WIP request
Hit cluster detector efficiency analysis

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Aim for this presentation

- I would like to request the plots to be approved with label of “Work in Progress”for the JPS.

- I will show the plots about the hit cluster detection efficiency.

→ **All plot in this slide need to be approved with label “WIP”**

- Sorry for not preparing the formal label of the plots, and I will add the following information:
  - ***sPHENIX*** (Simulation) Work in Progress
  - Run24 Au+Au $\sqrt{S_{NN}} = 200\ \mathrm{GeV}$

What is my study

- This study is the feasibility study of using two-layer barrel strip tracker to perform the hit detection efficiency measurement

- I used **the vertex** for the measurement of detection efficiency using **only two-layer**.

The algorithm of the mesurement

1. Get the position of the outer cluster.

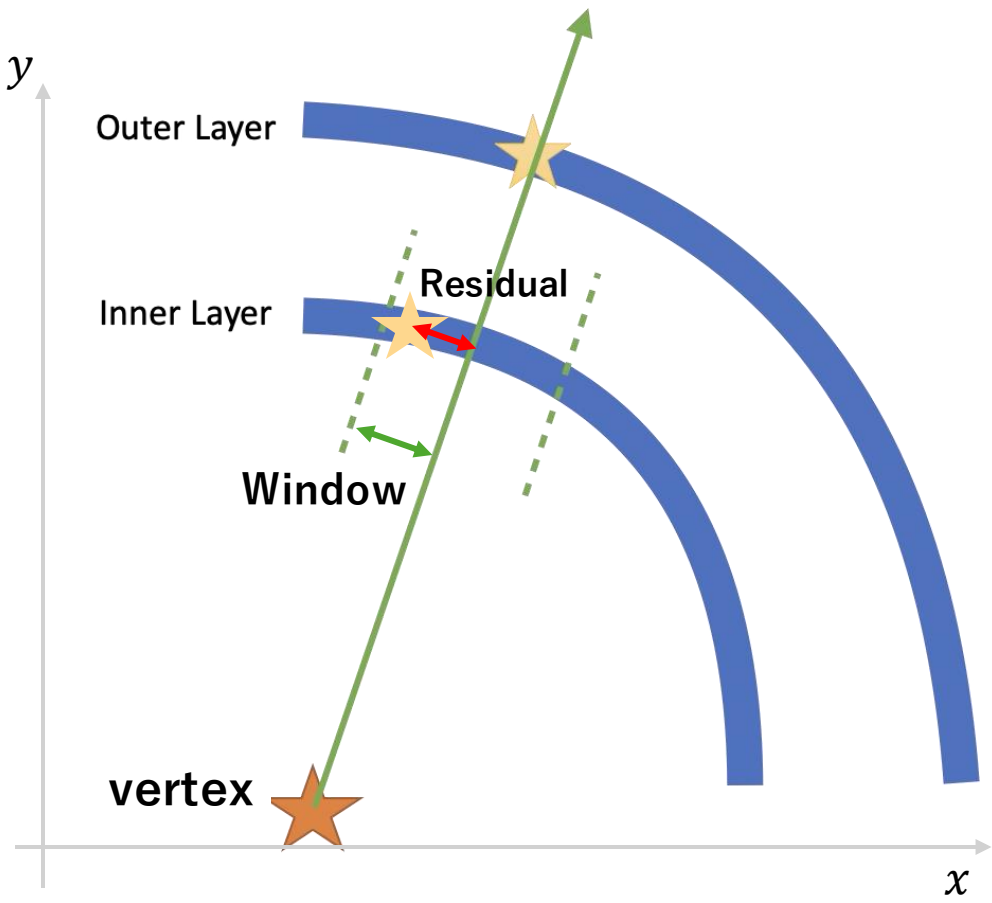
2. Determine the best pair inner cluster.

   The minimum requirements
   $|residual\ XY| < 2cm\ \&\&\ |residual\ RZ| < 4cm$

3. Count the following num:
   good pair : the pair inner cluster within the window.
   bad pair : the pair inner cluster not within the window
   No pair : the pair is not found
   ※ I set the window in XY plane.

4. Calculate the detection efficiency ε

$$\varepsilon = \frac{good\ pair}{No\ pair + bad\ pair + good\ pair}$$



The plots need to be approved

- Muon simulation(fixed vertex)
  - Event Display(good/bad)
  - Residual XY distribution
  - Efficiency vs Window
- Muon simulation (varied vertex)
  - Event Display(good/bad)
  - Residual XY distribution
  - Efficiency vs Window
- Au+Au simulation
  - Event Display(good/bad)
  - Residual XY distribution
  - Efficiency vs Window
- Au+Au data
  - Event Display(good/bad)
  - Residual XY distribution
  - Efficiency vs Window

Muon simulation

Simple simulation 1

- A particle (μ^-)/event
- $P_T = 1\ \mathrm{GeV}$
- # of events : 10K
- Magnetic field : 0T
- Incident point:
  Fixed $(x, y, z) = (0, 0, 1)cm$
- Incident direction :
  $\phi = 0,\ \eta = 0$
- No dead channel

Simple simulation 2

- A particle (μ^-)/event
- $P_T = 1\ \mathrm{GeV}$
- # of events : 10K
- Magnetic field : 0T
- Incident point:
  Varied $(x, y, z) = (0, 0, 0)cm$
  $(\sigma_x, \sigma_y, \sigma_z) = (0, 0, 20)cm$
- Incident direction :
  $-\pi < \phi < \pi\ ,\ -1 < \eta < 1$
- No dead channel

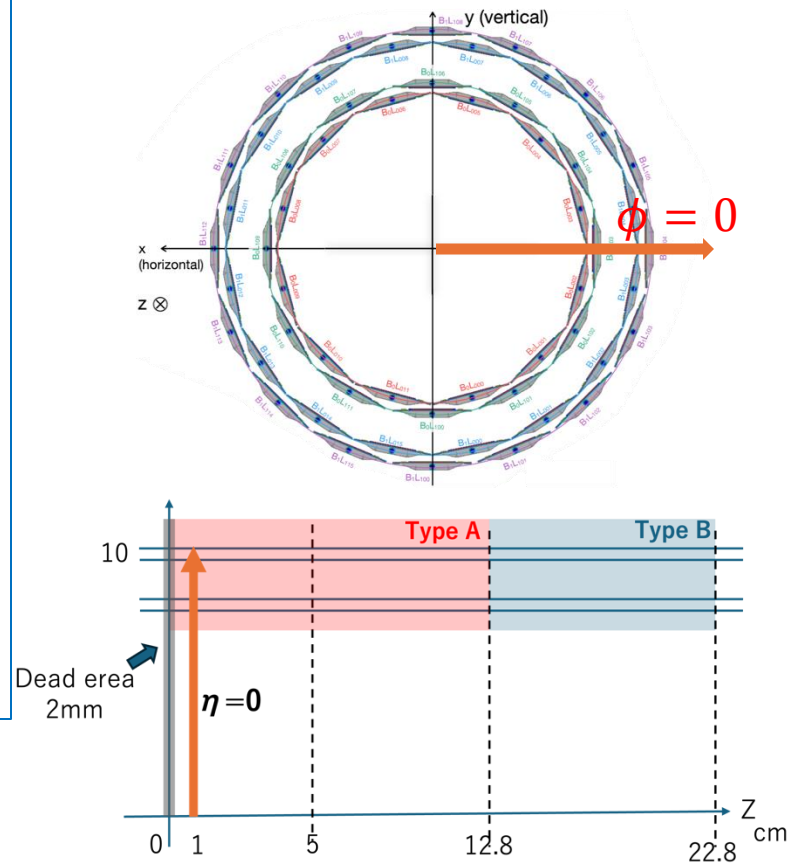
Muon simulation

Aim of this simulation:
Show the performance of my algorithm in the simplest event

Simple simulation 1

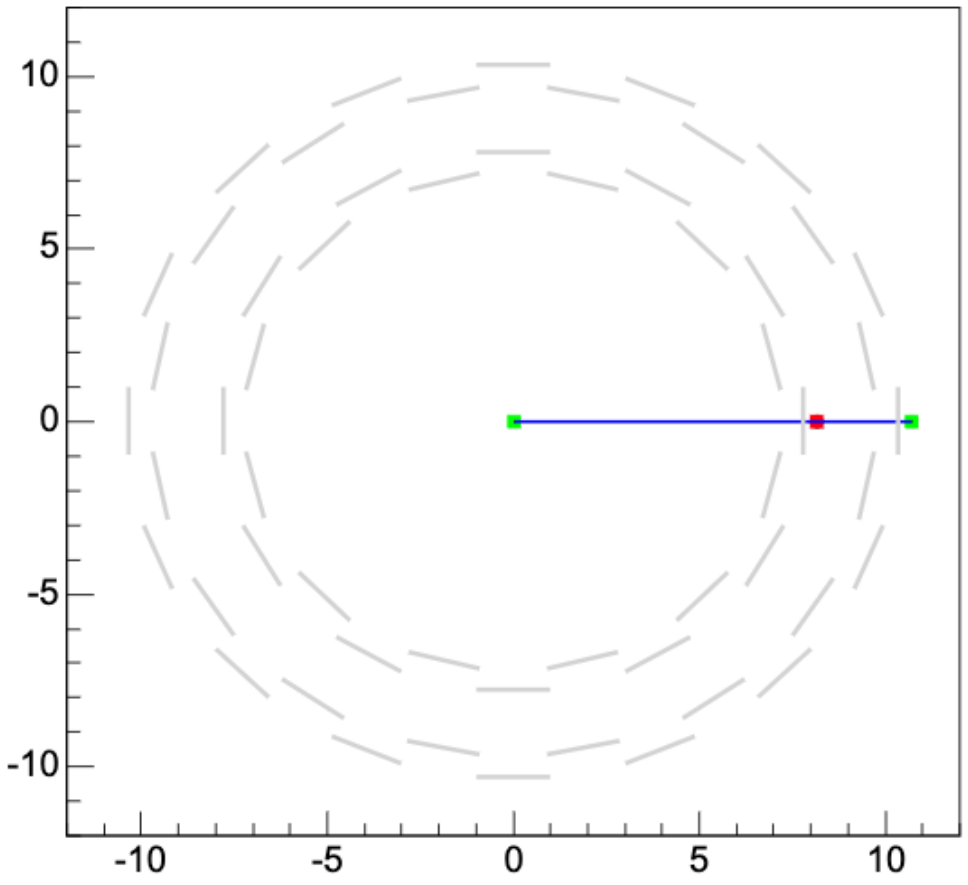
- A particle (μ^-)/event
- $P_T = 1\ \mathrm{GeV}$
- # of events : 10K
- Magnetic field : 0T
- Incident point:
  Fixed $(x, y, z) = (0, 0, 1)cm$
- Incident direction :
  $\phi = 0,\ \eta = 0$
- No dead channel

