Gain uniformity and gain dependence on T/P for real size prototype triple GEM for CBM experiment

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Introduction

The Compressed Baryonic Matter (CBM) experiment at FAIR is designed to study the matter under high density environment. Triple GEM detectors will be used in CBM experiment for detecting dimuons at FAIR. It is always required that the gain has to be stable and uniform over different regions of the detector. So the study of gain uniformity and the effect of environmental parameters (such as Temperature and Pressure) on detector gain is important. We have tested the gain uniformity and gain dependence on T/P for real size prototype triple GEM detector at VECC Lab using Fe^{55} source (5.9 keV X-ray) and using a self triggered elctronics called n-XYTER FEBs[1]. In this paper, we report a detailed study of variation of the gain characteristics of the detector.

Detector layout and Experimental Setup

Fig.1 shows the picture of the test setup showing the trapezoidal module under tests. The top visible side is the drift side while the FEBs are connected at the bottom. The FEBs are cooled with simple computer fans. Holes of 1 mm in diameter are provided at different positions on the drift side of the detector as indicated in the figure, for the source tests in lab. The active region of the detector is 708 mm in radial direction and the arc length of innerside 100.25 mm and outerside is 381 mm respectively[2]. The gap configuration of this detector is 3 mm(Drift) / 1 mm(Transfer1) / 1 mm(Transfer2) / 1.5 mm(Induction).

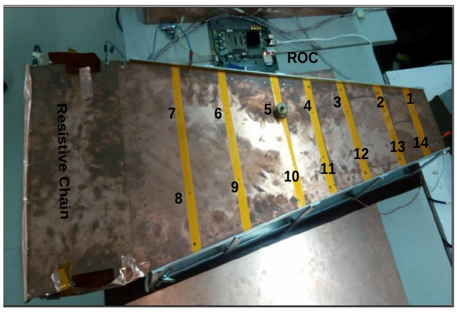

FIG. 1: Experimental Setup in Lab.

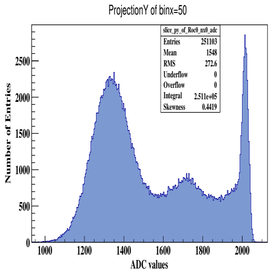

FIG. 2: Raw spectrum of Fe^{55}.

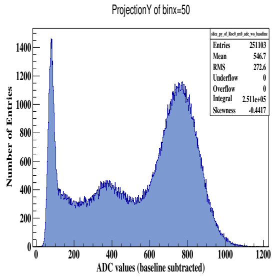

FIG. 3: Corrected spectrum of Fe^{55}.

The readout plane has a projective geometry having 1° progressively increasing pad sizes of 3.9 mm x 3.9 mm (innerside) to a maximum of 16.6 mm x 16.6 mm (outerside). A premixed gas mixture of Ar/CO_2 (70:30) was used. For Temperature (T) and Pressure(P) monitoring we have used a datalogger which records the T and P values, and the data is acquired using DABC software developed at GSI[3]. For gain dependence with time we have kept the Fe^{55} source fixed at one of the hole positions and measured the photopeak position at regular time-intervals lasting upto several hours. For the measurement of gain uniformity over the surface we have varied the position of the source and measured

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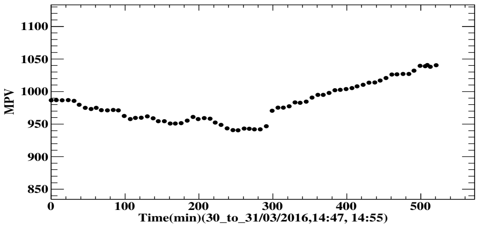

FIG. 4: Variation of photo-peak with time.

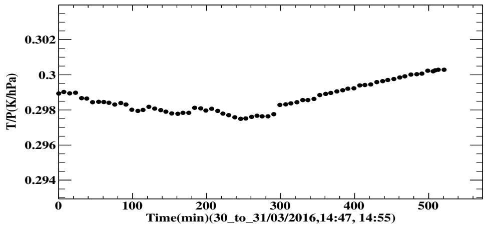

FIG. 5: Variation of T/P(K/hPa) with time.

the photo-peak at each of these positions.

Results and Discussion

For negative signal n-XYTER gives ADC output representing higher signal at lower ADC channel and vice-versa. Fig. 2 and Fig. 3 show the raw and baseline-corrected pulse height spectra of Fe^{55}, respectively.

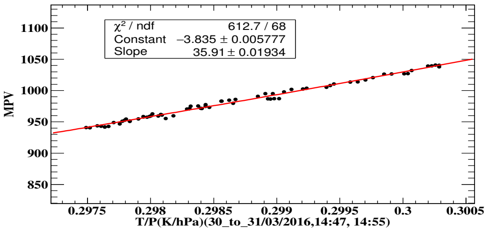

FIG. 6: Variation of photo-peak with T/P(K/hPa).

The variation of photo-peak and T/P with time is shown in Fig. 4 and Fig. 5, respectively. There is seen a good correlation between photo-peak and T/P. Since the gain increases with increase in T/P, both T/P and photo-peak follow the same trend. This variation of photo-peak with T/P has been plotted in Fig. 6. The data points are fitted with an exponential distribution indicating an exponential dependence of gain on T/P as per expression below,

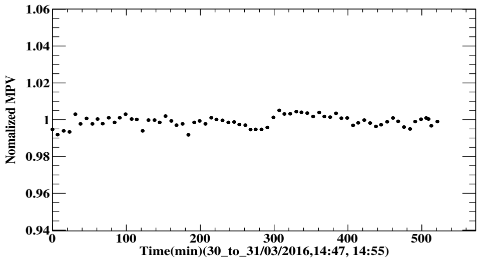

FIG. 7: Variation of normalized photo-peak with time.

$$G(T/P) = Aexp(B*(T/P)). \quad (1)$$

where A and B are the fit parametres and T/P is in K/hPa unit, respectively. The normalized gain is expected to be independent of environmental parametrs and can be computed as

$$g = G/Aexp(B*(T/P). \quad (2)$$

The variation of normalized photo-peak with time is shown in Fig. 7. This reveals a very stable gain with time fluctuating within 4 %. The variation of photo-peak at diffrent position is shown in Fig. 8. The gain uniformity is within 20 %.

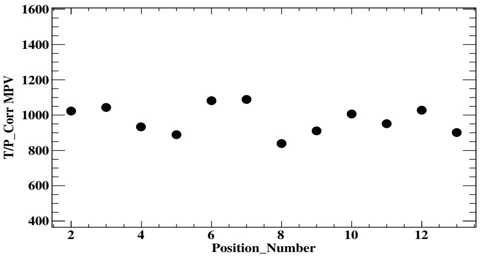

FIG. 8: Variation of photo-peak at different position.

References

[1] https://cbm-wiki.gsi.de/foswiki /pub/Public/PublicNxyter/nXYTER.pdf.

[2] DAE Symp. on Nucl. Phys. **60**, 1018-1019 (2015).

[3] IEEE Transactions on Nuclear Science 09/2011; 58(4-58):1728 - 1732.