# HK 11: Instrumentation

Zeit: Montag 16:30–19:00 Raum: P 2

**Gruppenbericht** HK 11.1 Mo 16:30 P 2

**Development of a High-Rate GEM-TPC** — •Felix Valentin Böhmer for the GEM-TPC-Collaboration — Technische Universität München

A Time Projection Chamber (TPC) with its low material budget constitutes an ideal device for 3-dimensional tracking of charged particles. In the past, an important limitation of TPCs has been the necessity to introduce a gating grid in order to prevent the migration of ions created in the gas amplification stage into the active volume. Unfortunately, such gating techniques limit the possible trigger rates to $\mathcal{O}(100\,\mathrm{Hz})$.

To make the advantages of a TPC (low material budget, good $\mathrm{d}E/\mathrm{d}x$ performance, robust pattern recognition even in very high track densities) available to modern particle physics experiments with interaction rates exceeding this limit by many orders of magnitude, it has to be operated in a continuous, ungated mode. The development of such a device is the goal of this project. The suppression of ion back-drift is achieved by utilizing a stack of Gas Electron Multiplier (GEM) foils as gas amplification stage.

A large prototype of the GEM-TPC (728 mm length, 154 mm radius) with $\sim$ 10000 readout channels has been built and successfully used in a physics campaign ($\pi$ beam on different nuclear targets) at the FOPI experiment at GSI, Darmstadt. The data acquisition is realized with the AFTER ASIC, which has been originally developed for the T2K experiment. Details of the detector design, electronics setup as well as simulation and reconstruction algorithms will be presented, complemented with first results from data analysis.

HK 11.2 Mo 17:00 P 2

**Energy Calibration of a GEM-TPC Prototype** — •Roman Schmitz for the GEM-TPC-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn

A Time Projection Chamber (TPC) with Gas Electron Multiplier (GEM) readout has been developed with an inner/outer diameter of 105/300 mm and a total drift length of 725 mm. A triple GEM stack is used for gas charge amplification to reach sufficiently high gain. In addition the GEM stack provides an intrinsic strong secondary ion backflow suppression without the necessity for an ion gate, which opens the possibility to operate such a detector in a continuous mode even at high interaction rates. The anode of the prototype GEM-TPC consists of 10254 hexagonal pads with an outer radius of 1.5 mm which are read out by 42 front end cards based on the T2K/AFTER chip. The TPC is used to improve the inner tracking and vertexing of the FOPI experiment at GSI and serves as a full-scale prototype for the CBELSA/TAPS experiment. In order to perform an accurate channel-wise relative gain calibration and a total gain estimation, a $^{83\mathrm{m}}$Kr source is used. Its gaseous form makes it perfectly suitable for this purpose and several conversion electron peaks between 9.4 keV and 41.55 keV enable gain calibration over a wide energy range. The short half-life of 1.83 h allows for normal detector operation after a short flushing period of about one hour. Details on source production, integration and first calibration results compared to calibration results obtained with cosmic rays are presented.
This work is supported by DFG SFB/TR 16.

HK 11.3 Mo 17:15 P 2

**Gain Calibration of the ALICE TRD using the Decay of 83mKr as an Electron Source** — •Johannes Stiller für die ALICE-Kollaboration — Physikalisches Institut, Heidelberg, Deutschland

For an early calibration of the ALICE Transition Radiation Detector (TRD) on the level of individual readout pads, a dedicated calibration run with a Krypton source was carried out. We recorded 2.28 billion decays of metastable 83mKr in the 646k readout-pads of the 10 TRD super modules presently installed in the ALICE experiment at CERN. In our analysis the gain uniformity within each chamber as well as the energy resolution of all installed chambers were obtained. These results are crucial for good online particle identification and triggering. In an iterative analysis step, the gain calibration results in a gain uniformity of better than 2 %. A comparison between our results and corresponding findings from earlier measurements during chamber construction was performed and good agreement was found. The gain factors are now available for download to the front-end electronics and online calibration and analysis.

HK 11.4 Mo 17:30 P 2

**Fast Simulation Studies for a Crystal Ball TPC** — •Martin Wolfes, Oliver Steffen, Wolfgang Gradl, and Martin Hattemer for the A2-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, D-55099 Mainz

The A2-Collaboration at MAMI studies photon induced reactions with the Crystal Ball/TAPS detector, which covers almost the whole solid angle of $4\pi$. The photon beam is produced via energy tagged bremsstrahlung. The inner detector system includes a two-layer MWPC for the detection of charged particle tracks.

The increased rate of charged particles for future $\eta$ and $\eta'$ production experiments exceeds the rate capabilities of these MWPCs. A possible solution is to replace the existing tracking detectors with a small Time Projection Chamber (TPC). This type of detector has higher rate capability and provides the means for real track reconstruction.

To study detector and track resolution we have developed a parameter-driven fast simulation, in which different chamber geometries and readout pad configurations can be implemented very easily. The simulation includes ionisation statistics, transversal and longitudinal diffusion within the electric field, gas amplification of an arbitrary number of GEM foils and signal response from the electronics. The fast simulation can also be used to test the reconstruction software. We present recent results obtained with this simulation.