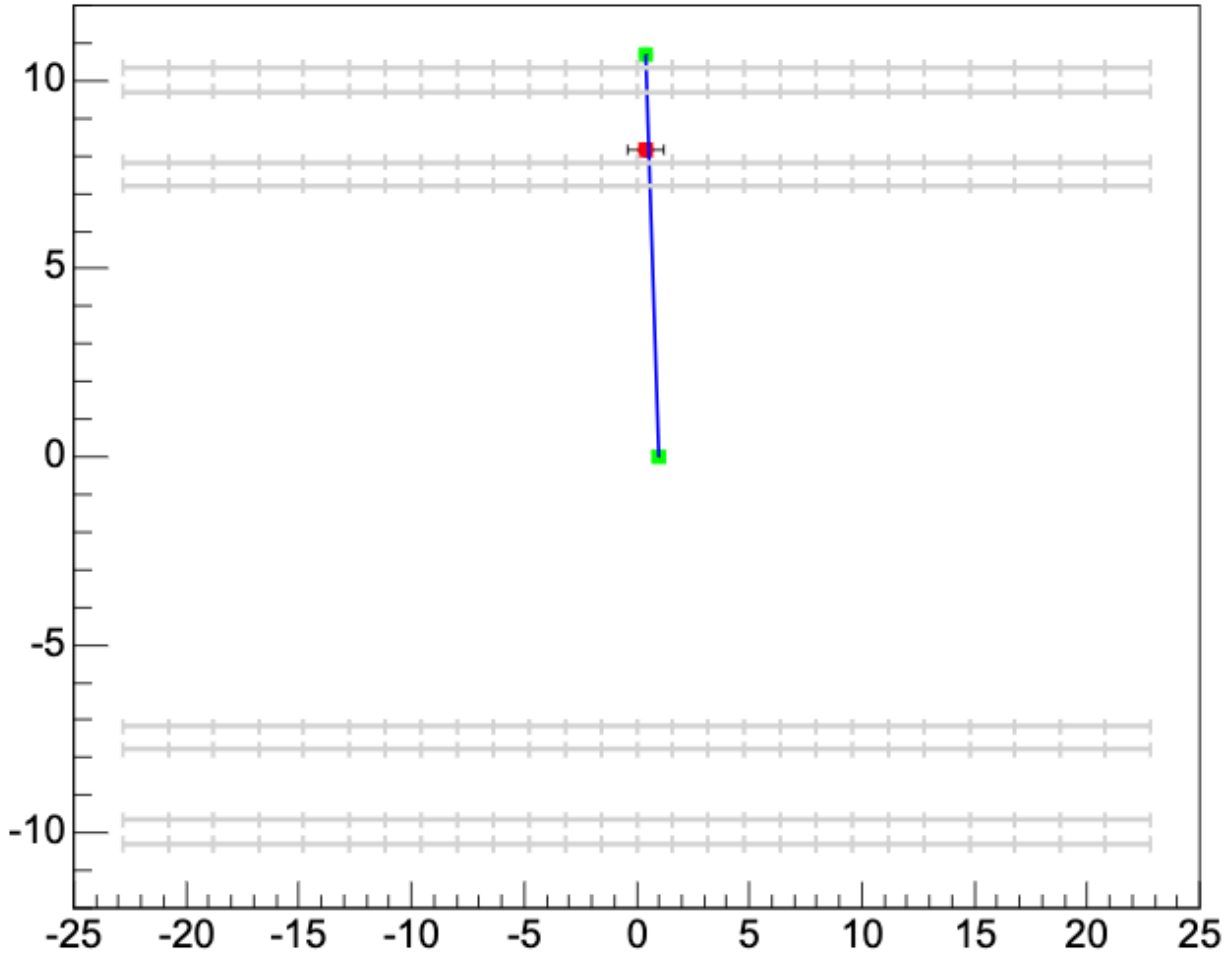
Meaning of the simplest event



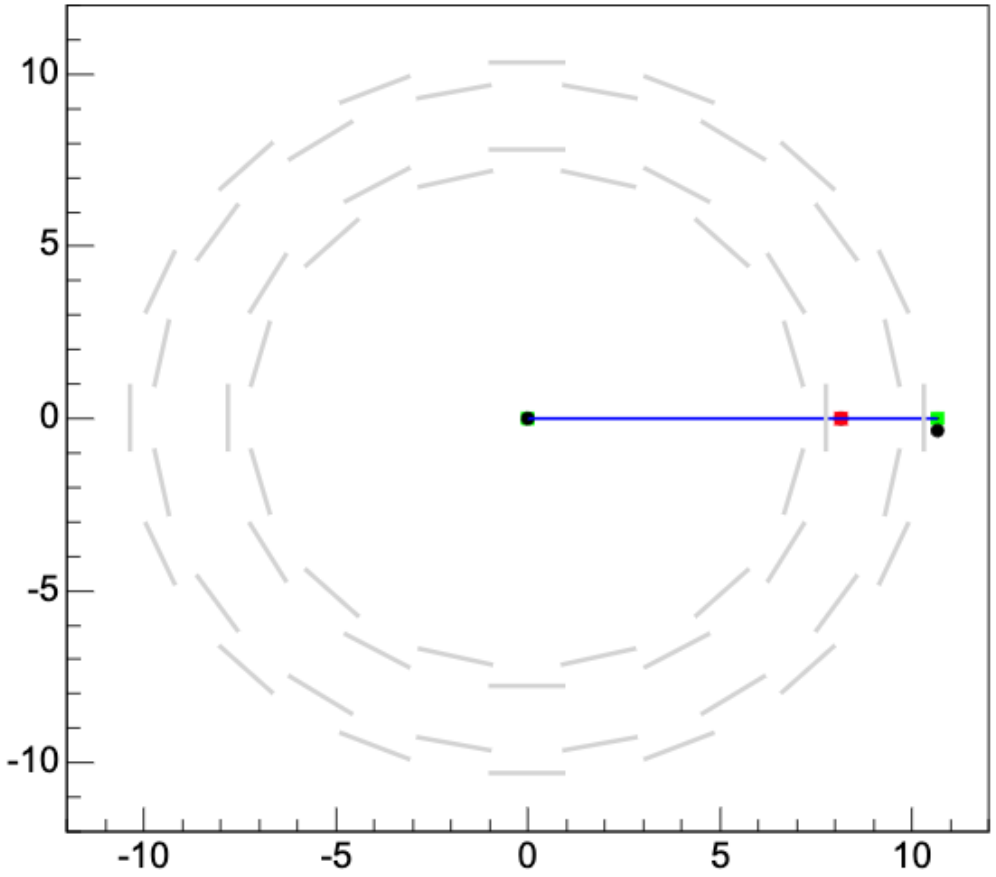
- Incident at the center of the sensor
- Avoid the dead area between barrels
- Avoid the dead area between sensors

