

Development of AT-TPC for observation of (α, p) scattering

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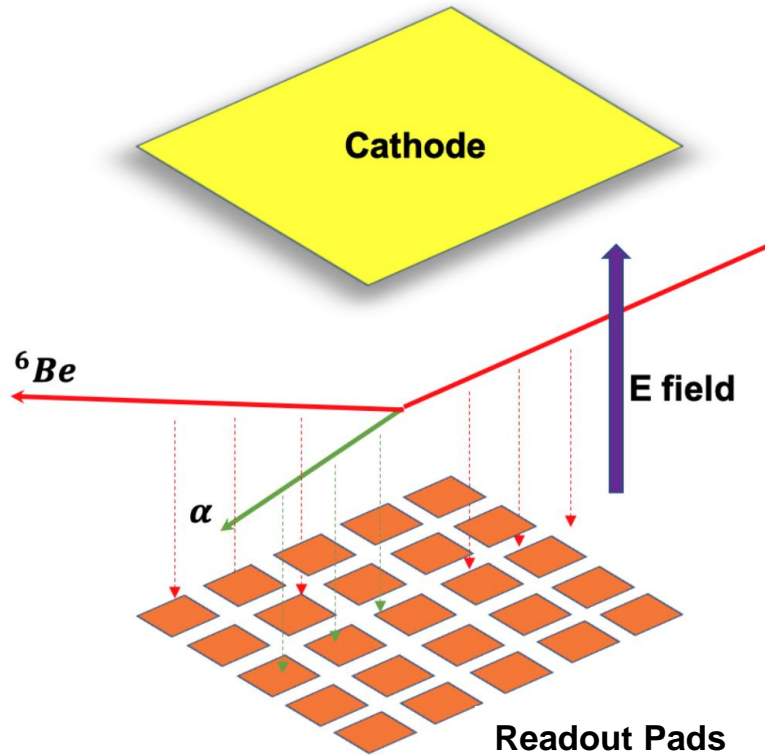


세종대학교
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Active Target Time Projection Chamber

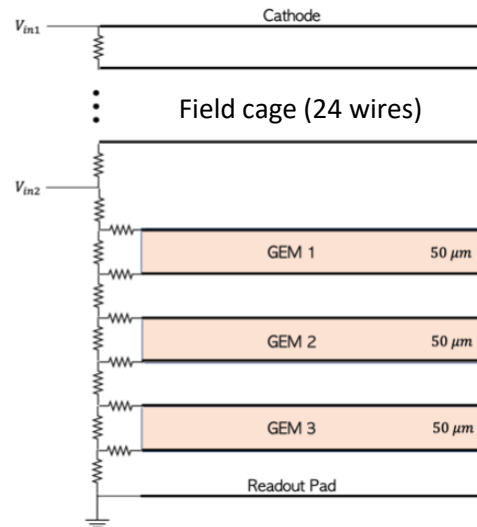
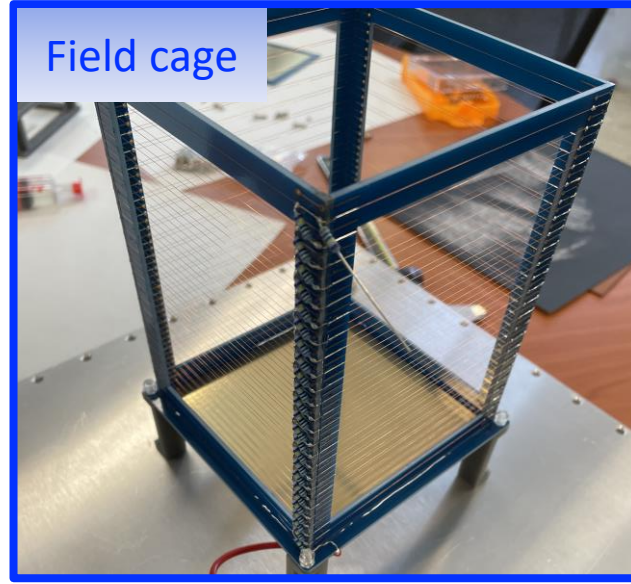
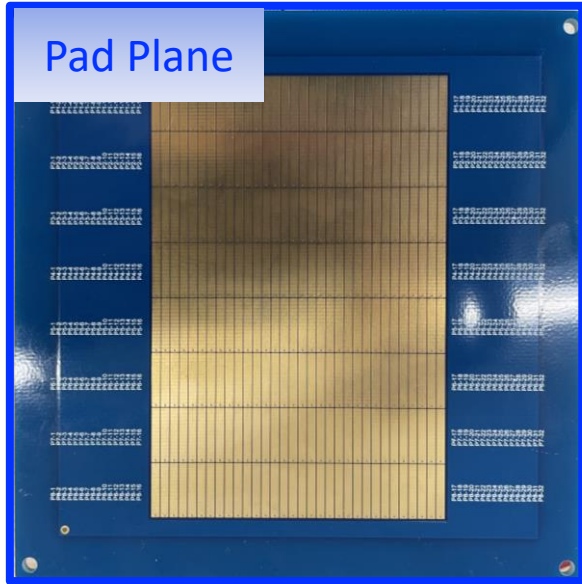


- Time Projection Chamber (TPC) is a type of gas chamber to track particles
- The "active target" means that drift gas is used for target as well
- The active volume can be extended to the entire volume including the collisional vertex

This will allow new studies using the AT-TPC as the main component to measure a scattering of alpha particles and heavy ions, in particular, associated with the formation of alpha cluster resonance.

We propose this for low energy LAMPS experiment at RAON

The main parts of the prototype ATTPC



Pad Plane

- Rectangle pads
- Ver 1: 2.625 x 12.0 mm², 0.5 mm, 256ch
- Ver 2: 1.900 x 11.9 mm², 0.1 mm, 256ch

