Update on GEM development at VECC

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With regard to the ongoing R&D on GEM-based detectors for the CBM-MuCH [1, 2], we discuss in this report the performance test of a triple-GEM chamber assembly mainly using cosmic rays. The aim is to determine the charged particle detection efficiency of the detector.

A triple-GEM prototype chamber was built by assembling three GEM foils (10 cm x 10 cm) made and framed by CERN. Two such chambers with 512 readout channels each were fabricated: chamber A with 3 mm x 3 mm pad size and chamber B with 4 mm x 4 mm pad size. This granularity was chosen based on realistic MuCH simulations. While the drift gap of chamber A was 5 mm, that of chamber B was 3 mm. Tests with cosmic rays were performed for chamber B.

For the efficiency estimation with cosmic rays, the readout connections from all pads were shorted together to form a single output of the GEM signal, which was coupled to conventional NIM electronics (Ortec 142 IH +572A). A timing SCA was used to produce the corresponding analog and logic signal. A suitable threshold was applied on the SCA window to suppress the noise. For all tests, a gas mixture of Ar and CO_2 (70:30) was used in the chamber.

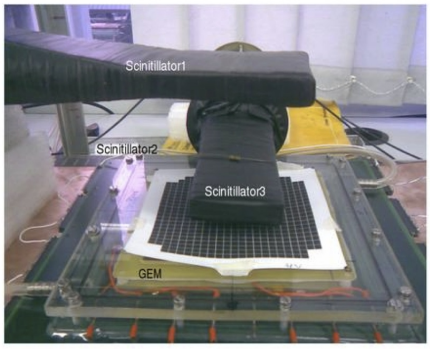

Figure 1: Test setup for cosmic rays at VECC

The cosmic ray test setup was assembled using three scintillators each coupled to a PMT via light guides. The detector was placed between the middle and the bottom scintillator as shown in Fig. 1. The middle scintillator, which was kept very close to the detector, had an area of 5 cm x 5 cm, well within the active area of the detector (10 cm x 10 cm). The cosmic muon trigger was defined as threefold coincidence of the three scintillators. The corresponding coincidence outputs were fed to a counter. The detector efficiency was estimated as the ratio of the number of detected tracks (4-fold counts) to the total number of triggers (3-fold counts).

The pulse height spectra corresponding to a MIP, fitted to Landau distributions, are shown in the left panel of Fig. 2 for two different bias voltages. The right panel shows the variation of efficiency with bias voltage. It increases with voltage because of the increase in gain. The maximal efficiency achieved is around 95% and is found to saturate around this value at $\Delta V_{\mathrm{GEM}} \approx 425$ V for the chamber layout described above.

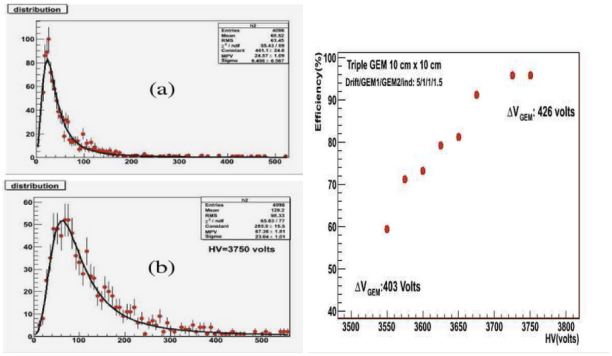

Figure 2: (Left) Pulse height spectra for cosmic ray data for two different bias voltages; (Right) Variation of efficiency with applied high voltage

The chambers were also successfully tested with proton beams at the Jessica beam line at FZ Jülich in December 2010. Fig. 3 shows the beam spot seen on-line by the two chambers with a cut of 900 ns on the time difference of chamber hit to beam trigger signal. The analysis of the data from this beam test is still ongoing.

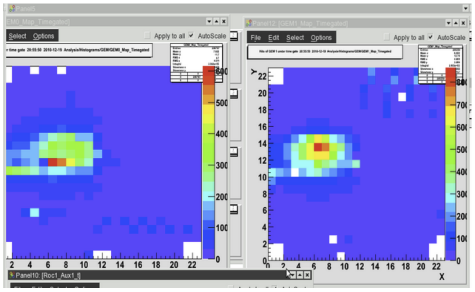

Figure 3: On-line snapshot of the proton beam as seen in the two triple-GEM chambers

References

[1] A. Dubey *et al.*, *CBM Progress Report 2008*, Darmstadt 2009, p. 32

[2] S. Chattopadhyay *et al.*, *CBM Progress Report 2009*, Darmstadt 2010, p. 28