HK 2: Heavy-Ion Collisions and QCD Phases I

Time: Monday 16:30–18:30 Location: H1

Group Report HK 2.1 Mon 16:30 H1

Space-charge distortions in the ALICE TPC in Run 3 — •Matthias Kleiner for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

The Time Projection Chamber (TPC) is the main tracking and particle identification detector of the ALICE experiment at the CERN LHC. For Run 3, starting in 2022, interaction rates of 50 kHz in Pb-Pb collisions require 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, such as variations in the number of collisions for a given time interval, cause fluctuations of the space-charge distortions on very short time scales. These fluctuations have to be corrected in time intervals of 5-10 ms to preserve the intrinsic space point resolution of the TPC of 100 μm. To accomplish this challenging task, a dedicated correction scheme based on data-driven machine learning techniques is developed.

In this talk, an overview about space-charge distortions and distortion fluctuations in the ALICE TPC in Run 3 will be presented, along with simulations of the expected distortions and the planned correction procedures.

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HK 2.2 Mon 17:00 H1

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

When traversing the Quark-Gluon Plasma (QGP), partons lose energy via collisional and radiative processes. The amount of lost energy depends on the particle mass and manifests in a reduced jet multiplicity in heavy-ion collisions with respect to proton-proton collisions, for which no QGP is expected to form. A detailed knowledge about the charm and bottom-jet production in proton-proton collisions is thus inevitable for further investigations on particle energy loss within the QGP.

Owing to the relatively large lifetimes and the cascade of weak decays of B hadrons, transverse impact parameter spectra, as a measure for the distance between particle tracks and the primary vertex, offer a great opportunity to investigate the bottom-jet production. Results of a performance analysis of a bottom-jet selection algorithm based on transverse impact parameter spectra will be presented for 13 TeV proton-proton collisions.

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HK 2.3 Mon 17:15 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.

HK 2.4 Mon 17:30 H1

Identification of photon conversions from Monte-Carlo simulations in ALICE using XGBoost — •Xuan-Xuyen Nguyen — Physikalisches Institut, Heidelberg, Baden Württemberg

ALICE measures photons by reconstructing photon conversions in the detector material. In the standard analysis a photon candidate sample is obtained by applying a sequence of manually set cuts. In order to improve the photon identification, a XGBoost classifier was trained on Monte-Carlo simulated data in this study. The simulated events were obtained by propagating proton-proton collisions generated with PYTHIA and lead-lead collisions generated with HIJING through the detector setup using the GEANT simulation package. The XGBoost models achieve a more constant and an up to 10% higher signal efficiency than the cut-based model at the same purity. A comparison between the XGBoost and the Random Forest models showed that both make similarly good predictions.

HK 2.5 Mon 17:45 H1

Studies of the ALICE material budget between TPC and TOF — •Oscar Castro Serrano and Ivan Vorobyev for the ALICE-Collaboration — Technische Universität München

The material located between the Time Projection Chamber (TPC) and Time-of-Flight (TOF) detectors is one of the most dense parts of the ALICE apparatus at mid-rapidity, with the main contribution coming from the Transition Radiation Detector (TRD). However, the description of this material budget used in Monte Carlo simulations was not yet validated with experimental data. The knowledge of this material budget plays significant role in various ALICE analyses which employ TOF detector for particle identification.

In this talk we show the method which facilitates validation of the ALICE detector material between TPC and TOF with pure sample of protons and pions, for which the inelastic cross sections for interactions with matter are well known from the experiment. The analysis is performed in p-Pb collisions at 5.02 TeV using pure samples of protons from lambda decays and pions from K0 decays reconstructed with the Inner Tracking System (ITS) and TPC detector. The number of protons and pions matched to a hit in the TOF detector is compared with the number of protons and pions in the TPC. The obtained TOF/TPC matching efficiency is compared to the results from full-scale ALICE simulations using GEANT3 and Geant4 toolkits for propagation of particles through the ALICE detector. As a result, the material budget between TPC and TOF can be validated in the momentum range of 0.5<p<5.0 GeV/c within ~5% precision.

HK 2.6 Mon 18:00 H1

Spadic response to single photon ionization based signals — •Marius Kunold for the CBM-Collaboration — Goethe-Universität Frankfurt am Main, Deutschland

The aim of the Compressed Baryonic Matter experiment at the Facility for Antiproton and Ion Research is to explore the QCD phase diagram in the region of high net-baryon densities. The Transition Radiation Detector is designed to identify light nuclei and deliver information for the global track reconstruction. Therefore, 4 layers of multi-wire proportional chambers with a segmented cathode readout will be installed. The signals will be readout by the Self-triggered Pulse Amplification and Digitization ASIC (SPADIC). For a successful particle identification a precise knowledge of the originally deposited energy and the position and time of the traversing particle is mandatory. Therefore, it is of high importance to have a detailed knowledge about the response of the SPADIC to the signals on the cathode plane.

The poster presents an analysis of the SPADIC response to single photons from a ^{55}Fe source. Especially the theoretical expectations are compared to the measured signal-shapes. The investigation is an initial step towards more elaborate time and charge reconstruction methods. To extract the charge and absolute time of the single signals a fit of the ADC sample distribution, based on the theoretical response function together with effective parameters, is performed. This new method is compared to the old charge extraction by reproducing an iron-spectrum.

HK 2.7 Mon 18:15 H1

Using CMOS technologies in ALICE for high luminosity experiments — •Abhishek Nath for the ALICE-Collaboration — Physikalisches Institut, Ruprecht Karl University of Heidelberg, Germany

The LHC may extend the heavy-ion program to Run 5 (2033) using lighter ions to achieve a large luminosity increase. To further contribute to the characterization of the macroscopic QGP properties with unprecedented precision, the ALICE Collaboration is writing an LOI of a next-generation multipurpose detector, the ALICE 3. It is a fast and light detector based on the use of monolithic active pixel sensors (MAPS) in combination with deep sub-micron commercial CMOS technologies. It has an excellent vertexing and tracking performance (Si tracker of about 100 m^2), and a large pseudorapidity coverage of $\Delta\eta = 8$. The rate capabilities should be a factor of about 50 higher with respect to ALICE in Run 4, being able to exploit the whole delivered p−A and A−A luminosity. The physics potential of the ALICE 3 experiment is very broad. For example, the search for de-confinement and coalescence with multi-charmed baryons, precision measurements of dileptons and in-medium interaction. Moreover, the unprecedented low momentum reach and particle identification properties of the detectors can be used to carry on searches in low energetic dielectrons and photons giving an opportunity to test theories like Low's theorem. In this talk, an overview of the ALICE 3 experiment and its capabilities to identify low energetic electrons via preshower detector will be presented.