Zvertex determination

The plots for approval session

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20240911 INTT MT

Poster session at HardProbe 2024

- I will participate in Hard Probe 2024.
- My plots are included in Performance plots of INTT.
  You can find our analysis note from the link below.
  https://sphenix-invenio.sdcc.bnl.gov/records/p2899-21c57?preview=1
- In my analysis, 2 plots will be showed at approval session.
  My previous analysis is here
  https://sphenix-invenio.sdcc.bnl.gov/communities/sphenixcommunity/requests/2a27e268-b2bc-4d8e-8213-f048029ef859

Content for Poster at HardProbe

- Z_vertex determination methods with simulation data.
  - DCAz distribution for a single event.
  - The difference between the reconstructed z_vertex and truth z_vertex.

Used Data

simulation data, p+p collision, no magnetic field(Pythia (8.307)),10K events

- Z_vertex determination with data taken in 2024.

Used Data

Run 41349, p+p collision, no magnetic field

Run 50889, p+p collision, Streaming data, 0 [mrad]

Run 52412, p+p collision, Streaming data, 1.5 [mrad]

The content of my poster

- Z_vertex determination methods with simulation data.
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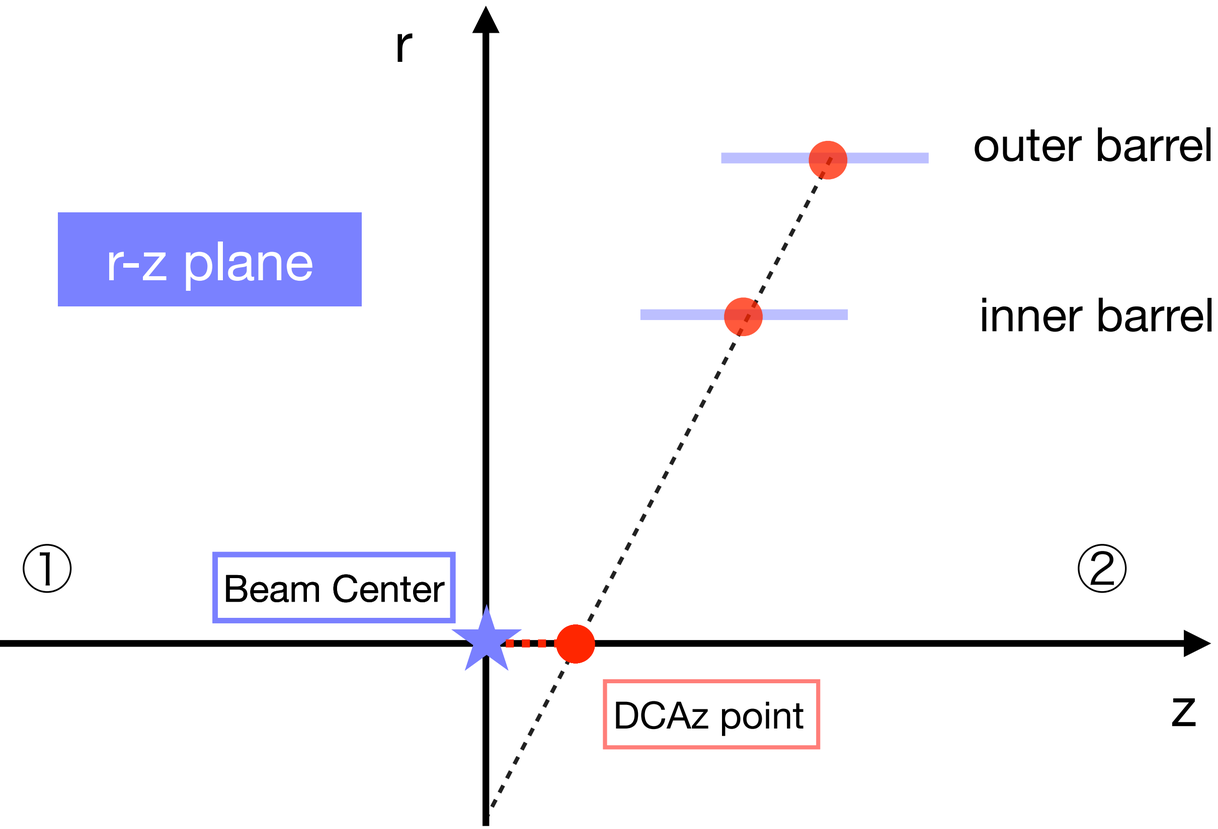
Run 52412, p+p collision, Streaming data, 1.5 [mrad]

Reconstructed method of Zvertex

from Cheng-Wei's method



1. Select each cluster on the inner, outer barrel. Connect them with a line.
2. Calculate the distance of closest approach (DCA) of the track to the beam center. DCAz is defined as z component of DCA.

