Development of a large area TEGIC-detector for heavy ions *

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Upcoming new accelerator facilities with increased intensities for primary and secondary beam experiments are taking established detector systems to their limit of operation and require faster detectors for the beam identification. We have designed a concept for a full-scale Tilted Electrode Gas Ionisation Chamber (TEGIC) with a position sensitive extension and realized and tested it with a full scale detector prototype.

The most common method of element identification of secondary beams produced by fragmentation reactions is by the precise measurement of the energy loss in the active volume of a detector. Due to the high intensities Solid State Detectors (SSDs) are facing radiation damage which can alter their properties or even destruct the devices. Gas detectors however are radiation hard detectors as their active volume gets continuously exchanged and makes them the perfect candidate.

Typically used MUlti Sample Ionisation Chambers (MUSIC) have a limited rate capability due to long drifting paths for the charges produced. To overcome these limitations a new concept was introduced, the Tilted Electrode Gas Ionisation Chamber (TEGIC) [1], consisting of planar electrodes tilted by 60 degree with respect to the beam axis in combination with a fully digital readout for pile up treatment.

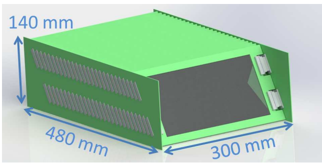

Figure 1: CAD rendered model of the 27 detector electrodes mounted on PCBs inside the detector housing (from [2]).

Figure 1 shows a typically structure for a internal component of the TEGIC-Detector. For the electrodes thin (d = 2 μm) Mylar foils which are coated on both sides with a conductive layer (Aluminum d = 250 nm) and stretched on standard PCB frames. The foils of the position extensions consist also of Mylar foils (d = 5 μm) with chemical etched conductive strips structured in x and y on one side each.

The electrodes are connected alternating to ground or potential to provide a drift field between neighbouring electrodes. Every anode is read out individually and connected to a charge sensitive pre-amplifier MPR-16 (Mesytec) to measure the energy loss for each segment independently.

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A test experiment was performed at the FRS using a primary uranium beam at E = 1 AGeV and a Be target (d = 2.5 g/cm^2) to produce a heavy secondary beam cocktail in the mass region around Z = 50. For a systematic study of the energy loss a resolution of $\Delta Z \sim 0.64$ (FWHM) was obtained for ions in this range. A correlation of the identified fragment charges from the standart FRS MUSIC detector and the TEGIC detector is plotted in Figure 2.

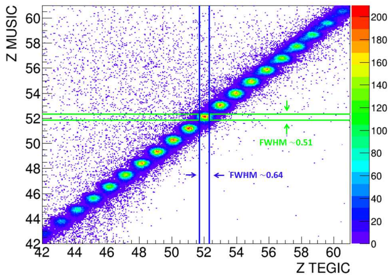

Figure 2: Z MUSIC versus Z TEGIC for ions in the range of Z = 50 with respective resolutions (from [2]).

For the position reconstruction which is presented as a correlation with the standard FRS TPC in Figure 3 a resolution of approximately $\Delta Y = 0.7$ mm for the TEGIC is obtained. Non linearities in the charge distribution over the 12 mm wide strips are still under investigation.

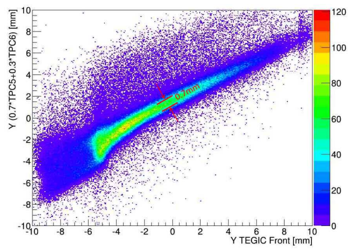

Figure 3: y position TPC versus y position TEGIC with a resolution of $\Delta Y = 0.7$ mm. The non linearities in the charge distribution are still under investigation (from [2]).

References

[1] K. Kimura et al., NIM A 538 (2005), 608-614

[2] S. Maurus, Development of a Large Area TEGIC-Detector for Heavy Ions, MSc thesis, Technische Universitat München (2015)

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