Real size triple GEM detector for mCBM experiment

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Introduction

Large area triple GEM (Gas Electron Multiplier) detectors will be used for the first two stations of MUCH (Muon Chamber) in CBM (Compressed Baryonic Matter) experiment. The detectors in these stations will have to handle a high particle rate and a harsh radiation environment. A CBM full system test-setup called mCBM [1] (mini-CBM) is presently being installed at the SIS18 facility of GSI/FAIR. The mCBM experiment will allow to test and optimise the performance of the detector subsystems including the complete data acquisition software chain under realistic experimental conditions. This facility not only ensures a running system for tests of the detectors but also aims to significantly reduce the commissioning time for CBM at SIS100 [2]. A schematic of mCBM setup is shown in Fig. 1. The setup includes mSTS, mMUCH, mTRD, mTOF and mRICH detectors. In this regard, we have built two real-size trapezoidal shaped triple GEM detectors using NS-2(glue-less) technique. These are the first such chambers which employ an opto-coupler based HV biasing scheme [3]. The readout of the detector consist of ∼2000 pads having progressively increasing pad sizes. The detector prototypes powered via opto-couplers were first tested with Fe^{55} source at VECC. The picture of the detector (left) and Fe^{55} spectrum (right) is shown in Fig. 2.

The actual picture showing the module fixed on mounting frame is shown in Fig. 3. These modules will be installed in mCBM at the end of this year.

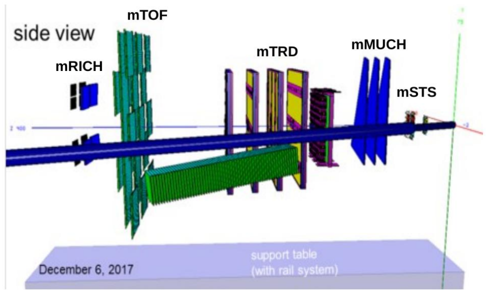

FIG. 1: Schematic of mCBM test setup

Test of opto-couplers

We assembled first time large size triple GEM detector with novel opto-coupler based HV design. This opto-coupler will act like a switch which we will use for removing the bad segments of the GEM foil at the time of experiment. The picture of the opto-coupler mounted on detector is shown in Fig. 4. The HV lines for powering each segments of the GEM foil is shown in the picture. We performed following test regarding stability of the opto-coupler and its effect on the detector gain.

A. Short segment test

If any of the segment is bad then we can switch off that segment by switching off the opto-coupler without disturbing the branch current of the divider circuit. We manually shorted one the of segment of the GEM foil and tested the opto-couplers. At HV = 4550V branch current I = 688μA at normal condi-

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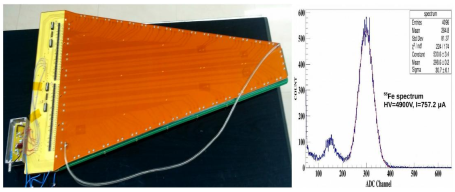

FIG. 2: Left : Picture of the GEM detector. Right : Fe^{55} spectrum

FIG. 3: Schematic of mCBM test setup

tion. After shorting one of the segments the current increased to 754 μA. Then we switched off that segment (using opto-coupler) and the current restored at normal value (I = 688.6 μA).

B. Effect of sparks in GEM foil on opto-couplers

We tested the stability of opto-couplers for the sparks in the GEM foil. The picture of the setup is shown in Fig. 3. We applied voltage across the GEM foil through opto-coupler

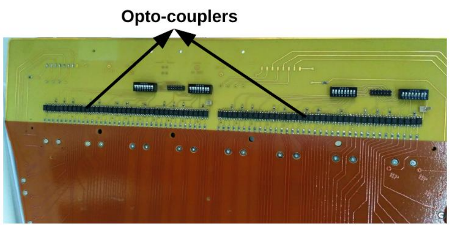

FIG. 4: opto-coupler mounted on drift PCB.

With opto-coupler			Without opto-coupler		
HV (V)	Current (μA)	Photo-peak ADC	HV (V)	Curren t (μA)	Photo-peak ADC
4650	713.2	174	4650	713.1	169
4750	728.6	295	4750	728.3	293
4800	736.1	401	4800	736.0	404

FIG. 5: Photo-peak ADC with and without opto-coupler

and measured the number of sparks. The HV, current and number of sparks are shown in the Fig. 5.

TABLE I: Table for sparks test of opto-coupler

GEM Voltage (V)	Current (nA)	Time (min)	Number of sparks
530	1/2	35	22
550	1/2	178	48
570	1/2	200	45
590	2/3	153	260

C. Gain of detector with and without opto-couplers

We also studied the gain of the detector with and without opto-couplers. We observed that the gain with and without opto-coupler are same within less than 1%. The results are shown in the table given below.

We are planning to test this detector at GIF++ [4] facility. All these along with the test results of GIF++ will be discussed in details.

References

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[3] *http://www.sympnp.org/proceedings/61/G30.pdf.*
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