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R&D Activities in Aachen for a TPC with Gas Amplification by GEM Foils

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1 Introduction

In the joint ECFA/DESY study on physics and detectors for a linear electron-positron collider a large Time Projection Chamber (TPC) is envisaged as the central tracking device of the large all-purpose detector. We express our interest in participating in the design, development and construction of this detector.

Our goal is to investigate the possibility of replacing the conventional gas amplification in TPCs using proportional wires by Gas Electron Multipliers (GEM) [1]. The use of multiple GEM foils promises an easy way to suppress the drift of the ions into the large gas volume and hence avoiding the need of additional wire planes on gated high potential, the classical way employed to absorb the produced ions. In addition, finer structures of the readout pickup pads could be used to increase the spatial resolution.

2 Activities

Currently we are operating multi-layer GEM structures with simplified readout pads in a small gas volume. A flexible, modular system has been designed in which GEM foils and pickup pads can be changed very easily and which enables us to perform several important experiments relevant for the use of GEM foils in a TPC. This setup is used to study pulse shapes and to measure the gas amplification. Also, first results on the ion feedback and the transparency of GEM foils can be obtained by irradiating this device with high intensity γ and X-ray sources. These experiments are performed by measuring the currents on anode, cathode and all GEM electrodes to nano-ampere precision.

In parallel we are setting up are a large TPC with about $1.5\,\mathrm{m}^3$ gas volume in a cosmic ray test bench. It will be used to study the feasibility of the use of GEM foils in a large TPC. Readout structures, consisting of GEM foils and pickup pads, which are developed and tested in the small gas volume can subsequently be installed in the large TPC to investigate other aspects of their application in a large chamber.

3 Future Plans

We intend to continue the measurements of the ion feedback and the transparency of multi-layer GEM structures using high intensity γ and X-ray sources. These measurements will be accompanied by numerical simulations of the structures allowing the optimisation of the geometry of the GEM foils, their electrical operation potentials and the readout pads.

Provided that the above studies reinforce the practicability of using GEM foils for a TPC at a linear collider, we plan to investigate the achievable spatial resolution of these structures and the prospects for the measurement of the specific ionisation ($\mathrm{d}E/\mathrm{d}x$). Initial studies might be performed using the small, flexible setup before the extrapolation to large volumes is verified using the large TPC.

On a longer time scale we are also interested in contributing to the design of an appropriate readout electronics for a large TPC with several million readout channels, operated under the conditions of the TESLA collider.

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References

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