Garfield Simulation for Gating Grid Performance of TexAT_v2 and AToM-X

Seungkyung Do
Korea University

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Garfield

Garfield : A simulation tool modeling gas-based particle detectors and electric field configuration

Goals of Simulation

- Assess the feasibility of the actual experiment
- Measure detector efficiency
- Identify potential systematic errors
- Develop and test analysis macros

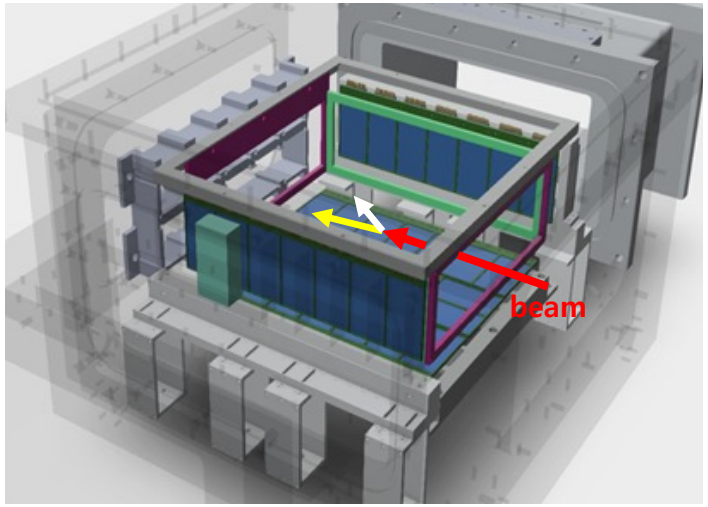
Simulation list

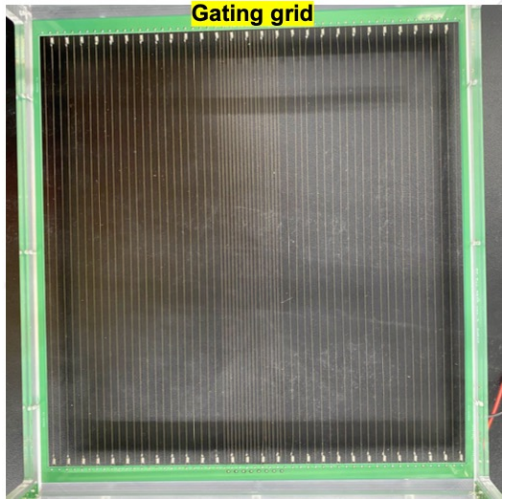
1. **TexAT_v2 Garfield simulation ① -** Verify the **gating grid** performance
2. **TexAT_v2 Garfield simulation ② -** Check the impact of **gating grid** from **Micromegas map**
3. **AToM-X Garfield simulation -** Verify the **gating grid** performance

Detector

TexAT_v2

(**Tex**as **A**ctive **T**arget TPC **version 2**)





→ One of **A**ctive **T**arget **TPC**s **(AT-TPC**s**)**, composed of

- Field cage
- Silicon and CsI(Tl) detectors
- Micromegas(MM) + GEM
- Chamber
- DAQ system using GET electronics

Detector

TexAT_v2

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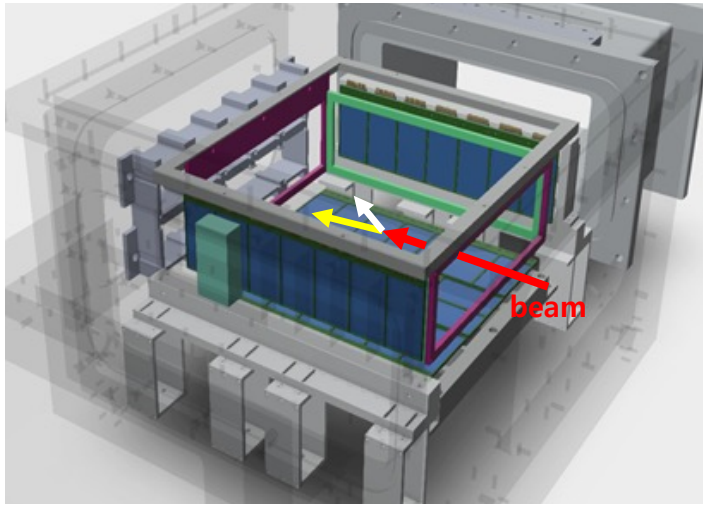
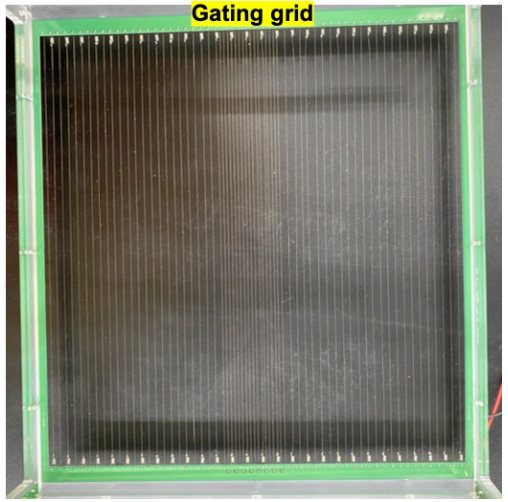
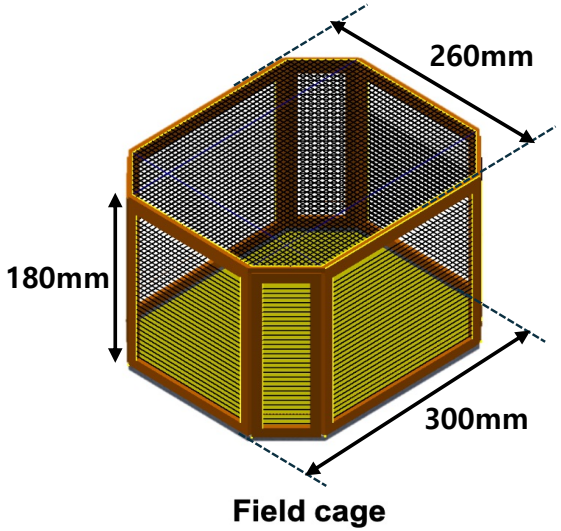






→ One of **A**ctive **T**arget **TPC**s **(AT-TPC**s**)**, composed of

- Field cage

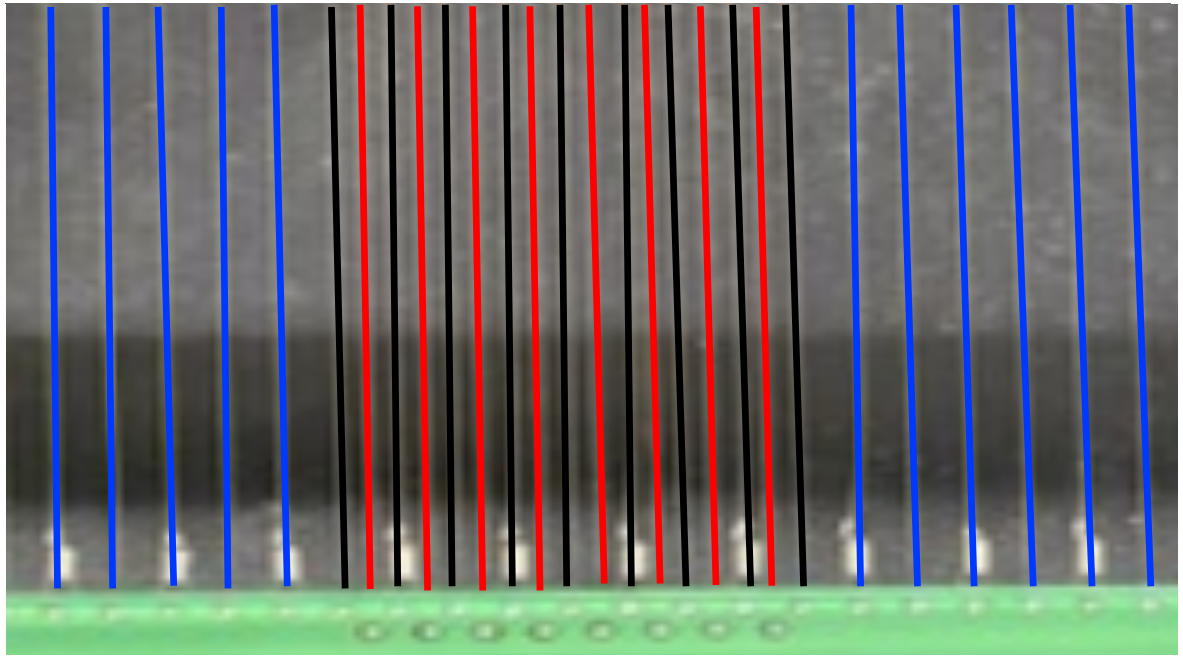
  : It provide uniform Electric field in the active volume

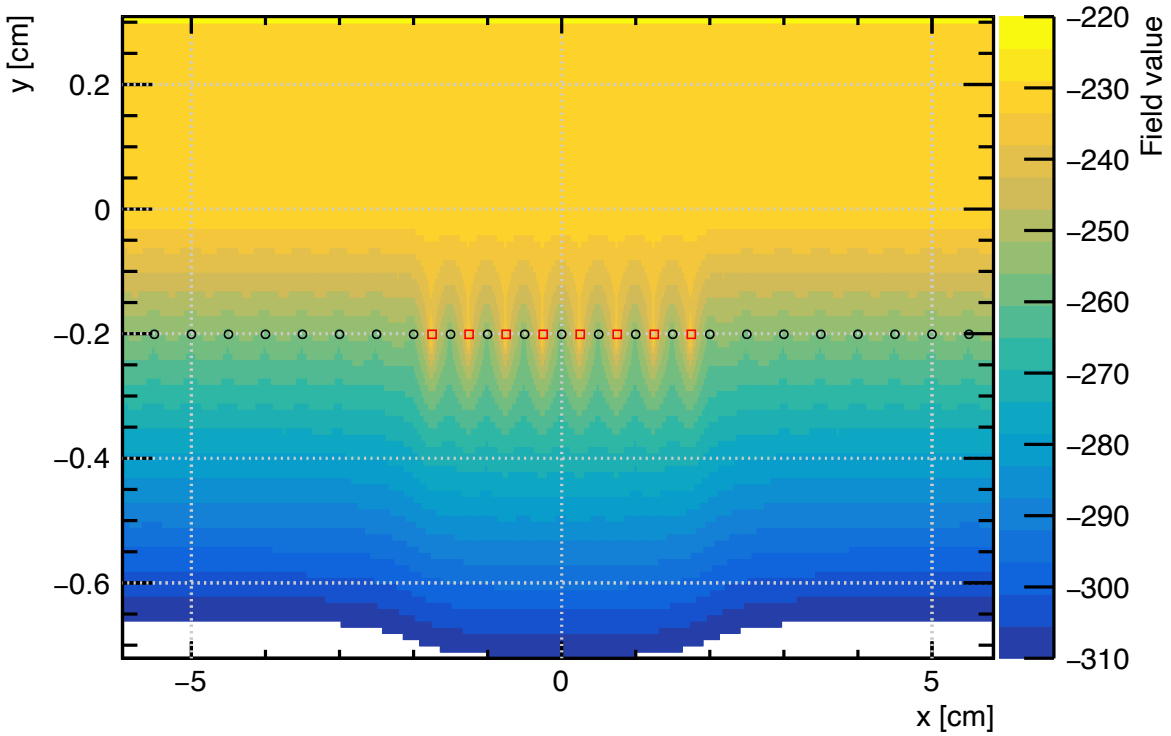
  : It made of Au-plated tungsten wire (50μm-thick) due to the particle transmission

Detector

TexAT_v2

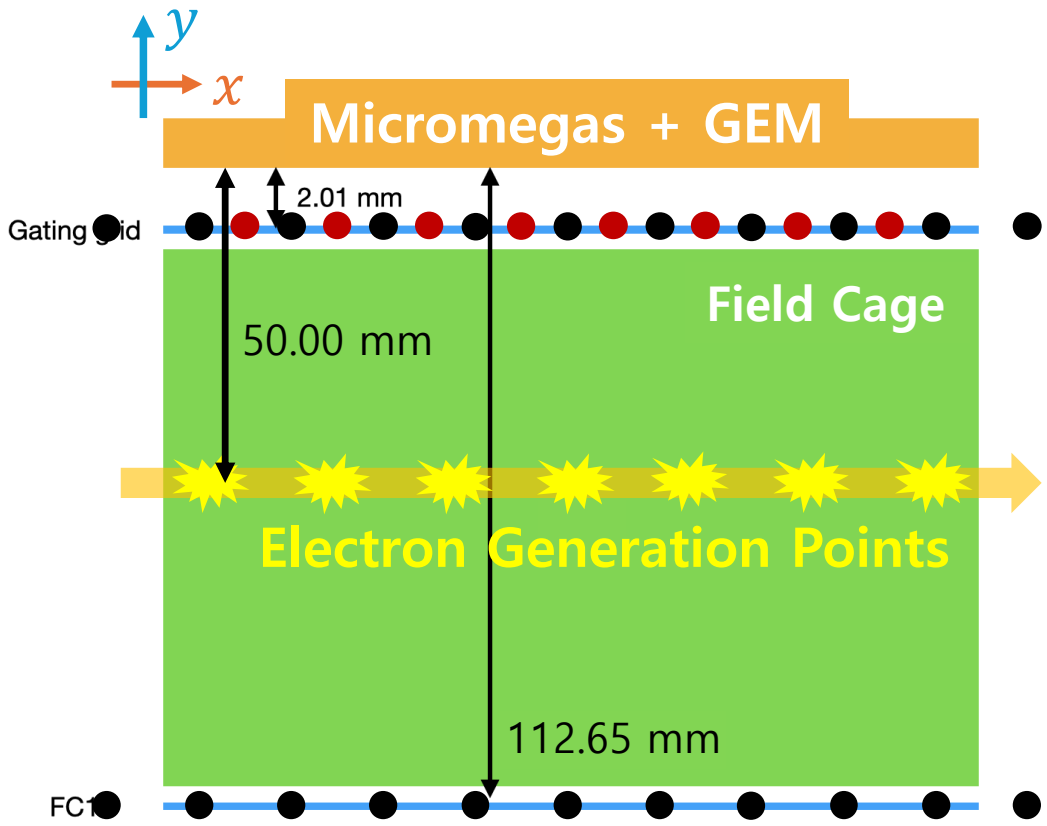
(**Tex**as **A**ctive **T**arget TPC **version 2**)





