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Fachverband Physik der Hadronen und Kerne (HK)

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Overview of Invited Talks and Sessions

(Lecture halls HK-H1 to HK-H10)

Invited Talks

HK 1.1	Mon	11:00–11:30	HK-H1	**A supernova in the lab - Astrophysics with stored, radioactive ions** — •Jan Glorius
HK 1.2	Mon	11:30–12:00	HK-H1	**Exotic quark-made formations** — •Mikhail Mikhasenko
HK 1.3	Mon	12:00–12:30	HK-H1	**Nuclear ab-initio theory for neutrino oscillations** — •Joanna Sobczyk, Sonia Bacca, Bijaya Acharya
HK 22.1	Tue	11:00–11:30	HK-H1	**Towards background-free measurements of double-beta decay events: a quest to increase the detection sensitivity of the neutrinoless double beta decay mode** — •Samuel Ayet San Andres
HK 22.2	Tue	11:30–12:00	HK-H1	**Baryon spectroscopy with the Jülich-Bonn dynamical coupled-channel approach** — •Deborah Rönchen
HK 22.3	Tue	12:00–12:30	HK-H1	**Hadronen und Kerne in der Öffentlichkeit** — •Christian Klein-Bösing
HK 23.1	Tue	14:00–14:30	HK-H1	**Jets in heavy-ion collisions** — •Jasmine Brewer
HK 23.2	Tue	14:30–15:00	HK-H1	**The initial state of the quark-gluon plasma at the intersection of hadronic and nuclear physics** — •Giuliano Giacalone
HK 23.3	Tue	15:00–15:30	HK-H1	**High-precision mass spectrometry with ISOLTRAP at ISOLDE/CERN** — •Jonas Karthein
HK 34.1	Wed	11:00–11:30	HK-H1	**Nuclear equation of state constrained by nuclear physics, microscopic and macroscopic collisions** — •Sabrina Huth
HK 34.2	Wed	11:30–12:00	HK-H1	**Electromagnetic Counterparts of Neutron Star Mergers: Signatures of Heavy r-Process Nucleosynthesis** — •Andreas Flörs, Luke Shingles, Gabriel Martínez-Pinedo
HK 34.3	Wed	12:00–12:30	HK-H1	**Towards a next-generation LHC heavy-ion Experiment with ALICE** — •Raphaelle Bailhache
HK 55.1	Thu	11:00–11:30	HK-H1	**Online data processing with GPUs in ALICE during LHC Run 3** — •David Rohr
HK 55.2	Thu	11:30–12:00	HK-H1	**From outer space to deep inside: nuclear physics prospects at MAMI and MESA** — •Michaela Thiel
HK 55.3	Thu	12:00–12:30	HK-H1	**CMOS Monolithic Active Pixel Sensors** — •Michael Deveaux
HK 75.1	Fri	11:00–11:30	HK-H1	**Hyperon Physics with PANDA at FAIR** — •Jennifer Pütz
HK 75.2	Fri	11:30–12:00	HK-H1	**3-hadron problem from lattice QCD** — •Maxim Mai

Invited talks of the joint symposium Plasmas in the Universe (SYPU)

See SYPU for the full program of the symposium.

SYPU 1.1	Wed	9:00– 9:30	Audimax	**Recent progress in simulations of dense quantum plasmas and warm dense matter** — •Michael Bonitz, Paul Hamann, Tobias Dornheim, Zhandos Moldabekov, Alexey Filinov, Jan Vorberger, Pavel Levashov
SYPU 1.2	Wed	9:30–10:00	Audimax	**The quark gluon plasma: from the laboratory to neutron stars** — •Jan Steinheimer
SYPU 1.3	Wed	10:00–10:30	Audimax	**Characterizing the QCD Plasma** — •Andrea Dubla

Invited talks of the joint symposium Plasma Induced Accelerators (SYPA)

See SYPA for the full program of the symposium.

SYPA 1.1	Wed	11:00–11:30	Audimax	**Laser-driven ion acceleration -20 years of research: applications and prospect-** — •Markus Roth
SYPA 1.2	Wed	11:30–12:00	Audimax	**Laser-plasma ion accelerators for radio-biological research** — •Karl Zeil
SYPA 1.3	Wed	12:00–12:30	Audimax	**Hybrid plasma accelerators towards higher-quality electron beams** — •S. Karsch, M. Foerster, A. Döpp, M. Gilljohann, J. Götzfried, K. v. Grafenstein, F. Haberstroh, J. Wenz, S. Corde, O. Kononenko, B. Hidding, T. Heinemann, T. Kurz, J. Couperus-Cabadag, U. Schramm, A. Debus, A. Martinez de la Ossa

Sessions

HK 1.1–1.3	Mon	11:00–12:30	HK-H1	**Invited Talks I**
HK 2.1–2.5	Mon	14:00–15:30	HK-H1	**Heavy-Ion Collisions and QCD Phases I**
HK 3.1–3.5	Mon	14:00–15:30	HK-H2	**Heavy-Ion Collisions and QCD Phases II**
HK 4.1–4.5	Mon	14:00–15:30	HK-H3	**Instrumentation I**
HK 5.1–5.5	Mon	14:00–15:30	HK-H4	**Instrumentation II**
HK 6.1–6.6	Mon	14:00–15:30	HK-H5	**Instrumentation III**
HK 7.1–7.6	Mon	14:00–15:30	HK-H6	**Structure and Dynamics of Nuclei I**
HK 8.1–8.6	Mon	14:00–15:30	HK-H7	**Structure and Dynamics of Nuclei II**
HK 9.1–9.5	Mon	14:00–15:30	HK-H8	**Hadron Structure and Spectroscopy I**
HK 10.1–10.4	Mon	14:00–15:30	HK-H9	**Hadron Structure and Spectroscopy II**
HK 11.1–11.5	Mon	14:00–15:30	HK-H10	**Nuclear Astrophysics I**
HK 12.1–12.5	Mon	16:00–17:30	HK-H1	**Heavy-Ion Collisions and QCD Phases III**
HK 13.1–13.5	Mon	16:00–17:15	HK-H2	**Heavy-Ion Collisions and QCD Phases IV**
HK 14.1–14.4	Mon	16:00–17:30	HK-H3	**Instrumentation IV**
HK 15.1–15.5	Mon	16:00–17:30	HK-H4	**Instrumentation V**
HK 16.1–16.6	Mon	16:00–17:30	HK-H5	**Instrumentation VI**
HK 17.1–17.6	Mon	16:00–17:45	HK-H6	**Structure and Dynamics of Nuclei III**
HK 18.1–18.6	Mon	16:00–17:45	HK-H7	**Structure and Dynamics of Nuclei IV**
HK 19.1–19.6	Mon	16:00–17:45	HK-H8	**Hadron Structure and Spectroscopy III**
HK 20.1–20.5	Mon	16:00–17:30	HK-H9	**Hadron Structure and Spectroscopy IV**
HK 21.1–21.4	Mon	16:00–17:30	HK-H10	**Astroparticle Physics I**
HK 22.1–22.3	Tue	11:00–12:30	HK-H1	**Invited Talks II**
HK 23.1–23.3	Tue	14:00–15:30	HK-H1	**Invited Talks III**
HK 24.1–24.5	Tue	16:00–17:30	HK-H1	**Heavy-Ion Collisions and QCD Phases V**
HK 25.1–25.5	Tue	16:00–17:30	HK-H2	**Heavy-Ion Collisions and QCD Phases VI**
HK 26.1–26.6	Tue	16:00–17:30	HK-H3	**Instrumentation VII**
HK 27.1–27.5	Tue	16:00–17:30	HK-H4	**Instrumentation VIII**
HK 28.1–28.6	Tue	16:00–17:45	HK-H5	**Computing I**
HK 29.1–29.6	Tue	16:00–17:30	HK-H6	**Structure and Dynamics of Nuclei V**
HK 30.1–30.5	Tue	16:00–17:30	HK-H7	**Outreach**
HK 31.1–31.6	Tue	16:00–17:45	HK-H8	**Hadron Structure and Spectroscopy V**
HK 32.1–32.5	Tue	16:00–17:30	HK-H9	**Hadron Structure and Spectroscopy VI**
HK 33.1–33.5	Tue	16:00–17:30	HK-H10	**Nuclear Astrophysics II**

HK 34.1–34.3	Wed	11:00–12:30	HK-H1	**Invited Talks IV**
HK 35.1–35.5	Wed	14:00–15:30	HK-H1	**Heavy-Ion Collisions and QCD Phases VII**
HK 36.1–36.5	Wed	14:00–15:30	HK-H2	**Heavy-Ion Collisions and QCD Phases VIII**
HK 37.1–37.5	Wed	14:00–15:30	HK-H3	**Instrumentation IX**
HK 38.1–38.5	Wed	14:00–15:30	HK-H4	**Instrumentation X**
HK 39.1–39.8	Wed	14:00–16:00	HK-H5	**Computing II**
HK 40.1–40.5	Wed	14:00–15:30	HK-H6	**Structure and Dynamics of Nuclei VI**
HK 41.1–41.5	Wed	14:00–15:30	HK-H7	**Structure and Dynamics of Nuclei VII**
HK 42.1–42.5	Wed	14:00–15:30	HK-H8	**Hadron Structure and Spectroscopy VII**
HK 43.1–43.5	Wed	14:00–15:30	HK-H9	**Hadron Structure and Spectroscopy VIII**
HK 44.1–44.4	Wed	14:00–15:30	HK-H10	**Astroparticle Physics II**
HK 45.1–45.4	Wed	16:00–17:15	HK-H1	**Heavy-Ion Collisions and QCD Phases IX**
HK 46.1–46.4	Wed	16:00–17:15	HK-H2	**Heavy-Ion Collisions and QCD Phases X**
HK 47.1–47.6	Wed	16:00–17:30	HK-H3	**Instrumentation XI**
HK 48.1–48.5	Wed	16:00–17:15	HK-H4	**Instrumentation XII**
HK 49.1–49.4	Wed	16:00–17:00	HK-H5	**Instrumentation XIII**
HK 50.1–50.6	Wed	16:00–17:45	HK-H6	**Structure and Dynamics of Nuclei VIII**
HK 51.1–51.5	Wed	16:00–17:30	HK-H7	**Structure and Dynamics of Nuclei IX**
HK 52.1–52.6	Wed	16:00–17:30	HK-H8	**Hadron Structure and Spectroscopy IX**
HK 53.1–53.5	Wed	16:00–17:30	HK-H9	**Hadron Structure and Spectroscopy X**
HK 54.1–54.5	Wed	16:00–17:30	HK-H10	**Nuclear Astrophysics III**
HK 55.1–55.3	Thu	11:00–12:30	HK-H1	**Invited Talks V**
HK 56.1–56.5	Thu	14:00–15:30	HK-H1	**Heavy-Ion Collisions and QCD Phases XI**
HK 57.1–57.6	Thu	14:00–15:30	HK-H2	**Heavy-Ion Collisions and QCD Phases XII**
HK 58.1–58.6	Thu	14:00–15:30	HK-H3	**Instrumentation XIV**
HK 59.1–59.5	Thu	14:00–15:30	HK-H4	**Instrumentation XV**
HK 60.1–60.6	Thu	14:00–15:30	HK-H5	**Instrumentation XVI**
HK 61.1–61.5	Thu	14:00–15:30	HK-H6	**Structure and Dynamics of Nuclei X**
HK 62.1–62.5	Thu	14:00–15:30	HK-H7	**Structure and Dynamics of Nuclei XI**
HK 63.1–63.5	Thu	14:00–15:30	HK-H8	**Hadron Structure and Spectroscopy XI**
HK 64.1–64.5	Thu	14:00–15:30	HK-H9	**Fundamental Symmetries I**
HK 65.1–65.6	Thu	16:00–17:30	HK-H1	**Heavy-Ion Collisions and QCD Phases XIII**
HK 66.1–66.5	Thu	16:00–17:15	HK-H2	**Heavy-Ion Collisions and QCD Phases XIV**
HK 67.1–67.5	Thu	16:00–17:30	HK-H3	**Instrumentation XVII**
HK 68.1–68.4	Thu	16:00–17:15	HK-H4	**Instrumentation XVIII**
HK 69.1–69.6	Thu	16:00–17:30	HK-H5	**Instrumentation XIX**
HK 70.1–70.6	Thu	16:00–17:45	HK-H6	**Structure and Dynamics of Nuclei XII**
HK 71.1–71.5	Thu	16:00–17:30	HK-H7	**Structure and Dynamics of Nuclei XIII**
HK 72.1–72.5	Thu	16:00–17:30	HK-H8	**Hadron Structure and Spectroscopy XII**
HK 73.1–73.5	Thu	16:00–17:45	HK-H9	**Fundamental Symmetries II**
HK 74	Thu	18:00–19:00	HK-MV	**Annual General Meeting**
HK 75.1–75.2	Fri	11:00–12:00	HK-H1	**Invited Talks VI**

Annual General Meeting of the Hadronic and Nuclear Physics Division

Thursday, March 31, 2022 18:00–19:00 HK-MV
The meeting will take place in a virtual format. The zoom link and the agenda will be communicated by email.

HK 1: Invited Talks I

Time: Monday 11:00–12:30 Location: HK-H1

Invited Talk HK 1.1 Mon 11:00 HK-H1

A supernova in the lab - Astrophysics with stored, radioactive ions — •Jan Glorius for the E127-Collaboration — GSI Helmholtzzentrum, Darmstadt, Germany

Stars are giant nuclear reactors responsible for the synthesis of every element beyond hydrogen and helium. They generate vast amounts of material through nuclear conversions acting over millions of years or in the blink of an eye, e.g., in quiescent stellar burning or in violent star explosions, respectively. Simulations of the internal stellar processes can reproduce the main features of the solar inventory, however the production of many naturally occurring nuclei is still a mystery. This applies in particular to the so-called p-nuclei arising from stellar explosions, for which the models suffer from large nuclear uncertainties.

This contribution will introduce a novel experimental approach to shed light on such eluding cases by providing data on nuclear key reactions to produce strong constraints for explosive nucleosynthesis. The experimental campaign focuses on proton-capture reactions and is based on the production of radioactive ion beams at GSI, which are subsequently accumulated, cooled and decelerated in the heavy ion storage ring ESR. After years of development with stable beams, the first successful measurement has been conducted recently with a radioactive beam, namely ^{118}Te. The talk will discuss the experimental technique in detail, as well as the status and results of the recent and precursor experiments. Furthermore, the plans for an extension of the campaign to the new CRYRING facility at GSI will be presented.

Invited Talk HK 1.2 Mon 11:30 HK-H1

Exotic quark-made formations — •Mikhail Mikhasenko — ORIGINS Excellence Cluster, Munich, Germany — Ludwig Maximilian University of Munich

Conventional hadrons incorporate three-quark baryons like proton and neutron, and quark-antiquatk mesons, as e.g. pion, kaon, and J/ψ. Recent discoveries in particle-physics experiments around the world change our understanding of the quark-made formations. The tetraquarks of the XYZ family, narrow pentaquarks, and long-lived double-heavy-flavor tetraquarks do exists and heat the scientific debates on their microscopic nature. The talk will review the most amazing findings of hadron spectroscopists that paved the way to the rich world of the exotic states what we know of now. I will focus on the newest observation of the doubly charmed tetraquark T_{cc}^{+} using data collected by the LHCb experiment at the Large Hadron Collider.

Invited Talk HK 1.3 Mon 12:00 HK-H1

Nuclear ab-initio theory for neutrino oscillations — •Joanna Sobczyk[1], Sonia Bacca[1], and Bijaya Acharya[2] — [1]Johannes Gutenberg-Universitat, Mainz, Germany — [2]Oak Ridge National Laboratory, Oak Ridge, USA

We are entering an era of high-precision neutrino oscillation experiments (T2HK, DUNE), which potentially hold answers to some of the most exciting questions in particle physics. Their scientific program requires a precise knowledge of neutrino-nucleus interactions coming from fundamental nuclear studies. Ab initio many-body theory has made great advances in the last years and is able to give relevant predictions for medium-mass nuclei.

In my talk I will give an overview of the recent progress that has been made in describing neutrino-nucleus scattering within the ab-initio coupled-cluster framework, combined with the Lorentz integral transform. These techniques open the door to obtaining nuclear responses (and consequently cross-sections) for medium-mass nuclei starting from first principles. A series of steps has been made in this direction. Firstly, the nuclear 1- and 2-body currents have been rederived and checked for the case of neutrino-deuteron scattering. Afterwards, the Coulomb sum rule of 16O has been calculated, introducing a new technique to remove the center-of-mass contamination. This allowed us to calculate for the first time the longitudinal response of 40Ca. Recently, we obtained spectral functions which enabled us to extend our calculations to the relativistic regime within the impulse approximation.

HK 2: Heavy-Ion Collisions and QCD Phases I

Time: Monday 14:00–15:30 Location: HK-H1

Group Report HK 2.1 Mon 14:00 HK-H1

Measurement of neutral mesons in pp, p–Pb and Pb–Pb collisions with ALICE — •Marvin Hemmer for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

Multiplicity-dependent measurements of the neutral meson production in pp, p–Pb, and Pb–Pb collisions can be utilised to study different aspects of the hadronisation such as multi-parton interactions and collective effects. Furthermore, a better understanding of the neutral meson production can help to better constrain theoretical models of the production processes and can serve as crucial input for cocktail calculations needed for direct photon and dielectron analyses.

In ALICE, neutral mesons can be measured using different reconstruction methods. For the π^0 and η mesons these methods are based on the detection of decay photons with calorimeters or by reconstructing e^+e^- pairs from conversions in the detector material with the central tracking system. The ω meson is reconstructed using the measured π^0 mesons together with an additional photon ($\omega \to \pi^0\gamma$) or opposite charged pion tracks ($\omega \to \pi^+\pi^-\pi^0$).

In this talk, an overview of the π^0, η and ω measurements with ALICE is presented. In particular, we will focus on a multiplicity dependent measurement of π^0 and η in pp collisions at $\sqrt{s} = 13$ TeV.

Supported by BMBF and the Helmholtz Association.

HK 2.2 Mon 14:30 HK-H1

Reconstruction of neutral mesons via photon conversion method in Ag-Ag collisions at 1.58A GeV with HADES* — •Tetiana Povar for the HADES-Collaboration — University of Wuppertal

A main goal of the HADES (High Acceptance DiElectron Spectrometer) experiment is to investigate properties of strongly interacting matter at moderate temperatures and large baryo-chemical potential. One tool is the study of virtual photons and their decays into electron pairs $\left(e^- + e^+\right)$ in hadron and heavy-ion collisions. Due to their large mean free path in the final state, electrons and positrons are particularly ideal probes to study the pair production also in the dense nuclear medium. Dalitz-decays of the light neutral mesons π^0, η constitute a major contribution to the observed dielectron spectrum at low invariant masses (below the vector-meson pole mass). A precise determination of their abundance is crucial for proper control of the composition of the whole spectrum.
In HADES, these mesons can be reconstructed via their dominant $\gamma\,\gamma$ decays (BR $\sim$ 99%) utilizing double photon detection in the electromagnetic calorimeter (ECAL) or via double external pair conversion $\gamma_{\text{material}} \to e^+ + e^-$ in target or detector material with subsequent electron/positron identification.
We will present preliminary results of π^0 and η production yields in Ag-Ag collisions at 1.58A GeV incident beam energy applying the double photon conversion method (PCM).

* Work supported by BMBF (05P19PXFCA), and GSI.

HK 2.3 Mon 14:45 HK-H1

Production of ω-meson in pp collisions at 13 TeV — •Jens Robert Lühder for the ALICE-Collaboration — Institut für Kernphysik, Wilhelm-Klemm-Str. 9, 48149 Münster

Measurements of neutral mesons in small collision systems can serve as a baseline to understand modifications in heavy-ion collisions, where a QGP is formed. These measurements can also be used to test pQCD predictions and to constrain fragmentation functions as well as parton distribution functions. Furthermore, a good understanding of particle production enables the measurement of direct photons yields, where a large background of decay photons is present and needs to be ac-

counted for.

In this talk the invariant cross section of the ω-meson production in pp collisions at a center of mass energy of $\sqrt{s} = 13\,\text{TeV}$, as measured by ALICE via its dominant decay channel $\omega \to \pi^+\pi^-\pi^0$, will be presented. While charged pions can directly be measured by the ALICE central barrel trackers, neutral pions are reconstructed using their decay channel into two photons. This reconstruction is realized with several complementary methods making use of various calorimeters and the ALICE central barrel trackers. The combined result covers an unprecedented p_T range with small statistical and systematic uncertainties.

HK 2.4 Mon 15:00 HK-H1

Measurement of ω mesons in pp and p–Pb collisions at $\sqrt{s_{\text{NN}}}$=5.02 TeV with ALICE — •Nicolas Strangmann for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

The ALICE experiment at the LHC investigates the properties of hot and dense nuclear matter in heavy-ion collisions. By comparing the particle production in pp and p–Pb collisions, possible initial state effects can be isolated, which arise from the partons being bound within nuclei. Measurements of the ω meson spectra in pp and p–Pb collisions not only allow for a determination of the nuclear modification factor R_{pA}, but also provide vital input for direct photon cocktail simulations.

In the analysis presented in this talk, ω mesons are reconstructed via their primary decay channel into three pions ($\pi^+\pi^-\pi^0$). While the two charged pions can be identified with the tracking detectors (TPC, ITS), the π^0 has to be reconstructed from its two decay photons, that are detected in the electromagnetic calorimeter (EMCal).

In this talk, the measurement of the ω meson production in pp and p–Pb collisions at $\sqrt{s_{\text{NN}}}$=5.02 TeV will be presented. This includes the signal extraction and various corrections of the ω meson yields as well as the derivation of the R_{pA}.

Supported by BMBF and the Helmholtz Association.

HK 2.5 Mon 15:15 HK-H1

Neutral pion identification from merged clusters with machine learning methods in ALICE — •Jan Honermann for the ALICE-Collaboration — Institut für Kernphysik, Münster, Deutschland

The ALICE detector at CERN LHC is designed for the study of hot nuclear matter. Historically, one of the first probes to confirm the presence of such hot nuclear matter in heavy-ion collisions were neutral pions. The production of neutral pions was found to be significantly suppressed in heavy-ion collisions compared to pp or deuteron-gold collisions. Most traditional identification methods for neutral pions in these studies rely on an invariant mass analysis of the decay products. When the energy of the neutral pion becomes too large, these methods stop working though, since hits of decay products can not be resolved individually any longer. In this talk, initial efforts to distinguish between these merged clusters from neutral pions and coincidental hits from background processes with the help of neural networks in 13TeV pp-collisions will be presented.

Supported in the contex of the BMBF ErUM Framework.

HK 3: Heavy-Ion Collisions and QCD Phases II

Time: Monday 14:00–15:30 Location: HK-H2

Group Report HK 3.1 Mon 14:00 HK-H2

Kinetics of the chiral phase transition in a quark-meson σ model — •Hendrik van Hees, Carsten Greiner, and Alex Meistrenko — Institut für Theoretische Physik, Goethe-Universität Frankfurt, Max-von-Laue-Str. 1, D-60438 Frankfurt am Main

A challenging goal in relativistic heavy-ion physics is the investigation of the phase diagram of strongly interacting matter and the determination of its phase structure, governed by the approximate chiral symmetry of the light-quark sector of QCD. In this study [1] we investigate a linear quark-meson σ model in and out of equilibrium employing Schwinger-Keldysh real-time techniques to derive a set of coupled Boltzmann-Uehling-Uhlenbeck (BUU) equations for the σ-mean field (the order parameter of the phase transition) and the quark- and meson phase-space distribution function from a Φ-derivable approximation. We numerically solve the equations to evaluate the grand-canonical baryon-number fluctuations for an expanding fireball. The evolution results in a temporary buildup of higher-order fluctuations of the net-baryon number like the curtosis at low momenta when the system is evolving close to the critical point or the first-order phase-transition line due to slowly evolving σ-mean field. This is partially counterballanced by the further dissipative evolution due to collisions of the quarks, mesons, and the mean field, leading to a considerable weakening of the final fluctuations, depending on the expansion rate of the fireball.

[1] Annals of Physics **431**, 168555 (2021)

HK 3.2 Mon 14:30 HK-H2

Non-hydrodynamic modes from linear response in effective kinetic theory — •Stephan Ochsenfeld, Xiaojian Du, and Sören Schlichting — Bielefeld University, Bielefeld, Germany

Viscous hydrodynamics serves as a successful mesoscopic description of the quark-gluon plasma (QGP) produced in relativistic heavy-ion collisions (HICs). In order to investigate, how such an effective description emerge from the underlying microscopic dynamics we calculate the linear response of energy and flow perturbations in the sound and shear channels from a first-principle calculation in kinetic theory. By using multiple collision integrals we investigate the similarities and differences of the excitations in different microscopic theories and compare them to first and second order hydrodynamics. Surprisingly, we find that even for large gradients the Greens functions in QCD Kinetic theory are well described by one hydrodynamic and one non-hydrodynamic mode. We extract the dispersion relations of hydrodynamic and non-hyrodynamic modes and speculate how these results can be used to improve hydrodynamic descriptions of hot QCD matter.

HK 3.3 Mon 14:45 HK-H2

J/Ψ formation within microscopic Langevin simulations — •Naomi Oei, Nadja Krenz, Juan Torres-Rincon, Hendrik van Hees, and Carsten Greiner — Institute for Theoretical Physics, Frankfurt am Main, Germany

We present a microscopic model to describe dissociation and recombination processes of charmonia in the quark-gluon plasma. For this we simulate the time evolution of a system with several charm-anticharm-quark pairs, in which the heavy quarks are able to interact over a Coulomb like potential. The motion of the heavy quarks and the interaction with the medium are based on a Fokker-Planck equation, which can be realized with Langevin simulations. In this approach we use a momentum-dependent drag force and include random momentum kicks due to collisions with the medium particles. Therefore, through interactions of the heavy quarks with the medium, recombination and dissociation processes are possible. We describe the evolution of the medium as a boost-invariant transversally expanding fireball. We demonstrate that the system reaches the expected thermal distribution in the equilibrium limit and bound-state properties were tested in box simulations. The initial momentum distribution of the pairs is generated using the PYTHIA event-generator and results of the model are studied at RHIC and at LHC energy. We analyze results for different numbers of charm-anticharm-pairs for two initial conditions: The charm- and anticharm-quarks are either placed randomly inside the system or are initially created as a bound state. We show first results of the elliptic flow of charm-quarks and of bound states.

HK 3.4 Mon 15:00 HK-H2

Dynamical broadening of vector-meson spectral functions — •Renan Hirayama[1,2], Jan Staudenmaier[2], and Hannah Elfner[1,2] — [1]Helmholtz Forschungsakademie Hessen für FAIR (HFHF), GSI Helmholtzzentrum für Schwerionenforschung, Frankfurt am Main, Germany — [2]Frankfurt Institute for Advanced Studies (FIAS), Frankfurt am Main, Germany

We reconstruct effective spectral functions of the ρ-meson in different scenarios via lifetime analysis using the hadronic transport SMASH. The theoretical interest in the behavior of in-medium spectral func-

tions lies in the expected restoration of chiral symmetry at high energy densities, which may be accessed experimentally by studying dilepton mass spectra in heavy-ion collisions. Within SMASH, a direct assessment of particle lifetimes and the mass distributions is possible. Our reconstruction of the spectral function consists in using the total width – considering both decays and collisions – as input for a Breit-Wigner ansatz. The broadening of the spectral function in a thermal system is shown to be consistent with model calculations, and the dependence of total width on local hadron density is provided. This broadening develops dynamically, since SMASH relies only on vacuum properties of resonances as an input. On the other hand, we present the effective ρ-meson spectral function for the dynamical evolution of heavy-ion collisions, finding a clear correlation of broadening to system size. The results shown in this work are of interest to distinguish dynamical broadening from additional genuine medium-modified spectral functions.

HK 3.5 Mon 15:15 HK-H2

Diffusion coefficients for hot hadron gases in the quark flavor representation — •Jakob Lohr, Jan Fotakis, and Carsten Greiner — University of Frankfurt

Heavy ion collisions play a big role in exploring the properties of hot and dense nuclear matter. In these the baryon number B, the electric charge Q, and the strangeness S of the produced matter are conserved. Their transport could especially be relevant in the description of the evolution of highly compressed baryonic matter, where strong gradients in baryon number are expected.

In general, the diffusion currents generated by gradients in the charge densities are coupled to each other, the coupling of which is characterized by the so-called diffusion coefficient matrix. In most works concerning diffusion coefficients or conductivites, the constituents of matter are usually characterized through the above mentioned conserved charges (BQS). However, in the case of strongly-interacting matter the particles can as well be characterized by their quark content and the corresponding conserved quark flavors.

In this talk, we will give a systematic discussion of the diffusion coefficient matrix of various hadronic systems in the so-called quark flavor representation using linear response theory in relativistic kinetic theory.

HK 4: Instrumentation I

Time: Monday 14:00–15:30 Location: HK-H3

Group Report HK 4.1 Mon 14:00 HK-H3

Der PANDA Luminositätsdetektor — •Florian Feldbauer für die PANDA-Kollaboration — Ruhr-Universtität 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. 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 Vakuumsystem, Kühlung und Elektronik diskutiert, sowie Einblicke in die Datenanalyse gegeben.

HK 4.2 Mon 14:30 HK-H3

Silizium-Pixelsensoren für den PANDA-Luminositätsdetektor — •Niels Boelger für die PANDA-Kollaboration — Ruhr-Universität Bochum, AG Physik der Hadronen und Kerne, 44780 Bochum

Das PANDA-Experiment ist eines der Schlüsselexperimente an der zukünftigen Beschleunigeranlage FAIR in Darmstadt. Es dient der Untersuchung des Aufbaus von Hadronen und von Aspekten sowohl der starken und schwachen Wechselwirkung als auch der exotischen Materiezuständen.
Der PANDA-Detektor wird über einen Luminositätsdetektor, 11 Meter strahlabwärts vom Interaktionspunkt verfügen. Dieser aus zwei verfahrbaren Halbdetektoren bestehende Luminositätsdetektor verwendet Silizium-Pixelsensoren, um damit die Verteilung der elastisch gestreuten Antiprotonen in Abhängigkeit vom Streuwinkel zu messen und daraus die Luminosität zu bestimmen. Bei den zur Spurrekonstruktion im Luminositätsdetektor vorgesehenen MuPix-Sensoren handelt es sich um HV-MAPS, was für High-Voltage Monolithic Active Pixel-Sensor steht und gegenüber herkömmlichen Pixelsensoren zwei Vorteile bietet: Zum einen sind der aktiven Sensorteil und die Ausleseelektronik auf dem selben Chip vereint. Zum anderen kann aufgrund der anlegbaren Hochspannung der Ladungsträgertransport schneller erfolgen, als es durch einen Driftprozess möglich wäre. Die Fertigung von aus mehreren Pixelsensoren bestehenden Sensormodulen, sowie die Datenerfassung (DAQ) werden im Vortrag erläutert.
This project is supported by the BMBF - Gefördert durch das BMBF

HK 4.3 Mon 14:45 HK-H3

In-beam characterisation of a 65 nm CMOS technology Digital Pixel Test Structure towards a future ALICE Inner Tracking System 3 — •Pascal Becht for the ALICE-Collaboration — Physikalisches Institut, Heidelberg University, Germany

Recently, a new Inner Tracking System (ITS2) based on Monolithic Active Pixel Sensors (MAPS) has been installed in the ALICE detector. For a future upgrade of this tracker, it is intended to replace the three innermost layers of the current ITS2 with a novel vertex detector, the ITS3. The proposed design features wafer-scale, ultra-thin, truly cylindrical MAPS. In oder to benefit from the smaller feature size and the larger available wafers, the new sensors are supposed to be produced in 65 nm CMOS technology.

An extensive R&D programme is established in order to qualify this technology for the application in MAPS. It is supported by the BMBF funded High-D consortium for future particle detector development efforts. As one of the first steps towards the new sensor design, different variants of Digital Pixel Test Structures (DPTS) have been produced and tested in an electron beam at DESY. First results from this testbeam campaign are presented with emphasis on the detection efficiency. It is shown that the measured sensor efficiency exceeds 90%. This outcome is very encouraging for the application of the 65 nm CMOS technology in future MAPS-based detectors.

HK 4.4 Mon 15:00 HK-H3

Towards a wafer-scale, bent silicon prototype for the ALICE ITS3 — •Alperen Yuncu for the ALICE-Collaboration — Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Germany

ALICE aims at replacing the three innermost layers of its Inner Tracking System (ITS2) in the LHC Long Shutdown 3. The new vertex detector (ITS3) will be based on wafer-scale, ultra-thin, cylindrical Monolithic Active Pixel Sensors (MAPS). The new sensors will have a thickness of $20 - 40\,\mu$m and a length of 28 cm. They will be installed around a new beam pipe and the closest layer will be at a radial distance of only 18 mm from the interaction point.

The thickness of the sensors reaches unprecedented values for wafer-scale sensors, which poses a number of R&D challenges. To advance the study of mechanical and electrical properties for large, ultra-thin sensors, before the final silicon for ITS3 will become available, "super-ALPIDE" chips are produced and characterized. These consist of a matrix of 9×2 ALPIDEs (the sensors used for ITS2) diced out from a wafer as a single piece of silicon and have a size of 13.5×6 cm, close to 1/2 the final layer 0. They were produced in three different thicknesses (30, 40, 50 μm) and are now used for mechanical and electromechanical integration tests.

HK 4.5 Mon 15:15 HK-H3

Performances of the MIMOSIS-1 CMOS Monolithic Active Pixel Sensor* — •Hasan Darwish for the CBM-MVD-

Collaboration — GSI Darmstadt — Goethe Universität Frankfurt am Main — Université de Strasbourg, CNRS, IPHC UMR 7178, Strasbourg

The CMOS Monolithic Active Pixel Sensor MIMOSIS will be used in the Micro Vertex Detector (MVD) of the CBM experiment at FAIR in Darmstadt. The 50 μm thin sensor will feature 1024×504 pixels with a pitch of 27×30 μm^2, a peak rate capability of 80 MHz/cm^2 and combine a time resolution of 5 μs with a spatial resolution of ~ 5 μm.

The full size prototype MIMOSIS-1, the second MIMOSIS prototype along its three-prototype development process, was tested with electron and pion beams in several beam tests at DESY and CERN. Sensor performances including detection efficiency, spatial resolution, fake hit rate and pixel cluster multiplicity were measured for a total of 12 combinations of three different kinds of active volumes and four flavours of pixels. Moreover, the tolerance to radiation doses of up to 5 MRad and 3×10^{14} n_{eq}/cm^2 was evaluated.

The technology of the sensor is introduced and first results of the beam tests are shown.

*This work has been supported by BMBF (05P19RFFC1), GSI, CREMLINplus, HFHF, and TANGERINE.

HK 5: Instrumentation II

Time: Monday 14:00–15:30 Location: HK-H4

Group Report HK 5.1 Mon 14:00 HK-H4

The DarkMESA Experiment — •MIRCO CHRISTMANN for the MAGIX-Collaboration — Institute for Nuclear Physics, Johannes Gutenberg University Mainz, Germany

At the Institute for Nuclear Physics in Mainz the new electron accelerator MESA will go into operation within the next years. The high-power beam dump of the P2 experiment (150 MeV, 150 μA) is ideally suited for a parasitic dark sector experiment – DarkMESA.

The experiment is designed for the detection of Light Dark Matter (LDM) which in the simplest model couples to a massive vector particle, the dark photon γ'. It can potentially be produced in the beam dump by a process analogous to photon Bremsstrahlung and may then decay into Dark Matter (DM) particle pairs $\chi\bar{\chi}$. A fraction of them scatter off electrons or nuclei in the DarkMESA calorimeter.

For the calorimeter, high-density PbF_2 and lead glass SF5 Cherenkov radiators readout with photomultipliers will be used. Within a `MadGraph` and `Geant4` simulation the accessible parameter space was evaluated. For the prototype stage, a hermetic veto system with two layers of plastic scintillators and 1 cm of lead shielding is currently under development.

DarkMESA DRIFT is currently considered as an addition to the project. A negative ion Time Projection Chamber (TPC) filled with CS_2 at low pressure will serve as DM detector. With the nuclear recoil threshold being in the keV range the accessible parameter space can be extended.

HK 5.2 Mon 14:30 HK-H4

Status of a HPGe-BGO Pair Spectrometer for ELI-NP — •ILJA HOMM for the ELI-NP Pair Spectrometer-Collaboration — 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 γ-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 γ-beam intensity monitor and to investigate the cross section for pair production near the threshold. A prototype pair spectrometer, consisting of 64 BGO crystals with SiPM (silicon photomultiplier) readout, has been designed and built. Two test measurements with high energy photons have been performed at the University of Cologne and at the ILL in Grenoble. First results are going to be presented.

This work is supported by the German BMBF (05P15RDENA) and the LOEWE-Forschungsschwerpunkt "Nukleare Photonik".

HK 5.3 Mon 14:45 HK-H4

Characterization system for CsI crystals coupled to APDs — •HAN-BUM RHEE, ANNA-LENA HARTIG, NOEL MERKEL, CHRISTIAN SÜRDER, and THORSTEN KRÖLL for the R3B-Collaboration — Institut für Kernphysik, TU Darmstadt, Germany

CALIFA @ R3B/FAIR is a highly granular detection system based on CsI(Tl) scintillation crystals with readout via avalanche photodiodes (APD). It aims to detect gamma rays and light charged particles. CALIFA consists of 2464 detection units and each detection unit has to be characterized. In order to automatize the characterization two system have been built.

The gain and the noise of the APDs depend on both temperature and bias voltage, hence both have to be controlled. The temperature of the system is controlled via a Peltier unit.

In CALIFA CsI crystals with several distinct trapezoidal shapes are used. This causes inhomogeneities in the crystal light output. These inhomogeneities were investigated by measuring the response of the detector-APD unit to a collimated source, which is placed close to the crystal but at different positions relative to the APD readout. For the placement of the source, a x-y scanning table with stepping motors was employed.

This work is supported by BMBF (05P19RDFN1, 05P21RDFN1) and the GSI-TU Darmstadt cooperation contract.

HK 5.4 Mon 15:00 HK-H4

Recovery study of lead tungstate scintillation crystals for the $\overline{\text{P}}$ANDA-EMC. — •PAVEL ORSICH[1], VALERY DORMENEV[1], MARKUS W. H. MORITZ[1], HANS-GEORG ZAUNICK[1], KAI-THOMAS BRINKMANN[1], and MIKHAIL KORJIK[2] — [1]II. Physikalisches Institut, Justus-Liebig-Universität, Gießen — [2]Institute for Nuclear Problems, Minsk, Belarus

Degradation of the optical transmittance of lead tungstate scintillation crystals in the scintillation spectral range under ionizing radiation leads to the loss of light output, which results in the deterioration of the energy resolution and limits the operation time of calorimeters made from the scintillator. This effect is especially prominent for calorimeters operating at low temperature, such as the Electromagnetic Calorimeter (EMC) of the $\overline{\text{P}}$ANDA experiment, where the calorimeter will be operated at -25 °C to gain an additional factor four in light yield.

We report new results on stimulated recovery of radiation damage in lead tungstate scintillation crystals induced by an external source of infrared photons. This method allows fast and efficient in-situ recovery of the crystals optical transmittance either during beam-off periods or even online in parallel to data acquisition. The application of light for recovery can substantially extend the running period the $\overline{\text{P}}$ANDA-EMC by keeping the radiation damage at a tolerable level.

This work is supported by BMBF, GSI and HFHF.

HK 5.5 Mon 15:15 HK-H4

Serial calibration 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

One of the main components of the upcoming PANDA experiment at the future FAIR complex in Darmstadt will be the Electromagnetic Calorimeter (EMC) inside a 2 T solenoid. The EMC's lead-tungstate crystals are read out by Large Area Avalanche Photodiodes (LAAPDs). Due to the required energy resolution, timing and spacial constraints, the individual bias voltage adjustments for the Photodiodes need to be accurate and stable on a level of 100 mV. At the same time, space constraints in the inner detector volume limit options for individual cable routing and connections for the LAAPD bias voltage. These constraints demanded new, innovative and specialized electronics to adjust the individual LAAPD voltage within the inner detector volume. The key elements of the high-voltage adjustment concept will be described. To enable a stable operation of the specialized electronics within a broad temperature window, tests of the slow-control

electronics were conducted. First results of these preproduction tests and conclusions leading towards an automated calibration algorithm will be presented in this talk. *gefördert durch das BMBF, GSI und HFHF.

HK 6: Instrumentation III

Time: Monday 14:00–15:30 Location: HK-H5

HK 6.1 Mon 14:00 HK-H5

Gain Calibration of the Upgraded ALICE TPC — •Philip Hauer — Helmholtz-Institut für Strahlen- und Kernphysik – Universität Bonn

For the upcoming Run 3 of the Large Hadron Collider (LHC), the collision rate of lead-lead beams will be increased to 50 kHz. In order to cope with this rate, the TPC was upgraded with a new amplification stage which is now based on Gas Electron Multiplier (GEM) foils. After its re-installation in the experiment, an extensive commissioning and testing program was performed.

One of the main goals of the commissioning program was the calibration of the gain. This comprises a coarse equalisation of the gas gain by fine-tuning the high voltage settings of each GEM foil stack, but also a pad-by-pad gain calibration for each electronic readout channel. In order to achieve this goal, two different types of measurements were conducted. The first one makes use of an X-ray tube which irradiated the active volume of the TPC. The second method is based on the gaseous and meta-stable radioactive isotope Kr-83m which was injected into the TPC.

In this talk, both methods will be explained in more detail. In addition to being indispensible for reaching the desired $\mathrm{d}E/\mathrm{d}x$ performance of the TPC, the results of the measurements reveal interesting details on stretching issues and edge effects.

Supported by BMBF.

HK 6.2 Mon 14:15 HK-H5

Towards the PUMA pion tracker — •Sabrina Zacarias[1], Emanuel Pollacco[2], Christina Xanthopoulou[1], Alexandre Obertelli[1], and PUMA collaboration[1] — [1]TU-Darmstadt — [2]CEA-IRFU

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 6.3 Mon 14:30 HK-H5

Development of the trigger barrel for PUMA — •Christina Xanthopoulou, Sabrina Zacarias, Dominic Rossi, and Alexandre Obertelli — Technische Universität Darmstadt

The antiProton Unstable Matter Annihilation project aims at the study of the periphery of short-lived nuclei by using low-energy antiprotons. The antiprotons annihilate with the nucleons on the surface of the nucleus which results in pions that pass through the detection system. By identifying the produced pions we are able to determine the ratio of protons to neutrons on the nuclear surface. The detection system consists of one time projection chamber and a trigger barrel. With the time projection chamber we are able to reconstruct the pions trajectories. The trigger barrel is composed of plastic scintillators to which Silicon PhotoMultipleres are attached. It will be used to trigger the trajectory measurements of the pions passing the time projection chamber. Simulations for the characterization of the trigger barrel are performed. Additionally, a trigger barrel test setup is build and used for benchmarking the simulation outcome. In the poster, the current status on the simulations and the test setup for the trigger barrel are presented.

HK 6.4 Mon 14:45 HK-H5

A calibration system for a modular small-format TPC with GEM amplification — •Dmitri Schaab, Reinhard Beck, and Bernhard Ketzer for the CBELSA/TAPS-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik

The performance of a Time Projection Chamber (TPC) relies on a good knowledge of the electric field inside the sensitive volume. This is crucial since deviations from a homogeneous drift field, either due to mechanical imperfections or due to space charge effects at high particle rates, deteriorate the spatial resolution of the detector if they remain uncorrected. One calibration method is to release electrons via the photoelectric effect at well-known positions on the cathode. By the electric field, these electrons are guided across the drift region towards the readout plane and show the integrated spatial distortions. In addition, a drift velocity measurement is provided. This photoelectric calibration concept, first employed at the T2K experiment, was implemented on a small scale involving a test tracking detector and a pulsed UV-laser. The laser light is conditioned using an optical setup and fed into the detector with the help of a multimode fiber bundle. Calculations were made in order to provide a uniform illumination of the detector cathode. The photoelectric calibration system was implemented in a newly built small TPC (sTPC) with GEM amplification. Its fully modular design allows for spatially resolved studies of field distortions using different GEM configurations or readout geometries.

The development of the measurement setup as well as characterizing photoelectric measurements will be presented.

HK 6.5 Mon 15:00 HK-H5

Distortions in the ALICE TPC caused by charge-up effects in the field cage — •Tim Geiger for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

ALICE is the dedicated heavy-ion experiment at the LHC at CERN. The main tracking and particle identification detector of ALICE is a large-volume Time Projection Chamber (TPC). To cope with the increased Pb-Pb interaction rate of 50kHz in Run 3, starting in 2022, the TPC was upgraded from multi-wire proportional chambers to a readout based on Gas Electron Multipliers (GEMs) which allows for a continuous readout of the detector.

In order to achieve its intrinsic track reconstruction resolution, a good understanding of possible space-point distortions is required. To study possible distortions, a dedicated commissioning campaign with x-ray illumination at different intensities was carried out. At the same time, a laser system was used to create ionization tracks in the TPC. The laser light also creates photo electrons at the aluminized high-voltage electrode of the drift field. Distortions in the drift time of the photo electrons are observed, varying with the x-ray intensity. This is caused by charge-up effects near the high-voltage electrode, locally modifying the electric field.

In this poster, we present an analysis of the measured distortions. They are compared to electrostatic calculations of different possible scenarios of modifications in the drift field.

HK 6.6 Mon 15:15 HK-H5

Photon Detection with THGEMs — •Thomas Klemenz[1], Laura Fabbietti[1], Piotr Gasik[2], Roman Gernhäuser[1], Berkin Ulukutlu[1], and Tobias Waldmann[1] — [1]Technische Universität München — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt

Traditional devices for photon detection like the Photomultiplier Tube or more recent technologies such as Silicon Photomultipliers are very cost-intensive. Therefore, especially with large area experiments in mind it is exciting to investigate new ways of detecting photons.

In this project we are taking the approach of combining a photosensitive material with a Thick GEM (THGEM) to produce a gaseous photon detector. THGEMs are robust, low-cost devices, which can be easily implemented in large area applications. One side of the THGEM is coated with a photosensitive material and placed within an electrical field. Photons captured by the active surface lead to a release of electrons which drift into the THGEM hole where they undergo avalanche multiplication due to strong electric fields applied. Below the THGEM an anode is reading out the amplified electron signal. Depending on

the gain of the THGEM this could enable single photon detection.

We want to study the potential of this approach while trying different photosensitive materials. Ultimately, we aim to measure visible wavelength photons and to provide a low-cost, large area solution for neutrino observation in water and ice environments. In the talk the current status of the project is discussed.

HK 7: Structure and Dynamics of Nuclei I

Time: Monday 14:00–15:30 Location: HK-H6

HK 7.1 Mon 14:00 HK-H6

Investigation of neutron-induced γ-rays from Ge-nuclides in the ROI of GERDA/LEGEND — •Marie Pichotta[1], Hans Hoffmann[1], Konrad Schmidt[2], Steffen Turkat[1], and Kai Zuber[1] — [1]Institut für Kern- und Teilchenphysik, TU Dresden, Dresden — [2]Helmholtz-Zentrum Dresden Rossendorf, Dresden

GERDA has been a pioneering experiment in the search for the still undetected neutrinoless double beta ($0\nu\beta\beta$)-decay of ^{76}Ge and this will also hold for the successor experiment LEGEND. The discovery of this extremely rare process would prove the Majorana character of neutrinos and consequently physics beyond the Standard Model. For an explicit identification of a signal caused by the $0\nu\beta\beta$-decay, which correspond to an energy of 2039 keV for ^{76}Ge, a precise understanding of all background contributions in the region of interest (ROI) is crucial.

Previous experiments indicated γ-lines, produced by neutron activation (n,p) and neutron scattering (n,n') processes on ^{76}Ge and ^{74}Ge but until now, no significant indications of their existence were found. In order to confirm the existence of the γ-lines in this ROI, an enriched Ge-sample was alternately irradiated by neutrons from a DT generator and measured by a HPGe detector. The γ-spectra of more than 40 irradiation cycles show two peaks in the ROI of GERDA/LEGEND. The experimental procedure and the analysis of the peaks will be presented. This project is supported by BMBF (05A17OD1).

HK 7.2 Mon 14:15 HK-H6

Neutrino-induced pion-production off the nucleon in chiral effective field theory — •Niklas Döpper and Norbert Kaiser — Physik-Department T39, Technische Universität München, D-85747 Garching, Germany

The current status of the analysis of neutrino-induced single pion production off the nucleon in the framework of manifestly Lorentz-invariant chiral perturbation theory is presented. The calculation of tree and one-loop diagrams is performed up to and including fourth chiral order with an explicit treatment of the $\Delta(1232)$ resonance. Terms that break the power counting between the loop and small momentum expansion are treated in the extended on-mass-shell scheme. This calculation aims to predict the total cross sections for the reactions of neutrino or antineutrino induced pion production off neutrons and protons at low energies. The present result has implications for the nuclear two-body axial exchange current as generated by one-pion exchange.

This work has been supported in part by DFG (Project-ID 196253076 - TRR 110) and NSFC.

HK 7.3 Mon 14:30 HK-H6

Reaction studies around the Ca isotopic chain in inverse kinematics with the R3B setup — •Christian Sürder for the R3B-Collaboration — Institut für Kernphysik, TU Darmstadt, Germany

In Feb. 2020 an experiment to study isotopes around the Ca isotopic chain, reaching from the proton-rich to the neutron-rich side, was performed with the versatile R3B setup at GSI, Darmstadt, Germany. The isotopes were produced through fragmentation of a primary beam of ^{86}Kr at a beam energy of 580MeV/A on a ^{9}Be target. The secondary cocktail beam included isotopes of Cr, V, Ti, Sc, Ca, K, Ar and Cl. This experiment, part of the R3B Phase 0 program at FAIR, allowed for exclusive studies in inverse kinematics, employing reactions like (p2p), (p2pn), etc. The knocked out particles were detected with CALIFA, a CsI detector with high granularity, situated around the target area. The talk focuses on CALIFA, showing the detector performance and presenting first results of the reaction studies.

This work is supported by BMBF under contract 05P19RDFN1 and 05P21RDFN1 and the Helmholtz Research Academy Hesse - HFHF.

HK 7.4 Mon 14:45 HK-H6

Investigation of 220<A<230 Po-Fr nuclei in the south-east frontier of the A-225 island of octupole deformation — •Nicolas Hubbard[1,2], Marta Polletini[3,4], Helena Albers[2], Giovanna Benzoni[4], Julgen Pellumaj[5,6], and Jose Javier Valiente-Dobon[5] for the DESPEC-S460-Collaboration — [1]Technische Universitaet Darmstadt, Darmstadt, Germany — [2]GSI Helmholtzzentrum fuer Schwerionenforschung, Darmstadt, Germany — [3]Universita degli Studi di Milano, Italy — [4]INFN Senzione di Milano, Italy — [5]INFN, Laboratori Nazionali di Legnaro, Italty — [6]Universita di Ferrara, Italy

The Ra-Th (Z=88-90) actinide nuclei around mass number A˜225 delimit the region of the nuclear chart where the strongest octupole correlations manifest. In general, there is a dearth of experimental information on the structure of nuclei in this region. An experiment was performed at GSI in April 2021 utilising the FRS+DESPEC setup to directly measure beta-decay half-lives, alpha-branching ratios and lifetimes of excited nuclear states. These results can be used to study the interplay between quadrupole and octupole correlations at the far end of the isle-of-deformation, to obtain beta-decay information beyond N=126 to better model the rapid neutron-capture (r-)process and to study shape isomers in 220,220Po where super-deformed and hyper-deformed structures at low excitation energies are expected. Furthermore, a calibration of the FRS+DESPEC setup using the alpha-emitting Rn and Fr isotopes was employed, providing a high-efficiency ion-decay correlation test as well as refining alpha-decay information.

HK 7.5 Mon 15:00 HK-H6

Branching-ratio of the mixed-symmetry 2^+-state of ^{132}Te* — •R. Mayer[1], T. Stetz[1], T. Beck[1], V. Werner[1], R. Zidarova[1], P. Koseoglou[1], N. Pietralla[1], R.-E. Mihai[2], R. Borcea[2], S. Calinescu[2], C. Costache[2], I. Dinescu[2], A. Ionescu[2], N. Marginean[2], C. Mihai[2], C.-R. Nita[2], S. Pascu[2], L. Stan[2], and S. Toma[2] — [1]IKP, TU Darmstadt — [2]IFIN-HH, Bucharest

^{132}Te is two protons and two neutron holes away from the doubly-magic ^{132}Sn. Its second 2^+ state has been found [1] to be a mixed-symmetry state which mostly decays by a strong M1 transition to the first 2^+ state. The transition to the 0^+ ground state occurs with a small branching ratio of 1.0(5)%. The large relative uncertainty of this ground-state decay branch prevented a precise determination of the $2_2^+ \rightarrow 2_1^+$ M1 strength from Coulomb-excitation data [1]. In a recent experiment, populating the 2_2^+ state of ^{132}Te via the two-neutron transfer reaction ^{130}Te(^{18}O,^{16}O)^{132}Te in an experiment at IFIN-HH, we employed the ROSPHERE HPGe array for a Doppler-shift attenuation measurement aimed at the determination of the 2_2^+ lifetime. While that analysis is ongoing, we sought to use the significant background reduction due to the use of the particle detection system SORCERER [2] to obtain a new value for the ground-state decay branch of the 2_2^+ state.

[1] M. Danchev et al., Phys. Rev. C 84, 061306(R) (2011)
[2] T. Beck et al., Nucl. Inst. Meth. Phys. A 951 (2020) 163090
*Supported by the BMBF under the Grants No. 05P19RDFN1 and 05P21RDFN1.

HK 7.6 Mon 15:15 HK-H6

HYDRA: HYpernuclei Decay at R3B Apparatus — •Simone Velardita, Liancheng Ji, Alexandre Obertelli, and Yelei Sun for the R3B-Collaboration — Technische Universität Darmstadt

HYDRA is a physics program within the R^{3}B collaboration at the decay spectroscopy of hypernuclei produced from heavy-ion collisions at GSI/FAIR. The program aims at measuring with high resolution the in-flight pionic decay of light and medium mass hypernuclei. The pion tracker is conceived as a time projection chamber inside the GLAD magnet of the R^{3}B setup.

As a first step, a prototype TPC was built to implement all the technologies proposed for the full TPC. The prototype covers an active area of 256 x 88 mm^2 decomposed into 5632 pads. In the drift region in which the drift length is 300 mm, a homogeneous electric

field is held up by a two-layer wire field cage. A compact metal-core Micromegas pad plane is used to amplify and collect drift electrons. The prototype was tested at TU Darmstadt. The first results will be presented in the poster.

The full experimental setup has been simulated within the R3BROOT framework. Simulations were used to optimise the geometry and to define conditions for a forthcoming experiment at GSI/FAIR. Results will be detailed. The first experiment to be proposed with the HYDRA prototype, aiming at the mass radius of hypernuclei such as the hypertriton, expected to be halo, from interaction cross section measurement will be detailed in the poster.

HK 8: Structure and Dynamics of Nuclei II

Time: Monday 14:00–15:30 Location: HK-H7

HK 8.1 Mon 14:00 HK-H7

New evidence for alpha clustering structure in the ground state band of ^{212}Po — •Martin von Tresckow for the IFIN-HH212Po-Collaboration — IKP TU Darmstadt

^{212}Po has two-protons and neutrons outside the doubly-magic nucleus ^{208}Pb and it may be assumed that the nuclear structure can be well described within the shell-model. But various experimental properties, such as the short-lived ground state, are better predicted by an α-clustering model. The B(E2) values of the decays of the low lying yrast-states are an important finger print to describe the structure of ^{212}Po. Especially the missing B(E2; $4_1^+ \rightarrow 2_1^+$) value are important in this discussion. We have performed an α-transfer experiment to excited ^{212}Po and determine the lifetimes using the ROSPHERE γ-ray detector array at IFIN-HH in Magurele, Romania. This array consisted of 15 HPGe detectors and 10 $LaBr_3$(Ce) scintillator detectors and was supplemented with the SORCERER particle detector system. The combination of γ-ray and the particle detectors was an important tool to determine the mean lifetimes of all ground state band levels up to the 8^+ state applying the fast-timing method [Ma. von Tresckow et al., PLB 821, 136624 (2021)]. I will present our lifetime analysis and discuss the results within the shell-model and α-clustering model. This work is financially supported by EURONS2, IFA via grant 04FAIR/2020, MCDI via grant PN19060102, UK-STFC via grant ST/P005101/1, Ministry of Science and Higher Education of the Russian Federation under contract No. 075-10-2020-117.

HK 8.2 Mon 14:15 HK-H7

The Systematic Study of Pygmy Dipole States in ^{40,44,48}Ca Induced in the (p,p′γ) Reaction — •Barbara Wasilewska, Anna Bohn, Sarah Prill, Michael Weinert, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics, 50937 Cologne, Germany

The calcium nuclei form a unique isotopic chain. It is the only element with two stable doubly-magic isotopes and the masses spread over a wide range of N/Z ratios. The second feature is especially interesting for studies of the Pygmy Dipole Resonance (PDR). This additional E1 strength in the region of the neutron separation energy (S_n) has been shown to increase with the N/Z ratio, but its nature is a subject of discussion [1]. The recent progress in nuclear physics theory enabled *ab-initio* calculations in the medium-mass region [2], making calcium isotopes a perfect probe to examine the states forming the PDR. In a series of experiments at the Institute for Nuclear Physics, University of Cologne, the isotopes ^{40}Ca, ^{44}Ca and ^{48}Ca were studied in the (p,p′γ) reaction at E_p = 12, 15 MeV. Employment of the SONIC@HORUS setup allowed a high-precision measurement of the excitations near S_n. In the talk, the experimental set-up and the analysis process will be briefly described. The obtained relative excitation cross-sections close to S_n will be shown and compared with other experiments. The attempt to extract spins of observed states will also be discussed.
Supported by the DFG (ZI 510/10-1).
[1] D. Savran *et al.*, Prog. Part. Nucl. Phys. **70** (2013) 210.
[2] S.G. Pickstone *et al.*, Nucl. Inst. Meth. A**875** (2017) 104.

HK 8.3 Mon 14:30 HK-H7

Lifetimes of non-yrast states in ^{104}Mo — •Matthias Rudigier[1], Martin von Tresckow[1], Thorsten Kröll[1], Jan Jolie[2], Yung-He Kim[3], Ulli Köster[3], Kosuke Nomura[4], and Jean-Marc Regis[2] — [1]Institut für Kernphysik, Technische Universität Darmstadt, Darmstadt, Germany — [2]Institut für Kernphysik, Universität zu Köln, Köln, Germany — [3]Institute Laue Langevin, Grenoble, France — [4]Physics Department, University of Zagreb, Zagreb, Croatia

The region of neutron-rich nuclei around N=60 is well known for abrupt changes in nuclear structure from N=58 to N=60 for Zr and Sr. The deformation changes quickly and competing minima in the potential energy surface appear which result in shape coexistence. For the heavier isotopes Mo and Ru the evolution is much more smooth. Nuclear structure theory is capable of describing the ground state band of Mo isotopes in this mass region quite well. However, experimental data on non-yrast states is not reproduced similarly well. This is especially true for the first excited 0^+ state in the Mo isotopic chain. We performed an experiment at the Lohengrin mass separator at the ILL, to measure lifetimes of non-yrast states using the fast timing method with the goal to obtain more detailed information on the configurations present in ^{104}Mo. In particular the aim is to determine the lifetime of the first excited 0^+ state. Preliminary results will be discussed in comparison to neighbouring nuclei, as well as in terms of theoretical predictions on level energies and transition strengths.Funding support is acknowledged from the EURONS2 and HFHF.

