Testing of $31cm \times 31cm$ GEM Chamber at COSY


$^1$Bose Institute, Centre for Astroparticle Physics And Space Sciences, Kolkata-91, INDIA
$^2$Variable Energy Cyclotron Centre, Kolkata-64, INDIA
$^3$GSI Helmholtzzentrum für Schwerionenforschung GmbH (GSI), Darmstadt, Germany

Introduction

Operation of CBM-MUCH at high interaction rate requires a detector with large acceptance, high granularity and high rate capability. In this direction, we have conducted a beam test of triple GEM detectors at COSY using 2.36 GeV/c proton beams. Our goal was to study the response of the detector with high intensity beam using nXYTER based self-triggered readout electronics and also to test for the first time the performance of a large size triple GEM detector. In this study, we compare the results at different peak intensities in a typical spill in a run. The highest intensity as calculated from spill structure is $\sim565kHz/cm^2$ which is close to the peak intensity expected by the 1st MUCH detector station. Here we report preliminary results of the beam test.

Experimental Setup

The schematic layout of the test setup is shown in Fig.1. Out of the three GEM detectors tested, first two detectors (GEM1 & GEM2) are of $10cm \times 10cm$ size having square readout pads of sizes $3mm \times 3mm$ and $6mm \times 6mm$ respectively. The drift, transfer and induction gap of GEM1 are $3mm$, $1mm$, $1.5mm$ and the corresponding values for GEM2 are $3mm$, $2mm$, $2mm$. Third detector (GEM3) is made out of large GEM foils of $31cm \times 31cm$ in size with trapezoidal readout pads of radially increasing size [1]. The drift, transfer and induction gap of the chamber are $3mm$, $1mm$, $1.5mm$. A premixed gas mixture of Ar and CO$_2$ mixed in the ratio of 70:30 by mass was used for all the GEMs. Data were acquired by DABC based DAQ system. GEM1 and GEM2 were read out using 2 nXYTER and one ROC while GEM3 was read out using 8 nXYTERs and 4 ROCs. In this test beam, the feedback parameter $v_b$, $f_b$ of nXYTER was set as per high frequency requirement as reported in [2]. All the hits above a predefined threshold and time-correlated with the trigger window are used for analysis.

Results

The beamspots of GEM2 and GEM3 are shown in Fig.2. We do not observe any structure inside the beamspot as was the case in the earlier beam tests at higher intensities. The ADCs are obtained by assuming a baseline value of 2000 ADC for all the nXYTER channels. The pulse height distributions for GEM2 and GEM3 for both low and high intensity cases fitted to a Landau distribution have been shown in Fig.3 corresponding to the pad with highest ADC taken event by event.

Figure 2: Beam spot of GEM2 (left) and GEM3 (right) at high intensity

Figure 3: Pulse height spectra for GEM2 (A,B) and GEM3 (C,D) respectively for $\Delta V_{GEM}$ = 359.06V. The peak intensities corresponding to (A), (B), (C), (D) are 30 kHz, 253kHz, 25.23 kHz and 357kHz respectively.

The MPVs of the ADC spectra at low and high intensities are 124.85 and 122.53 for GEM2 and 240.0 and 227.0 for GEM3 respectively for given sets of high voltage of GEM2 and GEM3. The MPVs of GEM2 differ from GEM3 due to different configurations of the detectors mentioned earlier. We observed that the MPV remains nearly same for both high and low intensity cases for the two detectors. Preamplifier saturation effects as observed in earlier beam tests is no longer present owing to the choice of appropriate $v_b$, $f_b$ values. Further analysis of the data is under process.

References