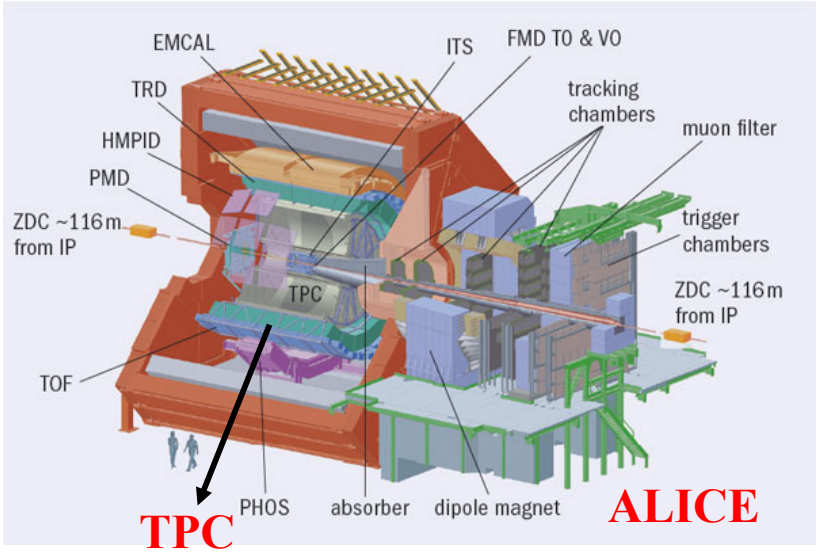
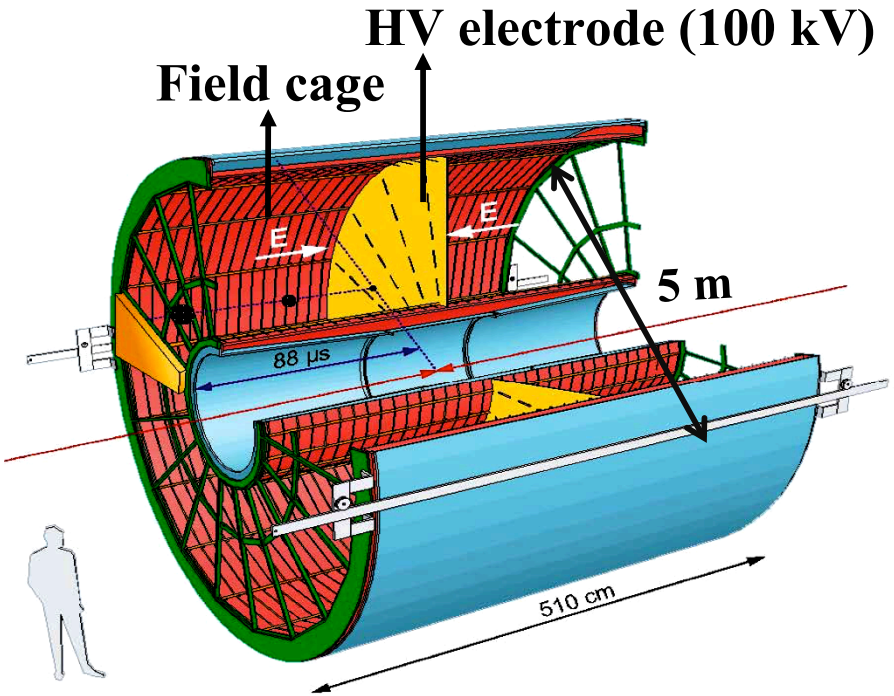
Study of characteristics of 4-GEM detector prototype

Institute of Physics, Bhubaneswar

ALICE TPC upgrade

- Continuous read-out
- No Gating grid
- High rate 50 kHz (Pb - Pb)
- Increase luminosity L= 6 x 10^{27} cm



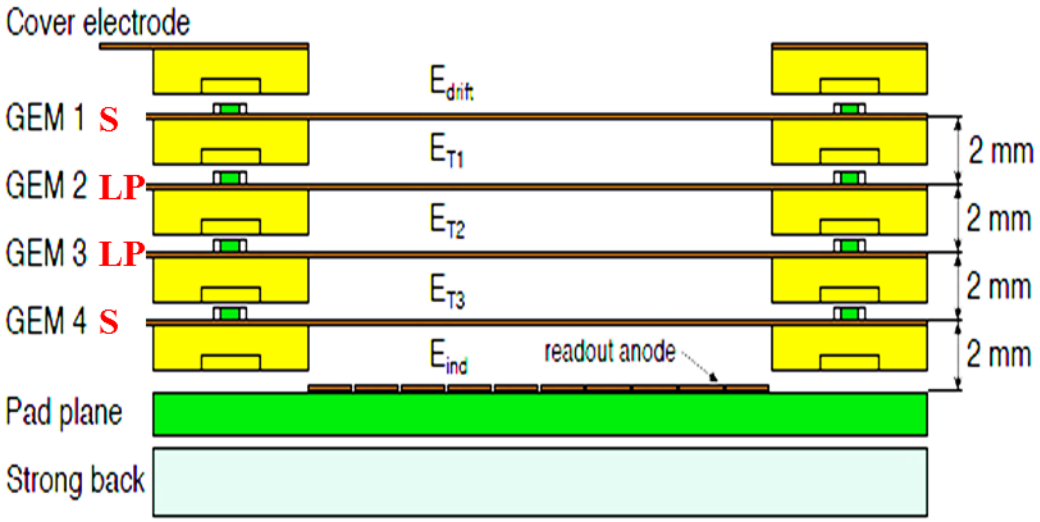


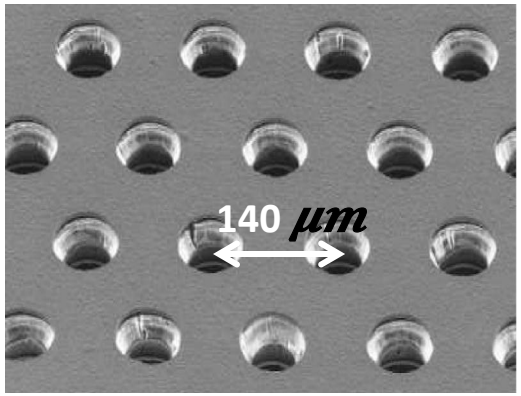
- IBF < 1%
- Ne/CO_2 /N_2 – (90/10/5)
- GEM replace MWPC
- Large pitch(280 μm) use with Standard pitch(140 μm)