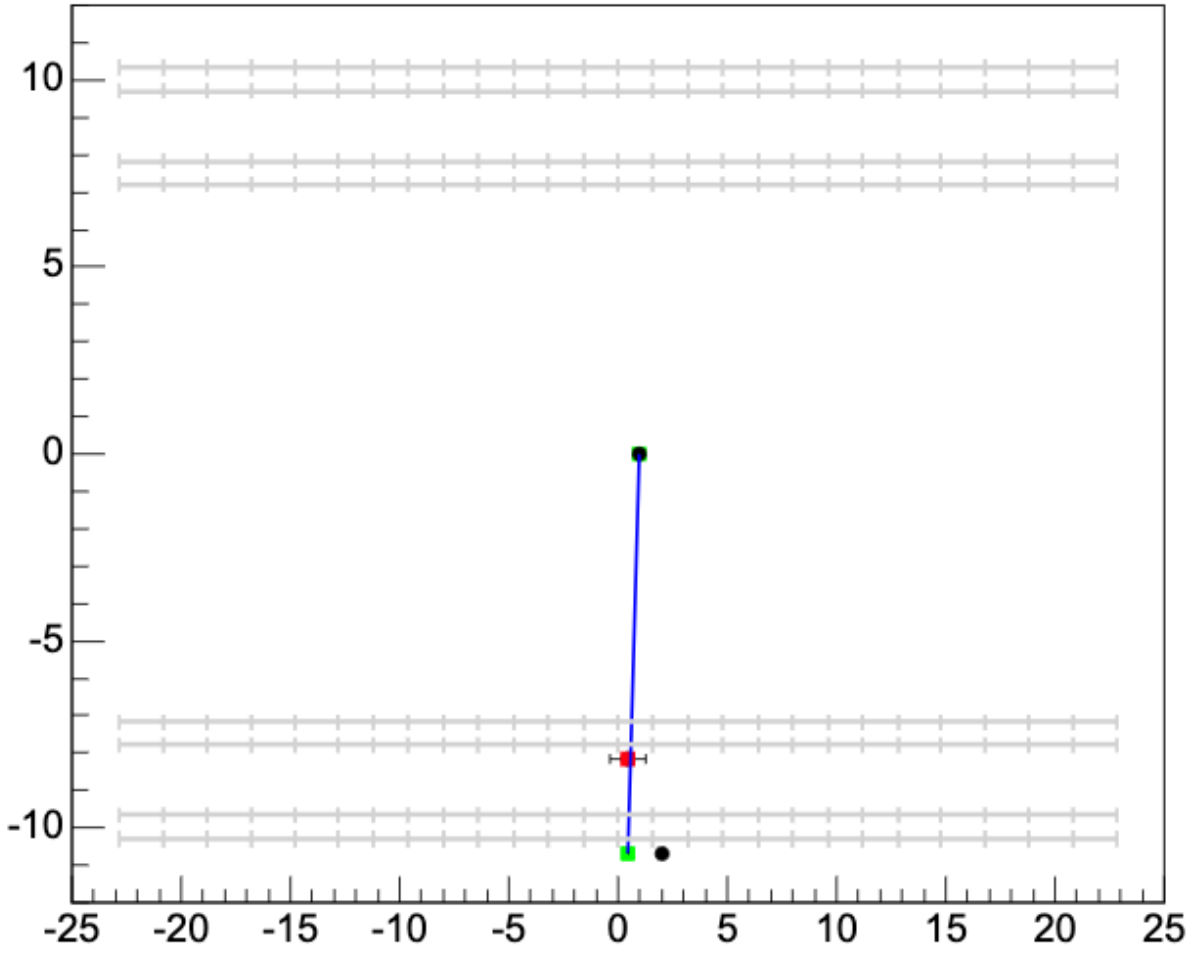
Event Display（good）



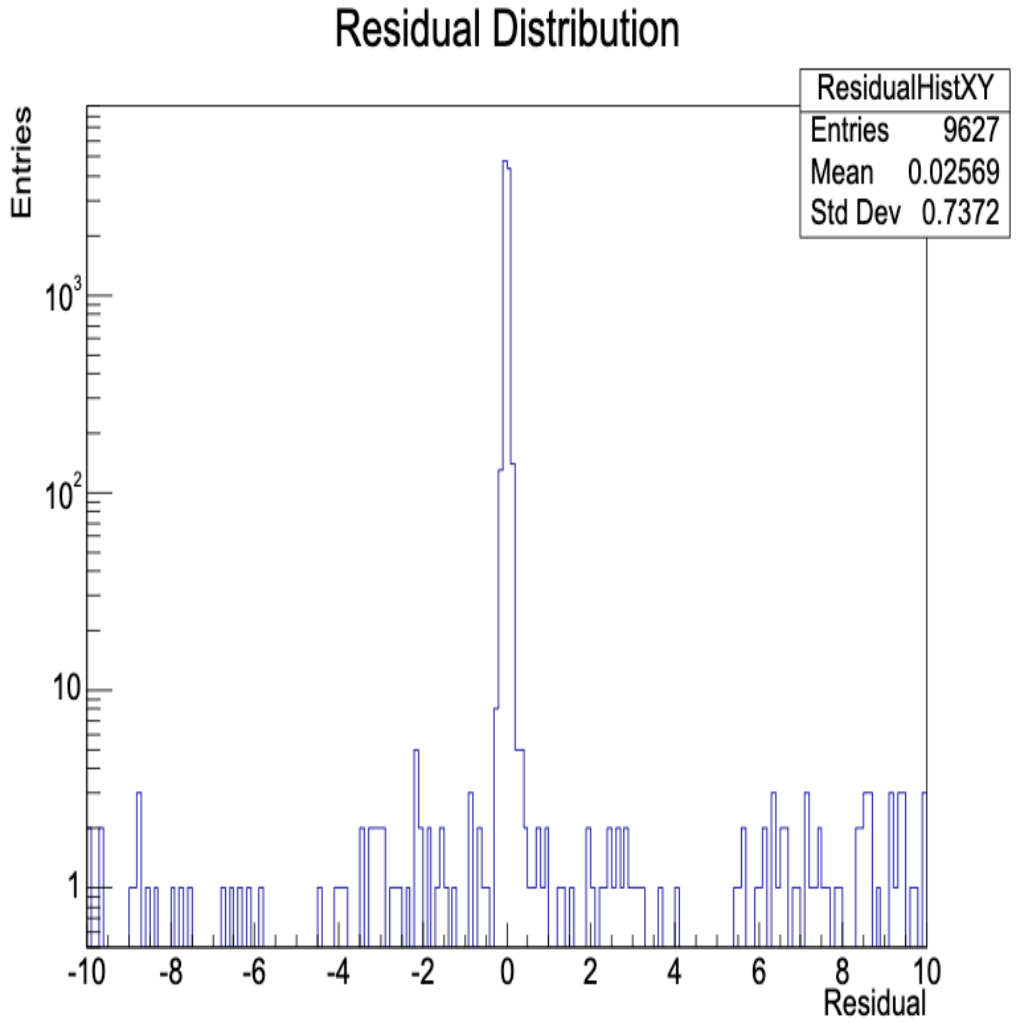


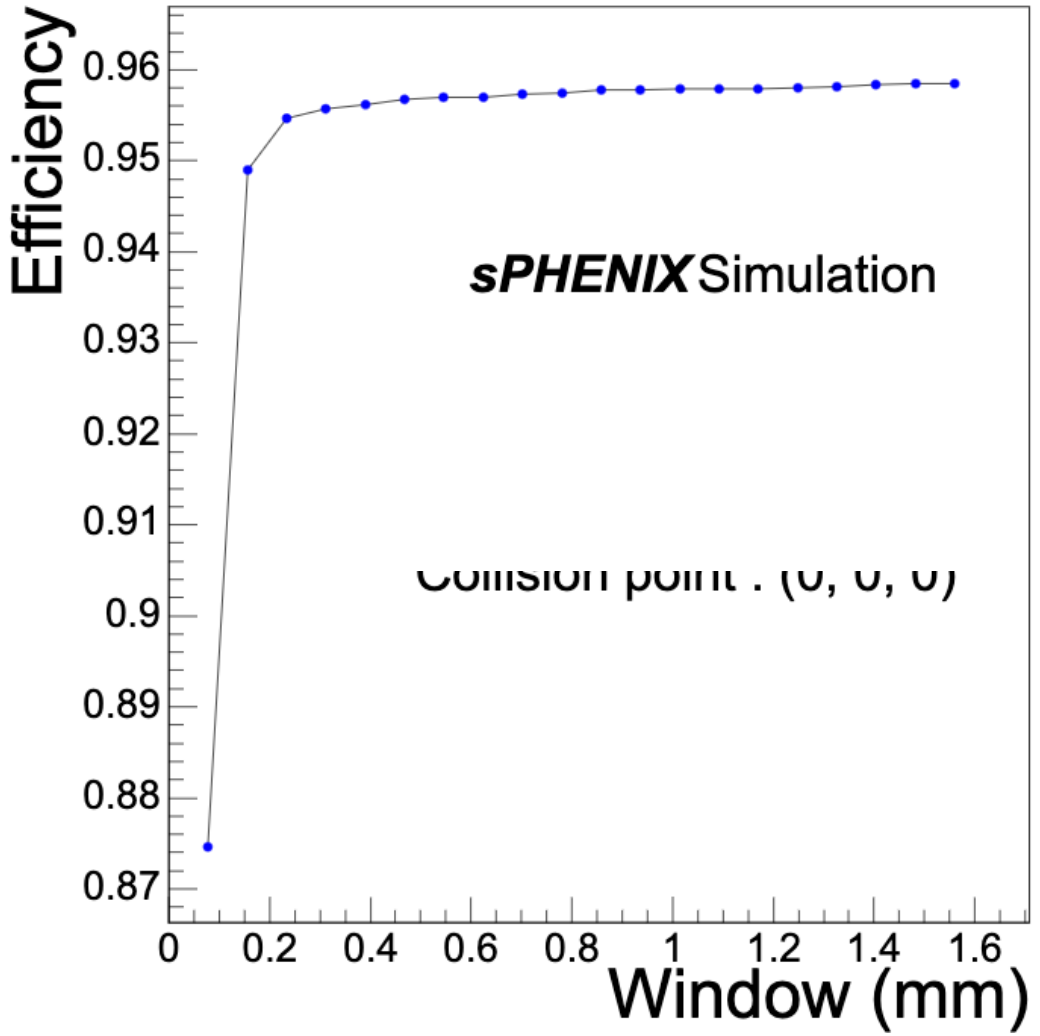
Event Display（bad）



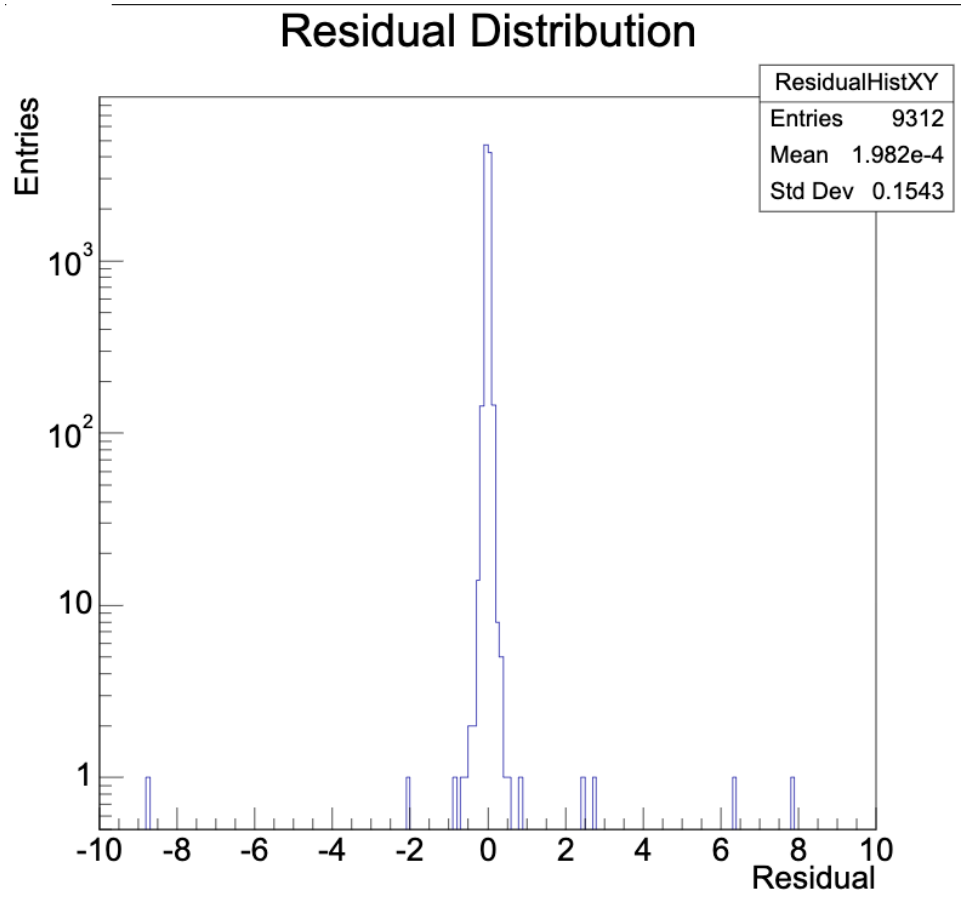


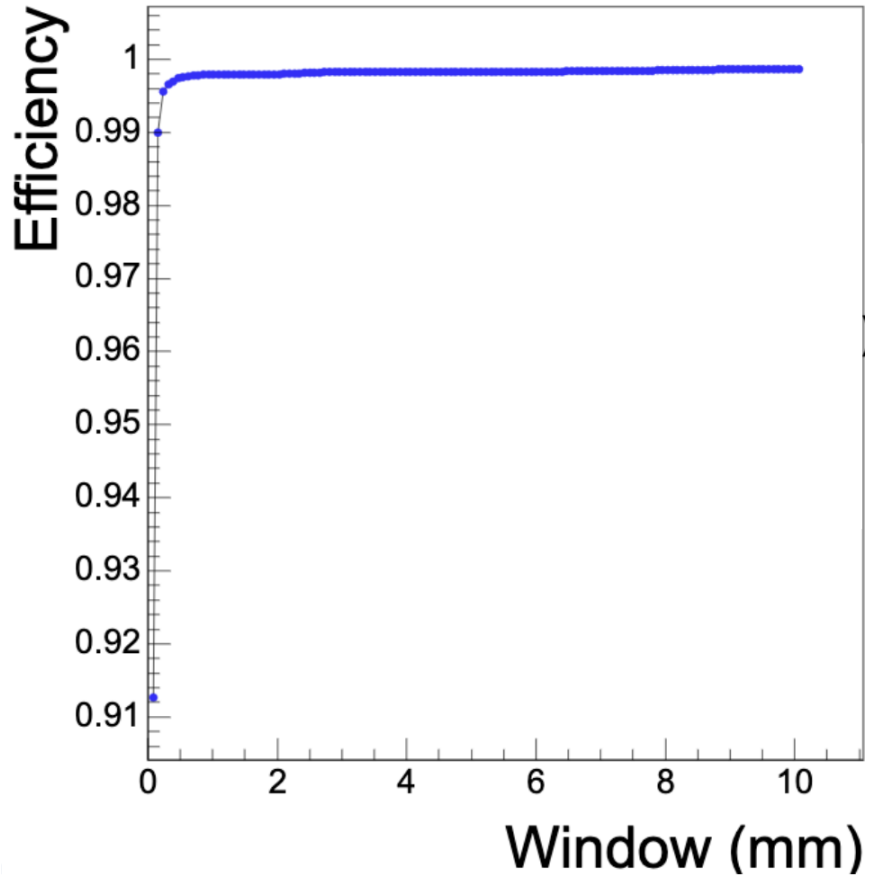
Result


Residual Distribution
ResidualHistXY
Entries 9627
Mean 0.02569
Std Dev 0.7372
Entries
10^3
10^2
10
1
-10 -8 -6 -4 -2 0 2 4 6 8 10
Residual


Efficiency
0.96
0.95
0.94
0.93
0.92
0.91
0.9
0.89
0.88
0.87
sPHENIX Simulation
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6
Window (mm)

Result (After event cut "# of outer clusters = 1")





The remaining 4% can mostly be explained by the particle generation.

