VTX Detector and Cross Section Measurements at CNAO2025

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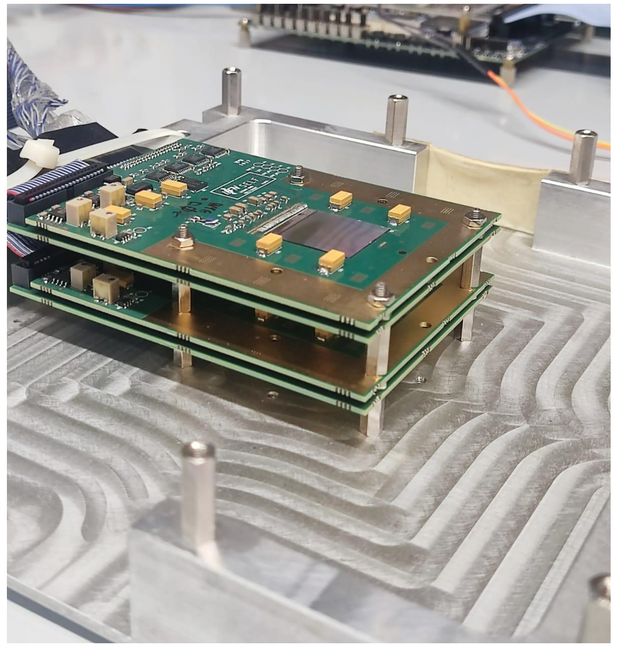
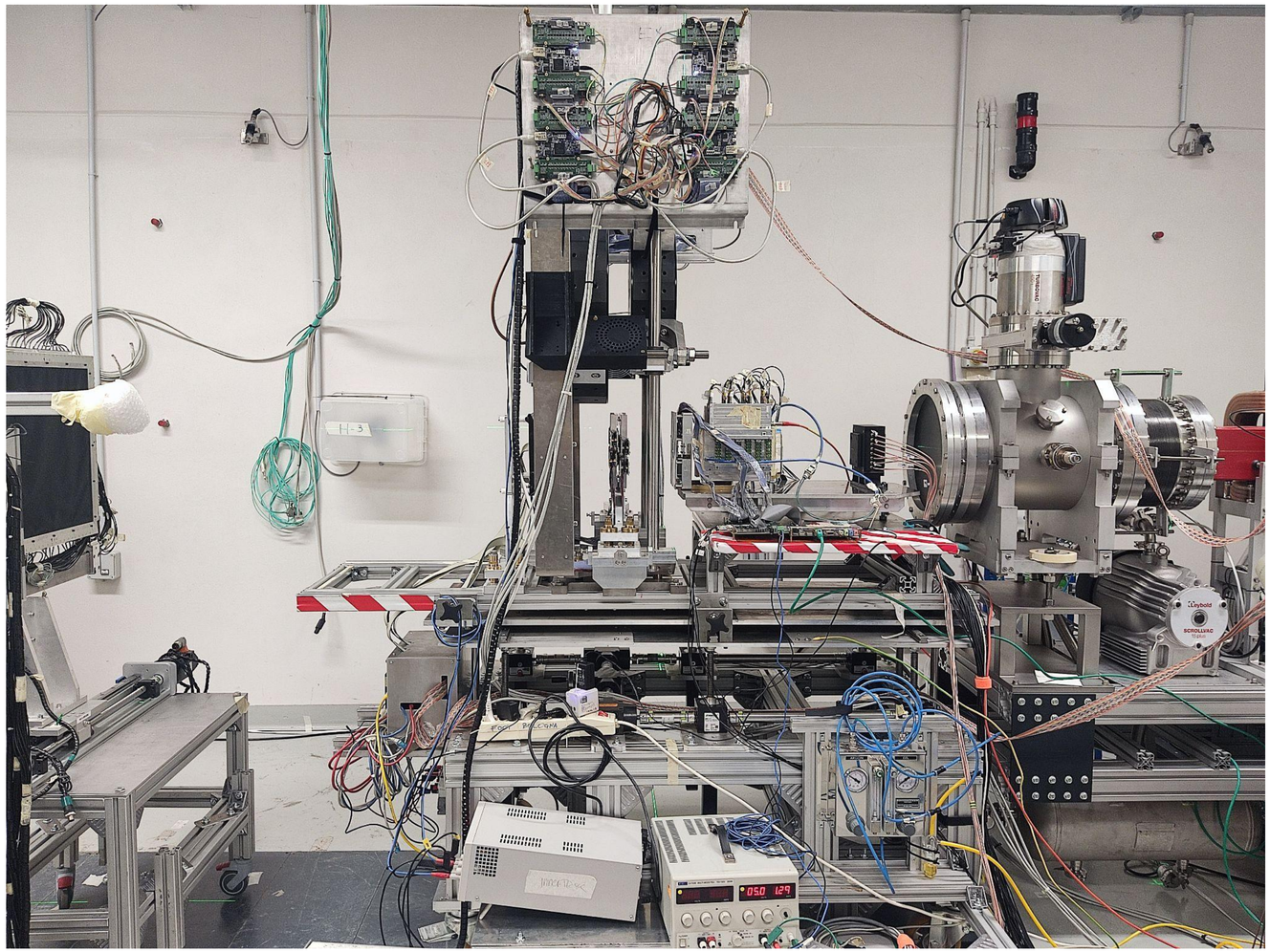
VTX at CNAO2025

- During CNAO2025, the VTX operated with a threshold set at 7σ.
- The achieved efficiencies are remarkably high.
- Pile-up is very low.

Monte Carlo sample: CNAO22PS_MC

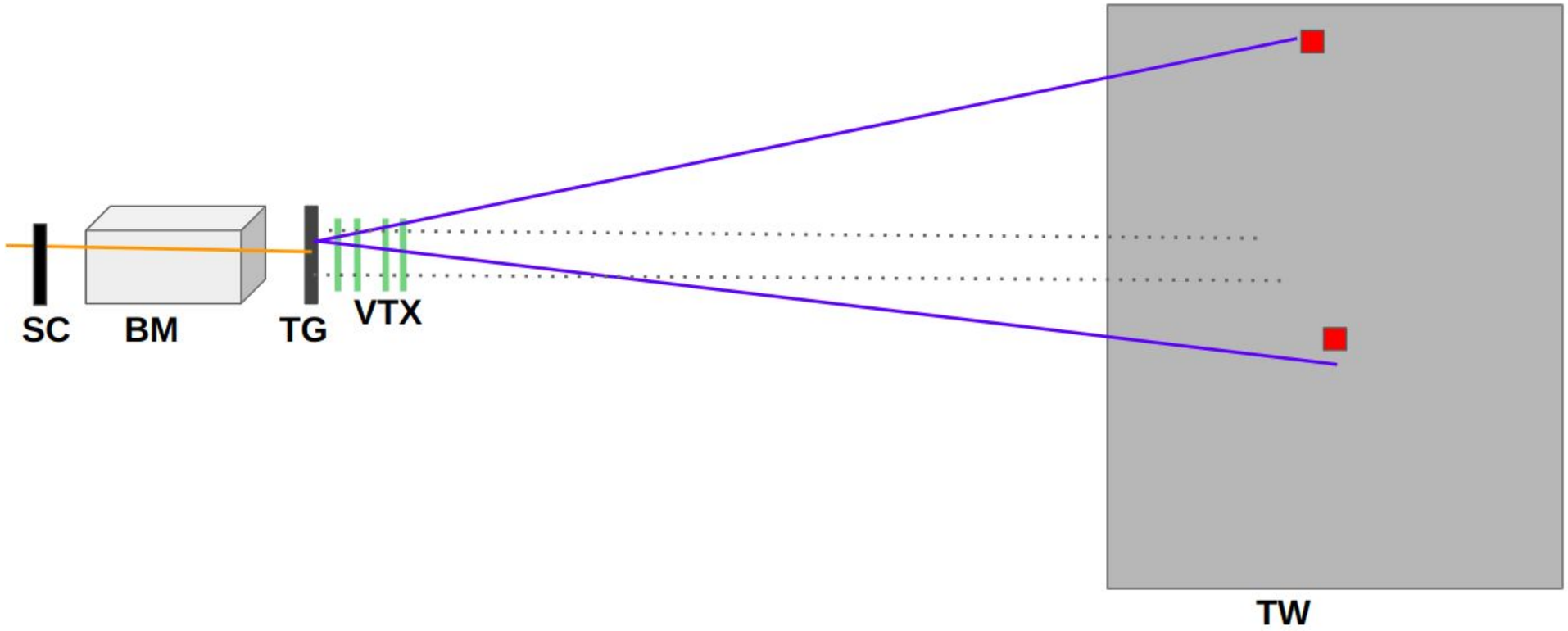




Yield selection

Given an event with only 1BM track in VTX acceptance (a primary):