GEM arrangement in TPC

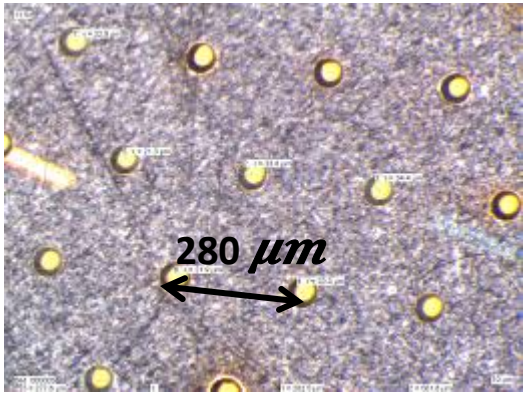
- 4 single mask GEM
- S-LP-LP-S
- Energy resolution : 12 %

  5.9keV
- IBF < 1%

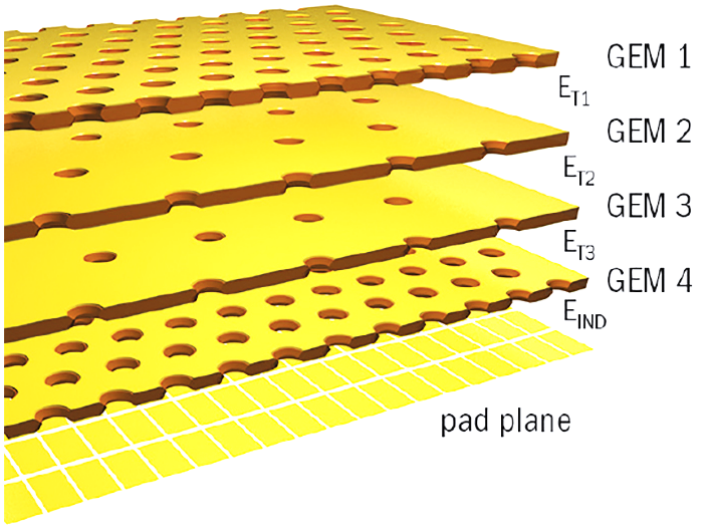




STANDARD PITCH (S)

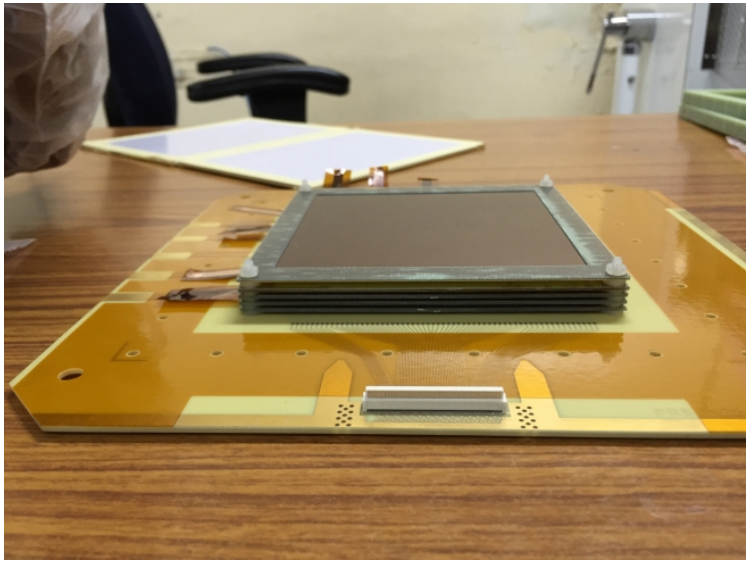


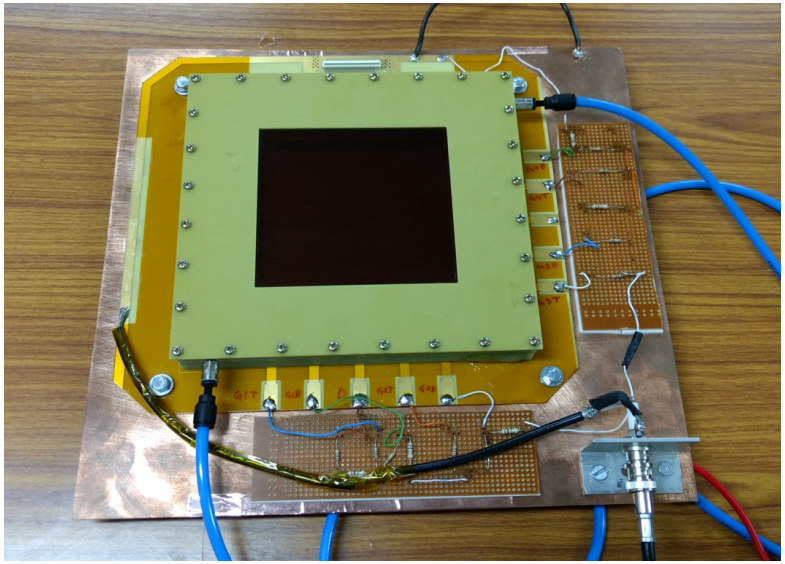
LARGE PITCH (LP)



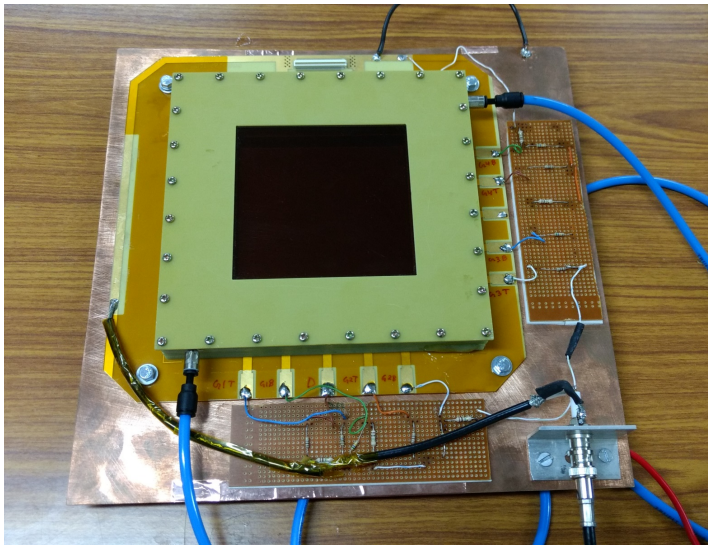
4GEM setup at IOP

- **Building of first 4-GEM detector prototype**
- **High voltage testing with good V-I characteristics**
- **Tested with Cosmic signal**

