der Yrast-Bande in ^{53}Ti — •Alina Goldkuhle für die AGATA-Kollaboration — Institut für Kernphysik, Köln

Für das Verständnis der Schalenstruktur, insbesondere der (Unter-)Schalenabschlüsse bei $N = 30, 32$, spielen die Übergangswahrscheinlichkeiten in neutronenreichen Ti Isotopen eine besondere Rolle. Neben zahlreichen Untersuchungen der gerade-gerade Ti Isotope mit $A \leq 54$, sind zudem bereits einige ungerade Ti Isotope mit $A \leq 51$ in dieser Region untersucht worden. Allerdings liegen noch wenige Informationen über ^{53}Ti vor. Daher wurden in dieser Arbeit angeregte Zustände in $^{46-54}$Ti mit Hilfe von Multinukleonentransferreaktionen bevölkert und Lebensdauern mittels der Recoil distance Doppler-shift Methode gemessen. Das Experiment wurde 2016 am GANIL mit dem Detektorsystem AGATA, dem Spektrometer VAMOS++ zur Teilchenidentifikation sowie dem Kölner Kompakt-Plunger für tiefinelastische Reaktionen durchgeführt. Nachdem Zustandslebensdauern in ^{52,54}Ti aus dem Datensatz bestimmt wurden und mittels derer die Schalenstruktur Nähe der (Unter-)Schalenabschlüsse bei $N = 30, 32$ untersucht wurde, wurden anschließend zunächst vorläufige Lebensdauern der $(5/2^-)$ bis $13/2^-$ Zustände in ^{53}Ti mittels der Differential decay curve Methode zum ersten Mal ermittelt und nachfolgend mit auf Geant4 basierenden Monte-Carlo-Simulationen geprüft und reduzierte Übergangswahrscheinlichkeiten berechnet. Die Ergebnisse werden in diesem Vortrag vorgestellt und mit aktuellen Schalenmodellrechnungen verglichen.

HK 18.6 Tue 18:30 J-HS H

Probing novel nuclear forces with the IM-SRG — •Jan Hoppe[1,2], Christian Drischler[3,4], Kai Hebeler[1,2], Achim Schwenk[1,2,5], and Johannes Simonis[6] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Department of Physics, University of California, Berkeley — [4]Lawrence Berkeley National Laboratory, Berkeley — [5]Max-Planck-Institut für Kernphysik, Heidelberg — [6]Institut für Kernphysik and PRISMA$^+$ Cluster of Excellence, Johannes Gutenberg-Universität Mainz

We apply consistent nucleon-nucleon plus three-nucleon interactions at N^{3}LO in chiral effective field theory with realistic saturation properties in the in-medium similarity renormalization group. To this end we use three-nucleon forces fitted to saturation properties and the triton binding energy. We present results for ground-state energies as well as charge radii of closed-shell medium-mass nuclei, with the goal to explore connections between predictions for finite nuclei and nuclear-matter properties. We further investigate variations of the low-energy constants to test their sensitivity in nuclei.

*This work was supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Projektnummer 279384907 - SFB 1245.

HK 18.7 Tue 18:45 J-HS H

One-nucleon removal from ^{14}O at 100 MeV/nucleon with a thin hydrogen target — •Thomas Pohl, Yelei Sun, Alexandre Obertelli, and SAMURAI 31 Collaboration — TU Darmstadt, Darmstadt, Germany

Direct reactions at intermediate energies are an important tool for nuclear structure studies, but some reaction mechanisms are still not understood. One debated phenomenon is the asymmetric parallel momentum distribution (PMD) of the residual nucleus occurring occasional in one nucleon removal reactions [1-3]. Recent theoretical calculations of *(p,pN)* reactions with ^{14}O at 100 MeV/nucleon with the distorted-wave impulse approximation (DWIA) predict a large asymmetric PMD [4]. The low momentum tail is due to the phase volume effect and the high momentum fall off due to the attractive potential of the residues and the outgoing nucleons. Comparison with experimental data is necessary for validation and will be a basis for further spectroscopic factor studies. We performed an experiment with ^{14}O beam at 100 MeV/nucleon impinging on a 2-mm thick solid hydrogen target at RIBF at RIKEN. Momentum of the residues is extracted from the SAMURAI spectrometer. Details of the experiment, the analysis procedure and preliminary results will be presented.

[1] A. Gade *et al.*, Phys. Rev. C 71, 051301(R)(2005).
[2] K.L. Yurkewicz *et al.*, Phys. Rev. C 74, 024304 (2006).
[3] F. Flavigny *et al.*, Phys. Rev. Lett. 108, 252501 (2012).
[4] K. Ogata *et al.*, J. Phys. Rev. C 92, 034616 (2015).

HK 19: Fundamental Symmetries II

Time: Tuesday 17:00–18:30 Location: J-HS B

Group Report HK 19.1 Tue 17:00 J-HS B

Status of the COMET experiment — •Andreas Jansen, Thomas Kormoll, Dominik Stöckinger, and Kai Zuber — TU Dresden, Institut für Kern- und Teilchenphysik, Germany

COMET is an experiment at the Japan Proton Accelerator Research Complex (J-PARC), which will search for coherent neutrinoless transition of muons to electrons in the coulomb field of atomic nuclei ($\mu^- + \mathrm{N} \rightarrow e^- + \mathrm{N}$). Since this process violates charged lepton flavor conservation it is highly suppressed in the Standard Model and thus provides a promising channel to constrain new physics.

The COMET experiment will operate in two stages. Phase-I is currently under construction at J-PARC and is aiming at two orders of magnitude improvement over the current limit. In Phase-II this will be additionally improved by at least two orders of magnitude. Refinements on the experimental design based on ongoing investigations and experience gained from Phase-I will be used to push this even further for a total improvement of five orders of magnitude.

This talk will give an overview of both phases, along with recent updates about the facility and the current status of detector developments.

Group Report HK 19.2 Tue 17:30 J-HS B

Muonic X-ray measurements with the MiniBall germanium detector array. — •Frederik Wauters — Johannes Gutenberg Universität Mainz

Negative muons at rest quickly get captured by nearby atoms in highly excited atomic states. The muonic atom de-excites until the muon ends up in the 1S orbital. The photons emitted during this process are called muonic X-rays. Due to the large overlap between the muon wave function and the nucleus, they are sensitive to the nuclear size and structure and short range interactions. The MuX collaboration performs muonic X-ray measurements at the Paul Scherrer Institute (PSI) with medium- and high-Z nuclei. The physics program focuses on atomic parity violation (APV), with first measurements performed in 2017 and 2018. During the fall of 2019, the high-resolution MiniBall germanium detector array was brought from the ISOLDE/CERN facility to PSI. This opportunity sparked an extensive and diverse measurement program. In this talk I will give a summary of this year's campaign. The main goal of the 2019 run was to measure the muonic X-rays of 226Ra to determine it's charge radius. Radium is a promising candidate for a high-precision APV measurement at low Q2. We also measured the 2S1S transition in muonic Zn, investigating the feasibility of an experiment measuring APV directly with muonic atoms. Two weeks of beam time were dedicated to investigate nuclei of interest for neutrinoless double beta-decay experiments. In addition, muonic X-ray spectroscopy measurements were performed on archaeological artifacts to determine their elemental and isotopic composition.

HK 19.3 Tue 18:00 J-HS B

Spin Tune Measurements for Electric Dipole Moment Searches — •Abhiroop Sen for the JEDI-Collaboration — Institut für Kernphysik, Forschungszentrum Jülich — III. Physikalisches Institut B, RWTH Aachen

The electric dipole moment (EDM) of particles is an important property that can be studied to shed light on physics beyond the Standard Model, as well as answer questions about the matter-antimatter asymmetry in the universe (since it is CP violating). The JEDI Collaboration, using the Cooler Synchtrotron (COSY) at Forschungszentrum Jülich, is working towards measuring the EDM of charged particles (protons and deuterons), which would be the first step to further, more detailed, studies about EDMs.

EDMs are measured by studying their influence on the spin motion. One important quantity in this context is the so called spin tune, defined as the number of times the spin precesses about the polarisation axis per particle turn in the ring. Using different approaches, one can analyse the spin tune of particle bunches in COSY and determine the spin coherence time (SCT), which is an estimate of how long the spins of the particles remain in phase, while they precess in the horizontal plane. This talk will concentrate on the analysis of spin tunes for longer cycles of $\sim 10^3$ s.

HK 19.4 Tue 18:15 J-HS B

Polarization measurements for storage ring electric dipole moment Investigations — •Achim Andres for the JEDI-Collaboration — Institute for Nuclear Physics II , FZ Jülich, Germany — III. Physikalisches Institut B, RWTH Aachen University, Germany

The matter-antimatter asymmetry in the universe cannot be explained by the Standard Model of elementary particle physics. According to A. Sakharov additonal CP violating phenomena are needed in order to understand the matter-antimatter asymmetry. Permanent Electric Dipole Moments (EDMs) of subatomic elementary particles violate both time reversal and parity asymmetries and therefore also violate CP if the CPT-theorem holds. They could thus provide this additional CP violation.

The JEDI-Collaboration (Jülich Electric Dipole moment Investigations) is preparing a direct EDM measurement for protons and deuterons: first at the storage ring COSY (COoler SYnchrotron) at Forschungszentrum Jülich and later at a dedicated storage ring. As COSY is an all magnetic storage ring, a direct measurement of the EDM is not possible as polarization build up effects due to the EDM cancel out over time. The basic idea is to modulate the spin oscillation of deuterons and protons with a radio frequency (RF) Wien filter without perturbing the beam itself to measure a net vertical polarization build up due to the EDM. In this talk, a new method to match the fields inside the Wien Filter as well as the resonance frequency of the kicks of the magnetic field B_{WF} to the spin precession vector will be presented.

HK 20: Instrumentation III

Time: Tuesday 17:00–18:30 Location: J-HS C

HK 20.1 Tue 17:00 J-HS C

Optimization of a PANDA track finding algorithm based on the Apollonius problem — •Anna Scholl, Tobias Stockmanns, and James Ritman — Forschungszentrum Jülich

This work presents a track finding algorithm for the barrel part of the PANDA Straw Tube Tracker (STT). It consists of over 4200 gas-filled drift tubes arranged in a dense packing. The STT hits are not point-like, but tubes (isochrones) around the center of the straw tubes resulting from the measured drift time of the electrons to the anode. The track of the charged particle must pass tangentially to the isochrone. Algorithms based on two or three dimensional hitpoints usually do not use the additional isochrone information. For the STT, however, a tracking algorithm is needed that finds tracks that are tangential to every isochrone. To deal with this challenge, this work presents an approach based on the Apollonius problem, which is a mathematical solution to find a circle that is tangential to three other circles. This mathematical description is the basis for a Hough transformation to find the track of the charged particle.

To improve the performance of the Hough transform, the results from several different data preselection methods will be presented. Another challenge the algorithm needs to deal with is that the particle tracks are not perfectly continuous, but there may also be losses of hits or noise. Therefore a merging algorithm was implemented to combine different tracklets to a track. A more detailed description and first results of the algorithm described above will be shown.

HK 20.2 Tue 17:15 J-HS C

Machine learning approaches for multi-neutron detection with NeuLAND — •Jan Mayer and Andreas Zilges for the R3B-Collaboration — Institute for Nuclear Physics, University of Cologne

Upcoming experiments featuring Reactions with Relativistic Radioactive Beams ($\mathrm{R^3B}$) at the Facility for Antiproton and Ion Research

(FAIR) require precise multiplicity and energy information of the emitted neutrons. NeuLAND, the New Large Area Neutron Detector, is dedicated to the detection of up to five high-energy neutrons.

Reconstruction of the multiplicity and the first interaction points from the complex, superimposed hit patterns is challenging. As an alternative to classical methods, we study modern machine learning methods ranging from simple scikit-learn classifiers to deep neural networks with keras.

Here we give an overview of challenges, solutions, and results obtained with a diverse set of approaches and ideas for integration in a data analysis pipeline.

Supported by the BMBF (05P19PKFNA) and the GSI (KZILGE1416).

HK 20.3 Tue 17:30 J-HS C

Position reconstruction methods for the CBM-TRD — •Felix Fidorra for the CBM-Collaboration — Institut für Kernphysik, Universität Münster

The Compressed Baryonic Matter (CBM) experiment will be a fixed target heavy-ion experiment at FAIR. The CBM Transition Radiation Detector (TRD) is one of the key detectors to provide electron identification and charged particle tracking. The TRD will be built based on a Multi-Wire Proportional Chamber (MWPC) with a 5 mm drift region, and an irregular foam foil radiator. Concerning reconstruction of detector data, currently different methods are being evaluated and will be discussed in this talk. The application of the discussed methods on testbeam data from DESY electron beam will be shown. This work is supported by BMBF grant 05P19PMFC1.

HK 20.4 Tue 17:45 J-HS C

Machine Learning Approach for Track Finding Using Language Models — •Jakapat Kannika, James Ritman, and Tobias Stockmanns — Forschungszentrum Jülich, Jülich, Germany

In the particle physics experiments, track finding is a pattern recognition task in which input hits are clustered into different groups of output tracks. The hits are signals of the particles traveling through the detectors, and the tracks are groups of trajectories of those particles. This study is focusing on implementing a track finding algorithm using language models for straw tube based tracking systems. The language model is a probability distribution which is used in order to recognize the sequences of data. The model is widely used in the field of natural language processing, where applications such as speech recognition, handwriting recognition, word prediction also use the language models. In the current study, we extract features from the hit data and treat them as discrete values similarly to words, then do a language modeling. The obtained language model is used in the same way as in the word prediction applications, but in this case, it predicts the next hits. The algorithm is now able to learn how to distinguish between true hit and noise, and it can also recognize tracks with long dependency patterns. The current status and an outlook on the overall performance will be presented.

HK 20.5 Tue 18:00 J-HS C

Analysis plane optimization for background reduction in the KATRIN experiment — •Benedikt Bieringer for the KATRIN-Collaboration — Institut für Kernphysik, Uni Münster, Germany

The Karlsruhe Tritium Neutrino experiment (KATRIN) aims at determining the electron antineutrino mass with a sensitivity of 0.2 eV (90% CL). Two spectrometers, electrostatic filters of MAC-E filter type, are used to measure the integral energy spectrum of Tritium β decay electrons from a windowless gaseous tritium source. To reach the specified sensitivity, it is crucial to reduce experimental backgrounds as far as possible. Two main sources of background in the main spectrometer are assumed to be highly excited Rydberg atoms ionized by thermal radiation, and secondary electrons produced by trapped Radon-219 decay electrons. By optimization of the electric and magnetic fields inside the main spectrometer, the volume dependent Rydberg background can be drastically lowered. In this talk, the effort of field optimization with real time field calculations is presented. This work is supported under BMBF contract number 05A17PM3.

HK 20.6 Tue 18:15 J-HS C

Event reconstruction for dark photon searches at the NA64 experiment at CERN — •Srijan Sehgal, Nabeel Ahmed, Michael Hösgen, and Bernhard Ketzer — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

The NA64 experiment is an active beam-dump experiment at CERN, searching for possible vector particles as a portal to a hypothetical dark matter sector. High-energy beam electrons are tracked and then stopped in a hermetic calorimeter, which acts as an active target. Interesting events are those, where not the full energy has been deposited in the calorimeter.

The presentation describes the event reconstruction for the 2017 and 2018 data for the invisible mode. In this mode some energy is lost by producing a dark photon, which then flies through the detector without interacting. For the alignment of the tracking detectors, we use the principle of least-squares minimization that takes into account both global (e.g. positional correction) and local (e.g. slope of track) parameters. The talk will also cover the Monte-Carlo reconstruction of particle tracks and the energy deposited in the calorimeter for the 2018 visible mode data. In the visible mode the dark photon is produced in an additionally placed tungsten calorimeter and decays into an e^-e^+ pair, which is detected by the downstream detectors.

These studies advance the implementation of the data analysis in the CORAL and PHAST frameworks, providing a more flexible and more modular environment than the monolithic code presently used by the NA64 collaboration.

HK 21: Instrumentation IV

Time: Tuesday 17:00–18:30 Location: J-HS D

Group Report HK 21.1 Tue 17:00 J-HS D

The development of the MAGIX experiment for the MESA project in Mainz — •Sabato Stefano Caiazza for the MAGIX-Collaboration — Institut für Kernphysik, JGU Mainz

The new MESA accelerator under development at the Institute for Nuclear Physics in Mainz is planned to be commissioned at the beginning of the new decade. By that time, the MAGIX experiment will sit on the energy recovery line of the accelerator. o take advantage of all the potential of the new machine, MAGIX will use an innovative jet-target system coupled without windows with a couple of magnetic spectrometers. In the focal plane of those spectrometers we will install a GEM-based TPC with additional trigger and veto detectors. Additionally we will integrate a recoil detector in the scattering chamber, a Moeller luminosity detector and zero-degree spectrometer in the forward direction. All the instrumentation is currently under development and the most recent updates will be presented in this talk.

HK 21.2 Tue 17:30 J-HS D

Studies on proton acceleration via laser-cluster interaction — •Lukas Lessmann[1], Bastian Aurand[2], Christian Mannweiler[1], Kerstin Maria Schwind[2], Oswald Willi[2], and Alfons Khoukaz[1] — [1]Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, 48149 Münster, Germany — [2]Institut für Laser- und Plasmaphysik, Heinrich-Heine-Universität Düsseldorf, 40223 Düsseldorf, Germany

The CryoFlash experiment investigates the interaction of the high intensity, short-pulse Ti:Sa laser of the Arcturus Facility Düsseldorf with a cryogenic cluster-jet target constructed at the WWU Münster. A cluster-jet target provides a continuous flow of nanometer sized particles of approximately solid density by pressing pre-cooled gas or liquid through a very narrow Laval nozzle. This combines the advantages of gas-jet targets (continuous flow) and solid targets (local high density) for an operation at high laser repetition rates with a single-species and debris-free acceleration scheme.

The electric field of the incoming laser ionises the atoms and accelerates the electrons out of the clusters in a few laser cycles. The remaining proton clusters undergo coulomb explosions resulting in proton energies of a few hundred keV. The measured proton spectra show very little shot-to-shot fluctuations and the maximal energy can easily be tuned with the target parameters.

Measurements taken with two Thomson parabola spectrometers in summer 2019 will be presented and discussed.

This project has received funding from BMBF (05K16PM3).

HK 21.3 Tue 17:45 J-HS D

$\overline{\text{P}}$ANDA Cluster-Jet Target - Beam Interaction Studies at COSY — •B. Hetz, P. Brand, D. Klostermann, and A. Khoukaz for the PANDA-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, 48149 Münster, Germany

The internal, windowless $\overline{\text{P}}$ANDA cluster-jet target provides a target thickness of more than 2×10^{15} atoms/cm^2 in a distance of more than 2 m from its nozzle and will be the phase one target for the upcoming $\overline{\text{P}}$ANDA experiment at the antiproton storage ring HESR at GSI/FAIR. Despite the ongoing construction of the HESR, the $\overline{\text{P}}$ANDA cluster-jet target already showed its excellent performance not only during its routinely operation at the University of Münster laboratories, but also in several beam times at the COSY accelerator in Jülich. During these beam times detailed studies concerning the proton beam-target interaction, beam energy loss, beam heating, Schottky measurements, and studies of physical data quality using the WASA forward detection system have been performed. Furthermore, studies concerning the beam life time and beam qualities in conjunction with the stochastic cooling system of HESR, which is installed at COSY for test operation, in presence of the $\overline{\text{P}}$ANDA cluster-jet target were started. Both systems showed an excellent performance concerning COSY beam quality and target thickness and stability. Further beam times at COSY at even higher target thicknesses are planed for 2020. Obtained data and the upcoming experimental program of the $\overline{\text{P}}$ANDA cluster target at COSY will be presented. This project has received funding from BMBF (05P19PMFP1) and GSI F&E.

HK 21.4 Tue 18:00 J-HS D

Pellet target development for an EDM measurements at COSY — •Otari Javakhishvili for the JEDI-Collaboration — Forschungszentrum Jüelich GmbH

The JEDI (Jülich Electric Dipole moment Investigation) collaboration in Jülich is conducting a set of experiments at COSY, aiming to develop precise equipment and experimental techniques to measure the EDMs of charged particles. One of the key elements of these experiments is the new modular JEDI polarimeter with a special target system.

In the current configuration, horisontal and vertical block targets are used in polarimeter. Targets are mounted on stepper linear actuators and dedicated hardware and software are used to control target movements. Target control system is EPICS based, it can access accelerator and detector data and use them as a feedback for automatic target movement or finding proper target position in beam. The system is controlled by user friendly GUI. Also it has software and hardware interlock systems. This system was successfully tested in last beam time. In addition, we are working on a special target system, which will allow to oscillate pellet through the beam. Frequency and speed of oscillation must be variable to achieve desired effective target density. Monitoring system must be developed, including precise triggering, track reconstruction and data synchronization units, this allow us to synchronize data of target with other systems in detector. In this talk achievements and experimental results will be summarized and ongoing activities towards dedicated ballistic pellet target development presented.

HK 21.5 Tue 18:15 J-HS D

Concept of high-bandwidth pickups for a novel low charge bunch arrival time monitor as a part of the all-optical synchronization system at the European XFEL and FLASH — Bernhard Scheible[1], Marie Kristin Czwalinna[2], Wolfgang Ackermann[3], Holger Schlarb[2], Herbert De Gersem[3], and •Andreas Penirschke[1] — [1]Technische Hochschule Mittelhessen, Germany — [2]DESY Hamburg, Germany — [3]Technische Universität Darmstadt, Germany

X-ray free-electron lasers open up new frontiers across many areas of research and science. Numerous experiments require pulse durations in the order of a few femtoseconds only - this demands for an overall time resolution with sub-10 fs precision.

Simultaneously the generation of ultrashort X-ray pulses is only feasible by shorter bunches in a low bunch charge operation mode. The European XFEL is currently operated with bunch charges down to 20 pC with a synchronization with sub 10 fs range - future experiments demand operation modes with bunch charges down to 1 pC with an overall timing stability below (5+1) fs rms. Ultra-low charges are a major challenge for the current all-optical synchronization system implemented in FLASH and European XFEL.

In the scope of this contribution a novel ultra-broadband pickup design for frequencies up to 100 GHz is presented. In order to achieve sufficient driving voltage for the attached electro-optical modulator, several pickups circularly assembled in the beamline need to be combined.

HK 22: Hadron Structure and Spectroscopy V

Time: Wednesday 14:00–16:00 Location: J-HS A

Group Report HK 22.1 Wed 14:00 J-HS A

Truncated partial-wave analyses and complete experiments in pseudoscalar meson photoproduction — •Yannick Wunderlich — HISKP, Universität Bonn

The unravelling of the nucleon excitation spectrum poses a long lasting challenge on the way towards a precise understanding of bound-state formation in QCD. Experiments on the photoproduction of mesons have been performed, in order to find resonances which have escaped observations before. The photoproduction of a single pseudoscalar meson allows for the extraction of 16 polarization observables.

One can search for so-called "complete experiments", i.e. for minimal subsets of the 16 observables which still allow for an unambiguous determination of the underlying set of 4 spin-amplitudes. At least for studies of numerically precise pseudo-data, 8 carefully selected observables can form a complete experiment. The numerical extraction of the 4 spin-amplitudes is termed a complete experiment analysis (CEA).

In a truncated partial-wave analysis (TPWA), i.e. the extraction of a finite number of photoproduction multipoles from angular distributions of the data, fewer than 8 observables can be already sufficient. However, the apparent reduction of complete sets in the TPWA breaks down once one attempts to determine high multipoles from data with realistic error-bars. In this case, further constraints are needed.

The presentation will outline a new bipartite fit-method for the TPWA, which includes constraints from the results of a previously performed CEA. Preliminary results for an analysis of eta photoproduction ($\gamma p \longrightarrow \eta p$) will be shown.

HK 22.2 Wed 14:30 J-HS A

η' beam asymmetry at threshold using the BGO-OD experiment — •Stefan Alef for the BGO-OD-Collaboration — Physikalisches Institut Universität Bonn

The unexpected nodal structure of the beam asymmetry recently reported by the GRAAL collaboration in η' photoproduction very close to threshold could be explained by a previously unobserved very narrow resonance. Therefore, the measurement is important to be independently confirmed.

This possibility is offered by the BGO-OD experiment. It is well suited for the detection of forward going charged particles which in the threshold region of interest allows the identification of the reaction $\gamma p \to \eta' p$ solely based on the proton going in forward direction. This yields unprecedented statistics if in the missing mass analysis of the η' meson the background can be sufficiently well controlled. A linearly polarized photon beam produced via coherent bremsstrahlung off a diamond radiator makes it possible to measure the η' beam asymmetry.

In this talk I will present preliminary results on the determination of the η' beam asymmetry close to threshold.

Supported by DFG (PN 50165297).

HK 22.3 Wed 14:45 J-HS A

Search for a narrow nucleon resonance at 1685 MeV — •Mariana Nanova, Volker Metag, and Kai-Thomas Brinkmann for the CBELSA/TAPS-Collaboration — II. Physikalisches Institut, Justus-Liebig-Universität Giessen

The excitation spectrum of the nucleon is still not sufficiently understood despite various long-lasting experimental and theoretical efforts.

Recently the interest in the existence of pentaquark states has been renewed since such states have been observed in the charm sector. Particular attention has been paid to the recently claimed narrow structure observed at 1685 MeV in the $N\pi\eta$ channel [1], because this narrow structure could be identifed as the second member of the exotic anti-decuplet predicted in [2]. We have studied the two-meson photoproduction with the CB/TAPS detector system at the ELSA accelerator in Bonn in the reaction $\gamma p \to p\pi^0\eta$. High statistics have been obtained by irradiating a liquid hydrogen target with photon beams in the incident energy range from 0.9 to 3.0 GeV. A kinematic fit has been used in the reconstruction and identification of the exit channels. In the search for the narrow structure at 1685 MeV acceptance corrected M(pη) invariant mass spectra will be presented and discussed.

[1] V. Kuznetsov *et al.*, *JETP Letters* **106** (2017) 693
[2] D. Diakonov, V. Petrov and M. Polyakov, *Z. Phys. A* **359** (1997) 305.

HK 22.4 Wed 15:00 J-HS A

Studies of π^0 and η Reconstruction Efficiencies for the PANDA Day-1 Setup — •Jana Rieger[1,2], Tetyana Galatyuk[1,2], Klaus Götzen[1], Ralf Kliemt[1,3], Frank Nerling[1,4], and Klaus Peters[1,4] — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt — [2]Technische Universität Darmstadt — [3]Helmholtzinstitut Mainz — [4]Goethe-Universität Frankfurt

The PANDA experiment represents the central part of the hadron physics program at the FAIR facility that is under construction at GSI in Darmstadt. In the early stages of the experiment, during the commissioning phase, a proton beam instead of an antiproton beam will be provided by the accelerator and a reduced PANDA setup, the so-called Day-1 setup, will be available. The reconstruction efficiency for π^0 and η of the Day-1 setup has been studied. Cross section measurements of $pp \to pp\pi^0/\eta$ which are important to estimate nucleon-nucleon cross sections in nuclear reactions, can already be performed during the commissioning phase. Simulation studies show the feasibility of the reconstruction of the relevant final states at high statistics using the PANDA detector.

HK 22.5 Wed 15:15 J-HS A

The hadronic contribution to the running of the electromagnetic coupling — •Miguel Teseo San José Pérez[1,2,3], Marco Cè[1,2], Antoine Gérardin[4], Harvey Meyer[1,2,3], Kohtaroh Miura[1,2,5], Konstantin Ottnad[2,3], Andreas Risch[2,3], Jonas Wilhelm[2,3], and Hartmut Wittig[1,2,3] — [1]Helmholtz-Institut Mainz, Johannes Gutenberg-Universität Mainz, Germany — [2]PRISMA+ Cluster of Excellence, Johannes Gutenberg-Universität Mainz, Germany — [3]Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Germany — [4]John von Neumann-Institut für Computing (NIC), DESY Zeuthen, Germany — [5]Kobayashi-Maskawa Institute for the Origin of Particles and the Universe, Nagoya University, Japan

The electromagnetic coupling that intervenes in the interactions between charged particles varies with the energy due to off-shell processes. In this work we compute the leading hadronic contribution to this running at low energies, where QCD is fully non-perturbative.

We employ a subset of CLS (Coordinated Lattice Simulations) ensembles with Nf = 2+1 and O(a) improved Wilson fermions in open boundary conditions in time and periodic in space. For each ensemble we have extracted the vacuum polarization function, which is proportional to the running, using the time-momentum representation. The set of ensembles has different particle masses and four lattices spacings, in such a way that we have been able to perform the chiral and continuum extrapolation.

HK 22.6 Wed 15:30 J-HS A

Reconstruction of complex decay channels using genetic algorithm — •Áron Kripkó, Markus Moritz, and Kai Thimas-Brinkmann for the PANDA-Collaboration — II. Physikalisches Institut, Justus Liebig Universität Gießen, 35392 Gießen, Germany

A common problem in the topic of hadron spectroscopy is the reconstruction of complex decay channels. During the procedure cuts are applied to the properties of the reconstructed candidates along the decay tree with the aim of maximizing the significance. In case of complex decay channels, finding the optimal set of cuts is not obvious.

The application of genetic algorithm to this problem was investigated in PANDARoot. Genetic algorithm is an optimisation algorithm inspired by the process of natural selection. PANDARoot is the common simulation framework for feasibility studies of the PANDA experiment.

The talk will present the reconstruction of a complex decay channel of a predicted charmonium exotic state ($\tilde{\eta}_{c1}$) using genetic algorithm.

This work is supported by HIC for FAIR and BMBF.

HK 22.7 Wed 15:45 J-HS A

Results of the TPWA of the reaction $\gamma p \to \eta p$ — •Philipp Krönert for the CBELSA/TAPS-Collaboration — HISKP, Uni Bonn

The motivation to study pseudoscalar meson photoproduction is to improve the current understanding of the quantum mechanical interaction of the initial $|\gamma p\rangle$ and final state $|\eta p\rangle$. Chew, Goldberger, Low and Nambu [1] expressed (in 1957) the fundamental transition matrix in so-called complex electro-magnetic multipoles, which are connected to partial waves.

The technique of truncated partial wave analysis (TPWA) is a straightforward method to extract these multipole parameters, up to an overall phase, from experimental data.

Results of a truncated partial wave analysis will be shown in this presentation for the reaction $\gamma p \to \eta p$. This includes Legendre coefficients as well as multipole parameters for different truncation orders ($l_{max} = 2, 3$).

[1] G. F. Chew, M. L. Goldberger, F. E. Low, and Y. Nambu. Relativistic dispersion relation approach to photomeson production. Phys. Rev., 106:1345*1355, Jun 1957

HK 23: Hadron Structure and Spectroscopy VI

Time: Wednesday 14:00–15:45 Location: J-HS M

Group Report HK 23.1 Wed 14:00 J-HS M

Study of neutral pion-pair production in two-photon scattering at BESIII — •Max Lellmann and Achim Denig for the BESIII-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz

The anomalous magnetic moment of the muon a_μ is one of the most precisely measured observables of the Standard Model, yet it shows a discrepancy of 3-4σ between Standard Model prediction and direct measurement. It is still under discussion whether this discrepancy is a hint for New Physics or caused by the limited understanding of the strong interaction at small energies.

Information on the production of pion pairs in two-photon fusion processes plays an important role in the calculation of the hadronic light-by-light scattering contribution to a_μ.

The BESIII experiment, a τ-charm-factory located at the institute of high energy physics in Beijing, China, offers a perfect testbed for the investigation of two-photon processes at small momentum transfers. The processes $\gamma\gamma \to \pi^0\pi^0$ and $\gamma\gamma^* \to \pi^0\pi^0$ are investigated in the channel $e^+e^- \to e^+e^+\pi^0\pi^0$ using the BESIII experiment. This presentation will discuss the current status of the analysis.

Supported by DFG (SFB1044)

Group Report HK 23.2 Wed 14:30 J-HS M

Meson transition form factor measurements with A2 at MAMI — Achim Denig[1], Lena Heijkenskjöld[1], Sergey Prakhov[2], and •Sascha Wagner[1] — [1]Johannes Gutenberg-Universität, Mainz, Germany — [2]University of California Los Angeles, USA

A meson transition form factor (TFF) describes the interaction between photons and mesons and hence provides an important probe of

the intrinsic electromagnetic structure of mesons. Studies of how the TFF depends on the momentum transfer of the photons, q^2, provide a deeper understanding of the dynamics involved. However, only certain q^2-regions are accessible experimentally. Within the time-like region ($q^2 > 0$), the TFFs of pseudoscalar mesons can be accessed in decays of π^0, η, ω and η' mesons.

The A2 experiment at the Mainz Microtron (MAMI) provides a high yield of light mesons produced by photo-induced reactions on protons, which makes the experiment ideal for precision measurements of meson TFFs. Both completed and upcoming contributions to such measurements by the A2 collaboration will be presented.

Supported by DFG under contract SFB1044.

HK 23.3 Wed 15:00 J-HS M

A FAIR Phase-0 Project at MAMI — L. Capozza[1], A. Dbeyssi[1], A. Greiner[1], S. Katilmis[1], F. Maas[1,2,3], J. Moik[1], O. Noll[1,2], D. Rodriguez Pineiro[1], P. Schöner[1], and •S. Wolff[1] — [1]Helmholtz-Institut Mainz, Mainz, Germany — [2]Institute of Nuclear Physics, Mainz, Germany — [3]PRISMA Cluster of Excellence, Mainz, Germany

Within the FAIR phase-0 project, the use of FAIR equipment at other facilities before the completion of the civil construction is envisaged. The PANDA EMC is a good candidate for FAIR Phase-0, due to the advanced state of its development. In particular, the backward endcap (BWEC) of the PANDA EMC, which is developed and built at HIM in Mainz, could be ready by 2021, three years before its foreseen installation. Therefore, an experiment at the MAMI electron beam facility making use of the BWEC is envisaged.
The π_0 electromagnetic transition form factor via the electroproduction on a nuclear Coulomb field will be quantified. To select this channel, the momentum distribution of the π_0 needs to be measured by detecting the decay γ particles and the scattered electron in the EMC. Monte Carlo simulations on the detection efficiency are ongoing. These will help to set the final geometry of the calorimeter for the FAIR Phase-0 project. Furtheremore, an event generator with realistic signal and background events will be implemented. The talk will address the current status of the simulation for FAIR Phase-0 at MAMI.

HK 23.4 Wed 15:15 J-HS M

Feasibility Studies of Axial and Tensor Meson Production in Two-Photon Fusion Processes at BESIII — •Nick Effenberger, Achim Denig, and Christoph Florian Redmer for the BESIII-Collaboration — Institut für Kernphysik ,Johannes Gutenberg-Universität, Mainz, Deutschland

The precision of the Standard Model prediction of the anomalous magnetic moment of the muon, a_μ, is completely limited by the knowledge of the hadronic contributions. Data driven approaches have been developed to improve the calculations. Recent calculations demonstrate the importance of axial and tensor mesons with masses larger than 1 GeV for the hadronic Light-by-Light scattering contribution to a_μ.

The BESIII experiment, located at the BEPCII collider in Beijing, China, has collected data with center-of-mass energies residing in the τ-charm region. These can be used to study the production of axial and tensor mesons in two-photon fusion processes with quasi-real or virtual photons. In this presentation, we discuss the prospects of studying axial and tensor mesons decaying into three or four pion final states. — Supported by DFG SFB1044.

HK 23.5 Wed 15:30 J-HS M

Towards a Measurement of the Hadronic R Value Using Initial State Radiation at BESIII — •Thomas Lenz, Achim Denig, and Christoph Florian Redmer for the BESIII-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland

The hadronic vacuum polarization is an important contribution to the running QED coupling constant at the Z pole, $\alpha_{\mathrm{QED}}(M_Z^2)$, and the anomalous magnetic moment of the muon $a_\mu = (g_\mu - 2)/2$. Both quantities allow for crucial precision tests of the Standard Model and their theoretical uncertainties are dominated by hadronic contributions. Experimental inputs, like the hadronic R value $R_{\mathrm{had}} = \sigma(e^+e^- \to \mathrm{hadrons})/\sigma(e^+e^- \to \mu^+\mu^-)$, are used in dispersive approaches to calculate these quantities.

The large data sets collected at the BESIII experiment at the e^+e^- collider BEPCII in Beijing, China, offer an excellent environment for initial state radiation (ISR) measurements. This presentation discusses the feasibility of using the ISR technique to measure R_{had} in a continuous spectrum.

Supported by DFG (SFB 1044).

HK 24: Heavy-Ion Collisions and QCD Phases V

Time: Wednesday 14:00–16:00 Location: J-HS F

Group Report HK 24.1 Wed 14:00 J-HS F

Latest flow results and new developments in the flow analyses techniques — •Ante Bilandzic for the ALICE-Collaboration — Technical University of Munich, Germany

With the advent of large statistics heavy-ion datasets at RHIC and LHC, comprising particularly events with the very large number of produced particles, it is becoming feasible to study the properties of Quark-Gluon Plasma with unprecedented precision. One of the most informative probes in such studies is the collective anisotropic flow, which can be measured very reliably with multiparticle correlation techniques in an environment characterized with large multiplicities and large values of flow harmonics.

In this group report we present an overview of latest flow results, which include: First ALICE results for the recently developed flow observables dubbed higher order Symmetric Cumulants, new analysis technique for the measurement of symmetry plane correlations, development of new hydro-based model to explain "flow-like" signals in pp collisions, study of universal non-flow scaling in azimuthal correlators, feasibility study for the usage of multiparticle correlations in flow analyses at CBM experiment, and finally, update on the status of applying multiparticle correlations in femtoscopy.

HK 24.2 Wed 14:30 J-HS F

Symmetry-plane correlations in flow analyses in ALICE — •Marcel Lesch for the ALICE-Collaboration — Technische Universität München, Germany

The study and experimental analysis of collective phenomena in heavy-ion collisions are nowadays to a great extent built on the so-called flow amplitudes v_n and symmetry-planes Ψ_n. Both appear as two distinct degrees of freedom in the Fourier series expansion which is used to parametrize the distribution of azimuthal angles of produced particles in high-energy nuclear collisions. Using multiparticle correlation techniques, the studies of flow amplitudes v_n and correlations amongst them have seen a lot of advancements over the past years.
In this talk, we address the complementary degrees of freedom by summarizing recent developments in the direction of symmetry-plane correlations (SPC) and the introduction of new observables for their measurement. We provide predictions of these observables for the initial coordinate space with the MC-Glauber model and for the final momentum space by iEBE-VISHNU for Pb–Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 2.76\,\mathrm{TeV}$. Finally, we present the first experimental results of SPC measured with these new observables using ALICE data for Pb–Pb at $\sqrt{s_{\mathrm{NN}}} = 2.76\,\mathrm{TeV}$ (2010).

HK 24.3 Wed 14:45 J-HS F

ALICE studies of the particle-species dependent anisotropic flow with spectators — •Michael Ciupek for the ALICE-Collaboration — Physikalisches Institut, Heidelberg, Deutschland — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Deutschland

In relativistic heavy-ion collisions, the initial energy density in the overlap region of the colliding nuclei is asymmetric. Due to interactions, this asymmetry is transferred to the momentum distribution of particles in the final state. The measurement of the anisotropic flow relative to the spectator plane is of special interest since the spectators decouple very early from the collision and are sensitive to the spatial shape of the initial energy density distribution.
The thermodynamic expansion of the quark-gluon plasma (QGP) results in a mass ordering of the anisotropic flow of particles as function

of the transverse momentum. As such, the anisotropic flow of identified particles with respect to the spectator plane is sensitive to the three-dimensional evolution of the QGP. Additionally, the difference of the anisotropic flow of particles and anti-particles, such as protons and anti-protons, allows investigating the transport of different quantum numbers (e.g. baryon number) in the QGP.
In this talk, studies of the particle-species dependent anisotropic flow with respect to spectators in Pb-Pb collisions with ALICE are presented. The particle identification is performed using a Bayesian approach, combining the information from different detectors. The spectator plane is reconstructed with the Zero Degree Calorimeter.

HK 24.4 Wed 15:00 J-HS F

First measurements of multi-harmonic correlations in ALICE — •Cindy Victorine Simone Mordasini for the ALICE-Collaboration — Technische Universität München (DE)

Genuine multiparticle azimuthal correlations have shown their usefulness to study and constrain the properties of the Quark-Gluon Plasma (QGP). Recently introduced, the measurements of the correlated fluctuations between two different flow amplitudes using Symmetric Cumulants have exhibited a better sensitivity to the transport properties of the QGP than the studies of single flow amplitudes.

The question of the genuine correlations between more than two flow amplitudes has then arisen. Their measurements can bring new and independent constraints on the system produced in heavy-ion collisions. In that respect, a generalisation of the Symmetric Cumulants has recently been proposed. This new set of observables is sensitive only to the genuine correlations between three and more flow amplitudes and has been named higher order Symmetric Cumulants.

In this talk, we present the first experimental results of these new higher order multi-harmonic correlations using data collected by ALICE in Pb–Pb collisions at $\sqrt{s_{\rm NN}} = 2.76$ TeV. We will address their potential to provide new insights on the origin of the correlations between the flow amplitudes. We will show comparisons with state-of-the-art hydrodynamic models as well.

HK 24.5 Wed 15:15 J-HS F

CBM performance for charged hadron flow measurements — •Viktor Klochkov[1,2] and Ilya Selyuzhenkov[1,3] for the CBM-Collaboration — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany — [2]Goethe Universität Frankfurt, Frankfurt am Main, Germany — [3]National Research Nuclear University (Moscow Engineering Physics Institute), Moscow, Russia

The Compressed Baryonic Matter experiment (CBM) at FAIR aims to study the area of the QCD phase diagram at high net baryon densities and moderate temperatures using collisions of heavy ions at center-of-mass energies of a few GeV per nucleon. Anisotropic transverse flow is among the key observables to study the properties of matter created in such collisions. The CBM performance for anisotropic flow measurements is studied with Monte-Carlo simulations using gold ions at SIS-100 energies with lab momentum up to 12A GeV/c employing different heavy-ion event generators. Various combinations of CBM detector subsystems are used to investigate the possible systematic biases in flow measurement and to study the effects of detector azimuthal non-uniformity. The resulting performance of CBM for flow measurements is demonstrated for different harmonics of identified charged hadron anisotropic flow as a function of rapidity and transverse momentum in different centrality classes.

HK 24.6 Wed 15:30 J-HS F

Collective flow measurements with HADES in Au+Au collisions at 1.23 AGeV — •Behruz Kardan — Goethe-Universität, Frankfurt am Main

HADES provides a large acceptance combined with a high mass-resolution and therefore allows to study dielectron, hadron and light nuclei production in heavy-ion collisions with unprecedented precision. The high statistics measurements of flow coefficients for protons and light nuclei including ^{3}He and ^{4}He in Au+Au collisions at 1.23 AGeV are presented here. In addition to the directed (v_1) and elliptic (v_2) flow components also the higher coefficients v_3 and v_4 are investigated for the first time in this energy regime. All flow coefficients are studied multi-differential for different centrality classes over a large region of phase space, i.e. as a function of transverse momentum p_t and rapidity. We will discuss the scaling properties of the varios flow harmonics as function of p_t, rapidity and centrality. This provides the possibility to characterize the production process of light nuclei, i.e. via coalescence, and puts strong constraints on the determination of the properties of dense matter, such as its viscosity and equation-of-state (EOS).

Supported by GSI F&E, HIC for FAIR, HGS-HIRe and H-QM.

HK 24.7 Wed 15:45 J-HS F

Confronting the fluid description of extreme QCD matter with experimental data from RHIC and the LHC — •Damir Devetak[1], Andrea Dubla[2], Stefan Floerchinger[3], Eduardo Grossi[3], Silvia Masciocchi[1,2], Aleksas Mazeliauskas[4], and Ilya Selyuzhenkov[2] — [1]Physikalisches Institut, Universität Heidelberg — [2]GSI Helmholtzzentrum für Schwerionenforschung — [3]Institut für Theoretische Physik, Universität Heidelberg — [4]Theoretical Physics Department, CERN

In heavy-ion collisions at relativistic energies, QCD matter reaches extreme conditions in terms of temperature and energy density. Its space-time evolution is successfully described within a framework of relativistic fluid dynamics. A new efficient and flexible computational framework to solve the fluid equations will be discussed. In this contribution, detailed comparison to experimental data on identified charged particle production in nucleus-nucleus collisions at RHIC and the LHC energies, differentially in event centrality and the particle momentum will be presented. The speed and flexibility of our calculations, together with the high precision of recent experimental measurements, allow to extract fundamental properties of hot and dense deconfined QCD matter such as its transport coefficients and freeze-out temperature. We also investigate tensions between experimental data and the fluid description, which forms a platform for testing new hypotheses.

HK 25: Heavy-Ion Collisions and QCD Phases VI

Time: Wednesday 14:00–16:00 Location: J-HS G

HK 25.1 Wed 14:00 J-HS G

Exploring the initial conditions of HIC beyond the boost invariant approximation — •Pragya Singh — University Of Bielefeld, Bielefeld, Germany

The pre equilibrium stage of Heavy-Ion collision is well described by the Color Glass Condensate (CGC), an effective theory of high energy QCD, which claims the existence of the Glasma. Within the CGC framework, a plethora of solutions for understanding the Glasma, are based on shock wave limit, where the Lorentz contracted, longitudinal extent of the fast-moving nuclei are considered to be infinitesimally thin. In order to understand the structure and the dynamics of the longitudinal direction of the fireball and to get the nontrivial rapidity dependent observables, one has to go beyond the boost invariant approximation. This talk mainly focusses on how the assumption of infinitesimally thin shock waves can be relaxed by solving the discretized 3+1 Dimensional Yang-Mills equation in classical statistical real-time lattice simulations.

HK 25.2 Wed 14:15 J-HS G

Relativistic kinetics of a BEC with inelastic processes — •Hendrik van Hees[1], Richard Lenkiewicz[1], Alex Meistrenko[1], Kai Zhou[2], Zhe Xu[3] und Carsten Greiner[1] — [1]Institute for Theoretical Physics, Goethe University, Frankfurt/Main — [2]Frankfurt Institute of Advanced Studies, Frankfurt/Main — [3]Tsinghua University Beijing

Motivated by the Color Glass Condensate model for the early stages of ultrarelativistic heavy-ion collisions, we investigate the time evolution of a Bose Einstein Condensate (BEC), including both elastic $2 \to 2$ and inelastic (particle-number changing) $2 \leftrightarrow 3$ processes. Employing a simple model with constant cross sections we solve the Boltzmann equation by numerically integrating the collision term, implementing the principle of detailed-balance. It is found that only for tiny inelastic cross sections in comparison to the elastic ones, $\sigma_{23}/\sigma_{22} \ll 1$, a transient BEC is formed for a short time, before the time evolution converges to the expected thermal equilibrium without a BEC [1].

Supported by DFG through CRC-TR 211.

[1] R. Lenkiewicz et al, Phys. Rev. D **100**, 091501(R) (2019)

HK 25.3 Wed 14:30 J-HS G

Charged particle production as a function of multiplicity measured with ALICE at the LHC — •Mario Krüger for the ALICE-Collaboration — Institut für Kernphysik Frankfurt

Heavy-ion collisions at the Large Hadron Collider facilitate the study of the Quark-Gluon-Plasma in the laboratory. Complementary measurements of smaller collision systems have shown that already for p–p collisions signs of collectivity can be observed. The great challenge for modern Monte-Carlo event generators is to describe particle production in a consistent way for all of the collision systems.

One sensitive observable to probe the particle production mechanisms implemented in these models is the correlation between transverse momentum spectra and event multiplicity. In this talk, we report the ALICE measurement of unidentified charged-particle p_{T} spectra obtained using a 2d-unfolding technique. We present derived quantities of these spectra and compare different collision systems and energies.

Supported by BMBF and the Helmholtz Association.

HK 25.4 Wed 14:45 J-HS G

Probing the path-length dependence of jet energy loss with correlation functions in JEWEL — •Luisa Bergmann for the ALICE-Collaboration — Physikalisches Institut, Universität Heidelberg

In relativistic heavy-ion collisions, a deconfined medium with high energy density is created, the quark-gluon plasma. Amongst other observables, jets – originating from primordial hard scatterings – act as useful probes for the properties of this medium. As the initial partons traverse the quark-gluon plasma, they lose energy by interacting with the constituents of the medium. The study of this so called "jet quenching" yields insight into the properties of the medium.

This talk focuses on the study of the path-length dependence of energy loss via correlation functions. By analyzing the angular dependence of the distribution of charged hadrons in two-particle and multi-hadron correlations, one obtains the informations in a statistical approach which is independent of particular jet definitions and sensitive in regions with high background contributions. To provide a well formed basis for future data analyses, the analysis of correlations is first performed with models, in particular by employing JEWEL. The usage of Monte-Carlo event generators offers the possibility to gain knowledge about the interaction processes in a controlled environment, which can then be used to understand structures in real data. This information ultimately helps to constrain the models of energy loss and of interactions of colored probes and media.

HK 25.5 Wed 15:00 J-HS G

Nuclear modification of charged-particle production with the ALICE experiment — •Youssef El Mard Bouziani for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

The ALICE experiment at the LHC is designed to study the properties of the hot and dense deconfined QCD medium, the Quark-Gluon Plasma, believed to be created in high-energy heavy-ion collisions. The interaction between quarks or gluons and the medium can be investigated by comparing the charged-particle production in Pb-Pb collisions and a corresponding reference measurement in pp collisions. This comparison is expressed by means of the nuclear modification factor R_{AA}, the ratio of the yield in AA collisions and the yield in pp collisions scaled by the number of binary collisions.

In this talk, we present the nuclear modification factor of charged particles based on Pb-Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV recorded in 2015 and 2018 with special focus on high p_{T}. This analysis of R_{AA} furthermore draws upon the improved precision of the charged-particle production in pp collisions at $\sqrt{s} = 5.02$ TeV measured in 2017.

Supported by BMBF and the Helmholtz Association.

HK 25.6 Wed 15:15 J-HS G

Jet-hadron correlations in Pb–Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV — •Jiyoung Kim — Physikalisches Inistitut, Heidelberg, Germany

An object which travels faster than the speed of sound in a medium generates a conical pressure wave front, called 'Mach shock wave'. Such shock wave can be produced by hard-scattered partons, which fragment into clusters of hadrons known as 'jets', which propagate through the Quark-Gluon Plasma (QGP). The jets interact with the QGP and lose a part of their energy in the propagation. The transfered energy from the jets to the medium leads to a increase of soft particle production. An angular correlation analysis allows us to improve our understanding of the interaction between the QGP and jets as well as to enable to search Mach shock wave generated in the medium.

In this presentation, we show angular correlations of inclusive hadrons and identified protons with respect to the axis of charged jets produced in Pb–Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV in the ALICE detector. As proton abundance in the medium is relatively higher than that in the jet fragmentation, when we study both the jet-hadron and the jet-proton correlation, it allows us to compare signals which have different amount of jet fragments in the correlation functions. Moreover, in order to enhance possibility to search the Mach shock signal, we studied additional hadron-hadron correlation only around the axis of quenched jet in simulation and in the data analysis. Those results are also presented in this talk.

This work is supported by BMBF and HGS-HIRe.

HK 25.7 Wed 15:30 J-HS G

Two-particle correlations with high-p_{T} Λ baryons and K^0_S mesons in pp collisions at ALICE — •Lucia Anna Husova for the ALICE-Collaboration — Westfälische Wilhelms Universität, Münster, Germany

Due to the high particle multiplicities produced in Pb-Pb collisions, low-energy jets are difficult to reconstruct using standard jet algorithms. Two-particle correlations in $\Delta\eta$ and $\Delta\varphi$ can instead be used to study jets, their properties and their particle composition. In this work, two-particle correlations between a high-momentum K^0_S meson, Λ baryon, or $\bar{\Lambda}$ baryon (V^0s) and charged hadrons are used to study strange particle production in jets. Recent ALICE results on the production of strange particles in small systems (pp and p-Pb collisions) reveal the possibility that similar strange quark production mechanisms could be present in all collision systems. Thus the per-trigger yields of the associated hadrons were studied on both the near-side and away-side of the V^0-h and h-V^0 correlation functions as a function of the transverse momenta of the trigger and associated particles as well as the event multiplicity in pp collisions at $\sqrt{s} = 13$ TeV collected with the ALICE experiment at the LHC. Moreover the h-h correlations were used as basis for the per-trigger yield ratios, which were compared to different MC generators.

