Testing of large size GEM detector with Pb+Pb collision at CERN-SPS

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Introduction

Large size triple GEM (Gas Electron Multiplier) detectors will be used for the first two stations of MUCH (Muon Chamber) in CBM (Compressed Baryonic Matter) experiment which face high particle rate and harsh radiation environment. We tested two large size prototype detectors with particles coming from the Pb+Pb collisions at different beam momenta (13 AGeV/c, 30AGeV/c and 150 AGeV/c). Simultaneous response from the full active area of the detector was studied unlike with single particle beam[1]. The performance of the detector in a multiparticle environment was studied for the first time wherein spray of particles produced from nucleus-nucleus collision passed through different regions of the detector, as the case would be in the actual CBM experiment. Data with 20 cm Fe absorber were also taken. This test was carried out at the H4 beam-line of CERN-SPS. This was also the first test with new CBM-DAQ, which took data in a free streaming mode.

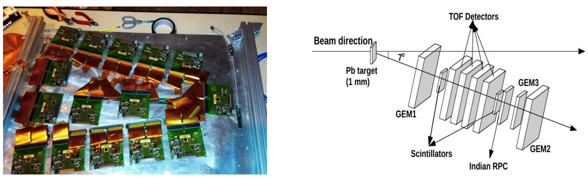

FIG. 1: Left: Detector and FEBs mounted on 10 mm Al cooling plate. Right: Schematic of experimental setup.

FIG. 2: Picture of experimental setup at CERN-SPS.

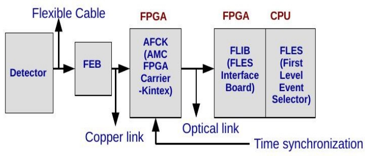

FIG. 3: Block diagram of DAQ system.

Experimental Setup

We tested our detectors with almost full FEB (front end board) coverage. With such large number of working FEBs an elaborate cooling[2] were implemented for the first time. The picture of cooling plate along with the detector with all the FEBs mounted on it is shown in the FIG. 1 (left panel). The schematic of the experimental setup is shown in the FIG. 1 (right panel). We tested our triple GEM detectors along with the CBM-TOF (MRPC) module. The detector axis was tilted about 7° from the beam axis, considering target (Pb of size 9 cm x 9 cm x 1 mm) centre at (0,0,0), to avoid direct beam. A diamond detector were placed just before the target. We used two real size trapezoidal shaped triple GEM modules, one in the front (GEM1) and the other at the back (GEM2) of the setup as shown in the figure. The z-distance of the GEM1 was about 3.1 m away from the target and 39 cm below the beam axis.

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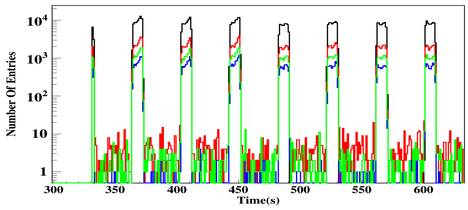

FIG. 4: Spill structure: GEM1 (green), GEM2 (red), GEM3 (blue) and diamond (black).

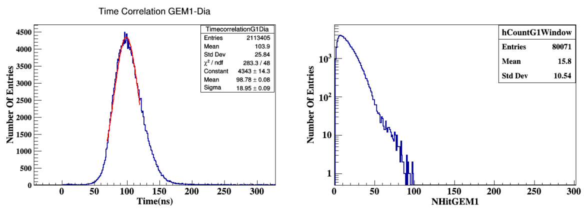

FIG. 5: Left: Time difference distribution between GEM1 and diamond. Right: Number of hits per event for GEM1

The z-distance for GEM2 was about 6.0 m away from the target. A third GEM detector of size 10 cm x 10 cm, GEM3, having 256 pads of 6 mm x 6 mm, was also put at a later stage. A picture of the experimental setup in the cave of H4 area is shown in FIG. 2. Block diagram of the data acquisition system is shown in Fig. 3. A new version of n-XYTER (rev-F) was used as front end readout. These FEBs were connected to GEM readout connector via 10 cm Kapton based flexible cable. Data were processed by FPGA based Data Processing Board (DPB)[3]. Twisted pair LVDS flat ribbon cables, 6 metres in length were used as signal cables from the back-end of FEBs to the front-end of DPB boards. An optical cable of 50 meter in length was used from back-end of the DPB to the FLIB (FLES Interface Board) board which was mounted on FLIB-PC. FLESnet running on CBMRoot framework was used to acquire data from GEM detectors for the first time. Two dedicated DPB board were used (master and slave) for time-synchronization.

Results and Discussion

The preliminary results of the beam test has been discussed below. FIG. 4 shows the spill

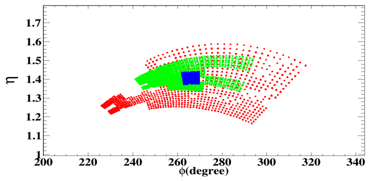

FIG. 6: η-ϕ distribution of detector hits.

structure seen in GEM1 (green), GEM2 (red), GEM3 (blue) and diamond (black) detectors with 1 sec bin width. Time interval between two spill was 30 seconds and spill length was 9-10 seconds. The beam rate as estimated using hits in diamond detector, is about ˜ 3.4 kHz. Data were taken and stored in time slices of 30 ms. Events were reconstructed by grouping the hits between two successive diamond hit-times. The distribution of time difference between GEM1 plane (ADC cut of 50 ADC channel) and diamond detector is shown in FIG. 5 (left panel), which implies the hits in GEM are correlated in time with diamond. Number of hits per event (hit multiplicity) for GEM1 is shown in FIG. 5 (right panel) for ADC cut of 50. The systematic study of hit multiplicity for different voltages as well as for different thresholds has been studied and will be discussed. FIG. 6 shows the η-ϕ distribution of detector hits for GEM1 (red), GEM2 (green) and GEM3 (blue) with respect to target. A straight line tracking has been done using (x,y,z) of detector hits in each plane by constraining the η-ϕ window, such that we get an overlap of active regions in each plane. The study of effect of absorber on detector hits is under progress. All these results will be discussed and presented.

Acknowledgments

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References

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