

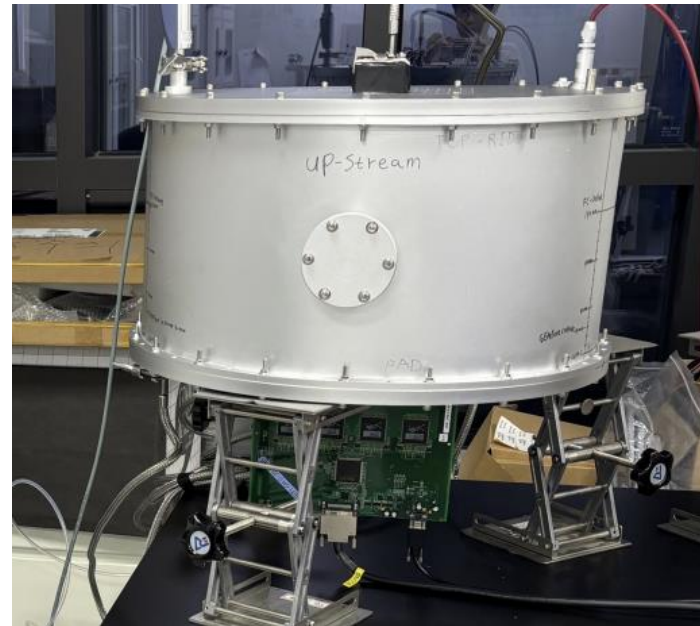
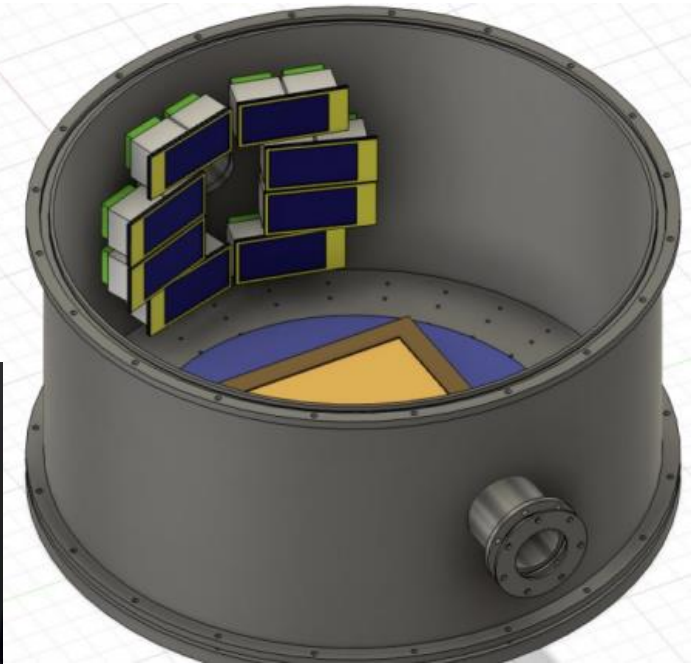
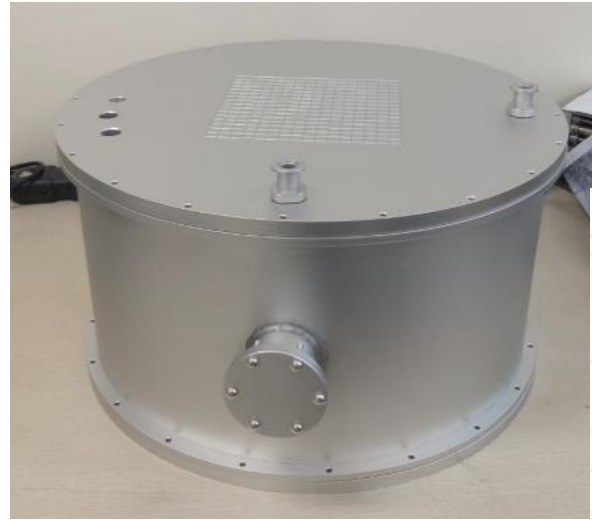
Development of TPC-Drum

Seonggeun Hwang



Outline

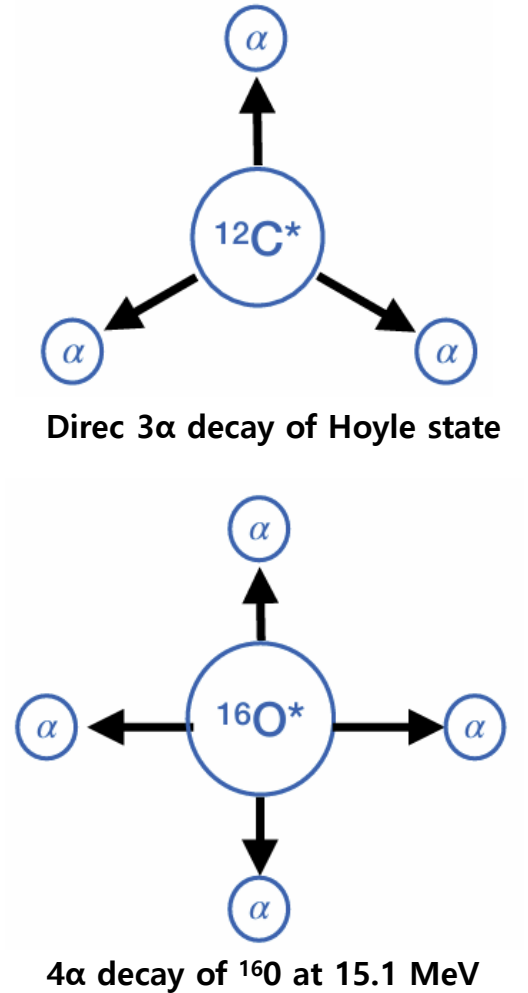
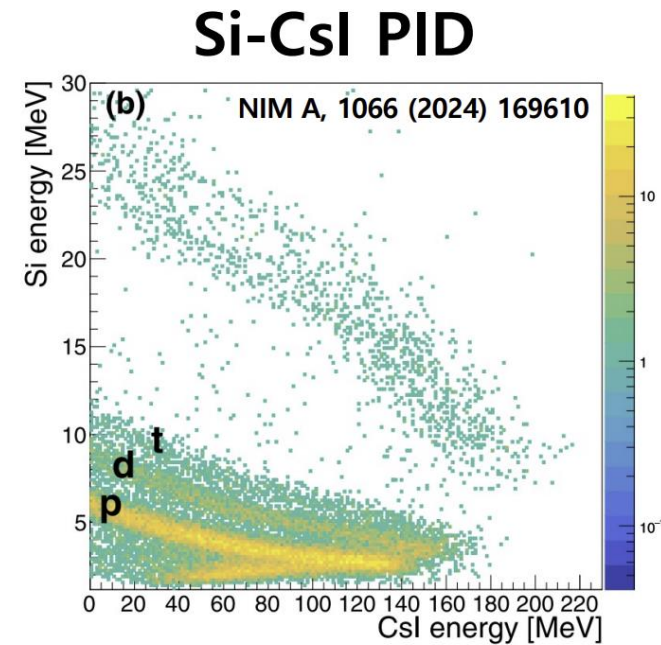
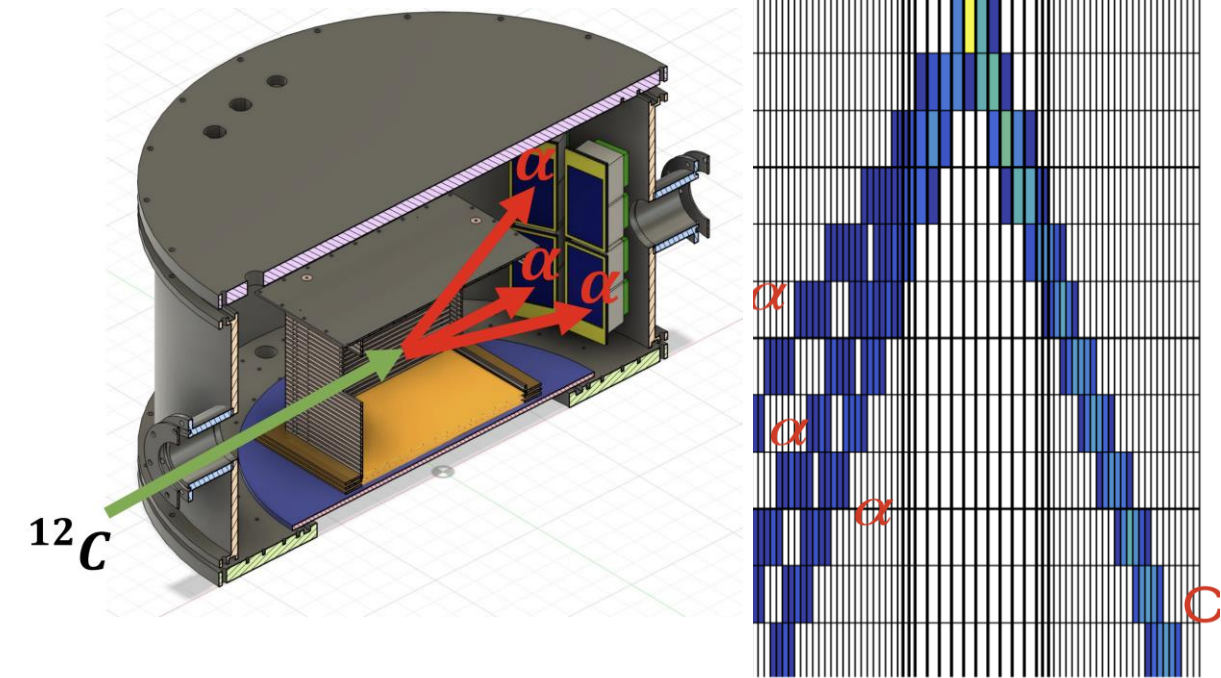
- TPC-Drum
- Readout padplane
- Gas system
- GEM
- Field cage
- Noise subtraction
- Calibrations for GEM gain
- Future work