HK 25.8 Wed 15:45 J-HS G

Non-equilibrium evolution of Jets in the QGP medium — •Ismail Soudi — Bielefeld University

During high-energy Heavy-Ion collisions a dense medium of deconfined quarks and gluons is formed. One important evidence of the quark-gluon plasma creation is the suppression of high transverse-momentum jets.

I will discuss how we study the non-equilibrium evolution and the chemical equilibration of these jets, using an effective kinetic theory of QCD. Applying what we learn about Jets or high-pT particles, we can explore the non-equilibrium evolution of the medium.

HK 26: Structure and Dynamics of Nuclei V

Time: Wednesday 14:00–16:00 Location: J-HS E

Group Report HK 26.1 Wed 14:00 J-HS E

Systematics of the Electric Dipole Response in Stable Tin Isotopes* — •Sergej Bassauer[1], Peter von Neumann-Cosel[1], and Atsushi Tamii[2] for the E422-Collaboration — [1]Institut für Kernphysik, TU Darmstadt, Darmstadt, Germany — [2]RCNP, Osaka, Japan

The electric dipole response is an important property of heavy nuclei. Precise knowledge of the electric dipole response provides information

on the dipole polarisability which in turn allows to extract important constraints on neutron-skin thickness in heavy nuclei and parameters of the symmetry energy. Another important property of nuclei which can be extracted from the electric dipole response is the gamma strength function (GSF). GSFs serve as input in calculations of cross sections in astrophysics, reactor design and waste transmutation within statistical models. Using the so called fluctuation analysis it is also possible to determine level densities in the GDR region. The tin isotope chain is particularly suited for a systematic study of the dependence of the electric dipole response on neutron excess as it provides a wide mass range of accessible isotopes with little change of the underlying structure. An inelastic proton scattering experiment under forward angles on even-even $^{112-124}$Sn was performed with a focus on the low energy strength and polarisability. In this talk results on the dipole polarisability, gamma strength function and level density extracted from these data will be presented.

*Supported by the DFG through SFB 1245.

HK 26.2 Wed 14:30 J-HS E

Parametrizations of relativistic energy density functionals with tensor couplings — •Stefan Typel[1] and Diana Alvear Terrero[2] — [1]Technische Universität Darmstadt, Institut für Kernphysik, Darmstadt, Germany — [2]Uniwersytet Wrocławski, Instytut Fizyki Teoretycznej, Wrocław, Poland

Many parametrizations of relativistic energy density functionals with minimal nucleon-meson couplings have been developed in the past assuming a dependence of the couplings on the vector density. This approach is extended here by introducing tensor couplings of nucleons to ω and ρ mesons and by considering both vector and scalar density dependencies of the minimal couplings. The parameters of the new effective interactions are found by fitting to properties of finite nuclei. The uncertainties of the observables in the χ^2 function are determined self-consistently. They allow to characterize the merits and drawbacks of the various parametrizations.

Supported by the Erasmus+ program of the European Union.

HK 26.3 Wed 14:45 J-HS E

Study of ^{116,118}Sn using the particle-γ coincidence Doppler-shift attenuation method — •Sarah Prill[1], Anna Bohn[1], Vera Everwyn[1], Michelle Färber[1], Florian Kluwig[1], Pavel Petkov[2,1], Philipp Scholz[1], Michael Weinert[1], and Andreas Zilges[1] — [1]Institute for Nuclear Physics, University of Cologne — [2]National Institute for Physics and Nuclear Engineering, Bucharest, Romania

The tin isotopes at the nuclear shell closure $Z = 50$ present ideal candidates to study nuclear properties and their evolution with increasing number of valence neutrons. The isotopes ^{112,114}Sn [1] were already studied in Cologne with the Doppler-shift attenuation method (DSAM) using particle-γ coincidences [2]. Now, results on ^{116,118}Sn were obtained with the same method to increase the knowledge on the tin isotopic chain. For this, inelastic proton and alpha scattering experiments were performed at the SONIC@HORUS setup [3] at the 10 MV FN-Tandem accelerator of the University of Cologne, yielding particle-γ coincidence data ideally suited to extract level lifetimes in the femto- to low picosecond range. This contribution will present the newest results, including nuclear level lifetimes and transition strengths.

Supported by the DFG (ZI-510/9-1). A.B. is supported by the Bonn-Cologne Graduate School for Physics and Astronomy.

[1] M. Spieker *et al.*, Phys. Rev. C **97** (2018) 054319
[2] A. Hennig *et al.*, Nucl. Instr. and Meth. A **794** (2015) 171
[3] S. G. Pickstone *et al.*, Nucl. Instr. and Meth. A **875** (2017) 104

HK 26.4 Wed 15:00 J-HS E

The γ-ray strength function of ^{87}Rb and the s-process branching-point nucleus ^{86}Rb — •Julius Wilhelmy[1], Philipp Erbacher[2], Johann Isaak[3], Bastian Löher[4], Miriam Müscher[1], Deniz Savran[4], Philipp Scholz[1], Ronald Schwengner[5], Werner Tornow[6], and Andreas Zilges[1] — [1]Institute for Nuclear Physics, University of Cologne — [2]Institute for Applied Physics, Goethe University Frankfurt — [3]Institute for Nuclear Physics, TU Darmstadt — [4]GSI, Darmstadt — [5]Helmholtz-Zentrum Dresden-Rossendorf — [6]Department of Physics, Duke University

The N=50 isotone ^{87}Rb was measured in bremsstrahlung experiments at different electron energies (8.2 MeV and 13.2 MeV) at the γELBE facility at the Helmholtz-Zentrum Dresden-Rossendorf, Germany [1]. Complementary measurements with almost mono-energetic γ-ray beams at the γ^3 setup [2] at the High-Intensity Gamma-ray Source (HIγS) at TUNL, Durham, USA yield information on total photoabsorption cross sections. The radiative neutron capture of the s-process branching-point nucleus ^{86}Rb is constrained by statistical model calculations using the measured photon strength function (PSF) of ^{87}Rb, which is directly connected to the photoabsorption cross section. The results will be presented and discussed.

Supported by the BMBF (05P18PKEN9).

[1] R. Schwengner et al., Nucl. Instr. Meth. A **555** (2005) 211
[2] B. Löher *et al.*, Nucl. Instr. and Meth. A **723** (2013) 136

HK 26.5 Wed 15:15 J-HS E

Structure of the first 2^- state in ^{88}Br — •Felix Dunkel[1], Jean-Marc Régis[1], Ulli Köster[2], Yung Hee Kim[2], Waldemar Urban[3], Jan Jolie[1], Arwin Esmaylzadeh[1], Lisa Marie Gerhard[1], Lukas Knafla[1], Mario Ley[1], and Kerstin Schomacker[1] — [1]Institut für Kernphysik der Universität zu Köln, Zülpicher Str. 77, 50937 Köln, Germany — [2]Institut Laue-Langevin, 71 Avenue des Martyrs, 38042 Grenoble, France — [3]Faculty of Physics, University of Warsaw, ul.Pasteura 5, PL-02-093 Warsaw, Poland

The structure of the first 2^- state in ^{88}Br was studied at the Institut Laue-Langevin by measuring the lifetime of this level with the gamma-gamma fast-timing technique using a setup with four $LaBr_3$(Ce) detectors. For this purpose an isomeric ^{88m}Br beam was produced by thermal-neutron induced fission of ^{235}U and mass separated using LOHENGRIN. A highly accurate lifetime result together with deduced transition strengths will be presented and discussed in the context of the shell model and possible collective effects in ^{88}Br.

HK 26.6 Wed 15:30 J-HS E

Prompt and delayed spectroscopy of ^{94}Kr with the NuBall-Spectrometer* — •Rosa-Belle Gerst, Andrey Blazhev, and Nigel Warr for the NuBall-Collaboration — Institut für Kernphysik, Universität zu Köln

The isotopic chain of krypton isotopes from the proton rich to the neutron rich side has been investigated extensively in recent years since they are home to a variety of shape phenomena. In 2018, the neutron-rich isotopes were again studied, this time with fast-neutron induced fission of ^{238}U as part of the NuBall campaign at the ALTO facility at the IPN Orsay. A fast-neutron beam was produced with the neutron source LICORNE which uses a p(^{7}Li,^{7}Be)n inverse reaction. The ^{7}Li beam was provided by the 15 MV Tandem Van de Graaff accelerator in a 400ns pulsed mode. The fast neutrons then impinged on a 100g ^{238}U target to induce fission. The gamma-rays from the excited fission fragments were measured with the NuBall-array [1], a novel hybrid gamma-spectrometer consisting of 24 HPGe clover, 10 HPGe Phase I and 20 LaBr3 detectors. The pulsed beam allows the investigation of prompt and delayed gamma-transitions separately and in coincidence. During the analysis of the data, a new short-lived isomer was discovered in 94Kr [2] extending the previously known level scheme [3].

*Supported by the DFG under Grant No. BL 1513/1-1

[1] M. Lebois *et al.*, to be published
[2] R.-B. Gerst *et al.*, in preparation
[3] T. Rzaca-Urban *et al.*, The European Physical Journal A - Hadrons and Nuclei 9, 165 (2000)

HK 26.7 Wed 15:45 J-HS E

Measuring the 2s-1s transition in Muonic atoms — •Nilesh Deokar — Johannes Gutenberg University of Mainz, Johann-Joachim-Becher-Weg 45, 55128 Mainz, Germany

2s-1s muonic X-rays are a potential observable to study Atomic Parity Violation (APV) in muonic atoms. Muonic X-rays are produced when negative muons cascade down the different energy levels of an atom. To detect the 2s-1s X-rays, a zinc target was placed in a negative muon beam from the piE1 beamline at the Paul Scherrer Institute, Switzerland. The muons were stopped inside the zinc target which leads to the cascade. The target was surrounded by High Purity Germanium (HPGe) detectors on two sides which detected the outgoing muonic X-rays. The data taking was carried out over a period of 8 days with beam momenta ranging from 33 MeV/c to 35 MeV/c. The 2s-1s transition in zinc corresponds to the energy value of ~1640 keV. This transition is overshadowed by background transitions and also the scattered X-rays between the HPGe detectors which give rise to satellite peaks. X-ray-X-ray coincidences can help to suppress this background. The analysis of the data acquired will revolve around separating the 2s-1s transitions from the background. A clear observation of the 2s-1s transition opens up to the possibility for an APV experiment with muonic atoms.

HK 27: Structure and Dynamics of Nuclei VI

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

Group Report HK 27.1 Wed 14:00 J-HS H

Effective field theory for nuclear wobbling motion — •Qibo Chen[1], Norbert Kaiser[1], and Ulf-G. Meissner[2,3,4] — [1]Physik-Department, Technische Universität München, D-85747 Garching, Germany — [2]Helmholtz-Institut für Strahlen- und Kernphysik and Bethe Center for Theoretical Physics, Universität Bonn, D-53115 Bonn, Germany — [3]Institute for Advanced Simulation, Institut für Kernphysik, Jülich Center for Hadron Physics and JARA-HPC, Forschungszentrum Jülich, D-52425 Jülich, Germany — [4]Ivane Javakhishvili Tbilisi State University, 0186 Tbilisi, Georgia

In recent years, effective field theory (EFT) has achieved many successes in hadronic and low-energy nuclear physics, and the investigation of wobbling motion of triaxially deformed nuclei has become one of hottest topics in nuclear structure physics. In our previous work [1, 2], the EFT has been extended successfully to investigate the rotational and vibrational motions of triaxially deformed even-even nuclei. In this work, the EFT is further extended to investigate the collective motion of triaxial odd-mass nuclei. This extension requires a systematic treatment of the coupling between the single-particle motion and the collective rotational motion. The applicability of the obtained EFT is examined to study the wobbling motion in Lu isotopes.

*Supported by DFG and NSFC (CRC 110).

[1] Q. B. Chen, N. Kaiser, Ulf-G. Meißner, J. Meng, Eur. Phys. J. A 53, 204 (2017).

[2] Q. B. Chen, N. Kaiser, Ulf-G. Meißner, J. Meng, Phys. Rev. C 97, 064320 (2018)

HK 27.2 Wed 14:30 J-HS H

Mass measurements of neutron-deficient Yb isotopes around the N=82 shell closure, close to the proton dripline — •Beck Sönke for the TITAN-Collaboration — Justus-Liebig Universität, Giessen — GSI, Darmstadt

The nuclear mass reflects the binding energy of a nucleus and provides key information for nuclear structure, nuclear reactions and related fields like nuclear astrophysics. Mass measurements of exotic nuclei provide insight into the limits of nuclear existence and changes of the nuclear structure far from stability.

At TRIUMF's Ion Trap for Atomic and Nuclear science (TITAN), masses of neutron-deficient lanthanides have been measured. The ions were produced by a proton beam impinging on a Ta target. The yield of Yb isotopes was enhanced by laser ionization. Mass measurements of the exotic nuclei were performed with TITAN's Multiple-Reflection Time-of-Flight Mass Spectrometer (MR-TOF-MS). For the first time, the MR-TOF-MS was used as its own isobar separator by re-trapping the ions of interest and measuring their masses consecutively. This reduced isobaric background and more exotic nuclei could be measured.

Several masses were measured for the first time. This allows studying the evolution of the $N = 82$ shell closure farthest away from stability. One measured mass is an anchor point of an α decay chain and as such determines the mass values of several heavier isotopes. Mass uncertainties of more than 10 isotopes are reduced by this measurement. The determination of their masses helps in pinning down the exact position of the drip line and finding possible p- and 2p-emitters.

HK 27.3 Wed 14:45 J-HS H

Sub-nanosecon K-isomers in ^{178}W — •M. Rudigier[1,2], P.M. Walker[1], R.L. Canavan[1,3], Zs. Podolyak[1], P.H. Regan[1,3], and P.-A. Söderström[3,4] for the NuBall N-SI-99-Collaboration — [1]Department of Physics, University of Surrey, Guildford, GU2 7XH, UK — [2]ent of Physics, UniverInstitut für Kernphysik, Technische Universität Darmstadt, Schlossgartenstrasse 9, 64289 Darmstadt, Germany — [3]National Physical Laboratory, Teddington, Middlesex, TW11 0LW, UK — [4]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany

New data on half lives of nuclear excited states in ^{178}W are presented. Data were taken in a measurement using the NuBall array at the IPN Orsay. Previously unkown half lives in the sub-nanosecond range of excited states of ^{178}W have been measured by employing the fast timing method using 20 $LaBr_3$ detectors. In particular, the half lives of the 12^+ state at 3235 keV and the 11^- state at 3053 keV have been measured for the first time. Reduced transition rates and hindrance factors were calculated based on the new experimental data. The study shows evidence for anomalously high transition rates from these levels to the ground state band. An 1389 keV E1 transition depopulating the 11^- state at 3053 keV is the first observation of such an anomalous E1 transition rate from a K-isomer in an even-even nucleus. The results are discussed in terms of t-band admixture to the ground state band.

HK 27.4 Wed 15:00 J-HS H

Description of ^{31}Ne in Halo EFT — •Wael Elkamhawy[1] and Hans-Werner Hammer[1,2] — [1]IKP, TU Darmstadt — [2]EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH

Previous investigations of ^{31}Ne via $1n$-removal reactions on C and Pb targets revealed that it is a deformed nucleus with a significant P-wave halo component. We construct a P-wave Halo EFT for ^{31}Ne in order to provide an appropriate framework for its description. Thereby, we use a spherical Halo EFT that is ideally suited to describe the properties of halo nuclei beyond S-waves.

Within this framework, we calculate electromagnetic properties such as the form factors and extract the different multipole moments and the corresponding radii. Since the low-energy observables appear explicitly within Halo EFT, we are able to establish universal correlations between them. Moreover, we consider the photodisintegration of ^{31}Ne into the continuum and determine the differential B(E1) transition strength which in practice is measured using Coulomb excitation of the ^{31}Ne nucleus.

* This work is supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Projektnummer 279384907 - SFB 1245.

HK 27.5 Wed 15:15 J-HS H

Resonances and virtual states in 3n systems — •Sebastian Dietz[1], Sebastian König[1,2,3], and Hans-Werner Hammer[1,2] — [1]IKP, TU Darmstadt — [2]EMMI, GSI Darmstadt — [3]North Carolina State University, Raleigh, NC, USA

We present the analytical continuation of the three-neutron (3n) T-matrix to the unphysical sheets searching for resonances and virtual states. Based on explicit as well as implicit contour deformations of the corresponding Faddeev equation in momentum space we will explore the 3n pole trajectory as a function of the two-neutron interaction strength and show the accessible energy regions. Results are presented for a two-neutron interaction represented by a Yamaguchi potential as well as an interaction derived from pionless effective field theory.

* Funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) * Projektnummer 279384907 * SFB 1245

HK 27.6 Wed 15:30 J-HS H

Spurious poles in hadronic three-particle problems — •Martin Ebert[1], Hans-Werner Hammer[1,2], and Akaki Rusetsky[3] — [1]IKP, TU Darmstadt — [2]EMMI, GSI Darmstadt — [3]HISKP and BCTP, Universität Bonn

The particle-dimer picture is a useful tool to simplify the three-particle problem by including information about the two-particle system. However, in higher orders the dimer propagator can exhibit spurious poles. We present a non-perturbative approach to deal with this problem and compare to fully perturbative schemes. The method is tested with a Yamaguchi model potential.

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HK 27.7 Wed 15:45 J-HS H

Electromagnetic currents from chiral EFT in few-nucleon systems — •Rodric Seutin[1,2,3], Sebastian König[1,2], Kai Hebeler[1,2], and Achim Schwenk[1,2,3] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Planck-Institut für Kernphysik, Heidelberg

Using chiral EFT one is able to construct current operators at the one- and two-body level as they provide important contributions to observables. For example, a significant part of magnetic observables comes

from two-body current contributions. We discuss the development of electromagnetic currents in few-nucleon systems and their applications to electromagnetic form factors, radii, and magnetic moments. All results are obtained by using chiral nucleon-nucleon plus three-nucleon interactions combined with current operators at the one- and two-body level. In particular, we study results for 3H and 3He and explore the theoretical uncertainties.

* This work is supported by the IMPRS-PTFS and the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Projektnummer 279384907 - SFB 1245.

HK 28: Astroparticle Physics I

Time: Wednesday 14:00–15:45 Location: J-HS B

Group Report HK 28.1 Wed 14:00 J-HS B

Searching for neutrinoless double-beta decay with GERDA: results and status — •Ann-Kathrin Schütz for the GERDA-Collaboration — Eberhard Karls Univerität Tübingen

The GERmanium Detector Array (Gerda) experiment aims for the discovery of neutrinoless double beta decay ($0\nu\beta\beta$) decay in ^{76}Ge. It uses HPGe detectors enriched in the isotope ^{76}Ge, which are directly immersed into liquid argon (LAr). In Phase II, the radio-pure cryogenic liquid acts not only as cooling medium for the detectors and passive shielding but also as active shielding. The second phase (Phase II) of Gerda started data taking in Dec 2015 with the design goal of increasing the sensitivity to $T^{0\nu}_{1/2} = O\left(10^{26}\right)$ yr by reducing the background by one order of magnitude. Due to the active veto system detecting LAr scintillation light, the superior energy resolution and an improved background recognition, already the initial release of Phase II showed a background rate in the energy region of interest (ROI), after pulse shape discrimination (PSD) and liquid argon veto cuts, in the range of a few counts/(ROI·ton·yr). This made Gerda the first $0\nu\beta\beta$ experiment being background free up to its design exposure of 100 kg·yr. With the latest data release in mid 2018, Gerda remained in the background free regime. It is the first experiment to surpass a median sensitivity on the half-life of 10^{26} yr for $0\nu\beta\beta$ decay. Meanwhile the experiment has been upgraded by deploying also a new type of germanium detector and by improving the LAr instrumentation. In this talk, a summary of the latest results and an outlook on the performance after the upgrade of the experiment will be given.

HK 28.2 Wed 14:30 J-HS B

Observation of two-neutrino double electron capture in ^{124}Xe with XENON1T — •Christian Wittweg for the XENON-Collaboration — Institut für Kernphysik, WWU Münster

Two-neutrino double electron capture (2νECEC) is a second-order weak process with predicted half-lives that surpass the age of the Universe by far. After indications of 2νECEC in ^{78}Kr and ^{130}Ba, the XENON1T dark matter experiment achieved the first direct observation of 2νECEC in ^{124}Xe with a significance 4.4σ. The corresponding half-life $T^{2\nu\mathrm{ECEC}}_{1/2} = (1.8 \pm 0.5_{\mathrm{stat}} \pm 0.1_{\mathrm{sys}}) \times 10^{22}$ yr is the longest ever measured directly [XENON Collaboration. Nature 568, 532–535 (2019)] and agrees well with recent matrix element calculations [Coello Pérez et al., PLB 797 (2019) 134885]. It provides an important input for nuclear structure models from the proton-rich side of the nuclide chart and is a first step in the search for 0νECEC.

Moreover, decay modes involving positrons such as $0\nu\mathrm{EC}\beta^+$ are energetically allowed, would provide coincidence signatures, and could exhibit half-lives accessible to future detectors. Experimental proof of neutrinoless decays would imply lepton number violation and the Majorana nature of neutrinos. This talk will present the XENON1T result and discuss detection prospects for ^{124}Xe decays involving positrons, both with and without neutrino emission, in the next-generation of xenon-based experiments currently under construction. The work of the author is supported by Deutsche Forschungsgemeinschaft (DFG) through the Research Training Group "GRK 2149: Strong and Weak Interactions - from Hadrons to Dark Matter".

HK 28.3 Wed 14:45 J-HS B

Treatment of systematic uncertainties in the KATRIN neutrino mass analysis — •Leonard Köllenberger — Institute for Nuclear Physics, Karlsruhe Institute of Technology

The KATRIN collaboration aims to determine the neutrino mass with a sensitivity of 0.2 eV/c^2 (90 % CL). This will be achieved by measuring the endpoint region of the tritium β-decay spectrum.

KATRIN's first science run led to an improved upper limit of 1.1 eV (90 % CL) on the neutrino mass, with statistics-dominated uncertainties. Collecting more data in future measurement campaigns will increase the importance of the systematic error contribution.

Several approaches to account for systematic uncertainties can be applied within the analysis. Among these are the use of pull terms, the covariance matrix method, Monte Carlo propagation, and Markov Chain Monte Carlo (MCMC). A comparative discussion of these approaches will be presented. The MCMC approach is used in the KaFit framework and is investigated for treatment of systematics in future neutrino mass analysis.

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).

HK 28.4 Wed 15:00 J-HS B

Investigation of the KATRIN tritium source properties — •Fabian Friedel for the KATRIN-Collaboration — Karlsruher Institut für Technologie

The aim of the **Ka**rlsruhe **Tri**tium **N**eutrino (KATRIN) experiment is to determine the effective mass of the electron antineutrino with a sensitivity of 200 meV/c^2 (90% C.L.). This will be achieved by measuring the β-spectrum of tritium close to the kinematic endpoint at 18.6 keV. The tritium gas is injected into the center of the **W**indowless **G**aseous **T**ritium **S**ource (WGTS) with an inlet flow of 1.8 mbarℓ/s. The neutral gas is pumped at both ends of the 10 m long WGTS beam line while the charged particles are guided by a magnetic field of up to 3.6 T. In order to assure stable conditions for the neutrino mass measurement the source parameters like temperature and gas density have to be stabilized on the per mille level. In addition, a number of systematic effects have to be understood. One of them is related to the formation of a plasma consisting of tritium ions as well as β- and thermal electrons. This may lead to spatial and temporal potential inhomogeneities which would smear out the measured β-spectrum. During two measurement campaigns with tritium in 2019 the WGTS properties and systematics have been studied in detail. The most important results of these investigations will be presented with the main focus on the investigations of the tritium plasma. This work has been supported by BMBF (05A17VK2), KSETA and the Helmholtz Association.

HK 28.5 Wed 15:15 J-HS B

Atmospheric neutrino physics with JUNO — •Giulio Settanta[1], Stefano M. Mari[2,3], Cristina Martellini[2,3], Paolo Montini[2,3], Christoph Genster[1], Yuhang Guo[1,5], Alexandre S. Göttel[1,4], Philipp Kapmann[1,4], Runxuan Liu[1,4], Livia Ludhova[1,4], and Yu Xu[1,4] — [1]Institut für Kernphysik, Forschungszentrum Jülich — [2]Università degli Studi Roma 3 — [3]INFN, sezione di Roma 3 — [4]Physikalisches Institut B, RTWH Aachen University — [5]School of Nuclear Science and Technology, Xi'an Jiaotong University,Xi*an 710049, China

The atmospheric neutrino flux represents a continuous source that can be exploited to infer properties about Cosmic Rays and neutrino oscillation physics. The JUNO observatory, a 20 kt liquid scintillator currently under construction in China, will be able to detect the atmospheric flux, given the large fiducial volume and the excellent energy resolution. In this study, a sample of Monte Carlo events has been generated from theoretical models of the atmospheric neutrino flux, through the Genie software. To evaluate the JUNO performance, the events have then been processed by a full Geant4-based simulation. The different time evolution of light on the PMTs allows to discriminate the flavor of the primary neutrinos. A probabilistic unfolding method has been used, in order to infer the primary neutrino energy spectrum from the detector output. JUNO will be particularly sensitive in the energy range (100-1000) MeV, where neutrino-induced events can be fully contained within the instrumented volume. Future perspectives

about atmospheric neutrino oscillation physics are presented.

HK 28.6 Wed 15:30 J-HS B

Pulse shape analysis in GERDA — •Vikas Bothe for the GERDA-Collaboration — Max Plank Institute for Nuclear Physics, Heidelberg

The GERDA experiment searches for the neutrinoless double-beta decay of 76Ge using enriched high purity Germanium diodes as a source as well as a detector. For such a rare event search, the sensitivity of the experiment can be improved by employing active background suppression techniques. Pulse shape analysis of the signals generated by the interaction of radiation within a detector is employed to discriminate background events. Analysis of time development of pulse can discriminate between the interaction of electron, an interaction of alpha and interaction of Compton scattered photon inside the detector. In Phase II, GERDA operates 35.6 kg HPGe detectors which include 6 semi-coaxial detectors and 30 BEGe detectors. Different pulse shape analysis techniques are employed for these two types of detectors due to their different geometries. We will discuss the results from the pulse shape analysis of these detectors in GERDA.

HK 29: Instrumentation V

Time: Wednesday 14:00–16:00 Location: J-HS C

Group Report HK 29.1 Wed 14:00 J-HS C

Pulse-Shape Analysis and Position Resolution in Highly Segmented HPGe Detectors — •Lars Lewandowski, Peter Reiter, Jürgen Eberth, Herbert Hess, and Rouven Hirsch for the AGATA-Collaboration — Institut für Kernphysik, Köln

The performance of the Pulse-Shape Analysis (PSA) in AGATA HPGe detectors was investigated and improved employing a γ-ray source measurement based on e^+e^- annihilation radiation after decays of ^{22}Na by β^+ decay. The first interaction positions of the two 511 keV γ rays were determined and the connecting line of these two positions was compared to the known source position as a measure for the PSA performance. The position resolution and its dependence on the PSA parameters were investigated by varying most relevant input quantities: the charge carrier mobility of the holes, the response of the employed measuring electronics especially the preamplifier rise time. The relative statistical weight of charge signals and transient signals was scrutinized. The optimal distance metric of the grid-search algorithm and its impact on the position resolution was determined.

HK 29.2 Wed 14:30 J-HS C

Latest development of KoalaSoft for KOALA experiment — •Yong Zhou and Huagen Xu — Institute for Nuclear Physics (IKP), Forschungszentrum Jülich, Germany

The KOALA experiment will measure the antiproton-proton elastic scattering differential cross-section over a wide range of four-momentum transfer |t| from 0.0008 to 0.1 $(GeV/c)^2$ at the upcoming HESR ring of FAIR. It aims to provide key input parameters for PANDA's luminosity determination. KoalaSoft is the simulation software for KOALA experiment. It is developed based on FairRoot and combines the simulation, reconstruction and analysis tasks into one framework. Several new features are developed in KoalaSoft for the KOALA beam test experiment at COSY. First, a new type of FairSource based on raw binary data from the data acquisition system is implemented so that KoalaSoft can now decode the beam test data directly and streamline the analysis process smoothly. Second, all tasks are transformed into FairMQ-based tasks so that configuring the topology of KoalaSoft simulation job or analysis job is more convenient and flexible in a parallel environment. A new online program is also developed based on these new tasks. Finally, a more realistic digitization task of the recoil detector is developed in KoalaSoft to study the differences of event features between elastic scattering and other background reactions. Based on this study, an effective selection procedure for elastic scattering events has been developed and applied to the latest beam test data. All these new developments and a comparison between the simulation and the beam test result are presented in this talk.

HK 29.3 Wed 14:45 J-HS C

Crystal Barrel Trigger Upgrade — •Peter Klassen for the CBELSA/TAPS-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik, Nussallee 14-16, 53115 Bonn

The excitation spectrum of baryons consists of many resonances, which contribute to distinct decay channels. In the CBELSA/TAPS experiment such resonances can be generated using real photons impinging on a polarizable target. The experimental setup is well-suited to observe their decays into final states with uncharged mesons and a proton. To improve the trigger efficiency for purely neutral reactions off neutrons the main calorimeter, the Crystal Barrel detector, was included into the first level trigger.

To achieve this, the frontend electronics were upgraded to an avalanche photo diode (APD) based readout, which allowed for the introduction of a previously non-existent Crystal Barrel timing branch. Core component of the timing branch is an FPGA-based, dual threshold discriminator board. At trigger level, the FPGA reduces the time walk of the digitized signals. These are afterwards processed by a free running clustering algorithm with a latency of 80 ns and an update rate of 5 ns. The cluster information is then passed on to the central experiment trigger. Furthermore, within the FPGA both thresholds are recorded by a multi-hit TDC for an improved offline time walk correction. In this talk the design and achieved performance of the new Crystal Barrel trigger will be presented.

Supported by the Deutsche Forschungsgemeischaft (SFB/TR16) and Schweizerischer Nationalfonds.

HK 29.4 Wed 15:00 J-HS C

Entwicklung und Inbetriebnahme eines neuen (e,e'x)-Datenaufnahmesystems für das QCLAM-Spektrometer am S-DALINAC * — •Maxim Singer, Antonio D'Alessio und Peter von Neumann-Cosel — Institut für Kernphysik, TU Darmstadt

Am supraleitenden Elektronenbeschleuniger S-DALINAC wurde für das hochauflösende QCLAM-Magnetspektrometer ein neues Datenaufnahmesystem für (e,e'x)-Elektronenstreuexperimente entwickelt. Das Detektorsystem des Spektrometers besteht aus drei Vieldrahtdriftkammern zur Elektronenbahnbestimmung und einem Triggerdetektor. Die Driftkammersignale und die Koinzidenzdetektoren werden durch ein VME-basiertes, auf drei Crates verteiltes System ausgelesen. Gezeigt wird das Konzept der Datenaufnahme, sowie das speziell darauf zugeschnittene Online-Monitoring-Programm QCLAMon. Die Funktionsfähigkeit des Systems wird anhand von Messergebnissen aus einer aktuellen Strahlzeit präsentiert.

* Gefördert durch die DFG im Rahmen des SFB 1245.

HK 29.5 Wed 15:15 J-HS C

A new streaming DAQ for future measurements at the M2 beam line at CERN — •Benjamin Moritz Veit[1,2], Igor Konorov[3], Stefan Huber[3], Martin Zemko[2], Matthias Gorzelik[5], and Vladimir Frolov[4] — [1]Institut für Kernphysik der Johannes Gutenberg-Universität, Mainz, Deutschland — [2]CERN — [3]Technische Universität München — [4]Joint Institute for Nuclear Research — [5]University of Freiburg

Currently proposals are under revision at CERN for future measurements with muon and hadron beams at the M2 beam line of the CERN SPS. For this experiments it is planned to transform the current classical triggered DAQ approach to a free running DAQ scheme which is based on an trigger-less read-out of all detectors, and later online and offline data reduction stages based on FPGA and x86 filter technologies (High Level Triggers). One of the first experiments is the measurement of the proton radius by elastic muon proton scattering. For this experiment two data taking phases are foreseen. For the first phase, with an low intensity muon beam a full, not reduced data sample will be written to disk. This allows a complete un-biased data analysis and the validation of an filter scheme which needed for a possible later high intensity data taking period to reduce the amount of data. The DAQ and Trigger/Filtering scheme and requirements for both of these measurements will be presented.

HK 29.6 Wed 15:30 J-HS C

Energy Sum Trigger for the Crystal Barrel Detector — •Bence Mitlasoczki for the CBELSA/TAPS-Collaboration — Universität Bonn

The CBELSA/TAPS experiment at the ELSA accelerator in Bonn performs baryon spectroscopy measurements. The 1320 crystals of the main calorimeter, the Crystal Barrel, are included in the trigger system via discriminators, and a cluster finder is utilized to trigger on the number of clusters.

For reactions with small cross sections the trigger selectivity is the main limiting factor to the acquisition of relevant events due to background reactions using up a large part of the readout capacity. The inclusion of the total energy into the trigger system will provide an improvement.

In this talk, I will present an improved design and first performance tests of the recently installed energy sum modules. To be able to precisely set an energy threshold, the difference in amplitudes of the responses to deposited energy of each crystal needs to be accounted for. For this purpose, a weighting of individual signals is needed. The summing modules use multiplying DACs to provide this weight adjusting capability. A DAC is used for removing the offset in the sum signal. Communication with the modules is possible via I2C.

HK 29.7 Wed 15:45 J-HS C

Conceptual Studies on a Beam Abort System for HADES — •Florian Marx for the HADES-Collaboration — Goethe-Universität Frankfurt

The physics cases studied with the HADES experiment at SIS-18 (GSI Darmstadt) require high beam intensities of several MHz well focused on a target. During the beam time, there is a risk of the beam not hitting the target but rather its surroundings, potentially harming the detectors and electronics. Reasons may be bad beam alignment or failure of guiding magnets for the particle beam. The aim of this work is to design and realize an FPGA based monitoring system, which is able to analyze the relevant hit rates in various detectors and compare them to a preset default. A dedicated algorithm can assess whether the rates significantly exceed the given limits and cause a possible thread for the detectors and/or electronics. As a results various follow-up actions can be triggered, including aborting the beam on a short time scale. This talk will present the implementation and first test results. This work has been supported by BMBF (05P19RFFCA) and GSI.

HK 30: Instrumentation VI

Time: Wednesday 14:00–16:00 Location: J-HS D

Group Report HK 30.1 Wed 14:00 J-HS D

Status of the Barrel and Disc DIRC detectors at PANDA — •Merlin Böhm for the PANDA-Collaboration — Physikalisches Institut, Universität Erlangen-Nürnberg

One of the main experiments at FAIR is PANDA, where high intensity antiprotons annihilate with protons in a momentum range of 1.5-15 GeV/c. For this experiment an excellent π/K separation with $\geq 3\sigma$ is required. Two ring imaging Cherenkov detectors of the DIRC-type (Detection of Internally Reflected Cherenkov light) will be built. The Barrel DIRC surrounds the interaction region, covering polar angles from 22° to 140°. The Endcap Disc DIRC (EDD) is placed in the forward beam direction and covers polar angles from 5° to 22°. The Barrel DIRC is based on the BaBar and SuperB FDIRC designs with key improvements like lenses, prisms, and ultra-fast sensors, the EDD is a novel design. The radiators of both DIRCs are made from precisely polished fused silica glass to conserve the Cherenkov angle during many internal reflections and to maximize the photon transport efficiency. The photons are guided to readout planes by a lens and prism or by focusing elements and are detected by lifetime-enhanced MCP-PMTs, read out by FPGA-based TRB boards and TOFPET ASICs. This talk will give an overview of the designs, performance, and status of both DIRCs. The advanced and cost-optimized technical designs of the DIRCs are finalized and the TDRs are now completed. Mass production of components has been started for the Barrel DIRC, a first quadrant of the EDD will soon be under construction. - Funded by BMBF and GSI -

HK 30.2 Wed 14:30 J-HS D

The PANDA Disc DIRC Project — •Ilknur Köseoglu[1,2], Simon Bodenschatz[1], Lisa Brück[1], Michael Düren[1], Avetik Hayrapetyan[1], Jan Hofmann[1], Sophie Kegel[1], Jhonatan Pereira de Lira[1], and Mustafa Schmidt[1] for the PANDA-Collaboration — [1]II. Physikalisches Institut, Justus Liebig University of Giessen, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

The fixed target experiment PANDA at the new Facility for Antiproton and Ion Research (FAIR) near Darmstadt/Germany is planned to investigate fundamental questions of hadron physics by using an antiproton beam with a momentum range of 1.5 to 15 GeV/c. In order to achieve an excellent particle identification (PID) for the polar angle range from 5° to 22°, a novel disc shaped Endcap Disc DIRC (EDD) has been developed to perform a π/K separation with at least 3 σ up to 4 GeV/c particle momenta. The Cherenkov radiator of the EDD is a 2 cm thin plate of synthetic fused silica, divided into 4 identical independent quadrants. They will be polished with highest precision in order to conserve the Cherenkov angle during the light propagation to the outer rim. The light guides and light sensors, that are lifetime enhanced Microchannel Plate PMTs (MCP-PMTs), are positioned at the outer rim to detect the signal with an ASIC-based readout system. A full size quadrant was delivered in August 2019, and the precision of the optical system has been investigated using a laser system. After accomplishment of the quality measurements, the Cherenkov radiation will be measured in the Giessen Cosmic Station (GCS).

HK 30.3 Wed 14:45 J-HS D

Commissioning of the GlueX DIRC at JLab — Ahmed Ali[1,2], •Roman Dzhygadlo[1], Klaus Peters[1,2], and Jochen Schwiening[1] for the GlueX-Collaboration — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt — [2]Goethe-Universität Frankfurt

The GlueX experiment at Jefferson Laboratory aims to perform quantitative tests of non-perturbative QCD by studying the spectrum of light-quark mesons and baryons. A Detector of Internally Reflected Cherenkov light (DIRC) was recently installed to enhance the particle identification (PID) capability of the GlueX experiment by providing clean π/K separation up to 4 GeV/c momentum in the forward region (θ<11 degree), which will allow the study of hybrid mesons decaying into kaon final states with significantly higher efficiency and purity.

The new PID system is build using radiators from the decommissioned BaBar DIRC counter, combined with new compact photon cameras based on the SuperB FDIRC concept. The first half of the system was successfully installed and commissioned in early 2019. Commissioning of the complete GlueX DIRC with beam is scheduled for December 2019. We will discuss the status of the DIRC detector and its performance during commissioning.

HK 30.4 Wed 15:00 J-HS D

Performance of the mRICH detector in the mCBM experiment at SIS18 — •Adrian Amatus Weber for the CBM-Collaboration — Justus-Liebig Universität Giessen

The Compressed Baryonic Matter (CBM) experiment is a key experiment of the upcoming FAIR facility next to GSI in Darmstadt and part of the C.B.M. pillar. The CBM experiment will measure the QGP phase diagram at high net baryonic densities with high interaction rates of up to 10MHz and a free streaming detector readout in combination with advanced online reconstruction and selection methods.

The Ring Imaging Cherenkov (RICH) detector is a central part of CBM with highly advanced readout electronics and excellent PID capabilities. As an important step towards the final CBM experiment a prototype of the RICH detector, the mRICH, was build to test the performance and reliability of the readout concept in a common free streaming readout with other CBM detector prototypes in the mCBM experiment at GSI. The mRICH detector is based on the newly developed DiRICH front end electronics, which is already used in the HADES RICH detector, in combination with two aerogel radiator blocks. The common free streaming readout with the mRICH was successfully tested in march 2019 in Ag+Au collisions at 1.58 AGeV.

The readout concept of the mRICH as well as performance with respect to time and spacial correlations to the other subdetectors will be presented in this talk.

HK 30.5 Wed 15:15 J-HS D

HADES RICH upgrade and performance — •Jörg Förtsch and Christian Pauly for the HADES-Collaboration — Bergische Universität Wuppertal

The HADES experiment at GSI in Darmstadt is studying baryonic matter at low temperatures in pion, proton and heavy ion induced reactions on both light and heavy nuclei. In 2018 / 2019 a major detector upgrade has been carried out including a new MAPMT based photon detector for the RICH, which replaced the old CsI+MWPC based VUV photon camera. Readout of the new photon detector is accomplished using the DiRICH readout chain which aims in particular on good timing precision.

The upgraded RICH detector has been successfully operated in a very successful 4 week measurement campaign of Ag+Ag collisions at 1.58A GeV.

We have studied the performance of the RICH detector with respect to electron identification efficiency and timing precision. We present the upgrade and show first results on the performance.

The work has been supported by BMBF (05P19PXFCA), GSI and HIC for FAIR.

HK 30.6 Wed 15:30 J-HS D

Development of a Ronchi Test at the CBM-RICH Mirrors — •Cornelius Feier-Riesen[1] and Semen Lebedev[2] for the CBM-Collaboration — [1]Justus-Liebig-Universität Gießen — [2]GSI Darmstadt

The CBM (Compressed Baryonic Matter) experiment is designed to explore the QCD Phase Diagram at moderate temperatures and high net-baryon densities. CBM will be located at the future FAIR facility in Darmstadt/Germany. The detector is designed to record, trigger and analyze reaction rates up to 10 MHz for p+p, p+A and A+A collisions.

The CBM RICH (Ring Imaging Cherenkov) detector will distinguish pions from electrons. The conically emitted Cherenkov photons are reflected by the CBM RICH mirrors onto the photon detector plane. The RICH has two spherical mirror planes, each mirror plane consisting of 40 (5 * 8) single squared mirror tiles. Since the photon yield is very small it is of great importance to ensure that the mirrors will map the photons with very high accuracy onto the PMT plane.

In this talk, the development of a Ronchi test for the CBM RICH mirrors will be presented. This test determines the local geometry of the surface, more precisely its deviation from an ideal sphere.

HK 30.7 Wed 15:45 J-HS D

Radiator Studies with CBM-TRD Prototypes in Testbeams at DESY — •Adrian Meyer-Ahrens for the CBM-Collaboration — Institut für Kernphysik, Münster, Deutschland

The Transition Radiation Detector (TRD) is a part of the Compressed Baryonic Matter (CBM) experiment at FAIR. The detector is composed of a radiator, consisting of layers of irregular polyethylene (PE) foam foils, and a multi-wire proportional chamber (MWPC). For the CBM-TRD's main tasks, especially for electron identification with a high suppression of pions, a high yield of TR generated by electrons passing through the radiator is crucial. In a dedicated testbeam campaign, two CBM-TRD prototypes were set up at DESY in August of 2019 and tested with electron beams using various radiator thicknesses.

In this talk, analysis results concerning the performance of the detector in this testbeam campaign will be presented. This work is supported by BMBF grant 05P19PMFC1 and the GSI F&E programme.

HK 31: Outreach methods II (joint session T/HK)

Time: Wednesday 16:30–18:45 Location: H-HS VI

HK 31.1 Wed 16:30 H-HS VI

Erste Erfahrungen mit den BELLE II-Daten bei den International Masterclasses 2020 — •Maike Hansen[1], Florian Bernlochner[1], Jochen Dingfelder[1], Thomas Kuhr[2], Kilian Lieret[2], Christoph Schwanda[3], Barbara Valeriani-Kaminski[1], Barbara Wankerl[4] und Christian Wessel[1] für die Netzwerk Teilchenwelt-Kollaboration — [1]Universität Bonn, Germany — [2]LMU München, Germany — [3]HEPHY Wien, Austria — [4]Max-Planck-Institut für Physik München, Germany

Bei den International Masterclasses "hands on particle physics" erhalten jedes Jahr mehr als 13000 Jugendliche weltweit einen Einblick in die Grundlagen und Forschungsmethoden der Teilchenphysik sowie in die Arbeitswelt von Wissenschaftlerinnen und Wissenschaftlern. Zu diesem Zweck stellen immer mehr Experimente auf der ganzen Welt aktuelle Daten zur Verfügung. Gleichzeitig werden Materialien entwickelt, die Schülerinnen und Schülern die Analyse der Daten ermöglichen.

Unter den "Newcomern" bei den International Masterclasses ist das BELLE II-Experiment am Forschungszentrum KEK in Japan. Im Rahmen der International Masterclasses 2020, die zwischen dem 26. Februar und dem 8. April 2020 stattfinden, werden erstmals im deutschsprachigen Raum BELLE II-Masterclasses angeboten. In diesem Vortrag werden die Erfahrungen der Masterclasses in Bonn, München und Wien präsentiert: Wie wurden die Teilnehmer/innen auf ihre Aufgaben vorbereitet und wie kamen sie mit den Daten zurecht? Außerdem werden Schwierigkeiten und positive Überraschungen diskutiert sowie Impulse für zukünftige Veranstaltungen gegeben.

HK 31.2 Wed 16:45 H-HS VI

3D und Virtual-Reality-Umgebungen zur Vermittlung von Grundlagenforschung am Beispiel des ALICE-Detektors am CERN-LHC — •Christian Klein-Bösing[1], Philipp Bhatty[2], Stefan Heusler[3] und Reinhard Schulz-Schaeffer[2] — [1]Institut für Kernphysik, WWU Münster, Germany — [2]Department Design, HAW Hamburg, Germany — [3]Institut für Didaktik der Physik, WWU Münster, Germany

Detektoren in der Elementarteilchenphysik, wie der ALICE-Detektor am LHC, können in der Regel der breiten Öffentlichkeit nur an Hand von Bildern oder Filmen präsentiert werden. Die Darstellung in einer Echtzeit-3D-Umgebung, wie einer Virtual-Reality- und Web3D-Applikation, ermöglicht hingegen direkt die Größe des Experimentes erfahrbar zu machen, aber auch neue, virtuelle Handlungsräume und Handlungsoptionen zu erforschen und zielgruppengerecht einzusetzen. Die Entwicklung einer solchen Web3D-Lernumgebung sowie einer VR-Lernapplikation, inklusive der empirischen Bewertung verschiedener Darstellungsoptionen, der Gestaltung von Nutzerinteraktion und interaktiver Lernaufgaben, erfordert eine enge Kooperation zwischen Grundlagenforschung in der Elementarteilchenphysik, der Didaktik der Physik und der Wissenschaftsillustration.

Wir präsentieren den aktuellen Entwicklungsstatus basierend auf einer interaktiven Visualisierung des ALICE-Detektors in VR (Smartphone und VR-Systeme) und Web-3D (Browser).

HK 31.3 Wed 17:00 H-HS VI

Das Feynman-Puzzle: Ein spielerischer Ansatz zur Vermittlung von fundamentalen Wechselwirkungen — •Kai Gerschlauer, Philip Bechtle, Johanna Rätz und Barbara Valeriani-Kaminski für die Netzwerk Teilchenwelt-Kollaboration — Physikalisches Institut der Universität Bonn, Deutschland

Das Netzwerk Teilchenwelt hat sich zur Aufgabe gemacht, den Schüler*innen die Faszination der Teilchenphysik zu vermitteln und die Neugier der Jugendlichen für die Grundbausteine unseres Universums zu wecken. Um zu verstehen, was in einem Teilchenbeschleuniger passiert und welche Prozesse bei einer Teilchenkollision stattfinden, bieten Feynman-Diagramme eine anschauliche Übersetzung der komplexen Mathematik. Das Feynman-Puzzle soll genau dort ansetzen und aufbauend auf einem Online-Vorbereitungskurs den Schüler*innen die möglichen Wechselwirkungsprozesse des Standardmodells (SM) und die dazugehörigen Materie- und Austauschteilchen vermitteln. Schritt für Schritt können sich die Schüler*innen sowohl einfache Prozesse, die sie aus der Schule kennen, als auch komplexere Beschreibungen von Signal/Untergrund-Prozessen in Form von Feynman-Diagrammen aneignen. Da die Spielkarten auf den Vertizes des SM beruhen, vermitteln sie direkt ein Verständnis dafür, welche Prozesse von der Eichstruktur des SM erlaubt sind und welche verboten. So können beispielsweise Produktion und Zerfall des Higgs-Bosons erarbeitet und auch ein Verständnis dafür geschaffen werden, welche Prozesse mehr oder weniger wahrscheinlich sind.

HK 31.4 Wed 17:15 H-HS VI

Die nächste Generation von CosMO-Detektoren — •Jonathan Schöttke, Carolin Schwerdt, Heike Prokoph, Michael Wal-

ter und Dorothee Braun für die Netzwerk Teilchenwelt-Kollaboration — Deutsches Elektronen-Synchrotron DESY, Platanenallee 6, 15738 Zeuthen, Germany

Jugendlichen einen authentischen Einblick in die Detektion der kleinsten uns bekannten Teilchen zu ermöglichen, ist das Ziel des Detektorprojektes von Netzwerk Teilchenwelt. In diesem Zusammenhang wurde auch das Cosmic Muon Observer (CosMO) Experiment entwickelt. CosMO besteht aus einem Szintillationszähler mit Datenauslesekarte und einem Computer mit schülerfreundlichem Analyseprogramm, welches seit über sieben Jahren an vielen kooperierenden Instituten, Forschungseinrichtungen sowie Schulen zum Einsatz kommt. Wegen des anhaltenden Bedarfs an diesem Experiment sollen nun weitere CosMO-Setups gebaut werden. In diesem Beitrag werden Untersuchungen zur Optimierung des Detektorbaus vorgestellt, welche vor allem auf eine vereinfachte Fertigung und Wartung Wert legen und zeitgleich Neuerungen auf dem Gebiet der Silizium-Photomultiplier (SiPMs) in Betracht ziehen. Es wurde untersucht, ob das aufwendige Einkleben der Lichtleitfasern in den Szintillator umgangen werden kann, indem die Fasern lediglich in eine Art Tunnel im Szintillator geschoben werden oder sogar die SiPMs direkt an den Szintillator angebracht werden können. Dafür wurden unterschiedlich große SiPM von verschiedenen Herstellern charakterisiert und zusammen mit dem veränderten Detektor-Setup getestet.

HK 31.5 Wed 17:30 H-HS VI

CERN Open Data im Schülerpraktikum — •Artur Monsch und Günter Quast — Karlsruher Institut für Physik

Die Bereitstellung von Messdaten und Simulationen auf dem öffentlich zugänglichen CERN Open Data Portal schafft eine Möglichkeit diese Daten im Bildungsbereich einzusetzen, um das Interesse an der Teilchenphysik zu wecken und ein tieferes Verständnis der Vorgehensweisen und Arbeitsmethoden zu erreichen. Vorgestellt wird ein an unterschiedliche Kompetenzstufen anpassbares Konzept, das anhand dieser Daten die Entdeckung des Higgs-Bosons auf didaktischer Ebene im Rahmen eines Computer-Kurses nachvollziehbar macht. Dazu wird das Spektrum der invarianten Masse im 'goldenen Zerfallskanal' H in 4 Leptonen untersucht. Ausgehend von dem Aufbau und der Funktionsweise eines Detektors werden die Teilnehmer mit den notwendigen Grundkonzepten der Rekonstruktion und Selektion der Daten vertraut gemacht, um anschließend aus der gewonnen Verteilung der invarianten Massen auf die statistische Signifikanz des Signals für ein Higgs-Boson mit der Masse von 125 GeV zu schließen. Die initiale Auslegung auf das Fortgeschrittenenpraktikum im Physikstudium kann durch eine selektive Eingrenzung des Themenumfanges auch im schulischen Umfeld oder in Schülerprogrammen an der Universität zur Anwendung kommen.