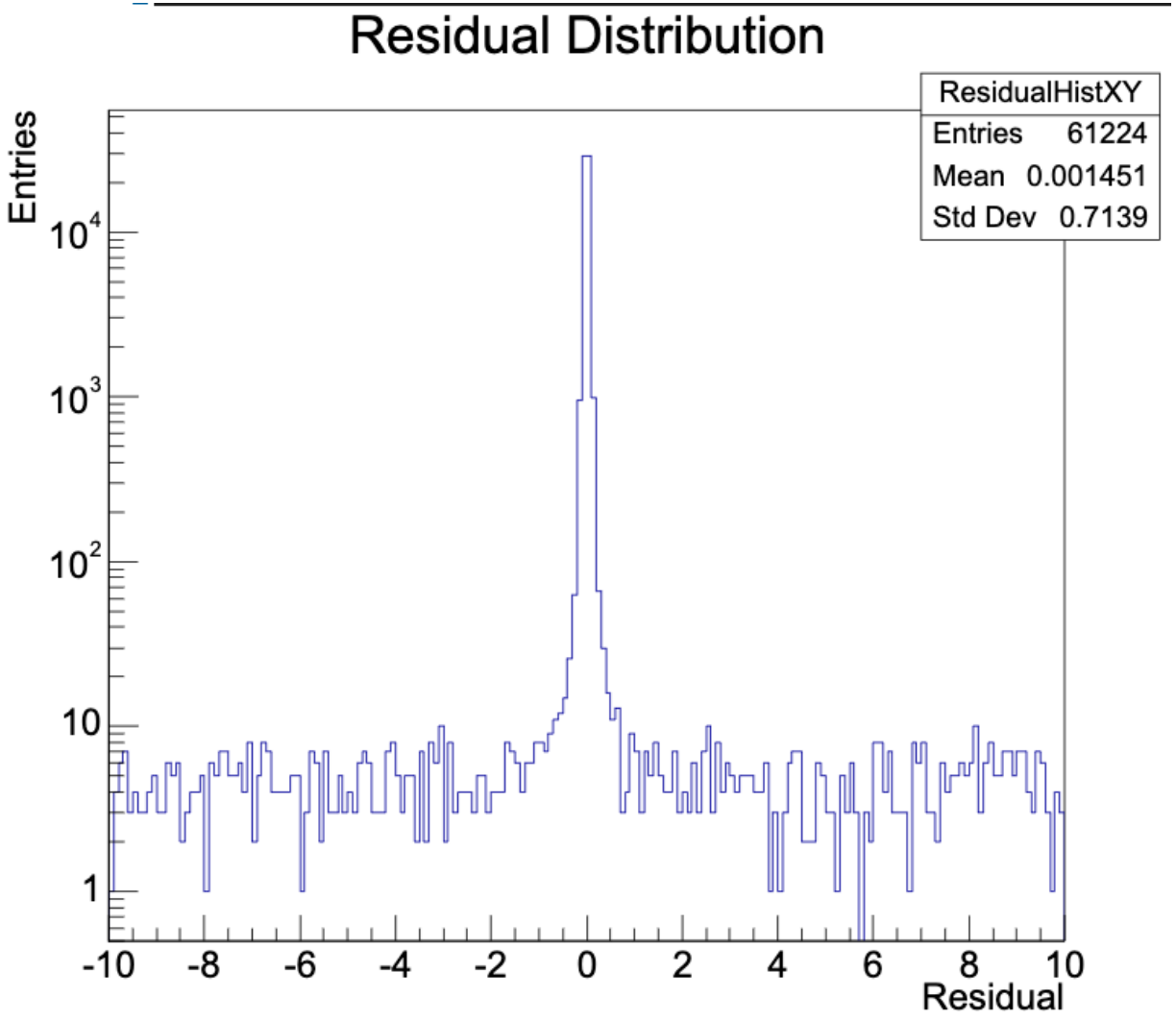
Muon simulation

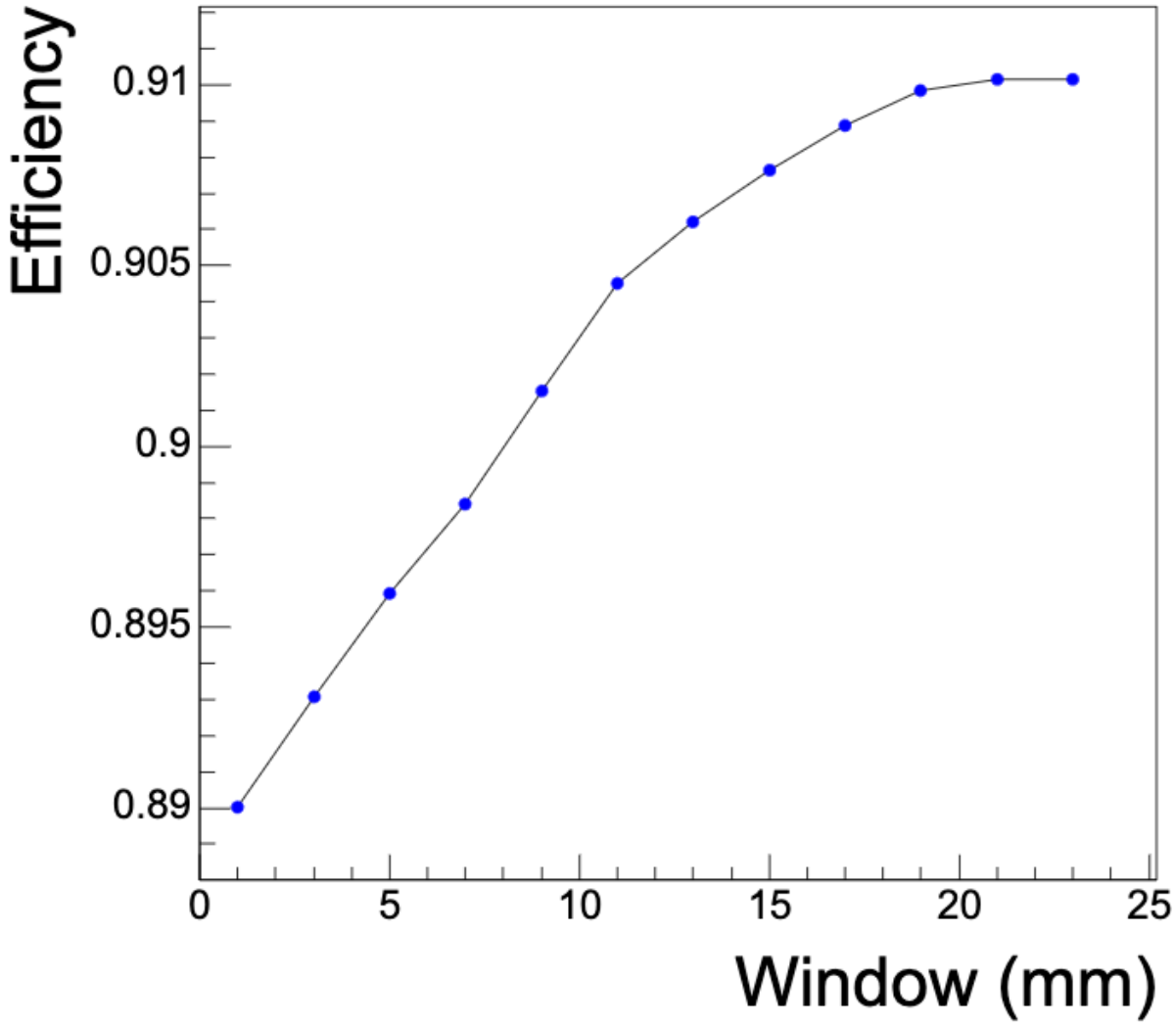
Simple simulation 2

- A particle (μ^-)/event
- $P_T = 1\ \mathrm{GeV}$
- # of events : 10K
- Magnetic field : 0T
- Incident point:
  Varied $(x, y, z) = (0, 0, 0)cm$
  $(\sigma_x, \sigma_y, \sigma_z) = (0, 0, 20)cm$
- Incident direction :
  $-\pi < \phi < \pi\ ,\ -1 < \eta < 1$
- No dead channel

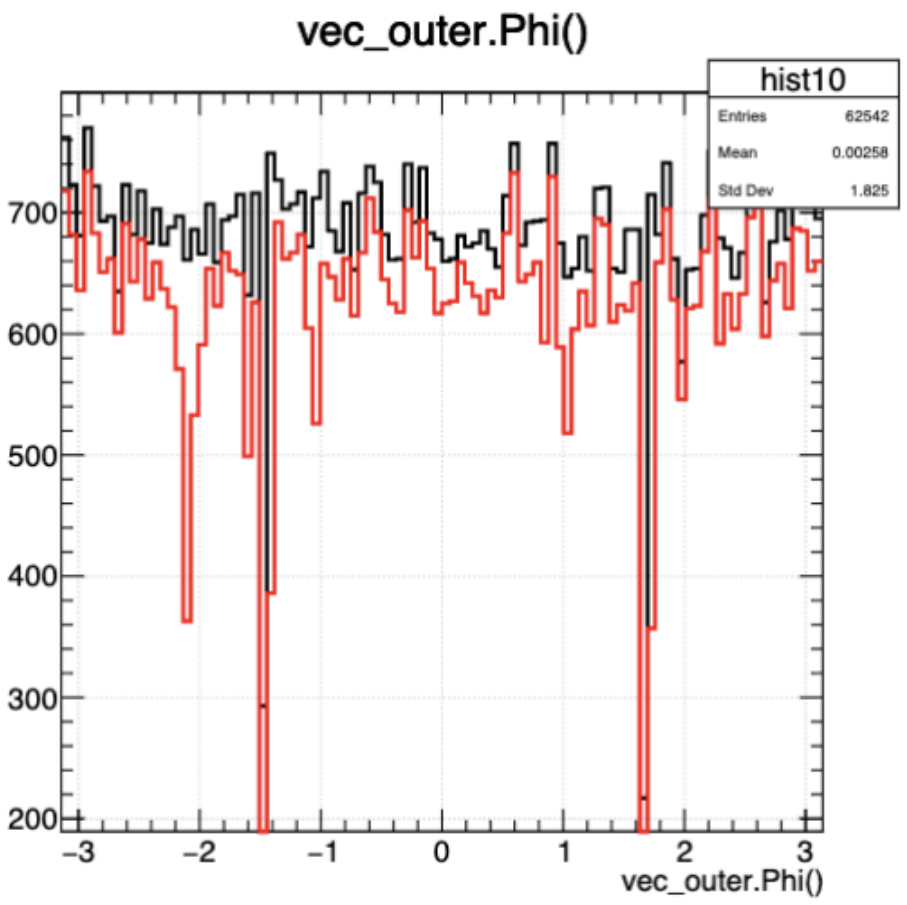
Aim of this simulation:
Show the performance of my algorithm in the simplest event as lowest multiplicity event.
→ The results shows maximum performance of this algorithm.