TPC-Drum

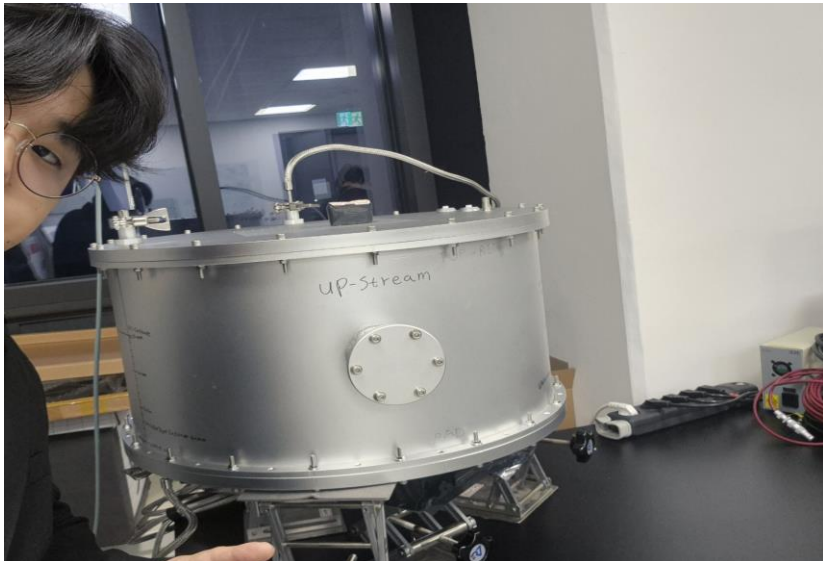
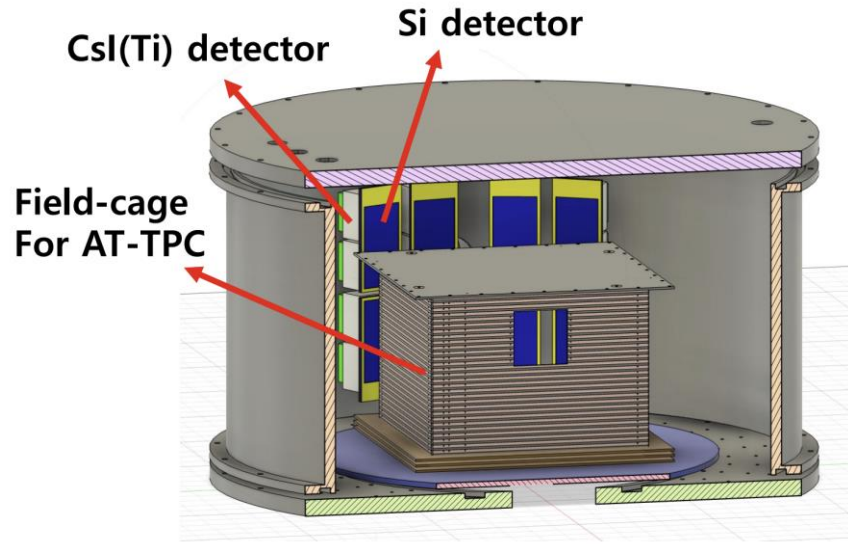
TPC-Drum

- Motivation



- Find evidence for α -condensate state of ^{12}C and ^{16}O using ^{20}Ne or ^{40}Ar beam with α gas
- Commissioning as the final prototype for the low LAMPS TPC

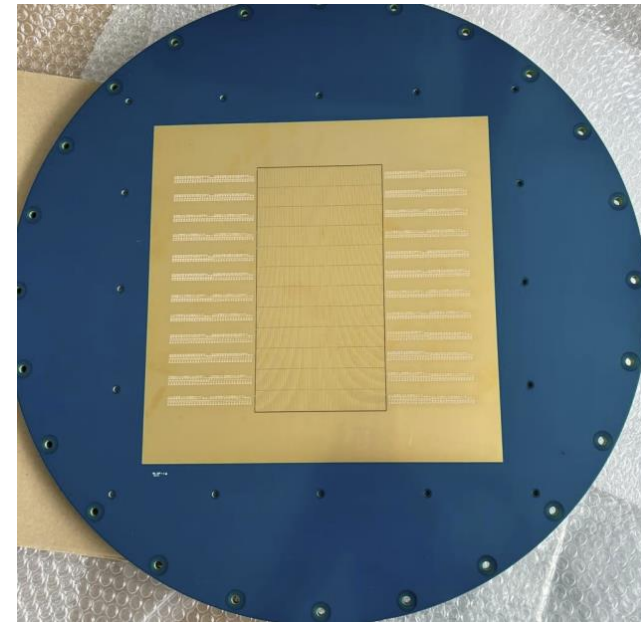
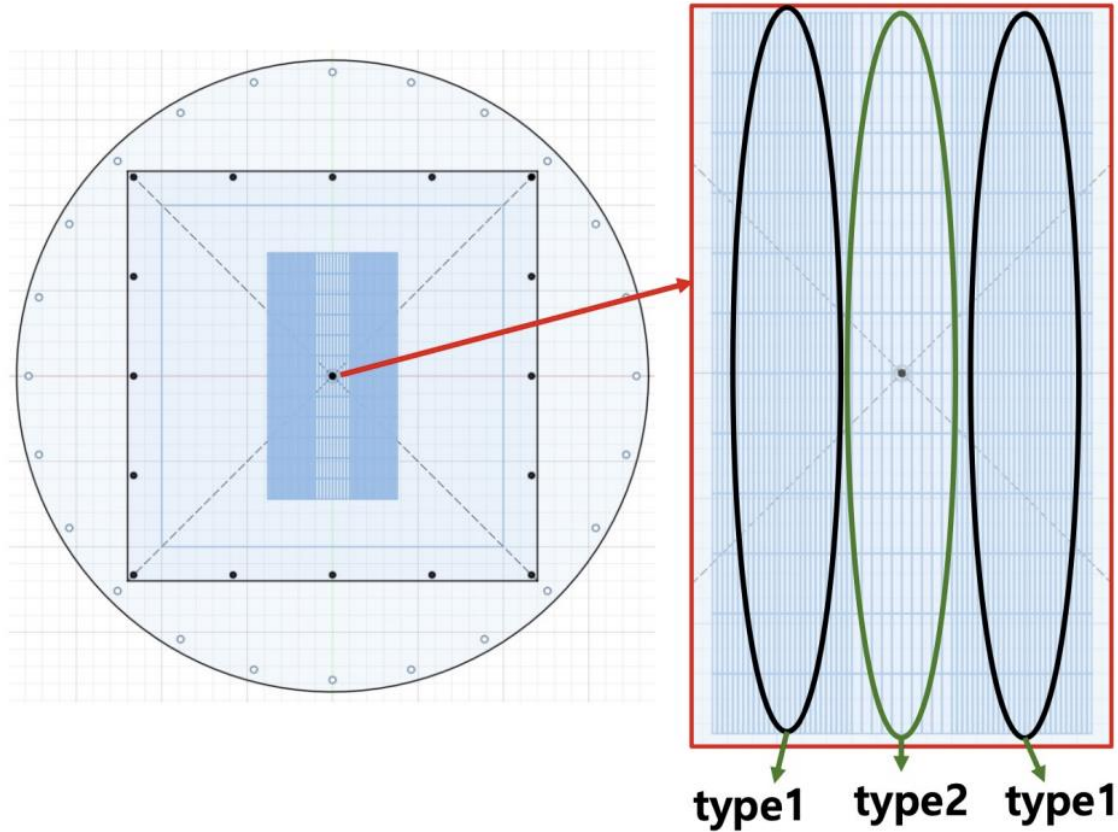
TPC-Drum



- ✓ # of Si detector : 8
- ✓ # of Csi(Ti) detector : 16
- ✓ # of TPC pad channel : 768
- ✓ TPC active area : $200 \times 200 \times 150 \text{ mm}^3$
- ✓ TPC gas : ^4He (90%) + CO_2 (10%) mixture
- ✓ Triple-GEM structure

Read-out pad plane

Read-out pad plane

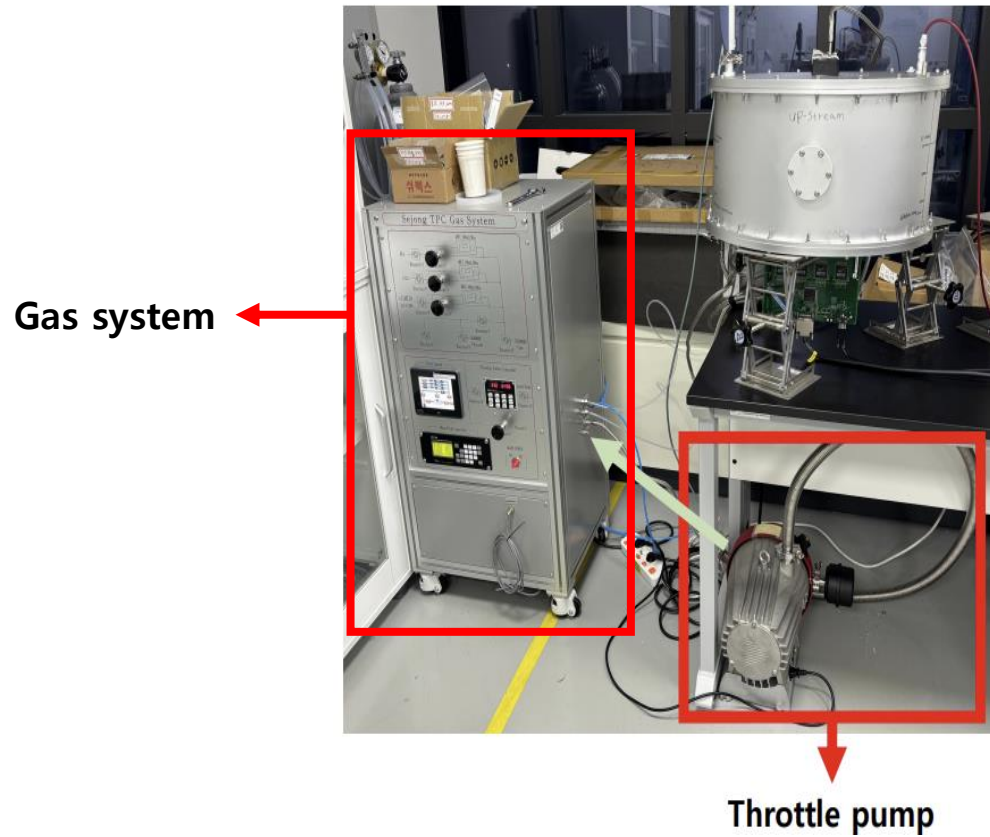


- **# of channel** : 768 channels
- **Channel size**
 - **Type 1** : $0.9 \times 11.9 \text{ mm}^2$
 - **Type 2** : $1.9 \times 11.9 \text{ mm}^2$
 - **Gap size** : 0.1 mm
- **Pad plane considered to measure daughter particles**

