Stability study of triple GEM detector with radioactive source


Bose Institute, Kolkata

RD51 Mini-Week, 4-6 December 2018, CERN
At Bose Institute, an initiative has been taken for R&D of GEM detector (stability test) for ALICE TPC upgrade and CBM Muon Chamber (MuCh)
Set-up at Bose Institute

- NIM electronics
- Data logger
- GEM Straw tube
- Scintillator
Triple GEM detector
Triple GEM detector
Schematic representation of the electronics setup

- Gas: Ar/CO$_2$ gas in 70/30
- Flow rate: 3 lt/hr
- Conventional NIM electronics
- Pre-amplifier: VV 50-2 (Heidelberg)
Fe$^{55}$ Signals from GEM
Energy Spectrum

\[ \chi^2 / \text{ndf} \quad 117.6 / 98 \]

Constant \( 2.129 \times 10^4 \pm 5.426 \)

Mean \( 305.7 \pm 0.08695 \)

Sigma \( 31.79 \pm 0.1068 \)

@ -4100 V

Ar/CO\(_2\) : 70/30
Fe$^{55}$ spectra at different voltages
Gain and Energy resolution Vs. GEM voltage
Experimental details

- Same Fe$^{55}$ source used for irradiation and monitoring spectrum
- Gas: Ar/CO$_2$ 70/30
- Constant applied voltage to the divider: -4100 V
- $\Delta V \sim 384$ V
- Rate $\sim 350$ kHz in 50 mm$^2$ area
- Fe$^{55}$ spectrum obtained in every 10 minutes
- Temperature, pressure are measured continuously
Gain and T/p Vs. time
Correlation of gain and $T/p$

\[ \text{gain} = p_0 e^{p_1 \frac{T}{p}} \]

- $\chi^2 / \text{ndf} = 2.396e+04 / 615$
- $p_0 = 0.00531 \pm 4.113e-05$
- $p_1 = 0.04719 \pm 2.314e-05$
Normalised gain Vs. dQ/dA

Distribution of normalized gain

Fluctuation ~15%
Energy resolution Vs. time
Energy resolution Vs. T/p

\[ \text{resolution} = p_0 e^{p_1 \frac{T}{p}} \]

\[ \chi^2 / \text{ndf} = 6.028e+04 / 615 \]

\[ p_0 = 1.332e+08 \pm 4.937e+05 \]

\[ p_1 = -0.05151 \pm 1.293e-05 \]
Normalised resolution Vs. dQ/dA
Distribution of normalised energy resolution

Fluctuation ~20%
Uniformity

Gain

Energy resolution

Rate

Uniformity

Fluctuation ~8.4%

18.6%

17.9%
Summary

- Characteristic studies are performed for GEM detector with Ar/CO$_2$ gas mixture using conventional NIM electronics.
- Count rate, gain, energy are studied
- Stability of gain and energy resolution at high rate is under investigation for GEM detector. No ageing after accumulation of 7 mC/mm$^2$
- Uniformity checked

Thank you!