- **Normal wire : -260 V**
- **Gating Grid 1 : -260 V**
- **Gating Grid 2 : -230 V**

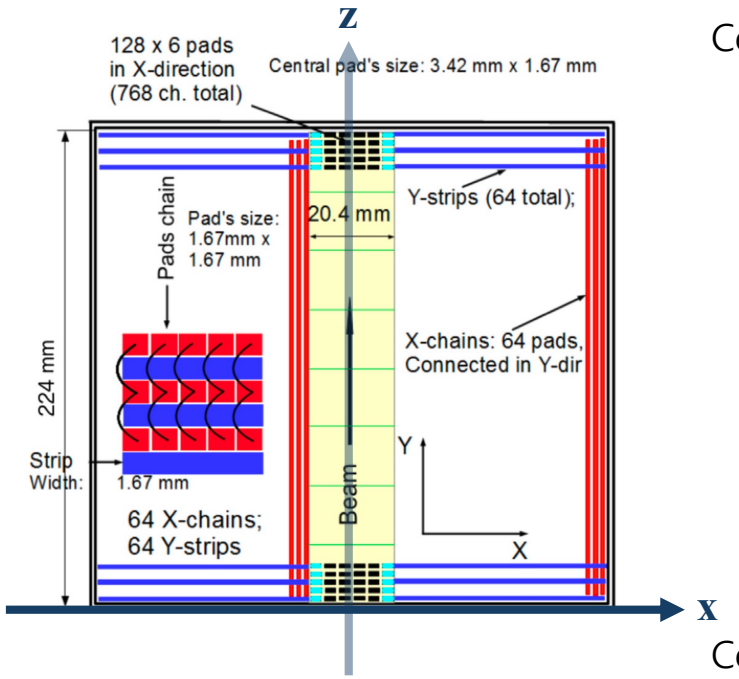
TexAT_v2 Garfield simulation ①



● : normal wire & gating grid 1
(anode -260V / cathode -1600V)

● : gating grid 2 (-230V)

TexAT_v2 Garfield simulation ①



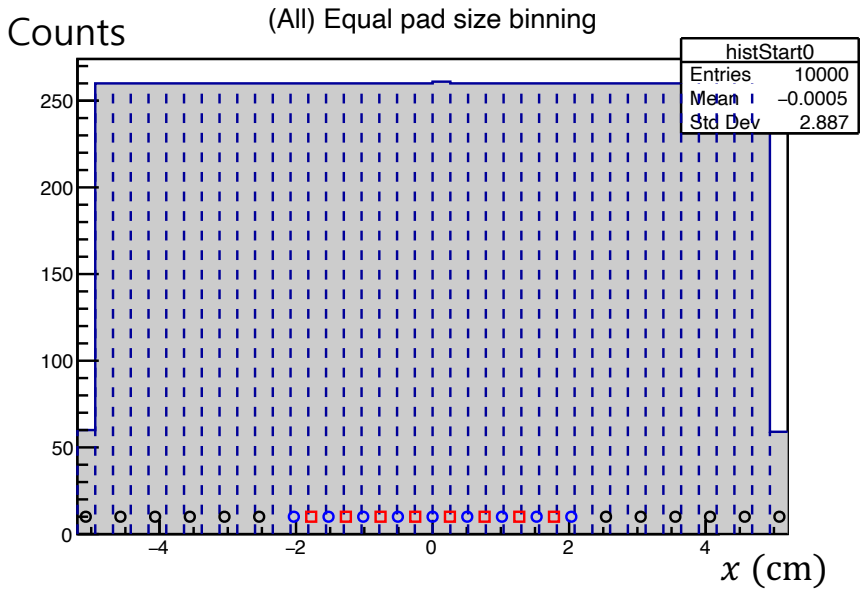
Comparing the Gating grid zone,

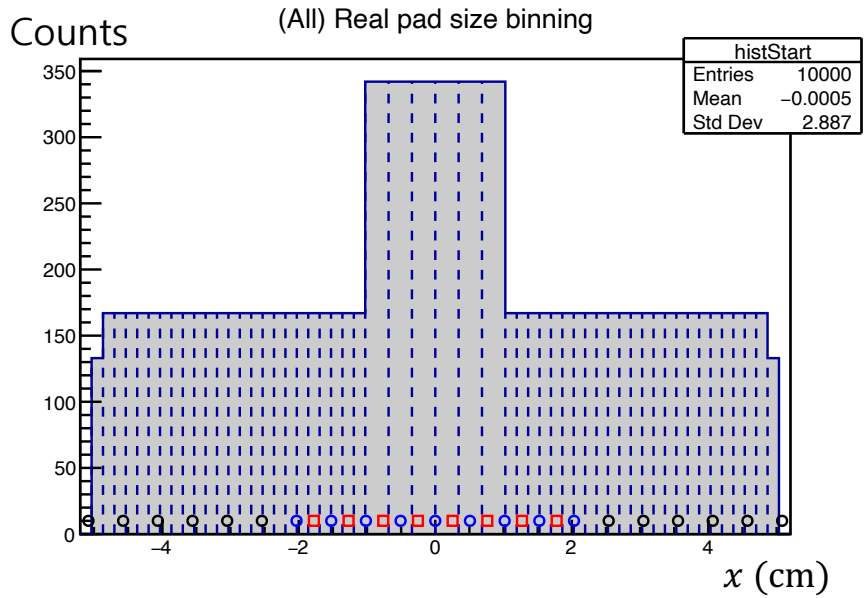
About 65% of the generated electrons arrive