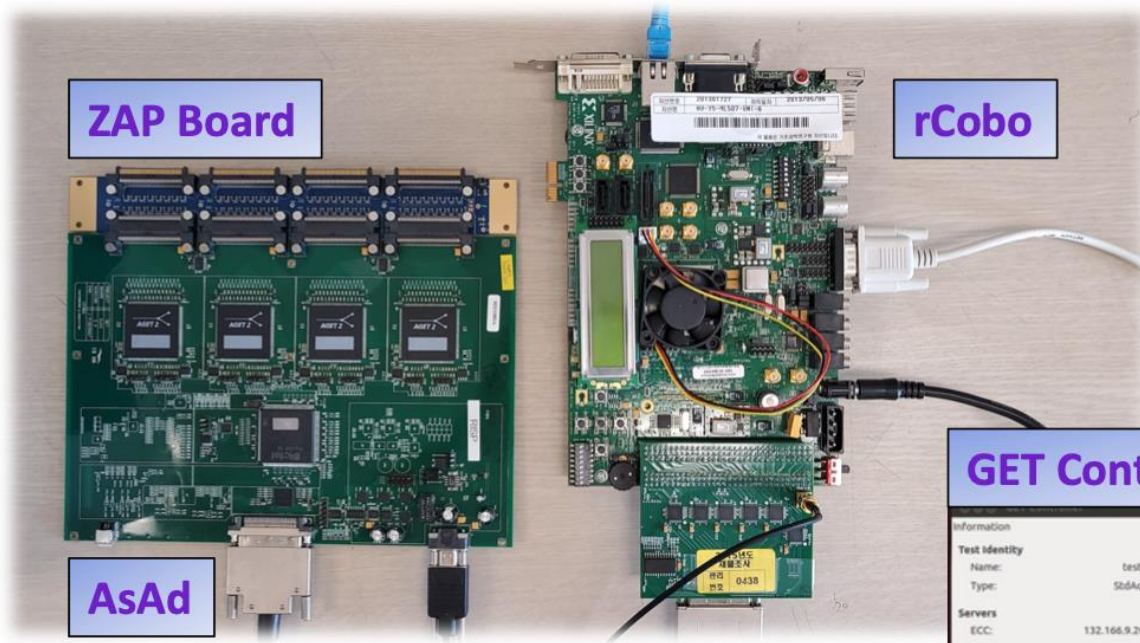
Field cage

- Cathode
- Field-Cage frame
- Copper wires ($\phi = 0.1$ mm)
- Ver 1: 49 single wire, 3 mm
- Ver 2: 24 double wire, 6 mm

GEM

- Triple GEM
- GEM to GEM spacing : 2 mm
- Active area : 100 x 100 mm²

GET (General Electronics for TPC)



rCobo (reduced Collection Board)

- Digital data from AsAd
- Zero suppression
- Network transfer to PC
- 4 AsAd controlled by 1 CoBo

