

# **Construction and QA/QC of Large-Size GEM Modules for Muon Chamber Station 1 in CBM.**

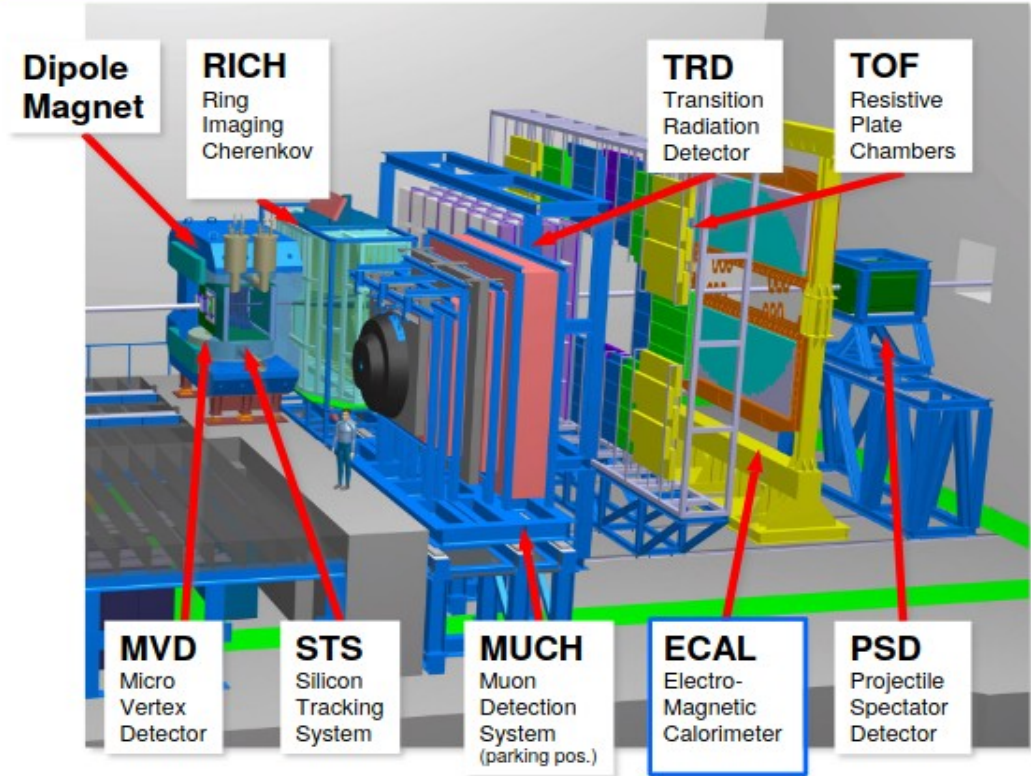
**Rajeshranjan Rath, VECC  
Behalf of CBM-India-MuCh team**

# Outline

- **Introduction**
- **CBM and MuCh detector concept**
- **Fabrication steps of large-area GEM modules for St-1**
- **QA/QC procedures and performance characterization**
- **Summary and outlook**

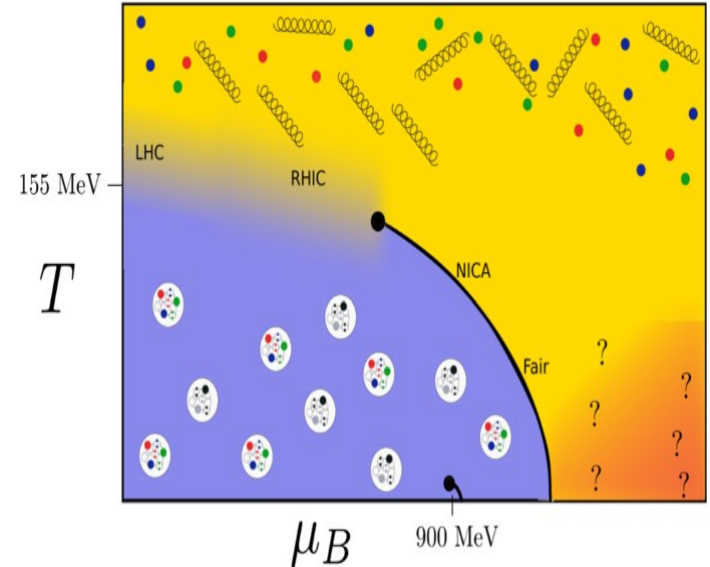
# CBM(Compressed Baryonic Matter) EXPERIMENT AT SIS-100 ENERGIES

- Fixed target experiment
- Beam Energy( $\sqrt{s_{NN}}$ )  $\approx$  2.3–4.7 GeV
- Baryon Chemical Potential( $\mu_B$ )  $\approx$  500-800MeV
- Interaction Rate: Up to 10 MHz events



# PHYSICS AT CBM

- Aims to study the QCD equation of state at this high baryon density.
- The high interaction rate will allow to study the rare probes .
- In medium modification of vector mesons
- Information about Temperature, lifetime and evolution of QGP.

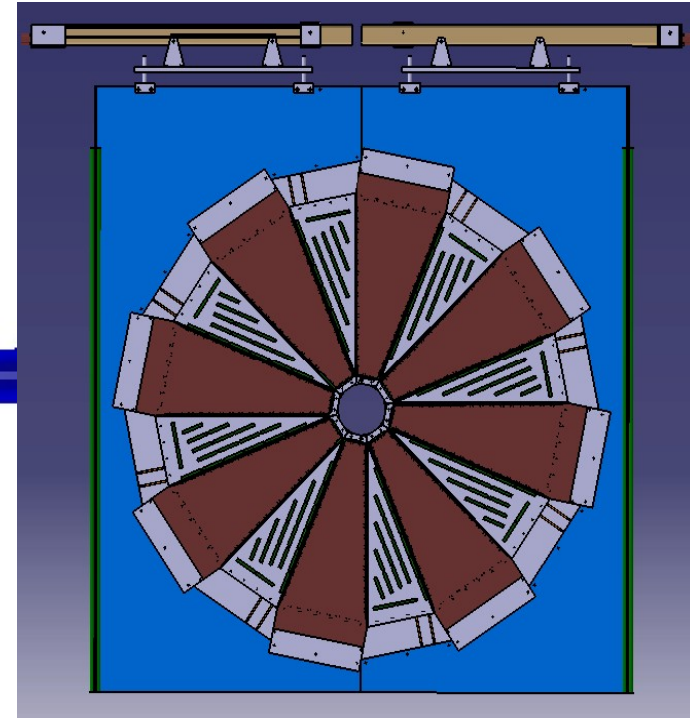
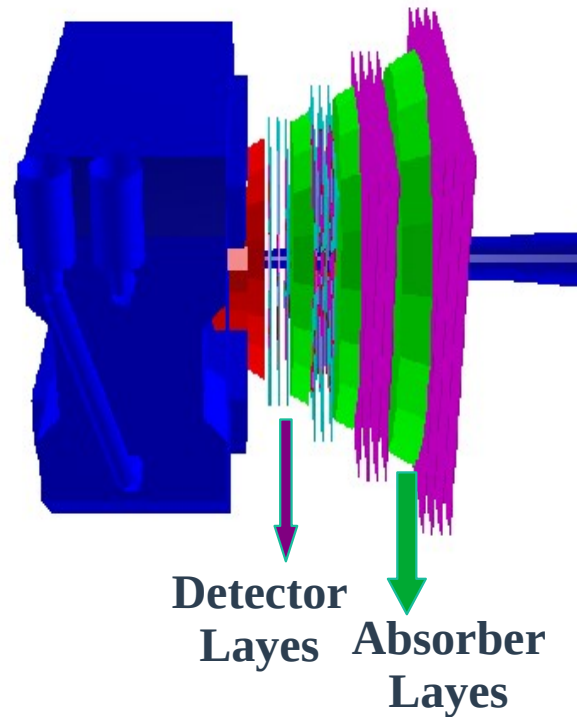