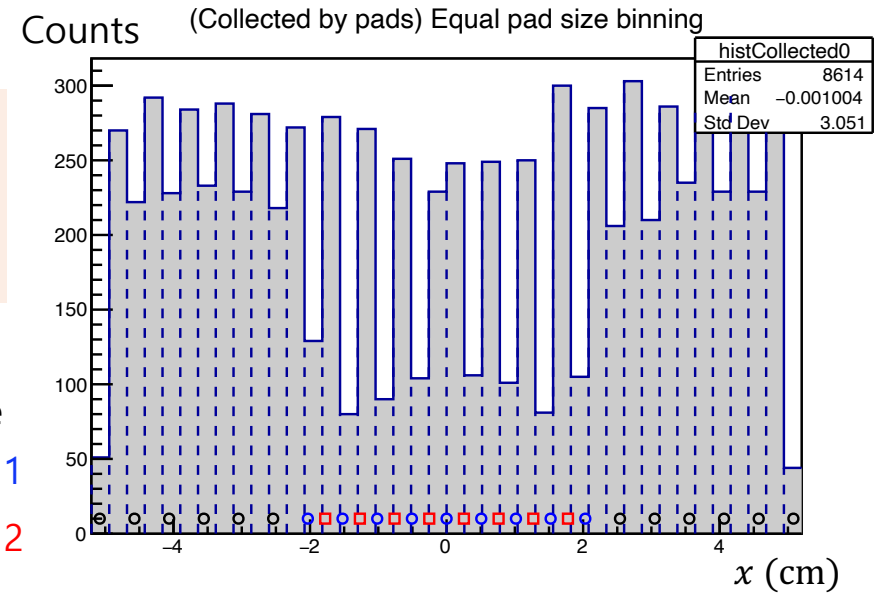
○ : normal wire

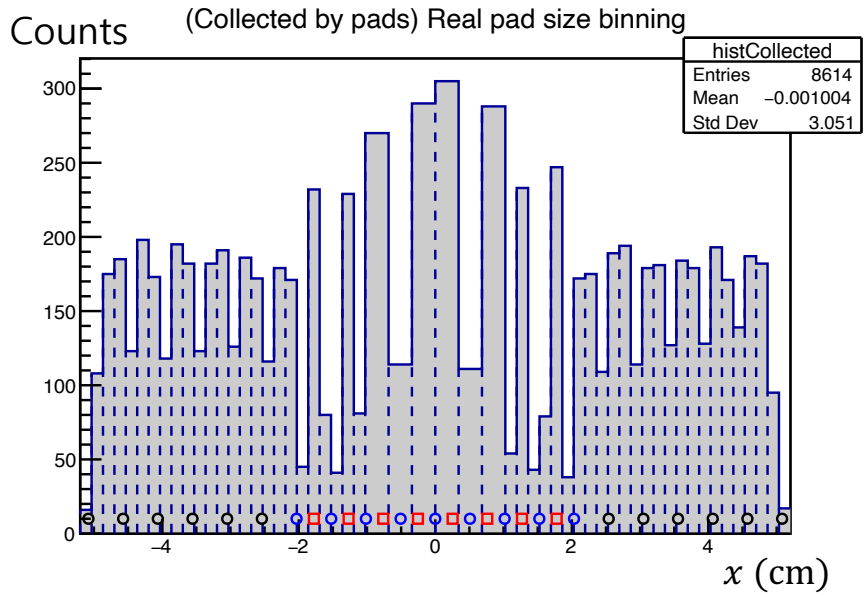
○ : gating grid 1

□ : gating grid 2

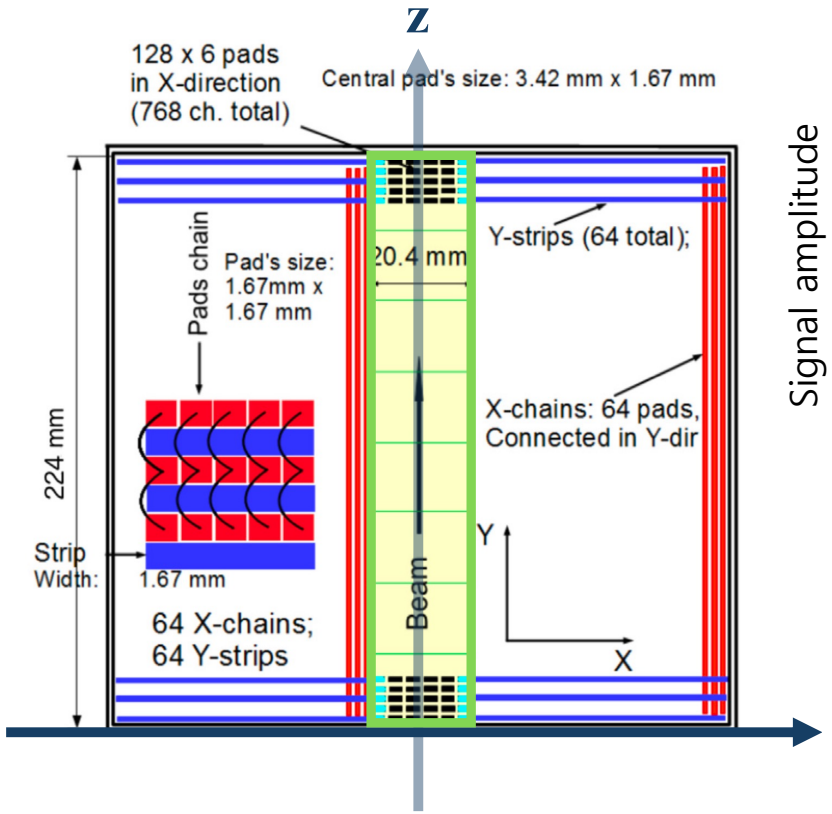


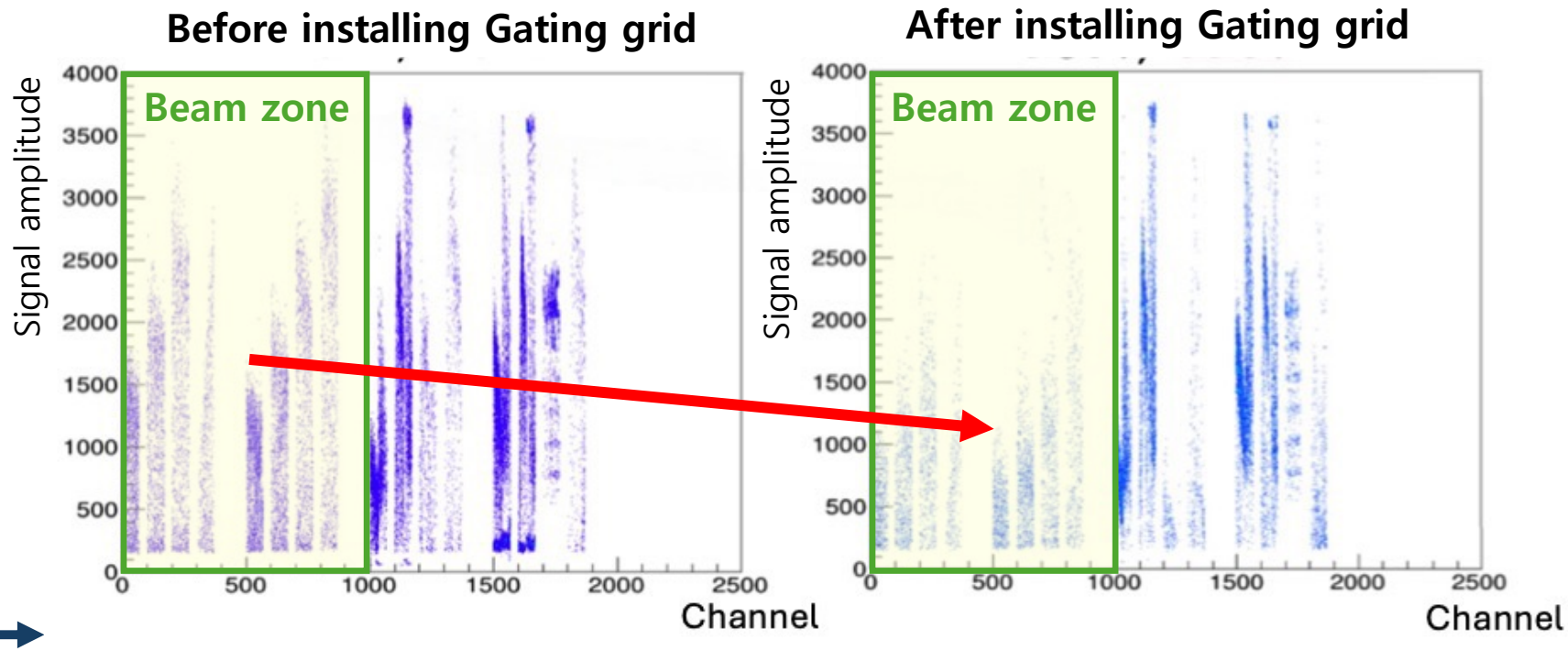






TexAT_v2 Garfield simulation ①

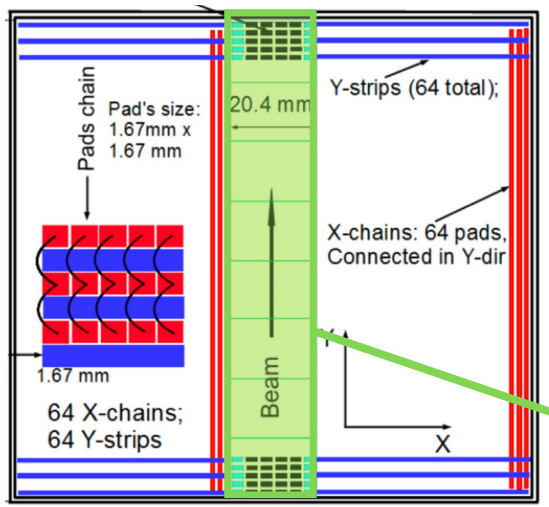




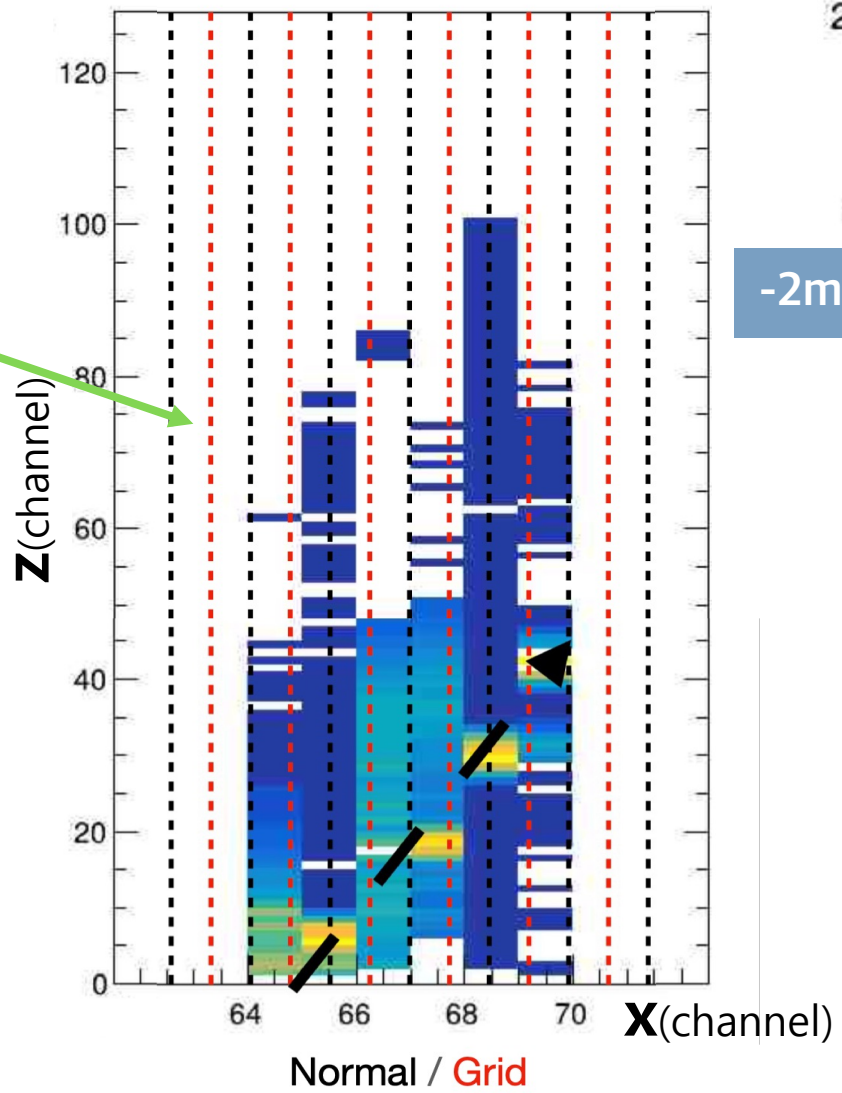
$$\frac{1100}{1700} \simeq 0.647$$

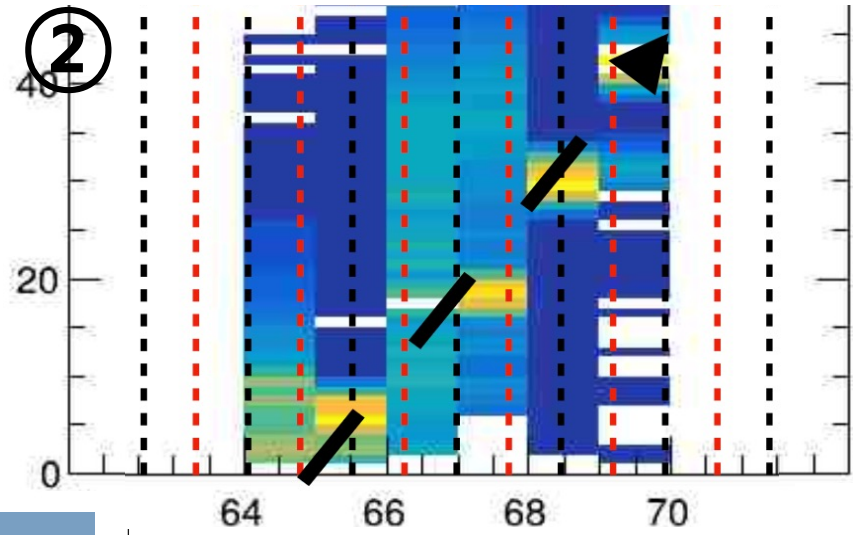
TexAT_v2 Garfield simulation ②

Check the impact of gating grid from Micromegas map

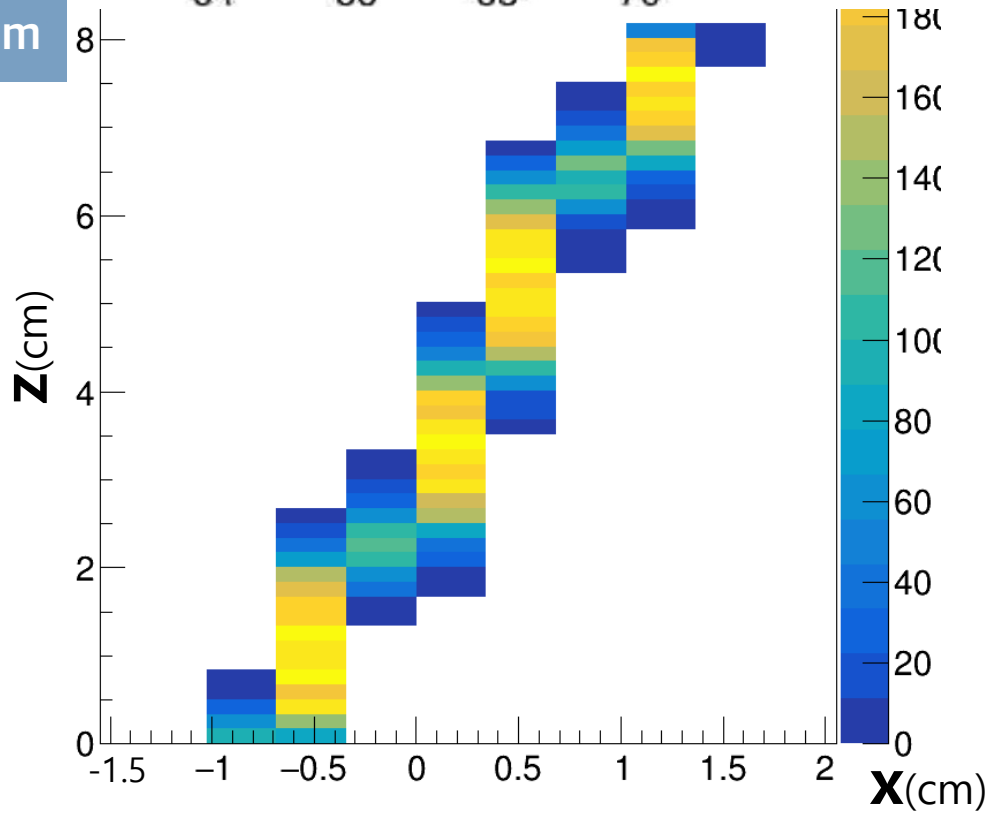


Energy deposited on Micromegas





-2mm



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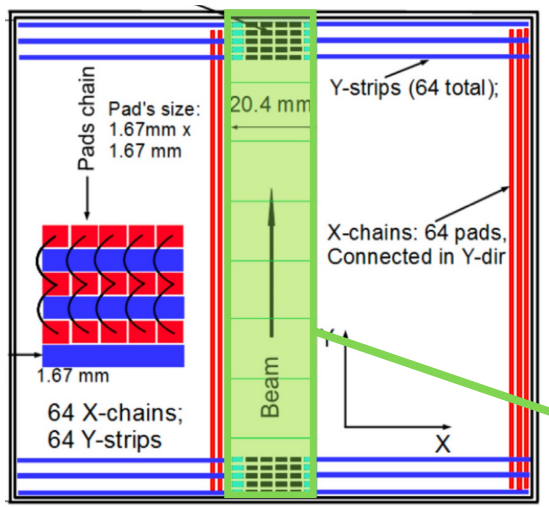

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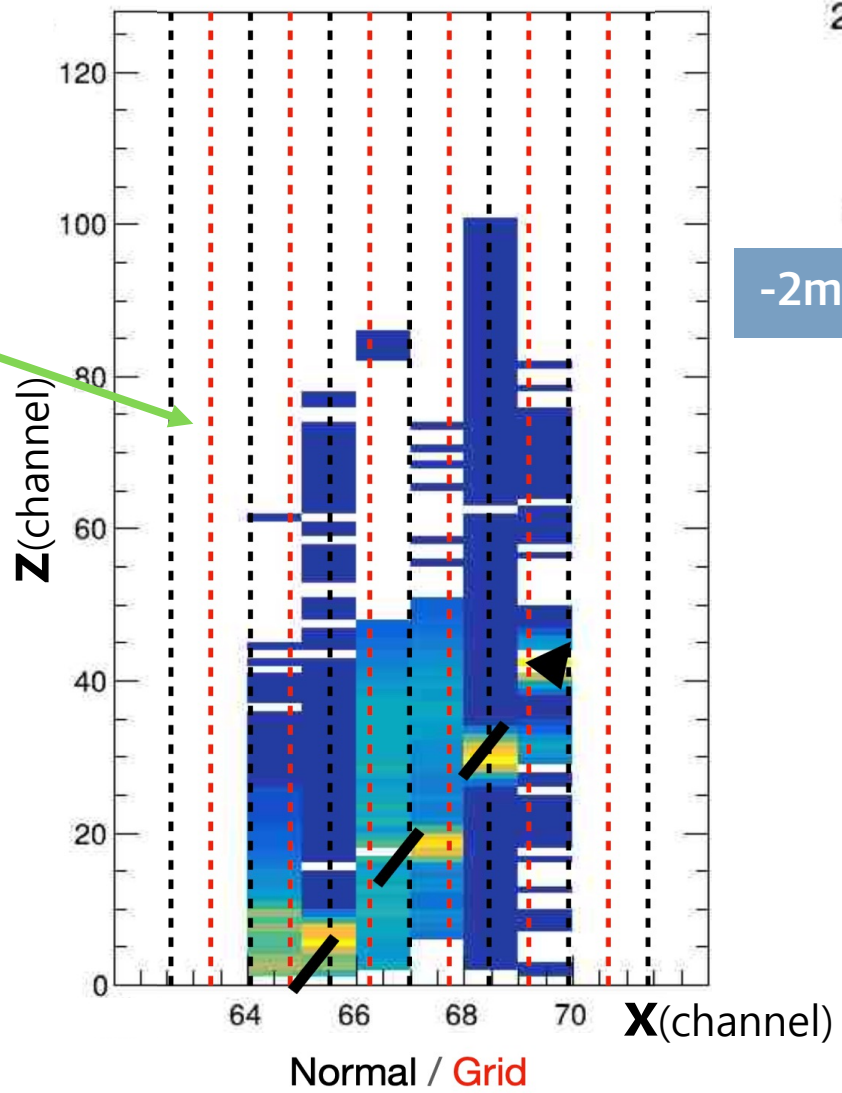
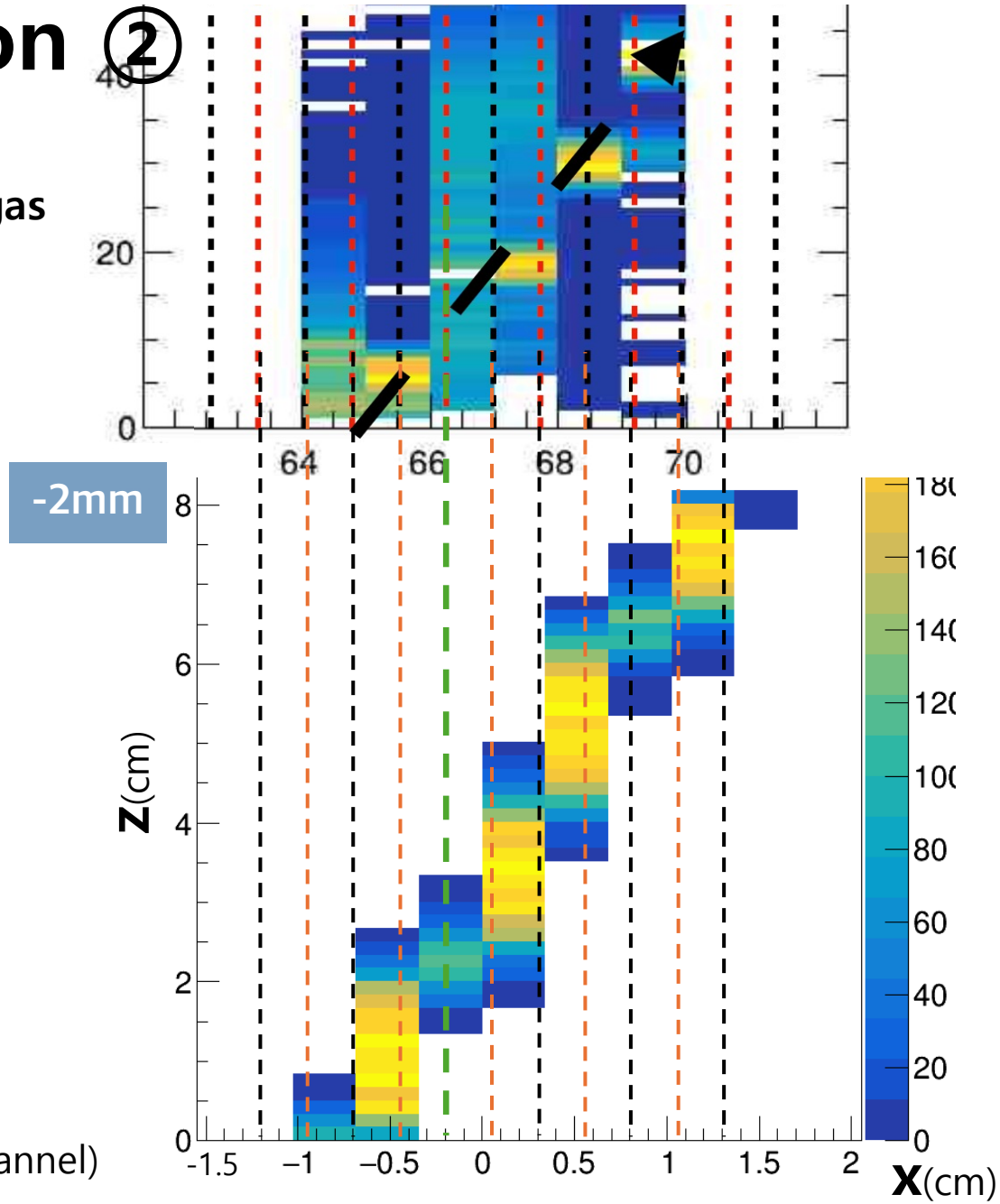
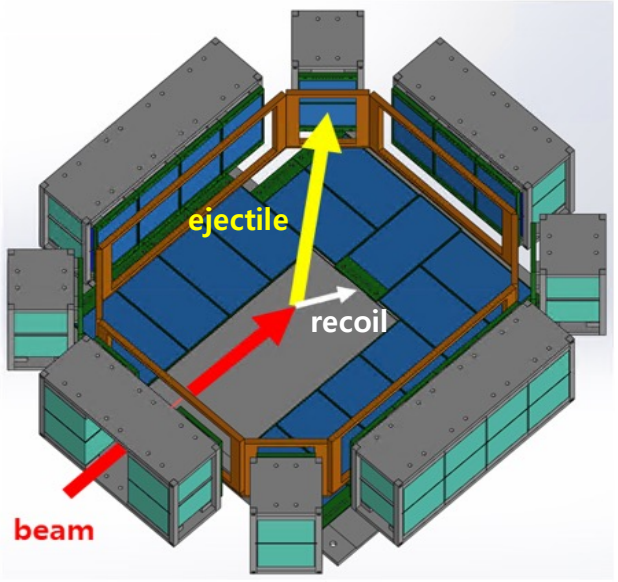