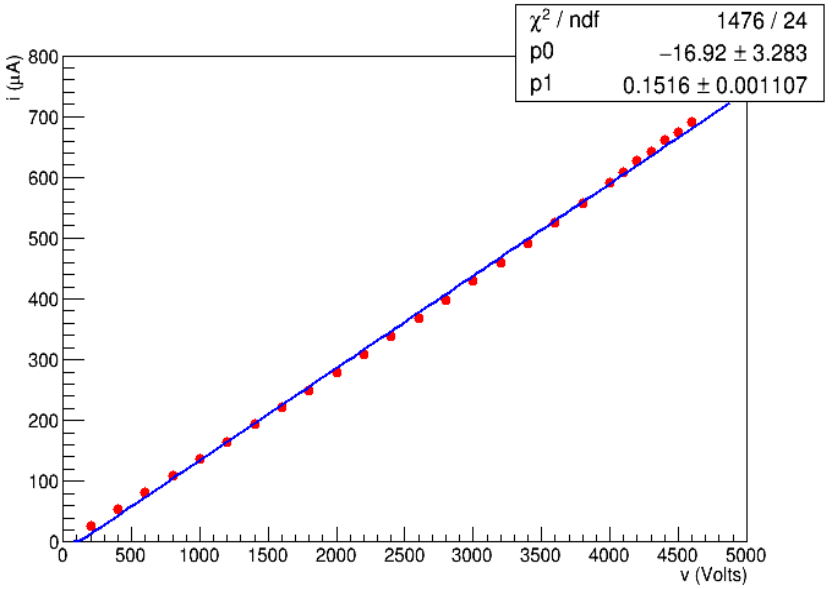




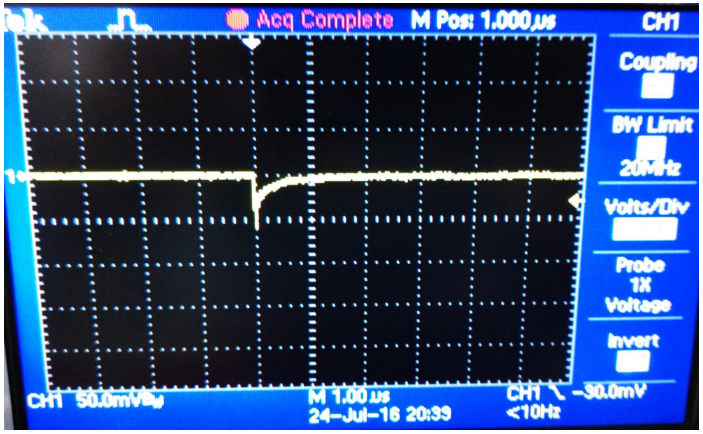
4GEM setup at IOP



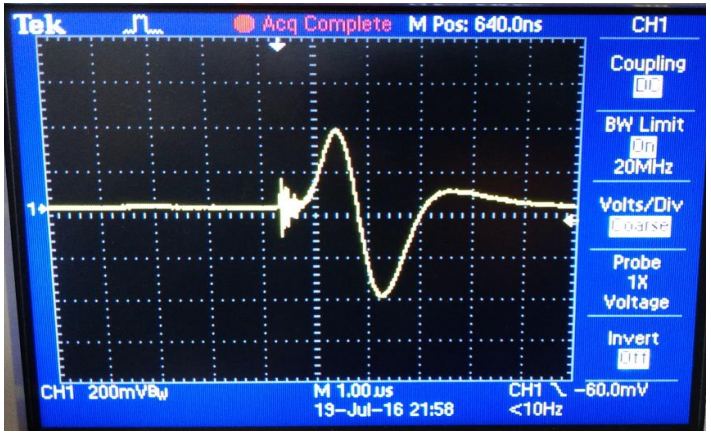
4-GEM detector prototype



High voltage testing with good V-I characteristics



Cosmic signal after Pre-amplifier



Cosmic signal after Amplifier

Study of 4GEM at GSI

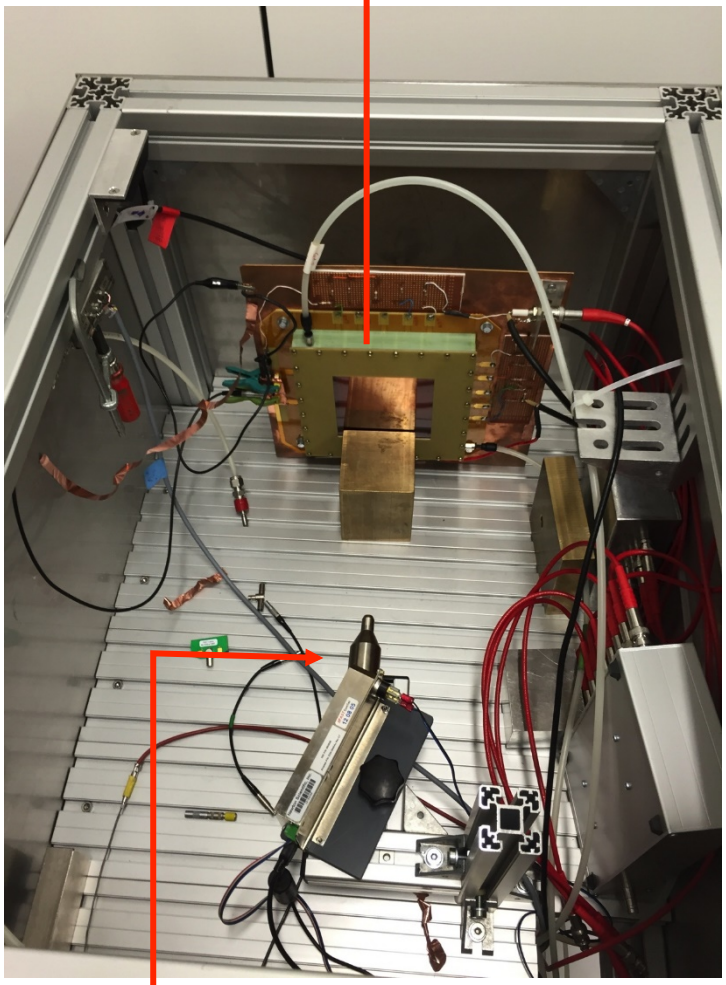
○ Measurements done using IOP 4GEM

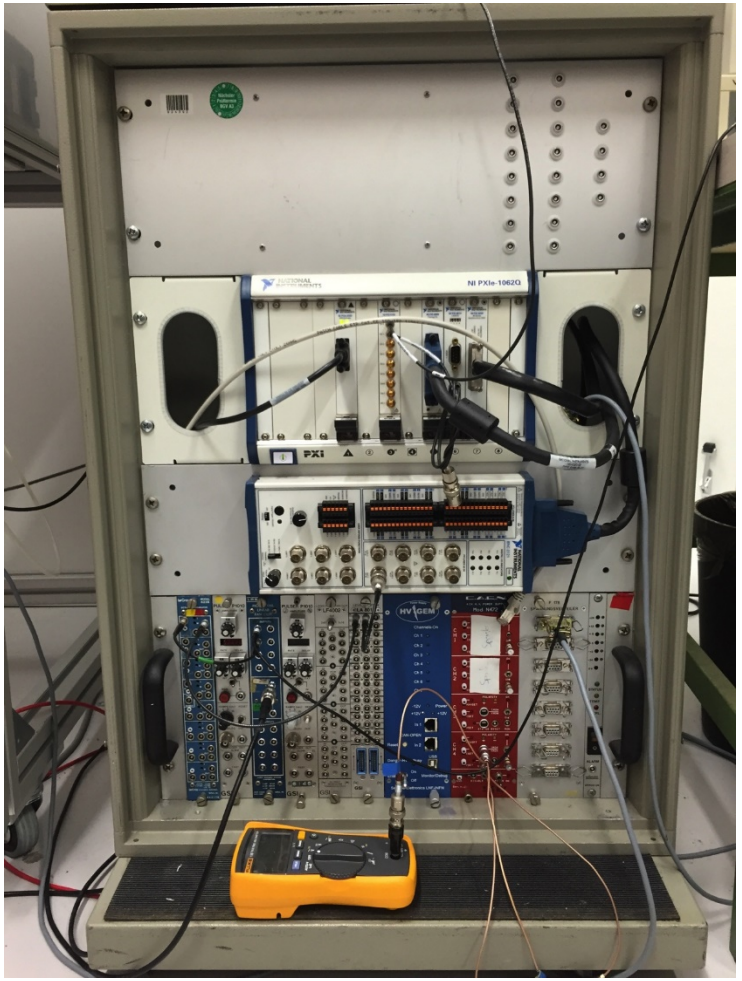