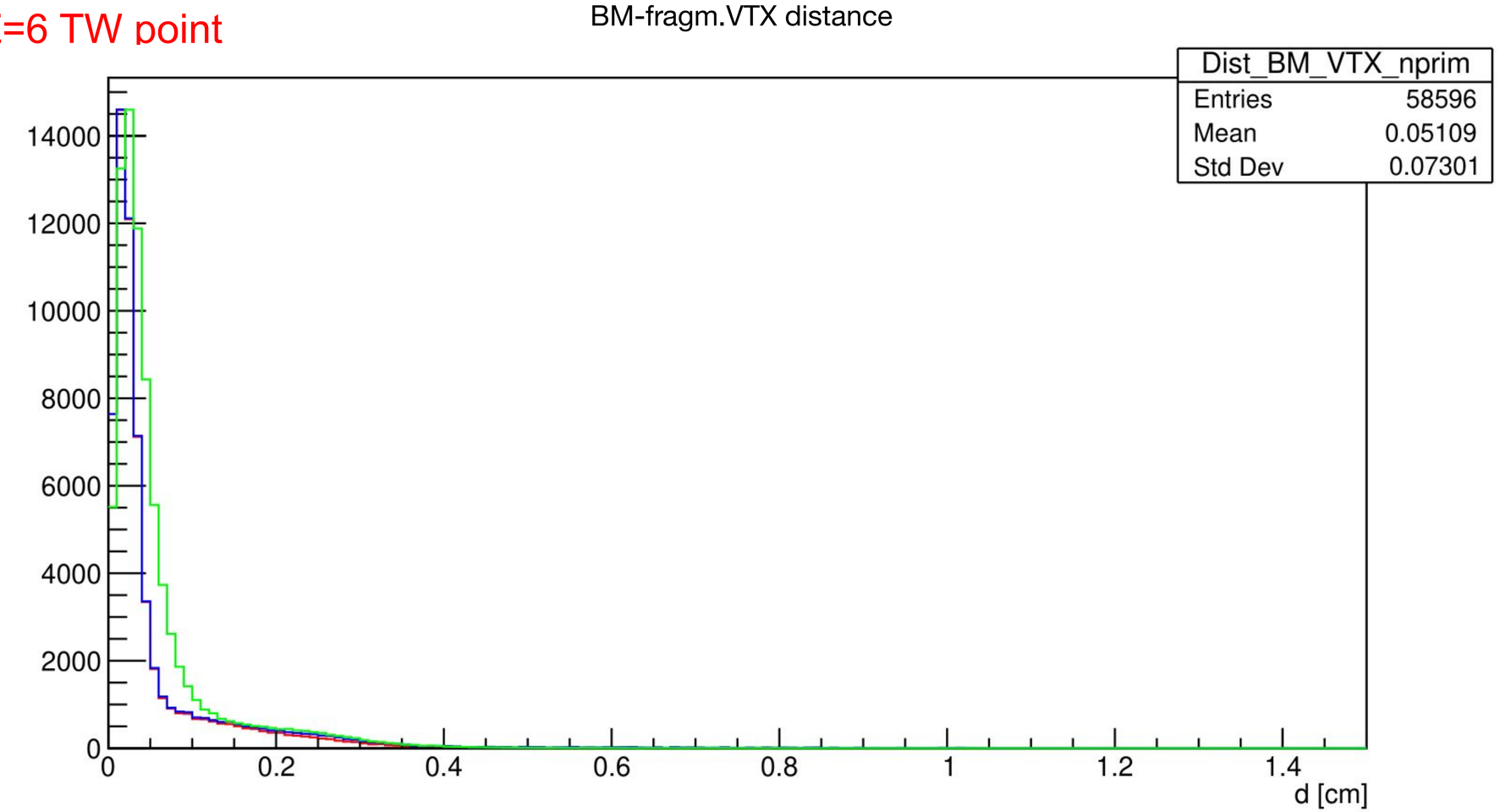
- Discard events with **Z = 6** detected in TW
- Check for the presence of a **fragmentation vertex** in the VTX
- If a vertex is found → **project VTX tracks** onto the TW plane
- Search for a **TW point** near the projected track position



Control plots

❖ **Distance between BM track and fragmentation VTX**

- all fragmentation VTX
- fragmentation VTX with no Z=6 TW point
- MC (no PileUp)



Control plots

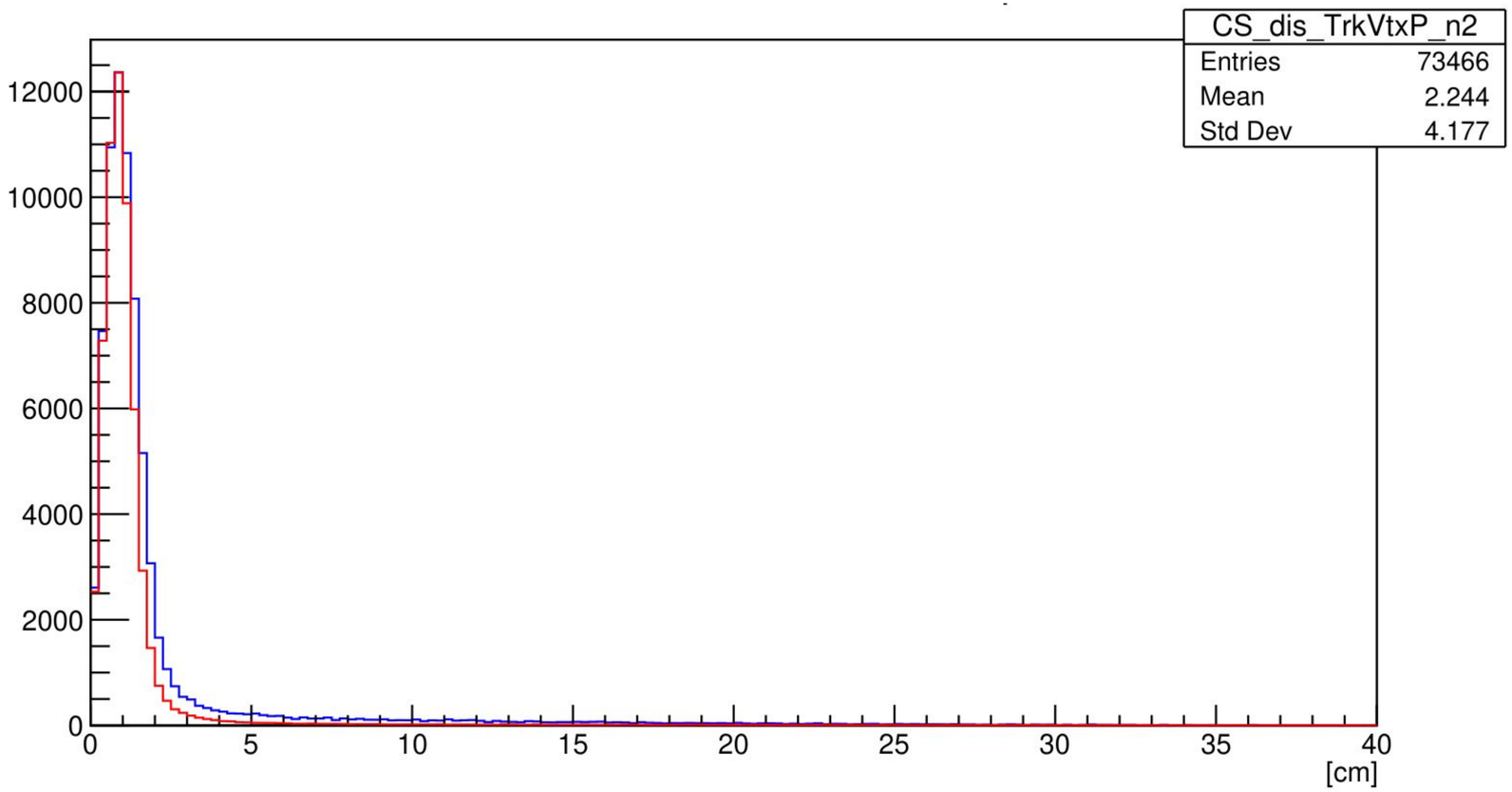
❖ Track–TW Point Distance

The reconstructed VTX tracks are projected onto the TW detector plane. For each projected track, the closest TW point is searched.