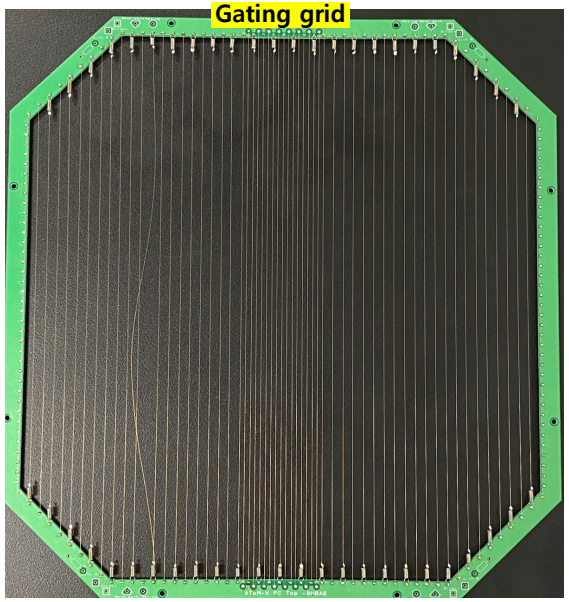


Detector

AToM-X

(Active target **T**PC f**o**r Multiple nuclear e**X**periment**)**





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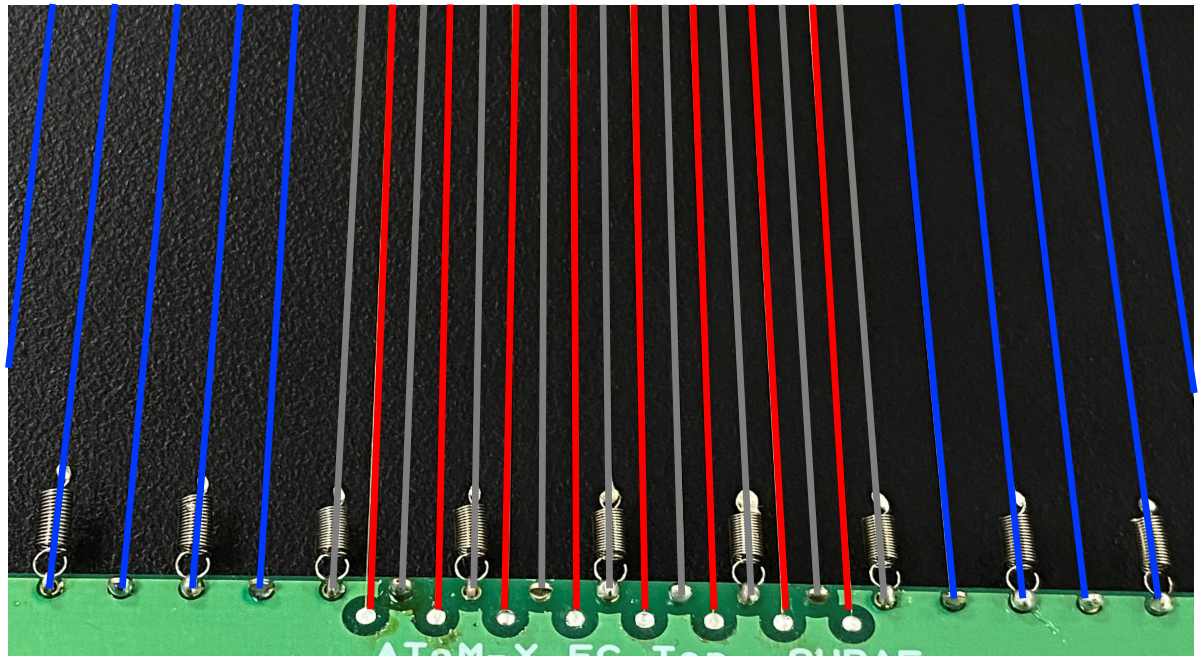
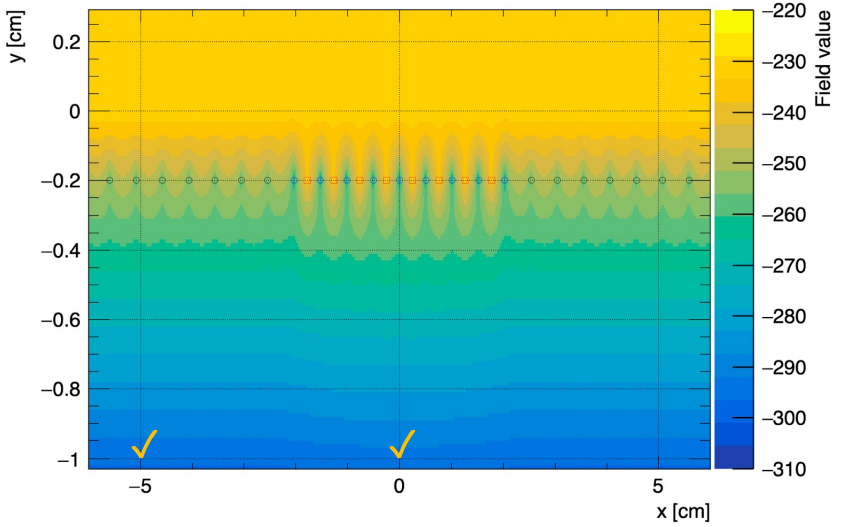


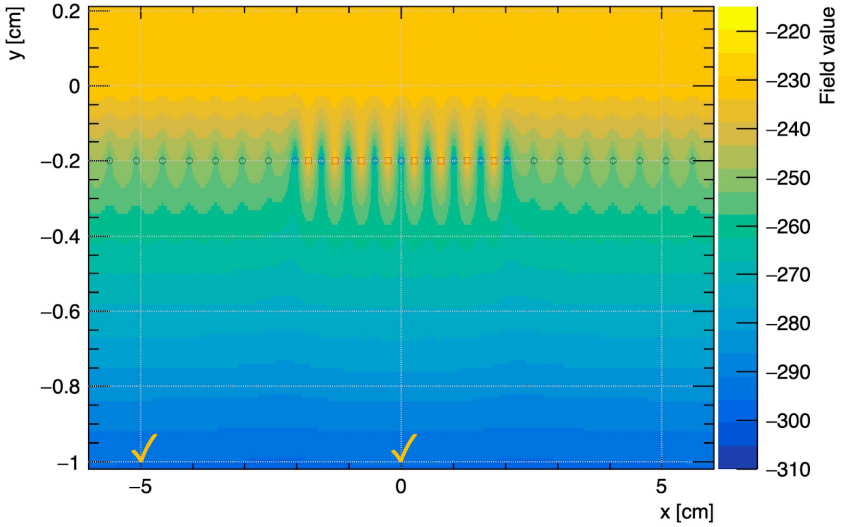
Gating Grid 1	Gating Grid 2
-270	-230
-280	-225
-280	-230
-290	-215
-290	-220
…	…

- **Normal wire : -260 V**
- **Gating Grid 1 : - ??? V**
- **Gating Grid 2 : - ??? V**