Reconstructed method of Zvertex

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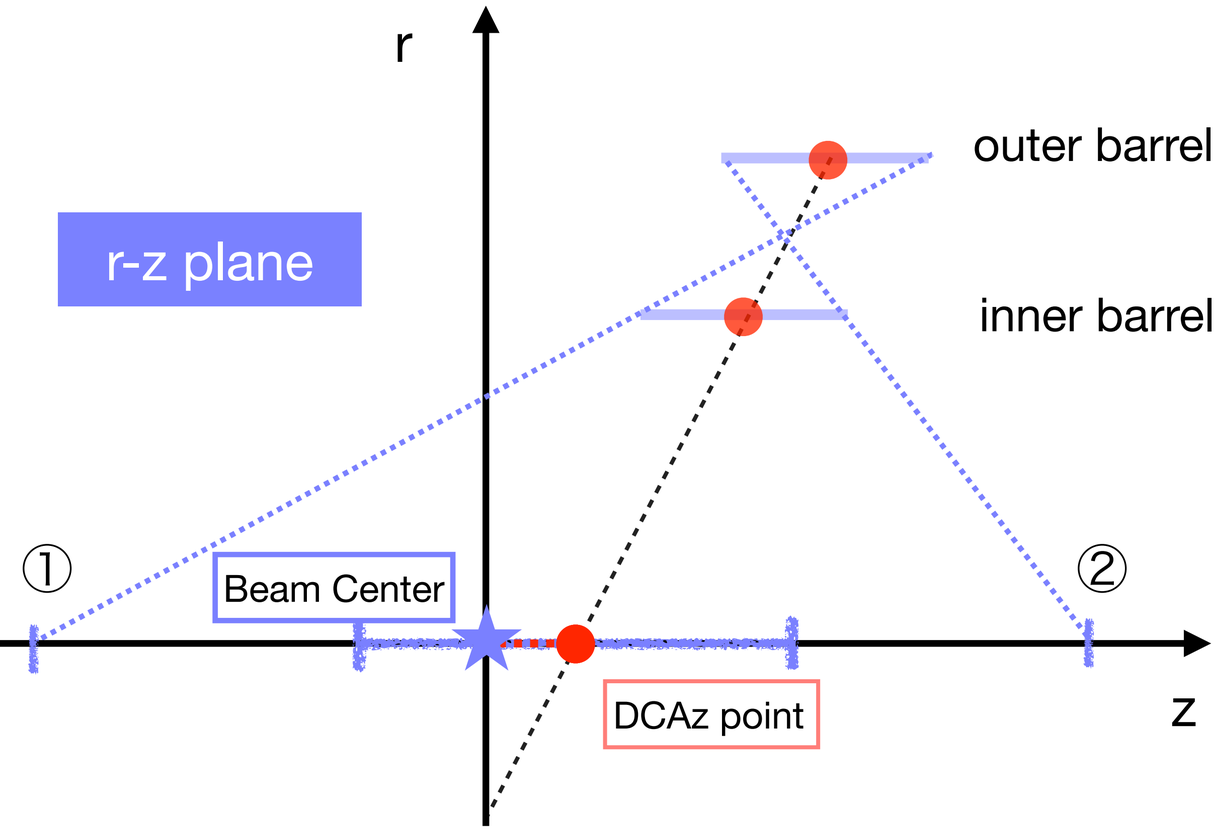

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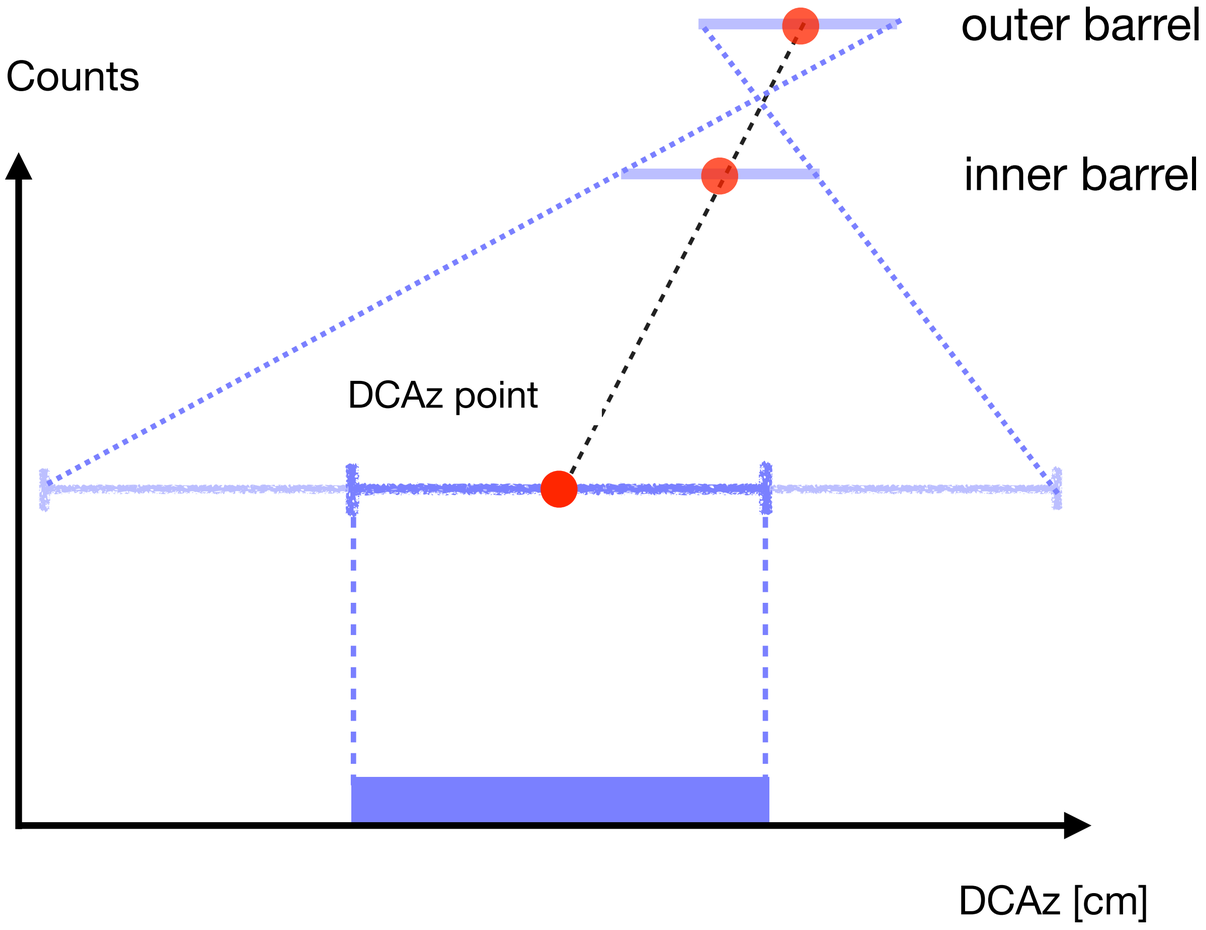
2. Calculate the distance of closest approach (DCA) of the track to the beam center. DCAz is defined as z component of DCA.
3. Determine the DCAz error range by dividing the width between ① and ② by $\sqrt{12}$.