# Muon Chamber(MuCh) in CBM

- 4 stations with alternating absorbers
- GEM based tracking Stations each with 3 layers
- Station 1: 48 Modules
- Station 2: 60 Modules

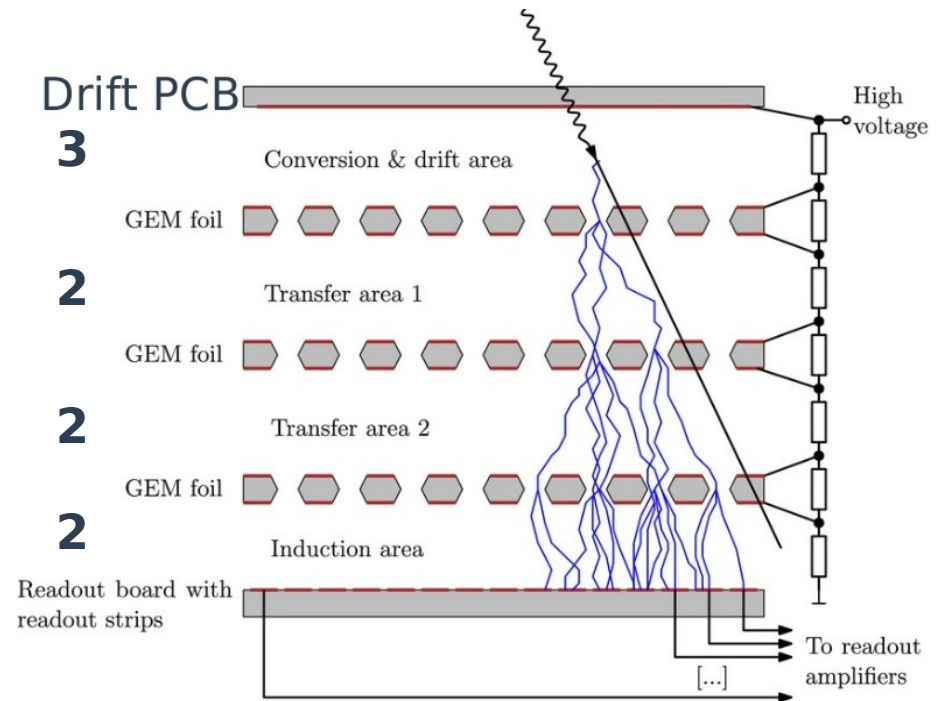
## Absorbers:

- 1 carbon-58 cm, 3 iron- 70cm
- Filters out hadrons

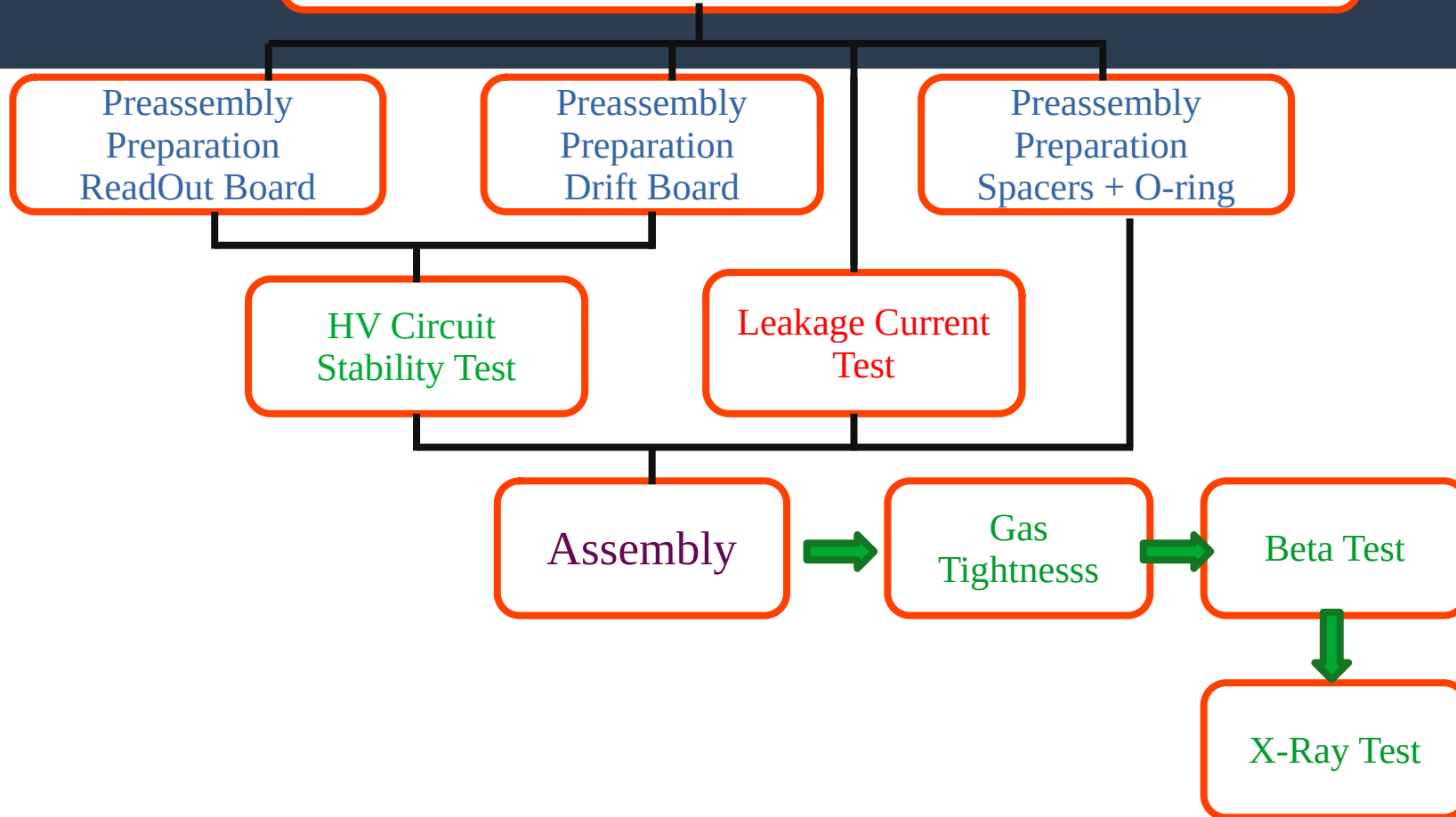


# GEM(Gas Electron Multiplier) Detector

- High rate capability( $10^5$  Hz/mm<sup>2</sup>)
- Good Spatial Resolution $\sim 100$   $\mu$ m
- Good Time Resolution
- Large area Coverage
- High gain
- Gap configuration of CBM  
MuCh : 3-2-2-2(Drift-Transfer-  
Transfer- Induction)
- Gas mixture: Ar/CO<sub>2</sub>(70/30)



# GEM detector Module QA/QC procedure



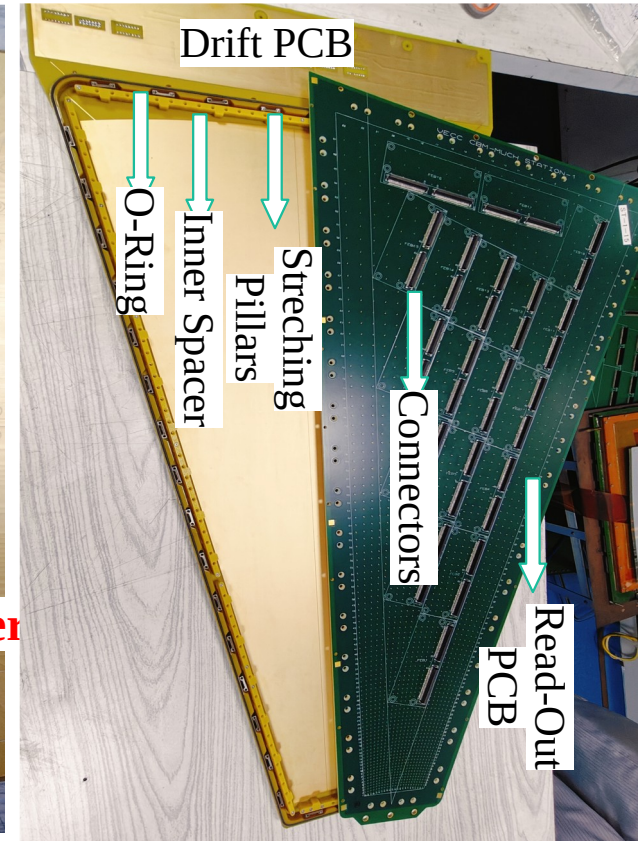
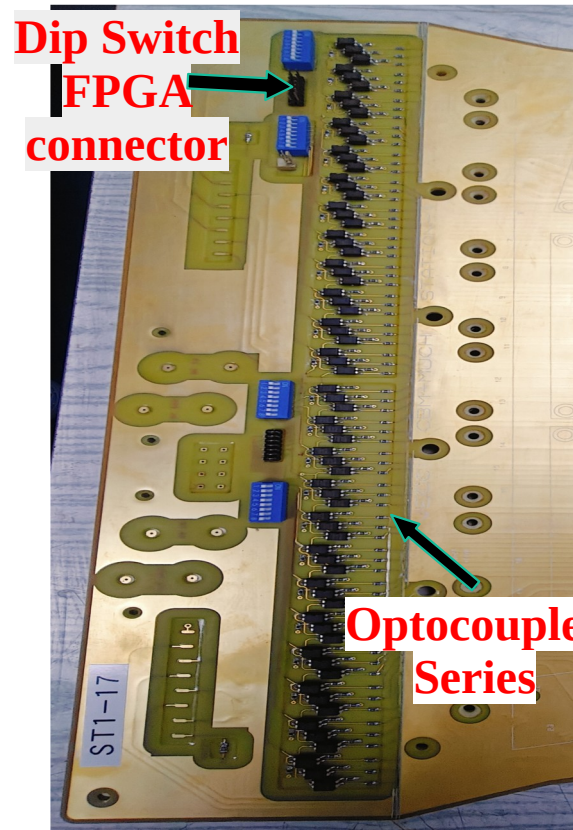
# Readout and Drift PCB Preparation

## Drift PCB

- Physical Inspection and checked divider circuit points.
- Optocoupler 72 no. and Resistors soldered
- Dip switch FPGA connectors
- 78 HV pins for HV biasing soldered

## ReadOut

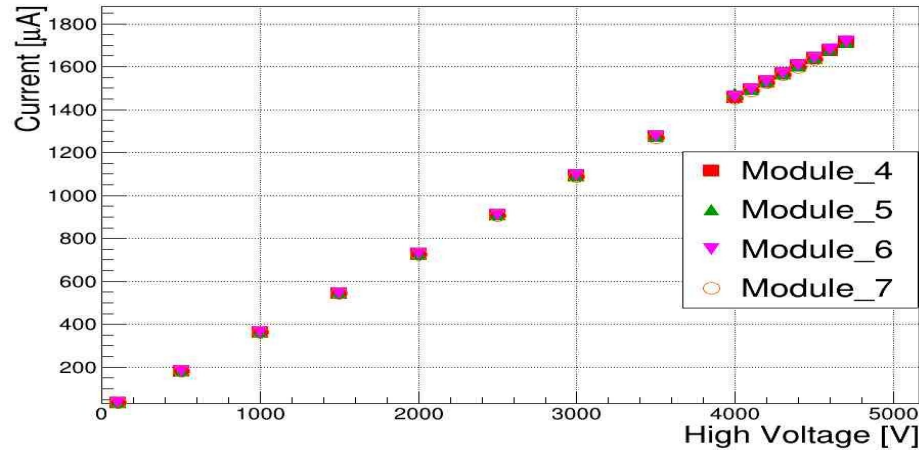
- Soldering 10 $\Omega$  resistors
- Soldered 18 connectors
  
- 60 Readout + 60 Drft board + Spacers fabricated in **India** and delivered to VECC