HK 8.4 Mon 14:45 HK-H7

Spectroscopy of ^{94}Pd — •Aleksandrina Yaneva for the DESPEC-S480-Collaboration — GSI Helmholzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany — IKP, Univerity of Cologne, Cologne, Germany

In March 2020 the first formally approved DESPEC experiment (part of the FAIR phase-0 campaign) was performed at GSI Helmholtzzentrium für Schwerionenforschung. This experiment was focused on the measurement of electromagnetic transition rates between yrast excited states in the ^{94}Pd nucleus. The goal was to measure the lifetimes of the $I^\pi=6^+$ and 8^+ states in this N=Z+2 isotope, which would provide insight into the evolution of the wave function around the ^{100}Sn region.

The nuclei of interest were produced, identified and transported through the Fragment Separator to be implanted into the AIDA (Advanced Implantation Detector Array) active stopper. AIDA was surrounded by the FATIMA ($LaBr_3$) and GALILEO (HPGe) detector arrays, which provided the fast-timing and precise energy information respectively.

The data obtained from the measurements is currently being analyzed by looking for correlations between ion implantation in AIDA and isomeric decays in FATIMA. In order to measure isomeric lifetimes in FATIMA the prompt response of the detectors has been determined. Similarly precise energy and timing information are being extracted after proper calibration and drift corrections. I will present the current analysis status of the experimental data.

HK 8.5 Mon 15:00 HK-H7

Lifetime measurement in ^{50}Cr with a new compact differential 3-foil Plunger — •Marcel Beckers[1], Christoph Fransen[1], Alfred Dewald[1], Claus Müller-Gatermann[2], Franziskus von Spee[1], Peter Reiter[1], Jan Jolie[1], and Casper Lakenbrink[1] — [1]Institute for Nuclear Physics, University of Cologne — [2]Argonne National Laboratoy

A a new, multi-purpose differential 3-foil plunger has been commissioned. It can be used together with several gamma-ray spectrometers and charged-particle detectors, due to its compact size. As a commissioning experiment, level lifetimes of the 2_1^+ and the 4_1^+ excited states of ^{50}Cr have been measured, using the Differential Decay Curve (DDC) method for 3-foil plungers. This experiment was conducted at the Cologne FN Tandem Accelerator, using the reaction ^{24}Mg(^{32}S,4p2n)^{50}Cr. Results of this measurement with special respect to the performance of the 3-foil plunger device are presented. This project was supported by the BMBF under the contract number 05P18PKFN9.

HK 8.6 Mon 15:15 HK-H7

Erste direkte Lebensdauerbestimmung des 2_1^+-Zustandes von

^{210}Pb — •C. M. Nickel[1], M. Beckers[2], D. Bittner[2], A. Esmaylzadeh[2], B. Falk[2], C. Fransen[2], J. Garbe[2], L. Gerhard[2], K. Geusen[2], A. Goldkuhle[2], K. E. Ide[1], P. R. John[1], J. Jolie[2], V. Karayonchev[2], R. Kern[1], E. Kleis[2], L. Klöckner[2], M. Ley[2], G. Rainovski[3], F. Spee[2], M. Steffan[2], T. Stetz[1] und V. Werner[1] — [1]TU Darmstadt — [2]U Köln — [3]U Sofia

Die Untersuchung des Übergangs vom 2_1^+- in den Grundzustand in Kernen nahe dem doppelt-magischen ^{208}Pb erlaubt die Anpassung von Parametern in Kernmodellen, wie z.B. die effektiven Ladungen im Schalenmodell. Besonders wichtig sind hierbei Kerne mit zwei Valenznukleonen [1], deren elementare Anregungen die niedrigliegenden Kernzustände bilden, wie ^{210}Pb. Am 10 MV FN Tandem-Beschleuniger des Instituts für Kernphysik der Universität zu Köln wurde der 2_1^+-Zustand von ^{210}Pb in einer Zwei-Neutronen-Transferreaktion direkt bevölkert und seine Lebensdauer mithilfe des Kölner Plungers unter Nutzung der Recoil-Distance Doppler-shift-Methode gemessen. Dabei wurden HPGe-Detektoren zur Detektion der Gammastrahlung und Silizium-Detektoren zur Messung der bei der Kernreaktion rückgestreuten Teilchen genutzt. Somit wurde die Lebensdauer des 2_1^+-Zustandes von ^{210}Pb erstmalig direkt bestimmt, verträglich mit, aber deutlich genauer als, der einzige bekannte Literaturwert aus Triton-Streuung [2].

[1] D. Kocheva et al., Eur. Phys. J. A 53, 175 (2017).
[2] C. Ellegaard et al., Nucl. Phys. A 162, 1 (1971).

*Gefördert durch das BMBF unter Projekt-Nr. 05P21RDCI2.

HK 9: Hadron Structure and Spectroscopy I

Time: Monday 14:00–15:30 Location: HK-H8

Group Report HK 9.1 Mon 14:00 HK-H8

Investigation of the Σ^0 production mechanism in p(3.5 GeV)+p collisions at HADES experiment — •Waleed Esmail[1,2] and James Ritman[1,2,3] for the HADES-Collaboration — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany — [2]Forschungszentrum Jülich, 52428 Jülich, Germany — [3]Ruhr-Universität Bochum, 44801 Bochum, Germany

The production of hyperons serves as a tool to investigate the strong interaction in the non-perturbative energy regime. This talk presents a study of the Σ^0 production mechanism via the exclusive reaction $pp \to pK^+\Sigma^0$ at a beam kinetic energy 3.5 GeV with the HADES detector. The dynamics of the reaction $pp \to pK^+\Sigma^0$ was investigated by studying the angular distributions in the CMS, Gottfried-Jackson and helicity frames. The angular distributions in the CMS frame supports the pion exchange mechanism. Furthermore, the helicity angular distributions are highly non-isotropic, which is a clear indication that there is a resonant component of the Σ^0 production. In order to provide a better description of the experimental angular distributions, the Bonn-Gatchina Partial Wave Analysis (Bo-Ga PWA) has been employed. However, due to the insufficient statistics, it was not possible to obtain an unambiguous determination of the relative contribution of each intermediate nucleon resonance to the overall final state. Nevertheless, significant contributions of nucleon resonances $N^*(1710)$ ($J^P=1/2^+$), $N^*(1900)$ ($J^P=3/2^+$) and $\Delta^*(1900)$ ($J^P=1/2^-$) are certainly preferred by the PWA fit.

HK 9.2 Mon 14:30 HK-H8

Status of the CALIFA Calorimeter and its performance at FAIR-Phase-0 experiments at R^{3}B — •Leyla Atar for the R3B-Collaboration — Technische Universität Darmstadt, Germany

CALIFA (the CALorimeter for In Flight detection of γ-rays and light charged pArticles) is one of the key detectors of the R^{3}B experiment at the GSI/FAIR facility. CALIFA is highly segmented and will consist of 2528 scintillation CsI(Tl) crystals after completion surrounding the reaction target area to facilitate measurement of the emission angle and energy of reaction products. CALIFA covers a huge dynamic range to allow a simultaneous measurement of γ-rays down to 100 keV and scattered light particles up to 300 MeV. A special feature of Califa is the digital Quick Particle Identification (QPID) enabling γ-rays and charged particle identification through Pulse Shape Analysis (PSA) of the scintillation light output.

I will shortly introduce the CALIFA calorimeter and its auxiliary detector systems and give an overview of the performance of CALIFA in the frame of FAIR-Phase-0 experiments performed at the R^{3}B/FAIR setup. Particularly first results, energy resolution and efficiency as well as QPID will be discussed for specific physics cases. The current development status of CALIFA and further enhancements will be presented.

This work is supported by BMBF contracts (05P19RDFN1) and (05P19RWOFN1).

HK 9.3 Mon 14:45 HK-H8

Feasibility study of the reaction $\bar{p}p \to e^+e^-\pi^0$ with the PANDA experiment at FAIR — •Alaa Dbeyssi[1], Frank Maas[1,2,3], Luigi Capozza[1], Oliver Noll[1], David Rodriguez Pineiro[1], Christoph Rosner[1], Sahra Wolff[1], Alexander Greiner[1], Julian Moik[1], Samet Katilmis[1], and Dong Liu[1] for the PANDA-Collaboration — [1]Helmholtz-Institut Mainz, Germany — [2]Institute of Nuclear Physics, Johannes Gutenberg University, Mainz, Germany — [3]Prisma Cluster of Excellence, Mainz, Germany

The feasibility of measuring the reaction $\bar{p}p \to e^+e^-\pi^0$ with the PANDA detector is investigated within the PANDARoot simulation framework. At high center of mass energy and high invariant mass squared of the lepton pair, a collinear factorisation description of the reaction amplitude, based on nucleon-to-meson transition distribution amplitudes, is predicted in the near forward and near backward regimes. At low lepton invariant mass squared, a parametrisation that assumes the exchange of dominant baryon Regge trajectories is suggested. Such a parametrisation will allow us to study the proton electromagnetic form factors in the so called "unphysical region". The collinear factorisation theorem for the nucleon-to-meson transition distribution amplitudes has not yet been proven experimentally. In addition, no data exist so far on the proton electromagnetic form factors in the unphysical region. The capability of PANDA to measure the differential cross sections for the reaction $\bar{p}p \to e^+e^-\pi^0$ and perform validity tests of the predicted QCD models will be shown in this talk.

HK 9.4 Mon 15:00 HK-H8

Accessing three-body strong interactions of p–p–π^+ and p–p–π^- with ALICE at the LHC — •Marcel Lesch for the ALICE-Collaboration — TUM

In the quest of understanding the nuclear equation of state, which is linked to the modelling of neutron stars, the QCD axion might play a crucial role. The properties of axions are expected to change in systems at finite baryonic densities and in particular they can be related to the in-medium properties of pions. Constraining these properties is thus crucial for the study of the QCD axion and its impact on the description of neutron stars.

The in-medium pion properties can be accessed by the measurement of interactions between pions and many nucleons produced in pp and p-Pb collisions at the LHC. These small systems produce particles at distances of ~ 1 fm, mimicking a large density environment. This talk will present the first experimental three-body correlations of the p–p–π^+ and p–p–π^- triplets by using the three-body femtoscopy technique. The results have been obtained by analysing high-multiplicity pp collisions at $\sqrt{s} = 13$ TeV measured by ALICE. The three-body effects are probed by employing the Kubo cumulant formalism to subtract the lower order contributions from the measured triplet correlation functions.

HK 9.5 Mon 15:15 HK-H8

LHCspin: towards a polarized gas target for the LHC — •Erhard Steffens[1], Paolo Lenisa[2], Vito Carassiti[2], Giuseppe Ciullo[2], Pasquale Di Nezza[3], Luciano L. Pappalardo[2], and Marco Santimaria[3] — [1]FAU, Erlangen, Germany — [2]U. Ferrara and INFN, Italy — [3]INFN Lab. Nat. di Frascati, Italy

The LHCspin project aims at unpolarized (SMOG2) and polarized fixed-target measurements by means of a gas target upstream of the LHCb detector, close to the vertex detector VELO. The forward geometry of the LHCb spectrometer ($2 < \eta < 5$) allows for the reconstruction of particles produced in fixed-target collisions, with center-of-mass energies ranging from $\sqrt{s_{NN}} = 72$ GeV with Pb beam to $\sqrt{s} = 115$ GeV in pp collisions. The use of H and D targets, polarized transversely

to the beam will allow to study the quark TMDs in pp collisions at unique kinematics. In addition, with LHCb being specifically designed for heavy-flavor physics, final states with c- or b-quarks will be efficiently reconstructed as demonstrated in detailed simulations, thus providing access to the so-far unknown gluon TMDs.

The design and status of the study will be presented. An openable storage cell with wake field suppressor and unpolarized gas feed system (SMOG2) is installed and ready to be tested during early 2022. A similar target with transverse B-field plus atomic beam source and diagnostics is being designed. The 7 TeV/1 A beam traversing the target might cause instabilities, which must be suppressed. This is studied in close collaboration with the LHC machine group.

HK 10: Hadron Structure and Spectroscopy II

Time: Monday 14:00–15:30 Location: HK-H9

Group Report HK 10.1 Mon 14:00 HK-H9

Experimental Inputs to the Hadronic Light-by-Light Contribution to the Anomalous Magnetic Moment of the Muon from BESIII — •Christoph Florian Redmer, Achim Denig, Nick Effenberger, and Max Lellmann for the BESIII-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland

Despite being one of the most precisely studied observables in particle physics, there remains a discrepancy of $4.2\,\sigma$ between the average value of the most recent direct measurements and the prediction within the Standard Model of the anomalous magnetic moment of the muon $a_\mu = \frac{(g-2)_\mu}{2}$. The precision of the prediction is limited by the knowledge of the hadronic contributions, which cannot be determined perturbatively, but depend on input from experiments. One of these contributions is the hadronic Light-by-Light scattering, which depends on the knowledge of transition form factors of light pseudoscalar, scalar, axial, and tensor mesons as well as the coupling of multi-meson systems to two photons, which is accessible in e^+e^- collisions.

The BESIII experiment, operated at the BEPCII accelerator in Beijing, China, has collected the world's largest data sets of e^+e^- collisions in the τ-charm region between 2 GeV and 5 GeV. The data are ideally suited to measure the momentum dependence of transition form factors at space-like momentum transfers of $Q^2 \approx 1\,\mathrm{GeV}^2$, which is of special relevance in the context of a_μ. In this presentation we discuss recent results, ongoing projects, and future prospects of the measurements at the BESIII experiment.

Group Report HK 10.2 Mon 14:30 HK-H9

Study of exclusive reactions in muon-proton scattering at COMPASS — •Johannes Giarra — on behalf of the COMPASS collaboration - Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Johann-Joachim-Becher-Weg 45, 55099 Mainz

In 2016/17 a measurement of exclusive reactions in the muon-proton scattering was performed in order to determine the cross section of the Deeply Virtual Compton Scattering (DVCS) process and exclusive meson production.
The COMPASS spectrometer is located at the M2 beamline of the CERN SPS, which provides a 160 GeV positively and negatively charged muon beam. The muons were scattered off a 2.5m long liquid hydrogen target. To perform an exclusive measurement of the processes the COMPASS spectrometer was supplemented by an additional electromagnetic calorimeter to increase the acceptance for the detection of large angle photons and a proton recoil detector.
The talk will summarize the current status in the analysis for determining the cross section of the DVCS and the exclusive single π^0 production. A focus will be on a detailed description of the methods and analysis steps used to extract the cross sections. A preliminary result on the t-dependence of the DVCS cross section will be presented.

HK 10.3 Mon 15:00 HK-H9

Measurement of the Proton Radius in High-Energy Elastic Muon-Proton Scattering at AMBER — •Christian Dreisbach for the AMBER-Collaboration — 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 2023. 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. The core setup consisting out of silicon tracking detectors up- and downstream of a prototype TPC is studied in a feasibility test measurement in the year 2018 and a pilot run in 2021 under comparable conditions as the proposed measurement. A beam test of a new unified tracking station utilizing scintillating fibers and monolithic pixel-silicon detectors and commissioning of the novel triggerless DAQ system is foreseen in 2022. We present results of the on-going analysis and developments towards a possible setup in 2023.

HK 10.4 Mon 15:15 HK-H9

Radiative corrections to elastic muon-proton scattering — •Norbert Kaiser[1], Yonghui Lin[2], and Ulf-G. Meissner[2] — [1]Physik Department T39, Technische Universität München — [2]HISKP and Bethe Center for Theoretical Physics, Universität Bonn

In support of the upcoming AMBER experiment at CERN to measure the proton charge-radius, the radiative corrections to elastic muon-proton scattering $\mu^\pm p \to \mu^\pm p$ are calculated, keeping the full dependence on the lepton mass. Besides vacuum polarization and the photon-loop form factors $F^\gamma_{1,2}(t)$ of the muon, one has to consider the photon-loop around the proton. The corresponding electric and magnetic form factors $G^\gamma_{E,M}(t)$ consist of infrared-divergent and infrared-finite pieces that are evaluated by including proton structure through electromagnetic form factors (caused by the strong interaction) and the excitation to the $\Delta^+(1232)$-resonance. The same features apply to the computation of the two-photon exchange box-diagrams. It is found that after cancelation of infrared divergences the (soft) photon bremsstrahlung plays a prominent role among the radiative corrections. Therefore, the calculation of bremsstrahlung should be extended beyond the soft photon approximation and adapted to the specific experimental conditions.

This work has been supported in part by DFG (Project-ID 196253076 - TRR 110) and NSFC.

HK 11: Nuclear Astrophysics I

Time: Monday 14:00–15:30 Location: HK-H10

Group Report HK 11.1 Mon 14:00 HK-H10

The explosive nucleosynthesis of proton-rich nuclei mimicked in the laboratory — •Felix Heim, Martin Müller, Svenja Wilden, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics

The universe was born with just hydrogen, helium and small traces of lithium. Most of the heavy nuclei beyond the iron-peak region are created by neutron-capture processes. A group of 30 to 35 proton-rich stable isotopes however, is shielded against these processes. These p nuclei are most likely produced in explosive stellar scenarios by the astrophysical γ process, which is a complex network of thousands of nuclear - mostly photodisintegration - 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, the extension of the experimental database of measured cross sections is one of the tasks of nuclear laboratories. Also, experimental

data are required to constrain the nuclear physics parameters entering the theoretical calculations and to test their predictive power. In this contribution, details of the experimental setup and techniques will be presented that are used to measure nuclear reactions relevant for the nucleosynthesis of the p nuclei. In addition, emphasis will be put on studies of the underlying nuclear physics properties.
Supported by the DFG (ZI 510/8-2).

HK 11.2 Mon 14:30 HK-H10

Investigation of ^{170,172}Yb$(\alpha,n)^{173,175}$Hf cross sections in a stacked target experiment — •Martin Müller, Felix Heim, Yanzhao Wang, Svenja Wilden, and Andreas Zilges — Institute for Nuclear Physics, University of Cologne

In spite of decades of research, many observed nuclear abundances remain that can not be reproduced by p-process nucleosynthesis calculations [1]. This is mainly due to the lack of constraints for the involved nuclear physics models. Previous studies have shown that key reactions affecting the abundance of the p-nucleus ^{168}Yb are the ^{164,166}Yb(α,γ) reactions and that these are mostly sensitive to the α-optical-model-potential (α-OMP) [2,3]. To study the α-OMP in the Yb chain and its dependence on the proton-to-neutron ratio, a stacked target activation experiment was performed at the University of Cologne's *Cologne Clover Counting* setup investigating the ^{170,172}Yb$(\alpha,n)^{173,175}$Hf reaction cross sections. The results were validated by simultaneous measurements of the well established ^{55}Mn$(\alpha,(2)n)^{57,58}$Co and ^{54}Fe$(\alpha,n)^{57}$Ni reaction cross sections. All measurements were compared to statistical model calculations performed using the TALYS-1.95 code [4].
Supported by the DFG (ZI 510/8-2).

[1] M. Arnould and S. Goriely, Phys. Rep. **384**, 1 (2003)
[2] T. Rauscher *et al.*, Mon. Not. R. Astron. Soc. **463**, 4153 (2016)
[3] T. Rauscher *et al.*, Astrophys. J. Suppl. Ser. **201**, 26 (2012)
[4] A. J. Koning *et al.*, Nucl. Data Sheets **113**, 2841 (2012)

HK 11.3 Mon 14:45 HK-H10

First results of total and partial cross-section measurements of the ^{87}Rb$(p,\gamma)^{88}$Sr reaction — •Svenja Wilden, Felix Heim, Martin Müller, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics, 50937 Cologne, Germany

The existence of most of thestable very neutron deficient nuclei - the p nuclei - cannot be explained via neutron-capture reactions. Therefore, at least one other process has to exist in order to describe their origin, the γ process. Since most photodisintegration reactions involved in the process are not directly accessible, reliable statistical model calculations are needed to predict cross sections and reaction rates. To improve the calculations the nuclear input parameters need to be constrained and a large experimental database is needed. Via comparison of experimental data to theoretical predictions different models can be excluded or constrained. In order to study the ^{87}Rb$(p,\gamma)^{88}$Sr reaction, for the first time an in-beam experiment at the high-efficiency HPGe γ-ray spectrometer HORUS at the University of Cologne was performed. Proton beams with energies between $E_p = 2.0 - 5.0$ MeV inside the Gamow window were provided by the 10 MV FN Tandem accelerator.
Supported by the DFG (ZI 510/8-2).

HK 11.4 Mon 15:00 HK-H10

Investigation of the 3He(α,γ)7Be reaction at the Felsenkeller shallow underground facility — •Steffen Turkat[1], Daniel Bemmerer[2], Axel Boeltzig[2], Fabia Dietrich[2], Armin Freimann[2], Thomas Hensel[1], Jonas Koch[2], Till Lossin[2], Felix Ludwig[2], Jannis Michaelis[2], Max Osswald[2], Simon Rümmler[2], Konrad Schmidt[2], Julian Schwengfelder[2], and Kai Zuber[1] — [1]Institut für Kern- und Teilchenphysik, TU Dresden, Dresden, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

The ^{3}He$(\alpha,\gamma)^7$Be reaction plays a significant role in Big Bang nucleosynthesis, as well as in solar fusion processes. It affects the predicted solar ^{7}Be and ^{8}B neutrino fluxes as well as the nucleosynthesis of primordial ^{7}Li.
A measurement of the γ-ray angular distribution is currently underway in order to enable a better comparison between several experimental data sets at E = 0.7 - 1.3 MeV and a unique data set from the LUNA collaboration at E = 0.09 MeV - 0.13 MeV. A setup using 21 HPGe detectors and implanted 3He targets is used at the 5 MV Felsenkeller underground accelerator. In addition to the angular distribution study, the activated samples are counted offline. First results of this ongoing campaign will be summarized. - Supported by DFG (ZU123/21-1)
The use of GAMMAPOOL resources is gratefully acknowledged.

HK 11.5 Mon 15:15 HK-H10

Energy calibration of the 5MV accelerator at the Felsenkeller shallow-underground laboratory — •Simon Rümmler[1], Daniel Bemmerer[1], Axel Boeltzig[1], Fabia Dietrich[1], Armin Freimann[1], Jonas Koch[1], Till Lossin[1], Felix Ludwig[1], Max Osswald[1], Konrad Schmidt[1], Julian Schwengfelder[1], Steffen Turkat[2], and Kai Zuber[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Institute of Radiation Physics — [2]TU Dresden, Institute of Nuclear and Particle Physics

Astrophysical radiative capture reactions occur at low energies, resulting in low cross sections and hence low counting rates in the γ-detectors. This calls for accelerator facilities that are located underground, shielded from cosmic rays. The shallow-underground laboratory at Felsenkeller in Dresden provides 45 meters of rock overburden for the installed 5MV Pelletron accelerator. In addition to a low-background setting, an energy calibration of the accelerator is needed to perform precise measurements.

During the commisioning of the accelerator and its two ion sources, as well as during first astrophysically relevant experiments, measurements for different methods of an energy calibration were recorded. The results of the individual methods were obtained independently and provide consistent results, even at different accelerator voltages. The overall result of the completed energy calibration and a comparison of the methods will be presented.

HK 12: Heavy-Ion Collisions and QCD Phases III

Time: Monday 16:00–17:30 Location: HK-H1

Group Report HK 12.1 Mon 16:00 HK-H1

Measurements of Heavy-flavour Baryon Production with ALICE at the LHC — •Jeremy Wilkinson for the ALICE-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt

The measurement of charmed baryons in hadronic collision systems at the LHC has recently shown an enhancement of the charmed baryon-to-meson ratios (Λ_c^+/D^0 and Ξ_c/D^0) with respect to previous measurements in e^+e^- and e^-p collisions, challenging previous assumptions about the universality of charm hadronisation processes between different collision systems. This in turn has a significant effect on the measured total charm cross section, where previously the relative contributions of charmed baryons had to be assumed based on results from leptonic collision experiments.

This talk will present the latest measurements performed by the ALICE Collaboration for charmed baryon production at mid-rapidity in pp and p–Pb collisions at the LHC. In particular, we highlight recent developments in analysis techniques using the XGBoost algorithm for machine learning selections, and the KFParticle package, which uses a Kalman filter to re-fit the decay tracks from baryon candidates and provide constraints to improve the mass resolution. These methods provide unprecedented experimental access to the low-p_T region for Λ_c^+ to serve as a constraint on the charm fragmentation fractions. In addition, they can be used to give indirect access to the beauty sector through non-prompt Λ_c^+, as well as previously inaccessible decays such as $\Omega_c^0 \to \Omega^-\pi^+$ and $\Xi_c^+ \to \Xi^-\pi^+\pi^+$.

HK 12.2 Mon 16:30 HK-H1

Reconstruction of $\Xi_c^+ \to \Xi^-\pi^+\pi^+$ in proton-proton collisions at $\sqrt{s} = 13$ TeV with the ALICE detector — •Carolina Reetz — Physikalisches Institut, Universität Heidelberg — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt

Recent measurements of charmed-baryon production at midrapidity

in pp and p-Pb collisions show a baryon-to-meson ratio significantly higher than the one in e^+e^- collisions, suggesting that the fragmentation of charm quarks into hadrons is not universal across different collision systems.
The reconstruction of the Ξ_c^+ baryon decaying to $\Xi^-\pi^+\pi^+$ with the ALICE detector is the subject of the studies presented in this contribution. The reconstruction of the complex decay topology is performed with the help of the KF Particle Package. It supports the reconstruction of full particle decay chains, exploiting the use of invariant mass and topological constrained fits and including the complete treatment of tracking and vertexing uncertainties. These features are of crucial importance in the selection of reconstructed candidates which is performed by applying machine learning techniques in the form of Boosted Decision Tree (BDT) models using XGBoost.
The application of these advantageous techniques is of utmost importance in the search for rare signals and allows to extract signal even in low p_T-intervals where the signal-to-background ratio is rapidly decreasing. The cross section measurement together with the full treatment of the systematic uncertainties and the comparison to model calculations is reported.

HK 12.3 Mon 16:45 HK-H1

Reconstruction of beauty jets in proton-proton collisions at $\sqrt{s} = 13$ TeV with ALICE — •Katharina Demmich — Westfälische Wilhelms-Universität Münster, Germany

In this contribution, the performance of a beauty-jet tagging algorithm based on transverse impact-parameter threshold cuts will be discussed for data collected by the ALICE experiment in proton-proton collisions at $\sqrt{s} = 13$ TeV. Owing to the relatively large lifetimes and the cascade of weak decays of beauty hadrons, the measurement of the impact parameter of tracks within jets can be utilised to select beauty jets.

Measuring the beauty-jet production cross section in proton-proton collisions is a fundamental step towards a thorough testing of QCD calculations for the production and fragmentation of heavy flavours in nucleon-nucleon collisions. Thereby, the ALICE experiment offers excellent capabilities to assess theory predictions down to low $p_{T,Jet}$ due to its unique tracking performance.
In addition, the investigation of beauty-jet observables in proton-proton collisions is a reference for respective analyses on heavy-ion collisions. As such, it opens the possibility to study the mass dependence of particle interactions with the Quark-Gluon Plasma (QGP).

HK 12.4 Mon 17:00 HK-H1

Measurement of charm production cross-section via electron-muon coincidence — •Victor Feuillard for the ALICE-Collaboration — Physikalische Institut, Heidelberg, Germany

The measurement of the production of heavy-flavor hadrons, meaning hadrons with charm or beauty quarks, in proton-proton collisions provides a test of quantum chromodynamics (QCD), the theory of the strong interaction. Indeed, in hadronic collisions, heavy quarks are almost exclusively produced through initial hard partonic scattering processes because of their large masses.

One available method to investigate heavy-flavor production is the measurement of the contribution of semi-leptonic decays of heavy-flavor hadrons to the dilpeton spectra. In particular, it is possible to measure the production of heavy mesons in the electron-muon spectrum.

In this talk, we will present the measurement of the charm production cross section in pp collisions at $\sqrt{s} = 13$ TeV in ALICE using electron-muon coincidence.

HK 12.5 Mon 17:15 HK-H1

Hydrodynamic approach to heavy-quark diffusion in the quark-gluon plasma — •Federica Capellino[1,2], Andrea Beraudo[3], Andrea Dubla[2], Stefan Floerchinger[4], Silvia Masciocchi[1,2], Jan M. Pawlowski[4], and Ilya Selyuzhenkov[2] — [1]Physikalisches Institut Heidelberg, Heidelberg, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany — [3]INFN Sezione di Torino, Torino, Italy — [4]Institut für Theoretische Physik, Heidelberg, Germany

In this work, a new hydrodynamic approach to the transport of heavy quarks in the quark-gluon plasma (QGP) is presented. We exploit the conservation of the number of heavy quark-antiquark pairs within the evolution of the QGP to construct causal second-order hydrodynamic equations of motion. The hydrodynamic transport coefficients associated with the heavy-quark diffusion current are then compared with the momentum-diffusion coefficients obtained in transport theory (Fokker-Planck equation). By investigating the relation between the two approaches, we provide new insights concerning the level of local thermalization of charm and bottom quarks inside the expanding QGP. Our results show that a fluid dynamic description of diffusion is feasible for charm quarks. In particular, in Bjorken flow the hydrodynamization time of charm quarks is in general short compared to the typical expansion time of the QGP, justifying a fluid description of charm diffusion. This work is funded via the DFG ISOQUANT Collaborative Research Center (SFB 1225).

HK 13: Heavy-Ion Collisions and QCD Phases IV

Time: Monday 16:00–17:15 Location: HK-H2

HK 13.1 Mon 16:00 HK-H2

Coarse Grained Transport Dynamics with FRG spectral function — •Maximilian Wiest[1], Tetyana Galatyuk[1,2,4], Ralf-Arno Tripolt[3], Lorenz von Smekal[3,4], Jochen Wambach[1], and Joachim Stroth[2,4,5] — [1]TU Darmstadt, Germany — [2]GSI, Darmstadt, Germany — [3]Justus Liebig University Giessen, Germany — [4]Helmholtz Research Academy Hesse for FAIR (HFHF), Germany — [5]Goethe University Frankfurt, Germany

The bulk of the detected particles stemming from heavy ion collisions are hadrons. Being strongly interacting, they are heavily influenced by final state interactions. As produced dileptons are not subject to the strong interaction, they do not suffer from this disadvantage and can leave the fireball undisturbed, probing the hot and dense matter before it freezes out. We use the microscopic transport model UrQMD to simulate gold-gold collisions at 1.23 AGeV at different centrality classes. Employing a Coarse Graining approach, we are able to combine the simulated microscopic dynamics with in-medium spectral functions obtained from FRG methods. This allows us to study the thermal dilepton production in heavy-ion collisions at SIS 18 energies. Our aim is to investigate the consistency of our approach. For this purpose, we will compare different methods of extracting the bulk observables as well as determining thermalization and explore the effect of variations in the underlying parameters like grid sizes. Supported by VH-NG-823, DFG CRC-TR 211 and GSI.

HK 13.2 Mon 16:15 HK-H2

Quantum Mechanical Bound State Formation in Time Dependent Potentials — •Jan Rais[1], Hendrik van Hees[2], and Carsten Greiner[3] — [1]Institute for theoretical physics, Goethe Universität Frankfurt — [2]Institute for theoretical physics, Goethe Universität Frankfurt — [3]Institute for theoretical physics, Goethe Universität Frankfurt

We study the formation of quantum mechanical bound states within a 1-dimensional attractive square well potential, by first solving the stationary system and then study a time dependent system. Here we introduce a time dependent potential, which could generally be of every shape. In our case, we introduce Gaussian potentials which are sufficiently small in space, due to the size of the box and differ due to different time lengths. We are interested to study the time scales, in which bound states populate and depopulate. Therefore we also clarify how to treat the question, where to obtain Heisenberg's uncertainty relation in energy and time and how it is fulfilled in our system. Furthermore we study the applicability of first order perturbation theory on the considered quantum system.

HK 13.3 Mon 16:30 HK-H2

Dynamic critical behavior of spectral functions via classical statistical real-time simulations — •Frederic Klette and Sören Schlichting — Bielefeld University, Bielefeld, Germany

Finding the position of the critical point in the QCD phase diagram

and determining the behavior in its vicinity has been the subject of active research for several decades. Spectral functions of a system and other real-time observables, can not be reconstructed with an acceptable accuracy from Euclidean time data. Due to QCD being difficult to simulate directly in real time we use universality to investigate the physics near the QCD critical point. Using the fact that models with an O(n) symmetry are in the same, or at least a similar universality class as the chiral model, we study these via classical statistical simulations to learn about their dynamic critical behavior. More precisely, we aim to develop a detailed analysis of the dynamic critical scaling behavior of the spectral function and related observables of an O(4) symmetric model in (3+1) dimensions.

HK 13.4 Mon 16:45 HK-H2

Non-Equilibrium Transport of Conserved Charges in High-Energy Heavy Ion Collisions — •Philip Plaschke and Sören Schlichting — Bielefeld University, Germany

Non-equilibrium Green*s functions provide an efficient way to describe the pre-equilibrium evolution of macroscopic quantities in early stages of heavy-ion collisions. Within the kinetic theory framework we use moments of the distribution functions to calculate time dependent non-equilibrium Green*s functions describing the evolution of initial energy/momentum/charge perturbations [1]. Using kinetic theory in relaxation time approximation we will study the pre-equilibrium evolution of a Bjorken background and compute Green*s functions for the charge current and energy-momentum tensor for initial perturbations around this background. By calculating the Green*s functions, we show that only modes with long wavelength survive up into the hydrodynamic regime. [1] [Kamata, Martinez, PP, Ochsenfeld, Schlichting, Phys. Rev. D (2020)]

HK 13.5 Mon 17:00 HK-H2

Classifying the QCD equation of state in heavy-ion collision experiments with Deep Learning — •Manjunath Omana Kuttan[1,2,3], Kai Zhou[1], Jan Steinheimer[1], Andreas Redelbach[1,4], and Horst Stöcker[1,2,5] — [1]FIAS, Frankfurt am Main, Germany — [2]Institut fur Theoretische Physik, Johann Wolfgang Goethe Universität, Frankfurt am Main, Germany — [3]Xidian-FIAS international Joint Research Center, Frankfurt am Main, Germany — [4]Institut fur Informatik, Johann Wolfgang Goethe Universität, Frankfurt am Main, Germany — [5]GSI Helmholtzzentrum fur Schwerionenforschung GmbH, Darmstadt, Germany

We present a novel technique to identify the nature of QCD transitions that happen in a heavy-ion collision experiment, particularly at the CBM experiment [1]. We show that Deep Learning (DL) models based on PointNet can be used as a fast, online method for identifying a first order phase transition from a crossover transition that happens in heavy-ion collision experiments. We use a comprehensive data preparation method to train and evaluate the models in several hypothetical experimental scenarios. A model trained on the reconstructed tracks from CBM detector simulations requires only about 40 events for accurate predictions. This makes the PointNet models an ideal candidate for online analysis of the continuous datastream produced in the CBM experiment. The DL model is shown to have up to 99.8% prediction accuracy and outperforms conventional methods based on mean observables such as the V_2 or $<P_t>$.

[1] Omana Kuttan, M., et al. JHEP, 2021(10), 1-25.

HK 14: Instrumentation IV

Time: Monday 16:00–17:30 Location: HK-H3

Group Report HK 14.1 Mon 16:00 HK-H3

Status of the CBM Micro Vertex Detector* — •Benedict Arnoldi-Meadows for the CBM-MVD-Collaboration — Goethe-Universität Frankfurt am Main

The Compressed Baryonic Matter (CBM) Experiment will be a core experiment of the future FAIR facility. Its Micro Vertex Detector will be composed from four stations and operate in the target vacuum. Its mission is to reject background in di-electron spectroscopy and to reconstruct weak decays of multi-strange baryons and open charm created in the up to 10 MHz p+p and up to 100 kHz Au+Au collisions of the fixed target experiment. The $0.3 - 0.5\%$ X_0 thin stations will be equipped with 50 μm thin, highly granular Monolithic Active Pixel Sensors named MIMOSIS, which are being designed by the IPHC Strasbourg and will combine a spatial and time resolution of 5 μm and 5 μs, respectively, with a peak rate capability of 80 MHz/cm^2.

We discuss first results from tests of the MIMOSIS-1 full size sensor prototype, which was irradiated with doses up to 3×10^{14} n_{eq}/cm^2 and 5 MRad and tested hereafter at DESY and the CERN-SPS. Moreover, the status of the R&D on detector integration will be summarized.

*This work has been supported by BMBF (05P19RFFC1), GSI, CREMLINplus, and HFHF.

Group Report HK 14.2 Mon 16:30 HK-H3

The LHCb Upgrade II Plans with focus on the MightyTracker — •Klaas Padeken[1], Sebastian Neubert[1], and LHCb MightyTracker group[2] — [1]Rheinische Friedrich-Wilhelms Universität Bonn — [2]CERN

For the HL-LHC the LHCb Collaboration plans a major Upgrade in the long shutdown 4 (2031) to increase the instantaneous luminosity from $2 \cdot 10^{33}$ cm^{-2}s^{-1} to $1.5 \cdot 10^{34}$ cm^{-2}s^{-1} with streaming, triggerless output. This requires a major redesign of a few subdetectors. This talk will focus on MightyTracker, which will replace the current SciFi Tracker with a hybrid detector, comprised of HV-CMOS pixel sensors surrounding the beampipe and scililating fibers further outside. This will be the largest CMOS detector with a total of 18 m^2 of active area. The current developments and plans will be presented.

HK 14.3 Mon 17:00 HK-H3

Material budget imaging of carbon foam support structures using ALPIDE sensors — •Bogdan Mihail Blidaru for the ALICE-Collaboration — Physikalisches Institut, Heidelberg University, Germany

During the next LHC Long Shutdown, ALICE plans to replace the three innermost layers of the recently upgraded Inner Tracking System (ITS2) with a novel vertex detector based on wafer-scale, ultra-thin, truly cylindrical Monolithic Active Pixel Sensors (MAPS). The new sensors will be thinned down to 20-40 μm, featuring an unprecedented low material budget of less than 0.05% x/X_0 per layer and will be arranged concentrically around the beam pipe, as close as 18 mm from the interaction point.

To reach such ultra low material budget levels, the routing of power and signals will be integrated onto the sensor and the water cooling and mechanical support will be removed. A series of ultra-lightweight half-ring spacers, made of open cell carbon foam will be instead used in the active area. They will be inserted between the sensor layers to define their relative radial position and offer mechanical support.

To study the effects of scattering, carbon foam wedges of different proposed materials are tested in a high-resolution ALPIDE telescope using electron beams in the GeV-range at the DESY Test Beam Facility. The material budget is estimated with good accuracy by measuring the position-resolved scattering angle distribution of the beam particles. The foam structure is properly resolved and good agreement between expectations and data is found.

HK 14.4 Mon 17:15 HK-H3

Sensor tests for the PANDA Micro-Vertex-Detector — •Nils Tröll for the PANDA-Collaboration — II. Physikalisches Institut, Giessen, Germany

Double sided silicon strip detectors are part of the Micro-Vertex-Detector (MVD), which is the innermost detector of PANDA. High resolution track measurements are to be carried out to investigate the strong interaction in particular.

Methods for accuracy measurements on test structures of the silicon-strip-sensors will be presented. These techniques and full-sensor measurements are used for characterization and quality testing of the final MVD sensors. In addition, radiation tolerance characterization on silicon diodes using a neutron source will be shown.

HK 15: Instrumentation V

Time: Monday 16:00–17:30 Location: HK-H4

Group Report HK 15.1 Mon 16:00 HK-H4

A new high level filter system for the AMBER experiment at the CERN SPS — •Benjmain Moritz Veit for the AMBER-Collaboration — Institut für Kernphysik der Johannes Gutenberg-Universität, Mainz

AMBER is a new experiment at the European Organization for Nuclear Research (CERN) dedicated to study fundamental questions related to the emergence of hadron mass from QCD. Therefore a variety of measurements with muon and hadron beams, which will cover a wide range in the squared four-momentum transfer Q2, at the M2 beam line of the Super Proton Synchrotron (SPS) are forseen. One of the first measurements in AMBER phase 1 is the elastic scattering of high-energy muons off protons to precisely determine the proton charge radius. For this experiment, it is planned to transform the current classical DAQ approach to a streaming DAQ scheme, in which detectors deliver continuous time-stamped data streams with data rates of up to 20GB/s to the DAQ. This data streams will be concentrated by a system of FPGA-based multiplexers and a timeslice builder switch before the full data stream is stored by readout computers on a temporary local storage. The local storage allows for extraction and validation of calibration information before the final processing. The newly developed asynchronous running high level filter system (HLT) use this information to partially reconstructed, analyse, and eventually reduced the amount of data. The goal of the filter system is to reduce the data rate below 500MB/s before it is written to permanent storage. An overview of the design of the filter system will be presented.

HK 15.2 Mon 16:30 HK-H4

NuDAQ - A flexible and extendable data acquisition system for above-small size nuclear physics setups — •Michael Weinert, Christoph Fransen, Andreas Harter, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics, 50937 Cologne, Germany

The increasing number of channels in modern day nuclear physics experiments led to a redesign of the digital data acquisition system (DAQ) and the overall approach to setting up experiments at the Institute for Nuclear Physics in Cologne. While a high channel count and low dead times are welcomed features of modern digital acquisition systems, the highest achievable spectral resolution is mandatory for experiments that depend on the analysis of e.g. γ-ray energies well below 1 keV precision or direct lifetime measurements in the ps regime. A new DAQ system was built around the commercially available V1730 and V1782 digitizer modules by CAEN SpA, which are used to process signals from semiconductor detectors as well as photomultiplier-based detectors. A centralized server station, connected to each setup via fibre channel, builds the heart of the DAQ system that does not have to be moved between experiments, is accessible even when beam is on target, and benefits from an independent power supply and a fast uplink. An online-coincidence filter module has been implemented on the CAEN V2495 FPGA module which also allows to process veto signals per detector. This contribution presents the new system and improved workflow and display the high performance available for local experiments. Supported by the BMBF (05P21PKEN9).

HK 15.3 Mon 16:45 HK-H4

A Cost-Effective Modular Data Logger for Detector Laboratories — •Philip Hauer, Mario Engel, Oliver Adam, Thomas Block, Jan Paschek, Tobias Rudolph, and Bernhard Ketzer — Helmholtz-Institut für Strahlen- und Kernphysik – Universität Bonn

Many important parameters of a gaseous detector (e.g. the gas gain) depend on environmental parameters such as pressure and temperature. For the operation of gaseous detectors it is therefore crucial to monitor these parameters precisely and reliably. In order to fulfil this task, a modular logger for environmental parameters in laboratories was developed. In addition, the used temperature and pressure sensor is so small that it can be placed inside the gas system such that it can measure the temperature and pressure of the gas directly.

The logger is based on different sensors that are connected to a micro-controller which has a built-in WiFi chip. The micro-controller connects to a local wireless network which is created by a Raspberry Pi. Via the MQTT protocol, the recorded data are sent to the Raspberry Pi which forwards the data to a remotely accessible database for long-term storage.

On this poster, the setup is described in more detail. Some exemplary data and how they are used to correct gain fluctuations are also shown.

Supported by BMBF.

HK 15.4 Mon 17:00 HK-H4

Developing Feature Extraction Algorithms with Vivado HLS for the CBM-TRD — •David Schledt — Infrastructure and Computer Systems in Data Processing, Frankfurt, Deutschland

Traditionally FPGA firmware was developed solely with Hardware Description Languages (HDL) like Verilog or VHDL. However, with the steady improvements of tools like Vivado HLS (High Level Synthesis) it is now possible to write parts of the firmware with higher level languages like C++. Using HLS allows faster development cycles, easier code reuse and, most importantly, to efficiently write complex algorithms for the FPGA.

The Compressed Baryonic Matter (CBM) experiment at the Facility for Antiproton and Ion Research (FAIR) will investigate the QCD phase diagram at high net-baryon densities. The experiment employs a free streaming data acquisition with self-triggered front-end electronics (FEE). At interactions rates of up to 10 MHz the readout firmware has to process very high data loads. The CBM Transition Radiation Detector (TRD) is equipped with the SPADIC front-end ASIC. The SPADIC allows for an oscilloscope-like sampling of the detector signals. From the sampled signal several different features can be extracted, such as the deposited charge or a time resolution above the pure sampling frequency. In this talk I will present how different feature extraction algorithms were implemented in the FPGA with Vivado HLS.

This work is supported by BMBF-grant 05P21RFFC3.

HK 15.5 Mon 17:15 HK-H4

Firmware improvements for the FPGA-based Sampling-ADC readout of the Crystal Barrel Calorimeter — •Benedikt Otto for the CBELSA/TAPS-Collaboration — HISKP, Uni Bonn

The CBELSA/TAPS experiment investigates the photoproduction of neutral mesons. Since June 2021, the experiment's main calorimeter is equipped with a new Sampling-ADC (SADC) readout, based on 14bit@80MS ADCs and Kintex7 FPGAs. The firmware taking care of feature extraction and UDP/IP communication is currently developed further and improved.

Part of these enhancements is the resource-efficient implementation of a finite-impulse-response (FIR) filter to perform effective noise reduction. Additional improvements to the feature-extraction algorithms themselves are presented as well. To furthermore accommodate multihit-features and a custom waveform compression method, the packet structure had to be adapted.

As integral part of the firmware development, a comprehensive test suite was implemented using python and cocotb which allows convenient and automated testing of firmware components.

HK 16: Instrumentation VI

Time: Monday 16:00–17:30 Location: HK-H5

HK 16.1 Mon 16:00 HK-H5

Beam measurements with the RD51 beam telescope using the VMM3a and SRS — •Karl Jonathan Flöthner[1,2], Lucian Scharenberg[1,2], Daniel Petri Sorvisto[4], Eraldo Oliveri[1], Francisco Fuentes[3], and Bernhard Ketzer[2] — [1]CERN — [2]Univ. of Bonn (DE) — [3]Helsinki Institute of Physics — [4]Univ. of Aalto (FI)

RD51 is an international research and development collaboration at CERN with focus on advanced gas-avalanche detector technologies and

associated electronic-readout systems. For testbeam campaigns the RD51 collaboration provides a GEM-based beam telescope for detector studies. It consists of several triple-GEM detectors with an active area of 10x10 cm^2 and additional scintillators to generate a trigger signal for the start of events. During the last year the telescope was equipped with the new VMM3a ASIC coupled to the Scalable Readout System (SRS). In this configuration the system can provide a MHz counting rate-capability, spatial resolutions in the order of 50 μm (COMPASS like triple-GEM detector) and time resolutions in the 10-ns regime (VMM capable of few ns). The new setup was tested in the laboratory and during two testbeam campaigns (July/October 2021). The system contains five GEM-detectors and a total of 42 VMMs (2688 channels). During the last beam campaign, the telescope has been used to investigate different fine-pitch GEM foils to understand the impact on spatial resolution with MIPs. The talk will discuss some challenges of the system and present first results of the last testbeam data, focussing on the performance of the fine-pitch GEM.
Supported by BMBF.

HK 16.2 Mon 16:15 HK-H5

New GEM detectors for AMBER — •Jan Paschek[1], Karl Flöthner[3], Markus Ball[1], Michael Hösgen[1], Michael Lupberger[1,2], and Bernhard Ketzer[1] — [1]Helmholtz-Institut für Strahlen- und Kernphysik der Universität Bonn, Bonn, Germany — [2]Physikalisches Institut der Universität Bonn, Bonn, Germany — [3]CERN GDD, Meyrin, Schweiz

Phase II of the COmmon Muon Proton Apparatus for Structure and Spectroscopy (COMPASS) is planned to be finished in 2022 by measuring the transverse-momentum dependent PDFs in deep inelastic scattering of muons on a deuterium target.
Using the COMPASS spectrometer a new proposal for a future QCD facility at the M2 beamline of the SPS accelaror, at CERN has been accepted. Running under the name AMBER, the physics program includes a measurement of the proton radius in elastic muon-proton scattering. The GEM stations are mandatory for scattered muon tracking. With a low material budget, high efficiency ($> 97\%$) and a good spatial resolution (around 70μm) the triple GEM detectors are an ideal tracking system. Combined with further detectors and a magnetic field, the momentum of scattered muons can be determined.
However, the existing GEM detectors have to be replaced as they cannot cope with the anticipated beam rates and have suffered from 20 years of operation COMPASS. A new detector layout was developed. In this contribution, first test results as well as the quality assurance procedure for detector construction will be presented.

HK 16.3 Mon 16:30 HK-H5

Impact of the gas choice and the geometry on the breakdown limit in (TH)GEM-based detectors — •Lukas Lautner[1,2], Piotr Gasik[3], Andreas Mathis[1], Laura Fabbietti[1], Tobias Waldmann[1], Berkin Ulukutlu[1], and Thomas Klemenz[1] — [1]Physik Department, Technische Universität München — [2]CERN — [3]GSI - Helmholtzzentrum fur Schwerionenforschung GmbH

In this study we investigate the intrinsic stability limits of Gas Electron Multiplier (GEM) and Thick GEM detectors upon irradiation with alpha particles. The measurements are performed in Ar- and Ne- based mixtures with different CO_2 content to study the influence of the gas on discharge probability and critical charge limits. The latter are obtained by comparing the experimental data to results obtained within a Geant4 simulation framework. The measurements provide a direct comparison between GEMs and THGEMs and allow us to evaluate the influence of geometrical parameters, such as hole size, pitch and (TH)GEM thickness, on the stability of a structure and the resulting critical charge value. We observe that the breakdown limit is strongly dependent on the gas, and that the amount of quencher in the mixture does not necessarily correlate with higher stability. The outcome of these studies is of particular interest for currently running or planned photon and hadron-blind detectors based on THGEM technology as well as cryogenic applications.

HK 16.4 Mon 16:45 HK-H5

Charge density breakdown limits in Micromegas structures — •Tobias Waldmann[1], Berkin Ulukutlu[1], Piotr Gasik[2], Laura Fabbietti[1], Thomas Klemenz[1], and Lukas Lautner[1] — [1]Technische Universität München — [2]GSI Helmholtzzentrum

Micro Mesh Gaseous Structures (Micromegas) are detectors implemented in a wide range of modern particle physics experiments. Among their major advantages are high achievable gains, good energy resolution and intrinsic ion backflow suppression. However, a major limiting factor to the performance is the formation of electrical discharges inside the amplification region, which can eventually blind or permanently damage the involved detector components. Therefore, the limits of safe operation of such detectors need to be studied in detail. In our studies we investigated the discharge stability of Micromegas with respect to different mesh geometries and gas mixtures. As in previous studies with GEMs and THGEMs, the measurements show clear evidence for charge density being a driving factor in the discharge formation process in Micromegas. This is observed through a dependence on the used gas mixture, where Neon-based mixtures with low CO2 content yield the best stability against the development of discharges. The results provide further constraints and limits for the safe operation of Micromegas-based detectors, opening up new possibilities for their optimization.

HK 16.5 Mon 17:00 HK-H5

A Pulsed Drift Tube for 100keV Antiprotons — •Jonas Fischer, Alexandre Obertelli, and Frank Wienholtz — IKP TU Darmstadt, Deutschland

The PUMA collaboration aims at trapping, storing and transporting 10^9 antiprotons in a cryogenic penning trap. To achieve this, antiprotons from ELENA need to be decelerated from 100keV to 4keV in a first step. To minimise losses in the deceleration process, a Pulsed Drift Tube (PDT) was installed at LNE51 at CERN. A good vacuum of below 10^{-10} mbar is necessary to avoid the annihilation of the antiprotons with residual gas molecules. This, and the high voltage, pose strict restrains on the design and operation of the pulsed drift tube. In this talk I will give an overview over the pulsed drift tube designed for PUMA.

HK 16.6 Mon 17:15 HK-H5

Testing Low's theorem with the Forward Conversion Tracker of ALICE 3 — •Martin Völkl for the ALICE-Collaboration — Universität Heidelberg

Soft theorems play a fundamental role in the development of quantum field theory. In scattering processes the production of soft photons diverges in the infrared in a controlled manner. Low's theorem relates the production cross section of a process with and without additional soft photon emission by a simple formula without dependence on the details of the process. However, this simple and fundamental prediction was found to strongly underestimate measured soft photon production in hadronic processes for previous experiments.

With this contribution we discuss the prospects of measuring and investigating this effect with the future ALICE 3 experiment using the proposed Forward Conversion Tracker (FCT). This detector can measure photons from collisions at LHC energies down to very low photon momenta. The resulting measured photons can then be related to the information about the hadronic event measured with ALICE 3. This allows exploration of the apparent discrepancy between calculations and experiment which would significantly impact our fundamental understanding of quantum field theories.

HK 17: Structure and Dynamics of Nuclei III

Time: Monday 16:00–17:45 Location: HK-H6

Group Report HK 17.1 Mon 16:00 HK-H6

Absolute electromagnetic transition rates in the semi-magic 211At nucleus and their implications for the nuclear structure above 208Pb. — •Jan Jolie[1], Vasil Karayonchev[1], Andrey Blazhev[1], Arwin Esmaylzadeh[1], Christoph Fransen[1], Lukas Knafla[1], Claus Mueller-Gatermann[1], Jean-Marc Regis[1], and Pieter Van Isacker[2] — [1]IKP, Universitaet zu Koeln, Zuelpicher Str. 77, D-50937 Koeln, Germany — [2]GANIL, CEA/DRF-CNRS/IN2P3, Bvd Henri Becquerel, F-14076 Caen, France

Motivated by the abnormal yrast B(E2) values in 210Po[1], lifetimes of excited states in 211At were measured using the electronic gamma - gamma fast timing technique and the Recoil Doppler Shift Method (RDSM) at the Cologne FN Tandem accelerator. For the fast timing experiment the 208Pb(6Li,3n) fusion-evaporation reaction and the HORUS detector array equipped with eight HPGe detectors and nine LaBr3(Ce) scintillators were used[2]. For the RDSM experiment the 209Bi(16O,14C) two-proton transfer reaction was performed and 14C was detected with solar cells mounted in the Cologne plunger setup. Several lifetimes were determined for the first time. The results are compared to shell model calculation using two approaches: analytical calculations using a semiempirical interaction for three particles in a single j = 9/2 shell and untruncated numerical full shell model calculations with the modified Kuo-Herling interaction. Very good agreement is obtained, especially with the analytical single-j calculation. [1] D. Kocheva, et al., Eur. Phys. J. A 53 (2017) 175;[2] V. Karayonchev, et al., Phys. Rev. C 99 (2019) 024326.

HK 17.2 Mon 16:30 HK-H6

Investigation of collectivity in ^{142}Xe by Coulomb excitation — •Corinna Henrich for the IS548-MINIBALL-Collaboration — TU Darmstadt, Darmstadt, Germany

The isotope ^{142}Xe lies in the neutron-rich area north-east of the doubly-magic ^{132}Sn, in a region through which the astrophysical r-process is expected to pass. This nucleus is of particular interest as it allows to follow the onset of octupole collectivity, which is expected to peak for the nearby ^{144}Ba, and the evolution of quadrupole collectivity.

A perfect tool to investigate the low-lying structure and collectivity of ^{142}Xe is "safe" Coulomb excitation as it gives access to reduced transition strengths as well as spectroscopic quadrupole moments.

The experimental campaign was carried out at HIE-ISOLDE (CERN). After the excitation on a lead target, the deexcitation gamma rays are detected using the MINIBALL spectrometer in coincidence with the corresponding particles. The latter are detected utilizing the silicon detector array C-REX.

Final experimental results are presented and compared to SCCM and LSSM calculations.

This work is supported by the German BMBF under contracts 05P15RDCIA, 05P18RDCIA, and 05P21RDCI2, by the EU within ENSAR2 under grant no. 654002, and by ISOLDE.

HK 17.3 Mon 16:45 HK-H6

Lifetime measurements to investigate γ-softness and shape coexistence in ^{102}Mo — •Arwin Esmaylzadeh[1], Vasil Karayonchev[1], Jan Jolie[1], Kosuke Nomura[2], Marcel Beckers[1], Andrey Blazhev[1], Christoph Fransen[1], and Lukas Knafla[1] — [1]Institut für Kernphysik, Universität zu Köln — [2]Department of Physics, University of Zagreb

Lifetimes of low-spin excited states in ^{102}Mo populated in a ^{100}Mo(^{18}O, ^{16}O)^{102}Mo two-neutron transfer reaction were measured using the recoil-distance Doppler-shift technique at the Cologne FN Tandem accelerator. Lifetimes of the 2_1^+, 4_1^+, 6_1^+, 0_2^+, 2_γ^+, 3_γ^+ states and one upper limit for the lifetime of the 4_γ^+ state were obtained. The energy levels and deduced electromagnetic transition probabilities are compared with the ones obtained within the mapped interacting boson model framework with microscopic input from Gogny mean field calculations. With the newly obtained signatures a more detailed insight in the γ-softness and shape coexistence in ^{102}Mo is possible and discussed in the context of the $Z \approx 40$ and $N \approx 60$ region. The nucleus of ^{102}Mo follows the γ-soft trend of the Mo isotopes. The properties of the 0_2^+ state indicate, in contrast to the microscopic predictions, shape coexistence which also occurs in other $N = 60$ isotones [1].

[1] A. Esmaylzadeh et al., Phys. Rev. C (accepted in PRC) (2022)

HK 17.4 Mon 17:00 HK-H6

Configuration Interaction Monte Carlo with Chiral Three-Body Forces — •Pierre Arthuis[1,2,3], Carlo Barbieri[3,4,5], Francesco Pederiva[6,7], and Alessandro Roggero[6,7,8] — [1]Technische Universität Darmstadt, Department of Physics — [2]ExtreMe Matter Institute EMMI, GSI — [3]Department of Physics, University of Surrey — [4]Dipartimento di Fisica, Università degli Studi di Milano — [5]INFN, Sezione di Milano — [6]Physics Department, University of Trento — [7]INFN-TIFPA Trento Institute of Fundamental Physics and Applications — [8]InQubator for Quantum Simulation (IQuS), Department of Physics, University of Washington

Neutron matter from saturation to low densities is a particluarly interesting system, its equation of state (EoS) directly affecting the structure of the inner core of neutron stars and the skin of heavy neutron-rich nuclei. High-accuracy methods are thus of remarkable importance.

Configuration Interaction Monte Carlo (CIMC) combines the natural language needed to deal with momentum-dependent interactions to the efficiency of Quantum Monte Carlo techniques while satisfying the variational ansatz. The method demonstrated very efficient for two-body Hamiltonians, but was never extended to tackle three-body interactions.

Here we present the first CIMC results obtained for cold neutron matter at densities below and around nuclear saturation density with a chiral potential including three-body forces. Besides the EoS of neutron matter, we will display also results for the momentum distribution and the static structure factor.