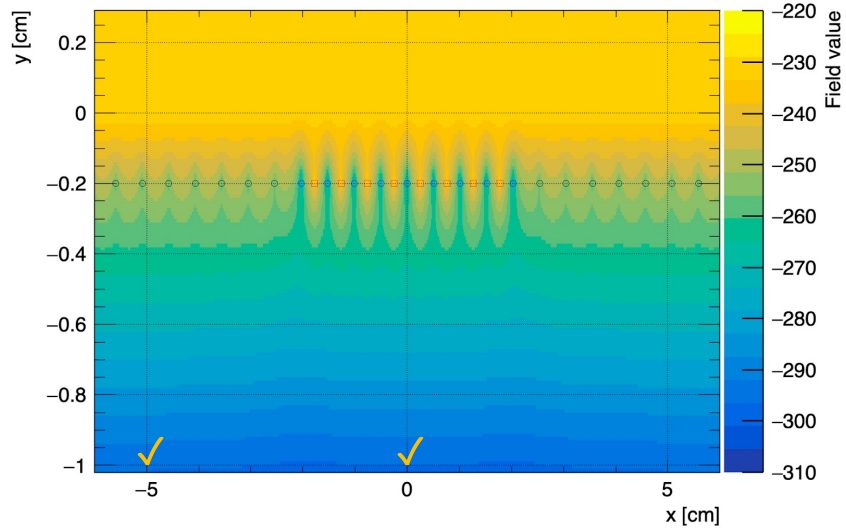
-270V/-230V



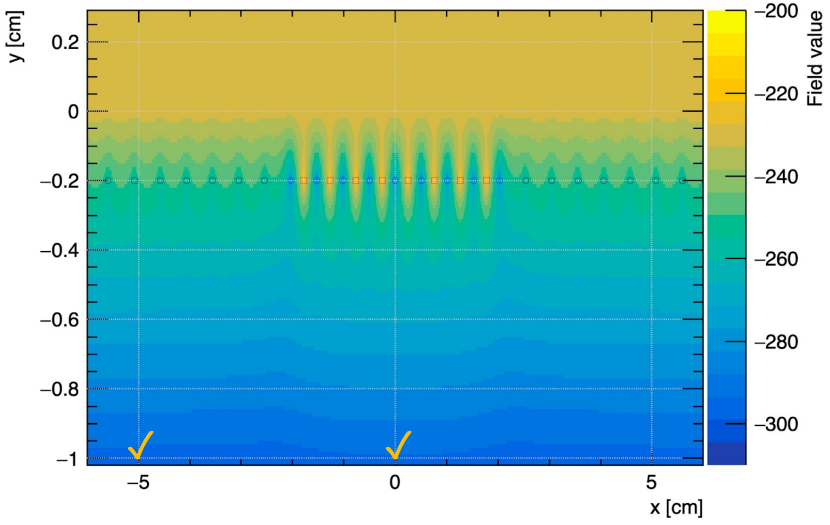
-280V/-225V



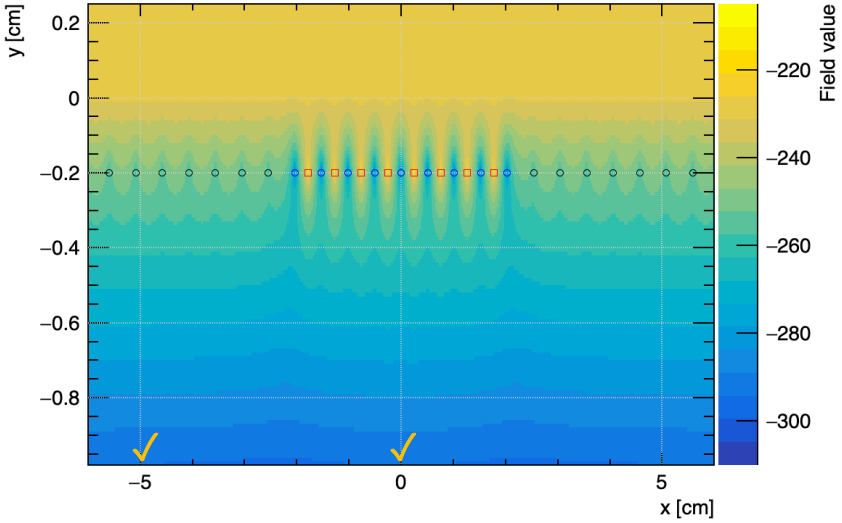
-280V/-230V



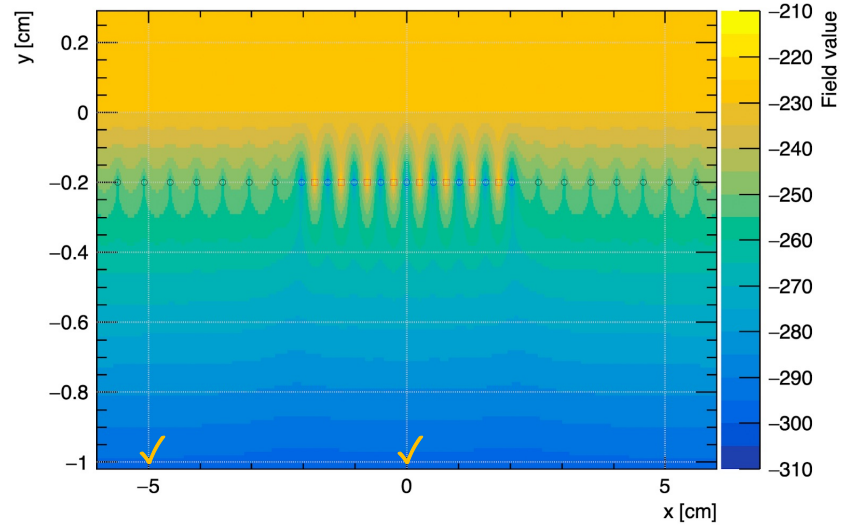
-290V/-210V



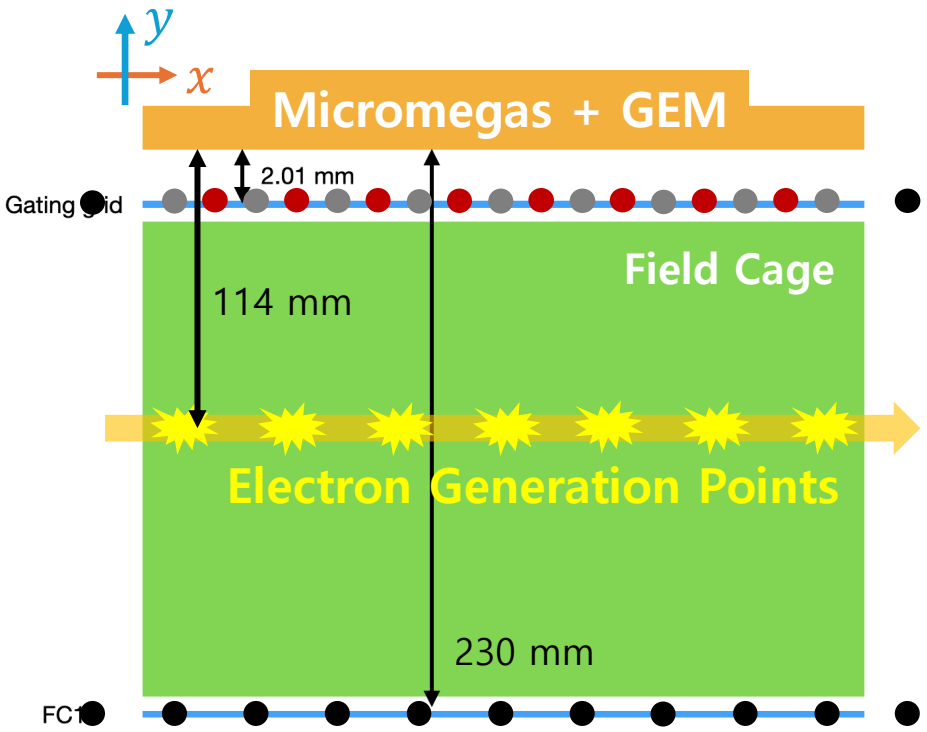
-290V/-215V



-290V/-220V



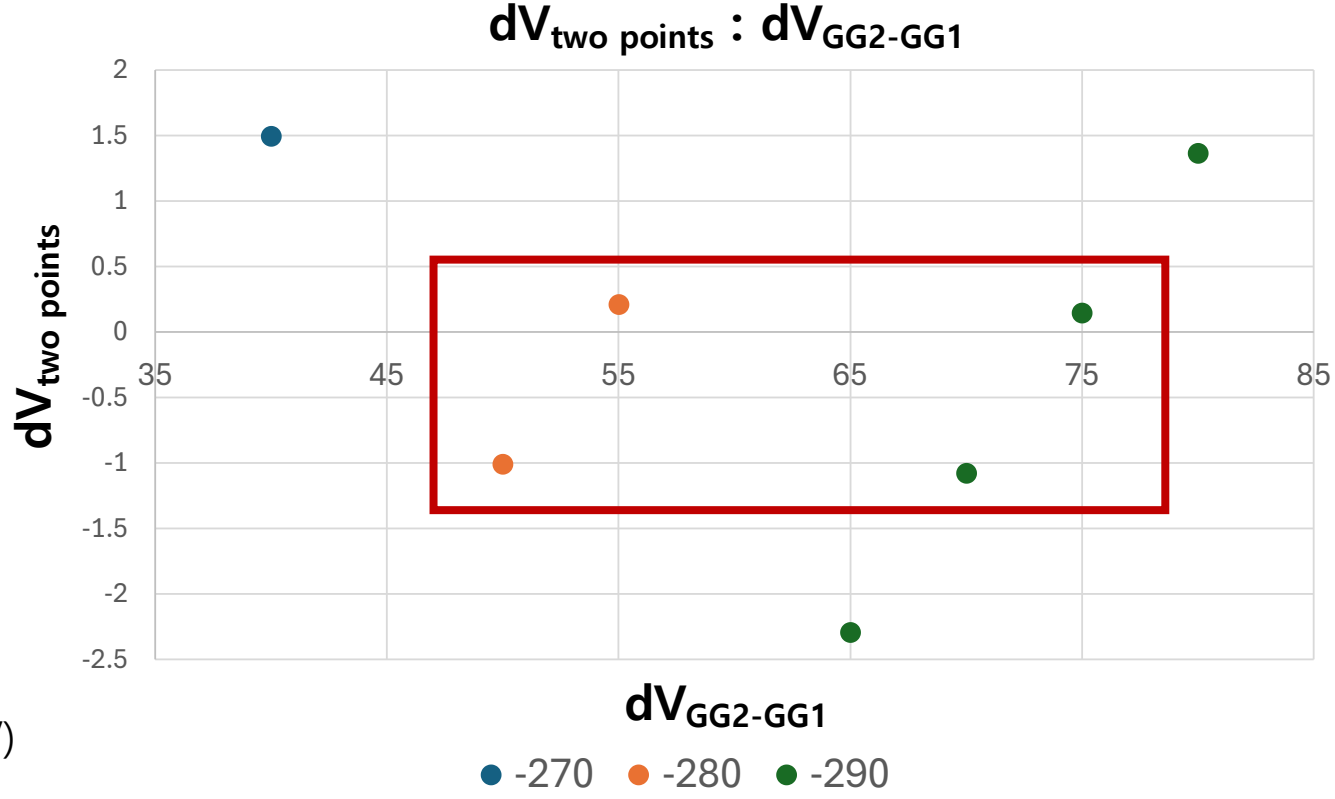
AToM-X Garfield simulation



● : normal wire (anode -260V / cathode -1600V)

● : gating grid 1 (- ??? V)

● : gating grid 2 (- ??? V)



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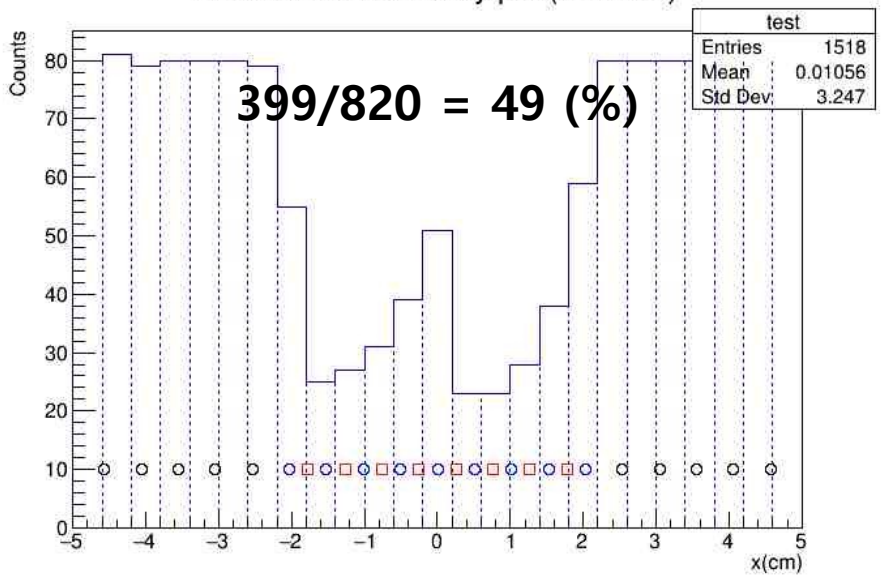

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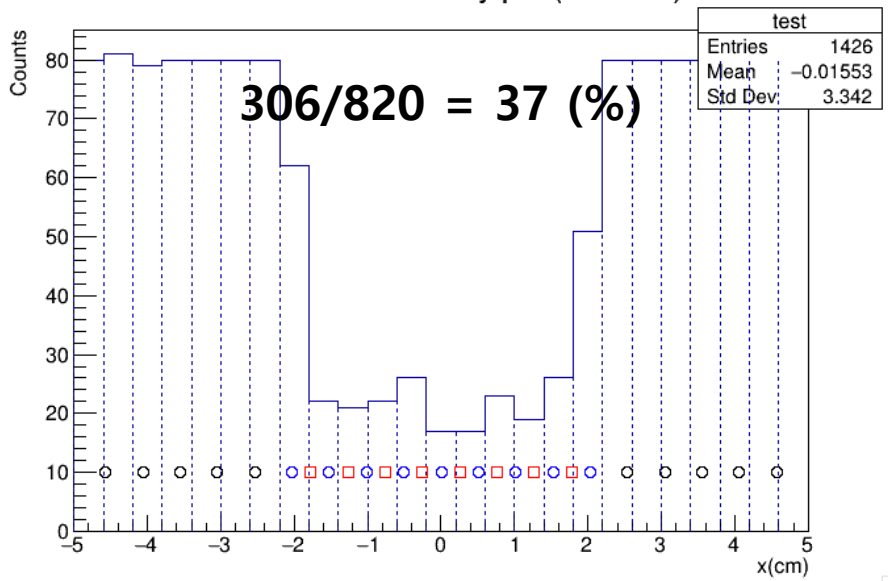
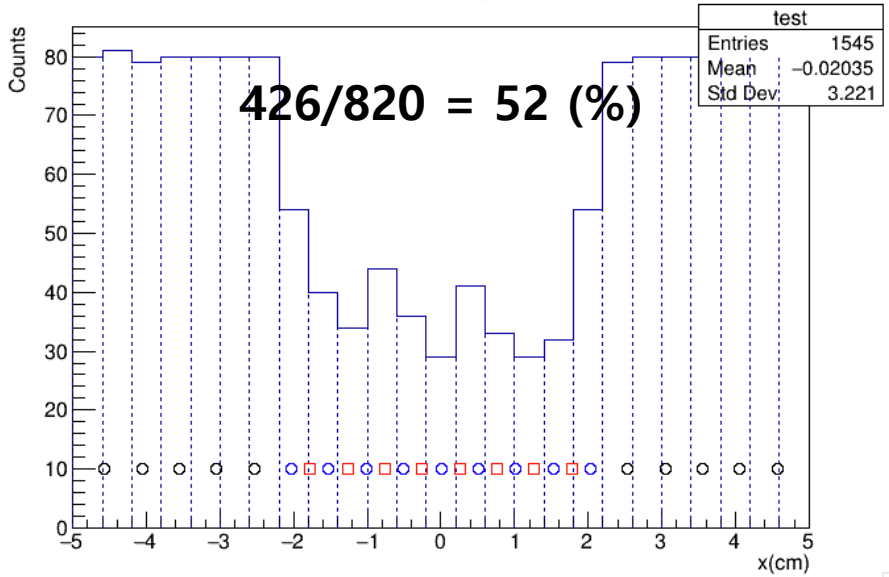


-280V/-230V

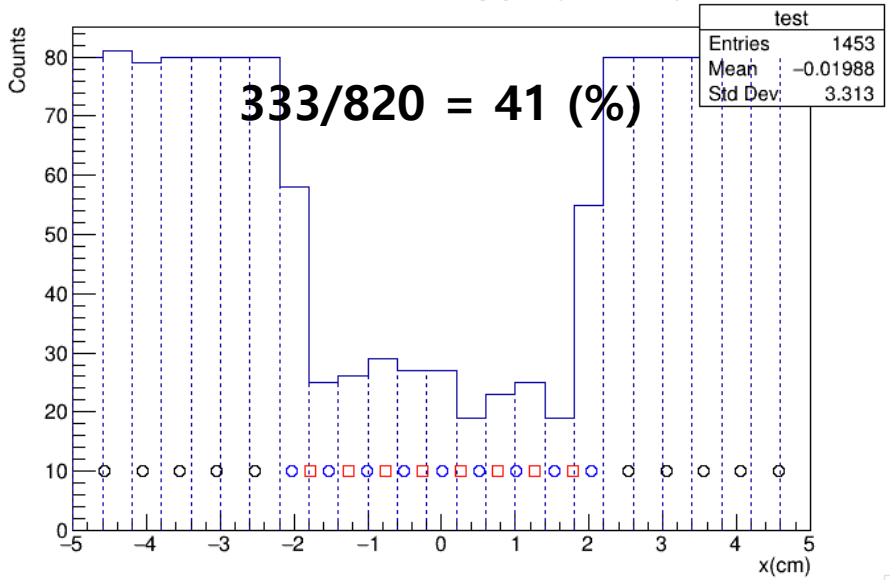


○ : normal wire

○ : gating grid 1

□ : gating grid 2

-290V/-220V



Summary

- Gating grid simulations for TexAT_v2 were performed and compared with experimental data, confirming good agreement between simulation and observation.

- A dedicated simulation was conducted to investigate the discrete beam tracks observed in Micromegas. The results indicate that the discretization is indeed caused by gating grid.

- For AToM-X, where wire voltage settings have not yet been finalized, multiple voltage combinations were tested from Garfield simulation to identify effective gating grid configurations.

- Different voltage configurations showed 40–50% electron suppression while maintaining field uniformity. This can help adjust beam signal levels during the experiment.

