CBM muon tracker R & D: testing of triple GEM prototypes with proton beams

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Introduction

The Indian collaboration has proposed to build a Muon detector for the Compressed Baryonic Matter (CBM) [1] experiment at the upcoming FAIR facility at GSI, Darmstadt. In the very high baryon density environment created in nucleus-nucleus collisions, in-medium modification of J/Ψ is considered to be an effective probe to investigate the onset of chiral symmetry restoration and to search for the predicted first order phase transition from the hadronic phase to the QGP phase [2]. High rate detectors based on micropattern technology, such as GEM(Gas Electron Multipliers) have been considered as suitable options.In this direction, we have already built GEM prototype chambers and successfully obtained signals from both radioactive sources as well as from proton beams in our first beam test at GSI in September 2008 [3]. However, the test with protons was carried out with first prototype of FEE, which had alternately bonded channels. In the present contribution, we have presented and discussed the results of second beam test which took place in Aug-Sep 2009, with a new version of FEE with all the electronic channels connected. The results of this testbeam would help in the direction of optimizing the detector parameters, namely granularity, operating voltage, efficiency, etc.

The prototype chambers and test setup

Starting from six 10 cm x 10 cm framed GEM foils procurred from CERN, we built two triple GEM chambers at VECC. Each detector consisted of a readout plane, a drift plane and three layers of GEMs as the amplifying elements. Ar/CO2 mixed in the ratio 70:30 was the gas mixture used. Each chamber had a total 256 pads. Fig 1 shows the readout plane in one of the chambers(chamber 1). The pads on the left have a dimension of 3.5 mm x 8 mm while that on the right are 1.6mm x 16 mm in size. The idea was to test the response of the chamber with MIPs in terms of charged

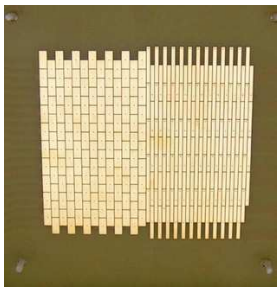

FIG. 1: layout of the readout plane of chamber 1

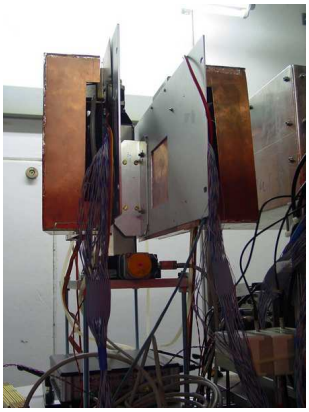

FIG. 2: GEM chambers as mounted in the beamarea

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particle detection efficiency and cluster size. The second chamber(chamber 2) had the all the pads of 3.5 mm x 8 mm but with larger induction gap for a comparative study. The test was carried out using 2.5 GeV/c proton beams at SIS18 facility at GSI, during Aug-Sep 2009. The pads were readout using N-xyter [4] electronics which is a self-triggered 32 MHz, 128 channel ASIC,

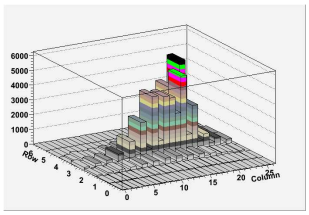

FIG. 3: Distribution of the affected pads due to proton beam in the fine granularity region of chamber 1.

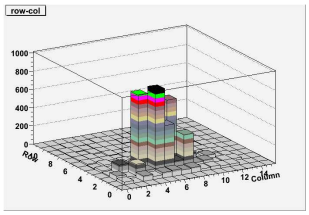

FIG. 4: Distribution of the affected pads due to proton beam in the coarse granularity region of chamber 2.

being development for use in the CBM experiment. The FEB was coupled to a readout controller(ROC) from where it was sent to DAQ; an external signal from a two fold scintillator positioned downstream related to the beam trigger was provided to the ROC to facilitate the efficiency measurements by comparing the corresponding time stamps in the detector, offline. Fig.2 shows the test chambers as mounted in the beam area. At any given moment, the beam was incident on one half of each detector(128 channels).

Results

Fig. 3 and Fig 4 clearly indicate the beamspot due to protons on the two chambers: chamber 1- fine granularity region and chamber-2(with coarse granularity), respectively. Fig 5 shows the pulse height distribution for 2.5 GeV/c proton as seen from the fine granularity pads. It fits nicely with a Landau distribution function. A typical timing difference spectra between the beam trigger and hits in the GEM detector is shown in Fig 6. Data was taken for a range of GEM voltages for both the chambers. The detailed results would be presented and discussed.

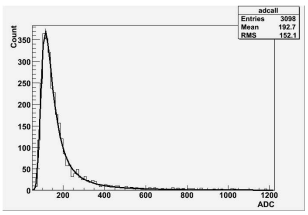

FIG. 5: Pulse height distribution for a proton beam as obtained from chamber 1

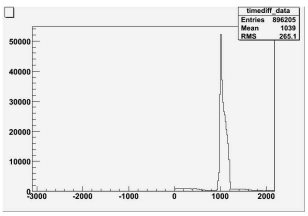

FIG. 6: The time difference spectra between hits in the detector and beam trigger (in ns) for chamber 1.

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[3] DAE Symp. On Nucl.Phys. V53 (2008).Int. Symp. on Nucl. Phys. **54**, 1 (2009).
[4] NIM A (568) (2006) 301-308