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A GEM-TPC for the CBELSA/TAPS experiment

Thursday 25 May 2017 15:10 (4 minutes)

The CBELSA/TAPS experiment located at the Elektronen Stretcher Anlage (ELSA) in Bonn (Germany) aims to investigate the excitation spectrum of baryons and the properties of baryon resonances.
The high-resolution electromagnetic calorimeter is optimized for the study of reactions with photons in the final state.
In order to enhance the sensitivity of the detector system to charged particles, a Time Projection Chamber (TPC) is foreseen as a new tracking detector, which provides track and vertex reconstruction for charged particles.
Along with its particle identification power via the specific energy loss, the TPC will significantly increase the physics potential of the experiment, granting access to channels with charged pions in the final state, like omega photoproduction (dominant decay mode $\omega \rightarrow \pi^+\pi^-\pi^0$) or charged-meson photoproduction like $\gamma p \rightarrow n\pi^+$ or $\gamma p \rightarrow p\pi^+\pi^-$.

A cylindrical gaseous TPC will be mounted inside the electromagnetic calorimeterof CBELSA/TAPS.
In order not to compromise the energy resolution for neutral particles, the vessel has to have an extremely low material budget.
The fixed-target geometry of the experiment results in a strong forward boost of the reaction products.
Therefore, only a single-sided readout is foreseen on the upstream endcap of the TPC.
For the gaseous amplification stage, a stack of multiple Gas Electron Multipliers (GEMs) was chosen.
GEMs, in contrast to other techniques, as, for example, multiwire proportional chambers, have the advantage to intrinsically suppress the backflow of ions, which would otherwise distort the drift field and worsen the detector resolution.
This will allow us to operate the TPC in a continuous mode without dead time.
A careful optimization in terms of sufficient electron transmission, low ion backflow, spatial and energy resolution is sought.
This can be achieved by tuning the composition of the stack in terms of GEM geometries and electric field settings.
Detailed ANSYS and Garfield++ simulations were carried out and compared to measurements to find the optimum operation point.

The presentation will cover the implementation of a TPC at the CBELSA/TAPS experiment, the commissioning of the TPC-prototype and its related soft- and hardware infrastructure.
Furthermore results of comprehensive studies of GEM geometry and electric field setting effects will be shown.

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Session Classification: Coffee Break and Poster Session - 2