Reconstructed method of Zvertex

from Cheng-Wei's method



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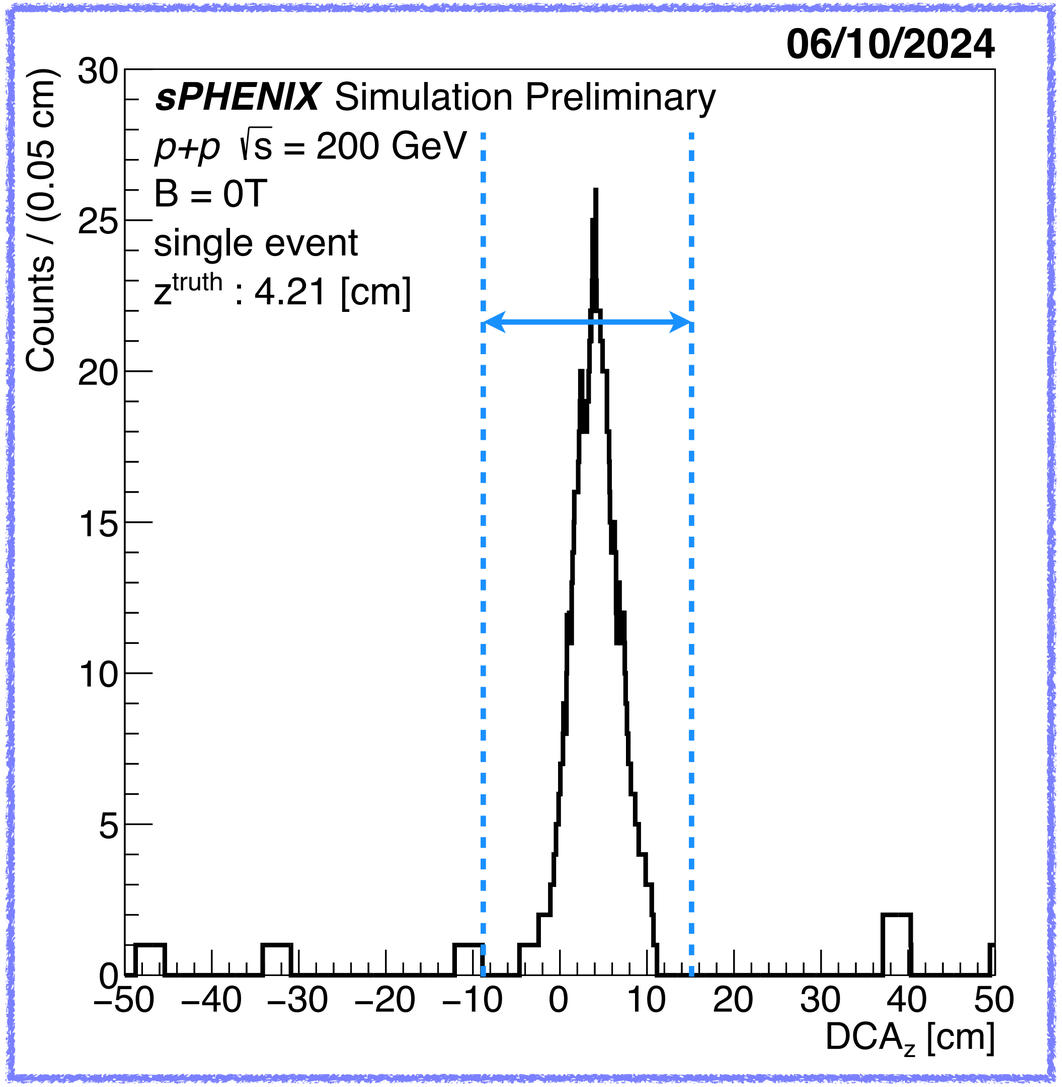
2. Calculate the distance of closest approach (DCA) of the track to the beam center. DCAz is defined as z component of DCA.
3. Determine the DCAz error range by dividing the width between ① and ② by $\sqrt{12}$.
4. Plot the DCAz points with this range. Calculate the z_{vertex}.

Reconstructed method of Zvertex

DCAz distribution for a single event



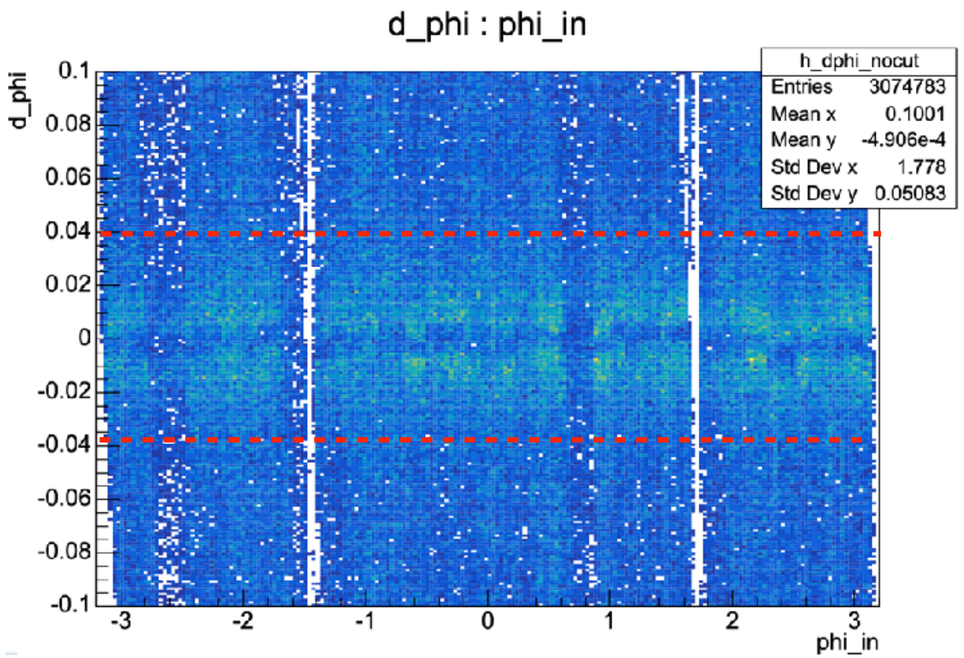
- To calculate the mean value using only data within 1σ from the average point of DCAz distribution.
- Left plot already got approval and showed in AGS meeting.