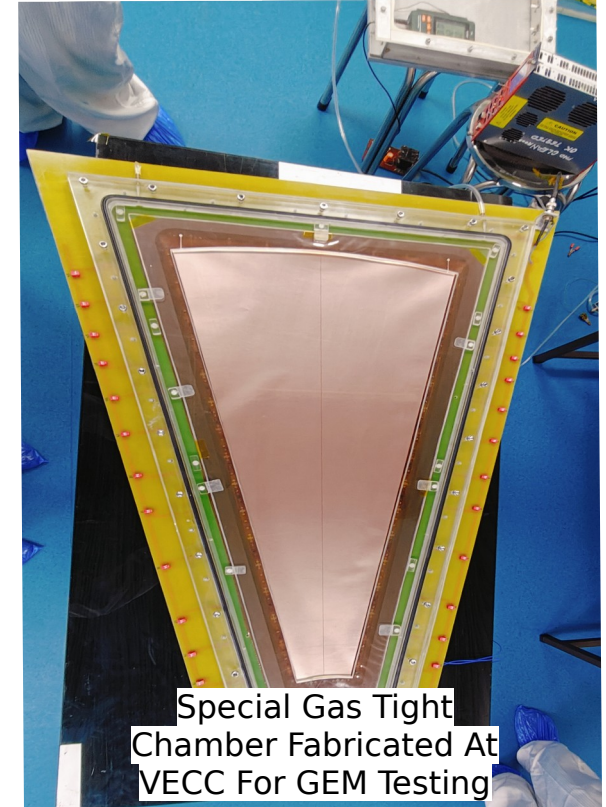
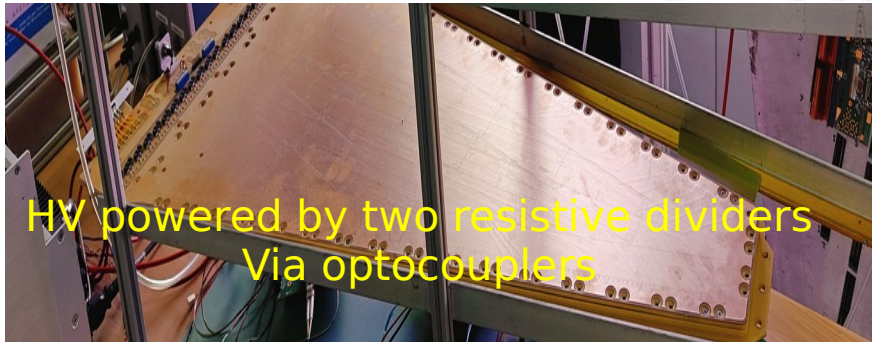
# Ready drift PCB test

# Leakage current test

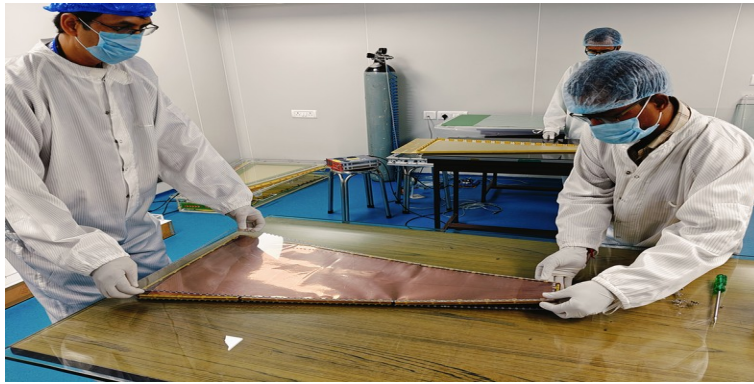
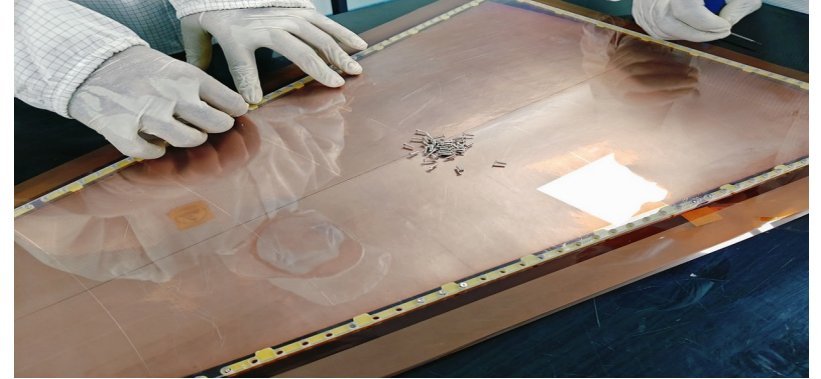
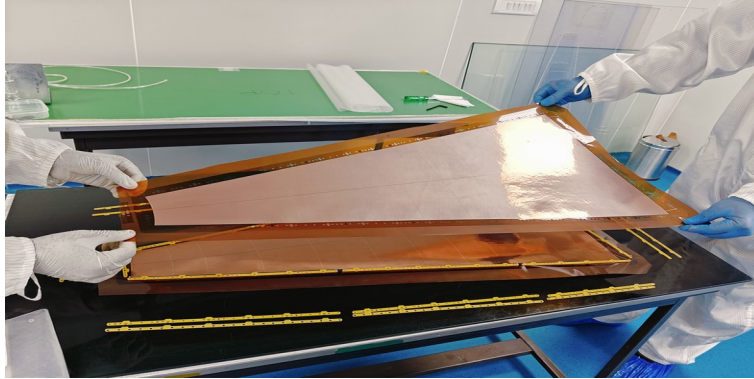
Module Currents vs HV



- 24 switches to power each segment independently
- Each Segment is independently powered and measure  $<50$  pA current
- Total leakage current is measured to be  $\sim 3$ nA.