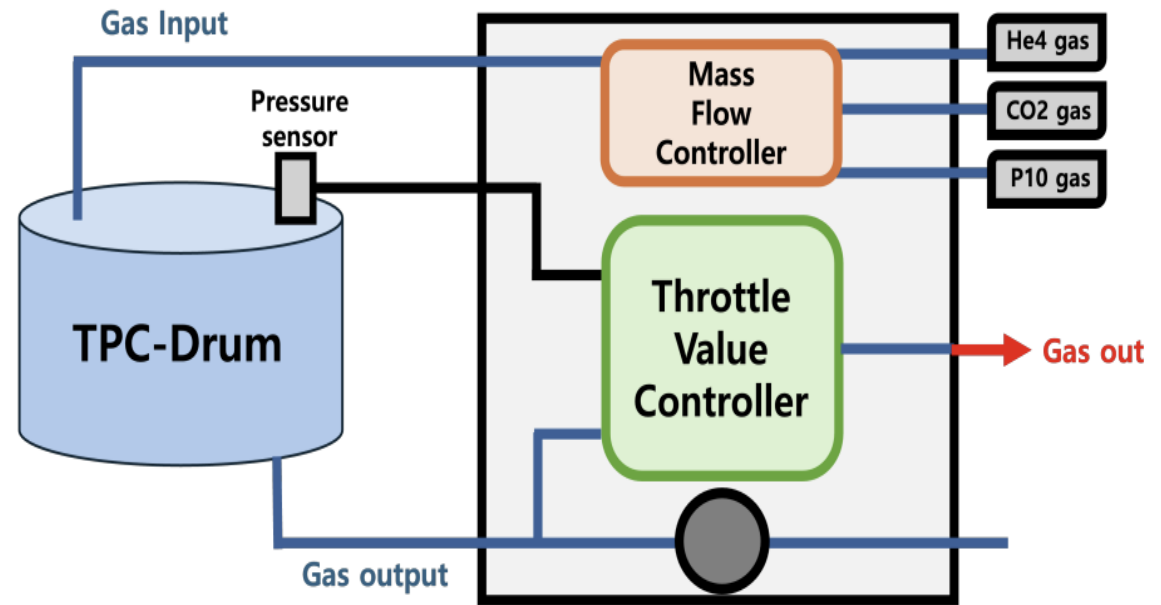
Gas system

Gas system

- System schematics



Gas system

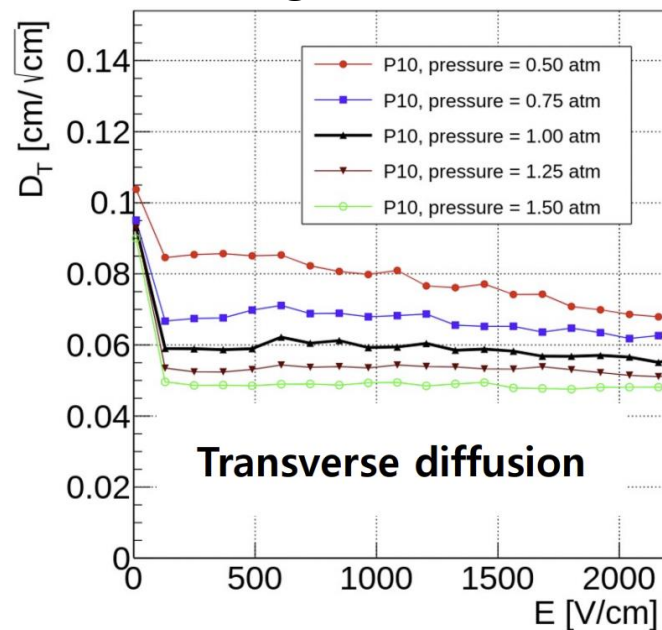


- Operating pressure : 500 ~ 1000 Torr

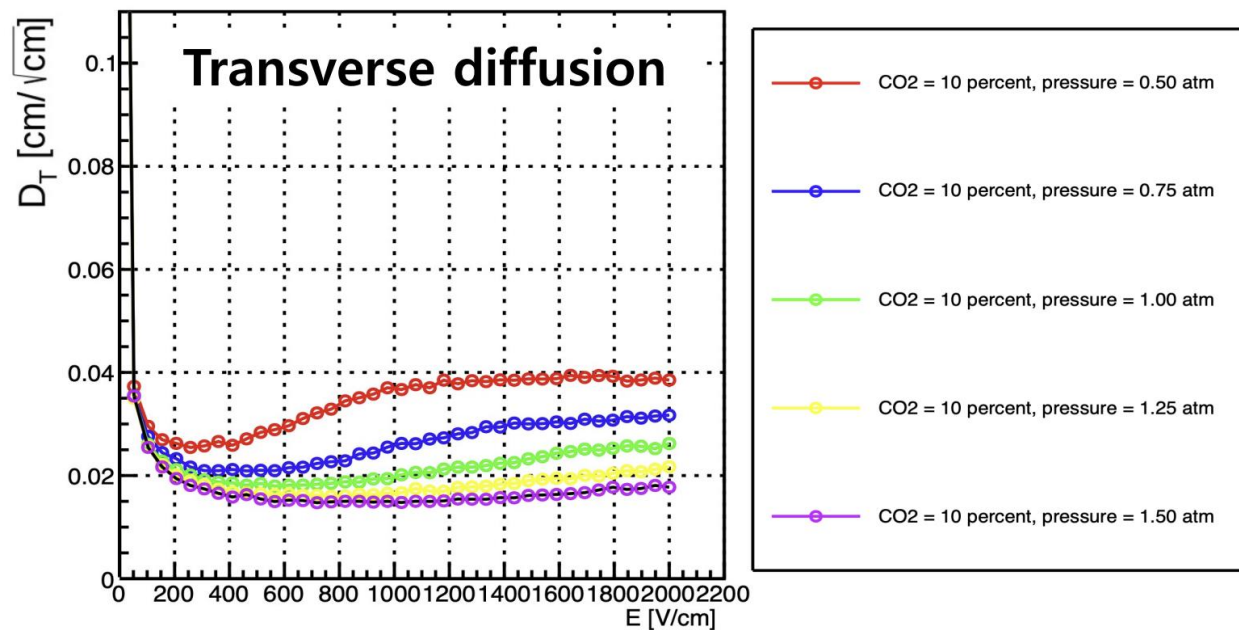
Gas system

- Gas properties

P10 gas (reference)



^4He (90%) + CO_2 (10 %) gas (Garfield++)

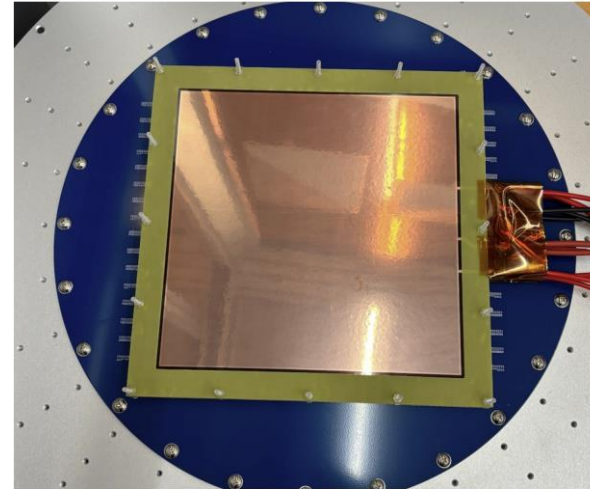
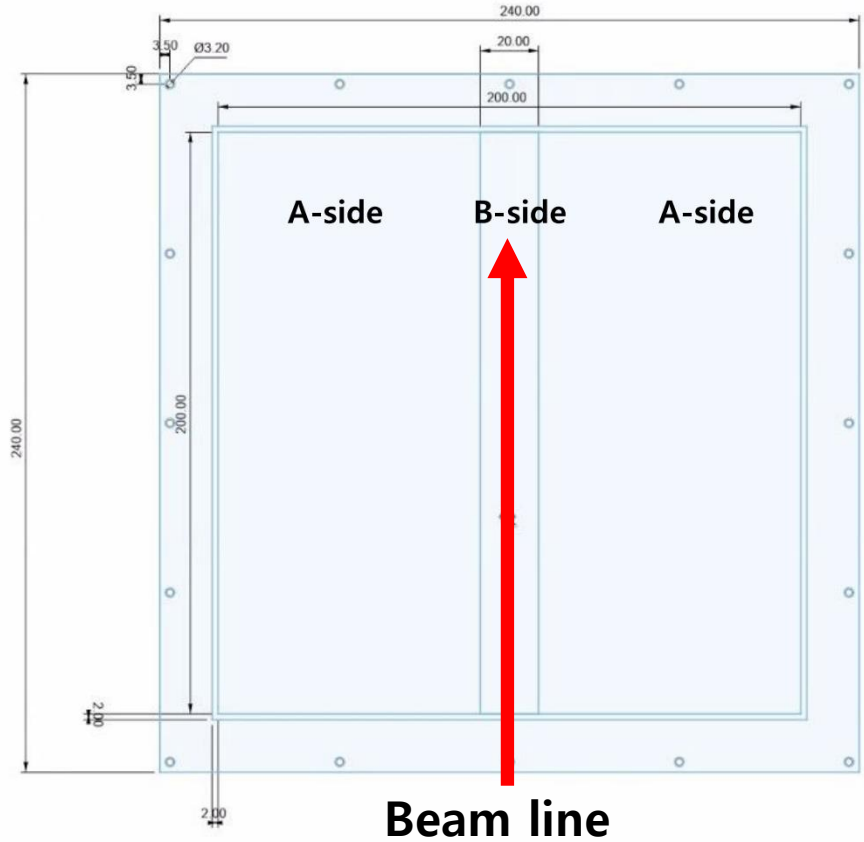


- ^4He + CO_2 gas mixture is three times less diffusion than P10 gas.
- We also reduced the pad width to cluster each hit.

