Construction and first performance studies of a CBM TRD prototype with alternating wires developed in Frankfurt*

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Introduction

The Transition-Radiation Detector (TRD) for the Compressed Baryonic Matter (CBM) experiment at the Facility for Antiproton and Ion Research (FAIR) has to deliver electron identification and tracking performance in a high particle-density environment. To deliver the required fast detector response for the expected high signal rates, a thin Multi-Wire Proportional Chamber (MWPC) without drift region has been developed [1].

One key challenge of this setup is the sensitivity of the field geometry to deformations of the cathode planes. With a thin foil as front cathode, even minor internal pressure variations can affect the gas gain [2]. In order to minimize this effect, the robust field geometry of an alternating wire structure, as proposed for the ALICE VHMPID [3], has been explored. Field wires are introduced between the sense wires to generate field lines from the field to the sense wires that are independent of the front cathode. Consequently, the electrical field in the sensitive area near the entrance window becomes significantly lower.

Construction and experimental set-up

To study the effects of an alternating wire set up on the gas gain, a small aluminium prototype with dimensions of 21,8 x 21,8 cm^2 has been built. Thin sense wires (gold-plated tungsten, 20 μm) and thicker field wires (copper, 79 μm) are arranged on the anode plane with a pitch of 2.5 mm. A thin aluminized Mylar-foil (19 μm) serves as front cathode and entrance window at the same time. A padplane with 15 read-out pads is used as rear cathode. Both, front and rear cathode, have a distance of 4 mm to the anode plane, leading to a total gas gap of 8 mm (see Fig. 1).

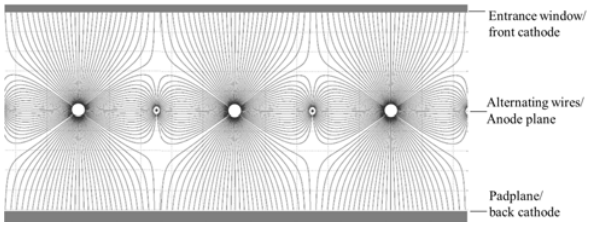

Figure 1: Schematic profile with field lines of the new prototype with alternating wires.

First measurements in a laboratory environment were performed with an ^{55}Fe source. The sense wire current was measured for different positions at various differential pressures. Field wires were on ground potential. A standard prototype without field wires and with similar dimensions was employed for reference measurements.

Results

The first tests give a clear indication for a superior performance in terms of gas gain stability for the new prototype. The effect that the gas gain shows variations up to 60 % in the case of internal overpressure, as seen for the standard set up, is drastically reduced for the setup with alternating wires (variations are below 10 %, as shown in Fig. 2).

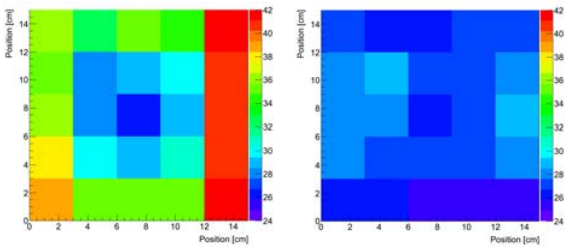

Figure 2: Gas gain as function of position at 0.5 mbar overpressure for standard (left) and new prototype (right).

Outlook

The superior performance of the new prototype will be further investigated to confirm it on a quantitative level. Measurements with different field wire potentials and of the energy resolution will be performed.

A second prototype with alternating wires and an asymmetric structure, i.e. the wire plane is moved towards the readout cathode, has been built and will be tested as well.

References

[1] P. Dillenseger et al., "In-beam performance studies of the first full-size CBM-TRD prototypes developed in Frankfurt ", GSI Scientific Report 2012 (2013) 66.

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[3] D. Varga et al., "Close cathode chamber: Low material budget MWPC", Nuclear Instruments and Methods in Physics Research, 2013, p. 11-18.

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