ZAP board

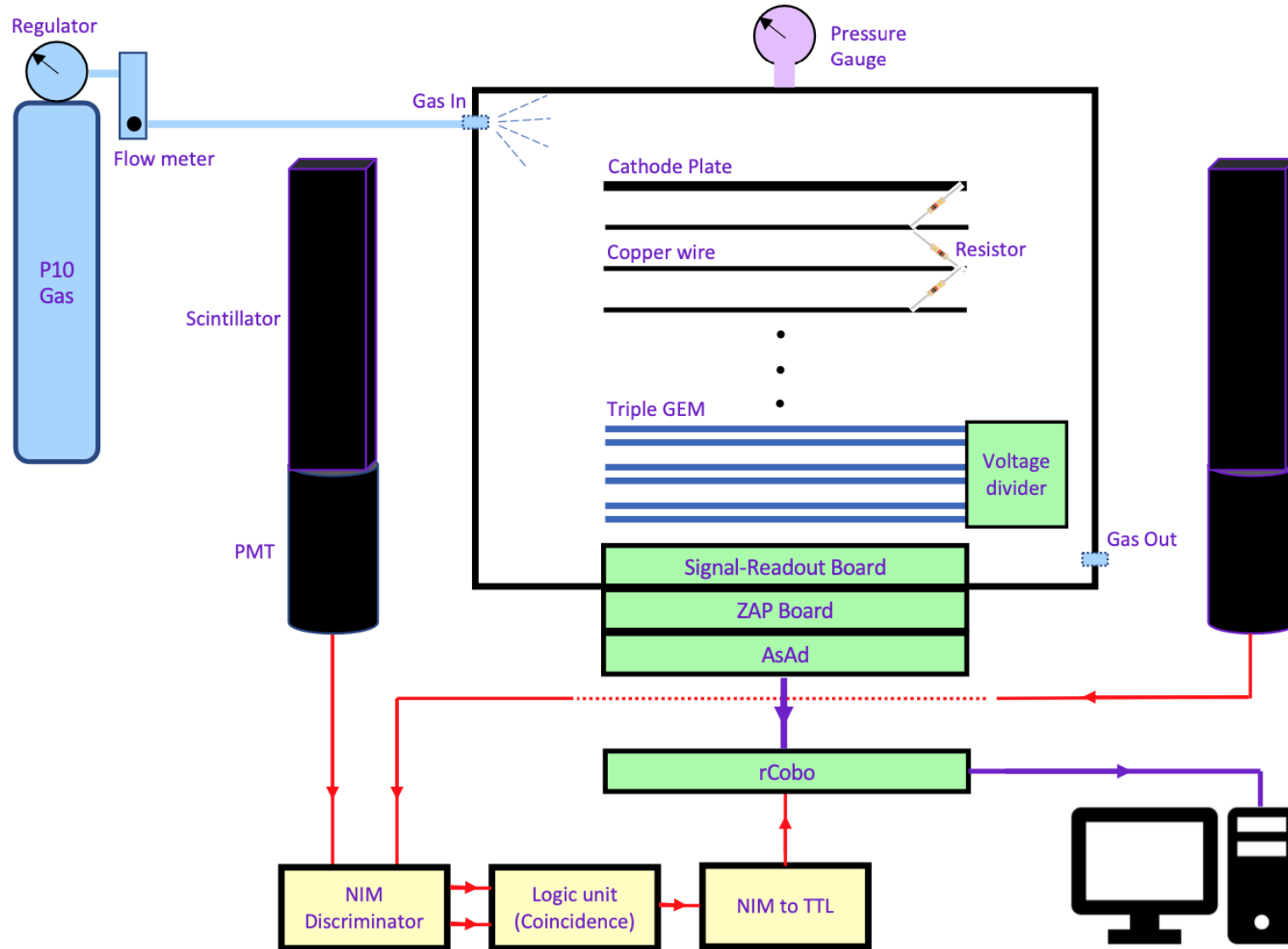
- To protect AGET chip in AsAd board

AsAD

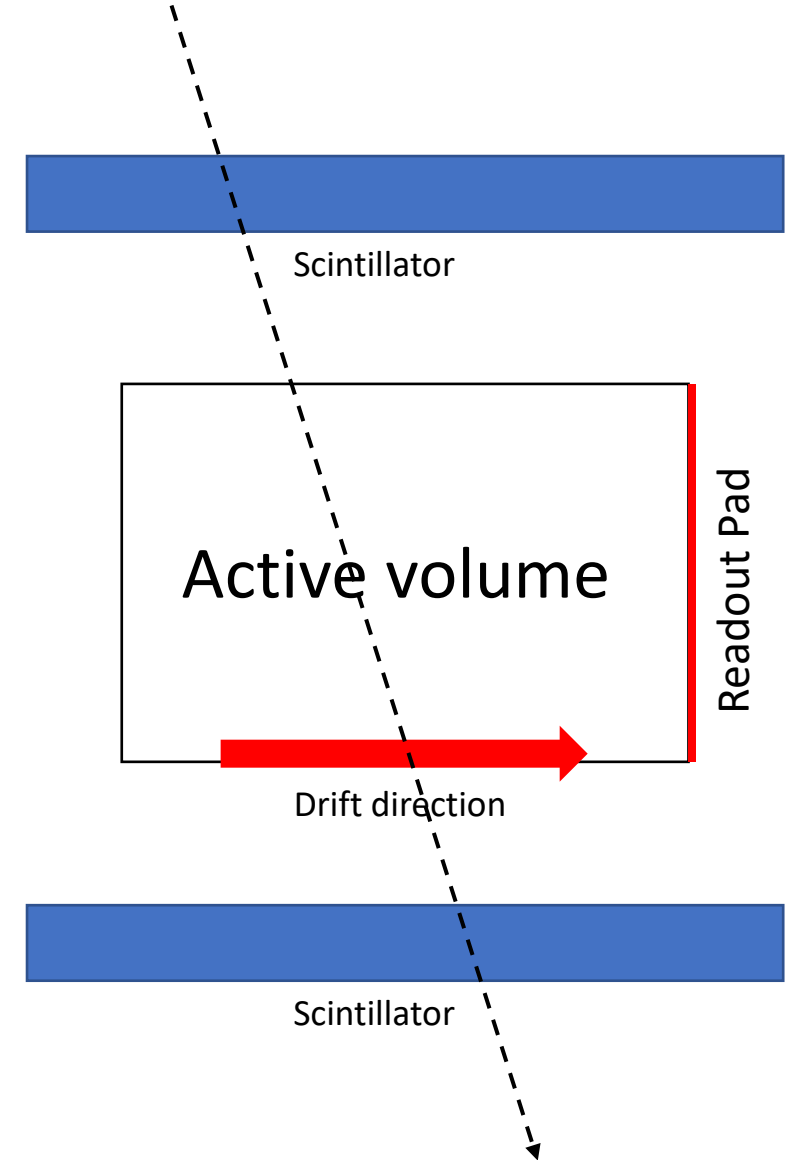
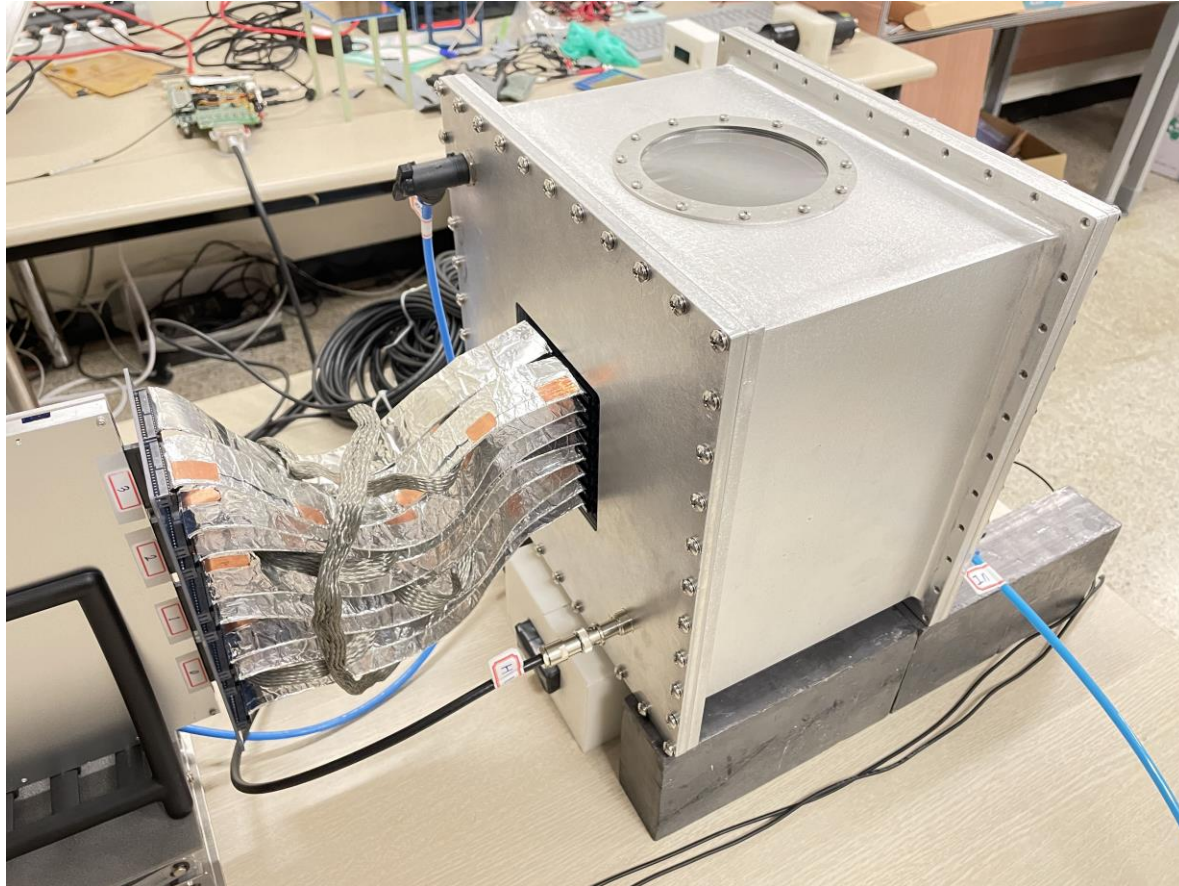
- AGET support for Analog to Digital
- 4 AGET (256 ch) in 1 AsAd
- 12 bit ADC (up to 100 MHz rate)