- data
- MC

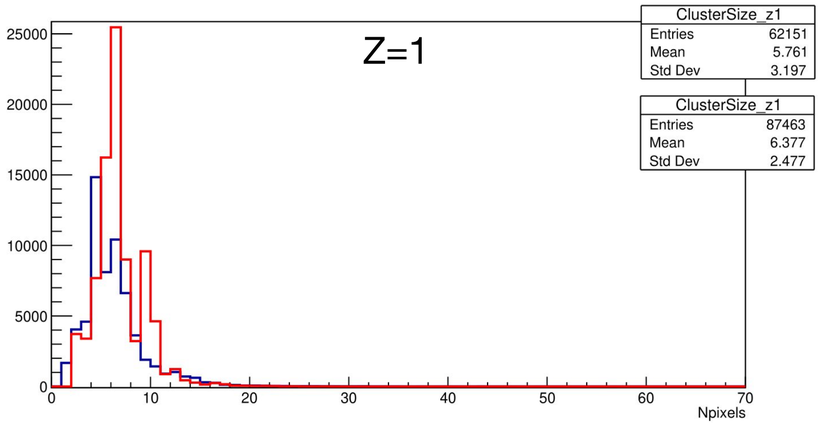
The TW point is **associated** to that track if :

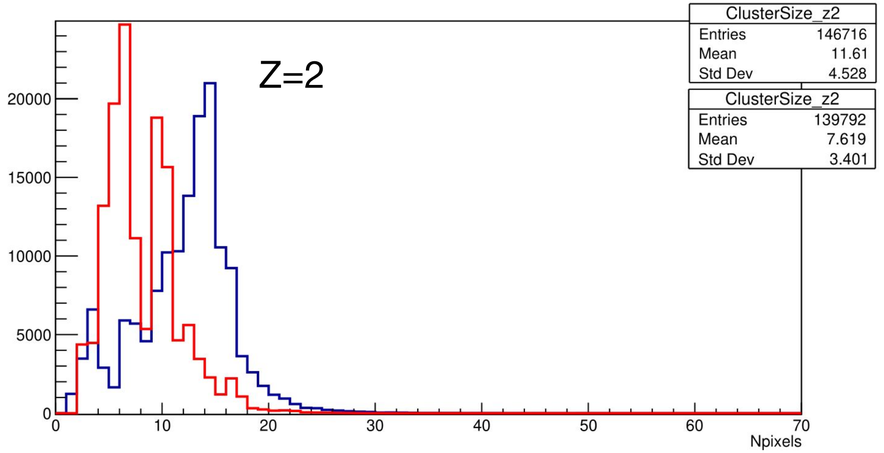
- distance < 3cm
- distance < 2cm

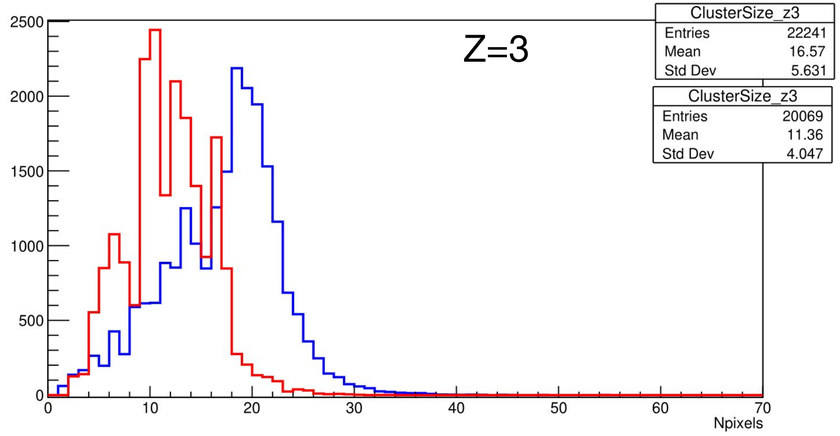


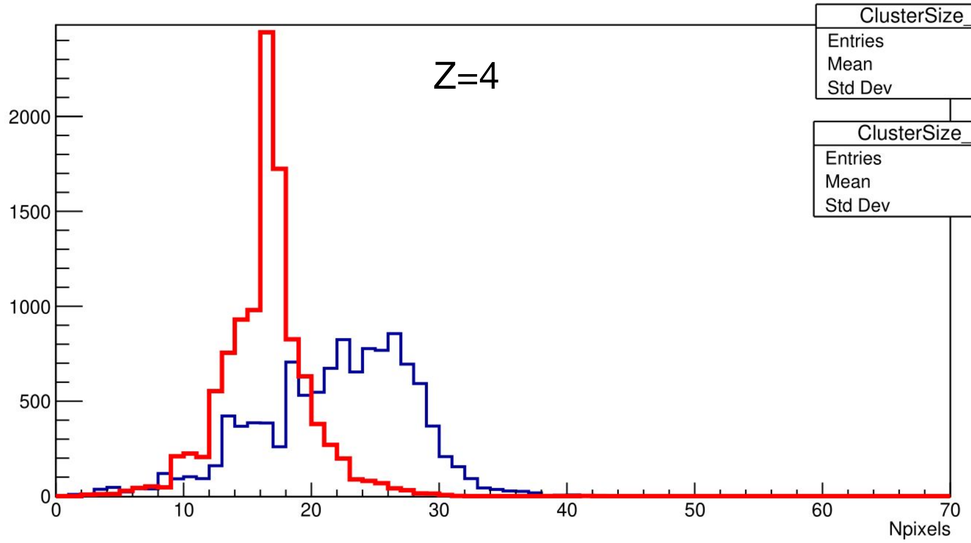
Cluster size

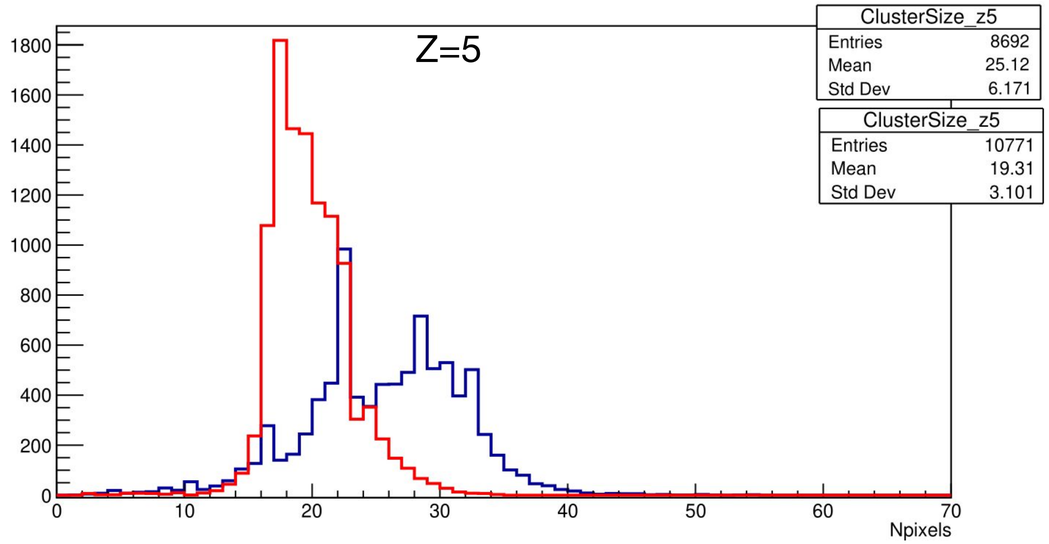
- data
- MC