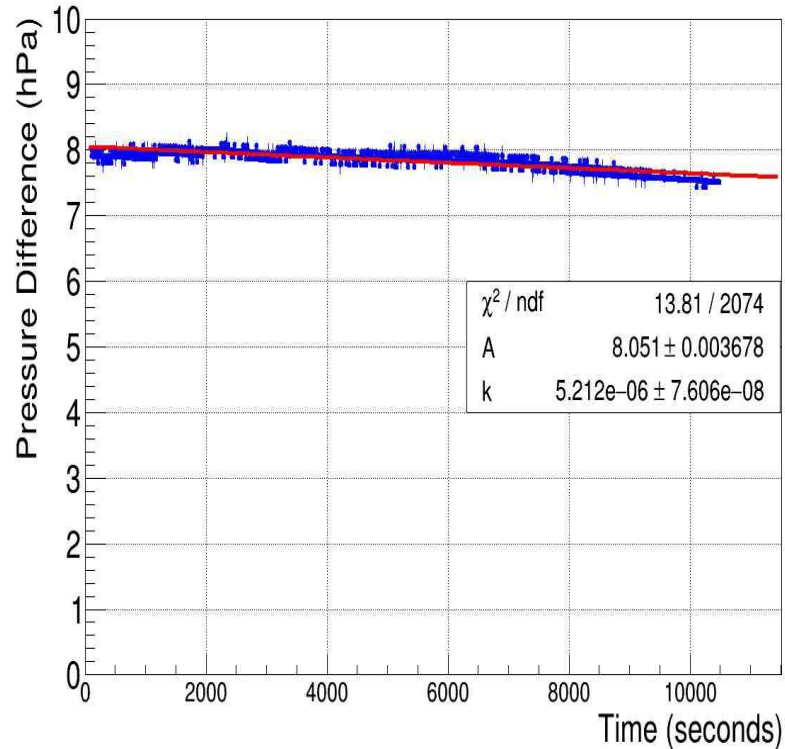


# Stacking and Assembling

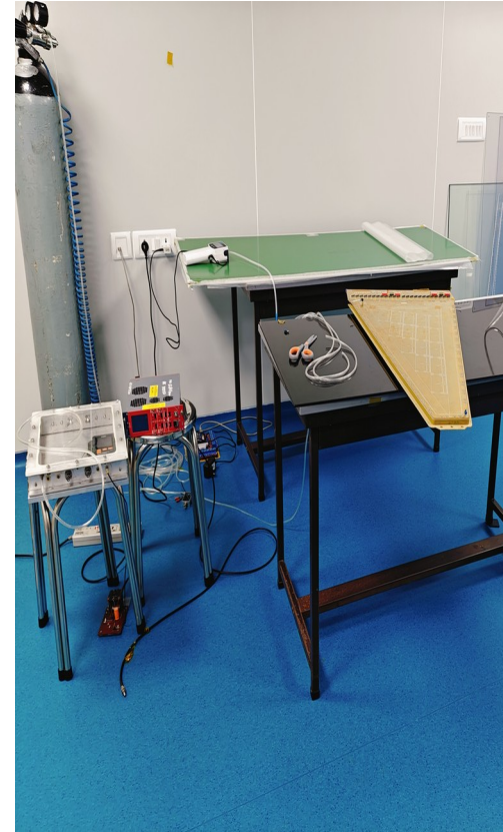


# Gas Tightness Test

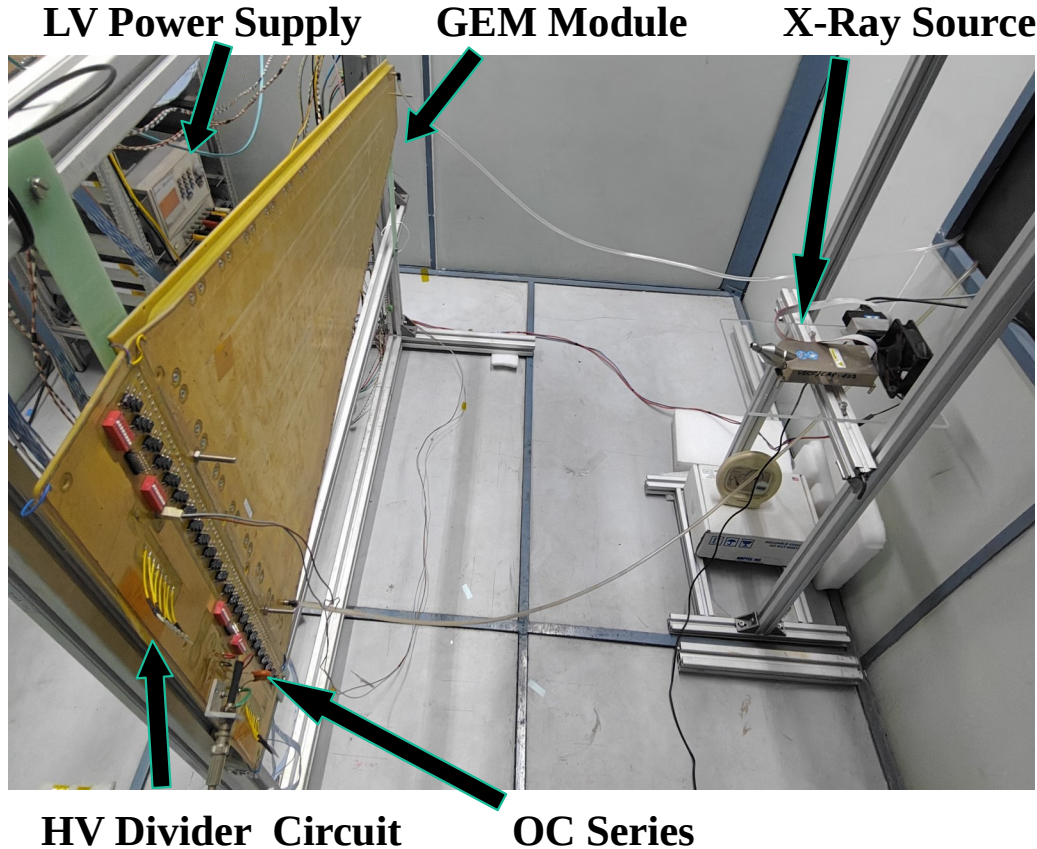
Pressure Difference with Exponential Fit



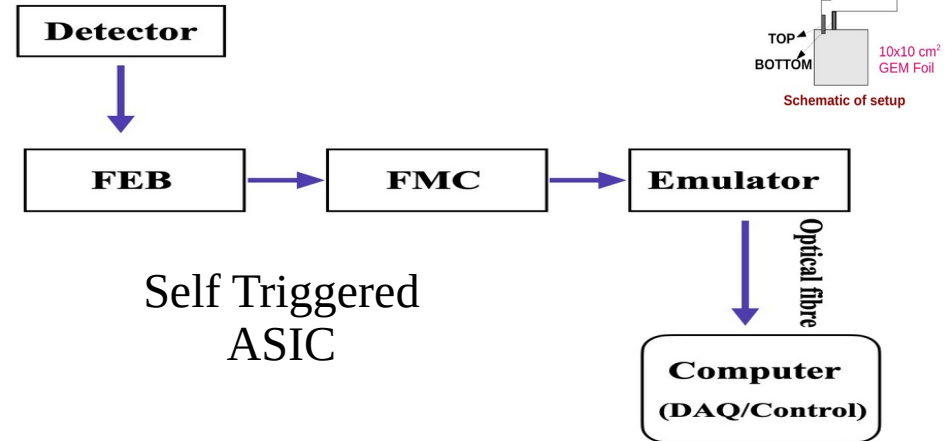
- **Using Flow meter, Input flow and outlet flow was measured**
- **Checked if it is under 1% leak**
- **Also checked the pressure difference between chamber pressure and atmospheric pressure.**