HK 31.6 Wed 17:45 H-HS VI

Physik-Projekt-Tage – Gleichstellung in der Physik an Hand eines Workshops nur für Schülerinnen — •Roman Kogler, Anna Benecke und Melanie Eich — Universität Hamburg

Dass Gleichstellungsarbeit besonders in der Physik ein wichtiges Thema ist, zeigen nicht zuletzt die Einschreibezahlen von Studentinnen in den Physikstudiengängen. In Kiel liegt der Prozentsatz von Frauen bei etwa 15%. Um ein angemessenes Geschlechterverhältnis auf allen Karrierestufen zu erreichen genügt es daher nicht, erst an der Universität mit Gleichstellungsarbeit zu beginnen - es muss bereits in der Schule angesetzt werden. Mit den Physik-Projekt-Tagen (PPT) wurde ein viertägiger Workshop nur für Schülerinnen ins Leben gerufen. Die Teilnehmerinnen haben die Möglichkeit, zu Schuljahresbeginn vier Tage lang in einem Projekt ihrer Wahl zu experimentieren, ihr Interesse an Physik zu steigern und Netzwerke über Schulgrenzen hinweg aufzubauen. Die Projekte umspannen verschiedene Forschungsfelder der Physik und reichen von Teilchenphysik, über Laserphysik und Plasmaphysik bis hin zu Nanowissenschaften. Zur Qualitätssicherung und Weiterentwicklung dieser Veranstaltung werden die PPT von einer kritischen Evaluation begleitet. Das Konzept der PPT, Inhalte und ausgesuchte Ergebnisse der Evaluation werden vorgestellt. Seit 2015 ist das Projekt im Instrumentenkasten für Gleichstellungsarbeit der DFG.

HK 31.7 Wed 18:00 H-HS VI

Entwicklung einer TPC als Demonstrationsexperiment — •Johannes Streun, Klaus Desch und Jochen Kaminski — Physikalisches Institut der Universität Bonn

Die SchulTPC ist eine kompakte, hochauflösende Zeitprojektionskammer. Der Detektor erfasst Spuren ionisierender Strahlung und bietet die Möglichkeit, diese direkt digital auszuwerten und darzustellen. Dadurch eignet er sich als Demonstrationsexperiment in Ausstellungen und Museen. Außerdem wird auch angestrebt, mit dem Detektor Experimente in der Schule aufzubauen, zum Beispiel als Exkurs im Physikunterricht oder als Thema einer Facharbeit. Zu den Besonderheiten des Detektors gehören die kompakten Maße von ca. 10cm x 10cm x 15cm, die Hochspannungsversorgung in der Größe eines Schuhkartons und eine Ausleseeinheit, welche über USB betrieben und ausgewertet werden kann. Ziel ist es, ein Demonstrationsmodell zu schaffen, welches technisch nahe an den tatsächlich in aktueller Forschung eingesetzten Detektoren liegt, jedoch kompakt und somit transportabel ist, sowie eine Bedienung zu schaffen, welche auch für den Laien klar und verständlich ist. Der Vortrag beschäftigt sich vorwiegend mit den anfänglichen Planungen des Detektors und der technischen Realisierung sowie der Konstruktion des Prototypen. In Folge dessen wird auf einzelne technische Details der Zeitprojektionskammer eingegangen und auf die spätere Anwendung bezogen. Im Anschluss wird über erste Erfahrungen mit der SchulTPC als Demonstrationsmodell berichtet u. a. bei den "Highlights der Physik 2019" in Bonn.

HK 31.8 Wed 18:15 H-HS VI

Myonteleskop aus modularen Szintillationsdetektoren mit SiPM-Auslese für das physikalische Praktikum — •Anja Schmidt[1], Günter Quast[1], Ralph Engel[1], Joachim Wolf[1], Andreas Haungs[1] und Thomas Huber[1,2] — [1]Karlsruher Institut für Technologie (KIT) — [2]Deutsches Elektronen-Synchrotron (DESY)

Basierend auf dem KIT IceScint Prototyp des Szintillator-Upgrades des IceCube-IceTop Detektors werden neue Szintillationsdetektoren entwickelt, welche zukünftig im Fortgeschrittenenpraktikum im Rahmen des Physikstudiums eingesetzt werden. Diese werden an die Bedingungen und den Messbereich der Praktikumsziele angepasst. Das Detektorprinzip basiert auf Szintillationsdetektoren, durch welche wellenlängenschiebende Fasern gezogen werden. Die Fasern leiten das Licht zu einem SiPM (Silizium-Photomultiplier), welcher dann mithilfe der für IceScint entwickelten Ausleseelektronik ausgelesen wird. Das verstärkte SiPM Signal wird anschließend mit einem PicoScope aufgenommen. Damit wird die neueste Detektortechnologie Studierenden zugänglich gemacht. Außerdem kann diese auch für die Experimente des Netzwerk Teilchenwelt eingesetzt werden.
Im Praktikum werden drei Detektoren als Hodoskop übereinander aufgebaut. Zusammen mit einem Absorber und einem Magneten können mit diesem Aufbau über Koinzidenzmessungen die Lebensdauer und der Lande-Faktors des Myons bestimmt werden.
In diesem Vortrag werden das Detektordesign, Ergebnisse der Charakterisierung der Detektoren und erste Messergebnisse gezeigt.

HK 31.9 Wed 18:30 H-HS VI

Mini NM and MT measurements on the German research vessel Polarstern — •Bernd Heber[1], Dennis Galsdorf[1], Konstantin Herbst[1], Vladimir Mares[2], Carolin Schwerdt[3], Du Toit Strauss[4], and Michael Walter[3] — [1]Christian-Albrechts-Universität Kiel — [2]Helmholtz Zentrum München, Neuherberg, Germany — [3]Deutsches Elektronen-Synchrotron DESY Zeuthen, Germany — [4]Center for Space Research, North-West University, Potchefstroom 2520, South Africa

Neutron Monitors (NMs) are ground-based devices to measure the variation of the intensity of the secondary neutrons from Galactic Cosmic Rays (GCRs). Since their measurements are influenced by the variable Earth magnetic field and the atmospheric conditions close to its position a detailed knowledge of the instrument sensitivity with geomagnetic latitude (rigidity), atmospheric pres- sure and the local environment is essential. Portable NMs, constructed by the North West University campus Potchefstroom, South Africa, and Muon Tele- scopes (MTs), constructed by DESY Zeuthen have been installed aboard the German research vessel Polarstern at the Neumeier III in Antarctica at sea level and at the Environmental Research Station Schneefernerhaus (UFS) Zugspitze at altitude of 2660 m a.s.l. Here we present the theoretical background that is utilized to determine the instrument response with respect to the geomagnetic position and the atmospheric pressure. The latter will be shown by investigating the measurements in Antarctica and on the Zugspitze. The dependence with the geomagnetic position is explored by analyzing Polarstern measurements.

HK 32: Combined detector session (joint session HK/T/ST/EP)

Time: Wednesday 16:30–18:30 Location: H-HS X

Invited Talk HK 32.1 Wed 16:30 H-HS X
Detectors for Measuring Space Radiation — •Robert F. Wimmer-Schweingruber and and the Kiel Extraterrrestrial Physics Team — Christian-Albrechts-Universität zu Kiel, Kiel, Germany

Radiation in the solar system comes from various sources, primarily galactic cosmic radiation (GCR) and solar (cosmic) radiation, as well as particles trapped and/or accelerated in and at planetary magnetospheres and traveling shock waves. While measurements of radiation on Earth and in its atmosphere have been performed for more than a century, measuring space radiation is more complicated, mainly because of the limited resources available on spacecraft. In this talk I will discuss examples of how to measure space radiation on Mars, the Moon, and in the inner solar system, i.e., between the Sun and Earth, thus covering measurements on a body with a (thin) atmosphere, with no atmosphere, and in free space. The examples include the Radiation Assessment Detector (RAD) on NASA*s Mars Science Laboratory (MSL), the Lunar Lander Neutrons and Dosimetry (LND) instrument on China*s Chang*E 4 lander on the far side of the Moon, and the four sensors STEP, EPT, SIS, and HET on ESA*s Solar Orbiter which is scheduled for launch on February 7, 2020, at the time of writing this abstract.

Invited Talk HK 32.2 Wed 17:00 H-HS X
Modern Timing Detectors in HEP — •Jörn Lange — II. Physikalisches Institut, Georg-August-Universität Göttingen, Germany

Particle detectors with precise time information are traditionally used in HEP as time-of-flight detectors. A new generation of high granularity and radiation-hard timing detectors with a precision of few tens of picoseconds is being developed for event time measurements at the High-Luminosity upgrades of the LHC experiments. By measuring the arrival time of each particle in the detector, its underlying collision vertex can be identified to suppress the background from event pileup in an environment with up to 200 collisions per proton-proton bunch crossing. This is made possible thanks to the rapid advance of new detector technologies like Silicon Low Gain Avalanche Detectors (LGADs). For the longer term future, 4D tracking detectors are being developed, which combine precise timing with the high granularity and spatial resolution of today's pixel detectors, enabling enhanced pattern recognition in high density track environments. This presentation will motivate and introduce the novel timing detectors and their technologies. New developments such as 4D-tracking and possible other applications will be discussed as well.

Invited Talk HK 32.3 Wed 17:30 H-HS X
Experimental time resolution limits of modern SiPMs and TOF-PET detectors — •Stefan Gundacker — CERN, Esplanade de Particules 1, 1211 Meyrin, Switzerland — UniMIB, Piazza dell'Ateneo Nuovo, 1-20126, Milano, Italy

Time Of Flight (TOF) information applied in Positron Emission Tomography (PET) has shown to improve the image quality, shorten scan times and reduces the patient radiation dose. A Coincidence Time Resolution (CTR) in the range of 20 ps FWHM would enable to access image voxels of 3x3x3mm^3 along the line of response and is likely to revolutionize clinical PET. Inorganic scintillator-based detectors are able to record the 511 keV annihilation gammas with high sensitivity and have strongly benefited from the appearance of solid-state photodetectors (e.g. the SiPM), new crystal types (e.g. LYSO:Ce codoped with divalent ions) and improved front-end electronic readout. Such developments enabled commercial PET systems to achieve CTRs around 210 ps FWHM (Siemens Biograph vision). Nevertheless, a complete assessment of state-of-the-art scintillators and SiPMs in terms of their currently achievable time resolution limits was still missing and will be given in this paper. That is important, as it helps to define future strategies and directions of research in order to improve the system CTR by at least an order of magnitude. Furthermore, general aspects of the theoretical CTR limits in TOF-PET will be discussed along with some considerations on how to bring promising laboratory results into real world medical applications.

Invited Talk HK 32.4 Wed 18:00 H-HS X
260 megavoxel camera with continuous readout - the upgraded ALICE TPC — •Laura Fabbietti for the ALICE-Collaboration — JamesFranckstr. 1

The ALICE Time Projection Chamber (TPC) is the world largest detector of this type. It is the main tracking and PID device of the ALICE detector. It is currently being upgraded with a new readout system, including new GEM-based Readout Chambers and new front-end electronics. The upgraded TPC will operate in continuous mode, recording the full minimum-bias interaction rate of 50 kHz in Pb-Pb offered by the LHC in Run 3 and beyond. This will result in a significant improvement on the sensitivity of rare probes*that are considered key observables to characterise the QCD matter created in such*collisions. In this presentation I will discuss the physics potential of the upgraded TPC and show the status of the TPC upgrade activities during the ongoing LHC Long Shutdown 2. First results of the commisioning tests will be presented.

HK 33: Hadron Structure and Spectroscopy VII

Time: Wednesday 16:30–18:30 Location: J-HS A

Group Report HK 33.1 Wed 16:30 J-HS A
ALICE: A new Laboratory to Investigate and Constrain Exotic hadron-hadron interactions — •Dimitar Mihaylov for the ALICE-Collaboration — Technische Universität München, James-Franck-Straße, 85748, Garching, Germany

The study of baryon-hyperon interactions is essential for understanding the Equation of State of dense objects like neutron stars. Recent results from lattice calculations, based on fundamental QCD principles, provide theoretical predictions for an attractive interaction between p−Ξ^- and p−Ω^-, and a hint that the latter could form a bound state. At the moment all experimental attempts to study these predictions were inconclusive.

Pioneering studies by the ALICE collaboration demonstrated the potential of employing femtoscopy to investigate and constrain baryon-baryon interactions with unprecedented precision, thus providing a unique opportunity to study exotic baryon-hyperon pairs. In this contribution we present the latest ALICE results on p−Λ, p−Σ^0, p−Ξ^- and p−Ω^- interactions, based on the analysis of high-multiplicity pp collisions at $\sqrt{s}$ =13 TeV. To achieve the required precision, a novel procedure to model the emission source of all baryons, based on the explicit correction for the effect of short lived resonances, was developed. The p−Λ correlation provides new constraints to theoretical models, in particular related to the effects of the coupling to N−Σ. In the multi-strangeness sector, the p−Ξ^- and p−Ω^- interactions are confirmed to be attractive. The possible existence of a bound state in the p−Ω^- system will be discussed in detail.

HK 33.2 Wed 17:00 J-HS A
Search for $c\bar{c}s\bar{s}$ exotic states in B decays at Belle — •Ashish Thampi[1], Elisabetta Prencipe[1], Soeren Lange[2], and James Ritman[1] — [1]IKP-1, Forschungszentrum Juelich — [2]Physikalisches Institut II, JLU Giessen

The $B \to J/\psi\phi K$ transition most likely proceeds as a three body decay. Investigating this decay is important in the search for possible $c\bar{c}s\bar{s}$ exotic states in the $J/\psi\phi$ invariant mass system. Indeed LHCb has confirmed enhancements at 4140, 4274, 4500 and 4700 MeV/c^2 by studying the charged B meson decays. In order to provide a better understanding of the process and understanding the nature of these enhancements, we have analyzed the $J/\psi\phi$ invariant mass system produced in both, charged and neutral B meson decays, $B^{\pm} \to J/\psi\phi K^{\pm}$ and $B^0 \to J/\psi\phi K^0$. This analysis uses 711 fb^{-1} integrated luminosity data collected at the energy in the center of mass of $\Upsilon(4S)$ resonance

by the Belle detector during the years 1999-2010. MC studies for evaluating the branching ratio and the study of the $J/\psi\phi$ invariant mass system are shown.

HK 33.3 Wed 17:15 J-HS A

Search for the Y(2175) in Photo-production at GlueX — •Abdennacer Hamdi[1,2], Klaus Götzen[1], Frank Nerling[1,2], and Klaus Peters[1,2] — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany — [2]Institut für Kernphysik, Goethe-Universität, Frankfurt am Main, Germany

Understanding the Hadron spectrum is one of the primary goals of non-perturbative QCD. Many predictions have been experimentally confirmed, but others remain under experimental investigation. Of particular interest is how gluonic excitations give rise to states with constituent glue. One class of such states are hybrid mesons that are predicted by theoretical models and Lattice QCD calculations. Searching for and understanding the nature of these states is a primary physics goal of the GlueX experiment at the CEBAF accelerator at Jefferson Lab in the US. We will present the status to search for a hybrid meson candidate, the $Y(2175)$, in $\phi(1020)\pi^+\pi^+$ and $\phi(1020)f_0(980)$ channels in photo-production at the GlueX experiment.

HK 33.4 Wed 17:30 J-HS A

Heavy-Light Tetraquarks in a Bethe-Salpeter Approach — •Nico Santowsky and Christian S. Fischer — JLU Gießen, Germany

We investigate heavy-light tetraquarks with quark content $(c\bar{c}q\bar{q})/(cc\bar{q}\bar{q})$ with a fixed heavy quark mass $m_{c=\text{charm}}$ and a variable light quark mass m_q using the Dyson-Schwinger/Bethe-Salpeter framework (DSE/BSE). We explicitly treat internal 'cluster' structures *mesonic* $(c\bar{q}-\bar{c}q)$, *hadro-charmonium* $(c\bar{c}-q\bar{q})$ and *diquarkonic* $(cq-\bar{c}\bar{q})$, with meson and diquark states, determined by their DSE/BSEs. We investigate possible candidates for the states $X(3872)$, $Z(3900)$ and $(cc\bar{u}\bar{u})_{0^+/1^+}$. For the $X(3872)$ and the $Z(3900)$ we find that these are essentially dominated by the mesonic $D\bar{D}^*$ component indicating the possibility of a molecular structure. The scalar $(cc\bar{u}\bar{u})$ shows two states, where the ground state seems to be dominated by the mesonic $\eta_c\pi$ component, whereas the excited one has diquarkonic contributions.

HK 33.5 Wed 17:45 J-HS A

Inclusive charmonium mesons production above 4 GeV — •Simon Nakhoul[1,2], Klaus Götzen[1], Ralf Kliemt[1], Frank Nerling[1,2], and Klaus Peters[1,2] — [1]GSI Helmholtzzentrum für Schwerionenforschung — [2]Goethe-Universität Frankfurt

Since 2003, the XYZ charmonium-like states have become a hot topic in the hadron spectroscopy field. The Beijing Spectrometer III (BESIII) at the Beijing Electron-Positron Collider II (BEPC II) is one of the leading experiments in the XYZ-related physics. It has brought us numerous breakthrough discoveries, e.g., the first observation of the $Z_c(3900)$. In order to understand the nature of these intriguing states and their decay patterns, an inclusive analysis is performed using the recoil mass technique approach for different particles $(\pi^+\pi^-, K^+K^-, \pi^0\pi^0...)$ at center of mass energies above 4 GeV. The aim of this analysis is to search for new unobserved $Y(4260)$ decay channels and to provide accurate inclusive cross section measurements for $e^+e^- \to X_{\bar{c}c} + \pi^+\pi^-(X_{\bar{c}c} = J/\psi, h_c, \psi(2S))$ then compare them to the corresponding exclusive BESIII measurements.

HK 33.6 Wed 18:00 J-HS A

Inclusive analysis of the Y(4260) with baryonic recoil at the BESIII/BEPCII experiment — •Mathilde Himmelreich[1], Klaus Götzen[3], Ralf Kliemt[2,3], Frank Nerling[1,3], Simon Nakhoul[1,3], and Klaus Peters[1,3] — [1]Goethe Universität Frankfurt — [2]Helmholtzinstitut Mainz — [3]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt

The BESIII experiment is operating since 2008 and is well suited for charmonium spectroscopy.Besides the conventional charmonium states, many unexpected charmonium-like states with exotic properties, the so-called XYZ states, have been discovered. The nature of these states is still unclear, they are not in agreement with the theoretical expectations. The vector charmonium-like state Y(4260) has been discussed to be a hybrid or a tetraquark state. Precise cross section measurements of the hidden-charm final states of the Y(4260) in the BESIII data resolve meanwhile two resonance structures, the Y(4220) and the Y(4390). Additional studies of open-strange final states such as $\Lambda\overline{\Lambda}$ and $\Sigma\overline{\Sigma}$ will help to clarify the nature of these two vector states.

HK 33.7 Wed 18:15 J-HS A

Glueballs from Dyson-Schwinger equations — •Markus Huber[1], Christian Fischer[1], and Helios Sanchis-Alepuz[2] — [1]Institut für Theoretische Physik, Justus-Liebig–Universität Giessen, 35392 Giessen, Germany — [2]Institute of Physics, University of Graz, NAWI Graz, Universitätsplatz 5, 8010 Graz, Austria

We report on the calculation of the ground states and the first excited states of the scalar glueball sector in pure QCD in the framework of Dyson-Schwinger/Bethe-Salpeter equations. Our setup takes into account recent advances in the calculation of Yang-Mills correlation functions.

HK 34: Heavy-Ion Collisions and QCD Phases VII

Time: Wednesday 16:30–18:30 Location: J-HS F

Group Report HK 34.1 Wed 16:30 J-HS F

Low-Mass Dielectron Measurements in pp, p-Pb and Pb-Pb Collisions with ALICE — •Jerome Jung for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

Low-mass dielectrons present an exceptional tool to deepen our understanding of the Quark-Gluon Plasma (QGP) created in the collision of ultra-relativistic heavy-ions, since they are produced at all stages of the collision while being unaffected by the strong interaction. To single out the interesting signal characteristics of the QGP, the primordial e^+e^--pair production in vacuum has to be understood first. Therefore, measurements in pp collisions serve as a medium-free baseline while the measurements in p-Pb collisions help to separate cold nuclear matter effects from those of the hot and dense medium.

In this talk, recent results of the dielectron measurements from the ALICE experiment will be presented. For the first time, dielectron production is studied via a consistent system scan of pp, p-Pb and Pb-Pb collisions at $\sqrt{s_{\rm NN}}$=5 TeV displaying medium modifications as a function of invariant mass and pair transverse momentum. Finally, super-soft dielectron production is discussed comparing the measurement of pp collisions at $\sqrt{s}$=13 TeV using a low-magnetic field setup with expectations from known hadronic sources to address the long-standing question of a possible soft-dilepton excess in pp collision at LHC energies.

Supported by BMBF and the Helmholtz Association.

HK 34.2 Wed 17:00 J-HS F

Low-mass dielectron measurements in minimum-bias pp collisions at 5.02 TeV with ALICE — •Leonhardt Viebach for the ALICE-Collaboration — Goethe Universität Institut fur Kernphysik, Johann Wolfgang Goethe-Universitat Frankfurt (IKF), Frankfurt, Germany

Low-mass dielectrons play a key role in the understanding of the chiral-symmetry restoration and in the study of the Quark-Gluon Plasma (QGP). To single out the interesting signal characteristics of the QGP, the primordial e^+e^- pair production in vacuum needs to be first understood. It can be studied in minimum-bias pp collisions. Dielectron measurements in elementary collision systems serve not only as a reference for the heavy-ion analysis but provide also a test for Monte-Carlo event generators, aiming to reproduce the heavy-flavour production mechanisms. In this talk, I will present the results of the dielectron analysis in pp collisions at $\sqrt{s} = 5.02$ TeV with ALICE. The dielectron yield is studied as a function of invariant mass and pair transverse momentum and compared to the expected dielectron yield from known hadronic sources. The charm and beauty production cross sections are extracted from the data by fitting the spectra in the intermediate-mass region and are then compared to measurements at $\sqrt{s} = 7$ TeV and $\sqrt{s} = 13$ TeV as well as to single heavy-flavour hadron measurements

and to FONLL calculations. Finally, the results in pp collisions can be compared to Pb–Pb and p–Pb results measured at the same center of mass energy per nucleon, $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV, which allows a direct comparison to estimate cold- and hot-nuclear matter effects.

HK 34.3 Wed 17:15 J-HS F

Azimuthal anisotropy of virtual photons measured with HADES — •Dominique Dittert for the HADES-Collaboration — Technische Universität Darmstadt

In Au+Au collisions at $\sqrt{s_{NN}} = 2.42$ GeV HADES observed a strong excess radiation which is remarkably well described assuming emission out of a thermalized system. The observation of a dilepton azimuthal anisotropy or the elliptic flow (v_2) would add an important evidence for a collective expansion dynamics, and would thus shine extra light to the possible origin of the excess radiation. We present results for azimuthal anisotropy of e^+ e^- excess. To characterize the emitting source further, we study the orientation of the electron decay axis in the virtual photon rest (helicity) frame. Prospects for dilepton v_2 from the Ag+Ag at $\sqrt{s_{NN}} = 2.55$ GeV run will be shown.

Supported by BMBF ErUM-FSP C.B.M. (05P18RDFC1) and HGS-HIRe

HK 34.4 Wed 17:30 J-HS F

Thermal dileptons in a coarse-grained transport dynamics — •Maximilian Wiest[1], Tetyana Galatyuk[1,2], Ralf Rapp[3], Florian Seck[1], and Joachim Stroth[2,4] — [1]TU Darmstadt — [2]GSI, Darmstadt — [3]Texas A&M Univ, College Station, USA — [4]Goethe-Universität, Frankfurt

Dileptons provide a unique way to access the properties of the fireball created in heavy-ion collisions. Hadrons are not suited for doing this in the same way, since their properties are subject to the strong interactions in the fireball. We study dilepton production in the SIS18 energy range by utilizing an approach that uses coarse-grained transport simulations to calculate thermal dilepton emission applying state-of-the-art in-medium spectral functions from hadronic many-body theory. To ensure an accurate description of the fireball, we have used several microscopic transport models and compared the effect of the space-time evolution on resulting dilepton spectra. We will also present a systematic comparison of the results for different colliding nuclei as well as for the number of individual participants in the collision (system size) and different collision energies as measured recently by the HADES Collaboration.

Supported by VH-NG-823, DFG CRC-TR 211 and GSI

HK 34.5 Wed 17:45 J-HS F

Signal for a 1st order phase transition in dilepton spectra — •Florian Seck[1], Tetyana Galatyuk[1,2], Ayon Mukherjee[3,4], Ralf Rapp[5], Jan Steinheimer[4], and Joachim Stroth[2,3] — [1]TU Darmstadt, Germany — [2]GSI, Darmstadt, Germany — [3]Goethe-Universität Frankfurt, Germany — [4]FIAS, Frankfurt, Germany — [5]Texas A&M University, College Station (TX), USA

Due to their penetrating nature dileptons are an excellent tool to study the properties of hot and dense QCD matter created in relativistic heavy-ion collisions. Thermal dilepton emission rates need to be folded with the space-time dynamics of the fireball to calculate the invariant mass spectrum of the excess radiation recorded in heavy-ion experiments. One approach, that has been established to reproduce the measured data in the energy regime of a few GeV, is the coarse-graining of microscopic transport simulations.

In this contribution we present our study on the applicability of ideal relativistic hydrodynamics for the fireball evolution with two different equations of state provided by the Quark-Hadron Chiral Parity Doublet (QχP) model – one with a cross-over and one with a 1st order phase transition. We compare the properties of the resulting invariant mass and transverse momentum spectra for the two cases. We show how and why the dilepton spectra are modified in the presence of a phase transition and discuss the implications for the search of landmarks in the QCD phase diagram via dileptons.

Supported by DFG under CRC TR-211, by the AI grant of SAMSON AG, by the BMBF under the ErUM-Data project, by the U.S. NSF.

HK 34.6 Wed 18:00 J-HS F

Feasibility studies of low mass di-electrons with the HADES and CBM experiments at FAIR SIS100 — •Marten Becker for the HADES-Collaboration — Justus-Liebig-Universität Giessen

The High Acceptance DiElectron Spectrometer (HADES) and the Compressed Baryonic Matter experiment (CBM) are dedicated to study strongly interacting matter at high net-baryon densities and moderate temperatures. di-electrons as penetrating probes are a key observable to get direct access to the properties of the fireball generated in A+A collisions.

Currently the HADES experiment is located at SIS 18 at GSI, Darmstadt and will be moved in future to continue its physics program at SIS100 where higher beam energies are available. Both experiments, HADES and CBM are complementary to each other in terms of detector setup and measureable energy range making it interesting to study one system at both experiments for comparison and verification of the CBM results. Currently Ag+Ag collisions at 4.5A GeV is favored.

We present di-electron feasibility studies based on simulated Ag+Ag collisions at 4.5A GeV for the HADES and CBM detector setup and compare the results.

HK 34.7 Wed 18:15 J-HS F

Simulations of thermal dielectrons for the CBM experiment — •Etienne Bechtel for the CBM-Collaboration — Goethe University Frankfurt , IKF

The Compressed Baryonic Matter (CBM) experiment will access a wide range of physics observables for heavy-ion collisions in the region of highest net- baryon densities. One of the important topics of its physics program is the study of rare dilepton channels, which were not precisely measured before with other experiments in this energy range. The spontaneously broken chiral symmetry of the vacuum is assumed to be restored at finite temperatures and net-baryon densities and should be accessible in heavy-ion collisions. A precision measurement of the ρ-meson and its chiral partner, the a_1-meson, would be sensible to this restoration. On the other hand, the measurement of direct thermal photons from the early stages of the fireball evolution provides information about the temperature of the emitting source and its excitation function and could provide hints for a potential first order phase transition. This talk will cover the newest results on the simulation of different dielectron channels, including the measurement of the thermal radiation of the fireball itself, as well as newly added machine learning techniques in the analysis chain. This work is supported by BMBF.

HK 35: Heavy-Ion Collisions and QCD Phases VIII

Time: Wednesday 16:30–18:30 Location: J-HS G

Group Report HK 35.1 Wed 16:30 J-HS G

Protons and Light Nuclei from Au+Au Collisions at $\sqrt{s_{\mathrm{NN}}} = 2.4$ GeV measured with HADES — •Melanie Szala for the HADES-Collaboration — Goethe-Universität, Frankfurt am Main, Germany

The HADES experiment at the SIS18 accelerator of the GSI Helmholtzzentrum für Schwerionenforschung in Darmstadt measured Au+Au collisions at 1.23A GeV.
In this energy regime protons make up the bulk of the produced particles, yet a large fraction of them (≈40%) are bound in light nuclei.

With the goal to unterstand the created system in heavy-ion collisions in this energy regime and the production mechanism of these nuclei, we present the results of p, d, t and ^{3}He. The production of nuclei in heavy ion collisions is commonly discussed within two different scenarios: the thermal-statistical hadronization models and the coalescence model. We will compare our data to state of the art models and compare the results to those in heavy-ion collisions at higher energies.

This work has been supported by BMBF (05P19RFFCA), GSI and HIC for FAIR.

HK 35.2 Wed 17:00 J-HS G

Deuteron production in Au-Au collisions at 1.23A GeV in SMASH — •Martha Ege[2,3], Justin Mohs[1,2,3], and Hannah Elfner[1,2,3] — [1]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt — [2]Institute for Theoretical Physics, Goethe University Frankfurt am Main — [3]Frankfurt Institute for Advanced Studies, Frankfurt am Main

For nuclear physics it is of big interest to get a better understanding about how light nuclei are formed in heavy-ion collisions. In this work we investigate the production of deuterons at $E_{lab} = 1.23$A GeV. We study light nuclei production in the framework of a hadronic transport approach called SMASH. In this approach deuterons are implemented as degrees of freedom. This approach has been successfully applied in an afterburner calculation at LHC energies. In this work, the exact same approach is applied to low beam energy collisions, where the whole evolution is described with hadronic transport approaches. We investigate the dynamics of the produced deuterons by calculating flow coefficients and spectra and compare them to the results for protons under the same conditions. For comparison the same calculations are performed using coalescence instead of propagating the deuteron in SMASH. The results are compared to recent experimental data from the HADES collaboration. The most important reactions for deuteron production are determined.

HK 35.3 Wed 17:15 J-HS G

Application of the 3-Fluid Hydrodynamic Event Generator THESEUS to CBM — •Elena Volkova for the CBM-Collaboration — Tuebingen University, Germany

The Compressed Baryonic Matter experiment (CBM) at FAIR will measure nucleus-nucleus collisions at beam energies up to 11 AGeV for Au. The key objective of CBM is to investigate the QCD phase diagram in the region of the highest net-baryon-densities. The experiment is well suited to explore the Equation-of-State of nuclear matter at densities as they might occur in the interior of neutron stars or during neutron star mergers.

The new generator THESEUS for heavy ion collisions describes the whole evolution of the system which begins with the fireball creation, its expansion and ends with free-streaming particles, which can be accounted for in event based simulations. The generator based on hydrodynamics and thus requires, and equation of state(EoS). It is possible to choose between 3 different scenario: 1st order phase transition, crossover and pure hadron gas. A status of various for the analysis for various observables(rapidity distributions. transverse mass spectra) employing different EoS with and without CBM detector will be presented. We will discuss an effect on observables and the ways to possibly distinguish between different EoS.

HK 35.4 Wed 17:30 J-HS G

Reconstruction of tracks with very low momentum in TPC detector — •Grigory Kozlov[1,2], Ivan Kisel[1,3,4], and Yuri Fisyak[5] for the CBM-Collaboration — [1]Goethe-Universität, Frankfurt, Germany — [2]JINR, Dubna, Russia — [3]FIAS, Frankfurt, Germany — [4]GSI, Darmstadt, Germany — [5]BNL, Upton, USA

Within the CBM Phase-0 we develop and study the Cellular Automaton (CA) track finder in the iTPC detector of the STAR experiment (RHIC, BNL). The Beam Energy Scan BES-II program at STAR will explore region of the QCD phase diagram with energies 7.7-19.6 GeV (collider) and 3.0-7.7 GeV (fixed-target), which poses new challenges for the tracking algorithm. Collision of beam at these energies in STAR leads to production of particles with very low momenta. Such particles move parallel to the beam axes along spiral trajectories that significantly complicates the operation of the TPC detector, especially in fixed target (FXT) mode, as well as the eTOF detector (CBM TOF). Reconstruction of such loopers is a difficult task, as the used track model allows to reconstruct them only in the form of a set of segments of a helical trajectory. Increasing the number of pad rows in the iTPC detector has made the number of measurements in segments sufficient to find them locally using the CA algorithm. Therefore an additional procedure to merge the reconstructed segments into long loopers has been developed. The algorithm thus allows to increase the acceptance of TPC for low momentum tracks which is especially important for particle identification with eTOF in the FXT program. The CA algorithm and the results of its application are presented and discussed.

HK 35.5 Wed 17:45 J-HS G

Measurement of (anti-)^{3}H and (anti-)^{3}He production in pp collisions at $\sqrt{s} = 13$ TeV — •Michael Habib for the ALICE-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung, Planckstr. 1, 64291 Darmstadt — Institut für Kernphysik Technische Universität Darmstadt, Schlossgartenstr. 9, 64289 Darmstadt

The formation of light (anti-)nuclei in high-energy hadronic collisions is not understood and under debate in the scientific community. Recent experimental results indicate that the dominant production mechanism seems to evolve smoothly with the charged-particle multiplicity which is related to the size of the system created in the collision.

In this talk, the measurement of the (anti-)^{3}H and (anti-)^{3}He production in pp collisions at $\sqrt{s} = 13$ TeV as a function of multiplicity will be presented. The results are compared with the predictions from the canonical statistical hadronization model and the coalescence approach, which assume very different production mechanisms. The relevance of this measurement for direct searches of dark matter in space experiments will also be discussed.

HK 35.6 Wed 18:00 J-HS G

Elliptic and triangular flow of light (anti-)nuclei in Pb–Pb collisions at $\sqrt{s_{\rm NN}} = 5.02$ TeV — •Alberto Calivà for the ALICE-Collaboration — GSI, Planckstraße 1, 64291 Darmstadt

The production of light (anti-)nuclei in ultrarelativistic heavy-ion collisions and their survival to temperatures exceeding their typical binding energy by almost two orders of magnitude are still not understood and under debate. The radial and azimuthal flow of light (anti-)nuclei are key observables to test the phenomenological models used to describe their production mechanism and to study the dynamics of the interactions in the post-hadronization phase.
In this presentation, the recent results on the elliptic and triangular flow of (anti-)deuteron and (anti-)^{3}He measured by ALICE in Pb–Pb collisions at $\sqrt{s_{\rm NN}} = 5.02$ TeV will be presented.

HK 35.7 Wed 18:15 J-HS G

Production of (anti-)t and (anti-)^{4}He in Pb–Pb collisions at $\sqrt{s_{\rm NN}} = 5.02$ TeV with ALICE at the LHC — •Esther Bartsch for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

The high collision energies reached at the LHC lead to significant production yields of light (anti-)nuclei in proton-proton and, in particular, Pb–Pb collisions. The excellent particle identification capabilities of the ALICE Time Projection Chamber, using the specific energy loss ($\mathrm{d}E/\mathrm{d}x$), and the time-of-flight measurement, allow for the detection of these rarely produced particles.

Recent results on (anti-)triton and (anti-)^{4}He production in Pb–Pb collisions at $\sqrt{s_{\rm NN}} = 5.02$ TeV will be presented and compared to coalescence and statistical hadronization models to provide insight into their production mechanism in heavy-ion collisions.

Supported by BMBF and the Helmholtz Association.

HK 36: Heavy-Ion Collisions and QCD Phases IX

Time: Wednesday 16:30–18:45 Location: J-HS H

Group Report HK 36.1 Wed 16:30 J-HS H

Two-particle azimuthal correlations as a probe of collective behaviour in deep inelastic *ep* scattering at HERA — •Dhevan Gangadharan for the ZEUS-Collaboration — Universitat Heidelberg, Heidelberg, Deutschland

Two-particle azimuthal correlations have been measured in neutral current deep inelastic *ep* scattering with virtuality $Q^2 > 5$ GeV^2 at a centre-of-mass energy $\sqrt{s} = 318$ GeV recorded with the ZEUS detector at HERA. The correlations of charged particles have been measured in the range of laboratory pseudorapidity $-1.5 < \eta < 2$ and transverse momentum $0.1 < p_{\rm T} < 5$ GeV and event multiplicities $N_{\rm ch}$ up to six times larger than the average $\langle N_{\rm ch}\rangle = 5$. The two-particle correlations are measured in terms of the angular observables $c_n\{n\} = \langle\langle\cos n(\varphi_1 - \varphi_2)\rangle\rangle$, where the harmonic n is between 1 and

4 and φ_i is the azimuthal angle of particle i. The correlations observed in HERA data do not indicate the kind of collective behaviour as recently observed at the highest RHIC and LHC energies in high multiplicity hadronic collisions. Available Monte Carlo models of deep inelastic scattering, tuned to reproduce the inclusive particle production, provide a qualitative description of the HERA data.

HK 36.2 Wed 17:00 J-HS H

CBM performance for strange hyperon flow measurements — •Oleksii Lubynets[1,2,3], Ilya Selyuzhenkov[1,4], and Viktor Klochkov[1,2] for the CBM-Collaboration — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany — [2]Goethe Universität Frankfurt, Frankfurt am Main, Germany — [3]Frankfurt Institute for Advanced Studies, Frankfurt am Main, Germany — [4]National Research Nuclear University (Moscow Engineering Physics Institute), Moscow, Russia

The main goal of the CBM experiment is to study highly compressed baryonic matter produced in collisions of heavy ions. SIS100 accelerator at FAIR will give a possibility to investigate the QCD matter at temperatures about 120 MeV and net baryon densities 5-6 times larger than a nuclei density. Strange hyperons produced in the dense phase of the heavy-ion collision provide information about the equation of state of the QCD matter. The measurement of their anisotropic flow is important for understanding the evolution of the QCD matter.

In this work the status of the CBM performance for strange particle anisotropic flow measurement is presented. Flow coefficients are calculated relative to the spectator plane estimated with the CBM Projectile Spectators Detector. Strange hyperons decay within the CBM detector volume and are reconstructed via their decay topology. Kalman Filter Particle Finder package is a very powerful tool, which allows to reconstruct decays with high efficiency. In the current work its simplified version, the KF Simple, is used to optimize selection criteria of the strange hyperon reconstruction and for CBM flow performance study.

HK 36.3 Wed 17:15 J-HS H

Recent results on higher moments of net-baryon distributions in Pb-Pb collisions from ALICE — •Mesut Arslandok for the ALICE-Collaboration — Physikalisches Institut Heidelberg

The fluctuations of conserved charges in ultrarelativistic heavy-ion collisions provide insights into the properties QCD phase diagram. At LHC energies there would be, for vanishing light quark masses, a temperature-driven genuine phase transition of second order between the hadron gas and the quark-gluon plasma. For realistic quark masses, however, this transition becomes a smooth cross over. Nevertheless, due to the small masses of current quarks one can still probe critical phenomena at the LHC energies, which can be confronted with the ab-initio LQCD calculations at vanishing baryon chemical potential.

In this contribution, the latest results will be presented on event-by-event analysis of net-baryon number fluctuation measurements in Pb-Pb collisions recorded by the ALICE Collaboration at the CERN LHC. The cumulants of net-proton distributions, as proxy to net-baryon distributions, up to third order will be discussed. The experimental results are confronted with corresponding signals from dynamical models and the dependence of fluctuation measurements on phase-space coverage of detected particles are addressed in view of the calculations from Lattice QCD (LQCD) and the Hadron Resonance Gas (HRG) model. Moreover, contributions from non-dynamical fluctuations such as those stemming from the baryon number conservation will be addressed.

Supported by BMBF and SFB 1225 ISOQUANT.

HK 36.4 Wed 17:30 J-HS H

The QCD phase diagram and baryon number fluctuations from Dyson-Schwinger equations — •Philipp Isserstedt[1], Michael Buballa[2], Christian S. Fischer[1], and Pascal J. Gunkel[1] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität Gießen, 35392 Gießen, Germany — [2]Theoriezentrum, Institut für Kernphysik, Technische Universität Darmstadt, 64289 Darmstadt, Germany

In this talk we summarize our latest results on the QCD phase diagram and baryon number fluctuations using the nonperturbative framework of Dyson-Schwinger equations [1]. To this end, we solve a coupled set of these equations for the quark and gluon propagators of three-flavor QCD in Landau gauge. We present fluctuations and ratios thereof up to fourth order, ranging from vanishing chemical potential to the critical endpoint. In comparison with preliminary experimental data from the STAR collaboration for the skewness and kurtosis ratios, our results are compatible with a critical endpoint at large chemical potential and a freeze-out line that bends below it.

[1] P. Isserstedt, M. Buballa, C. S. Fischer, and P. J. Gunkel, Phys. Rev. D 100, 074011 (2019), arXiv:1906.11644

HK 36.5 Wed 17:45 J-HS H

Using spectators to probe anisotropic flow fluctuations in Pb-Pb collisions with ALICE at the LHC — •Lukas Kreis for the ALICE-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt — Ruprecht-Karls-Universität Heidelberg

In heavy-ion collisions, the fluctuating phase-space distribution of the participant and spectator nucleons results in anisotropic flow fluctuations of the produced particles. Before the quark-gluon plasma is formed, the deflection of the spectators is imprinted in the initial energy-momentum distribution in the overlap zone. The pattern of flow fluctuations can be determined by comparing flow coefficients measured relative to the plane defined by the spectator deflection to those measured relative to the participant plane. These two measurements should exhibit the same behaviour for central and semi-central collisions and differ for peripheral, according to calculations, in which anisotropic flow fluctuations emerge from Gaussian fluctuations of initial spatial eccentricity. In this presentation, ALICE measurements of the anisotropic flow in Pb–Pb collisions relative to the spectator deflection are presented. The deflection is determined using the Zero Degree Calorimeter. Together with ALICE measurements of two and multi-particle cumulant methods this allows to probe flow fluctuations and their deviation from the Gaussian shape.

HK 36.6 Wed 18:00 J-HS H

Linearized kinetic description of non-equilibrium dynamics in pp and pA collisions — •Clemens Werthmann — Universität Bielefeld, Bielefeld, Deutschland

Momentum anisotropies caused by collective flow phenomena in HICs have been known to convey a rich amount of information on the collision geometry. In pp and pA collisions the collision area is too small - resulting in density gradients that are too large - for the well-understood hydrodynamic description of these anisotropies to be applicable. Instead, a microscopic description of the non-equilibrium dynamics has to be employed. Indeed, numerical simulations based on kinetic theory have reproduced the anisotropies, but they do not allow insight into the mechanisms of their emergence. This prompts attempts to employ analytical treatments of the kinetic theory description, which is highly nontrivial. In order to simplify the problem, the strategy presented in this talk is to apply an appropriate expansion scheme of the Boltzmann equation and then linearize in small anisotropic perturbations of the initial distribution on top of an isotropic Gaussian background.

HK 36.7 Wed 18:15 J-HS H

Fluid dynamics of heavy ion collisions with mode expansion — •Andreas Kirchner[1], Daniel Boness[1], Stefan Floerchinger[1], and Eduardo Grossi[2] — [1]Institut für Theoretische Physik, Heidelberg, Deutschland — [2]Stony Brook University, Stony Brook, USA

In this talk we present a way to describe a quark gluon plasma in its fluid dynamical regime with the self written Mathematica package FluiduM. We use a background-fluctuation splitting together with a mode expansion technique to solve the Israel Stewart type hydrodynamic equations of motion.

We are able to perform a systematic comparison of experimental data for pions, kaons and protons at LHC energies using the FluiduM code package.

HK 36.8 Wed 18:30 J-HS H

A hydrodynamical model for observed particle correlations in pp collisions — •Seyed Farid Taghavi — Technical University of Munich, Munich, Germany

The observed long-range correlations in pp collision in 2010 lead to an on-going debate about the collectivity in small systems. In the present talk, we introduce a semi-analytic hydrodynamical model to examine the applicability of hydrodynamics in small systems. We show that there is a lower bound for the rms radius of the system proportional to the inverse of the square root of the total energy in the transverse direction. By introducing a rather generic model for the initial state, we compare the outcome of our model with the experimental data. The model can describe the two-particle azimuthal correlation in pp

collision. Moreover, it explains the multiplicity dependence of four-particle correlation, at least qualitatively, which has not been produced by other hydrodynamical models so far.

Based on: [arXiv: 1907.12140]

HK 37: Structure and Dynamics of Nuclei VII

Time: Wednesday 16:30–18:30 Location: J-HS E

Group Report HK 37.1 Wed 16:30 J-HS E

Study of electromagnetic transition rates in the N=126 isotones 210-Po, 211-At and 213-Fr. — •Jan Jolie[1], Vasil Karayonchev[1], Lisa Kornwebel[1], Diana Kocheva[2], Andrey Blazhev[1], Arwin Esmaylzadeh[1], Lukas Knafla[1], Jean-Marc Régis[1], Georgi Rainovski[2], and Pieter Van Isacker[3] — [1]IKP, Universität zu Köln, Zülpicher Str. 77, 50937 Köln — [2]Faculty of Physics, St. KlimenOhridski University of Sofia, 1164 Sofia, Bulgaria — [3]GANIL, Bd. Henri Becquerel BP55027, 14076 Caen, France

Lifetimes of excited states in 210-Po, 211-At and 213-Fr were measured at the FN Tandem accelerator of the Institute for Nuclear Physics, University of Cologne. The nuclei of interest were populated using two-proton transfer reactions and fusion-evaporation reactions. The lifetimes were obtained using the Doppler Shift Attenuation (DSA) and the Recoil Distance Doppler Shift (RDDS) methods and using the electronic gamma-gamma fast timing technique. The experimental electromagnetic transition rates are compared to shell-model calculations, using the modified Kuo-Herling interaction in a multi-j model space. For 211-At they are also compared to a semi-empirical calculation for three particles in a single j=9/2 shell.

HK 37.2 Wed 17:00 J-HS E

Nuclear Isovector Valence-shell Excitation of ^{202,204}Hg — •Ralph Kern[1], Robert Stegmann[1], Norbert Pietralla[1], Georgi Rainovski[2], Mike P. Carpenter[3], Robert V. F. Janssens[4,5], Marc Lettmann[1], Oliver Möller[1], Thomas Möller[1], Christian Stahl[1], Volker Werner[1], and Shaofei Zhu[3] — [1]Institut für Kernphysik, TU Darmstadt, Darmstadt, Germany — [2]Faculty of Physics, University of Sofia St. Kliment Ohridski, Sofia, Bulgaria — [3]Physics Division, ANL, Argonne, IL, USA — [4]Department of Physics and Astronomy, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA — [5]Triangle Universities Nuclear Laboratory, Duke University, Dunham, NC, USA

In the framework of the IBM-2, a class of excited states is predicted, where the collective valence-neutron and proton motions are out of phase. These so-called mixed-symmetry states (MSS) represent a rare physics case in which the interplay between nuclear collectivity, shell structure, and isospin degrees of freedom can be studied. MSS were observed in nuclei near shell closures in the $A = 90, 130$ mass regions, and recently near the doubly-magic ^{208}Pb [1]. To extend the knowledge about this data in the $A = 208$ mass region, projectile Coulomb excitation experiments with stable Hg ion beams were performed at the ATLAS facility at Argonne National Laboratory [2,3].

Supported by the BMBF under Grant No. 05P18RDCIA.

[1] D. Kocheva *et al.*, Phys. Rev. C **93**, 011303(R) (2016).
[2] R. Stegmann *et al.*, Phys. Lett. B **770**, 77 (2017).
[3] R. Kern *et al.*, Phys. Rev. C **99**, 011303(R) (2019).

HK 37.3 Wed 17:15 J-HS E

Lifetime of the 4_1^+ state in ^{212}Po using the fast timng technique — •Martin von Tresckow for the IFIN-HH-212Po-Collaboration — TU Darmstadt

The isotope ^{212}Po has two protons and neutrons more than the doubly magical nucleus ^{208}Pb and it can anticipated that this nucleus can be well described by the nuclear shell-model. However, experimental lifetimes of excited states don't agree well with predictions from the shell model. The nucleus has rather a mixture between shell-model and cluster configurations. The B(E2) value of the 4_1^+ state is an important puzzle piece to solve the question about the structure of ^{212}Po but previous attempts to measure this value had very large errors which did not allow for any conclusion.

In November 2019, we performed an experiment at the Tandem accelerator of IFIN-HH in Magurele, Romania, to determine the lifetime applying the fast timing technique. We used the α transfer between a ^{10}B beam and a ^{208}Pb target to investigate the unstable isotope ^{212}Po. The γ-rays were detected by ROSPHERE consisting of 15 Ge CLOVER detectors, 10 $LaBr_3$(Ce) detectors and 6 solar cell detectors at backward angles to measure the beam like products.

For the fast timing technique applying the centroid shift method, the precise determination of prompt time response is crucial. A novel method has been tested in this experiment to determine the time response at low energies using the internal activity of the $LaBr_3$(Ce) crystals. This method will be presented, as well as preliminary results from the data analysis.

HK 37.4 Wed 17:30 J-HS E

Photofission on ^{238}U using quasi-monochromatic, polarized γ-rays — •M. Peck[1], J. Enders[1], S.W. Finch[2], A. Göök[3], C.R. Howell[2], A.-L. Katzenmeier[1], A. Oberstedt[4], S. Oberstedt[3], J.A. Silano[5], A.P. Tonchev[5], and W. Tornow[3] — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]Duke University and TUNL, Durham, USA — [3]European Commission, Joint Research Centre, Geel, Belgium — [4]ELI-NP, Măgurele, Romania — [5]Nuclear and Chemical Sciences Division, LLNL, Livermore, USA

Photofission on actinides using quasi-monochromatic, polarized γ-rays from Laser-Compton-Backscattering (LCB) has been studied recently at Duke University's High-Intensity γ-ray Source (HIγS). Fission-fragment mass and energy distributions as well as polar and azimuthal angular distributions are determined using a position-sensitive twin Frisch-grid ionization chamber. We have investigated the feasibility of measuring prompt fission neutrons using four liquid scintillator detectors. Results for the ^{238}U(γ,f) reaction at incident linear/circular polarized γ-ray energy of 11.2 MeV at a flux of up to 4.0×10^8 γ/s will be presented.

Supported by BMBF (05P2018RDEN9), HMWK (LOEWE research cluster "Nuclear Photonics") and DOE (DE-FG02-97ER41033).

HK 37.5 Wed 17:45 J-HS E

High-precision mass spectrometry of superheavy elements at SHIPTRAP: latest results, status and outlook. — •Francesca Giacoppo for the SHIPTRAP-Collaboration — GSI Darmstadt — HIM Mainz

During the experimental campaign in summer 2018 the masses of ^{251}No and ^{254}Lr has been directly measured for the first time at the mass spectrometer SHIPTRAP at GSI. In addition, the long-lived, low-lying isomeric states ^{251m}No and ^{254m,255m}Lr have been probed with high accuracy. This was made possible by the first application of the Phase-Imaging Ion-Cyclotron-Resonance (PI-ICR) technique in the region of the heaviest elements. Thus, with its superior mass resolving power and precision, the PI-ICR technique was established as a complementary tool to decay spectroscopy. Furthermore, with its high efficiency the PI-ICR technique allowed a first mass measurement of the ground state of ^{257}Rf, and thereby opened the doorway to the exotic superheavy elements which are characterized by their particularly low production yields.

In the meantime, the SHIPTRAP setup has been prepared for the next beam time scheduled for early 2020. It is planned to look for low-lying states of the Rf isotopes as well as to extend direct high-precision mass spectrometry to even heavier and more exotic nuclides, including Dubnium (Z=105).

In this contribution, an overview on the latest efficiency optimization of SHIPTRAP together with the status of the 2020 campaign will be reviewed.