HK 17.5 Mon 17:15 HK-H6

Investigation of the B(E2; $0_{gs}^+ \rightarrow 2_1^+$) value of ^{116}Sn — •M. Beuschlein[1], O. Papst[1], J. Kleemann[1], V. Werner[1], N. Pietralla[1], T. Beck[1,3], M. Berger[1], I. Brandherm[1], A. D'Alessio[1], U. Friman-Gayer[1,2], M. Hilcker[1], K. E. Ide[1], J. Isaak[1], R. Kern[1], F. Niederschuh[1], P. C. Ries[1], G. Steinhilber[1], J. Wiederhold[1], and R. Zidarova[1] — [1]IKP, TU Darmstadt — [2]Duke University and TUNL, Durham, NC, USA — [3]FRIB, East Lansing, MI, USA

The tin isotopes, being proton-magic with a long chain of experimentally accessible nuclei, are an important testing ground for nuclear structure models. Present data show systematic deviations between measured electric quadrupole (E2) ground-state excitation strengths depending on the used techniques. Also, various nuclear structure models come to different predictions on the systematics of B(E2) strengths, particulary around ^{116}Sn. We performed a measurement of ^{116}Sn relative to ^{112}Sn using the nuclear resonance fluorescence method at S-DALINAC at TU Darmstadt. A beam of continuous bremsstrahlung up to an endpoint energy of 2.2 MeV was used to populate the first excited 2^+ states of ^{112}Sn and ^{116}Sn. Photons of the subsequent de-excitation were measured by three high-purity germanium detectors. With our relative measurement we aim to provide a test for a predicted dip of E2 strengths around ^{116}Sn [1], and obtain the absolute B(E2) strength from a previous measurement of ^{112}Sn.

Supported by the DFG through the research grant SFB 1245.

[1] T. Togashi *et al.*, Phys. Rev. Lett. **121**, 062501 (2018)

HK 17.6 Mon 17:30 HK-H6

Transition strengths of the intruder band of ^{96}Zr — •T. Stetz[1], T. Beck[1], N. Pietralla[1], V. Werner[1], M. Boromiza[2], I. Gheorge[2], A. Ionescu[2], R. Kern[1], R. Lica[2], N. Mărginean[2], R. Mărginean[2], C. Mihai[2], R.-E. Mihai[2], C.R. Nita[2], O. Pabst[1], S. Pascu[2], C. Sotty[2], L. Stan[2], A. Turturica[2], J. Wiederhold[1], and W. Witt[1] — [1]TU Darmstadt, Germany — [2]IFIN-HH, Romania

The zirconium (Zr) isotopes have recently been discussed in terms of type-II shell evolution [1,2], with ^{98}Zr closest to the critical point of a quantum phase transition from spherical to deformed ground-state shapes [3,4]. Spherical and deformed structures were found to coexist, weakly mixing, already in ^{96}Zr [2], but key data to classify the observed structures is missing [4]. Therefore, ^{96}Zr has been studied in an experiment, populating excited states of the intruder band in the 2n transfer reaction ^{94}Zr(^{18}O,^{16}O)^{96}Zr at 49 MeV at the 9 MV tandem accelerator in IFIN-HH. The HPGe ROSPHERE array in a combination with the SORCERER particle detector was used to obtain the data. With the Doppler shift attenuation method, the lifetime of the first excited 4^+ state was determined. From this, transition strengths to lower lying states have been obtained and compared with theoretical approaches in order to study the shape of the intruder band.

[1] T. Togashi *et al.*, Phys. Rev. Lett. **117** 172502 (2016)
[2] C. Kremer *et al.*, Phys. Rev. Lett. **117** 172503 (2016)
[3] W. Witt *et al.*, Phys. Rev. C **98** 041302 (2018)
[4] W. Witt *et al.*, Eur. Phys. J. A **55** 79 (2019)
*Supported by BMBF 05P18RDCIA-TP1 and 05P21RDCI2-TP1.

HK 18: Structure and Dynamics of Nuclei IV

Time: Monday 16:00–17:45 Location: HK-H7

Group Report HK 18.1 Mon 16:00 HK-H7

The search for the tetraneutron — •Meytal Duer[1] and Thomas Aumann[1,2] for the NeuLAND-SAMURAI-Collaboration — [1]TU Darmstadt — [2]GSI Helmholtzzentrum

Whether multi-neutron systems can exist as weakly bound states or very short-lived unbound resonant states has been a long-standing quest. The discovery of such a system would have far-reaching implications for many aspects of nuclear physics, from the nature of the force itself up to the way it builds nuclei, and also for the modeling of neutron stars.

The experimental search for isolated multi-neutron systems has been going for six decades, with a particular focus on the four-neutron system called tetraneutron, resulting in up to date only few indications for its existence, leaving it an elusive nuclear system.

In this talk I will present our most recent result from an experiment performed at the RIKEN Nishina Center located in Japan. The measurement was conducted at the SAMURAI setup, there using a new experimental approach based on a knockout reaction at large momentum transfer with radioactive high-energy ^{8}He beam we were able to investigate the four-neutron system.

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

HK 18.2 Mon 16:30 HK-H7

Precise and Accurate Measurement of the Neutron-Neutron Scattering Length — •Marco Knösel[1] and Thomas Aumann[1,2,3] for the NeuLAND-SAMURAI-Collaboration — [1]Technische Universität Darmstadt — [2]GSI Helmholtz-Zentrum für Schwerionenforschung — [3]Helmholtz Forschungsakademie Hessen für FAIR

In this contribution, a new experimental approach is presented to determine the neutron-neutron scattering length using the knockout reactions ^{6}He$(p,p\alpha)2n$ and $t(p,2p)2n$ as well as the charge-exchange reaction $d(^{7}\mathrm{Li},^{7}\mathrm{Be})2n$. In order to coincidently detect the two neutrons in the final states of these reactions with sufficient time and position accuracy, a new high-resolution neutron detector has to be developed. This is done at Technische Universität Darmstadt in cooperation with the SAMURAI collaboration at RIKEN in Japan, where the experiment will take place. The value of the neutron-neutron scattering length can be inferred from the comparison of the experimentally determined $2n$ relative-energy spectrum to halo EFT calculations.

This work is supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Project-ID 279384907 - SFB 1245, the BMBF under contract number 05P21RDFN2 and the GSI-TU Darmstadt cooperation agreement.

HK 18.3 Mon 16:45 HK-H7

Ground and dipole excited states of the ^{8}He halo nucleus from ab initio coupled-cluster theory — •Francesca Bonaiti[1], Sonia Bacca[1,2], and Gaute Hagen[3,4] — [1]Institut für Kernphysik and PRISMA^{+} Cluster of Excellence, Johannes Gutenberg-Universität, 55128 Mainz, Germany — [2]Helmholtz-Institut Mainz, Johannes Gutenberg-Universität Mainz, D-55099 Mainz, Germany — [3]Physics Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA — [4]Department of Physics and Astronomy, University of Tennessee, Knoxville, TN 37996, USA

We perform coupled-cluster calculations of ground- and dipole excited-state properties of the ^{8}He halo nucleus with nucleon-nucleon and three-nucleon interactions from chiral effective field theory, both with and without explicit delta degrees of freedom. By increasing the precision in our coupled-cluster calculations from inclusion of leading order three-particle three-hole excitations in the cluster operator, we are able to reproduce (within uncertainties) the available experimental data for the ground-state energy and the charge radius. We also investigate the excited states induced by the electric dipole operator and present a discussion on the Thomas-Reiche-Kuhn and cluster sum rules. Finally, we compute the electric dipole polarizability, providing a theoretical benchmark for future experimental determinations that will study this exotic nucleus.

HK 18.4 Mon 17:00 HK-H7

E1 strength distribution of ^{11}Li in Halo EFT — •Matthias Göbel[1], Daniel R. Phillips[2], and Hans-Werner Hammer[1,3] — [1]Technische Universität Darmstadt, 64289 Darmstadt, Germany — [2]Ohio University, Athens, Ohio 45701, USA — [3]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany

Low-energy enhancements of E1 strength distributions are a characteristic property of halo nuclei. We use Halo EFT with a ^{9}Li core and the two halo neutrons as degrees of freedom to calculate this observable for the two-neutron halo nucleus ^{11}Li.

The E1 strength distribution is significantly influenced by final-state interactions. We investigate their role and test different approximation schemes. The comparison of the leading-order results with experimental data from RIKEN [T. Nakamura et al., Phys. Rev. Lett. 96, 252502 (2006)] shows reasonable agreement.

This work was supported Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Project-ID 279384907 - SFB 1245 and by the U.S. Department of Energy (Contract No. DE-FG02-93ER40756).

HK 18.5 Mon 17:15 HK-H7

Three-body resonances in pionless effective field theory — •Sebastian Dietz[1], Hans-Werner Hammer[1,2], Sebastian König[3,1], and Achim Schwenk[1,2,4] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI and Helmholtz Forschungsakademie Hessen für FAIR (HFHF), GSI Darmstadt — [3]Department of Physics, North Carolina State University, Raleigh — [4]Max-Planck-Institut für Kernphysik, Heidelberg

We investigate the appearance of resonances in three-body systems using pionless effective field theory at leading order. The Faddeev equation is analytically continued to the unphysical sheet adjacent to the positive real energy axis using a contour rotation. We consider both the three-boson system and the three-neutron system. For the former, we calculate the trajectory of Borromean three-body Efimov states turning into resonances as they cross the three-body threshold. For the latter, we find no sign of three-body resonances or virtual states at leading order.

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HK 18.6 Mon 17:30 HK-H7

Investigating Short-Range Correlations in exotic nuclei at R3B using inverse kinematics — •Enis Lorenz[1], Thomas Aumann[1,2], Anna Corsi[3], Aldric Revel[3], Meytal Duer[1,2], Or Hen[4], and Julian Kahlbow[4,5] for the R3B-Collaboration — [1]TU Darmstadt, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung Darmstadt, Germany — [3]CEA-Saclay, France — [4]Massachusetts Institute of Technology, Cambridge, USA — [5]Tel Aviv University, Tel Aviv, Israel

Short-Range Correlations (SRC) are two-body components of the nuclear wave function with high relative momentum and low center-of-mass momentum relative to the Fermi momentum, k_F. These high-momentum nucleons, which are absent in a simple Fermi gas model, are formed as temporary closed-proximity nucleon pairs with high density, several times the nuclear saturation density. Studying the characteristics of SRC-pairs gives an unique opportunity to explore the interaction of cold dense nuclear matter as in neutron stars.

The first kinematically complete measurement of SRC in exotic nuclei will be performed at the R3B setup as part of the FAIR Phase-0 experimental program in Spring 2022 by scattering a ^{16}C beam off a liquid hydrogen target in inverse kinematics at energy of 1.25 GeV/nucleon.

This work is supported by the State of Hesse within the Research Cluster ELEMENTS project 500/10.006 and by the German Federal Ministry for Education and Research (BMBF) under contract number 05P21RDFN2.

HK 19: Hadron Structure and Spectroscopy III

Time: Monday 16:00–17:45 Location: HK-H8

Group Report HK 19.1 Mon 16:00 HK-H8

Coupled Channel Partial Waves Analysis with PAWIAN — •Meike Küssner[1], Bertram Kopf[1], Malte Albrecht[1], Fritz-Herbert Heinsius[1], Helmut Koch[1], Marc Pelizäus[1], Xiaoshuai Qin[1], Matthias Steinke[1], Ulrich Wiedner[1], and Lianjin Wu[2] — [1]Ruhr-Universität Bochum, Germany — [2]Shandong University, Qingdao, China

The light meson regime still holds open questions that can only be answered using sophisticated analysis strategies to describe the data. Coupled channel partial wave analyses offer unique possibilities to disentangle the different states in the highly populated spectrum of light mesons and to overcome challenges such as interfering and overlapping resonances that decay into multiple channels and occur close to kinematical thresholds.

This also requires the use of performant software that incorporates sophisticated dynamical models taking into account unitarity and analyticity constraints. The software package PAWIAN offers such possibilities and proved its capabilities in recent coupled channel analyses. The talk will discuss recent results of coupled channel analyses performed with data stemming from different production mechanisms like $\bar{p}p$ annihilation, $\pi^- p$ scattering, radiative J/ψ decays and two-photon production as well as $\pi\pi$ scattering and discuss future objectives.

Supported by DFG CRC110 and FOR 2359

HK 19.2 Mon 16:30 HK-H8

Amplitude analysis of the decays $B_S \to \psi(2S)K^+K^-$ and $B_S \to \psi(2S)\pi^+\pi^-$ — •Piet Nogga — Rheinische Friedrich-Wilhelms Universität Bonn

We present $\psi(2S)K^+K^-$ and $\psi(2S)\pi^+\pi^-$ final state data originating from B_S mesons recorded during Run I and Run II at the LHCb experiment corresponding to an integrated luminosity of 1,2 and 6 fb^{-1} at $\sqrt{s} = 7, 8$ and 13 TeV, respectively, with the goal of investigating the spectrum of scalar mesons. These are particularly interesting as they may contain possible glueball contributions, a discussion which was recently rekindled by a BESIII analysis regarding radiative charmonium decays.

The unambiguous extraction of resonance parameters requires sophisticated amplitude models and techniques for the simultaneous analysis of both channels.

This talk will present a preliminary selection of these final states and discuss the coupled channel analysis.

HK 19.3 Mon 16:45 HK-H8

A truncated partial wave analysis using bayesian inference — •Jean Noël for the CBELSA/TAPS-Collaboration — HISKP, Rheinische Friedrich-Wilhelms Universität Bonn.

Following the description of the Standard Model of particle physics, more specifically quantum chromodynamics (QCD), so called hadrons are bound states of quarks and gluons. A difficulty in investigating these fundamental particles arises from being unable to observe them in isolation due to confinement.

One approach for investigating the formation of hadrons is the photoproduction of mesons.
The focus will lie on the reaction $p + \gamma \to p + \pi^0$. By employing a truncated partial wave analysis (TPWA) the approach can be kept model independent. A fully bayesian investigation will be employed and the advantages of extracting the partial waves (up to an overall phase) with this method will be discussed.

Preliminary results obtained from this approach will be shown.

HK 19.4 Mon 17:00 HK-H8

Meson Spectrum from Functional Methods beyond Rainbow-Ladder — •Stephan Hagel[1,2] and Christian S. Fischer[1,2] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität Gießen, 35392 Gießen, Germany — [2]Helmholtz Forschungsakademie Hessen für FAIR (HFHF), GSI-Helmholtzzentrum für Schwerionenforschung, Campus Gießen, 35392 Gießen, Germany

A novel approach to construct an expression for the quark self-energy from a Bethe-Salpeter kernel is presented. It can be shown that this approach satisfies the axialvector Ward-Takahashi identity. This approach is used to calculate the quark propagator and solve the corresponding Bethe-Salpeter equation. Furthermore, it is investigated, how different tensor structures in the quark-gluon-vertex effect the light meson spectrum.

HK 19.5 Mon 17:15 HK-H8

Multidimensional density estimation using Normalizing Flows — •Ellinor Eckstein — University of Bonn, Bonn, Germany

The investigation of multi-body hadronic decays of beauty and charm hadrons requires detailed estimates of efficiencies and background distributions in multidimensional phase space.

A fairly new approach for model independent density estimation are Normalizing Flows, a Machine Learning technique, which gained popularity in recent years. They provide a method to construct flexible probability density distributions by applying a series of trainable transformations on a simple base distribution. A special feature of these distributions is their invertibility. Consequently, the entire Normalizing Flow is invertible and, thus, a very transparent tool for parametrisations. Due to their straightforward structure NFs are easily expandable into multiple dimensions making them attractive for efficiency or background estimation. This talk gives a brief introduction to Normalizing Flows and demonstrates its performance on LHCb data.

HK 19.6 Mon 17:30 HK-H8

4-quark states from functional methods — •Joshua Hoffer[1,2] and Christian S. Fischer[1,2] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität Gießen, 35392 Gießen, Germany — [2]Helmholtz Forschungsakademie Hessen für FAIR (HFHF), GSI-Helmholtzzentrum für Schwerionenforschung, Campus Gießen, 35392 Gießen, Germany

Since the discovery of tetraquarks, there has been a lot of excitement around this topic from the theoretical as well as the experimental side. To study the poperties of these 4-quark states we use a functional framework which combines (truncated) Dyson-Schwinger and Bethe-Salpeter equations in Landau gauge. This approach allows us to extract qualitative results for mass spectra, decay widths and wavefunctions of tetraquark candidates. Furthermore, we can investigate the possible internal structure of such states. We report on recent developments and results using this functional framework and give an overview about the current status as well as future developments.

HK 20: Hadron Structure and Spectroscopy IV

Time: Monday 16:00–17:30 Location: HK-H9

Group Report HK 20.1 Mon 16:00 HK-H9

Polarisation observables Σ, T, P, and H in π^0 and η photoproduction off quasifree nucleons — •Nicolas Jermann for the CBELSA/TAPS-Collaboration — University of Basel, Switzerland

The excitation spectrum of the nucleon is an important testing ground for quantum chromodynamics in the regime where it cannot be treated perturbatively. During the last two decades much progress has been made on the theory side, e.g. lattice gauge methods, and in experiments, particularly using energy tagged photon beams at electron accelerators, which has now reached a state where not only differential cross sections but also asymmetries measured with polarised photons and polarised targets allow for detailed partial wave analyses. This provides much more stringent information about the involved reaction multipoles and thus the contributing nucleon resonances.

The present experiment was done at the ELSA accelerator in Bonn with the CBELSA/TAPS detector setup. The incident electron beam

of 3.2 GeV impinged on a diamond radiator where it produced coherent bremsstrahlung photons with linear polarisation, which again impinged on a transversely polarised, deuterated butanol target. This allows the simultaneous measurement of the polarisation observables Σ, T, P, and H. Analysed were the final states $N\pi^0$ and $N\eta$ with the almost 4π covering electromagnetic calorimeter CBELSA/TAPS.

One of the main motivations of this experiment was a more detailed investigation of the not yet understood narrow structure in the excitation function of the $\gamma n \to n\eta$ reaction at approximately 1 GeV. Preliminary results will be discussed.

HK 20.2 Mon 16:30 HK-H9

Helicity dependent cross sections for the photoproduction of $\pi^0\pi^\pm$ pairs from quasi-free nucleons — •Debdeep Ghosal for the CBELSA/TAPS-Collaboration — University of Basel, Basel, CH

Photon induced $\pi^0\pi^\pm$-pairs production from quasi-free nucleons bound in the deuteron has been investigated in view of the helicity dependence of those two reactions. Measurements with a liquid deuterium target were used to extract the unpolarized cross sections for protons and neutrons. A deuterated, longitudinally polarized butanol target together with a circularly polarized photon beam was used to measure the double polarization observable E. Antiparallel and parallel spin configurations of the beam photon and target nucleon correspond to the spin-dependent cross sections $\sigma_{1/2}$ and $\sigma_{3/2}$ respectively, which have been derived from E. The measurements were done at the Mainz MAMI accelerator with tagged photon beams produced via bremsstrahlung from longitudinally polarized electron beams. The reaction products from the two target types were detected with an almost 4π solid-angle covering calorimeter composed of the Crystal Ball, TAPS detectors and particle identification detectors. The results are sensitive to sequential decays of nucleon resonances via intermediate states and also by emission of charged ρ mesons. Furthermore, the results have been compared to the recent available model calculation.

HK 20.3 Mon 16:45 HK-H9

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

Muonic X-rays are produced when negative muons are stopped inside matter and cascade down the different energy levels of an atom. The 2s-1s muonic X-rays are a potential observable to study the Atomic Parity Violation (APV) in muonic atoms. For a Krypton (2018) and a Zinc (2019) target, Muonic X-ray measurements were carried out at the Paul Scherrer Institute using muon beam from the piE1 beamline facility to detect these 2s-1s X-rays. High Purity Germanium (HPGe) detectors surrounded the targets to detect the outgoing Muonic X-rays. The X-rays of interest in Krypton and Zinc are in the 1-2 MeV energy range. The signal though, is buried under background arising from delayed Michel electrons, nuclear capture background from muons, Bremsstrahlung etc. A scan of various time and energy cuts along with X-ray-Xray coincidences is implemented to reduce this background and optimize the signal to background ratio. A clear observation of the 2s-1s transition opens up to the possibility for an APV experiment with muonic atoms.

HK 20.4 Mon 17:00 HK-H9

Accessing the coupled-channel dynamics with two-particle correlations at ALICE — •Valentina Mantovani Sarti for the ALICE-Collaboration — TUM, Garching, Germany

The strong interaction between hadrons can be characterised by the so-called coupled-channel dynamics, responsible for inelastic processes such as absorption and annihilation. The strength of the coupling to the inelastic channels can lead to the formation of molecular states, such as the $\Lambda(1405)$ in the $\overline{\mathrm{K}}\mathrm{N}$–$\Sigma\pi$ system and it also plays a crucial role in the possible existence of new bound states, as it might occurs in baryon-antibaryon interaction.

Measurements of two-particle correlations in the relative momentum space performed in different colliding systems and probing different inter-particle distances opens the possibility to partially isolate the elastic interaction and to provide experimental constraints for the coupling to the inelastic channels. In this talk we will present results on the coupled-channel dynamics of $\overline{\mathrm{K}}\mathrm{N}$ interaction, and on the annihilation processes in p-$\overline{\mathrm{p}}$, p-$\overline{\Lambda}$ and p-$\overline{\Lambda}$ interactions obtained in pp, p–Pb and Pb–Pb collisions. The effect of inelastic contributions in these systems has been investigated within the C^{3}ATS framework.

HK 20.5 Mon 17:15 HK-H9

New experimental limits on the effective strong interaction between multi-strange hadrons by ALICE — •Georgios Mantzaridis[1] and Otón Vazquez Doce[2] for the ALICE-Collaboration — [1]Technische Universität München, Fakultät für Physik, James-Franck-Str. 1, 85748 Garching — [2]Laboratori Nazionali di Frascati, Via Enrico Fermi 40, 00044 Frascati (Roma)

Understanding from first principles the strong interaction between hadrons with $S < -1$ is one of the key challenges for nuclear physics today. Traditional experimental techniques such as scattering or hypernuclei experiments are not able to access these strangeness sectors because of the small lifetimes of the involved hadrons. On the other hand calculations using lattice QCD are particularly stable in this regime because of the larger quark masses.

In an attempt to close this gap we present the direct measurement of two interactions of the $S = -3$ sector: the p-Ω^- and the Λ-Ξ^- interaction. For both systems the correlation function was measured in high-multiplicity pp collisions at $\sqrt{s} = 13$ TeV with ALICE at the LHC.

We have compared the p-Ω^- interaction to first principle lattice QCD calculations and found that they agree with the measured data if the inelastic channels are neglected. The Λ-Ξ^- correlation function is compared to predictions from leading order chiral effective field theory, meson exchange models as well as lattice QCD calculations. The data supports a shallow Λ-Ξ^- interaction which is more compatible with small scattering parameters.

HK 21: Astroparticle Physics I

Time: Monday 16:00–17:30 Location: HK-H10

Group Report HK 21.1 Mon 16:00 HK-H10

The Search for Neutrinoless Double-Beta Decay with LEGEND — •Michael Willers for the LEGEND-Collaboration — Physik-Department, Technische Universität München, Germany

The **L**arge **E**nriched **G**ermanium **E**xperiment for **N**eutrinoless $\beta\beta$ **D**ecay (LEGEND) is a ton-scale, ^{76}Ge-based, neutrinoless double-beta ($0\nu\beta\beta$) decay experimental program with a discovery potential at half-lifes longer than 10^{28} years.

LEGEND employs a phased approach that enables the collaboration to gradually increase the detector mass and exposure, and at the same time reduce the background in the signal region of interest. The first, 200 kg, phase of the experiment (LEGEND-200) is being actively commissioned at the Gran Sasso underground laboratory (Laboratori Nazionali del Gran Sasso, LNGS) in Italy and data taking will start in 2022. The ton-scale phase of the experiment (LEGEND-1000) is currently in the conceptual design stage and construction is projected to start as early as 2025.

In this contribution, the ongoing commissioning activities at LNGS and the potential of LEGEND-200 will be presented and the prospects for the future ton-scale phase LEGEND-1000 will be discussed.

This work is supported in part by the German Research Foundation via the collaborative research center *SFB1258* and the cluster of excellence *ORIGINS*, the German Federal Ministry for Education and Research, and the Max-Planck Society.

Group Report HK 21.2 Mon 16:30 HK-H10

Detecting CEνNS and beyond with the CONUS reactor neutrino experiment — •Aurelie Bonhomme for the CONUS-Collaboration — Max Planck Institut für Kernphysik (MPIK), Heidelberg

The detection of neutrinos through coherent elastic neutrino-nucleus scattering (CEνNS) process opens a new window to study the fundamental properties of this elusive particle and to probe physics beyond the Standard Model. The CONUS experiment - operational since April 2018 - is located at 17m from the 3.9GW$_{\mathrm{th}}$ core of the nuclear power plant Brokdorf (Germany) and aims to detect CEνNS in the fully coherent regime with four 1 kg-sized HPGe point-contact detectors with

a $\sim$300eV$_{ee}$ energy threshold. The full spectral analysis of the first CONUS dataset allowed to set the current best limit on CEνNS with reactor antineutrinos and to bring competitive limits on physics beyond the standard model, such as non-standard neutrino interactions or neutrino magnetic moment. These new results will be presented in this talk. Furthermore, a special emphasis will be put on the strategy followed by the collaboration to further reduce the uncertainties, in particular via a dedicated measurement of the ionization quenching factor of nuclear recoils in germanium.

HK 21.3 Mon 17:00 HK-H10

New results on the ^{76}Ge double beta decay with neutrinos and exotic decay modes from GERDA Phase II — •Elisabetta Bossio for the GERDA-Collaboration — Physik Department, Technische Universität München, Garching, Germany

Two-neutrino double beta ($2\nu\beta\beta$) decays are amongst the rarest nuclear processes ever observed. Precision studies of the electron sum energies require ultra-low background and an excellent understanding of the experiment's response. Both are key features of the Germanium Detector Array (GERDA) experiment, which searched for neutrino-less double beta ($0\nu\beta\beta$) decay with enriched high purity germanium detectors in Liquid Argon at Laboratori Nazionali del Gran Sasso (LNGS) in Italy. The measurement of the Standard Model $2\nu\beta\beta$ decay half-life of ^{76}Ge was performed with unprecedented precision, profiting from the high signal-to-background ratio and the small systematic uncertainties. It provides essential inputs for nuclear structure calculations, that benefit the interpretation of $0\nu\beta\beta$ decay results. Furthermore, the search for distortions of the $2\nu\beta\beta$ decay spectrum allows exploring new physics, like $0\nu\beta\beta$ decay with Majorons emission, Lorentz invariance, or search for sterile neutrinos. The new results of the ^{76}Ge $2\nu\beta\beta$ decay half-life and improved limits on exotic decay modes will be presented in this talk. This research is supported by the BMBF through the Verbundforschung 05A20WO2 and by the DFG through the Excellence Cluster ORIGINS and the SFB1258.

HK 21.4 Mon 17:15 HK-H10

Constraining the $^{77(m)}$Ge Production with GERDA Data and Implications for LEGEND-1000 — •Moritz Neuberger[1], Luigi Pertoldi[1], Stefan Schönert[1], and Christoph Wiesinger[1,2] for the GERDA-Collaboration — [1]Physik-Department E15, Technische Universität München — [2]Max-Planck-Institut für Physik (Werner-Heisenberg-Institut) Föhringer Ring 6 80805 München

The delayed decay of $^{77(m)}$Ge, produced by neutron capture on ^{76}Ge, is a potential background for the next-generation neutrino-less double-beta decay experiment LEGEND-1000, especially when considering the alternative LNGS site. Based on Monte Carlo simulations, various mitigation strategies and suppression techniques have been proposed to tackle this background [1,2]. In this talk we will present first results on $^{77(m)}$Ge searches in the full GERDA data. Given the very similar configuration - bare germanium detectors in liquid argon - it serves as a benchmark for our LEGEND-1000 predictions. This research was supported by the BMBF through the Verbundforschung 05A20WO2 and by the DFG through the SFB1258 and Excellence Cluster ORIGINS.

[1] C. Wiesinger et al., Eur. Phys. J. C (2018) 78: 597
[2] LEGEND-1000 pCDR, arXiv 2107.11462

HK 22: Invited Talks II

Time: Tuesday 11:00–12:30 Location: HK-H1

Invited Talk HK 22.1 Tue 11:00 HK-H1

Towards background-free measurements of double-beta decay events: a quest to increase the detection sensitivity of the neutrinoless double beta decay mode — •Samuel Ayet San Andres for the NEXT-Collaboration — Justus-Liebig-University Giessen

Neutrinoless double beta decay, whose discovery would reveal the Majorana nature of neutrinos, is an extremely rare decay mode consisting of two simultaneous beta decays in which two electrons and no neutrinos are emitted. The current experiments in the search of such decay mode are far from a background-free condition, and the level of background achieved plays a crucial role in the limits of the reportable half-life of this decay mode. A method that allows discarding all the events except the ones produced via double beta decay is the correlation of the events with the detection of the daughter nuclei of the decay, leaving only the two-neutrino double beta decay as the only background of the experiment. The different research lines within the NEXT collaboration in the pursuit of a background-free experiment in order to increase the half-life sensitivity for the neutrinoless double beta decay will be presented.

Invited Talk HK 22.2 Tue 11:30 HK-H1

Baryon spectroscopy with the Jülich-Bonn dynamical coupled-channel approach — •Deborah Rönchen — Institute for Advanced Simulation and Jülich Center for Hadron Physics, Forschungszentrum Jülich, 52425 Jülich, Germany

In order to probe the nature of the strong interactions in the medium-energy regime, where a perturbative expansion of QCD is not possible, the spectrum of excited baryons provides important information. Over the time, different approaches have been developed to connect predictions from quark models or lattice calculations to experimental data. Among those, dynamical coupled-channel models are especially suited for a simultaneous analysis of multiple reactions with different initial and final states. Unitarity and analyticity are preserved which allows for an extraction of resonance parameters in a well defined way, i.e. in terms of pole positions and residues.

I will give an introduction into the framework of the so-called Jülich-Bonn dynamical coupled-channel model, and present results of a combined study of pion- and photon-induced hadronic reactions. Recently, the approach was also extended to electroproduction reactions.

Invited Talk HK 22.3 Tue 12:00 HK-H1

Hadronen und Kerne in der Öffentlichkeit — •Christian Klein-Bösing — Institut für Kernphysik, WWU Münster, Germany

Die Hadronen- und Kernphysik befasst sich mit der Suche nach Antworten auf fundamentale Frage wie: Woraus besteht unsere Welt und was hält sie im Innersten zusammen? Fragen, die jede Forscherin und jeder Forscher sicherlich schon im kleineren Kreis diskutiert hat, z.B. im Kontext einer gerade eingereichten Abschlussarbeit.

Diese Kommunikation durch die Forschenden in organisierter Form an die breite Öffentlichkeit zu tragen (Outreach) dient dabei unterschiedlichen Gesamtzielen, beispielsweise: vorhandene Neugier auf Grundlagenforschung zu stillen, Interesse an Grundlagenforschung zu wecken, Wertschätzung für Erkenntnisgewinn durch Grundlagenforschung zu fördern, die Öffentlichkeit über wissenschaftliche Methodik aufzuklären oder auch Nachwuchs zu gewinnen. Durch jede Outreach-Aktivität kommt es aber auch zu einer entscheidenden Rückkopplung der Öffentlichkeit mit der aktuellen Forschung.

In diesem Vortrag werden Outreach-Konzepte für die Hadronen und Kernphysik in Deutschland vorgestellt, die unter anderem von den Forschungsgruppen im bundesweiten Netzwerk Teilchenwelt umgesetzt werden.

HK 23: Invited Talks III

Time: Tuesday 14:00–15:30 Location: HK-H1

Invited Talk HK 23.1 Tue 14:00 HK-H1

Jets in heavy-ion collisions — •Jasmine Brewer — CERN, Espl. des Particules 1, 1211 Meyrin Switzerland

Heavy-ion collisions provide unprecedented experimental access to the high-temperature phase of QCD, the quark-gluon plasma, where quarks and gluons are deconfined. Ongoing experimental and theoretical efforts aim to understand the structure and interactions of this novel material. Energetic particles and jets produced in heavy-ion collisions interact with the quark-gluon plasma and can provide unique insight on the structure of the quark-gluon plasma on different length scales. I will give a brief review of the theory and phenomenology of jet modification in heavy-ion collisions.

Invited Talk HK 23.2 Tue 14:30 HK-H1

The initial state of the quark-gluon plasma at the intersection of hadronic and nuclear physics — •Giuliano Giacalone — ITP Heidelberg

Experiments conducted in the world's largest accelerator machines, the BNL Relativistic Heavy Ion Collider (RHIC) and the CERN Large Hadron Collider (LHC), have established that by smashing heavy nuclei at high energy one produces small lumps of a fluidlike substance, namely, the hot state of strong-interaction matter, dubbed the quark-gluon plasma (QGP). The established hydrodynamic paradigm of the QGP have permitted us over the years not only to perform quantitative extractions of the transport properties of this medium from data, but also to obtain a more and more refined understanding of its initial condition. I review the current status of the initial condition of the QGP, emphasizing the outcome of state-of-the-art models and the overall picture that they yield. I discuss the progress made in the definition of observable quantities that offer a specific sensitivity to the physics of the initial state, allowing us to place stringent constraints on the parameters of initial-state Monte Carlo generators from experimental data. Such advances have established, in particular, the importance of having an accurate implementation of the structure of the colliding ions, and the nucleons therein, in such frameworks. The initial state of heavy-ion collisions provides, hence, fertile ground for new interdisciplinary connections involving different aspects of hadronic and nuclear physics across energy scales.

Invited Talk HK 23.3 Tue 15:00 HK-H1

High-precision mass spectrometry with ISOLTRAP at ISOLDE/CERN — •Jonas Karthein — Massachusetts Institute of Technology, Cambridge MA 02139, USA

This talk summarizes recent results of the ISOLTRAP mass spectrometer located at the radioactive ion beam facility ISOLDE at CERN. First, the latest hardware and software developments regarding the high-precision time-of-flight and Penning trap mass spectrometers will be introduced. Furthermore, recent results probing the edges of existence on the neutron-rich and deficient sides of the nuclear chart around the $Z = 50$ closed nuclear shell will be discussed, highlighting a recent publication in the vicinity of the doubly-magic ^{100}Sn [Nature Physics 17, 1099 (2021)].

HK 24: Heavy-Ion Collisions and QCD Phases V

Time: Tuesday 16:00–17:30 Location: HK-H1

Group Report HK 24.1 Tue 16:00 HK-H1

Measurements of J/ψ production at midrapidity with ALICE at the LHC — •Minjung Kim for the ALICE-Collaboration — Physikalische Institut, Unversität Heidelberg, Heidelberg, Germany

The measurement of J/ψ production in heavy-ion collisions has been used as a valuable tool to study the properties of the quark*gluon plasma (QGP) since charm quarks are mainly produced via initial hard scatterings. Especially at LHC energies, the production of low transverse momentum J/ψ, which can be measured precisely with the ALICE (A Large Ion Collider Experiment) detector, is sensitive to the regeneration mechanism. Measurements of J/ψ production in p*Pb collisions provide an opportunity to study cold–nuclear–matter effects as well as possible final state mechanisms, which can modify its production with respect to the one in pp collisions.
Based on the electron identification capability provided by the Time Projection Chamber (TPC) installed at midrapidity, J/ψ production is measured via the dielectron decay channel in ALICE. In addition, it is possible to statistically separate the contribution of J/ψ from a weak decays of beauty hadrons (non-prompt J/ψ) using the long life time of beauty hadrons, relying on excellent track pointing resolution provided by the Inner Tracking System (ITS).
In this presentation, we will show latest measurements of J/ψ production in p-Pb and Pb-Pb collisions at midrapidity by ALICE, in comparison with theoretical calculations.

HK 24.2 Tue 16:30 HK-H1

J/ψ identification in ALICE with XGBoost — •Lasse Bassermann for the ALICE-Collaboration — Physikalisches Institut der Universität Heidelberg

In ALICE (A Large Ion Collider Experiment), J/ψ meson production is analyzed at midrapidity via the decay to an electron-positron-pair. Until now this identification was done by hand using a cut-based-method, which assumes that electrons, if they match certain parameters, originate from the decay of a J/ψ meson. Another method to identify J/ψ mesons could be through machine learning algorithms, such as XGBoost. XGBoost is an open-source software that provides machine learning algorithms using a gradient boosting framework, where an ensemble of weak prediction models is used.

In this poster the first steps of implementing an XGBoost algorithm for identifying J/ψ mesons are presented. This includes the first adaptions of the algorithm to the data used as well as the selection of the data. First comparisons with the cut-based method are discussed.

HK 24.3 Tue 16:45 HK-H1

J/ψ production as a function of charged-particle multiplicity in pp collisions at the LHC — •Ailec de la Caridad Bell Hechavarria for the ALICE-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster

The increase of the inclusive J/ψ yields as a function of charged-particle multiplicity was found to be stronger than linear in previous ALICE publications, where both J/ψ and the charged-particle multiplicity were measured at midrapidity. The causes for this behavior have been investigated in previous studies with PYTHIA8 and attributed to possible auto-correlation effects. Insight on this effect could be gained by measuring the charged-particle multiplicity in three azimuth regions relative to the direction of the J/ψ.

Data collected with ALICE at the LHC during Run 2 is used to investigate the relative J/ψ yield, measured at mid-rapidity ($|y|<0.9$) in its di-electron decay channel and as a function of the charged-particle multiplicity, in various regions of the azimuthal angle with respect to the emission of the J/ψ meson.

In this contribution, new measurements of this correlation performed in pp collisions at $\sqrt{s}$=13 TeV TeV will be shown.

***Supported by DFG under GRK2149**

HK 24.4 Tue 17:00 HK-H1

J/ψ production as a function of the event multiplicity in p-Pb collisions at the LHC — •Tabea Eder for the ALICE-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster

Previous ALICE results indicate a stronger than linear increase of the inclusive normalized J/ψ yield with charged-particle multiplicity, both measured at mid-rapidity, in proton-lead collisions at $\sqrt{s_{NN}} = 5.02$ TeV. The corresponding ALICE results on proton-proton collisions at $\sqrt{s} = 13$ TeV provide a clearer picture of a stronger than linear increase.
In PYTHIA8, this behavior has been associated with auto-correlation

effects in proton-proton collisions. This has been achieved by investigating the multiplicity dependence of J/ψ production in different regions of the azimuthal angle, which is the difference between the J/ψ meson and the charged particle emission angle. For proton-lead collisions, no results on these distributions for the J/ψ meson are available yet.
In this talk first results on the multiplicity dependence of the normalized J/ψ yield for proton-lead collision in regions of the azimuthal angle will be presented, using ALICE data at $\sqrt{s_{NN}} = 5.02$ TeV recorded during the LHC data taking Run 2 in 2016.
Supported by BMBF within the ErUM Program.

HK 24.5 Tue 17:15 HK-H1

Measurement of J/ψ polarization in proton-proton collisions at $\sqrt{s} = 13$ TeV with the ALICE muon spectrometer — •Federica Zanone for the ALICE-Collaboration — Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Germany

ALICE is the experiment at the CERN LHC devoted to the study of quark-gluon plasma, but it is also well suited to perform other QCD studies, such as the investigation of quarkonium polarization.

Polarization is the measure of the degree to which the spin of a particle is aligned with respect to a chosen axis and reflects the process responsible for its production. At present theoretical models have difficulties in explaining both the quarkonium production cross section and polarization, so precise results from experiments are necessary to better constrain the theory approaches. The polarization of a vector meson, such as J/ψ, can be experimentally determined by measuring the angular distribution of its decay products since such distributions can be expressed in terms of the eigenvalues corresponding to the mother angular momentum eigenstates. This study focuses on the decay channel $J/\psi \to \mu^+\mu^-$ in the pseudorapidity region $-4.0 < \eta < -2.5$ and addresses the highest J/ψ statistics sample collected so far by ALICE in pp collisions. This analysis provides the measurement of J/ψ polarization parameters as a function of p_T in the helicity and Collins-Soper reference frames and investigates the range $p_T < 15\ GeV/c$, extending, for the first time, the measurement down to $p_T = 0$. Comparisons of the results to previous measurements both in pp and PbPb collisions, as well as to theoretical models, are provided, too.

HK 25: Heavy-Ion Collisions and QCD Phases VI

Time: Tuesday 16:00–17:30 Location: HK-H2

Group Report HK 25.1 Tue 16:00 HK-H2

The Compressed Baryonic Matter (CBM) experiment and its demonstrator mCBM at FAIR — •Adrian Amatus Weber for the CBM-Collaboration — Justus-Liebig Universität Gießen

The key objective of the Compressed Baryonic Matter experiment (CBM) at FAIR is to explore the QCD phase diagram at high net-baryon density and moderate temperatures in nucleus-nucleus collisions. At the FAIR energy regime, a rich phase structure could occur comprising the potential restoration of chiral symmetry and a first order phase transition, resulting in a substantial discovery potential. CBM is designed as a fixed-target experiment and will be equipped with fast and radiation-tolerant detector systems to measure with unprecedented interaction rates of up to 10MHz which will allow to study extremely rare probes with high precision. To achieve the required performance, a triggerless-streaming data acquisition and data transport system is being developed sending data with up to 1 TB/s to a large-scale computer farm for event reconstruction and first-level event selection. The presentation will summarize the preparation status of the CBM experiment including latest results of the mCBM experiment. With mCBM ("mini-CBM") a CBM precursor experiment and demonstrator has been set up within the FAIR phase-0 program, comprising pre-series and prototype modules of all CBM detector systems. During the 2021 beam campaign, high-rate tests for various detector subsystems could be performed as well as first runs with the final DAQ / data transport configuration of CBM were taken.

HK 25.2 Tue 16:30 HK-H2

CBM performance for (multi-)strange hadron measurements using Machine Learning techniques — •Shahid Khan[1], Viktor Klochkov[1], Olha Lavoryk[2], Oleksii Lubynets[3,4], Andrea Dubla[3], and Ilya Selyuzhenkov[3,5] for the CBM-Collaboration — [1]University of Tuebingen — [2]University of Kyiv — [3]GSI, Darmstadt — [4]University of Frankfurt — [5]NRNU MEPhI, Moscow

The Compressed Baryonic Matter (CBM) experiment at FAIR will investigate the QCD phase diagram at high net-baryon density ($\mu_B >$ 400 MeV) in the energy range of $\sqrt{s_{NN}} = 2.9-4.9$ GeV. Precise determination of dense baryonic matter properties requires multi-differential measurements of strange hadron yields, both for the most copiously produced kaons and Λ as well as for rare (multi-)strange hyperons and their anti-particles.

This work focuses on the multi-differential reconstruction and yield of strange hadrons (K^0_s, Λ, and Ξ^-) using Machine Learning (ML) algorithms such as XGBoost for different collision energies. The hadrons are reconstructed via their weak decay topology using the Kalman Filter algorithm. The ML algorithms allow efficient, non-linear, and multi-dimensional selection criteria to be implemented and achieve a high signal to background ratio in the region around the invariant mass peak of the candidates. The ML algorithms are deployed and the yield extraction (multi-step fitting procedure) is implemented differentially in centrality, transverse momentum, and rapidity. Estimation of systematic uncertainties and a novel approach to study feed-down contribution to the primary strange hadrons using ML will also be discussed.

HK 25.3 Tue 16:45 HK-H2

Charged Kaon and ϕ Reconstruction in Ag+Ag Collisions at $\sqrt{s_{NN}} = 2.5$ GeV with HADES — •Marvin Kohls for the HADES-Collaboration — Goethe-Universität Frankfurt am Main

Heavy ion collisions in the few GeV energy regime probe similar temperatures and densities as created in neutron stars, which provides 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 from this measurement series.
As these strange hadrons are produced below the free nucleon-nucleon production threshold, they are a good probe for in-medium effects with respect to their steep excitation function. In this presentation the relative yields of strange particles with different excitation energies are compared and the consistency with theoretical models is reviewed. Furthermore the system size dependence of strangeness production is tested by comparing central and peripheral collisions.
The work has been supported by BMBF (05P19RFFCA), the State of Hesse within the Research Cluster ELEMENTS (Project ID 500/10.006), 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 25.4 Tue 17:00 HK-H2

Emission of light nuclei from semi-central events in Au+Au collisions at $s_{NN} = \sqrt{2,42}$ GeV with HADES — •Holger Huck for the HADES-Collaboration — Goethe-Universität, Frankfurt am Main, Deutschland

In the few GeV energy regime light nuclei are emitted abundantly, contributing to the bulk of created matter. We present results on p, d, t and ^3He momentum spectra as yields from central and semi central Au+Au collisions at $s_{NN} = \sqrt{2,42}$ GeV.

After particle identification the transverse mass spectra of the particle candidates are extracted. Subsequently, they are corrected for acceptance and efficiency losses. The centrality dependance of the obtained spectra and yields are then compared and put into context of the world data.

HK 25.5 Tue 17:15 HK-H2

Ambiguities in the hadro-chemical freeze-out of Au+Au collisions at SIS18 energies and how to resolve them — •Anton Motornenko[1], Jan Steinheimer[1], Volodymyr Vovchenko[3], Reinhard Stock[4,1], and Horst Stoecker[1,2,5] — [1]FIAS, Frankfurt — [2]ITP, Goethe Universität — [3]Nuclear Science Division, LBL

— [4]IKP, Goethe Universität — [5]GSI, Darmstadt

The thermal fit to preliminary HADES data of Au+Au collisions at $\sqrt{s_{NN}} = 2.4$ GeV shows two degenerate solutions at $T \approx 50$ MeV and $T \approx 70$ MeV. The analysis of the same particle yields in a transport simulation of the UrQMD model yields the same features, i.e. two distinct temperatures for the chemical freeze-out. While both solutions yield the same number of hadrons after resonance decays, the feeddown contribution is very different for both cases. This highlights that two systems with different chemical composition can yield the same multiplicities after resonance decays. The nature of these two minima is further investigated by studying the time-dependent particle yields and extracted thermodynamic properties of the UrQMD model. It is confirmed, that the evolution of the high temperature solution resembles cooling and expansion of a hot and dense fireball. The low temperature solution displays an unphysical evolution: heating and compression of matter with a decrease of entropy. These results imply that the thermal model analysis of systems produced in low energy nuclear collisions is ambiguous but can be interpreted by taking also the time evolution and resonance contributions into account. [1] Phys.Lett.B 822 (2021) 136703, arXiv:2104.06036 [hep-ph]

HK 26: Instrumentation VII

Time: Tuesday 16:00–17:30 Location: HK-H3

HK 26.1 Tue 16:00 HK-H3

Performance and quality testing of frontend electronics for the CBM RICH detector * — •Pavish Subramani for the CBM-Collaboration — University of Wuppertal

The CBM experiment is a high collision rate rate experiment, producing estimated single Cherenkov photon rates of up to ~ 300 kHz per pixel in its Ring Imaging Cherenkov Detector (RICH). Signals of the 8×8 pixel Multianode Photomultiplier Tubes (MAPMT) are digitized using the FPGA-TDC based DIRICH frontend readout chain, providing excellent timing precision. A dedicated lab setup producing realistic detector signals using a pulsed laser light source was set up in order to validate the high rate capability of the DIRICH readout. It is found that individual readout channels can withstand photon rates up to 2.2 MHz/pixel, limited only by maximum data rate capability and buffer size on the frontend board. In addition, also effects of high photon occupancy on the MAPMTs were investigated, which might cause additional signals due to capacitive cross talk within the MAPMT or readout chain. Occupancies of up to 55 % (simultaneous photon hits on more than half of the MAPMT pixels) were investigated, indicating that in the expected occupancy range of 10–15 % the readout works flawlessly with very low crosstalk. The talk will focus on the laboratory test setup and qualification measurements of the readout chain obtained herewith.

* supported by BMBF (05P19PXFCA, 05P21PXFC1) and GSI.

HK 26.2 Tue 16:15 HK-H3

Precursor of the NOVEC-649 based cooling system for the CBM Micro Vertex Detector — •Franz A. Matejcek — Goethe-Universität Frankfurt

The Micro Vertex Detector of the Compressed Baryonic Matter Experiment (CBM) is placed 5 cm behind the target. The pixel detector with low material budget operates in vacuum. It consists of four stations equipped with 288 thin and large area CMOS sensors which produce a total of around 70 W of heat. To ensure their radiation hardness and detecting efficiency they have to be operated below -10 °C. The material budget-optimized cooling concept relies on efficient conductive cooling of the sensors, glued onto TPG carriers, providing very high thermal conductivity in the geomatrical acceptance. Actively cooled heat sinks outside the acceptance transfer the heat to the dedicated high-tech coolant NOVEC-649 (3M), featuring low viscosity in the temperature range of interest and good radiation hardness. This contribution will focus on the steps towards routine operation with NOVEC-649 and the evaluation of the thermal performance of a MVD prototype. This work has been supported by BMBF (05P19RFFC1), CremlinPLUS, GSI and HIC for FAIR.

HK 26.3 Tue 16:30 HK-H3

Study of the material budget and data rates for the STS detector system of the CBM experiment — •Mehulkumar Shiroya for the CBM-Collaboration — Goethe University Frankfurt, Frankfurt am Main, Germany

The Compressed Baryonic Matter (CBM), a fixed target experiment is under development at the Facility for Anti-Proton and Ion Research (FAIR) in Darmstadt(Germany). The aim of the experiment is to study the QCD phase diagram of strongly interacting matter at high density and moderate temperature employing heavy-ion beams in the energy range between 2 AGeV-11 AGeV.

The experiment is designed to run with beam intensities up to 10^9 Au + Au particles/sec and an interaction rate of up to 10^7 collisions/sec. Therefore, fast and free streaming electronics is needed for read-out and data transfer. The read-out electronics are connected to the silicon micro-strips sensors via polyimide-Al micro-cables and are placed outside the active region of STS to minimize the material budget. Detailed realistic knowledge of the detector geometry, including both active and passive material, is necessary to estimate the material budget of the detector which has a large impact on the absorption of delta electrons created in beam-target interaction, as well as in nuclear interaction of particles created in the heavy-ion collision with the active and passive materials. We present the status of the simulations of the STS detector geometry and its impact on the expected signal rates.

HK 26.4 Tue 16:45 HK-H3

Proof-of-Principle of Collinear Laser Spectroscopy on Neutral Atoms following Photodetachment — •Laura Renth[1], Bernhard Maass[1,4], Dag Hanstorp[3], Phillip Imgram[1], Daniel Koestel[2], Di Lu[3], Wilfried Nörtershäuser[1], and Thomas Walther[2] — [1]IKP, TU Darmstadt — [2]IAP, TU Darmstadt — [3]University of Gothenburg — [4]Argonne National Laboritory, Chicago, USA

At the Collinear Apparatus for Laser Spectroscopy and Applied Physics (COALA) [1] in Darmstadt a new experimental approach was tested to perform collinear laser spectroscopy on boron atoms produced from a negative ion sputtering source.

An ion sputtering source produced negatively charged boron ions which where then guided into the COALA beamline. From this ion beam an atomic beam was created by photodetachement with a pulsed laser. Then, collinear laser spectroscopy was performed for the $2p\ ^2P_{1/2} \rightarrow 3s\ ^2S_{1/2}$ and for the $2p\ ^2P_{3/2} \rightarrow 3s\ ^2S_{1/2}$ transitions of ^{11}B and on the the $2p\ ^2P_{3/2} \rightarrow^3 s\ ^2S_{1/2}$ transition of ^{10}B. The resonance was only observed after implementing new diagnostic tools at COALA, namely a Wien filter and the generation of short ion pulses to perform time-of-flight (TOF) spectrometry. First results will be presented and the potential of this approach are discussed.

[1] K. König, J. Krämer, C. Geppert, P. Imgram, B. Maaß, T. Ratajczyk, W. Nörtershäuser. A New Collinear Apparatus for Laser Spectroscopy and Applied Science (COALA). Rev. Sci. Instr. 91, 081301 (2020).

HK 26.5 Tue 17:00 HK-H3

Integration of a Resistive Plate Chamber for Precise Measurement of High-Momentum Protons in Short Range Correlations — •Manuel Xarepe[1,2], Thomas Aumann[1,4], Alberto Blanco[3], Daniel Galaviz[2], Luis Lopes[3], Andrea Jedele[1,4], João Saraiva[3], Hans Törnqvist[1,4], Bastian Löher[4], and Håkan Johansson[5] for the R3B-Collaboration — [1]TU-Darmstadt — [2]LIP-Lisbon — [3]LIP-Coimbra — [4]GSI — [5]Chalmers-UT

Within the framework of the FAIR Phase-0 experimental program, that will study for the first time of Short Range Correlations (SRC) in radioactive nuclei at the R3B (Reactions with Relativistic Radioactive Beams) experiment of the FAIR laboratory, by measuring the breakup reaction of 16C on a proton target in inverse kinematics, an innovative approach based on Resistive Plate Chambers (RPC) as a proton Time-of-Flight (ToF) is presented. The excellent time resolution properties of the RPC (about 50 ps) will allow for a precise measurement of the momentum of the forward emitted protons from high-momentum correlated pairs. In this work the RPC detector will be introduced, the characteristics of the integration of the detector in the R3B experi-

ment will be presented, and first results from calibrations using cosmic rays, radioactive sources and a test beam time after installation in the experimental cave will be shown.

HK 26.6 Tue 17:15 HK-H3

Characterization of plastic scintillators with radioactive sources for the DarkMESA experiment — •Matteo Lauss for the MAGIX-Collaboration — Institute for Nuclear Physics, Mainz University, German

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 (150 MeV, 150 μA) the P2 experiment will measure the weak mixing angle in electron-proton scattering in 10,000 hours operation time. The beam dump of this experiment is ideally suited for a parasitic dark sector experiment - the DarkMESA experiment. It is designed for the detection of Light Dark Matter (LDM) which in the simplest model couples to a massive vector particle, the dark photon γ'.

A highly efficient veto detector surrounding the calorimeter hermetically is essential to probe the target parameter space of DarkMESA successfully. The veto detector will mainly consist of plastic scintillation counters. A detector prototype is currently under construction using 2 cm thick plastic scintillators of type EJ-200 and a matrix of 5 × 5 lead fluoride crystal bars for the calorimeter. The measurement of the scintillation light is accomplished by silicon photomultipliers (SiPM) mounted on a specially designed electronic board. Systematic studies with a selection of commonly used radioactive sources were conducted to determine the homogeneity of the light yield across the scintillators. The light yield was determined by extracting the Compton edge for gamma emitters with an appropriate response function.

HK 27: Instrumentation VIII

Time: Tuesday 16:00–17:30 Location: HK-H4

Group Report HK 27.1 Tue 16:00 HK-H4

The TRD in CBM: status and steps towards series production — •Florian Roether — Institut für Kernphysik, Frankfurt, Deutschland

In 2025, the Compressed Baryonic Matter Experiment (CBM) at FAIR is scheduled to start operation. Starting end of 2023, the various detectors will be installed, including the Transition Radiation Detector (TRD). The main task of the TRD is to identify electrons above momenta of 1 GeV/c. In addition, the TRD also contributes to the identification of nuclear fragments. After an intensive and thorough research and development phase, we will start series production of the chambers for the TRD in 2022.

This presentation will summarize the status of the project and the development of the workflows required for series production. We will also present first results and findings from the pre-series production of the detector chambers.

This work is supported by BMBF-grant 05P21RFFC3.

HK 27.2 Tue 16:30 HK-H4

Application of TRD Trigger on the Hypertriton Analysis in p–Pb collisions at ALICE — •Benjamin Brudnyj for the ALICE-Collaboration — Institut für Kernphysik, Goethe Universität, Frankfurt am Main

The production of light (anti-)(hyper-)nuclei has recently become a topic of high interest. One interesting example is the lifetime of the lightest hypernucleus, the hypertriton. Several measurements indicate a significant deviation from the theoretical expectation, in particular in heavy-ion collisions. Therefore, it is important to also measure these rare nuclei in pp and p–Pb collisions.

Due to their short lifetime only their decay products can be measured, e.g. the charged two body decay channel ${}^{3}_{\Lambda}\mathrm{H} \rightarrow {}^{3}\mathrm{He} + \pi^{-}$. In order to be able to measure these rare (anti-)fragments also in pp and p–Pb collisions, a trigger on nuclei was implemented on p–Pb collisions at $\sqrt{s_{NN}} = 8.16$ TeV to increase the statistics by using the ability of the ALICE-TRD to perform fast trigger decisions.

In this talk the performance of a trigger on different light nuclei will be presented, as well as the current status of a hypertriton analysis using data on p–Pb collisions at $\sqrt{s_{NN}} = 8.16$ TeV. In order to measure the hypertriton with a sufficient significance and a good signal-to-background ratio, a study to optimize topological cuts is performed. Supported by BMBF and the Helmholtz Association.

HK 27.3 Tue 16:45 HK-H4

CBM-TRD QA algorithm results for mCBM 2021 — •Axel Puntke — Institut für Kernphysik, Münster, Germany

The Compressed Baryonic Matter (CBM) experiment at the future Facility for Antiproton and Ion Research (FAIR) will explore the QCD phase diagram in the region of very high net baryon densities. The Transition Radiation Detector (TRD) is an important subdetector of the final CBM experiment and is used to identify electrons at high momenta, contributes to tracking of particles and supports the identification of light nuclei via their energy loss.

For commissioning and performance measurements, the TRD takes part in the mCBM high-rate beam campaigns at the SIS18 accelerator, which are part of the FAIR-Phase 0 program. For this purpose, a set of QA algorithms is developed which can automatically produce QA plots, based on the used configuration parameters of the current setup. This also includes correlations with other subsystems (e.g. TOF) which have recorded data simultaneously.

In this poster, the first results, based on the data recorded during the mCBM 2021 beamtime, will be shown . Besides TRD there were also the subsystems TOF, STS, RICH and PSD involved and can be used for temporal and spatial correlations.

This work is supported by BMBF grant 05P21PMFC1.

HK 27.4 Tue 17:00 HK-H4

n2EDM - coating of ultra-cold neutron storage vessel — •Noah Yazdandoost für die nEDM-Kollaboration — Department of Chemistry, Johannes Gutenberg-University, Mainz

The n2EDM experiment at PSI aims to measure the neutron electric dipole moment (nEDM) with ultra-cold neutrons (UCN). UCN are neutrons with energies in the range of nano electron-volts.
A non-zero nEDM would break time and parity reversal symmetry and could explain observations like the matter-antimatter asymmetry of the universe. To measure the nEDM, polarized UCN are filled into a storage vessel where a constant electric and magnetic field is applied. The Ramsey method of separated oscillatory fields is used to measure the Larmor precession frequency of the UCN in the storage vessel. A measured shift in the Larmor precession frequency between parallel and antiparallel field orientation implies a non-zero nEDM. The maximum energy of the stored UCN is limited by the Fermi pseudo-potential of the material the vessel is made of. Besides having a high Fermi pseudo-potential, the material needs to be non-magnetic and electrically insulating.
This talk gives an overview of the n2EDM experiment and the coating process of the insulating rings of the experiment.