HK 11.5 Mo 17:45 P 2

**Particle identification using clustering algorithms** — •Roland Wirth[1,2], Enrico Fiori[1,2], Bastian Löher[1,2], and Deniz Savran[1,2] — [1]ExtreMe Matter Institute EMMI and Research Division, GSI Helmholtzzentrum, Darmstadt, Germany — [2]Frankfurt Institute for Advanced Studies FIAS, Frankfurt

Particle identification (PID) is an important task for many experimental techniques. A well-known approach for PID in many detection systems is based on pulse shape analysis (PSA), i.e. identification based on the difference in the pulse shape produced by different particle species. In most methods specific features of the detector signals are analyzed employing profound knowledge of the involved pulse shapes and the need of precise adjustments for individual detectors. A new approach to achieve PID based on PSA uses clustering algorithms without making any assumptions on the shape of detector pulses and is thus applicable to many detector types. The method is also self-tuning, i.e. no adjustment to a specific detector is necessary. In this talk a method is presented that uses the fuzzy c-means clustering algorithm and has already been applied to liquid scintillators for $\gamma$-n discrimination [1]. The same method can be used without modifications to perform $\gamma$-p discrimination for CsI(Tl) scintillator signals and in particular produces identical results for different individual detectors.

* Supported by the Alliance Program of the Helmholtz Association (HA216/EMMI)

[1] D. Savran *et al.*, Nucl. Inst. and Meth. A, **624** (2010) 675

HK 11.6 Mo 18:00 P 2

**ALICE TRD GTU Online Tracking and Trigger Performance in recent p-p and Pb-Pb Collisions** — •Felix Rettig, Stefan Kirsch, and Volker Lindenstruth for the ALICE-Collaboration — Frankfurt Institute for Advanced Studies, Johann Wolfgang Goethe-Universtät, Frankfurt

The Transition Radiation Detector of the ALICE experiment at the LHC is designed to provide fast trigger contributions based on an online reconstruction of charged tracks with high transverse momentum.

Within about 4 microseconds after a collision, a total of 1.2 million analog channels is scanned for short track segments by more than 65,000 custom multi-chip modules in the front-end electronics. The parametrizations of these segments are transferred to the Global Tracking Unit (GTU) at up to 2.2 TBit/s.

The GTU is a massively parallel low-latency computing system consisting of 109 dedicated high-performance FPGA-based nodes. 90 nodes in the input layer perform a full 3D reconstruction and momentum calculation for high-momentum tracks. 18 middle layer nodes and one top-layer node then infer various Level-1 trigger contributions about 6 microseconds after the collision.

Presented here is a performance analysis of the online tracking in p-p as well as Pb-Pb collisions over the past two years of LHC operation. Selected trigger algorithms based on the online tracking are outlined.

HK 11.7 Mo 18:15 P 2

**Online Electron Identification for Triggering with the ALICE Transition Radiation Detector** — •Benjamin Hess for the ALICE-Collaboration — Physikalisches Institut, Universität Heidelberg

The ALICE Transition Radiation Detector (TRD) is a fast tracker with good $e/\pi$-separation for high momenta already at the trigger level. It can be used to enhance rare probes such as high-$p_t$ jets and electrons. For the latter, a strategy for Particle Identification (PID) based on look-up tables containing the electron likelihoods for different deposited charges has been studied. The deposited charge of electrons is higher than that of pions due to a higher specific energy loss and a much more probable emission of transition radiation.

Monte Carlo simulations have been used to systematically investigate the PID performance. The best achievable pion suppression was found to be around 40 for an electron efficiency of 90%.

The PID performance depends on several parameters, like gas gain and drift velocity. The simulations showed that the gas gain changes critically limit the stability of the PID performance and that a stable drift velocity is also important.

The results of these studies allow to assess the tolerances of gas gain and drift velocity that are required for a reliable PID performance.

HK 11.8 Mo 18:30 P 2

**Performance of CBM TRD Prototypes from Münster** — •Cyrano Bergmann — Institut für Kernphysik, WWU Münster

CBM is a fixed target heavy-ion experiment at the future FAIR facility. The CBM Transition Radiation Detector (TRD) is one of the key detectors to provide electron identification and charged particle tracking. Based on the ALICE TRD design, four CBM TRD prototype modules were built in Münster and tested during October 2011 in beam at the CERN Proton Synchroton with electrons and pions of momenta up to 10 GeV/$c$. Readout was performed with the time sampling Self-triggered Pulse Amplification and Digitization asIC (SPADIC), an especially designed front-end electronics component for the CBM TRD.

The objectives of the beam test included measurements of: electron identification performance for different radiators, position resolution and dependence on particle momentum. First results of these measurements will be presented. The layout of the final TRD will be driven by these beam test results. Depending on the achieved electron identification performance, the TRD could be constructed in 6-10 layers, consisting in total of several 100 individual detector modules covering an area of up to 600 $\mathrm{m}^2$.

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HK 11.9 Mo 18:45 P 2

**Results on the CBM TRD prototype performance from the test beam time at CERN-PS** — •Andreas Arend for the CBM-Collaboration — Institut für Kernphysik, Goethe University Frankfurt, Germany

The development of a Transition Radiation Detector (TRD) for the Compressed Baryonic Matter (CBM) Experiment at the future FAIR facility is aimed to provide good electron-pion-separation and tracking capabilities in an environment of unprecedented high particle fluxes.

In this talk, an approach to employ thin and fast Multi-Wire Proportional Chambers (MWPC) without drift region to fulfill the given requirements will be presented. Several prototypes with different wire geometries and a variety of radiator types, such as regular foil stack radiators, a foam based radiator and a fiber radiator have been developed and constructed. Measurements with different MWPC and radiator combinations have been performed during the test beam campaign at the CERN-PS in October 2011. Results for the CBM-TRD prototypes will be presented. The electron-pion-separation capabilities for different radiator types will be discussed as well as its dependency on the geometry of the MWPC.