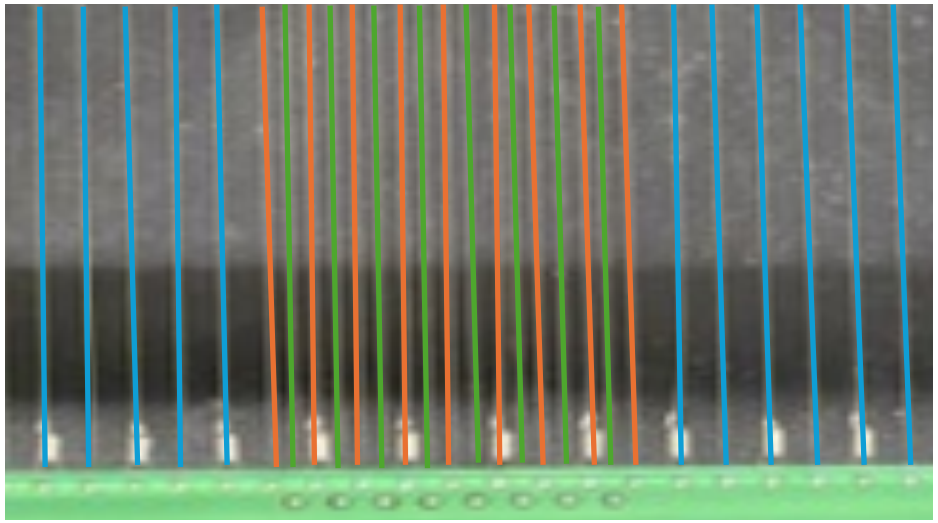
Collaborators : Korea University, Center for Exotic Nuclear Studies, Sungkyunkwan University, Ewha Womans University, Center for Nuclear Study

Thank you !

Detector

TexAT_v2

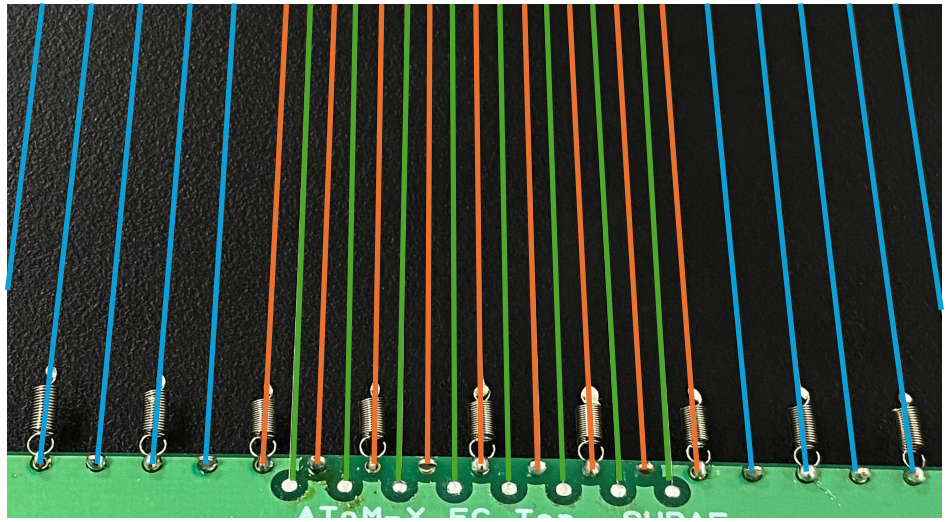
(Texas **A**ctive **T**arget TPC **version 2)**



- Normal wire 1 : -260 V
- Normal wire 2 : -260 V
- Gating Grid : -230 V

AToM-X

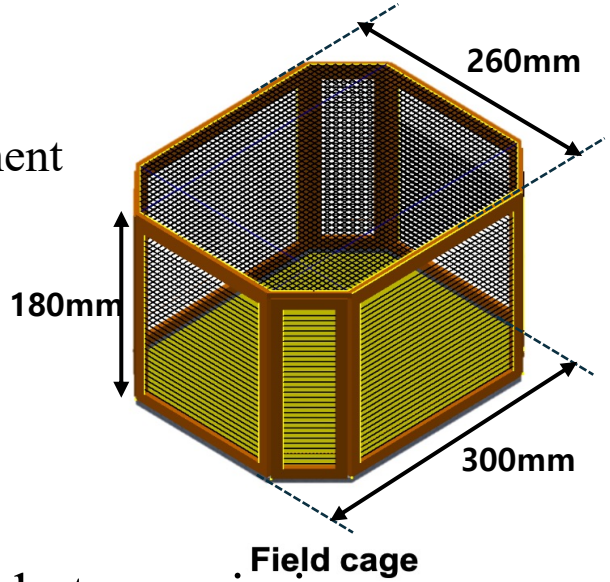
(Active target **T**PC f**o**r Multiple nuclear e**X**periment)



- Normal wire 1 : -290 V
- Normal wire 2 : -260 V
- Gating Grid : -230 V

AToM-X

: **A**ctive target **T**PC f**o**r **M**ultiple nuclear e**X**periment

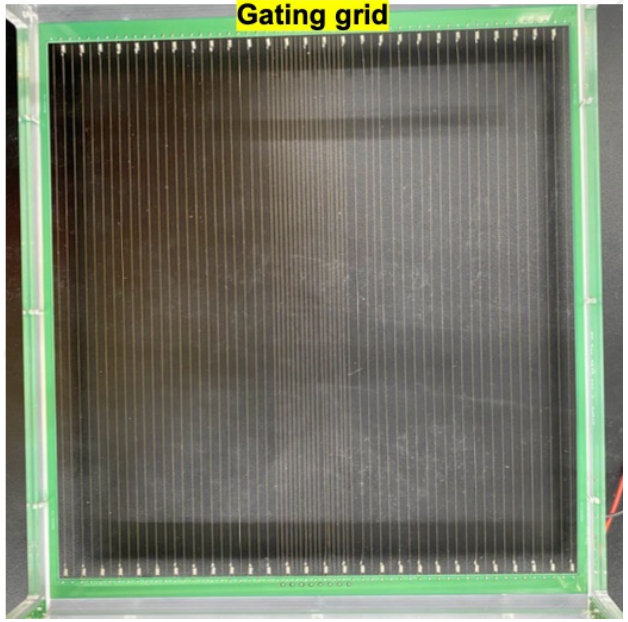


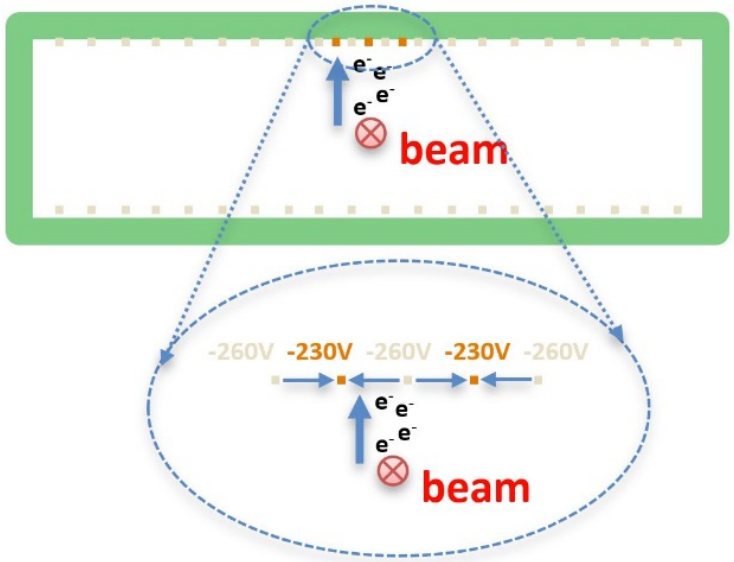
- **Consists of**

1) Field cage

- It provide **uniform Electric field** in the active volume
- It made of PCB board (Type 1) and

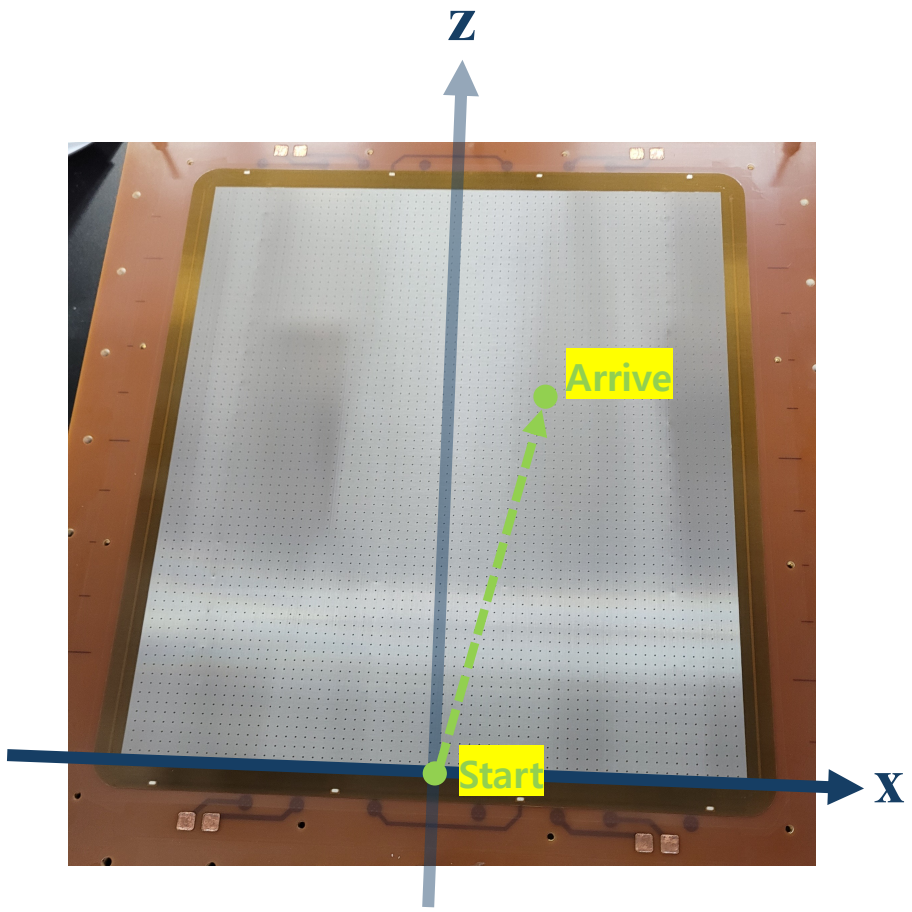
  Au-plated tungsten wire (50μm-thick) (Type 2) due to the particle transmission.

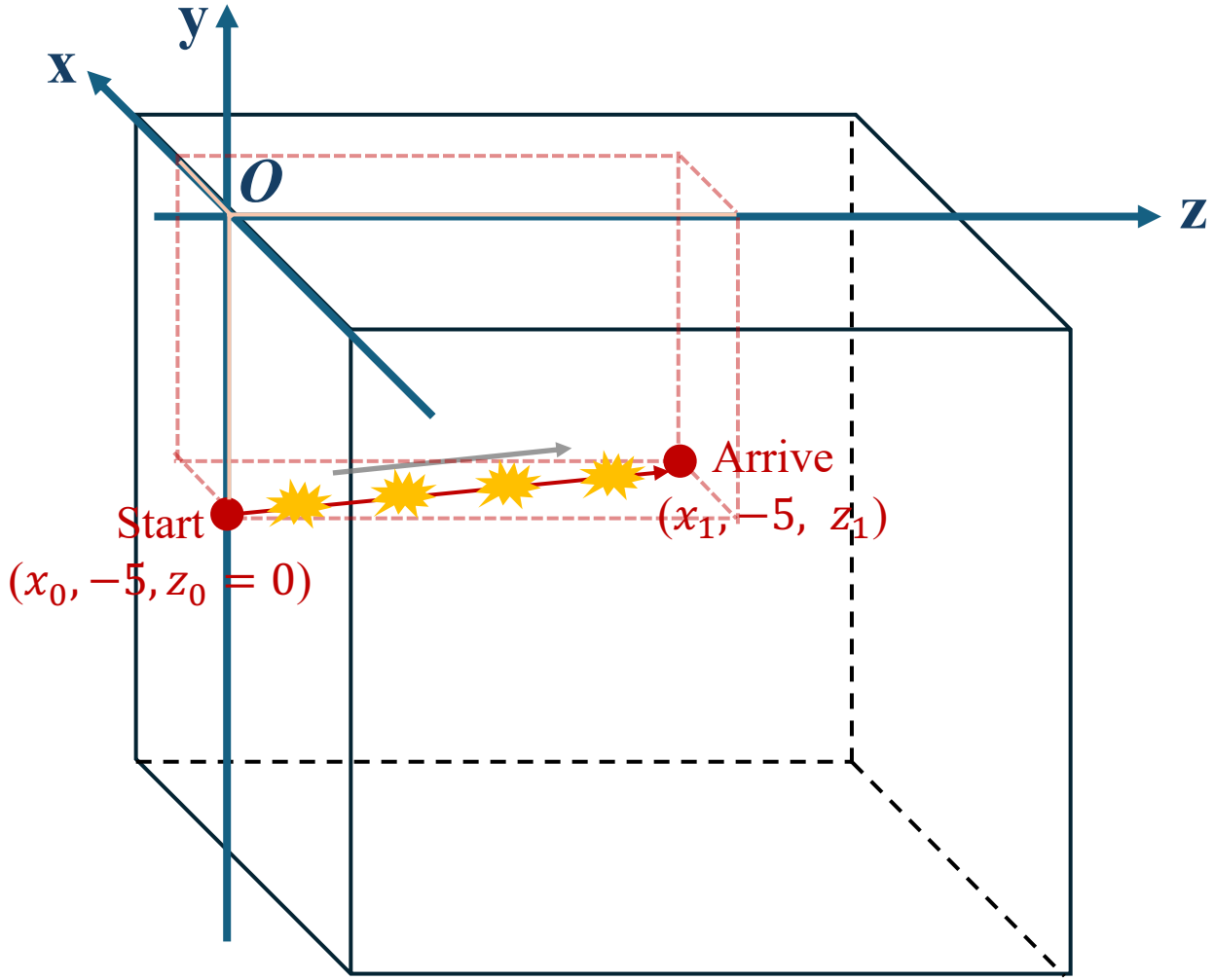




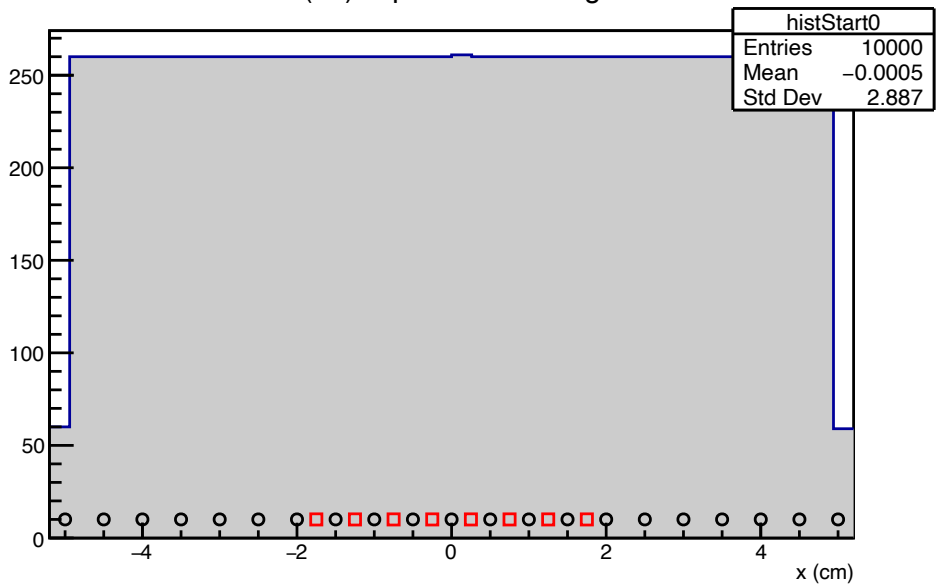
$^{14}O(\alpha,p)^{17}F$ Garfield simulation