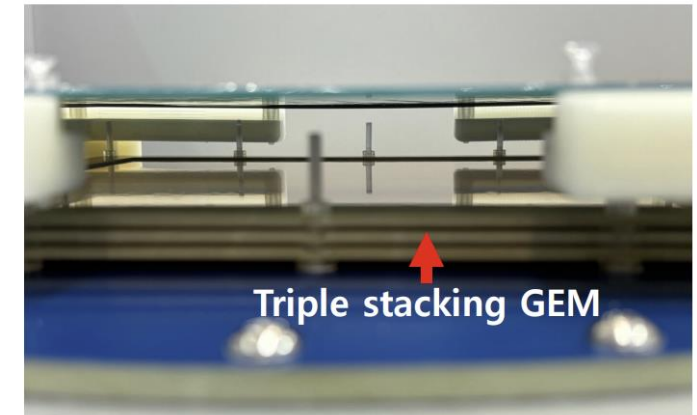
GEM

GEM

- Geometry



Top view

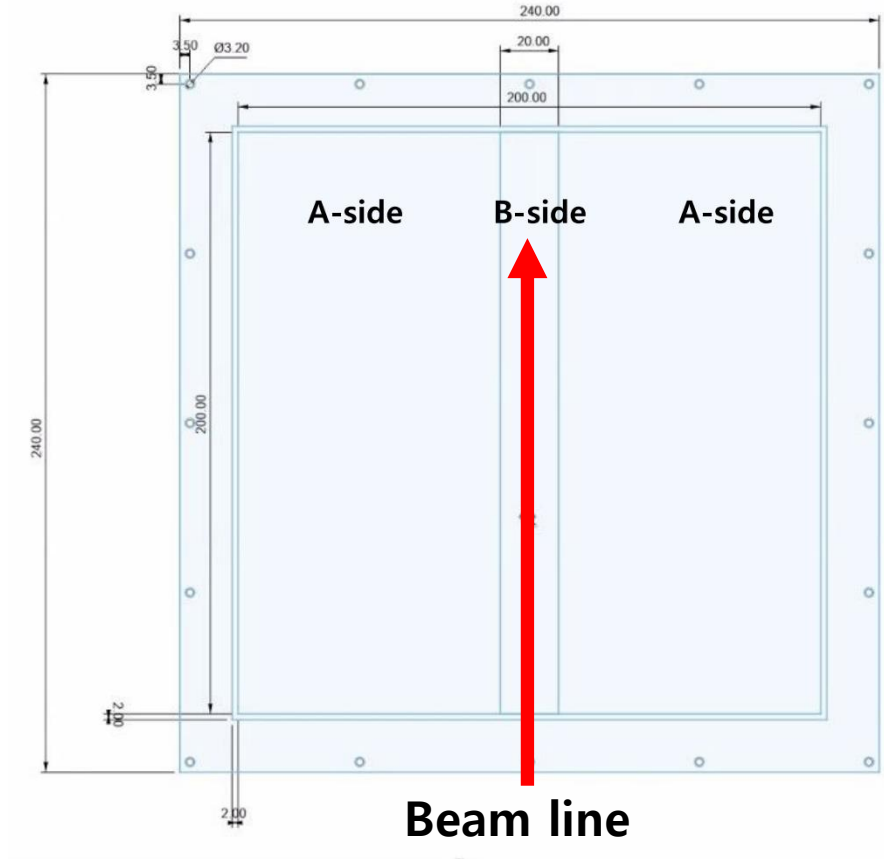


Front view

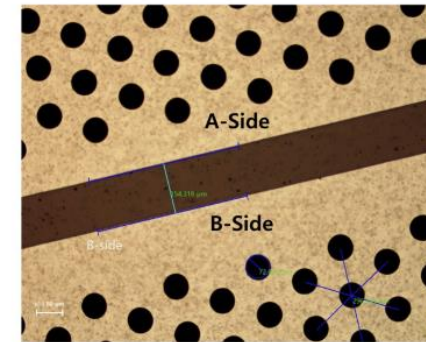
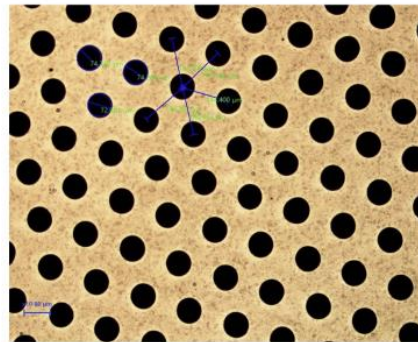
- Active area : 200 x 200 mm²
- A-side : Standard gain area
- B-side : **low gain area (Type-2 GEM)**
- Triple stacking GEM used with type-1 and type-2 GEM with space 3mm

GEM

<Type – 1 >



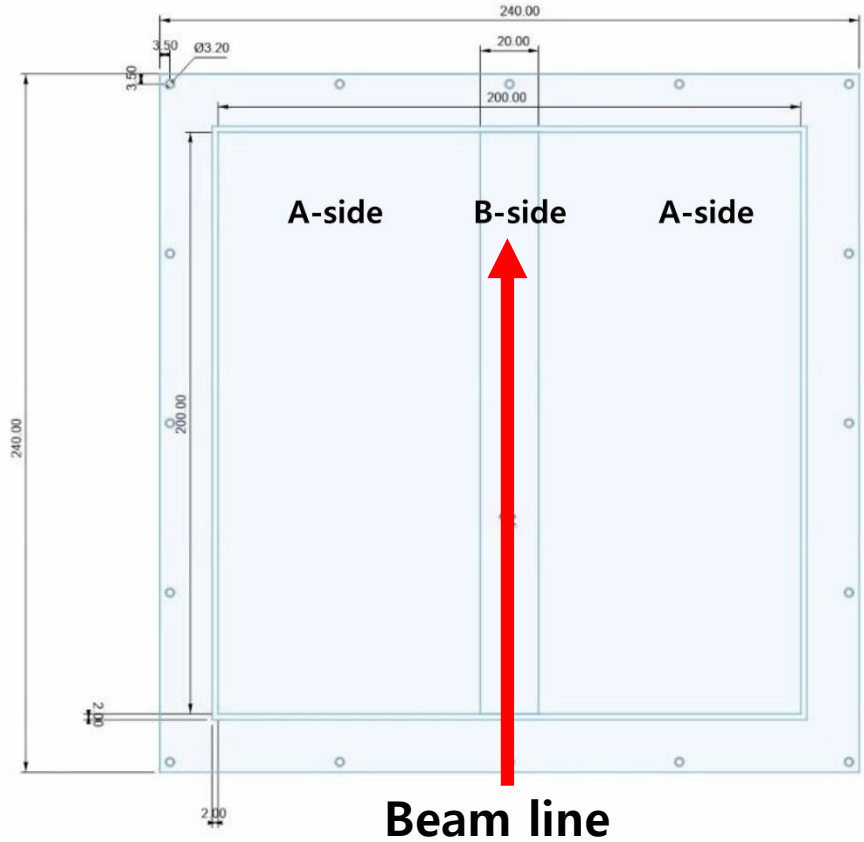
- GEM thickness : 256 μm
- Hole size (diameter) : $\sim 75 \mu\text{m}$



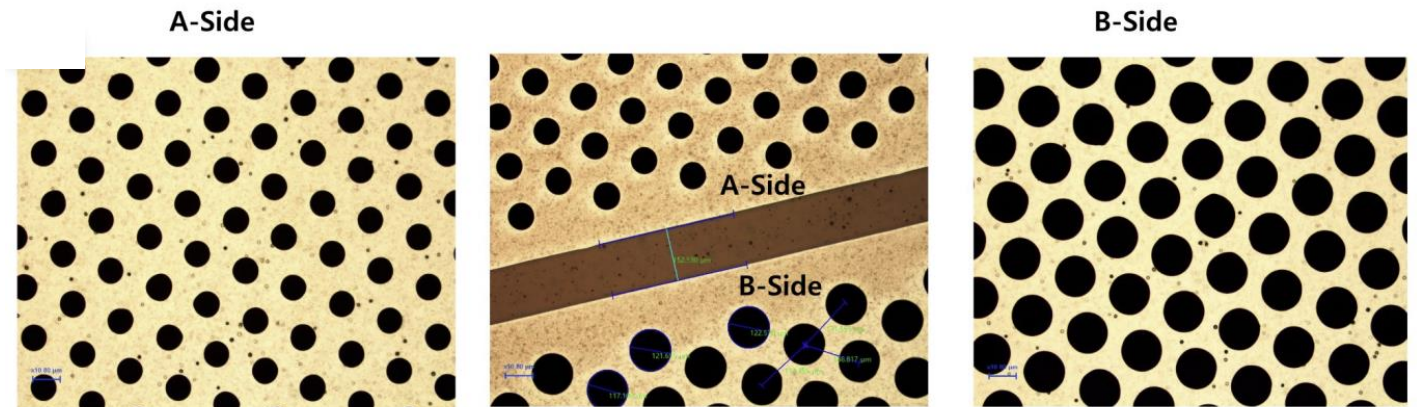
- A-side and B-side have same size

GEM

<Type – 2 >



- GEM thickness : 256 μm
- Hole size (diameter)
 - A-side : $\sim 75 \mu\text{m}$
 - B-size : $\sim 120 \mu\text{m}$

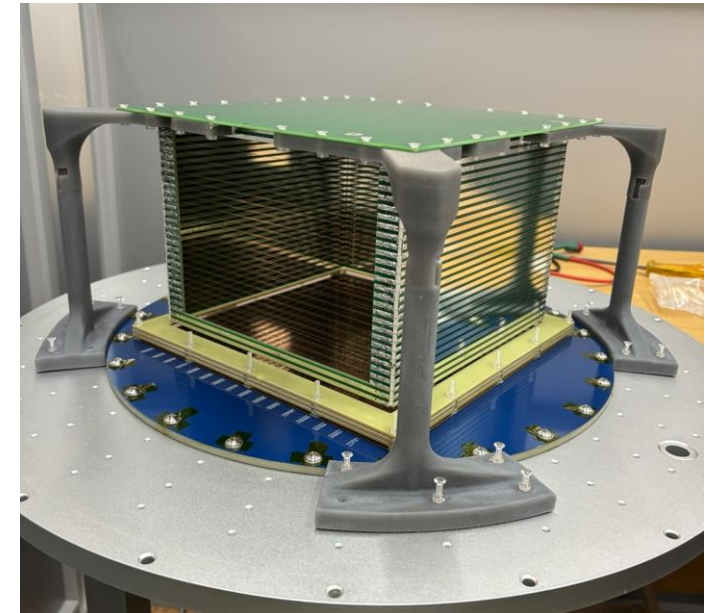
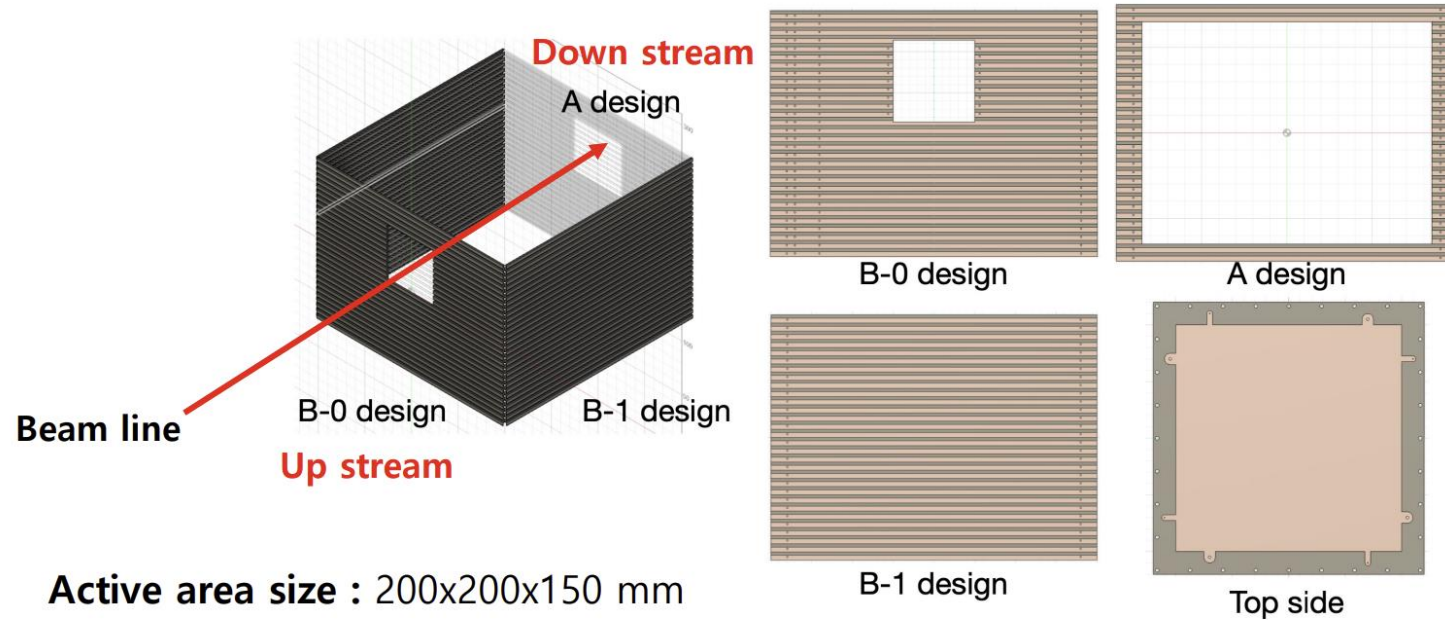