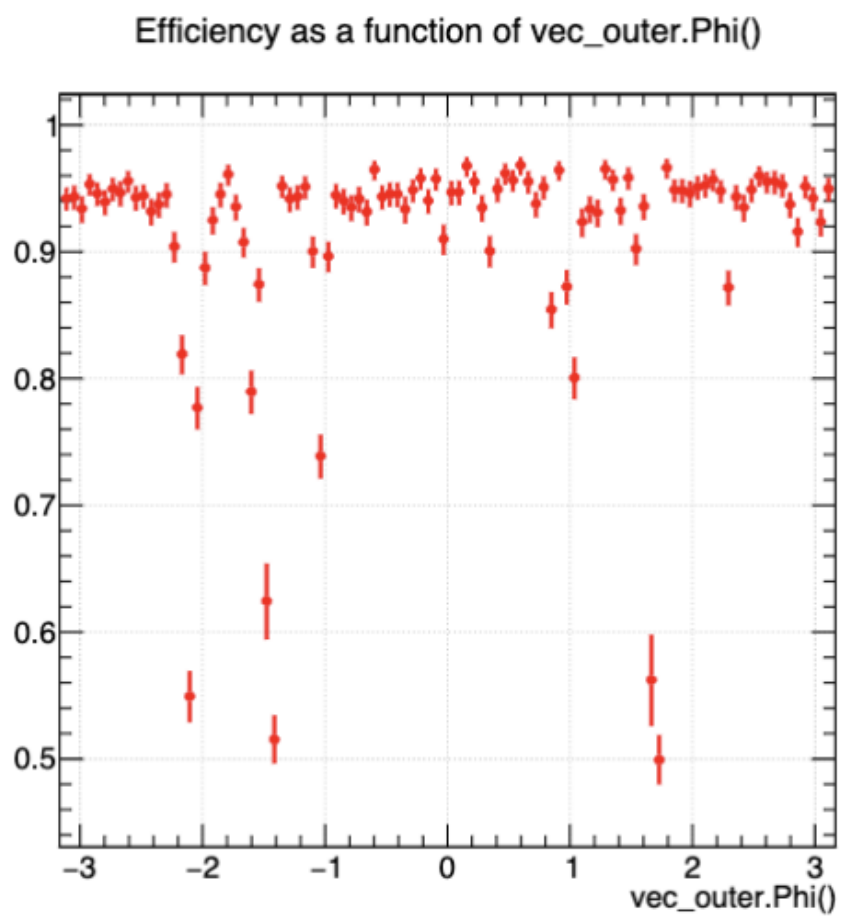
Result


Residual Distribution
ResidualHistXY
Entries 61224
Mean 0.001451
Std Dev 0.7139
Entries
10^4
10^3
10^2
10
1
-10 -8 -6 -4 -2 0 2 4 6 8 10
Residual

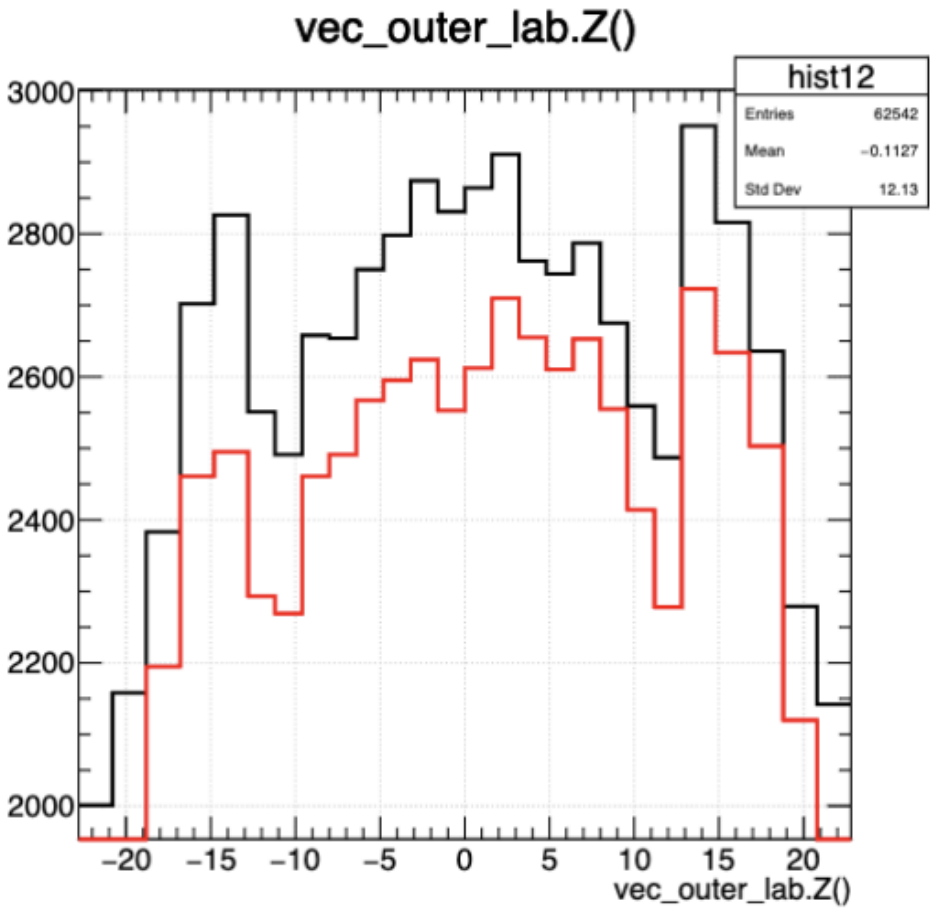

Efficiency
0.91
0.905
0.9
0.895
0.89
0 5 10 15 20 25
Window (mm)

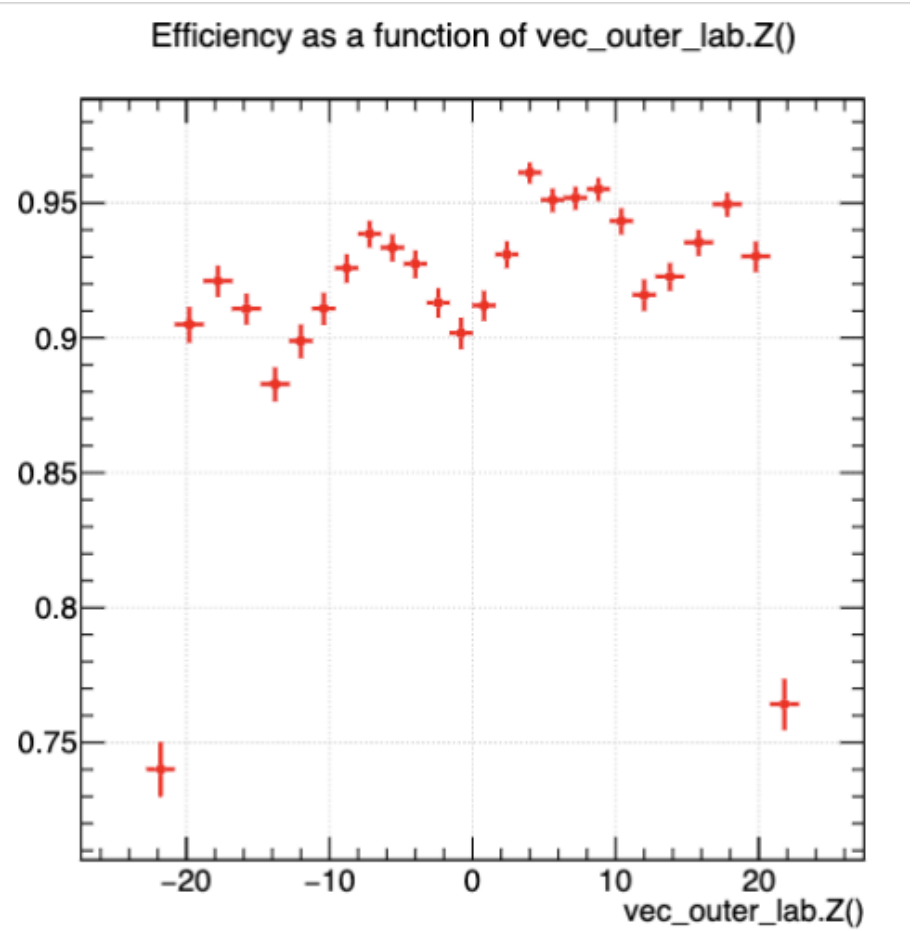
Phi Scan（Effect of dead area）





Z Scan（Effect of dead area）





Au+Au

simulation

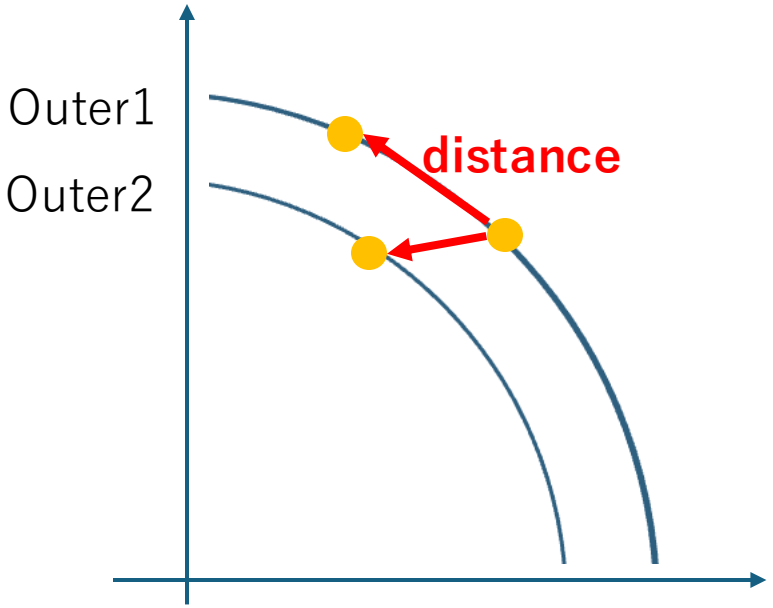
- A particle (μ^-)/event
- $P_T = 1\ \mathrm{GeV}$
- # of events : 10K
- Magnetic field : 0T
- Incident point:
  Fixed $(x, y, z) = (0, 0, 1)cm$
- Incident direction :
  $\phi = 0,\ \eta = 0$
- No dead channel

data

- A particle (μ^-)/event
- $P_T = 1\ \mathrm{GeV}$
- # of events : 10K
- Magnetic field : 0T
- Incident point:
  Varied $(x, y, z) = (0, 0, 0)cm$
  $(\sigma_x, \sigma_y, \sigma_z) = (0, 0, 20)cm$
- Incident direction :
  $-\pi < \phi < \pi\ ,\ -1 < \eta < 1$
- No dead channel

Isolation Cut

- High density has possibility to cause mis-pairing
- I cut the clusters from the distance of clusters