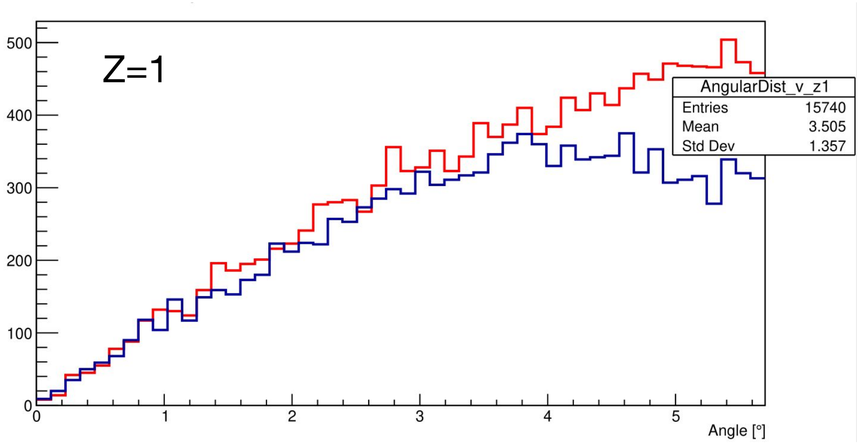


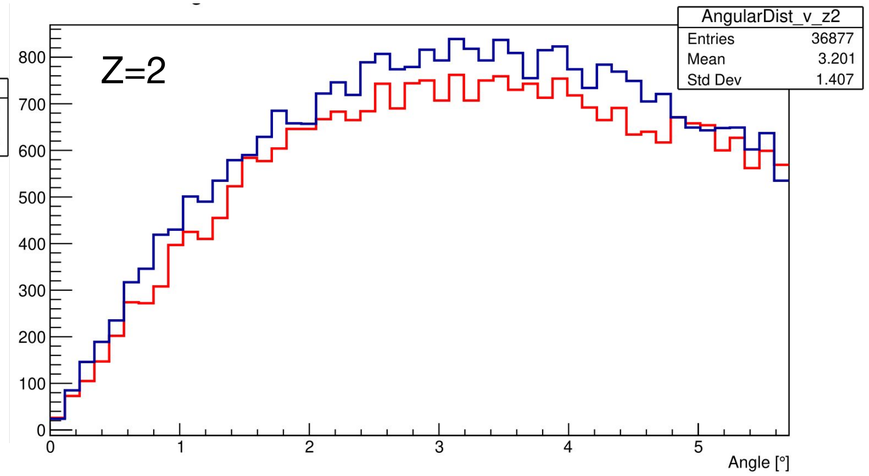


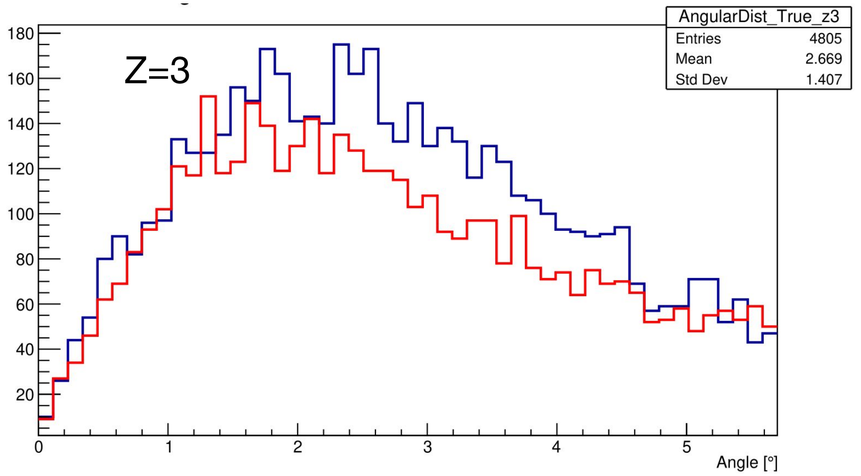


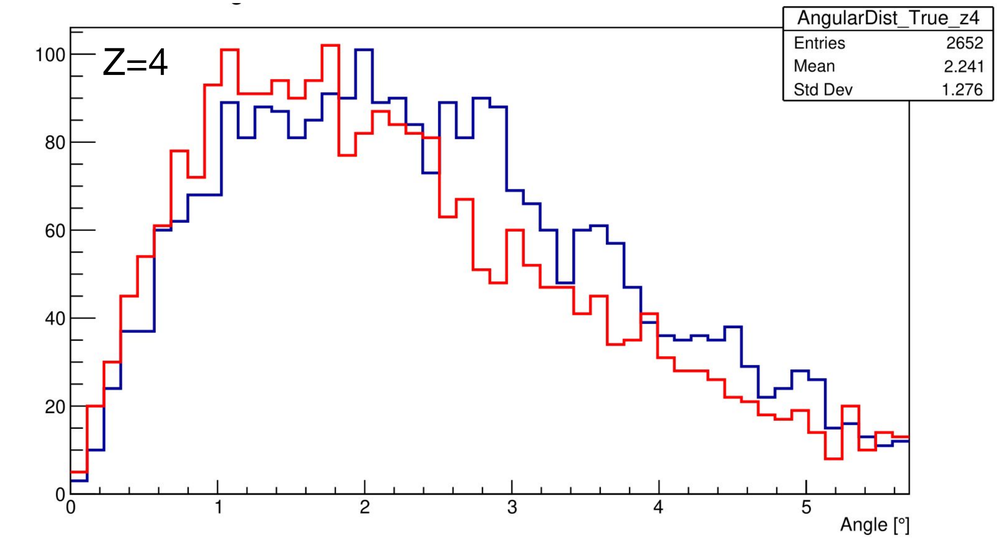
Angular distribution

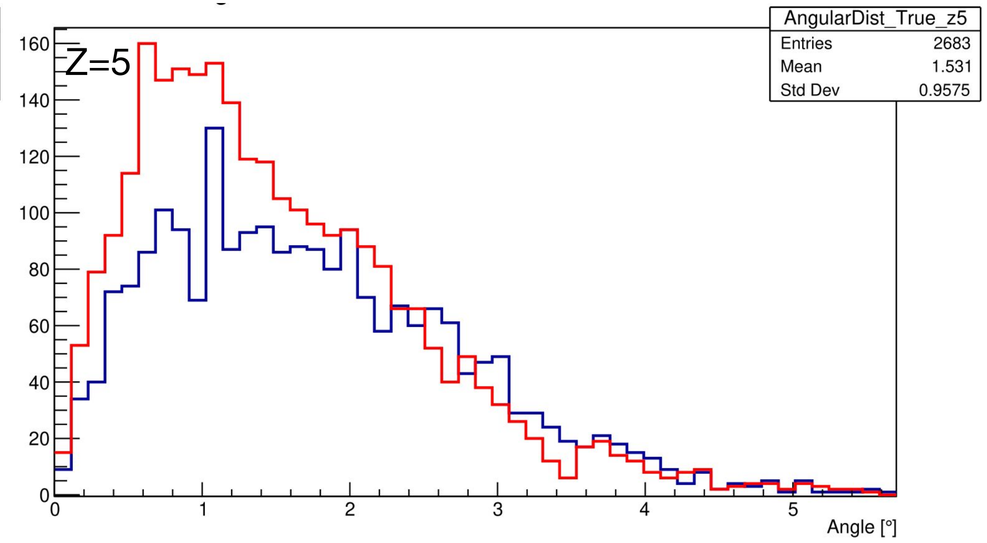
- data
- MC











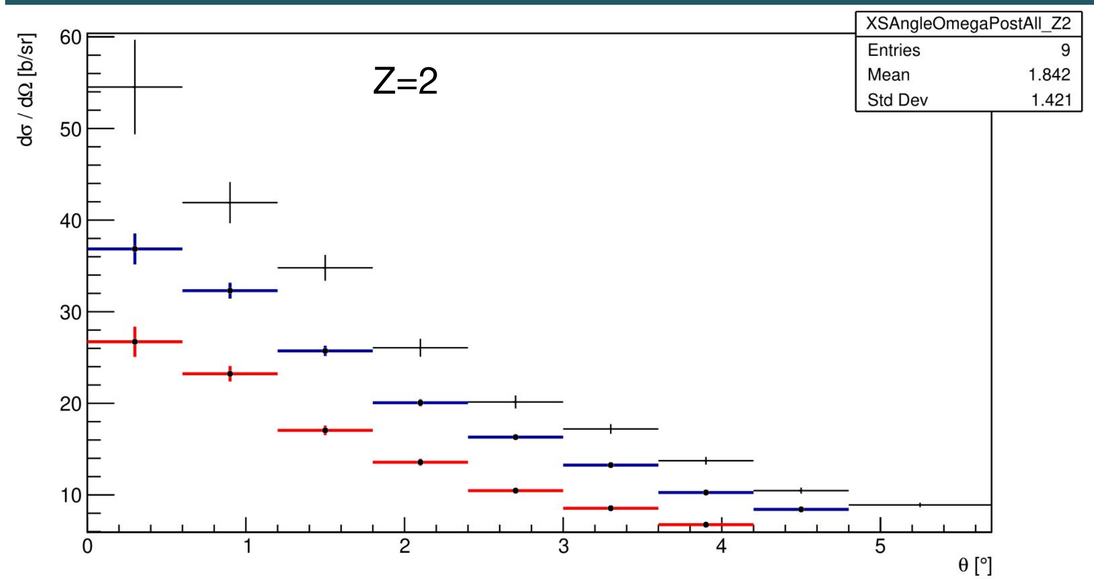
Percentage of valid VTX

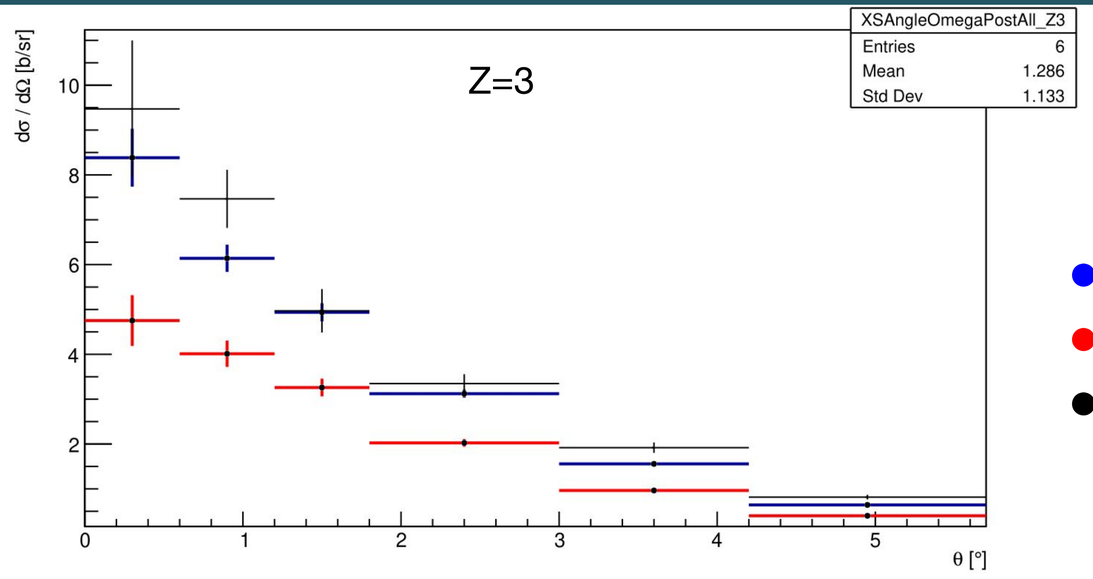