# X-Ray Test Setup

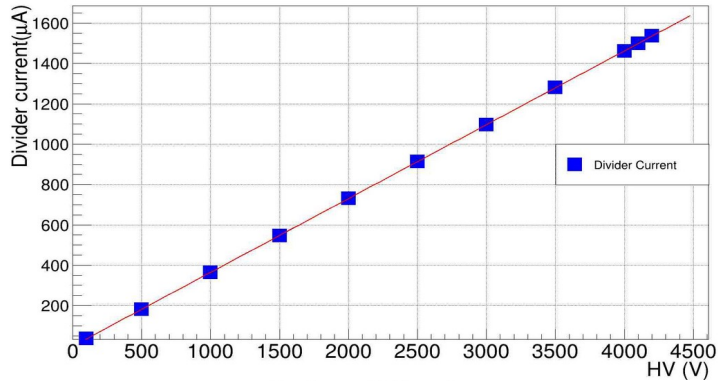


- **Linearity Test**
- **Gain Uniformity Test**
- **Rate capability Test**
- **Stability Test**

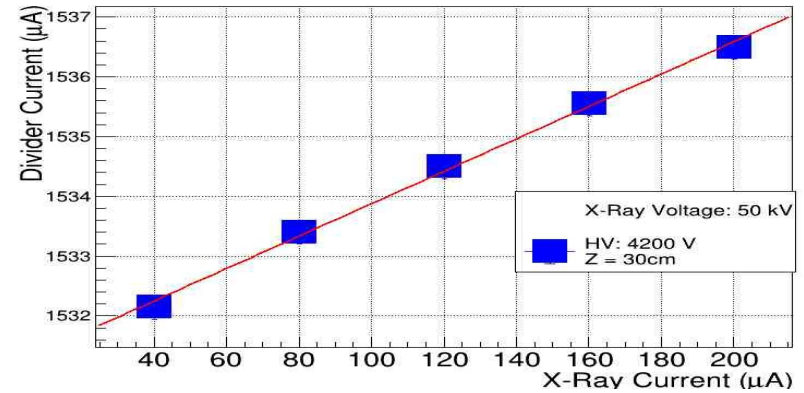


# Test Results : Linearity Test and Gain (Module 3) Tested with X-Ray Source

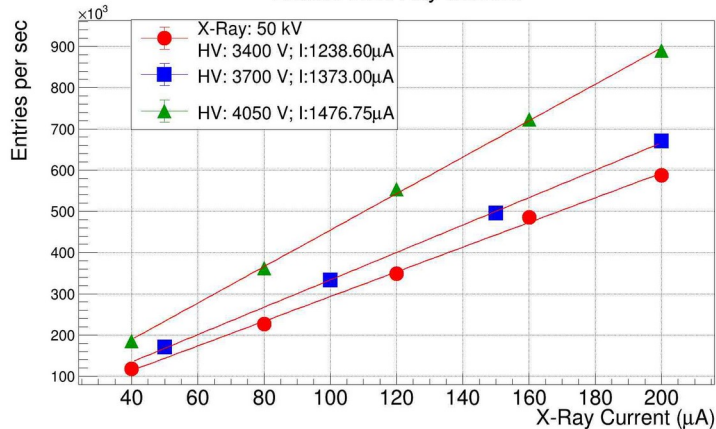
Divider\_current vs HV



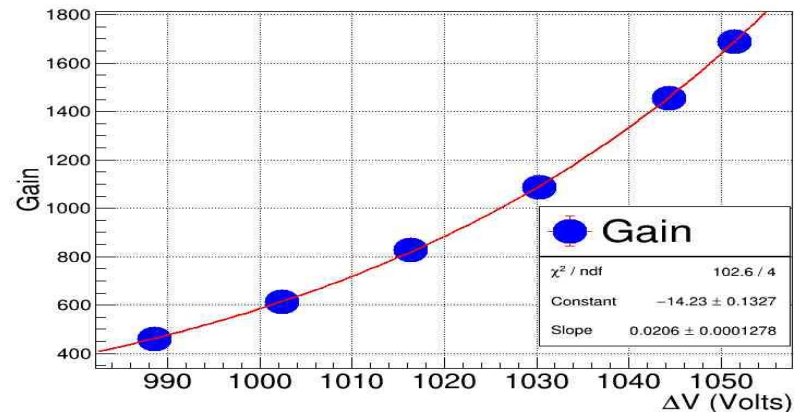
Divider Current vs X-Ray Current