The distances between Outer clusters = Density

Cut

- Event cut

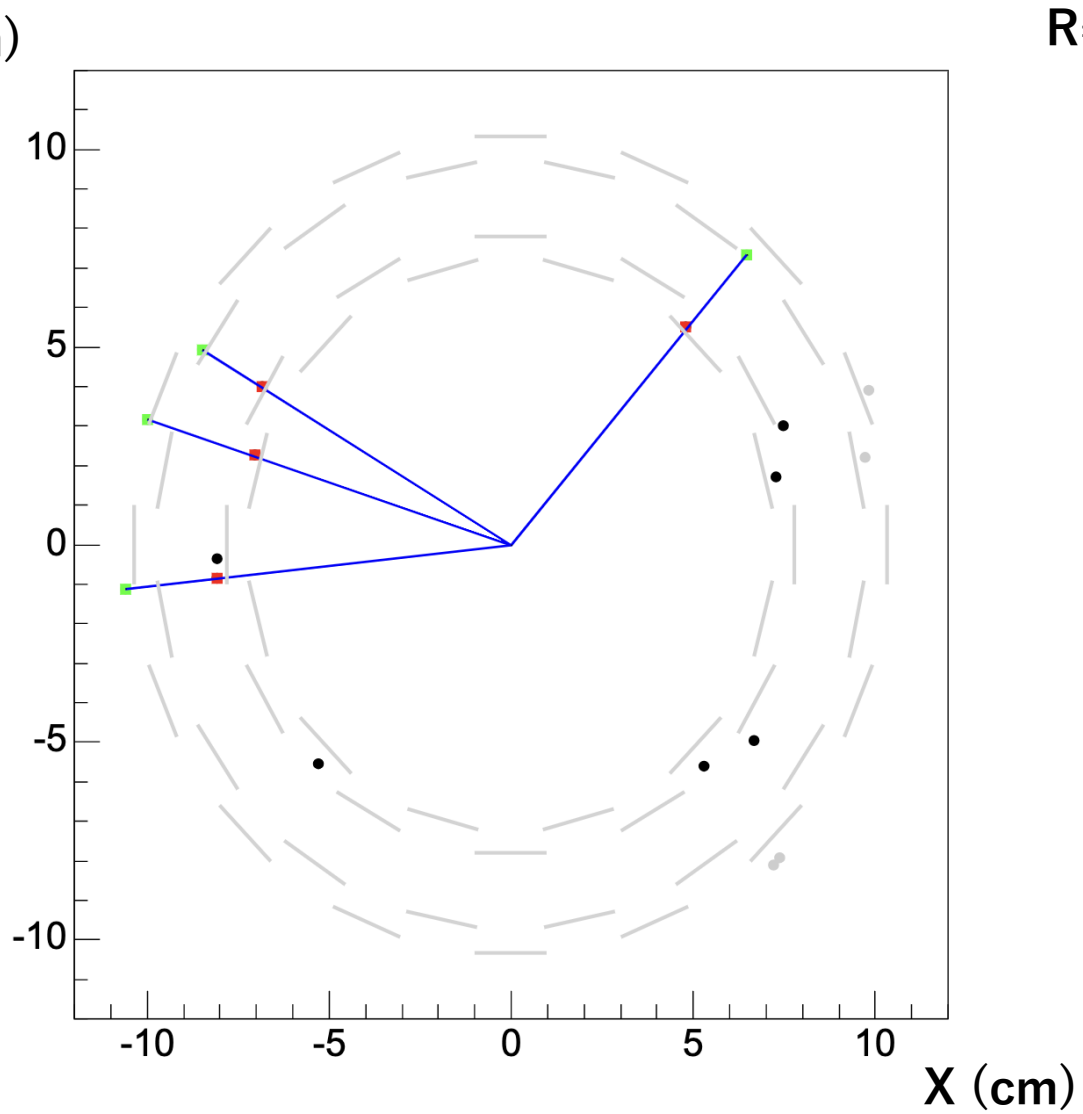
  Cheng-Wei recommend cut
  - NClus < 15 || NClus > 150
  - MBD_centrality != MBD_centrality
  - MBD_z_vtx != MBD_z_vtx
  - is_min_bias != 1
  - MBD_z_vtx< -23 || MBD_z_vtx > 23
  - InttBcoFullDiff_next <= 61
  - INTTvtxZ != INTTvtxZ
  - MBD_z_vtx - INTTvtxZ < -2 || MBD_z_vtx - INTTvtxZ > 2
  - TrapezoidalFitWidth < 1.5 || TrapezoidalFitWidth > 10
  - TrapezoidalFWHM < 2 || TrapezoidalFWHM > 14

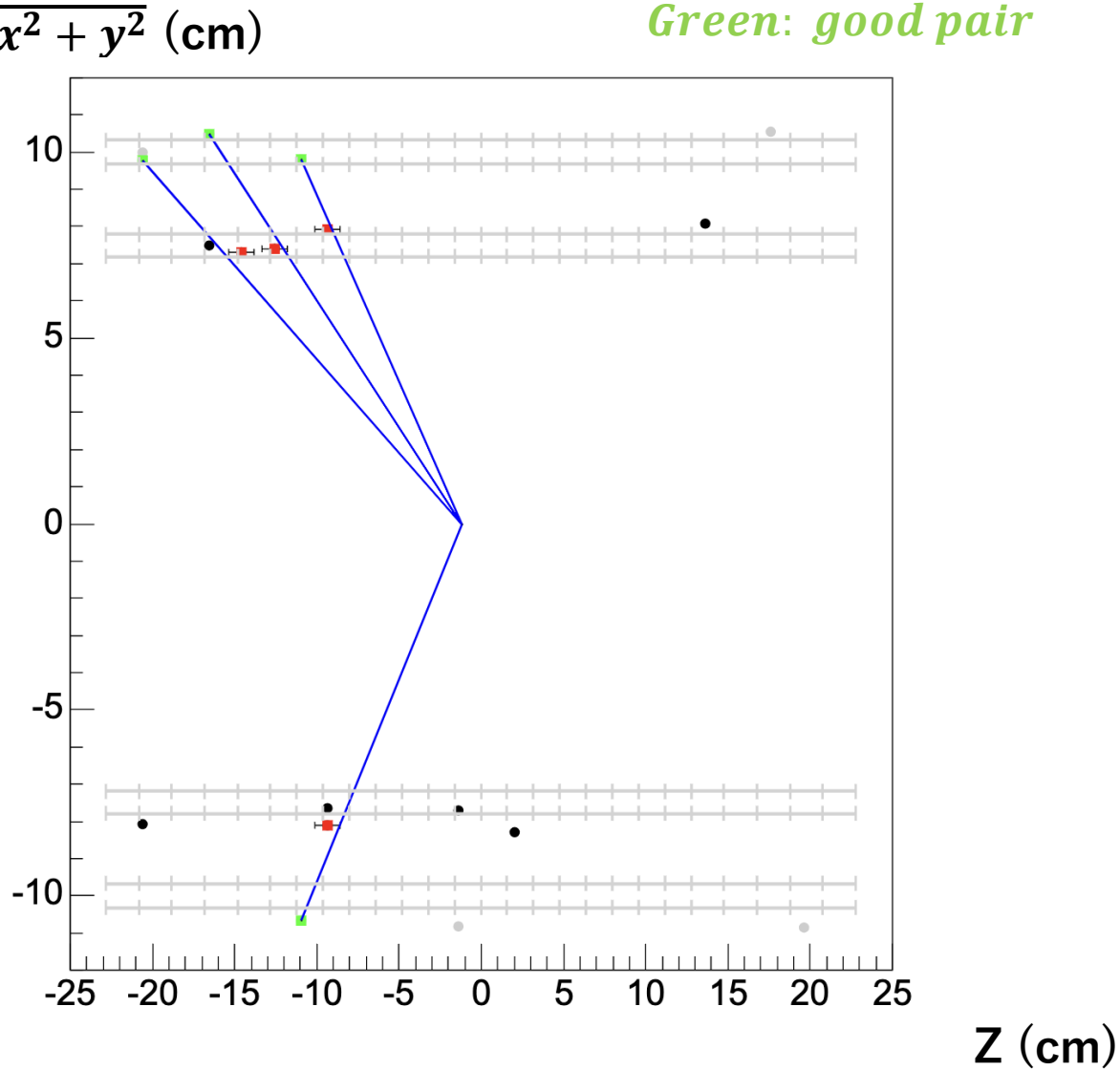
  My adding cut
  - nClusters<60
  - INTTvtxZ<-10 || INTTvtxZ>10

- **Outer cluster cut**
  - Isolation cut (distance of outer clusters < 1cm)
  - ADC <60
  - Cluster Size > 3

Event Display -good- (Au+Au data)

