The Study on the performance of THGEM using MFC

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Introduction

The thick gas electron multiplier (THGEM) is mechanically an expansion of standard GEM, with its various dimensions being enlarged by factors ranging from 5 to 50.

The THGEM has several applications at atmospheric and low-pressure both. An electric potential applied across the THGEM establishes a strong dipole electric field within the holes, responsible for the focusing and multiplication of the gas ionization electrons into holes in a gas avalanche process. The resulting avalanche electrons are efficiently extracted from the holes; they can be either collected on an anode or transferred to successive multiplier elements. In this report, we have investigated mainly two characteristics such as energy resolution and gain of a single THGEM detector. The experiment was carried out with ^{55}Fe source Ar and Ar/CH_4 (95:5) using a Mass Flow Controller (MFC) at atmospheric pressure is shown in Fig. 1.

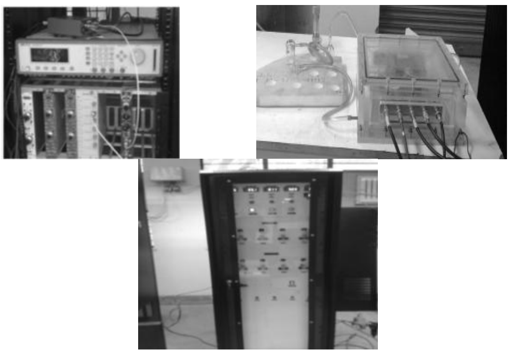

Fig. 1 The Experimental Set Up with MFC

The Experiment

The schematic diagram of experimental set up using a single THGEM is shown in Fig. 2. The Ar and Ar/CH_4(95:5) gas were flushed separately at 1 atm pressure through the gas chamber where the single THGEM template was accommodated [1,2]. The electric field between two electrodes of THGEM was generated putting high voltages independently to two electrodes using CAEN N471A. The signal from the detector was recorded by an amplifier Ortec 572A via a charge sensitive preamplifier Ortec 142IH.

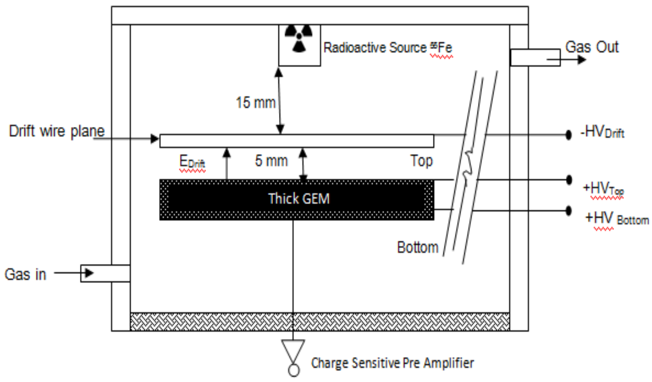

Fig. 2 The Schematic Diagram of Experimental Set Up

The Results

The 5.9 keV X-rays from ^{55}Fe source entering in the gas volume of the detector interact with gas molecules through photoelectric absorption, photoelectrons are emitted and full energy is deposited in the sensitive volume of detector. In the energy spectrum, the two peaks were obtained; one from 5.9 KeV photo peak for the full energy deposition and other smaller peak for the 2.94 keV argon escape peak [1,2].

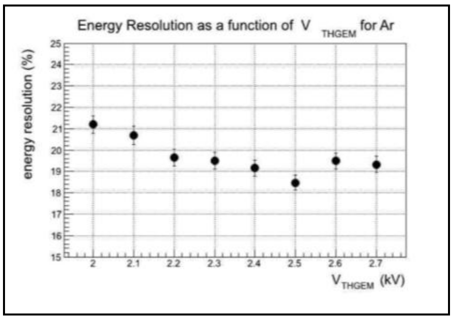

Fig. 3 The Energy Resolution as a function of V_{THGEM} for Ar

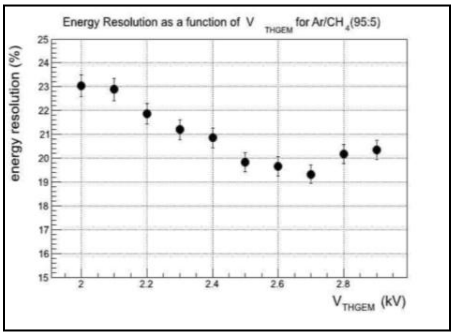

Fig. 4 The Energy Resolution as a function of V_{THGEM} for Ar/CH_4 (95:5)

The Calibration

The calibration was done using a 5.6 fC capacitor directly connected to the pre-amplifier input and to a precision pulse generator in which voltage was varied from 75 mV to 275 mV keeping frequency 1000 Hz. The charges in fC were calculated from the calibration plot i.e. charge (fC) as a function of ADC channel [3]. The charges in fC were calculated for different ADC centroid of the corresponding V_{THGEM} using calibration coefficients. The secondary electrons were calculated from the charges. The true gain was measured from the ratio of secondary and primary electrons [4].

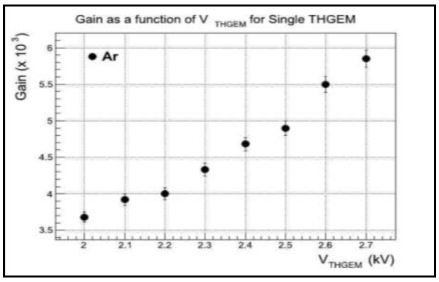

Fig. 5 The Gain as a function of V_{THGEM} for Ar

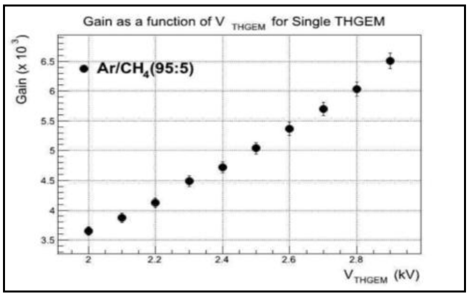

Fig. 6 The Gain as a function of V_{THGEM} for Ar/CH_4 (95:5)

The Discussions

The energy resolution becomes worse at lower V_{THGEM} since argon escape peak and the photo peak cannot be separated out very distinctly. The minimum energy resolutions were obtained 18.47% and 19.33% respectively for Argon at V_{THGEM} = 2500 Volt and for Ar/CH_4(95:5) at V_{THGEM} = 2700 Volt where two peaks are separated out nicely. A further increase of voltage will lead small discharges and the energy resolution becomes worse again.

The gain increases with the increase of V_{THGEM} for Ar and Ar/CH_4 (95:5) both. The gain is the order of $\sim 10^3$. The linearity in the increasing trend of gain is much better for Ar/CH_4 (95:5).

References

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[3] Post MSc Lab Report, SINP (18 / 9 / 2012).

[4] NIM 558 468-474; 475-489(2006).