Entries vs X-Ray Current

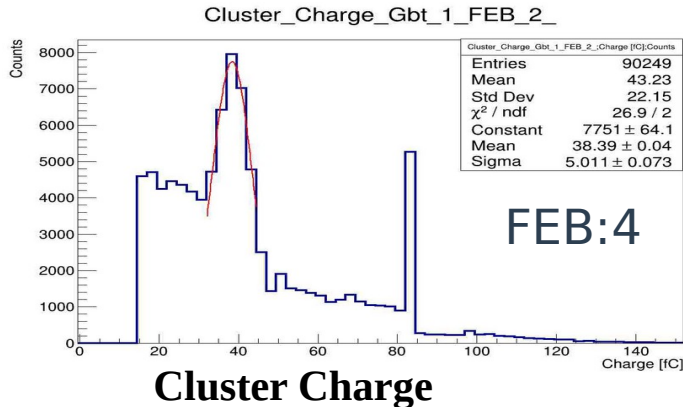


Gain vs  $\Delta V$

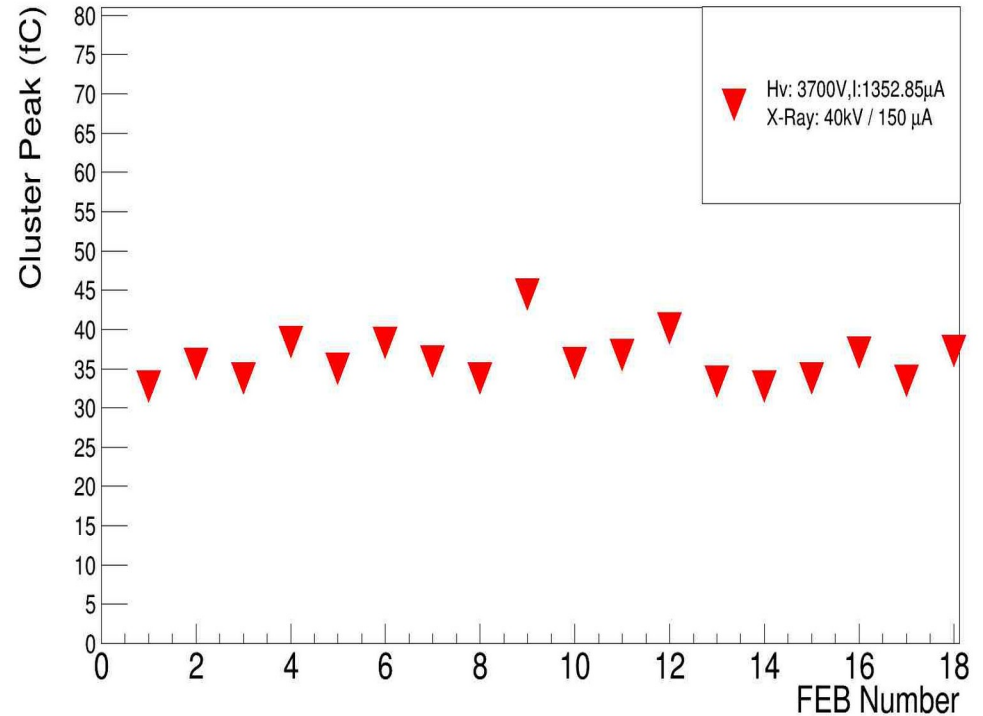


# Test Results : Uniformity Test (Module 3) Tested with X-Ray Source

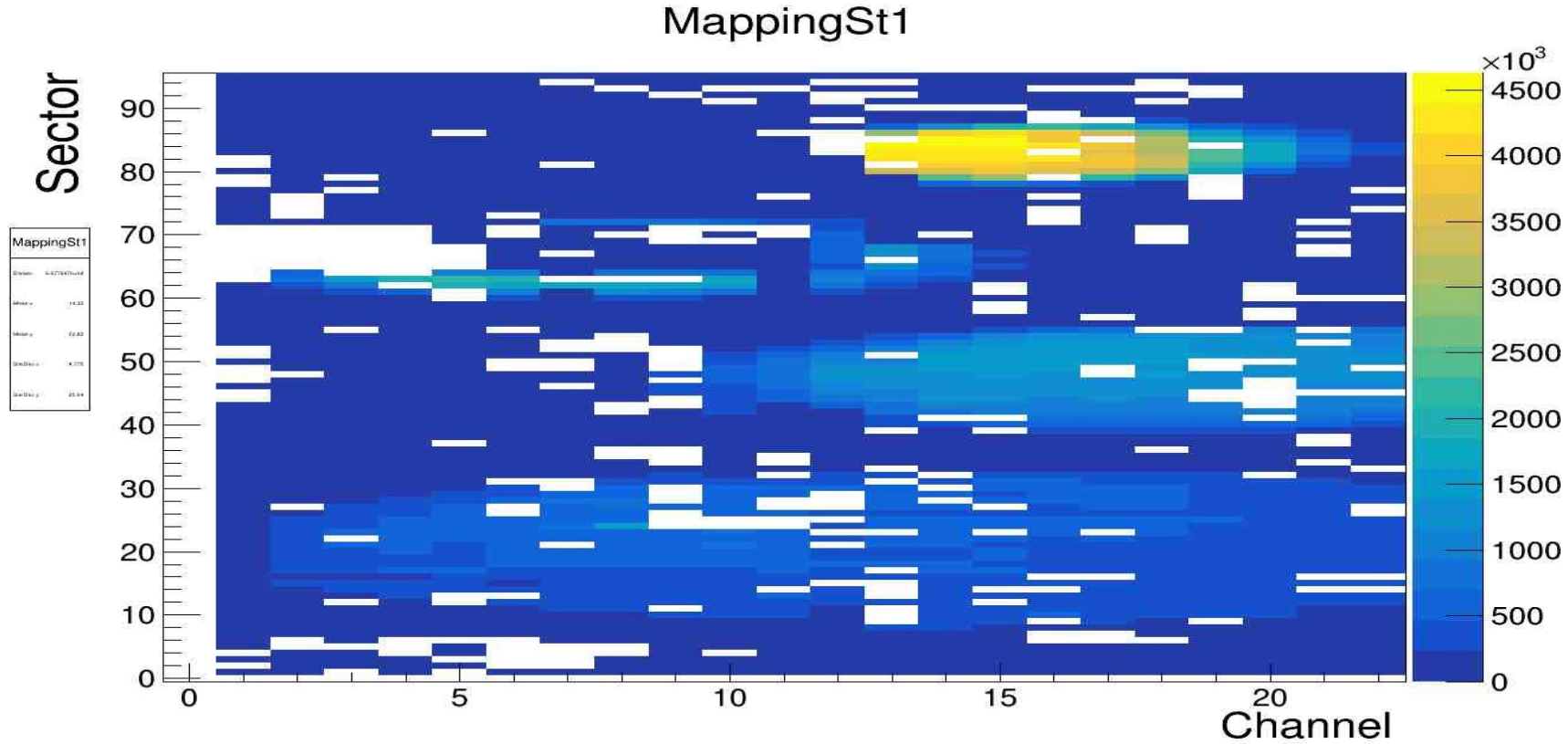
- **HV = 3700V, I = 1352.85uA**
- **Z = 30 cm**
- **X-ray: 40kV/150  $\mu$ A**
- **Gas: Ar/Co<sub>2</sub> (70/30%)**
- **Flux:  $5.76 * 10^6$  counts/s/mm<sup>2</sup>**
- **Uniformity is well under 15%**