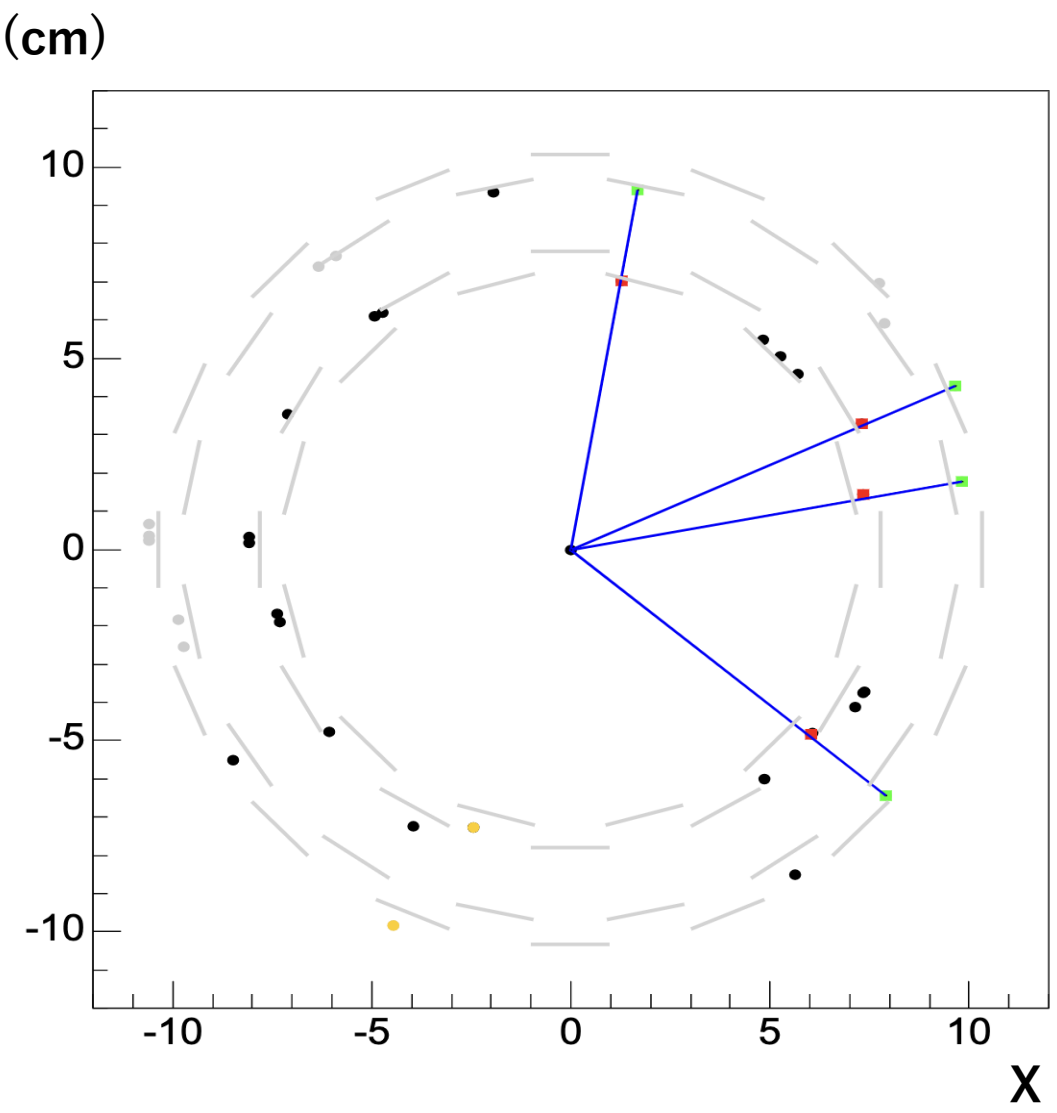
Grey: Cluster cut
Green: good pair

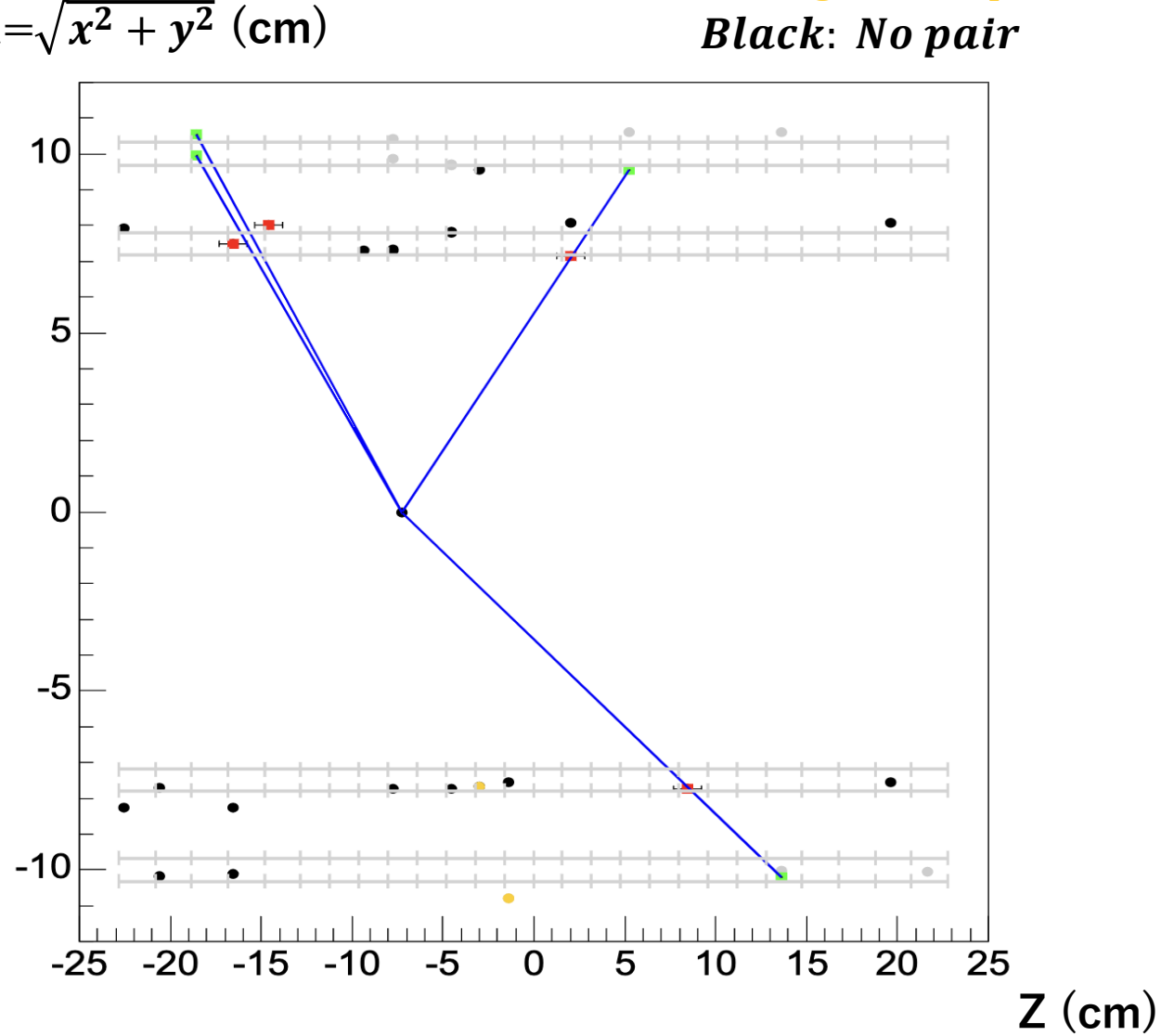




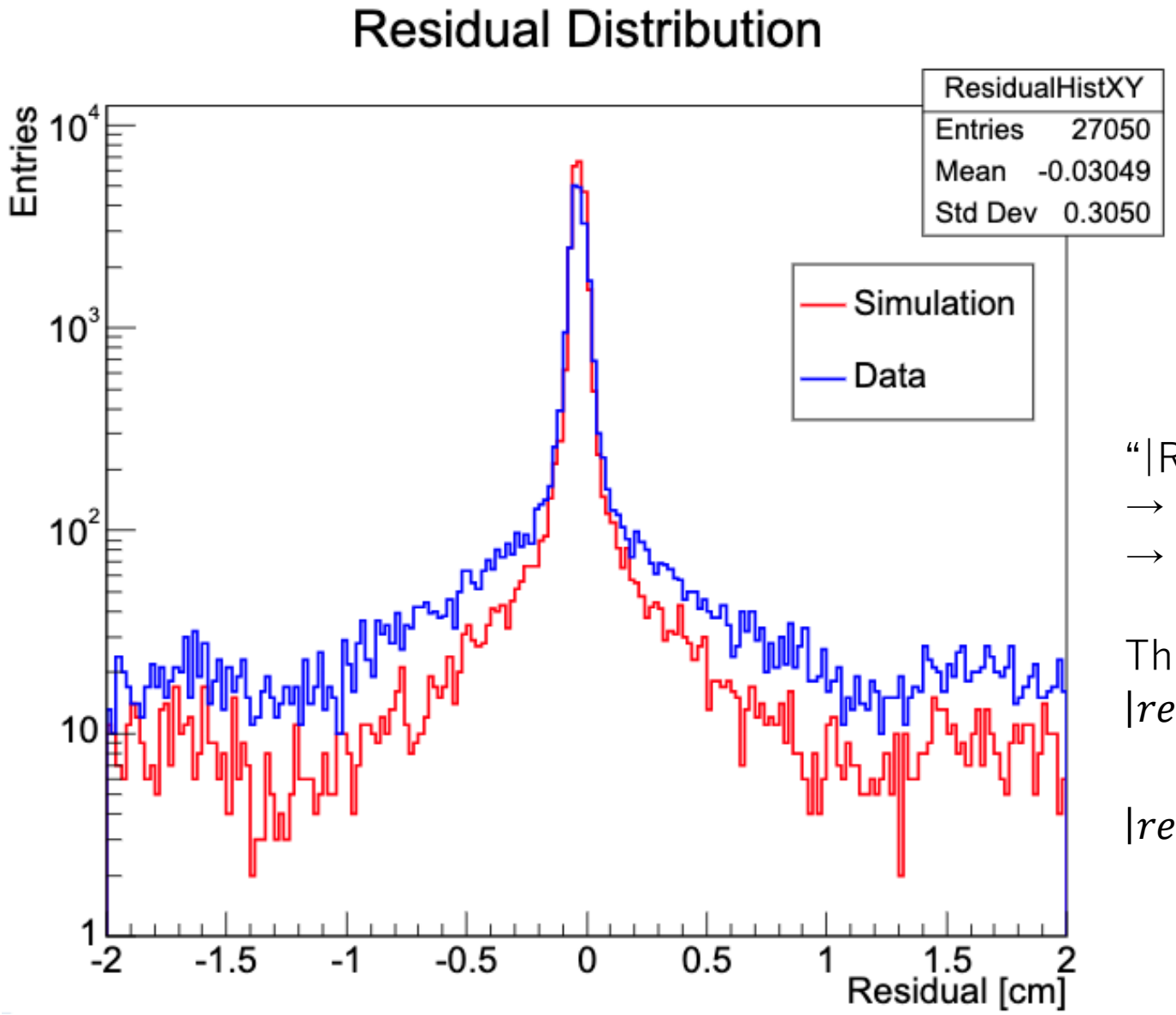
Event Display -bad- (Au+Au data)

Grey: Cluster cut
Green: good pair
Orange: bad pair
Black: No pair





Compare (simulation vs data)



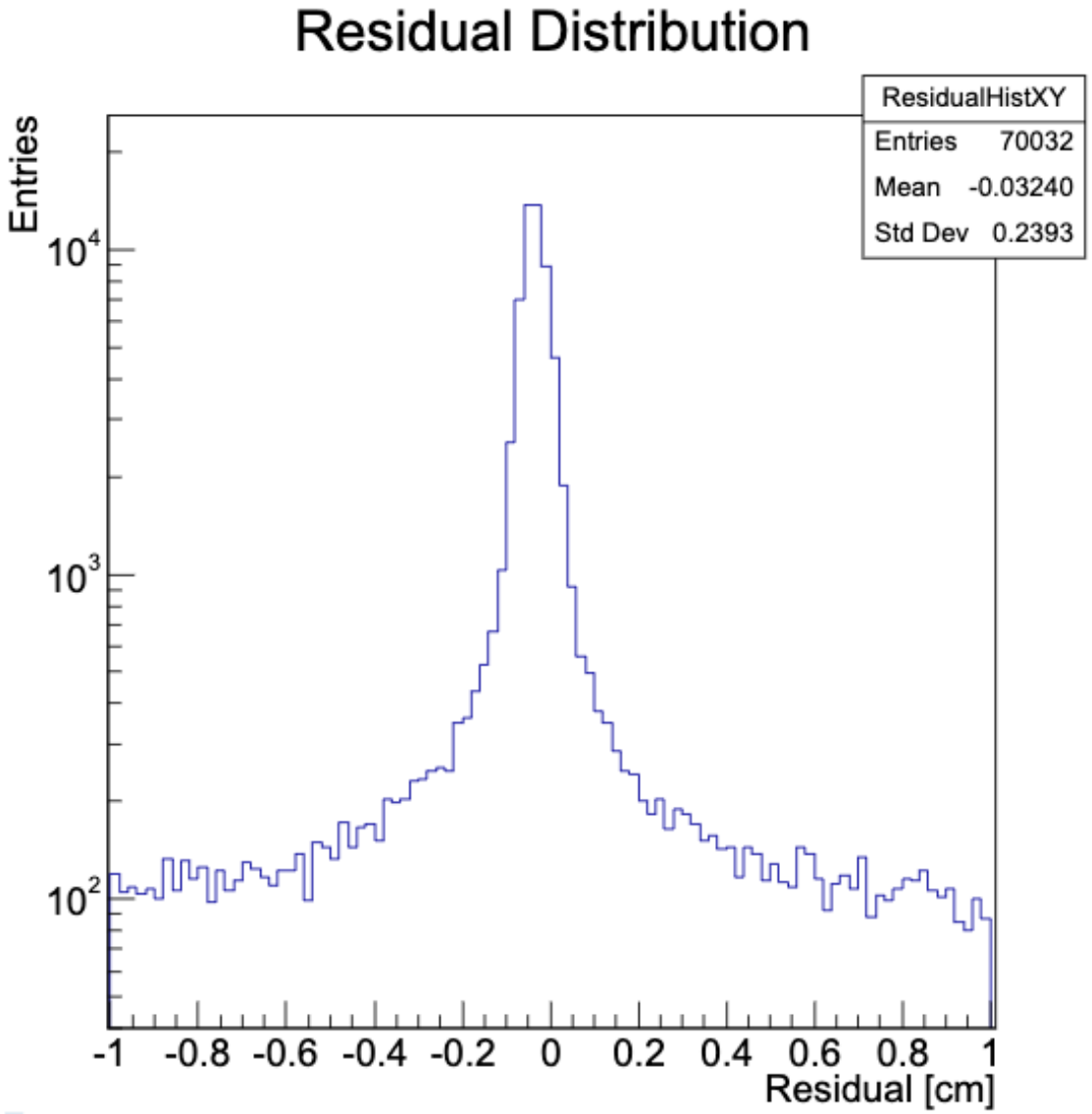
"|Residual XY|>1cm " area is flat each other
→ It's the evidence of the accidental pair
→ The focus range is changed to -1< Res <1