Analysis cut

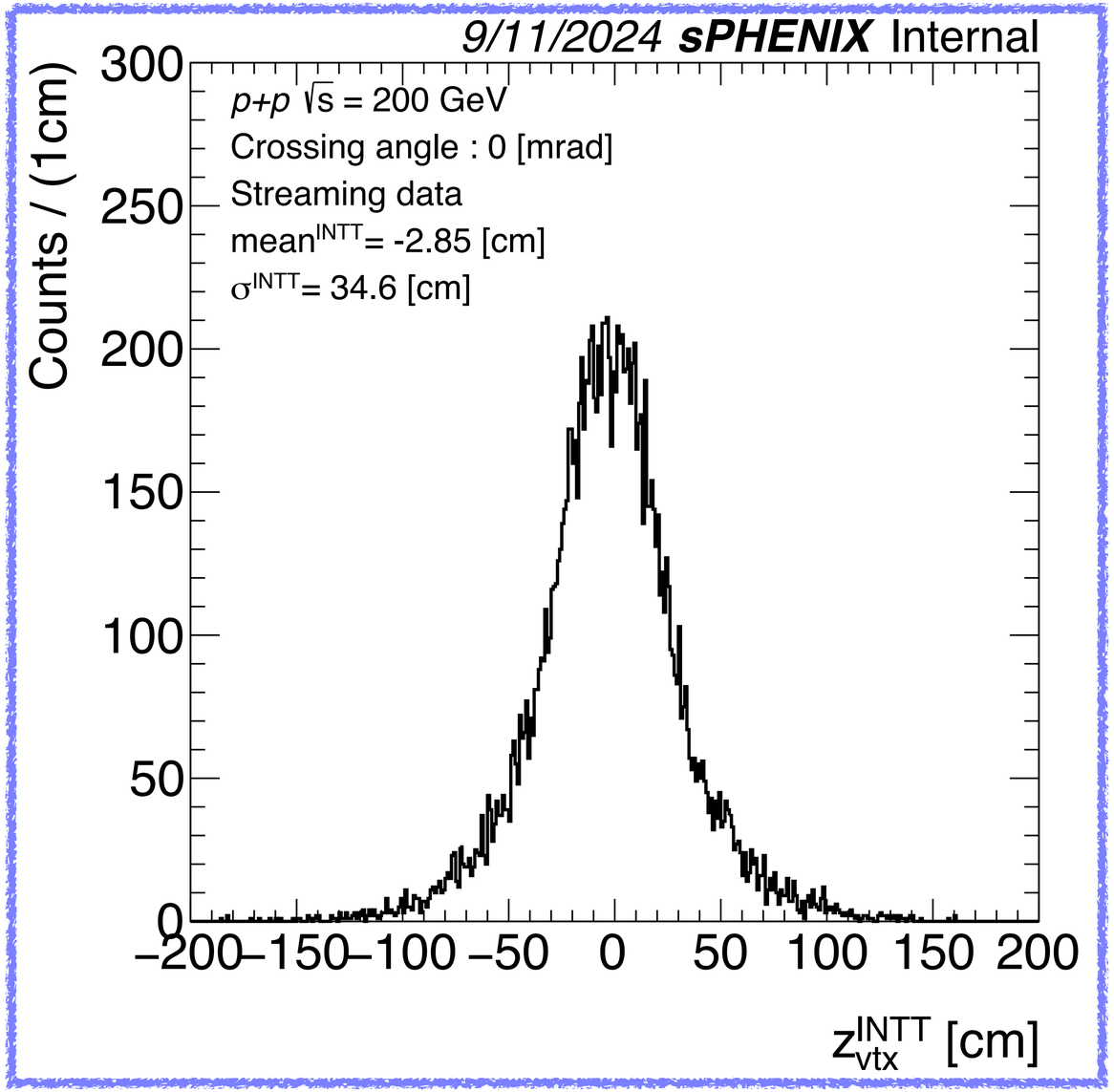
- Hot channel cut
- Delta phi cut

  Tracklets are selected for which the angular difference between inner cluster and outer cluster $|\Delta\phi| < 0.04$ [rad].

- Number of tracks < 3
- FPHX BCO cut



Plot 1 : Zvertex distribution (0 mrad)