- p_ValidVTX= event with a valid VTX / primaries
- p_GoodValidVTX = event with a valid VTX matched with TW / primaries

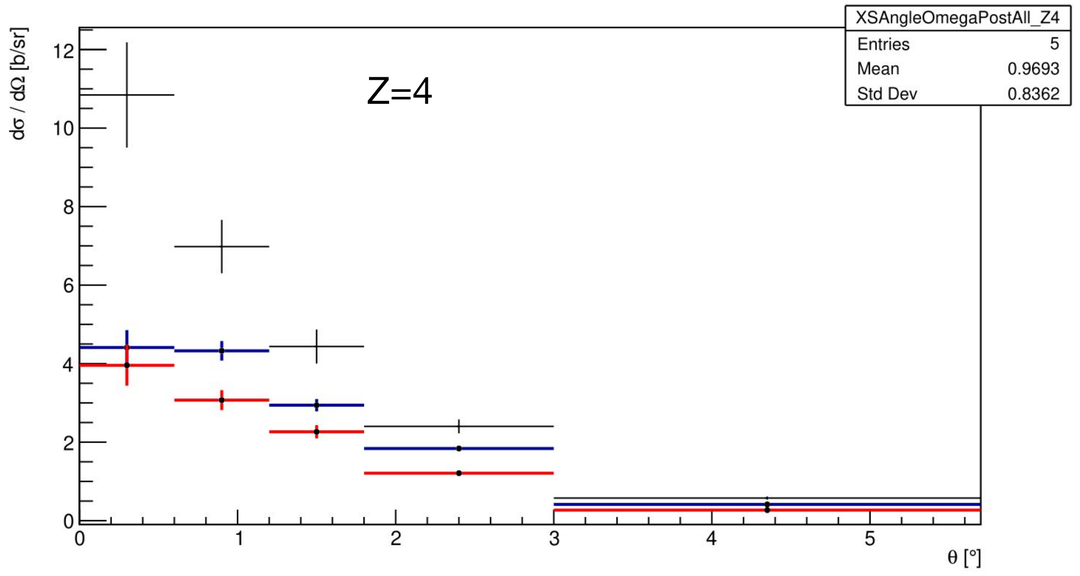
VTX config: (Std; shd=0.03; PlanesForTrackMinimum=3)

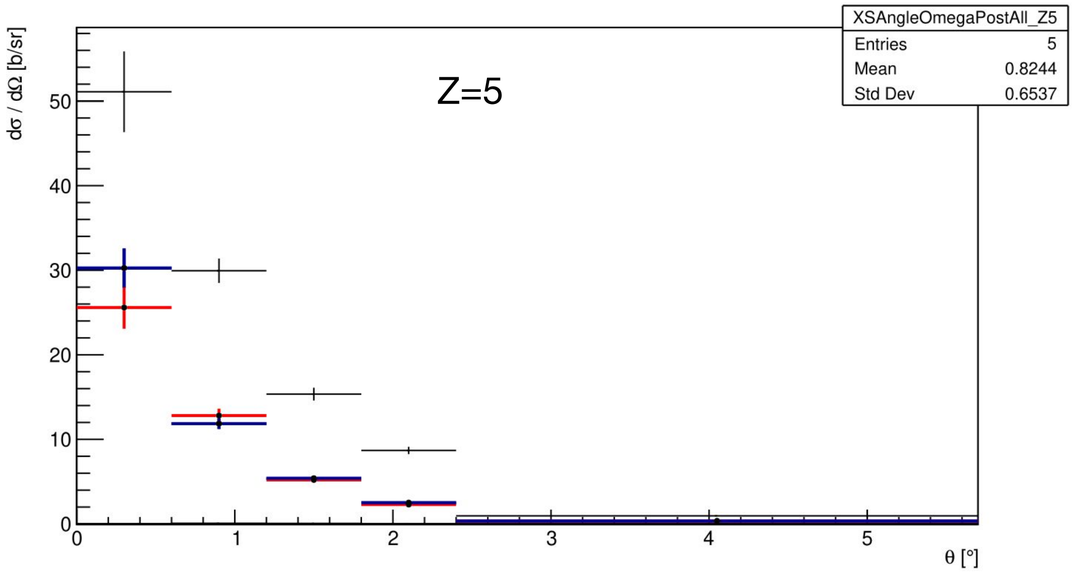
CAMPAIGN	p_ValidVTX	p_GoodValidVTX	PileUp
CNAO2025	2.58%	1.83%	15%
CNAO2022	2.52%	1.37%	30%
CNAO22PS_MC	2.96%	2.28%	X

