HK 20: Instrumentation V

Time: Tuesday 15:45–17:15 Location: SR Exp1A Chemie

HK 20.1 Tue 15:45 SR Exp1A Chemie

Optimizations of the specific energy loss measurement and data to Monte Carlo matching for ALICE TPC — •Tuba Gündem — Institut für Kernphysik, Max-von-Laue-Str. 1, 60438 Frankfurt am Main

The Time Projection Chamber (TPC) serves as the primary detector for tracking and particle identification (PID) in the ALICE experiment. PID is accomplished by reconstructing particle momentum and measuring specific energy loss ($\mathrm{d}E/\mathrm{d}x$). The $\mathrm{d}E/\mathrm{d}x$ value for a given track is derived from the clusters associated with that track. However, in RUN 3, the high interaction rate (IR) leads to significant occupancy effects, which must be corrected to ensure accurate $\mathrm{d}E/\mathrm{d}x$ calculations. Additionally, factors such as electron attachment and gain variations can introduce discrepancies between the reconstructed $\mathrm{d}E/\mathrm{d}x$ and the simulated $\mathrm{d}E/\mathrm{d}x$ in Monte Carlo (MC).

This talk will present methods for optimizing $\mathrm{d}E/\mathrm{d}x$ calculations, along with techniques for tuning the MC attachment and gain parameters to better align the simulated $\mathrm{d}E/\mathrm{d}x$ with the reconstructed $\mathrm{d}E/\mathrm{d}x$.

HK 20.2 Tue 16:00 SR Exp1A Chemie

Neural Network Corrections for Particle Identification at the ALICE TPC — •Jonathan Witte — University of Heidelberg, Germany — for the ALICE german Collaboration

The Time Projection Chamber (TPC) of ALICE (A Large Ion Collider Experiment) has been a cornerstone of the detector, providing critical insights into the physics of heavy-ion collisions for over a decade. The TPC, a gaseous detector filled with a Neon-CO_2-N_2 (90-10-5) mixture, offers exceptional performance and accounts for more than 90% of the raw data produced by the ALICE detector. Its capability to measure the tracks of hundreds of particles produced in each Pb*Pb collision makes it indispensable. Due to the measurement of the specific energy loss, the TPC allows for extensive particle identification (PID). The Bethe-Bloch formula accurately describes the energy loss of particles in a medium, leveraging the well-characterized properties of the TPC gas to provide up to 152 $\mathrm{d}E/\mathrm{d}x$ samples per particle. This PID feature is unique among LHC detectors. To identify particles based on their $\mathrm{d}E/\mathrm{d}x$ samples, a Bethe-Bloch (BB) fit is applied. However, the measured signal and precision alter strongly with environmental conditions, fluctuations in gain calibration, detector occupancy etc. Neural networks (NNs) are the technology of choice for applying corrections here. With large training datasets with clean samples of electrons, kaons, pions and protons, NNs can learn to identify patterns and anomalies, improving the calibration of PID. This talk will present the mechanism of PID of the ALICE TPC and the neural network-based corrections applied to LHC Run 3 data.

HK 20.3 Tue 16:15 SR Exp1A Chemie

Status of the GEM production and quality assurance at the FTD — •Tim Schüttler[1,2], Markus Ball[1,2], Yevgen Bilevych[2], Philip Hauer[1,2], Shania Müller[1], Dmitri Schaab[2], and Bernhard Ketzer[1,2] — [1]Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn — [2]Forschungs- und Technologiezentrum Detektorphysik, Universität Bonn

Gas Electron Multipliers (GEMs) play a crucial role as amplification stages in modern gaseous detectors, offering high spatial and temporal resolution at moderate cost, even at large sizes and high particle rates. At the newly established Research and Technology Center Detector Physics (FTD) in Bonn, we have successfully implemented a reliable process for producing standard 10×10 cm^2 GEM foils that was developed in close collaboration with CERN's MPT workshop, which traditionally acts as the main supplier of GEM foils to the community. This achievement represents an important step forward, providing enhanced flexibility for research and development.

The production process at the FTD employs a double-mask photolithographic technique, and makes use of a wide variety of equipment such as wet benches, a dry-film laminator, and UV exposition systems. Through iterative improvements, each production step has been refined to ensure high-quality results consistently. This talk will detail the production and quality assurance workflow, highlight key innovations, showcase measurement results confirming the reliability of the foils, and outline plans for exploring novel GEM parameters and geometries. Supported by BMBF.

HK 20.4 Tue 16:30 SR Exp1A Chemie

StarryNight - A calibration system for the time projection chamber at MAGIX — •Daniel Steger for the MAGIX-Collaboration — Institute for Nuclear Physics, Johannes Gutenberg University Mainz, Germany

The MESA accelerator will host the MAGIX experiment, which is based on the scattering of an electron beam on a gas jet target. This enables scattering on gases like hydrogen while minimizing interaction with any other materials allowing us to perform high precision experiments. The measurement of the scattered particles is performed by two magnetic spectrometers using a GEM based TPC to track the particle trajectories. To achieve the precision desired an independent system to calibrate the TPC is necessary.

Such a system has been designed, utilizing LEDs with a wavelength of 255 nm that are operated in pulses directed at fused silica panes sputtered with aluminium at the cathode of the active volume of the TPC. This produces individual free electrons at known positions and times which drift along the electric field lines of the TPC and thereby allow a precise characterization of the field.

In this contribution the setup of this calibration system will be presented.

HK 20.5 Tue 16:45 SR Exp1A Chemie

Drift-field distortion corrections of the ALICE TPC in LHC Run 3 — •Matthias Kleiner for the ALICE Germany-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

The Time Projection Chamber (TPC) in the ALICE experiment at the CERN LHC provides excellent tracking and particle identification capabilities. In order to cope with the high interaction rates of up to 50 kHz in Pb–Pb collisions during Run 3, the Multi-Wire Proportional Chambers (MWPCs) in the TPC were replaced by stacks of four Gas Electron Multiplier (GEM) foils to allow for continuous data acquisition. Despite the intrinsic ion-blocking properties of the 4-GEM system, a residual 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 further effects, such as fluctuations in the interaction rate or the decay of the LHC beam, cause time dependent variations of the distortions due to space-charge. Additional detector effects cause significant static and time dependent drift-field distortions. These drift-field distortions have to be corrected to preserve the intrinsic tracking precision of the TPC.

In this talk, an overview of drift-field distortions in the ALICE TPC in Run 3 will be presented, along with the precision of the correction procedures.

Supported by BMBF and the Helmholtz Association

HK 20.6 Tue 17:00 SR Exp1A Chemie

TPC cluster shape analysis — •Janis Noah Jäger for the ALICE Germany-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

An important aspect of the latest ALICE upgrade is the upgrade of the Time Projection Chamber (TPC). The TPC is the main tracking and particle identification device in ALICE. The replacement of the Multi-Wire Proportional Chambers (MWPC) with stacks of four Gas Electron Multiplier (GEM) foils enables a continuous readout of the TPC. This modification demanded a significant upgrade of the entire readout chain, including the front-end cards, data acquisition and distribution, online reconstruction and data compression. Additionally, the entire reconstruction and calibration software underwent a complete rewrite, along with the TPC cluster finding algorithm.

This talk will address the topic of the TPC cluster shape in relation to track and gas parameters. A comparative analysis of Run 3 data with Monte Carlo simulations will provide insight into the characteristic response functions and diffusion coefficients in the ALICE TPC.