- Type-2 GEM designed to reduce the space charge for high-rate beam ion

Field cage

Field cage

- Schematic view



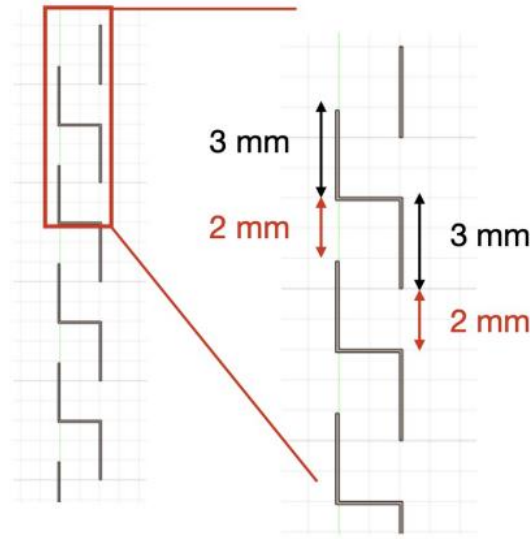
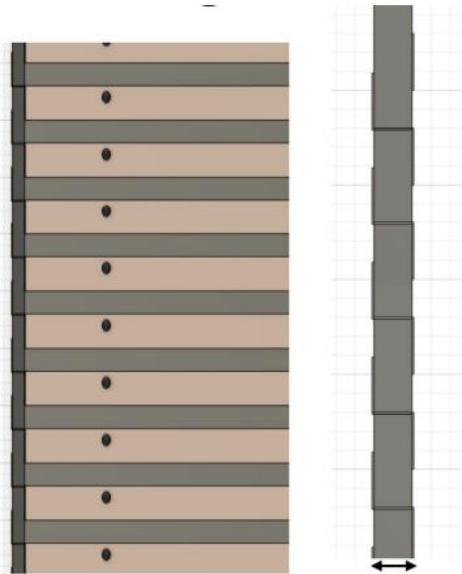
Field cage

- Schematic view

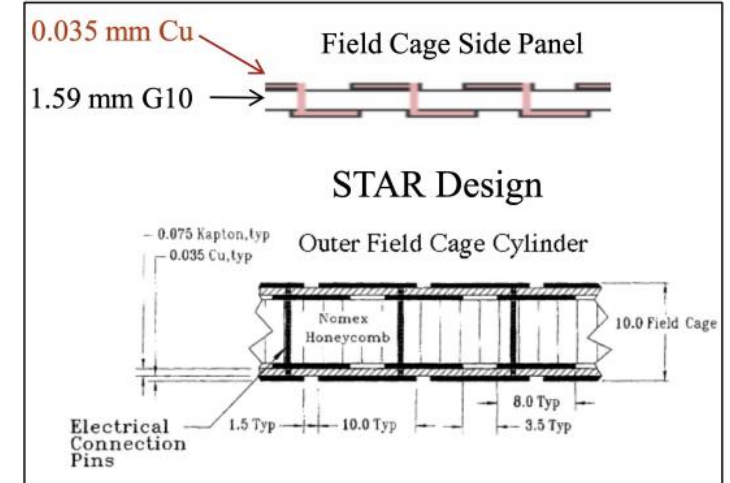
#Electrode layer : 30

#Layer spacing : 5 mm

Front-view side-view

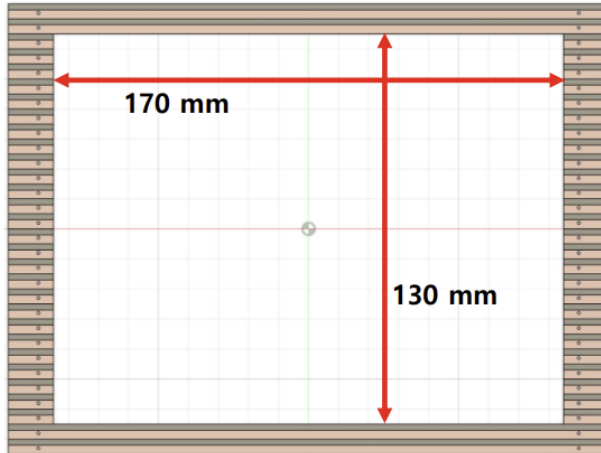


- Field-cage reference
(Sprit TPC and STAR TPC)

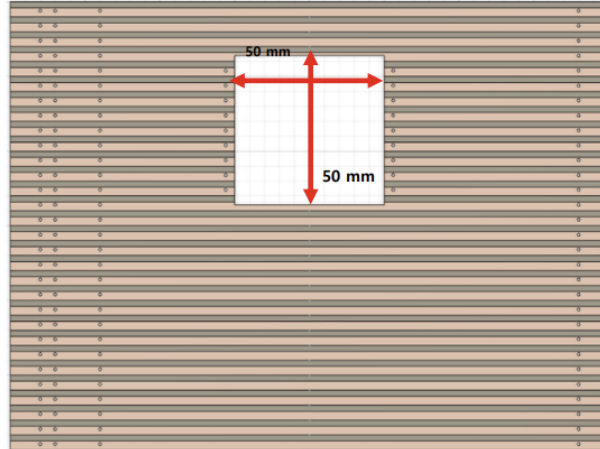


Field cage

- Schematic view



Down-stream plane



Up-stream plane

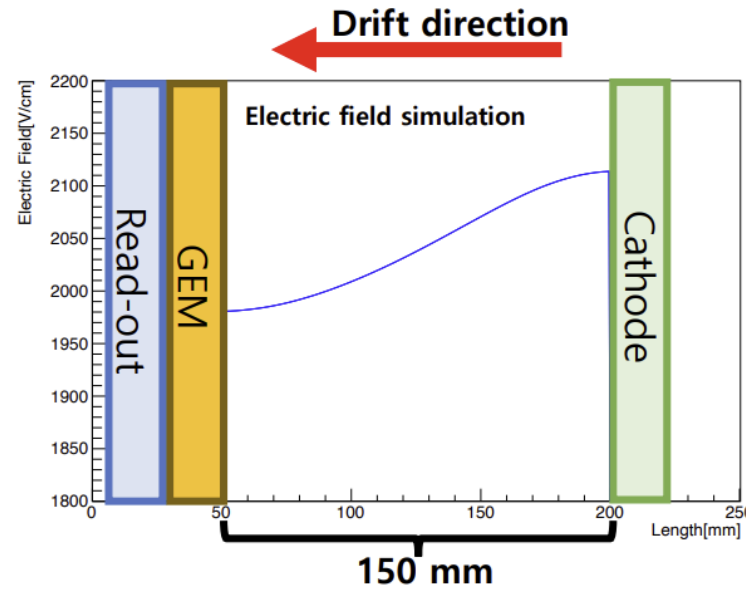
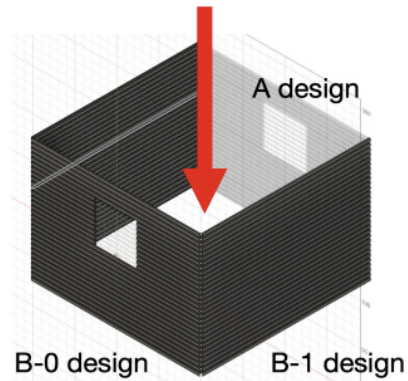


Down stream view

- Empty area has a double-wire structure to avoid particle energy loss and scattering

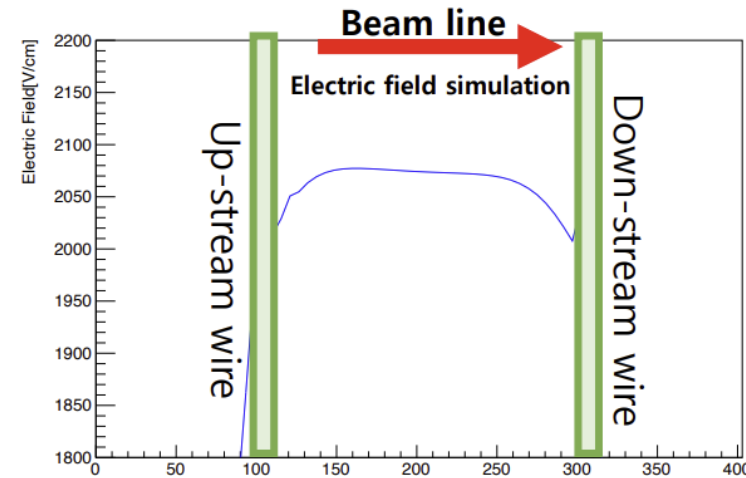
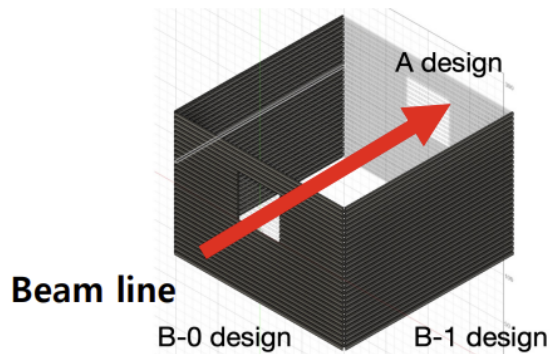
Field cage

