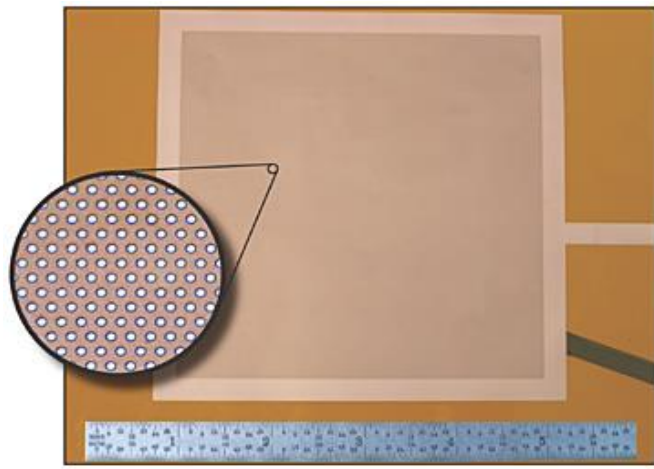
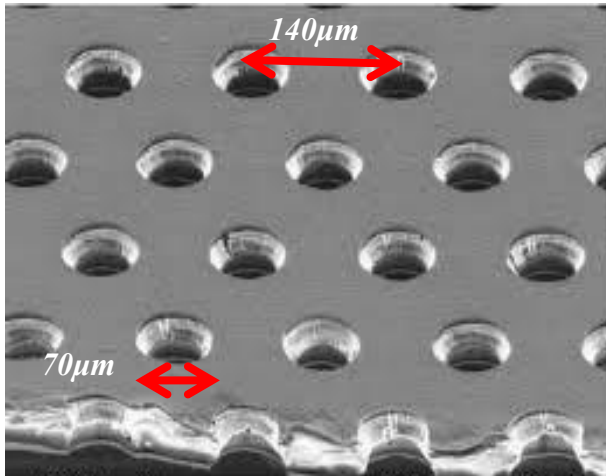
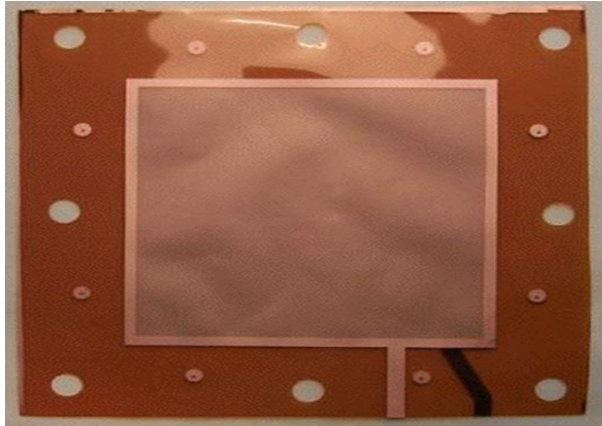


Characteristics of 4GEM detector with Am²⁴¹ at different gas flow rates

**Sagarika Swain, S. Sahu,
D. Bhattacharya, P. K. Sahu, S. Biswas**
Institute of Physics, Bhubaneswar
Bose Institute, Kolkata

○ Gas Electron Multiplier detector (GEM)

- Micro-pattern gas detector(MPGD).
- Consists of GEM foil made up of copper (5 μm) cladded kapton foil (50 μm) with array of holes



hole diameter -70 μm , pitch -140 μm

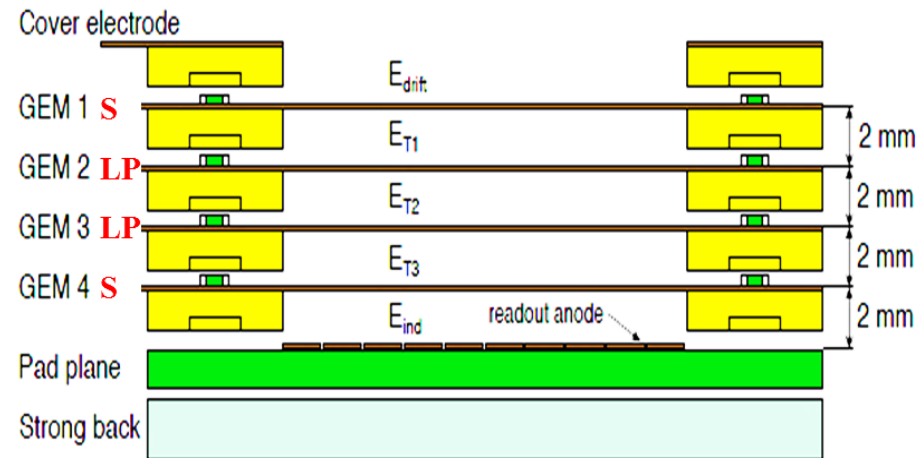
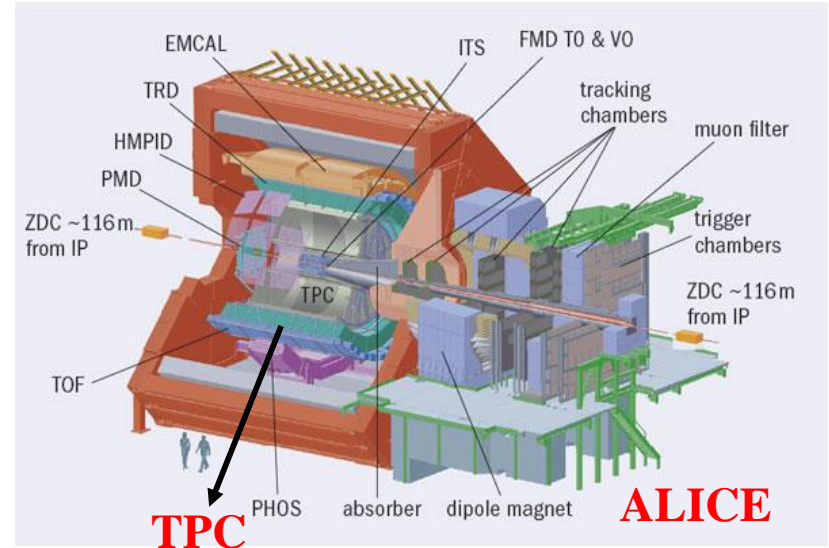
- High voltage is applied across foils which creates avalanche of electrons through holes

○ ALICE TPC upgrade

- **Excellent Spatial resolution**
- **High rate detection**
- **Flexibility in design**