1. **Fe 55 Source**
   - **ADC spectrum**
   - **Anode current**
   - **Gain and Resolution measurement**
2. **X-ray generator**
   - **X-ray voltage scan**
   - **X- ray current scan**

○ Set up required for experiment

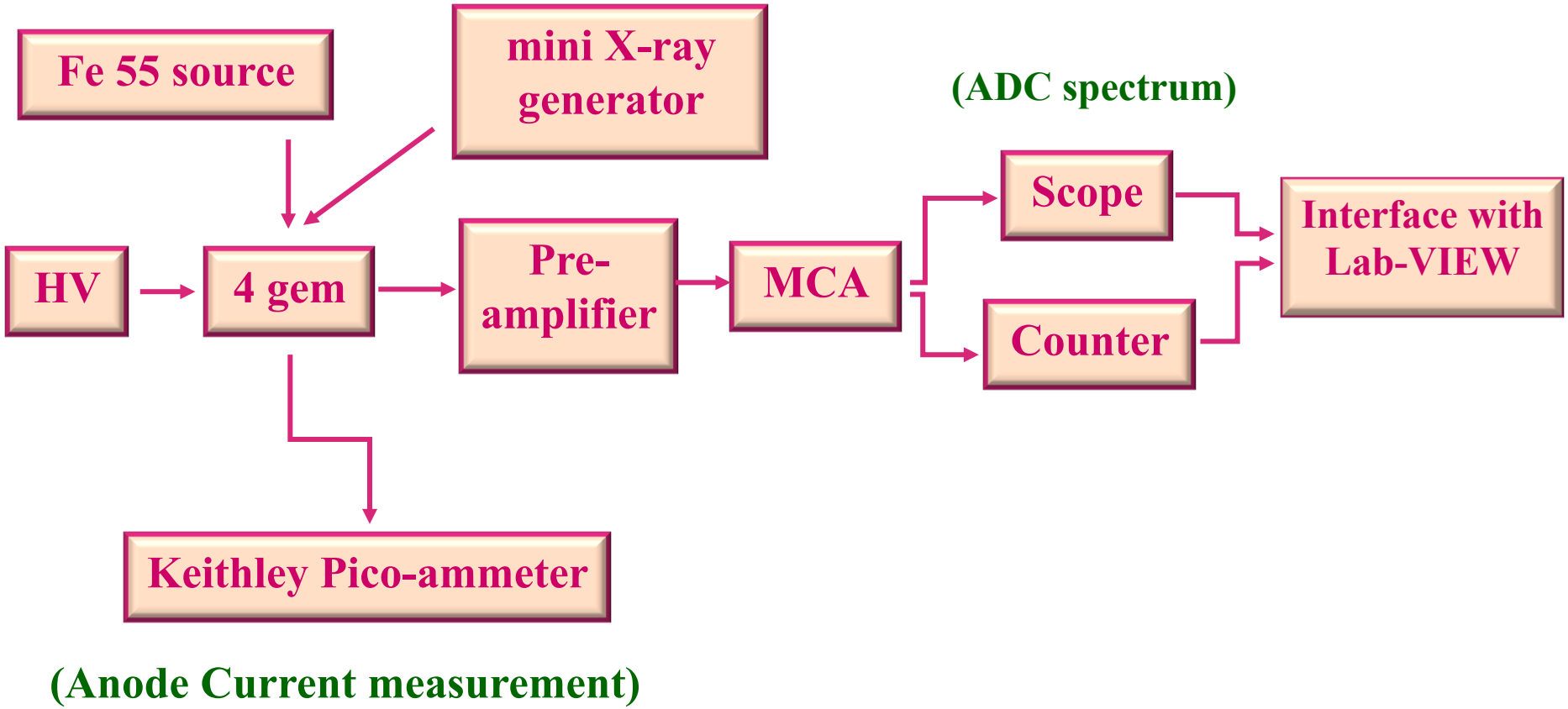
- **Gas mixture: Ar/CO_2: 70/30**
- **7 channel HVG210 power supply**
- **1 sum-up board is used for signal (1×128, 9×9 mm^2 pads)**
- **PXI Lab-View based DAQ is used**