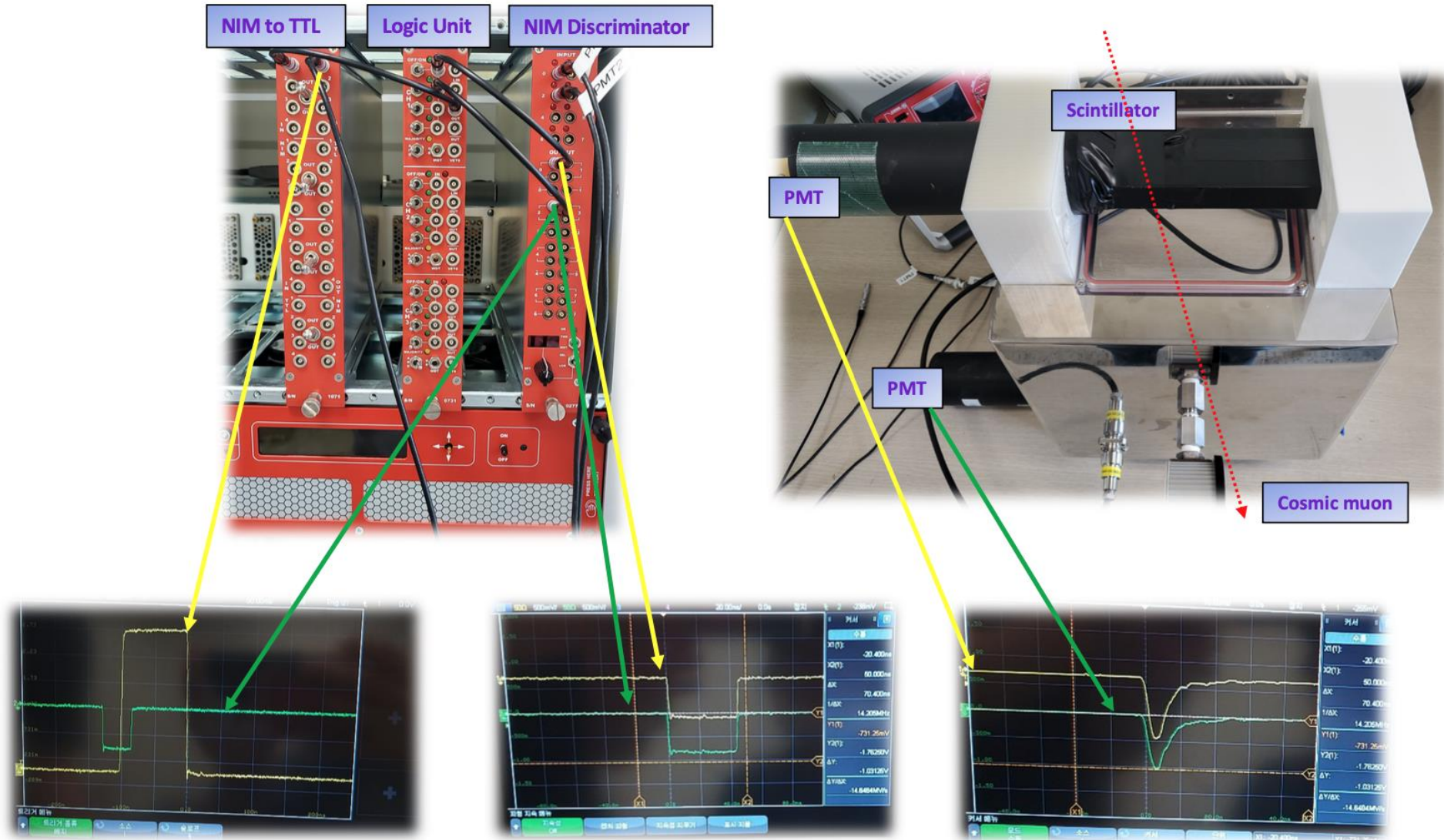
Schematic diagram of the prototype ATTPC



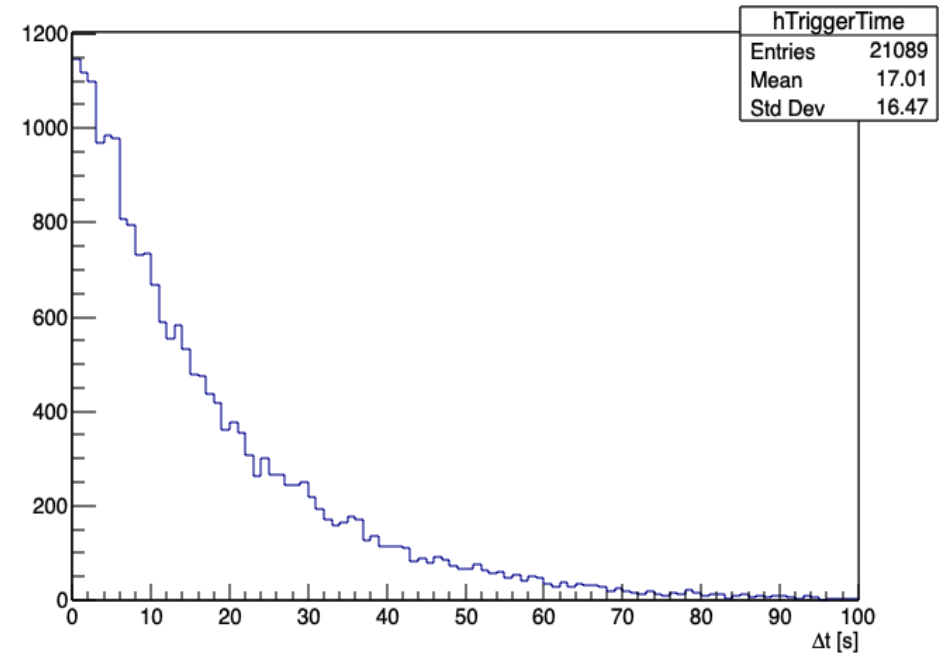
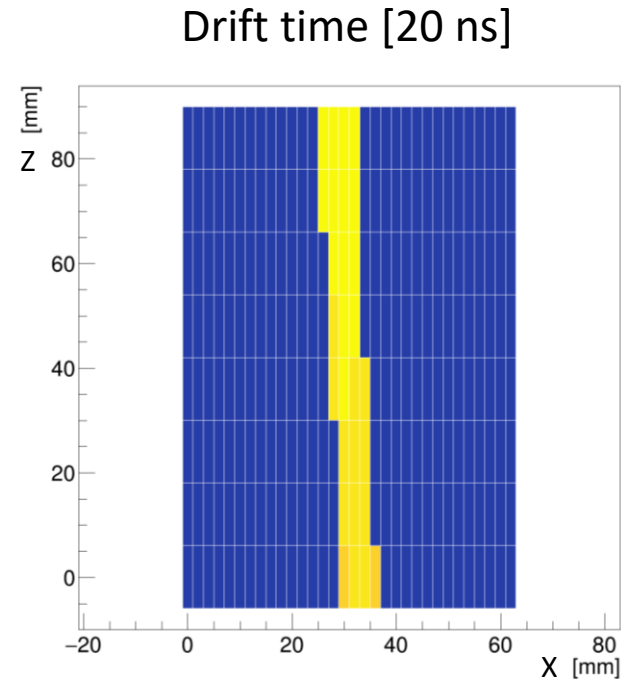
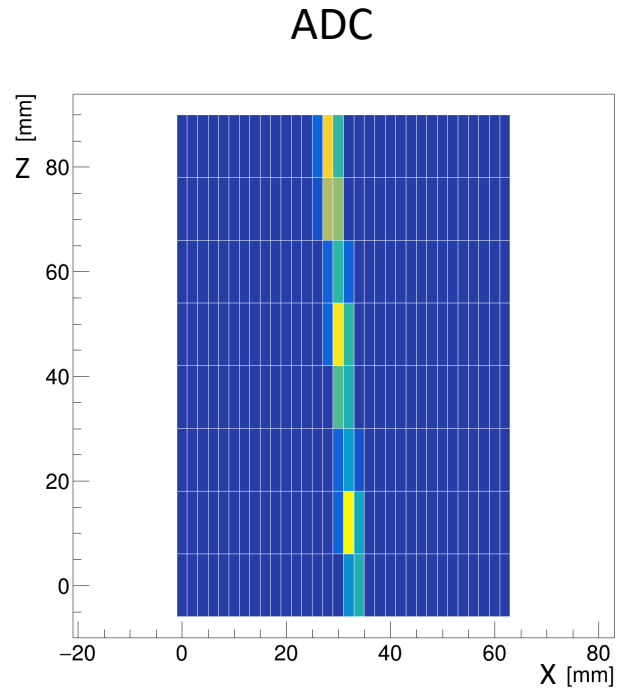
Cosmic muon test setup



