

## Performance test of a triple GEM chamber with Cosmics

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### Introduction

GEM(Gas Electron Multipliers)[1] based gaseous detectors are used in several particle physics experiments[2], such as COMPASS, PHENIX, etc. We at VECC are involved in developing a GEM based muon detector for the Compressed Baryonic Matter (CBM) experiment at the upcoming accelerator facility at FAIR, GSI. By detecting muons, the goal is to carry out the measurements of rare probes such as the charmonium  $J/\psi$ ,  $\psi'$  and the low mass vector mesons via their di-muonic decay channels. It is thus required to build a large acceptance high resolution detector which can cope with the expected high rates in the CBM experiment. A high charged particle detection efficiency is one of the necessary criteria for the muon detector. In this paper, we report the response of the detector to the cosmic muons and have estimated the efficiency of charged particle detection of the chamber at different GEM voltages. This study would help in optimizing the operating conditions of the triple GEM chamber.

### Prototype Chamber Fabrication and Test Setup

The triple GEM prototype chamber was made by assembling three 10 cm x 10 cm CERN-made and framed GEM foils stacked one over the other with appropriate gaps between them. This stack was sandwiched between a drift mesh and a segmented readout plane consisting of several pads. For efficiency estimation, the readout connections from all the

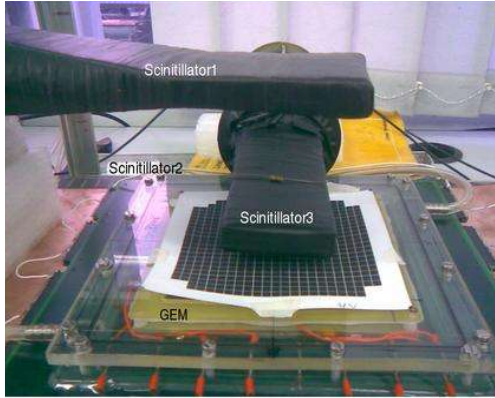
pads were shorted and fed as single input to the preamp. The detector elements were housed in a 12 cm x 12 cm x 10 cm gas tight chamber made out of perspex. The typical drift, transfer and induction gaps were: 5 mm, 1 mm, 1.5 mm respectively. The three GEMs and the drift mesh were biased via a single resistive chain. A premixed gas mixture of Ar/CO<sub>2</sub> in the ratio 70/30 was the chamber gas used for all our tests.

A cosmic ray test setup was assembled in lab using three scintillators each coupled to a PMT. The detector was placed in 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, which was well within the active area(10 cm x 10 cm) of the detector. The three scintillators in a three fold coincidence provided the cosmic trigger. Standard Ortec electronics (142IH preamplifier and 572A amplifier) was used to read the GEM signal. The detector signal was coupled to the trigger via a timing gate to form a 4-fold coincidence. The corresponding coincidence outputs were then fed to a counter. Efficiency of the detector was then estimated as the ratio of the number of detected tracks (4-fold counts) to the total number of triggers(3-fold counts).

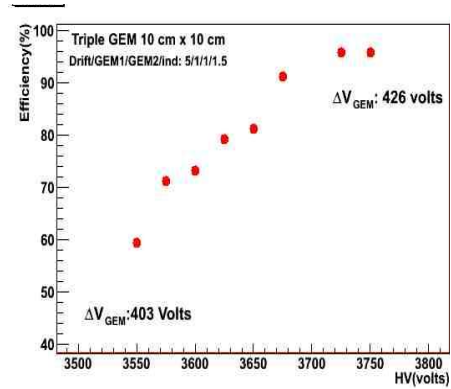
### Results

The pulse height spectra corresponding to a MIP is shown in Fig2.(a) and Fig2(b) for two different bias voltages. The two spectra is fit to a Landau distribution. Fig.3 shows the variation of efficiency with varying bias voltages. It increases with voltage as the gain of the detector increases and then saturates at certain value. The

maximum efficiency achieved is observed to be around 95% and is found to saturate around this value at GEM voltage of 425 volts for the above described chamber layout. Further tests are in progress by changing the other GEM parameters and studying the effect. The detailed response of the triple GEM chamber would be presented and discussed.



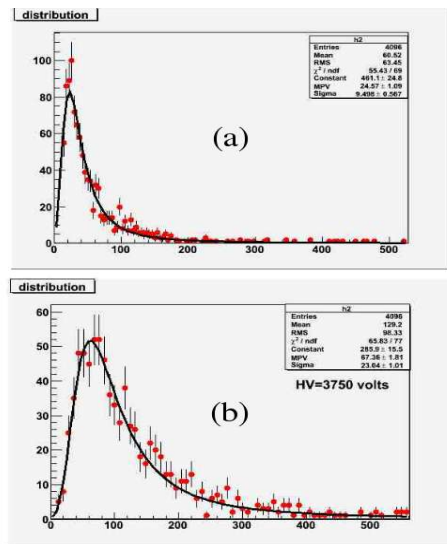
**Fig. 1** Cosmic ray test setup: three scintillators and GEM detector under test.



**Fig.3** Variation of efficiency with high voltage for a triple GEM chamber.

## References

- [1] F. Sauli, Nucl. Instrum. Methods A386(1997) 531
- [2] B. Ketzer, et. al, IEEE Trans. Nucl. Sc. **48**, 1065 (2001)



**Fig.2** Pulse height spectra for a MIP at (a) HV=3600 Volts (b) at HV=3750 volts.