HK 27.5 Tue 17:15 HK-H4

Laser cooling of C3+ ions at the Experimental Storage Ring at GSI — •Ken Ueberholz[1], Volker Hannen[1], Danyal Winters[2], Christian Weinheimer[1], Noah Eizenhöfer[4], Michael Bussmann[3], Max Horst[4], Daniel Kiefer[4], Nils Kiefer[5], Sebastian Klammes[2], Thomas Kühl[2,6], Markus Löser[3], Xinwen Ma[7], Wilfried Nörtershäuser[4], Rodolfo Sanchez[2], Ulrich Schramm[3,8], Mathias Siebold[3], Peter Spiller[2], Markus Steck[2], Thomas Stöhlker[2,6,9], Thomas Walther[4], Hanbing Wang[7], Weiqiang Wen[7], Benedikt Langfeld[4], and Lars Bozyk[2] — [1]WWU Münster — [2]GSI Darmstadt — [3]HZDR Dresden — [4]TU Darmstadt — [5]Uni Kassel — [6]HI Jena — [7]IMP Lanzhou — [8]TU Dresden — [9]Uni Jena

In May 2021, an improved XUV fluorescence detection system and a new tuneable pulsed UV laser system were employed in a *beam experiment* for laser cooling of bunched relativistic (47% of c) carbon ions stored at the Experimental Storage Ring at GSI Helmholtzzentrum Darmstadt. Successful laser cooling was demonstrated using the powerful (~200 mW), high repetition rate (~10 MHz) and tuneable (wavelength and pulse duration) UV laser system. One of the main points of interest was to study the effects of ion bunch and laser pulse timing on the cooling process and on the fluorescence detection, which was done

by varying the delay of the laser pulses. In the talk preliminary results of these measurements will be presented and discussed. This work has been supported by BMBF under contract number 05P19PMFA1.

HK 28: Computing I

Time: Tuesday 16:00–17:45 Location: HK-H5

Group Report HK 28.1 Tue 16:00 HK-H5

Track Finding with PANDA — •Anna Alicke[1], Tobias Stockmanns[1], and James Ritman[2,1,3] for the PANDA-Collaboration — [1]Forschungszentrum Jülich, Institut für Kernphysik — [2]GSI Helmholtzzentrum für Schwerionenforschung — [3]Ruhr-Universität Bochum, Experimentalphysik, Lehrstuhl I

An overview of the various track finding methods for the barrel part of the PANDA detector will be presented. PANDA's barrel tracking system consists of three detector parts. The innermost tracking detector is the Micro-Vertex-Detector (MVD). Surrounding the MVD is the the Straw Tube Tracker (STT), which consists of over 4200 drift tubes. Additionally, forward boosted tracks are identified by the Gas Electron Multiplier plates (GEM). The STT tubes produce coarse track information given by their tube ID and a drift time information which significantly improves the spatial resolution. The drift time information determines circles (isochrones) to which the tracks must pass tangentially.

Track finding is divided into two parts: track finding for primary particles and for secondary particles. Two algorithms for each part are presented and compared. The two algorithms for primary particles are global tracking algorithms. The first algorithm is the current default track finder in PANDA and is based on adding hits to existing track assumptions. The second one is a track finder based on Hough transformations. For secondary particles a well optimized track finder based on a cellular automaton is compared to a novel approach that uses three chosen hits to find the true particle track.

HK 28.2 Tue 16:30 HK-H5

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 track particles in square and hexagonal geometries in conditions where noise or crossing tracks are presented. The current status and an outlook on the overall performance will be presented.

HK 28.3 Tue 16:45 HK-H5

Space-charge distortions in the ALICE TPC I: A data-driven approach to model space-charge distortion fluctuations — •Matthias Kleiner — 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 2022, interaction rates of 50 kHz in Pb-Pb collisions required a major upgrade of the TPC readout system. The Multi-Wire Proportional Chambers (MWPCs) were replaced by stacks of four Gas Electron Multiplier (GEM) foils, allowing continuous data acquisition. Due to intrinsic properties of the GEMs, a significant amount of ions produced during the electron amplification drifts into the active volume of the TPC, leading to space-charge distortions of the nominal drift field. Various effects cause fluctuations of the space-charge distortions on very short time scales. These fluctuations have to be corrected to preserve the intrinsic tracking precision of the TPC of 100 μm. A dedicated calibration procedure has been developed for the correction of the space-charge distortions. The measured integrated digital currents (IDCs) on the pads, which are used as an estimate for the space-charge density, are processed and taken as an input for a data-driven machine learning approach.

In this talk, procedures for the optimization of the IDCs for the space-charge distortion calibration for the ALICE TPC in Run 3 will be presented.

Supported by BMBF and the Helmholtz Association

HK 28.4 Tue 17:00 HK-H5

Space-charge distortions in the ALICE TPC II: Data-driven machine learning algorithms for the space-charge distortion calibration — •Ernst Hellbär[1], Harald Appelshäuser[2], Marian Ivanov[1], Matthias Kleiner[2], Silvia Masciocchi[1], and Jens Wiechula[2] for the ALICE-Collaboration — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany — [2]Institut für Kernphysik, Goethe-Universität Frankfurt, Germany

The Time Projection Chamber (TPC) plays a crucial role in tracking and particle identification for the ALICE experiment at the CERN LHC. The readout of the TPC was upgraded during the long shutdown 2 of the LHC in order to provide the capability to continuously record collision data at 50 kHz of Pb-Pb collisions. The intrinsic properties of the new readout chambers based on Gas Electron Multiplier (GEM) technology lead to a backflow of amplification ions into the drift volume of the TPC which is minimized to below 1%. In combination with the expected particle multiplicities and high interaction rates in Pb-Pb collisions, the ion backflow (IBF) causes significant space-charge distortions and distortion fluctuations. The latter are relevant on time scales of the order of 10 ms and have to be fully corrected accordingly to restore the intrinsic space-point resolution of the TPC of the order of a few 100 μm. The calibration of the distortion fluctuations is performed using data-driven machine learning algorithms which are trained with simulated data. The calibration procedure and first result of the performance will be presented.

This contribution is supported by BMBF.

HK 28.5 Tue 17:15 HK-H5

The mSTS as a pathfinder for the Detector Control System of the STS in the CBM experiment — •Marcel Bajdel for the CBM-Collaboration — Goethe-Universität Frankfurt am Main

The Compressed Baryonic Matter (CBM) experiment dedicated to the study of the properties of the strongly interacting matter is now under construction at the Facility for Anti-proton and Ion Research (FAIR) in Darmstadt.

In order to optimize the performance of experimental subsystems, a small-scale mCBM demonstrator was installed for the test purposes. As the future Silicon Tracking System (STS) is the core detection system of CBM, the mSTS is now a subject of the intensive investigation.

The CBM's Detector Control System (DCS) focuses on monitoring of the detector operation conditions, provides tracking of its vital parameters, data storage, and ensures a safe operation of the mSTS. A novel approach based on the containerization was implemented for these purposes. A Experimental Physics and Industrial Control System (EPICS) based system was configured and deployed in order to control, monitor and store process variables (PV) associated with the hardware.

In this presentation, we will present the results from the beam-test campaigns in 2020-2021, which allowed us to evaluate the performance of its soft- and hardware components.

HK 28.6 Tue 17:30 HK-H5

Comparison of simulation frameworks for the $\bar{\text{P}}$ANDA FAIR phase-0 experiment at MAMI — •Alexander Greiner[1], Alaa Dbeyssi[1], David Rodriguez Pineiro[1], Dong Liu[1], Frank Maas[1,2,3], Julian Moik[1], Luigi Capozza[1], Oliver Noll[1], Peter-Bernd Otte[1], Sahra Wolff[1], and Samet Katilmis[1] for the PANDA-Collaboration — [1]Helmholtz-Institut Mainz, Germany —

[2]Institute of Nuclear Physics, Johannes Gutenberg University, Mainz, Germany — [3]PRISMA Clus- ter of Excellence, Mainz, Germany

A complex detector system is being developed for the $\bar{\text{P}}$ANDA experiment at the FAIR accelerator facility in Darmstadt. The electromagnetic process group (EMP) at the Helmholtz institut in Mainz is developing the backward end-cap (BWEC) of this detector and a preliminary version will be used in the $\bar{\text{P}}$ANDA FAIR Phase-0 project to measure the electromagnetic transition form factor of π^0 at the MAMI-accelerator in Mainz. To verify that the planned setup of the BWEC can withstand the radiation exposure of the experiment without affecting the data acquisition through malfunctions, simulations were performed to estimate the radiation exposure of the whole experiment and of single important components. In the context of these simulations a comparison between the used simulation framework GEANT4 and the prominent FLUKA framework was performed.

HK 29: Structure and Dynamics of Nuclei V

Time: Tuesday 16:00–17:30 Location: HK-H6

HK 29.1 Tue 16:00 HK-H6

Total Reaction Cross-Section Measurements in the S444 Commissioning Experiment for R^{3}B — •Lukas Ponnath[1], Roman Gernhäuser[1], Tobias Jenegger[1], Philipp Klenze[1], and Thomas Aumann[2] for the R3B-Collaboration — [1]Technische Universität München — [2]Technische Universität Darmstadt

The R^{3}B (Reactions with Relativistic Radioactive ion Beams) experiment at the research facility FAIR, currently under construction in Darmstadt, enables kinematically complete reaction studies for the most exotic nuclei.
The S444 commissioning experiment for R^{3}B, performed in the FAIR Phase-0 campaign in 2019, was the first operation of many new R^{3}B detectors in a common setup. With a stable ^{12}C beam and a set of different beam energies ranging from 400AMeV to 1AGeV we challengend this large installation around the GLAD magnet using the ^{12}C(p,2p)^{11}B benchmark reaction.
During this successful commissioning we could measure the energy dependence of total reaction cross-sections of a ^{12}C beam on a ^{12}C target, which is poorly known for energies above 400AMeV. This is an important input for current calculations based on the eikonal reaction theory.
In my Talk I will present the current status and preliminary results of the analysis and discuss the technique and evaluated error budget for the different steps.
(supported by BMBF 05P21WOFN1)

HK 29.2 Tue 16:15 HK-H6

Recent high-precision mass spectrometry of heavy and superheavy nuclides at SHIPTRAP — •Oliver Kaleja for the SHIPTRAP-Collaboration — University of Greifswald, Germany — GSI Darmstadt, Germany

Within the recent FAIR phase-0 program, the Penning-trap mass spectrometer SHIPTRAP at GSI in Darmstadt, Germany, was used to extend direct high-precision mass spectrometry to superheavy nuclides ($Z \geq 104$) in the vicinity of the $N = 152$ shell closure. Besides lowest production rates down to few atoms per hour, an improved efficiency, ion sensitivity and mass-resolving power of up to 11 000 000 allowed resolving metastable states with half-lives >200 ms, i.e, ^{251m,254m}No($Z = 102$), ^{254m,255m}Lr($Z = 103$), ^{257m}Rf($Z = 104$), and ^{258m}Db($Z = 105$) from their respective ground state. For the first time, isomer excitation energies in the range of $\approx$ 30 keV to 1.3 MeV were determined directly. In addition, multiple metastable states in a variety of heavy isotopes, many of which are close to the $Z = 82$, $N = 126$ shell closures, have been measured, e.g., for isotopes of Pb, Bi, Po, At, Rn, Fr ($Z = 82 - 87$), Th($Z = 90$), and Cf($Z = 98$). This allowed the direct determination of the excitation energies of long-lived isomeric states and therefore to contribute to the understanding of the level and decay schemes of these heavy nuclei, complementing the findings from decay and laser spectroscopy investigations. In this contribution an overview of the experimental challenges and results is given.

HK 29.3 Tue 16:30 HK-H6

Commissioning and status of a gas-jet apparatus for laser spectroscopy of the heaviest elements — •Jeremy Lantis for the GSI Gas Jet-Collaboration — Johannes Gutenberg University Mainz, 55099 Mainz, Germany — Helmholtz Institute Mainz, 55099 Mainz, Germany

Laser spectroscopy measurements can provide information about fundamental properties of both atomic and nuclear structure. These techniques are of particular importance for the heaviest actinides and superheavy elements, where atomic data are sparse. Recent resonance ionization spectroscopy experiments at GSI, Darmstadt have focused on in-gas-cell measurements using the RADRIS technique, with success measuring several nobelium and fermium isotopes. However, the limited resolution of these measurements hampers the precision in determining the nuclear moments and spin. To overcome these limitations, a new gas-jet apparatus has been constructed to perform laser spectroscopy of atoms in a hypersonic jet, providing an almost collision-free and reduced Doppler broadened environment, which improves the achievable resolution by an order of magnitude and provides substantially improved nuclear data of exotic nuclei. The reach and capabilities of the apparatus will be discussed, as well as planned online experiments involving the determination of the nuclear moments of ^{253,255}No and the definitive identification of the nucleonic configuration of the $K^\pi = 8^-$ isomer of ^{254m}No.

HK 29.4 Tue 16:45 HK-H6

Perturbative inclusion of core excitation in a structure model of one-neutron halo nuclei — •Live-Palm Kubushishi and Pierre Capel — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany

Halo nuclei are exotic nuclear structures found near the dripline and thus short-lived. In standard reaction models, halo nuclei are described as simple two or three-body systems: an inert core with one or two weakly bound neutrons. However, some breakup data suggest that the structure of the core, and in particular its excitation to its excited states, can play a role in the dynamics of the reaction [1]. In this talk, we propose a simple structure model to account for that effect. Here we consider the example of the one-neutron halo nucleus ^{11}Be. To improve our description of the ^{10}Be core without resorting to a purely microscopic model, we use a collective one: the rigid rotor. We assume the core to be weakly deformed, which we treat at the first order of perturbations to couple it to its 2^+ first excited state, and we add this degree of freedom to the halo effective field theory description of ^{11}Be [2]. Our calculations were performed using the R-matrix method on a Lagrange mesh. In this context, we have been able to reproduce with a good agreement, the coupled-channels results [3] and improve the halo-EFT model [2] with respect to *ab initio* results [4].
[1] R. de Diego, et al., *Phys. Rev. C* 95, 044611 (2017).
[2] P. Capel, et al., *Phys. Rev. C* 98, 034610 (2018).
[3] F.M. Nunes, et al., *Nucl. Phys. A* 596, 171 (1996).
[4] A. Calci, et al., *Phys. Rev. Lett.* 117, 242501 (2016).

HK 29.5 Tue 17:00 HK-H6

Investigation of fission in quasi-free-scattering experiments at R^{3}B — •Tobias Jenegger, Philipp Klenze, Lukas Ponnath, and Roman Gernhäuser — Technische Universität München, Germany

The advanced R^{3}B Setup at GSI allows to investigate fission of exotic nuclei in inverse kinematics via the (p,2pf) reaction. Fission via quasi-free-scattering is a new method to directly determine the excitation energy of the fissile nucleus and its fission barrier. This can only be achieved by kinematically complete measurement of all reaction products. Hence the CALIFA calorimeter, covering a polar angular acceptance from 22° up to 89° in the laboratory system around the target, plays a crucial role. It enables the detection of γ-rays with energies from 100 keV up to 30 MeV as well as protons and other light charged particles with energies up to 700 MeV, hence giving the opportunity to detect both the two coincident protons from the quasi-free-scattering process and emitted γ-rays from deexcitation of the fission products.
We present first analysis steps from a pilot experiment performed in the FAIR Phase-0 campaign in March 2021 with a relativistic ^{238}U beam and a LH2 target focussing on the identification of the fission

products and the kinematic analysis of the (p,2pf) reaction.
(supported by BMBF 05P21WOFN1)

HK 29.6 Tue 17:15 HK-H6

Electron scattering off ^{10}B under 180° — •Maximilian Spall, Maxim Singer, Jonny Birkhan, Isabelle Brandherm, Martha Liliana Cortés, Florian Gaffron, Katharina E. Ide, Johann Isaak, Igor Jurosevic, Peter von Neumann-Cosel, Florian Niederschuh, Norbert Pietralla, Gerhart Steinhilber, and Tim Stetz — Institut für Kernphysik, Technische Universität Darmstadt

Electron scattering experiments under 180° are an excellent tool to study transversal form factors of magnetic excitations due to the suppression of longitudinal excitations by several order of magnitudes with respect to the transversal excitations and the associated radiative tail background from elastic scattering at this angle. A measurement was performed with the 180° system at the S-DALINAC [1], in order to investigate the M3 transition of the 3^+ ground state to the excited 0^+ state at 1.74 MeV in ^{10}B which is the analogue to the second-forbidden beta-decay of ^{10}Be. The measurement will extend existing data towards lower momentum transfer allowing to improve the precision of the determined transition strength. The combined information from electron scattering and beta-decay will serve as a precision test of the unified description of electroweak observables in ab-initio models. First results of the new ^{10}B(e,e') data will be presented and a novel approach for the scattering angle calibration will be discussed.
*Supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Project-ID 279384907 - SFB 1245.
[1] C. Lüttge et al., Nucl. Instrum. Meth. A 366, 325*331 (1995).

HK 30: Outreach

Time: Tuesday 16:00–17:30 Location: HK-H7

Group Report HK 30.1 Tue 16:00 HK-H7

Übersichtsvortrag Mainzer Outreach Aktivitäten — •Stephan Aulenbacher[1], Achim Denig[1], Wiebke Kött[2] und Heike Enzmann[2] für die Netzwerk Teilchenwelt-Kollaboration — [1]Institut für Kernphysik, Mainz — [2]Institut für Physik, Mainz

Seit Januar 2019 ist Mainz nicht nur lokaler Knotenpunkt des Netzwerk Teilchenwelt, sondern darüber hinaus auch noch thematischer Knotenpunkt für Hadronen und Kerne. Dieser Vortrag soll einen Überblick über die Mainzer Outreach Projekte geben. Im Fokus stehen dabei Veranstaltungen wie die jährliche Mainzer Teilchenphysik Akademie sowie die neu etablierte Detektorschule. Aber auch routinierte Veranstaltung wie das Angebot der Masterclasses, mit besonderem blick auf die neue Streubretter Masterclass, sowie das Schülerpraktikum und die Führung durch die Beschleunigeranlage MAMI werden vorgestellt werden. Darüber hinaus werden Sonderprojekte präsentiert werden.

HK 30.2 Tue 16:30 HK-H7

Präzise geplant - die interaktive Wanderausstellung "Präzision" — •Renée Dillinger-Reiter und Wiebke Kött — Johannes Gutenberg-Universtität, Mainz

In den letzten zwei Jahren wurde eine mobile Ausstellung zur öffentlichen Präsentation der Forschung unseres Exzellenzclusters "Precision Physics, Fundamental Interactions and Structure of Matter" geplant und umgesetzt. Im November 2021 wurde sie in Berlin eröffnet und ist aktuell in Mainz zu sehen.

Bei der Konzeption einer solchen Ausstellung ergeben sich vielfältige Herausforderungen: neben der Finanzierung und einem hohen Arbeitsaufwand bei Entwurf und praktischer Umsetzung müssen die Inhalte geschärft werden. Dies betrifft unter anderem die Suche nach dem zentralen Leitthema, die Schwerpunktsetzung, das Herunterbrechen der wissenschaftlichen Details auf eine für Laien verständliche Ebene, die Auswahl einzelner Beispiele und die Ansprache der Zielgruppe durch interaktive Elemente.

HK 30.3 Tue 16:45 HK-H7

Entwicklung einer LHCb-Masterclass auf Grundlage von Hadronenspektroskopie — •Stefan Harst, Sebastian Neubert, Barbara Valeriani-Kaminski, Hannah Schmitz, Mindaugas Sarpis und Klaas Padeken für die Netzwerk Teilchenwelt-Kollaboration — Rheinische Friedrich-Wilhelms-Universität Bonn

Teilchenphysik Masterclasses ermöglichen Schüler:innen einen tieferen Einblick in das Thema der Teilchenphysik. Dabei beinhalten sie einführende Vorträge in die Teilchen- und Detektorphysik und schließen mit einer Analyse von Messdaten ab, welche von den Schüler:innen eigenständig durchführt wird.

Um die Physik der schweren Baryonen Schüler:innen näher zu bringen, wurde eine neue LHCb-Masterclass zum Thema Hadronensprektroskopie entwickelt. In dieser Masterclass analysieren Schüler:innen Messdaten des Zerfalls $\Omega_c^0 \to \Xi_c^+ K^-$, die der LHCb-Detektor im Zeitraum 2011-2015 aufgenommen hat.

Der Vortrag befasst sich mit der Entwicklung dieser Masterclass im Rahmen einer Bachelorarbeit und gibt weiterhin Eindrücke eines ersten Praxistests wieder.

HK 30.4 Tue 17:00 HK-H7

Escape Radon: Entwicklung eines digitalen Escape Rooms für den Physikunterricht — •Hannes Nitsche — Technische Universität Dresden

Digitale Spiele werden über die letzten Jahre vermehrt zu Lehrzwecken genutzt und sollen Lernkonzepte auf spielerische Art und Weise erweitern. Eine der außergewöhnlicheren Spielformen, die ihren Weg in die Bildung findet, ist die des digitalen Escape Rooms. Grundlage dieses Vortrags ist eine wissenschaftliche Arbeit, in der der didaktische Mehrwert dieses Spielformats für den Physikunterricht untersucht wurde. Dazu wurde eine digitale Escape Story entwickelt, welche sich inhaltlich mit der Radonbelastung in Deutschland auseinandersetzt und dabei kernphysikalische Grundlagen vermittelt. Im Vortrag wird die Escape Story 'Escape Radon' sowie die Ergebnisse ihrer Erprobung und Evaluation vorgestellt. Des Weiteren wird erörtert, welche Gestaltungselemente von digitalen Escape Rooms das Interesse der Lernenden am Lehrinhalt fördern können und wieweit sich die Methode für Lehrzwecke adaptieren lässt.

HK 30.5 Tue 17:15 HK-H7

Archimedes principle and Galileo's free fall experiments — •Rainer Schicker for the ALICE-Collaboration — Phys. Inst., Im Neuenheimer Feld 226, 69120 Heidelberg

Archimedes of Syracuse formulated a principle ($\sim$ 246 BC) according to which a body immersed in a fluid is subject to a buoyant force. The free fall of objects was studied by Galileo Galilei by dropping unequal masses from the Leaning Tower of Pisa ($\sim$ 1590 AD). The synthesis of Archimedes Principle and Galileo's free fall conclusions is feasible by measuring the fall of differently shaped objects in liquids of different densities. The interpretation of such measurements necessitates the understanding of physics concepts widely used and discussed in nuclear and particle physics, such as gravitational, inertial and in-medium mass.

A setup was designed and built which is capable of recording the falling time at multiple positions over a falling height of 90 cm. These measurements can be made in air as well as in liquids. The technical details of this setup are described, and first results will be presented and discussed.

HK 31: Hadron Structure and Spectroscopy V

Time: Tuesday 16:00–17:45 Location: HK-H8

Group Report HK 31.1 Tue 16:00 HK-H8

Study of resonant states with $c\bar{c}s\bar{s}$ quark content with BaBar and Belle combined data sets — •Elisabetta Prencipe[1], Dmytro Meleshko[1], Jens Soeren Lange[1], Ihor Melnyk[2], James Ritman[3], and Ashish Thampi[3] — [1]JLU-Giessen, Giessen, Germany — [2]TSNU-Kyiv, Kyiv, Ukraine — [3]FZJ, Juelich, Germany

The B factories Belle and BaBar have collected huge data sets at the energy in the center of mass of the $\Upsilon(nS)$, n = 1,2,3,4, Belle even at that of the $\Upsilon(5S)$, integrating roughly 1.5 ab^{-1} data. This offers unique opportunities to perform spectroscopy studies *e.g.* in radiative decays or ISR analyses. Waiting that the new Belle II experiment will collect the whole planned data sets, 50 ab^{-1}, we have now the opportunity to perform the analysis of invariant mass systems with $c\bar{c}s\bar{s}$ quark content.

A study of resonances with double cs quark content has been conducted with combined BaBar and Belle data sets. We present the results obtained by analyzing the invariant mass systems of $J/\psi\phi$ and $D_s^+ D_{sJ}^{(*)-}$ in different production mechanisms: B decays, B_s decays (Belle) and in the continuum. Interesting results are obtained, some of them confirming the LHCb observations in the $J/\psi\phi$ invariant mass though B decays. Results obtained in the neutral B channel, B_s and in the continuum are original measurements. This program has been approved by DFG as the first spectroscopy analysis with combined data sets from B factories.

HK 31.2 Tue 16:30 HK-H8

Search for the Strange Charmonium-like State Z_{cs} in the Reaction $e^+e^- \to \eta_c K^* K$ with BESIII — •Frederik Weidner[1], Nienke Balz[1], Helge Balzen[1], Johannes Bloms[1], Anja Brüggemann[1], Christopher Fritzsch[1], Titus Heinig[1], Nils Hüsken[2], Nikolai in der Wiesche[1], Lois Kröger[1], Sascha Lennartz[1], Peter Sandmann[1], and Alfons Khoukaz[1] for the BESIII-Collaboration — [1]Westfälische Wilhelms-Universität, Münster, Germany — [2]Indiana University, Bloomington, USA

In recent years the search for exotic hadrons has identified more and more states which seem to be incompatible with the conventional classification of hadrons as a two or three quark state. However, in most cases the classification of these particles is still inconclusive. One of the areas to search for them is the charmonium region where states have been found which carry isospin or strangeness. These states, called $Z_{c(s)}$, are good candidates for four quark states.
With the newly taken datasets between 4.6 and 4.9 GeV BESIII is searching for $Z_{c(s)}$ states. In this report the search for the Z_{cs} in the decay $Z_{cs} \to \eta_c K^*$ is presented as this decay is predicted to be one of the main decay channels of the Z_{cs}. Since the η_c meson does not have a golden channel for its reconstruction, in total 14 different decays are considered in a combined fit including three recoiling systems ($K^*K = K^{*+}K^-, K^{*-}K^+$ and $K^{*0}K_s$). In the end the product of the production cross section and the branching ratio will be calculated.
This work is funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - 269952272, 271236083 and 443159800.

HK 31.3 Tue 16:45 HK-H8

Search for exotic states in η_c decays at BESIII — •Anja Brüggemann[1], Nienke Balz[1], Helge Balzen[1], Johannes Bloms[1], Christopher Fritzsch[1], Titus Heinig[1], Nils Hüsken[2], Nikolai in der Wiesche[1], Lois Kröger[1], Sascha Lennartz[1], Peter Sandmann[1], Frederik Weidner[1], and Alfons Khoukaz[1] for the BESIII-Collaboration — [1]Westfälische Wilhelms-Universität Münster, Germany — [2]Indiana University Bloomington, USA

The BESIII detector at the e^+e^- collider BEPCII in Beijing, China, provides the world's largest data sample of the charmonium J/ψ with 10 billion events taken from 2009 to 2019.

Resulting from the radiative J/ψ decay to $\gamma\eta_c$ we analyse the reactions $\eta_c \to \eta' h\bar{h}$, where the $h\bar{h}$ system represents the K^+K^-, K_SK_S, $\pi^+\pi^-$, $\pi^0\pi^0$ and $\eta\eta$ systems. Since the majority of these η_c decay modes are still unlisted in the particle data group database we determine the corresponding branching ratios. Furthermore, since these mesonic η_c decays constitute a gluon-rich environment they offer the opportunity to investigate possible exotic content within $h\bar{h}$ intermediate states, that lie in the mass region below 2 GeV/c^2, where the lightest glueball is predicted.

Incorporating the analysed η_c decay modes our study is based on a combined partial wave analysis, which gives access to the partial decay widths of contributing resonances decaying to $h\bar{h}$. These widths are directly comparable to theory predictions.

The current status of the analysis will be presented.

This work is funded by DFG - 269952272, 271236083 and 443159800.

HK 31.4 Tue 17:00 HK-H8

Feasibility study of predicted decay channels of a hybrid charmonium candidate with $\overline{\mathrm{P}}$ANDA — •Áron Kripkó, Markus Moritz, and Kai-Thomas Brinkmann for the PANDA-Collaboration — II. Physikalisches Institut, Justus Liebig Universität Gießen, 35392 Gießen, Germany

The $\overline{\mathrm{P}}$ANDA experiment will be one of the key experiments at FAIR, which is currently under construction in Darmstadt, Germany. It will be a fixed-target experiment using an antiproton beam with beam momenta between 1.5 GeV/c and 15 GeV/c.
One of the main goals of $\overline{\mathrm{P}}$ANDA is the detailed investigation of the spectrum of charmonia and charmonium-like hybrids. Compared to the the light meson spectrum, the charmonium spectrum is well separated, providing a clean environment to search for non-conventional states. States with exotic J^{PC} can be made in associated formation processes: $p\bar{p} \to mh$, where m is a light meson (π, η) and h is a charmonium hybrid.
Lattice QCD calculations predict the ground-state hybrid charmonium to be a spin exotic with quantum numbers of $J^{PC} = 1^{-+}$ at a mass of around 4.3 GeV/c^2. Its width is expected to be around 20 MeV/c^2 due to the dynamical suppression of its decay into open charm.
The talk will present a preliminary feasibility study for a measurement of the most probable decay channels of this hybrid charmonium candidate performed with PANDARoot, the common simulation framework for such studies of the $\overline{\mathrm{P}}$ANDA experiment.
This work is supported by HFHF and BMBF.

HK 31.5 Tue 17:15 HK-H8

Pentaquark search in $\Lambda_b^0 \to \Lambda_c^+ \bar{D}^{*0} K^-$ decays with missing neutrals — •Mindaugas Sarpis — University of Bonn, Bonn, Germany

Charmonium-pentaquarks, P_c, were observed by LHCb in 2015 and 2019 as resonances in the $J/\psi p$ final state from $\Lambda_b \to J/\psi p K^-$ decays. The nature of these resonances is not yet fully understood, but their proximity to baryon-meson thresholds, like $\Sigma_c \bar{D}^{*0}$, motivate 'molecular' pentaquark models. Several phenomenological studies predict large branching fractions for the decay of $P_c \to \Lambda_c^+ \bar{D}^{*0}$. The ratio of branching fraction of the exclusive $\Lambda_b^0 \to \Lambda_c^+ \bar{D}^{*0} K^-$ channel with respect to $\Lambda_b^0 \to \Lambda_c^+ D_s$ was measured to be $0.569 \pm 0.015 \pm 0.017 \pm 0.016$, where the first uncertainty is statistical, the second systematic, and the third due to the uncertainty on the D branching fractions. Due to the low reconstruction efficiency of π^0 or γ candidates in the decay $\bar{D}^{*0} \to \bar{D}^0\pi^0/\gamma$, a kinematic over-constraint method, Extended Cone Closure, is employed to reconstruct the four-momentum of the $\bar{D}^{*0}$ and be able to study the Dalitz plot of $\Lambda_c^+ \bar{D}^{*0} - \bar{D}^{*0} K^-$. A model independent approach using Legendre moments analysis and the limit setting procedure for the upper limit on P_c yield is presented.

HK 31.6 Tue 17:30 HK-H8

Measuring Generalized Distribution Amplitudes from the $\overline{p}p \to \gamma\gamma$ and $\overline{p}p \to \pi^0\gamma$ channels with $\overline{\mathrm{P}}$ANDA at FAIR — •Faiza Khalid, Stefan Diehl, and Kai-Thomas Brinkmann for the PANDA-Collaboration — II. Physikalisches Institut, Justus Liebig Universität Gießen 35392, Germany

The future PANDA experiment at FAIR with the HESR antiproton beam provides unique possibilities to study the 3D nucleon structure with exclusive channels in $\overline{p}p$ annihilation. Among of the channels of interest for the measurement of Generalized Distribution Amplitudes (GDAs) are $\overline{p}p \to \gamma\gamma$ and $\overline{p}p \to \pi^0\gamma$. Several simulations at center-of-mass energies squared of, $s = 2.5$ GeV^2 , $s = 5$ GeV^2 , $s = 10$ GeV^2 and $s = 15$ GeV^2, were done for these two signal channels and for their associated background channel(s) to check the feasibility of the measurement. The talk will present the feasibility study for the measurement of the cos(θ) dependence of the differential cross-section for $\overline{p}p \to \pi^0\gamma$ and $\overline{p}p \to \gamma\gamma$ at different integrated luminosities. The cross

sections have been estimated based on data, which is available in a limited kinematic range from the E760 experiment at Fermilab. Results of count rate estimates and estimates of the expected statistical uncertainty for different integrated luminosity values as well as the signal to background ratio will be presented. Different event selection cuts have been investigated to optimize the signal to background ratio while keeping a reasonable reconstruction efficiency.

The work is supported by BMBF and HFHF.

HK 32: Hadron Structure and Spectroscopy VI

Time: Tuesday 16:00–17:30 Location: HK-H9

Group Report HK 32.1 Tue 16:00 HK-H9

The ComPWA project: amplitude analysis with symbolic expressions and multiple computational backends — •Remco de Boer[1], Miriam Fritsch[1], Klaus Götzen[3], Wolfgang Gradl[2], Sebastian Jäger[1], Mathias Michel[2], Klaus Peters[3], Stefan Pflüger[1], Peter Weidenkaff[2], and Leonard Wollenberg[1] — [1]Ruhr-Universität Bochum — [2]Johannes Gutenberg Universität Mainz — [3]GSI Helmholtzzentrum Darmstadt

The search for conventional and exotic hadronic states is a challenging endeavour that has seen significant progress in the past decade. One of the most important techniques for identifying and classifying these states is Partial Wave Analysis. PWA is, however, notoriously difficult, as it requires a thorough understanding of several aspects in particle physics, as well as High Performance Computing. The ComPWA project makes PWA easier to understand and implement with a collection of modern Python libraries. One of the highlights of the project is the ability to express amplitude models as symbolic mathematical formulas that can be inspected and adapted to the specific requirements of an analysis. These expressions not only offer a comprehensible experience of analysing a particle reaction, but also serve as templates to computational backends like TensorFlow that can efficiently fit the model to large data samples.

HK 32.2 Tue 16:30 HK-H9

Quenched glueball spectrum from functional equations — •Markus Huber[1], Christian Fischer[1,2], and Helios Sanchis-Alepuz[3] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität Giessen, Heinrich-Buff-Ring 16, 35392 Giessen, Germany — [2]Helmholtz Forschungsakademie Hessen für FAIR (HFHF), GSI Helmholtzzentrum für Schwerionen- forschung, Campus Gießen, 35392 Gießen, Germany — [3]Silicon Austria Labs GmbH, Inffeldgasse 33, 8010 Graz, Austria

We give an overview of results for the quenched glueball spectrum from two-body bound state equations based on the 3PI effective action. The setup, which uses self-consistently calculated two- and three-point functions as input, is completely self-contained and does not have any free parameters except for the coupling. The results for $J^{PC} = 0^{\pm+}, 2^{\pm+}, 3^{\pm+}, 4^{\pm+}$ are in good agreement with recent lattice results where available.

HK 32.3 Tue 16:45 HK-H9

Chiral EFT of nucleons and pions in the presence of external gravitational field — •Herzallah Alharazin, Dalibo Djukanovic, Jambul Gegelia, and Maxim Polyakov — Ruhr-University Bochum

Effective chiral Lagrangian of nucleons and pions in external gravitational field and the corresponding energy-momentum tensor will be considered. Gravitational form factors of the nucleon and their relation to internal forces will be discussed.

HK 32.4 Tue 17:00 HK-H9

Electromagnetic form factors of the nucleon in $N_f = 2 + 1$ lattice QCD — Dalibor Djukanovic[1,2], Georg von Hippel[3], Harvey B. Meyer[1,2,3], Konstantin Ottnad[3], •Miguel Salg[3], Jonas Wilhelm[3], and Hartmut Wittig[1,2,3] — [1]Helmholtz Institute Mainz, Staudingerweg 18, 55128 Mainz, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, 64291 Darmstadt, Germany — [3]PRISMA$^+$ Cluster of Excellence and Institute for Nuclear Physics, Johannes Gutenberg University of Mainz, Johann-Joachim-Becher-Weg 45, 55128 Mainz, Germany

We present results for the electromagnetic form factors of the nucleon computed on the Coordinated Lattice Simulations (CLS) ensembles with $N_f = 2 + 1$ flavors of $\mathcal{O}(a)$-improved Wilson fermions and an $\mathcal{O}(a)$-improved conserved vector current. From the Q^2-dependence of the form factors, we determine the electric and magnetic charge radii and the magnetic moment of the proton. In order to estimate the excited-state contamination, we employ several source-sink separations and apply the summation method. The quark-disconnected diagrams entering into the isoscalar quantities are computed explicitly. For this purpose, a stochastic estimation based on the one-end trick is performed, in combination with a frequency-splitting technique and the hopping parameter expansion. By these means, we obtain a clear signal for the form factors including the quark-disconnected contributions, which have a statistically significant effect on our results.

HK 32.5 Tue 17:15 HK-H9

Lower-order contributions in three-particle femtoscopic correlation functions — •Philipp Schulze-Hagen — TUM, Munich, Germany

In recent years, the femtoscopy technique has been used by the ALICE Collaboration in small colliding systems at the LHC to investigate the strong interaction between hadron pairs. The extension of this experimental technique to the three-particle case aims to deliver the first measurements of genuine three-hadron interactions in the next years. To this end, the two-body effects in the three-particle correlation functions have to be properly accounted for. A recently introduced approach, known as the projector method, combined with the cumulant expansion rule, allows the calculations of such lower-order contributions by projecting known two-particle correlation functions on the three-body phase space. In this work, the relativistic generalization of the projector method will be presented and discussed in the specific case of p–p–π^- and p–p–π^+. It will be shown, in particular, that such method provides significantly smaller uncertainties with respect to the standard data-driven approaches in the extraction of the signal due to the genuine three-particle correlations.

HK 33: Nuclear Astrophysics II

Time: Tuesday 16:00–17:30 Location: HK-H10

Group Report HK 33.1 Tue 16:00 HK-H10

Electromagnetic Counterparts of Neutron Star Mergers: Signatures of Heavy r-Process Nucleosynthesis — •Andreas Flörs[1], Luke Shingles[1], and Gabriel Martínez-Pinedo[1,2] — [1]GSI, Darmstadt, Germany — [2]TU Darmstadt, Darmstadt, Germany

It has long since been established that observable actinides in the universe originate from the r-process. In 2017, the electromagnetic counterpart to the gravitational wave detection of two merging neutron stars was observed. From the light curve alone it was possible to characterise two ejecta components: one that contains low-Y_e material such as lanthanides and possibly actinides, and a high-Y_e component with low lanthanide abundances. The dividing characteristic between the two components is the opacity of the material: lanthanides have a ∼100 times higher opacity than iron-group material. The opacity of actinides is expected to be on a similar level as that of the lanthanides, or, possibly, even higher.

To identify specific elements, spectroscopic information is required. However, so far no clear detection of individual lanthanides or actinides has been made in the only observed neutron star merger. A great challenge for spectroscopic modelling of kilonovae using radiative transfer codes is the almost non-existent atomic data currently available for

lanthanides and actinides. I will present converged and, where possible, calibrated atomic structure calculations from Zr to U. I will then use this collection of atomic data to show how we can use radiative transfer simulations to identify signatures or place constraints on the amount of heavy r-process material synthesized in kilonovae.

HK 33.2 Tue 16:30 HK-H10

Long Term Evolution of Neutron Star Merger Ejecta — •Christian Schwebler[2,1], Gabriel Martínez-Pinedo[1,2,3], Andreas Bauswein[1], Oliver Just[1], and Ninoy Rahman[1] — [1]GSI Helmholtzzentrum für Schwerionenforschung, Planckstraße 1, 64291 Darmstadt, Germany — [2]Institut für Kernphysik (Theoriezentrum), Fachbereich Physik, Technische Universität Darmstadt, Schlossgartenstraße 2, 64298 Darmstadt, Germany — [3]Helmholtz Forschungsakademie Hessen für FAIR, GSI Helmholtzzentrum für Schwerionenforschung, Planckstraße 1, 64291 Darmstadt, Germany

Binary neutron star mergers (BNS) are at the moment the most promising events for r-process nucleosynthesis. We simulate the long term properties of the dynamical merger ejecta, which are crucial for the nucleosynthesis, by three dimensional numerical-relativity simulations. Starting with initial data from BNS merger simulations, which typically cover timescales of milliseconds, our goal is to investigate the ejected material up to several days or weeks, the timescale in which the kilonova, the electromagnetic signal of a BNS merger, is detectable. We focus on the dynamical evolution and the impact of r-process heating on the material.

This project is supported and funded by HGS-Hire and the European Research Council (ERC) under the European Union's Horizon research and innovation programme (ERC Advanced Grant KILONOVA No. 885281)(ERC Starting Grant GreatMoves No.759253)

HK 33.3 Tue 16:45 HK-H10

Neural network reconstruction of the dense matter equation of state from neutron star observables — •Shriya Soma[1], Lingxiao Wang[1], Shuzhe Shi[2], Horst Stoecker[1], and Kai Zhou[1] — [1]Frankfurt Institute for Advanced Studies, Frankfurt am Main, Germany — [2]Stony Brook University, Stony Brook, New York, USA

The equation of state (EoS) of strongly interacting cold and ultradense matter still remains a major challenge in the field of nuclear physics. With the advancements in measurements of neutron star masses, radii and tidal deformabilities from electromagnetic and gravitational wave observations, neutron stars play an important role in constraining the EoS. In this work, we present a novel method that exploits deep learning techniques to reconstruct the dense matter EoS from mass-radius (M-R) observations of neutron stars. We employ neural networks (NNs) to represent the EoS in a model-independent way, within the range 1-7.4 times the nuclear saturation density. In an unsupervised manner, we implement the Automatic Differentiation (AD) framework to optimize the EoS, so as to yield an M-R curve that best fits the observations. We demonstrate the rebuilding of an EoS on mock data, i.e., M-R pairs derived from a generated set of polytropic EoSs. We show that it is possible to reconstruct the EoS with reasonable accuracy, using just 12 mock M-R pairs, which is nearly equivalent to the current number of observations. We finally deploy the NNs in the AD scheme on real M-R data, including the recent measurements from NICER, to infer the neutron star EoS and present the results hereof.

HK 33.4 Tue 17:00 HK-H10

Core-collapse supernova simulations with reduced nucleosynthesis networks — •Gerard Navo[1], Moritz Reichert[2], Martin Obergaulinger[2], and Almudena Arcones[1,3,4] — [1]Institut für Kernphysik, Technische Universität Darmstadt, Darmstadt, Germany — [2]Departament d'Astronomia i Astrofísica, Universitat de València, Burjassot (València), Spain — [3]Helmholtz Forschungsakademie Hessen für FAIR, GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany — [4]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

Core-collapse supernovae play a critical role in the chemical history of the universe. In recent years, huge advances have been reported about multidimensional simulations, magnetic fields, neutrino treatment and reactions, high-density equations of state, nucleosynthesis, and long-time evolution connecting to observations. Here we focus on the nucleosynthesis and their treatment within the simulations. Including large nuclear networks in multidimensional simulations is not feasible because of the computational expense. Therefore, often a simple treatment is used for the composition at temperatures where the nuclear statistical equilibrium can no longer be applied. We have now included reduced networks into state-of-the-art supernova simulations (Obergaulinger & Aloy 2017) to account for the composition and energy generation from nuclear reactions. I will present, the impact of several reduced networks based on multidimensional core-collapse supernovae simulations for different progenitors.

HK 33.5 Tue 17:15 HK-H10

Reevaluation of the cosmic antideuteron flux from cosmic-ray interactions and from exotic sources — •Laura Serksnyte[1], S. Königstorfer[1], I. Vorobyev[1], L. Fabbietti[1], D. M. Gomez Coral[2], P. von Doetinchem[2], J. Herms[3], A. Ibarra[1], T. Pöschl[1], A. Shukla[2], and A. Strong[4] — [1]TUM — [2]University of Hawaii at Manoa — [3]MPI für Kernphysik — [4]MPI for Extraterrestial Physics

The studies of antinuclei cosmic rays are of great interest as they represent one of the most promising indirect probes of exotic phenomena in our Galaxy such as dark matter annihilation and primodial black hole evaporation. However, the antinuclei cosmic rays also contain a background contribution from antinuclei produced in cosmic-ray collisions with the interstellar gas. In order to interpret any future measurement of the cosmic ray antinuclei fluxes, it is imperative to have a full understanding of the uncertainties involved from production to propagation. This requires a data driven estimation of the production and annihilation cross sections of antinuclei, as well as a state-of-the-art propagation model. We studied the antideuteron cosmic-ray flux using the GALPROP propagation model and we obtained the fluxes stemming from exotic sources and from cosmic-ray interactions. We used the most up-to-date antideuteron production cross sections and for the first time included a data-driven estimation of the inelastic antideuteron cross sections. In this talk we will present our results including an in depth study of the prevailing uncertainties such as antideuteron production modeling, propagation parameters and others.

HK 34: Invited Talks IV

Time: Wednesday 11:00–12:30 Location: HK-H1

Invited Talk HK 34.1 Wed 11:00 HK-H1

Nuclear equation of state constrained by nuclear physics, microscopic and macroscopic collisions — •Sabrina Huth — Institut für Kernphysik, TU Darmstadt — EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt

Interpreting high-energy, astrophysical phenomena, such as supernova explosions or neutron-star collisions, requires a robust understanding of matter at supranuclear densities. We present new equations of state where the parameter range of the energy-density functional underlying the equation of state is constrained by chiral effective field theory as well as by functional renormalization group computations based on QCD. We implement observational constraints from measurements of heavy neutron stars, the gravitational wave signal of GW170817, and NICER results. Thermal effects are captured by a novel effective mass parametrization. This has been shown to determine the proto-neutron star contraction in supernova simulations.

Additionally, we use Bayesian inference to combine data from astrophysical multi-messenger observations of neutron stars and from heavy-ion collisions with microscopic nuclear theory calculations to improve our understanding of dense matter. Our findings show that constraints from heavy-ion collision experiments show a remarkable consistency with multi-messenger observations and provide complementary information on nuclear matter at intermediate densities.

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

Invited Talk HK 34.2 Wed 11:30 HK-H1

Electromagnetic Counterparts of Neutron Star Mergers: Sig-

natures of Heavy r-Process Nucleosynthesis — •Andreas Flörs[1], Luke Shingles[1], and Gabriel Martínez-Pinedo[1,2] — [1]GSI, Darmstadt, Germany — [2]TU Darmstadt, Darmstadt, Germany

It has long since been established that observable actinides in the universe originate from the r-process. In 2017, the electromagnetic counterpart to the gravitational wave detection of two merging neutron stars was observed. From the light curve alone it was possible to characterize two ejecta components: one that contains low-Y_e material such as lanthanides and possibly actinides, and a high-Y_e component with low lanthanide abundances. The dividing characteristic between the two components is the opacity of the material: lanthanides have a ∼100 times higher opacity than iron-group material. The opacity of actinides is expected to be on a similar level as that of the lanthanides, or, possibly, even higher.

To identify specific elements, spectroscopic information is required. However, so far no clear detection of individual lanthanides or actinides has been made in the only observed neutron star merger. A great challenge for spectroscopic modeling of kilonovae using radiative transfer codes is the almost non-existent atomic data currently available for lanthanides and actinides. I will present converged and, where possible, calibrated atomic structure calculations from Zr to U. I will then use this collection of atomic data to show how we can use radiative transfer simulations to identify signatures or place constraints on the amount of heavy r-process material synthesized in kilonovae.

Invited Talk HK 34.3 Wed 12:00 HK-H1

Towards a next-generation LHC heavy-ion Experiment with ALICE — •Raphaelle Bailhache for the ALICE-Collaboration — Goether-universität Frankfurt am Main, Germany

Ultrarelativistic heavy-ion collisions are used to study the physics of strongly interacting matter under extreme conditions, i.e. high temperature and density, similar to those of the early universe. In such collisions a deconfined state of quarks and gluons, the Quark-Gluon Plasma (QGP), is formed. Nuclear collisions at the LHC provide access to the highest-temperature, longest-lived experimentally accessible QGP. After three years of Long Shutdown and intensive installation of detector and accelerator upgrades, ALICE is about to take data at a peak Pb–Pb collision rate of 50 kHz to further characterize the properties of this unique state of matter. In spite of the ambitious scientific programme for the upcoming Runs 3 and 4, crucial questions will still remain unanswered with the present detector concepts. Therefore, a next-generation LHC heavy-ion experiment ALICE 3 is proposed for the 2030s. Among others, this should give access to next-level measurements of electromagnetic probes down to unprecedented very low momenta and a clean reconstruction of heavy-flavour hadrons including multi charm states and exotic objects inaccessible in LHC Run 3 and 4. Such measurements call for a substantial increase in luminosity in combination with unprecedented detector performance.

In this talk, we will present the physics programme of ALICE and the resulting detector requirements. We will then discuss a detector concept suitable to meet these requirements.

HK 35: Heavy-Ion Collisions and QCD Phases VII

Time: Wednesday 14:00–15:30 Location: HK-H1

Group Report HK 35.1 Wed 14:00 HK-H1

Creation of fragile anti- and hyper- matter 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 most prominent example is the (anti-)hypertriton, which is a bound state of a proton, a neutron and a Λ hyperon. These (anti-)(hyper-)nuclei are reconstructed by their decay products, e.g. in the case for the charged two-body decay channel of the hypertriton: ${}^{3}_{\Lambda}\mathrm{H} \rightarrow {}^{3}\mathrm{He} + \pi^{-}$. The excellent performance of the ALICE apparatus provides a clear particle identification of the daughters and a perfect reconstruction of the decay vertex. Together with results on the production of light (anti-)nuclei, we will show the latest measurement of the Λ separation energy and lifetime of the (anti-)hypertriton and a comparison to different production models. Furthermore, we will show first results on the measurement of (anti-)hypernuclei within the A=4 mass region.

Supported by BMBF and the Helmholtz Association.

HK 35.2 Wed 14:30 HK-H1

Hypernuclei studies in heavy-ion collisions at CBM — •Susanne Glässel, Christoph Blume, and Enxhela Vardhami for the CBM-Collaboration — IKF, Frankfurt

Under the extreme conditions of relativistic heavy-ion-collisions the creation of exotic matter like hypernuclei is possible. Hypernuclei measurements provide insights into the equation-of-state of hadronic matter at high net-baryon densities, as well as into hyperon-nucleon and hyperon-hyperon-interactions. The Compressed Baryonic Matter (CBM) experiment at the future Facility for Anti-Proton and Ion Research (FAIR) in Darmstadt offers the perfect conditions to explore the production of hypernuclei. At beam energies of around 12A GeV, in combination with high interaction rates of up to 10 MHz, an exceptionally high amount of hypernuclei will be created, and even very rare double hypernuclei like ${}^{6}_{\Lambda\Lambda}\mathrm{He}$ are expected. The reconstruction of hypernuclei was implemented into the CBM software PFSimple, which is based on the KFParticleFinder package. The reconstruction algorithm and parameters were optimized for the identification of hypernuclei with respect to important performance indicators. Expected efficiencies and signal-to-background-ratios were calculated for a reliable estimation of the number of reconstructable hypernuclei. Rapidity dependencies of these performance indicators were analyzed to identify the detector areas with an high efficiency for hypernucei measurements. The experimental sensitivity to properties of hypernuclei, such as their lifetime, was evaluated. Results for ${}^{3}_{\Lambda}\mathrm{H}$ will be discussed as an example. DFG-grant BL 982/3-1, DFG-grant BR 4000/7-1.

HK 35.3 Wed 14:45 HK-H1

Studies on hypertriton reconstruction in heavy-ion collisions at CBM — •Enxhela Vardhami, Christoph Blume, and Susanne Glässel for the CBM-Collaboration — IKF, Frankfurt

Under the extreme conditions of relativistic heavy-ion-collisions the creation of exotic matter like hypernuclei is possible. Hypernuclei measurements provide insights into the equation-of-state of hadronic matter at high net-baryon densities, as well as into hyperon-nucleon and hyperon-hyperon-interactions. The Compressed Baryonic Matter (CBM) experiment at the future Facility for Anti-Proton and Ion Research (FAIR) in Darmstadt offers the perfect conditions to explore the production of hypernuclei. At beam energies of around 12A GeV, in combination with high interaction rates of up to 10 MHz, an exceptionally high amount of hypernuclei will be created. The reconstruction of hypertriton was studied with the CBM software PFSimple. Focus was placed on the most probable 3-body-decay ${}^{3}_{\Lambda}\mathrm{H}\rightarrow\mathrm{d}+\mathrm{p}+\pi^{-}$ (branching ratio = 40.2 %). Different cuts were evaluated with regards to their performance indicators like efficiency, signal-to-background-ratio and significance. To further improve the reconstruction performance and speed, the correlations between several cuts were analyzed. A systematic study of cut combinations was performed to prepare optimized sets of cuts for various study purposes, eg. high efficiency, high background suppression or for different particle identification approaches.

HK 35.4 Wed 15:00 HK-H1

Extending strong-interaction studies in ALICE to nuclei: measurement of proton-deuteron and Lambda-deuteron correlations — •Bhawani Singh[1] and Michael Jung[2] for the ALICE-Collaboration — [1]Technische Universität München — [2]Goethe-Universität Frankfurt am Main

In the endeavour to explore the strong interaction among hadrons, ALICE has for the first time extended its femtoscopic studies to nuclei. The large data sample of high-multiplicity pp collisions at $\sqrt{s} = 13\,\mathrm{TeV}$ allows us to measure both the proton–deuteron (p–d) and the Lambda–deuteron (Λ–d) momentum correlations.

In this contribution, the measured correlation functions for p–d and Λ–d are presented and compared to theoretical predictions. A large discrepancy between data and theory is observed in the case of p–d cor-

relations, where the data show a depletion at low relative momenta, while the models predict a strong attractive signal. Possible explanations include a late formation of the deuterons and the formation of a bound state. The Λ–d correlation is in agreement with no observed interaction, supporting the findings in p–d, but the current data would also allow for a remaining strong-interaction signal. Future measurements by ALICE in the upcoming LHC Run 3 will help to shed more light on the sector of nuclei in femtoscopy.

HK 35.5 Wed 15:15 HK-H1

Measurement of the Λ separation energy in hypertriton with ALICE using machine learning techniques — •Regina Michel for the ALICE-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung — Technische Universität Darmstadt

Hypertritron $^{3}_{\Lambda}$H is the lightest hypernucleus, consisting of a Λ hyperon, a proton and a neutron. It is structured as a halo nucleus, where the Λ hyperon is very loosely bound to a "deuteron core". Measurements of the Λ separation energy can be used as a test for QCD, for some models of neutron stars and to constrain the difference of the lifetimes of $^{3}_{\Lambda}$H and Λ. The Λ separation energy can be measured via the invariant mass of the hypertriton decay products. The two-body-decay $^{3}_{\Lambda}$H $\rightarrow ^{3}$He+π is considered. Monte Carlo simulations are conducted to simulate the hypertriton interactions and decays while flying through the detector. A data sample from Pb-Pb collisions at $\sqrt{s_{\rm NN}}$ = 5.02 TeV recorded with ALICE at the LHC is analyzed using machine learning techniques.

HK 36: Heavy-Ion Collisions and QCD Phases VIII

Time: Wednesday 14:00–15:30 Location: HK-H2

Group Report HK 36.1 Wed 14:00 HK-H2

Charged pion emission from central heavy-ion collisions measured with HADES — •Marvin Nabroth for the HADES-Collaboration — Goethe-Universität Frankfurt, Frankfurt, Germany

Relativistic heavy-ion collisions provide an experimental tool to generate strongly interacting matter that exhibits extreme densities and high temperatures. With the HADES (High-Acceptance-Dielectron-Spectrometer) experiment the emission of several particle species including di-leptons, originated from a heavy-ion collisions are probed at SIS18 energies at a few GeV. Pions are, due their low mass, the most abundantly emitted mesons. Especially, charged pions can be easily detected by magnet-spectrometry. The resulting high statistics allow to precisely determine their production multiplicities as function of participants, to investigate the condition at the kinematic freeze-out as well as to examine anisotropies in the collective emission behaviour. The fact that the charged pion's spectra are experimentally covered still with high abundance at low transverse momenta makes them a suitable probe for the investigation in regard of the Coulomb effect. Within the scope of this talk, we will discuss the recent published results on charged pions from Au+Au collisions at $\sqrt{s_{NN}}$ = 2.4 GeV as well as the ongoing analyis regarding charged pions from Ag+Ag collisions at $\sqrt{s_{NN}}$ = 2.55 GeV. Covered are the measured production rates, the results on directed, elliptic and triangular anisotropic flow and the determination of the Coulomb potential. This work has been supported by BMBF (05P19RFFCA), GSI and HIC for FAIR.

HK 36.2 Wed 14:30 HK-H2

Charged-particle production in pp collisions at $\sqrt{s}$ = 900 GeV with LHC Run 3 ALICE data — •Peter Stratmann for the ALICE-Collaboration — Westfälische Wilhelms-Universität Münster, Germany

The ALICE experiment at the Large Hadron Collider (LHC) is designed to investigate properties of the quark-gluon plasma (QGP) created in high-energy heavy-ion collisions. Medium effects can be investigated by comparing to the charged-particle production in pp collisions, where no QGP is expected. In the upcoming LHC Run 3, the ALICE collaboration prepares to collect Pb–Pb data at unprecedented peak-collision rates of about 50 kHz. To accomplish this, the main tracking detectors underwent fundamental upgrades and a brand new reconstruction and analysis framework was developed.

In this talk, we present one of the first measurements performed with these new detectors and software. We investigate the bulk particle production in pp collisions at $\sqrt{s}$ = 900 GeV observed in data taken during a five day pilot beam in the end of October 2021. We discuss the tracking performance and show the correlation of $p_{\rm T}$ spectra with multiplicity for inclusive charged particles obtained with a 2d unfolding procedure that was already used in a comprehensive analysis of Run 1 and Run 2 data. These first results are compared to minimum bias spectra of inclusive charged particles at the same energy, which were among the first measurements when ALICE started taking data.

Supported by BMBF within the ERuM framework and the Helmholtz Association.

HK 36.3 Wed 14:45 HK-H2

Light (anti-)nuclei production in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV measured with ALICE — •Malavika Panikkassery Salvan for the ALICE-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt — Technische Universität Darmstadt

The production mechanism of light (anti-)nuclei in heavy-ion collisions is not yet fully understood and is under debate in the scientific community. Two prominent phenomenological models typically used to describe the experimental data are: the statistical hadronization model (SHM) which assumes that all hadrons are emitted from a thermal source in local thermal and hadrochemical equilibrium, and the coalescence model where the baryons close to each other in phase space form a nucleus at the kinetic freeze-out.

The ratio of integrated yields of (anti-)deuterons to (anti-)protons in heavy-ion collisions is sensitive to the production mechanism as the two models predict different trends.

In this contribution, the deuteron-to-proton yield ratio measured in central (0-10%) Pb-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV with ALICE is presented and the results are discussed in the context of the two phenomenological models.

HK 36.4 Wed 15:00 HK-H2

Charged-particle $p_{\rm T}$ spectra as a function of multiplicity in pp, p–A and A–A collisions measured with ALICE — •Youssef El Mard Bouziani for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

The ALICE experiment focuses on the study of the hot and deconfined QCD medium, the Quark-Gluon Plasma (QGP), by investigating heavy-ion collisions at ultra-relativistic energies. Particle production in different collision systems can be examined by means of the correlation between charged-particle transverse momentum ($p_{\rm T}$) spectra and the event multiplicity.

In this talk, a differential analysis of charged-particle $p_{\rm T}$ spectra as a function of charged-particle multiplicity density is presented. The spectra are obtained by means of a 2-dimensional unfolding procedure. The energy and system-size dependence of charged-particle production is inspected studying the correlation of $p_{\rm T}$ and charged multiplicity in different collision systems and center-of-mass energies. In particular, resulting spectra measured in pp, p–Pb, Pb–Pb and Xe–Xe collisions are considered. Comparisons of the measurements to predictions from Monte-Carlo event generators are reported.