HK 37.6 Wed 18:00 J-HS E

How well do we know nuclear magnetic moments: The cases of ^{207}Pb and ^{209}Bi — •Wilfried Nörtershäuser[1], Verena Fella[1], Leonid V. Skripnikov[2], Magnus R. Buchner[3], H. Lars Deubner[3], Florian Kraus[3], Alexei F. Privalov[1], Vladimir M. Shabaev[2], and Michael Vogel[1] — [1]TU Darmstadt — [2]St. Petersburg State University — [3]Philipps-Universität Marburg

Tabulated nuclear magnetic moments of stable isotopes are often used as reference values, e.g., in studies of short-lived isotopes. Results from nuclear magnetic resonance measurements are often provided with very high accuracy but are affected with chemical and diamagnetic shifts

which are not always well under control. We will report on two extreme cases recently investigated. Motivated by discrepancies between QED calculations and laser spectroscopic investigations on highly charged ions [1], we performed new NMR studies on ^{207}Pb and ^{209}Bi [2] where we found significant discrepancies to the tabulated values [3].
[1] J. Ullmann *et al.*, Nature Comm. **8** 15484 (2017).
[2] L. Skripnikov *et al.*, Phys. Rev. Lett. **120**, 093001 (2018).
[3] N. Stone, Atomic Data Nuclear Data Tables **90**, 75 (2005).
This work was supported by BMBF under contract 05P19RDFAA.

HK 37.7 Wed 18:15 J-HS E

TDRIV g factor measurement of the 2_1^+ state of ^{18}O — •J. Wiederhold[1], V. Werner[1], C. Fransen[2], C. Müller-Gatermann[2], N. Pietralla[1], M. Beckers[2], M. Berger[1], A. Blazhev[2], A. Dewald[2], A. Goldkuhle[2], P.R. John[1], J. Jolie[2], R. Kern[1], C. Stahl[1], S. Thiel[2], W. Witt[1], and R. Zidarova[1] — [1]IKP, TU Darmstadt — [2]IKP, Universität zu Köln

Magnetic dipole moments are an important indicator of the proton neutron wave function composition and therefore the single-particle properties of the investigated excited states. The available experimental data for *sd* shell nuclei can overall be reproduced by shell model calculations, but deviations exist at the edges, i.e. for ^{18}O and ^{38}Ar. To clarify the picture for ^{18}O, a g factor measurement has been performed at the IKP Cologne, employing the electron-configuration-reset time-differential recoil-in-vacuum technique [1]. The technique is based on the traditional TDRIV method, but the excited ions are not stopped but only attenuated in a degrader foil and can be detected by a particle detector. Excited states of ^{18}O were populated by Coulomb excitation on a ^{58}Ni target. The experimental setup consisted of the HORUS detector array in combination with the DARCY plunger device and a double-sided silicon strip detector. The obtained results for the g-factor measurement will be presented.
*Supported by the DFG under Grant No. SFB 1245 and by the BMBF under the Grants No. 05P18RDFN9, and 05P19RDFN1 within the collaboration 05P2018 NuSTAR R&D.
[1] A. Stuchbery *et al.*, Phys. Rev. C **71**,047302 (2005).

HK 38: Instrumentation VII

Time: Wednesday 16:30–19:00 Location: J-HS C

Group Report HK 38.1 Wed 16:30 J-HS C

Design optimizations and assembly status of the Electromagnetic Target Calorimeter of the $\overline{P}ANDA$ experiment — •Markus Moritz, Kai-Thomas Brinkmann, Valerii Dormenev, Anniko Falk, Christopher Hahn, Pavel Orsich, Marvin Peter, Matthias Sachs, and Hans-Georg Zaunick for the PANDA-Collaboration — II. Physikalisches Institut, Justus-Liebig-Universität, Gießen

The future $\overline{P}ANDA$ experiment with a next generation detector will focus on hadron spectroscopy. It will use cooled anti-proton beams with a momentum between 1.5 GeV/c and 15 GeV/c interacting with various targets. This allows to direct form all states of all quantum numbers and measure there widths with an accuracy of a few tens of keV. Its electromagnetic target calorimeter will be located inside a 2T solenoid and has the challenging aim to detect photons with excellent energy resolution over the full dynamic range. To reach this goal, improved $PbW0_4$ scintillator crystals, cooled down to $-25°C$ have been chosen. The target calorimeter itself is divided into into a barrel and two endcaps. The individual crystal will be read out with two precisely matched large area avalanche photo sensors (APD). In the very inner part of the forward endcap vacuum phototetrodes will be used instead. In this talk the construction and assembly status will be presented. This includes for example the assembly of detector subunits, mechanical support structure, the cooling system, optical monitoring system and front end electronics.
This project is supported by the BMBF, GSI and HIC for FAIR.

HK 38.2 Wed 17:00 J-HS C

APD-Gain optimization for the $\overline{P}$ANDA Barrel EMC — •Aniko Tim Falk, Markus Moritz, Hans-Georg Zaunick, Kai-Thomas Brinkmann, Valera Dormenev, Kim Tabea Giebenhain, Christopher Hahn, Marvin Peter, Matthias Sachs, and René Schubert for the PANDA-Collaboration — II. Physikalisches Institut, Justus-Liebig-Universität, Gießen

The future electromagnetic calorimeter of the PANDA Experiment will provide an excellent energy resolution over a wide dynamic range. In order to reveal the full potential of its readout, the gain of the APDs can still be further optimized. With the goal to detect high energy photons over a wide energy range from a few dozens of MeV up to 15 GeV, the gain must provide a most excellent energy resolution over the whole spectrum whilst maintaining the needed dynamic range of the individual readout-electronics. The progress made on this subject over the last year shall be briefly summarized in this contribution. Various measurements have been made on a complete setup, that is very close to the final read out of the $\overline{P}$ANDA EMC. To match environmental conditions during operation, the setup was cooled to −25 °C.
This project is supported by the BMBF, GSI and HIC for FAIR.

HK 38.3 Wed 17:15 J-HS C

Qualitätskontrolle der Bleiwolframat-Kristalle für das $\overline{P}$ANDA-Experiment — •Jan Seelbinder[1], Kai-Thomas Brinkmann[1], Valera Dormenev[1], Mikhail Korzhik[2,3], Markus Moritz[1], Pavel Orsich[1] und Hans-Georg Zaunick[1] für die PANDA-Kollaboration — [1]2. Physikalisches Institut Justus-Liebig-Universität, Gießen, Deutschland — [2]Institute for Nuclear Problems of Belarusian State University, Minsk, Belarus — [3]NRC Kurchatov Institute, Moscow, Russia

Bleiwolframat(PWO)-Kristalle finden Verwendung im Elektromagnetischen Kalorimeter (EMC) des $\overline{P}$ANDA Experiments. Das ausgesendete Szintillationslicht dient hier der Energiebestimmung elektromagnetisch wechselwirkender Teilchen. Da die Kristalle mit hohen Strahlendosen belastet werden, ist u.A. eine genaue Bestimmung der Strahlenschäden essenziell für den Erfolg des $\overline{P}$ANDA Experiments.
Dieser Vortrag präsentiert die verschiedenen Methoden der Überwachung der laufenden Massenproduktion sowie die erreichten Parameter.
Dieses Projekt wird unterstützt vom BMBF, der GSI und HIC for FAIR.

HK 38.4 Wed 17:30 J-HS C

Beam accelerator experiments with the new GAGG scintillator — •Pavel Orsich[1], Valerii Dormenev[1], Kai-Thomas Brinkmann[1], Markus Moritz[1], Hans-Georg Zaunick[1], Dmitry Kozlov[2], and Mihkail Korzhik[2] — [1]2nd Physics Institute, JLU, Giessen, Germany — [2]Institute for Nuclear Problems, Minsk, Belarus

Recently developed mono-crystalline materials with garnet type structure, $Gd_3Al_2Ga_3O_{12}$ (GAGG), expected to be one of the tolerant crystals to detect different types of ionizing radiation. Relatively high density, fast scintillation kinetics, high light yield and high radiation hardness make GAGG a promising scintillator for calorimetry applications in harsh radiation environments.

Due to the content of Gd, which absorbs neutrons with following emission of γ-quanta, GAGG can be considered as a candidate for different types of neutron detectors. Moreover, the GAGG scintillation detectors, possessing fast response to γ-quanta, allow precise time-of-flight discrimination of the fast neutrons.

Here we report results of beam tests for two different geometries: a matrix consisting of sixty-four 4x4x40 mm^3 GAGG pixels and a bulk geometry 20x20x25 mm^3 crystal. Tests were performed with a 220 MeV proton beam with different targets (Pb, Polyethylene). The presented results will give an understanding about the future potential of GAGG scintillator, especially for next generation promt γ-detectors and PET applications.

This work was supported by HIC for FAIR.

HK 38.5 Wed 17:45 J-HS C

DSB Glass and Glass Ceramic Scintillation Material for High Energy Physics Applications — •Valerii Dormenev[1], Andrey Borisevich[2], Kai-Thomas Brinkmann[1], Mikhail Korzhik[2,3], Dmitry Kozlov[2], Markus Moritz[1], Rainer Willi Novotny[1], Pavel Orsich[1], and Hans-Georg Zaunick[1] — [1]2nd Physics Institute, JLU, Giessen, Germany — [2]Institute for Nuclear Problems BSU, Minsk, Belarus — [3]NRC "Kurchatov Institute", Moscow, Russia

Glass and glass ceramics can be considered as alternatives to the crystal-based scintillators widely used in radiation detectors for the high-energy physics experiments as well as for applications in medical diagnostics. They can be prepared in a variety of geometrical shapes such as blocks, plates and fibers. Large quantities can be fabricated in a relatively short period of time. However, most of the glasses do not feature scintillation properties. Recently, it has been shown that novel glasses of binary composition enable fabrication of scintillating glasses heavily doped with Ce. Lead-free glasses with the composition BaO*2SiO2:Ce (DSB:Ce) have a density of 3.7 g/cm3 and were found to be radiation hard under irradiation with photons and high energy protons. Here we report the present status of the overall performance of small and large DSB:Ce samples. Moreover, the contribution will report on test results of 3x3 arrays of homogenous blocks and sampling modules assembled from DSB/Pb layers exposed to energy-marked photons up to 250 MeV.

The work was supported by the INTELUM, ATTRACT and Crystal Clear Collaboration Projects.

HK 38.6 Wed 18:00 J-HS C

Veto Prototype Studies for DarkMESA — •Mirco Christmann for the MAGIX-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz

At the Institute for Nuclear Physics in Mainz the new electron accelerator MESA will go into operation within the next years. In the extracted beam operation (155 MeV, 150 μA) the P2 experiment will operate 10,000 hours. Therefore, the high-power beam dump of this experiment is ideally suited for a parasitic dark sector experiment.

Theoretically, dark photons γ' are generated in the beam dump by a process analog to electromagnetic bremsstrahlung and decay invisibly to pairs of dark matter particles. Behind the beam dump and outside of the accelerator hall, electrons scattered off by dark matter particles can be detected in a calorimeter.

Suggested calorimeter materials were tested at MAMI with electrons below 14 MeV, where the materials PbF_2 and the Pb glass Schott SF5 performed best. This contribution presents a veto system for testing prototype detector arrays of these two materials.

The veto concept consists of two layers of plastic scintillators with Pb as shielding in between. The readout electronics with silicon photomultipliers were developed and various concepts with or without wavelength shifting fibers were studied during a beam test at MAMI. As well the sensitivity to neutrons was studied with an americium-beryllium source for the relevant materials.

HK 38.7 Wed 18:15 J-HS C

Commissioning Experiment for (e,e'γ) Measurements at the S-DALINAC * — •Gerhart Steinhilber[1], Antonio D'Alessio[1], Jonny Birkhan[1], Johann Isaak[1], Lars Jürgensen[1], Tobias Klaus[1], Ronan Lefol[2], Peter von Neumann-Cosel[1], Norbert Pietralla[1], Philipp C. Ries[1], and Maxim Singer[1] — [1]Institut für Kernphysik, TU Darmstadt — [2]Laval University

High resolution electron scattering experiments at low momentum transfer are performed at the S-DALINAC using the QCLAM spectrometer at the Institut für Kernphysik at the TU Darmstadt. The QCLAM spectrometerfeatures a comparatively large solid-angle coverage of 35 msr and a momentum acceptance of 20%. This makes it suitable for (e,e'x) coincidence measurements.

**We combine the large acceptance QCLAM spectrometer with fast timing LaBr:Ce detectors to perform (e,e*γ) coincidence experiments. The excitation of the nuclei is studied by measuring inelastically scattered electrons, so that the energy of the excited state is known. It's γ-decays are measured in coincidence by an array of high efficiency LaBr:Ce detectors with excellent timing properties.

**The combined data acquisition (DAQ) of the QCLAM spectrometer and the LaBr detectors has been tested by observing off-beam cosmic radiation showers. A comissioning experiment with a 30.5-MeV electron beam impinging on a carbon target was performed. Experimental setup, DAQ and results from the commissioning experiment will be presented. **

* Supported by the DFG within the CRC 1245.

HK 38.8 Wed 18:30 J-HS C

Simulationsstudien zur Kalibration der Vorwärtsendkappe des $\overline{\text{P}}$ANDA Kaloriemeters — •Lukas Linzen für die PANDA-Kollaboration — Ruhr-Universität Bochum, Institut für Experimentalphysik I

Das $\overline{\text{P}}$ANDA-Experiment an der zukünftigen Beschleunigeranlage FAIR wird Antiproton-Proton-Kollisionen mit Schwerpunktsenergien von bis zu $5,5\,\text{GeV/c}^2$ untersuchen. Ein wichtiger Bestandteil des Detektors ist das elektromagnetische Kalorimeter (EMC) des Targetspektrometers, welches aus einem fassförmigen Mittelteil und zwei Endkappen aus $PbWO_4$-Szintillationskristallen besteht. Um aus den gemessenen Szintillationssignalen auf die deponierte Energie eines Teilchens zu schließen, muss das EMC kalibriert werden.
Die Kalibration der Vorwärtsendkappe soll am Cooler Synchrotron (COSY) in Jülich, mittels Zerfällen von π^0- und η-Mesonen erfolgen, welche in Proton-Proton-Reaktionen produziert werden. Um die Kalibration auf eine möglichst effiziente Weise durchzuführen, muss der Impuls des Protonenstrahls optimiert und geeignete Reaktionen ermittelt werden. Dies erfolgt durch Monte-Carlo basierte Simulationsstudien. Erste Ergebnisse dieser Studien werden vorgestellt.

Gefördert durch das BMBF.

HK 38.9 Wed 18:45 J-HS C

Recent developments of the slow-control of the barrel part of the PANDA EMC front-end bus system* — •Christopher Hahn for the PANDA-Collaboration — II. Physikalisches Institut, Gießen,Deutschland

The Electromagnetic Calorimeter (EMC) will be a main component of the upcoming PANDA experiment at the future FAIR complex in Darmstadt. Due to the aimed energy resolution, timing and spacial constraints the individual high-voltage adjustments for the Large Area Avalanche Photodiodes (LAAPDs) demands innovative and specialized electronics, such as, for example, the individual bias-voltage adjustments for the Photodiodes needs to be accurate down to 0.1V. In the same time, no space can be occupied in the inner detector volume for individual cable routing and connections for the LAAPD bias voltage. The key elements of the high voltage adjustment concept will be described, with a special focus on the first and the second iteration of the dedicated control ASICs for the front-end bus system, the so-called SerialAdapter ASICs (SAA). The SAAs are also utilized for the communication and control of the APFEL preamplifier ASICs, which read out the APD photodetectors. The different versions of the SerialAdapter ASICs have been compared and their impact on the resulting high voltage adjustment will be presented in this talk.

*gefördert durch das BMBF, GSI und HIC for FAIR.

HK 39: Instrumentation VIII

Time: Wednesday 16:30–19:00 Location: J-HS D

Group Report HK 39.1 Wed 16:30 J-HS D

R^{3}B - a versatile setup at FAIR — •Kathrin Göbel for the R3B-Collaboration — Goethe-Universität Frankfurt, Germany

We study reactions with relativistic stable and radioactive beams at the R^{3}B experiment at the international accelerator facility FAIR in Darmstadt, Germany. The versatile setup allows kinematically complete measurements with high efficiency and resolution.

We present the new time-of-flight wall ToFD to identify fragments and the new scintillation fiber detectors to track fragments in combination with the superconducting magnet GLAD. We review the experiment on Coulomb dissociation of ^{16}O performed in 2019, and give an outlook on the quasi-free scattering and fission experiments scheduled for the experimental campaign in spring 2020.

The experiments are carried out within FAIR Phase 0 at GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt. The project is supported by the Bundesministerium für Bildung und Forschung (BMBF) (05P19RFFN1, 05P19WOFN1, 05P15RFFN1, 05P15RDFN1), HGS-HIRE, HIC for FAIR and the GSI-TU Darmstadt cooperation agreement.

Group Report HK 39.2 Wed 17:00 J-HS D

First results from commissioning of mCBM at GSI/FAIR — •Christian Sturm for the CBM-Collaboration — GSI, Darmstadt, Germany

To study extremely rare probes in nucleus-nucleus collisions with high precision, the Compressed Baryonic Matter experiment (CBM) at FAIR is designed to measure at unprecedented interaction rates up to 10 MHz. Hence, CBM will be equipped with fast and radiation hard detector systems, readout by a free-streaming data acquisition system, transporting data with up to 1 TB/s to a large scale computer farm, which provides first level event reconstruction and selection. To test and optimize all components and their complex interplay including firmware and software under realistic conditions the CBM full-system test-setup *mCBM* ("mini-CBM") comprising pre-series components and final prototypes of all CBM detector subsystems and their read-out chains has been set-up at the present SIS18 facility of GSI/FAIR. With runs in March, November and December 2019 performed within the FAIR Phase-0 program the commissioning of mCBM has started. First results of the mCBM beam campaigns will be presented.

Supported by BMBF and GSI/FAIR.

Group Report HK 39.3 Wed 17:30 J-HS D

The HADES detector upgrades: Current status and future perspectives — •Adrian Rost for the HADES-Collaboration — TU Darmstadt

The HADES spectrometer at GSI Helmholtzzentrum für Schwerionenforschung GmbH in Darmstadt was recently upgraded with new detector components. Besides a technical upgrade of the photon detector of the Ring-Imaging-Cherenkov (RICH) system a new electromagnetic calorimeter (ECAL) was installed in the spectrometer. In March 2019 a four week physics production beam time with an "Ag+Ag" beam at 1.58A GeV was carried out.

In this contribution the performance of the new detector systems under beam conditions will be presented. For future operations at the SIS18 accelerator HADES has a broad physics program which is mainly focused on pion/proton induced reactions. For these upcoming experiments T0 and new beam detectors utilizing Ultra Fast Silicon Detector (UFSD) technology will be used, front-end electronics of HADES tracking system will be upgraded and a new forward tracking system will be installed.

**This work has been supported by BMBF under ErUM-FSP C.B.M. and by DFG under GRK 2128.*

Group Report HK 39.4 Wed 18:00 J-HS D

KOALA experiment commissioning at COSY — •Huagen Xu — Forschungszentrum Juelich, Juelich, DE

The prime motivation of the KOALA experiment is the study of antiproton-proton elastic scattering at small momentum transfers at HESR. Since the evaluation of the pure Coulomb differential cross section, which proportional to $1/t^2$, is unambiguous, a measurement in the region of Coulomb dominance would determine the $\overline{p}p$ luminosity in an independent way and allow parameters of the $\overline{p}p$ interaction to be extracted. The idea of KOALA is to measure the scattered beam antiprotons at forward angles by fast timing detector and the recoil target protons near 90° by energy detectors.

To verify the method of KOALA a recoil detector has been built and successfully commissioned at former ANKE hydrogen cluster target station at COSY. It was found that the high rate of background limits the measurement to be extended to the desired small momentum transfer t. In order to suppress the background a forward detector consisting of scintillator bars has been built for the KOALA commissioning at COSY by measuring the pp elastic scattering. So far, the full KOALA setup has been installed at COSY. The latest results of KOALA commissioning measurements at COSY will be presented.

Group Report HK 39.5 Wed 18:30 J-HS D

Dedicated Precision Polarimeter for Charged Particle EDM searches at COSY — •Irakli Kesherashvili — Forschungszentrum Jülich GmbH

The international JEDI (Jülich Electric Dipole moment Investigations) collaboration in Jülich, has developed a dedicated polarimeter for the storage ring electric dipole moment experiment at COSY. The polarimeter is equipped with a carbon block target for the effective asymmetry measurement. It is a modular set-up and based on novel LYSO inorganic scintillator crystals coupled to new large area silicon arrays. The detector readout system is assembled with the fast sampling, high-resolution ADC's. The high-speed data transfer allows us online selection of event/hit and asymmetry monitoring. During the last three years, we have performed five beam times at the extracted beam experimental area to optimize detector operation. Currently, the polarimeter is installed at the COSY internal beam. The recent commissioning beam time with vertically polarized deuterons was auspicious, and in January 2020, the first in-plane polarization vector precession will be monitored with the new polarimeter. During this talk, important development steps and recent results will be presented.

HK 40: Instrumentation IX

Time: Wednesday 16:30–19:15 Location: J-HS K

Group Report HK 40.1 Wed 16:30 J-HS K

Status of upgrading the HADES tracking system frontend electronics — •Christian Wendisch for the HADES-Collaboration — GSI Helmholtz-Zentrum Darmstadt

HADES is one of the running experiments for FAIR phase 0 at SIS-18 (GSI Darmstadt). It is planned to continue running until being setup in the CBM cave for SIS-100 experiments. In the course of these plans an upgrade of the 20 years old frontend electronics of the tracking system is being conducted to further imrove the sensitivity the 24 drift chambers. For the analog part the PASTREC ASIC will replace the ASD8 chips employed so far. PASTREC was originally developped for straw tubes at AGH Krakov. A series of test campaigns has meanwhile been conducted to validate this ASIC for drift chambers, recently at COSY (Jülich). This report will present the status of this project with a focus on the latest test beam results.

supported by BMBF and GSI

Group Report HK 40.2 Wed 17:00 J-HS K

An FPGA-based Sampling-ADC Readout for the Crystal Barrel Calorimeter — •Johannes Müllers for the CBELSA/TAPS-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik, Bonn

The CBELSA/TAPS experiment at the electron accelerator ELSA (Bonn) investigates the photoproduction of mesons off protons and neutrons. After a redesign of the front-end and back-end electronics of the Crystal Barrel calorimeter, the experiment is taking data again since 2017.

One component remains to be exchanged: The charge-sensitive digitizer (QDC) of the calorimeter. It limits the readout rate of the experiment to 2kHz and cannot detect pile-up events in the high-rate forward angles. A new sampling-ADC has been adapted from the PANDA-SADC as a replacement for the QDC, featuring 14bit@80MS/s ADCs and Kintex 7 FPGAs. A custom firmware allows to extract energy and timing information and can detect pile-up pulses. The firmware has been tested with event rates well above 10kHz and delivers data reliably over a 1Gbit/s UDP link.

The sampling-ADCs have been running in a prototype setup in parallel to the QDC readout for multiple beam times, with one quarter of the calorimeter read out. The hardware development will be summarized and selected modules and algorithms of the firmware will be presented. The performance will be demonstrated with various analysis results.

HK 40.3 Wed 17:30 J-HS K

The front-end signal path of the P2 experiment at MESA — Sebastian Baunack[1], Michael Gericke[3], Kathrin Imai[1], •Rahima Krini[1], Werner Lauth[1], Frank Maas[1,2], David Rodriguez Pineiro[2], and Malte Wilfert[1] — [1]Institute for Nuclear Physics, Mainz, Germany — [2]Helmholtz Institute Mainz, Germany — [3]University of Manitoba, Canada

The MESA accelerator will be built in the Institute for Nuclear Physics in Mainz. In this facility the parity-violating asymmetry of the elastic electron-proton scattering will be measured with high precision at the

P2 experiment, in order to determine the weak mixing angle $\sin^2_{eff}(\theta)$. Therefore, many technical challenges have to be solved.

The small asymmetries $\mathcal{O}(10^{-8})$ and the high precision require very high statistics and therefore a long measurement time. A joint readout electronics for P2 experiment in Mainz and for Moeller experiment at the Jefferson Laboratory is under development by collaborators of University of Manitoba. The challenge is to control the integrating detector signal chain and all sources of electronics noise within the whole experimental P2 set-up. A first prototype was build and tested at MAMI (Mainzer Mikrotron).

HK 40.4 Wed 17:45 J-HS K

Status and development of FEBs for the CBM-TRD — •Florian Roether for the CBM-Collaboration — Institut für Kernphysik, Frankfurt am Main

The Compressed Baryonic Matter (CBM) experiment at the Facility for Antiproton and Ion Research (FAIR) will explore the QCD phase-diagram in the region of high net-baryon densities. The Transition Radiation Detector (TRD) with its multi-layer-design will provide electron identification and contribute to particle tracking as well as the identification of light nuclei.

The detector signals will be digitized by the Self-triggered Pulse Amplification and Digitization ASIC (SPADIC), collected by the GBTx based Readout Board (ROB) and pre-processed by the Data Processing Board (DPB).

Therefore, the SPADIC is the key component in the TRD Front End Electronic (FEE). This talk will focus on the current status and development of the corresponding Front End Boards (FEBs) for the TRD and on test results from a recent beam test at DESY.

This work is supported by BMBF-grant 05P15RFFC1 and 05P19RFFC1.

HK 40.5 Wed 18:00 J-HS K

Particle detection with Arduino-based readout electronics — •Markus Köhli[1,2], Jannis Weimar[1], Fabian Allmendinger[1], Fabian Schmidt[2], Jochen Kaminski[2], Klaus Desch[2], and Ulrich Schmidt[1] — [1]Physikalisches Institut, Heidelberg University, Germany — [2]Physikalisches Institut, University of Bonn, Germany

Open Hardware-based microcontrollers, especially the Arduino platform, have become a comparably easy-to-use tool for rapid prototyping and implementing creative solutions. Such devices in combination with dedicated frontend electronics can offer low cost alternatives for student projects and independently operating small scale instrumentation. Clocked at 8-96 MHz, the capabilities can be extended to data taking and signal analysis at decent rates. We present two projects, which cover the readout of proportional counter tubes and of scintillators or wavelength shifting fibers with Silicon Photomultipliers. With the SiPMTrigger we have realized a small-scale design for SiPMs as a trigger or veto detector. 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 analysis - time over threshold measurement and a 10-bit analog-to-digital converter for pulse heights. The device is therefore suitable for low to medium rate environments, where a good signal to noise ratio is crucial - in case presented here to monitor thermal neutrons.

HK 40.6 Wed 18:15 J-HS K

A Controller for the Crystal Barrel Sampling ADCs — •Knaust Jens and Müllers Johannes for the CBELSA/TAPS-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

The CBELSA/TAPS experiment at the accelerator ELSA (Bonn) performs photo-induced baryon spectroscopy. For the readout of the Crystal Barrel calorimeter, a new generation of data acquisition modules (Sampling ADCs) has been developed. Whilst these send the acquired event data directly via an Ethernet link, they rely on further interfaces for operation.

The controller designed and presented in this talk integrates the SADCs into the setup of the CBELSA/TAPS experiment. It supplies the experiment's trigger and synchronization logic, and access for a monitoring and control interface. For debugging and programming purposes, it is also possible to remotely access the JTAG interface of the modules.

The design's central control element is a Xilinx Zynq, which fuses a processor with an FPGA. This combines the advantages of both systems and is used to implement the remote JTAG interface as well as a convenient control interface. This browser based interface allows monitoring of all modules as well as more advanced tasks like reprogramming of their firmware.

The talk will present aspects of the hardware design such as the implementation of the remote JTAG implementation (Xilinx Virtual Cable) in the Linux subsystem.

HK 40.7 Wed 18:30 J-HS K

A Sampling ADC-readout for the Crystal Barrel Calorimeter - Digital Filtering and Deconvolution, Pile-Up Detection and Recovery — •Jan Schultes for the CBELSA/TAPS-Collaboration — HISKP, Universität Bonn

The Crystal Barrel Calorimeter consists of 1320 CsI(Tl) scintillating crystals, which are read out by Avalanche-Photo-Diodes after a recent upgrade. As first step of a further upgrade and since those have to cope with the highest rates, the signals of the forward part of the detector are now digitized by FPGA-controlled Sampling ADCs. This offers new possibilities to detect pile-up and perform pile-up recovery, thus allowing to reach even higher rates without a loss of data quality in the main calorimeter. It has been shown that it is possible to detect pile-up events with high sensitivity using the new setup. Results of the subsequent pile-up correction as well as its impact on data analysis are presented alongside the discussion of specifically developed methods in digital signal processing, filtering and deconvolution.

HK 40.8 Wed 18:45 J-HS K

The CBM-TRD Data Processing Board Firmware — •David Schmidt for the CBM-Collaboration — Infrastructure and Computer Systems in Data Processing, Frankfurt, Deutschland

The Compressed Baryonic Matter (CBM) experiment at the Facility for Antiproton and Ion Research (FAIR) in Darmstadt, Germany, is a fixed target heavy-ion physics experiment. The goal of the experiment is to probe the QCD phase diagram at very high net-baryon densities and moderate temperatures. The SIS-100 accelerator will provide a high luminosity heavy-ion beam, which allows for the measurement of particles with very low production cross sections. CBM is designed without a hierarchical trigger system, therefore self-triggered radiation hard readout electronics are required to cope with interaction rates of up to 10 MHz. The Transition Radiation Detector (TRD) employs the SPADIC 2.2 as the readout ASIC, featuring 32 channels and two GBTx e-links. The timestamped hit messages from the SPADIC have to be processed in the TRD-DPB (Data Processing Board) to be compatible with the CBM microslice readout. A microslice contains all the self-contained data in a given timeframe from a detector sub-system. An overview of the TRD-DPB firmware and in particular the data processing will be given.

This work is supported by BMBF-grants 05P15RFFC1 and 05P19RFFC1.

HK 40.9 Wed 19:00 J-HS K

A sampling ADC system for front end free straw tubes readout — •Paweł Kulessa[1], Andreas Erven[1], Tanja Hahnraths von der Gracht[1], Lioubov Jokhovets[1], Henner Ohm[1], Krzysztof Pysz[2], Jim Ritman[1], Christian Roth[1], Mario Schlösser[1], Thomas Sefzick[1], Valery Serdyuk[1], Stefan van Waasen[1], and Peter Wintz[1] — [1]FZJ Jülich, Germany — [2]INP PAN Kraków, Poland

Tracking systems consisting of several thousand straw tubes are forseen for the FAIR experiments. A readout must run in a triggerless mode at an average rate up to 1 MHz per straw and has to provide both time and energy loss information for particle tracking and identification. The standard readout scheme of such systems is to place front end electronics inside the detector and a free-running TDC readout outside.

This talk presents a sampling ADC (sADC) system, which has no electronic parts inside the detector, consequently no heating problems exist, no radiation damage can happen, the granularity of the system is very high and the space needed inside the detector is reduced.

The sADC system consists of: coaxial cables, HV decoupling boards in dedicated crates, preamplifiers and 250 MHz sADC boards placed in two openVPX crates. Per crate 14 sADC and preamplifiers (160 channels each), one data concentrator and one controller boards are foreseen. The FPGA (VIRTEX7) firmware provide: pulse and pile-up detection, baseline determination and correction, extraction of signals time and charge information. It can also provide other information e.g. signal amplitude, time over threshold or the "raw" signal shape.

HK 41: Invited Talks III

Time: Thursday 11:00–12:30 Location: H-HS X

Invited Talk HK 41.1 Thu 11:00 H-HS X
Highlights from the COMPASS Experiment and the COMPASS++/AMBER Proposal — •Boris Grube for the COMPASS-Collaboration — Physik-Department E18, Technische Universität München

With COMPASS, the largest multi-purpose fixed-target spectrometer setup at the CERN Super Proton Synchrotron, the structure and spectrum of hadrons is investigated by scattering high-energetic hadrons and polarized muons off various targets. The broad physics program aims at a better understanding of the strong interaction, which is theoretically described by quantum chromodynamics (QCD). The studied processes include soft reactions of hadrons to test the breaking of the chiral symmetry of QCD, production and decay of meson resonances to perform detailed studies of the excitation spectrum of light-quark mesons, and scattering of high-energy muons and pions off nucleons to unravel the role of spin and internal dynamics of the quark-gluon structure in the nucleon. We will present highlights from recent analyses.

Based on the very successful running of COMPASS, the new COMPASS++/AMBER experiment was proposed recently. The physics program entails a wide variety of measurements addressing fundamental questions of QCD. We will discuss the first part of the proposed program, which is intended to start 2021 and aims, among other things, at a measurement of the proton radius via elastic scattering of high-energetic muons in order to shed more light on the proton-radius puzzle.

Invited Talk HK 41.2 Thu 11:30 H-HS X
The charm of exotic bound states of the strong interaction — •Frank Nerling — Goethe-Universität Frankfurt & GSI Darmstadt

Exotic hadrons beyond the simple quark model are allowed for and predicted within quantum chromodynamics. They offer laboratories to study the strong interaction. Experimental searches are performed since decades, however, most of them were not conclusive yet. Since the beginning of the millenium, a new era has begun with the discovery of the so-called charmonium-like (exotic) XYZ states. With the observation of tetraquark candidates, the BESIII experiment has discovered manifestly exotic states in the meson sector. Other facilities such as the upcoming PANDA experiment at FAIR offer unique possibilities to finally clarify the nature of *e.g.* one of the first and most famous XYZ states that still 15 years after the observation is not yet understood.

Invited Talk HK 41.3 Thu 12:00 H-HS X
Characterizing baryon dominated matter with HADES measurements — •Szymon Harabasz for the HADES-Collaboration — TU Darmstadt / GSI

In heavy-ion reactions at beam energies of a few GeV per nucleon on stationary targets, QCD matter is substantially compressed (2-3 times nuclear saturation density) while temperatures are expected not to exceed T = 70 MeV. Matter under such conditions is being studied with HADES at SIS18.

This contribution discusses new experimental results on the mechanisms of strangeness production, the emissivity of matter and the role of baryonic resonances herein. The multi-differential representations of hadron and dilepton spectra, collective effects and particle correlations will be confronted with results of other experiments as well as with hitherto model calculations.

To provide a deeper understanding of the temperature and density dependence of the intriguing results obtained in the Au+Au and Ar+KCl runs, HADES has recently completed a run studying Ag+Ag collisions at $\sqrt{s_{\mathrm{NN}}} = 2.55$ GeV, optimized to reach a high enough beam energy for abundant strangeness and vector meson production while yet realizing a large interaction volume. The results obtained for heavy-ion collisions are confronted to studies of elementary reactions serving as a reference for medium effects.

HK 42: Hadron Structure and Spectroscopy VIII

Time: Thursday 14:00–15:45 Location: J-HS A

Group Report HK 42.1 Thu 14:00 J-HS A
Measurement of the proton radius with hydrogen TPC at MAMI — •Vahe Sokhoyan — Universität Mainz, Institut für Kernphysik

The so-called "proton radius puzzle" originated due to significant discrepancies between some of the results for the proton charge radius measured in experiments with electronic or muonic hydrogen and in electron-proton scattering experiments. Very recently, the PRad Collaboration published new results favoring smaller proton radius compared to many of the previous electron-proton scattering measurements. Further scattering experiments utilizing new concepts for detection of particles in the final state are underway.

We are planning to perform a new measurement of the electron-proton scattering cross section at low momentum transfer ($0.001\ \mathrm{GeV}^2 \leq \mathrm{Q}^2 \leq 0.04\ \mathrm{GeV}^2$) at the Mainz Microtron (MAMI). The project is conducted in collaboration between University of Mainz, Petersburg Nuclear Physics Institute, and collaborators from other contributing institutions. The experimental setup consisting of a Hydrogen Time Projection Chamber, Forward Tracker, and beam monitoring system will allow us to measure the energy and the angle of the recoil proton in combination with the angle of the scattered electron, and to determine the electron flux with high accuracy. The performance of this experiment will open avenue for further studies of this kind using deuterium and helium targets in combination with electron or photon beams. In this talk, the current status of this project and the future plans will be presented.

Group Report HK 42.2 Thu 14:30 J-HS A
Proton radius measurement in high-energy muon scattering at COMPASS — •Martin Hoffmann for the COMPASSplusplus/AMBER working group — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

The proton radius can be determined either by measuring the slope of the electric form factor via elastic lepton-proton scattering at low squared four-momenta Q^2 or by laser spectroscopy of hydrogen. Previous measurements of elastic electron-proton scattering and laser-spectroscopy of muonic hydrogen yielded contradicting results, which is known as the proton radius puzzle. In order to contribute to its solution, we propose a measurement using high-energy muon-proton elastic scattering at the M2 beam line of CERN's super proton synchrotron in 2022. A scattering experiment using muons instead of electrons is interesting for two reasons: (a) it has different systematic uncertainties and (b) it can test for lepton-flavour effects as a possible explanation of the puzzle. The transferred momentum to the proton will be determined using an active-target time projection chamber (TPC) filled with high-pressure hydrogen, yielding a high-precision measurement of Q^2. In order to over-constrain the reaction, the muon kinematics will be measured by the COMPASS spectrometer extended by precision silicon pixel detectors surrounding the hydrogen TPC. We present results from a test measurement in 2018 and plans for the final setup based on on-going Monte Carlo simulations. We also discuss the resolution on the proton radius that we plan to achieve.

Supported by BMBF.

HK 42.3 Thu 15:00 J-HS A
Surprising Features of the Neutron Electromagnetic Structure in Electron-Positron Annihilation — •Samer Ahmed[1,2], Alaa Dbeyssi[1], Paul Larin[1,2], Frank Maas[1,2,3], Christoph Rosner[1,2], and Yadi Wang[1] — [1]Helmholtz-Institut Mainz, Mainz, Germany — [2]Institute of Nuclear Physics, Mainz, Germany — [3]PRISMA Cluster of Excellence, Mainz, Germany

The neutron is one of the building blocks of visible matter. Its complicated structure emerges from the binding of three quarks by strong interaction. It cannot be calculated from first principles due to the

large color charge of quarks and due to the self-interaction of gluons. The electromagnetic form factors represent the simplest structure observables and serve as a test ground for our understanding of the strong interaction. The data situation for the neutron structure from annihilation processes is very scarce. In this contribution, we show new results for the cross section of the $e^+e^- \to n\bar{n}$ process and the effective form factor of the neutron at 18 centre of mass energies in the range $\sqrt{s}$ = (2.0 - 3.08) GeV using data sets being collected at the BESIII experiment with an integrated luminosity of 647.9 pb^{-1}. The achieved accuracy of the results for the effective form factor of the neutron is of a similar level as those from the electron scattering data. The electric and the magnetic form factor of the neutron have been measured for the first time using data from the e^+e^- annihilation. In this contribution, the results for the disentangled electric and magnetic form factor of the neutron will be shown as well.

HK 42.4 Thu 15:15 J-HS A

Proton Radius in High-Energy Muon Scattering — •Christian Dreisbach for the COMPASSplusplus/AMBER working group — Technische Universität München, Physik-Department, Garching, Germany

The proton radius can be determined by measuring the slope of the electric form factor G_E at small squared four-momentum transfer Q^2. Numerous elastic-scattering and laser-spectroscopy measurements of the proton radius have been performed with contradicting results, the so-called proton radius puzzle. We propose to measure the proton radius in high-energy elastic muon-proton scattering at the M2 beam line of CERN's Super Proton Synchrotron in the year 2022. A high-precision measurement at low Q^2 realized with a high-pressure hydrogen TPC can contribute to a solution of the puzzle, especially in view of the systematics of this approach compared to electron scattering. We present results of the on-going analysis on systematic effects in elastic lepton-proton scattering to leading and next-to-leading order to reach the required precision in the low-Q^2 region and discuss ideas for a possible setup in 2022.

HK 42.5 Thu 15:30 J-HS A

Dispersive Calculation of the Rho Meson Mass Difference — •Philip Lüghausen — Technische Universität München

The mass difference between charged and neutral rho mesons is a critical parameter when accounting for chiral symmetry breaking in high-precision calculations. For a phenomenological determination, we employ a dispersive formalism analogously to the Cottingham formula. A resonance model is used to obtain numerical results. The current PDG estimate of $M_{\rho^\pm} - M_{\rho^0} = 0.7 \pm 0.8\,\mathrm{MeV}$ is compatible with our result in the range of $0.8 \ldots 1.4\,\mathrm{MeV}$.

HK 43: Heavy-Ion Collisions and QCD Phases X

Time: Thursday 14:00–15:45 Location: J-HS F

Group Report HK 43.1 Thu 14:00 J-HS F

Measurement of the production of light (hyper-)nuclei and their antiparticles with ALICE at the LHC — •Sebastian Hornung for the ALICE-Collaboration — Ruprecht-Karls-Universität, Heidelberg, Deutschland — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Deutschland

The production mechanism of (anti-)nuclei and (anti-)hypernuclei in high-energy hadronic collisions is one of the open puzzles in high-energy physics. On the one hand, the yields can be described by statistical hadronization models. On the other hand, the production of nuclei can be explained by the coalescence of protons and neutrons which are close by in phase space. Studies of the light (anti-)nuclei production as a function of the charged-particle multiplicity density provide an important insight into the system-size dependence of the formation of multi-baryon states. The information drawn from the yields and spectra are complemented by the measurement of the momentum space anisotropies in the emission of nuclei. Further, the measurements of the lifetime and binding energy of (anti-)hypertriton can be used to study the interaction of hyperons with nucleons.

The measurement of (hyper-)nuclei is experimentally challenging due to the low production rates and the contamination by secondary nuclei produced in spallation reactions with the beam pipe or the detector material. An overview of recent ALICE results on the production of light (anti-)nuclei and the lifetime of (anti-)hypertriton will be presented.

HK 43.2 Thu 14:30 J-HS F

Investigations on light (anti-)hypernuclei with ALICE at the LHC — •Janik Ditzel for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität, Frankfurt, Germany

At the Large Hadron Collider at CERN copious production of light (anti-)(hyper-)nuclei has been measured in Pb–Pb collisions by the ALICE Collaboration. The production of such (anti-)(hyper-)nuclei has recently become a topic of high interest, connecting for instance to the possible strangeness content in neutron stars. The excellent performance of the Inner Tracking System, the Time Projection Chamber and the Time-Of-Flight detector of the ALICE apparatus provide a clear particle identification and vertex reconstruction. ALICE is currently performing its upgrade of the detector setup to cope with the interaction rate of 50 kHz in Pb–Pb collisions in Run 3. This will lead to an even larger sample of light (anti-)(hyper-)nuclei. These (anti-)(hyper-)nuclei are reconstructed by their decay products, e.g. in the charged two-body decay channel of the lightest known (anti-)(hyper-)nucleus ${}^3_\Lambda\mathrm{H} \to {}^3\mathrm{H} + \pi^-$. In order to predict the yields of the (anti-)${}^3_\Lambda\mathrm{H}$ and also (double-)(anti-)(hyper-)nuclei of mass number A=4 and A=5, it is essential to study the acceptance and efficiency in Monte Carlo simulations. For the measurement, a magnetic field is needed and currently by default set to B = 0.5 T. We show, that a lower value of the magnetic field provides a better reconstruction efficiency of (anti-)(hyper-)nuclei. In addition, we present the status of our new investigations on the ${}^4_{\Lambda\Lambda}\mathrm{H}$ with Run 2 Data.

HK 43.3 Thu 14:45 J-HS F

Feasibility Study of Hypernuclei Production in CBM at FAIR — •Anton Lymanets for the CBM-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH

The main goal of the CBM experiment at FAIR is to study the behavior of nuclear matter at very high baryonic density. This includes the exploration of the high density equation of state, search for the transition to a deconfined and chirally restored phase, critical endpoint. One of the promising diagnostic probes for these new states is the enhanced production of multi-strange (anti-)particles. The CBM detector is designed to measure such rare diagnostic probes multi-differentially with unprecedented precision and statistics. Important key observables are the production of hypernuclei and dibaryons. Theoretical models predict that single and even doubly-strange hypernuclei are produced in heavy-ion collisions with the maximum yield in the region of SIS100 energies. The discovery and investigation of new (doubly strange-)hypernuclei and of hyper-matter will shed light on the hyperon-nucleon and hyperon-hyperon interactions. In this talk, we will report the results of feasibility study on the production of single- and double-strange hypernuclei in CBM experiment. Implications on the high baryon density nuclear matter will be discussed.

HK 43.4 Thu 15:00 J-HS F

Nucleosynthesis in heavy-ion collisions at the LHC via the Saha equation — Volodymyr Vovchenko[1,2], •Kai Gallmeister[1], Jürgen Schaffner-Bielich[1] und Carsten Greiner[1] — [1]Institut für Theoretische Physik, Goethe Universität, Frankfurt/Main — [2]Frankfurt Institute of Advanced Studies, Frankfurt/Main

The production of light (anti-)(hyper-)nuclei in heavy-ion collisions at the LHC is considered in the framework of the Saha equation, making use of the analogy between the evolution of the early universe after the Big Bang and that of "Little Bangs" created in the lab. Assuming that disintegration and regeneration reactions involving light nuclei proceed in relative chemical equilibrium after the chemical freeze-out of hadrons, their abundances are determined through the famous cosmological Saha equation of primordial nucleosynthesis and show no exponential dependence on the temperature typical for the thermal model. A quantitative analysis, performed using the hadron resonance gas model in partial chemical equilibrium, shows agreement with experimental data of the ALICE collaboration on d, ^{3}He, ${}^3_\Lambda$H, and ^{4}He yields for a very broad range of temperatures at $T \lesssim 155$ MeV. The

presented picture is supported by the observed suppression of resonance yields in central Pb–Pb collisions at the LHC.
Supported by BMBF.

HK 43.5 Thu 15:15 J-HS F

RootInteractive on n-dimensional analysis pipeline — •Alperen Yüncü for the ALICE-Collaboration — Universität Heidelberg, Heidelberg, Deutschland

Multi-dimensional problems require multidimensional analysis, since the analysis of a projection on a single dimension may cause misinterpretations of the data. Thus, in multidimensional analysis, interactive multidimensional projections can be quite effective to observe the data from various viewpoints. In this contribution, an interactive visualization tool, called RootInteractive, which is currently being used in the physics analysis and calibration processes in ALICE experiment, will be presented.The usage of the tool will be demonstrated on the n-dimensional analysis pipeline of the ALICE experiment, which includes n-dimensional histogramming package, statistical maps extraction, local regression, and machine learning techniques.

HK 43.6 Thu 15:30 J-HS F

Tracking QA and search for primary vertices — •Artemiy Belousov[1], Yuri Fisyak[3], Ivan Kisel[1,2], and Maksym Zyzak[1] for the CBM-Collaboration — [1]FIAS, Germany — [2]GSI, Germany — [3]Brookhaven National Laboratory, USA

Modern experiments in high energy physics tend to increase the amount of data to be processed, thus, the execution speed of the algorithms becomes crucial. However, the efficiency and precision of the applied procedures cannot be compromised. Therefore, the Kalman filter method is usually used as a basis in particle tracks reconstruction, since it satisfies the above-mentioned requirements.

Current implementation of the Kalman filter method for reconstruction of primary vertices is added to the TPC primary vertex finder of the STAR experiment within the CBM Phase-0 program. The algorithm will be applied in the STAR during the Beam Energy Scan II (BES-II) program, which requires high operational speed. At the same time, quality of the fitting procedure should stay high. The developed Kalman filter based primary vertex fit will be optimized for working with real data in online mode within the High Level Trigger of STAR.

As a part of the preparation for the BES-II program the development of express quality assurance (xQA) is required. The developed express QA allows to monitor the data production process. The procedure shows that Express production provides high quality of the dE/dx measurement.

HK 44: Heavy-Ion Collisions and QCD Phases XI

Time: Thursday 14:00–15:45 Location: J-HS G

Group Report HK 44.1 Thu 14:00 J-HS G

Λ Polarization in Au+Au collisions at $\sqrt{s_{NN}}$ = 2.4 GeV measured with HADES — •Frederic Kornas for the HADES-Collaboration — TU Darmstadt, Darmstadt, Germany

In peripheral heavy-ion collisions there are very strong initial velocity profiles due to the different stopping power perpendicular to the beam axis. This might lead to vortical effects and manifest itself in a polarization of the particle spins. Such a polarization has been measured through the weak decay of the Λ hyperon by the ALICE and STAR collaboration showing an increase towards lower beam energies to $\sqrt{s_{NN}}$ = 7.7 GeV up to $P_\Lambda \approx 2\,\%$. In this contribution the Λ polarization measurement with HADES at $\sqrt{s_{NN}}$ = 2.4 GeV will be presented. In addition results for the flow components v_1 and v_2 of the Λ will be shown too.
This work has been supported by Stiftung GIERSCH.

HK 44.2 Thu 14:30 J-HS G

Predictions for particle production in Ag+Ag collisions at E_{kin}=1.58A GeV from a hadronic transport approach — •Natey Kübler[1,2], Jan Staudenmaier[1,2], and Hannah Elfner[3,2,1] — [1]Frankfurt Institute for Advanced Studies, Ruth-Moufang-Straße 1, 60438 Frankfurt am Main — [2]Goethe University, Max-von-Laue-Strasse 1, 60438 Frankfurt am Main — [3]GSI Helmholtzzentrum für Schwerionenforschung, Planckstr. 1, 64291 Darmstadt

The production of particles in heavy ion collisions is of great importance to inspect the properties and dynamics of hadronic matter. As part of the HADES experiment at GSI Ag+Ag collisions at beam energies of 1.58A GeV have been performed in spring 2019. In the light of these experimental studies this work provides a theoretical prediction of the expected results. The hadronic transport approach SMASH (Simulating Many Accelerated Strongly-interacting Hadrons) is applied in order to predict the production of particles (protons, pions, kaons) and their respective distributions in phase space. A special focus is given to the production rates of ϕ mesons and Ξ^- baryons and their agreement with recent HADES data. In addition to the analysis of multiplicities and rapidity spectra, the mean transverse masses for different centrality classes are explored. In this context the hadronic spectra are confronted with earlier HADES results for Au+Au and C+C collisions in order to study the system size dependence. Furthermore, predictions for the invariant mass spectra of dielectron emission are provided.

HK 44.3 Thu 14:45 J-HS G

Charged Kaon and ϕ Reconstruction in Ag+Ag Collisions at $\sqrt{s_{NN}}$ = 2.5 GeV with HADES — •Marvin Kohls for the HADES-Collaboration — Institut für Kernphysik, Goethe Universität Frankfurt am Main, Deutschland

Heavy ion collisions in the few GeV energy regime probe similar temperatures and densities as created in neutron stars, which gives us a tool to probe the matter created in those macroscopic collisions in earthly laboratories [1].
In March 2019, the HADES collaboration recorded $13 \cdot 10^9$ Ag(1.58A GeV)+Ag events as part of the FAIR Phase-0 program. Within this talk we present the status of the reconstruction of K^+, K^- and ϕ and further discuss preliminary results.
Due to the fact, that these strange hadrons are produced under the free nucleon-nucleon production threshold, they are a good probe for in-medium effects with respect to their steep excitation function. Furthermore, comparing the production yields in peripheral collisions to those in central collisions will provide a good test for strangeness enhancement effects.
The work has been supported by BMBF (05P19RFFCA), GSI and HIC for FAIR.

[1] Adamczewski-Musch, J., Arnold, O., Behnke, C. et al. *Probing dense baryon-rich matter with virtual photons.* Nat. Phys. 15, 1040*1045 (2019) doi:10.1038/s41567-019-0583-8

HK 44.4 Thu 15:00 J-HS G

Reconstruction of weakly decaying strange hadrons in Ag+Ag Collisions at $\sqrt{s_{NN}}$ = 2.55 GeV with HADES — •Simon Spies for the HADES-Collaboration — Goethe-Universität Frankfurt

In the scope of the FAIR Phase 0 program we recorded 13.7×10^9 Ag(1.58A GeV)+Ag events in March 2019 with the HADES detector located at the *GSI Helmholtzzentrum für Schwerionenforschung* in Darmstadt, Germany. In this contribution we discuss the status of the reconstruction of Λ hyperons and K^0_S mesons and present first preliminary multi-differential phase space distributions. Both hadrons are produced near their free nucleon nucleon threshold of $\sqrt{s}$ = 2.55 GeV where the excitation functions are steep and a high sensitivity to medium effects is expected. They are reconstructed via the invariant mass of their decay products while the sensitivity is enhanced by exploiting the weak-decay topology with the help of an artificial neural network (ANN).
This work has been supported by BMBF under ErUM-FSP (05P19RFFCA), GSI and HIC for FAIR.