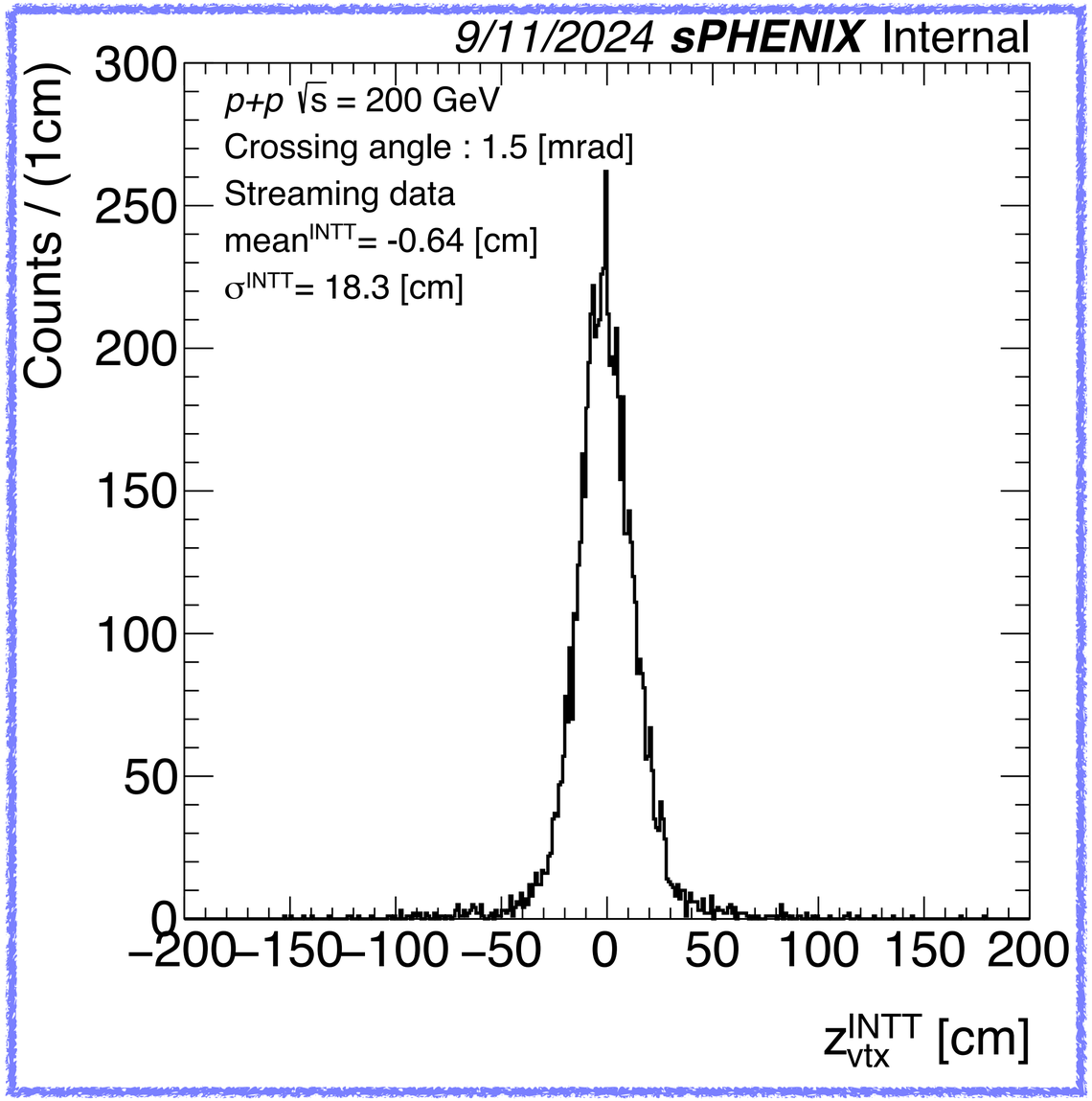


- Only hits associated with 10 FPHX BCOs were selected.
- Each files were created individually and then combined in order to get enough statistics. Each has 10K events and all together have 100k events.

Used Data

Run 50889, p+p collision, Streaming data, 0 [mrad]

Plot 2 : Zvertex distribution (1.5 mrad)



- Only hits associated with one FPHX BCO (BSO100, 100k events) was selected.
- Compare last plots, you can see the difference in distribution spread due to the difference in crossing angles.

Used Data

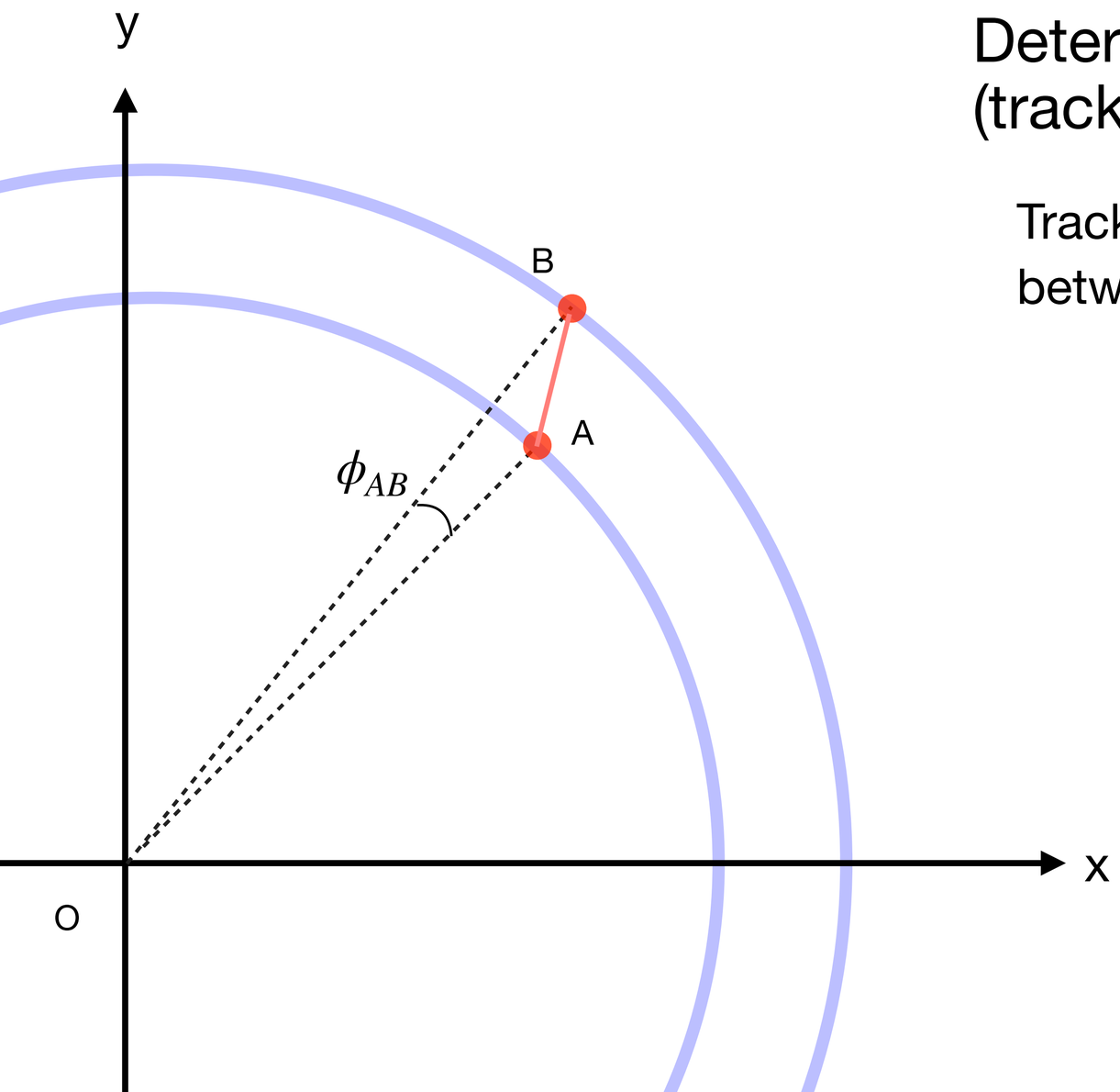
Run 52412, p+p collision, Streaming data, 1.5 [mrad]

Summary

- I will present my poster at Hard Probe 2024.
- I showed 2 plots for approval session. Approval session will be held next Friday (Thank you Nukazuka san…)
- Really thank you for your help, Jaein, Genki, Takashi and Hinako.