Trigger system for cosmic muon test



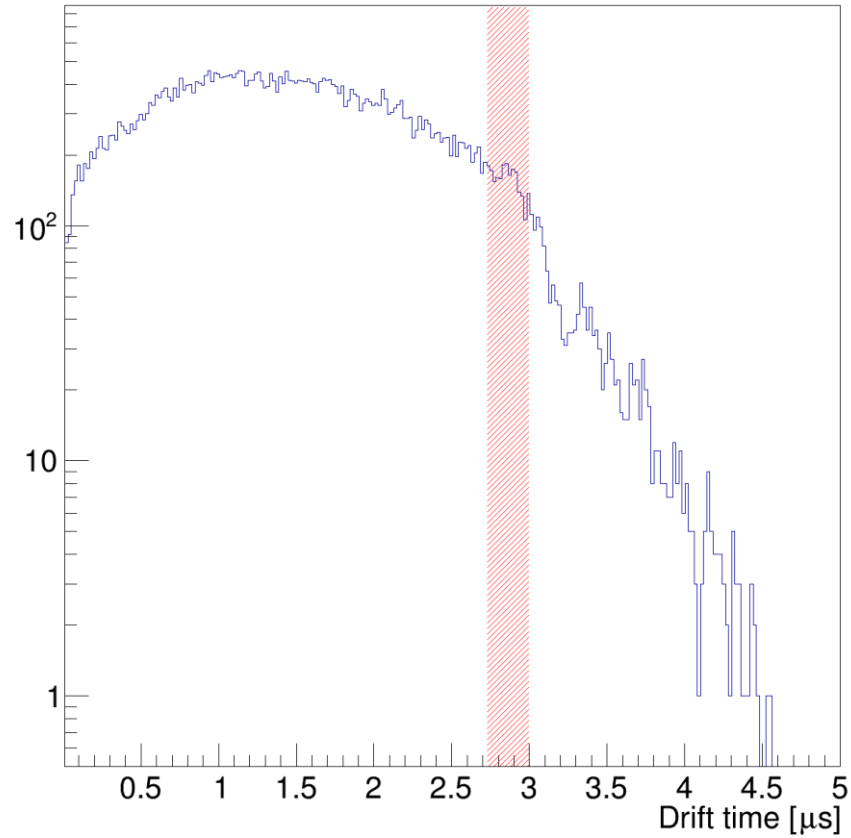
Event display of cosmic muon track



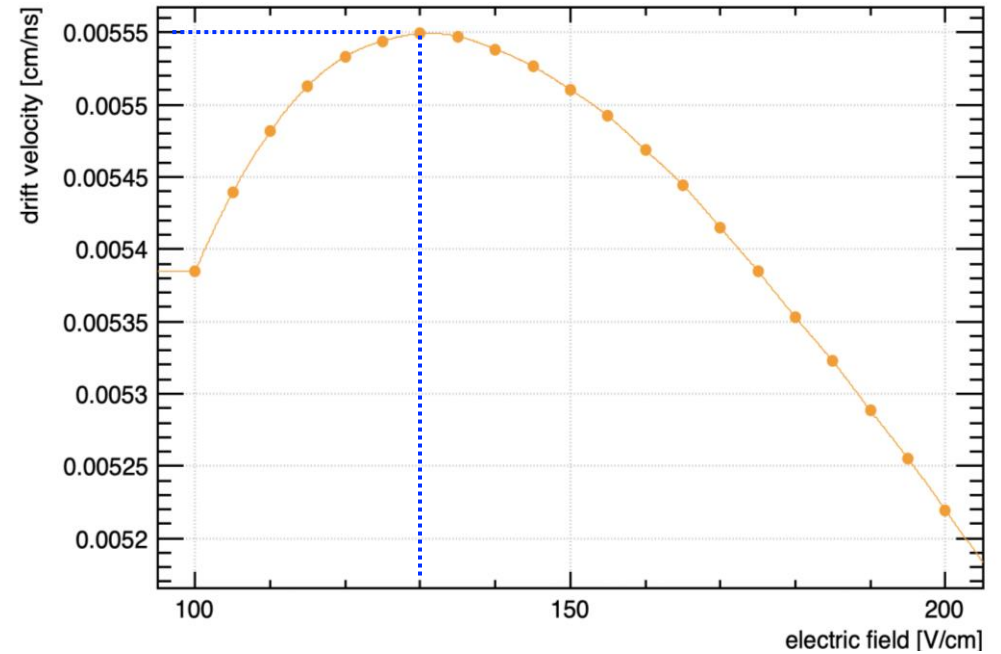
A typical cosmic muon track

Trigger rate ~ 3.5 /min