HK 44.5 Thu 15:15 J-HS G

Multi-strange Hyperons reconstruction at the CBM experiment — •Evgeny Lavrik for the CBM-Collaboration — Facility for Antiproton and Ion Research, Darmstadt, Germany

The main goal of the CBM experiment at FAIR is to study the behavior of nuclear matter at very high baryonic density. This includes the exploration of the high density equation of state, search for the transition to a deconfined and chirally restored phase, critical endpoint. The promising diagnostic probes for this new states are the enhanced production of multi-strange (anti-)particles. The CBM detector is designed to measure such rare diagnostic probes multi-differentially with unprecedented precision and statistics.

Results of feasibility studies of these key observables in the CBM experiment are discussed.

HK 44.6 Thu 15:30 J-HS G

Longitudinal dynamics of multiple conserved charges — •Jan Fotakis[1], Harri Niemi[2], Gabriel Denicol[3] und Carsten Greiner[1] — [1]Institut für Theoretische Physik, Goethe Universität, Frankfurt/Main — [2]Department of Physics, University of Jyväskylä — [3]Instituto de Física, Universidade Federal Fluminense

The constituents of nuclear matter produced at collider facilities carry a multitude of conserved charges, namely the baryon number, strangeness and electric charge, so that the diffusion currents of conserved charge couple with each other. Therefore, baryon density gradients in the high-density collision experiments at RHIC, FAIR or NICA will generate equalizing currents in all conserved charges. We provide for the first time a fluid dynamical approach including the complete diffusion coefficient matrix describing the evolution of a dense system with multiple conserved charges. A novel phenomenon arising from the coupled diffusion currents is the generation of positive and negative net-strangeness domains from originally net-strangeness neutral matter. We show how these domains are generated dynamically, and argue that observing the rapidity dependence of net-strangeness can give an experimental access to diffusion.

HK 45: Structure and Dynamics of Nuclei VIII

Time: Thursday 14:00–16:00 Location: J-HS E

Group Report HK 45.1 Thu 14:00 J-HS E

High-spin structures of transitional Xe and Ba nuclei in the $50 \leq Z, N \leq 82$ region — •L. Kaya[1], A. Vogt[1], P. Reiter[1], M. Siciliano[2,3], and A. Gargano[4] — [1]IKP, Universität zu Köln — [2]INFN - LNL, Italy — [3]INFN Padova, Italy — [4]INFN Napoli, Italy

The $50 \leq Z, N \leq 82$ region is a fertile testing ground for the predictions of modern shell-model calculations. Xe and Ba nuclei with $A \approx 135$ form an important link in the smooth evolution from spherical to deformed shapes and were investigated after multinucleon-transfer employing the γ-ray tracking array AGATA coupled to the mass spectrometer PRISMA and in complementary fusion-evaporation reactions employing the HORUS γ-ray array at the University of Cologne. Pronounced proton and neutron alignments in the yrast bands of ^{131}Xe and ^{134}Ba were identified. The discoveries of $J^\pi = 19/2^+$ and $J^\pi = 23/2^+$ isomers in ^{133}Ba, ^{133}Xe and ^{135}Ba are closing gaps in the systematics along the $N = 77$ and $N = 79$ isotones towards the proton subshell-closure at $Z = 64$. Exploiting angular-correlation investigations, the ground-state band in ^{136}Ba was found to be interrupted by negative-parity states only a few hundred keV above the $J^\pi = 10^{(+)}$ isomer. Results on the first spectroscopy of high-spin states above the $J^\pi = 8^-$ isomeric bandhead in the odd-odd isotope ^{130}I are presented. Large-scale shell-model calculations employing the GCN50:82, SN100PN, PQM130, and a realistic effective interactions reproduce the experimental findings and provide guidance to the interpretation of the observed high-spin features. Supported by the German BMBF (05P15PKFN9 TP1, 05P18PKFN9 TP1) and ENSAR-TNA03.

HK 45.2 Thu 14:30 J-HS E

Lifetime measurement of excited states in octupole candidate ^{144}Ce — •Marcel Beckers, Claus Müller-Gatermann, Alfred Dewald, Christoph Fransen, Alina Goldkuhle, and Franziskus von Spee — Institut für Kernphysik, Köln

In the N≈88, Z≈56 region several nuclei exhibit characteristics that are related to octupole correlations. With both neutron and proton numbers very close to these values, ^{144}Ce is a good candidate for examining octupole deformation as well and indeed the literature reports a low-lying negative parity band which is attributed to this kind of deformation. To shed further light on the general structure, we performed a RDDS measurement to determine lifetimes of excited states in ^{144}Ce. To populate the nucleus of interest the transfer reaction ^{142}Ce(^{18}O,^{16}O) was used. The analysis which will be presented yielded a verification of the 2_1^+ state lifetime as well as the first measurement of the lifetime of the 4_1^+ and 6_1^+ state and a lifetime limit for the 3_1^- state. B(E2) values deduced from these lifetimes were used to compare them to shell model predictions. Furthermore B(E1) values for interband transitions have been determined to get indications about possible octupole deformation.

HK 45.3 Thu 14:45 J-HS E

Lifetime measurements above the N=82 closed neutron shell in ^{141,142,143}La — •Lisa Marie Gerhard[1], Arwin Esmaylzadeh[1], Felix Dunkel[1], Jan Jolie[1], Yung-Hee Kim[2], Lukas Knafla[1], Ulli Koester[2], and Jean-Marc Régis[1] — [1]Institut für Kernphysik, Universität zu Köln — [2]Insitut Laue-Langevin, Grenoble

Lifetimes of low-lying excited states in ^{141,142,143}La were determined using the fast-timing technique [1]. The experiment was performed at the Institut Laue-Langevin in Grenoble. Its high intensity research reactor is used to produce the nuclei of interest via neutron induced fission of ^{239}Pu. The fission fragments are separated with the Lohengrin spectrometer to select specific isotopes [2]. During this experiment, barium isotopes were used to produce the odd-Z ^{141,142,143}La via β decay. These isotopes lie above the N=82 closed neutron shell where the evolution from nearly spherical to a strongly deformed shape is investigated. Preliminary results will be presented in comparison to theoretical calculations.

[1] J.-M. Régis et al., Nucl. Instrum. Methods Phys. Res. 726C (2013)

[2] P. Armbruster et al., Nucl. Instrum. Methods 139 (1976)

HK 45.4 Thu 15:00 J-HS E

Nuclear structure study in 138Ce via γ-γ fast-timing — •Kerstin Schomacker, Jean-Marc Regis, Vasil Karayonchev, and Jan Jolie — Institut für Kernphysik, Universität zu Köln, Zülpicherstr.77, 50937 Köln, Germany

Good agreement between shell model calculated and experimental level scheme from 138Ce up to the 10+ state [1] motivated the measurement of transition strengths for the 6+, 8+ and 10+ level decays in this nucleus. This was done by lifetime measurements via the γ-γ fast-timing technique.

Excited states of 138Ce were populated in a fusion-evaporation reaction at the FN Tandem Accelerator at the Institute für Kernphysik at the Universität zu Köln. Accurate results were obtained by investigating triple gamma cascades using HPGe-LaBr(Ce)-LaBr(Ce) coincidences. The deduced transition strengths are compared with shell-model calculations.

[1] T. Alharbi et al., Phys. Rev. C 87, 014323 (2013)

HK 45.5 Thu 15:15 J-HS E

Lifetime measurement of excited states in ^{120}Te — •Franziskus von Spee, Alfred Dewald, Claus Müller-Gatermann, Christoph Fransen, Alina Goldkuhle, Marcel Beckers, and Casper Lakenbrink — Institut für Kernphysik, Köln, Deutschland

The nuclear structure of tellurium isotopes at Z=52 and the evolution of collectivity are of special interest due to the close proximity of the closed shell at Z=50 in the even-even neighbor Sn. A recoil distance Doppler-shift (RDDS) experiment was performed to investigate absolute transition probabilities in ^{120}Te. Excited states in ^{120}Te were populated using the ^{110}Pd(^{13}C,3n)^{120}Te reaction at the FN-Tandem accelerator facility located at the IKP of Cologne. The $\gamma - \gamma$ coincidence data were analysed with the differential decay-curve method (DDCM) eliminating problems related to feeding and absolute distances. Lifetimes of excited states in the yrast band up to the 8^+ state were measured and the corresponding B(E2) values were calculated. In this contribution we will present the results and compare these with known data from Coulomb excitation experiments.

HK 45.6 Thu 15:30 J-HS E

Direct Lifetime Measurement in ^{104}Pd — •Maximilian Droste, Konrad Arnswald, Rouven Hirsch, Levent Kaya, Lars Lewandowski, Claus Müller-Gatermann, Peter Reiter, Michael Seidlitz, and Burkhard Siebeck — Institut für Kernphysik, Universität zu Köln

A precise lifetime measurement, as a complementary approach to determine reduced transition strengths in ^{104}Pd, was performed at the FN Tandem accelerator of the IKP Cologne employing the Recoil-Distance Doppler-Shift method. Excited states of ^{104}Pd were populated via the fusion evaporation reaction ^{96}Zr(^{12}C,4n)^{104}Pd at 55 MeV. The B(E2; $2^+ \rightarrow 0^+$) value of the first excited state in ^{104}Pd has so far only been investigated via Coulomb excitation. Information on complementary, model-independent approaches like lifetime measurements, to determine reduced transition strengths in ^{104}Pd, are lacking. New lifetime values, which deviate strongly from the evaluated values, will be presented and reduced transition probabilities will be compared to previous results and shell model calculations. Due to its low excitation energy of the 2^+ state at 556 keV and its enhanced collectivity the mid-shell nucleus ^{104}Pd is used as target material in Coulomb-excitation experiments at, e.g., radioactive ion-beam facilities. For these experiments precise knowledge of the reduced E2 transition probabilities and the correlated quadrupole moments of the target materials are mandatory.

HK 45.7 Thu 15:45 J-HS E

Lifetime measurements in ^{102}Ru via the Doppler-shift attenuation method using pγ coincidences — •Vera Everwyn[1], Anna Bohn[1], Michelle Färber[1], Florian Kluwig[1], Pavel Petkov[2,1], Sarah Prill[1], Philipp Scholz[1], Michael Weinert[1], Julius Wilhelmy[1], and Andreas Zilges[1] — [1]Institute for Nuclear Physics, University of Cologne — [2]National Institute for Physics and Nuclear Engineering, Bucharest, Romania

The chain of stable ruthenium isotopes is well suited to study the evolution of nuclear structure, like mixed-symmetry states, along shape-transitional paths in the $A = 100$ mass region from spherical (^{96,98}Ru) to deformed shapes (^{104}Ru). Transition probabilities are a key component for understanding nuclear structure and can be deduced from lifetimes, branching, and multipole mixing ratios. However, the information on level lifetimes in ^{102}Ru is scarce. Therefore, an inelastic proton-scattering experiment on ^{102}Ru was performed using the SONIC@HORUS setup at the University of Cologne [1]. Lifetimes of excited states were measured via the Doppler-shift attenuation method, which benefits from the exclusion of feeding contributions due to the acquired pγ-coincidence data [2]. First results of this experiment will be presented and compared to the neighboring nuclei ^{96,98,100}Ru.

Supported by the DFG (ZI-510/9-1). A.B. is supported by the Bonn-Cologne Graduate School for Physics and Astronomy.

[1] S. G. Pickstone *et al.*, Nucl. Instr. and Meth. A **875** (2017) 104-110
[2] A. Hennig *et al.*, Nucl. Instr. and Meth. A **794** (2015) 171

HK 46: Structure and Dynamics of Nuclei IX

Time: Thursday 14:00–16:00 Location: J-HS H

Group Report HK 46.1 Thu 14:00 J-HS H

Accurate Nuclear Structure Studies with Consistent Chiral Two- plus Three-Nucleon Interactions — •Thomas Hüther, Stefan Alexa, Marco Knöll, Laura Mertes, Tobias Mongelli, Julius Müller, Tobias Wolfgruber, and Robert Roth — Institut für Kernphysik, Darmstadt, Deutschland

We have developed a family of chiral two- plus three-nucleon interactions for an accurate ab initio description of ground-state energies and charge radii up to the medium mass regime. This family uses consistent chiral order, regulator, and cutoff values for two- and three-nucleon interactions up to N^{3}LO and allows for a vigorous quantification of theory uncertainties based on the chiral order-by-order convergence and the cutoff dependence.

Recent advances in ab initio many-body methods, in particular, the no-core shell model and the in-medium similarity renormalization group, provide us with the opportunity to probe ground-states and excitation spectra in light as well as in medium mass nuclei. We focus on presenting oxygen and carbon spectroscopy results for the chiral interaction family.

Supported by DFG (SFB 1245).

HK 46.2 Thu 14:30 J-HS H

Elastic NN-Scattering with Coupled NΔ-Channels in Chiral Effective Field Theory — •Susanne Strohmeier and Norbert Kaiser — Technische Universität München

We study the elastic nucleon-nucleon scattering ($T_{\rm lab} \leq 300$MeV) by employing the dynamics of the coupled nucleon-delta channels. The potentials arising from one- and two-pion exchange, with iterative contributions properly subtracted, are derived from chiral effective field theory at next-to-leading order. For the chiral two-pion exchange we calculate directly the spectral functions (imaginary parts) and implement a local regulator. The short-range contact interaction in the coupled (NN, NΔ, ΔN, $\Delta\Delta$)-channels is constructed up to next-to-leading order (i.e. quadratic in momenta) and the low energy constants with significant influence are determined in fits to empirical NN-scattering phase shifts. We compare the phase shifts of this coupled channel approach with the next-to-next-to-leading order results of the uncoupled situation.

Work supported in part by DFG and NSFC (CRC110).

HK 46.3 Thu 14:45 J-HS H

Density-dependent NN-interaction from subleading chiral three-nucleon forces — •Norbert Kaiser — Physik Department, Technische Universität München

From the sub- and subsubleading contributions to the chiral 3N-force a density-dependent two-nucleon interaction $V_{\rm med}$ in isospin-symmetric nuclear matter is derived. $V_{\rm med}$ is calculated from the on-shell scattering process $N_1(\vec{p}) + N_2(-\vec{p}) \to N_1(\vec{p}\,') + N_2(-\vec{p}\,')$ in the nuclear matter rest frame. The momentum and k_f-dependent potentials associated with the isospin operators $1, \vec{\tau}_1 \cdot \vec{\tau}_2$ and five spin-structures $1\,, \vec{\sigma}_1 \cdot \vec{\sigma}_2\,, \vec{\sigma}_1 \cdot \vec{q}\vec{\sigma}_2 \cdot \vec{q}\,, i(\vec{\sigma}_1 + \vec{\sigma}_2) \cdot (\vec{q} \times \vec{p}), \vec{\sigma}_1 \cdot \vec{p}\vec{\sigma}_2 \cdot \vec{p} + \vec{\sigma}_1 \cdot \vec{p}\,'\vec{\sigma}_2 \cdot \vec{p}\,'$ are expressed in terms of functions, which are either given in closed analytical form or require at most one (or two) numerical integration. For the (most challenging) 3N-ring diagrams proportional to $c_{1,2,3,4}$, one gets at two-loop order regularized double-integrals $\int_0^\lambda dr\, r \int_0^{\pi/2} d\psi$ from which the λ^2-divergence has been subtracted and the logarithmic piece $\sim \ln(m_\pi/\lambda)$ is isolated. After partial wave decomposition these results are most helpful to implement the sub- and subsubleading chiral three-nucleon forces into nuclear many-body calculations.

Work supported in part by DFG and NSFC (CRC110).

HK 46.4 Thu 15:00 J-HS H

Exploring density-matrix expansions for local chiral interactions — •Lars Zurek[1,2], Eduardo A. Coello Pérez[3], Scott K. Bogner[4], Richard J. Furnstahl[5], and Achim Schwenk[1,2,6] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt — [3]Lawrence Livermore National Laboratory, Livermore, CA, USA — [4]Facility for Rare Isotope Beams and Department of Physics and Astronomy, Michigan State University, East Lansing, MI, USA — [5]Department of Physics, The Ohio State University, Columbus, OH, USA — [6]Max-Planck-Institut für Kernphysik, Heidelberg

We employ the density-matrix expansion originally introduced by Negele and Vautherin in order to rewrite one-body density matrices in terms of local densities and their derivatives. The resulting approximations for the density matrices are applied to calculate energy-density functionals at the Hartree-Fock level based on local interactions derived from chiral effective field theory. The accuracy of this approach is investigated and analyzed for various approximations and choices in the scalar density-matrix expansion.

* Funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Projektnummer 279384907 - SFB 1245 and the BMBF under Contract No. 05P18RDFN1.

HK 46.5 Thu 15:15 J-HS H

Precision calculation of deuteron form factors in chiral effective field theory — Arseniy A. Filin[1], •Daniel Möller[1], Vadim Baru[2,3,4], Evgeny Epelbaum[1], Hermann Krebs[1], and Patrick Reinert[1] — [1]Ruhr-Universität Bochum, Fakultät für Physik und Astronomie, Institut für Theoretische Physik II, D-44780 Bochum, Germany — [2]Helmholtz-Institut für Strahlen- und Kernphysik and Bethe Center for Theoretical Physics, Universität Bonn, D-53115 Bonn, Germany — [3]Institute for Theoretical and Experimental Physics, B. Cheremushkinskaya 25, 117218 Moscow, Russia — [4]P.N. Lebedev Physical Institute of the Russian Academy of Sciences, 119991, Leninskiy Prospect 53, Moscow, Russia

We employ the precise two-nucleon potentials worked out to fifth order in chiral effective field theory to perform high-accuracy calculations of the deuteron form factors. The corresponding electromagnetic charge and current operators are derived and regularized consistently with the potentials. The single-nucleon contributions to these operators are expressed in terms of the proton and neutron form factors, for which up-to-date empirical parametrizations are employed. The short-range two-nucleon operators contain undetermined parameters which are fixed from the deuteron static moments and/or the world data of deuteron form factors, allowing for different kinds of predictions. A comprehensive error analysis is carried out, including a Bayesian analysis of the uncertainty stemming from the truncation of the chiral expansion.

HK 46.6 Thu 15:30 J-HS H

Precise measurement of the neutron-neutron scattering length — •Marco Knösel[1] and Thomas Aumann[1,2] for the NeuLAND-SAMURAI-Collaboration — [1]Technische Universität Darmstadt — [2]GSI Helmholtz-Zentrum für Schwerionenforschung

In this contribution, a new experimental approach to determine the neutron-neutron scattering length is presented. In order to create free neutron pairs, the knockout reactions ^{6}He(p,$p\alpha$)^2n and t(p,2p)^2n as well as the charge-exchange reaction $d(^7\mathrm{Li},^7\mathrm{Be})^2n$ are proposed to be measured in inverse kinematics at the RIBF in RIKEN. In a kinematically complete measurement, the momenta and positions of the neutrons are determined using the new high-resolution neutron detector HIME, after they freely scattered off each other. From this information, the spectrum of relative energy of the two-neutron system can be obtained and by comparison to halo EFT calculations the neutron-neutron scattering length can be determined.

This work is supported by the DFG through grant no. SFB 1245, the BMBF under contract number 05P15RDFN1 and the GSI-TU Darmstadt cooperation agreement.

HK 46.7 Thu 15:45 J-HS H

Exploring alternative SRG generators in one dimension — •Matthias Heinz[1], Kai Hebeler[1,2], and Achim Schwenk[1,2,3] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Planck-Institut für Kernphysik, Heidelberg

The Similarity Renormalization Group (SRG) is used in nuclear theory to decouple high- and low-momentum components of nuclear interactions to improve convergence and thus reduce the computational requirements of many-body calculations. The SRG evolution is characterized by the generator, which determines toward what form the Hamiltonian is transformed. Currently, the standard choice for the generator is the kinetic energy, which evolves the Hamiltonian towards a diagonal form. However, it has been shown that significant contributions from four- and higher-body forces can be induced during the evolution, which limits the application of evolved potentials to many-body problems. Alternative generators may generate weaker many-body forces while offering the same improvements of the many-body convergence. In this talk, I will present some different generators tested in 1-D systems, analyzing their effect on many-body convergence and induced many-body forces.

This work is supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) – Projektnummer 279384907 – SFB 1245.

HK 47: Nuclear Astrophysics I

Time: Thursday 14:00–15:45 Location: J-HS B

Group Report HK 47.1 Thu 14:00 J-HS B

Electron capture processes in intermediate-mass stars — •Dag F. Strömberg[1,2], Gabriel Martínez-Pinedo[2,1], and Karlheinz Langanke[2,1] — [1]Institut für Kernphysik (Theoriezentrum), Technische Universität Darmstadt, Schlossgartenstr. 2, 64289 Darmstadt, Germany — [2]Gesellschaft für Schwerionenforschung, Planckstr. 1, 64259 Darmstadt, Germany

Following carbon burning, intermediate-mass stars (initial mass $\sim 7-11$ solar masses) form degenerate cores composed primarily of ^{16}O and ^{20}Ne, with smaller amounts of ^{23}Na, ^{24}Mg and ^{25}Mg. When such cores grow massive enough electron capture reactions are triggered due to the high chemical potential of the electrons. Most notably, the double electron capture $^{20}\mathrm{Ne} \rightarrow {}^{20}\mathrm{F} \rightarrow {}^{20}\mathrm{O}$ releases enough heat to ignite runaway oxygen burning resulting in either a collapse to a neutron star or a thermonuclear explosion.

In this contribution we will discuss how details of the electron capture reactions can affect the conditions at oxygen ignition and thus the outcome of the runaway reaction. Due to the comparatively low temperatures ($T < 1$ GK) prior to oxygen ignition the electron capture rates are fully determined by a small number of transitions. Some of these are forbidden, such as the recently measured $0^+ \rightarrow 2^+$ transition between the ground states of ^{20}Ne and ^{20}F. We will examine the impact of such transitions and how this depends on the growth rate and composition of the core.

This work is supported by the Deutsche Forschungsgemeinschaft via contract SFB 1245 and the EU COST Action CA1611 (ChETEC).

HK 47.2 Thu 14:30 J-HS B

Towards a study of the ^{12}C$(\alpha,\gamma)^{16}$O reaction at the new underground lab Felsenkeller — •Felix Ludwig[1,2], Daniel Bemmerer[1], Tamás Szücs[1], Steffen Turkat[2], and Kai Zuber[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden — [2]Technische Universität Dresden

The reaction $^{12}\mathrm{C}(\alpha,\gamma)^{16}\mathrm{O}$ is of paramount importance for the nucleosynthesis of elements in stars. It takes place during helium burning and determines the ratio of the abundances of ^{12}C and ^{16}O.

Due to its low cross section, underground experiments are needed to measure this reaction at astrophysically relevant energies. On the way towards a comprehensive study of this reaction at the new underground laboratory Felsenkeller in Dresden, ^{12}C beam tests and γ background data have recently been reported [1].

The contribution will present initial $^{12}\mathrm{C}(\alpha,\gamma)^{16}\mathrm{O}$ data from Felsenkeller. In a first phase, ^{12}C beam and implanted solid ^{4}He targets are used to study this reaction. Additional tests using two sevenfold Cluster detectors in Felsenkeller will be reported, as well.

– Supported by GAMMAPOOL resources, and by the Helmholtz Association (ERC-RA 0016).

[1] T. Szücs *et al.*, Eur. Phys. J. A 55, 174 (2019)

HK 47.3 Thu 14:45 J-HS B

Equation of state effects in core-collapse supernovae — •Sabrina Schäfer[1,2], Hannah Yasin[1], Almudena Arcones[1,3], and Achim Schwenk[1,2,4] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]GSI Helmholtzzentrum für Schwerionenforschung GmbH — [4]Max-Planck-Institut für Kernphysik, Heidelberg

We investigate the impact of different properties of the nuclear equation of state in core-collapse supernovae, with a focus on the proto-neutron-star contraction and its impact on the shock evolution. To this end, we introduce a range of equations of state that vary the nucleon effective mass, incompressibility, symmetry energy, and nuclear saturation point. This allows us to point to the different effects in changing these properties from the Lattimer and Swesty to the Shen et al. equations of state, the two most commonly used equations of state in simulations. In particular, we trace the contraction behavior to the effective mass, which determines the thermal nucleonic contributions to the equation of state. Larger effective masses lead to lower

pressures at nuclear densities and a lower thermal index. This results in a more rapid contraction of the proto-neutron star and consequently higher neutrino energies, which aids the shock evolution to a faster explosion.

*This work was supported by the Deutsche Forschungsgemeinschaft (DFG) - Projektnummer 279384907 - SFB 1245 and the European Research Council Grant No. 677912 EUROPIUM.

HK 47.4 Thu 15:00 J-HS B

Neutron matter at finite temperature based on chiral effective field theory interactions — •Jonas Keller[1,2], Kai Hebeler[1,2], Corbinian Wellenhofer[1,2], and Achim Schwenk[1,2,3] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Planck-Institut für Kernphysik, Heidelberg

We study the equation of state of neutron matter at finite temperature based on two- and three-nucleon interactions from chiral effective field theory. The free energy, pressure, entropy and internal energy are expanded in many body pertubation theory around the self-consistent Hartree-Fock solution. All calculations are performed including three-nucleon contributions without employing normal-ordering approximations, and include theoretical uncertainty estimates.

*This work is supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) – Projektnummer 279384907 – SFB 1245.

HK 47.5 Thu 15:15 J-HS B

A study of r-process nucleosynthesis in the aftermath of a binary neutron star merger — •Stylianos Nikas[1,2], Gabriel Martinez Pinedo[1,2], André Sieverding Sieverding[5], and Meng-Ru Wu[3,4] — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Planckstraße 1, 64291 Darmstadt, Germany — [2]Institut für Kernphysik (Theoriezentrum), Technische Universität Darmstadt,Schlossgartenstraße 2, 64289 Darmstadt, Germany — [3]Institute of Physics, Academia Sinica, Taipei 11529, Taiwan — [4]Institute of Astronomy and Astrophysics, Academia Sinica, Taipei 10617, Taiwan — [5]School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455, USA

The r-process is thought to create about half of elements heavier than Fe. The site of the r-process was unknown until recently. The detection of the electromagnetic radiation following the gravitational wave event GW170817 in addition to the detection of Sr in the electromagnetic spectrum established neutron star mergers as a site where heavy elements are created.

We perform a nucleosynthesis study for the creation of the first r-process peak elements determining the astrophysical conditions under which the peak is produced. Based on those conditions we determine the nuclear properties that affect the abundance pattern.

This work was supported by DFG through - Projektnummer 279384907 - SFB 1245 and HGS-HIRe

HK 47.6 Thu 15:30 J-HS B

The role of fission yields in the r-process — •Bowen Jiang[1,2], Gabriel Martínez-Pinedo[1,2], and Bastian Schütrumpf[1] — [1]GSI — [2]Technische Universität Darmstadt

The r-process nucleosynthesis in neutron star mergers may reach fissionable nuclei, which generates significant uncertainties in predicting of the final abundance of r-process materials. We demonstrate that in cases where fission happens, it will have an essential impact on the abundance pattern around the second r-process peak ($A \sim 130$) as well as the lanthanides regime ($A = 135 \sim 160$).

Our calculations also show that fission only accounts for modifying abundance ratios among materials in the first several seconds. Fission yields of the nuclei fissioning in this time span could impact the number of free neutrons in the environment as well.

We evaluate the impact of fission yields by using two versions of a semi-empirical fission model called GEF. Large uncertainties of the prediction provided by the GEF model on neutron-rich fissionable nuclei are shown. We also discuss how improvement could be made in the GEF model to cover physical effects in exodic nuclei, by new experimental data of fission yields on a single nuclei, i.e. ^{258}**Fm** and ^{252}**Cf**.

HK 48: Instrumentation X

Time: Thursday 14:00–16:00 Location: J-HS C

Group Report HK 48.1 Thu 14:00 J-HS C

Upgrade of the ALICE TPC — •Tariq Mahmoud for the ALICE-Collaboration — University of Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

After the Long Shutdown 2 (2019 − 2020), the LHC will deliver Pb-Pb-collisions with a minimum-bias interaction rate of 50 kHz. In order to make full use of the increased luminosity, the TPC, which is the main tracking and particle identification device of ALICE, is currently being upgraded with readout chambers (ROC) based on Gas Electron Multipliers (GEM). These avoid the long dead-time of the order of 200 μs generated by the ion gate and hence allow for continuous operation and readout. In summer 2019 the TPC was equipped with new GEM ROCs that had been constructed and tested in a collaborative effort of 9 European and 4 US institutions. The HV system was also upgraded for the safe operation of GEM detectors. In order to meet the new readout conditions, a new ASIC called SAMPA was developed, which contains an internal Pre-Amp, a Shaper, and a 10-bit ADC (sampling rate of 5 MHz) with 32 channels. First successful pre-commissioning tests using ionization tracks generated by cosmic rays and a UV-laser system were carried out around mid-November 2019 with the upgraded TPC. A systematic commissioning program will be taking place throughout December 2019 till February 2020. The status of the upgraded TPC will be presented as well as the results of the commissioning program. Supported by BMBF.

HK 48.2 Thu 14:30 J-HS C

A photoelectric-effect-based field calibration system for the Time Projection Chamber at the CBELSA/TAPS experiment — •Dimitri Schaab, Fabian Metzger, Markus Ball, Reinhard Beck, and Bernhard Ketzer — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn

The performance of a Time Projection Chamber (TPC) relies on a very good knowledge of the electric field inside the sensitive volume. This is crucial since deviations from a perfectly homogeneous drift field deteriorate the spatial resolution of the detector if they remain uncorrected. Reasons for these deviations are, on the one hand, static imperfections of the detector structure and, on the other hand, dynamic changes of the space charge inside the sensitive volume which mainly originate from fluctuations of the event rate.

For the new TPC for the CBELSA/TAPS experiment, a calibration system based on the one of the T2K experiment is being set up. With the help of a UV-laser, electrons are released via the photoelectric effect at well-known positions on the cathode. By the electric field, these electrons are guided towards the readout plane and show the integrated spatial distortions. The UV laser light is introduced into the TPC from the anode side through fibre bundles. Care was taken to achieve a uniform illumination of the cathode surface. In this scope, a small TPC (sTPC) has been designed and built in order to test the calibration system. The setup and first measurements will be presented.

Group Report HK 48.3 Thu 14:45 J-HS C

The CBM Time-of-Flight FAIR Phase 0 program — •Ingo Deppner and Norbert Herrmann for the CBM-Collaboration — Pysikalisches Institut, Uni. Heidelberg

In order to provide particle identification (PID) of charged hadrons at the future high-rate Compressed Baryonic Matter (CBM) experiment the TOF group has developed a large-area Time-of-Flight (ToF) wall equipped with high rate capable multi-gap resistive plate chambers (MRPC). Prior to its destined operation at the Facility for Antiproton and Ion Research (FAIR) - starting in 2025 - this high-rate timing MRPC technology will be used for physics research at two scientific pillars of the FAIR Phase-0 program: the end-cap TOF upgrade of the STAR experiment at RHIC and the mTOF wall of the mCBM experiment at SIS18. At STAR, the fixed- target program of the Beam Energy Scan II (BES-II) will rely on 108 CBM MRPC detectors for for-

ward PID at trigger rates of up to 2 kHz. At mCBM, high-performance benchmark runs of Λ-baryon production at top SIS18 energies and CBM design interaction rates of 10 MHz will become feasible with a PID backbone consisting of 25 CBM MRPC detectors. Apart from the physics perspective, these pre-FAIR involvements will help gathering experience in operating the final CBM TOF wall comprising about 1500 MRPC detectors and 110,000 readout channels. The status of the FAIR phase 0 program will be discussed. The project is partially funded by BMBF 05P15VHFC1.

HK 48.4 Thu 15:15 J-HS C

mini-TOF performance during mini-CBM beam time at SIS18 — •Qiunan Zhang for the CBM-Collaboration — Tsinghua University Beijing

The Compressed Baryonic Matter (CBM) experiment is one of the main pillars at FAIR. It aims to study the QCD phase diagram at high baryon densities with unprecedented interaction rate up to 10 MHz. This requires new free-streaming data acquisition methods, new data analysis concepts and radiation hard and high-rate capable detectors. The CBM Time of Flight wall (CBM-TOF) covers the task of charged particle identification. Muitl-gap Resistive Plate Chambers (MRPCs) with different rate capabilities will be used at their corresponding regions. To reduce the commissioning time for CBM, a CBM full system test-setup called mini-CBM (mCBM) has been installed and tested with various beams at GSI SIS18 facility. The high-rate MRPC prototypes developed at Tsinghua University, called MRPC3a, were selected to be implemented in mTOF modules for mCBM. Additional thin float glass MRPCs from USTC, foreseen for the low rate region, were also tested in mCBM experiment. Performance results from these prototypes regarding efficiency, time and spacial resolution and cluster size analyzed by the so called tracking method will be discussed during this talk. The project is partially founded by BMBF 05P15VHFC1.

Group Report HK 48.5 Thu 15:30 J-HS C

Status of the CBM-TRD — •Philipp Kähler for the CBM-Collaboration — Institut für Kernphysik, Universität Münster

The Transition Radiation Detector (TRD) of the Compressed Baryonic Matter experiment (CBM) will be based on four layers of irregular foam foil radiator and MWPC. It is designed to provide electron/positron identification for di-electron measurements, light-nuclei identification relevant for hyper-nuclei analyses and charged-particle tracking.

The general status of the CBM-TRD project will be presented. This includes studies on the high-rate performance at the CERN-GIF and results from electron beam measurements at DESY. The self-triggered readout, based on the SPADIC-ASIC, and its usage in the FAIR Phase 0 programme will be covered, and the overall system construction status will be summarised.

This work is supported by the BMBF grants 05P19PMFC1 and 05P19RFFC1, as well as the GSI F&E programme.

HK 49: Instrumentation XI

Time: Thursday 14:00–16:00 Location: J-HS D

Group Report HK 49.1 Thu 14:00 J-HS D

Towards the CBM-MVD* — •Michael Deveaux for the CBM-MVD-Collaboration — Goethe Universität Frankfurt

The Compressed Baryonic Matter Experiment (CBM) is one of the core experiments of the future FAIR facility. It will explore the phase diagram of strongly interacting matter in the regime of high net baryon densities with numerous probes, among them open charm. The Micro Vertex Detector (MVD) will contribute to the secondary vertex determination on a 10 μm scale, background rejection in di-electron spectroscopy and reconstruction of weak decays of multi-strange baryons. The detector comprises four stations placed next to the target in vacuum, allowing for two distinct station arrangements. The stations will be populated with 50 μm thin, highly-granular customized Monolithic Active Pixel Sensors (called "MIMOSIS"), which are being developed aiming at a spatial precision in the order of ~ 5 μm, a readout speed of less than 5 μs/frame, a radiation tolerance of $\sim 7 \times 10^{13}$ n_{eq}/cm^2 and 5 Mrad. This contribution will summarize the status of activities towards constructing the MVD, that involve in particular CMOS sensor development together with the IPHC Strasbourg.

*This work has been supported by BMBF ErUM-FSP C.B.M. (05P19RFFC1), GSI and HIC for FAIR.

Group Report HK 49.2 Thu 14:30 J-HS D

Der PANDA Luminositätsdetektor — •Florian Feldbauer für die PANDA-Kollaboration — Ruhr-Universität Bochum

Das PANDA-Experiment, welches im Antiproton-Speicherring HESR an der im Bau befindlichen Beschleunigeranlage FAIR in Darmstadt stehen wird, ist für Fragen der Hadronenphysik optimiert. Mit dieser Anlage wird es möglich sein, neue Zustände zu entdecken und die Linienform dieser wie auch bereits bekannter Zustände sehr präzise zu vermessen. Zur Normierung der dafür verwendeten Energie-Scan-Messungen wird die exakte Kenntnis der Luminosität benötigt.
Die Luminosität wird bei PANDA anhand der Winkelverteilung der elastischen Antiproton-Proton-Streuung bestimmt. Um eine absolute Messgenauigkeit von 5% zu erreichen werden die Spuren der gestreuten Antiprotonen gemessen. Dazu werden 4 Detektorebenen mit gedünnten Siliziumsensoren verwendet (HV-MAPS). HV-MAPS sind Pixelsensoren mit integrierter Ausleseelektronik. Sie werden mit einer Sperrspannung von 60 V betrieben, um die Strahlenhärte zu erhöhen. Die 4 Ebenen, die verfahrbar montiert sind, bestehen aus CVD-Diamanten auf denen die Sensoren aufgeklebt sind. Zur Reduktion der Vielfachstreuung wird der Aufbau im Vakuum betrieben.
Das Konzept des Luminositätsdetektors wird vorgestellt und dabei technische Aspekte wie Sensoren, Vakuumsystem, Kühlung und Elektronik diskutiert, sowie Einblicke in die Datenanlyse gegeben.

Group Report HK 49.3 Thu 15:00 J-HS D

The Silicon Tracking System of CBM: from design considerations towards first tests with heavy ion collisions — •Adrian Rodriguez Rodriguez for the CBM-Collaboration — Goethe University Frankfurt am Main

The Silicon Tracking System (STS) is the central detector for charged-particle identification and momentum determination in the future CBM experiment at the new FAIR accelerator facility. It is designed to measure up to 800 charged particles in nucleus-nucleus collisions at interaction rates up to 10 MHz, to achieve a momentum resolution better than 2% inside 1 Tm magnetic field, and to be capable of identifying complex particle decays topologies, e.g., such with strangeness content. The STS comprises eight tracking stations equipped with double-sided silicon microstrip sensors. Two million channels are read out with self-triggering electronics, matching the data streaming and online event analysis concept of the experiment. The STS functional building block is a module consisting of a sensor, micro-cables and two front-end electronics boards, carrying the custom-developed readout ASIC "STS-XYTER". This presentation aims to show an overview of the development status of the module components, readout chain and system integration towards the beginning of the series production, and in the context of FAIR Phase 0 activities.

HK 49.4 Thu 15:30 J-HS D

Aspects of ladder assembly for the Silicon Tracking System of the CBM Experiment at FAIR — •Shaifali Mehta for the CBM-Collaboration — University of Tuebingen

The Silicon Tracking System (STS) is the central detector for the charged-particle measure- ment and momentum determination in the future CBM experiment. It comprises of about 900 low-mass detector modules, based on double-sided silicon micro-strip sensors distributed on 8 tracking stations. These stations are made from mechanical half units onto which car- bon fiber detector ladders are mounted holding the modules. The positioning of modules assembled on the ladder is expected to be in the order of 100 μm. In STS self-triggering readout electronics are used which is capable of acquiring data at collision rate up to 10 Mhz. To read-out, the double-sided microstrip sensors, STS XYTER, a dedicated ASIC is used. In this presentation, different aspects and techniques of assembling a ladder will be discussed. During the assembly of the ladder and module, various glues are used at different steps and to test the thermal property of those glues is very important. Along with the assembly techniques, results from the thermal cycling tests will be presented in this talk.

HK 49.5 Thu 15:45 J-HS D

Upgrades to the LYCCA setup for FAIR@GSI — •David Werner[1], Madalina Ravar[1], Peter Reiter[1], Stefan Thiel[1], Christoph Goergen[1], Konrad Arnswald[1], Maximilian Droste[1], Herbert Hess[1], Rouven Hirsch[1], Levent Kaya[1], Lars Lewandowski[1], Michael Seidlitz[1], Kai Wolf[1], Dirk Rudolph[2], Pavel Golubev[2], Luis Sarmiento[2], and Patrick Coleman-Smith[3] — [1]University of Cologne, Institute for Nuclear Physics, Cologne, Germany — [2]Lund University, Department of Physics, Lund, Sweden — [3]Science and Technology Facilities Council, Daresbury, England

The Lund-York-Cologne-Calorimeter (LYCCA) is a detector array consisting of 24 Double-sided Silicon Strip Detectors (DSSSDs) and a digital data acquisition system using the ASIC based AIDA front-end electronics. Its more than 1.5π angular coverage, customizable detector positioning and 32 strips per detector side allow for precise measurement of angular correlations of particles with high efficiency. The setup was used during the NUSTAR-PRESPEC campaign and will be part of the NUSTAR HISPEC/DESPEC experiments at FAIR@GSI. During the past two years substantial improvements to LYCCA have been implemented, which will be detailed in the talk. After the upgrades a series of nuclear astrophysics experiments with a ^{nat}C(α, α')C* reaction with beam energies between 20 and 28.5 MeV were conducted at the 10 MV FN-tandem accelerator of the Institute for Nuclear Physics of the University of Cologne. Preliminary results from the latest two beam times will be presented. Supported by GSI F&E KREITE 1416.

HK 50: Instrumentation XII

Time: Thursday 14:00–15:45 Location: J-HS K

Group Report HK 50.1 Thu 14:00 J-HS K

The new APD Based Readout of the Crystal Barrel Calorimeter — •Christian Honisch, Peter Klassen, Johannes Müllers, and Martin Urban for the CBELSA/TAPS-Collaboration — HISKP, University of Bonn, Nussallee 14-16, 53115 Bonn

The Crystal Barrel is an electromagnetic calorimeter located at the electron accelerator ELSA. The detector consisting of 1320 CsI(Tl) scintillator modules is used to detect the decay products of baryon resonances, $\vec{\gamma}\vec{n} \to N^* \to n\pi^0 \to n\gamma\gamma$.
To comprehensively study reactions that have no charged particles in the final state, an exchange of the readout electronics was necessary to achieve a high and uniform trigger efficiency for such reactions.
The upgrade was finished in 2017 and this talk gives an overview over the key challenges:
- Fast signals from CsI(Tl) while maintaining a reasonable SNR,
- Clustering in the 26 matrix in 100 ns,
- APD gain measurement and stabilization.
The talk will introduce the new readout and present its achieved performance in prototype tests and the first production beamtimes.

HK 50.2 Thu 14:30 J-HS K

Test measurements of the cZDD prototype for the BESIII experiment — •Saskia Plura, Achim Denig, Yasemin Schelhaas, Werner Lauth, Peter Drexler, and Igor Beltschikow for the BESIII-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Germany

The BESIII experiment is located at the BEPCII electron-positron collider in Beijing, China, which is operated in the τ-charm energy region. Physics events, such as Initial State Radiation (ISR) processes, require an instrumentation close to the beam axis.

The crystal Zero Degree Detector (cZDD) is a small calorimeter consisting of LYSO crystals, which was proposed for BESIII. A first prototype of the cZDD has been studied at the test beam facility at the MAMI accelerator in Mainz. We report on GEANT4 simulations, which have been carried out to provide similar beam conditions compared to BESIII at the test stand. We also present the results of the test beam time and implications for the final setup at the BESIII experiment.

This work is supported by DFG SFB1044.

HK 50.3 Thu 14:45 J-HS K

Simulation of the Crystal Zero Degree Detector at BESIII for Two Photon Physics Analyses — •Jan Muskalla, Achim Denig, Thomas Lenz, Christoph Florian Redmer, and Yasemin Schelhaas — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland

The BESIII experiment at the electron positron collider in Beijing (BEPCII) is collecting data in the τ-charm energy region. To increase the detection efficiency at small polar angles, a crystal zero degree detector (cZDD) is developed. The cZDD is comprised of two arrays of scintillating LYSO crystals and will be placed in the very forward and backward regions. It was developed primarily for the detection of photons from initial state radiation. This contribution will present simulation studies aiming to investigate up to which extent scattered leptons from two photon processes, such as $e^+e^- \to e^+e^-\pi^0$, can be detected as well. — Supported by DFG (SFB1044)

HK 50.4 Thu 15:00 J-HS K

Test beam results for the SiPM readout electronics of the crystal Zero Degree Detector for BESIII — •Yasemin Schelhaas, Igor Beltschikow, Achim Denig, Peter Drexler, Werner Lauth, and Saskia Plura for the BESIII-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland

The BESIII experiment is situated at the e^+e^- collider BEPCII at the Institute of High Energy Physics in Beijing, China. It is designed to study hadron and τ-charm physics to high accuracy. The investigation of processes in which particles are emitted under strongly forward and backward peaked angles, however, suffers from a limited detection efficiency. For this purpose, a small angle calorimeter is currently under construction, the crystal Zero Degree Detector (cZDD). It consists of two arrays of scintillating LYSO crystals that are separated by a gap to reduce the impact of the high flux of low energetic photons from Bhabha scattering processes. The scintillation light is collected by silicon photomultipliers (SiPMs).

In this contribution, results of a test beam time in July 2019 at the MAMI electron accelerator in Mainz are presented. During this beam time the SiPM readout electronics were tested with regard to saturation effects.

Supported by DFG SFB 1044.

HK 50.5 Thu 15:15 J-HS K

A Scaled-Down Version of the Crystal Barrel Calorimeter for Lectures — •Eugenia Fix, Christian Honisch, Johannes Müllers, and Reinhard Beck for the CBELSA/TAPS-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn

At the Crystal Barrel Calorimeter at the electron accelerator ELSA in Bonn, an upgrade of the read-out electronics was performed. The new components are now being used at a small version of the Crystal Barrel calorimeter consisting of 18 calorimeter crystals dedicated to student measurements.
In the setting of an annual master's course lecture, participants have the opportunity to perform a self-contained measurement at ELSA, where the tasks include assembly and commissioning of the experimental set-up as well as the analysis of the measured data.
In this presentation read-out characteristics of the upgraded set-up are presented, such as energy and timing resolution, with special focus on performance of the newly developed SADC.

HK 50.6 Thu 15:30 J-HS K

Afterglow and delayed gain recovery effects of recently developed Microchannel-Plate Photomultipliers (MCP-PMTs) — •Steffen Krauss, Merlin Böhm, Albert Lehmann, and Daniel Miehling — Physikalisches Institut, Universität Erlangen-Nürnberg

The new FAIR accelerator facility for antiproton and ion research is currently being built at GSI Darmstadt. The PANDA experiment will investigate antiproton-proton annihilations to study new QCD phenomena. For this an excellent particle identification is mandatory, accomplished by Cherenkov detectors of the DIRC-type. Because their focal planes reside inside an up to 1 Tesla magnetic field, lifetime-enhanced MCP-PMTs were chosen as sensors. Recent measurements with MCP-PMTs revealed unexpected effects like increased dark currents and gain losses after a high photon intensity illumination. After

further studies these dark currents, here called afterglow, were identified as photons emitted from the MCPs. The other effect revealed itself in a gain loss which needs several seconds to minutes to recover to the gain level existent before the illumination. We call this a delayed gain recovery. For the high photon rates expected in the PANDA DIRCs it has to be guaranteed that these afterglow and delayed gain recovery effects have no negative impact on the MCP-PMT performance. This talk will discuss our investigations of the afterglow and delayed gain recovery effects.

- Funded by BMBF and GSI -

HK 51: Poster (a)

Time: Thursday 16:30–18:30 Location: Zelt

HK 51.1 Thu 16:30 Zelt

Feasibility study for the applicability of multiparticle correlations in flow analyses at CBM — •Ante Bilandzic for the CBM-Collaboration — Technical University of Munich, Germany

Analyses techniques based on multiparticle azimuthal correlations are widely used at RHIC and LHC experiments in the measurements of anisotropic flow and related phenomena. These techniques are a precision tool only in the environment characterized both by a large number of produced particles and large values of flow harmonics, for instance in mid-central heavy-ion collisions at relativistic energies. This limitation originates from the fact that in flow results obtained with multiparticle correlations both the statistical error and the most important sources of systematic error scale with inverse powers of multiplicity and flow.

In this poster, we present the outcome of the first Monte Carlo studies for the feasibility of using multiparticle azimuthal correlations in the Compress Baryonic Matter experiment at GSI.

HK 51.2 Thu 16:30 Zelt

Charge diffusion coefficient calculations of the hot hadron gas — •Philip A. Karan[1,2], Jean-Bernard Rose[1,2], Jan A. Fotakis[2], Moritz Greif[2], Hannah Elfner[1,2,3], Carsten Greiner[2], and Jan Hammelmann[1,2] — [1]Frankfurt Institute for Advanced Studies, Ruth-Moufang-Strasse 1, 60438 Frankfurt am Main, Germany — [2]Institute for Theoretical Physics, Goethe University, Max-von-Laue-Strasse 1, 60438 Frankfurt am Main, Germany — [3]GSI Helmholtzzentrum für Schwerionenforschung, Planckstrasse 1, 64291 Darmstadt, Germany

To characterize the hot and dense nuclear matter, transport coefficients like the baryon, electric and strangeness charge diffusion are important to know. The interaction of these different charges lead to a diffusion matrix which has been previously suggested in Fotakis et. al. [1711.08680v1] as the cross-charge diffusion. We calculate the coefficients at temperatures in and below the region of the expected phase transition to the QGP using the SMASH transport code that simulates the hadron gas and the Green-Kubo formalism to extract the coefficients. After validating the approach for simple systems we gradually increase the number of degrees of freedom until we reach the full hadronic resonance gas as described by our current knowledge. Our results show that there are significant differences in the temperature dependence of the different components of the diffusion matrix and that a charge*s diffusion current is strongly not only affected by the gradients of their corresponding charge current, but also by the other charges* gradients. This result can be used to provide input to hydrodynamics which take conserved charges into account.

HK 51.3 Thu 16:30 Zelt

Response functions for the fluid dynamics of heavy ion collisions — Andreas Kirchner[1], •Daniel Boness[1], Stefan Floerchinger[1], and Eduardo Grossi[2] — [1]Institut für Theoretische Physik, Heidelberg, Deutschland — [2]Stony Brook University, Stony Brook, USA

We present a way to describe a quark gluon plasma in its fluid dynamical regime using Israel Stewart type hydrodynamic equations of motion with the self written Mathematica package FluiduM. In the package we implemented a background-fluctuation splitting together with a mode expansion technique to solve the equations.

FluiduM enables us to calculate response functions which can be used to compare experimental data for pions, kaons and protons at LHC energies with our theoretical model.

HK 51.4 Thu 16:30 Zelt

Omega Meson Production in $\sqrt{s} = 13$ TeV pp collisions with ALICE — •Marvin Hemmer for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

A hot and dense medium, the so-called quark-gluon plasma (QGP), is believed to be created in ultra-relativistic heavy-ion collisions. The dedicated heavy-ion experiment ALICE at LHC is designed to study the properties of the QGP. Measurements in pp collisions function as a baseline for the measurements in Pb-Pb collisions and further provide insights in the particle production processes. A comparison of neutral pion (π^0) and omega meson (ω) production allows for a study of the mass dependence of the production mechanisms of particles with similar quark content. In the ALICE experiment, omega mesons are measured via the decay channels $\omega \to \pi^+\pi^-\pi^0$ and $\omega \to \pi^0\gamma$. The $\pi^0\gamma$ decay channel is measured facilitating the photon conversion method (PCM) and the electromagnetic calorimeter (EMCal).

In this poster, we report on the current status of the $\omega \to \pi^0\gamma$ measurement in pp collisions at $\sqrt{s} = 13$ TeV.

Supported by BMBF and the Helmholtz Association.

HK 51.5 Thu 16:30 Zelt

Σ^+ production in pp collisions at $\sqrt{s} = 13\ TeV$ in ALICE — •Steven Merkel for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

The ALICE experiment at the CERN LHC investigates the properties of the quark-gluon plasma (QGP) which is believed to be produced in ultra-relativistic heavy-ion collisions at high collision energies. Hadron production measurements in pp collisions provide information about the underlying QCD processes and fragmentation functions. Furthermore, pp results provide an important baseline for the interpretation of ultra-relativistic heavy-ion collisions.

A proper description of the production of strange particles still poses a challenge for Monte Carlo generators like PYTHIA. The measurement of the production of strange hadrons like Σ^+ can help to better constrain the theoretical models. In the ALICE experiment, Σ^+ can be measured via the decay channel $\Sigma^+ \to \mathrm{p} + \pi^0$. π^0 can be measured via the two-photon decay channel, utilizing the calorimeters EMCal and PHOS; protons can be measured with the TPC.