● Electric Field



Longitudinal Electric field

6.3% Distortion



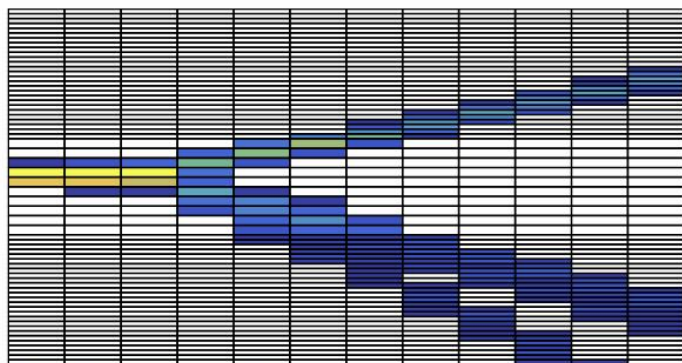
Beam-line Electric field

4% Distortion

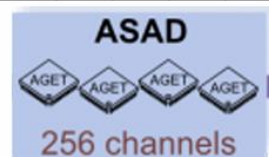
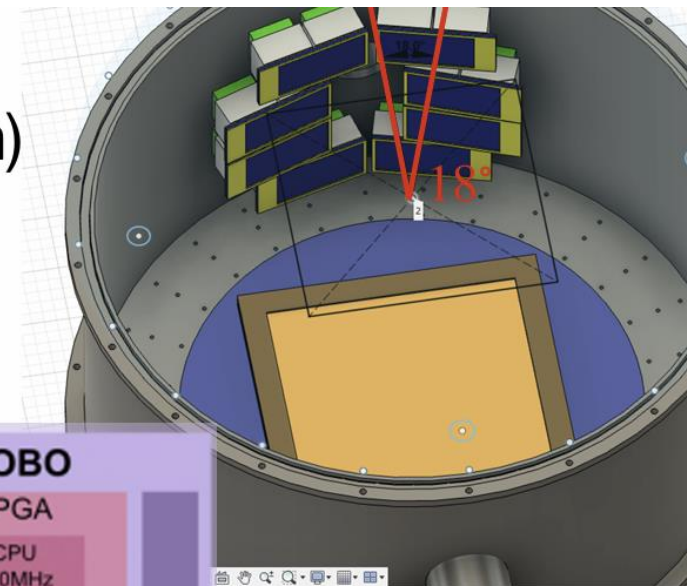
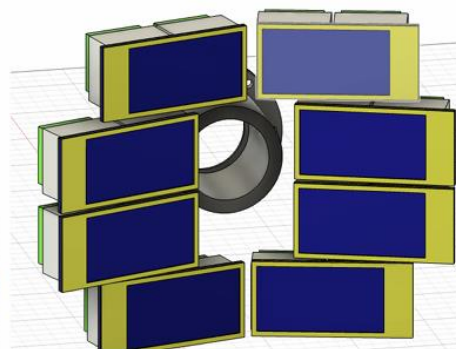
Noise subtraction

DAQ Setup

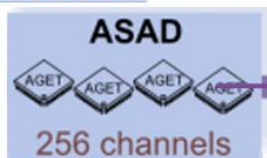
AT-TPC (768 ch)



Si-Csl (176 ch)