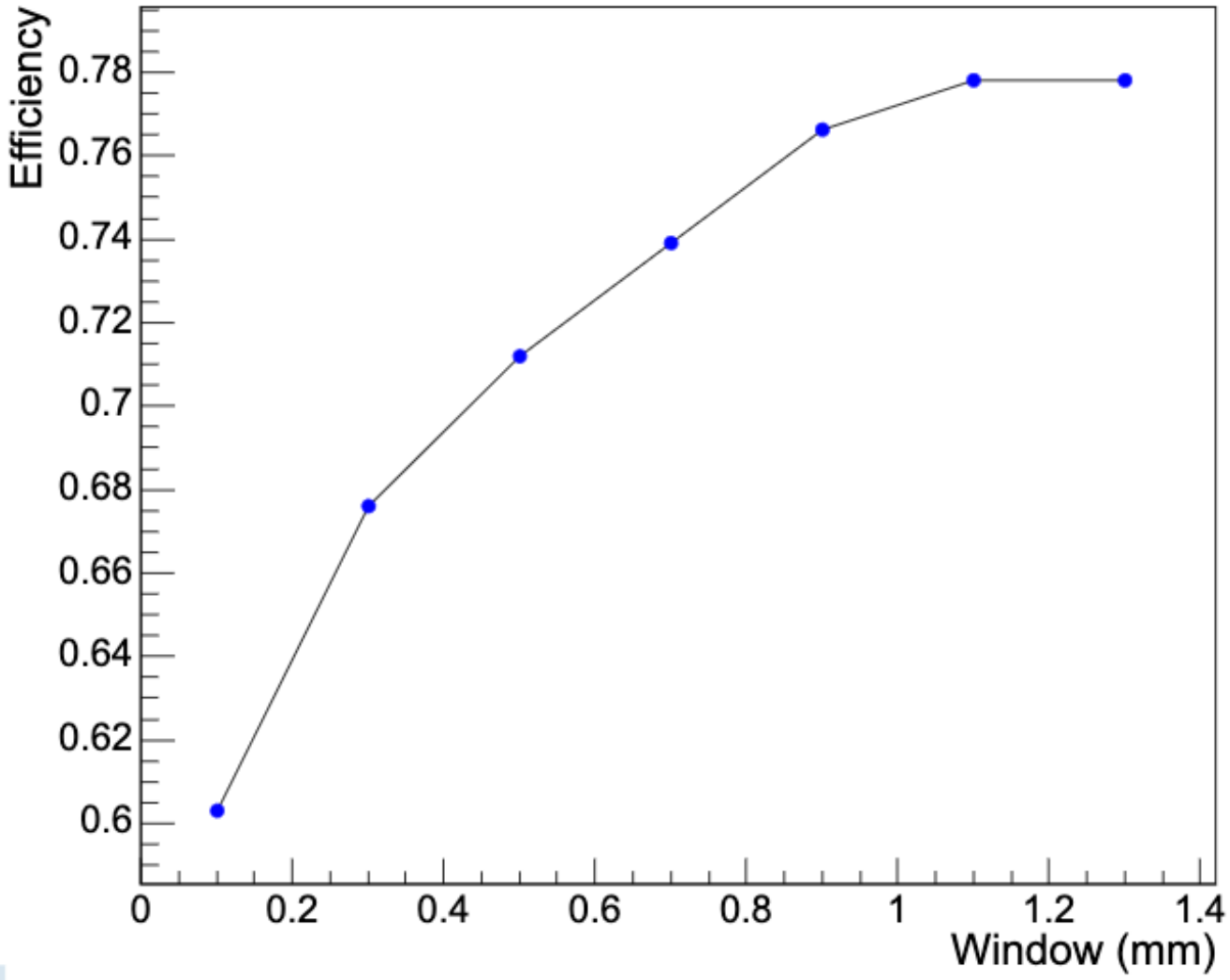
The pair requirement also changed

$|residual\ XY| < 2cm\ \&\&\ |residual\ RZ| < 4cm$

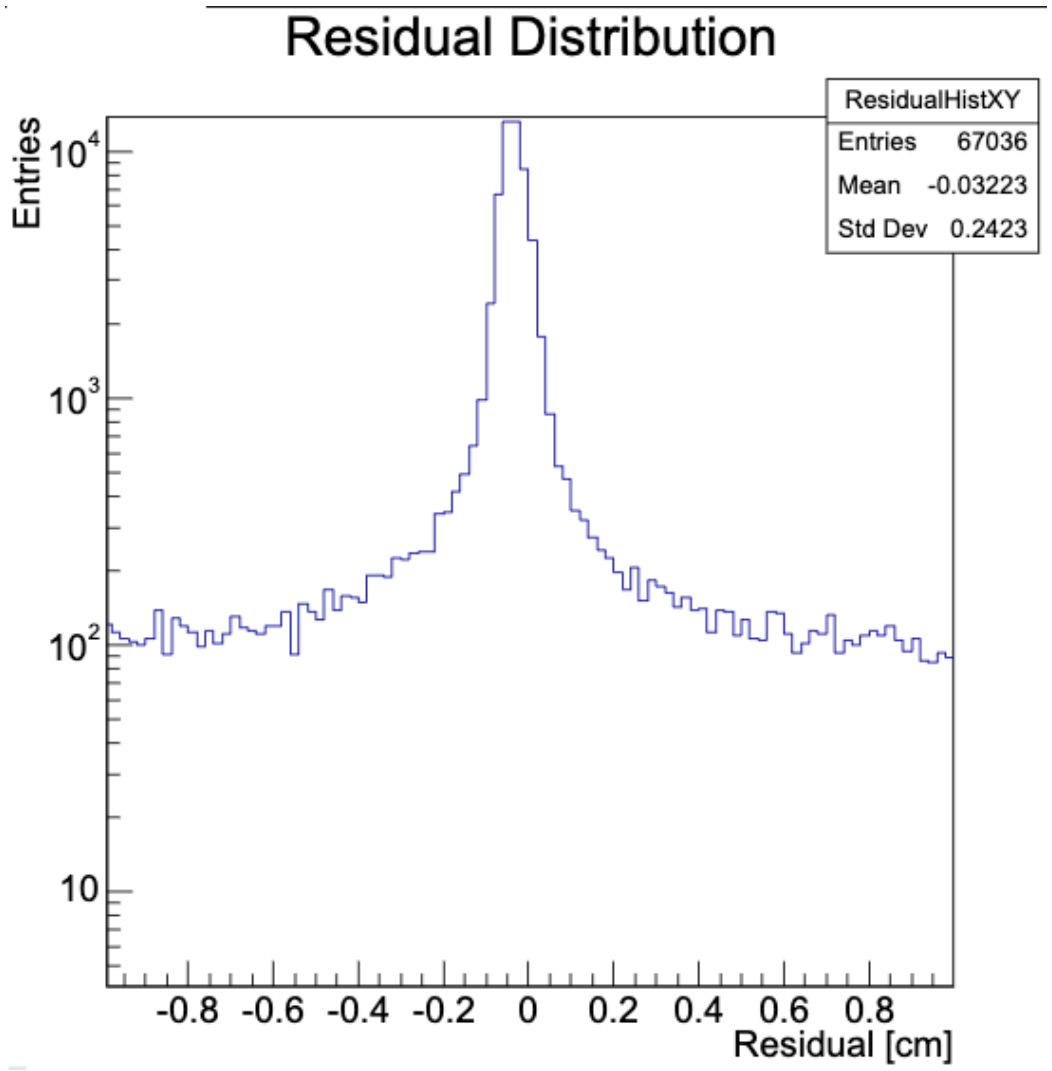
$|residual\ XY| < 1cm\ \&\&\ |residual\ RZ| < 4cm$

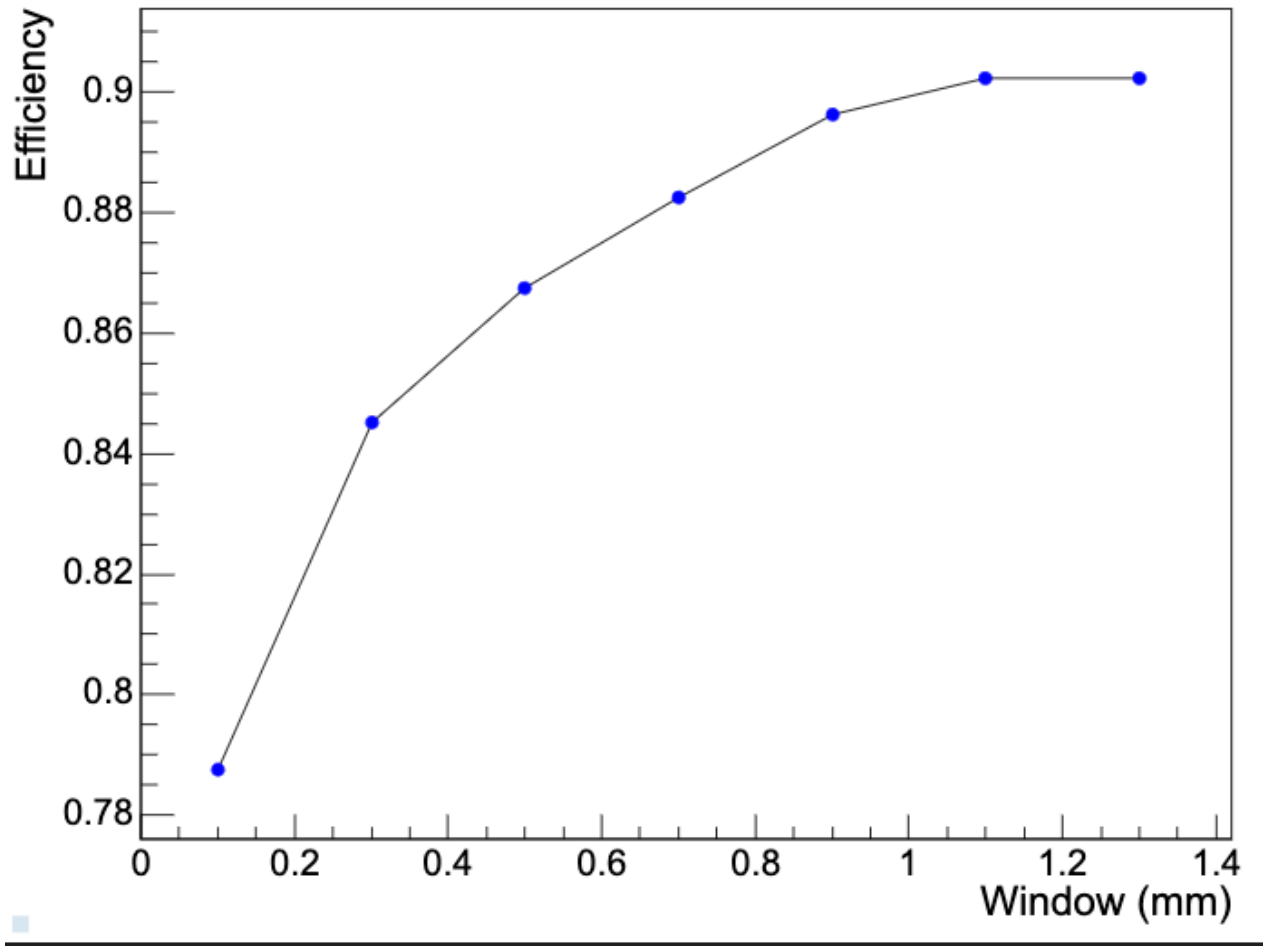
Result (data)


Residual Distribution
ResidualHistXY
Entries 70032
Mean -0.03240
Std Dev 0.2393
Entries
10^4
10^3
10^2
-1 -0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8 1
Residual [cm]


Efficiency
0.78
0.76
0.74
0.72
0.7
0.68
0.66
0.64
0.62
0.6
0 0.2 0.4 0.6 0.8 1 1.2 1.4
Window (mm)

Result (simulation)





Result -Ratio (data/simulation)