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]