MWPC \longrightarrow GEM

- **Increase luminosity**
 $L = 6 \times 10^{27} \text{ cm}^{-2} \text{ s}^{-2}$
- **High rate 50 kHz (Pb - Pb)**
- **Energy resolution < 12% for 5.9 keV Fe 55 source**



○ Significance of the study

- GEM detectors operates in a gas flow mode

(Ar/CO₂ : 70/30)

- Role played by the gas mixture

 - Ions are created in avalanche process



Pollutes the gas and deprecate the detector performance



Has to be replaced by neutral gas molecules

- Slower gas flow rate



Less availability of gas

- Faster gas flow rate

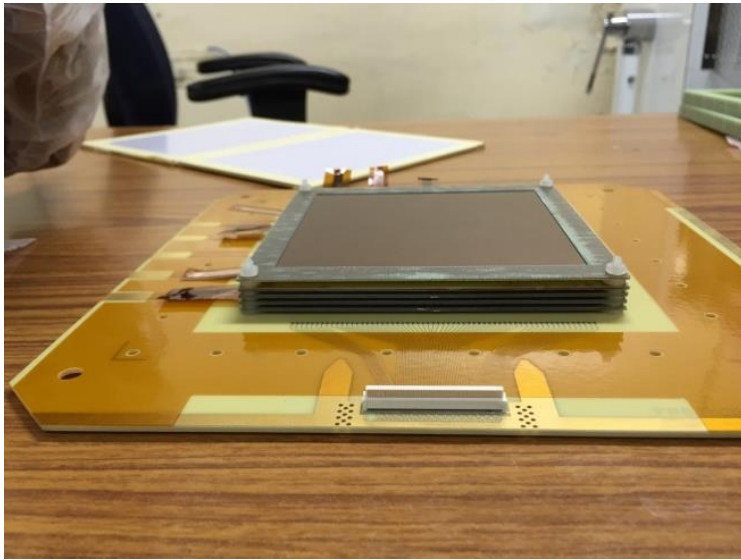


Turbulent gas flow

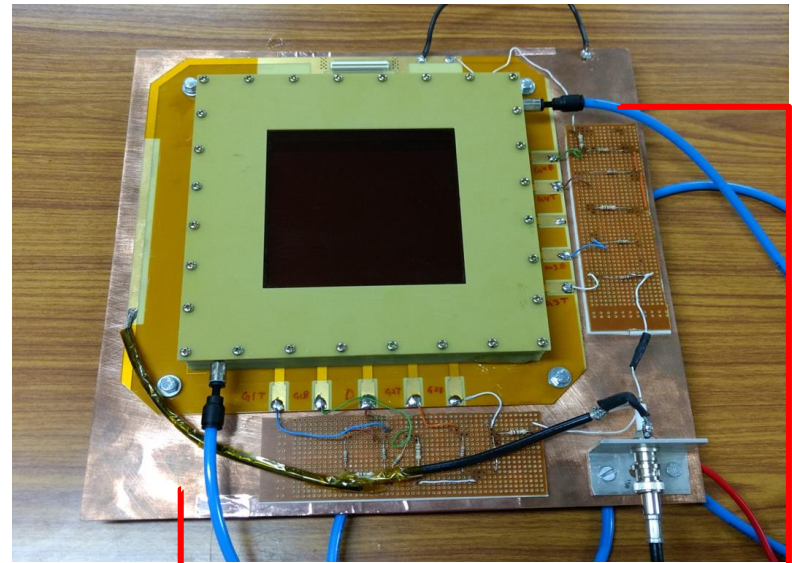
Effect on GEM characteristics

○ Experimental set up

- 4GEM prototype (10cm × 10cm, standard single mask)
- Gas mixture (Ar/CO₂ : 70/30)
- Gas flow rate (40 SCCM to 160 SCCM)
- Am²⁴¹ (60 keV gamma)