Cross Section









- CNAO2025
- CNAO2022
- SC+BM+TW


come fai..SBAI

Percentage of valid VTX

- p_ValidVTX= event with a valid VTX / primaries
- p_GoodValidVTX = event with a valid VTX and matched with TW / primaries

VTX config: (Std; shd=0.03; PlanesForTrackMinimum=3)

CAMPAIGN	p_ValidVTX	p_GoodValidVTX	PileUp
CNAO2025	2.58%	1.83%	15%
CNAO2022	2.52%	1.37%	30%
CNAO22PS_MC	2.96%	2.28%	X

VTX config: (Std; shd=0.03; PlanesForTrackMinimum=2)

CAMPAIGN	p_ValidVTX	p_GoodValidVTX	PileUp
CNAO2025	2.88%	1.95%	15%
CNAO2022	4.22%	1.87%	30%

Analysis strategy

Detectors used: **ST + BM + VTX + TW**

$$\frac{\mathrm{d}\sigma}{\mathrm{d}\Omega}(Z,\theta) = \frac{Y(Z,\theta)}{N_{\mathrm{prim}} \cdot N_{\mathrm{TG}} \cdot \varepsilon(Z,\theta) \cdot \Delta\Omega}$$

- $Y(Z, \theta)$ corresponds to the number of reconstructed fragments with charge Z at a given angle θ
- N_{prim} is the number of primary particles incident on the target and within the acceptance of the VTX
- N_{TG} is the number of interaction centers in the target per unit area
- $\epsilon(Z, \theta)$ is the efficiency
- $\Delta\Omega$ is the width of the solid angle bin

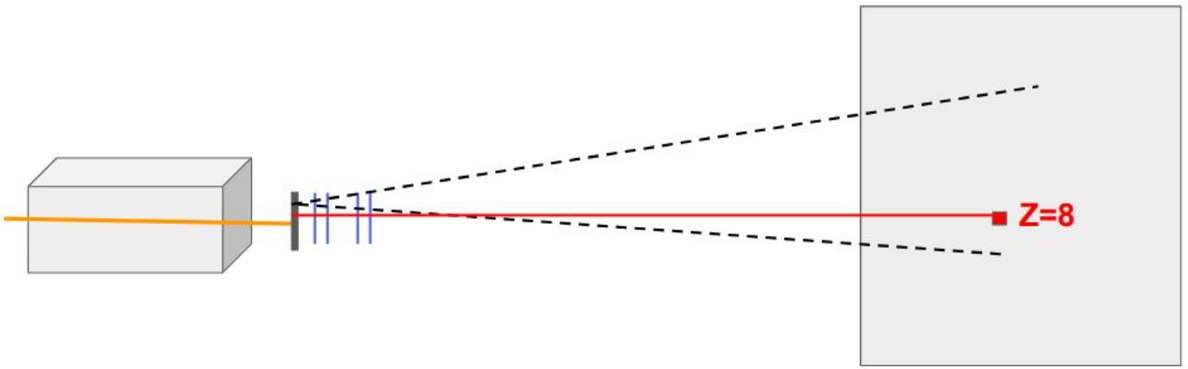
Selection Cuts applied in the analysis

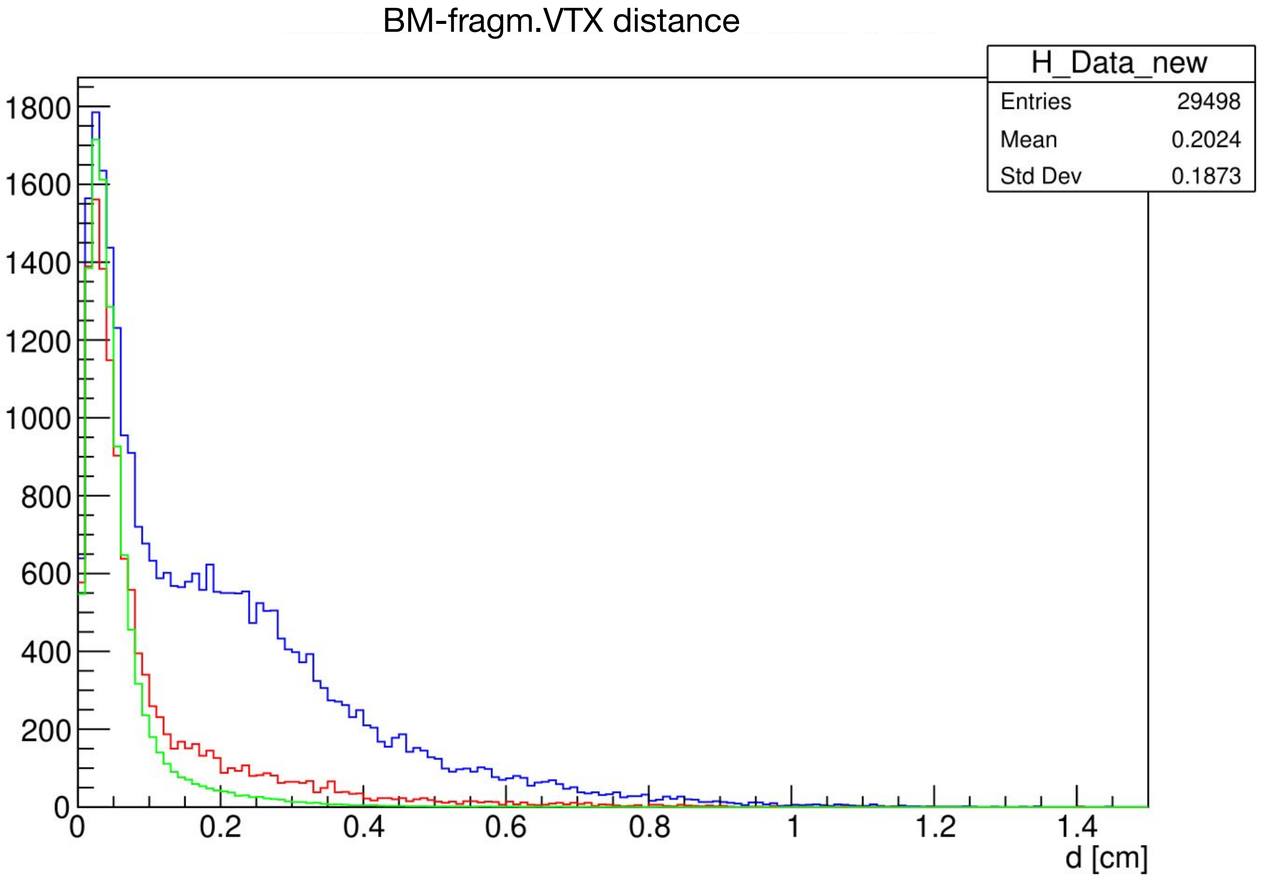
❖ **Fragmentation vertexes discarded if Z=8 is found in TW**

If a **Z = 8** is detected in TW, it means that a **primary particle** reached the TW. Any fragmentation vertex found is due to **pile-up**.