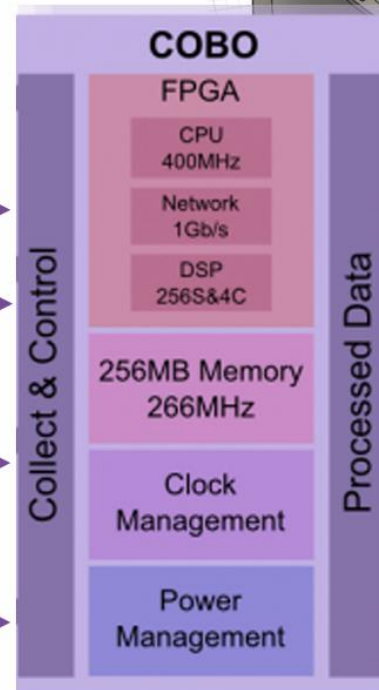
256 ch



256 ch



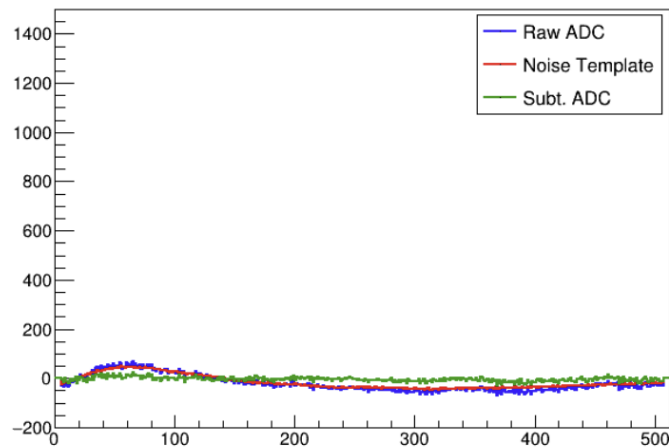
256 ch



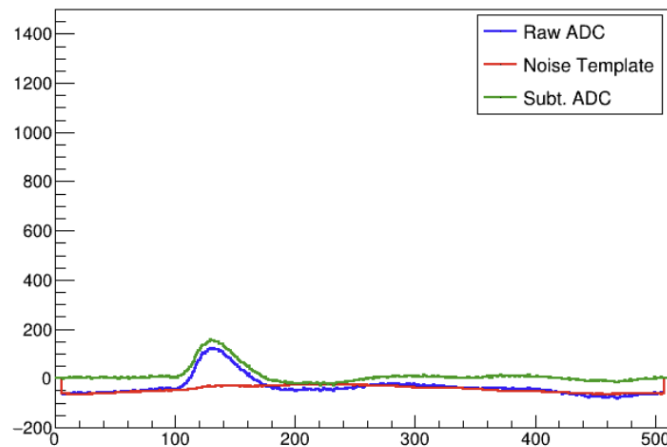
.Graw file

Pulse noise subtraction

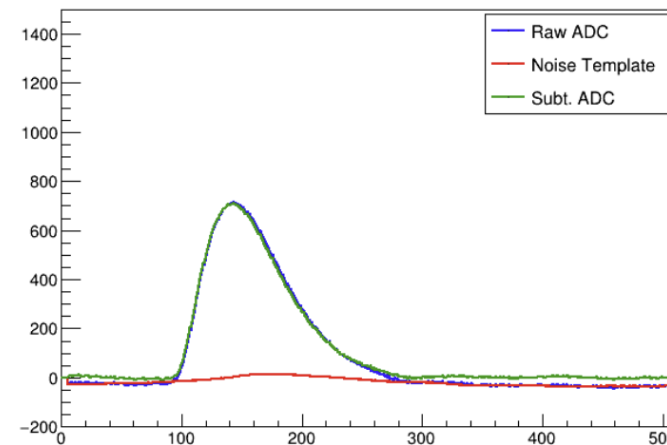
event0 | pad0, layer4, row517



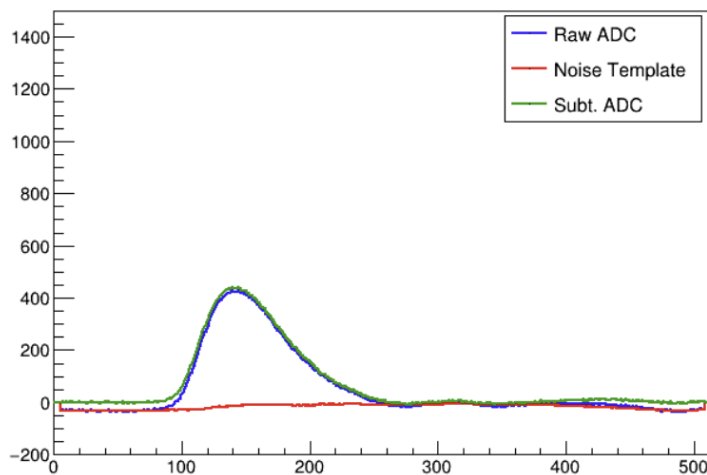
event99 | pad0, layer49, row517



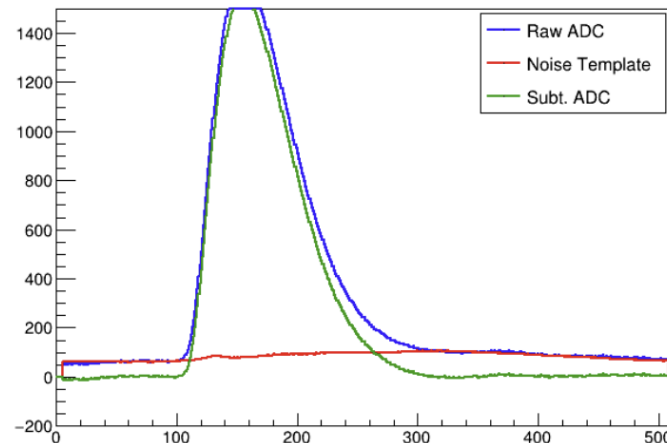
event105 | pad2, layer16, row517



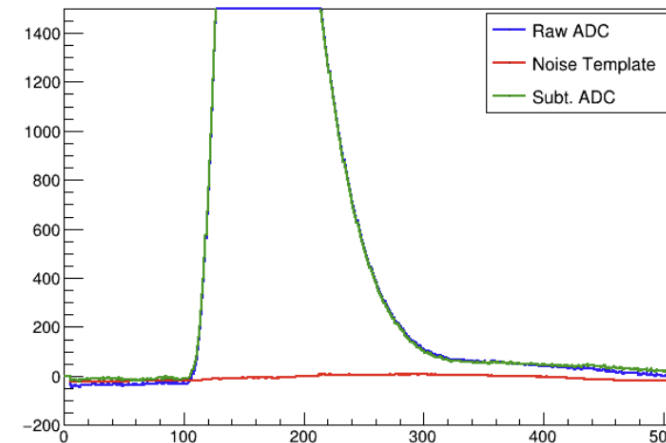
event121 | pad3, layer57, row517



event116 | pad1, layer13, row517



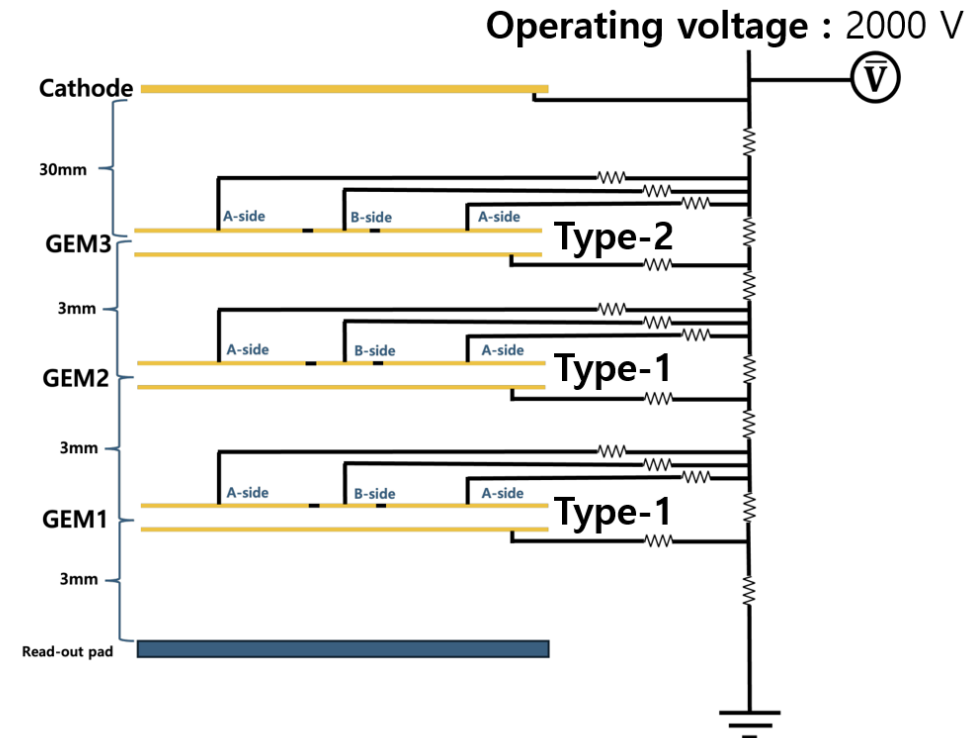
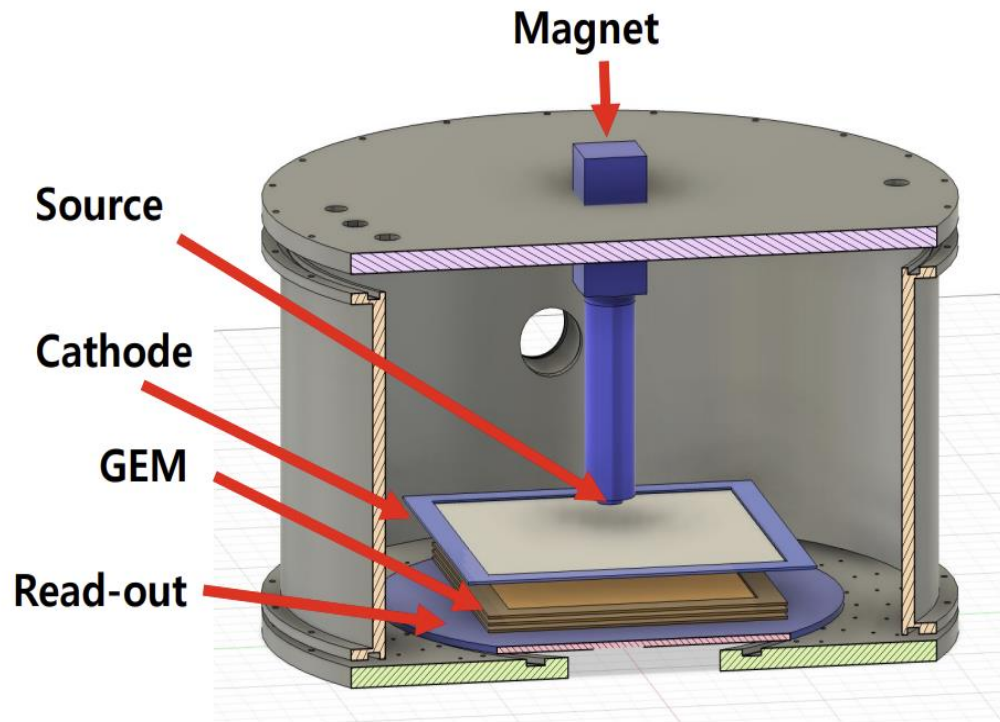
event54 | pad2, layer34, row517



Calibrations for GEM gain

Calibrations for GEM gain

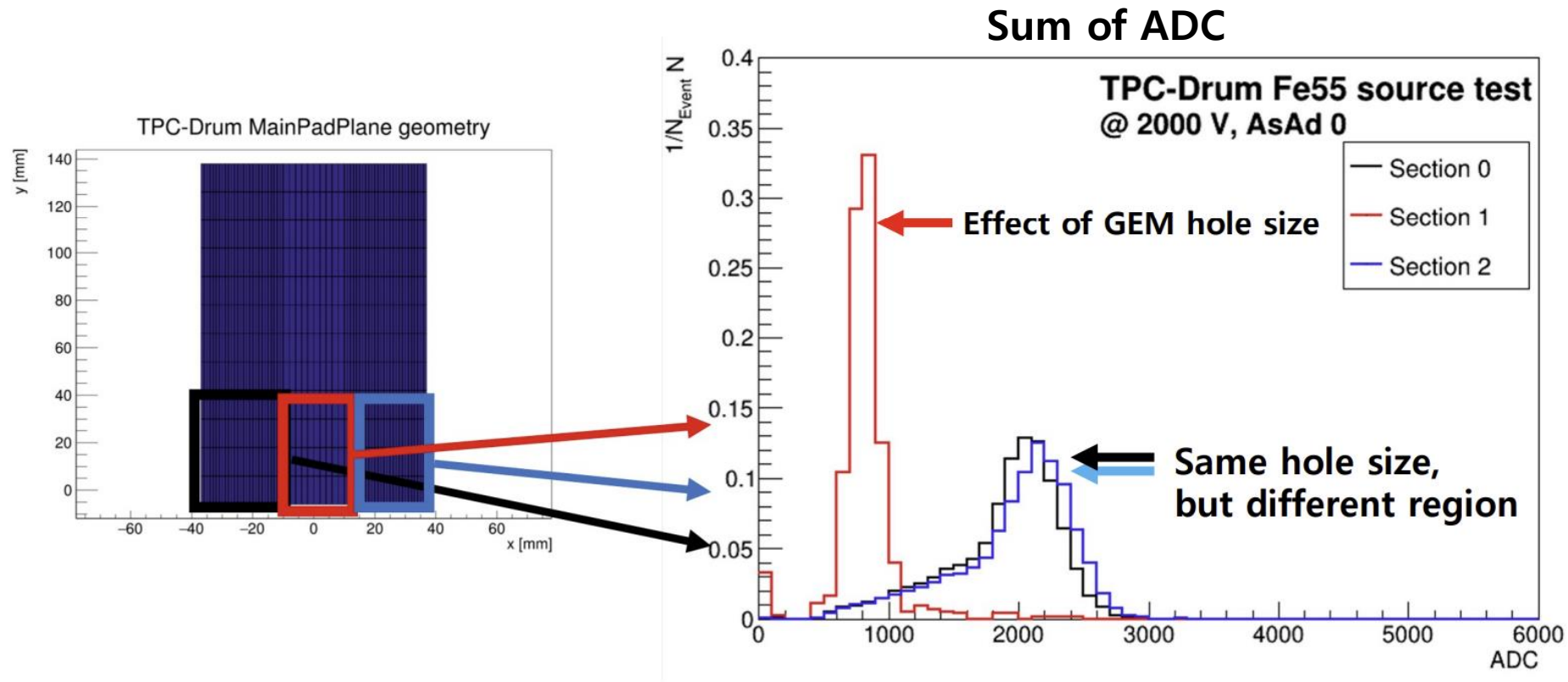
- ^{55}Fe source test



- Magnet can move source position to getting statistics for desired region

Calibrations for GEM gain

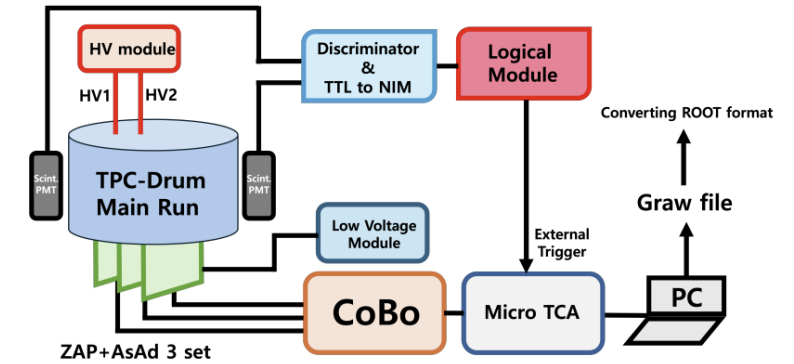
- ^{55}Fe source test



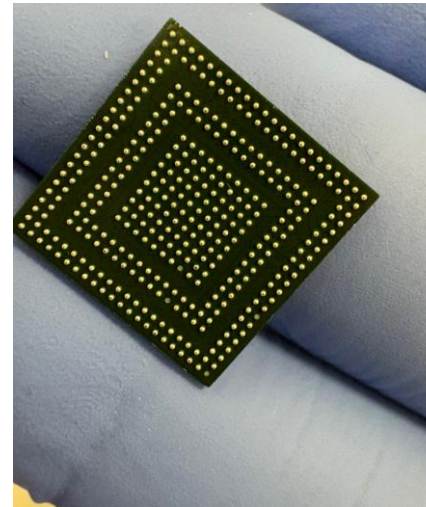
Future work

Future work

- ✓ Cosmic muon test with 2 external PMT trigger to measure track
- ✓ ^{241}Am alpha source test for dE/dx



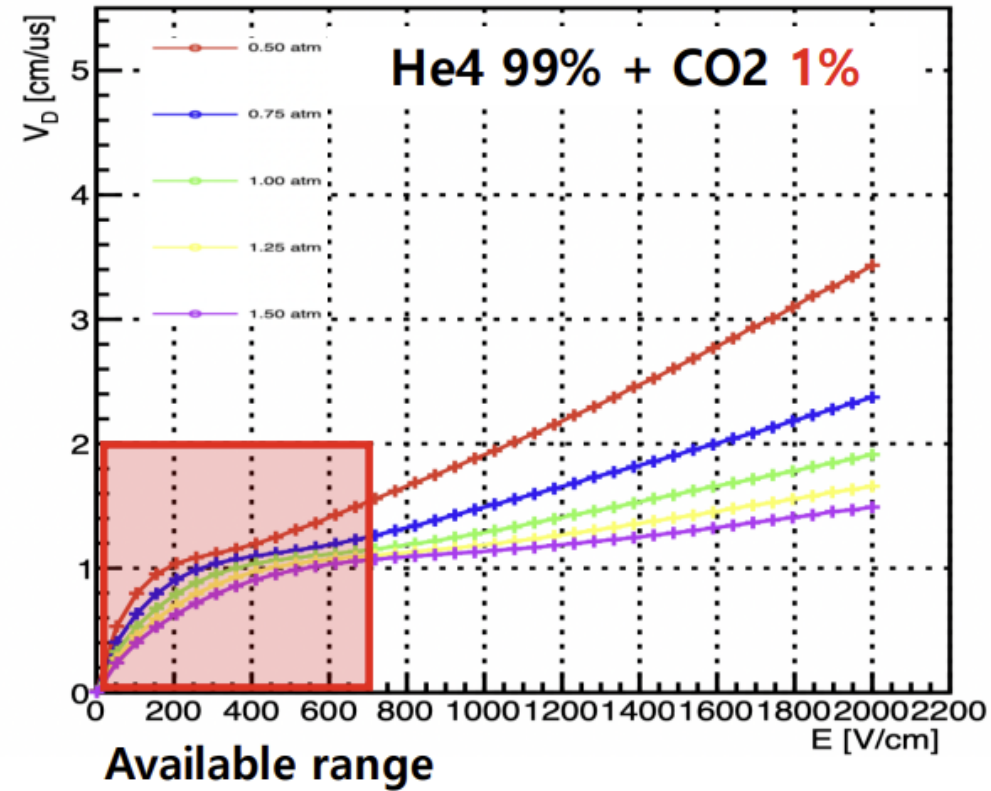
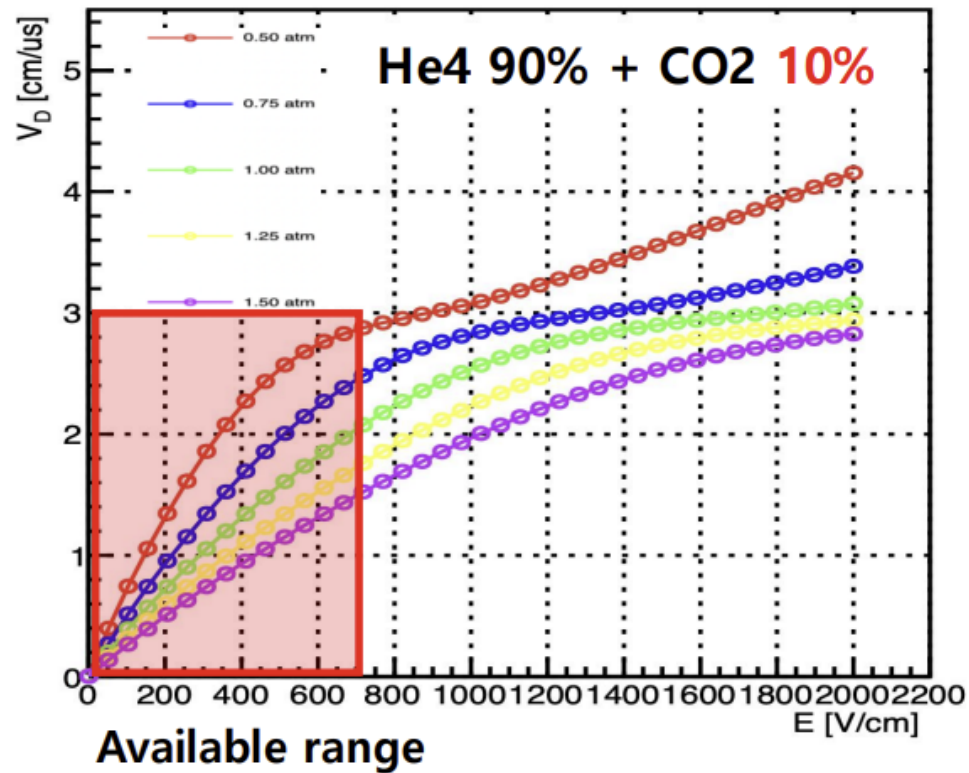
- ✓ We are considering conducting experiments with TPC-Drum using the RAON beam this year.
- ✓ We are considering replacing the TPC-Drum's readout system from the existing GET system to a SAMPA chip