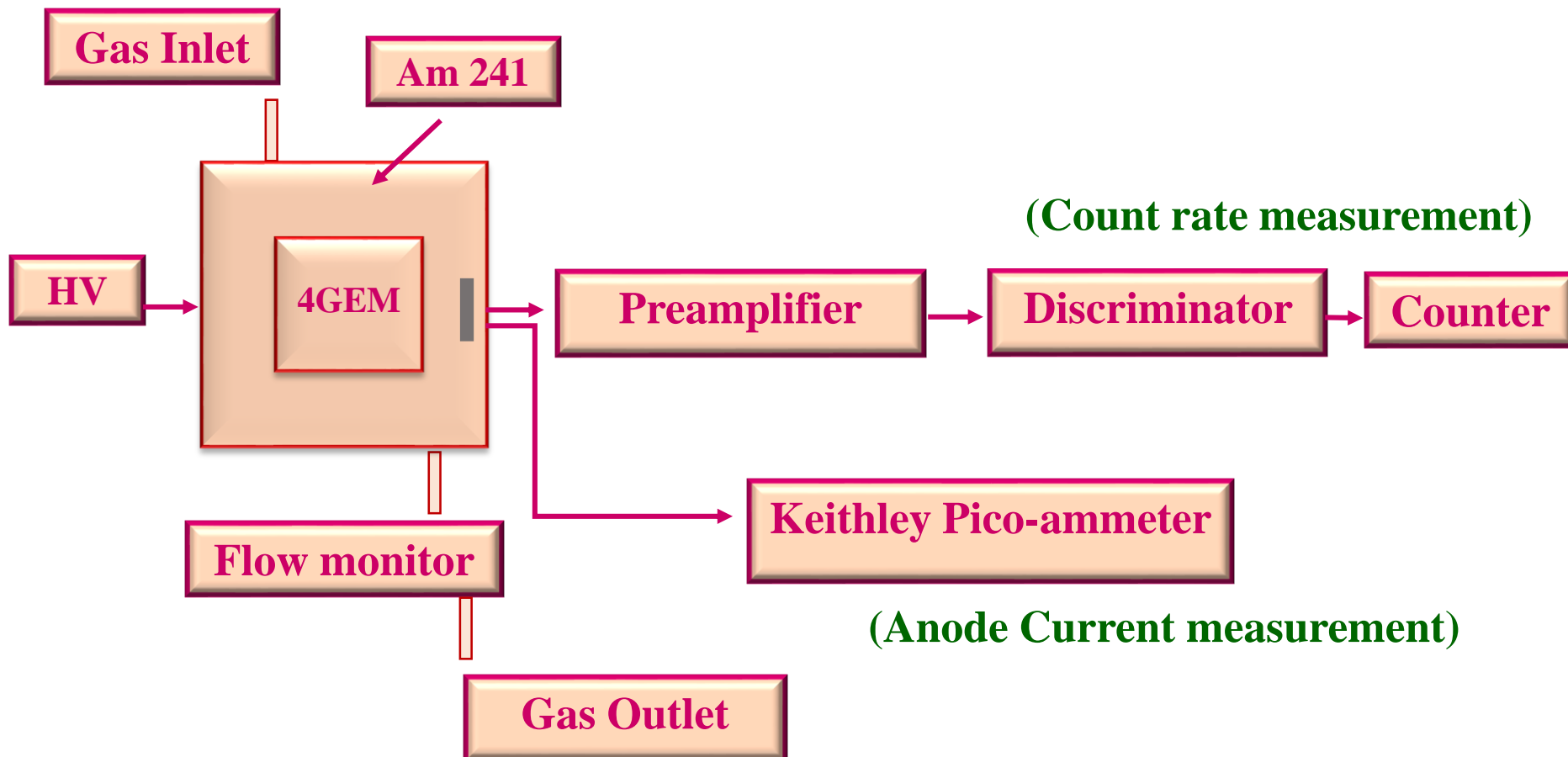


4gem detector along readout board



gas inlet and outlet

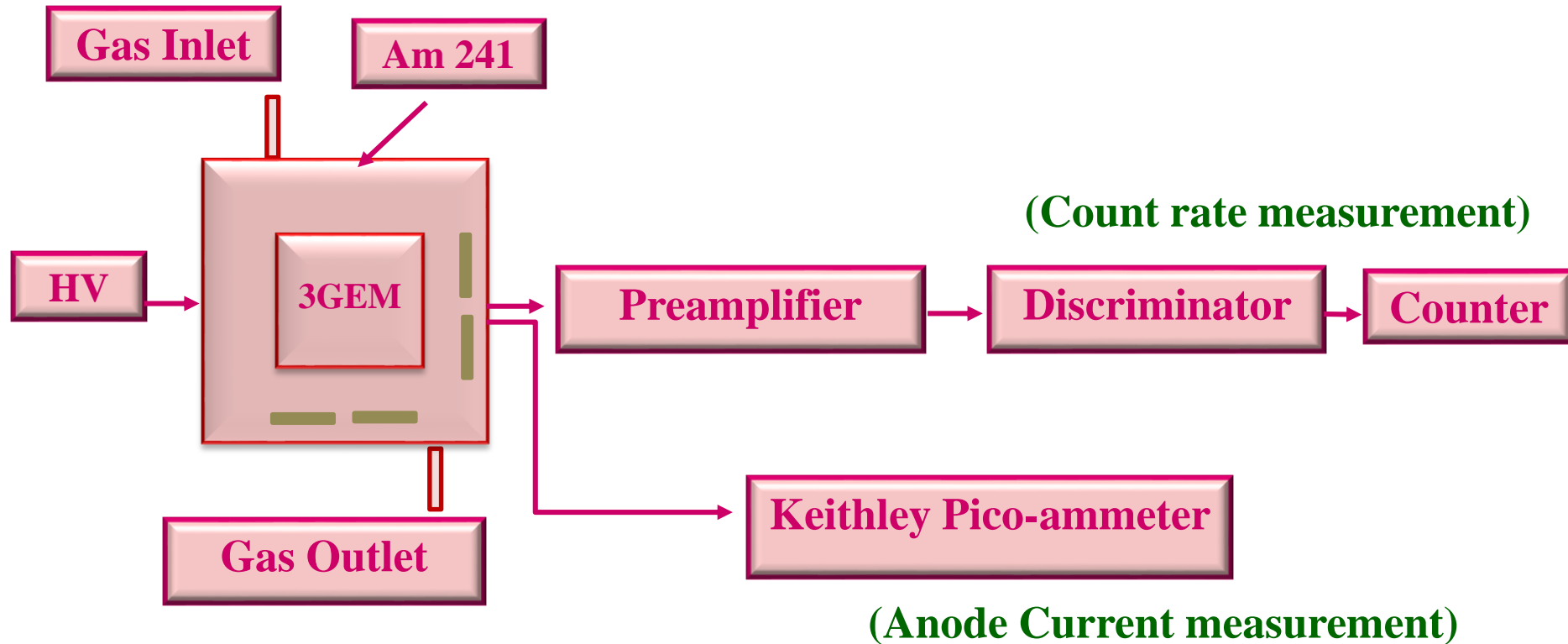
○ Experimental set up



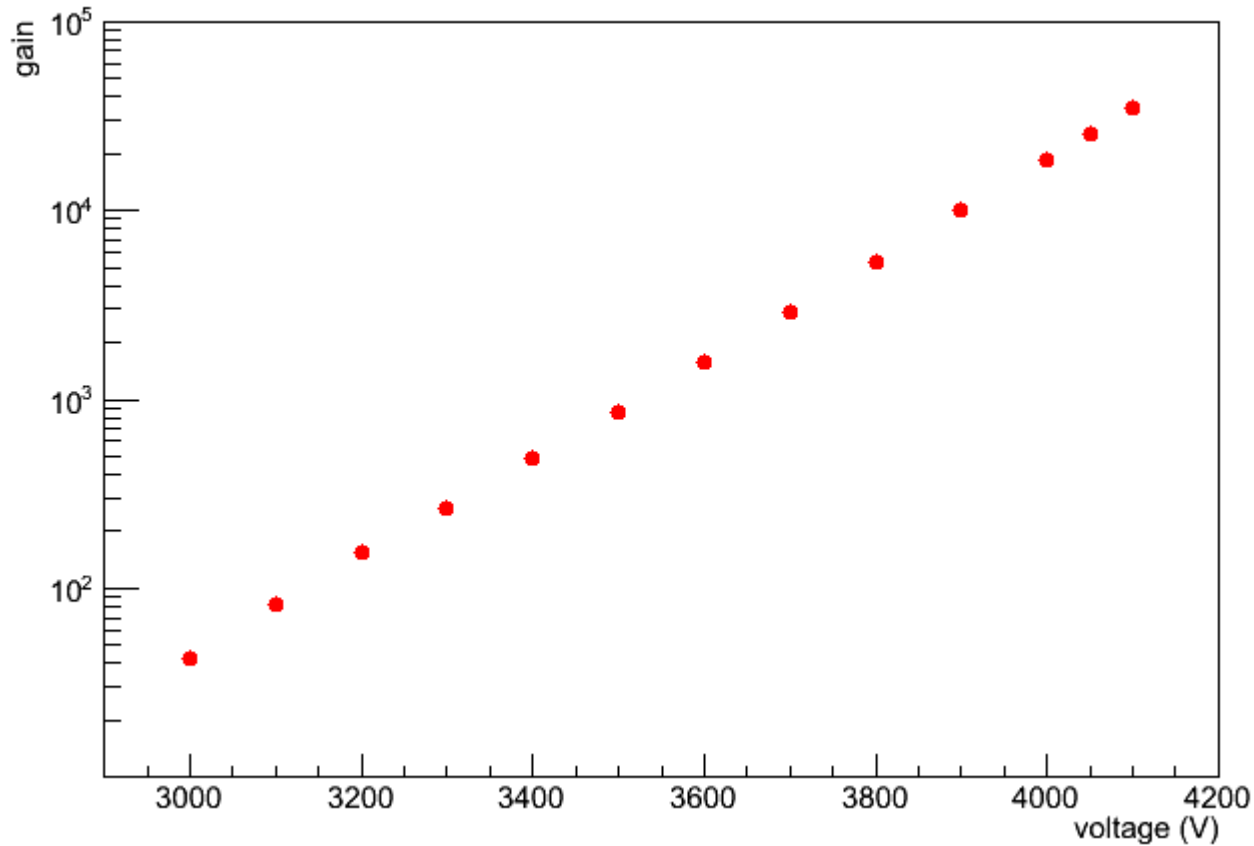
Calibration with Am^{241} (60 keV)