Supported by BMBF and the Helmholtz Association.

HK 36.5 Wed 15:15 HK-H2

Study of the production mechanism of light nuclei in small systems at the LHC with ALICE — •Luca Barioglio[1] and Michael Habib[2,3] for the ALICE-Collaboration — [1]Technische Universität München, Garching bei München, Deutschland — [2]GSI, Darmstadt, Deutschland — [3]Technische Universität Darmstadt, Darmstadt, Deutschland

At the LHC, an abundant production of light (anti)nuclei is observed in all collision systems and at all energies. However, their production mechanism is still under debate in the scientific community. The ALICE Collaboration has recently published the measurement of the production of (anti)deuteron and (anti)helion in pp collisions at $\sqrt{s}$ = 5 TeV and at $\sqrt{s}$ = 13 TeV.

In this presentation, the measurement of the coalescence parameter

B_A, both as a function of transverse momentum and as a function of multiplicity, and the measurement of the yield-ratios of nuclei and protons as a function of multiplicity will be shown. In particular, B_A as a function of the transverse momentum is, for the first time, compared with theoretical predictions which take into account both the nuclear wave function and the dependence on the size of the emitting source.

HK 37: Instrumentation IX

Time: Wednesday 14:00–15:30 Location: HK-H3

Group Report HK 37.1 Wed 14:00 HK-H3

The new Sampling-ADC readout of CBELSA/TAPS - Feature-Extraction, Pulseshape-Analysis and Pile-Up-Recovery — •Jan Schultes, Benedikt Otto, and Johannes Müllers for the CBELSA/TAPS-Collaboration — HISKP, Uni Bonn

The Crystal Barrel Calorimeter consists of 1320 CsI(Tl) scintillating crystals, which are read out by APDs. The signals are digitized using FPGA-controlled Sampling-ADCs.

Different feature-extraction algorithms are employed on the FPGAs to not only extract energy and timing information, but to perform online pile-up detection as well. In addition to the feature data, the sampled pulseshape can be stored in case of a detected pile-up event, to facilitate the recovery of affected features.

The talk's main focus lies on the subsequent analysis of the data and various custom methods developed to efficiently and accurately recover the features affected by pile-up. Since CsI(Tl) exhibits different scintillation characteristics dependent on the particle species, special care has to be taken in order to address this in the recovery process. Digital filtering as well as custom deconvolution methods are employed.

Finally, the setup's performance during the recent June2021 and November2021 beamtimes and the impact of the recovered data on the reconstruction of physical events is evaluated.

HK 37.2 Wed 14:30 HK-H3

Detector Readout Algorithms and Data Flow Programming on FPGAs with Intel HLS — •Thomas Janson and Udo Kebschull — IRI, Goethe-Universität Frankfurt am Main, Max-von-Laue-Straße 12, 60438 Frankfurt am Main, Germany

We discuss an alternative approach to implementing algorithms for detector readout with FPGAs. The talk is a continuation of past presentations and discusses the implementation of various algorithms that can be implemented on Intel FPGAs using Modern C++. The algorithms are implemented using a data flow C++ template library that we developed specifically for this use case of detector readout. We show how generic template programming can be used to describe algorithms as a data flow graph and compare the results with the conventional HLS C++ programming technique. Metrics such as latency, flow and resource consumption are discussed and compared. The results are then compared and evaluated with the traditional method, which implements algorithms using a hardware description language such as Verilog or VHDL.

HK 37.3 Wed 14:45 HK-H3

Investigations and improvements of the TRB3/DiRICH DAQ system used for the PANDA Barrel DIRC — •Merlin Böhm, Katja Gumbert, Steffen Krauss, Albert Lehmann, and Daniel Miehling for the PANDA-Collaboration — Physikalisches Institut , Universität Erlangen-Nürnberg

To identify charged and fast moving particles two DIRC (detection of internally reflected Cherenkov light) detectors will be built for the PANDA experiment at FAIR. A Barrel DIRC of 16 sectors surrounds the interaction point cylindrically and an endcap disc DIRC made of four identical quadrants covers the forward hemisphere. Since the focal planes of both DIRCs are located in a $\gtrsim 1$ Tesla B-field, Microchannel-Plate Photomultipliers (MCP-PMTs) are the only viable option to detect the generated Cherenkov photons. For the Barrel DIRC the FPGA based GSI TRB3/DiRICH data acquisition system is foreseen to read out the MCP-PMTs. Several improvements were applied to improve the performance of this DAQ system. E.g., with modifications of the power supply for the FPGAs on the TRB3 boards the timing precision was improved significantly. Furthermore, the TRB/DiRICH boards planned for the final PANDA experiment were operated in magnetic fields up to 3 T to investigate the B-field effects on the thresholds and pulse heights and different input stage modifications were tested. The recent modifications and the obtained measurement results will be shown and discussed in this talk.

- Funded by BMBF and GSI -

HK 37.4 Wed 15:00 HK-H3

The front-end signal path of the P2 experiment at MESA — Sebastian Baunack[1], Boris Gläser[1], Kathrin Imai[1], •Rahima Krini[1], Frank Maas[1,2], David R. Pineiro[2], Tobias Rimke[1], and Malte Wilfert[1] — [1]Institute for Nuclear Physics, Mainz, Germany — [2]Helmholtz Institute Mainz, Germany

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 an accuracy of 0.15% at a low four-momentum transfer of Q^2=4.5·10^{-3}GeV^2. In combination with existing measurements at the Z pole with comparable accuracy, this comprises a test of the standard model with a sensitivity towards new physics up to a mass scale of 50 TeV. The experiment will be built at the future MESA accelerator in Mainz.

The small asymmetries $\mathcal{O}(10^{-8})$ and the high precision require very high statistics and therefore an integrating measurement with the associated integrating data acquisition readout chain. A joint read-out electronics for P2 experiment in Mainz and for Moeller experiment at the Jefferson Laboratory is under development in collaboration with a group of University of Manitoba. The first prototype of a full differential integrating detector signal chain was build and tested at MAMI (Mainzer Mikrotron). The results fulfill the requirements of the P2 parity violation experiment and will be presented in this talk.

HK 37.5 Wed 15:15 HK-H3

Streaming readout for the AMBER GEM detectors — •Michael Lupberger[1], Chiara Alice[2], Lukas Bayer[1], Karl Jonathan Flöthner[1,3], Christian Honisch[1], Marco Mignone[4], Jan Paschek[1], Benjamin Roth[1], Dimitri Schaab[1], Maxim Alexeev[2], and Bernhard Ketzer[1] — [1]Universität Bonn — [2]CERN — [3]Universita e INFN sez. Torino — [4]INFN sez. Torino

The Apparatus for Meson and Baryon Experimental Research (AMBER) will be a fixed-target experiment at CERN's SPS. In the approved phase I of the experiment, running also under the name NA66, a proton radius measurement by elastic muon-proton scattering is foreseen in 2023 and 2024. The recoil proton will be measured in a high-pressure Time Projection Chamber (TPC). The muon kinematics is determined with a spectrometer, which partly uses the existing COMPASS detectors.

Due to the higher beam rate and the need for a continuous readout to match the instantaneous muon track with delayed information of the recoil proton in the TPC, significant detector upgrades and novel developments are necessary. The muon reconstruction will rely on new large-area GEM detectors with self-triggering readout. Tests of prototype detectors with two possible candidate ASICs, the VMM and the TIGER chips, have been performed in order to evaluate their performance.

The contribution will report on the results of the tests of the GEM detectors with the new streaming readout.

HK 38: Instrumentation X

Time: Wednesday 14:00–15:30 Location: HK-H4

Group Report HK 38.1 Wed 14:00 HK-H4

Status of the CBM Time-of-Flight project — •Ingo Deppner and Norbert Herrmann — Physikalisches Institut, Uni. Heidelberg

In order to provide an excellent particle identification (PID) of charged hadrons at the future high-rate Compressed Baryonic Matter (CBM) experiment the CBM-TOF group has developed a concept of a 120 m^2 large Time-of-Flight (ToF) wall (with 93000 channels) equipped with multi-gap resistive plate chambers (MRPC). The MRPC detectors were extensively tested in several beam campaigns at particle fluxes of up to a 30 kHz/cm^2 and reached by now the close to final design. Prior to its destined operation at the Facility for Antiproton and Ion Research (FAIR), a preproduction series of MRPCs is being used for physics research at two scientific pillars of the FAIR Phase-0 program. At STAR, the fixed-target program of the Beam Energy Scan II (BES-II) relies on 108 CBM MRPC detectors for forward PID at interaction rates of up to 2.5 kHz with 3 to 31.2 AGeV Au beams. At mCBM, high-performance benchmark runs of Λ production at top SIS18 energies (1.5/1.9 AGeV for Au/Ni beams) and CBM design interaction rates of 10 MHz became feasible. Apart from the physics perspectives, these FAIR Phase-0 involvements allowed for high rate detector tests and long term stability tests. Observations and conclusions for the upcoming mass production will be discussed. The project is partially funded by BMBF contract 05P21VHFC1.

HK 38.2 Wed 14:30 HK-H4

Inner-TOF, a Trigger Scintillator for HADES — •Dieter Grzonka[1], Pawel Kulessa[2], James Ritman[2,3,1], Thomas Sefzick[1], and Marcin Zielinski[4] — [1]Institut für Kernphysik, Forschungszentrum Jülich, 52428 Jülich, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany — [3]Ruhr-Universität Bochum, Institut für Experimentalphysik I, 44801 Bochum, Germany — [4]Jagiellonian University, 30-348 Krakow, Poland

In order to reduce the trigger rate originating from background in proton induced reaction studies at the HADES experiment an additional trigger scintillator was built. It consists of large trapezoidal shaped modules (height∼730mm, long side∼700mm, short side∼90mm) containing three separate plastic scintillator plates with a thickness of about 6 mm, which are read out by 6x6 mm^2 SiPMs. Each scintillator is equipped with 12 SiPMs attached to the scintillator edge. A trigger signal is generated by exceeding a certain SiPM signal multiplicity resulting in a close to 100% efficiency for the detection of a minimum ionizing particle which was investigated with cosmic particles and proton beams at COSY. The detector system and its performance will be presented.

HK 38.3 Wed 14:45 HK-H4

Development of a coincidence time resolution (CTR) setup for measuring timing characteristics of scintillation materials utilizing SiPMs — •Marvin Peter, Kai-Thomas Brinkmann, Valera Dormenev, and Hans-Georg Zaunick — II. Physikalisches Institut, Justus-Liebig-Universität Giessen, Germany

Coincidence time resolution (CTR) measurements have been conducted with different SiPM-based scintillation detectors. The results of measurements with a Raspberry Pi time-to-digital converter (TDC) board based on the TDC-GPX2 chip from Sciosense are compared to those obtained by using a high sampling rate oscilloscope. The goal was to find an optimum setup for fast timing measurements which will be used in the evaluation of new scintillation materials regarding their timing characteristics. Measurement setup, methods and results are discussed in this contribution. This work was carried out in the framework of BMBF Project 05K2019 - UFaCal.

HK 38.4 Wed 15:00 HK-H4

Deployment of digital fast-timing method for picosecond precision lifetime measurements using the NuDAQ system at IKP Cologne — •Andreas Harter, Jean-Marc Régis, Michael Weinert, Lukas Knafla, and Jan Jolie — University of Cologne, Institute for Nuclear Physics, 50937 Cologne, Germany

The comissioning of the NuDAQ digital data acquisition system built at the Institute for Nuclear Physics in Cologne is presented. Special regard is set on the ability of high-precision timing of the incoming detector pulses using a digital timing algorithm. Usually, analogue constant-fraction-discriminators (CFDs) and time-to-amplitude converters (TACs) are used to provide a timing signal with precision of around 1 ps or even better (dependent on the DAQ). However, the complexity of an analogue fast-timing electronics setup increases rapidly with the number of detectors. The digital CFD integrated in the V1730 digitizer modules with a sampling rate of 500 MHz uses a digital algorithm to determine a time stamp of an incoming signal with a precision of 2 ps [1]. Our results using the γ-γ timing technique impressively show that this easy-to-use digitizer using the sophisticated timing algorithm is competitive to the conventional analogue timing technique. [1] CAEN SpA, https://www.caen.it/products/v1730/

HK 38.5 Wed 15:15 HK-H4

Performance status for the endcap-time-of-flight upgrade of STAR — •Philipp Weidenkaff — 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 beam-energy-scan II (BES II) program from 2019 to 2021. 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. In this talk, an evaluation of PID capabilities and physics performance improvements is shown. The results are based on the 2020 fixed target run.

The project is partially founded by BMBF 05P15VHFC1.

HK 39: Computing II

Time: Wednesday 14:00–16:00 Location: HK-H5

HK 39.1 Wed 14:00 HK-H5

Machine Learning Algorithms for Pattern Recognition with the PANDA Barrel DIRC — •Yannic Wolf — GSI Helmholtzzentrum für Schwerionenforschung

Precise and fast hadronic particle identification (PID) is crucial to reach the physics goals of the PANDA detector at FAIR. The Barrel DIRC (Detection of Internally Reflected Cherenkov light) is a key detector for the identification of charged hadrons in PANDA. Several reconstruction algorithms have been developed to extract the PID information from the measured location and arrival time of the Cherenkov photons. In comparison to other Ring Imaging Cherenkov detectors, the hit patterns observed with DIRC counters do not appear as rings on the photosensoer plane but as complex, disjoint 3D-patterns.

Using the recent advances in machine learning (ML) algorithms, especially in the area of image recognition, we plan to develop new ML PID algorithms for the PANDA Barrel DIRC and compare the results to conventional reconstruction methods.

HK 39.2 Wed 14:15 HK-H5

Event Analysis for the FAIR Phase-0 Experiment at MAMI — •Julian Moik[1], Luigi Capozza[1], Alaa Dbeyssi[1], Alexander Greiner[1], Samet Katilmis[1,2,3], Dong Liu[1], Frank Maas[1,2,3], Oliver Noll[1,2], Peter Bernd Otte[1], David Rodriguez Pineiro[1], Christoph Rosner[1], and Sahra Wolff[1] for the PANDA-Collaboration — [1]Helmholtz-Institut Mainz, Germany — [2]Institute of Nuclear Physics, Johannes Gutenberg University, Mainz,Germany — [3]PRISMA Clus- ter of Excellence, Mainz, Germany

The PANDA experiment at the future FAIR facility requires a complex detector system, whose backward calorimeter is being developed by the EMP group at the Helmholtz Institute in Mainz. A preliminary version of this detector will be used in a PANDA FAIR Phase-0 ex-

periment at the electron accelerator MAMI for a measurement of the electromagnetic transition form factor of the neutral pion.

Primasoft is a Geant4 based Monte Carlo simulation environment designed specifically for this experiment. By working with simulated pion events, analysis methods can be developed while the experiment is still under construction. In this context a neural network was developed to assist in the event reconstruction process. More specifically a feed forward network was implemented to improve the position reconstruction and the energy estimation of measured particles, thereby improving the error of the kinematic variables.

HK 39.3 Wed 14:30 HK-H5

Using Neural Network regression to describe the expected energy loss in the ALICE TPC in Run3 — •Christian Sonnabend for the ALICE-Collaboration — Physikalisches Institut, Universität Heidelberg

The ALICE experiment at CERN uses the largest Time Projection Chamber (TPC) built to date to identify particles that are created in collisions at the LHC. Particle identification is done by simultaneous measurement of the specific energy loss ($\mathrm{d}E/\mathrm{d}x$) and momentum (p) of the traversing particles, and comparison to the expected energy loss described by a Bethe-Bloch function. However, in practice, the expected $\mathrm{d}E/\mathrm{d}x$ cannot be described by a simple one-dimensional function, but several effects have to be taken into account. E.g. the inclination angle of a particle track has an effect on the charge deposited in a given region of the TPC readout, thus changing its $\mathrm{d}E/\mathrm{d}x$ signal (η-correction (pseudorapidity)). In order to correct for such effects, fits to a multidimensional parameter space consisting of e.g. p, η, multiplicity or particle mass are performed to adjust the expected $\mathrm{d}E/\mathrm{d}x$ signals of the tracks.

With the application of Machine Learning in particle physics, new methods can be exploited to extract such functional forms. Thus, a variety of neural network fits to data are conducted to investigate their performance and compare their ability to describe deviations of the expected energy loss from an input Bethe-Bloch parametrisation in a multi-dimensional space.

HK 39.4 Wed 14:45 HK-H5

Reconstruction of Photon Conversions with the ALICE Transition Radiation Detector — •Martin Kroesen for the ALICE-Collaboration — Physikalisches Institut, Universität Heidelberg

So called direct photons give us an undisturbed insight to the Quark Gluon Plasma created in relativistic heavy ion collisions. A huge statistics is needed for this analysis since the background is large and the reconstruction efficiency via the Photon Conversion Method (PCM) relatively low. Therefore the ALICE Transition Radiation Detector (TRD), which is located at a radius of about 3 m, is now employed for photon reconstruction using the PCM. It is shown that it is possible to reconstruct these photons with the TRD information only. This enables an increase of the total photon efficiency in ALICE as well as a cross check additional to the standard reconstruction of photon conversions in the Time Projection Chamber. For that purpose a full stand alone tracking algorithm using a combinatorial search was developed. Based on TensorFlow a high precision photon hypothesis test and parameter fit completes the reconstruction by exploiting topological constraints. The stand alone TRD tracks can also be used for other purposes such as calibration or nuclear interaction analyses. First results from the p-Pb run in 2018 are presented, showing a peak for $\pi^0 \to \gamma\gamma \to e^+e^-e^+e^-$.

HK 39.5 Wed 15:00 HK-H5

Analysis status of ETOF at STAR — •Yannick Söhngen — Physikalisches Institut Universität Heidelberg

In 2025/2026 the CBM-Experiment will start operation at the SIS100, currently under construction at FAIR in Darmstadt. To facilitate a smooth start of physics analysis of the experiments at the SIS100 the FAIR Phase 0 program comprises the usage of pre-series equipment in running experiments. As part of the CBM-TOF FAIR Phase 0 program an Endcap-Time-Of-Flight (ETOF) wheel consisting of 108 RPC*s designed for the CBM-TOF wall, was operated at the STAR-Experiment located at RHIC at Brookhaven. This provides on the one hand the opportunity to study the impact of long periods of operation on the system and the detectors and thus helps to streamline the decision-making process for the CBM TOF-Wall. This provides on the one hand the opportunity to explore the physics reach of the installed counters with their superb timing resolution. Of special interest is the performance in the Fixed Target BESII campaign covering the available energy in the CMS range from 3GeV to 13GeV. The status of the data-analysis chain, integrating CBM-analysis elements, and its modeling in the STAR Monte-Carlo framework will be presented and discussed. Preliminary results for the production of the Phi meson and the Lambda baryon will be shown. The project is partially funded by BMF contract 05P21VHFC1.

HK 39.6 Wed 15:15 HK-H5

The PUNCH4NFDI consortium in the NFDI - status, first results, and outlook — •Thomas Schörner for the PUNCH4NFDI-Collaboration — Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg

With the "Nationale Forschungsdateninfrastruktur" (NFDI, national research data infrastructure), a massive effort is undertaken in Germany to provide a coherent research data management, to make research data sustainably utilisable and to implement the FAIR data principles. PUNCH4NFDI is the consortium of particle, astro- and astroparticle, as well as hadron and nuclear physics within the NFDI. It aims for a FAIR future of the data management of its community and at harnessing its massive experience not least in "big data" and "open data" for the benefit of "PUNCH" sciences (Particles, Universe, NuClei and Hadrons) as well as for physics in general and the entire NFDI. In this presentation, we will introduce the work programme of PUNCH4NFDI, its connection to everyday work in the physical sciences and beyond, and in particular the idea of digital research products and the PUNCH science data platform.

HK 39.7 Wed 15:30 HK-H5

Simulation Method for Calculating the Summing Effect Correction Factor — •Yanzhao Wang, Jan Mayer, Felix Heim, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics, 50937 Cologne, Germany

γ-ray spectrometers have been utilized to investigate the radioactive properties of either activation or in-beam experiments since decades. One of the main problems undermining the measurement accuracy is called coincidence summing, which occurs when multiple γ-rays have energy depositions at the same detector almost simultaneously [1]. To offset this effect, correction factors on the initial γ-ray countings are calculated using the Geant4-based Monte Carlo simulation of consecutive emissions from all possible γ-ray cascades in the decay scheme. Compared to traditional analytical methods, the method presented in this talk does not only simplify the calculating procedure in case of complex decay schemes, but also is more accurate with the consideration of the Compton scattering in the detector volume.

Supported by the BMBF (05P21PKFN1).

[1] T.M. Semkow *et al.*, Nucl. Instrum. Methods Phys. Res. A **290** (1990) 437

HK 39.8 Wed 15:45 HK-H5

anan — ein Debugger für Hochleistungsrechner — •Alexander Adler — Goethe-Universität Frankfurt

Das Projekt `anan` ist ein Werkzeug zur Fehlersuche in verteilten Hochleistungsrechnern. Die Neuheit des Beitrags besteht darin, dass die bekannten Methoden, die bereits erfolgreich zum Debuggen von Soft- und Hardware eingesetzt werden, auf Hochleistungs-Rechnen übertragen worden sind. Im Rahmen der vorliegenden Arbeit wurde ein Werkzeug namens `anan` implementiert, das bei der Fehlersuche hilft. Außerdem kann es als dynamischeres Monitoring eingesetzt werden. Beide Einsatzzwecke sind getestet worden.

Das Werkzeug besteht aus zwei Teilen:

1. aus einem Teil namens `anan`, der *interaktiv* vom Nutzer bedient wird
2. und aus einem Teil namens `anand`, der *automatisiert* die verlangten Messwerte erhebt und nötigenfalls Befehle ausführt.

Der Teil `anan` führt *Sensoren* aus — kleine mustergesteuerte Algorithmen —, deren Ergebnisse per `anan` zusammengeführt werden. In erster Näherung lässt `anan` sich als Monitoring beschreiben, welches (1) schnell umkonfiguriert werden (2) komplexere Werte messen kann, die über Korrelationen einfacher Zeitreihen hinausgehen.

HK 40: Structure and Dynamics of Nuclei VI

Time: Wednesday 14:00–15:30 Location: HK-H6

Group Report HK 40.1 Wed 14:00 HK-H6

The Microscopic Structure of the Low-Energy Electric Dipole Response of ^{120}Sn — •Michael Weinert, Florian Kluwig, Markus Müllenmeister, Miriam Müscher, Barbara Wasilewska, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics, 50937 Cologne, Germany

The low-energy electric dipole response of ^{120}Sn was studied in a ^{119}Sn(d,pγ)^{120}Sn experiment, using the SONIC@HORUS setup at the University of Cologne. Unprecedented access to the single-particle structure of excited $J^\pi=1^-$ states below and around the neutron-separation threshold was obtained by comparing experimental data to a novel theoretical approach that combines detailed nuclear structure input from energy-density functional (EDF) plus quasiparticle-phonon model (QPM) theory with reaction theory. The EDF+QPM approach correctly predicts the energies of the relevant neutron single-particle levels in ^{120}Sn and especially the fragmentation of the observed spectroscopic strength [1]. Furthermore, the EDF+QPM approach predicts the increasing contribution of complex configurations to states at higher excitation energies, which has been recently suggested as a cause for the discrepancy between (γ,γ') and (p,p') experiments [2,3]. This contribution will present the combined efforts and discuss possible connections between the spectral fragmentation observed in ^{119}Sn(d,pγ) and ^{120}Sn(α,α'γ). Supported by the DFG (ZI 510/10-1).

[1] M. Weinert *et al.*, Phys. Rev. Lett. **127**, 242501 (2021)
[2] S. Bassauer *et al.*, Phys. Rev. C **102**, 034327 (2020)
[3] M. Müscher *et al.*, Phys. Rev. C **102**, 014317 (2020)

HK 40.2 Wed 14:30 HK-H6

Electric dipole polarizability in ^{58}Ni from forward angle proton scattering — •Isabelle Brandherm[1], Peter von Neumann-Cosel[1], Hiroaki Matsubara[2], and Atsushi Tamii[2] — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]RCNP, Osaka, Japan

Inelastic proton scattering at very forward angles is an excellent tool for studying the dipole response in nuclei [1]. A (p, p') experiment on ^{58}Ni was performed at the Research Center for Nuclear Physics (RCNP) in Osaka, using a proton beam with 295 MeV and scattering angles close to 0°. With the present setup the electric dipole response is accessible over a wide excitation energy range. This enables the extraction of photoabsorption cross sections as well as the electric dipole polarizability. The latter is correlated to the neutron skin thickness and thus to the symmetry parameter of the equation of state. In addition the isovector spin-flip M1-response can be observed, which forms an isospin analogon to Gamow-Teller transitions. Electric and magnetic dipole contributions to the total experimental cross section were separated by performing a multipole decomposition analysis based on DWBA calculations.

[1] P. von Neumann-Cosel and A. Tamii, Eur. Phys. J. A 55, 110 (2019).

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

HK 40.3 Wed 14:45 HK-H6

γ-decay of the Pygmy Dipole Resonance of ^{150}Nd — •O. Papst[1], J. Isaak[1], N. Pietralla[1], D. Savran[2], V. Werner[1], G. Battaglia[3], T. Beck[1,4], M. Beuschlein[1], S. W. Finch[5,6], U. Friman-Gayer[1,5,6], E. Hoemann[7], K. E. Ide[1], R. V. F. Janssens[6,8], N. Kelly[9], J. Kleemann[1], FNU Krishichayan[5,6], D. R. Little[6,8], B. Löher[2], M. Müscher[7], E. E. Peters[10], P. C. Ries[1], M. Scheck[9], J. Sinclair[9], M. Spieker[4], W. Tornow[5,6], S. W. Yates[10], R. Zidarova[1], and A. Zilges[7] — [1]IKP, TU Darmstadt — [2]GSI, Darmstadt — [3]U. Strathclyde, Glasgow, UK — [4]MSU, East Lansing, MI, USA — [5]Duke U., Durham, NC, USA — [6]TUNL, Durham, NC, USA — [7]IKP, U. Köln — [8]UNC, Chapel Hill, NC, USA — [9]UWS, Paisley, UK — [10]UKY, Lexington, KY, USA

The sensitivity of the Giant Dipole Resonance to axial nuclear deformation results in a separation into two parts (K-splitting). For heavy nuclei, low-lying E1 strength called Pygmy Dipole Resonance [1], often attributed to a semi-collective oscillation of a neutron skin, is expected to exhibit a similar sensitivity. Mean properties of the dipole strength of ^{150}Nd were studied using a new high-resolution mode of the High Intensity γ-ray Source (HIγS) in photon scattering experiments with polarized γ-ray beams below separation thresholds. For the first time for a heavy deformed nucleus, different mean decay branches to the ground-state band could be resolved individually in the Pygmy-region.

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

[1] D. Savran *et al.*, Prog. Part. Nucl. Phys. **70**, 210 (2013)

HK 40.4 Wed 15:00 HK-H6

Dipole response in ^{144}Nd — •Florian Kluwig[1], Miriam Müscher[1], Ronald Schwengner[2], Mark Spieker[3], Werner Tornow[4], and Andreas Zilges[1] — [1]University of Cologne, Institute for Nuclear Physics — [2]Helmholtz-Zentrum Dresden-Rossendorf — [3]Department of Physics, Florida State University — [4]Department of Physics, Duke University and TUNL

For several years, the so-called Pygmy Dipole Resonance (PDR) has been a research topic of great interest [1,2]. It occurs as a concentration of electric dipole strength around and below the neutron separation energy. Systematic studies are essential to improve the knowledge of this excitation mode. For this purpose, the Nd isotopic chain is well-suited due to its wide range of stable, even-even isotopes. Therefore, two complementary (γ,γ') experiments on the rare-earth nucleus ^{144}Nd have been performed at the γELBE facility at the Helmholtz-Zentrum Dresden-Rossendorf [3] using a continuous bremsstrahlung beam and with quasi-monoenergetic γ rays at HIγS [4]. The results of these experiments will be presented in this contribution.

This work is supported by the BMBF (05P21PKEN9).

[1] D. Savran *et al.*, Prog. Part. Nucl. Phys. **70** (2013) 210
[2] A. Bracco *et al.*, Prog. Part. Nucl. Phys. **106** (2019) 360
[3] R. Schwengner *et al.*, Nucl. Instr. and Meth. A **555** (2005) 211
[4] H.R. Weller *et al.*, Prog. Part. Nucl. Phys. **62** (2009) 257

HK 40.5 Wed 15:15 HK-H6

γ-decay Behavior of the Giant Dipole Resonances of ^{154}Sm and ^{140}Ce — •J. Kleemann[1], U. Friman-Gayer[2,3], J. Isaak[1], N. Pietralla[1], V. Werner[1], A. D. Ayangeakaa[2,4], T. Beck[1,5], M. L. Cortés[1], S. W. Finch[2,3], M. Fulghieri[2,4], D. Gribble[2,4], K. E. Ide[1], X. James[2,4], R. V. F. Janssens[2,4], S. R. Johnson[2,4], P. Koseoglou[1], FNU Krishichayan[2,3], O. Papst[1], D. Savran[6], N. Sensharma[2,4], W. Tornow[2,3], and A. Williams[2,4] — [1]IKP, TU Darmstadt — [2]TUNL, Durham, NC, USA — [3]Duke University, Durham, NC, USA — [4]UNC, Chapel Hill, NC, USA — [5]FRIB, MSU, East Lansing, MI, USA — [6]GSI, Darmstadt

The giant dipole resonance (GDR) is one of the most fundamental nuclear excitations and dominates the dipole response of all nuclei. Yet, its γ-decay behavior, despite being a key property, is still mostly unknown. Recently, novel data on the γ-decay of the GDR of the well-deformed nuclide ^{154}Sm and the spherical nuclide ^{140}Ce were obtained through photonuclear experiments at the HIγS facility. Individual regions of the GDR were selectively excited by HIγS' intense, linearly-polarized and quasi-monochromatic γ-ray beam. This enables an excitation-energy resolved determination of the GDR's γ-decay behavior. For ^{154}Sm in particular, the obtained data allow for a first experimental test of the commonly accepted K-quantum-number assignments to the double-humped GDR observed in deformed nuclei.

This work was supported by the State of Hesse under the grant *Nuclear Photonics* within the LOEWE program and within the Research Cluster *ELEMENTS*.

HK 41: Structure and Dynamics of Nuclei VII

Time: Wednesday 14:00–15:30 Location: HK-H7

Group Report HK 41.1 Wed 14:00 HK-H7

Mass measurements of short-lived exotic nuclei at TITAN - update on recent developments — •Tobias Murböck for the TITAN-Collaboration — TRIUMF, Vancouver, British Columbia, Canada — II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Gießen, Germany

The mass of a nucleus is determined by the number of its constituents, protons and neutrons, and the binding energy resulting from the interaction between those fundamental building blocks. High-precision mass measurements therefore provide relevant data for studies of the nucleus's structure, nuclear astrophysics and fundamental symmetries. In the pursuit of exotic nuclei with extreme proton-to-neutron ratios and half-lives of just a few ms, fast and sensitive experiments are required. One of those experiments, TRIUMF's Ion Trap for Atomic and Nuclear science (TITAN), is located at TRIUMF, Canada's particle accelerator center, in Vancouver. Complementing a Penning trap mass spectrometer, a Multiple-Reflection Time-Of-Flight Mass-Spectrometer (MR-TOF-MS) has been recently added to TITAN. With its capacity for fast, non-scanning, sensitive and high-resolution mass spectrometry, the MR-TOF-MS has helped to extend TITAN's measurement program to even more exotic nuclei. Here we present recent measurements of neutron-rich $^{63-65}$Cr and $^{67-70}$Fe in the region of the N=40 island of inversion, and data from the neutron-deficient nuclei $^{60-61}$Ga and $^{74-76}$Sr in the path of the rp-process. In addition we give an update on technical developments like the improvements in mass resolution to 6E5 and the increased stability of the system.

HK 41.2 Wed 14:30 HK-H7

Energy-density functionals from local chiral interactions — •Lars Zurek[1,2], Rodrigo Navarro Pérez[3], Scott K. Bogner[4], Richard J. Furnstahl[5], and Achim Schwenk[1,2,6] — [1]Technische Universität Darmstadt, Department of Physics — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Department of Physics, San Diego State University — [4]Facility for Rare Isotope Beams and Department of Physics and Astronomy, Michigan State University — [5]Department of Physics, The Ohio State University — [6]Max-Planck-Institut für Kernphysik, Heidelberg

We construct semi-phenomenological nuclear energy-density functionals starting from conventional Skyrme functionals, here considered to represent short-range physics. Pion exchanges are added explicitly at the Hartree-Fock level by applying a density-matrix expansion to local interactions derived from chiral effective field theory. We determine energy-density functionals obtained in this fashion at different orders in the chiral expansion and investigate several choices in the density-matrix expansion.

* Funded by the BMBF Contract No. 05P21RDFNB.

HK 41.3 Wed 14:45 HK-H7

Precision mass measurements of actinides at SHIPTRAP — •Manuel J. Gutiérrez[1,2], Michael Block[1,2,3], Christoph E. Düllmann[1,2,3], Francesca Giacoppo[1,2], Oliver Kaleja[1,4], Kanika Kanika[1,5], Jacques J. W. van de Laar[2,3], Yury Nechiporenko[6,7], Yuri Novikov[6,7], Wolfgang Quint[1,5], and Dennis Renisch[2,3] — [1]GSI Darmstadt, Germany — [2]HIM Mainz, Germany — [3]JGU Mainz, Germany — [4]University of Greifswald, Germany — [5]University of Heidelberg, Germany — [6]PNPI Gatchina, Russia — [7]Saint Petersburg State University, Russia

The existence of superheavy nuclides is possible due to quantum-mechanical shell effects. A region of enhanced stability, dubbed *island of stability*, was long ago predicted at the next spherical shell closure above the doubly magic ^{208}Pb. Although not yet experimentally found, its location has been pinned down to around Z=114–126 and N=184. More information can be retrieved from the study of the actinides, linked to heavier nuclides by decay chains.

Penning-trap mass spectrometry provides precise measurements of atomic masses, which directly translate into binding energies. Their high-resolution measurement provides a powerful indicator of nuclear structure effects. An offline campaign for direct mass measurements of selected U and Pu isotopes was recently carried out at the SHIPTRAP mass spectrometer at GSI, usually devoted to the investigation of superheavy elements. This campaign complements the more extensive program carried out at the TRIGA-TRAP setup in Mainz. This contribution presents the first results of the SHIPTRAP campaign.

HK 41.4 Wed 15:00 HK-H7

Nuclear charge radii of neutron-deficient scandium isotopes — •Kristian König[1,2], Robert Powel[1,3], Andrew Klose[4], Stephan Fritzsche[5], Jeremy Lantis[1,6], Yuan Liu[1], Kei Minamisono[1,3], Witek Nazarewicz[1,3], Wilfried Nörtershäuser[2], Skyy Pineda[1,6], Paul-Gerhard Reinhard[7], and Dominic Rossi[2] — [1]FRIB, Michigan State University — [2]Institut für Kernphysik, Technische Universität Darmstadt — [3]Department of Physics and Astronomy, Michigan State University — [4]Department of Chemistry, Augustana University — [5]Helmholtz-Institute Jena — [6]Department of Chemistry, Michigan State University — [7]Institut für Theoretische Physik II, Universität Erlangen-Nürnberg

Charge radii of neutron deficient ^{40,41}Sc (Z=21) isotopes have been determined at the BEam COoler and LAser spectroscopy facility at FRIB to investigate the N=20 shell closure. Particularly, the typical kink structure in the charge radius evolution at N=20 is very weak in Ar, K and Ca while it is strongly pronounced at N=28. With one additional proton in the $1f_{7/2}$ shell in Sc, additional cross-shell interactions occur and affect the behavior at the shell closure. The results will be presented, which promote a global understanding of the structure around ^{40}Ca, and the weak shell-closure signature at N=20.

This work is supported by NSF grant PHY-15-65546.

HK 41.5 Wed 15:15 HK-H7

Status report on the TRIGA-Trap experiment — •Szilard Nagy[1], Klaus Blaum[1], Michael Block[2,3,4], Stanislav Chenmarev[1,5], Christoph E. Düllmann[2,3,4], Steffen Lohse[2,3], and Jacques J. W. van de Laar[2,3] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, DE — [2]Department Chemie - Standort TRIGA, Johannes Gutenberg-Universität Mainz, DE — [3]Helmholtz-Institut Mainz, DE — [4]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, DE — [5]Petersburg Nuclear Physics Insitute, Gatchina, RU

The TRIGA-Trap setup [1] is a double Penning-trap mass spectrometer at the research reactor TRIGA Mainz. Currently we are performing high-precision mass measurements of long-lived transuranium isotopes. A new cylindrical measurement trap made possible the implementation of the phase-imaging ion cyclotron resonance (PI-ICR) technique [2], originally developed at SHIPTRAP. The current status including results for several long-lived actinide isotopes will be presented. Our results find application in nuclear structure studies and provide reliable atomic mass anchor points in the transuranium region.

1. J. Ketelaer *et al.*, Nucl. Instrum. Meth. A **594**, 162-177 (2008).
2. S. Eliseev *et al.*, Phys. Rev. Lett. **110**, 082501, (2013).

HK 42: Hadron Structure and Spectroscopy VII

Time: Wednesday 14:00–15:30 Location: HK-H8

Group Report HK 42.1 Wed 14:00 HK-H8

Experimental Inputs to the Hadronic Vacuum Polarisation Contribution of the Anomalous Magnetic Moment of the Muon at the BESIII Experiment. — •Riccardo Aliberti for the BESIII-Collaboration — Johannes Gutenberg-Universität

The recent result from the Fermilab Muon $g-2$ Experiment has confirmed the tension between the standard model (SM) prediction of the anomalous magnetic moment of the muon (a_μ) and the experimental measurement at a 4.2 σ level. Currently, the uncertainties on experimental and predicted values are very similar (41×10^{-10} and

43×10^{-10}, respectively) and further improvement in both are to be expected in the next years.
The uncertainty on the SM prediction is dominated by hadronic contributions and particularly by the Hadronic Vacuum Polarisation (HVP) component, which is evaluated with a dispersive formalism from the measurement of hadron production cross sections in electron-positron annihilations.
The BESIII experiment, located at the BEPCII collider in Beijing, collects since 2008 data with center-of-mass energies between 2 and 5 GeV, resulting in the world's largest dataset in e^+e^--annihilations in the τ-charm energy region. In this talk the current status and perspective for the measurement of hadron production cross sections, entering the evaluation of the HVP contribution to a_μ, at BESIII are reviewed.

HK 42.2 Wed 14:30 HK-H8

Small Angle Initial State Radiation Analysis of the Pion Form Factor at BESIII — •Yasemin Schelhaas, Riccardo Aliberti, and Achim Denig for the BESIII-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland

One of the most precisely measured quantities in modern physics is the anomalous magnetic moment of the muon. However, there is a discrepancy of 4.2 standard deviations between the Standard Model (SM) prediction and the average of the latest direct measurements at BNL and Fermilab. This fact is known as the Muon $(g-2)$-puzzle. For the SM prediction the main uncertainty arises from hadronic contributions and can be improved systematically using measurements of hadronic cross sections at e^+e^- colliders. One of the most important processes is $e^+e^- \to \pi^+\pi^-$. Using a data set of $3.2\,\mathrm{fb}^{-1}$ at a center of mass energy of 4.18 GeV, the $\pi^+\pi^-$ cross section is measured at the BESIII experiment located at the BEPCII collider in Beijing, exploiting the initial state radiation technique at small angles. The analysis aims to determine the pion form factor at masses above 0.8 GeV, which is also interesting for hadron spectroscopy. In this talk the current status of the analysis is presented.

Supported by DFG.

HK 42.3 Wed 14:45 HK-H8

A FAIR Phase-0 Project at MAMI — Luigi Capozza[1], Alaa Dbeyssi[1], Alexander Greiner[1], Samet Katilmis[1], Dong Liu[1], Frank Maas[1,2,3], Julian Moik[1], Oliver Noll[1,2], David Rodriguez Piñeiro[1], Christoph Rosner[1], and •Sahra 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 2022, three years before its foreseen installation. Therefore, an experiment at the MAMI electron beam facility making use of the BWEC is envisaged.

The goal is to measure the π_0 electromagnetic transition form factor in virtual Primakoff-kinematics via the electroproduction of a π_0 in the Coulomb field of a heavy nucleus. 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.
This talk will address the current status of the FAIR Phase-0 experiment at MAMI.

HK 42.4 Wed 15:00 HK-H8

The new Forward Tracker System for the HADES and PANDA Phase-0 experiment — •Gabriela Perez-Andrade[1], James Ritman[2,1], and Peter Wintz[1] for the HADES-Collaboration — [1]Forschungszentrum Jülich — [2]Helmholtzzentrum für Schwerionenforschung

HADES is a fixed-target experiment where proton, pion, and heavy-ion induced reactions are used to study nuclear matter and the properties of baryonic resonances. HADES is in operation at the SIS18 in GSI, Darmstadt, and is part of the phase-0 program of the future FAIR facility. The new Straw Tracking Stations (STS1/2) installed at HADES were built in collaboration with the PANDA experiment. The STS1/2 enlarge the HADES acceptance for hyperon reconstruction in p+p reactions. Each station has four double layers of gas-filled straws. The straw design is based on the PANDA central and forward straw trackers (STT, FT). Four azimuthal orientations of the double layers are used for 3D track reconstruction, and to resolve ambiguities in multi-track events. From pre-commissioning tests, a spatial resolution of 0.13 mm for MIPs was determined. The system was installed at GSI at the end of 2020, and a dedicated commissioning beamtime in February 2021 with proton beams impinging on an LH2 target showed a stable STS operation. The collected data are used to develop the calibration and track reconstruction methods in the experiment analysis software HYDRA. A description of the STS system and a summary of the results from the beamtime will be presented.

HK 42.5 Wed 15:15 HK-H8

Performance Improvement of Deep Machine Learning for the PANDA Software Trigger — •Peiyong Jiang[1,2], Klaus Goetzen[1], Ralf Kliemt[1], Klaus Peters[1], and Frank Nerling[1] for the PANDA-Collaboration — [1]GSI Helmholtzzentrum fuer Schwerionenforschung GmbH, Darmstadt, Germany — [2]Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou, China

Deep machine learning methods have been studied for the PANDA software trigger with data sets from full Monte Carlo simulation using PandaRoot. Following the first comparison of multiclass and binary classification, the binary classification has been selected because of higher signal efficiencies. In total seven neural network types have been compared and the residual convolutional neural network with 4 residual blocks has been chosen. The results of optimized neural networks and those of the conventional method have been compared, showing an efficiency gain of up to 140% for the deep machine learning method. The flatness quality parameters on Dalitz plots and theta-phi projections have been obtained.

HK 43: Hadron Structure and Spectroscopy VIII

Time: Wednesday 14:00–15:30 Location: HK-H9

Group Report HK 43.1 Wed 14:00 HK-H9

Prospects for Spin-Parity Determination of Ξ Resonances in the $\overline{\Xi}\Lambda K^-$ Final State at $\overline{\mathrm{P}}$ANDA — •Jennifer Pütz for the PANDA-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung

In order to deepen our insights into the mechanisms of non-perturbative QCD it is essential to understand the excitation pattern of baryons. Up to now only the nucleon excitation spectrum has been subject to systematic experimental studies while very little is known about the excited states of double or triple strange baryons.
In studies of antiproton-proton collisions the $\overline{\mathrm{P}}$ANDA experiment is well-suited for a comprehensive baryon spectroscopy program in the multi-strange sector. A large fraction of the inelastic $\bar{\mathrm{p}}\mathrm{p}$ cross section is associated to final states with a baryon-antibaryon pair together with additional mesons, enabling high rate studies of excited states both in the baryon and the antibaryon channel.
In Monte Carlo studies, it has been demonstrated that $\overline{\mathrm{P}}$ANDA will be able to observe the $\overline{\Xi}^+\Lambda K^-$ channel with high statistics, and at the same time kinematic constraints will suppress the background to negligible levels. In this study, the feasibility of $\overline{\mathrm{P}}$ANDA to determine the mass, width, spin and parity of two specific Ξ resonances, Ξ(1690) and Ξ(1820), is investigated by making use of a partial wave analysis employing the PAWIAN framework. This talk will present results demonstrating the capability of the $\overline{\mathrm{P}}$ANDA experiment to determine the spin-parity of these resonances using a data sample that can be collected within three days of data collection.

HK 43.2 Wed 14:30 HK-H9

GPD measurements with PANDA based on antiproton scattering — •Stefan Diehl for the PANDA-Collaboration — II. Physikalisches Institut, JLU Giessen, Germany

Generalized parton distributions (GPDs) are a well-established tool to

study the three-dimensional nucleon structure in terms of the transverse position and the longitudinal momentum component of the partons. Classically, GPDs are measured in hard exclusive lepton scattering processes such as deeply virtual Compton scattering and deeply virtual meson production, which are currently extensively studied at Jefferson Laboratory with experiments such as CLAS12. While PANDA at FAIR has been designed to study antiproton annihilation, which yields access to time-like GPDs, also known as generalized distribution amplitudes (GDAs), it can also be used to study hard exclusive antiproton scattering processes such as $\bar{p}p \to \bar{p}pe^+e^-$ and $\bar{p}p \to \bar{p}p\mu^+\mu^-$. Such processes can be theoretically described with a dual handbag approach based on classical GPDs. The talk will present a feasibility study for the measurement of hard exclusive lepton pair production in antiproton scattering with PANDA and discuss its impact on the measurement of GPDs. A special focus will be set on the application of neural networks to optimize the particle ID and background suppression.

*Supported by BMBF within ERUM-FSP T08:PANDA and HFHF.

HK 43.3 Wed 14:45 HK-H9

Testing the Chiral Anomaly from Primakoff Reactions in COMPASS Data — •Nan-Hee Kang and Dominik Ecker for the COMPASS-Collaboration — Institute for Hadronic Structure and Fundamental Symmetries, Technische Universität München

In the years 2009 and 2012, the COMPASS collaboration at CERN has measured pion-photon scattering reactions via the Primakoff effect. In these reactions, high-energetic pions scatter off quasi-real photons stemming from the Coulomb field of a nucleus. The low-energy dynamics of the single-π^0 production ($\pi^-\gamma^{(*)} \to \pi^-\pi^0$) is driven by the chiral anomaly and described by the low-energy theorem for $F_{3\pi}$. Previous extractions of the chiral anomaly date back to the Serpukhov experiment in 1987, are restricted to the kinematic threshold region, and extracted $F_{3\pi}$ to a 10%-level. COMPASS measured the invariant mass spectrum including the $\rho(770)$-resonance which allows for more precise extraction of $F_{3\pi}$. The contribution will present the status of the analysis of the 2009 data set and compare its kinematic distributions to the larger 2012 data set.

HK 43.4 Wed 15:00 HK-H9

Diffractively produced $f_1(1285)\pi$ system in the reaction $\pi^- + p \to \pi^-\pi^+\pi^-\eta + p$ at 190 GeV/c from COMPASS — •David Spülbeck, Henri Pekeler, Mathias Wagner, Simon Havemann, and Bernhard Ketzer for the COMPASS-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik der Universität Bonn, Bonn, Germany

Hybrids are strongly interacting bound states with explicit gluonic degrees of freedom. Models and recent lattice QCD simulations alike predict the lightest hybrid state with spin-exotic quantum numbers 1^{-+} to have a strong branching into $f_1(1285)\pi$. This particular decay can be studied well using the data recorded by the COMPASS collaboration on the scattering of a 190 GeV/c pion beam off a fixed hydrogen target. Selecting diffractive reactions of the kind $\pi^- + p \to \pi^-\pi^+\pi^-\eta + p$ yields the world's largest data sample for a partial wave analysis that includes the $f_1(1285)\pi$ channel of interest. This contribution introduces the fundamental principles of the event selection for the $\pi^-\pi^+\pi^-\eta$ final state using COMPASS data. We discuss the selected data sample in detail and show the contributions of several resonances by identifying decay chains that end up in the four-body final state in question. A comparison to the data sample of the E852 collaboration will be made, which gave evidence for the spin-exotic state to decay into $f_1(1285)\pi$. As the COMPASS data sample is about eight times larger, a PWA in bins of the 4-momentum transfer and the invariant mass will be possible, giving important constraints to disentangle resonant and non-resonant processes. Supported by BMBF.

HK 43.5 Wed 15:15 HK-H9

New experimental frontiers in the study of many-hadron systems with ALICE at the LHC — •Raffaele Del Grande for the ALICE-Collaboration — TUM, Munich, Germany

The femtoscopy technique has recently been extended by the ALICE Collaboration to study the strong interaction among hadrons in three-particle systems. Three-body forces involving both nucleons and hyperons are necessary in the theoretical description of nuclear bound objects and represent an important ingredient in the calculation of the nuclear equation of state of neutron stars. Solid experimental constraints to the interaction models are currently missing and therefore, direct measurements of three-hadron interactions are strongly demanded.

The results presented in this talk are obtained using high-multiplicity pp collisions at $\sqrt{s} = 13$ TeV measured by ALICE at the LHC. The first measurement of p–p–p and p–p–Λ correlations will be shown. The corresponding genuine three-particle correlations are obtained by subtracting the known two-body effects from the measured correlation functions of the triplets. A non-zero three-particle cumulant is observed providing an insight on the three-body dynamics for p–p–p and p–p–Λ. The same approach has been used in the measurement of p–p–K^+ and p–p–K^- correlations. The study of these systems is relevant, in particular, for the search of exotic bound states of antikaons and nucleons, whose possible formation is driven by the attractive nature of the isospin I=0 $\bar{K}N$ interaction below the mass threshold.

HK 44: Astroparticle Physics II

Time: Wednesday 14:00–15:30 Location: HK-H10

Group Report HK 44.1 Wed 14:00 HK-H10

Results from the first search for axion like particles in storage rings — •Swathi Karanth for the JEDI-Collaboration — Marian Smoluchowski Institute of Physics, Jagiellonian University, Cracow, Poland

The axion was originally proposed to explain the small size of CP violation in quantum chromodynamics. If sufficiently abundant, it might be a candidate for dark-matter in the universe. Axions or axion-like particles (ALPs), when coupled with gluons, induce an oscillating Electric Dipole Moment (EDM) along the nucleon's spin direction. This can be used in an experiment to search for axions or ALPs using charged particles in a storage ring.

In spring of 2019, at the Cooler Synchrotron (COSY) in Jülich, we performed a first test experiment to search for ALPs using an in-plane polarized deuteron beam with a momentum of 0.97 GeV/c. At resonance between the spin precession frequency of deuterons and the ALP induced EDM oscillation frequency there will be an accumulation of the polarization out of the ring plane. Since the axion frequency is unknown, the momentum of the beam was ramped to search for a vertical polarization jump that would occur when the resonance is crossed. At COSY, four beam bunches with different polarization directions were used to make sure that no resonance was missed because of the unknown relative phase between the polarization precession and the EDM oscillations. A frequency window of about 1-kHz width around the spin precession frequency of 121 kHz was scanned. This talk will describe the experiment and provide an upper limit to oscillating EDM.

Group Report HK 44.2 Wed 14:30 HK-H10

The MONUMENT Experiment; ordinary muon capture as a benchmark for $0\nu\beta\beta$ decay nuclear structure calculations — Elisabetta Bossio[1], •Elizabeth Mondragon[1], Stefan Schönert[1], Mario Schwarz[1], and Christoph Wiesinger[1,2] for the MONUMENT-Collaboration — [1]Lehrstuhl für Experimentalphysik E15, Technische Universität München, Garching — [2]Max-Planck Institut für Physik, München

Extracting particle physics properties from neutrinoless double-beta ($0\nu\beta\beta$) decay requires a detailed understanding of the involved nuclear structures. Still, modern calculations of the corresponding nuclear matrix elements (NMEs) differ by factors 2-3. The high momentum transfer of Ordinary Muon Capture (OMC) provides insight into highly excited states similar to those that contribute virtually to $0\nu\beta\beta$ transitions. The precise study of the γ's following the OMC process makes this a promising tool to validate NME calculations. The MONUMENT collaboration is performing a series of explorative OMC measurements involving typical $\beta\beta$ decay daughter isotopes such as ^{76}Se and ^{136}Ba, as well as other benchmark isotopes. In this talk the experiment carried out at the Paul Scherrer Institute and first results from

the beamtime in 2021 will be presented. This research is supported by the DFG Grant 448829699.

HK 44.3 Wed 15:00 HK-H10

Characterisation of the plasma in the tritium source of KATRIN with Krypton-83m — •Matthias Böttcher[1], Caroline Fengler[2], Manuel Klein[2], Moritz Machatschek[2], Magnus Schlösser[2], and Jaroslav Storek[2] for the KATRIN-Collaboration — [1]WWU Münster, Germany — [2]KIT, Karlsruhe, Germany

The KATRIN experiment has the aim to measure the electron-antineutrino mass with the unprecedented sensitivity of 0.2 eV/c^2 at 90 % C. L., using a direct kinematic measurement of the tritium beta spectrum. This requires precise understanding of systematic effects in the gaseous tritium source. Within this radioactive source, a low-density plasma at around 80 K forms, consisting of secondary electrons and ionised molecules. The plasma, influenced by the properties of the source tube, exhibits an electric potential distribution which smears out the beta spectrum. To characterize this effect, gaseous Kr-83m can be injected into the tritium source. Its well defined conversion electron lines, especially the narrow N_{23} doublet, allow for precise determination of energy broadenings and shifts. A dedicated measurement phase with an ultra high intensity krypton source was performed in 2021. In this talk, we describe the use of Kr-83m to assess the plasma systematics of the KATRIN source.

This work is supported by BMBF under contract number 05A20PMA.

HK 44.4 Wed 15:15 HK-H10

Status of the KATRIN neutrino mass analysis using Monte Carlo propagation and a novel neural network approach — Christian Karl[1,2], Susanne Mertens[1,2], Alessandro Schwemmer[1,2], and •Christoph Wiesinger[1,2] for the KATRIN-Collaboration — [1]Max-Planck-Institut für Physik, München — [2]Physik-Department, Technische Universität München, Garching

The Karlsruhe Tritium Neutrino (KATRIN) experiment probes the effective electron anti-neutrino mass by a precision measurement of the tritium beta-decay spectrum near the endpoint. A world-leading upper limit of 0.8 eV c^{-2} (90 % CL) has been set with the first two measurement campaigns. New operational conditions for an improved signal-to-background ratio, the reduction of systematic uncertainties and a substantial increase in statistics allow to expand this reach. The performance figures of three additional datasets, analysed with the Monte Carlo propagation method, and an outlook on their combination using a novel neural network technique will be presented in this talk.

HK 45: Heavy-Ion Collisions and QCD Phases IX

Time: Wednesday 16:00–17:15 Location: HK-H1

Group Report HK 45.1 Wed 16:00 HK-H1

Vector and Axial-Vector Mesons in Nuclear Matter — •Ralf-Arno Tripolt[1], Tetyana Galatyuk[2,3], Lorenz von Smekal[1,4], Jochen Wambach[2], and Maximilian Wiest[2] — [1]Justus Liebig University Giessen, Germany — [2]TU Darmstadt, Germany — [3]GSI, Darmstadt, Germany — [4]Helmholtz Research Academy Hesse for FAIR (HFHF), Campus Giessen, Germany

We present recent results on the in-medium spectral functions of the rho(770) vector meson and the a1(1260) axial-vector meson in nuclear matter, as well as on the resulting thermal dilepton rate. As an effective description of the thermodynamics and the phase structure of nuclear matter we use a chiral baryon-meson model, taking into account the effects of fluctuations from scalar mesons, nucleons, and vector mesons within the Functional Renormalization Group (FRG) approach [1]. Our results show strong modifications of the spectral functions in particular near the chiral critical endpoint which suggest an enhanced dilepton yield at lower energies. Such an enhancement is also found in GiBUU transport simulations for C+C at 1A GeV when including effects of chiral symmetry restoration in the kinetic equations for baryon propagation [2]. Our results may therefore well be of relevance for electromagnetic rates in heavy-ion collisions or neutrino emissivities in neutron-star merger events and help to identify phase transitions and the critical endpoint.

[1] R.-A. Tripolt, C. Jung, L. von Smekal, J. Wambach, Phys. Rev. D 104, 054005 (2021)

[2] A. B. Larionov, L. von Smekal, arXiv: 2109.03556

HK 45.2 Wed 16:30 HK-H1

Dielectron physics opportunities with ALICE 3 — •Florian Eisenhut for the ALICE-Collaboration — Goethe University Frankfurt am Main

ALICE 3 is a compact, next-generation multipurpose detector at the LHC planed as a follow-up to the present ALICE experiment. It will provide unprecedented tracking, particle identification and vertexing capabilities down to a few tens of MeV/c with a large rapidity coverage $|\eta| < 4$. At very low p_{T} and invariant mass (m_{ee}) the thermal dielectron production rate in heavy-ion (AA) collisions is expected to be particularly sensitive to the electric conductivity of the medium. At higher dielectron invariant masses, the spectral shape of thermal radiation from the hot hadron gas carries information about the chiral-symmetry restoration mechanisms, among those is the chiral mixing between ρ and a_1 mesons. In the mass region $1.1 < m_{\mathrm{ee}} < 2.7$ GeV/c^2 the spectrum of thermal dielectrons is dominated by dieletrons from the QGP which directly provides a mean to estimate the early temperature of the medium. Finally, an elliptic flow measurement as a function of m_{ee} and pair transverse momentum allows a study of the dynamic of the medium as a function of time.

This talk will present performance studies for dielectron analyses with ALICE 3. The procedure to determine expected uncertainties of the thermal e^+e^- spectra will be presented and a so-called prefilter technique to reduce the combinatoric background will be explained. Furthermore, feasibility studies of the early temperature of the medium via exponential fits of the invariant mass spectra will be shown.

HK 45.3 Wed 16:45 HK-H1

Feasibility Studies of Di-Electron Spectroscopy with CBM at FAIR — •Cornelius Feier-Riesen for the CBM-Collaboration — GSI, Darmstadt, Germany — Justus-Liebig-Universität Gießen, Gießen, Germany

The Compressed Baryonic Matter experiment (CBM) at FAIR is designed to explore the QCD phase diagram at high net baryon densities and moderate temperatures by means of heavy ion collisions with energies from 2-11 AGeV beam energy (Au+Au collisions) and interaction rates up to 10 MHz, provided by the SIS100 accelerator.

Leptons as penetrating probes not taking part in the strong interaction leave the fireball without being modified thus carrying information from the dense baryonic matter. However, di-leptons are rare probes therefore calling for high efficiency and high purity identification capabilities. In CBM, electron identification will be performed by a Ring Imaging Cherenkov Detector (RICH) and by a Transition Radiation Detector (TRD).

In this contribution, feasibility studies of di-electron spectroscopy from low mass vector meson decays will be presented. Special emphasis is put on the experimental challenge to reduce the combinatorial background in order to get a high significance of the extracted di-electron signal.

