# Specific Energy Loss Performance of the GEM-TPC in FOPI*

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## A GEM TPC in Ungated Operation

Time Projection Chambers (TPCs) are usually equipped with a gating structure to prevent the migration of avalanche ions created during gas amplification – traditionally realized with Multi Wire Proportional Chambers (MWPCs) – in order to maintain drift field homogeneity. This, however, limits the application of TPCs to experiments with trigger rates smaller than $\mathcal{O}(10^3\,\mathrm{Hz})$. To overcome this important limitation introduced by gating techniques, one has to find other means of ion suppression. To test the capabilities of an ungated TPC equipped with Gas Electron Multiplier (GEM) [1] instead of MWPC we have built the largest GEM-TPC so far [2, 3].

## The GEM-TPC in the FOPI Spectrometer

The GEM-TPC was installed inside the FOPI [4] spectrometer at GSI (Darmstadt, Germany). The FOPI spectrometer delivers a vertex resolution of few millimeters in the $x-y$ plane and a resolution along the beam axis of around 5 cm. The momentum resolution for particles in FOPI reaches 4-10 %. The main motivation to include a GEM-TPC in FOPI was to improve substantially the vertex and secondary vertex resolutions by an additional tracking detector. The performance of the prototype matches the expectations in terms of improving the momentum resolution of the existing spectrometer by 30 %. Furthermore the GEM TPC improve the track reconstruction in the forward region of phase space due to its large acceptance.

## Measurement of the Specific Energy Loss

One of the key features of a TPC is the measurement of the specific energy loss as a function of the momentum. This allows identification of charged particles. The TPC was operated within FOPI measuring the reactions of a pion beam of $1.7\ \mathrm{GeV}/c$ hitting a carbon target. A gas mixture of Ar/$CO_2$ in the ratio 90/10 with a drift field of 235 V/cm has been used. The GEM amplification system produced a gain of about 1500. In Figure 1 the measured dE/dx distribution as a function of the particle momentum is shown. The particle momentum was reconstructed from a combined fit of the TPC together with the Central Drift Chamber (CDC) of FOPI. The energy loss was determined by the GEM-TPC alone. To minimize the influence of $\delta$-electrons 40 % of the higher energetic samples have been truncated. The mean number of of samples is 21 with a sample length of 5 mm, which corresponds to an average track length of 10.5 cm. Cuts were made on the minimal number of samples ($N_{Sample} > 12$), on the scattering angle $\theta$ in the laboratory system ($0.4 < \theta < 2.4$) to match the acceptance of the CDC and on the $\chi^2_r$ of the track fit ($\chi^2_r < 5$). In Figure 1 one can see that pions, protons and also deuterons can be clearly separated. The band of kaons due to their much lower statistics is less pronounced, but also visible.

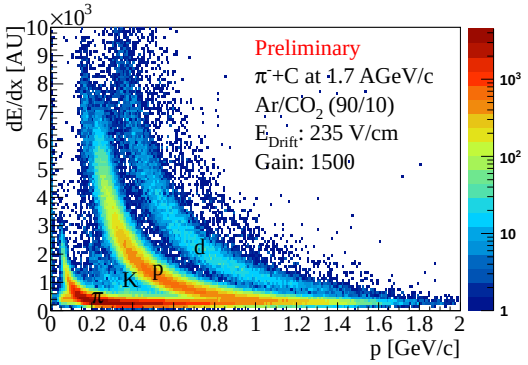


Figure 1: Specific energy loss (dE/dx) in the GEM-TPC. The the $\pi$-, proton- and deuteron-bands as function of the momentum can be clearly distinguished.

## References

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* Work supported by EU, BMBF, GSI

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