Triple GEM detector

○ Experimental set up



○ Gain vs Voltage : triple GEM with Fe 55 source



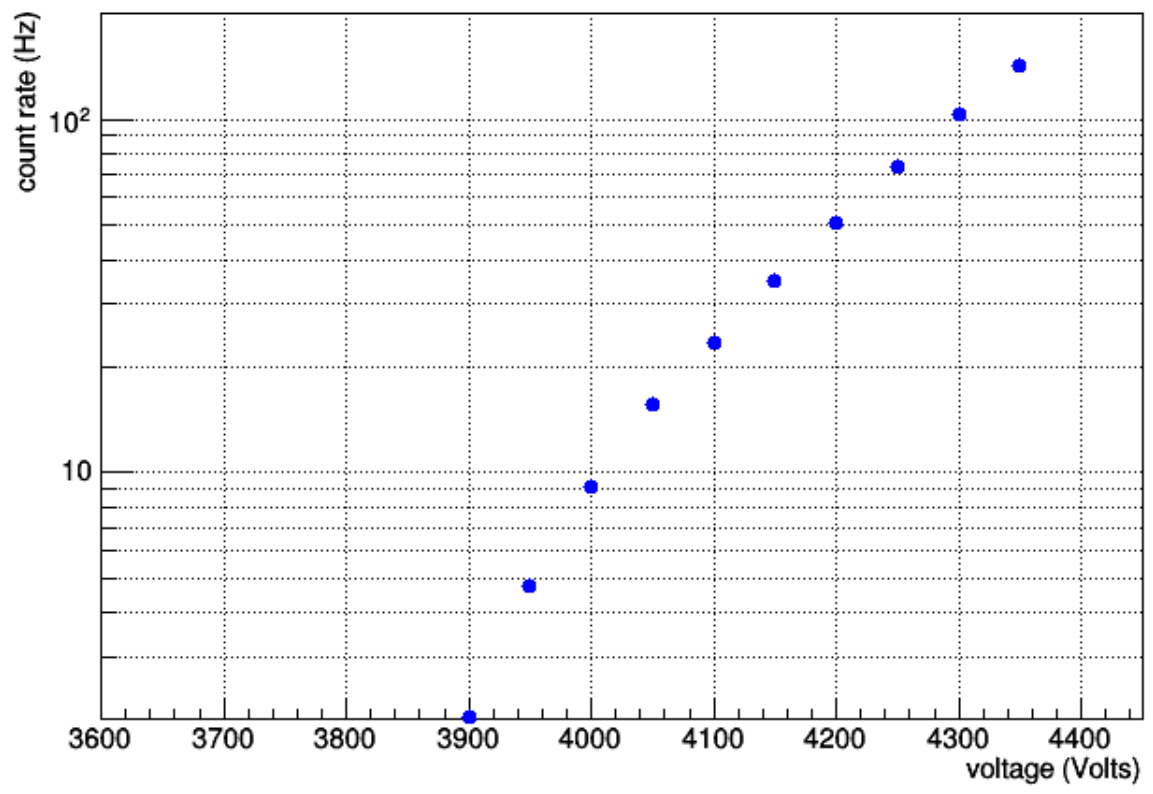
$$\text{Gain} = \frac{i_{\text{anode}}}{R \times N \times e}$$

R = count rate

N = no of primary electrons (212)