4GEM set up with Electronics

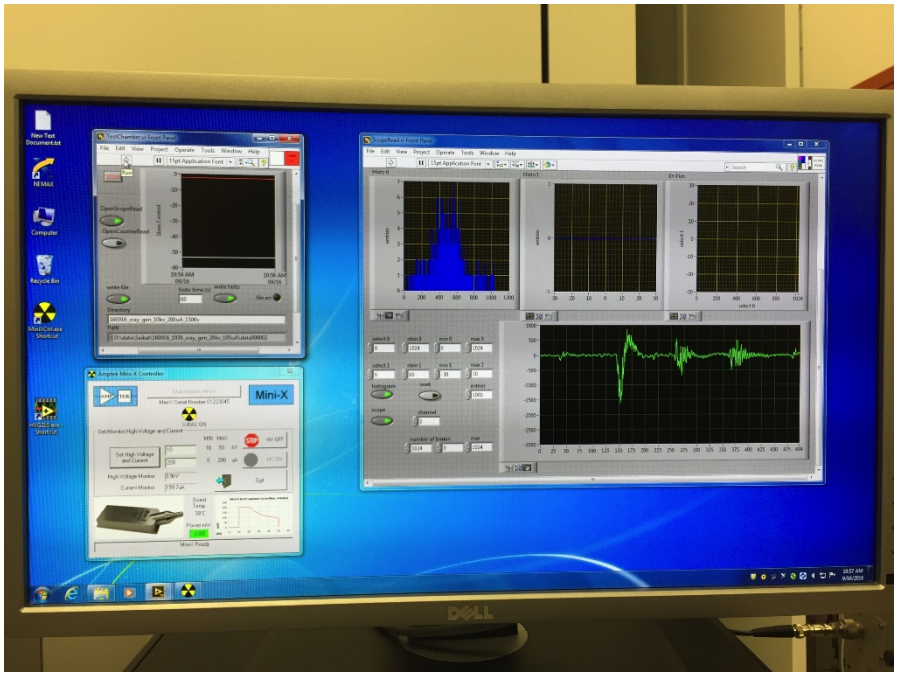




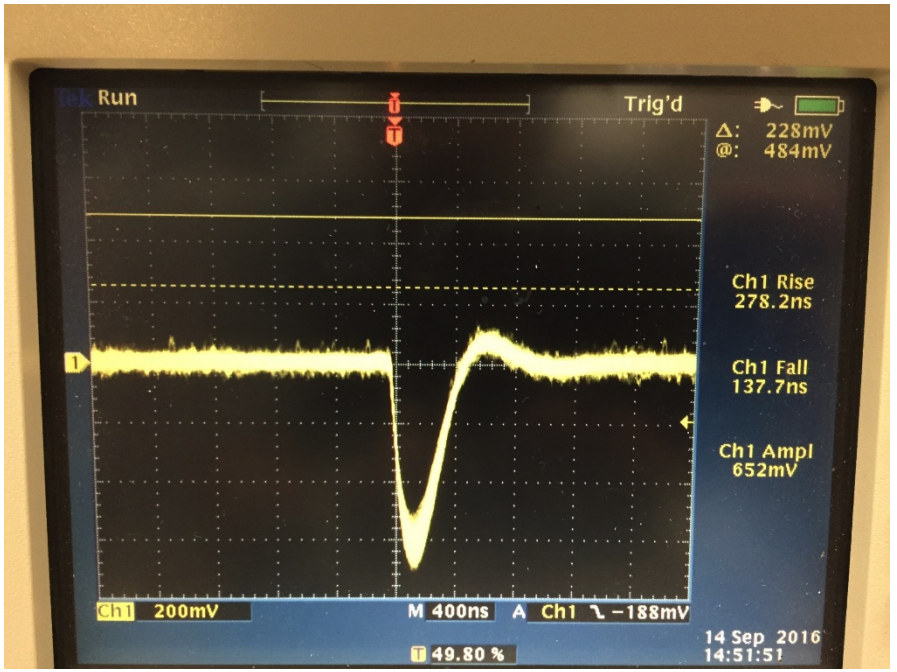
Experimental set up



○ Signals



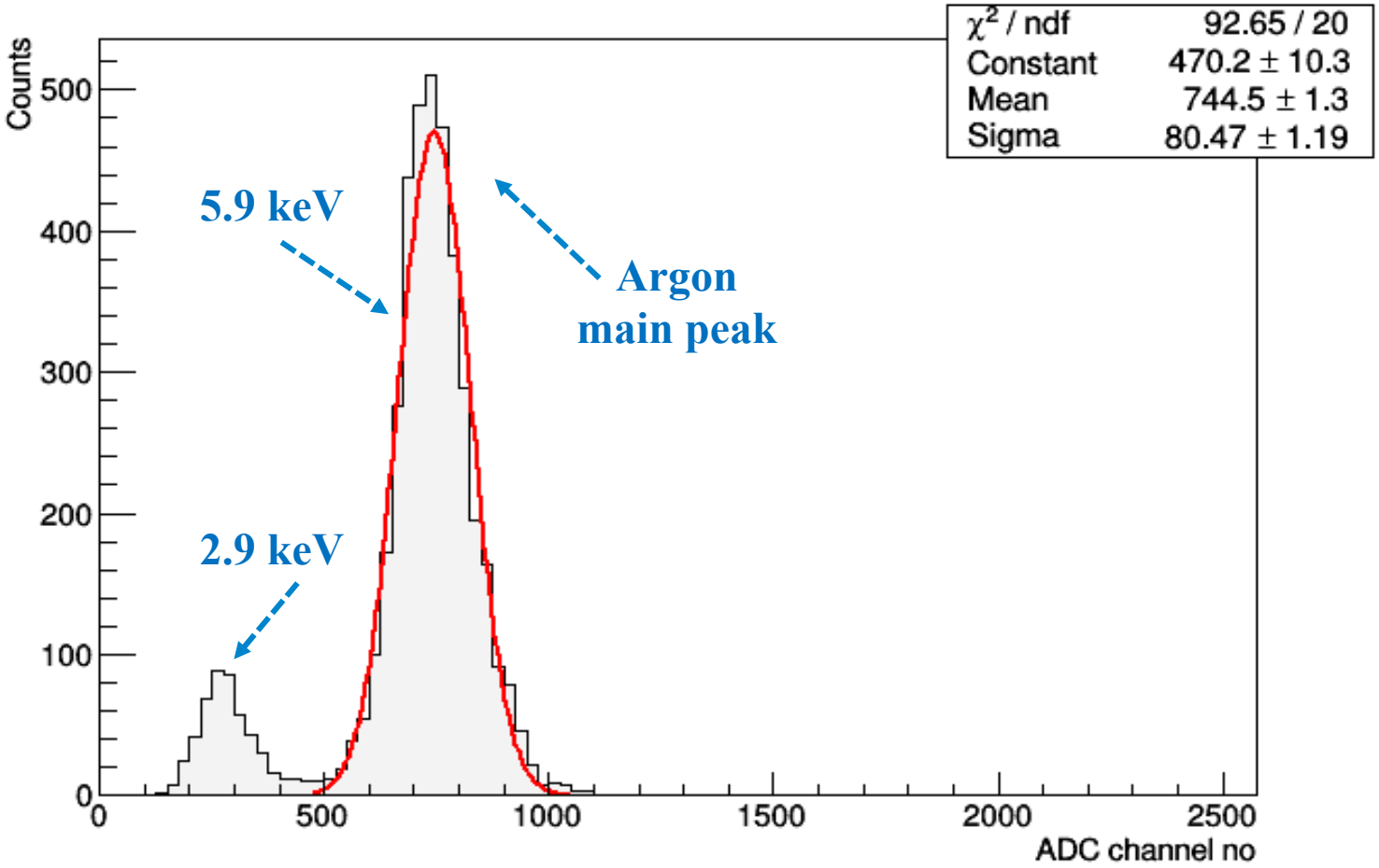
Interface with Lab-VIEW



Signal

Tests with Fe 55 source

ADC spectrum with Fe 55 source



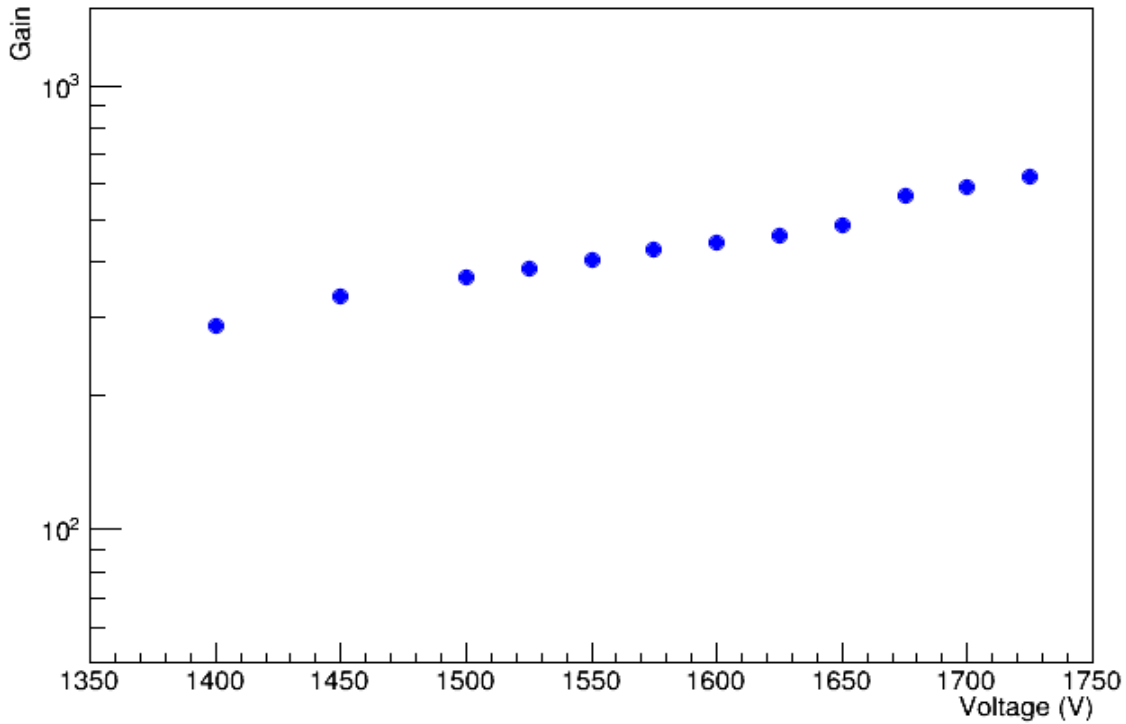
GEM Voltage = -1600 V, $\Delta V\downarrow gem$ = 120 V, Ar/$CO\downarrow 2$ (70/30)

• Gain vs. applied voltage

- **Gain** = $Q_{output} / N_p q_e$

N_p = no of primary electrons
q_e = electron charge
G_{pre} = pre amplifier gain
peak = ADC main peak mean