HK 45.4 Wed 17:00 HK-H1

Dielectron production in Pb–Pb collisions with ALICE — •Jerome Jung for the ALICE-Collaboration — IKF, Goethe University, Frankfurt, Germany

The study of dielectron production is an exceptional tool to disect the evolution of heavy-ion collisions. In peripheral collisions, a clear excess of dielectrons is observed which exceeds the hadronic decay background at low pair momenta. These soft dielectrons can be attributed to coherent interactions of photons originating from electromagnetic fields generated by the highly Lorentz-contracted colliding ions. In more central collisions, the energy densities are sufficient to create a hot and dense medium. Thermal radiation of this medium can be observed as an excess over the hadronic decay cocktail beyond the pion region. For invariant masses above 1.1 GeV/c^2, correlated heavy-flavour hadron decays are expected to dominate the dielectron yield. Their contribution is modified in the medium compared to elementary collisions

to an unknown extend. Therefore, a topological separation based on the distance-of-closest approach (DCA) to the primary vertex can be applied to disentangle them from thermal dielectrons.

In this talk, ALICE measurements of dielectron production in Pb–Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV, will be presented. In peripheral collisions, final results will be compared to theory and measurements at lower energies. In central collisions, the dielectron spectra will be compared to expectations from the hadronic decay cocktail. Finally, a outlook on a DCA analysis in Pb–Pb is given.

HK 46: Heavy-Ion Collisions and QCD Phases X

Time: Wednesday 16:00–17:15 Location: HK-H2

Group Report HK 46.1 Wed 16:00 HK-H2

Regulator dependence of the chiral phase transition at high densitities — Konstantin Otto[1], •Christopher Busch[1,2], and Bernd-Jochen Schaefer[1,2] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität Gießen — [2]Helmholtz Forschungsakademie Hessen für FAIR (HFHF)

Functional methods like the functional renormalization group (FRG) provide a powerful tool for the study of non-perturbative phenomena such as the spontaneous breaking of chiral symmetry in QCD. Recent FRG investigations of the QCD phase diagram at low temperature and high densities show a strange back-bending of the chiral phase transition line combined with the appearance of a negative entropy density in the chirally symmetric phase. Among possible physical reasons for these observations technical artifacts caused by common FRG truncation schemes are part of ongoing discussions. In this talk we will focus on this issue and will elucidate the role played by different FRG regulator choices. First results of the regulator effects in this regime of the phase diagram will be given.

HK 46.2 Wed 16:30 HK-H2

Critical endpoint of QCD in a finite volume — •Julian Bernhardt[1,2], Christian S. Fischer[1,2], Philipp Isserstedt[1,2], and Bernd-Jochen Schaefer[1,2] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität Gießen, 35392 Gießen, Germany — [2]Helmholtz Forschungsakademie Hessen für FAIR (HFHF), GSI Helmholtzzentrum für Schwerionenforschung, Campus Gießen, 35392 Gießen, Germany

We summarize recent results on the volume dependence of the location of the critical endpoint in the QCD phase diagram. To this end, we employ a sophisticated combination of Lattice Yang-Mills theory and a (truncated) version of Dyson-Schwinger equations in Landau gauge for $2+1$ quark flavors. We study this system at small and intermediate volumes and determine the dependence of the location of the critical endpoint on the boundary conditions and the volume of a three-dimensional cube with edge length L. Additionally, we report on the chiral limit of the light quarks for different strange quark masses at vanishing chemical potential.

HK 46.3 Wed 16:45 HK-H2

Phase structure and thermodynamics of QCD from Dyson–Schwinger equations — •Philipp Isserstedt[1,3], Michael Buballa[2,3], Christian S. Fischer[1,3], Pascal J. Gunkel[1,3], and Thorsten Steinert[1] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität Gießen, 35392 Gießen, Germany — [2]Technische Universität Darmstadt, Department of Physics, Institut für Kernphysik, Theoriezentrum, 64289 Darmstadt, Germany — [3]Helmholtz Forschungsakademie Hessen für FAIR (HFHF), Germany

We summarize our recent results on the phase structure and thermodynamics of QCD obtained within the nonperturbative framework of Dyson–Schwinger equations. Our results are based on solutions to a truncated set of these equations for the quark and gluon propagators of $(2+1)$-flavor QCD in Landau gauge. First, we present baryon number fluctuations and ratios thereof, ranging from vanishing chemical potential up to the critical endpoint. In comparison with experimental data, our results are compatible with the scenario of a critical endpoint at large chemical potential and a freeze-out line that bends below the endpoint [1]. Second, we discuss a truncation-independent method to obtain thermodynamic quantities like the pressure, entropy density, energy density, and interaction measure across the QCD phase diagram from Dyson–Schwinger equations [2], which has been accomplished so far only within simple truncations of the rainbow-ladder type.

[1] Phys. Rev. D 100, 074011 (2019), arXiv:1906.11644 [hep-ph].
[2] Phys. Rev. D 103, 054012 (2021), arXiv:2012.04991 [hep-ph].

HK 46.4 Wed 17:00 HK-H2

Fluctuations and phases in baryonic matter — •Len Brandes — Technical University of Munich

The phase structure of baryonic matter is investigated with focus on the role of fluctuations beyond the mean-field approximation. The prototype test case studied is the chiral nucleon-meson model, with added comments on the chiral quark-meson model. Applications to nuclear matter include the liquid-gas phase transition. Extensions to high baryon densities are performed for both nuclear and neutron matter. The role of vacuum fluctuations is systematically explored. It is pointed out that such fluctuations tend to stabilize the hadronic phase characterized by spontaneously broken chiral symmetry, shifting the chiral restoration transition to very high densities. This stabilization effect is shown to be further enhanced by additional dynamical fluctuations treated with functional renormalisation group methods.

This work has been supported in part by DFG (Project-ID 196253076 - TRR 110) and NSFC as well as the DFG Excellence Cluster ORIGINS.

HK 47: Instrumentation XI

Time: Wednesday 16:00–17:30 Location: HK-H3

HK 47.1 Wed 16:00 HK-H3

Performance of the mSTS detector in O+Ni collisions at 2 AGeV with the mCBM setup at SIS18 — •Dario Alberto Ramirez Zaldivar for the CBM-Collaboration — GSI Helmholtzzentrum f r Schwerionenforschung GmbH, Darmstadt, Germany — Goethe University, Frankfurt, Germany

The Compressed Baryonic Matter (CBM) is one of the experimental pillars at the FAIR facility. CBM focuses on the search for signals of the phase transition between hadronic and quark-gluon matter, the QCD critical endpoint, new forms of strange-matter, in-medium modifications of hadrons, and the onset of chiral symmetry restoration. The Silicon Tracking System is the central detector for momentum measurement and charged-particle identification. It is designed to measure Au+Au collisions at interaction rates up to 10 MHz. It consists have 1.8 million channels, having the most demanding requirements in terms of bandwidth and density of all CBM detectors. In the context of FAIR phase 0, the mini-CBM (mCBM) project is a small-scale precursor of the full CBM detector, consisting of sub-units of all major CBM systems which aim to verify CBM's concepts of free-streaming readout electronics, data transport, and online reconstruction. In the 2021 beam campaign at SIS18 (GSI) O+Ni collisions at 2 AGeV were measured with a beam intensity up to 10^{10} ions per spill. The mini-STS (mSTS) setup used for the 2021 campaign consists of 2 stations with 11 sensors. First results obtained from data taken in the 2021 beam campaign will be presented with a focus on the hit reconstruction and mSTS performance studies.

HK 47.2 Wed 16:15 HK-H3

Mechanics, integration, and assembly of the Silicon Tracking System of CBM — •Maksym Teklishyn[1,2], Patrick Dahm[1], Ulrich Frankenfeld[1], Johann Heuser[1], Piotr Koczoń[1], Anton Lymanets[1], Jens Thaufelder[1], and Oleg Vasyliev[1] for the CBM-Collaboration — [1]GSI, Darmstadt — [2]KINR, Kyiv

The Silicon Tracking System is the main tracking detector of the future CBM experiment. Its design fulfills competing requirements of low material budget, high granularity, and free-streaming operation of the detector modules.

The sensitive volume of the detector is formed by 8 tracking layers comprising 106 vertical ladders — highly integrated light-weight structures with a particular set of modules mounted on top. Each of the 876 detector modules consists of a rectangular double-sided silicon micro-strip sensor interconnected with the front-end electronics outside the physics aperture through a set of 32 ultra-thin analogue read-out micro cables of up to 500 mm length.

The detector is to be be integrated inside a constrained volume of about $3\,m^3$ in the aperture of 1 Tm dipole magnet together with its multiple services: high- and low-voltage lines, read-out optical fibres, cooling lines for dry gas and NOVEC liquid at $-40°C$, DCS links and sensors.

A set of dedicated testing routines is foreseen at each step of the system assembly to ensure its adequate performance. The design choices together with the assembly and testing sequences are being validated with various prototypes.

HK 47.3 Wed 16:30 HK-H3

Präzisionsvermessung der Vakuumbox des PANDA-Luminositätsdetektors — •Jannik Petersen für die PANDA-Kollaboration — Institut für Kernphysik, Mainz, Deutschland

Beim PANDA-Experiment an der neuen Beschleunigeranlage FAIR bei Darmstadt sollen anhand von Antiproton-Proton-Reaktionen offene Fragen der Hadronenphysik beantwortet werden. Eine Säule des Forschungsprogramms bei PANDA ist die Charmonium-Spektroskopie. Dabei soll auch die Energy-Scan-Methode eingesetzt werden, die die Linienform neuer als auch bereits entdeckter Resonanzen mit noch nie dagewesener Präzision vermessen soll. Bei dieser Methode ist die Luminosität die entscheidende Kenngröße zur Normierung der unabhängigen Scan-Schritte. Daher befindet sich ca. 11 m hinter dem Wechselwirkungspunkt ein dedizierter Detektor, der die Winkelverteilung der am Target elastisch gestreuten Antiprotonen vermessen soll. Aus dieser kann die Luminosität extrahiert werden. Um eine Genauigkeit der Kenntnis der absoluten Luminosität von $< 5\%$ und der relativen Luminosität von $< 1\%$ zu erreichen, muss die Position der verfahrbaren Siliziumpixeldetektoren im Luminositäts-Detektor relativ zum Wechselwirkungspunkt auf 0,2 mm bekannt sein. Diese Sensoren befinden sich in einer Vakuumbox, die sich durch den Atmosphärendruck verformt. Deswegen ist eine präzise Vermessung der Box erforderlich, was während des Vortrags erläutert werden wird.

HK 47.4 Wed 16:45 HK-H3

Design of a luminosity monitor for the P2 parity violating experiment at MESA — Sebastian Baunack[1], Boris Gläser[1], Kathrin Imai[1], Rahima Krini[1], Frank Maas[1,2,3], •Tobias Rimke[1], 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 P2 experiment at the future MESA accelerator in Mainz plans to measure the weak mixing angle $\sin^2(\theta_W)$ in parity violating elastic electron-proton scattering. The aim of the experiment is a very precise measurement of the weak mixing angle with a accuracy of 0.15% at a low four-momentum transfer of $Q^2 = 4.5 \cdot 10^{-3}$ GeV^2. In order to achieve this accuracy, it is necessary to monitor the stability of the electron beam and the liquid hydrogen target. Any helicity correlated fluctuations of the target density lead to false asymmetries.

Therefore, it is planned to install a luminosity monitor in forward direction close to the beam axis. The motivation and challenges for designing an air Cherenkov luminosity monitor will be discussed in this talk.

HK 47.5 Wed 17:00 HK-H3

Design of a Luminosity Monitor for MAGIX — •Theodoros Manoussos for the MAGIX-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität, D-55099 Mainz, Germany

The MAinz Gas Injection target eXperiment (MAGIX) will be operated in the energy-recovery mode of the Mainz Energy-recovery Superconducting Accelerator (MESA), a high-intensity electron accelerator currently under construction at the Institute of Nuclear Physics of the Johannes Gutenberg University in Mainz. The windowless design of the two multi-purpose spectrometers enables high precision measurements of the electromagnetic form factors of several nuclei, including the proton, the study of nuclear reactions of astrophysical relevance, as well as dark photon searches. Thereby, the luminosity is an important parameter, which needs to be accurately measured. In this talk, a design study for a luminosity monitoring system using the bremsstrahlung process will be presented.

HK 47.6 Wed 17:15 HK-H3

The Cooling Concept of the CBM Silicon Tracking System — •Kshitij Agarwal for the CBM-Collaboration — Eberhard Karls Universität Tübingen, Tübingen, Germany

As the core detector of the CBM experiment at the under-construction FAIR facility, the Silicon Tracking System (STS) located in the dipole magnet (1 T.m) provides track reconstruction ($> 95\%$) & momentum determination ($< 2\%$) of charged particles from the beam-target interactions ($sqrt(s_{NN}) = 2.9$ - 4.9 GeV). Due to the expected non-ionising irradiation damage at the end-of-lifetime (10^{14} n_{eq}(1MeV)/cm^2), the innermost silicon microstrip sensors will dissipate up to 6 mW/cm^2 at -10°C. So, it is crucial to always keep the silicon sensors at temperatures close to -10°C to avoid thermal runaway and reverse annealing by introducing minimal material budget in the detector acceptance.

The first part of this contribution will focus on the silicon sensor cooling concept, where cold gas (at -10°C) will be carried via thin carbon-fibre (CF) perforated tubes to directly cool the innermost silicon sensors. This will include the CFD Analysis of the sensor cooling concept with a 'toy model', and manufacturing of the perforated CF-tubes. The second part will touch upon the electronic cooling concept, where mono-phase 3M NOVEC 649 (at -40°C) will be used to keep the electronics temperature at -10°C. This will be substantiated with the CFD & Thermal Analysis. The contribution will be concluded by presenting the status of the thermal demonstrator, which will demonstrate the cooling concept under realistic operating conditions.

HK 48: Instrumentation XII

Time: Wednesday 16:00–17:15 Location: HK-H4

HK 48.1 Wed 16:00 HK-H4

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

HK 48.2 Wed 16:15 HK-H4

Crossing the Widom line: Cluster formation as sensitive

probe of supercritical fluids — •Sophia Vestrick, Clara Fischer, and Alfons Khoukaz — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, 48149 Münster, Germany

In contrast to the well-defined vapor pressure curve for fluids below the critical point, there is no distinct characterization as liquid or gas in the supercritical regime. Hence, the Widom line is proposed as location of a phase transition higher order. Whereas its experimental determination is typically challenging, we found a new and simple method for precisely measuring the phase transition of supercritical hydrogen using the formation of cluster beams. Due to the two distinct cluster formation mechanisms in the liquid and in the gaseous phase, an unambiguous assignment of supercritical fluids to liquid-like and gas-like regions is possible. The novel determination of the Widom line using cluster beams represents a universal method that can be easily applied to a wide range of elements or chemical compounds. This project has received funding from BMBF (05P21PMFP1), GSI FuE (MSKHOU2023) and the EU's Horizon 2020 programme (824093).

HK 48.3 Wed 16:30 HK-H4

Development of a high luminosity lithium target system — •Philipp Eckert, Patrick Achenbach, Julian Geratz, Pascal Klag, and Josef Pochodzalla — Institut für Kernphysik, Mainz, Germany

In preparation for a precision measurement of the hypertriton mass at MAMI by decay pion spectroscopy, a high luminosity lithium target has been developed. It is designed to be 5 cm long in the beam direction but at the same time narrow to minimize the momentum straggling for sideways exiting particles.

The setup is equipped with a cooling system to prevent the lithium from melting as well as thermal cameras to observe the deposited heat and the beam alignment. Before the data taking, a test beamtime with the target is foreseen for next spring.

This project is supported by the Deutsche Forschungsgemeinschaft, Grant Number PO256/7-1 and the European Union's Horizon 2020 research and innovation programme No. 824093.

HK 48.4 Wed 16:45 HK-H4

Electron scattering in argon at the MAGIX windowless gas jet target — •Maximilian Littich for the MAGIX-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland

MAGIX is a fixed target electron scattering experiment at the upcoming MESA accelerator. It will be operated in the energy recovery mode of the accelerator which allows to reach beam currents of at least 1 mA. This operation mode requires a thin target for which MAGIX will use an internal, windowless gas jet target. This cryogenic supersonic gas jet target will be able to run with different gases, e.g. hydrogen, deuterium, helium, oxygen, argon or xenon.

The MAGIX target is already existing and can be tested in the laboratory. At the existing A1 multi-spectrometer facility at the electron accelerator MAMI, we were able to operate the target with argon as the target gas and beam energies of 700 MeV and 240 MeV.

This talk will present the experimental setup used in the A1 facility and give a summary of the measurements performed. Finally an overview of the target performance and the current state of the analysis is given.

HK 48.5 Wed 17:00 HK-H4

Cluster size determination using shadowgraphy measurements — •Hanna Eick, Christian Mannweiler, Sophia Vestrick, and Alfons Khoukaz — Institute for Nuclear Physics, Westfälische Wilhelms-Universität Münster

Cluster-Jet Targets from the WWU Münster are an important component of several experiments at different research facilities.
One of them is the HHU Düsseldorf where the ARCTURUS laser is used to investigate the laser-cluster interaction. In this context measurements are performed in order to study the properties of the clusters themselves. These properties include the size of the clusters and their size distribution as well as the amount of gas in which the measured clusters are embedded.
The method used for this purpose is based on the shadowgraphy principle, in which images were taken during the illumination of the cluster beam by <30 fs ultrashort ARCTURUS laser pulses. The evaluation of cluster diameters has to be automated due to the large number of recorded photos.
The talk provides an overview of the evaluation method and presents the results of these analyses. First results show an average cluster size in the order of a few micrometer, which will also be of high interest for other installations using cluster beams.
This project has received funding from the EU's Horizon 2020 programme (824093).

HK 49: Instrumentation XIII

Time: Wednesday 16:00–17:00 Location: HK-H5

HK 49.1 Wed 16:00 HK-H5

Development of a method for the calibration of the backward end cap of the PANDA calorimiter — •Samet Katilmis[1], Alaa Dbeyssi[1], Alexander Greiner[1], David Rodriguez Pineiro[1], Dong Liu[1], Frank Maas[1,2,3], Julian Moik[1], Luigi Capozza[1], Oliver Noll[1,2], Peter-Bernd Otte[1], Sahra Wolff[1], and Cristoph Rosner[1] for the PANDA-Collaboration — [1]Helmoltz Institut Mainz, Germany — [2]Institute of Nuclear Physics, Johannes Gutenberg University, Mainz, Germany — [3]PRISMA Cluster of Excellence, Mainz, Germany

The PANDA-Experiment (Antiproton and Proton Annihilation at Darmstadt) is one of the main experimental pillars at the **F**acility for **A**ntiproton and **I**on **R**esearch at Darmstadt (FAIR), which currently is under construction.

The Backward Endcap Calorimiter (BWEC) is developed and built by the EMP group at the Helmholtz Institute Mainz. The BWEC consists of subunits called submodules. Each submodule houses electronic components, such as high voltage boards, ASICS, photodiodes, and others, whose characteristics must be determined for optimal operating settings. This includes determining the characteristics of avalanche photodiodes, high-voltage scans, and various other tests. This procedure is repeated several times for 48 submodules, so convenient, automatic and reconstructable calibration methods are developed.

HK 49.2 Wed 16:15 HK-H5

Recent developments regarding the final $\overline{\text{P}}$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 $\overline{\text{P}}$ANDA experiment will provide an excellent energy resolution over a wide dynamic range from a few dozens of MeV up to 15 GeV. The barrel part will consist of 16 segments. Each segment, with the exception of the two for the target pipe, includes 710 individual detectors. The main parts of each detector are a PWO-II crystal, two individual large area avalanche photo diodes and a preamplifier ASIC named APFEL (ASIC for Panda Frontend Electronics). In order to reveal the full potential of the calorimeter, even beyond the design goals, such aspects as the calibration, the APFEL settings and APD gains of each detector must be optimized to provide the best possible energy resolution.

In this talk the most recent progress concerning the final Barrel EMC design shall be presented.

This project is supported by BMBF, GSI and HFHF.

HK 49.3 Wed 16:30 HK-H5

Development of BaO*2SiO2:Ce (DSB:Ce) glass and glass ceramic scintillation material for future detectors — •Valerii Dormenev[1], Andrey Borisevich[2], Kai-Thomas Brinkmann[1], Mikhail Korzhik[2,3], Dmitry Kozlov[2], Markus Moritz[1], Rainer Novotny[1], Pavel Orsich[1,2], and Hans-Georg Zaunick[1] — [1]2nd Physics Institute, Justus Liebig University, Giessen, Germany — [2]Institute for Nuclear Problems of Belarus State University, Minsk, Belarus — [3]NRC "Kurchatov Institute", Moscow, Russia

Utilization of fast and efficient scintillating materials for radiation de-

tectors has played a crucial role in the discovery of the properties of matter in the last decades. However, the operation in a harsh radiation environment generated at high intensity machines such as the LHC and FAIR demonstrated their limitations and underlined the requirements for materials more tolerable to radiation damage in particular caused by high energy hadrons. Glass and glass ceramics can be considered as alternatives to crystal-based scintillators. Here we report on the performance of a low cost glass (BaO*2SiO2) and the glass ceramics DSB: Ce/Gd and in addition on aspects of industrial mass production. Admixing gadolinium oxide (Gd3+) even provides up to five times larger light yield. This work summarizes the present status of the overall performance of small and large samples.

The work was supported by funding of EU Horizon 2020 under Grant Agreement No 777222 (ATTRACT) and No 654002 (INTELUM), BMBF Project 05K2019 - UFaCal and in the spirit of the Crystal Clear Collaboration.

HK 49.4 Wed 16:45 HK-H5

Construction of the crystal Zero Degree Detector for BESIII — •Frederic Stieler[1], Achim Denig[1], Peter Drexler[1], Leonard Koch[2], Wolfgang Kühn[2], Werner Lauth[1], Jan Muskalla[1], Saskia Plura[1], Christoph Florian Redmer[1], and Yasemin Schelhaas[1] — [1]Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland — [2]II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Deutschland

The crystal Zero Degree Detector (cZDD) is a proposed addition to the BESIII experiment in China. In order to measure hadronic cross sections with the Initial State Radiation (ISR) method for a more precise calculation of the hadronic vacuum polarization contribution to the anomalous magnetic moment of the muon, ISR photons have to be detected. Since these photons are mostly emitted at small angles in relation to the colliding particles, the cZDD will measure these photons at angles of about 1.5 mrad to 10.4 mrad, that are not covered yet by the already existing detectors at BESIII.
In this presentation the design of the first prototype of the cZDD is discussed and further steps are motivated.

HK 50: Structure and Dynamics of Nuclei VIII

Time: Wednesday 16:00–17:45 Location: HK-H6

Group Report HK 50.1 Wed 16:00 HK-H6

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

The photoabsorption cross section of atomic nuclei has 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], can enhance reaction rates in the rapid neutron-capture process [2].
Real photon-scattering experiments are well suited to selectively study dipole excited states [3]. In these experiments, 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 bremsstrahlung (at DHIPS [4] and γELBE [5]) and with quasi-monoenergetic photons (at HIγS [6]) will be presented.
This work is supported by the BMBF (05P21PKEN9).

[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 50.2 Wed 16:30 HK-H6

Status report on the progress on the analysis of the NewSUBARU data — •Nikolina Lalić[1], Thomas Aumann[1,2], Takashi Ariizumi[3], Patrick van Beek[1], Ioana Gheorghe[4], Heiko Scheit[1], Dmytro Symochko[5], and Hiroaki Utsunomiya[3] — [1]Technische Unitversität Darmstadt, Germany — [2]GSI Helmholtzzentrum, Germany — [3]Department of Physics, Konan University, Japan — [4]"Horia Hulubei" National Institute for R & D in Physics and Nuclear Engineering (IFIN HH), Romania — [5]Physikalisch-Technische Bundesanstalt (PTB), Germany

The photoneutron cross sections of ^{112}Sn, ^{116}Sn, ^{120}Sn and ^{124}Sn were measured in (γ, xn) reactions, where $x \in [1, 4]$, using a quasi-monochromatic laser Compton-scattering γ-ray beam at the NewSUBARU facility. The goal of the experiment is to resolve the long-standing discrepancy of the total and partial cross sections measured by the Livermore and the Saclay groups. Measurements were done with γ energies from 8 MeV to 38 MeV. As a neutron counter a detector with a flat efficiency was used to take advantage of the direct neutron-multiplicity sorting technique. The (γ, xn) cross sections $x \in [1, 4]$ will be determined as well as the total photo absorption cross sections.
In this report the experiment and the current state of the ongoing analysis will be presented.
Suported by HMWK (LOEWE centre "Nuclear Photonics") and DFG (SFB 1245).

HK 50.3 Wed 16:45 HK-H6

Observational indications for broken axial symmetry in heavy nuclei — •Eckart Grosse[1] and Arnd R. Junghans[2] — [1]IKTP Technische Universität Dresden — [2]Helmholtz-Zentrum Dresden-Rossendorf

Following the observation of quadrupole moments in atomic hyperfine structure it became a custom to consider most nuclei as axially symmetric; this assumption is still in wide use, albeit it was falsified in several cases. Giving up axiality the apparent shapes in very many giant dipole resonances agree much better to data [EPJA 53, 225 (2017)] and we started to examine other experimental observations with respect on their sensitivity to axiality. Here we had to acknowledge that the popular I(I+1)-rule for rotational energy is strictly connected to axial symmetry. This changes the interpretation of ground state bands e.g. in actinide nuclei. The widely known R42 values (ratios of low level excitation energies) very surprisingly correlate to gamma-triaxialities derived in HFB-calculations modified by a generator coordinate approximation. And these values together with the backshift between experimental and Thomas-Fermi ground state masses allow satisfactory predictions of neutron resonance spacings in quasi all heavy nuclei. As also average widths of such resonances are predicted quite well we consider our findings a falsification of assuming axiality and point out that recent calculations of MC-shell model type [PRC 97, 014315 (2018)] support this statement.

HK 50.4 Wed 17:00 HK-H6

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

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 occuring occasional in one nucleon removal reactions[1-3]. Recent theoretical calculation of (p,pN) reactions with ^{14}O at 100 MeV/nucleon with the distorted-wave impulse approximation (DWIA) predicted a large asymmetric PMD [4]. The low momentum tail is due to the attractive potential between the residues and the outgoing nucleons and the steep falloff on the high momentum side is due to the energy and momentum conservation. Still, comparison with experimental data is necessary for validation and will be a basis for further spectroscopic factor studies. We have performed ^{14}O$(p,pn)^{13}$O and ^{14}O$(p,2p)^{13}$N reactions at 100 MeV/nucleon with a thin solid hydrogen target at SAMURAI at RIKEN. Momentum of the residues were extracted from the SAMURAI spectrometer. Details of the data analysis and preliminary results of the cross section and PMD 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 50.5 Wed 17:15 HK-H6

Correlation experiments in photofission — •Vincent Wende[1], Marius Peck[1], Joachim Enders[1], Sean W. Finch[2], Alf Göök[3], Calvin R. Howell[2], Maximilian Meier[1], Andreas Oberstedt[4], Stephan Oberstedt[5], Norbert Pietralla[1], Jack A. Silano[6], Anton P. Tonchev[6], and Werner Tornow[2] — [1]Institut für Kernphysik, TU Darmstadt, Darmstadt, Germany, — [2]Triangle Universities Nuclear Laboratory, Duke University, Durham, NC, USA, — [3]KTH Stockholm, Stockholm, Sweden, — [4]ELI-NP, IFIN-HH, Magurele, Romania, — [5]EC-JRC Geel, Belgium — [6]Lawrence Livermore National Laboratory, Livermore, CA, USA

Photon-induced reactions provide precision data on nuclear fission due to their selectivity on excitations of low multipolarity. Quasi-monochromatic polarized photon beams allow one to extract information about the transition states and channels through which the fission proceeds. To this end, the masses, total kinetic energy, and polar as well as azimuthal angular distributions of the fission fragments were measured simultaneously in a position-sensitive twin Frisch-grid ionization chamber [1]. We present first results of a pioneering ^{238}U(γ,f) experiment at the High-Intensity γ-Ray Source (HIγS) at an excitation energy of 11.2 MeV [2].

[1] A. Göök et al., Nucl. Instrum. Methods A 830, 366 (2016); M. Peck et al., EPJ Web of Conferences 239, 05011 (2020).
[2] M. Peck, Dissertation, TU Darmstadt (2020).

Supported by DFG (05P18RDEN9) and HMWK (LOEWE Cluster Nuclear Photonics).

HK 50.6 Wed 17:30 HK-H6

Temperature-dependent relative self absorption measurements in ^{27}Al at DHIPS — •P. Koseoglou, M. L. Cortes, J. Isaak, V. Werner, O. Papst, J. Kleemann, M. Beuschlein, N. Pietralla, U. Ahmed, K. E. Ide, I. Jurosevic, C. Nickel, M. Spall, T. Stetz, and R. Zidarova — Institut für Kernphysik, Technische Universität Darmstadt, 64289 Darmstadt, Germany

Self-absorption measurements probe the photoexcitation process of nuclear resonances and, thus, provide direct sensitivity to ground-state transition widths [1-3]. First temperature-dependent relative self-absorption (T-RSA) in nuclear resonance fluorescence measurements on ^{27}Al were performed at the Darmstadt High Intensity Photon Setup (DHIPS) of S-DALINAC. A technique was tested in which measurements are done at multiple absorber temperatures. The advantage of this technique, over the regular RSA, is the possibility to overcome the need for theory input on the effective temperatures, which can be complicated for compound materials, and the uncertainties that they introduce in the measured level widths [2]. The technique and the preliminary results of the first measurements will be presented.

This work was supported by the State of Hesse under grant "Nuclear Photonics" within the LOEWE program.

[1] N. Pietralla et al., Phys. Rev. C **51** 1021 (1995).
[2] U. Friman-Gayer et al., Phys. Rev. Lett. **126** 102501 (2021).
[3] A. Zilges, D. L. Balabanski, J. Isaak, N. Pietralla, Prog. Part. Nucl. Phys. **122** 103903 (2022).

HK 51: Structure and Dynamics of Nuclei IX

Time: Wednesday 16:00–17:30 Location: HK-H7

Group Report HK 51.1 Wed 16:00 HK-H7

Studying Exotic Nuclei with the FRS Ion Catcher — •Sönke Beck for the FRS Ion Catcher-Collaboration — Justus-Liebig-Universität, Gießen, Germany — GSI, Darmstadt, Germany

At the FRS at GSI, exotic nuclei are produced at relativistic velocities by projectile fragmentation or fission. With the FRS Ion Catcher (FRS-IC) experiment they can be slowed down and thermalized in a cryogenic stopping cell (CSC), which in addition contains a ^{252}Cf spontaneous fission source. Their mass and abundance can be measured using a multiple-reflection time-of-flight mass-spectrometer (MR-TOF-MS). The MR-TOF-MS has single-ion sensitivity and features resolving powers of up to one million, or broadband measurements, like covering more than 20 mass units with mass resolving powers exceeding 250 000 in a measurement time of about 10 ms. Thus, very low yields can be handled and masses of nuclei from different production mechanisms can be measured accurately.

High-accuracy mass measurements at the borders of the known nuclear landscape were performed, including neutron-deficient light lanthanides close to the proton drip line and neutron rich nuclei around the $N = 126$ shell closure. Masses of nuclei close to the $N = Z$ line shed light on nuclear structure, for instance the proton-neutron interaction. From the ^{252}Cf internal source, masses and yields of spontaneous fission products can be obtained. Further upgrades will allow studying multi nucleon transfer reactions, and the masses of the respective neutron-rich products can improve nuclear astrophysics r-process calculations. Recent results will be discussed, concluded by an outlook.

HK 51.2 Wed 16:30 HK-H7

Fission isomer studies with the FRS — •Jianwei Zhao[1], Timo Dickel[1,2], Moritz P. Reiter[3], Peter G. Thirolf[4], Michiharu Wada[5], Nazarena Tortorelli[4,1], and Ziga Brencic[6] for the S530-Collaboration — [1]GSI, Darmstadt, Germany — [2]JLU Gießen, Gießen, Germany — [3]University of Edinburgh, Edinburgh, UK — [4]LMU Munich, Munich, Germany — [5]Wako Nuclear Science Center, Saitama, Japan — [6]University of Ljubljana, Ljubljana, Slovenia

Multi-humped fission barriers as they occur in the actinide region give rise to isomeric fission. Such barrier shapes can be described as the result of superimposing microscopic shell corrections to the macroscopic liquid drop barrier. A whole 'island' of fission isomers has been identified in the actinide region (Z = 92 - 97, N = 141- 151) with presently 35 experimentally observed fission isomers. Half-lives range from 5 ps to 14 ms. We will present the results of fission isomer studies with the FRS at GSI. For the first time, the fragmentation of 1 GeV/u ^{238}U projectiles, instead of so-far used light-particle induced reactions, was employed to study fission isomers. The projectile fragmentation gives access to isotopes hard or impossible to reach by light particle reactions and the in-flight separation with FRS allows studying fission isomers with short half-lives. Most importantly, it provides beam with a high purity and with the event-by-event identification. Two detection methods were used to cover fission isomers with half-lives in the range of about 50 ns to 50 ms: beam implantation in a fast plastic scintillator and in a cryogenic stopping cell at the FRS Ion Catcher.

HK 51.3 Wed 16:45 HK-H7

Towards solving the puzzle of high temperature light (anti)-nuclei production in ultra-relativistic heavy ion collisions — •Tim Neidig[1], Carsten Greiner[1], Kai Gallmeister[2], Volodymyr Vovchenko[3], and Marcus Bleicher[1] — [1]Institut for Theoretical Physics, Frankfurt am Main, Germany — [2]nstitut for Theoretical Physics, Gießen, Germany — [3]Lawrence Berkeley National Laboratory, Berkeley, USA

The creation of loosely bound objects in heavy ion collisions, e.g. light clusters, near the phase transition temperature (T ~ 155 MeV) has been a puzzling observation that seems to be at odds with Big Bang nucleosynthesis suggesting that deuterons and other clusters are formed only below a temperature T ~ 0.1-1 MeV. We showed that the light cluster abundancies in heavy ion reactions stay approximately constant from chemical freeze-out to kinetic freeze-out. To this aim we develop an extensive network of coupled reaction rate equations including stable hadrons and hadronic resonances to describe the temporal evolution of the abundancies of light (anti-)(hyper-)nuclei in the late hadronic environment of an ultrarelativistic heavy ion collision. However, because of the partial chemical equilibrium of the stable hadrons, including the nucleon feeding from resonances, the abundancies of the light nuclei stay nearly constant during the evolution and cooling of the hadronic phase and are in excellent agreement with those measured by ALICE at LHC.

HK 51.4 Wed 17:00 HK-H7

Coalescence in Monte Carlo generators and implications for cosmic ray studies — •Maximilian Horst — Technical University Munich

Coalescence is one of the main models used to describe the formation of light (anti)nuclei. It is based on the hypothesis that two nucleons close in phase space can coalesce and form a nucleus. Coalescence has been successfully tested in hadron collisions at colliders, from small (pp col-

lisions) to large systems (Au-Au collisions). However, in Monte Carlo simulations (anti)nuclear production is not described by event generators. A possible solution is given by the implementation of coalescence afterburners, which can describe nuclear production on an event-by-event basis. This idea would find application in astroparticle studies, allowing for the description of (anti)nuclear fluxes in cosmic rays, which are crucial for indirect Dark Matter searches. In this presentation, the implementation of event-by-event coalescence afterburners will be discussed, focusing on different approaches and on the comparison with the experimental results for different collision systems.

HK 51.5 Wed 17:15 HK-H7

The PUMA Experiment: Investigating Short-lived Nuclei with Antiprotons — •Alexander Schmidt, Alexandre Obertelli, and Frank Wienholtz — Technische Universität Darmstadt

The antiProton Unstable Matter Annihilation (PUMA) experiment is a nuclear physics experiment at CERN which will provide the ratio of protons to neutrons in the tail of the nucleon density distributions to constrain nuclear structure theories. To determine this ratio, the interaction of antiprotons and nuclei at low relative energies is used. Following the captures of the antiproton by the nucleus (formation of antiprotonic atom), the antiproton cascades towards the nucleus and eventually annihilates with a nucleon. This annihilation conserves the total charge, so that the annihilated nucleon can be identified by detecting all charged pions produced in the annihilation. The process takes place at larger radii than usual nuclear reactions (e.g. nucleon removal reactions), making this method unique for nuclei with a high neutron-to-proton asymmetry, i.e. short-lived nuclei close to the driplines, halo nuclei and nuclei with a thick neutron skin. As there is no joint facility for antiprotons and short-lived nuclei available, a transportable experimental setup is needed to bring antiprotons from ELENA/CERN to the nuclei at ISOLDE/CERN.

This talk will give an overview over the fundamental physics, the experimental setup and technique as well as the current status of the experiment.

HK 52: Hadron Structure and Spectroscopy IX

Time: Wednesday 16:00–17:30 Location: HK-H8

HK 52.1 Wed 16:00 HK-H8

Recent polarization observable results in η- and η'-photoproduction off the proton. — •Jakob Krause for the CBELSA/TAPS-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn.

While generally good agreement exists for low lying baryonic resonances, especially for high masses there are much more resonances predicted than actually found. This is also known as the problem of the "missing resonances", indicating the poor understanding of QCD in the non-perturbative region. Studying meson photoproduction off the nucleon promises to give further insight into the nucleon excitation spectrum. The analysis thereof requires partial wave analysis (PWA) to identify contributing resonances. It is essential to measure single and double polarization observables in order to find unambiguous PWA solutions. The CBELSA/TAPS experiment located at the electron stretcher accelerator ELSA in Bonn is dedicated to measuring different polarization observables in meson photoproduction employing a polarized photon beam and a polarized target.

This talk will present preliminary results concerning the polarization observable Σ in the reactions $\gamma p \to p\eta$ and $\gamma p \to p\eta'$ measured at the CBELSA/TAPS experiment, which were obtained using Bayesian inference.

HK 52.2 Wed 16:15 HK-H8

Study of neutral-pion pair production in two-photon scattering at BESIII — •Max Lellmann, Achim Denig, and Christoph Florian Redmer 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 4.2σ between Standard Model prediction and measurement. It is still unclear whether this discrepancy is due to a mistake in the measurement, due to a hint for New Physics, or due to a poor understanding of strong interaction at low energies.

The uncertainty of the standard model prediction of a_μ is currently limited by the calculation of the hadronic contributions. The hadronic Light-by-Light contribution to a_μ yields the largest relative uncertainty of all contributions. It is crucial to obtain a better understanding of the coupling of photons to hadrons, especially at small momentum transfers.

The BESIII experiment, located at the institute of high energy physics in Beijing/China, offers a perfect test bed for the investigation of two-photon processes at small momentum transfers. The process $e^+e^- \to e^+e^-\pi^0\pi^0$ is measured at the BESIII experiment at centre-of-mass energies between 3.77 and 4.6 GeV with a total integrated luminosity of more than 10 fb^{-1}. This presentation will discuss the current status of the analysis.

HK 52.3 Wed 16:30 HK-H8

Study of the diffractively produced $\pi\pi\omega$ Events at COMPASS — •Philipp Haas — Physik-Department E18, Technische Universität München

The COMPASS experiment is a multi-purpose fixed-target experiment at the CERN SPS. One of its major goals is the search for so-called exotic mesons that cannot be described as quark-antiquark states. To this end, COMPASS has acquired large data samples on diffractive production of exited light mesons by a 190 GeV/c π^- beam on a proton target. The $\pi_1(1600)$ meson with spin, parity, and charge-conjugation quantum numbers $J^{PC} = 1^{-+}$, which are forbidden for $q\bar{q}$ states, is a promising candidate for a hybrid meson and agrees with predictions from lattice QCD. Lattice QCD further predicts that the $\pi_1(1600)$ dominantly decays into $b_1(1235)\pi$.

While $\pi_1(1600)$ signals have been found in the COMPASS data on $\rho(770)\pi$, $\eta\pi$, and $\eta'\pi$ decay modes, the $b_1(1235)\pi$ channel has so far not been studied. We will present first results of an analysis of COMPASS data on the diffractive process $\pi^-p \to \pi^-\pi^0\omega(782)p$, which includes the $b_1(1235)\pi$ channel. We performed an event selection resulting in a data sample of 730000 events. These data contain clear signals for $b_1(1235) \to \omega(782)\pi$ and will help us to study the $\pi_1(1600)$, and to verify the $\pi_1(2015)$ signal claimed by the BNL E852 experiment.

HK 52.4 Wed 16:45 HK-H8

The full COMPASS dataset of the diffractively produced $\eta^{(\prime)}\pi^-$ final state — •Henri Pekeler, Simon Havemann, David Spülbeck, Mathias Wagner, and Bernhard Ketzer for the COMPASS-Collaboration — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

The diffractive production of the $\eta^{(\prime)}\pi^-$ system in the $p + \pi^- \to \eta^{(\prime)}\pi^- + p$ channel is very exciting because the partial wave with orbital angular momentum $L = 1$ between the two pseudoscalars carries spin-exotic quantum numbers $J^{PC} = 1^{-+}$. The observation of a resonance in this wave is considered a smoking gun for a hybrid meson with gluonic degrees of freedom.

Data for diffractive π^- proton scattering was taken by COMPASS in two different years. In the talk, we will present the full data set, which, together with recent improvements for the reconstruction, yields an increase of the data sample around a factor of 2 with respect to the data published previously by COMPASS, and around a factor of 4 compared to earlier data sets collected by the E852 collaboration. This allows us to perform a 2-dim. PWA in bins of the invariant mass and the 4-momentum transfer squared t.

Supported by BMBF.

HK 52.5 Wed 17:00 HK-H8

Analysis of data from a pilot run to measure the proton charge radius at AMBER — •Martin Hoffmann for the AMBER-Collaboration — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

The proton charge 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 as

well as laser-spectroscopy of muonic and ordinary hydrogen yielded contradicting results. The AMBER collaboration plans to conduct a precision measurement of the proton electric form factor using high-energy muon-proton elastic scattering. This complementary approach avoids many of the systematic uncertainties of low-energy electron-proton elastic scattering.

The recoil proton is going to be detected in a high-pressure hydrogen time projection chamber (TPC), measuring the transferred momentum. The muon kinematics will be measured with silicon tracking detectors surrounding the TPC and parts of the upgraded COMPASS spectrometer. In 2021, a pilot run was performed in order to study key parts of the full setup under realistic beam conditions.

This contribution presents preliminary results of the pilot run analysis and on-going Monte Carlo simulations.

Supported by EU.

HK 52.6 Wed 17:15 HK-H8

Unified Tracking Stations for the Proton-Radius Measurement at AMBER — •Karl Eichhorn for the AMBER-Collaboration — 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 2023. 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. A combined measurement of the recoil proton and the muon trajectory will be performed. In addition to the precise information about the recoil proton provided by the TPC, a novel unified tracking station is foreseen for an accurate measurement of the scattered muon. Thin scintillating fibers read out by SiPMs joint with monolithic silicon-pixel detectors are used for the reconstruction of the scattered muon. A first prototype beam test is foreseen in the year 2022. We present on-going studies and developments of this unified tracking station.

HK 53: Hadron Structure and Spectroscopy X

Time: Wednesday 16:00–17:30 Location: HK-H9

Group Report HK 53.1 Wed 16:00 HK-H9

The BGOOD Experiment at ELSA - Exotic Structures in the *uds* Sector? — •Johannes Gross for the BGOOD-Collaboration — Physikalisches Institut Bonn

The discoveries of the X-, Y-, Z-states in the hidden charm meson sector by Belle and the P_c baryon states by LHCb shed a new light on our understanding of hadronic structure formation: Multi-quark states beside the conventional $q\bar{q}$ and qqq states now have unambiguously been realised. Such states could manifest themselves as single color-bound objects or, contrary, as molecular-like meson-meson or meson-baryon formations. Intriguingly, similar effects to those in the charm sector may be evidenced in the light *uds* sector. In order to study this, access to extreme forward angles and low transverse momentum kinematics is mandatory. To realise this, the BGOOD experiment at ELSA combines a central calorimeter for neutral meson identification with a forward spectrometer for charged particle identification. First results of the BGOOD experiment that support the possibility of such exotic structures are presented, e.g. cross section measurements of $\gamma p \rightarrow K^+\Lambda(1405)$, $\gamma p \rightarrow K^+\Sigma^0$ and $\gamma n \rightarrow K^0\Sigma^0$ that show pronounced structures in the proximity of production thresholds.

Supported by DFG projects 388979758/405882627 and the European Union's Horizon 2020 programme, grant 824093.

HK 53.2 Wed 16:30 HK-H9

Search of the exotic nuclear two-photon emission decay in isochronous heavy ion storage rings — •David Freire[1,2,3,4], F. Çağla Akinci[5], Klaus Blaum[1,2], Wolfram Korten[3], Yuri A. Litvinov[2,4], Shahab Sanjari[4,6], and the E143 Collaboration[4] — [1]Max Planck Institute for Nuclear Physics, D-69117 Heidelberg, Germany — [2]Heidelberg University, D-69117 Heidelberg, Germany — [3]IRFU, CEA, Université Paris-Saclay, F-91191 Gif-sur-Yvette, France — [4]GSI Helmholtz Center, D-64291 Darmstadt, Germany — [5]Istanbul University, T-34452 Istanbul, Turkey — [6]Aachen University of Applied Sciences, D-52005 Aachen, Germany

The nuclear two-photon (2γ) decay is a rare decay mode in atomic nuclei whereby a nucleus in an excited state emits two gamma rays simultaneously. First order processes usually dominate the decay, however two-photon emission may become significant when first order processes are forbidden or strongly retarded, which can be achieved at the experimental storage ring ESR (GSI/FAIR). Within this work we will present the implemented methodology and the obtained results of two beam times performed in 2021, when for the first time the isochronous mode of ESR alongside non-destructive Schottky detectors were operated for the study of short-lived isomer production yields and lifetimes. We investigated specifically the isotope ^{72}Ge, as it is the most easily accessible nucleus having a first excited 0^+ state below the pair creation threshold paramount for the study of 2γ decay without competition of first order decays. In addition, the nuclei ^{70}Se and ^{72}Br were studied, as their isomeric states play a major role in nuclear astrophysics.

HK 53.3 Wed 16:45 HK-H9

Lifetime Measurement in ^{206}Rn and ^{202}Pb via γ-γ Fast-Timing Spectroscopy — •Mario Ley, Arwin Esmaylzadeh, Lukas Knafla, Jean-Marc Régis, and Jan Jolie — Institut für Kernphysik, Universität zu Köln

Lifetimes of the first excited 2^+ , 4^+ , 6^+ , 8^+ states in ^{206}Rn and the 2^+ and 4^+ states in ^{202}Pb were measured using the γ-γ fast-timing technique with a detector array consisting of $LaBr_3$(Ce) and HPGe detectors. The experiment was performed at the FN-Tandem accelerator of the Institute for Nuclear Physics at the University of Cologne. The well established Generalized Centroid Difference (GCD) method [1], which is suitable for the determination of lifetimes in the pico- to nanosecond regime, was used to determine the lifetimes.

The derived reduced transition probabilities are discussed with regard to the onset of collective structures for low-lying excited states in ^{206}Rn and the results are compared with shell-model calculations based on the Nucleon Pair Approximation [2].

[1] J.-M. Régis et al., Nucl. Instrum. Methods Phys. Res. A 726 (2013)
[2] Z. Y. Xu, Y. Lei, Y. Zhao, A. Arima, et al., Phys. Rev. C, 79:054315, (2009)

HK 53.4 Wed 17:00 HK-H9

Preliminary results of Lifetime Measurements in ^{208}Rn via γ-γ Fast-Timing Spectroscopy — •Jan Garbe, Dennis Bittner, Arwin Esmaylzadeh, Guillaume Häfner, Vasil Karayonchev, Jean-Marc Regis, and Jan Jolie — Institut für Kernphysik, Universität zu Köln

Lifetimes of low-lying excited states in ^{208}Rn were measured using the γ-γ fast-timing technique with a detector array consisting of 12 $LaBr_3$(Ce) and 8 HPGe detectors. The experiment was performed at the 10 MV FN-Tandem accelerator of the Institute for Nuclear Physics at the University of Cologne. The sub-nanosecond lifetimes were determined by means of relative centroid shift measurements.
These results were then compared to shell-model calculations.

HK 53.5 Wed 17:15 HK-H9

Lifetime measurements in the ground-state band in ^{104}Pd — •Maximilian Droste[1], Andrey Blazhev[1], Peter Reiter[1], Nigel Warr[1], Konrad Arnswald[1], Marcel Beckers[1], Robert Hetzenegger[1], Rouven Hirsch[1], Levent Kaya[1], Lukas Knafla[1], Lars Lewandwoski[1], Claus Müller-Gatermann[1], Pavel Petkov[2,1], Dawid Rosiak[1], Burkhard Siebeck[1], Andreas Vogt[1], and Kai Wolf[1] — [1]Institut für Kernphysik, Universität zu Köln — [2]Horia Hulubei National Institute for Physics and Nuclear Engineering, Romania

Direct lifetime measurements in ^{104}Pd were motivated to close a gap

along the Pd isotope chain. Excited states were populated via the fusion evaporation reaction ^{96}Zr(^{12}C,4n)^{104}Pd at 55 MeV. Lifetime values and reduced transition probabilities were determined in the ground-state band up to the 12^+ state in ^{104}Pd employing the Recoil Distance Doppler-Shift method. The new B(E2; $2^+ \rightarrow 0^+$) value deviates from the evaluated values, which were determined using Coulomb excitation. The transition strengths of higher lying states were obtained for the first time. Recent investigations in other medium weight even-even Pd isotopes question the vibrational character of these Pd isotopes. The experimental results are compared to Large Scale Shell-Model calculations (LSSM) employing the Sr88MHJM interaction. LSSM along the $^{96-106}$Pd isotope chain were performed allowing detailed comparison of level schemes and reduced transition strength values.

HK 54: Nuclear Astrophysics III

Time: Wednesday 16:00–17:30 Location: HK-H10

Group Report HK 54.1 Wed 16:00 HK-H10

Neutronen-induzierte Reaktionen für die Astrophysik — •Mario Weigand, Ernest Ademi, Marcel Bennedik, Lukas Bott, Benjamin Brückner, Sophia Florence Dellmann, Philipp Erbacher, Madeleine Gail, Nicolai Gimbel, Kathrin Göbel, Alexandra Härth, Tanja Heftrich, Svenja Heil, Benedict Heybeck, Alexander Huhn, Sabina Kasilovskaja, Deniz Kurtulgil, Tabea Kuttner, Rim Mourad, Markus Reich, René Reifarth, Tom Staab, Janina Strahl, Diego Vescovi und Meiko Volknandt — Goethe-Universität, Frankfurt a.M., Germany

Für das Verständnis der Häufigkeiten der meisten Elemente schwerer als Eisen spielen Neutroneneinfangreaktionen eine entscheidende Rolle, da die Synthese dieser Elemente durch sukzessive Neutroneneinfänge und Betazerfälle in Sternen verschiedener Stadien erfolgt. Entsprechende Nukleosynthese-Modelle bedürfen experimenteller Daten zu den beteiligten Reaktionsraten. Die Forschungsgruppe "Experimentelle Astrophysik" an der Goethe-Universität Frankfurt hat daher einen Schwerpunkt auf die Messung von Neutroneneinfangwirkungsquerschnitten im astrophysikalisch relevanten Energiebereich gelegt und nutzt dazu die etablierte Aktivierungsmethode. Dabei werden neue Ansätze verfolgt, um Wirkungsquerschnitte für quasistellare Neutronenspektren von T = 5 bis 90 keV zu bestimmen. In diesem Vortrag werden aktuelle Projekte und die neuesten Ergebnisse der letzten Messkampagnen vorgestellt und ein Ausblick über künftige Vorhaben gegeben. Diese Forschungsarbeiten werden gefördert durch das Helmholtz International Center for FAIR.

HK 54.2 Wed 16:30 HK-H10

Proton capture on stored radioactive ions — •Sophia Florence Dellmann[1], Jan Glorius[2], Yuri Litvinov[2], René Reifarth[1], Thomas Stöhlker[2,3], Laszlo Varga[2], and Mario Weigand[1] for the E127-Collaboration — [1]Goethe University Frankfurt, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung Darmstadt, Germany — [3]Helmholtz-Institut Jena, Germany

By combining two unique facilities at GSI (Helmholtz Centre for Heavy Ion Research), the fragment separator FRS and the experimental storage ring ESR, the first direct measurement of a proton capture reaction of a stored radioactive isotope has been accomplished. The cross section of the ^{118}Te(p,γ) reaction was measured at energies of astrophysical interest.

The ions were stored with energies of 6 and 7 MeV/nucleon and interacted with a hydrogen jet target. The produced ^{119}I ions were detected with double-sided silicon strip detectors. The radiative recombination process of the fully stripped ^{118}Te ions and electrons from the hydrogen target was used as a luminosity monitor. The proof-of-principle experiment had been performed in 2016 with the stable isotope ^{124}Xe [1]. An overview of the experimental method and preliminary results from the ongoing analysis will be presented.

[1]J. Glorius et al., Phys. Rev. Lett. 122, 092701 (2019)

HK 54.3 Wed 16:45 HK-H10

Nearly background-free measurement of proton-capture reactions using the Experimental Storage Ring — •Laszlo Varga[1], Sophia Florence Dellmann[2], Jan Glorius[1], Yuri A. Litvinov[1], René Reifahrt[2], and Thomas Stöhlker[1,3] for the E127-Collaboration — [1]GSI Helmholtzzentrum für Schwerionenforschung Darmstadt, Germany — [2]Goethe University Frankfurt, Germany — [3]Helmholtz-Institut Jena, Germany

After the successful campaign for proton-capture measurements on stored stable beams at the Experimental Storage Ring at GSI in 2009 and 2016 [1-2], new experiments have been carried out in 2020 and 2021 using a radioactive ion beam. The complex spatial ion hit distributions on the employed UHV-compatible double sided silicon strip detectors (DSSSD) have been modeled through Monte-Carlo based ion-optical simulations using the MOCADI code [3]. To improve the sensitivity of the experimental method the "Elimination of the Rutherford elAstic ScattEring" (ERASE) technique has been developed. With the application of ERASE the sensitivity for the ions of interest is dramatically increased. The suitability of the method was demonstrated in 2020 and in 2021. In this talk, the measured ion-hit spectra of the DSSSD will be introduced focusing on the effects of the ERASE technique. The newly developed method is a powerful tool to study the proton-capture efficiently on nuclei hardly accessible in large quantities.

[1] - Mei B et al 2015 Phys. Rev. C92 035803
[2] - Glorius J et al 2019 Phys. Rev. Lett. 122 092701
[3] - Iwasa N et al 1997 NIM B 126 284-289

HK 54.4 Wed 17:00 HK-H10

Analysis of the 3α-decay of the 0_2^+ state in ^{12}C — •David Werner[1], Madalina Ravar[1,3], Peter Reiter[1], Konrad Arnswald[1], Maximilian Droste[1], Pavel Golubev[2], Rouven Hirsch[1], Hannah Kleis[1], Nikolas Königstein[1], Dirk Rudolph[2], Alessandro Salice[1], and Luis Sarmiento[2] — [1]University of Cologne, Institute for Nuclear Physics, Cologne — [2]Lund University, Department of Physics, Lund, Sweden — [3]TU Darmstadt, Institute of Nuclear Physics, Darmstadt

The branching ratios of the three-particle decay of the Hoyle state, the 0_2^+ excited state in ^{12}C, are an important probe for the inner structure of ^{12}C and relevant to the topic of stellar nucleosynthesis. A ^{12}C(α,α') reaction at 27 MeV beam energy was utilized to populate the state of interest. Two high-statistics experiments were performed at the 10 MV FN-tandem accelerator of the Institute for Nuclear Physics of the University of Cologne. The Lund-York-Cologne-Calorimeter (LYCCA) was used to study the three-particle decay branches of the Hoyle state. The 18 highly-segmented double-sided silicon strip detectors allowed individual detection of the reaction's four α particles with very high angular precision. Results from particle spectra are compared with Geant4 Monte-Carlo simulations. Preliminary results of the analysis, in particular Dalitz plots, will be presented.

HK 54.5 Wed 17:15 HK-H10

Measurement of the inelastic cross sections of antinuclei with ALICE and the implications for indirect dark matter searches — •Stephan Koenigstorfer for the ALICE-Collaboration — Technische Universität München

Antinuclei in cosmic rays are considered a unique probe for signals from exotic physics, such as WIMP Dark Matter annihilations. Indeed, these channels are characterised by a very low astrophysical background, which comes from antinuclei produced by high energy cosmic ray interaction with ordinary matter. In order to make quantitative predictions for antinuclei fluxes near earth, both the production and annihilation cross sections of antinuclei need to be accurately known down to low energies.

In ultra relativistic pp and Pb-Pb collisions at the CERN LHC, matter and antimatter are abundantly produced in almost equal amounts, allowing us to study the production of antinuclei and measure their absorption in the detector material. The antinuclei absorption cross section is evaluated on the average ALICE material. Using this result, we then predict the transparency of our galaxy to anti-3He from both dark matter annihilations and high energy cosmic ray collisions. In this talk we present the first measurements of the anti-3He and anti-3H absorption cross section with ALICE and we discuss the implications of these results for indirect Dark Matter searches using cosmic antinuclei.

HK 55: Invited Talks V

Time: Thursday 11:00–12:30 Location: HK-H1

Invited Talk HK 55.1 Thu 11:00 HK-H1

Online data processing with GPUs in ALICE during LHC Run 3 — •David Rohr for the ALICE-Collaboration — CERN, Geneva, Switzerland

The ALICE experiment has undergone a major upgrade for LHC Run 3 and will record 50 times more heavy ion collisions than before. The new computing scheme for Run 3 replaces the traditionally separate online and offline frameworks by a unified one. Processing will happen in two phases. During data taking, a synchronous processing phase performs data compression, calibration, and quality control on the online computing farm. The output is stored on an on-site disk buffer. When there is no beam in the LHC, the same computing farm is used for the asynchronous reprocessing of the data which yields the final reconstruction output. ALICE will employ neither hardware nor software triggers for Pb-Pb data taking but instead store all collisions in compressed form. This requires full online processing of all recorded data, which is a major change compared to a traditional online systems, which sees only the data selected by a hardware trigger. To cope with the increased data rate and computing requirement, ALICE employs graphics cards (GPUs) as the backbone of the online processing. In order to make full use of the online farm also for asynchronous reconstruction, also a large fraction of the asynchronous phase is being designed to run on GPUs. The talk will detail the ALICE Run 3 computing scheme, and outline the hardware architecture and software design for synchronous and asynchronous processing.