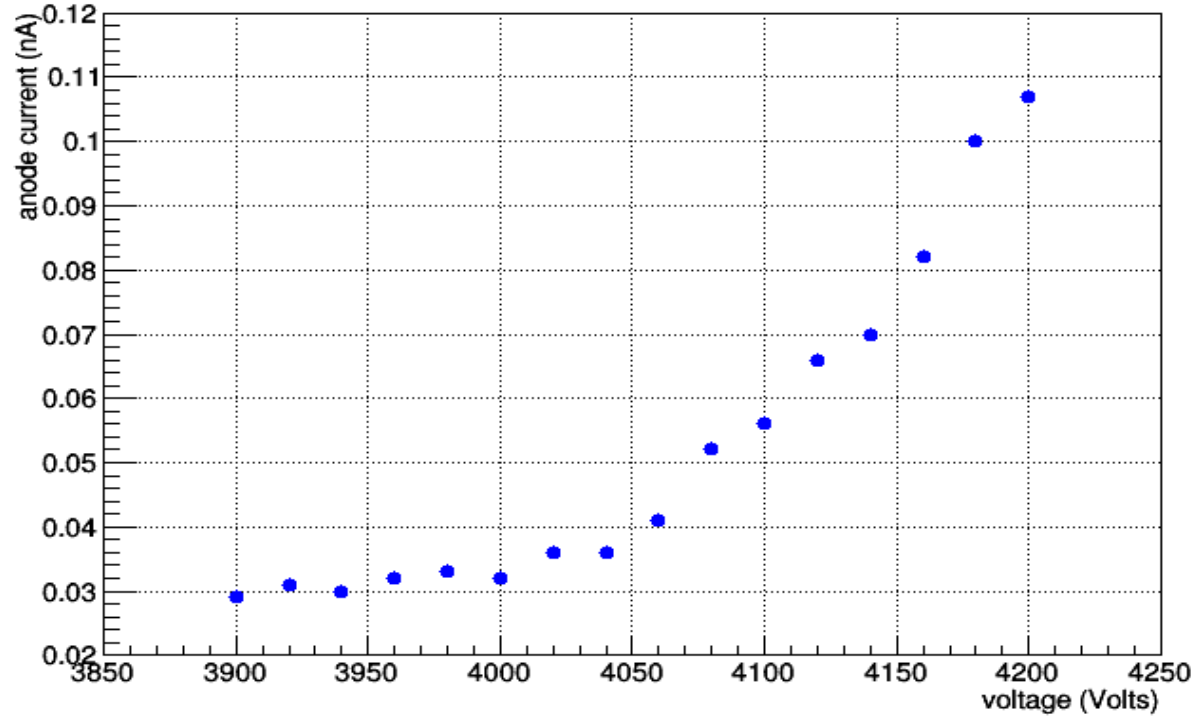
e = electron charge

○ Count rate vs Voltage : triple GEM with Am²⁴¹ source



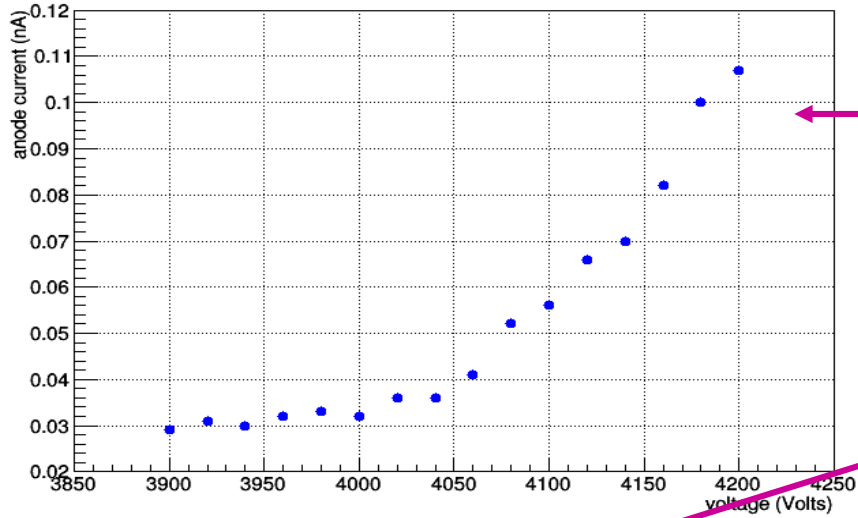
$$R = \frac{\text{count with source} - \text{count with out source}}{\text{time}} \text{count/sec}$$

○ Anode current vs Voltage : triple GEM with Am²⁴¹ source

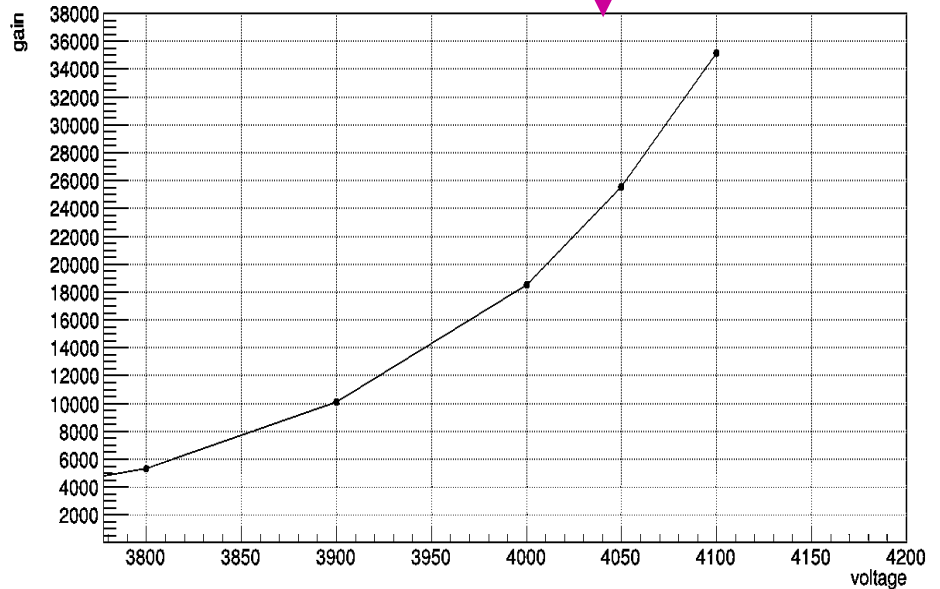
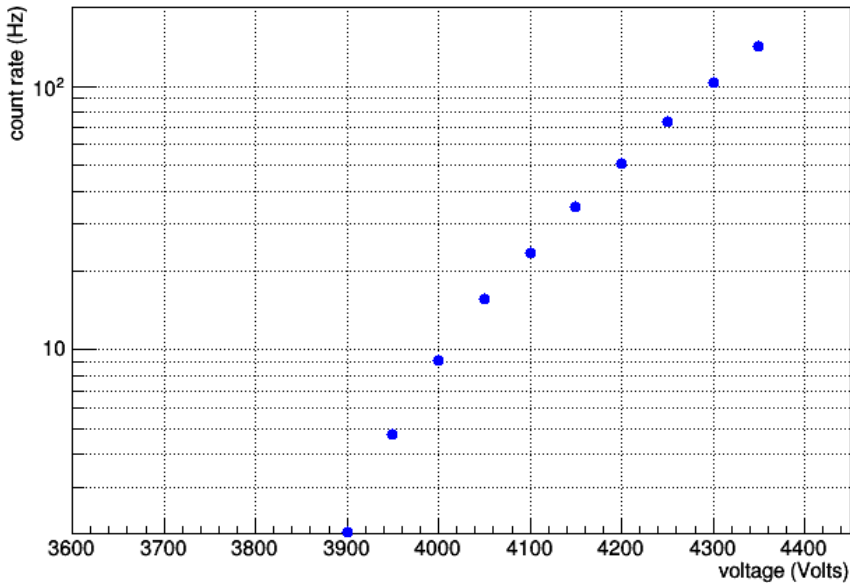