where, Q_{output} = peak (in mV) / G_{pre}

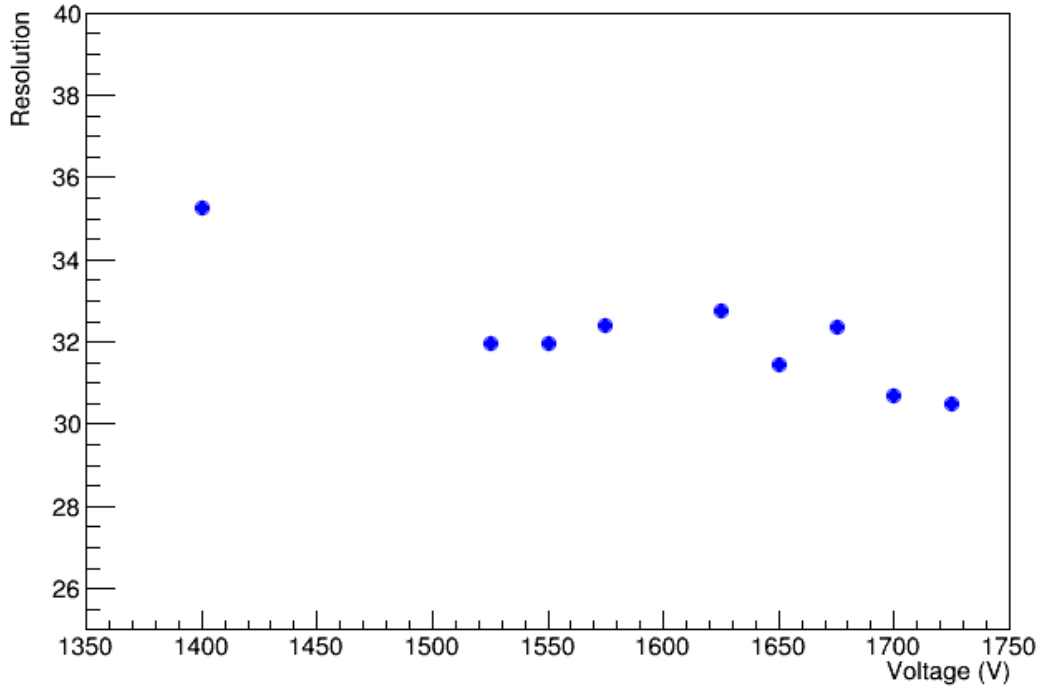


• Energy resolution vs. applied voltage

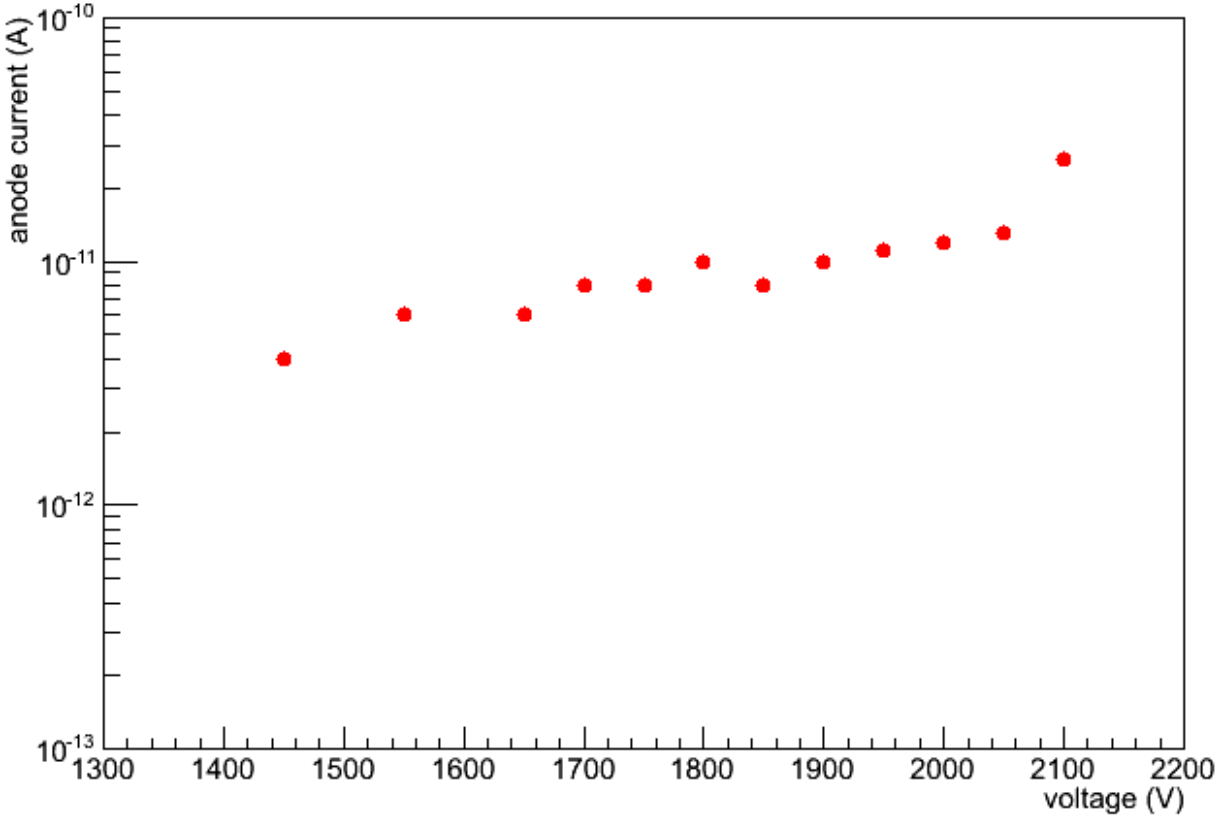
- **Resolution** = $2.35\,\sigma$ /peak $\times 100\%$