In this poster, a new study of the measurement $\Sigma^+ \to \mathrm{p} + \pi^0$ in ALICE is presented for pp collisions at $\sqrt{s} = 13\ TeV$.

Supported by BMBF and the Helmholtz Association.

HK 51.6 Thu 16:30 Zelt

Comparison of charged-particle production in ALICE with Monte Carlo simulations using RIVET — •Kristina Schmitt for the ALICE-Collaboration — Institut für Kernphysik, Goethe Universität, Frankfurt

The ALICE experiment at CERN-LHC is dedicated to study the properties of the so-called Quark-Gluon Plasma by investigating high-energy pp, p-Pb and Pb-Pb collisions. The comparison of the data with theoretical models is crucial to understand the underlying physical processes of these collisions.

The RIVET toolkit provides an interface between theoretical models, implemented in Monte Carlo generators, and experimental analyses, allowing for a wide range comparison between experiment and theory.

In this poster, we present a systematic comparison of measured transverse momentum (p_T) distributions of charged particles as a function of charged-particle multiplicities for different center of mass energies with a range of different theoretical models, employing the RIVET toolkit.

Supported by BMBF and the Helmholtz Association.

HK 51.7 Thu 16:30 Zelt

Low-p_T π^0 and η reconstruction via their Dalitz decay in pp collisions at $\sqrt{s}$=13 TeV with ALICE — •Florian Eisenhut for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

At the Intersecting Storage Rings (ISR) at CERN, an excess of dielectron pairs over the expectation from known dielectron sources had been

measured at low invariant mass and small pair $p_{T,ee}$ in pp collisions at $\sqrt{s} = 63$ GeV. With the ALICE experiment a similar measurement can be performed by reducing the magnetic field of the central barrel solenoid. However, in order to conclude on such an excess an independent measurement of the η meson by ALICE at LHC energies is crucial as it represents the dominating contribution to the hadronic background in the LMR region.

In this poster, first results of the π^0 and η measurement via its Dalitz decay channel in pp collisions at $\sqrt{s} = 13$ TeV with reduced magnetic field will be presented. This alternative approach allows a reconstruction of these mesons at lower momentum compared to similar analysis using calorimeters while trying to reduce the systematic uncertainties compared to the analysis of the two-photon decay channel via conversions. Thus, it could help to answer the question of a possible excess of the dielectron production at LHC energies.

Supported by BMBF and the Helmholtz Association.

HK 51.8 Thu 16:30 Zelt

Pad-by-Pad gain calibration of the ALICE TPC using reconstructed particle tracks — •Matthias Kleiner for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

The Time Projection Chamber (TPC) is the main tracking and particle identification detector of the ALICE experiment at the CERN LHC. For RUN 3 starting in 2021, interaction rates of 50 kHz in Pb-Pb collisions require a major upgrade of the TPC readout system. The MultiWire Proportional Chambers (MWPCs) are replaced by stacks of four Gas Electron Multiplier (GEM) foils. Due to manufacturing tolerances, the hole diameters vary over the surface of the foils. This leads to variations in the electron amplification.

In this poster, a new self-normalizing method to calculate topological gain variations using particle tracks is presented. This method together with the high data rates allows to study variations of the gain as a dependence of time.

Supported by BMBF and the Helmholtz Association.

HK 51.9 Thu 16:30 Zelt

Quality Assurance and Spark Detection of GEMs for the ALICE-TPC-Upgrade. — •Thomas Block, Philip Hauer, Markus Ball, and Bernhard Ketzer — University of Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany Germany

The MWPC-based readout of the ALICE-TPC is limited to a trigger rate of 3.5 kHz. In order to make full use of the increased luminosity after the Long Shutdown 2, which will result in a minimum-bias interaction rate of 50 kHz, currently an upgrade of the TPC to GEM-based readout chambers is being performed.

For the upgrade more than 800 GEM foils were produced. A rigorous quality assurance scheme was developed and followed to guarantee an excellent quality of the GEMs.

In this poster a summary of the production, the QA scheme, the yields and the most common defects found during chamber construction are presented.

In order to simplify high-voltage tests of GEM foils a webcam-based Spark Detection System (SDS) was developed in Bonn. Discharges, recorded optically with a webcam, can give information about manufacturing defects or dust remnants, which may result in an increased number of discharges and ultimately in short circuits. The design and capabilities of the SDS used for the large ALICE-TPC-GEMs and of a 3D-printable SDS for $10 \times 10\text{cm}^2$ GEMs is presented.

Supported by BMBF.

HK 51.10 Thu 16:30 Zelt

Gas gain calibration of the ALICE TPC with X-rays — •Tim Geiger for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

The ALICE experiment at LHC is a heavy-ion experiment designed to create and study the properties of a so-called quark-gluon plasma (QGP). The QGP is a hot and dense state of matter presumed to be created in heavy-ion collisions. The main tracking and particle identification detector of ALICE is a large volume time projection chamber (TPC). Particle identification is achieved by simultaneous reconstruction of momentum and specific energy loss. To obtain the desired precision, a proper calibration is required. One important calibration is the equalization of topological gain variations over the readout area. The variation can be measured via releasing a fixed amount of charge into the amplification region. So far this was done by releasing radioacitve ^{83}Kr into the gas volume of the TPC. Using X-rays instead could provide a faster and easier way measuring the gas amplification.

In this poster, we present a feasibility study of gas gain calibration via X-rays.

Supported by BMBF and the Helmholtz Association.

HK 51.11 Thu 16:30 Zelt

Simulation Of Ionization Energy Loss In Gases — •Philipp Bielefeldt, Ankur Yadav, Markus Ball, and Bernhard Ketzer — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

Accurate tracking of charged particles in particle detectors can be achieved with Time Projection Chambers (TPC). A frequently used amplification stage are Micro-Pattern Gaseous Detectors, such as Gas Electron Multipliers (GEM). Examples of such devices include the ALICE GEM-TPC at LHC, and the future charged-particle tracking system in the CBELSA/TAPS experiment. Characterization of the GEM-TPC requires a thorough comprehension of the physics processes involved in signal creation. This can be vastly improved using Monte-Carlo Simulations of all processes that contribute to the detector signal.

A full detector simulation chain is developed based on the Geant4 platform. Geant4 describes physics processes in complementary models tailored for varying requirements. Different energy loss representations are used, including the phenomenological Photoabsorption Ionization model and the Bethe-Bloch energy deposition model developed by the NA49 collaboration.

A comparison of the ionisation energy deposition straggling between different representations is given. The results are compared to experimental data on ionization energy loss and results from microscopic simulations. Monte-Carlo calculations for the spatial distribution of ionization clusters in thin absorbers are presented.

HK 51.12 Thu 16:30 Zelt

Pre-Commissioning of the ALICE TPC and Common Mode Analysis — •Panagiota Chatzidaki for the ALICE-Collaboration — Physikalisches Institut der Universität Heidelberg

In order to operate the ALICE Time Projection Chamber (TPC) in continuous mode, recording the full minimum-bias interaction rate of 50 kHz in Pb−Pb, as anticipated at the LHC in Run 3 (2021−2023) and beyond, the gated Multi Wire Proportional Chambers (MWPCs) were replaced by GEM-based readout chambers (Gas Electron Multipliers). After the assembly and before commissioning of the TPC underground, a pre-commissioning in the clean room at the LHC Point 2 was performed during November 2019−February 2020, in order to ensure the functionality of all readout chambers (ROCs) and Front End Electronics (FEE). During that time, dedicated pedestal and noise measurements, calibration pulser measurements, as well as measurements with the TPC laser system were essential in developing algorithms that will perform online and offline corrections during the normal TPC operation with beam. Crucial is the correction of the Common Mode Effect, which, if not accounted for, results in a significant deterioration of the $\mathrm{d}E/\mathrm{d}x$ resolution, and therefore the particle identification performance of the TPC. We describe the pre-commissioning steps, and present the status of the analysis of the Common Mode Effect, by studying non-zero-suppressed laser events.

HK 51.13 Thu 16:30 Zelt

New GEM Detectors for COMPASS/COMPASS++ — Emorfili Terzimpasoglou[1], •Karl Jonathan Flöthner[1], Dimitri Schaab[1], Christian Honisch[1], Igor Konorov[2], Markus Ball[1], and Bernhard Ketzer[1] — [1]Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany — [2]Technische Universität München, E18, München, Germany

The COmmon Muon Proton Apparatus for Structure and Spectroscopy (COMPASS) came into operation in 2001 and is one of the longest running experiments at CERN. Its phase II is scheduled to be completed in 2021 with a measurement of transverse-momentum dependent PDFs in deep inelastic scattering of muons on a deuterium target. A new proposal for a future QCD facility at the M2 beamline has been submitted recently. Running under the name COMPASS++/AMBER, the plans include, among others, a measurement of the proton radius in elastic muon-proton scattering and studies of the pion PDFs using the Drell-Yan process. The upcoming experiments require an upgrade of the existing GEM tracking system. In the long run, new large-size GEM detectors with pixel readout in the central region are planned. In addition, the front-end electronics should

allow for a self-triggered readout of signal channels. As a first step, an improved version of medium-size GEM detectors will be constructed in order to replace some of the existing detectors. The poster will report on the design of these detectors and on studies comparing the existing APV25 front-end chip with the new VMM-3 ASIC. Supported by BMBF.

HK 51.14 Thu 16:30 Zelt

A laser-system for field calibration studies of the Time Projection Chamber at the CBELSA/TAPS experiment — •Fabian Metzger, Dimitri Schaab, Markus Ball, and Bernhard Ketzer for the CBELSA/TAPS-Collaboration — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

The calibration of the electric field of a Time Projection Chamber (TPC) is of central importance since deviations from a homogeneous field in the drift region would otherwise lead to imprecise track reconstructions and detereorate the spatial resolution. For that reason, a proper correction is crucial for the detector performance.
For the CBELSA-TPC, a calibration system is planned, whose idea is adopted from the T2K experiment. Here, the calibration principle makes use of the photoelectric effect. With the help of laser light pulses which are coupled into the detector through optical fibre bundles, electrons are extracted from known positions on the cathode. The measurement of these electrons shows the integrated field distortions between anode and cathode.
The poster will present the optical setup with its components, a control system for the laser as well as the produced fibre profiles. Here, special attention is paid to a homogeneous illumination of the cathode.

HK 51.15 Thu 16:30 Zelt

Implementation of a MiniTAPS Trigger Board for the CBELSA/TAPS Experiment — •Lisa Richter, Annika Thiel, Janis Hoff, and Christian Honisch for the CBELSA/TAPS-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn

Baryon spectroscopy is performed with the CBELSA/TAPS experiment through the study of reactions that are produced with a photon beam impinging on a nucleon target. The detector setup is optimized for the production of neutral mesons which decay mainly in photons.
The MiniTAPS calorimeter is located in the forward region and is therefore one of the central parts of the detector system. It covers the forward angle between 1° and 12° and can capture photons with energies between 10 MeV and 2.0 GeV.
The detector consists of 216 hexagonal BaF_2 crystals which are read out via photomultiplier tubes. To avoid wrong information due to overlapping clusters, the crystals are arranged in four sectors and the number of hits in a sector in one event is determined by the trigger.
The new MiniTAPS trigger is currently developed to replace the old MCU (multiple coincidence unit) electronics. It will be realized by a single FPGA in a VME module. This will not only simplify the electronics but also allow for more sophisticated trigger algorithms including e.g. a fast cluster finder.
The new setup of the trigger and first results of the analysis will be presented on this poster.

HK 51.16 Thu 16:30 Zelt

Design Studies on cryopumps for $\overline{\text{P}}$ANDA at FAIR — •Christian Mannweiler, Daniel Klostermann, Benjamin Hetz, Daniel Bonaventura, and Alfons Khoukaz — Westfälische Wilhelms Universität, Münster, Deutschland

The $\overline{\text{P}}$ANDA experiment at the future HESR accelerator at FAIR will aim to explore open questions about the strong interaction, the existence of exotic particles as well as other topics by utilising anti-proton-proton collisions. For these studies, optimal vacuum conditions are crucial for event reconstruction, background suppression as well as antiproton beam lifetime.

To this end, novel cryopump geometries for a possible installation at the HESR beam pipe were studied and simulated. A cryopump employs a different operating principle from other conventional pumps such as turbo- or roots pumps. In a cryopump, a suitable medium such as activated charcoal is cooled to cryogenic temperatures of well below 20 K. At these temperatures atoms and even hydrogen molecules which impinge on the carbon surface are adsorbed without being desorbed later, creating a pumping mechanism.

Design studies were performed to identify a cryopump geometry which is suited best to $\overline{\text{P}}$ANDA's unique needs before simulating these pumps with the MOLFLOW+ software package.

These design studies as well as the obtained simulation results will be presented and discussed.

This project has received funding from BMBF (05P19PMFP1) and GSI F & E

HK 51.17 Thu 16:30 Zelt

Untersuchung der Beschleunigerstrahlqualität und -lebensdauer an COSY mit dem $\overline{\text{P}}$ANDA Cluster-Jet Target — •Hanna Eick, Philipp Brand, Benjamin Hetz, Daniel Klostermann und Alfons Khoukaz für die PANDA-Kollaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, 48149 Münster, Germany

Das interne, fensterlose $\overline{\text{P}}$ANDA Cluster-Jet Target der WWU Münster wird das *Phase-One* Target des im Aufbau befindlichen Antiprotonen Speicherings HESR der zukünftigen GSI/FAIR-Anlage sein. Mit einer Targetdichte von mehr als 2×10^{15} Atome/cm^2 ohne zeitliche Substrukturen und einem Abstand der Targetdüse von mehr als 2 m vom Wechselwirkungspunkt ist es für Experimente mit hoher Luminosität bestens geeignet. Von besonderem Interesse während der Test-Strahlzeiten an COSY sind Untersuchungen der Strahl-Target-Wechselwirkung. Besonderes Augenmerk wurde im August 2019 auf Messungen der Beschleunigerstrahlqualität und -lebensdauer in Verbindung mit dem $\overline{\text{P}}$ANDA Target und den ebenfalls an COSY installierten Elementen der stochastischen Kühlung des HESR gelegt. Einen Überblick über das $\overline{\text{P}}$ANDA Cluster-Jet Target und die im August 2019 durchgeführten Messungen an COSY werden im Rahmen dieses Posters präsentiert.
Dieses Projekt wurde durch das BMBF (05P19PMFP1) und das GSI F&E Programm gefördert.

HK 51.18 Thu 16:30 Zelt

Impact of Laval Nozzle Length on Properties of Cluster Beams — •Sophia Vestrick, Philipp Brand, Silke Grieser, and Alfons Khoukaz for the PANDA-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, 48149 Münster, Germany

The understanding of cluster formation processes within Laval nozzles is from highest interest for targets for high luminosity experiments, e.g. for the $\overline{\text{P}}$ANDA cluster-jet target with a thickness of more than 2×10^{15} atoms/cm^2 in a nozzle distance of > 2 m. One important parameter is the nozzle length. With a smaller nozzle length the typically challenging fabrication process becomes easier and therefore nozzles of higher quality can be produced.

The influence of the nozzle length on the cluster formation process and the quality of the resulting cluster beam were investigated at the $\overline{\text{P}}$ANDA cluster-jet target prototype at the University of Münster using a 35 μm nozzle by shortening its diverging outlet section. In comparison to these measurements, computational fluid dynamics (CFD) is used to simulate the gas flow through the used nozzle in dependence of different nozzle lengths and stagnation conditions. The results of these measurements and simulations together can give further insights into the cluster production process and an optimized nozzle length.

This project has received funding from BMBF (05P19PMFP1) and GSI F&E.

HK 51.19 Thu 16:30 Zelt

Mechanics of PANDA Backward End-Cap of the Electromagnetic calorimeter in the Phase 0 — •David Rodriguez Pineiro[1], Luigi Capozza[1], Alaa Dbeyssi[1], Alexander Greiner[1], Samet Katilmis[1], Frank Maas[1,2,3], Julian Moik[1], Oliver Noll[1], Paul Schöner[1], and Sahra Wolff[1,2] for the PANDA-Collaboration — [1]Helmholtz-Institut Mainz, Mainz, Germany — [2]Institute of Nuclear Physics, Mainz, Germany — [3]PRISMA Cluster of Excellence, Mainz, Germany

The PANDA experiment will be one of the key projects of the new accelerator facility FAIR in Darmstadt. With its mature detector system, it will be able to observe a variety of physical channels. Thus it will make a huge contribution to the understanding of the strong interaction. The electromagnetic process group (EMP) in Mainz is developing the backward end-cap (BWEC) of the electromagnetic calorimeter. This detector will be first installed at the Mainz Microtron facility (MAMI) for the Phase 0. Due to the lack of geometrical constraints around it a greater number of crystals will be used (640). Crystals will be mounted in submodules of 16 units, equipping them with 16, and 8 crystals assemblies which will be later used in the phase 1. Mass production for these components has been started. New cooling system will be developed which also will also serve as a test bench to be

optimized for Phase 1.

HK 51.20 Thu 16:30 Zelt

Optimierung eines Droplet Targets für kryogene Gase — •Christina Westphälinger, Daniel Bonaventura, Christian Mannweiler, Lana Söltzer und Alfons Khoukaz — Institut für Kernphysik, WWU Münster, 48149 Münster, Germany

Droplet Targets bieten für eine Vielzahl von Beschleunigerexperimenten in der Hadronen-, Leptonen- und Laserphysik eine interessante Alternative zu Gas- und Cluster-Jet Targets. Hierbei sind die Interaktionspunkte zwischen Beschleunigerstrahl und Target wegen der festen Dropletfrequenz und der kleinen lokalen Ausdehnung der Streuzentren individuell rekonstruierbar. Gleichzeitig ist eine hohe Dichte und damit eine hohe Ereignisrate vorhanden. Dazu wird mittels mikrometerfeiner Düsen und i.d.R. kryogen verflüssigten Gasen ein laminarer Flüssigkeitsstrahl aus z.B. Argon oder Wasserstoff erzeugt, der mittels erzwungener Düsenschwingungen im Vakuum zu Tröpfchen aufbricht und einen kontinuierlichen, periodischen Tröpfchenstrahl liefert. Die Optimierung des bestehenden Prototypen bezüglich einzelner Komponenten und Betriebsparameter im Hinblick auf Langzeitstabilität steht dabei im Vordergrund. Insbesondere werden beim verwendeten Düsensystem systematische Studien durchgeführt, um Düsenverstopfungen zu vermeiden. Des Weiteren werden Droplet-Beleuchtung und optische Auswertung optimiert. Der aktuelle Stand des Targetaufbaus sowie die Eigenschaften der erzeugten Droplets werden im Folgenden dargestellt und diskutiert. Dieses Projekt wurde mit Mitteln des EU Horizon 2020 Forschungs- und Innovationsprogramms No 824093 gefördert.

HK 51.21 Thu 16:30 Zelt

SONIC III - The improved particle spectrometer for particle-gamma experiments at the Cologne Tandem accelerator — •Florian Kluwig, Anna Bohn, Vera Everwyn, Michelle Färber, Miriam Müscher, Sarah Prill, Philipp Scholz, Max Steffan, Michael Weinert, Julius Wilhelmy, and Andreas Zilges — Institute for Nuclear Physics, University of Cologne

The particle spectrometer SONIC [1] at the 10 MV FN-Tandem accelerator of the University of Cologne has been continuously enhanced in the last years. In its recent and third version, SONIC consists of 12 silicon detectors which can be mounted as single detectors or ΔE-E telescopes, and reaches a total solid angle coverage of 9%. Combined with the γ-ray detector array HORUS [2], particle-γ coincidence measurements are performed to investigate inelastic scattering or transfer reactions in a wide mass region. In this contribution, SONIC III and recent experimental campaigns will be presented.

A.B. and M.S. are supported by the Bonn-Cologne Graduate School for Physics and Astronomy.

[1] S. G. Pickstone *et al.*, Nucl. Instr. and Meth. A **875** (2017) 104
[2] L. Netterdorn *et al.*, Nucl. Instr. and Meth. A **754** (2014) 94

HK 51.22 Thu 16:30 Zelt

Development of a HPGe-BGO Pair Spectrometer for ELI-NP — •Ilja Homm and Thorsten Kröll — Technische Universität Darmstadt, Germany

The new European research facility called ELI-NP (The **E**xtreme **L**ight **I**nfrastructure - **N**uclear **P**hysics) is being built in Bucharest-Magurele, Romania. ELI-NP will offer unprecedented opportunities for photonuclear reactions with high intensity, brilliant and fully polarized photon beams at energies up to 19.5 MeV.

The 8 HPGe CLOVER detectors of ELIADE are important instruments for the gamma spectroscopic study of photonuclear reactions. We investigate the possibility to operate an advanced version of an anti-Compton shield (AC shield) as escape γ-rays pair spectrometer for one of the ELIADE CLOVERS. This should improve the performance at high energies where the pair production process dominates. The BGO shield operated as a stand-alone device can also be used as intensity monitor and to investigate the cross section for pair production near the threshold. The main tasks are to develop and test such an AC shield consisting of BGO crystals with SiPM (silicon photomultiplier) readout. The results of prototype testing are reported. First measurements with high energy photons are planned for 2020.

This work is supported by the German BMBF (05P15RDENA) and the LOEWE-Forschungsschwerpunkt "Nukleare Photonik".

HK 51.23 Thu 16:30 Zelt

Dead region correction of HPGe detectors in Geant4 — •Markus Müllenmeister, Jan Mayer, Philipp Scholz, and Andreas Zilges — Institute for Nuclear Physics, University of Cologne

Dead regions can develop in HPGe detectors over time. For the nearly 20 year old coaxial detectors of the SONIC@HORUS spectrometer [1], we assume that the efficiency loss can be modeled by a cylindrical inactive region around the inner contact, as the inner contact poses a greater chance of introducing defects into the detecting crystal volume.

Geant4 simulations with varying thickness of the inactive zone were conducted in G4Horus [2]. The differences from the calibration data were compared via the χ^2-method.

It was found that the cylindrical inactive region reproduces experimental data very well. The changes for this adaptation of the detectors is minuscule and easy to implement in existing simulations. The inclusion of inactive regions should be considered for simulations of older detectors.

[1] S. G. Pickstone *et al.*, Nucl. Instr. and Meth. A 875 (2017) 104
[2] J. Mayer, https://gitlab.ikp.uni-koeln.de/jmayer/g4horus

HK 51.24 Thu 16:30 Zelt

Recent development of the LED based monitoring system for CALIFA CALorimeter for In flight detection of γ rays and high energy charged pArticles — •Christian Sürder, Anna-Lena Hartig, Alexander Ignatov, Thorsten Kröll, and Han-Bum Rhee for the R3B-Collaboration — Institut für Kernphysik, Technische Universität Darmstadt, Darmstadt, Deutschland

CALIFA is part of the R^3B setup of the future FAIR facility. The used detector units consisting out of an Avalanche Photo Diode and a CsI(Tl) scintillation crystal. With these detector units it is possible to built a high resolution calorimeter, which is insensitive to present magnetic fields. It is common to monitor the properties of a calorimeter with a corresponding monitoring system. For CALIFA it was decided to implement a LED based monitoring system, which delivers a light pulse via plastic optical fibers to monitor the detection process starting from the scintillation crystal. To have control over the LED source, a reference system with a detector and a standard radioactive source runs alongside. The recent status and the developments of this system will be presented.

HK 51.25 Thu 16:30 Zelt

Event identification electronics for low count-rate thermal neutron proportional counters — •Benjamin Brauneis[1], Jannis Weimar[1], Markus Köhli[1,2], and Ulrich Schmidt[1] — [1]Physikalisches Institut, Heidelberg University, Germany — [2]Physikalisches Institut, University of Bonn, Germany

Thermal neutron proportional counters are used in low-count rate environments such as experimental halls for monitoring the beam luminosity or the cosmic-ray induced environmental radiation. However, in order to provide substantially good statistics, such instruments have to be large. This makes gaseous detectors susceptible to background like protons, (Compton) electrons, gammas, myons and nuclear fragments which are emitted from the wall material. Furthermore, due to the helium-3 crisis the baseline technology shifted towards boron-lined detectors, which have an energy spectrum continuously extended downwards to 0 eV. An event from thermal neutron conversion, however, can be distinguished from non-signal events by the drift time characteristics of the ionization track in the gas. Within the COSMIC Sense collaboration we are developing readout electronics for large-scale neutron detectors based on microcontrollers which act as digitizers as well as a triggered data acquisition. The frontend features a pulse-shape analysis for signal height and time over threshold including rise time discrimination using the built-in 10 bit analog-to-digital converter. We present the current status of the frontend electronics DAQ and measurements of the separation efficiency for this readout.

HK 51.26 Thu 16:30 Zelt

Installation of CALIFA@R3B (GSI) — •Han-Bum Rhee, Anna-Lena Hartig, Noel Merkel, Thorsten Kröll, and Christian Sürder for the R3B-Collaboration — Institut für Kernphysik, Darmstadt,Germanny

CAIFA is a part of the R3B experiment at GSI and the future FAIR facility. It is a calorimeter and spectrometer that aims to detect gamma rays and light charged particles. CALIFA is divided into a cylindrical barrel and a forward endcap. The forward endcap comprises two distinct detection systems: iPhos and CEPA. The CALIFA barrel and iPhos consist of 2464 CsI(Tl) scintillating crystals, which are individually read out with Avalanche Photodiodes (APDs).

As first versions of CALIFA, the collaboration has built demonstrator arrays and has done several campaigns with these. In preparation of the second FAIR-Phase0 campaign in 2020, the crystals are mounted

on the final CALIFA frame and this frame is now located in R3B setup.

Before assembly of the detectors, the temperature dependency on the gain of the APDs was tested. The assembled detector units were characterized regarding the light-output non-uniformity and the energy resolution.

This work is supported by German BMBF(05P15DFN1,05P19RDFN1), HIC for FAIR and GSI-TU Darmstadt cooperation contract.

HK 51.27 Thu 16:30 Zelt

Cold Field Emission Electron Source for the PUMA Ion Trap — •Jonas Fischer and Noritsugu Nakatsuka for the PUMA-Collaboration — TU Darmstadt, Darmstadt, Germany

The goal of the PUMA (antiProton Unstable Matter Annihilation) experiment is to investigate the neuron and proton density distribution in short-lived nuclei. This is to be achieved by the annihilation of antiprotons with the outermost nucleons of the nucleus. To make these measurements possible, one has to transport antiprotons to a radioactive ion beam facility. PUMA will first collect antiprotons at the AD (Antiproton Decelerator) and then transport them to the radioactive ion beam facility ISOLDE at CERN. For the storage of the antiprotons and the collision with the nuclei a cryogenic Penning trap is being designed and built. Approximately one billion antiprotons will be stored in the trap, but since their energy will be to high to keep them in the trap for a sufficiently long time, they will be cooled by means of sympathetic cooling using electrons. To create a sufficient amount of electrons without introducing an additional heat load, a cryogenic field emission electron source will be incorporated into the trap system. In this contribution the design and test of such an electron source will be presented. This contribution is supported by ERC-COG through grand no. 726276.

HK 51.28 Thu 16:30 Zelt

Towards the PUMA pion tracker — •Sabrina Zacarias for the PUMA-Collaboration — Institut für Kernphysik, TU Darmstadt

The PUMA project (antiProton Unstable Matter Annihilation) aims at using low energy antiprotons to probe the tail of the radial density of short-lived nuclei. With PUMA, the ratio of proton and neutron annihilations after capture will be determined, giving access to a new observable to quantify the ratio of proton to neutron densities at the nuclear periphery. To accomplish it, PUMA aims at transporting one billion low-energy antiprotons (produced at CERN/ELENA) to the CERN/ISOLDE facility where short-lived nuclei are produced. In the poster, the detection system (consisting of a time projection chamber and a trigger barrel) and the readout electronics development will be detailed.

HK 51.29 Thu 16:30 Zelt

Optics Study for Differential Pumping and Beaming Cancellation for PUMA — Audric Husson, •Clara Klink, and Alexandre Obertelli for the PUMA-Collaboration — TU Darmstadt, Darmstadt, Germany

The PUMA (AntiProton Unstable Matter Annihilation) project at CERN focuses on observing the ratio of neutrons to protons in the nuclear density tail of exotic nuclei using antiprotons. The antiprotons will be accumulated at the deceleration ring ELENA, where up to one billion antiprotons will be trapped and stored in the Penning trap of PUMA, and then transported to ISOLDE. At ISOLDE, annihilations between the antiprotons and nucleons in the nuclear density tail are investigated. The antiproton storage trap operates at extreme high vacuum (XHV). PUMA requires a vacuum of 10^{-11} mbar at the entrance of the device. A differential pumping is needed to isolate PUMA from the ISOLDE beam line at approx. 10^{-6} mbar. The beaming effect of the differential pumping system shapes the residual gas velocity towards the beam line direction and therefore increases the flux of neutral particles towards the PUMA trap. This effect has to be cancelled to reduce the amount of residual gas entering the PUMA trap and to avoid unwanted annihilations of antiprotons with neutral particles. In this poster, preliminary beam-optics simulations for a differential pumping section of the beam line designed to reduced beaming of neutral particles are presented.

HK 51.30 Thu 16:30 Zelt

Geometry Optimization of a Scintillation Detector for Detection of Cosmic Air Showers — •Sven Peter, Hans-Georg Zaunick, Markus Moritz, Lukas Nies, Marvin Peter, and Kai-Thomas Brinkmann — II. Physikalisches Institut, JLU Gießen

The geometry of a plastic scintillator for the detection of air showers was optimized using a Geant4 simulation with explicit treatment of optical photons. Starting from a rectangular shape of the scintillator, the corners were cut-off at various angles relative to the short sides of the rectangle. A SiPM at one of the short sides of the rectangle was used as a read-out. A teflon wrapping was simulated using the GODDeSS extension for Geant4. To study the spatially resolved efficiency, minimum ionizing muons that traverse the scintillator at various positions were simulated.

For certain configurations of the cut-off angles, the effect of the reduced scintillator area was overcompensated by the increased light yield due to a focusing effect. A muon detection efficiency of 84% was reached. The spatial homogeneity of the detection efficiency was improved as well. The well-known positive effect of silicone oil as optical coupling between scintillator and the SiPM could be quantified. It doubles the number of detected photons. Furthermore, the light collections efficiency with roughened surfaces was found to be 10 to 15% lower than the efficiency of a perfectly polished one.

HK 51.31 Thu 16:30 Zelt

Photon interaction position determination in monolithic scintillators via Neural Network algorithms — •Maria Kawula[1], Tim Binder[1,2], Silvia Liprandi[1], Katia Parodi[1], and Peter G. Thirolf[1] — [1]Ludwig-Maximilians-Universität München — [2]KETEK GmbH München

Monolithic scintillators are an attractive alternative to pixelated crystals as a part of multiple-component photon detectors like Compton cameras. We propose a novel algorithm for determining the position of γ-ray interactions in a monolithic scintillation crystal, based on Supervised Machine Learning involving Convolutional Neural Networks (CNN). The new method is an alternative to well-established algorithms such as "k-Nearest Neighbours" (kNN), which suffers from long computation time and high memory requirements. Two crystals, $LaBr_3$:Ce and $CeBr_3$, of size 50 mm×50 mm×30 mm were examined. The spatial resolution of the CNN algorithms was tested for three energies of the initial γ quanta: 662 keV (^{137}Cs), 1.17 MeV and 1.33 MeV (^{60}Co). A spatial resolution of the algorithm of 1.04 ($\pm$0.04 stat. $\pm$ 0.2 sys.) mm at 662 keV and 0.90 ($\pm$0.02 stat. $\pm$ 0.2 syst.) mm at 1.3 MeV for $LaBr_3$:Ce and $CeBr_3$, respectively, was achieved. The new reconstruction scheme is compatible with CPUs and GPUs and can reconstruct up to $2 \cdot 10^4$ events/s, which is four orders of magnitude faster than the kNN. Memory requirements are reduced by $\approx$1/1000. This work was supported by the DFG Cluster of Excellence MAP (Munich Centre for Advanced Photonics) and the Bayerische Forschungsstiftung.

HK 51.32 Thu 16:30 Zelt

HI-TREX - A highly integrated Setup for Transfer experiments at REX-HIE-ISOLDE — •Christian Berner — Technische Universität München - Nukleare Astrophysik, 85748 Garching, Deutschland

HI-TREX is the acronym for a highly integrated setup for transfer experiments at REX-HIE-ISOLDE. HI-TREX is the upgraded successor of TREX. As there is a close interplay between a detector and its electronics, the main upgraded components feature two basic developments going hand-in-hand with each other: The silicon detector upgrade and the accompanying custom made electronics. For the first part, the newly developed, very thin, AC-coupled DSSSDs are a technological novelty and many efforts have been made in meeting the specifications. A concept for a triple-stack detector setup has been evaluated, enabling a two-fold energy sampling and thus extending the partidle-identification capabilities. As for the electronics part, the integration of the custom-made ASICs SKIROC has been done successfully by the GEneric Asic Readout board GEAR, which was developed within this work. The back-end integration, as well as the development of any peripheral components resulted in a working prototype for the full HI-TREX setup.

HK 51.33 Thu 16:30 Zelt

A superfluid liquid helium target for low-momentum electron scattering experiments at the S-DALINAC — •Michaela Hilcker, Jonny Birkhan, Antonio D'Alessio, Tobias Klaus, Peter von Neumann-Cosel, Norbert Pietralla, Maxim Singer, and Gerhart Steinhilber — Institut für Kernphysik, TU Darmstadt

At the Institute for Nuclear Physics of the TU Darmstadt, high-resolution inelastic electron scattering is used to investigate the nuclear structure at low momentum transfers. The QCLAM spectrometer, one

of the two large magnetic spectrometers, is used to determine the momentum of the scattered electrons.

We plan to perform an electron scattering experiment at low momentum transfer to investigate the first excited 0^+ state of ^{4}He, since previous experiments [1] deviate strongly from current 'ab initio' calculations in chiral EFT [2], and also the longitudinal response function at excitation energies above 22 MeV, since the effect of 3 body forces is particularly visible there. The use of superfluid helium as target material is necessary to obtain sufficiently good statistics and to keep experimental uncertainties of the target density under control. A suitable setup will be presented and the results of a commissioning experiment [3] will be shown.

[1] T. Walcher, Phys. Lett. B **31**, 442 (1970).
[2] S. Bacca, N. Barnea, W. Leidemann, and G. Orlandini, Phys. Rev. Lett. **110**, 042503 (2013).
[3] M. Hilcker et al., submitted to Nucl. Instrum. Methods (2019).
Funded by the Deutsche Forschungsgemeinschaft - SFB 1245.

HK 51.34 Thu 16:30 Zelt

Development of detector read-out electronics for the P2 experiment at MESA — Sebastian Baunack[1], Michael Gericke[3], Kathrin Imai[1], •Rahima Krini[1], Werner Lauth[1], Frank Maas[1,2], David Rodriguez Pineiro[2], and Malte Wilfert[1] — [1]Institute for Nuclear Physics, Mainz, Germany — [2]Helmholtz Institute Mainz, Germany — [3]University of Manitoba, Canada

The Mainz Energy recovering Superconducting Accelerator (MESA) is being built at the Institute for Nuclear Physics in Mainz. At MESA the P2 experiment is planned for a precision measurement of the weak mixing angle. The upcoming measurement of MESA-P2 will be one of the most challenging and most precise experiments of a parity violating asymmetry in electron scattering of order $20{\cdot}10^{-9}$ with a relative uncertainty of $\frac{\Delta A^{PV}}{A^{PV}} \approx 2.41\%$.

The Cherenkov ring detector consist of fused silica bars equipped with photomultiplier tubes with high quantum efficiency. The challenge is to control the integrating detector signal chain and all sources of electronics noise within the whole experimental P2 set-up. The first prototype is developed and first tests at the MAMI accelerator were performed. This allows for a determination of the weak mixing angle with an accuracy of 0.15% and a test for new physics up to a mass scale of 49 TeV.

HK 51.35 Thu 16:30 Zelt

Precision Stabilization of KATRIN's Retarding Potential — •Caroline Rodenbeck[1], Julius Hartmann[3], Thomas Thümmler[2], and Sascha Wüstling[3] for the KATRIN-Collaboration — [1]Institut für Kernphysik, WWU Münster — [2]IKP, Karlsruher Institut für Technologie — [3]IPE, Karlsruher Institut für Technologie

The Karlsruhe Tritium Neutrino (KATRIN) experiment aims to determine the neutrino mass by measuring the tritium beta spectrum using a MAC-E filter type spectrometer. The spectrometer's energy defining retarding voltage needs to be stable within 60 mV for KATRIN to reach its sensitivity target of $0.2\,\mathrm{eV/c^2}$ (90% C.L.). This translates to a stability requirement of 3 ppm for the high voltage system creating the retarding potential of −18.6 kV inside the spectrometer.

KATRIN's high voltage system meets these stability requirements on a wide range of time scales ranging from several months down to $1\,\mu$s (1 MHz). Dedicated calibration methods ensure a long-term stability of the precision high voltage dividers, measuring the retarding potential. A stabilization on shorter time scales is ensured by a custom-built post regulation system. With a new feedback loop between one of the precision high voltage dividers and the post regulation a sub-ppm stabilization of the retarding potential for longer than 30 hours is achieved.

The poster will give an overview of KATRIN's high voltage system with a focus on the post regulation and its perfomance during the recent KATRIN neutrino mass runs. This project is supported by BMBF under contract number 05A17PM3.

HK 51.36 Thu 16:30 Zelt

Prototype of the Detector Control System for the mSTS/mCBM experiment — •Marcel Bajdel for the CBM-Collaboration — Goethe University Frankfurt am Main

One of the major steps towards completion of the STS (Silicon Tracking System) construction in the CBM (Compressed Baryonic Matter) experiment at FAIR is the mCBM (mini-CBM) experiment which is considered as a FAIR Phase-0 activity. The mCBM experiment aims to test and optimize the performance of the detector subsystems including the software and hardware aspects. The Detector Control System (DCS) is a crucial part of the whole system which enables the supervision over a large range of devices and observables including high voltage, low voltage power supplies, cooling thermostats and environment sensors. Moreover, the DCS allows for error and alarm recognition and handling, as well as archives operational parameters of the detector. To realize this task many advanced solutions are being used including EPICS (Experimental Physics and Industrial Control System), Control System Studio and Docker. An overview on the prototype of the detector control system for mSTS detector, which will be scaled upfor the STS detector, will be presented.

HK 51.37 Thu 16:30 Zelt

Evaluation and test of the CBM-TRD readout-ASIC at the DESY testbeam facility. — •Dennis Spicker for the CBM-Collaboration — Institut für Kernphysik Frankfurt, Goethe-Uni-Frankfurt, Max-von-Laue-Straße 1, 60438 Frankfurt

At the future Facility for Antiproton and Ion Research (FAIR) the Compressed Baryonic Matter experiment (CBM) is supposed to measure particles from heavy-ion collisions at very high interaction rates. For this purpose, the data acquisition will run in a free-streaming mode without an hierarchical trigger system. For the Transition Radiation Detector (TRD), which will provide tracking and particle identification information, the readout system is based on the Self-triggered Pulse Amplification and Digitization ASIC (SPADIC). It features a charge-sensitive Amplifier, a continuously sampling ADC, a programmable digital filter and a hit detection logic. The latest version is SPADIC 2.2, which was submitted in early 2019. It introduces new switchable features such as a low-gain mode, an additional shaping order and digital baseline tracking.

In August 2019, test measurements were performed at the Deutsches Elektronen-Synchrotron (DESY) with two TRD readout-chambers, equipped with SPADIC 2.2 ASICs, mounted on prototype single-chip front-end boards. In an electron beam with a momentum of 1 to 4 GeV/c, among other measurements also the new features of the SPADIC have been tested and results will be presented in this contribution. Supported by the German BMBF-grants 05P15RFFC1 and 05P19RFFC1.

HK 52: Poster (b)

Time: Thursday 16:30–18:30 Location: Grotte

HK 52.1 Thu 16:30 Grotte

Improving the precision of the hypertriton binding energy by pion spectroscopy — •Pascal Klag[1], Patrick Achenbach[1], Philipp Eckert[1], Toshiyuki Gogami[2], Philipp Herrmann[1], Masashi Kaneta[3], Sho Nagao[3], Satoshi Nakamura[3], Josef Pochodzalla[1], and Yuichi Toyama[3] — [1]Johannes Gutenberg-Universität Mainz — [2]Kyoto University, Kyoto — [3]Tohoku University, Sendai

A precise binding energy measurement of hypertriton $^3_\Lambda$H is planned for the near future at MAMI. Currently the precision is limited by the absolute momentum calibration of the decay-pion spectrometers. Presently this limitation is caused by the uncertainty of the absolute beam energy of $\delta E_{beam} = 160\,\mathrm{keV}$. For the hypertriton experiment two independent high precision beam energy measurements are under development. For one method a dipole of the beam-line leading to the spectrometer facility is used as a high-accuracy beam spectrometer. It is based on an acurate field map and precise monitoring of the beam trajectory. Secondly, a method based on undulator radiation interferometry is in development which is optimized for the lower energy range.

Supported by DFG (PO 256/7-1)

HK 52.2 Thu 16:30 Grotte

Development and beam test of a high luminosity lithium target at MAMI — •Philipp Herrmann[1], Patrick Achenbach[1], Toshiyuki Gogami[2], Philipp Eckert[1], Masashi Kaneta[3], Pascal Klag[1], Sho Nagao[3], Satoshi Nakamura[3], Josef Pochodzalla[1], and Yuichi Toyama[3] — [1]Johannes Gutenberg-Universität Mainz — [2]Kyoto University, Kyoto — [3]Tohoku University, Sendai

One of the near future goals of the strangeness nuclear physics program at Mainz is a precise binding energy measurement of hypertriton ${}^{3}_{\Lambda}$H. Detailed simulations show that lithium is the optimal target nucleus for this experiment. To reach a high luminosity and to minimize energy straggling of outgoing pions, the target is 50 mm long in beam direction and 1 mm wide. To withstand the heating by a 10 μA beam current, the target was embedded in a cooling system. Such a target system was successfully tested under these beam conditions.

Supported by DFG (PO 256/7-1)

HK 52.3 Thu 16:30 Grotte

Exploring the ^{12}C$(e, e'\pi^+\pi^+)$ and ^{12}C$(e, e'p\,\pi^+)$ reactions at the A1 multi-spectrometer facility at MAMI — •Philipp Eckert[1], Toshiyuki Gogami[2], Masashi Kaneta[3], Sho Nagao[3], Satoshi Nakamura[3], and Yuichi Toyama[3] — [1]Johannes Gutenberg-Universität Mainz — [2]Kyoto University — [3]Tohoku University, Sendai

Within the past years the chart of observed nuclides was continuously extended to more extreme proton-to-neutron ratios. For a further high resolution study of especially neutron rich nuclei, a new experimental method via electron scattering was explored at the Mainz Mikrotron. This method includes the missing mass spectroscopy of the reactions ^{12}C$(e, e'\pi^+\pi^+)$ and ^{12}C$(e, e'p\,\pi^+)$, where the three spectrometer facility of the A1 Collaboration and the precise MAMI beam energy would allow a yet unprecidented missing mass resolution of around 100 keV/c^2.

We will present the results of a test experiment performed at MAMI.

HK 52.4 Thu 16:30 Grotte

Proton Time-Like Electromagnetic Form Factor Measurement with the Scan Method at BESIII — •Christoph Rosner[1], Yadi Wang[1], Samer Ali Nasher Ahmed[1], Alaa Dbeyssi[1], Paul Larin[1], Dexu Lin[1], Frank Maas[1,2,3], and Cristina Morales[1] — [1]Helmholtz-Institut Mainz, 55128 Mainz, Germany — [2]Institute of Nuclear Physics, Mainz, Germany — [3]PRISMA Cluster of Excellence, Mainz, Germany

Electromagnetic form factors (FF) provide valuable insight to the internal structure and dynamics of the proton. While they are well known in the space-like region through electron scattering experiments, the time-like region, typically accessed by annihilation experiments, is known with much less precision. Specifically the separation of the electric and magnetic FF has only been possible with low accuracy due to the low luminosity of previous data.

This contribution reports on the analysis based on 688.5 pb^{-1} of data taken at 22 energy points between 2.0 and 3.08 GeV with the Beijing Spectrometer III (BESIII) at the Beijing Electron Positron Collider II (BEPCII). The born cross section of $e^+e^- \to p\bar{p}$ is measured with the energy scan technique for the first time. Additionally, the absolute value of the proton electric and magnetic FF as well as their ratio are measured with high accuracy by analysing the helicity angular distribution of the outgoing protons.

HK 52.5 Thu 16:30 Grotte

Radiative corrections in proton-antiproton annihilation to electron-positron and their application to the PANDA experiment — •Alaa Dbeyssi[1], Manuel Zambrana[1], Frank Maas[1,2,3], Egle Tomasi-Gustafsson[4], Yuri M. Bystritskiy[5], Vladimir A. Zykunov[5], Samer Ahmed[1], Luigi Luigi[1], Oliver Noll[1], David Rodriguez Pineiro[1], and Sahra Wolff[1] — [1]Helmholtz-Institut Mainz, Germany — [2]Institute of Nuclear Physics, Johannes Gutenberg University, Mainz, Germany — [3]Prisma Cluster of Excellence, Mainz, Germany — [4]CEA, IRFU, SPhN, Saclay, France — [5]Joint Institute for Nuclear Research, Dubna, Russia

The precise measurements of the time-like electromagnetic form factors of the proton, expected at the future PANDA experiment via the reaction $\bar{p}p \to e^+e^-$, require to take into account radiative corrections. In this work, first order radiative corrections to the reaction $\bar{p}p \to e^+e^-$ are calculated in the proton point-like approximation, including virtual and real photon emission. Soft and hard photon emission regimes are covered in the calculation. A Monte Carlo event generator is developed on the basis of the calculated radiative cross section and its application to the PANDA experiment is illustrated.

HK 52.6 Thu 16:30 Grotte

Gas gain measurements for the CBM-TRD MWPCs — •Isabel Kuhn for the CBM-Collaboration — Institut für Kernphysik, Uni Frankfurt

The Compressed Baryonic Matter (CBM) experiment at the Facility for Antiproton and Ion Research (FAIR) in Darmstadt will allow the investiga- tion of the phase diagram of Quantum Chromodynamics (QCD) at high net- baryon densities with unprecedented precision. Part of the detector setup will be a Transition Radiation Detector (TRD) The TRD will be composed of an irregular foam radiator and a Multi Wire Proportional Chamber (MWPC).It is part of the track reconstruction concept of CBM and will deliver particle identification, mainly providing the electron and pion separation capabilities at high particle momenta. A precise knowledge of the gas gain is an important factor in the opti- misation of the detector performance. Thus, a prototype MWPC with the given geometrical configuration was build for thes investigations. This poster will review the production of the prototype and the procedure of the gas gain measurement. Finally, the results of the measurement with different gas mixtures at high voltage settings will be presented. Supported by the German BMBF-grant 05P19RFFC1

HK 52.7 Thu 16:30 Grotte

Femtoscopic study of the lambda-deuteron interaction in pp collisions at 13 TeV — •Michael Jung for the ALICE-Collaboration — Goethe Universität Frankfurt

A study of the lambda-deuteron interaction using femtoscopic methods in high-multiplicity pp collisions at 13 TeV will be presented. This interaction is in particular important to understand the properties of the hypertriton, a bound state made of a lambda and deuteron. With the good momentum resolution and particle identification capabilities of the ALICE experiment at the CERN LHC, a so called correlation function can be measured. Since this function depends on the two particle wave function, the potential of the interacting particles can be determined using comparisons to theoretical models. In this poster, the femtoscopy technique and the status of the analysis will be presented.

HK 52.8 Thu 16:30 Grotte

Beta-gated gamma spectroscopy using GALILEO detector system — •Arzoo Sharma[1,7], J. Gerl[1], M. Gorska-Ott[1], H. M. Albers[1], I. Kojouharov[1], H. Schaffner[1], A. Mistry[1,2], Nicolas J. Hubbard[1,2], T. Arici[1], A. Banerjee[1], E. Sahin[1,2], S. Alhomaidhi[1,2], M. Polettini[3,4], A. Yaneva[1,5], R. Palit[6], and Pushpendra P. Singh[7] — [1]GSI Helmholtzzentrum für Schwerionenforschung, Plackstrasse 1, Darmstadt, 64291, Germany — [2]TU Darmstadt, Karolinenpl. 5, Darmstadt, 64289, Germany — [3]Università degli Studi di Milano, Via Festa del Perdono, 7, Milano MI, 20122, Italy — [4]INFN, Sezione di Milano, 20133, Italy — [5]Sofia University, "St. Kliment Ohridski", bul. "Tsar Osvoboditel" 15, 1504, Sofia, Bulgaria — [6]TIFR, Homi Bhabha Road, Colaba Mumbai 400005, India — [7]Dept. of Physics, IIT Ropar, Rupnagar, Punjab-140001, India

The goal of DEcay SPECtroscopy (DESPEC) experiments is to study the decay of a nucleus of interest. The experimental set-up at GSI comprises FRS (Fragment Separator), AIDA DSSDs (Double-Sided Silicon Strip Detector), bPlast (plastic scintillator detector), FATIMA (FAst TIMing Array of Lanthanum Bromide detectors) and an array of GALILEO triple cluster detectors (3 HPGe crystals each). The nuclei of interest are implanted in AIDA and their decay is studied. A DESPEC beam commissioning run has been performed with 40Ar primary beam at 300MeV/U energy and secondary beam of 34Si produced via fragmentation. The beta decay of 34Si has been used in this test. The first test results of performance of the GALILEO detectors will be presented.

HK 52.9 Thu 16:30 Grotte

Characteristics of background electrons due to radioactive decays in the KATRIN spectrometers — •Dominic Hinz for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT), Institute for Nuclear Physics (IKP)

The Karlsruhe Tritium Neutrino (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. 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 is currently limited by a higher than anticipated background. Dedicated commissioning measurements showed that the sensitivity is affected by background electrons which are correlated to radioactive decays. Therefore, an understanding of the remaining background processes induced by radioactivity is of high relevance.

This poster focuses on background events due to radioactive decays in the KATRIN spectrometers and its impact on neutrino mass analysis.

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).

HK 52.10 Thu 16:30 Grotte

Avoiding anomalies — •Klaus Morawetz — Münster University of Applied Sciences,Stegerwaldstrasse 39, 48565 Steinfurt, Germany — International Institute of Physics- UFRN,Campus Universitário Lagoa nova,59078-970 Natal, Brazil

The quantum anomaly can be written alternatively as conservation-breaking term or as non-gauge invariant current. This is exemplified on the anomalous term $\sim \vec{E}\vec{B}$ in the balance of the chiral density. This term is derived from the quantum kinetic equations for systems with SU(2) structure within a completely conserving approach. Therefore the origin of this term is not a unique signal of symmetry-breaking terms in the field-theoretical Lagrangian. By reinterpreting the many-body averaging the connection to Pauli-Villars regularization is established which gives the anomalous term a new interpretation as arising from quantum fluctuations at short distances. A proper balance of these fluctuations by many-body effects on the same level avoids these anomalies. The origin of the $\sim \vec{E}\vec{B}$ is therefore proposed not due to anomalies but as a completely conventional quantum kinetic effect. [Eur. Phys. J. B 92 (2019) 176, Phys. Lett. A 383 (2019) 1362]

HK 52.11 Thu 16:30 Grotte

Determination of beam intensities from proton scattering experiments between 2 MeV and 15 MeV — •Marco Menen, Felix Heim, Sarah Prill, Philipp Scholz, Michael Weinert, and Andreas Zilges — Institute for Nuclear Physics, University of Cologne

Cross section measurements are of great importance for nuclear astrophysics and our understanding of the structure of atomic nuclei. At the University of Cologne, we use two different target chambers dedicated to special types of experiments: The particle-γ spectrometer SONIC@HORUS is used to examine nuclear structure and determine branching ratios, while the target chamber dedicated for nuclear astrophysics is used to measure cross sections for astrophysically important nuclear reactions. Both target chambers will be presented with focus on their ability to determine precisely the number of impinging particles, which are needed to calculate absolute cross sections.