$$i_{\text{anode}} = i_{\text{with source}} - i_{\text{with out source}}$$

Calculation of N: triple GEM with Am²⁴¹ source



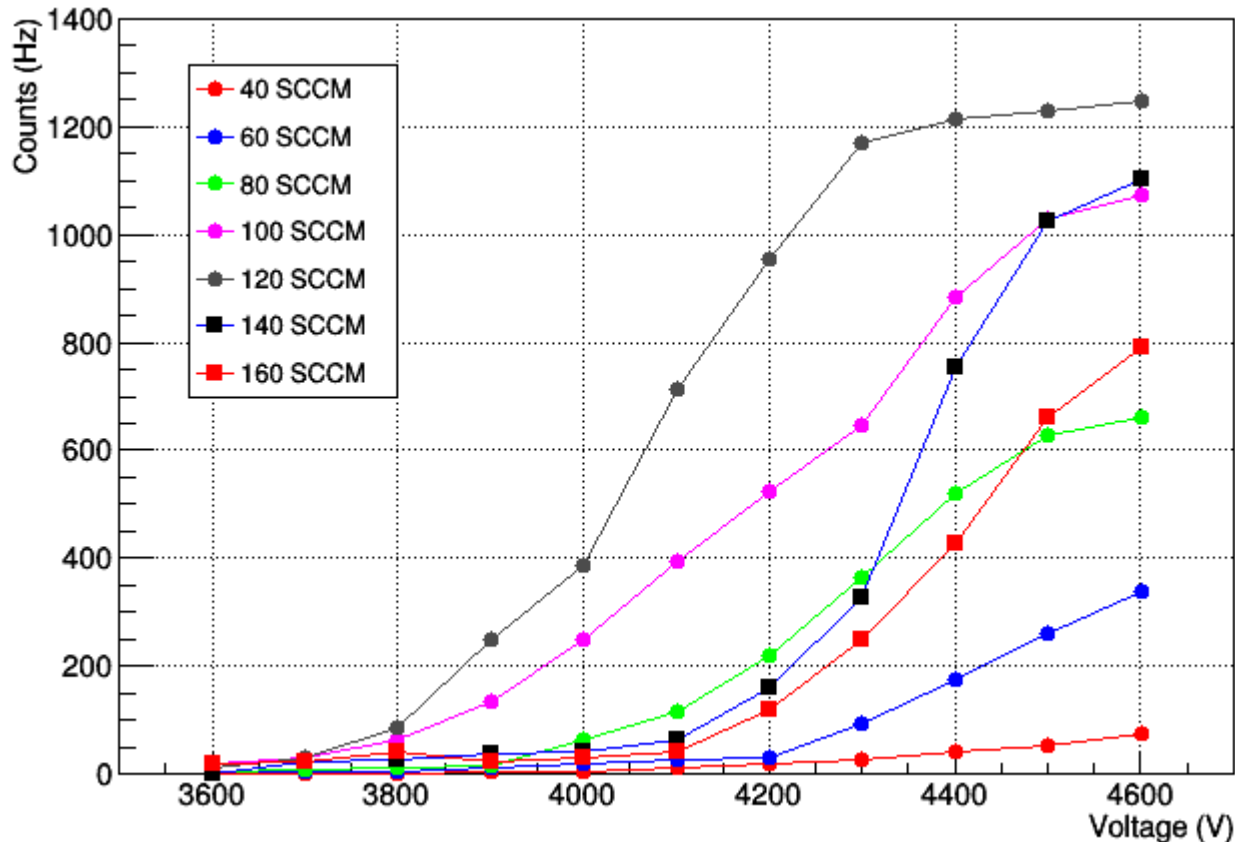
$$N_{Am241} = \frac{i_{anode}(Am241)}{R_{Am241} \times Gain_{(Fe55)} \times e}$$