Check the impact of gating grid from Micromegas map

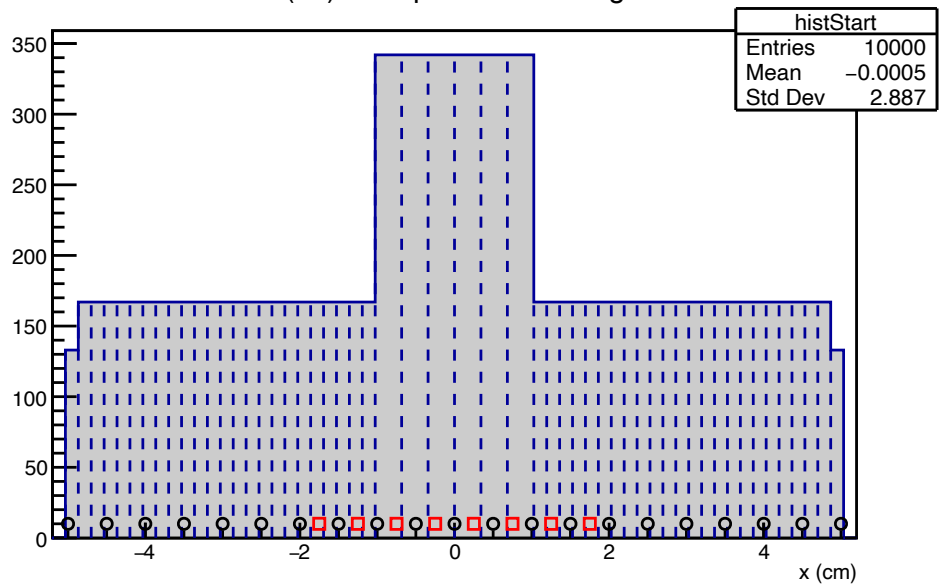




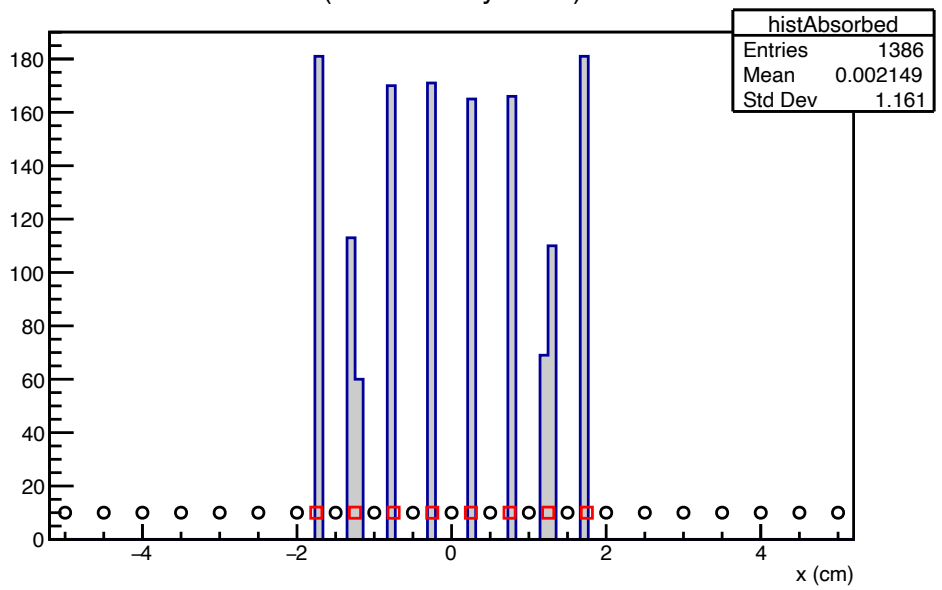
(All) Equal size binning



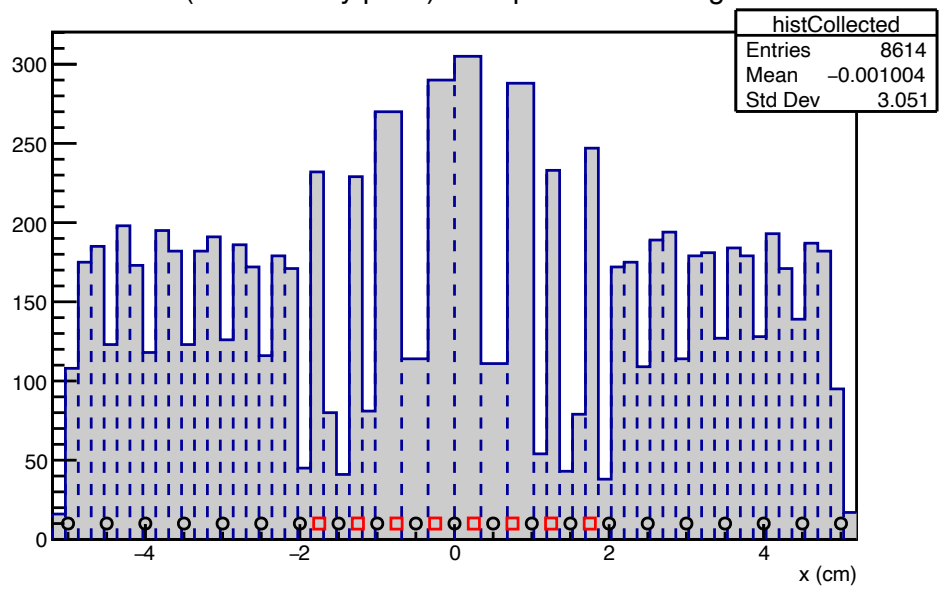
(All) Real pad size binning



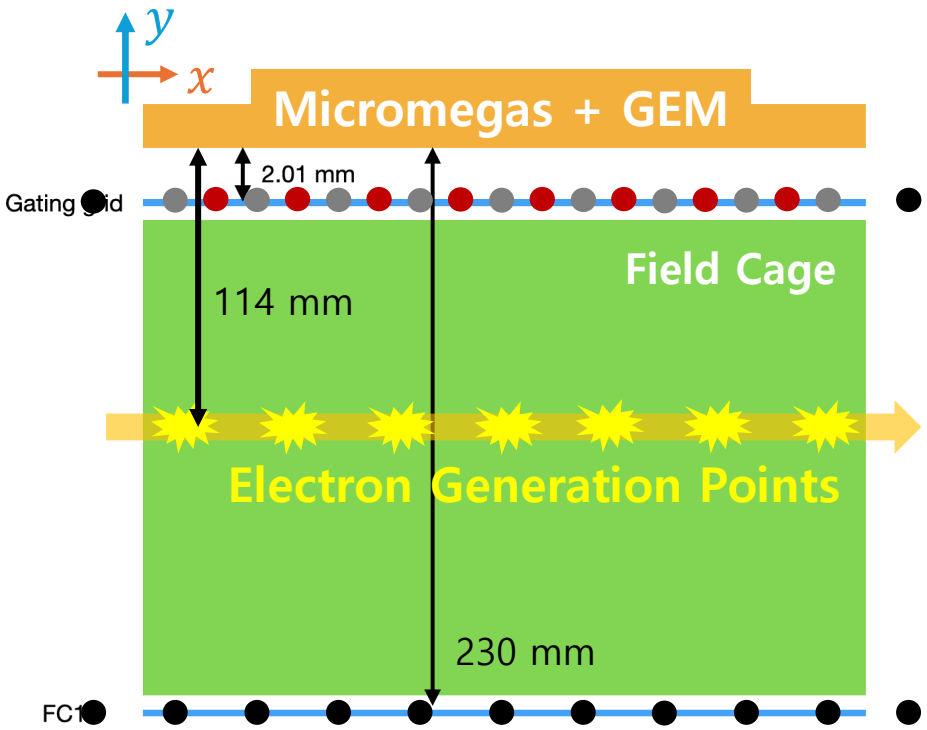
(Absorbed by wires)



(Collected by pads) Real pad size binning



TexAT_v2 Garfield simulation ①



● : normal wire & gating grid 1
(anode -260V / cathode -1600V)

● : gating grid 2 (-230V)

Electrons collected by pad

Comparing the Gating grid zone,

About 65% of the generated electrons arrive

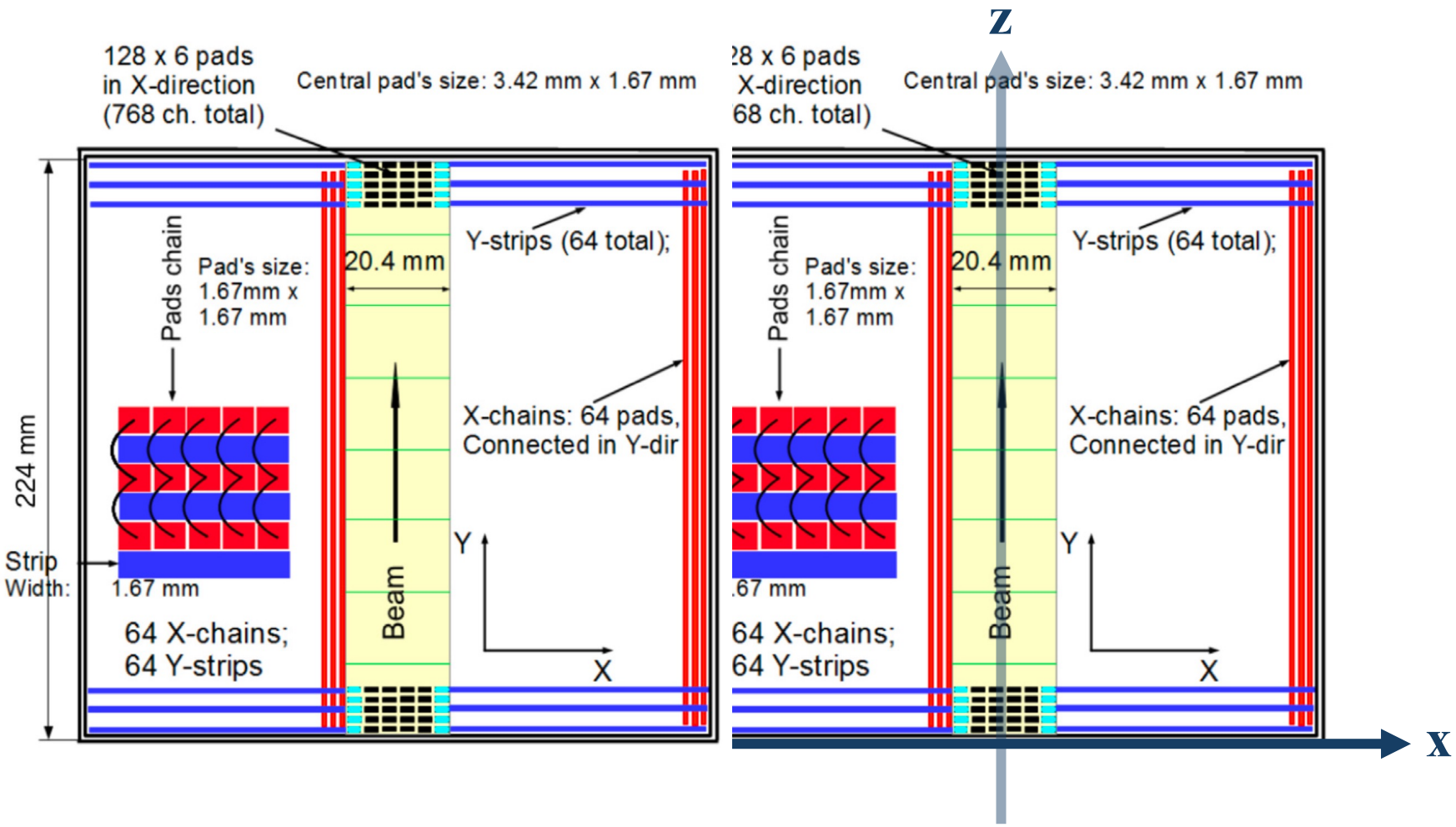
x (cm)

Generated electrons

○ : normal wire

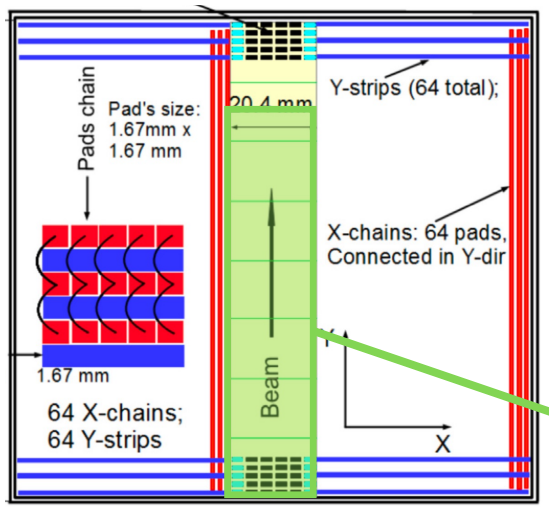
□ : gating grid

x (cm)