Supported by the DFG (ZI 510/9-1).

HK 52.12 Thu 16:30 Grotte

Ongoing investigation of a new Doppler-shift attenuation-approach to determine nuclear-level lifetimes — •Anna Bohn, Vera Everwyn, Michelle Färber, Florian Kluwig, Miriam Müscher, Sarah Prill, Philipp Scholz, Michael Weinert, Julius Wilhelmy, and Andreas Zilges — Institute for Nuclear Physics, University of Cologne

The Doppler-shift attenuation-method is a well-established technique to determine nuclear-level lifetimes in the range of sub-picoseconds. Such experiments are performed at the combined detector array SONIC@HORUS at the 10 MV FN-Tandem accelerator in Cologne, which provides complete knowledge of the reaction kinematics via particle-γ coincidences [1-3].

An alternative analyzing technique has been tested where the entire data set is Doppler corrected by assuming different values for the attenuation factor $F(\tau)$, which connects the lifetime τ to the observed energy shift of the de-exciting γ-ray. The optimal attenuation factor, which minimizes the Doppler broadening of the analyzed γ peak, yields the lifetime. This procedure uses summed up statistics and thus might be more efficient for weakly excited states. First results on ^{130}Te are in good agreement with known level lifetimes. Further tests to benchmark the new technique are planned.

Supported by DFG (ZI 510/9-1). A.B. is supported by the BCGS.

[1] A. Hennig *et al.*, Nucl. Instr. and Meth. A **794** (2015) 171
[2] M. Spieker *et al.*, Phys. Rev. C **97** (2018) 054319
[3] S. G. Pickstone *et al.*, Nucl. Instr. and Meth. A **875** (2017) 104

HK 52.13 Thu 16:30 Grotte

Antihyperons in nuclei at PANDA day-1 — •Falk Schupp[1], Sebastian Bleser[1], Marcell Steinen[1], Michael Bölting[1], Josef Pochodzalla[1,2], and Patrick Achenbach[1,2] — [1]Helmholtz-Institut Mainz — [2]Institut für Kernphysik, Universität Mainz

The exclusive production of hyperon-antihyperon pairs close to their production threshold in $\bar{p}$-nucleus collisions offers a unique and hitherto unexplored opportunity to elucidate the behavior of antihyperons in nuclei. Calculations find a substantial sensitivity of the transverse momentum correlations of coincident $\Lambda\bar{\Lambda}$-pairs to the assumed depth of the $\bar{\Lambda}$-potential. [Lorente et al., Phys. Lett. B 749 (2015) 421]

The facility for antiproton and ion research (FAIR) currently under construction in Darmstadt, Germany will offer a high quality, high luminosity $\bar{p}$-beam to be used in experiments. Starting from 2026 the PANDA experiment at FAIR will begin with its "day-1" setup where a partial setup of the detector and reduced luminosity will be available. Because of the high cross section for the process and the simplicity of the experimental method the "day-1" setup can be used to measure these momentum correlations.

We present our current feasibility study of the event reconstruction for the reaction $\bar{p} +^{20} Ne \rightarrow \Lambda\bar{\Lambda}$ close to production threshold in the PANDA "day-1" setup. The GiBUU framework is used to simulate the primary interaction and GEANT4/GENFIT2 for propagation, tracking and reconstruction. The detector efficiency and resolution are being studied and the observable momentum correlations calculated.

HK 52.14 Thu 16:30 Grotte

Has the $^{4}_{\Lambda\Lambda}$n been observed? — Sebastian Bleser[1], •Michael Bölting[1], Theodoros Gaitanos[2], Josef Pochodzalla[1,3], Falk Schupp[1], and Marcell Steinen[1] — [1]Helmholtz-Institut Mainz, Deutschland — [2]Aristoteles-Universität Thessaloniki, Griechenland — [3]Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland

Despite several promising experimental results, the question whether bound or resonant light neutral nuclei exist is not yet answered beyond doubt. The E906 experiment was the first fully electronic experiment to produce and study double hypernuclei with large statistics [J. K. Ahn *et al.*, Phys. Rev. Lett. **87**, 132504 (2001)]. We show, that the interpreatation of the dominant structure in the correlated $\pi^-\pi^-$ momentum matrix at (133, 114) MeV/c in terms of $^{3}_{\Lambda}$H + $^{4}_{\Lambda}$H remains questionable. Neither hypernuclei production from stopped Ξ^- by a ^{9}Be nuclues nor interactions of energetic Ξ^- with ^{9}Be nuclei in the target material can produce a sufficient amount of such twin pairs. We have therefore explored the conjecture that decays of the $^{4}_{\Lambda\Lambda}$n may be responsible for the observed structure. Indeed, the inclusion of $^{4}_{\Lambda\Lambda}$n with a two-body π^- branching ratio of 50% in a statistical multifragmentation model allows to describe the E906 data remarkably well. This interpretation is, however, hampered by the fact, that this neutral nucleus is predicted to be unbound.

HK 52.15 Thu 16:30 Grotte

Coulex of ^{142}Xe — •Corinna Henrich for the IS548-MINIBALL-Collaboration — TU Darmstadt, Darmstadt, Germany

The low-lying nuclear structure of ^{142}Xe was probed in a "safe" Coulomb excitation experiment at HIE-ISOLDE (CERN). While beam and target nuclei were detected utilizing the segmented Silicon detector array C-REX, the MINIBALL spectrometer was used to detect the emitted gamma rays in coincidence. ^{142}Xe is located north east of the doubly-magic nucleus ^{132}Sn and in the proximity of ^{144}Ba. The latter shows the largest octupole collectivity in the region. Therefore, this work aims to follow the evolution of quadrupole and octupole collectivity by means of spectroscopic quadrupole moments and reduced transition probabilities.

This work is supported by BMBF under contract 05P15RDCIA and 05P18RDCIA, by the EU under contract ENSAR 262010 and by ISOLDE.

HK 52.16 Thu 16:30 Grotte

Lifetime measurements of excited states in ^{55}Cr — •H. Kleis, M. Seidlitz, P. Reiter, K. Arnswald, M. Droste, and L. Kaya — IKP, Universität zu Köln

Lifetime measurements in neutron-rich Cr nuclei provide key observables to study the $N = 32$ sub-shell closure. Following an earlier measurement in ^{56}Cr [1], excited states in the neighboring $N = 31$ isotope ^{55}Cr have been populated in a ^{48}Ca(^{11}B, $p3n$)^{55}Cr fusion-evaporation reaction at a beam energy of 32 MeV at the FN tandem accelerator of the University of Cologne. The Cologne plunger device, surrounded by a γ-ray detector array consisting of one EUROBALL cluster detector and five Ge detectors, was employed to determine lifetimes with the recoil distance Doppler-shift method (RDDS). $\gamma\gamma$-coincidence data were analyzed using the differential decay-curve method (DDCM) and precise lifetimes for the first $5/2^-$ and $9/2^-$ states of $\tau = 5.61(28)$ ps and $\tau = 6.33(46)$ ps, respectively, were extracted. In addition, the experimentally determined transition probabilities were confronted with the theoretical results from large-scale shell-model calculations.

[1] M.Seidlitz et al., Phys. Rev. C 84, 034318 (2011)

HK 52.17 Thu 16:30 Grotte

A cryogenic Paul trap for ^{229}Th — •Daniel Moritz[1], Benedict Seiferle[1], Lars von der Wense[1,2], and Peter G. Thirolf[1] — [1]LMU München — [2]JILA , Boulder , USA

The comparably low energy of the isomeric first excited nuclear state of ^{229}Th, which has most recently been constraint to 8.28±0.17 eV [1], allows for direct laser excitation with current technology. This offers the unique opportunity to develop a nuclear clock [2] capable of competing with existing atomic clocks. One of the next steps towards the realization of such a clock is the determination of the ^{229}Th isomer's ionic lifetime, which is expected to be in the range of several minutes up to hours. In order to achieve the required ion storage times, a cryogenic Paul-trap is currently set up at the LMU Munich.

This work was supported by DFG (Th956/3-2) and by the European Union's Horizon 2020 research and innovation program under grant agreement 6674732 "nuClock".

[1] B.Seiferle et al., Nature 573, 243 (2019).
[2] E.Peik & C.Tamm, Europhys. Lett. 61, 181 (2003).

HK 52.18 Thu 16:30 Grotte

Subatomic particles represented as focal points. — •Osvaldo Domann — Stephanstr. 42, 85077 Manching, Germany

Examples of approaches to represent subatomic particles (SPs) are point-like, strings, wave-packets, etc. The present work is based on an approach where (SPs) are represented as focal points of rays of Fundamental Particles (FPs) that move from infinite to infinite. FPs are emitted from the focal point and at the same time regenerate it. FPs store the energy of a SP as rotation defining angular momenta. Interactions between SPs are so the product of the interactions of the angular momenta of their FPs. **One important finding is that the interaction between two charged SPs tends to zero for the distance between them tending to zero. Atomic nuclei can thus be represented as swarms of electrons and positrons that neither attract nor repel each other. As atomic nuclei are composed of nucleons which are composed of quarks, the quarks can also be seen as swarms of electrons and positrons. The charge quantum number Q of a quark is now interpreted as the relative charge of electrons and positrons. No fractional charges Q are required and the charge of an electron or positron is thus the unit charge of nature. Another important finding is that all four forces are electromagnetic forces and described by QED. As quantum-mechanics rely heavily on classical physics, all new findings of the latter have repercussions on the former. More at: www.odomann.com

HK 53: Annual General Meeting of the Hadron and Nuclear Physics Division

Time: Thursday 19:00–20:00 Location: H-HS X

Duration: 60 min.

HK 54: Invited Talks IV

Time: Friday 9:00–10:30 Location: H-HS X

Invited Talk HK 54.1 Fri 9:00 H-HS X

The Compressed Baryonic Matter experiment at FAIR — •Alberica Toia for the CBM-Collaboration — GSI — Goethe University of Frankfurt

The study of QCD matter in extreme conditions of temperature and density such as those existing shortly after the Big Bang or in the core of neutron stars brings many insights into the innermost structure of the matter and the forces between its building blocks.

While gravitational wave events revealed a glimpse of QCD matter at extreme conditions, the future Facility for Antiproton and Ion Research (FAIR) will directly create and investigate its properties in the laboratory. Nucleus-nucleus collisions at SIS100 beam energies produce very high net-baryon densities, where phenomena such as a first order phase transition between hadronic and partonic matter or even exotic phases, are expected.

The Compressed Baryonic Matter (CBM) is a dedicated heavy-ion experiment designed to explicitly access rare observables sensitive to the medium. For high-statistics measurements of rare probes, event rates of up to 10 MHz are needed. To meet these demands, the CBM experiment uses fast and radiation hard detectors, self-triggered detector front-ends and a free-streaming readout architecture.

Several of the CBM detector systems, the data read-out chain and event reconstruction are commissioned and already used in experiments during the FAIR phase 0, and also within a full-system setup at GSI SIS18. In this presentation the physics program of CBM will be reviewed and the current status of the experiment will be reported.

Invited Talk HK 54.2 Fri 9:30 H-HS X

Short-Ramge-Correlations in neutron-rich nuclei — •Meytal Duer for the CLAS-Collaboration — Technische Universität Darmstadt

Analysis of high-energy scattering experiments shows that some nucleons (protons and neutrons) in the nuclear ground state form temporarily close-proximity neutron-proton pairs with large relative momentum and small center-of-mass momentum, relative to the Fermi momentum of the nucleus. These pairs are referred to as Short-Range Correlated (SRC) pairs. However, how excess neutrons in neutron-rich nuclei form such pairs remains unclear.

Using data from CLAS detector at Jefferson Laboratory, we measure protons and, for the first time, neutrons knocked out by high-energy electrons. We show that the fraction of high-energy protons increases markedly with the neutron excess in the nucleus, whereas that of neutrons decreases slightly. This effect is surprising because in the classical nuclear shell model, protons and neutrons obey the Fermi statistics, have little correlation and mostly fill independent energy shells. These nucleons are important for understanding of neutron-rich systems such as neutron stars, the internal structure of bound nucleons, and more.

So far SRC measurements were done in direct kinematics off stable nuclei (N/Z<1.5). We will also present the next generation of proposed studies at GSI and the future FAIR facilities, using radioactive beams. This will allow a fully exclusive measurement of SRC pairs in very asymmetric nuclei (N/Z>1.5).

Invited Talk HK 54.3 Fri 10:00 H-HS X

Das Physikprogramm des MESA-Beschleunigers — •Harald Merkel für die MAGIX-Kollaboration — Institut für Kenrphysik, Johannes Gutenberg-Universität Mainz,

In Mainz wird zur Zeit der Mainz Energy Recovery Superconductiong Accelerator (MESA) aufgebaut. Das besondere an diesem Elektronen-Beschleuniger ist die Möglichkeit zur Energierückgewinnung, d.h. nach Durchlaufen der Wechselwirkungszone wird die im Strahl enthaltene Energie wieder in die Beschleunigungskavitäten zurückgeführt. Auf diese Weise lassen sich Ströme von bis zu 10mA erzeugen. Da bei diesem Prinzip ein großer Teil der Strahlintensität ohne Beeinträchtigung der Strahlqualität für Experimente entnommen werden kann, können

hohe Luminositäten erreicht werden. Das Physikprogramm an diesem Beschleuniger konzentriert sich entsprechend auf Präzisionsmessungen im Energiebereich bis 150 MeV, da durch den hohen Strahlstrom mit fensterlosen Targets und Rückstossdetektoren gearbeitet werden kann. In diesem Vortrag wird das Physikprogramm an MESA anhand einiger Beispiele, u.a. zur Suche nach dunkler Materie und zu Messung von astrophysikalischen S-Faktoren vorgestellt, die mit diesem neuen Beschleuingerkonzept möglich werden.

HK 55: Hadron Structure and Spectroscopy IX

Time: Friday 11:00–12:30 Location: J-HS A

Group Report HK 55.1 Fri 11:00 J-HS A

Results of polarization observables in η- and $\pi^0\pi^0$-photoproduction off the proton from the CBELSA/TAPS experiment — •Farah Afzal for the CBELSA/TAPS-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn, Deutschland

The study of the nucleon excitation spectra allows to better understand the dynamics of the constituents inside the nucleons. Large discrepancies exist between experimentally observed states and predicted states from lattice QCD calculations or from phenomenological quark models. Experimentally, the nucleon excitation spectra can be investigated by studying different meson photoproduction reactions. Partial wave analyses are performed in order to extract the contributing resonances from experimental data. For an unambiguous solution it is not enough to only measure the unpolarized cross section, but several single and double polarization observables are needed in addition.

The CBELSA/TAPS experiment is located at the electron stretcher accelerator ELSA in Bonn. It offers the possibility to measure polarization observables with a linearly or circularly polarized photon beam and a longitudinally or transversely polarized target. The detection system consists mainly of two calorimeters: the Crystal Barrel and the MiniTAPS detector. Together, both cover almost the full 4π solid angle.

This talk will present recent results of several polarization observables from the CBELSA/TAPS collaboration and focus mainly on the $p\eta$ and $p\pi^0\pi^0$ final states.

HK 55.2 Fri 11:30 J-HS A

Search for polarization in the antiproton production process — •Dominika Alfs, Dieter Grzonka, and James Ritman — Institut für Kernphysik, Forschungszentrum Jülich, Germany

The goal of the P-349 experiment is to investigate a possible polarization of antiprotons produced in pA collisions in view of preparation of a polarized antiproton beam. Experimentally this is done by the measurement of the left-right asymmetry of elastic antiproton scattering on a liquid hydrogen target in the Coulomb-nuclear interference region.

Measurements were performed at the Proton Synchrotron test beam East Area (T11) at CERN. The analysis in ongoing, however, the expected statistics of reconstructed scattering events based on preliminary results is too low for a significant polarization analysis.

Therefore additional measurements are planned at CERN combined with precursor experiments with polarized proton scattering at Cooler Synchrotron (COSY) at Forschungszentrum Jülich.

In this talk the achieved results and details of the additional measurements will be presented.

HK 55.3 Fri 11:45 J-HS A

Determination of the target asymmetry T in the reaction $\gamma p \to p\pi^0$ — •Sebastian Ciupka for the CBELSA/TAPS-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn

Photoproduction experiments provide a tool to further our understanding of the experimentally observed nucleon excitation spectra, which show discrepancies to predictions based on e.g. lattice QCD. Since the resonances are strongly overlapping, a partial wave analysis is needed to disentangle the states. To unambiguously determine the complex amplitudes of the analysis, it is not enough to conduct unpolarised measurements, therefore measurements with a polarised beam, a polarised target or with a recoil nucleon polarimeter have to be realised.

At the CBELSA/TAPS experiment in Bonn a linearly or circularly polarised photon beam and a longitudinally or transversely polarised target are provided, giving access to single and double polarization observables. The two main detectors of the experiment are the Crystal Barrel (CB) calorimeter and the MiniTAPS calorimeter in forward direction, which in combination provide nearly 4π coverage.
This talk presents preliminary results for the target asymmetry T in π^0 photoproduction, determined from data collected after the upgrade of the CB readout system at the end of 2017. The data are compared with previously collected data and theoretical predictions.

HK 55.4 Fri 12:00 J-HS A

Photoproduction of $\pi^0\eta$ pairs on nuclei — •Vahe Sokhoyan for the A2-Collaboration — Universität Mainz, Institut für Kernphysik

In order to study the production mechanisms and possible modifications of baryon resonances in the nuclear medium, the beam helicity asymmetry $I^{\odot}$ was measured with the A2 setup at MAMI for the photoproduction of $\pi^0\eta$ pairs on carbon, aluminum, and lead targets. The new data for the nuclear targets are compared to the existing free proton data and to the corresponding model calculations performed within the Mainz model. The obtained results are interpreted in terms of contributions of the D_{33} partial wave with the $\eta\Delta(1232)$ intermediate state.

HK 55.5 Fri 12:15 J-HS A

Density Matrix and Dilepton Production in πN collision — •Deniz Nitt[1], Miklós Zétényi[2], and Michael Buballa[1] — [1]TU Darmstadt, Germany — [2]WCRP Budapest, Hungary

The study of hadronic interactions with a dilepton in the final state reveals crucial information about the underlying reaction mechanisms, since the electromagnetic probes can escape the collision volume easily. We use an effective lagrangian model [1, 2] to study the elementary reaction $\pi N \to Ne^+e^-$ in the first and second nucleon resonance region at $\sqrt{s} = 1.49GeV$ and $\sqrt{s} = 1.7GeV$ respectively, which coincides with HADES experiments at GSI [3]. Even though the initial particles are unpolarised, the virtual photon shows a tensor polarisation which results in angular anisotropy for the dilepton. We calculate differential cross sections, angular anisotropy and give predictions for the spin density matrix of the hadronic channel. This work is supported by GSI - TU Darmstadt F&E, HGS-HIRe and COST THOR action CA15213.

[1] Enrico Speranza et al. Phys. Lett. B764 (2017) [2] Tom Vrancx et al. Phys. Rev. C84 (2011) [3] J. Adamczewski-Musch et al. Eur. Phys. J. A53.9 (2017)

HK 56: Heavy-Ion Collisions and QCD Phases XII

Time: Friday 11:00–13:00 Location: J-HS F

Group Report HK 56.1 Fri 11:00 J-HS F

Measurement of light neutral mesons and direct photons in Pb-Pb collisions with ALICE at the LHC — •Meike Danisch for the ALICE-Collaboration — Physikalisches Institut Heidelberg

The ALICE experiment is dedicated to the study of the quark-gluon plasma (QGP) formed in heavy-ion collisions. Direct photons are excellent probes to investigate the space-time evolution and temperature of the QGP. Neutral mesons like π^0 and η can provide important information on the energy loss mechanisms of partons in the medium. Furthermore, they constitute the largest background contribution for direct photons. In the ALICE experiment, neutral mesons can be measured via their decay to two photons. Apart from the two calorimeters EMCal and PHOS, photons can also be reconstructed via the Photon

Conversion Method (PCM). The latter exploits the fact that a photon can convert to an electron-positron pair in the detector material. These charged particles can then be detected via their tracks in the Time Projection Chamber (TPC) and the Inner Tracking System (ITS). In this talk an overview of neutral meson and direct photon production in Pb–Pb collisions as measured by ALICE will be presented.

HK 56.2 Fri 11:30 J-HS F

Photon and neutral meson measurements with the conversion method in ALICE: Reducing the material budget uncertainty — •Stephan Stiefelmaier for the ALICE-Collaboration — Physikalisches Institut Heidelberg

One method to measure neutral mesons and direct photons in ALICE is to reconstruct electron-positron pairs from the conversion of photons in the detector material. This approach currently suffers from a 4% systematic uncertainty related to the knowledge of the material budget. A reduction of this uncertainty is key for establishing a signal of thermal direct photons at low pT ($1 < \mathrm{pT} < 3$ GeV/c) and for discriminating between models describing direct-photon production in heavy-ion collisions. We have explored whether the material budget uncertainty can be reduced by calibrating the rest of the detector material using the TPC gas as a well understood reference.

HK 56.3 Fri 11:45 J-HS F

Measurement of Neutral Mesons in pp Collisions at the LHC with ALICE — •Jens Lühder — Institut für Kernphysik, Münster

In ALICE, the measurement of photons is performed in two different ways: First, via the tracking of e^+-e^- pairs and secondly, via their energy deposits in electromagnetic calorimeters. The first method is called PCM (Photon Conversion Method) as photons may convert to e^+-e^- pairs when interacting with the detector material. For the second method, different calorimeters are used, whereas this talk will focus on the PHOS (PHOton Spectrometer). By using the measured photons to reconstruct the amount of neutral mesons, the fraction of decay photons out of all measured photons can be acquired. The talk will cover the measurement principles of the PCM, the calorimeters and the hybrid method, which combines these two methods in order to benefit from both detection principles. First results of the analysis of neutral mesons in the data of LHC Run 2 with a center of mass energy $\sqrt{s} = 13\,\mathrm{TeV}$ will be given.

HK 56.4 Fri 12:00 J-HS F

Measurement of neutral mesons in pp collisions at $\sqrt{s} = 13$ TeV with ALICE — •Joshua König for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

ALICE, the dedicated heavy-ion experiment at the LHC, investigates the properties of the quark-gluon plasma (QGP) that is believed to be produced in central AA collisions at high center-of-mass energies. Collective effects that were interpreted as an indication of the QGP in AA collisions have now also been observed in high multiplicity pp collisions. Measurements of the neutral meson (π^0, η) production in pp collisions as a function of multiplicity and sphericity at the highest available energies can reveal detailed insights into these effects. Additionally, those measurements are the baseline for direct-photon analyses.

The reconstruction of neutral mesons via their two photon-decay channel can be realized in ALICE with several complementary methods, including the calorimeters and the TPC. In this talk the status of the π^0 and η analysis in pp collisions at $\sqrt{s} = 13$ TeV with ALICE will be presented.

Supported by BMBF and the Helmholtz Association

HK 56.5 Fri 12:15 J-HS F

Measurement of neutral mesons in p-Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV with ALICE — •Andrea Hornung for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

ALICE, the dedicated heavy-ion experiment at the LHC, investigates the properties of the quark-gluon plasma (QGP). In collisions of high-energetic nuclei, energy loss effects have been observed in the production of hadrons at high transverse momenta. To disentangle effects on the particle production caused by the QGP and concurrent initial-state effects, in addition to collisions of heavy nuclei, collisions of protons and nuclei are studied. The measurement of neutral mesons, e.g. π^0 and η mesons, provides insight into these effects. Furthermore, a precise measurement of neutral mesons is mandatory for the measurement of direct photons. In ALICE, π^0 and η mesons can be measured via their two-photon decay channel using the ALICE calorimeters PHOS and EMCal or the photon conversion method.

With the new LHC RUN2 data, ALICE has collected eight times more statistics in p-Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV compared to the LHC RUN1 data. In this talk, the status of the analysis of π^0 and η mesons in the combined data set using the different available detection methods is presented.

Supported by BMBF and the Helmholtz Association.

HK 56.6 Fri 12:30 J-HS F

Feasibility study for the measurement of direct photon elliptic flow in central Pb-Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 17.3$ GeV with WA98 — •Tim Rogoschinski[1], Henner Büsching[1], and Klaus Reygers[2] — [1]Institut für Kernphysik, Goethe-Universität Frankfurt — [2]Physikalisches Institut, University of Heidelberg

The collaborations ALICE at LHC and PHENIX at RHIC have reported on the invariant yield and elliptic flow v_2 of direct photons in heavy-ion collisions. The PHENIX collaboration discovered a large excess of direct photons compared to the reference in p+p collisions as well as a large v_2 of direct photons. The magnitude of direct photon v_2 measured with ALICE is similar to the v_2 observed by PHENIX. For theoretical models the simultaneous description of the large yield and the large v_2 remains a challenge and is commonly referred to as the direct photon puzzle. A joint measurement of the direct photon yield and v_2 at SPS energy could provide additional input for theoretical models. The WA98 collaboration at SPS earlier has reported on the direct photon invariant yield [1]. In this talk, a reanalysis of the WA98 dataset from 1996 with a focus on the v_2 of direct photons produced in central Pb-Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 17.3$ GeV utilizing the Plastic-Ball and the LEDA detector will be presented.

Supported by BMBF and the Helmholtz Association.

[1] Phys.Rev.Lett. 85 (2000) 3595-3599

HK 56.7 Fri 12:45 J-HS F

Probing the evolution of heavy-ion collisions using direct photon interferometry — •Nicole Löher — Physikalisches Institut, Universität Heidelberg

A measurement of Hanbury-Brown Twiss (HBT) correlations of direct photons in nucleus-nucleus collisions offers an experimental tool to discriminate between different sources of photon enhancement. Unfortunately the statistics recorded so far at the ALICE experiment at the LHC was not sufficient for such a measurement, but the expected statistics in the upcoming high-luminosity LHC runs could lead to a significant signal. In order to demonstrate this, a feasibility study has been carried out in which two different photon sources in addition to the yields from standard hydrodynamical simulations are investigated. First a photon enhancement near the pseudo-critical temperature $T_c \approx 155$ MeV using a phenomenological ansatz and second additional photons, which are produced from the early pre-equilibrium stage, are discussed. For both scenarios the correlators for relative momenta q_{out}, q_{side} and q_{long} for different transverse pair momenta K_{T} are determined. Among the three directions the longitudinal correlation is the most sensitive to different photon sources. The performed study led to the conclusion that, considering only statistical uncertainties, the detection of 10^{10} heavy ion events could lead to a measurement of the HBT correlations for $K_{\mathrm{T}} < 1$ GeV which is statistically significant.

HK 57: Heavy-Ion Collisions and QCD Phases XIII

Time: Friday 11:00–12:15 Location: J-HS G

Group Report HK 57.1 Fri 11:00 J-HS G

Spectral functions and critical dynamics of the $O(4)$ model from classical-statistical lattice simulations — •Dominik Smith[1], Sören Schlichting[2], and Lorenz von Smekal[1] — [1]Justus-Liebig-Universität Gießen — [2]Universität Bielefeld

We calculate spectral functions of the relativistic $O(4)$ model from real-time lattice simulations in classical-statistical field theory. While in the low and high temperature phase of the model, the spectral functions of longitudinal (σ) and transverse (π) modes are well described by relativistic quasi-particle peaks, we find a highly non-trivial behavior of the spectral functions in the cross over region, where additional structures appear. Similarly, we observe a significant broadening of the quasi-particle peaks, when the amount explicit $O(4)$ symmetry breaking is reduced. We further demonstrate that in the vicinity of the $O(4)$ critical point, the spectral functions develop an infrared power law associated with the critical dynamics, and comment on the extraction of the dynamical critical exponent z from our simulations.

HK 57.2 Fri 11:30 J-HS G

Quark Number and Electric Flux in QCD — •Milad Ghanbarpour and Lorenz von Smekal — Institut für Theoretische Physik, Justus-Liebig-Universität Gießen, Deutschland

In pure $SU(3)$-gauge theory the free energy of a static quark in a finite volume can be rigorously defined to account for its electric flux, via suitable combinations of twisted boundary conditions relative to an enlarged ensemble with all temporal twists. In the infinite volume limit, it diverges in the confined phase and vanishes above the deconfinement phase transition. In full QCD with dynamical quarks, the situation is less clear. A straightforward definition via pseudo-canonical ensembles with quark numbers N_q that are not multiples of three fails, the corresponding partition functions vanish due to the Roberge-Weiss symmetry already in a finite volume. Such quark numbers are inconsistent with periodic boundary conditions. Therefore we first need to understand the correct boundary conditions to account for the elecrtic flux and the entanglement entropy of subsystems with $N_q \mod 3 \neq 0$. Here, we approach this problem from the heavy-dense limit of QCD at fixed quark number. The analogue system is a 3-states Potts model in three dimensions. In its naive formulation, the system suffers from a sign problem which can be solved in this case, however (see Alexandru et al., Phys. Rev. D 97 (2018) 114503). The solution consists of utilizing a cluster algorithm and improved estimators. Our first goal therefore is to adapt this scheme for non-periodic boundary conditions so that we can describe ensembles with arbitrary quark numbers in a finite volume. In this talk we review the current status of the project.

HK 57.3 Fri 11:45 J-HS G

Dynamic critical exponents from classical-statistical spectral functions — •Dominik Schweitzer[1], Sören Schlichting[2], and Lorenz von Smekal[1] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität Gießen — [2]Fakultät für Physik, Universität Bielefeld

When a thermodynamic system comes close to a critical point, large fluctuations lead to scale-invariant physics, not only in static but also dynamic observables, such as spectral functions. Such observables can be measured by a range of experiments, and will become relevant in future heavy-ion collision experiments closing in on the QCD critical point.

We investigate the dynamic critical behavior of self-interacting scalar fields with $\mathbb{Z}_2$ symmetry and hence the same static universal behavior as QCD at the critical endpoint. We calculate spectral functions of the order parameter at zero and non-vanishing momenta from classical statistical lattice simulations in real time. In the high-temperature phase, we find that the spectral functions are well described by relativistic quasi-particle peaks; at low temperatures, we find an additional mode with a different dispersion relation. Close to the transition temperature, we see a strong IR contribution building up.

Considering the equations of motion for a closed system as well as a system coupled to a heat bath, we determine the underlying universal scaling functions in the critical region, and extract the dynamic critical exponents z for two different dynamic universality classes, Model A & C.

HK 57.4 Fri 12:00 J-HS G

In-medium properties of vector and (pseudo-)scalar mesons — •Pascal Gunkel, Christian Fischer, and Philipp Isserstedt — Justus-Liebig Universität Gießen, 35392 Gießen, Deutschland

We report on recent results on the phase structure of strongly-interacting matter using the functional Dyson-Schwinger approach to QCD. We discuss results for masses, wave functions, and decay constants of (light) vector, scalar, and pseudoscalar mesons for finite chemical potentials up to the first-order phase transition. They are obtained from the corresponding homogeneous Bethe-Salpeter equations, coupled to a set of truncated Dyson-Schwinger equations for the quark and gluon propagators of Landau-gauge QCD. We confirm the Silver-Blaze property and extend previous calculations [1] to finite temperature.

[1] P. J. Gunkel, C. S. Fischer, P. Isserstedt, Eur. Phys. J. A 55 (2019) 169

HK 58: Nuclear Astrophysics II

Time: Friday 11:00–12:45 Location: J-HS B

Group Report HK 58.1 Fri 11:00 J-HS B

Experimental techniques for Nuclear Astrophysics in Cologne — •Felix Heim, Jan Mayer, Marco Menen, Martin Müller, Philipp Scholz, and Andreas Zilges — Institute for Nuclear Physics, University of Cologne

The universe was born with just hydrogen, helium, and small traces of lithium. The question of how the remaining elements were created by nuclear reactions in stars, stellar explosions, and stellar collisions is one of the main problems addressed by the interdisciplinary field of nuclear astrophysics. Most of the heavy nuclei beyond the iron-peak region are synthesized within complex nucleosynthesis networks which include thousands of nuclear reactions on stable and unstable nuclei. At present, most of the reactions rates involved are taken from theory in the framework of the Hauser-Feshbach model. Therefore, it is essential to extend the available experimental database on the one hand and to constrain the nuclear physics parameters entering the theoretical calculations on the other hand. Radiative proton-capture reactions are well-suited for this purpose, as the emitted prompt γ-rays yield important information about the statistical γ-decay behavior in the compound nucleus. α-induced reactions can be used to constrain the α-optical model potential. In this contribution, details of the experimental techniques will be presented as well as recent experimental results for the ^{107}Ag(p,γ)^{108}Cd, ^{63,65}Cu(p,γ)^{64,66}Zn, and ^{144}Sm(α,γ)^{148}Gd reactions.

Supported by the DFG (ZI 510/8-1).

HK 58.2 Fri 11:30 J-HS B

Study of the ^{2}H$(p,\gamma)^3$He reaction at LUNA — Klaus Stöckel[1,2], •Daniel Bemmerer[1], and Tamás Szücs[1] for the LUNA-Collaboration — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden — [2]Technische Universität Dresden

Highly precise measurements of the primordial ^{2}H abundance in damped Lyman-α systems have rekindled hope to decisively improve the precision of Big Bang nucleosynthesis (BBN) constraints on the primordial baryon to photon ratio. However, the interpretation of the ^{2}H abundance data is limited by the imprecise knowledge on ^{2}H destruction by the ^{2}H$(p,\gamma)^3$He reaction.

The present contribution will report on the recently completed measurement of the ^{2}H$(p,\gamma)^3$He cross section using a windowless gas target and a high-purity germanium detector in close geometry at the LUNA 400 kV accelerator, deep underground in the Gran Sasso laboratory, Italy. The new data are directly in the energy range of Big Bang

nucleosynthesis and present an important step towards improving the precision of cosmological constraints from BBN.

Supported by DFG (BE 4100/4-1).

HK 58.3 Fri 11:45 J-HS B

Study of ^{3}He(α,γ)^{7}Be at Dresden Felsenkeller — •Konrad Schmidt[1], Steffen Turkat[1], Daniel Bemmerer[2], and Kai Zuber[1] — [1]TU Dresden, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Germany

One of the key reactions in both Big-Bang nucleosynthesis (BBN) and p-p-chain hydrogen burning is the ^{3}He(α,γ)^{7}Be reaction. The aim of the present study is a comprehensive data set covering the entire BBN range. In a first campaign, γ-ray angular distributions have been measured at the 3 MV Tandetron accelerator of Helmholtz-Zentrum Dresden-Rossendorf (HZDR) with implanted ^{3}He targets. Activated samples of ^{7}Be ($\approx$ 53 d half-life) have been counted at the shallow-underground laboratory Dresden Felsenkeller using a new 163% HPGe detector shielded from cosmic rays by ultra-low background copper and lead, active plastic scintillation veto detectors and 140 m water equivalent of rock. A second campaign is planned underground at the new 5 MV Pelletron accelerator Dresden Felsenkeller with a gas target currently under construction that can be operated as an extended gas chamber or as a gas-wall jet. Preliminary results of the angular distribution and activation data from the first campaign will be presented as well as the latest status of the Felsenkeller gas-target setup. This work is supported by DFG (ZU 123/21-1).

HK 58.4 Fri 12:00 J-HS B

Study of the direct 3-α decay of the 0_2^+ state in ^{12}C with LYCCA — •Madalina Ravar[1], David Werner[1], Peter Reiter[1], Stefan Thiel[1], Christoph Goergen[1], Konrad Arnswald[1], Maximilian Droste[1], Herbert Hess[1], Rouven Hirsch[1], Levent Kaya[1], Lars Lewandowski[1], Michael Seidlitz[1], Kai Wolf[1], Dirk Rudolph[2], Pavel Golubev[2], Luis Sarmiento[2], and Patrick Coleman-Smith[3] — [1]University of Cologne, Institute for Nuclear Physics, Cologne, Germany — [2]Lund University, Department of Physics, Lund, Sweden — [3]Science and Technology Facilities Council, Daresbury, England

The topic of alpha-decay of the 0_2^+ state in ^{12}C, the so-called "Hoyle State", gained a lot of interest in the past few years. The mechanism of the 3-α decay and the branching ratio of the direct and the sequential decay have a direct impact on the calculated rates for the triple-alpha process in Helium burning in stars. The Lund-York-Cologne-CAlorimeter (LYCCA), a 24-DSSSDs array, was employed for this kind of measurement at the 10-MV FN-tandem accelerator at the Institute for Nuclear Physics, University of Cologne. The excited state of ^{12}C is obtained via an inelastic alpha scattering on a $^{nat.}$C target and the outgoing alpha particles are detected in coincidence. LYCCA, a NUSTAR device, planned for FAIR@GSI, is a powerful setup coming with better angular coverage and better detector granularity compared to other measurements performed for the 3-α decay of the Hoyle state until now. Preliminary results from recent beam times are being presented in this talk. Supported by GSI F&E KREITE 1416.

HK 58.5 Fri 12:15 J-HS B

In-beam cross section measurements in the Mo-Ru region for p-process nucleosynthesis — •Martin Müller, Felix Heim, Jan Mayer, Philipp Scholz, and Andreas Zilges — Institute for Nuclear Physics, University of Cologne

In spite of many years of research, nucleosynthesis simulations are still not able to reproduce many p-nuclei abundances accurately [1]. Among the most extreme cases are the light Molybdenum and Ruthenium p-isotopes. The ^{93}Nb(p,γ)^{94}Mo reaction is one of the key reactions affecting the ^{94}Mo abundance. Hence an in-beam experiment at the HORUS γ-spectrometer located at the University of Cologne [2] was performed. A second experiment measuring total cross sections of the ^{98}Ru(α, γ)^{102}Pd reaction was conducted at the RUBION facility of the Ruhr-Universität Bochum utilizing the 4π-summing technique [3]. Preliminary results for both measurements have been compared to Hauser-Feshbach statistical model calculations [4] in an attempt to further constrain its input parameters.

Supported by the DFG (ZI 510/8-1).

[1] M. Arnould and S. Goriely, *Phys. Rep.* **384**, 1 (2003)
[2] L. Netterdon *et al.*, *Nucl. Instr. Meth.* A **754**, 94 (2014)
[3] A. Spyrou *et al.*, *Phys. Rev. C* **76**, 1 (2007)
[4] W. Hauser and H. Feshbach, *Phys. Rev.* **87**, 366 (1952)

HK 58.6 Fri 12:30 J-HS B

α-spectroscopy to determine ^{144}Sm(α,γ)^{148}Gd production — •Heinrich Wilsenach[1], Philipp Scholz[2], Andreas Zilges[2], and Kai Zuber[1] — [1]TU Dresden, Institut für Kern- und Teilchenphysik, Germany — [2]University of Cologne, Institute for Nuclear Physics, 50937 Köln, Germany

Measurements of p-nuclei production rates help to shed some light on the observed abundances and help to constrain predictions made with extended reaction networks. One of the outstanding measurement is the ^{144}Sm(α,γ)^{148}Gd cross section [1]. The predicted cross section varies from the measurement by more than an order of magnitude [2], making this cross section the most uncertain p-process nuclide production. For this reason a re-measurement was performed using isotopically enriched ^{144}Sm, activated at various energies close to the Gamow window. The ^{148}Gd α-decay was used to determine the amount of the produced material. The decay rates were expected to be in the range of 4 per hour. To measure such a low count-rate an ultra-low background ionisation chamber at IKTP TU Dresden was used. The chamber achieved a background rate in the region of interest (1 MeV to 4 MeV) of around 0.27 counts per day per MeV. The subject of this talk is to describe the method used to determine the amount of ^{148}Gd produced in the (α,γ) activation of enriched ^{144}Sm samples. Advanced simulations are fitted to data to help constrain systematic uncertainties. [1] E. Somorjai *et al.* Astron. Astrophys. 333, (1998) 1112-1116 [2] T. Rauscher *et al.* Rep. Prog. Phys. 76, (2013) 066201 (38pp)

HK 59: Structure and Dynamics of Nuclei X

Time: Friday 11:00–13:00 Location: J-HS E

Group Report HK 59.1 Fri 11:00 J-HS E

The (18O, 16O) two-neutron transfer reaction as a gateway to study the low-spin structure of neutron-rich nuclei close to stability. — •Vasil Karayonchev, Jan Jolie, Arwin Esmaeilzadeh, Andrey Blazhev, Christoph Fransen, and Claus Müller-Gatermann — Institut für Kernphysik, Zülpicher Straße 77 50937 Köln, Deutschland

Successful feasibility studies of the (18O, 16O) two-neutron transfer reaction were performed with various targets, ranging from 50Ti to 204Pb, at the FN Tandem accelerator facility of the University of Cologne, opening new experimental possibilities to study neutron-rich nuclei close to stability. The reaction was used to obtain lifetimes of low-spin states in 90Sr and 98Zr using the Doppler shift attenuation method and the recoil distance Doppler shift technique, respectfully. The newly obtained lifetimes in 90Sr corroborate the effects of the subshell closure at Z=38 and also indicate the possible existence of a state of a mixed-symmetry character. The measured lifetimes in 98Zr suggest the coexistence of several shapes of different deformations which are weakly mixed.

HK 59.2 Fri 11:30 J-HS E

The (p,3p) reaction mechanism: a sequential process — •Axel Frotscher and Mario Gómez for the SEASTAR15-Collaboration — TU Darmstadt, Darmstadt, Deutschland

The knockout of nucleons from nuclei is a powerful tool to investigate nuclear structure. In particular, the knockout of nucleons at energies above 200 MeV/nucleon from a hydrogen target, so called quasi free scattering, is believed to be a clean probe for nuclear structure and have led to several recent experimental programs and theoretical developments. In this work, we are interested to reactions that lead to the removal of two nucleons. Indeed, it was observed in several occurrences that different final states in a nucleus are populated when produced from one nucleon knockout (p,2p) or from two nucleon knockout (p,3p). The understanding of the later could provide a new tool for nuclear spectroscopy.

The analysis of two experimental campaigns conducted at the RIBF in RIKEN, Japan, is presented here. The proton distribution from

several neutron-rich medium-mass nuclei were analysed. The radioactive nuclei were impinging onto a 100-mm long liquid hydrogen target. The protons issued from the reaction were measured with the MINOS time-projection chamber surrounding the target, giving access for the first time to angular correlations of the three protons in the final state. The obtained proton distributions have been benchmarked against kinematical models assuming three different reaction mechanisms.

This work is supported by the DFG through grant no. SFB1245.

HK 59.3 Fri 11:45 J-HS E

Current Status of the PUMA Project — Jonas Fischer, Erik Friedrich, Yuki Kubota, Noritsugu Nakatsuka, Alexandre Obertelli, •Alexander Schmidt, and Frank Wienholtz for the PUMA-Collaboration — TU Darmstadt, Darmstadt, Germany

The antiProton Unstable Matter Annihilation (PUMA) project aims at the investigation of the outermost density tail for the protons and neutrons of short-lived nuclei by the use of low-energy antiprotons at CERN. A special focus will be set on medium mass neutron-rich nuclei, for which a thick neutron skin or a neutron halo has been predicted but a solid experimental proof is still missing. In order to quantify if a nucleus has a halo or a neutron skin, the surface of the nucleus will be investigated by the means of annihilations with antiprotons. In these annihilation processes the produced energy is mainly carried away by charged and neutral pions, whose sum of the charges is equal to the sum of charges of the antiproton and the annihilated nucleon, which will allow us to distinguish between neutron and proton annihilations. Based on detecting and identifying all produced charged pions, the measurements will determine the ratio of protons to neutrons on the surface of the nucleus.

This contribution will provide an overview of the current status of the PUMA project with a special focus on the proof-of-principle setup for the diagnostics and the trapping scheme. It is supported by the ERC-COG through grant no. 726276.

HK 59.4 Fri 12:00 J-HS E

Extreme high vacuum for the PUMA trap — •Erik Friedrich[1], José António Ferreira Somoza[2], Paolo Chiggiato[2], Audric Husson[1], Wojciech Kubinski[1], Noritsugu Nakatsuka[1], Alexandre Obertelli[1], and Frank Wienholtz[1] for the PUMA-Collaboration — [1]Technische Universität Darmstadt, Darmstadt, Germany — [2]CERN, Geneva, Switzerland

The antiProton Unstable Matter Annihilation (PUMA) project targets to study short-lived nuclei with antiprotons at CERN. The technical challenge of PUMA is to store approximately one billion antiprotons for at least a month and transport them from the ELENA low-energy antiproton ring to the ISOLDE radioactive-ion beam facility at CERN. For this long-term storage, an extremely high vacuum (XHV) of about 10^{-17} mbar, corresponding to a gas density about $20\,\mathrm{cm}^{-3}$, should be achieved by cryopumping. The residual gas density at XHV region depends on the molecular occupation of hydrogen on the cryogenic surface. The key parameter to simulate this process is so-called the hydrogen isotherms at XHV. The specificity of the PUMA experiment is that the cryopumped region should be open to the beam line for the introduction of low-energy (few keV) ions into the PUMA device. The presentation reports on the vacuum cryostat of PUMA and summaries the simulations with Molflow+ and COMSOL Multiphysics to optimize the cryostat design. In addition, the development of a cryogenic gate valve is described.

HK 59.5 Fri 12:15 J-HS E

Current status of COALA - Towards an all-optical nuclear charge radius determination — •Phillip Imgram[1], Zoran Andelkovic[2], Axel Buss[3], Volker M. Hannen[3], Kristian König[4], Jörg Krämer[1], Konstantin Mohr[1], Patrick Müller[1], Rodolfo Sánchez[2], and Wilfried Nörtershäuser[1] — [1]IKP, TU Darmstadt — [2]GSI, Darmstadt — [3]IKP, WWU Münster — [4]NSCL, MSU, East Lansing, MI, USA

The Collinear Apparatus for Laser Spectroscopy and Applied Physics (COALA) at the Institute of Nuclear Physics of TU Darmstadt has been designed to perform high-precision experiments on stable isotopes for high-voltage measurements, atomic physics and nuclear structure research. The planned upgrade with an electron-beam ion source will allow us to study transitions in multiply-charged ions. Here, the focus will be on light ions to determine nuclear charge radii with an all-optical approach, i.e. without referencing to charge radii determined by elastic electron scattering or transitions in muonic atoms. Therefore, the $^3S_1 \rightarrow {}^3P_J$ transitions of He-like ions will be measured to an accuracy of $<1\,\mathrm{MHz}$ with simultaneous collinear and anticollinear laser spectroscopy. This experimental value can directly be compared with nonrelativistic QED calculations (NRQED) [1] that are currently being performed. This contribution will summarize the current status of the project which is supported by BMBF (05P19PMFA1 and 05P19RDFAA) and by DFG (SFB 1245).

[1] V.A. Yerokhin et al., Phys. Rev. A 98, 032503 (2018)

HK 59.6 Fri 12:30 J-HS E

Compact Collinear Laser Spectroscopy Setup for Ion Source Development and Educational Research — •Philipp Bollinger, Tim Ratajczyk, Tim Lellinger, and Wilfried Nörtershäuser — Institut für Kernphysik, Technische Universität Darmstadt

Collinear laser spectroscopy (CLS) is widely used to perform highly precise measurements of atomic spectra to extract nuclear properties, namely charge radii, magnetic dipole and electric quadrupole moments [Neugart et al. J. Phys. G. 44 064002 (2017)]. It has also been used to test QED calculations with light as well as highly charged heavy ions, and was applied on relativistic beams to test special relativity. We are developing a compact setup for CLS to be used as hands-on experience in the Students Lab to familiarize them with the technique and its science applications. Moreover, the apparatus will serve for quick equipment tests and ion source specifications. For this setup a specially designed 90° bender with static electric fields is used to superimpose the ion beam with a collinear laser beam. A Faraday cup provides means to optimize the ion beam path and an optical detection region consisting of elliptic mirrors and photomultipliers are used for fluorescence detection. We will present details of the layout and the current status of the project together with some first measurements with the 90° bender.

We acknowledge funding from HIC for FAIR

HK 59.7 Fri 12:45 J-HS E

Status of a buffer gas cooled Low-Emittance Laser Ablation Ion Source with two RF funnels — •Tim Lellinger[1], Tim Ratajczyk[1], Philipp Bollinger[1], Victor Varentsov[2,3], and Wilfried Nörtershäuser[1] — [1]Institut für Kernphysik, TU Darmstadt — [2]Facility for Antiproton and Ion Research in Europe (FAIRGmbH), Darmstadt — [3]Institute for Theoretical and Experimental Physics, Moscow, Russia

Ion sources of low-emittance are of interest in many applications of experimental low-energy physics, for example as ion sources for collinear laser spectroscopy or ion trap experiments, or as ion sources for accelerators and for production of fine focusing beams for industrial microelectronics technologies. Often, surface ion sources are used due to their simple construction and easiness of operation. However, they can only deliver a very small range of elements, mostly alkaline and alkaline earth ions and a few other species. Laser ablation in vacuum opens the possibility to produce ion beams even from transition metals or compound materials. The drawback of this technique is the high emittance of the beam. The presented ion source will counteract this drawback by using He buffer gas to stop the ions and extracting them through optimized RF funnels into high vacuum conditions.

This work is supported by BMBF 05P19RDFN1 and HIC for FAIR

HK 60: Structure and Dynamics of Nuclei XI

Time: Friday 11:00–13:00 Location: J-HS H

Group Report HK 60.1 Fri 11:00 J-HS H

Accepting the breaking of axial symmetry for all heavy nuclei improves the consistency of nuclear modelling — •Eckart Grosse[1], Arnd R. Junghans[2], Ralph Massarczyk[3], and Jon N. Wilson[4] — [1]IKTP, TU Dresden — [2]IRP, Helmholtz-Zentrum Dresden-Rossendorf, 01314 Dresden — [3]LANL, New Mexico 87545, USA — [4]IPN and CNRS/IN2P3, F-91406 Orsay, France

Although atomic hyperfine structure as well as most nuclear spectroscopy data do not deliver accurate information on nuclear axiality the ad-hoc assumption of symmetry about one axis found widespread use in nuclear models. In the theoretical interpretation of nuclear properties as well as in the analysis of experimental data triaxiality was considered - if at all - only for some, often exotic, nuclides. Detailed studies of the mass and charge dependence of the electric dipole strength in the range of and also outside of giant dipole resonances clearly indicate the need for accepting broken axial symmetry already for nuclei in the valley of stability. Allowing triaxiality for quasi all heavy nuclei helps to get rid of the need to introduce an arbitrary level density parameter $\tilde{a}$ to fit the accurate values observed in n-capture experiments. Using the value for $\tilde{a}$ as taken from nuclear matter studies allows to even extend such predictions to all spins when the yrast energies are no longer approximated as for an axial rigid rotor. Allowing a breaking of axial symmetry together with spin-independent moments of inertia (MI) a surprisingly simple parametrization is found without using VMI fitting and allowing symmetry breaking instead and hence predictions for compound nuclear reactions are improved.

Group Report HK 60.2 Fri 11:30 J-HS H

Towards a nuclear clock with ^{229}Th — •Benedict Seiferle[1], Daniel Moritz[1], Lars von der Wense[2], and Peter Thirolf[1] — [1]LMU Munich — [2]JILA, Boulder, USA

With an excitation energy of 8.28±0.17 eV [1], the first isomeric state in ^{229}Th (called ^{229m}Th) is the only (currently known) nuclear state that can be excited with today's laser technology. Its properties make ^{229m}Th an ideal candidate for a nuclear optical clock, which is expected to compete with optical atomic clocks. Experiments that led to the first direct energy determination of ^{229m}Th, as well as future experiments aiming towards a nuclear optical clock will be presented.

[1] B. Seiferle et al., Nature 573, 243 (2019).

This work was supported by DFG (Th956/3-2) and by the European Union's Horizon 2020 research and innovation program under grant agreement 6674732 "nuClock".