average $N_{Am241} = 800$

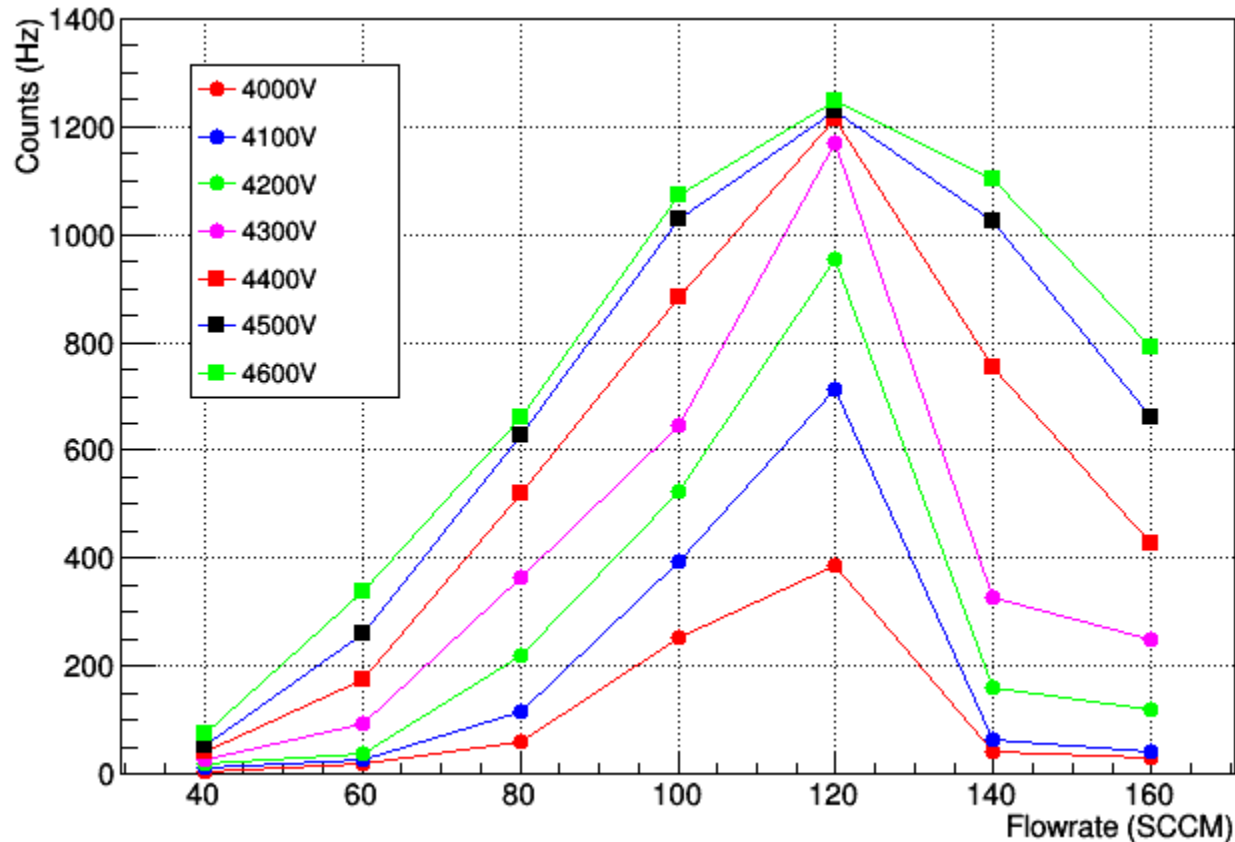
Study with gas flow rate 4GEM

○ Count rate with voltage at different flow rates



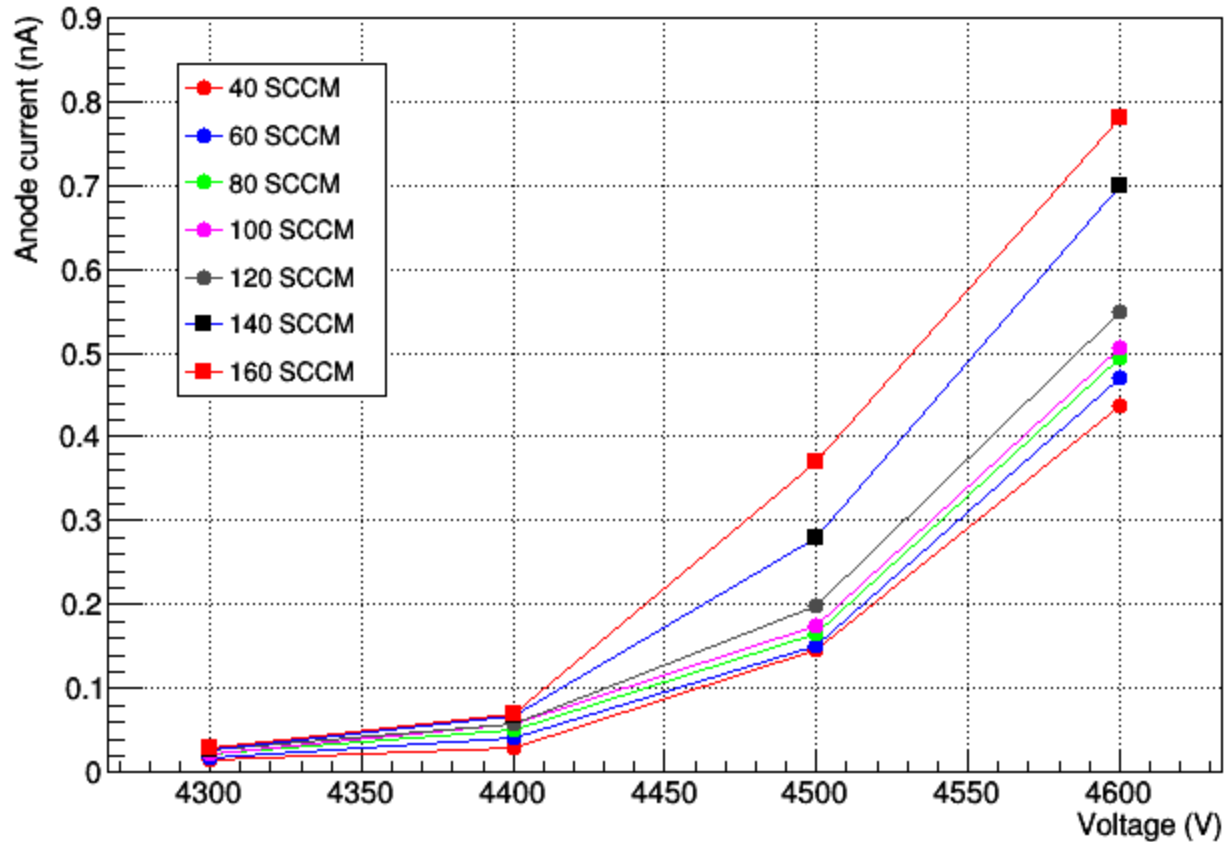
- **Count rates are showing increasing trend for 40 and 60 SCCM**
- **Saturates after 4400V for 60-120 SCCM**
- **Abruptly decreases for 140 and 160 SCCM**