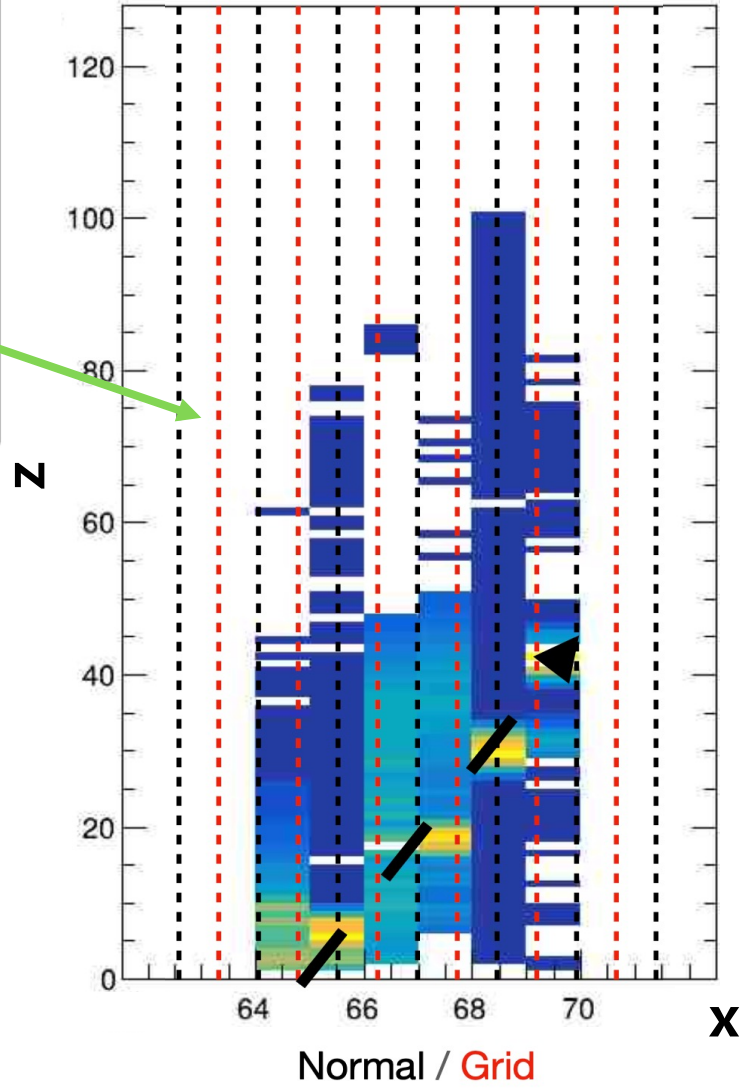

128 x 6 pads
in X-direction
(768 ch. total)
Central pad's size: 3.42 mm x 1.67 mm
Pads chain
Pad's size:
1.67mm x
1.67 mm
20.4 mm
Y-strips (64 total);
X-chains: 64 pads,
Connected in Y-dir
224 mm
Strip
Width:
1.67 mm
Beam
Y
X
64 X-chains;
64 Y-strips
z
x

TexAT_v2 Garfield simulation ②

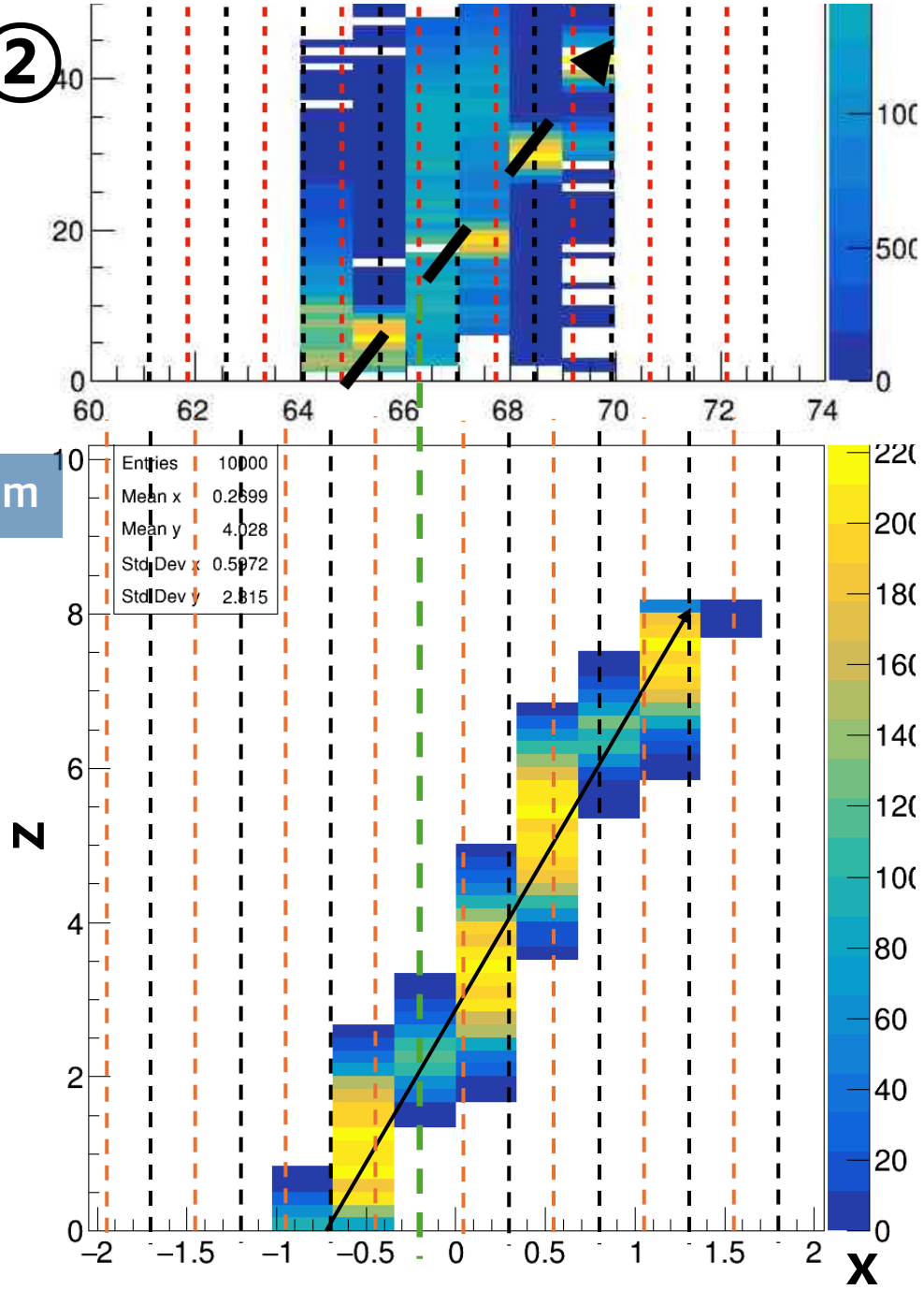
Check the impact of gating grid from Micromegas map



Energy deposited on Micromegas

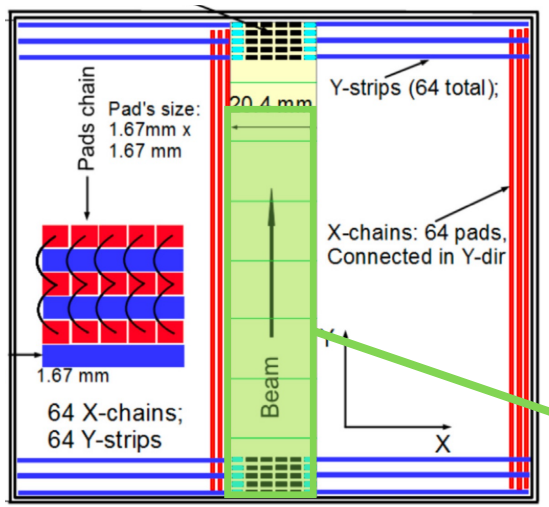


-2mm

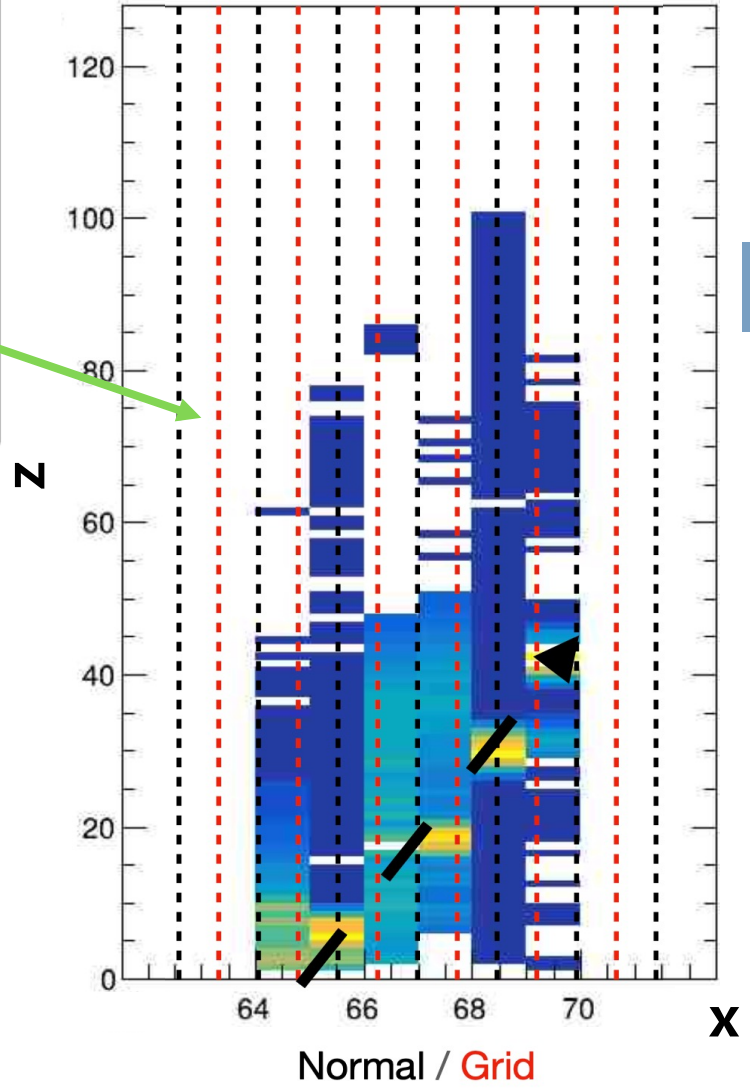


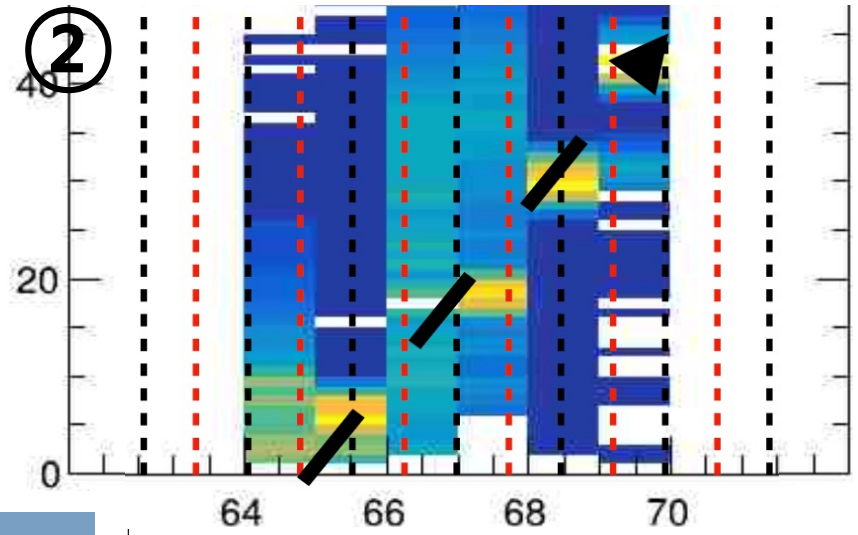
TexAT_v2 Garfield simulation ②

Check the impact of gating grid from Micromegas map

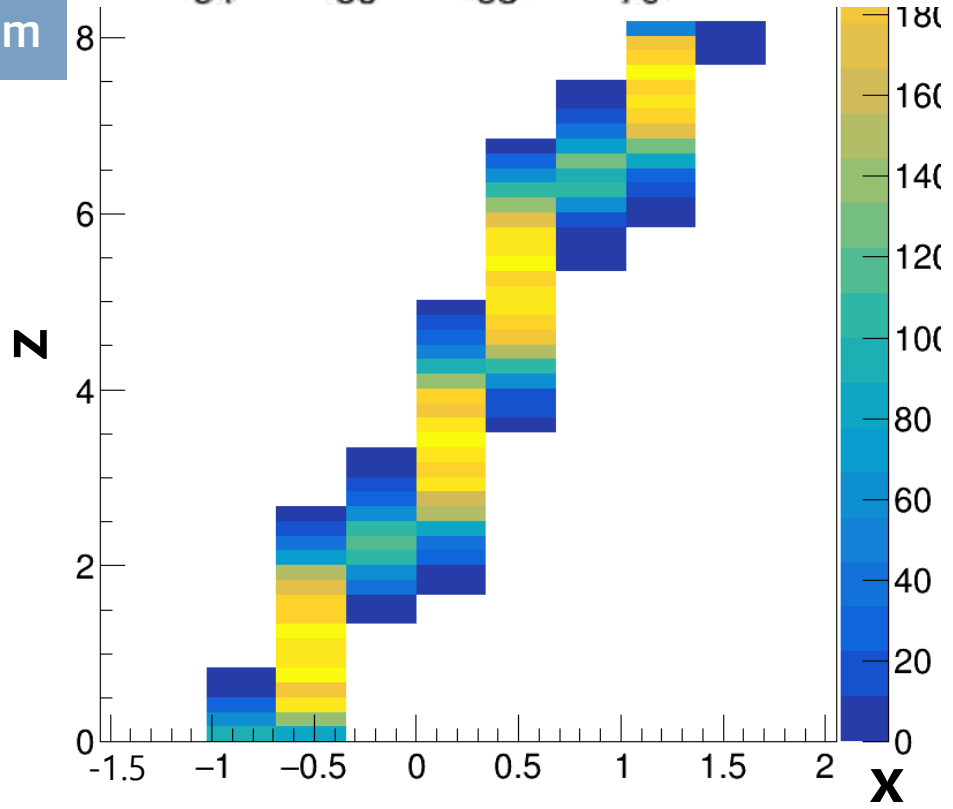


Energy deposited on Micromegas





-2mm



Energy deposited on Micromegas