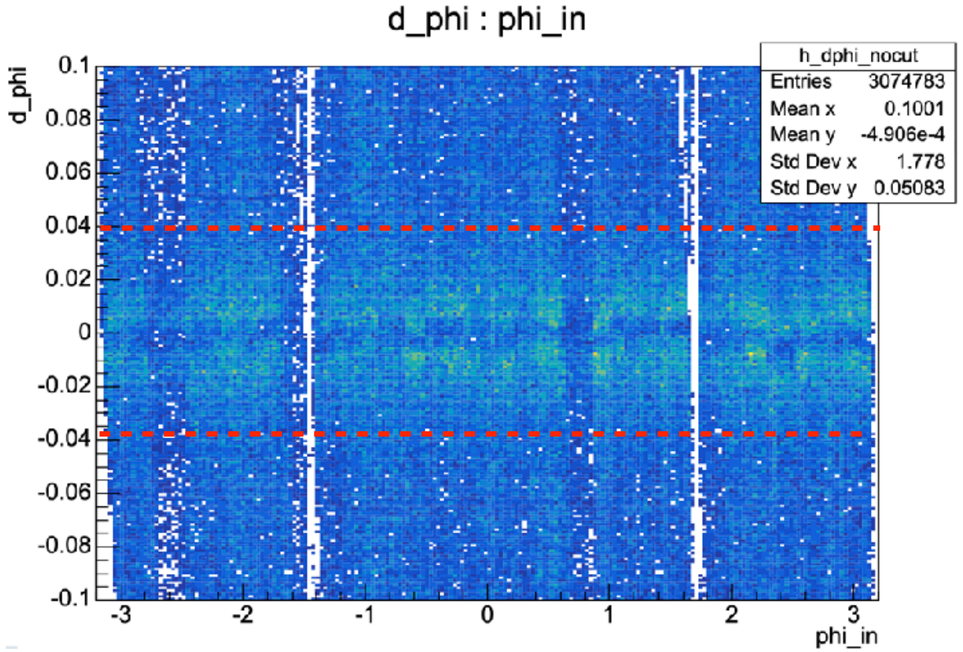
Back Up

Tracklet



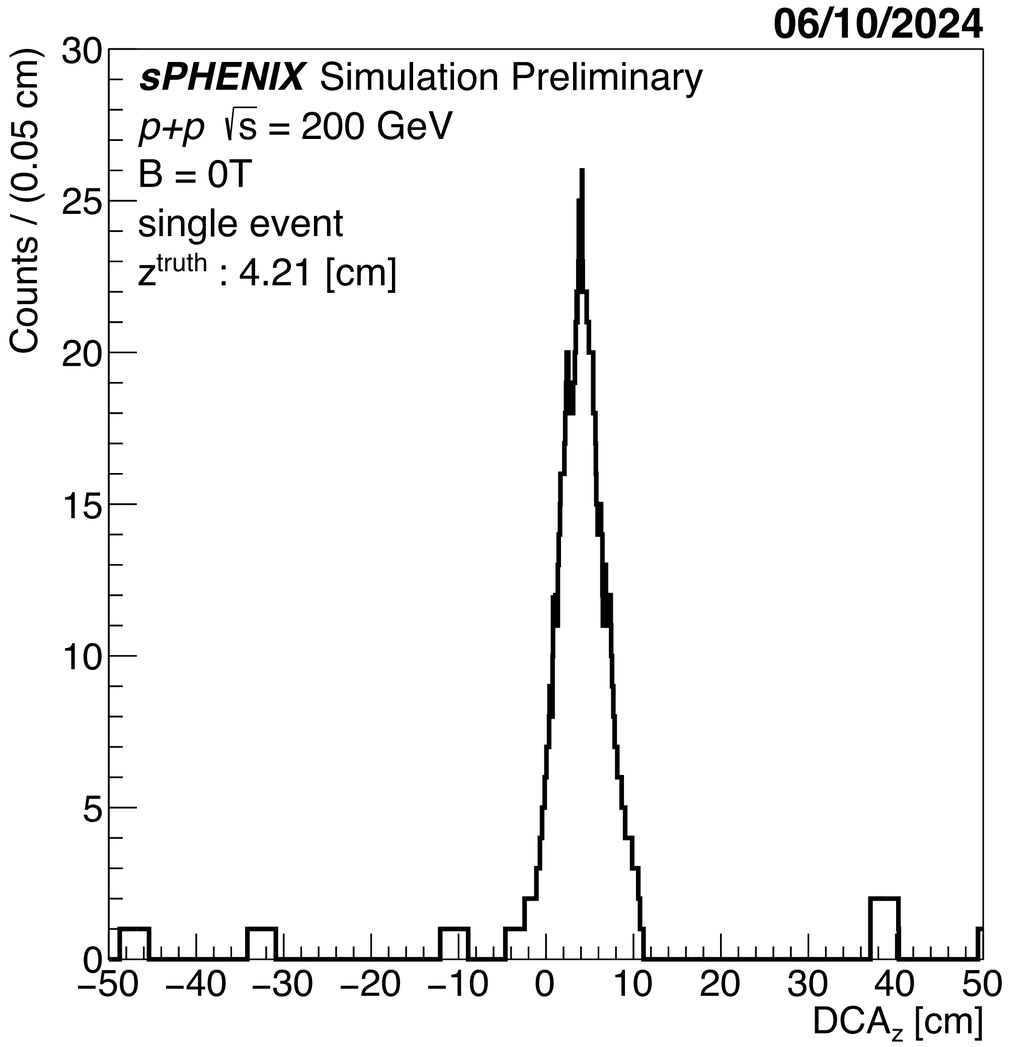
Determine the pair of Cluster A and Cluster B (tracklet) on the x-y plane.

Tracklets are selected for which the angular difference between cluster A and B $|\Delta\phi_{AB}| < 0.04$ [rad].