Cosmic muon: Drift speed



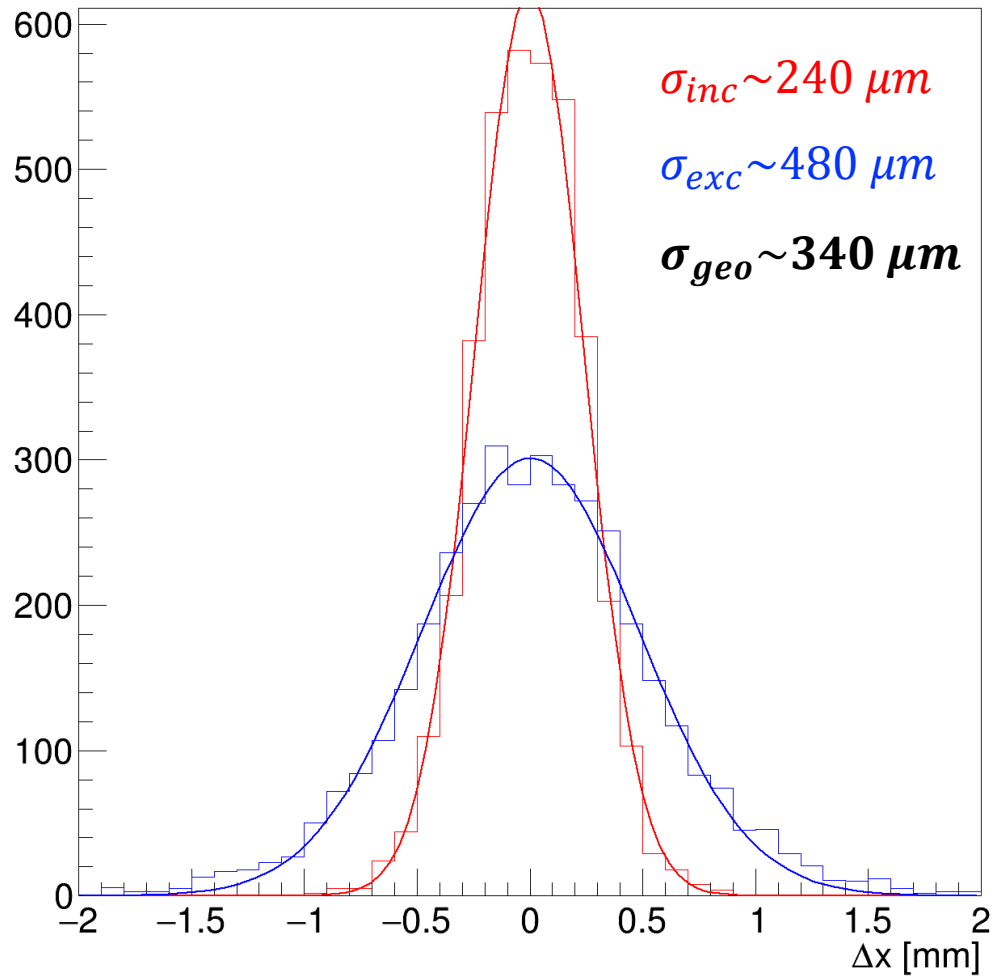
Drift speed (exp.) $\sim 5.25 \text{ cm}/\mu\text{s}$



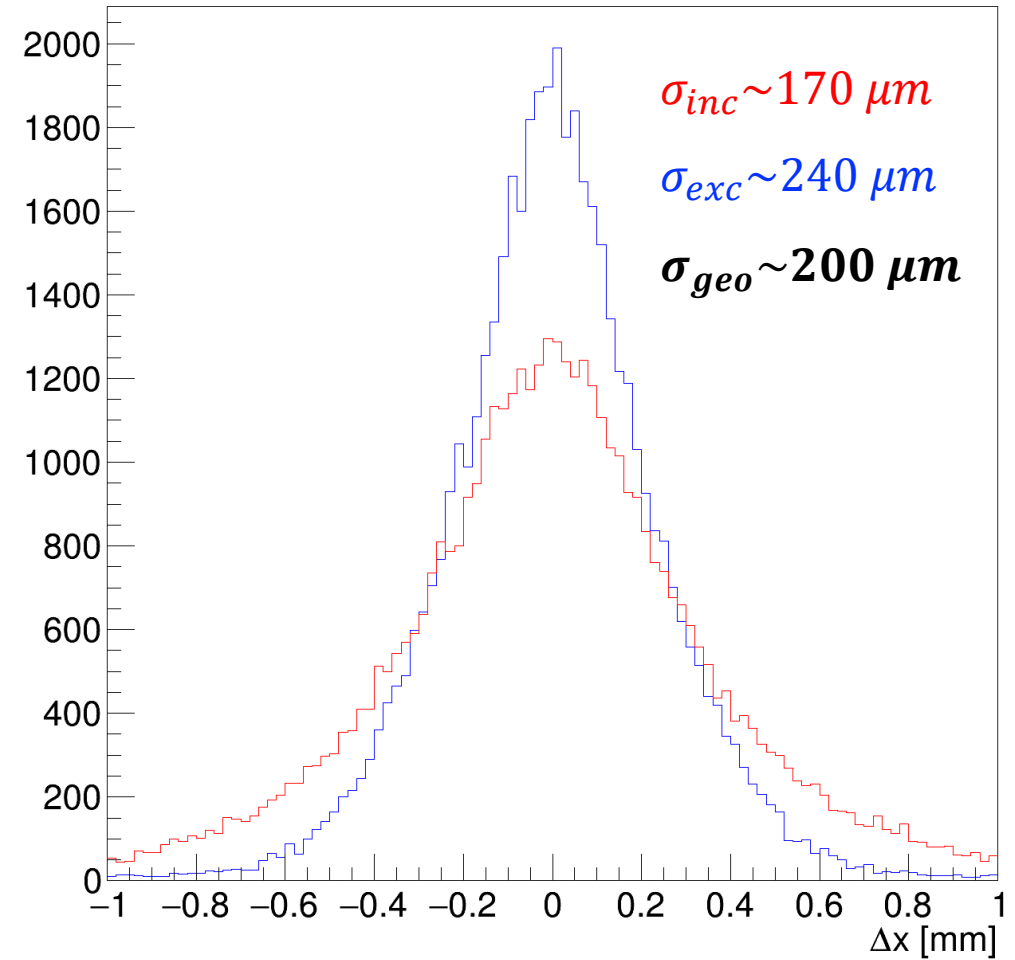
Drift speed (sim.) $\sim 5.5 \text{ cm}/\mu\text{s}$