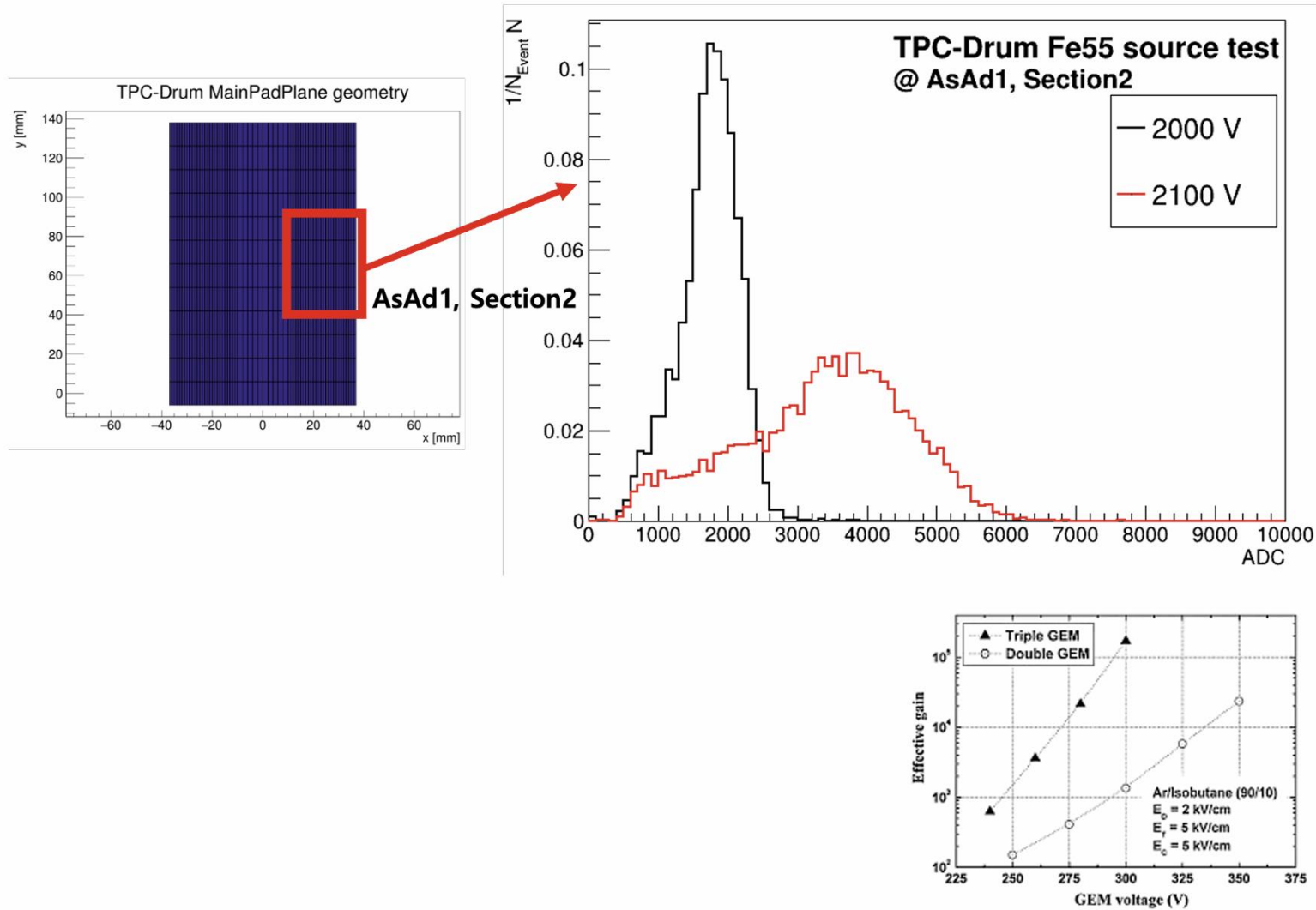
SAMPA chip

Backup slide

Drift Velocity in Drift area



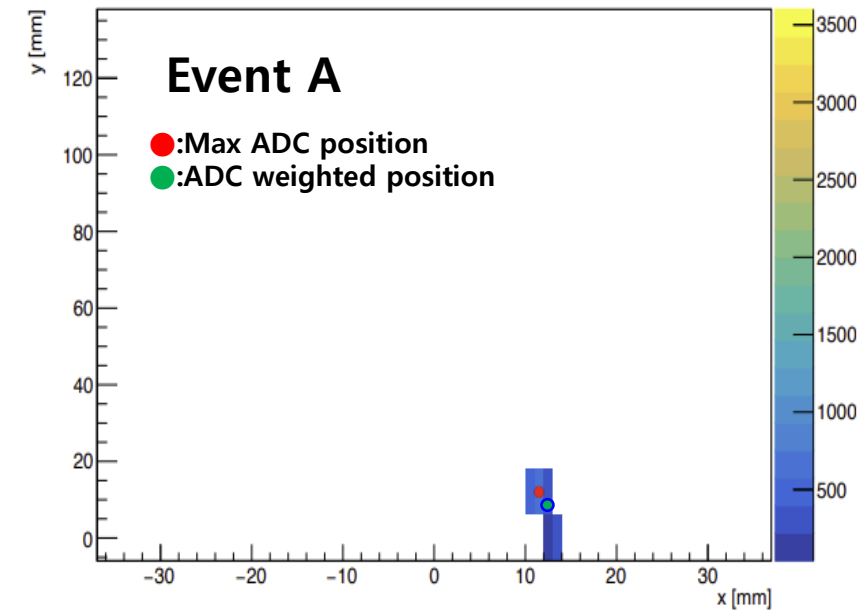
Triple GEM



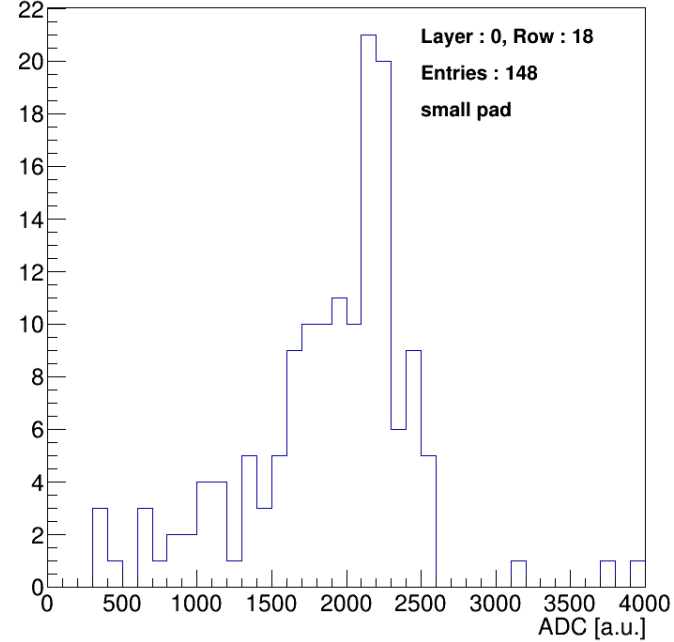
Calibrations

- ^{55}Fe source test

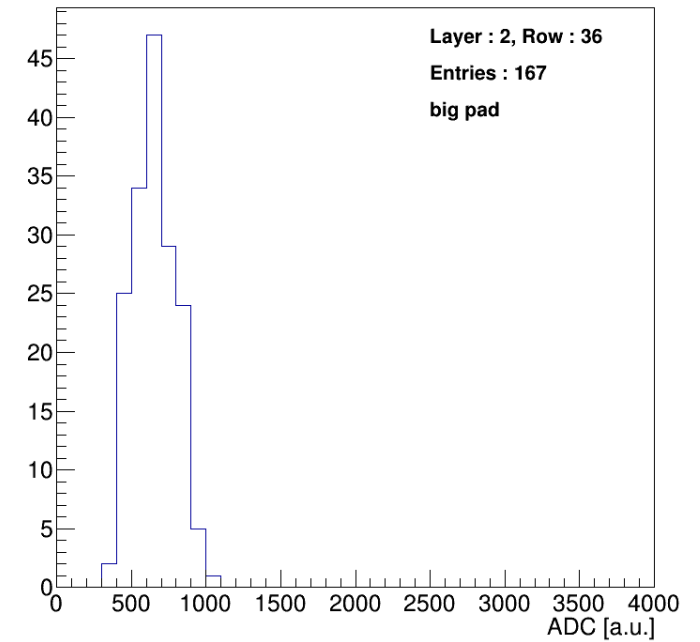
Event display



Sum of ADC (One Channel)



Sum of ADC (One Channel)



- To get a histogram of each channel, ADC weighted position is measured