Invited Talk HK 55.2 Thu 11:30 HK-H1

From outer space to deep inside: nuclear physics prospects at MAMI and MESA — •Michaela Thiel — Institut für Kernphysik, JGU Mainz

The Equation of State (EoS) links together fundamental properties of nuclear matter. Heavy nuclei, though orders of magnitude smaller than neutron stars, are governed by the same underlying physics, which is enshrined in the EoS. An accurate and model-independent determination of the neutron-skin thickness of heavy nuclei, using parity-violating electron scattering, will provide significant constraints on the density dependence of the nuclear symmetry energy, a key parameter of the EoS. Within the scope of the P2 experimental setup at MESA, the Mainz Radius EXperiment (MREX) will determine the neutron-skin thickness of ^{208}Pb with ultimate precision. For the interpretation of this and future parity-violation measurements at the precision frontier, theoretical predictions with uncertainties below those of the experiments are required. To that end it is mandatory to go beyond the one-photon exchange approximation and include higher-order corrections. Corresponding measurements of the beam-normal single spin asymmetry A_n, an observable sensitive to two-photon exchange processes, are essential to benchmark such calculations. A comprehensive systematic study of the Q^2 and Z dependence of A_n in the mass regime ^{12}C to ^{90}Zr at MAMI, using the A1 spectrometer setup, has laid an excellent foundation for the near-future parity-violation measurement program at MESA. Status and prospects of the projects will be presented. (Talk will be given on behalf of the A1 and P2 collaborations)

Invited Talk HK 55.3 Thu 12:00 HK-H1

CMOS Monolithic Active Pixel Sensors — •Michael Deveaux — GSI Darmstadt

Being pioneered by the IPHC Strasbourg, CMOS Monolithic Active Pixel Sensors for charged particle tracking feature an attractive combination of highest detection efficiency, spatial precision (~ 5 μm) and low power dissipation. The 50 μm thin sensors may be combined with ultra-light support structures and cooling systems. Thanks to progress in CMOS industry and the joined efforts of the community, their rate capability and radiation tolerance were improved by several orders of magnitude during the past 20 years. The maturity reached nowadays allows to use the sensors in multiple applications requiring highest tracking precision in combination with advanced rate capability and time resolution. This includes state-of-the-art tracking and vertex detectors as known from STAR, ALICE, the future CBM experiment and possibly future charm and Higgs factories.

The contribution summarizes the features, capabilities and remaining limitations of the technology and gives a brief insight into current R&D activities within and beyond the hadron physics community.

HK 56: Heavy-Ion Collisions and QCD Phases XI

Time: Thursday 14:00–15:30 Location: HK-H1

Group Report HK 56.1 Thu 14:00 HK-H1

ALICE 3 – A Next-Generation Heavy-Ion Experiment — •Sebastian Scheid for the ALICE-Collaboration — Goethe University, Frankfurt, Germany

In this contribution we will present ALICE 3, a detector proposed for the next-generation heavy-ion program in LHC Run 5 and 6. The innovative detector concept, will give access to novel measurements of electromagnetic and hadronic probes of the QGP at very low momenta that will remain inaccessible in LHC Run 3 and 4. This includes the multi-differential measurement of thermal dileptons, that provide insight on the early phases of the medium formation. The measurement of multi charm states and exotic objects in the heavy flavour sector, as well as the correlation of heavy-flavour hadrons can be used to gain information on the hadronisation and strong interaction processes.

To achieve these measurements the detector has to provide tracking and particle identification down to lowest transverse momenta with an unprecedented pointing resolution while keeping the material budget to a minimum.

HK 56.2 Thu 14:30 HK-H1

Production of non-prompt Λ_c^+ in pp collisions at $\sqrt{s} = 13$ TeV with ALICE — •Daniel Battistini for the ALICE-Collaboration — Università degli Studi di Torino, Turin, Italy

In proton-proton (pp) collisions, the production of heavy-flavour (HF) hadrons is typically described as a convolution of the parton distribution functions of the colliding protons, the partonic cross section, and the Fragmentation Functions (FFs). The latter describes the hadronisation of the heavy quarks in the different hadron species, and, since this process is non-perturbative, it is usually parametrised from measurements in e^+e^- collisions. However, recent studies by the ALICE Collaboration show that the ratio between the production of charm baryons with respect to mesons is significantly higher in hadronic collisions compared to e^+e^- interactions, invalidating the assumption that the FFs are independent of the collision system.

This contribution presents an extension of the studies on HF-baryon production in hadronic collisions to the beauty sector, via the measurement of the transverse-momentum-differential production cross section of Λ_c^+-baryon originating from beauty-hadron decays in pp collisions at $\sqrt{s} = 13$ TeV. The measurement will also be compared to theoretical predictions based on fixed order plus next to the leading logarithm pQCD calculations folded with the beauty-hadron to Λ_c^+ decay kinematics from PYTHIA8 simulations.

HK 56.3 Thu 14:45 HK-H1

CBM performance for the measurement of strange hyperons' anisotropic flow in Au+Au collisions at FAIR SIS-100 energies — •Oleksii Lubynets[1,2] and Ilya Selyuzhenkov[1,3] for the CBM-Collaboration — [1]GSI, Darmstadt, Germany — [2]Goethe Universität Frankfurt, Germany — [3]NRNU MEPhI, Moscow, Russia

The main goal of the CBM experiment is to study highly compressed baryonic matter produced in collisions of heavy ions. The SIS-100 accelerator at FAIR will enable investigation of the QCD matter at temperatures up to about 120 MeV and net baryon densities 5-6 times the normal nuclear density. Hyperons produced during the dense phase of a heavy-ion collision provide information about the equation of state of the QCD matter. The measurement of (multi)strange hyperons' anisotropic flow is important for understanding the dynamics and evolution of the QCD matter created in the collision.

We will present the status of performance studies for strange hyperons anisotropic flow measurement for the CBM experiment at FAIR. Strange hyperons decay within the CBM detector volume and are reconstructed via their decay topology. The Particle-Finder Simple package, which provides an interface to the Kalman Filter Particle mathematics, is used to reconstruct decay kinematics and to optimize criteria for strange hyperons candidates selection. Anisotropic flow of strange hyperons is studied as a function of rapidity, transverse momentum and collision centrality. The effects due to non-uniformity of the CBM detector response in the azimuthal angle, transverse momentum and rapidity are corrected using the QnTools analysis package.

HK 56.4 Thu 15:00 HK-H1

Σ^0 reconstruction in Ag+Ag collisions at $\sqrt{s_{NN}} = 2.55$ GeV with HADES — •Marten Becker for the HADES-Collaboration — Justus-Liebig-University Giessen

HADES investigates the moderate temperature and high density regime of the QCD phase diagram. Strangeness can give a direct insight into the created dense matter, in particular close to the nucleon nucleon production threshold. In 2019 HADES collected Ag+Ag collisions at 2.55 GeV center of mass energy. A newly installed electromagnetic calorimeter allows for photon detection. Furthermore the RICH detector was upgraded, which strongly improves electron identification and the detection of conversion-pairs. In this contribution preliminary results on the search for the Σ^0 baryon, decaying electromagnetically into $\Lambda + \gamma$ will be presented. Detailed simulations prove the feasibility of this measurement using photon detection in the electromagnetic calorimeter or by employing photon conversion method based on the reconstruction of low momentum electrons in the RICH. Using the photon detected in the electromagnetic calorimeter an estimate of the Λ/Σ^0 ratio will be extracted.

HK 56.5 Thu 15:15 HK-H1

K^0_S and Λ production in and outside jets in pp collisions at 13 TeV — •Lucia Anna Tarasovičová — Westfälis- che Wilhelms-Universität Münster, Germany

The contribution of jet fragmentation and soft processes to the strange hadron production in small collisions is still not understood well. Thus, angular correlations between particles can be utilised to study soft and hard fragmentation and production processes as well as the role of multiple parton interactions. Moreover, a study of the multiplicity dependence can further differentiate between the connection of bulk-particle and strangeness production in a more dense environment and the potential role of collective effects. In this talk, we present results on the two-particle correlation studies with respect to a primary charged hadron with high-p_{T} (3-20 GeV/c) in pp collisions at 13 TeV measured with ALICE. The production of associated K^0_S mesons, Λ hyperons and primary charged hadrons in jets and out of jets is studied as a function of the transverse momentum of the trigger and associated particles for several event-multiplicity classes. The yields will be compared among different associated particles and compared with PYTHIA and EPOS LHC event generators.

HK 57: Heavy-Ion Collisions and QCD Phases XII

Time: Thursday 14:00–15:30 Location: HK-H2

HK 57.1 Thu 14:00 HK-H2

Measurement of direct photons in $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV Pb-Pb collisions with ALICE at the LHC — •Meike Danisch for the ALICE-Collaboration — Physikalisches Institut Heidelberg

Measurements of direct photons can provide valuable information on the properties and dynamics of the quark-gluon plasma (QGP) by comparing them to model calculations that describe the whole evolution of the system created in heavy-ion collisions, from the initial conditions to the pre-equilibrium, QGP, and hadronic phases.

In the ALICE experiment, photons can be reconstructed either by using the calorimeters or via conversions in the detector material. The photon conversion method benefits from an excellent energy resolution and is able to provide direct photon measurements down to $p_{\mathrm{T}} = 0.4$ GeV/c.

In this talk, we present the first measurements of direct photon production in Pb–Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV by ALICE, including direct photon spectra from central to peripheral events.

HK 57.2 Thu 14:15 HK-H2

Virtual Photon Measurements with the HADES at GSI — •Jan-Hendrik Otto for the HADES-Collaboration — Justus-Liebig Universität, Gießen, Germany

The **H**igh **A**cceptance **DiE**lectron **S**pectrometer (HADES) is dedicated to the measurement of electromagnetic probes from heavy ion collisions and to study the in-medium behaviour of dileptons in the moderate temperature and high density regime of the QCD phase diagram. Dileptons as penetrating probes are messengers of this dense medium and can reveal the thermal properties and the lifetime of the medium but also give insight into meson properties at high densities. In this talk we present preliminary results of HADES on the dielectron analysis of 4.5 billion Ag+Ag collisions (0 − 40% centrality) at a centre-of-mass energy of $\sqrt{s_{NN}} = 2.55\,GeV$. The upgraded RICH detector offers excellent electron identification and suppression of conversion-pairs resulting in a signal-to-background ratio larger than 1 for $M_{e^+e^-} > 500 MeV/c^2$. The high statistics data sample in combination with a strongly increased electron detection effciency and background suppression allow for a differential analysis in terms of centrality or electron-pair-momentum with a signal up to the phi meson mass region. For higher pair-momenta a signal of the omega meson is clearly seen while vanishing for lower pair-momenta. The temperature extracted from the intermediate mass region compares well with the HADES measurement in Au+Au collisions at $\sqrt{s_{NN}} = 2.42\,GeV$. The obtained dielectron signal spectrum is compared to simulated hadronic cocktail and nucleon-nucleon reference spectra.

HK 57.3 Thu 14:30 HK-H2

Physics opportunities with photons for the ALICE3 experiment — •Abhishek Nath for the ALICE-Collaboration — Physikalisches Institut, Ruprecht Karl University of Heidelberg, Germany

The ALICE Collaboration is writing an LOI of a next-generation multipurpose detector, the ALICE 3, to further contribute to the characterization of the macroscopic QGP properties with unprecedented precision at the LHC Run 5.

Since direct photons provide information about the initial stage of the collision as well as the space-time evolution of the QCD medium, studying background photons signals from meson decays deserves mention. The possibility of reconstruction photons through their conversion in the detector material, benefiting from the good momentum resolution for charged particles, and the large pseudorapidity coverage of the ALICE 3 detector can be jointly exploited to measure neutral mesons with high precision over a large momentum range.

While measurements of J/ψ, Υ are abundant at the LHC, measurements of χ_c, χ_b and other $L = 1$ states in wide p_T and rapidity ranges are needed, to provide stronger constraints on the spectral properties of bound states in the QGP and allow for a more accurate description of the dynamics of quarkonium interactions with the medium.

In this talk, we present performance studies of η meson measurements using the photon conversion method for ALICE 3. Moreover, the performance of χ_c measured through the radiative decay channel $\chi_c \to J/\psi + \gamma$ is also presented.

HK 57.4 Thu 14:45 HK-H2

Direct photons in high-multiplicity pp collisions with dielectrons in ALICE — •Ivan Vorobyev for the ALICE-Collaboration — Technische Universität München

Low-mass e^+e^- pairs produced in ultra-relativistic heavy-ion collisions at the LHC carry important information about the system space-time evolution unperturbed by strong final-state interactions. The dielectron continuum is very rich in physics sources: on top of Dalitz and resonance decays of pseudo-scalar and vector mesons, thermal blackbody radiation contains the information about the temperature of the hot and dense system created in heavy-ion collisions. In proton–proton (pp) collisions, measurement of direct photons serves as a fundamental test for perturbative QCD calculations and as a baseline for the studies in heavy-ion collisions. Recently, pp collisions with high charged-particle multiplicities have been found to exhibit interesting phenom-

ena resembling some observations done in heavy-ion collisions. Low-mass dielectrons could provide additional information regarding the underlying physics processes in such collisions.

We present the latest results from the dielectron analysis of large data sample of pp collisions at $\sqrt{s}$ = 13 TeV collected with ALICE during the LHC Run 2. A particular focus of the discussion is put on the production of direct photons in pp collisions collected with a trigger on high charged-particle multiplicities. The relative increase of dielectron production in high-multiplicity events with respect to all inelastic collisions is compared to the expectations from already measured multiplicity-dependent production of light and heavy hadrons.

HK 57.5 Thu 15:00 HK-H2

Physics opportunities with photons for the ALICE3 experiment — •Abhishek Nath for the ALICE-Collaboration — Physikalisches Institut, Ruprecht Karl University of Heidelberg, Germany

The ALICE Collaboration is writing an LOI of a next-generation multipurpose detector, the ALICE 3, to further contribute to the characterization of the macroscopic QGP properties with unprecedented precision at the LHC Run 5.

Since direct photons provide information about the initial stage of the collision as well as the space-time evolution of the QCD medium, studying background photons signals from meson decays deserves mention. The possibility of reconstruction photons through their conversion in the detector material, benefiting from the good momentum resolution for charged particles, and the large pseudorapidity coverage of the ALICE 3 detector can be jointly exploited to measure neutral mesons with high precision over a large momentum range.

While measurements of J/ψ, Υ are abundant at the LHC, measurements of χ_c χ_b and other $L = 1$ states in wide p_T and rapidity ranges are needed, to provide stronger constraints on the spectral properties of bound states in the QGP and allow for a more accurate description of the dynamics of quarkonium interactions with the medium.

In this talk, we present performance studies of η meson measurements using the photon conversion method for ALICE 3. Moreover, the performance of chi_c measured through the radiative decay channel $\chi_c \rightarrow J/\psi + \gamma$ is also presented.

HK 57.6 Thu 15:15 HK-H2

Background studies for a soft-photon measurement with the Forward Conversion Tracker in ALICE 3 — •Tim Rogoschinski for the ALICE-Collaboration — IKF Frankfurt

We propose to construct a Forward Conversion Tracker at the LHC to measure photons of a few MeV in transverse momentum, so called ultra-soft photons, which have the potential to resolve the long standing "soft-photon puzzle": Several experiments have observed an excess of ultra-soft photons with respect to the expected yield from Low's theorem, which is very fundamentally relating ultra-soft photon production from inner Bremsstrahlung and the spectrum of charged hadrons. It is proposed to include a Forward Conversion Tracker (FCT) in ALICE 3, the next-generation heavy-ion collision experiment proposed for Run 5 and 6 at the LHC, to measure ultra-soft photons. The dominant background in this measurement, decay photons and external Bremsstrahlung, has been investigated and compared to the signal expectation derived from Low's theorem. pp collisions at 13 TeV are simulated via PYTHIA and the produced particles are propagated through the proposed ALICE 3 geometry implemented in a GEANT4 setup. Aiming at a significant measurement, several background-suppression capabilities have been explored: Major improvements were achieved by the rejection of events with an electron or positron in the η - range of the FCT and by reducing the material budget in optimising the shape of the beam pipe. In this talk the status of the simulation and the background studies for a soft-photon measurement with the FCT is presented.

HK 58: Instrumentation XIV

Time: Thursday 14:00–15:30 Location: HK-H3

HK 58.1 Thu 14:00 HK-H3

First steps towards the development of a spatially resolving detector for ultra-cold neutrons — •Konrad Franz for the tauSPECT-Collaboration — Department of Chemistry, Johannes Gutenberg University Mainz

One of the challenges in neutron detection is to convert the electrically inert neutron into an electrical signal. In the presented detector design this is achieved by employing a conversion layer stacked with a scintillation layer, in which the neutron induced α-particle generates a light pulse. This scintillation light is then guided onto an array of silicon photomultipliers (SiPM). Spatial resolution can be achieved by reading out every SiPM individually. A main advantage of this setup is its compatibility with high magnetic fields, which allows for in-situ detection of ultra-cold neutrons (UCN) in such environments. Combining spatial resolution with a magnetic field gradient UCN energy determination is possible.

The talk will give an overview of the proposed detector design and its advantages will be outlined. Furthermore, the first steps of the development will be presented and the main challenges moving forward will be discussed.

HK 58.2 Thu 14:15 HK-H3

The powering scheme of the CBM Silicon Tracking System — •Anton Lymanets[1], Oleksandr Kshyvanskyi[2], and Maksym Teklishyn[1,2] for the CBM-Collaboration — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH — [2]Kiev Institute for Nuclear Research, Ukraine

The Silicon Tracking System (STS) is the principal tracking detector of the future CBM experiment at FAIR. It will perform charged-particle track measurement with momentum resolution better than 2% in a 1 Tm dipole-magnetic field. A main challenge for the STS is to maintain high track reconstruction efficiency throughout the projected lifetime of the experiment which means being exposed to an accumulated fluence of up to 10^{14} n_{eq}/cm^2, expected to be reached in beam-target interaction rates of 10 MHz. Therefore, front-end electronics with self-triggering architecture needs to have sufficient signal-to-noise ratio (S/N>10) which requires an ultra-low noise system design.

The STS will consist of eight tracking stations comprising 876 double-sided silicon detector modules with a total of 1.8 million readout channels. Operation of the system requires a detailed understanding of the electrical scheme at different hierarchical levels, including: low and high voltage systems, copper data lines from the front-end electronics to the read-out and data combiner boards, signal path, as well as grounding and shielding concepts. The performance parameter of the system is equivalent noise charge (ENC) value measured by the front-end electronics. The electrical scheme of the system as well as its experimental validation in the laboratory and beam will be presented.

HK 58.3 Thu 14:30 HK-H3

Mechanical and thermal studies of various components of the Silicon Track- ing System — •Shaifali Mehta for the CBM-Collaboration — Eberhard Karls Universität Tübingen(UT-PIT)

The Silicon Tracking System (STS) located in the aperture of the dipole magnet is designed to perform the charged particle tracking to achieve a momentum resolution better then 2 micro strip sensors, distributed on 8 tracking stations. The stations are made from mechanical half units onto which 106 ultra-light carbon fibre support structures, referred as ladders, are mounted which hold the modules. During the assembly of modules, different glues are used at various steps of the assembly and it is very important to test for the thermal and mechanical properties of the glue. Once the modules are prepared, they are transferred to the ladder using a standard procedure. A well defined technique has been developed to mount the modules on a ladder to achieve the precision in order of 100 μm. Two full ladders and one half ladder has been assembled so far within the required mounting precision. The results from the thermal cycling of the different glues used in module assembly and the concept of mounting the modules onto the ladder for the STS within the defined mechanical precision will be presented in this talk.

HK 58.4 Thu 14:45 HK-H3

Lifetime and Performance of the very latest Microchannel-Plate Photomultipliers — •Daniel Miehling, Merlin Böhm,

Katja Gumbert, Steffen Krauss, and Albert Lehmann for the PANDA-Collaboration — Physikalisches Institut, Universität Erlangen-Nürnberg

Two DIRC detectors will be used for particle identification and in particular pion/kaon separation at the PANDA experiment at FAIR. The focal planes of both DIRCs will reside in a magnetic field of up to 2 Tesla. This and other constraints leave the usage of Microchannel-Plate Photomultipliers (MCP-PMTs) as the only option. A few years ago the most limiting parameter was the lifetime of the MCP-PMTs. During operation feedback ions produced in the residual gas and during electron multiplication at the MCP walls are accelerated towards the photo cathode and may damage it. This leads to a sizable quantum efficiency (QE) drop with increasing integrated anode charge. Coating the MCPs by applying an atomic-layer deposition technique (ALD) increased the lifetime drastically. Another important parameter is the detective quantum efficiency (DQE) which is the product of the QE and the difficult to measure collection efficiency (CE). This should also be as high as possible to detect as many Cherenkov photons as possible. Recently tubes with CE values of close to 100% are available. In this talk the results of these performance parameters will be presented and discussed along with an overview of the general performance of the very latest ALD-coated 2x2 inch^2 MCP-PMTs with 8x8 anode pixels from Photek and PHOTONIS. - Funded by BMBF and GSI -

HK 58.5 Thu 15:00 HK-H3

Low Gain Avalanche Diode based T0 Detector in HADES — •Wilhelm Krüger[1], Tetyana Galatyuk[1,2], Vadym Kedych[1], Sergey Linev[2], Jan Michel[3], Jerzy Pietraszko[2], Adrian Rost[1,4], Michael Träger[2], Michael Traxler[2], and Christian Joachim Schmidt[2] — [1]TU Darmstadt, Germany — [2]GSI GmbH, Darmstadt, Germany — [3]Goethe-Universität Frankfurt, Germany — [4]FAIR GmbH, Darmstadt, Germany

HADES at SIS18, GSI (Darmstadt, Germany), is going to use a Low Gain Avalanche Diode (LGAD) based reaction time (T0) detector in the upcoming high rate (10^8 p/s) pp experiment in February 2022. For the HADES physics program a T0 determination better than $\sigma_{T0} < 70$ ps is necessary, in order to ensure a precise particle identification using time of flight information. In addition, the T0 detector will be used for beam monitoring, which requires a position resolution better than 5 mm. As the detector will be placed in-beam, a high radiation hardness is also required. The recently emerged LGAD technology is a suitable candidate to fulfill all the above listed requirements.

In this contribution the performance of HADES T0-LGADs in a beam test at COSY in Jülich in November 2021 will be presented. The LGADs were tested w.r.t. their timing precision and efficiency, employing different front end electronics. The preliminary performance of the T0 detector during the beam time in February 2022 will be presented as well.

HK 58.6 Thu 15:15 HK-H3

HADES Driftchambers Electronics Upgrade: Power Supply — •Ole J. Artz for the HADES-Collaboration — Goethe-Universität Frankfurt

The readout electronics of the drift chamber tracking system of HADES will be upgraded in the comming year to allow for handling higher trigger rates in future experiments at SIS18 and SIS100. The upgrade is also aiming at an improved robustness w.r.t. electronic noise and the ability to resolve multiple hits in drift cells.

An important part of this activity is improving the power scheme both w.r.t. load and noise immunity. Due to the sensitivity of the detector, switching voltage regulators can not be installed on the front-end electronics, but need to be placed further away. These regulators will be remotely controllable using an Ethernet-capable microcontroller.

As a side-project, the same controller will be employed for flexible read-out of various sensors for the detectors' gas system.

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

HK 59: Instrumentation XV

Time: Thursday 14:00–15:30 Location: HK-H4

Group Report HK 59.1 Thu 14:00 HK-H4

The Silicon Tracking System of the CBM Experiment — •Osnan Maragoto Rodriguez for the CBM-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

The Silicon Tracking System (STS) is the central detector for charged-particle identification and momentum determination in the future CBM experiment. It is designed for tracking up to 1000 charged particles per event in nucleus-nucleus collisions at interaction rates up to 10 MHz. Its futures are a low material budget~2% of radiation length, a single-point resolution of ~30 μm inside 1 Tm magnetic field leading to a momentum resolution better than 2%. The experimental conditions pose demanding requirements in terms of channel density and read-out bandwidth: more than 1.6 million channels will be read out with self-triggering electronics. An online event analysis concept will be applied to provide real-time event building and selection. The test and characterization of detector modules, operated in high-intensity heavy-ion beam from the GSI-SIS18 accelerator, as well as the mechanical design and the cooling concepts are, currently, some of the most important goals of the project. This contribution will bring an overview of the STS detector with emphasis on the current status of the detector modules, their performance with beam-target interactions as part of the FAIR Phase 0 activities, the readout chain and system integration aspects aiming towards the pre-series production phase

HK 59.2 Thu 14:30 HK-H4

Quality control and position mapping of the silicon microstrip sensors for the CBM-STS detector — •Olga Bertini for the CBM-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

The central detector of the CBM experiment at FAIR, the Silicon Tracking System (STS), is designed to reconstruct up to thousand charged particle tracks produced at SIS100 in heavy-ion interactions at rates of up to 10 MHz.

The eight tracking stations of the STS, operating in the aperture of a super conducting dipole magnet with 1 T field, will cover the polar angles between 2.5° and 25°. The stations with a total sensor area of 4.2 m^2 will comprise about 900 detector modules consisting of double-sided silicon microstrip sensors, ultra-thin readout cables and front-end electronics that are mounted onto lightweight carbon fiber support strictures. More than 1000 double-sided sensor were produced and delivered to GSI, where their quality was controlled optically and electrically.

A summary of the tests carried out and the quality achieved will be given. The mapping of the sensors to the positions in the detector matching the quality grades and required radiation tolerance will be shown.

HK 59.3 Thu 14:45 HK-H4

The $\overline{\text{P}}$ANDA Cluster-Jet Target at COSY - recent Results and Developments — •Philipp Brand, Daniel Bonaventura, Hanna Eick, Benjamin Hetz, Christian Mannweiler, Sophia Vestrick, and Alfons Khoukaz for the PANDA-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, 48149 Münster, Germany

The $\overline{\text{P}}$ANDA cluster-jet target will be the Day-1 target for the $\overline{\text{P}}$ANDA experiment within the High Energy Storage Ring (HESR) at FAIR. With this device a target thickness of more than 10^{15} atoms/cm^2 is achieved at the interaction point more than 2 m below the nozzle.

To study the influence of such a target on the properties of an accelerator beam, it is installed at the COoler SYnchrotron (COSY) in Jülich. Here, also a barrier bucket cavity and the stochastic cooling are installed, which will be used later at FAIR in the HESR. Therefore, the studies performed within beam times at COSY will give important input for the PANDA experiment. Within this talk results from recent beam times as well as new developments on the target system are presented.

This project has received funding from BMBF (05P19PMFP1 and 05P21PMFP1), GSI FuE (MSKHOU1720 and MSKHOU2023) and the EU's Horizon 2020 programme (824093).

HK 59.4 Thu 15:00 HK-H4

A prototype for hydrogen-based droplet targets for nuclear and particle physics experiments — •Christian Mannweiler, Daniel Bonaventura, and Alfons Khoukaz — Westfälische Wilhelms Universität, Münster, Germany

Internal target experiments play an important role in in particle physics research. For example, the PANDA experiment at the future HESR accelerator at FAIR will use both a hydrogen cluster-jet target and a hydrogen pellet target.

Another target technology which is closely related to the pellet target is the droplet target. The operating principle of a hydrogen droplet target is to squeeze cryogenically cooled, fluid hydrogen through a small nozzle of, e.g. 10 microns. A piezo actor induces vibrations on the nozzle, causing the hydrogen beam passing through the nozzle to break up. Depending on the nozzle diameter and the piezo frequency, a droplet beam with a diameter of around 20 microns is created. Currently, there are several challenges concerning this technology, chiefly the issue of nozzle clogging, which occurs routinely and hinders the stable long-term operation of such targets.

To combat this issue and improve the overall performance of droplet targets, a new prototype droplet target was recently constructed and commissioned at the WWU Münster. It will be used to tackle the aforementioned nozzle clogging issue as well as other challenges.

In our contribution we will present the new target prototype and its capabilities as well as first results. This project has received funding from the EU Horizon 2020 programme (824093).

HK 59.5 Thu 15:15 HK-H4

The cryogenic stopping cell for the Super-FRS at FAIR: status and outlook — •Daler Amanbayev[1], Samuel Ayet San Andres[1], Timo Dickel[1,2], Hans Geissel[1,2], Wolfgang Plass[1,2], Christoph Scheidenberger[1,2], the Super-FRS Experiment Collaboration[2], and the FRS Ion Catcher Collaboration[2] — [1]II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Gießen, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

The beams of exotic nuclei for the high-precision experiments planned at the Low-Energy Branch (LEB) of the Super-FRS at FAIR are produced at relativistic energies of up to 1.5 GeV/u, and have to be slowed down and thermalized down to a few eV. A gas-filled cryogenic stopping cell (CSC) is a key device in this process.

In order to achieve its challenging design performance parameters of areal densities of up to 40 mg/cm^2 for stopping efficiencies of almost unity, fast ion extraction down to times of 10 ms and a rate capability of 10^7 ions per second, a novel two-stage orthogonal extraction concept has been developed. Detailed simulations of the CSC are verified and projected from the performance of the prototype CSC, which is being successfully used in online experiments as a part of the FRS Ion Catcher at GSI.

In this talk, the major components and processes of the CSC will be highlighted, such as fine-pitched radio-frequency carpet design, simulations of ion trajectories traversed by gas jets, a cryogen-free cooling system and an ultra-clean buffer gas recovery system.

HK 60: Instrumentation XVI

Time: Thursday 14:00–15:30 Location: HK-H5

HK 60.1 Thu 14:00 HK-H5

Monte-Carlo simulations of low-energy X-ray interactions in the ALICE TPC — •Ankur Yadav, Philip Hauer, Philipp Bielefeldt, and Bernhard Ketzer for the ALICE-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn

The ALICE Time Projection Chamber (TPC) was recently upgraded with a Gas Electron Multiplier (GEM) based readout in order to cope with the high Pb-Pb interaction rate of 50 kHz planned for Run 3 of the LHC. In the scope of an extensive commissioning program, several measurements were already conducted without the beam. This included the injection of the meta-stable radioactive isotope Kr-83m into the gas volume of the TPC as well as the irradiation of the TPC with an X-ray source.

In order to better understand and cross-check the measured data, the MC methods provided by the Geant4 toolkit were used to simulate the interaction of low energy X-rays and associated secondary particles in the TPC. A complete detector simulation chain was developed which includes drift, diffusion, gas amplification as well as the effects of electron attachment.

In this talk, the comparison between the simulations and the measured data will be presented.

Supported by BMBF

HK 60.2 Thu 14:15 HK-H5

Quality Control of the upgraded ALICE TPC — •Stefan Heckel for the ALICE-Collaboration — Technische Universität München

About three years ago, in December 2018, the LHC and concomitant the ALICE experiment went into a long shutdown. ALICE has used this time for major upgrades including new readout chambers for the Time Projection Chamber (TPC). The TPC can now be operated in continuous read-out mode, enabling much higher data-taking rates than before. Going along with the detector upgrades, the entire software framework for data taking, reconstruction and analysis is developed anew. Within this framework, the Quality Control (QC) of the detectors plays a crucial role to guarantee a successful data-taking campaing in the upcomming LHC Run 3.

In this talk, the development of the QC for the upgraded ALICE TPC will be summarised. Given the challenging data-taking conditions, the QC has to be able to assess the quality of the data synchronously during data taking. For this purpose, the data will be analysed online with trendings of important quantities as a function of time and automatic checking procedures raising alarms in case of any outlier behaviour observed. The QC results will be visulized using different tools for the ALICE shift crew in the ALICE control room and for the TPC experts. In October 2021, the upgraded ALICE has taken physics data for the first time during a pilot-beam test of the LHC. First results of these data from the TPC-QC point of view will be shown.

HK 60.3 Thu 14:30 HK-H5

Optimization of the calibration parameters for the font-end electronics of the Silicon Tracking System of the CBM experiment — •Dairon Rodriguez Garces for the CBM-Collaboration — GSI Helmholtzzentrum, Darmstadt, Germany

The CBM is a next-generation experiment to be operated at FAIR facility. Its goal is to investigate the phase diagram of strongly interacting matter in the region of high baryon-net densities. To achieve the high rate capability CBM will be equipped with fast and radiation hard detectors employing free-streaming readout electronics. The Silicon Tracking System (STS) is the main detector for charged particle measurements and momentum determination. It is designed as eight tracking layers built from 876 modules. The custom-designed front-end electronics for reading out the double-sided silicon sensors is the STS-XYTER ASIC: analog front-end for signal processing and digital part with hit generation and readout. The characterization of the chip is an extensive procedure that includes multiple functional tests such as proper amplitude and time calibration. These are necessary steps to correctly interpret the collected data. The design of the analog front-end, with a double processing path for independent time and energy measurements, implies that the calibration should consider not only the ADC linearity aspects but also a homogeneous time response among all channels, and a well-known correlation of the threshold in both measuring paths. This work describes the characterization of the timing discriminator of the ASIC, the optimization of other-related chip parameters, and their effect on the measured data.

HK 60.4 Thu 14:45 HK-H5

Towards pre-series production: Quality control of the Silicon Tracking System module and components — •Adrian Rodríguez Rodríguez for the CBM-Collaboration — GSI Helmholtzzentrum

The Silicon Tracking System (STS) is the main tracking detector of the future CBM experiment. It is designed to reconstruct trajectories of charged particles with high efficiency and to achieve a momentum resolution better than 2% inside a 1 Tm magnetic field. The STS

comprises 876 modules arranged in 8 tracking stations, where 1.8 million channels are read out with self-triggering electronics matching the experiment's data streaming and online event analysis concept. Currently, the STS project is entering the pre-series production phase, in which more than 30 modules are expected to be assembled with the final components and procedures. This is an essential task for proving the assembly concept of the final detector and requires a thorough quality control procedure in order to ensure the reliable performance of the modules and high production yield. For this purpose, multiple quality control steps have been implemented before and during the assembly of the components and the necessary hardware and software have been developed. This work will present the results of systematic testing of the STS modules and components, the steps to optimize the quality control concept, and the most significant challenges towards series production.

HK 60.5 Thu 15:00 HK-H5

Measurements of the Timing Characteristics of Silicon Photomultipliers

— •Christopher Wenzel — Ruhr-Universität Bochum, Institut für Experimentalphysik I

Silicon Photomultipliers (SiPMs) are solid-state detectors with single-photon sensitivity. Samples of the latest generation combine high gain with low noise and have an improved detection efficiency for blue and near-UV light. Due to short rise times below a few hundred picoseconds SiPMs are well suited for fast timing applications such as Time-of-Flight PET.
Within the UFaCal project, various SiPMs are being tested for possible application in a calorimeter prototype that will provide precise timing information in addition to energy.
To compare the timing performance of different SiPMs, the Single Photon Time Resolution (SPTR) was measured. The intrinsic time resolution of the photodetector can be extracted by deconvolving the measured SPTR value and the different contributions of the measurement setup. A limiting factor of the measurable SPTR is given by the pulse width of the used laser system.
This talk presents a setup for SPTR measurements using a femtosecond laser in combination with an optical trigger. Femtosecond pulses grant the ability to neglect the contribution of the laser pulse width to the measured SPTR value. The timing characteristics of a large selection of commercially available SiPMs will be presented.
Funded by BMBF

HK 60.6 Thu 15:15 HK-H5

Development of an Endcap Disc DIRC for PANDA and SCTF

— •Simon Bodenschatz, Lisa Brück, Michael Düren, Jan Niclas Hofmann, Sophie Kegel, Jhonatan Pereira de Lira, Mustafa Schmidt, Marc Strickert, Chis Takatsch, Leonard Welde und Vincent Wettig — 2. Physikalisches Institut Justus Liebig Universität Gießen

The Endcap Disc DIRC has been designed for the PANDA experiment at FAIR. The design is currently being iterated on for the future high luminosity Super Charm Tau Factory (SCTF) in Russia where not only pion/kaon separation, but also muon/pion separation is required in a broad momentum range. The DIRC prototypes are tested in the Gießen Cosmic Station, which provides track information of relativistic atmospheric muons and enables performance measurements of MCP-PMT and SiPMs based designs. Prototypes and teststand are readout by a free running DAQ system using TOFPET ASICs as digitizers.

HK 61: Structure and Dynamics of Nuclei X

Time: Thursday 14:00–15:30 Location: HK-H6

Group Report HK 61.1 Thu 14:00 HK-H6

DSAM lifetime measurements using particle-γ coincidences at SONIC@HORUS — •Sarah Prill, Anna Bohn, Christina Deke, Felix Heim, Michael Weinert, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics, 50937 Cologne, Germany

In recent years, the (p,p'γ) Doppler-shift attenuation method (DSAM) has been successfully applied to determine lifetimes of excited low-spin states in the sub-picosecond range [1,2]. The use of particle-γ coincidence data taken at the SONIC@HORUS spectrometer in Cologne [3] gives complete knowledge of the reaction kinematics and enables the direct selection of levels via their excitation energy, thus greatly reducing background and eliminating feeding from levels of higher energies. This contribution will present the DSA method and recent results obtained from experiments on Ru, Sn [2] and Te isotopes will be shown. Additionally, a complementary approach to the conventional DSA technique will be presented which aims to extract lifetimes from weak transitions and excited states with low statistics that cannot be analysed with the established method.
Supported by the DFG (ZI-510/9-1).
[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 61.2 Thu 14:30 HK-H6

Lifetime measurement of the 2_1^+ state of ^{170}W — •K.E. Ide[1], V. Werner[1], A. Goasduff[2,3], J. Wiederhold[1], P.R. John[1], D. Bazzacco[3], M. Beckers[4], J. Benito[5], M. Berger[1], D. Brugnara[2,3], M.L. Cortés[1], L.M. Fraile[5], C. Fransen[4], A. Gozzelino[3], E.T. Gregor[3], A. Illana[3], J. Jolie[4], L. Knafla[4], R. Menegazzo[3], D. Mengoni[2,3], C. Müller-Gatermann[4,6], O. Papst[1], G. Pasqualato[7], C.M. Petrache[8], N. Pietralla[1], F. Recchia[2,3], D. Testov[2,7], J.J. Valiente-Dobón[3], and I. Zanon[2,3,9] — [1]IKP, TU Darmstadt — [2]Uni Padova, Italy — [3]INFN, LNL, Italy — [4]IKP, Uni Köln — [5]Uni Madrid, Spain — [6]ANL, USA — [7]INFN, Padova, Italy — [8]Uni Paris-Saclay, France — [9]Uni Ferrara, Italy

Recent measurements of the mean lifetimes of the first 2^+ states in the region of the Hf and W isotopic chains pointed out a change of the previously measured mean lifetimes by enhanced experimental techniques. This results in an increased value of the $E2$ transition probability from $N = 114$ down to $N = 98$ with an unexpected sudden drop in the transition probability at $N = 96$, i.e. ^{170}W. The experiment to remeasure the mean lifetime of the 2_1^+ state of ^{170}W with the RDDS method was carried out at the Laboratori Nazionali di Legnaro (LNL). The GALILEO array, comprised of 24 HPGe detectors placed in 5 rings, was used in conjunction with the LNL plunger device. Experimental results are compared to predictions of the CBS model.
*Supported by the BMBF under Grant Nos. 05P18RDFN9 and 05P21RDFN9.

HK 61.3 Thu 14:45 HK-H6

In-beam gamma-ray spectroscopy of neutron rich scandium isotopes — •Radostina Zidarova[1], Martha Liliana Cortés[1], Volker Werner[1], Pavlos Koseoglou[1], Norbert Pietralla[1], Pieter Doornenbal[2], and Alexandre Obertelli[1] — [1]TU Darmstadt, Germany — [2]RIKEN-RIBF, Japan

Experimental data have shown that far from the valley of stability new magic numbers can emerge and the traditional ones can disappear. In particular, two new magic numbers at N=32 and N=34 have been suggested in the vicinity of Z=20 based on spectroscopy and mass measurements. The N=34 sub-shell closure is observed in Ca and Ar isotopes, but vanishes in the Ti isotopes. To get a complete picture of the shell evolution in this region, it is also necessary to study the neighbouring Sc isotopes with only one valence proton above Z=20 and determine their structural evolution towards the possible harmonic oscillator magic number N=40 . Investigation of exotic nuclei in this region was the goal of the third SEASTAR (Shell Evolution And Search for Two-plus energies At RIBF) campaign at RIKEN-RIBF. Neutron-rich isotopes in the vicinity of ^{53}K were produced by fragmentation of a primary ^{70}Zn beam on a ^{9}Be target. The γ rays of ^{55}Sc isotope were observed and γ rays from ^{57,59}Sc were identified for the first time. Observed γ spectra from ^{55,57,59}Sc will be presented together with preliminary level schemes. They will be discussed in the framework of the tensor force driven shell evolution.
Supported by BMBF under Grant Nos. 05P19RDFN1, 05P21RDFN1.

HK 61.4 Thu 15:00 HK-H6

Lifetime measurement of excited states in ^{120}Te — •Franziskus v. Spee[1], Alfred Dewald[1], Claus Müller-Gatermann[1,2], Marcel Beckers[1], Felix Dunkel[1], Lisa Kornwebel[1], Casper-David Lakenbrink[1], Jan Jolie[1], Nigel Warr[1], and Andrey Blazhev[1] — [1]Institut für Kernphysik, Cologne, Germany — [2]Argonne National Laboratory, Illinois, USA

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 and IBM1-Calculations. This work was supported by the Deutsche Forschungsgemeinschaft (DFG) under contract numbers FR 3276/2-1 and DE 1516/5-1.

HK 61.5 Thu 15:15 HK-H6

Extension of the level scheme of ^{104}Ru and lifetime determination using the Doppler-shift attenuation method — •Anna Bohn, Christina Deke, Felix Heim, Sarah Prill, Michael Weinert, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics, 50937 Cologne, Germany

The (p,p'γ) Doppler-shift attenuation method (DSAM) is a powerful tool to determine nuclear level lifetimes in the sub-picosecond range and was well established at the Institute for Nuclear Physics at the University of Cologne in recent years [1,2]. The combined particle-γ detector array SONIC@HORUS [3] enables the measurement of p-γ and p-γ-γ coincidences. Hence, knowledge of the complete reaction kinematics is provided and feeding contributions from energetically higher lying states can be eliminated.
In this contribution, results from a ^{104}Ru(p,p'γ) DSAM experiment will be presented. More than two dozen nuclear level lifetimes as well as over 50 previously unknown levels and decay transitions could be identified via the analysis of p-γ-γ coincidence data.
Supported by the DFG (ZI-510/9-1).
[1] A. Hennig *et al.*, NIM A **794** (2015) 171
[2] M. Spieker *et al.*, Phys. Rev. C **97** (2018) 054319
[3] S. G. Pickstone *et al.*, NIM A **875** (2017) 104

HK 62: Structure and Dynamics of Nuclei XI

Time: Thursday 14:00–15:30 Location: HK-H7

Group Report HK 62.1 Thu 14:00 HK-H7

Extension and acceleration of the in-medium similarity renormalization group — •Matthias Heinz[1,2,3], Jan Hoppe[1,2], Alexander Tichai[1,2,3], Kai Hebeler[1,2,3], and Achim Schwenk[1,2,3] — [1]Technische Universität Darmstadt, Department of Physics — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Plank Institut für Kernphysik, Heidelberg

The ab initio solution of the nuclear many-body problem for theoretical predictions of nuclear structure observables is a computationally challenging endeavor. Over the past decade, the in-medium similarity renormalization group (IMSRG) has been established as an important method capable of describing a broad range of nuclei up to mass numbers around 100 and beyond, including open-shell systems via different extensions of the method.

A key (as of yet unrealized) milestone in the IMSRG is the relaxation of the many-body truncation of the method, currently restricted to the normal-ordered two-body level, the IMSRG(2). We discuss studies of the next truncation, the IMSRG(3), in small systems and restricted model spaces. We additionally highlight recent developments to accelerate IMSRG calculations that might make the IMSRG(3) more feasible, including basis optimization via natural orbitals and importance truncation applied to the IMSRG.

* Funded by the ERC Grant Agreement No. 101020842 and by the DFG – Project-ID 279384907 – SFB 1245.

HK 62.2 Thu 14:30 HK-H7

Single-particle strength & nucleon correlations of the Ca isotopic chain. — •Luke Rose[1], Stefanos Paschalis[1], Marina Petri[1], Ryo Taniuchi[1], Thomas Aumann[2], Carlo Barbieri[3], Carlos Bertulani[4], Dolores Cortina-Gil[5], Heather Crawford[6], Roman Gernhäuser[7], Marc Labiche[8], Augusto Macchiavelli[6], Alexandre Obertelli[2], Heiko Scheit[2], Daniel Severin[9], Haik Simon[9], Helmut Weick[9], and Christian Sürder[2] for the R3B-Collaboration — [1]The University of York, York, UK — [2]Technical University of Darmstadt, Darmstadt, Germany — [3]University of Surrey, Guildford, UK — [4]Texas A&M University-Commerce, Commerce, USA — [5]Universidade de Santiago de Compostela, Santiago de Compostela, Spain — [6]Lawrence Berkeley National Lab, Berkeley, USA — [7]Technical University of Munich, Munich,Germany — [8]STFC Daresbury, Daresbury, UK — [9]GSI, Darmstdat, Germany

The unique shell structure of Ca isotopes provides an understanding of the evolution of the shell structure and an in-depth exploration of three-body forces used in microscopic shell-model interactions and ab-initio calculations. By extracting the spectroscopic factors of the ground state configuration along the neutron-rich component of the Ca isotopic chain, one can gain insight into the degree of weakening of the N=28 gap. The experiment was performed in 2020 at R3B as part of the Phase-0 program of FAIR probed proton and neutron configurations using (p,pn) and (p,2p) quasi-free scattering reactions.

HK 62.3 Thu 14:45 HK-H7

Density-dependent in-medium NN-potential from chiral four-nucleon force — •Maurus Geiger and Norbert Kaiser — Physik-Department T39, Technische Universität München, D-85747 Garching, Germany

Density-dependent in-medium NN-potentials are calculated analytically from the five classes of reducible four-nucleon forces (4NF) as derived in chiral effective field theory by Epelbaum (Eur. Phys. J. A34: 197-214 (2007)). An overview is given over the pertinent two-loop diagrams that are obtained by closing two nucleon lines. A fortunate feature of the chiral 4N forces is that due to their spin- and isospin dependence the selfclosing of a nucleon line gives a vanishing spin or isospin trace in nuclear matter. The current status of the evaluation of the remaining 42 diagrams for each class is presented together with results for the double Fermi-sphere integrals. Since the leading order chiral 4NF does not introduce any unkown parameters, this in-medium NN-potential can provide an interesting testing ground for the ability of chiral EFT to describe nuclear many-body systems.

This work has been supported in part by DFG (Project-ID 196253076 - TRR 110) and NSFC.

HK 62.4 Thu 15:00 HK-H7

An alternative scheme for effective range corrections in pionless EFT — •Martin Ebert[1], Hans-Werner Hammer[1,2], and Akaki Rusetsky[3,4] — [1]IKP, TU Darmstadt — [2]EMMI, GSI Darmstadt — [3]HISKP and BCTP, Universität Bonn — [4]Tbilisi State University

We discuss an alternative scheme for including effective range corrections in pionless effective field theory. The standard approach treats range terms as perturbative insertions in the T-matrix. In a finite volume this scheme can lead to singular behavior close to the unperturbed energies. We consider an alternative scheme that resums the effective range but expands the spurious pole of the T-matrix created by this resummation. We test this alternative expansion for several model potentials and observe good convergence.

*This work has been supported by Deutsche Forschungsgemeinschaft (Project ID 279384907, SFB 1245 and Project-ID 196253076, TRR 110), Volkswagenstiftung (grant no. 93562) and the Chinese Academy of Sciences (grant no. 2021VMB0007, PIFI).

HK 62.5 Thu 15:15 HK-H7

Lifetime measurements of excited states in ^{55}Cr — •Hannah Kleis[1], Michael Seidlitz[1], Andrey Blazhev[1], Levent Kaya[1], Peter Reiter[1], Konrad Arnswald[1], Alfred Dewald[1], Maximilian Droste[1], Christoph Fransen[1], Oliver Möller[1,2], Noritaka Shimizu[3], Yusuke Tsunoda[3], Yutaka Utsuno[3,4], Peter von Brentano[1], and Karl-Oskar Zell[1] — [1]Institut für Kernphysik, Universität zu Köln — [2]Institut für Kernphysik, Technische Universität Darmstadt — [3]Center for Nuclear Study, The University of Tokyo — [4]Advanced Science Research Center, Japan Atomic Energy Agency

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 recoil-distance Doppler-shift method combined with the differential decay-curve method are utilized for $\gamma\gamma$-coincidence analyses in order to determine precise lifetimes for the first $5/2^-$ and $9/2^-$ states of $\tau = 5.61(28)$ ps and $\tau = 6.33(46)$ ps, respectively [2]. In addition, the experimentally determined transition probabilities were confronted with results from the KB3G, FPD6, GXPF1A and GXPF1Br shell-model interactions. In particular, the $B(E2)$ and $B(M1)$ strengths are discussed with respect to the calculated wave functions configurations.

[1] M. Seidlitz et al., Phys. Rev. C 84, 034318 (2011)
[2] H. Kleis et al., Phys. Rev. C 104, 034310 (2021)

HK 63: Hadron Structure and Spectroscopy XI

Time: Thursday 14:00–15:30 Location: HK-H8

Group Report HK 63.1 Thu 14:00 HK-H8

The search for dibaryons in coherent photoproduction off the deuteron at the BGOOD experiment — •Thomas Jude for the BGOOD-Collaboration — Physikalisches Institut, Universität Bonn

The discovery of the $d^*(2380)$ hexaquark, first identified in the fusion reaction $pn \to d\pi^0\pi^0$ has sparked renewed interest in dibaryon searches in the non-strange sector. Evidence of the $d^*(2380)$, with $IJ^P = 03^+$, has been observed in a multitude of final states and observables. Conversely, recent models benefiting from high precision experimental data and theoretical developments have described the $d^*(2380)$ via triangle singularity mechanisms.

The BGOOD experiment at ELSA provides a unique approach to measure such mechanisms via the coherent reaction, $\gamma d \to \pi^0\pi^0 d$. The presented results are from a full kinematic reconstruction, with final state deuterons identified in the forward spectrometer and π^0 electromagnetic decays in the central BGO Rugby Ball. The strength of the measured differential cross section exceeds what can be described by models of coherent photoproduction and instead is consistent with the three isoscalar dibaryon candidates reported by the ELPH collaboration at 2.38, 2.47 and 2.63 GeV/c^2. A low mass enhancement in the $\pi^0\pi^0$ invariant mass is also observed at the $d^*(2380)$ centre-of-mass energy. At higher centre-of-mass energies, a narrow peak in the $\pi^0 d$ invariant mass at 2114 MeV/c^2 with a width of 20 MeV/c^2 supports a sequential two-dibaryon decay mechanism.

Supported by DFG projects 388979758/405882627 and the European Union*s Horizon 2020 programme, grant 824093.

HK 63.2 Thu 14:30 HK-H8

Study of Diffractively Produced $K^0_S\pi^-$, $K^0_SK^-$, and $\Lambda\bar{p}$ Final States at COMPASS — •Julien Beckers — Physik-Department E18, Technische Universität München

The COMPASS experiment is a multi-purpose two-stage spectrometer at the CERN SPS. One of its main goals is to probe the strong interaction at low energies by studying the excitation spectrum of light mesons. This is done by decomposing the data into partial-wave amplitudes with well-defined quantum numbers and searching for resonances in these amplitudes. However, before we can perform such a partial-wave analysis, we have to select the events that correspond to the processes of interest and separate them from background contributions with high purity.

We will present the analysis of three diffractive reactions: $\pi^- + p \to K^0_SK^- + p$, $K^- + p \to K^0_S\pi^- + p$, and $K^- + p \to \Lambda\bar{p} + p$. They have in common that the produced final states contain long-lived neutral particles, that are identified in the spectrometer via their secondary decay vertices. The $K^0_SK^-$ final state, allows us to study a_J- and π_J-like resonances with spin J and complements the $\pi^-\eta$, $\pi^-\eta'$ and $\pi^-\pi^-\pi^+$ final states that have already been studied at COMPASS. The $K^0_S\pi^-$ and $\Lambda\bar{p}$ final states allow us to study excited strange mesons over a wide mass range. We will present the event selection and discuss kinematic distributions, in which first resonance signals are observed. The high precision of our data will allow us to perform detailed searches for new resonances as well as improve parameters of known states.

HK 63.3 Thu 14:45 HK-H8

Search for the X17 boson at the BESIII experiment — •Saskia Plura, Achim Denig und Christoph Florian Redmer für die BESIII-Kollaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland

In 2016, the ATOMKI collaboration proposed the existence of a new neutral boson with a mass of 17 MeV to explain their observation of a significant enhancement in the angular correlations of e^+e^- pairs in nuclear transitions of ^{8}Be and ^{4}He. This new particle, referred to as the X17 boson, sparked interest in the particle physics community.

As the X17 should couple to nucleons, we developed a Monte Carlo generator to evaluate the possibility to search for the X17 boson in $J/\psi \to p\bar{p}\,e^+e^-$ decays, where the (anti-)proton emits an X17 which subsequently decays to an e^+e^- pair. J/ψ decays provide a clean source of nucleon-antinucleon pairs at e^+e^- colliders. We considered both possibilities of the X17 being either a pseudoscalar or an axial vector particle, as well as the QED background.

In this talk, we discuss the feasibility of searching for the X17 at the BESIII experiment, located at the BEPCII collider in Beijing, China, using the available data sample of 10^{10} J/ψ events.

HK 63.4 Thu 15:00 HK-H8

Investigating the ΛK interaction using the femtoscopic technique with ALICE at LHC — •Rossana Facen for the ALICE-Collaboration — Technische Universität München, München, Germany

Traditionally, the strong interaction among hadrons has been studied through scattering experiments. However, this experimental technique becomes very challenging when unstable particles are taken into account. For this reason, a new experimental method, femtoscopy, has been developed to achieve further understanding in the field of Quantum Chromodynamics (QCD): femtoscopy represents a valid method to investigate the interactions between strong interacting particles.

Recent femtoscopic measurements performed by the ALICE collaboration in Pb-Pb collisions were able to provide the scattering parameters of the interaction between Λ hadrons and charged K mesons, predicting an attractive force between Λ and antikaons and a repulsive potential between Λ and kaons.

In this talk we will present the results on the measured correlation functions of $\Lambda K^+ \oplus \bar{\Lambda}K^-$ and $\Lambda K^- \oplus \bar{\Lambda}K^+$ pairs obtained in high-multiplicity pp collision at $\sqrt{s} = 13$ TeV, recorded by the ALICE Collaboration. The small emitting source size achieved in such collisions, of the order of 1 fm, provides direct access to the underlying strong interaction between these hadrons. The scattering parameters extracted from the experimental data will be discussed in detail, compared to the findings obtained in Pb-Pb collisions as well as to the available theoretical chiral models.

HK 63.5 Thu 15:15 HK-H8

Precision studies of the strongly interacting NΛ–NΣ coupled system at the LHC — •Dimitar Mihaylov — TUM, Physics Department, James-Franck-Straße, 85748 Garching

The study of the strong interaction among stable and unstable hadrons is a fundamental question in nuclear physics and it is a key ingredient for the description of the Equation of State, and the understanding of the structure of dense stellar objects, such as neutron stars. Traditional measurements, including scattering and hypernuclei experiments, are insufficient to provide strong constraints to the theoretical modeling of the interaction between hadrons containing strangeness.

Two particle correlation measurements are a prominent tool to

probe the strong interaction with high precision even in the multi-strangeness sector. The ALICE collaboration has demonstrated that high-multiplicity pp collisions are particularly well suited due to the enhanced production of strangeness. Combined with the excellent tracking and particle identification capabilities of the ALICE detector, precision studies of the strong interaction among strange hadrons is possible. The present contribution will discuss the latest ALICE results on the study of the NΛ–NΣ coupled system through measurement of the pΛ correlation function.

HK 64: Fundamental Symmetries I

Time: Thursday 14:00–15:30 Location: HK-H9

Group Report HK 64.1 Thu 14:00 HK-H9

Probing charged lepton flavor violation with the Mu2e experiment — •Stefan E. Müller, Anna Ferrari, Oliver Knodel, and Reuven Rachamin for the Mu2e-Collaboration — Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

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

At the Helmholtz-Zentrum Dresden-Rossendorf, we use a pulsed Bremsstrahlung photon beam at the ELBE radiation facility to study the performance of the detector system that will monitor the rate of stopped muons in the aluminum target. Additionally, Monte Carlo simulations are performed for both the pion production target and the muon stopping target.

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

HK 64.2 Thu 14:30 HK-H9

Fierz interference term in neutron decay — •Max Lamparth[1], Karina Bernert[1], Hartmut Abele[3], Andreas Doblhammer[3], Erwin Jericha[3], Jens Klenke[2], Annabel Kropf[1], Kathrin Lehmann[2], Heiko Saul[1], Ulrich Schmidt[5], Torsten Soldner[4], and Bastian Märkisch[1] — [1]TUM Physik-Department, Garching, Germany — [2]Forschungsreaktor München, Garching, Germany — [3]Atominstitut Wien, Wien, Austria — [4]Institut Laue-Langevin, Grenoble, France — [5]Physikalisches Institut Heidelberg, Heidelberg, Germany

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 64.3 Thu 14:45 HK-H9

Electron Spectroscopy with PERC — •Karina Bernert[1], Jens Klenke[2], Max Lamparth[1], Manuel Lebert[2], Kathrin Lehmann[2], and Bastian Märkisch[1] — [1]Technische Universität München, Garching, Germany — [2]Forschungsreaktor München, Garching, Germany

The PERC (Proton Electron Radiation Channel) instrument is a neutron decay facility currently being set up at the research reactor FRM II of the Heinz Maier-Leibnitz Zentrum in Garching. Its main component is a 12-meter long superconducting magnet system, which was recently delivered to the FRM II. We aim to measure several correlation coefficients in neutron beta decay one order of magnitude more precisely than currently possible. From the results, we will derive the nucleon axial coupling and the CKM matrix element V_{ud} and search for scalar and tensor couplings.

The spectrum of electrons from neutron decay will be obtained using two detector systems: the primary detector downstream will be a scintillation or silicon detector. The secondary detector system, used to identify backscattering events, consists of two pixelated scintillation detectors read out by silicon photomultipliers. In this talk, we present the status of the experiment and its main components with a focus on the backscatter detector.

PERC is developed in cooperation with scientists from TU Vienna, Universität Heidelberg, Johannes Gutenberg-Universität Mainz and the ILL.

HK 64.4 Thu 15:00 HK-H9

The backward angle measurement at P2 — Sebastian Baunack[1], Maarten Boonekamp[4], Boris Gläser[1], Kathrin Imai[1], Rahima Krini[1], Frank Maas[1,2,3], Tobias Rimke[1], 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 — [4]IRFU, CEA, Université Paris-Saclay, Gif-sur-Yvette, France

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 an accuracy of 0.15% at a low four-momentum transfer of $Q^2 = 4.5 \cdot 10^{-3}\,\mathrm{GeV}^2$. In combination with existing measurements at the Z pole with comparable accuracy, this comprises a test of the standard model with a sensitivity towards new physics up to a mass scale of 50 TeV. The experiment will be built at the future MESA accelerator in Mainz.

In addition to the measurement under forward angle, a measurement under backward angle will be performed. This measurement will reduce the uncertainty on the axial form factor and the strange magnetic form factor and thus reducing the systematic uncertainty on the weak charge of the proton. The motivation and challenges for this measurement will be discussed in this talk.

HK 64.5 Thu 15:15 HK-H9

Search for low Q-value beat decays for neutrino mass determination — •zhuang ge[1,2], Tommi Eronen[2], and IGISOL collaboration[2] — [1]GSI Helmholtzzen-trum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany — [2]Department of Physics, University of Jyväskylä, P.O. Box 35, FI-40014 Jyväskylä, Finland

The scale of neutrino masses is one of the burning open questions in physics. The β decay experiments search the electron neutrino mass by measuring the slight distortion and energy deficit of the end-point of the β spectrum. As small as possible decay energy (Q value), is essential to maximize decay events near the end-point. We map out nuclei that potentially undergo β decay with an ultra-low Q value (< 1 keV) to an excited state in the daughter nucleus. A precise and accurate determination of these ultra-low Q values requires the measurements of the groud-state-to-groud-state (gs-to-gs) Q values to $\sim$ 100-eV level. We have measured gs-to-gs decay Q values of several candidates with the JYFLTRAP Penning trap setup. The high-precision Q-value measurement from our experiment combined with the nuclear energy level data will be used to determine whether the possible low Q-value β-decay candidate for the neutrino mass are energetically allowed and, if positive, how small. In this report, the experimental techniques of TOF-ICR and PI-ICR methods to determine the gs-to-gs Q value to a relative precision of $\sim 10^{-9}$ for the application of neutrino mass determination will be discussed and the preliminary results of some prospective cases will be presented.