Cosmic muon test: Spatial resolution

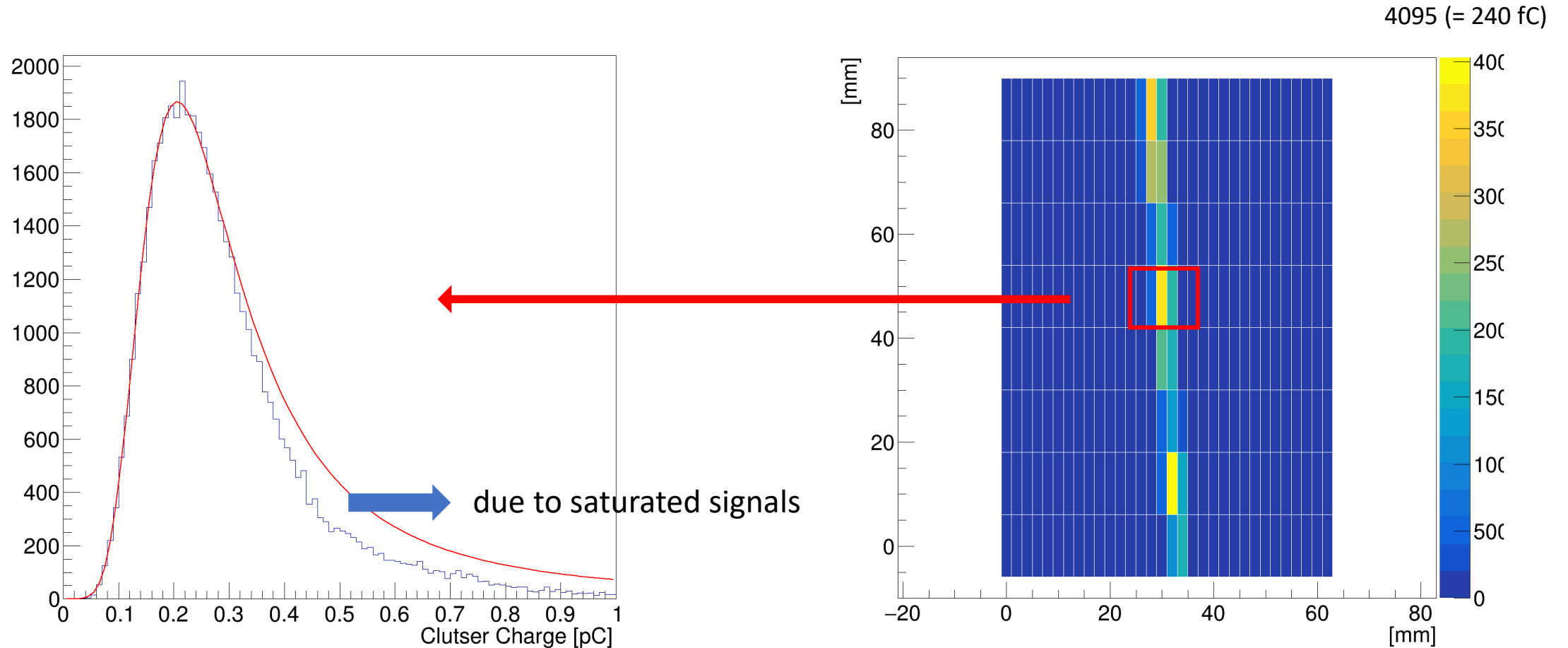
Spatial Resolution (ver. 1)



Spatial Resolution (ver. 2)

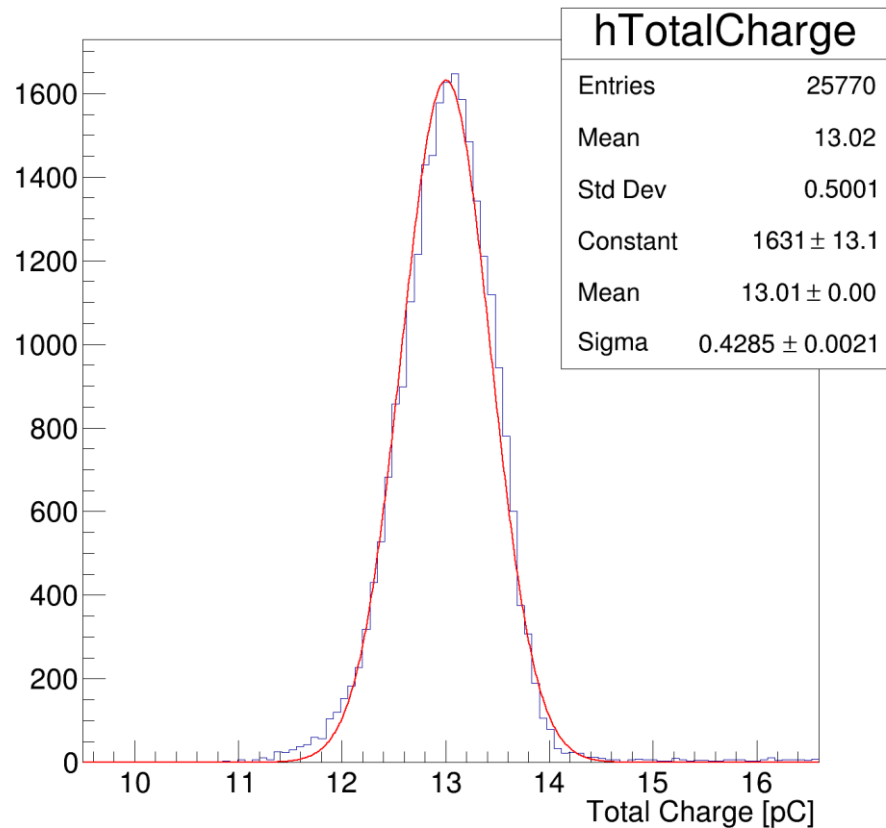


Cosmic muon: Cluster Charge (dE/dx)