σ and peak are in channel no.
peak = ADC main peak mean

where, **σ** = Standard deviation



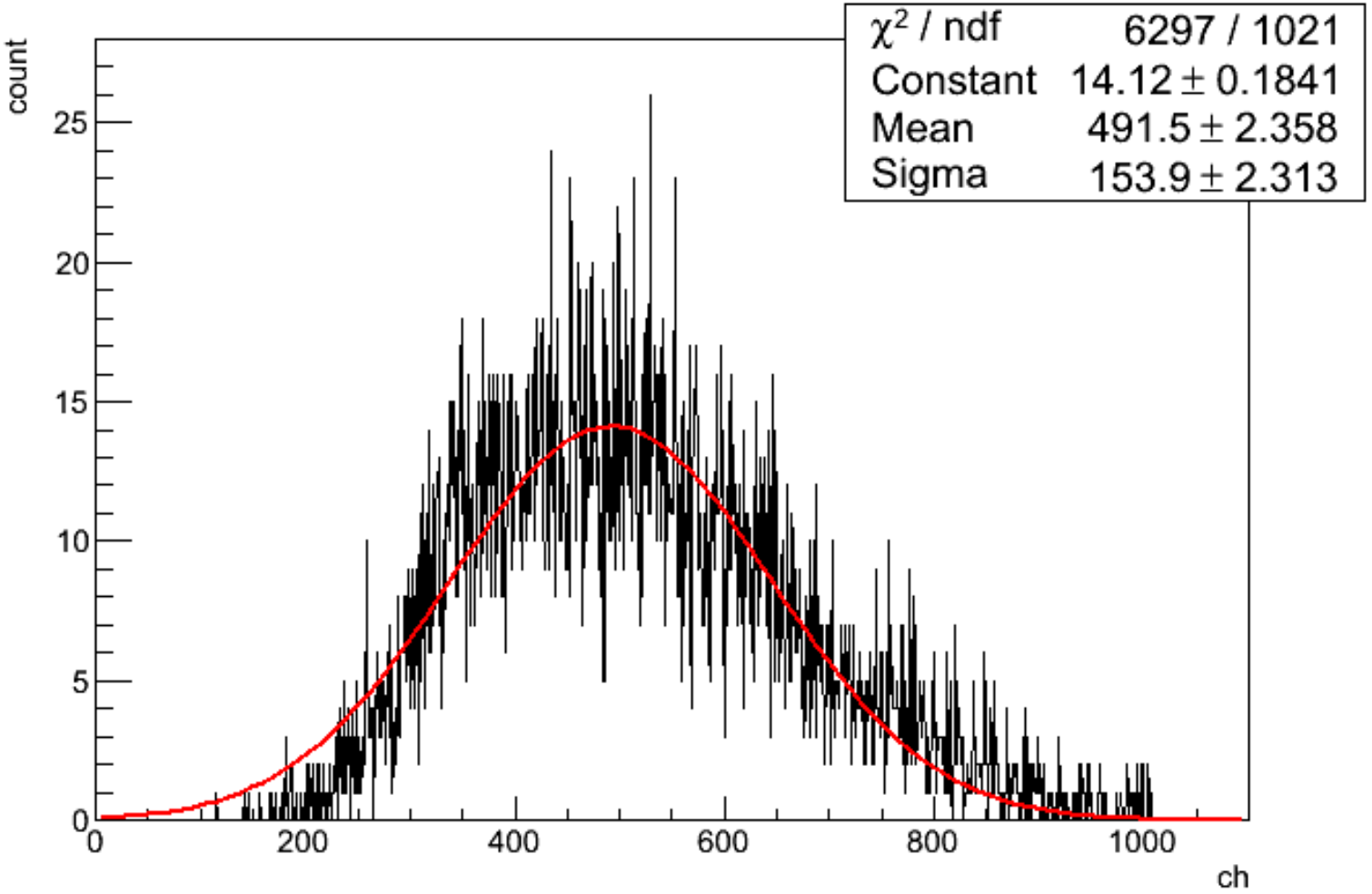
Anode current with Fe 55 source



Current is increasing exponentially with voltage

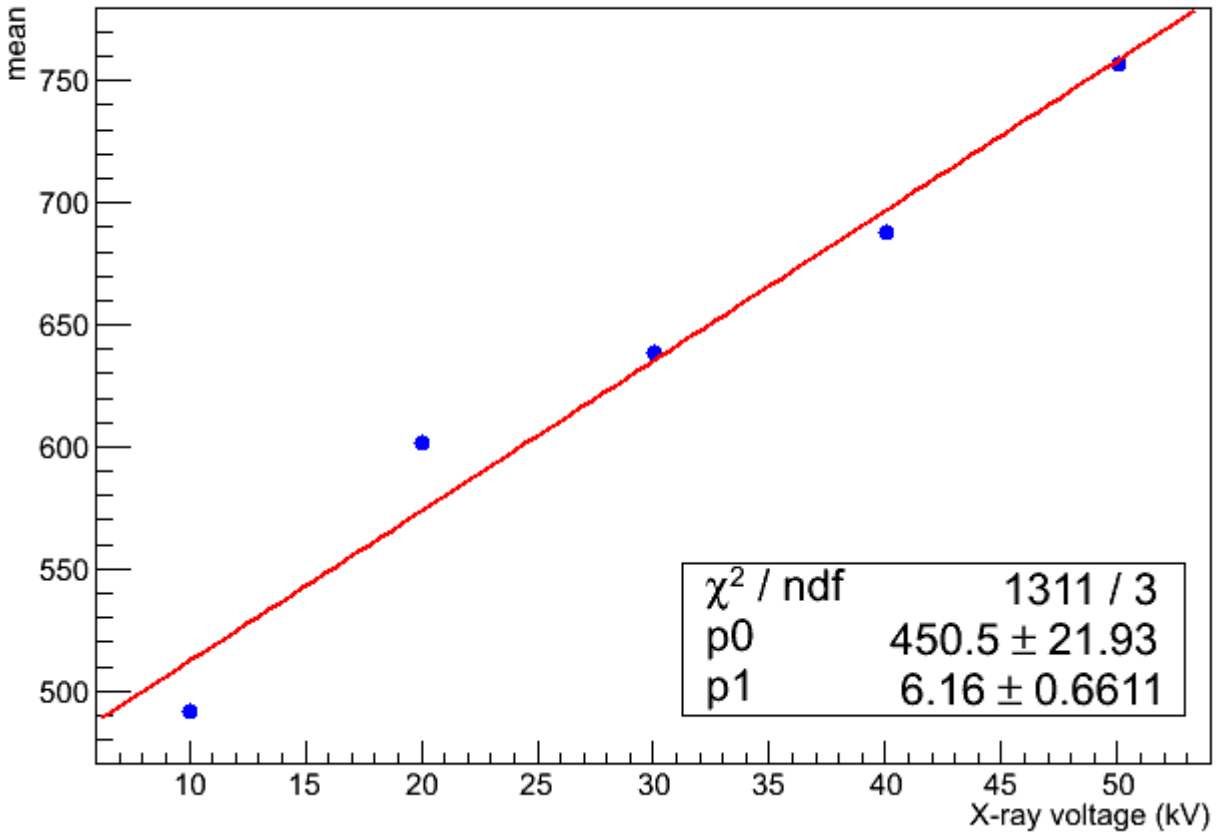
Tests with X-ray generator

○ Spectrum



GEM voltage = -1976 V, X-ray voltage 10kV, X-ray current 5 μA

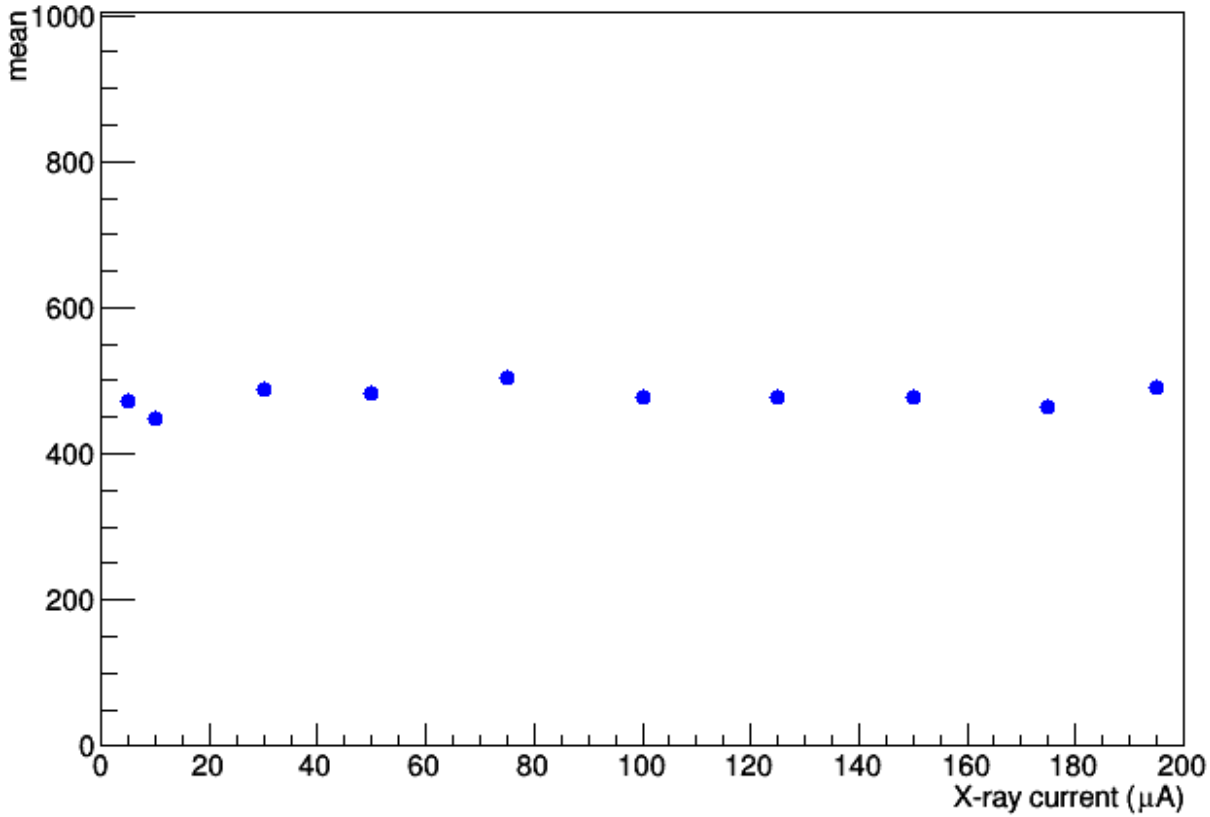
○ X-ray voltage scan



X-ray voltage = 10kV – 50 kV

GEM voltage = -1976 V, X-ray current 5 μA

○ X-ray current scan



X-ray current = 5 μA - 194 μA

Voltage = -1976 V, X-ray voltage = 20 kV

People involved to build 4GEM

- **IOP**
  - **Pradip Kumar Sahu (Team Leader)**
  - **Sanjib Kumar Sahu (Member)**
  - **Sagarika Swain (Student)**

- **Bose Institute**
  - **Saikat Biswas (collaborator)**
- **GSI ALICE team**
- **GSI Detector Laboratory**