○ Count rate with flow rates at different voltage



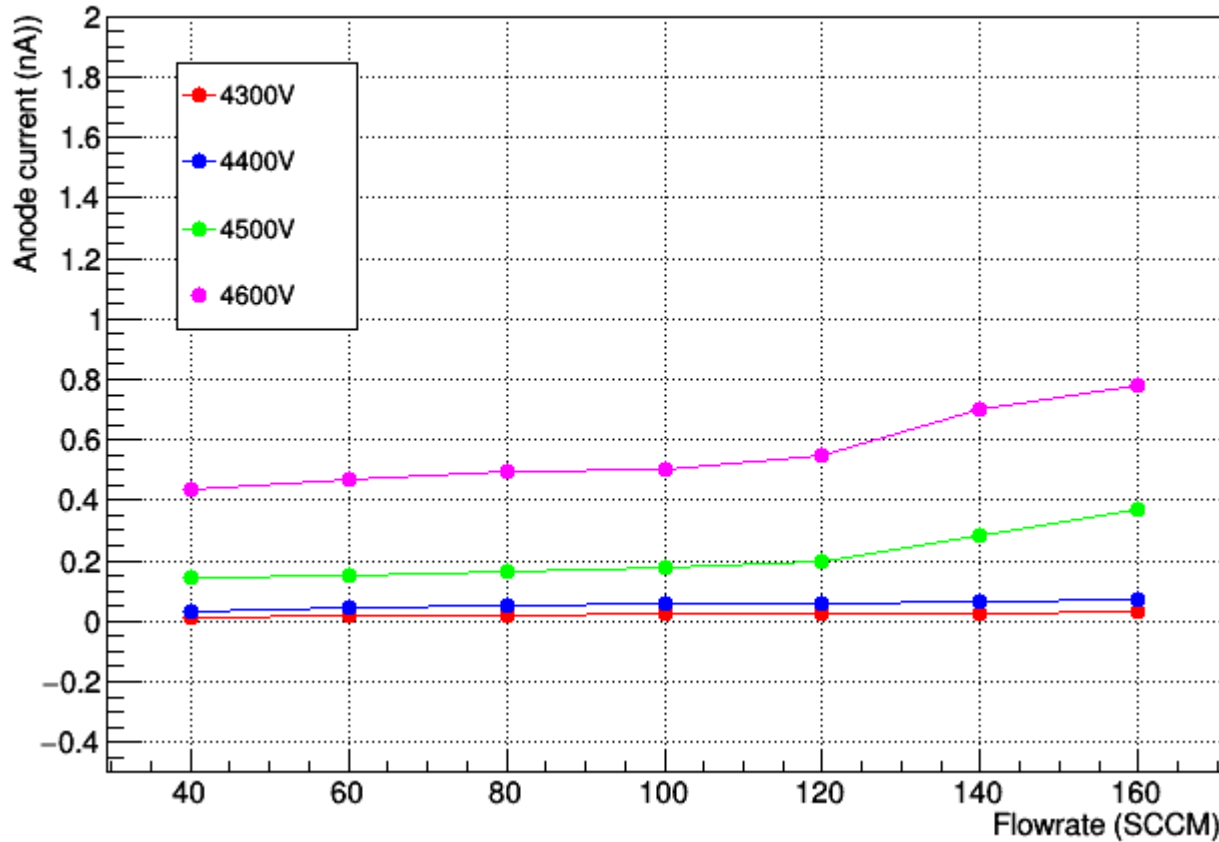
- Count rate is maximum at 120 SCCM for all voltages
- Increase in gas flow rate \longrightarrow electro negative O_2 content decreases \longrightarrow more avalanche electrons are available
- Flow rate > 120 SCM \longrightarrow Turbulent flow inside the detector \longrightarrow non uniformity in gas due to high pressure build up

○ Anode current with voltage at different flow rates



- **Anode current increases with voltage for different flow rates**

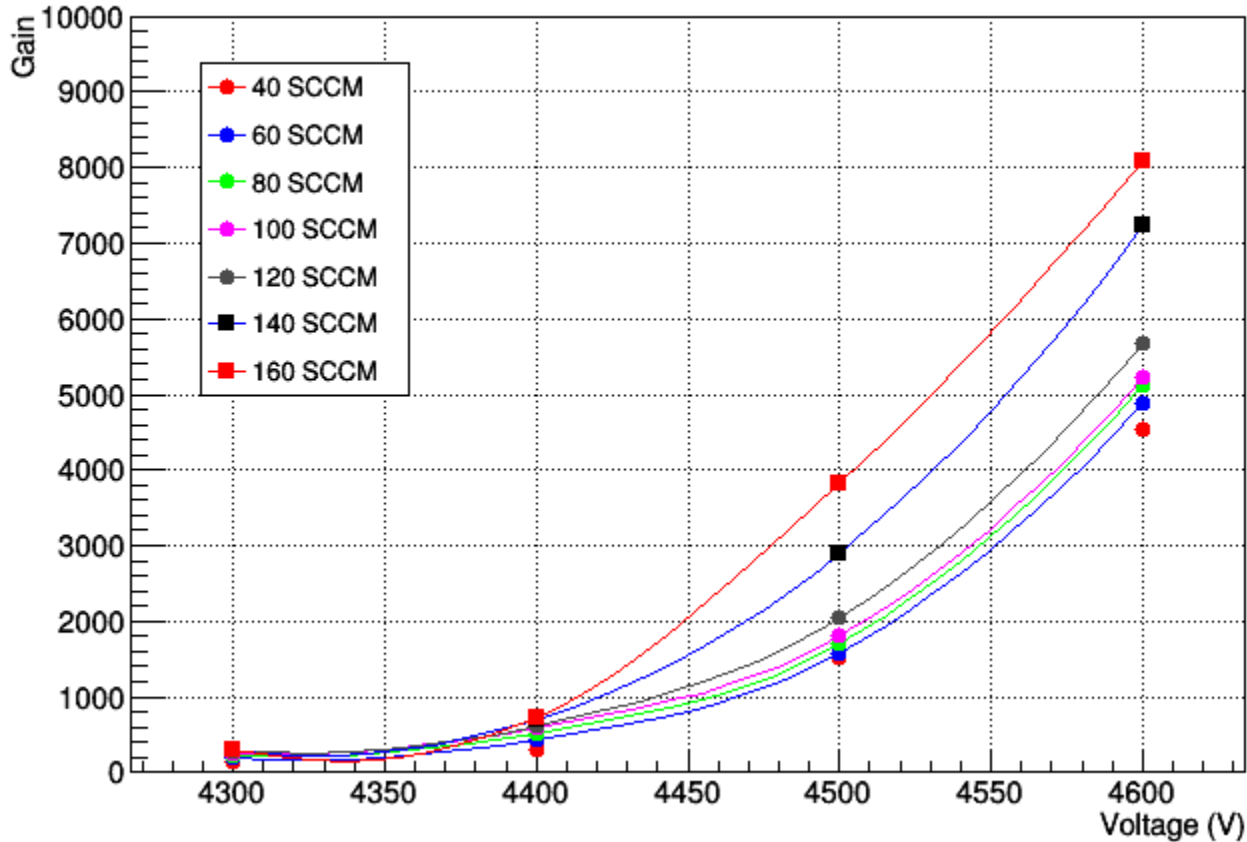
○ Anode current with flow rates at different voltage



| | <u>4500V</u> | <u>4600V</u> |
|-------------|--------------|--------------|
| $\Delta V1$ | 344 | 352 |
| $\Delta V2$ | 359 | 367 |
| $\Delta V3$ | 358 | 367 |
| $\Delta V4$ | 368 | 375 |

- **Anode current increases with flow rate only for voltages > 4400V**

○ Gain with voltage at different flow rates



- **Gain increases with voltage for different flow rates**

- **Gain is higher for higher flow rate (less electronegative O₂ contents)**

Summary and Outlook

- **Calibration is done for Am^{241} gamma source.**
- **The average number of primary electron is found to be 800.**
- **Variation of Count rate and Gain with voltage for different gas flow rates has been measured for 4GEM detector.**
- **It is clear that gas flow rate has an major effect on gem performance .!!!**
- **Gain study with Fe 55 source with different gas flow rates and different gas proportions.**
- **Long term stability test for 4GEM and Ion Back Flow.**

Thank You