Distance between BM track and fragmentation VTX

- all fragmentation VTX
- fragmentation VTX with no Z=8 TW point
- MC (no PileUp)



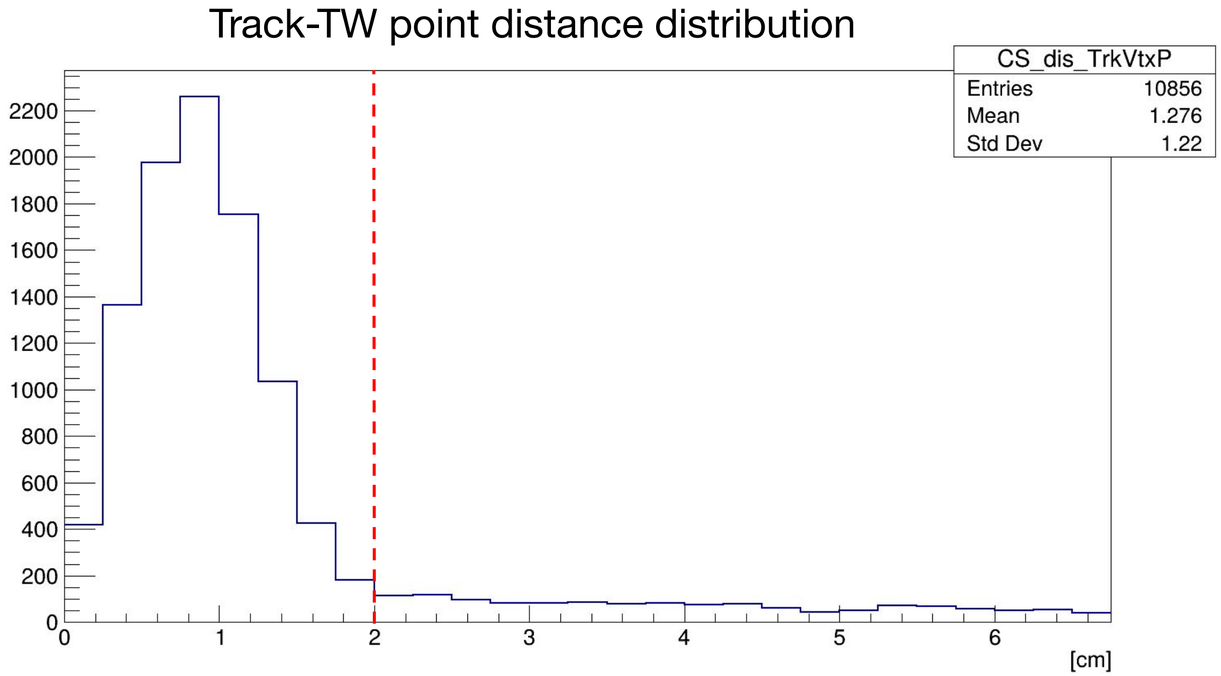


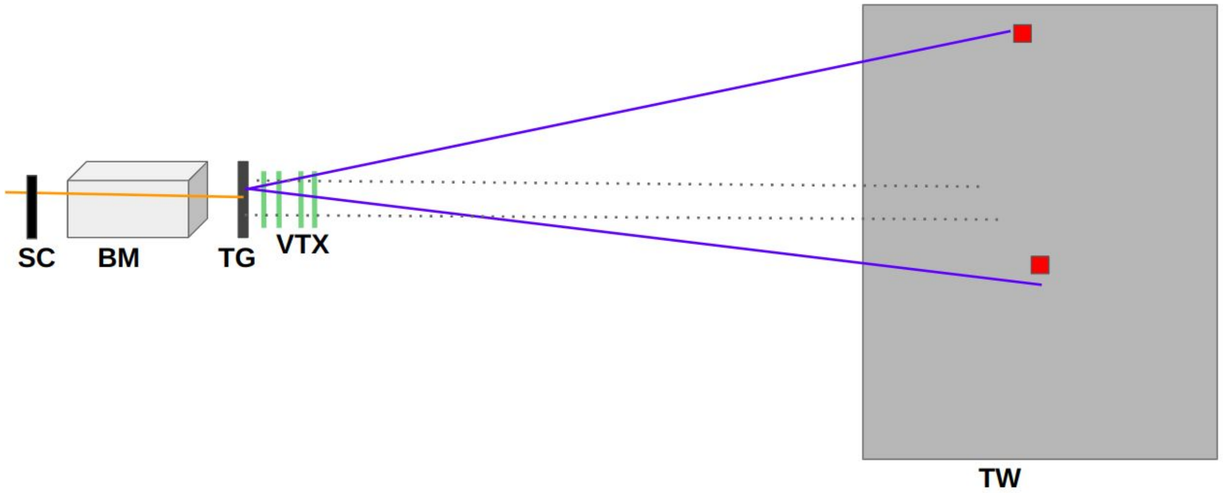
Selection Cuts applied in the analysis

❖ Track–TW Point Distance < 2 cm

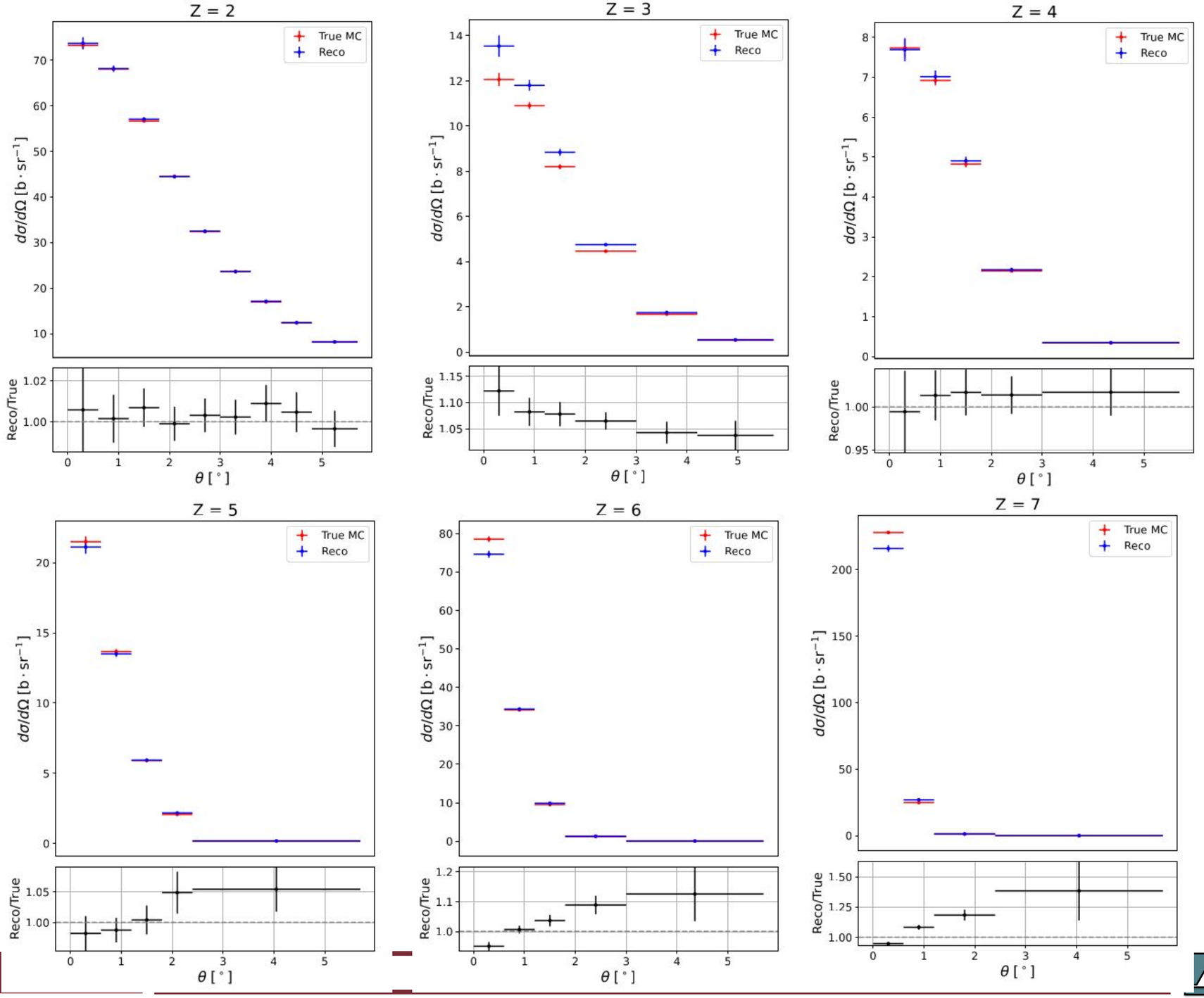
The reconstructed VTX tracks are projected onto the TW detector plane. For each projected track, the closest TW point is searched.

