Response study of triple GEM chambers to varying intensity in mCBM

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Introduction

Large area triple GEM detectors will be used for the first two stations of Muon Chamber (MuCh) system for the measurement of dimuon signals (decay product of J/ψ, ω, etc.) in Compressed Baryonic Matter (CBM) experiment at the FAIR facility GSI Germany. The goal of CBM is to explore the Quantum Chromodynamics (QCD) matter at high net-baryon density and moderate temperature. Two real-size GEM detectors has been installed and commissioned [1] in mini-CBM (mCBM) experiment, which is part of FAIR Phase-0 program. In this paper, we report the systematic study of response of GEM detector at high beam intensity. The data at mCBM was acquired for Pb+Au collision at 1.06 (approximately) beam energy at GEM voltage of 4500 V and 4600 V. The target thickness was 0.25 mm. The detail of the Runs considered for this analysis is mentioned in the Table I.

TABLE I: Runs with originally 10s spill length

Run Number	Intensity (Ions/9 second)	Voltage (V)
520*	4.5×10^5	4500
518*	4.5×10^5	4600
767	2.0×10^6	4600
786	2.0×10^7	4500
784	2.0×10^7	4600
536*	7.2×10^7	4500
534*	7.2×10^7	4600
790	2.0×10^8	4500

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Results and Discussion

Any Run has a length during which the beam is turned "ON" called "onspill" period. Similarly, there is a period during which beam is turned off called "offspill". In ideal case only particles hitting the detector should register. In reality though, there is some noise. Luckily, this noise is confined to only some particular pads on the GEM plane. These noisy pads may be identified by looking at the pads hit during the offspill period, since ideally there should be no hits in offspill because beam is turned off. Figure 1 shows the spill structure for Run 536 before (left) and after (right) noise cleanup. A spill in this run is 10 second long. It is clearly visible that after masking the noisy pads, the small amount of data that was visible before noise cleanup goes down to zero.

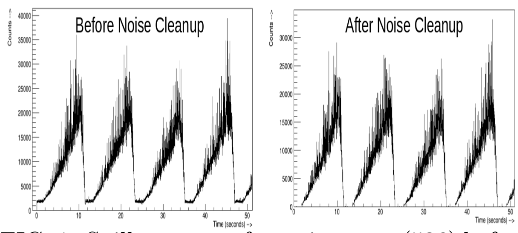

FIG. 1: Spill structure for a given run (536) before and after noise cleanup

A upstream view of one of the GEM readout board with full acceptance (according to scale) is shown in Fig. 2 (left). This readout boards has 23 vertical columns and 97 sectors in total. This makes a total of 2231 (23×97) pads. Each pad is in principle capable of giving independent information of particle hits. In actual case, some of these pads become noisy

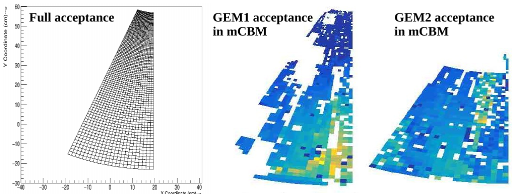

FIG. 2: Schematic of Muon Chamber readout

and have to be masked. But as must be evident from the geometry that masking one area shortens the acceptance of the detector. During comparison of several runs, several pads have to be masked to remove noise. Therefore, we have masked a particular area for all the runs under consideration. The pad readout after masking noisy pads is shown in the middle and right panel of Fig. 2 for GEM1 and GEM2 as per mCBM acceptance, respectively.

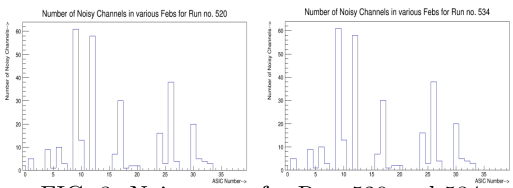

FIG. 3: Noise maps for Run 520 and 534

In reality, despite due diligence the identity of noisy pads is not same for all the runs. To combat this problem, we have made a common pool of noisy pads in all the runs used in this study. We have removed all of pads to ensure that acceptance remains identical. In Fig. 3, we show the address of the noisy pads removed in all the runs, henceforth called "Noise Map". This noise map is shown for two separate runs and it can be seen that these two are identical. In Fig. 1, we can observe that there are noisy areas and spikes in the spill. There were several such irregularities throughout the different Runs considered for this study. The intensity was normalized to 9 s. Total number of pads and their positions have been carefully kept the same throughout for both GEM1 and GEM2. As a result, the net acceptance is identical everywhere.

After all the corrections, the number of Digi/TS distribution for GEM1 module at two different intensity is shown in Fig 4. There

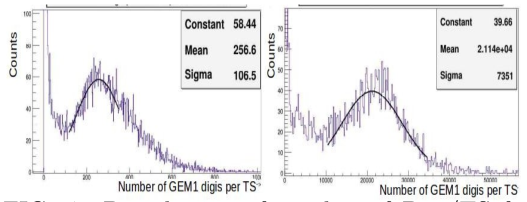

FIG. 4: Distribution of number of Digi/TS for GEM1

are two peaks: One for offspill (Lower X) and other for onspill (Higher X). We have fitted the onspill and offspill peaks for all the runs. As a final step, we have also subtracted the off-spill counts from each of the on-spill data point for good measure.

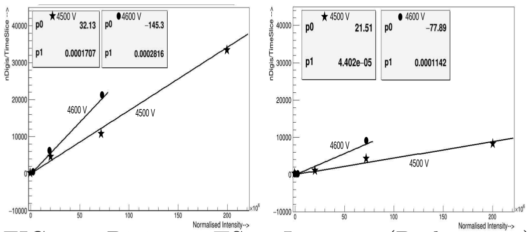

FIG. 5: nDigis per TS vs Intensity (Preliminary) per spill for GEM1

The results for intensity scan (average number of Digi/TS as a function of normalized intensity) for GEM1 and GEM2 are shown in the left and right panel of Fig 5, respectively. The graph is fitted a straight line for each of the two voltages. As expected the lower slope is for lower voltage (4500 V) and higher slope for higher voltage (4600 V). The statistical error bars is within marker size. The fit graph also passes close to (0, 0) showing the robustness of our noise removal algorithm. The linear behavior shows that response of our GEM modules is linear with increasing intensity. All these results will be presented in details.

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References

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