FEB Number Vs Cluster Peaks

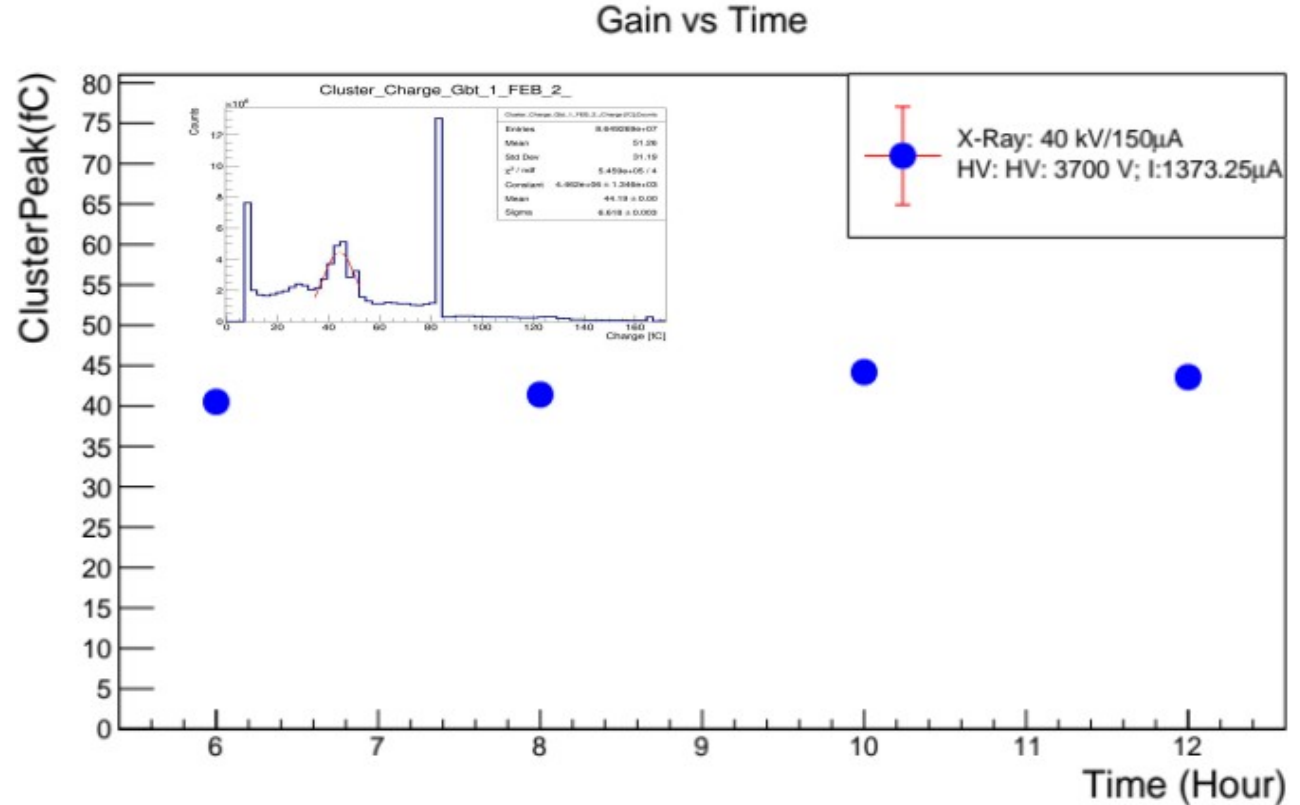


# Beam Spot:



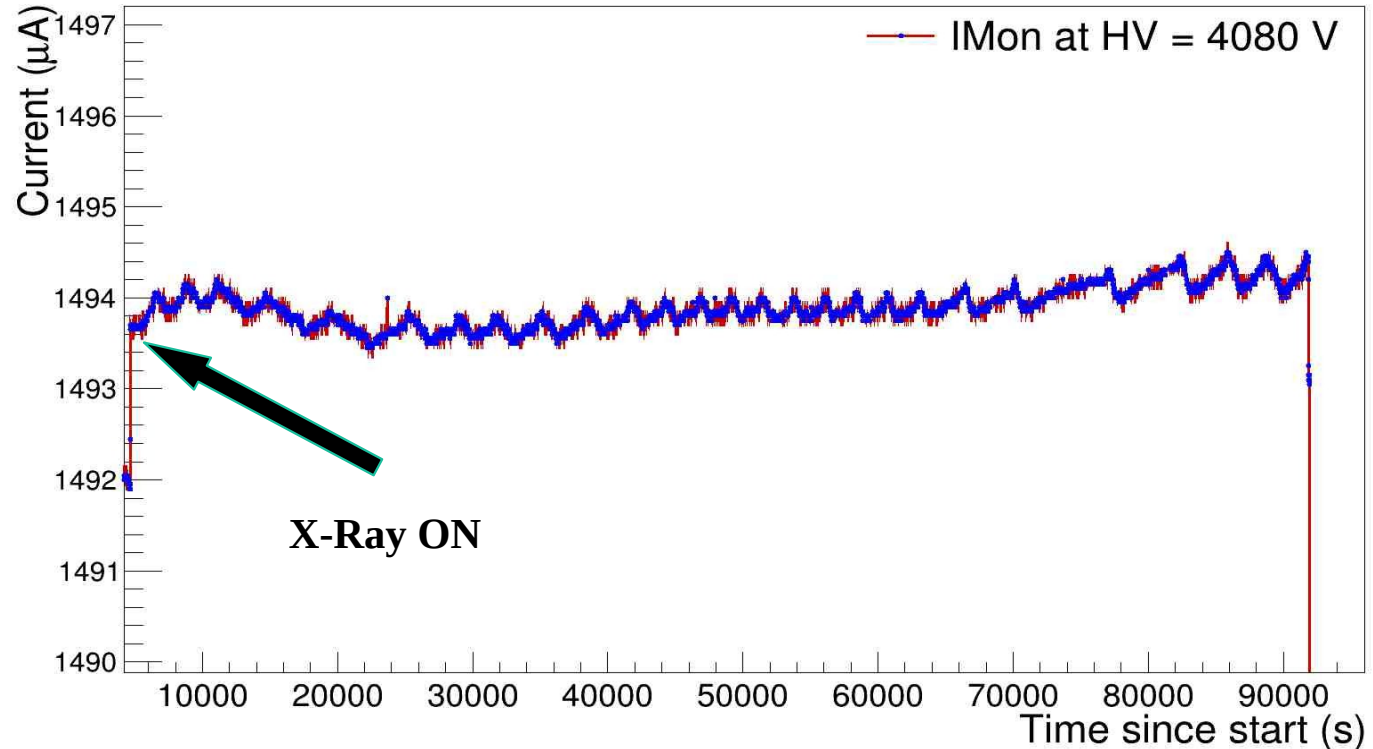
# Test Results : Stability Test (Module 3) Tested with X-Ray Source

- Gas: 70/30(Ar/CO<sub>2</sub>)
- Humidity = 60%,  
Temperature = 24<sup>0</sup> C
- Z= 30 cm
- HV= 3835 V,  
I=1402.40 μA
- X-Ray: 40kV/150  
μA:  
5.76 \* 10<sup>6</sup>  
counts/sec/mm<sup>2</sup>



# Test Results : Stability Test (Module 3) Tested with X-Ray Source

- Gas:  
70/30(Ar/CO<sub>2</sub>)
- Z= 30 cm
- HV= 4080 V,  
I=1491.95  $\mu$ A
- X-Ray:  
40kV/150  $\mu$ A
- With X-Ray  
increase of  
2 $\mu$ A in divider  
current



# SUMMARY

- **Have built and tested initial production modules of Station-1 of CBM-MuCh.**
- **Performed testing and gain characterization of Module 3 using an X-ray source.**
- **Comprehensive QA/QC procedures being finalised.**
- **Gain, uniformity, linearity and Stability have been observed under high voltage and high intensities.**

**Thank You**

# BackUp