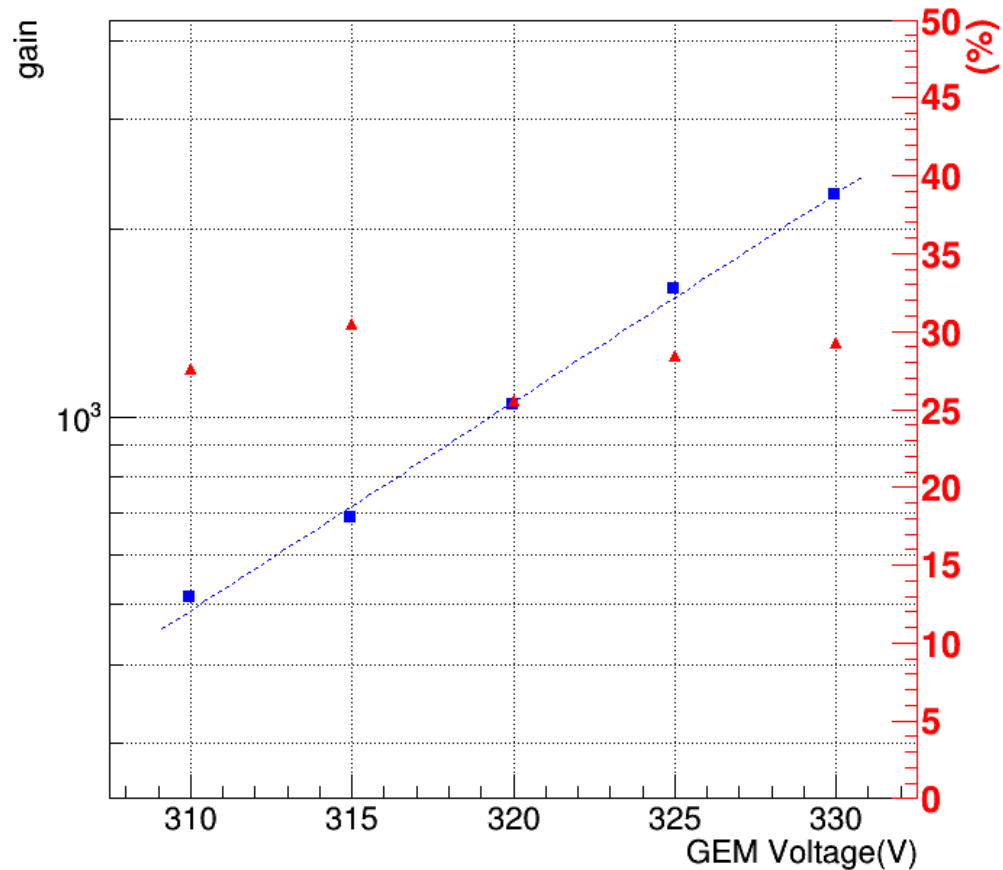
Source test: Gain & Energy Resolution (ver. 1)

Energy Reso.(FWHM)=~8%



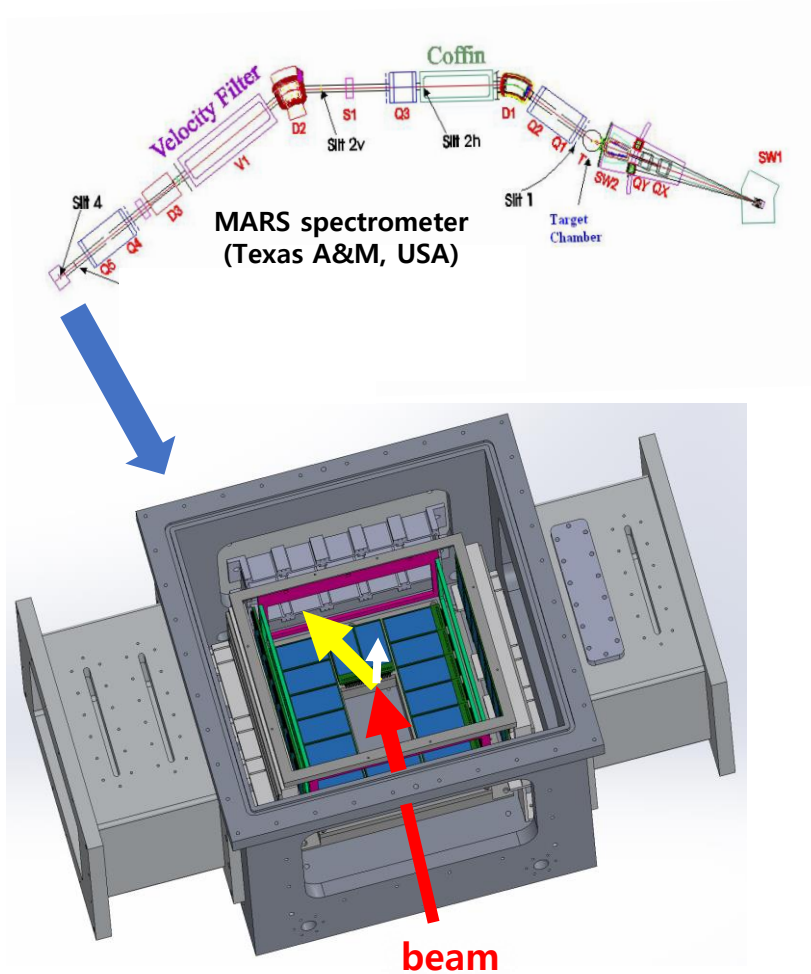
- Am 241 source
- Decay energy of α : 5.486 MeV
- $V_{\text{GEM}} = 310 \text{ V}$

Gain (Energy Reso.(FWHM) = ~28%)



- Fe 55 source
- Decay Energy of X-ray: 5.9 keV

TexAT_v2 test: $^{14}\text{O}(\alpha, p)^{17}\text{F}$ measurement



- TexAT is an Active Target TPC in Texas A&M University
- TexAT can handle $\sim 5 \times 10^5$ pps
- $^{14}\text{O}(\alpha, p)^{17}\text{F}$ is the trigger reaction of an X-ray burst
- $^{14}\text{O}(\alpha, p)^{17}\text{F}$ will be measured at CRIB

Plan

- In Feb. 2023, Quasi-free scattering experiment in HIMAC
- Develop ATTPC(≥ 1024 ch, gas pressure 0.1~2.0 atm) using 20 x 20 cm² GEM
- In 2023-24, we plan to measure a $^{17}\text{F}(\alpha, p)^{22}\text{Ne}$ or another (α, p) reaction for new ATTPC test in CRIB or Texas A&M...

Q&A