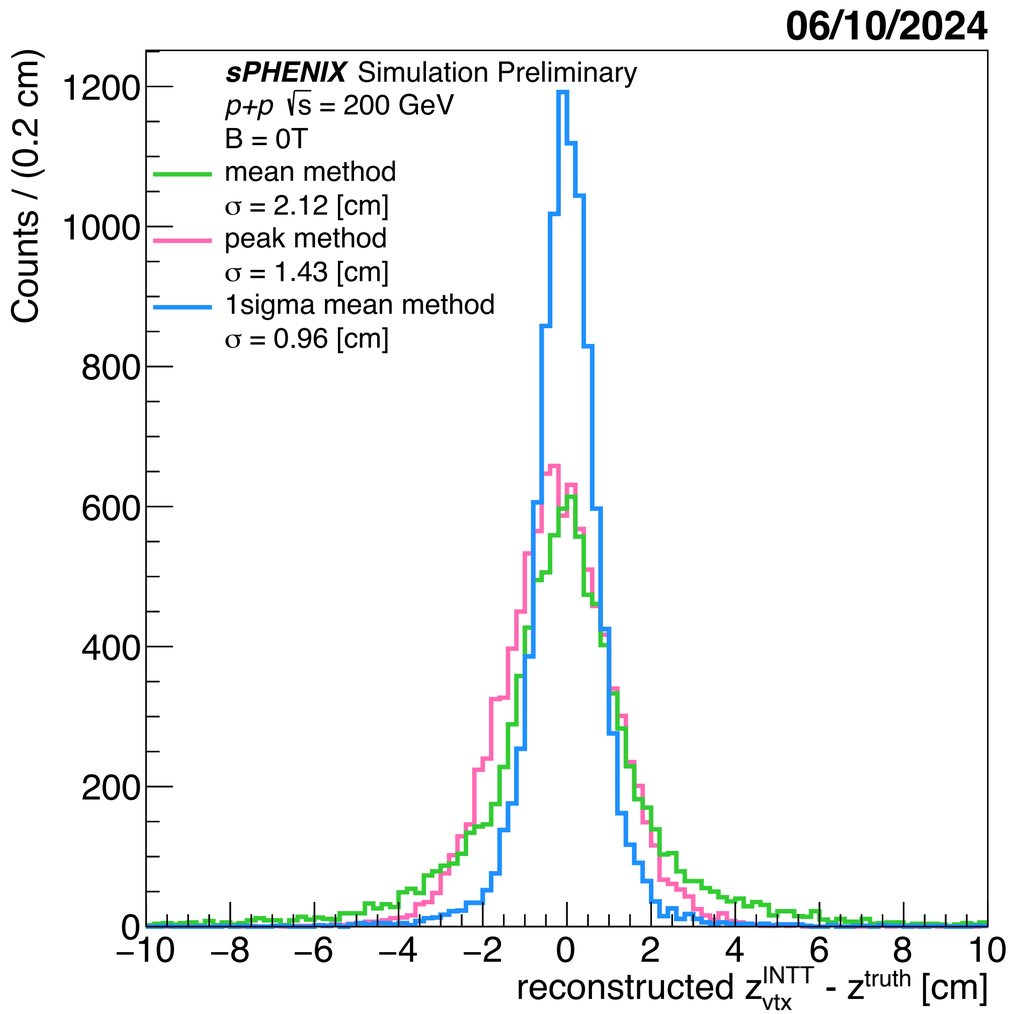
x axis : angular of cluster A
y axis : angular difference between cluster A and cluster B

Plot 1 : DCAz distribution for a single event



- In this distribution, the DCAz ("Distance of Closest Approach" of the track to the Beam Center) points have the error ranges.
- This ranges is considered to be the ranges of the possible zvtx.
- About the error ranges are explained on the next page.

Plot 2 : The difference between the reconstructed z vertex and MC truth



Mean method

To calculate the mean value of DCAz distribution, which is the z_vertex.

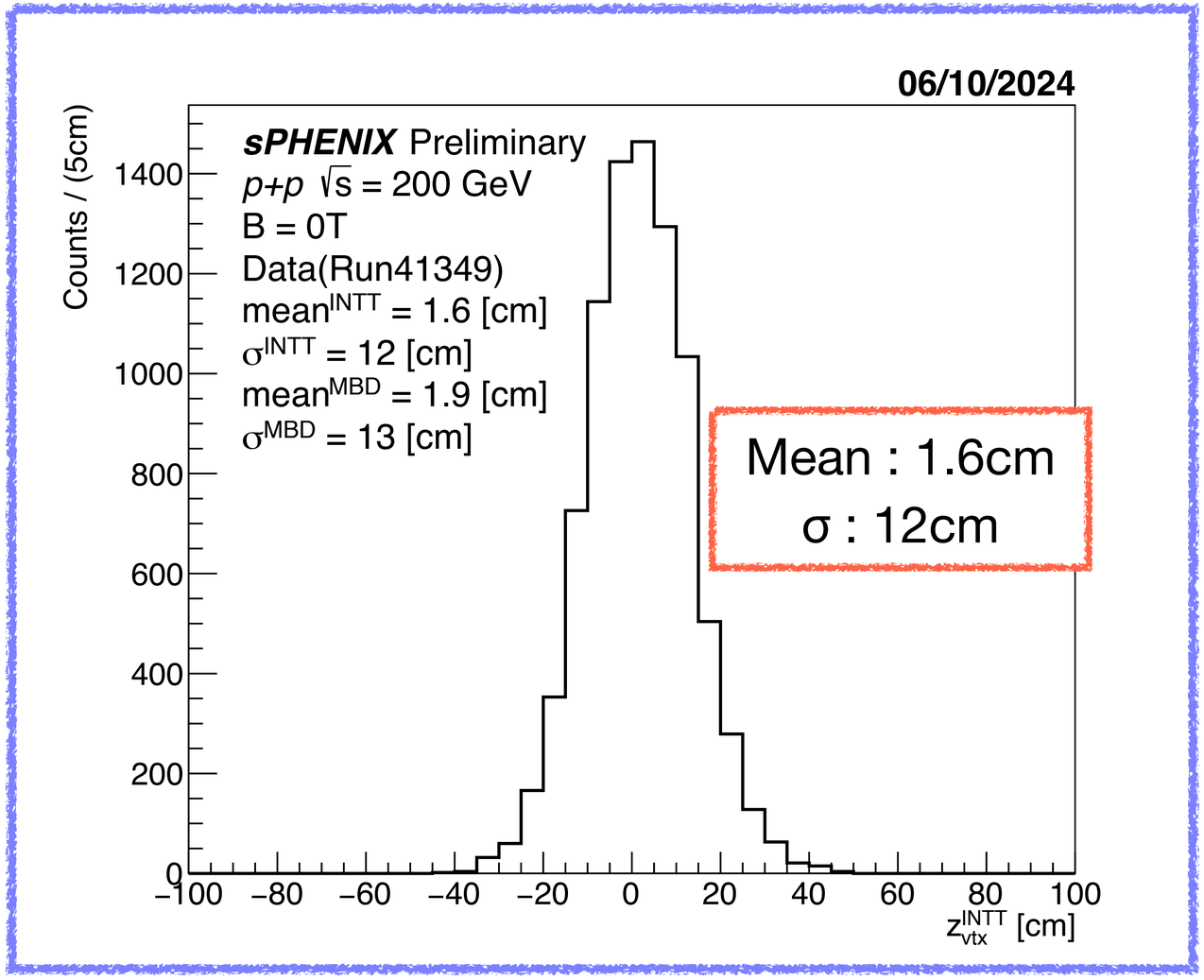
Peak method

To find the peak point of DCAz distribution.