HK 60.3 Fri 12:00 J-HS H

Dynamically assisted nuclear fusion — •Friedemann Queisser[1,2,3] and Ralf Schützhold[1,2,3] — [1]Fakultät für Physik, Universität Duisburg-Essen, Lotharstraße 1, Duisburg 47057, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstraße 400, 01328 Dresden, Germany — [3]Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany

We consider deuterium-tritium fusion as a generic example for general fusion reactions. For initial kinetic energies in the keV regime, the reaction rate is exponentially suppressed due to the Coulomb barrier between the nuclei, which is overcome by tunneling. Here, we study whether the tunneling probability could be enhanced by an additional electromagnetic field, such as an x-ray free electron laser (XFEL). We find that the XFEL frequencies and field strengths required for this dynamical assistance mechanism should come within reach of present-day or near-future technology.

Reference:

F. Queisser and R. Schützhold, Phys. Rev. C **100**, 041601(R) (2019)

HK 60.4 Fri 12:15 J-HS H

Experimental measurements of total inelastic cross sections of light anti-nuclei up to anti-Helium 3 in ALICE — •Stephan Koenigstorfer, Ivan Vorobyev, and Laura Fabbietti for the ALICE-Collaboration — Technische Universität München, Physik Department E62

Recent work by the ALICE Collaboration presented the first experimental measurement of the total inelastic cross section for anti-deuterons at low momenta between 0.5GeV/c and 4GeV/c, as well as new measurements of the total inelastic cross section for anti-protons at momenta between 0.3GeV/c and 4GeV/c, in p-Pb collisions. These measurements offer unprecedented constraints on the propagation of light anti-nuclei through matter. In particular, light anti-nuclei from dark matter decays can be separated from secondary anti-nuclei produced in high energy cosmic ray collisions only if their propagation through the interstellar medium can be accurately simulated.

In this contribution we present the studies of the total inelastic cross section of light anti-nuclei in ALICE. They are extended to high multiplicity triggered p-p collisions at $\sqrt{s} = 13TeV$, and from $\bar{p}$ and $\bar{d}$ to anti-Helium 3. The cross sections are extracted by measuring the difference in propagation between particles and anti-particles, and comparing it to Monte Carlo simulations.

HK 60.5 Fri 12:30 J-HS H

Neural network-based analysis of the nucleus-antiproton annihilation for the PUMA project — •Yuki Kubota[1], Yohei Ono[2], and Alexandre Obertelli[1] for the PUMA-Collaboration — [1]Institut für Kernphysik, Technische Universität Darmstadt, Germany — [2]The Open University of Japan, Japan

One of the most fascinating quantum phenomena in Nature is the occurrence of neutron skins and halos in atomic nuclei. The PUMA (antiProton Unstable Matter Annihilation) project aims at determining the neutron over proton densities at the surface of the short-lived nuclei by means of the nucleus-antiproton annihilation. The annihilation is followed by pion emission. The reconstruction of the total charge of the emitted pions allows for the determination of the annihilated particles: 0 in the case of proton and -1 in the case of neutron. However, the primordial pions may re-interact with the residual nucleus before being detected so that the total charge information is distorted. Thus the event-by-event basis identification is not possible.

We are developing the statistical analysis by using the neural network to determine the neutron-to-proton annihilation ratio from the multiplicity and total charge of charged pions. The typical uncertainty of less than 5% can be achieved with the 10^3 annihilation events, which was drastically improved by two orders of magnitude better than the previous study [1]. An overview of the analysis as well as a method to reduce the systematic uncertainty coming from the model dependence are presented.

[1] M. Wada and Y. Yamazaki, AIP Conf. Proc. 793, 233 (2005).

HK 60.6 Fri 12:45 J-HS H

Single-particle potentials of hyperons in nuclear and neutron matter: Role of 3-baryon forces — •Dominik Gerstung, Norbert Kaiser, and Wolfram Weise — Physik Department T39, TU München

The Brueckner G-matrix formalism is employed to calculate the single-particle potentials of nucleons and hyperons in isospin-symmetric nuclear matter and pure neutron matter. The underlying two-body interactions consist of NLO chiral two-baryon potentials and effective density-dependent baryon-baryon interactions derived from the leading order chiral three-baryon forces. We compute the chemical potentials of neutrons and $\Lambda(1116)$-hyperons in order to investigate the critical density for the onset of Λ-formation in neutron-star matter.

The contact and one-pion exchange components of the ΛNN 3-body force depend on two yet undetermined short-distance parameters H_1 and H_2, whose ranges are explored by imposing empirical constraints from Λ-hypernuclei and nuclear matter.

Work supported in part by DFG and NSFC (CRC110).

HK 61: Astroparticle Physics II

Time: Friday 11:00–12:30 Location: J-HS L

Group Report HK 61.1 Fri 11:00 J-HS L

Measurement of weak couplings in neutron beta decay — •Bastian Märkisch[1], Hartmut Abele[2], Dirk Dubbers[3], Holger Mest[3], Michael Klopf[2], Alexander Petoukhov[4], Christoph Roick[1], Heiko Saul[1], Torsten Soldner[4], Xiangzun Wang[2], and Dominik Werder[3] — [1]Physik-Department, Technische Universität München, Germany — [2]Technische Universität Wien, Atominstitut, Austria — [3]Physikalisches Institut, Universität Heidelberg, Germany — [4]Institut Laue-Langevin, Grenoble, France

We present the most precise determination of the nucleon axial coupling from a measurement of the beta asymmetry in the decay of polarized neutrons. The instrument Perkeo III was installed at the PF1b beamline at the Institut Laue-Langevin, Grenoble, France. Leading sources of systematic error are eliminated or controlled by using a pulsed cold neutron beam. This measurement confirms previous results by Perkeo II and UCNA with improved precision. From it we determinate the CKM matrix element V_{ud}, and derive constraints on tensor interactions and a best limit on the Fierz interference term b from neutron decay. We conclude by presenting the status of the follow-up facility PERC at the FRM II, Garching.

HK 61.2 Fri 11:30 J-HS L

Measurement of the Fierz interference term with PERKEO III — •Max Lamparth[1], Karina Bernert[1], Hartmut Abele[3], Andreas Doblhammer[3], Erwin Jericha[3], Jens Klenke[4], Annabel Kropf[1], Kathrin Lehmann[4], Martin Losekamm[1], Heiko Saul[1], Ulrich Schmidt[5], Torsten Soldner[2], Lukas Werner[1], and Bastian Märkisch[1] — [1]TUM Physik-Department, Garching b. München, Deutschland — [2]Institut Laue-Langevin, Grenoble, Frankreich — [3]Atominstitut Wien, Wien, Östereich — [4]FRM, Garching b. München, Deutschland — [5]Physikalisches Institut Universität Heidelberg, Heidelberg, Deutschland

Neutron beta decay is an excellent system to test the structure of the charged weak interaction. The Fierz interference term b is sensitive to hypothetical scalar and tensor interactions and absent in the Standard Model. The signature of a non-zero Fierz term in neutron beta decay is an extra energy-dependent phase-space contribution. Major systematic effects are hence related to the detector response: calibration, temporal stability, spatial uniformity and non-linearity effects.

The spectrometer PERKEO III was installed at the Institute Laue-Langevin, Grenoble, France, with the aim to determine the Fierz interference term with a precision of 5×10^{-3} from the beta spectrum. We present the measurement and discuss the status of the analysis.

HK 61.3 Fri 11:45 J-HS L

Atomic Tritium Production and Trapping for Neutrino Mass Measurement in Project 8 — •Alec Lindman for the Project 8-Collaboration — PRISMA+ Cluster of Excellence, JGU Mainz

Project 8 is a phased experiment using tritium β-decay to investigate the absolute neutrino mass. Good energy precision, high statistics, and well-controlled systematics are required to reach an electron antineutrino mass limit of $\leq$ 40 meV. Our technique, Cyclotron Radiation Emission Spectroscopy (CRES), has achieved eV-scale resolution at 17.8 keV, near the tritium endpoint. Project 8 will be the first laboratory neutrino mass experiment to use atomic tritium (T). Decay of a T_2 molecule excites rovibrational states that smear the observed energy by $\approx$ 1 eV. The decay of T, however, has an energy smearing of $\leq$ 0.1 eV. Our baseline calls for trapping 30 mK atomic tritium in a 2-T-deep, 10+-m^3 superconducting magnetic bottle. I will discuss our approach to this large-volume atomic CRES experiment, focusing on production and handling techniques for recombination-prone tritium atoms.

This work is supported by the PRISMA+ Cluster of Excellence at the University of Mainz, the US DOE Office of Nuclear Physics, the US NSF, and internal investments at all institutions.

HK 61.4 Fri 12:00 J-HS L

Investigation of coating methods for radon background reduction in liquid xenon experiments — •Mona Piotter, Florian Jörg, Hardy Simgen, and Guillaume Eurin — Max-Planck-Institut für Kernphysik, Heidelberg

Several cosmological and astrophysical observations hint that a large fraction of the energy density of today's universe is present in the form of non-luminous matter. One candidate for this so-called dark matter is the WIMP (weakly interacting massive particle). Liquid xenon detectors can be used to detect their rare interactions with baryonic matter for which a very low background is necessary. The biggest source of background in these experiments originates from radon. To reduce this background studies are carried out investigating the radon mitigation properties of surface coatings. The coating methods that are considered include: electrodeposition, physical vapor deposition (PVD), chemical vapor deposition (CVD) and epoxy coatings.

The coatings are done on thoriated tungsten welding rods containing ^{232}Th which decays to ^{220}Rn. Therefore these rods are useful because they are a strong enough radon source. Previous studies already showed that electrodeposition can offer a significant reduction in radon emanation. Now the different parameters of coating were systematically analyzed. Additionally studies on PVD and CVD are done especially of multilayer coatings and diamond like carbon coatings.

The results of these investigations will be discussed as part of the talk.

HK 61.5 Fri 12:15 J-HS L

Antimatter Coscmic Ray Simulation — •Laura Serksnyte, Laura Fabbietti, Stephan Paul, Thomas Pöschl, and Maximilian Horst — Technical University of Munich (TUM)

The existence of dark matter has been well established by the galaxy rotation curves, the Bullet cluster and many other observational experiments. But no dark matter particle has been detected yet. The indirect dark matter search is looking for the dark matter annihilation and decay signals in cosmic rays. The antimatter cosmic rays have the smallest background for such studies. The antiproton cosmic ray flux simulation requires knowledge of the propagation of cosmic rays in the galaxy and the heliosphere as well as the antiproton production cross sections in the cosmic ray collisions with the interstellar medium. In this talk we show our propagation scheme using GALPROP for the propagation in the galaxy and HelMod for the propagation in the heliosphere. We implemented several options for antiproton production cross sections including parametrizations and event generator, such as GiBUU and EPOS, output. We will show how the antiproton cosmic ray flux depends on the antiproton production cross sections as the final result.

HK 62: Combined Instrumentation Session: Silicon Strip Detectors (joint session HK/T)

Time: Friday 11:00–13:00 Location: H-HS XIII

HK 62.1 Fri 11:00 H-HS XIII

Investigation of Irradiated silicon strip Sensors using the Trasient Current Technique — •Nicky Potters[1], Christian Scharf[2], Heiko Lacker[2], Ingo Bloch[3], and Johanna Stachel[1] — [1]Ruprecht-Karls-Universität Heidelberg, Heidelberg ,Germany — [2]Humboldt-Universität zu Berlin, Berlin, Germany — [3]Deutsches Elektronen-Synchrotron (DESY), Zeuthen, Germany

A new edge-TCT setup has been built and commissioned at DESY Zeuthen. The setup allows for charge injection at defined depth or at the surface of un-irradiated and irradiated ATLAS17LS silicon strip sensors using red and infrared laser light with 100 ps pulse width and a minimum beam diameter of $w_0 = 7\mu$m. The current induced by the injected carriers is measured with GHz bandwidth electronics in up to four channels and information on the electric field and other quantities can be extracted at defined positions in the sensors. Results of the commissioning of the setup using non-irradiated silicon strip sensors as

well as measurements of irradiated strip sensors will be presented. The sensors were irradiated with 70 MeV/c protons to equivalent fluences of $1.0 \cdot 10^{13}$ cm^{-2}, $3.7 \cdot 10^{14}$ cm^{-2}, $1.0 \cdot 10^{15}$ cm^{-2}, $1.3 \cdot 10^{16}$ cm^{-2} and with 1 MeV neutrons to $4.0 \cdot 10^{14}$ cm^{-2}, $1.0 \cdot 10^{14}$ cm^{-2}, $1.3 \cdot 10^{15}$ cm^{-2}, and $5.0 \cdot 10^{16}$ cm^{-2}. The position-dependent electric field has been determined by using a new method of fitting the edge-TCT data. Additionally, strip sensors with different strip metal and strip implant widths have been studied.

HK 62.2 Fri 11:15 H-HS XIII

Analysis of 2.7 GeV proton-beam measurements with the STS detector for the CBM experiment — •Patrick Pfistner for the CBM-Collaboration — Karlsruhe Institute of Technology

The Compressed Baryonic Matter (CBM) experiment at the future Facility for Antiproton and Ion Research (FAIR) in Darmstadt, Germany, aims to explore the quantum chromodynamics phase diagram for highest baryon densities. CBM will measure rare probes with high statistics which requires fast and radiation hard detectors combined with free-streaming readout electronics. One of the core detectors of CBM is the Silicon Tracking System (STS). The STS is the key detector for measuring the momentum and tracks of up to 800 charged particles produced in Au+Au collisions happening at interaction rates of up to 10 MHz. In order to evaluate the detector performance, comprehensive tests have been performed with a minimum ionizing particle beam at the COSY accelerator in Jülich in November 2019. During the beamtime, one fully assembled prototype module consisting of a double-sided Silicon microstrip sensor, 32 low-mass aluminum microcables, 16 STS-XYTER 2.1 readout ASICs and two front-end boards (FEB-8), has been exposed to a 2.7 GeV proton beam. We will present the status of the beamtime data analysis and discuss the related detector performance metrics.

HK 62.3 Fri 11:30 H-HS XIII

First beam test with the final readout scheme of Phase-2 CMS Outer Tracker 2S prototype modules — •Christian Dziwok[2], Lutz Feld[1], Katja Klein[1], Martin Lipinski[1], Alexander Pauls[1], Oliver Pooth[2], Max Rauch[1], Nicolas Röwert[1], and Tim Ziemons[2] — [1]I. Physikalisches Institut B, RWTH Aachen University — [2]III. Physikalisches Institut B, RWTH Aachen University

For the upcoming Phase-2 Upgrade for the operation of CMS at the HL-LHC a new silicon tracker design will be implemented. With extended acceptance and giving additional input of track p_T to the level-1 trigger, the new Outer Tracker will consist of 2S modules with two coplanar strip sensors and PS modules with a macro-pixel sensor and a strip sensor. Therefore, for these specialized detector modules the p_T information of a track is already available online. Based on cluster size and position in a module's sensors and its sensor spacing, a first p_T trigger information is generated in its front-end ASIC and then constantly streamed to the back end at bunch crossing rate.

The final front-end ASIC CBC 3.1 was used alongside the concentrator ASIC CIC v1 and the serializer- and slow control ASICs GBTx and SCA without additional interface card for the first time. This final readout scheme of 2S modules has been tested with up to 4 modules at once at the test beam facility of DESY Hamburg using a 4 GeV electron beam and the AIDA telescope. This talk will showcase the efficiency of the new p_T discrimination mechanism and the test on synchronicity of modules.

HK 62.4 Fri 11:45 H-HS XIII

Abschätzung des Signal- und Leckstromverhaltens im äußeren CMS Phase-2 Spurdetektors — Felix Bögelspacher, Tobias Bravich, Alexander Dierlamm, Umut Elicabuk, Jan-Ole Gosewisch, Ulrich Husemann, •Marius Metzler und Thomas Müller — Institut für Experimentelle Teilchenphysik, Karlsruher Institut für Technologie

Im September 2019 wurde die finale Entscheidung bezüglich des verwendeten Sensormaterials für den äußeren Bereichs des zukünftigen CMS-Spurdetektors gefällt. Der jetzige Spurdetektor wird im Rahmen der Phase-2 Aufrüstung des CMS-Detektors komplett ausgetauscht und durch neuere Komponenten ersetzt. Die verwendeten Streifensensortypen, der 2S und der PS-s, sowie der Makropixelsensor PS-p, werden auf FZ290 Siliziumwafern prozessiert werden. Dabei handelt es sich um float zone Wafer mit einer physikalischen Dicke von 320 μm und einer 30 μm dicken, hochdotierten Rückseitenimplantation, welche die aktive Dicke auf 290 μm reduziert.

Im Zuge des Forschungs- und Entwicklungsprozesses wurden Bestrahlungsstudien mit Signal- und Leckstrommessungen an FZ290 Sensoren für durchgeführt. Der Vortrag zeigt, wie diese Daten verwendet werden können, um die jährliche, optimale Operationsspannungen für verschiedene Bereiche des äußeren CMS Phase-2 Spurdetektors abzuschätzen. Daraus lassen sich dann Leckstrom und die benötigte Kühlleistung ableiten.

HK 62.5 Fri 12:00 H-HS XIII

Quality assurance of the CBM Silicon Tracking System sensors — •Evgeny Lavrik for the CBM-Collaboration — Facility for Antiproton and Ion Research, Darmstadt, Germany

The Compressed Baryonic Matter (CBM) experiment at FAIR aims to study the properties of nuclear matter at high net-baryon densities. The Silicon Tracking System is the key detector to reconstruct charged particle tracks created in heavy-ion interactions. In order to assure the quality of more than 1100 silicon sensors including spares, highly efficient and highly automated procedures were developed.

In this contribution we report on the optical and electrical quality assurance procedures for silicon sensors. We describe dedicated hardware setups to perform basics tests and full characterization and their application for the quality assurance of the STS sensors. We present the results of ongoing QA campaign of sensors from mass production which begun in November 2019.

HK 62.6 Fri 12:15 H-HS XIII

Silicon strip detector set-up for α-particle detection at MAGIX — •Jennifer Geimer for the MAGIX-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität, Mainz, Germany

The MAGIX experiment will take place at the energy recovering superconducting electron accelerator MESA in Mainz. At MAGIX high-precision electron scattering experiments will be performed. The experimental set-up is currently under development, it comprises a windowless gas target and two identical high-resolution magnetic spectrometers including a GEM-based TPC. Additionally, a silicon strip detector is planned to detect recoil particles in the scattering chamber. Its resolution requirements are derived from simulation studies of the ^{16}O(γ*,α)^{12}C reaction, which we will examine to determine the S-factor of the nucleosynthesis reaction of carbon and alpha. The design of this detector system and first performance studies will be presented in this talk.

HK 62.7 Fri 12:30 H-HS XIII

Studying magnet-induced wire-bond oscillations for the ATLAS ITk Strip Detector — •Ben Brüers[1], Ruchi Gupta[1], Ksenia Solovieva[2], Dennis Sperlich[3], and Edoardo Rossi[1] — [1]DESY — [2]Imperial College London — [3]Albert-Ludwigs-Universität Freiburg

For the high luminosity phase of the LHC, the ATLAS collaboration plans to upgrade its current tracking detector with a new, all silicon Pixel and Strip Detector, referred to as Inner Tracker (ITk). The ITk Strip Detector modules will contain printed circuit flex boards carrying the read-out and powering chips. All chips will be connected to the printed circuit flex boards using 25 μm thick aluminium wire-bonds. Several of these wire-bonds will carry alternating currents. In the 2 T solenoid magnetic field of ATLAS surrounding the ITk, these wire-bonds can start oscillating. Damage by oscillations have been observed e.g. at the CDF detector, when the trigger frequency (and with that the alternating current frequency) accidentally aligned with the resonance frequency of the wire-bonds. To study the potential danger of resonant wire-bond oscillations for the ITk Strip Detector, a prototype module was exposed to a 1 T magnetic field and triggered at multiple frequencies between 0.1 kHz and 350 kHz. To observe oscillations, an innovative observation setup was employed and several hours of video material collected. While the module was not damaged, the search for wire-bond oscillations in the video material is on-going. This talk will introduce the procedure and show the latest results on assessing the resonant frequencies and sensitivities of the ITk Strip Detector wire-bonds to magnet-induced oscillations.

HK 62.8 Fri 12:45 H-HS XIII

characterization and operation of the frontend electronics of the CBM silicon tracking system — •Osnan Maragoto Rodriguez for the CBM-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

The Compressed Baryonic Matter (CBM) experiment is a fixed-target heavy-ion physics experiment at the Facility for Antiproton and Ion

Research (FAIR) in Darmstadt, Germany. The CBM physics program aims at exploring the QCD phase diagram at very high baryon densities. For high-statistics measurements of rare probes, CBM is designed to cope with very high interaction rates up to 10 MHz. To achieve this high rate capability, the CBM experiment will be equipped with fast and radiation hard detectors employing free-streaming readout electronics. The Silicon Tracking System (STS) is the essential component for tracking up to 1000 charged particles per event in A+A collision. The experimental conditions pose demanding requirements in terms of channel density and read-out bandwidth. The STS-XYTER is a dedicated ASIC for the readout of the double-sided silicon micro-strip sensors. It is a low power, self-triggering ASIC with 128 channels, 5-bit ADC charge and 14-bit timing information. It needs to be fully integrated into a very confined space and it should perform in a highly irradiated environment with strong magnetic field. Several tests are carried out to check chip functionalities, full detector modules performance and integration aspects. An overview of the frontend electronic, module tests and experimental results, for different data taking scenarios, will be presented.

HK 63: Combined Instrumentation Session: Semiconductor Detectors (joint session HK/T)

Time: Friday 11:00–13:00 Location: H-HS XV

HK 63.1 Fri 11:00 H-HS XV

Investigation of light enhanced annealing of irradiated silicon strip detectors and pad diodes — •Mägdefessel Sven, Parzefall Ulrich, and Mori Riccardo — Uni Freiburg, Germany

Thermally induced annealing of irradiated silicon devices has been widely studied. Latest results indicate that charge carriers being generated during the annealing procedure can change charge states of the defect centers and therefore influence the annealing behaviour. Therefore, we irradiated silicon strip detectors and pad diodes during the annealing process with IR and green light to achieve different penetration depths and performed CV based impedance spectroscopy to investigate differences in defect behaviour compared to annealing in the dark.

HK 63.2 Fri 11:15 H-HS XV

Temperature Scaling of Leakage Current in Irradiated Silicon Sensors — •Felix Wizemann, Kevin Kröninger, and Jens Weingarten — TU Dortmund, Experimentelle Physik IV

The leakage current of silicon sensors increases with radiation damage, which can be used to monitor fluence. For this, the bulk leakage current needs to be scaled with temperature using the parameter E_{eff}. In previous studies, this parameter was determined to be 1.21 eV for samples irradiated to fluences up to $1 \times 10^{15}\,\mathrm{n_{eq}cm^{-2}}$. Sensors irradiated to higher fluences have shown lower values of E_{eff}.

To investigate this change in scaling behaviour, E_{eff} was determined as a function of the applied bias voltage for irradiated samples with fluences from $1 \times 10^{14}\,\mathrm{n_{eq}cm^{-2}}$ to $3 \times 10^{15}\,\mathrm{n_{eq}cm^{-2}}$. Results of this study are presented in this talk.

HK 63.3 Fri 11:30 H-HS XV

Studie zur Auswirkung von Strahlenschäden auf die Zwischenstreifenisolation von n-in-p Siliziumstreifensensoren — Felix Bögelspacher, Alexander Dierlamm, Thomas Müller, •Jan-Ole Müller-Gosewisch, Andreas Nürnberg, Hans Jürgen Simonis und Pia Steck — Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

Der Gebrauch von n-in-p Siliziumstreifensensoren erfordert eine spezifische Zwischenstreifenisolation. Ohne diese kommt es insbesondere nach Bestrahlung durch Akkumulation von Ladungsträgern an der Oberfläche zu einem Kurzschluss der Streifen und einer Verringerung der Ortsauflösung. Ein Maß für die Güte der Isolation ist der Zwischenstreifenwiderstand. Entgegen den Erwartungen wurde bei Sensoren ohne spezifische Isolation ein ausreichend hoher Widerstand zwischen den Streifen nach Protonenbestrahlung mit einer Fluenz von $10^{15}\mathrm{n_{eq}/cm^2}$ beobachtet. Für ein genaueres Verständnis der beitragenden Effekte auf die Streifenisolation wurden Sensoren ohne Zwischenstreifenimplantat mit Röntgenstrahlen, Protonen und Neutronen bestrahlt. In diesem Vortrag werden Messungen und Simulationen der Zwischenstreifenwiderstände für unterschiedlichen Bestrahlungszusammensetzungen gezeigt und bewertet.

HK 63.4 Fri 11:45 H-HS XV

Study of thermal runaway of hadron-irradiated silicon sensors — Ingo Bloch[1], Heiko Lacker[2], •Felix Riemer[2], and Christian Scharf[2] — [1]Deutsches Elektronen-Synchrotron DESY — [2]Humboldt-Universität zu Berlin

Silicon sensors are widely used in the several parts of the ATLAS detector at the LHC. Low leakage current is desirable since the leakage current generates heat. At the same time the leakage current increases with increasing sensor temperature. Thermal runaway will occur if the heat removed from the sensor is lower than the heat generated by the sensor. During operation the silicon sensors at hadron colliders are exposed to high fluences of highly energetic particles which introduce defects in the crystal lattice strongly increasing the leakage current. The cooling infrastructure of the detector has to be adapted order to prevent thermal runaway during operation until the end-of-life. Therefore, the capacitance and current of irradiated silicon diodes have been measured as a function of the particle fluence, temperature, bias voltage, heating power, and for different pad areas. The diodes were irradiated with 70 MeV/c protons and 1 MeV/c neutrons to equivalent fluences between $1 \cdot 10^{13}$ cm^{-2} and $5 \cdot 10^{16}$ cm^{-2}. The goal of the study is to develop models for the capacity and reverse current of highly irradiated silicon sensors which can be used to estimate the cooling power needed to prevent thermal runaway while fully depleting the sensors after high particle fluences.

HK 63.5 Fri 12:00 H-HS XV

R&D for the Cooling Demonstrator of the CBM Silicon Tracking System (STS) — •Kshitij Agarwal for the CBM-Collaboration — Physikalisches Institut der Universität Tübingen

As the core detector of the CBM experiment, the Silicon Tracking System (STS) located in the dipole magnet aims to reconstruct charged-particle tracks & momentum from beam-target interactions.

Due to the expected non-ionising irradiation damage (fluence - 10^{14} $\mathrm{n_{eq}(1MeV)/cm^2}$), the silicon microstrip sensors will dissipate < 6 mW/cm^2 at -10°C. Thus it is imperative to keep the sensors at or below -10°C at all times to avoid thermal runaway and reverse annealing by forced N_2 cooling. The corresponding electronics connected via ultra-thin microcables are placed outside detector acceptance with a dedicated cooling system used to remove $\sim$ 40kW power dissipated.

To experimentally verify the aforementioned concepts under realistic mechanical constraints, a thermal demonstrator comprising a half-layer of STS is under development. This contribution will describe the electronics cooling system design and respective cooling performance simulations. Experimental proof-of-principle tests/simulations with 3M™ Novec™ 649 for electronics cooling and air cooling for silicon sensor cooling will be shown. Lastly, future plans on the demonstrator integration and design will be also presented.

This work is supported by GSI/FAIR.

HK 63.6 Fri 12:15 H-HS XV

Ultra Fast Silicon Detectors for timing applications in HADES — •Wilhelm Krueger[1], Nicolo Cartiglia[2], Marco Ferrero[2,3], Tetyana Galatyuk[1,4], Mladen Kis[4], Wolfgang Koenig[4], Michal Koziel[5], Sergey Linev[4], Jan Michel[5], Stefano Moneta[6], Jerzy Pietraszko[4], Adrian Rost[1], Arnaud Schemm[7], Valentina Sola[2], Konrad Sumara[8], Michael Traeger[4], Michael Traxler[4], and Christian Wendisch[4] — [1]TU Darmstadt, Germany — [2]INFN, Sezione di Torino, Italy — [3]Università del Piemonte Orientale, Novara, Italy — [4]GSI, Darmstadt, Germany — [5]Goethe-Universität Frankfurt, Germany — [6]Universita di Pisa, Italy — [7]IMT Atlantique, Campus de Nantes, France — [8]Jagiellonian University in Kraków, Poland

In order to measure a precise time zero (T0) for particle identification produced in nucleon-nucleon or nucleus-nucleus collisions a time precision of 50 ps or better is required. Ultra fast silicon detectors (UFSD)

enable such precision. In addition the combination of high spatial resolution, high time precision and high radiation hardness makes them an excellent alternative to the scCVD diamond detectors used so far by HADES for T0 measurements and for beam monitoring.

In this contribution we present the results of test measurements conducted at COSY in Juelich. Particular emphasis is put on achieving the desired precision for MIPs and on comparison of two different discriminator boards, one based on the NINO chip and the other, called PaDiWa, which is based on discrete components. This work has been supported by BMBF under ErUM -FSP C.B.M. and GSI.

HK 63.7 Fri 12:30 H-HS XV

A precision floating, high-voltage picoamperemeter — •Florian Rössing, Tobias Rudolph, Dimitri Schaab, and Bernhard Ketzer — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

Many modern tracking detectors, e.g. the Time Projection Chambers for ALICE and CBELSA, are based on Micropattern Gaseous Detector (MPGD) technology. In the examples given above, Gas Electron Multipliers (GEM) will be used for the amplification of primary charges. The optimization of MPGD often requires current measurements at the level of picoamperes on the high-voltage lines. Therefore, currentmeters with a complete electrical insulation from ground are needed, requiring wireless data transmission and floating power supply. Previous versions of devices custom-made at TU München and further developed at Bonn University showed problems with the overvoltage-protection, a residual non-linearity and a non-negligible temperature dependence. In order to overcome these issues the analog signal processing was completely revised. The shunt resistor configuration in use was replaced by a zero burden transimpedance amplifier, with high input impedance. A precise temperature sensor and a photovoltaic powering were added. In the talk design characteristics and the performance of the devices will be discussed.

HK 63.8 Fri 12:45 H-HS XV

Automatized dark current measurement system for irradiated SiPM detectors in COSY — •Anoop Nagesh Koushik for the JEDI-Collaboration — Forschungszentrum Jülich GmbH — III. Physikalisches Institut B, RWTH Aachen University

The JEDI (Jülich Electric Dipole moment Investigations) collaboration performs Electric Dipole Moments (EDM) experiments with deuteron beams at COSY (COoler Synchrotron) accelerator in Forschungszentrum Jülich. The beam is polarized and the determination of the polarization is based on a polarimeter using LYSO scintillators coupled to SiPM (Silicon Photo-Multiplier) modules. SiPM are preferred over traditional PMT's because of absence of high electric fields near the beam which affects the EDM measurements.

SiPMs near the beam pipe were accidentally exposed to intense radiation and were damaged. This radiation damage adds noise to the signal and hence decreases the resolution of the detector. The dark current of the irradiated SiPM was characterized and was found to be orders of magnitude higher.

An automatized system of dark current measurement for different SiPM reverse bias voltages was developed. 8x8 array mapping of the SiPM was designed to analyze the extent of the damage of the irradiated SiPM. Few SiPM arrays were annealed several times at different temperatures and was compared to the previous annealed results to determine the reduction of the damage. Extent of damage, the results of annealing and the comparison between them for the irradiated SiPM will be presented and discussed in the talk.

HK 64: Combined Instrumentation Session: Gaseous Detectors (joint session HK/T)

Time: Friday 11:00–13:00 Location: J-HS C

HK 64.1 Fri 11:00 J-HS C

Study of gas gain in GEM detectors — •Henning Keller, Thomas Hebbeker, Kerstin Hoepfner, Giovanni Mocellin, and Shawn Zaleski — III. Physikalisches Institut A, RWTH Aachen University

The Gas Electron Multiplier (GEM) technology is quite popular among the gaseous detector community due to the excellent performance, even in high-rate environments; it has strong resistance to aging as well as a flexible design. The heart of the detector consists of GEM foils with an etched hexagonal pattern of holes. The detection principle relies on electron multiplictation inside the holes, where a high electric field is apparent. GEM detectors are currently being installed in the CMS Muon system at the LHC in preparation for Run-3. New etching techniques have been used for the production of large-size ($\mathcal{O}(1\ \mathrm{m}^2)$) GEM foils needed for CMS. The new techniques result in different hole geometries inside the GEM foil. In order to better understand the gas gain dependance on the hole geometry, several measurements have been performed, and have been complemented by GARFIELD++ simulations. The findings are compared with other recent studies.

HK 64.2 Fri 11:15 J-HS C

Studies on a structured cathode to increase the detection efficiency of gaseous detectors — •Katrin Penski, Otmar Biebel, Bernhard Flierl, Maximilian Herrmann, Ralf Hertenberger, Christoph Jagfeld, Felix Klitzner, Maximilian Rinnagel, Sebastian Trost, Chrysostomos Valderanis, and Fabian Vogel — LMU München

Micropattern gaseous detectors show extremely good spatial resolution and high-rate capability. Nevertheless, due to the low density of the gas detector they exhibit only low detection efficiency for neutral particles such as e.g. high energy photons or neutrons. For these particles the detection efficiency can be increased by using a solid converter cathode e.g. of high-Z materials as gold for photons or materials with a large neutron interaction cross section e.g. ^{10}B for neutrons. In order to obtain even higher efficiencies several tilted converter layers can be stacked with large overlap. For photons several studies were performed to optimize the detection efficiency in regard to cathode geometry and detector performance. Especially, measurements of the drift electron movement and investigations of the improvement of the efficiency are presented and compared to results of corresponding simulations. These measurements were performed using a prototype cathode and a GEM detector.

HK 64.3 Fri 11:30 J-HS C

Charge transfer properties of a GEM stack – simulations and measurements — •Jan Paschek, Philip Hauer, Jonathan Ottnad, Markus Ball, and Bernhard Ketzer — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

Gas Electron Multipliers (GEM) are a micropatterned structure widely used as an amplification stage in gaseous detectors exposed to a high rate particle flux, e.g. Time Projection Chambers. Typically, a GEM consists of a polyimide foil which is coated with thin copper layers on both sides. Through a photolitographic process large numbers of holes are etched into this structure. In order to obtain the desired amplification a suitable voltage needs to be applied between both metal layers.

Typically, detectors consist of stacks of multiple GEM foils. The performance of a detector is highly influenced by the charge-transfer properties within the stack. To study these effects, a Monte-Carlo program simulating the charge transfer in a GEM stack using the frameworks Garfield++ and Ansys has been written. This program allows us to predict the properties of a GEM stack from the geometry of the GEM-foils and the applied fields. In order to verify the predictions a test detector has been assembled with a configuration corresponding to the quadruple GEM stack of the new readout chambers for the ALICE TPC. The talk will discuss the simulation program and compare the predictions to measurements with this test detector.

Supported by BMBF.

HK 64.4 Fri 11:45 J-HS C

The Charge-Up Effect in GEM Detectors – Simulations and Measurements — •Philip Hauer, Karl Flöthner, Dimitri Schaab, Markus Ball, and Bernhard Ketzer — Univ. Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

Gas Electron Multipliers (GEM) are widely used as an amplification stage in gaseous detectors exposed to high rates, e.g. in the Time Projection Chamber of the ALICE (A Large Ion Collider Experiment) experiment after its upgrade. Typically, the GEM consists of a polyimide foil which is coated from both sides with thin layers of copper.

Holes are etched into this structure in which electrons can get multiplied.

During the multiplication process, some electrons and ions diffuse to the polyimide part of the GEM and are adsorbed there, which change the electric field inside the holes. This is known as the *charge-up effect*. Many publications suggest that it is causing a change of the effective gain with time but a quantitative description is often missing.

In this work, the charge-up effect was investigated quantitatively in simulations and measurements. The simulations are based on an iterative approach, where new field maps are calculated with a finite element method and the deposition of charges is simulated with Garfield++. For the measurements, a dedicated test detector was set up with a single (standard) GEM foil as amplification stage. In this talk, the results from both approaches will be shown and compared to each other. A special focus lies on the influence of initial rate, applied voltage and different hole shapes on the charge-up effect.

Supported by BMBF.

HK 64.5 Fri 12:00 J-HS C

Propagation of discharges in a double-GEM detector — •Bogdan Blidaru for the ALICE-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

The Large Hadron Collider will provide Pb-Pb collisions at an interaction rate of 50 kHz from 2021 onward.

In order to cope with this, the ALICE Time Projection Chamber is being upgraded. Readout chambers equipped with a stack of four Gas Electron Multiplier (GEM) foils provide a continuous readout. After installation in the ALICE cavern, the GEM chambers will be inaccessible. Thus, long-term stability and reliable readout over a time span of about 10 years is required.

One of the major challenges GEMs must overcome are electrical discharges, which can short-circuit a GEM segment and render it inactive. Some peculiar aspects of the discharge phenomena are surfacing. This talk is focused on the propagating nature of discharges, from one GEM in a stack to another.

A small detector with two 10×10 cm^2 GEM foils is used to study the evolution of the GEM potentials during and after discharges. Particular emphasis is put on understanding and mitigating the appearance of discharges by using decoupling resistors that substantially reduce their propagation probability.

Moreover, some new results showing that photons are not solely responsible for the propagation of discharges are discussed. A considerable number of events where the propagation is delayed by more than 300 ns are observed and studied.

HK 64.6 Fri 12:15 J-HS C

Modelling of discharge in parallel-plate-type Micro-Pattern gaseous detectors — •Deb Sankar Bhattacharya, Raimund Ströhmer, and Thomas Trefzger — University of Wüzburg, Physik und ihre Didaktik, Emil-Hilb-Weg 22, 97074, Germany

The Micro-Pattern Gaseous Detectors (MPGD) have been widely adopted in nuclear and particle physics experiments, for their fast response and other excellent characteristics. To achieve the required signal strength and detection efficiency, sometimes they are operated at a high voltage range. This often challenges the limit of high voltage stability of the detector. Discharge in gaseous detectors is a complex process and there are several factors which may directly or indirectly influence. The microscopic geometrical structures of the MPGDs may itself sometimes induce discharges. In this study, we are numerically investigating the discharge phenomena in non-resistive Micromegas. Within the COMSOL framework, a 3-dimensional model is developed to observe the occurrence and the development of discharge in Micromegas. The effect of space charge has been taken into account in the calculation. The model allows to vary the geometrical parameters of the detector as well as to study the effects of gas impurities and a different number of primary charges.

HK 64.7 Fri 12:30 J-HS C

Status of MRPC performance for the endcap-time-of-flight upgrade of STAR — •Philipp Weidenkaff for the CBM-Collaboration — Ruprecht-Karls-Universität Heidelberg

As part of the FAIR phase 0 program, CBM-ToF MRPC modules have been installed as endcap-time-of-flight detectors in STAR for the current beam-energy-scan II (BES II) program in 2019 and 2020. These detectors provide a major improvement to the particle identification capability of the experiment in the forward region ($1.0 < \eta < 1.5$), which is especially necessary for the fixed target program. An Analysis of the MRPC performace in terms of time resolution, efficiency and matching to STAR-TPC tracks will be presentent in this talk. The Results are based on the 2019 run as well as first data of the 2020 run.

The project is partially founded by BMBF 05P15VHFC1.

HK 64.8 Fri 12:45 J-HS C

Development of a High Pressure Time Projection Chamber — •Philip Hamacher-Baumann, Thomas Radermacher, Stefan Roth, and Nick Thamm — III. Physikalisches Institut B, RWTH Aachen University

Gaseous detectors have long been used by particle physics experiments. Their low momentum threshold has made them interesting as active targets for long baseline neutrino experiments. To increase the statistics of neutrino interactions, but retain a low momentum threshold, pressurized Time Projection Chambers (TPCs) have been proposed. The Deep Underground Neutrino Experiment (DUNE) considers building one as part of its near detector complex.

Gas Monitoring Chambers are mini TPCs that are designed to measure gas properties. Such a system with the capability of testing common and new drift gas mixtures can provide input to the design process of new high pressure TPCs. This talk presents a High Pressure Gas Monitoring Chamber (HPGMC), capable of operating up to 10 bar pressure and a maximum drift field close to 1000 V/cm.

HK 65: Combined Instrumentation Session: Silicon Pixel Detectors (joint session HK/T)

Time: Friday 11:00–12:45 Location: J-HS K

HK 65.1 Fri 11:00 J-HS K

ATLASPix3 – A reticle sized HV-CMOS Detector for Construction of Multi-Sensor Modules — •Rudolf Schimassek[1], Felix Ehrler[1], Mridula Prathapan[1], Alena Weber[1,2], Winnie Wong[3], Hui Zhang[1], and Ivan Perić[1] — [1]Karlsruher Institut für Technologie — [2]Universität Heidelberg — [3]Université de Genève

Monolithic High-Voltage CMOS (HV-CMOS) detectors are a sensor type planned to be used for tracking in several particle physics experiments. HV-CMOS Sensors are especially well suited for applications with strict constraints on mass and spatial resolution. In addition, low power and radiation hardness, along with good time resolution are possible. Furthermore, the usage of standard CMOS processes makes the detectors highly available and cheap.

To overcome the mask size limit of HV-CMOS processes, the ATLASPix3 detector is designed to be used in multi-chip modules. It is a 2×2.1 cm^2 three side buttable pixel sensor, designed for the environment of layer 4 of the ATLAS inner tracker upgrade for High-Luminosity LHC. A single data input and a single data output are sufficient to control and read out the detector using protocols that are RD53 compatible. The detector was produced on a high resistivity substrate and the first production shows a good yield. In this contribution, measurements of the detector features and performances will be presented.

HK 65.2 Fri 11:15 J-HS K

CMS Phase-1 pixel detector never sleeps: results from the Hamburg group — •Irene Zoi, Finn Feindt, Alexander Froehlich, Erika Garutti, Johannes Haller, Andreas Hinzmann, Viktor Kutzner, Torben Lange, Malte Mrowietz, Yuval Nissan, Peter Schleper, Dennis Schwarz, Jory Sonneveld, Georg Steinbrueck, and Benedikt Vormwald — University of Hamburg

The CMS Phase-1 Pixel detector has already been successfully operated for two years and has collected more than a 100 fb^{-1} of data and consequently radiation. During the ongoing shut down it has been extracted from the experiment and has been kept cold and monitored in a clean environment. The Hamburg group has been involved in all these operations and continues to control the status of the detector, to study

the collected data to improve our knowledge of radiation damage and make predictions for future data taking. In this talk a broad overview of the achievements of the group will be offered. The radiation study on data and simulation will be covered. These are based on leakage current and cluster charge. The progress in detector monitoring in clean room and in the on-line monitoring tools and database will be presented. The improvements for the future data acquisition will be also described.

HK 65.3 Fri 11:30 J-HS K

First measurements with an ALPIDE MAPS telescope in an 40-Ar test beam at GSI — •Pascal Becht for the ALICE-Collaboration — GSI Helmholzzentrum für Schwerionenforschung, Darmstadt, Germany

In the framework of the ALICE Inner Tracking System (ITS) upgrade during LHC's long shutdown 2, a new silicon sensor chip was developed and produced. This ALICE Pixel Detector (ALPIDE) chip is entirely built up of Monolithic Active Pixel Sensors (MAPS) and can be thinned down to 50 μm. It features a low material budget of only 0.05% X/X_0 as well as a position resolution in the order of 5 μm, which makes it suitable for the use in high-resolution beam telescopes.

In order to investigate the detector performance different beam tests with e. g. proton or pion beams have been performed using an ALPIDE MAPS telescope. To study the performance of such telescopes being irradiated with highly ionising particles, a 7-layer ALPIDE MAPS telescope has been brought to GSI and installed in a test beam area. In this talk, first results of this 50 MeV/u 40-Ar beam test at GSI are discussed.

HK 65.4 Fri 11:45 J-HS K

Results from the MIMOSIS-0 CMOS Monolithic Active Pixel Sensor — •Benedict Arnoldi-Meadows for the CBM-MVD-Collaboration — Goethe Universität Frankfurt am Main

The next generation CMOS Monolithic Active Pixel Sensor MIMOSIS is being developed to respond to the challenges imposed by future applications including the CBM Micro Vertex Detector. The project, which is carried out by the PICSEL group of IPHC Strasbourg and the Goethe University Frankfurt, aims for a 50 μm thin and ~ 5 cm^2 sized sensor. This sensor will host 1024×504 pixels with a size of 26.9×30.2 μm^2. The pixels include the amplifier-shaper-discriminator chain known from the ALPIDE chip which was extended to achieve a compatibility with a fully depleted sensing element. Moreover, MIMOSIS will feature a continuous readout suited for a readout time of 5 μs and peak rates of 70 MHz/cm^2.

We show results from measurements performed with the preamplifier of a first prototype called MIMOSIS-0, which indicate that a time resolution well below 1 μs might be within reach. *This work has been supported by BMBF ErUM-FSP C.B.M. (05P19RFFC1), GSI and HIC for FAIR.

HK 65.5 Fri 12:00 J-HS K

Experiences with long-term operation of a CBM-MVD prototype module. — •Michal Koziel for the CBM-MVD-Collaboration — Goethe Universität Frankfurt

The Compressed Baryonic Matter Experiment (CBM) is one of the core experiments of the future FAIR facility. It will explore the phase diagram of strongly interacting matter in the regime of high net baryon densities with numerous probes, among them open charm. The Micro Vertex Detector (MVD) will contribute to the secondary vertex determination on a 10 μm scale, reconstruction of weak decays of multi-strange baryons, and low-momentum track reconstruction. The detector comprises four stations placed next to the target in vacuum. The stations will be populated with 50 μm thin, highly granular customized CMOS Monolithic Active Pixel Sensors (MAPS) called MIMOSIS.

The integration of the mechanically fragile MAPS to vacuum compatible detector stations was studied within the PRESTO project. This project aimed for building a quarter of a detector station including the necessary vacuum compatible cooling system and the steering electronics. The study was carried out with elder MIMOSA-26 sensors, which are considered as a representative precursor of the final sensor technology. We report the outcome of this study and the observations made while operating PRESTO for several months under vacuum conditions.

*This work has been supported by BMBF ErUM-FSP C.B.M. (05P19RFFC1), GSI and HIC for FAIR.

HK 65.6 Fri 12:15 J-HS K

The MuPix10 - design and status — •Alena Weber for the Mu3e-Collaboration — Physikalisches Institut, Universität Heidelberg — Karlsruher Institut für Technologie

The Mu3e experiment is going to search for the charged lepton flavour violating decay $\mu^+ \to e^+e^-e^+$ with a sensitivity of one in 10^{16} decays (in phase II). High Voltage Monolithic Active Pixel Sensors (HV-MAPS) with a minimal gate length of 180nm will be used for its tracking system which will be the core element of the detector.

In the last years several prototypes of different size for the Mu3e pixel sensors were designed and tested. In 2019 the latest version of the MuPix, the MuPix10, was submitted. MuPix10 is a chip of full reticle size (2.066 x 2.318 cm^2) and contains a pixel matrix with 256 columns each with 250 pixels. The pixel size is 80 um x 80 um. The readout buffer has two different operation modes, one providing ToT measurement and one implementing a two threshold method. Some new elements have been added, for example a delay circuit. The timestamp was extended to 11 bit, the ToT has now 5 bit. The pixels are organized together with the readout buffer and the end of column in a double column architecture.

In this contribution the MuPix10 design and the next steps will be presented.

HK 65.7 Fri 12:30 J-HS K

TCAD Simulation of High-Voltage Monolithic Active Pixel Sensors — •Annie Meneses Gonzalez, Heiko Augustin, and Andre Schöning — Physikalisches Institut, Universität Heidelberg

The requirements for precision physics and the experimental conditions of several Particle Physics experiments lead often to challenging tracking detectors. High-Voltage Monolithic Active Pixel Sensors (HV-MAPS) implemented in a commercial 180 nm High-Voltage CMOS process has been chosen as the baseline for the Mu3e Pixel Tracker and are under study for the application in future detectors like PANDA, P2, CLIC, and LHCb.

A full depletion over the pixel, a fast charge collection, and a high signal-to-noise ratio are essential to achieve highly efficient sensors and good time resolutions.

Technology Computer-Aided Design (TCAD) simulations have been used to develop and optimize HV-MAPS, aiming for a comprehensive understanding of the sensor characteristics. Simulation results of the pixel capacitance for different prototypes and pixel sizes will be presented.

HK 66: Invited Talks V

Time: Friday 14:30–16:00 Location: H-HS X

Invited Talk HK 66.1 Fri 14:30 H-HS X

Baryon Spectroscopy with the CBELSA/TAPS experiment at ELSA — •Annika Thiel for the CBELSA/TAPS-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn

The dynamics of the quarks and gluons inside the nucleon are a long-standing question in hadron physics. To shed more light on this topic, the excitation spectrum of the nucleons needs to be measured and compared to theoretical models like constituent quark models or lattice QCD calculations. Until now, most of the predicted resonances - especially at high masses - have not been found by experiments, which are the well-known "missing resonances". The missing resonances problem is a recent research project by several different experiments. One of them is the CBELSA/TAPS experiment, which is located at the ELSA accelerator in Bonn. This experiment features a detector system with nearly full 4π angular coverage and a high detection efficiency for photons, which makes it the ideal tool for the measurement of final states comprising neutral mesons. One of its features is the use of linearly or circularly polarized photon beams impinging on a longitudinally or transversely polarized butanol target. This allows for the measurement of single or double polarization observables, which are of major importance in the identification of weak resonance contributions.

In this talk, an overview of the recent status in baryon spectroscopy at the CBELSA/TAPS experiment will be given, which includes the measurement of different polarization observables and a review of their impact on the excitation spectra of the nucleons. Supported by the DFG (SFB/TR16).

Invited Talk HK 66.2 Fri 15:00 H-HS X

The BGOOD experiment at ELSA - exotic structures in the light quark sector? — •Thomas Jude for the BGO-OD-Collaboration — Physikalisches Institut, Universität Bonn

The recent discoveries of the pentaquark, P_C, states and XYZ mesons in the charmed quark sector began a new epoch in hadron physics, where multi-quark states beyond three and two quark systems have been realised. Such states could manifest as single colour bound objects, or evolve from meson-baryon and meson-meson interactions, creating molecular like systems and re-scattering effects near production thresholds. Intriguingly, similar effects may be evidenced in the light, *uds* sector in meson photoproduction. Access to a low momentum exchange and forward meson production region is crucial. BGOOD is uniquely designed to explore this kinematic region; a central calorimeter is complemented by a magnetic spectrometer in forward directions.

First results indicate a peak-like structure in the $\gamma n \to K^0\Sigma^0$ cross section at $W \sim 2\,\text{GeV}$ consistent with the meson-baryon interaction model which predicted the charmed P_C states. Unexpectedly, a drop in the $\gamma p \to K^+\Sigma^0$ cross section at forward angles at $W \sim 1.9\,\text{GeV}$ is also observed, consistent with threshold effects from meson-baryon interactions. BGOOD's forward acceptance also enables identification of coherent photoproduction from deuterons. This is currently being exploited to study the dibaryon, $d^*(2380)$, which may have an important impact upon the equation of state for neutron stars.

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Invited Talk HK 66.3 Fri 15:30 H-HS X

Double parton scattering and double parton distributions — •Peter Plössl — DESY Hamburg

Double parton scattering (DPS) describes the situation when two individual hard scattering reactions occur in a single hadron-hadron collision. In some regions of phase space DPS may give sizeable contributions to the production of multi-particle final states and thus be an important background to single parton scattering (SPS) in channels suitable for the search for physics beyond the standard model. Furthermore DPS is also an interesting phenomena in its own right, as it gives insight into the correlations of partons inside of hadrons.

A theoretical description of DPS processes from first principles can be achieved by deriving factorisation theorems akin to the ones known from SPS, with a central building block being the double parton distributions (DPDs). However, these DPDs are presently basically unknown as experimental data is still lacking.

As a consequence one has to rely on physically motivated models for DPDs to be able to calculate DPS contributions to a given process. One important constraint for such models is given by number and momentum sum rules for DPDs in close analogy to the well known PDF sum rules. Another constraint can be obtained by observing that in the limit of small distances between the two partons DPDs can in fact be matched onto a regular PDFs with a perturbative matching kernels.