The Characterization of THGEM using Ar/CH_4 (95:5)

T. Sinha[1],* A. Biswas[3], A. Roy[4], Dipankar Das[1], D. Das[2], L. Das[1] and S. Chattopadhyay[1]

[1]*High Energy Nuclear and Particle Physics Division, Saha Institute of Nuclear Physics, Kolkata - 700064, INDIA*
[2]*Applied Electronics Section, Saha Institute of Nuclear Physics, Kolkata - 700064, INDIA*
[3]*Department of Physics, Sikkim Manipal Institute of Technology, East Sikkim - 737136, INDIA*
[4]*Department of Physical Scciences, IISER, Kolkata – 741246, INDIA*
. * *email: tinku.sinha@saha.ac.in*

Introduction

In this report, we will present the characterization of the existing Thick Gas Electron Multiplier (THGEM) using Ar/CH_4 (95:5) gas mixture at one atmospheric pressure. The experimental set up with the description of THGEM and the gas mixing system Mass Flow Controller (MFC) are described in references [1], [2] and [3].

The Experiment

In this experiment, the Ar/CH_4 (95:5) gas-mixture was allowed to flush through the chamber where THGEM detector was kept along with a drift plane. Here Ar is the main detector medium and CH_4 is the quencher gas which absorbs photon released by Ar ion and dissipates the energy through elastic collision and also increases the lifetime of the THGEM. The main objective of this experiment was to measure gain along with energy calibration of this THGEM.

The calibration for Ar and CH_4 gas channels of MFC were done independently. The calibration was done sending Ar and CH_4 gas from the respective cylinders individually inside the calibration channels of MFC. The MFC gas flow reading was set to fixed values in the range of 10 - 100 for Ar and 1- 10 for CH_4. The requisite gas was flown in the inverted measuring cylinder of glass filled with water. For the calibration of Ar gas the time was measured for water column to change from 90 Cubic Centimetre (CC) to 20 CC. The actual flow rate was calculated dividing 70 CC water volume with the requisite time per minute in each case. In case of CH_4, the time was noted for water column to change from 90 CC to 60 CC. Here, the actual flow rate was calculated dividing 30 CC water volume with the requisite time per minute in each case. In the gas-mixture, CH_4 is only 5% and we calibrated this gas channel with lower valued range (1-10). Hence, the CH_4 gas flow was very slow through the water due to the lower valued range and we measured the volume of water column change for 30 CC only. These values of gas flow are the actual flow of gas through MFC for Ar and CH_4 both the channels. The plots were done taking the actual gas flow as a function of input gas flow (the gas flow ranges which were used) in the unit of Standard Cubic Centimeter per Minute (SCCM) for Ar and CH_4 both. We defined actual gas flow as Actual_SCCM and the input gas flow values as MFC_SCCM. The plots of Actual_SCCM as a function of MFC_SCCM produced the calibration graphs for Ar and CH_4 channels. According to the calibration plots of Ar and CH_4, the Ar and CH_4 gas flows were kept at 73 SCCM and 4.8 SCCM respectively to obtain 95% Ar and 5% CH_4 gas flow through the gas chamber of THGEM detector in the experimental set up. The high voltage (HV) was varied from 1.2 kV to 2.3 kV in step of 100 V keeping E_{Drift} at 0.45 kV/cm. The two characterization parameters of THGEM as gain and energy resolution were measured. The corresponding leakage current was measured from 1200 V to 2300 V.

Now, to know the number of secondary electros, the calibration of charge (fC) as a function of ADC channel was done using the test input of the preamplifier 142IH with known capacitor (1.0 pF) directly connected to a precision pulse generator in which voltage was varied from 300 mV to 1100 mV with a step of 100 mV keeping frequency 1000 HZ. Fig. 1 shows the charge (fC) as a function of ADC channel.

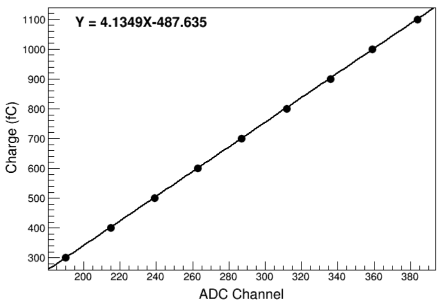

Fig. 1 The charge (fC) as a function of ADC channel

Results

The noise level in the experiment was minimized due to the good earthing which reduces the pick-up of ~ 1 Volt in the existing High Energy Physics laboratory of SINP, Kolkata. The data was taken in July, 2016 when ambient had huge humidity due to rainy season. But in the laboratory, the temperature and humidity were maintained as 26˚ C and 70.% respectively. The measured leakage current for the HV 1.2 kV to 2.3 kV is shown in Fig. 2.

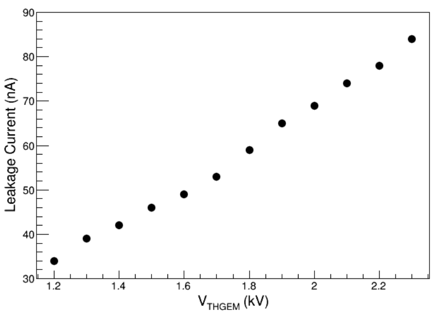

Fig. 2 The leakage current as a function of V_{THGEM}

The gain was measured from the ratio of secondary and primary electrons and has been shown in Fig. 3.

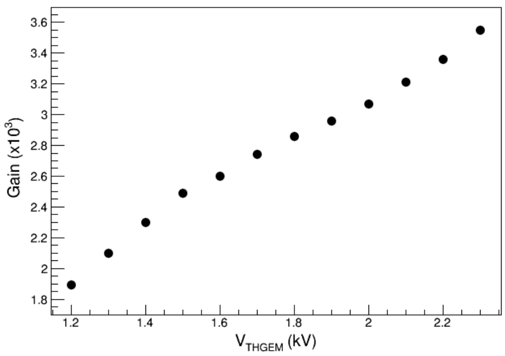

Fig. 3 The gain as a function of V_{THGEM}

Conclusions

The energy resolution of this single THGEM was also measured and the values of the energy resolution was improved from earlier observations due to the minimization of the noise.

References

[1] T. Sinha et al.; Proceedings of the DAE Symp. on Nucl. Phys. 55, 684 (2010).
[2] T. Sinha et al.; Proceedings of the DAE Symp. on Nucl. Phys. 56, 1090 (2011).
[3] T. Sinha et al.; Proceedings of the DAE Symp. on Nucl. Phys. 59, 934 (2014).