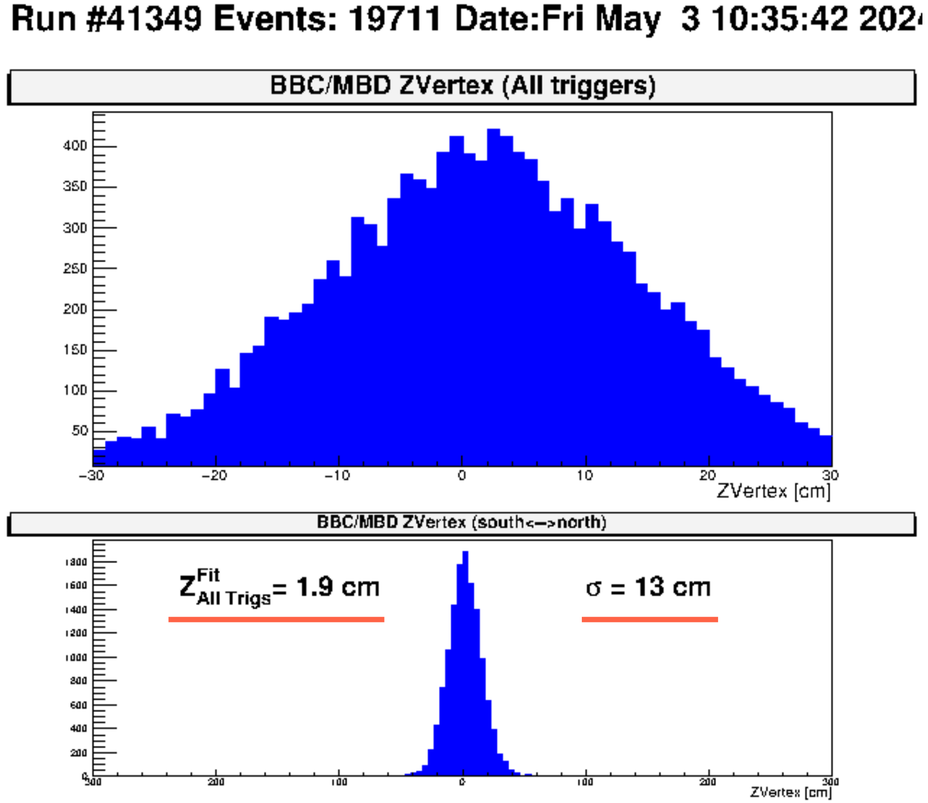
1σ mean method

To calculate the mean value using only data within 1σ from the average point of DCAz distribution.

Plot 3 : Reconstructed z_vertex distribution



- Reconstructed z_vertex distribution provided by MBD detector⬇



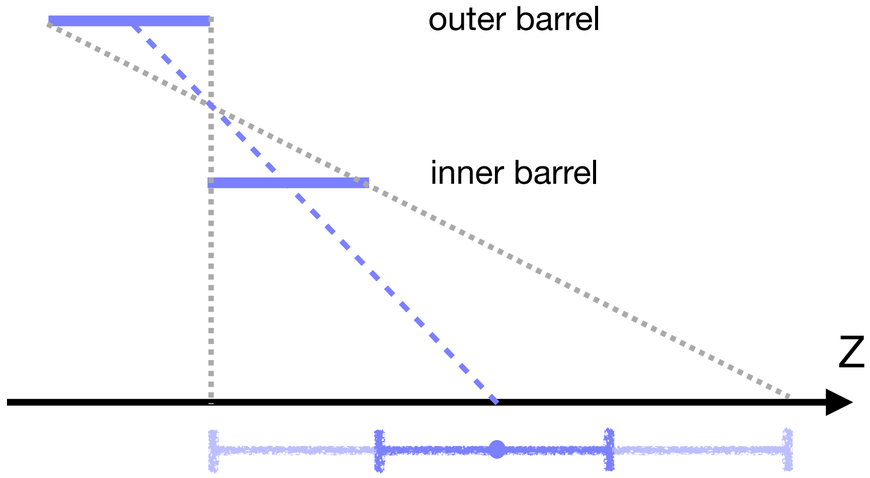
Consistent!!!

Plot 1 : DCAz distribution for a single event

When a single charged particle pass a sensor of width w, the incident positions are uniformly distributed.

Assuming the leftest position of the sensor to be Z_0, the existence probability density P can be expressed

$$P = \frac{1}{w}$$



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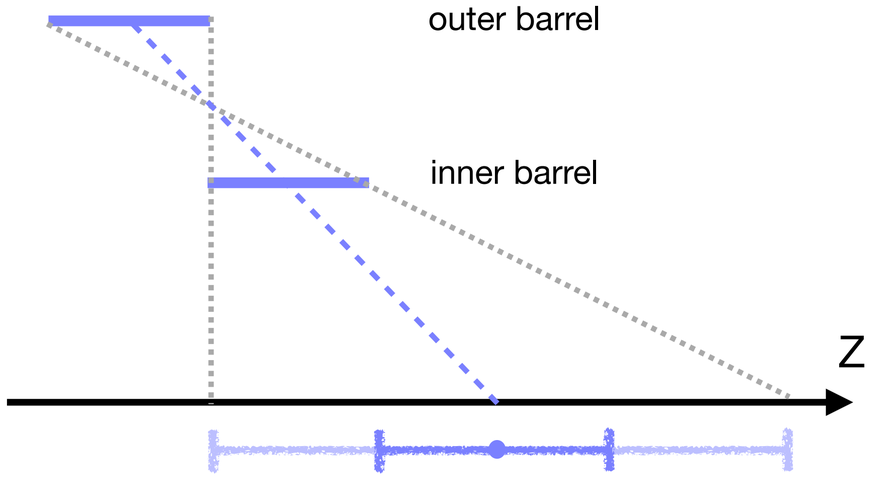
The expected value E of the incident position and position resolution σ are

$$E = \int_{Z_0}^{Z_0+w} PZ\,dw = Z_0 + \frac{1}{2}w$$

$$\sigma^2 = \int_{Z_0}^{Z_0+w} P \times (Z-E)^2\,dw = \frac{w^2}{12}$$



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$$\sigma = \frac{w}{\sqrt{12}}$$