HK 65: Heavy-Ion Collisions and QCD Phases XIII

Time: Thursday 16:00–17:30 Location: HK-H1

HK 65.1 Thu 16:00 HK-H1

Temperature and net baryochemical potential dependence of η/s in a hybrid approach — •Niklas Götz[1,2] and Hannah Elfner[3,1,2] — [1]Institute for Theoretical Physics, Goethe University, Max-von-Laue-Strasse 1, 60438 Frankfurt am Main, Germany — [2]Frankfurt Institute for Advanced Studies, Ruth-Moufang-Strasse 1, 60438 Frankfurt am Main, Germany — [3]GSI Helmholtzzentrum für Schwerionenforschung, Planckstr. 1, 64291 Darmstadt, Germany

In this work, the qualitative impact of the net baryochemical potential dependence of the shear viscosity to entropy density ratio η/s in hydrodynamical simulations is studied. The effect of a predicted non-constant $\eta/s(\mu_B)$ is largely unexplored in hydrodynamic simulations. Previous studies focus only on a temperature dependence or even only a constant effective shear viscosity. This work addresses this issue by studying qualitatively the effect of a generalized $\eta/s(T, \mu_B)$ in the novel hybrid approach SMASH-vHLLE, composed of the hadronic transport approach SMASH[1] and the (3+1)d viscous hydrodynamic code vHLLE[2]. In order to reduce the bias of the result on the equation of state used in the hydrodynamic part of the model, η/s is parameterized directly in the energy density and baryon number density. This work compares the impact of the density dependence for different system sizes and energies and constrains the behaviour of $\eta/s(T, \mu_B)$ by ruling out regions of the parameter space.

[1] https://github.com/smash-transport/smash
[2] https://github.com/yukarpenko/vhlle

HK 65.2 Thu 16:15 HK-H1

New developments in flow analyses with multiparticle $>$ correlations in ALICE and CBM — •Ante Bilandzic for the CBM-Collaboration — Technical University of Munich, Germany

Anisotropic flow measurements in small collision systems with multiparticle azimuthal correlations are not reliable, since correlation techniques are a precision tool only in an environment characterized by large multiplicities and large flow values. We present the first analytic results for combinatorial background in multi-particle azimuthal correlations, and demonstrate that for small multiplicities this contribution is not negligible. We show that the analytic solutions for the combinatorial background are universal as they can be written generically in terms of multiplicity-dependent combinatorial weights and marginal probability density functions of starting multivariate distribution. We conclude that the observed universality of flow measurements in pp, p–Pb and peripheral Pb–Pb collisions at LHC can be attributed solely to the interplay between nonflow correlations and combinatorial background, which always exhibits universal scaling as a function of multiplicity.

We present the feasibility study of using correlation techniques in flow analyses in the CBM experiment at FAIR. The first results for the flow harmonics estimated with multiparticle cumulants, $v_n\{k\}$, and the multiharmonic flow correlations obtained with symmetric cumulants, $\mathrm{SC}(m, n)$, are presented. We test the scaling of both statistical and systematical uncertainties for these observables in a fixed-target environment characterized by small multiplicities.

HK 65.3 Thu 16:30 HK-H1

SMASH as an afterburner: Advances in the non-equilibrium hadronic evolution — •Oscar Garcia-Montero — Institut für Theoretische Physik, Goethe Universität, Frankfurt am Main, Germany

The hot medium created by colliding two heavy ions is a system which is trying against all odds to thermalize. For this reason, we focus on the non-equilibrium dynamics of the late hadronic stage of the fireball. More specifically, two recent developments on the physics of the afterburner, using the code SMASH. First the role of multi-particle reactions in the late stages of heavy-ion collisions are demonstrated to be significant for the final deuteron [1] and proton [2] abundances at intermediate to high beam energies.

Additionally, we present a consistent photon production calculation from hadronic cross sections, including bremsstrahlung and 2-to-2 reactions [3]. Using the hadronic transport approach SMASH as the afterburner for the hadronic stage at RHIC and LHC energies, we find a significant increase in the calculated momentum anisotropies of these photons due to microscopic non-equilibrium dynamics. Non-equilibrium dynamics enhance the photon v_2 below $p_\perp \approx 1.5$ GeV.

[1] Jan Staudenmaier, D. Oliinychenko, J. M. Torres-Rincon, and H. Elfner, Phys. Rev. C 104, 034908 (2021)
[2] O. Garcia-Montero, Jan Staudenmaier, A. Schäfer, J. M. Torres-Rincon, abd H. Elfner, arXiv:2107.08812
[3] A. Schäfer, O. Garcia-Montero, J-F. Paquet, H. Elfner, and C. Gale. arXiv: 2111.13603

HK 65.4 Thu 16:45 HK-H1

Precision hydrodynamic predictions for particle production in isobar collisions at RHIC — •Andreas Kirchner[2], Federica Capellino[1], Stefan Floerchinger[2], Giuliano Giacalone[2], and Eduardo Grossi[3] — [1]Physikalisches Institut Heidelberg — [2]ITP Heidelberg — [3]IPhT Saclay

The STAR collaboration has recently released high precision measurements of soft particle production in Ru+Ru and Zr+Zr collisions permitting us to perform precision tests of hydrodynamic models of the quark-gluon plasma (QGP). In this contribution, we discuss hydrodynamic results for particle production in isobar collisions where we achieve the same precision reached in the experimental data. Our approach relies on a background-fluctuation splitting of the equations of hydrodynamics. We decompose the QGP as an event-averaged azimuthally-isotropic background plus an event-by-event fluctuation. We show that the leading contribution to the average final-state spectra are obtained from the 1+1D evolution of the isotropic background, which is very fast to run. We use, hence, FluiduM, a new solver for the 1+1D evolution of the QGP, to compute predictions for particle spectra, yields and average transverse momenta of identified hadrons. Looking at ratios of quantities between Ru+Ru and Zr+Zr systems, we find that they are insensitive to viscosities and other medium parameters. They are instead driven by initial-state effects driven mainly by the larger neutron skin of 96Zr.

HK 65.5 Thu 17:00 HK-H1

Elliptic flow of pions, kaons and protons relative to the spectator plane measured with ALICE at the LHC — •Michael Rudolf Ciupek[1,2], Lukas Kreis[1,2], and Ilya Selyuzhenkov[2] for the ALICE-Collaboration — [1]Physikalisches Institut, Heidelberg, Deutschland — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Deutschland

In relativistic heavy-ion collisions, the shape of the initial energy density in the overlap region of the colliding nuclei is asymmetric and fluctuates. Due to interactions, these are transferred to the momentum distribution of particles in the final state which is quantified by the flow coefficients v_n. Thermodynamic expansion of the quark-gluon plasma (QGP) results in a specific particle mass dependence of the v_n coefficients as a function of the transverse momentum. The measurements of the v_n relative to the spectator plane is of special interest, since the spectators decouple very early in the collision. Comparison of the v_n measured relative to the participant and that wrt. the spectator planes with the corresponding eccentricities allow constraining the initial state models. The particle type (mass) dependence of these differences is sensitive to the viscous effects in the QGP expansion.
In this talk, the ALICE measurements of the v_2 for pions, kaons, and protons with respect to the spectator plane in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ and 5.02 TeV are presented. Results are compared with v_2 extracted from two and four-particle cumulants. The spectator plane is reconstructed using the ALICE Zero Degree Calorimeters. The particle identification is performed using a Bayesian approach.

HK 65.6 Thu 17:15 HK-H1

Application of the Three-fluid Hydrodynamics-based Generator THESEUS to CBM. — •Elena Volkova, Hans Rudolf Schmidt, and Viktor Klochkov for the CBM-Collaboration — Eberhard Karls Universität Tübingen

The Compressed Baryonic Matter experiment (CBM) aims to study the area of the QCD phase diagram at high net baryon densities and moderate temperatures. It is predicted by Three-fluid Hydrodynamics-based Event Simulator (THESEUS) that one of the signatures of phase transition is a change in shape of the mid-rapidity curvature and yield.

In this contribution we will present CBM performance for proton rapidity- transverse mass spectra. The results are obtained for Au+Au

collisions at $\sqrt{s_{NN}}$ = 2.7 - 4.9 GeV/c produced by THESEUS model. CBM detector response is simulated with the GEANT3 engine and reconstruction is done using the CbmRoot framework. Protons are identified with Time-of-Flight technique using 2 different approaches. Obtained spectra are corrected for detector biases using the UrQMD event generator. Results are compared with simulated values and sources of systematic biases are discussed.

HK 66: Heavy-Ion Collisions and QCD Phases XIV

Time: Thursday 16:00–17:15 Location: HK-H2

HK 66.1 Thu 16:00 HK-H2

Jet-hadron correlations in PbPb collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02TeV with ALICE — •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.

By analyzing the angular correlations of jets with charged hadrons, one obtains information about the energy loss of jets in the medium. The study of these correlation functions for different orientations of the jet to the event plane allows for a measurement of the energy loss which is sensitive to the in-medium path-length of the jet. In this talk, first studies of event plane dependent jet-hadron correlations for data collected by the ALICE experiment in PbPb collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV are presented.

HK 66.2 Thu 16:15 HK-H2

Deuteron production in and out of jets measured with ALICE at the LHC — •Chiara Pinto for the ALICE-Collaboration — Technische Universität München, Garching bei München, Germany

The production mechanism of (anti)nuclei in ultrarelativistic hadronic collisions is under intense debate in the scientific community. The description of the experimental measurements is currently based on two competing phenomenological models: the statistical hadronisation model and the coalescence approach. For the first time, the deuteron production in pp collisions at $\sqrt{s}$ = 13 TeV is measured both in jets and in the underlying event. Due to the collimated emission of nucleons in a jet, the nuclear production by coalescence is expected to be enhanced. In this contribution, the results for the coalescence parameter B_2 in and out of the jet are presented in comparison with predictions from the coalescence model and a recently developed reaction-based production mechanism implemented in PYTHIA 8.3.

HK 66.3 Thu 16:30 HK-H2

Multi-particle correlation in proton-proton collisions from a toy hydrodynamic model — •Seyed Farid Taghavi — E62, Physics department, Technical university of Munich, Garching, Germany

Over the past years, there have been ongoing debates on the origin of the long-range correlations observed in proton-proton collisions at RHIC and LHC. In this talk, a toy model based on Gubser flow is introduced to shed light on the applicability of hydrodynamics in proton-proton collisions. The model, initial state fluctuation + Gubser solution + Cooper-Frye freeze-out, is validated by comparing its results with MC-Glauber + VISH2+1. A rather model-independent approach for the initial state is followed where the RMS radius and ellipticity event-by-event fluctuations are modeled instead of modeling the initial entropy density of individual events. This approach helps us to find out which initial state fluctuating properties would lead to a correct final multiparticle correlation. The toy model describes the multiplicity and transverse momentum dependence of two-point and four-point correlation functions in an accurate agreement with proton-proton collision experimental measurements. In particular, the sign of the four-point correlation function is the same as the observation. We find that neither AMPT nor T$_{\mathrm{R}}$ENTo with nucleonic substructure initial state models can produce the predicted fluctuation for the RMS radius and ellipticity.
Based on:
S. F. Taghavi, Phys.Rev.C 104 (2021) 5, 054906

HK 66.4 Thu 16:45 HK-H2

Differential studies of multi-harmonic flow correlations in ALICE — •Anton Riedel for the ALICE-Collaboration — TU Muenchen, Garching b. M., Deutschland

Symmetric cumulants are a reliable tool for estimating the multi-harmonic correlations between different flow harmonics and have been used in ALICE to constrain the details of η/s temperature dependence of the matter produced in heavy-ion collisions.

In this poster, we present a further differential study of multi-harmonic correlations obtained with symmetric cumulants, SC(k,l) and SC(k,l,m). We present the first results for symmetric cumulants as functions of pseudorapidity η and transverse momentum p_{T} utilizing Pb–Pb collision at LHC and show how granular the correlations can be extracted using the available statistics. These differential studies provide new and independent constraints both on initial conditions and on the properties of produced nuclear matter.

HK 66.5 Thu 17:00 HK-H2

Impact of hadronic interactions and conservation laws on cumulants of conserved charges in a dynamical model — •Jan Hammelmann[1] and Hannah Elfner[2,1] — [1]Frankfurt Institute for Advanced Studies (FIAS) — [2]GSI Helmholtzzentrum für Schwerionenforschung

Understanding the phase diagram of QCD by measuring fluctuations of conserved charges in heavy-ion collision is one of the main goals of the beam energy scan program at RHIC. Within this work, we calculate the role of hadronic interactions and momentum cuts on cumulants of conserved charges up to fourth order in a system in equilibrium within a hadronic transport approach (SMASH). In our model the net-baryon, net-charge and net-strangeness is perfectly conserved on an event-by-event basis and the cumulants are calculated as a function of subvolume sizes and compared to analytic expectations. We find a modification of the kurtosis due to charge annihilation processes in systems with simplified degrees of freedom. Furthermore the result of the full SMASH hadron gas for the net-baryon and net-proton number fluctuations is presented for systems with zero and finite values of baryochemical potential. Additionally we find that due to dynamical correlations the cumulants of the net-baryon number cannot be recovered from the net-protons. Finally the influence of deuteron cluster formation on the net-proton and net-baryon fluctuations in simplified system is shown. This analysis is important to better understand the relation between measurements of fluctuations in heavy-ion collisions and theoretical calculation which are often performed in a grand canonical ensemble.

HK 67: Instrumentation XVII

Time: Thursday 16:00–17:30 Location: HK-H3

Group Report HK 67.1 Thu 16:00 HK-H3

New detectors for high precision measurements of thermal neutrons — •Jochen Kaminski[1], Markus Gruber[1], Saime Gürbüz[1], Markus Köhli[2], Michael Lupberger[1], Divya Pal[1], Laura Rodríguez Gómez[1], and Klaus Desch[1] — [1]Physikalisches Institut, Universität Bonn, Bonn, Deutschland — [2]Physikalisches Institut, Universität Heidelberg, Heidelberg, Deutschland

In the light of neutron sources in the construction or the commissioning phase, such as the ESS or the CSNS, the demand for neutron detectors

is increasing. Because of the shortage and the subsequent rise in cost of helium-3 the availability of conventional neutron detectors is limited. Therefore, new types of detectors based on layers of solid state converters made of boron or gadolinium are being developed. Our group is developing three different types of detectors for high spatial and time resolution for which very different technologies are employed. One of them uses a boron and gadolinium loaded MCP as a converter and amplification stage with a readout by four Timepix3 ASICs, which is ideal for time resolved imaging applications. The two gaseous detectors are aimed for event-by-event high precision measurements of space and time of the conversion point. The detectors use boron-rich conversion layers and are based on the one hand on the TPC principle with a GridPix readout for high precision or on the other hand on a multi-layer GEM-based detector for high rates. In this presentation the principles and the current development statuses of the three detectors are discussed.

HK 67.2 Thu 16:30 HK-H3

Status of the neutron lifetime experiment τSPECT — •Kim Ulrike Ross for the tauSPECT-Collaboration — Department of Chemistry, Johannes Gutenberg University, Mainz

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 our magnetic trap after double spin flip loading. UCN which are produced in pulses at the TRIGA research reactor Mainz are trapped for varying storage times and afterwards remaining neutrons are counted. The neutron lifetime can then be extracted from an exponential fit. In contrast to previous lifetime experiments employing material walls, systematic effects are reduced significantly by the magnetic confinement of UCN. The target uncertainty in the measured neutron lifetime is $\Delta\tau_n = 1.0$ s in phase I of the experiment.

This talk will give an overview of the status of the τSPECT experiment including the magnetic field configuration, as well as the filling and measurement procedure.

HK 67.3 Thu 16:45 HK-H3

A normalization detector for the neutron lifetime experiment τSPECT — •Martin Engler for the tauSPECT-Collaboration — Department of Chemistry, Johannes Gutenberg University, Mainz

The τSPECT experiment aims to measure the free neutron lifetime, using fully magnetic storage. Neutrons with energies of ≈50 neV are stored in the magnetic field gradient and then counted after varying storage times. The individual measurements have to be normalized, in order to account for statistical and systematical changes in the yield of the neutron source. To monitor the neutron flux during the filling process, an in-situ neutron detector, detecting light from a ^{10}B coated ZnS:Ag scintillator coupled to an array of silicon photomultipliers, has been designed and built.

This talk will cover the detectors design, as well as the results of the first test run.

HK 67.4 Thu 17:00 HK-H3

Development of the compact, high resolution particle detection system HI-TREX for ISOLDE — Christian Berner, Roman Gernhäuser, •Sergei Golenev, and Robert Neagu for the MINIBALL-Collaboration — Technical University of Munich

Transfer reactions are a unique tool to populate and probe the structure of nuclei. Due to its unprecedented capabilities in producing and accelerating exotic nuclei, the HIE-ISOLDE facility at CERN provides an excellent opportunity for transfer experiments using radioactive ion beams. HI-TREX is a particle detection setup, optimized for this nuclei. HI-TREX is based on three technological pillars: very thin, AC-coupled, double-sided silicon strip detector (DSSSD); extremely low-powered, high resolution front-end electronics, based on the SKIROC ASICs; and a newly developed, custom made, FPGA based GEneric Asic Readout board GEAR for the TRB data acquisition system. We will present the concept, layout and a whole series of prototype tests towards this demanding technology.

Supported by BMBF 05P21WOCI1

HK 67.5 Thu 17:15 HK-H3

Determination of a high neutron flux using a DT generator — Marie Pichotta, •Hans Hoffmann, and Kai Zuber — TU Dresden IKTP, Dresden, Deutschland

Reproducing r-process reactions on earth is challenging because a very high neutron flux is needed. A promising way is DT implosion at the NIF (National Ignition Facility). There the cross section of reaction ^{40}Ar(2n,γ)^{42}Ar is going to be measured. The reaction ^{40}Ar(n,2n)^{39}Ar will monitor the neutron field. A measurement of the total cross section is needed because theoretical models for this cross section differ.

An argon gas sample enriched in ^{40}Ar was fed into a 20 mm diameter Al sphere at 20 bar. The argon-filled sphere was irradiated with a high neutron flux using the TU Dresden DT neutron generator. It is located at HZDR (Helmholtz-Zentrum Dresden - Rossendorf) and produces a 14 MeV neutron field with densities up to 10^{12} n/(s cm^2). The Ar-filled sphere was positioned in close geometry in order to gain a high neutron flux. 2 metal foils consisting of Al, Zr and Nb respectively, served as neutron monitors. After the irradiation, the monitors' activity was measured using a germanium detector surrounded by a lead shielding. It was calibrated using point sources of known activity and Monte-Carlo simulations. The irradiation procedure and neutron flux analysis will be presented.

HK 68: Instrumentation XVIII

Time: Thursday 16:00–17:15 Location: HK-H4

Group Report HK 68.1 Thu 16:00 HK-H4

Status of R3B setup for as part of the FAIR Phase-0 program — •Andrea Jedele for the R3B-Collaboration — Technische Universität Darmstadt, Fachbereich Physik, D-64289 Darmstadt — GSI Helmholtzzentrum für Schwerionenforschung, D-64291 Darmstadt — Helmholtz Forschungsakademie Hessen für FAIR, D-64289 Darmstadt

The R3B experimental setup located at GSI will be used for upcoming experiments as part of the FAIR Phase-0 program. The versatile setup with large geometric coverage and particle resolution allows for the study of nuclear reaction and structure at relativistic energies.

The experimental setup will be presented followed by an overview of the various detector subsystems. Preliminary results for each detector will be presented to highlight the performance capabilities of the complete setup for upcoming experiments.

This work is supported by the German Federal Ministry for Education and Research (BMBF) under contract number 05P21RDFN2 and by the GSI-TU Darmstadt cooperation agreement.

HK 68.2 Thu 16:30 HK-H4

The new MINIBALL triple cluster detector — •Jasper Wehlitz, Rainer Abels, Timon Büsken, Jürgen Eberth, Kai Henseler, Herbert Hess, Rouven Hirsch, Darius Luyken, and Peter Reiter — IKP Universität zu Köln, Cologne, Germany

The Miniball MB spectrometer consists of eight triple-cryostats, each housing three n-type six-fold segmented HPGe crystals. Major structural changes were made to the cryostat and its electronics to facilitate usability and to increase longevity. The HPGe crystals are individually encapsulated in reusable thin-walled aluminium housing using a new technique that is based on a temperature resistant full-metal elastic seal. As each crystal provides seven signals from the core and six segments a MB cryostat requires 21 preamplifiers. The cryogenically-cooled part of the preamplifier consists of seven jFET-type field effect transistors with their feedback circuits and a coupling capacitor. These parts were improved and coupled to the AGATA preamplifier [1] board in the warm part of the cryostat providing a high bandwidth needed for pulse-shape analysis. First measurements with the new MB triple cluster detectors show energy resolution values and crosstalk properties well within the specifications. The new MB detectors will be employed for future experiments with radioactive ion beams at HIE-ISOLDE (CERN).

[1] S. Akkoyun, et al., Nucl. Instrum. Methods Phys. Res. A 668 (2012) 26

HK 68.3 Thu 16:45 HK-H4

Double-Gamma Nuclear Decay Experiments using Ac-

tive Compton Supression — •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 upgraded with 16 LaBr3 detectors and a specially developed compton suppression system called BACCHUS. This made possible double gamma decay measurements with significantly reduced measuring time in comparison to previous experiments. Also the angular distribution between the two emitted photons can now be probed for a larger set of angles. The $\frac{11}{2}^- \rightarrow \frac{3}{2}^+$ transiton of 137-Ba is used as a benchmark to characterise the setup and evaluate future possible uses.
Supported by DFG (SFB 1245)

HK 68.4 Thu 17:00 HK-H4

Test measurement of the HISPEC plunger device at IKP Cologne — •Lisa Kornwebel[1], Christoph Fransen[1], Marcel Beckers[1], Andrey Blazhev[1], Alfred Dewald[1], Felix Dunkel[1], Jan Jolie[1], Casper Lakenbrink[1], Claus Müller-Gatermann[2], Franziskus von Spee[1], and Stefan Thiel[1] — [1]Institut für Kernphysik, Köln, Deutschland — [2]Physics Division, Argonne National Laboratory, IL, USA

The HISPEC plunger, developed and built by our group, is a core device for the HISPEC-DESPEC program which is part of the NUSTAR collaboration within FAIR. This device will be used for the measurement of level lifetimes in exotic nuclei at FAIR with the recoil distance Doppler-shift method. In order to prove the precision of this device, excited states of ^{181}Ta with well-known lifetimes were re-investigated in a test measurement with stable beam at the FN-Tandem accelerator facility at Cologne to determine absolute distances of the very large target and degrader foils in two perpendicular axes. We will present the results with respect to the foil parallelism and the repeat accuracy of these absolute distances. We will further relate the results to an independent measurement of the foil separations with an optical distance measurement system. This work was supported by the BMBF, grant No. 05P19PKFNA.

HK 69: Instrumentation XIX

Time: Thursday 16:00–17:30 Location: HK-H5

HK 69.1 Thu 16:00 HK-H5

The CALIFA trigger system — Leyla Atar[1], Tobias Jenegger[2], Roman Gernhäuser[2], •Philipp Klenze[2,3], and Lukas Ponnath[2] for the R3B-Collaboration — [1]Technische Universität Darmstadt — [2]Technische Universität München — [3]Gesellschaft für Schwerionenforschung, Darmstadt

With the recent completion of the forward region of the R^{3}B calorimeter, CALIFA now features 1504 channels. While previously each channel of CALIFA was operated in free-running mode, recent beamtimes have shown that this puts a huge load on the downstream processing facilities especially in experiments using high rate uranium beams.

Due to the slow signals of the calorimeter CsI(Tl) crystals special procedures have been established not to compromise efficiency. Using the White Rabbit Time Stamps (WRTS) differences of various detector systems, it is easy to verify that this is actually the case.

Additionally, we will discuss the ability of CALIFA to provide a high level trigger based on proton multiplicities or position to ancilliary detectors with limited readout capability in R^{3}B.

Supported by BMBF contract 05P19WOFN1.

HK 69.2 Thu 16:15 HK-H5

Magnet simulations for HISPEC position tracking detector — •Michael Armstrong and Gereon Hackenberg — University of Cologne

Future in-flight spectroscopy of radioactive heavy ion beams in HISPEC (HIgh resolution in-flight SPECtroscopy) experiments at GSI/FAIR will require highly precise beam tracking and timing [1]. For these experiments a pair of Secondary Electron Detector (SED) using Multi-Channel Plate (MCP) detectors are being designed to fulfil these requirements. In order to achieve the necessary precision the MCP's must be enveloped in a homogenous 100 gauss magnetic field. In this poster the design of a prototype permanent magnet is presented including simulations of the magnetic field it should be capable of providing.

This work was supported by GSI under F&E grant KJOLIE1820.

[1] - "Technical Report for the Design, Construction and Commissioning of the HISPEC/DESPEC Beam Line, Infrastructure and Tracking Detectors". HISPEC/DESPEC Collaboration. FAIR PAC NUSTAR. 11 May 2020.

HK 69.3 Thu 16:30 HK-H5

aTEF: Background reduction at KATRIN via an active transverse energy filter — •Kevin Gauda[1], Volker Hannen[1], Alexey Lokhov[1], Hans-Werner Ortjohann[1], Wolfram Pernice[2], Richard Salomon[1], Sonja Schneidewind[1], Maik Stappers[2], and Christian Weinheimer[1] — [1]Institut für Kernphysik, Universität Münster, Germany — [2]Physikalisches Institut, Universität Münster, Germany

The Karlsruhe Tritium Neutrino Experiment (KATRIN) aims at the direct measurement of the electron antineutrino mass with 0.2 eV/c^2 sensitivity from precision spectroscopy of the tritium beta decay. The analysis of its first two science runs yields a new upper limit of $m_\nu < 0.8$ eV (90 % C.L.).

Even in the shifted-analysis-plane (SAP) mode it is required to further lower the background rate to reach the target sensitivity. The background rate is dominated by electrons originating from ionisation of highly-excited (Rydberg) atoms produced by α-decays in the spectrometer walls. Thus, they cannot be distinguished from the signal electrons by energy but they possess much smaller angles w.r.t. the beam axis and, thus, much smaller cyclotron radii in the magnetic fields of KATRIN. The aTEF idea is to construct a detector by microstructuring that is mainly sensitive to the signal electrons because of their larger cyclotron radii. Investigations of first prototypes based on microstructured silicon PIN detectors are presented in this talk.

The work of the authors for KATRIN is supported by BMBF under contract number 05A20PMA.

HK 69.4 Thu 16:45 HK-H5

Influence of the fluorescence detection region on the determination of nuclear moments — •Patrick Müller[1,2], Phillip Imgram[1], Bernhard Maass[3], and Wilfried Nörtershäuser[1,2] — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]Helmholtz Forschungsakademie Hessen für FAIR, TU Darmstadt, Germany — [3]Argonne National Laboratory, Chicago, IL, USA

Collinear laser spectroscopy (CLS) is usually used at online facilities such as CERN or NSCL to determine isotope shifts as well as nuclear moments of neutron-deficient or -rich nuclei. At the COALA experiment at the Technische Universität Darmstadt, high-precision CLS is used to provide reference values of atomic transition frequencies and nuclear moments in stable isotopes required for online experiments, but also to test new measurement schemes or technical equipment. By recording fluorescence spectra of electric dipole transitions whose linewidths are of the order of the natural linewidth, small effects which shift or deform the classical Lorentzian profile become visible, such as quantum interference or photon recoils.

We report on measurements with a new lens-based fluorescence detection region (FDR) for COALA using Ca^+. Due to its well-defined positional and easy to adjust angular detection range, the FDR is particularly useful for investigating the influence of such geometric effects on fluorescence spectra and, therefore, on extracted nuclear moments.

Acknowledgment This work was supported by BMBF under contract *05P19RDFN1.*

HK 69.5 Thu 17:00 HK-H5

Improvement of Pulse Shape Simulations for Highly Segmented HPGe Detectors — •Rouven Hirsch, Rainer Abels, Jürgen Eberth, Kai Henseler, Herbert Hess, Darius Luyken, and Peter Reiter — Institut für Kernphysik, Universität zu Köln

36-fold segmented high purity germanium detectors are the basis for the Advanced GAmma Tracking Array (AGATA). In contrast to con-

ventional γ-ray spectrometers, AGATA utilizes the γ-ray tracking method which reconstructs the path of the γ rays through the detector array. Essential for the tracking is the determination of the γ-ray interaction positions with a sub-segment position resolution. This is obtained via pulse-shape analysis (PSA) of the 37 preamplifier signals. Simulated signal shapes are compared with the measured signals to match the interaction positions. Therefore, the final position resolution strongly depends on the quality and accuracy of the detector signal simulation. Simulated data bases of position dependent signals were generated for a cylindrical 36-fold segmented single ended coaxial HPGe detector employing the AGATA Detector Library [1] and Solid-StateDetectors.jl [2]. Systematic deviations were identified at the crystal borders and segmentation lines by comparing simulated pulse shapes and measured signals for both approaches. The impact of simulation input variables to the pulse shapes was investigated to improve the overall PSA performance. Supported by BMBF Project 05P18PKFN9 and 05P21PKFN9

[1] B. Bruyneel et al. Eur. Phys. J. A (2016) **52**: 70
[2] I. Abt et al. 2021 JINST **16** P08007

HK 69.6 Thu 17:15 HK-H5

Preparation of the hyperatom studies at $\overline{\text{P}}$ANDA — Patrick Achenbach[1,2], Sebastian Bleser[1], •Michael Bölting[1], Josef Pochodzalla[1,2], Falk Schupp[1], and Marcell Steinen[1] — [1]Helmholtz Institute Mainz, 55099 Mainz — [2]Johannes Gutenberg University, 55099 Mainz

The antiproton beam of the HESR at FAIR will allow to produce various hyperon-antihyperon pairs. The dedicated target system of the $\overline{\text{P}}$ANDA hyperatom setup will allow to bind negatively-charged (anti)hyperons and form heavy hyperatoms. First experiments with a ^{208}Pb target aim at studying X-ray transitions of atomically bound Ξ^-, Σ^- and possibly even $\overline{\Sigma}^-$.

The required target system needs to be integrated in the HESR beam pipe and the $\overline{\text{P}}$ANDA target spectrometer. Consequently, it must not only be vacuum-tolerant but also radiation hard and compatible with the present strong magnetic field within $\overline{\text{P}}$ANDA. Within this environment the required redundancy of the target setup can only be achieved by multiple primary targets exchangeable by a system of piezomotors.

In this contribution we will present the final design of the two-staged target system. First tests of the reliability and the precision of the system will be presented.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 824093.

HK 70: Structure and Dynamics of Nuclei XII

Time: Thursday 16:00–17:45 Location: HK-H6

Group Report HK 70.1 Thu 16:00 HK-H6

Lifetime studies in self-conjugate even-even nuclei in the $0f_{7/2}$ shell — •K. Arnswald[1], A. Blazhev[1], F. Nowacki[2], P. Petkov[3,1], and P. Reiter[1] — [1]Institut für Kernphysik, Universität zu Köln — [2]Université de Strasbourg, CNRS, IPHC UMR 7178, Strasbourg, France — [3]*„Horia Hulubei“* National Institute for Physics and Nuclear Engineering, Bucharest-Mägurele, Romania

Reduced transition strengths are sensitive signatures to describe collective excitations of atomic nuclei and the evolution of shell structures. They allow for stringent tests of present-day shell-model interactions in the $0f1p$ shell. In recent years, data were obtained from lifetime experiments utilizing the recoil-distance Doppler-shift technique as well as the Doppler-shift attenuation method and cover the even-even $N = Z$ nuclei between ^{44}Ti and ^{56}Ni. An enhanced collective behavior has been observed for the 2_1^+ states [1]. In ^{44}Ti this collectivity has been associated with core excitations. Precise values along the negative parity band in this nucleus were obtained. These states arise from a strong interplay between *sd*- and *pf*-shell orbitals and provide refined tests of cross-shell contributions [2]. For the doubly-magic nucleus ^{56}Ni only the $B(E2, 2_1^+ \rightarrow 0^+_{\text{g.s.}})$ value was known. Lifetimes of the 4_1^+ and 6_1^+ states were newly obtained and confronted with modern shell-model calculations. A comparison along the chain of $N = 28$ isotones between ^{48}Ca and ^{58}Zn shows maximum $B(E2)$ values for these states [3].

[1] K. Arnswald *et al.* Phys. Lett. B **772**, (2017) 599-606
[2] K. Arnswald *et al.* Phys. Rev. C **102**, 054302 (2020)
[3] K. Arnswald *et al.* Phys. Lett. B **820**, (2021) 136592

HK 70.2 Thu 16:30 HK-H6

Lifetime Measurement of the ^{26}O g.s. at SAMURAI — •S. Storck-Dutine[1,3], T. Aumann[1,2], C. Caesar[2,3], J. Kahlbow[4,3], V. Panin[2,3], and D. Rossi[1,2] for the NeuLAND-SAMURAI-Collaboration — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany — [3]RIKEN Nishina Center, Tokyo, Japan — [4]Massachusetts Institute of Technology, Cambridge MA, USA

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 MUlti-particle 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. The ratio of the number of decays happening inside and outside of the target will change according to the lifetime. 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 Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Project-ID 279384907 - SFB 1245, the BMBF under contract number 05P21RDFN2 and the GSI-TU Darmstadt cooperation agreement.

HK 70.3 Thu 16:45 HK-H6

Excited states from eigenvector continuation: the anharmonic oscillator — •Margarida Companys Franzke[1], Alexander Tichai[1,2,3], Kai Hebeler[1,2,3], and Achim Schwenk[1,2,3] — [1]Technische Universität Darmstadt, Department of Physics — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Plank Institut für Kernphysik, Heidelberg

Eigenvector continuation (EC) has recently attracted a lot attention in nuclear structure and reactions as a variational resummation tool for many-body expansions. While previous applications focused on ground-state energies, excited states can be accessed on equal footing. This work is dedicated to a detailed understanding of the emergence of excited states from the eigenvector continuation approach. For numerical applications the one-dimensional quartic anharmonic oscillator is investigated, which represents a strongly non-perturbative quantum system where the use of standard perturbation techniques break down. We discuss how different choices for the construction of the EC manifold affect the quality of the EC resummation and investigate in detail the results from EC for excited states compared to results from a full diagonalization as a function of the basis-space size.

* Funded by the DFG – Project-ID 279384907 – SFB 1245 and by the ERC Grant Agreement No. 101020842.

HK 70.4 Thu 17:00 HK-H6

Gamma ray spectroscopy of the neutron-rich ^{94,95,96}Kr* - results from the NuBall and SEASTAR campaigns — Rosa-Belle Gerst, •Andrey Blazhev, and Nigel Warr — Institut für Kerphysik, Universität zu Köln

The isotopic chain of krypton isotopes is home to a variety of nuclear-shape phenomena and has been studied extensively. In recent years, we have studied the neutron-rich isotopes during the SEASTAR campaign at the RIBF at the RIKEN Nishina Center and during the NuBall campaign at the ALTO facility at the IPN Orsay. While the former populated the isotopes of interest via nucleon knockout reactions, the latter used fast-neutron induced fission of ^{238}U. In all three studied nuclei, previously unknown gamma-transitions were observed extending the level schemes [1,2]. A new short-lived isomer was discovered in ^{94}Kr [1]. For ^{95}Kr, the analysis of prompt gamma-radiation with and without coincidence of delayed radiation identified the prompt gamma-

rays [2] as either feeding or bypassing the known isomeric state [3]. For ^{96}Kr, the measured new transitions imply the existence of low-lying low-spin non-yrast states [2]. The comparison of the new experimental results with 5DCH and mapped IBM calculations, both using the Gogny D1M interaction, could suggest oblate-prolate shape coexistence in the krypton isotopes already at N=60 [2].
*Supported by the DFG under Grant No. BL 1513/1-1
[1] R.-B Gerst et al., Phys. Rev. C 102, 064323 (2020).
[2] R.-B. Gerst et al., submitted to PRC.
[3] J. Genevey et al., Phys. Rev. C 73, 037308 (2006).

HK 70.5 Thu 17:15 HK-H6

Novel normal ordering framework for heavy nuclei — •Jan Hoppe[1,2], Kai Hebeler[1,2,3], Victoria Durant[4], Johannes Simonis[5], Matthias Heinz[1,2,3], Achim Schwenk[1,2,3], and Alexander Tichai[1,2,3] — [1]Technische Universität Darmstadt, Department of Physics — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Plank Institut für Kernphysik, Heidelberg — [4]Institut für Kernphysik, Johannes Gutenberg-Universität Mainz — [5]Jülich Supercomputing Centre

The inclusion of three-nucleon (3N) interactions plays a central role in the solution of the nuclear many-body problem, e.g., for the structure of finite nuclei or bulk properties of nuclear matter, but still represents a computational frontier. Normal-ordering (NO) has proven to be a powerful tool to systematically include 3N interactions in an efficient way. However, traditional NO frameworks require the representation of 3N interactions in a large single-particle basis, which typically necessitates a truncation on the 3N matrix elements. While these truncations have only a minor impact up to medium-mass nuclei, their effects become sizable for heavier systems and hence limit the scope of ab initio calculations. We present a novel NO framework that allows to circumvent this drawback by performing the NO directly in the Jacobi basis. We systematically study the convergence behavior of results obtained in this framework and present results for ground-state energies of selected nuclei up to ^{132}Sn. *Funded by the DFG - Project-ID 279384907 - SFB 1245 and by the ERC Grant Agreement No. 101020842.

HK 70.6 Thu 17:30 HK-H6

Electron-Gamma Coincidence Experiments at the S-DALINAC — •Gerhart Steinhilber, Jonny Birkhan, Isabelle Brandherm, Martha Liliana Cortes, Florian Gaffron, Johann Isaak, Igor Jurosevic, Peter von Neumann-Cosel, Florian Niederschuh, Norbert Pietralla, Maxim Singer, and Maximilian Spall — IKP, Technische Universität Darmstadt

Inclusive (e,e') electron scattering is an established tool in nuclear physics that provides insights in nuclear structure with high accuracy because of its pure electromagnetic nature. In (e,e'γ) coincidence experiments, the advantage of inclusive electron scattering is preserved and additional information, for example, γ-decay branchings of PDR/GDR and the interference of longitudinal and transversal components of low-lying electric dipole excitations are accessible. The existing (e,e') setup at S-DALINAC was extended by a detector array consisting of 6 $LaBr_3$:Ce detectors and successful (e,e'γ) measurements were conducted for the first time since the pioneering (e,e'γ) experiment nearly 40 years ago [1]. In 2021, a first production run was performed using the new (e,e'γ) setup to study the B(M1,$2^+_{ms}\rightarrow 2^+_1$) and B(E2,$2^+_{ms}\rightarrow 0^+_1$) transition strength of the 2^+_{ms} branching in ^{96}Ru [2] measuring γ-decay branchings. This talk will present the new setup and preliminary results of the ^{96}Ru measurement.
Work supported by DFG (GRK 2128)
[1] C. N. Papanicolas et al., Phys. Rev. Lett. 54 (1985).
[2] N. Pietralla et al., Phys. Rev. C 64 (2001).

HK 71: Structure and Dynamics of Nuclei XIII

Time: Thursday 16:00–17:30 Location: HK-H7

Group Report HK 71.1 Thu 16:00 HK-H7

Nucleon and nuclear structure from measurements in muonic and normal atoms — •Randolf Pohl — Johannes Gutenberg Universität Mainz

Laser spectroscopy of simple atoms is sensitive to properties of the atomic nucleus, such as its charge and magnetization distribution, or its polarizability. This allows determining the nuclear parameters from atomic spectroscopy, but also limits the attainable precision for the determination of fundamental constants or the test of QED and the Standard Model.

In light muonic atoms and ions, one negative muon replaces all atomic electrons, resulting in a calculable hydrogen-like system. Due to the muon's large mass (200 times the electron mass), the muon orbits the nucleus on a 200 times smaller Bohr radius, increasing the sensitivity of muonic atoms to nuclear properties by 200^3 = 10 million.

This has resulted in a 10fold increase in the precision of the charge radius of the proton, deuteron, and the stable helium nuclei. We're currently measuring the hyperfine structure in muonic hydrogen to obtain information about the magnetization of the proton. In Mainz, we're setting up an experiment to determine the triton charge radius by laser spectroscopy of atomic tritium.

HK 71.2 Thu 16:30 HK-H7

nuclear structure corrections in muonic atoms from chiral effective field theory — •simone salvatore li muli[1,2] and sonia bacca[1,2] — [1]Institut für Kernphysik, Johannes Gutenberg Universität, Mainz, Germany — [2]Helmholtz-Institut Mainz, Johannes Gutenberg Universität Mainz, Germany

Precision spectroscopic measurement in muonic atoms require precision theoretical calculations to be able to extract nuclear charge and magnetic radii. While quantum electrodynamics calculations are very precise, nuclear structure corrections are presently the largest source of uncertainty and consequently the bottle-neck for fully exploiting the experimental precision. Utilizing techniques and methods developed in few-body nuclear physics, we have been able to provide the so far most precise determination of nuclear structure corrections to the Lamb shift. I will present our recent calculations for light muonic atoms, where we use chiral effective field theory potentials and perform a study of the uncertainties induced by the order-by-order chiral expansion.

HK 71.3 Thu 16:45 HK-H7

Nuclear structure investigations on $^{253-255}$Es by laser resonance ionization spectroscopy — •Steven Nothhelfer for the Einsteinium-Collaboration — Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany — Helmholtz-Institut Mainz, 55099 Mainz, Germany — GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany

Experimental data on the hyperfine structure splittings and isotope shifts of spectral lines in transuranium elements reveal valuable information about the structure of their atomic nuclei. In this poster we will present results of laser resonance ionization spectroscopy performed on the rare isotopes $^{253-255}$Es at the RISIKO mass separator in Mainz. With small sample sizes ranging down to fg, the prominent 351.5 nm ground-state transition ($5f^{11}7s^2 \rightarrow 5f^{11}7s7p$) was measured in all three Es isotopes. Furthermore, four additional ground-state transitions were measured in ^{254}Es. Hyperfine structure analysis resulted in spin values of $I(^{254}\text{Es}) = 7$ and $I(^{255}\text{Es}) = 7/2$. Nuclear magnetic dipole moments as well as spectroscopic electric quadrupole moments were derived from the extracted hyperfine coupling constants. The literature value of the nuclear magnetic dipole moment for ^{254}Es obtained from angular anisotropy measurements of ^{254}Es α-radiation [1] deviates from our more precise value of this quantity.
Further measurements are planned on ^{254}Es using a new high-resolution gas-jet apparatus [2]. Most recent results will be presented.
[1] N. Severijns et al., Phys. Rev. C 79 (2009), 064322. [2] S. Raeder et al., Nucl. Instrum. Methods. Phys. Res. B 463 (2020), 272-276.

HK 71.4 Thu 17:00 HK-H7

First results of an all-optical nuclear charge radius determination at COALA — •Phillip Imgram[1], Emily Burbach[1], Bernhard Maass[2], Patrick Müller[1], and Wilfried Nörtershäuser[1] — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]Argonne National Laboratory, Chicago, IL, 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 recently applied upgrade with an electron-beam ion source allows us to study transitions in multiply-charged ions. Here, the focus is 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 a targeted accuracy of $<$1 MHz with simultaneous collinear and anti-collinear laser spectroscopy. This experimental value can directly be compared with nonrelativistic QED calculations [1] that are currently being performed. This contribution will summarize the current status of the project and present first results of $^{12}C^{4+}$ measurements. This project is supported by DFG (Project-ID 279384907 - SFB 1245) and by BMBF (05P21RDFN1).
[1] V. Patkós, Phys. Rev. A 103, 042809 (2021)

HK 71.5 Thu 17:15 HK-H7

CREMA-Measuring the Ground State Hyperfine splitting of Muonic Hydrogen — •Siddharth Rajamohanan[1], Ahmed Ouf[1], and Randolf Pohl[2] — [1]Johannes gutenberg universität mainz, Mainz, Germany — [2]PRISMA+Cluster of Excellence and Institute of Nuclear Physics, Johannes Gutenberg-Universitat Mainz, 55099 Mainz, Germany

Precision measurements on atoms and ions provide a wealth of information of bound state QED and is a unique test of the Standard Model. Significant work has been done to understand the proton radius puzzle. To this end, the CREMA collaboration is presently pursuing a pulsed laser spectroscopy measurement of ground state HFS in muonic hydrogen upto 1ppm accuracy to understand the Zemach radius, which encodes the magnetic properties of the proton. A unique laser system, the multi-pass cavity and the scintillation detection system are necessary for the experiment. We report our progress on the same.

HK 72: Hadron Structure and Spectroscopy XII

Time: Thursday 16:00–17:30 Location: HK-H8

Group Report HK 72.1 Thu 16:00 HK-H8

Role of a triangular singularity in the $\gamma p \rightarrow p\pi^0\eta$ reaction — •Volker Metag and Mariana Nanova for the CBELSA/TAPS-Collaboration — II. Physikalisches Institut, Universität Giessen, Giessen

Recently structures in invariant mass distributions and excitation energy spectra have been attributed to triangular singularities as discussed in e.g., [1,2] and in the review by Guo et al. [3]. These singularities emerge under specific kinematic conditions when new reaction channels open up. It will be shown that a triangular singularity associated with the opening of the $\gamma p \rightarrow pa_0 \rightarrow p\pi^0\eta$ channel can explain the observation of a structure in the $M_{p\eta}$ invariant mass distribution near 1700 MeV/c^2 in the $\gamma p \rightarrow p\pi^0\eta$ reaction [4].

[1] G. D. Alexeev *et al.*, The COMPASS Collaboration, Phys. Rev. Lett **127**, 082501 (2021).
[2] M. Mikhasenko, B. Ketzer and A. Sarantsev, Phys. Rev. D **91**, 094015 (2015).
[3] F. K. Guo *et al.*, Rev. Mod. Phys. D **90**, 015004 (2018).
[4] V. Metag *et al.*, arXiv:2110.05155.
Supported by DFG through SFB/TR16.

HK 72.2 Thu 16:30 HK-H8

Feasibility Studies of the $f_1(1420)$ Meson Production in Two-Photon Fusion Processes at BESIII — •Nick Effenberger, Christoph Florian Redmer, and Achim Denig 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. These are the hadronic Vacuum Polarization contribution as well as the hadronic Light-by-Light (HLbL) scattering contribution. For the latter, data-driven approaches have recently been developed. Recent estimates from such data-driven approaches demonstrate the importance of axial mesons with masses above 1 GeV for a_μ^{HLbL}.

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 mesons in two-photon fusion processes with quasi-real or virtual photons. In this presentation, we discuss the prospects of studying the $f_1(1420)$ meson via its decay to the $K^+K^-\pi^0$ final state.

HK 72.3 Thu 16:45 HK-H8

Search for the Production of the $f_1(1285)$ Resonance in e^+e^- Collisions using Initial State Radiation at BESIII — •Jan Muskalla, Achim Denig, Christoph Florian Redmer, and Riccardo Aliberti — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland

Hadronic light-by-light scattering (HLbL) is a limiting process for the precision of the Standard Model prediction for the anomalous magnetic moment of the muon a_μ. The uncertainty of a_μ^{HLbL} can be improved using detailed measurements of transition form factors (TFF) of the two-photon coupling to mesons. One such TFF study of interest is on the $f_1(1285)$ meson which can be produced via two-photon fusion processes in e^+e^- annihilations. The BESIII experiment at the electron-positron collider in Beijing (BEPC-II) has collected the world's largest data sets in the τ-charm energy region. Initial state radiation (ISR) allows for a search of the f_1 resonance at energies below the center of mass energy of the collider. The decay channel $e^+e^- \rightarrow f_1\gamma_{ISR} \rightarrow \pi^0\pi^0\eta\,\gamma_{ISR} \rightarrow 7\gamma$ is searched. If successful, this will shed light on the two-photon coupling to the f_1 resonance ($J^{PC} = 1^{++}$) since the resonance is only accessible in e^+e^- annihilation via a two-photon production process. To perform a blind analysis, Monte Carlo simulations for the signal and background channels are analyzed with the aim of performing the analysis on data sets from BESIII with a combined luminosity of 20 fb^{-1}.

HK 72.4 Thu 17:00 HK-H8

Proton-ϕ interaction studied in pp collisions with ALICE at the LHC — •Emma Chizzali for the ALICE-Collaboration — TUM, Munich, Germany

In order to constrain the equation of state of dense objects like neutron stars (NS) and subsequently solve the puzzle about their content, it is fundamental to understand the interaction between their hypothetical constituents. Hyperons might be contained in the core of NS which makes the hyperon-hyperon interaction relevant with the ϕ vector meson as effective exchange particle. Additionally, it is an interesting particle regarding the partial restoration of chiral symmetry in the nuclear medium. For such investigations it is relevant to constrain the vacuum properties of the interaction between the ϕ meson and nucleons. This can be studied experimentally by measuring the correlation function between proton and ϕ meson employing the femtoscopy technique in small collision systems. The small source size in HM pp collisions at the Large Hadron Collider at $\sqrt{s} = 13$ TeV makes it possible to study short-ranged strong potentials with unprecedented precision. The data used to derive the correlation function is measured by the ALICE experiment and corrected for non-genuine contributions. Finally, it is found to reflect the pattern of an attractive force between proton and ϕ meson and employed to extract the scattering parameters of the interaction.

HK 72.5 Thu 17:15 HK-H8

Messung des Verzweigungsverhältnisses des Zerfalls $J/\psi \rightarrow \bar{p}\Sigma^+K_S^0 + c.c.$ am BESIII-Experiment — •Leonard Wollenberg und Miriam Fritsch für die BESIII-Kollaboration — Ruhr-Universität Bochum

Das BESIII-Experiment am BEPC-2 Electron-Positron-Speicherring in Peking hat im Sommer 2018 die Datenaufname für den weltgrößten J/ψ-Datensatz beendet. Insgesamt wurden 10 Milliarden J/ψ-Ereignisse aufgezeichnet. Mit diesem Datensatz ist es möglich, sehr präzise Messungen der Zerfallseigenschaften des J/ψ durchzuführen. Von besonderen Interesse ist die Messung des Verzweigungsverhältnisse $J/\psi \rightarrow \bar{p}\Sigma^+K_S^0 + c.c.$, da diese Reaktion bisher nicht vermessen

wurde. Bisher gibt es nur eine Messung des Verzweigungsverhältnisses des Isospin Partners Zerfalls $J/\psi \to \bar{p}\Sigma^0 K^+$. In diesem Vortrag wird die erste Messung des Verzweigungsverhältnis des Zerfall Kanals $J/\psi \to \bar{p}\Sigma^+ K_S^0 + c.c.$ präsentiert.

HK 73: Fundamental Symmetries II

Time: Thursday 16:00–17:45 Location: HK-H9

Group Report HK 73.1 Thu 16:00 HK-H9

Electric dipole moments of charged particles at storage rings — •Vera Shmakova for the JEDI-Collaboration — University of Ferrara, Ferrara 44100, Italy

The Standard Model (SM) of Particle Physics cannot explain the matter-antimatter asymmetry in the Universe. Therefore, the search of physics beyond the SM is required and one way to achieve it is to strive for the highest precision in the search for electric dipole moments (EDMs). Permanent EDMs of particles violate both time reversal and parity invariance and, via the CPT theorem, also the combined CP symmetry. Finding an EDM would be a strong indicator for physics beyond the SM.

Storage rings offer possibility to measure EDMs of charged particles by observing the influence of the EDM on the spin motion in the ring. The Cooler Synchrotron COSY at the Forschungszentrum Jülich provides polarized protons and deuterons with momenta up to 3.7 GeV/s, making it an ideal testing ground and starting point for the JEDI collaboration (Jülich Electric Dipole moment Investigations) for such an experimental program. The talk will present the JEDI program for the measurement of proton and deuteron EDMs and discuss recent results of the first direct (precursor) measurements of the deuteron EDM in COSY.

Group Report HK 73.2 Thu 16:30 HK-H9

Muonic X-ray measurements at the Paul Scherrer Institute — •Frederik Wauters — Johannes Gutenberg University Mainz, Germany

When negative muons are stopped in a target material, they are quickly captured and form an exotic atom. During this formation process, muonic X-rays, which can have energies up to several MeV, are emitted until the 1s orbital is reached. The muon wave function in the lower orbits has a large overlap with the nucleus, making this system an excellent laboratory to study short range interactions between the muon and the atomic nucleus such as finite size effects, nuclear capture, and possble parity odd interactions.

The muX project at the Paul Scherrer Institute is performing muonic X-ray measurements on medium and high-Z nuclei, deploying a large high-purity germanium array in combination with muon, electron and neutron detectors. A new technique was developed utilizing transfer reaction in a H2/D2 gas cell to stop a standard muon beam in a few ug of target material.

A wide physics program is focusing on atomic parity violation (APV) by measuring the the charge radius of 226Ra, which will serve as an important input for an upcoming APV experiment with Ra in a Paul trap. We are also pursuing measuring APV directly in muonic atoms in the 2s-1s transition. Furthermore, absolute nuclear charge radii measurements serve as a benchmark for laser spectroscopy, and nuclear muon capture gives access to highly excited nuclear states of interest to determine double beta-decay matrix elements.

HK 73.3 Thu 17:00 HK-H9

Status report of the Fermilab Muon g–2 experiment — •René Reimann for the Muon g–2-Collaboration — Institute of Physics and Excellence Cluster PRISMA+, Johannes Gutenberg University Mainz, 55099 Mainz, Germany

In spring 2021 the Muon g–2 collaboration published the most precise measurement of the anomalous magnetic moment of the muon, a_μ, with a 460 ppb uncertainty. The measurement principle is based on a clock comparison between the anomalous spin precession frequency of spin-polarized muons, which is the deviation of the Larmor- from the cyclotron-frequency, and a high-precision measurement of the magnetic field environment using nuclear magnetic resonance (NMR) techniques, expressed in terms of the (free) proton spin-precession frequency. The published results are based on the run 1 data. In the meantime a data set of about 12.5 the size of run 1 has been acquired through runs 2-4 and more high-quality data is currently recorded through run 5. In this talk I summarize the current status and focus on improvements and systematic studies that the Muon g–2 collaboration implemented. In particular, I discuss the magnetic field stability and characterization.

HK 73.4 Thu 17:15 HK-H9

Magnetic field measurement in the Fermilab Muon g − 2 experiment — •Hassan Qureshi for the Muon g–2-Collaboration — Institute of Physics and Excellence Cluster PRISMA+, Johannes Gutenberg University Mainz, 55099 Mainz, Germany

The Fermilab Muon g − 2 experiment aims to measure the anomalous magnetic moment of the muon, a_μ, to a precision of 140 ppb. Run 1 results were published in April 2021 with an unprecedented precision of 460 ppb. This increased the new world average deviation between the Standard Model theory prediction and the average experimental measurements to $4.2\,\sigma$. The experiment measures the muon anomalous spin precession frequency w_a and the proton spin precession frequency w_p, the ratio of which is used to calculate a_μ. The w_p value expresses the magnetic field as experienced by the circulating muons in the experiment's storage ring. The magnetic field inside the ring is measured using two nuclear magnetic resonance (NMR) probe arrays. First is an array of 378 fixed NMR probes, spread evenly around the top and bottom walls of the vacuum chambers, which continuously measures the field drift within the muon storage ring. The second array consists of a set of 17 NMR probes, mounted on a trolley, which is periodically driven around the muon storage cavity to measure its spatial distribution of the field. In this talk I will discuss the method for tying together data from the two NMR probe arrays in time, in order to interpolate the magnetic field as experienced by muons during their storage time. Furthermore, I will discuss plans to streamline the tying procedure for Run 2 and 3 while improving the w_p uncertainty compared to Run 1.

HK 73.5 Thu 17:30 HK-H9

Electromagnetic interactions as the source of all known forces. — •Osvaldo Domann — Stephanstr. 42, 85077 Manching

Older physical theoretical models represent the space as filled with a substance (ether) where subatomic particles (SPs) are submerged. Newer models represent the space as empty and forces between SPs are explained with the exchange of fictitious carrier particles. In both type of models, the space is composed of SPs and of a fictitious substance or of fictitious carriers. An approach is presented where the space is filled with Fundamental Particles (FPs) with longitudinal and transversal angular momenta, FPs that move with light or infinite speed. The different types of SPs are formed by different configurations of FPs; fermions are focal-points of rays of FPs with aligned angular momenta, photons are rays of FPs with alternating opposed angular momenta, and neutrinos are pairs of FPs with opposed angular momenta. FPs are the constituents of all subatomic particles. Forces between subatomic particles are the product of the interactions (scalar and vector product) of the angular momenta of their FPs. Neither fictitious substances nor fictitious carriers are required. All forces are due to electromagnetic interactions and are described by QED. An important finding of the approach 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. More at: www.odomann.com

HK 74: Annual General Meeting

Time: Thursday 18:00–19:00 Location: HK-MV

Annual General Meeting

HK 75: Invited Talks VI

Time: Friday 11:00–12:00 Location: HK-H1

Invited Talk HK 75.1 Fri 11:00 HK-H1

Hyperon Physics with PANDA at FAIR — •Jennifer Pütz for the PANDA-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

In order to deepen our insights of color confinement in the mass range governed by non-perturbative QCD, it is essential to understand the excitation pattern of baryons. Up to now only the nucleon excitation spectrum has been subject to systematic experimental studies while very little is known about the excited states of double or triple strange baryons.

Antiproton-proton collisions offered by the PANDA experiment are 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, enabling studies with high statistics of ground states as well as excited states both in the baryon and the antibaryon channel.

The investigation of hyperons is a flagship component of the PANDA physics program, particularly, in the first phase ofcle the experiment. This talk will provide an overview on the hyperon physics with PANDA and highlights its uniqueness compared to complementary experiments worldwide.

Invited Talk HK 75.2 Fri 11:30 HK-H1

3-hadron problem from lattice QCD — •Maxim Mai — University Bonn, Bonn, Germany

The enigma of the spectrum of the strongly interacting particles (hadrons) includes many puzzles. What is the general form of the spectrum of excited states of hadrons? Why do some resonances resemble simple Breit-Wigner form and others do not? Can we say something about the nature of individual states?

The challenge in answering these questions arises from the very structure of the Quantum Chromodynamics (QCD) – the quantum field theory of strong interaction. In that, lattice gauge theory is the only tool available to us to tackle the non-perturbative dynamics of QCD which already led to many important insights.

Currently the frontier of hadron spectroscopy from first principles is entering a new phase, addressing dynamics of resonant multi-hadron states. This has become possible by many groundbreaking advances of theoretical and computational techniques, which I will describe in my talk. The remaining part of the talk will be devoted to the recent results on states of high relevance, bridging the gap to experimental results.