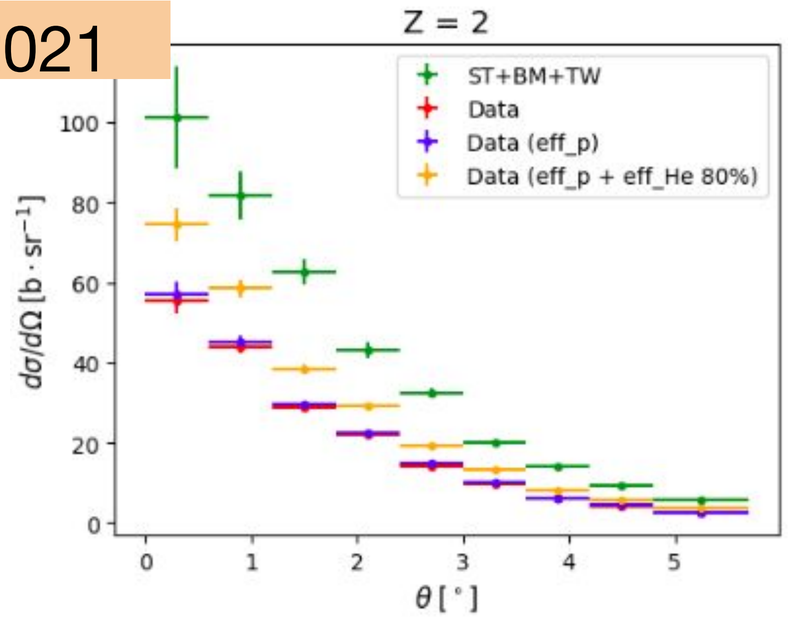
→ If the **distance is less than 2 cm**, the TW point is **associated** to that track.

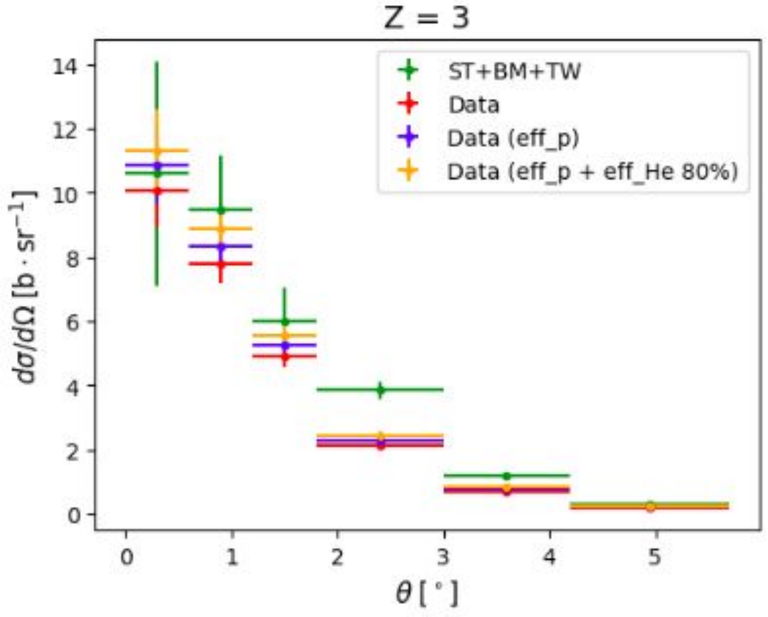


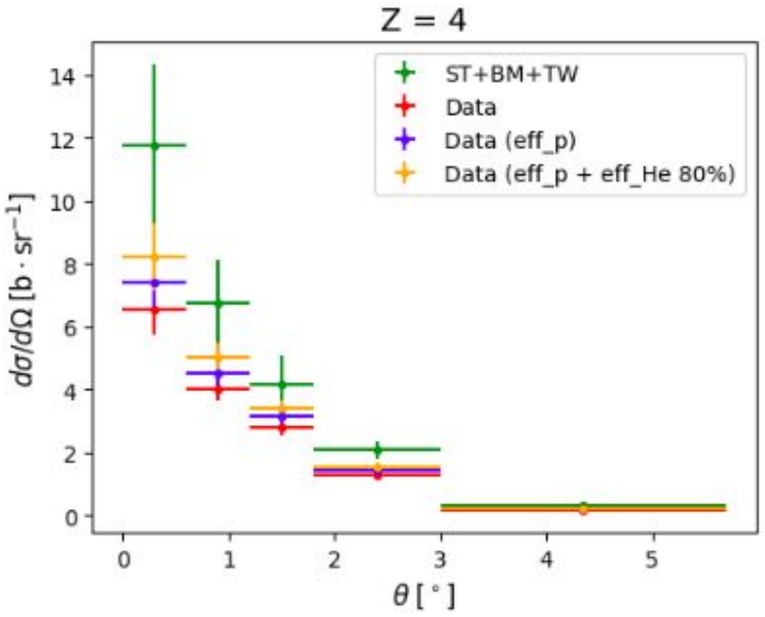


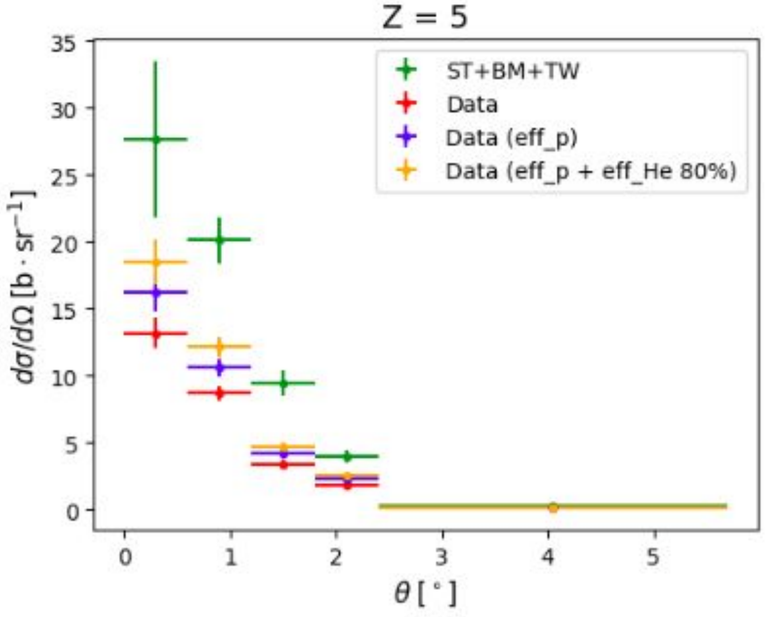
MC Closure Test

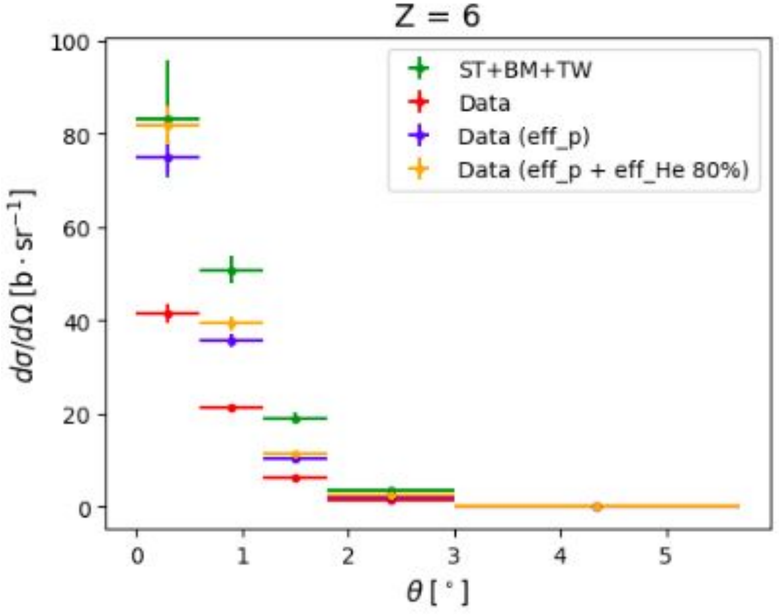


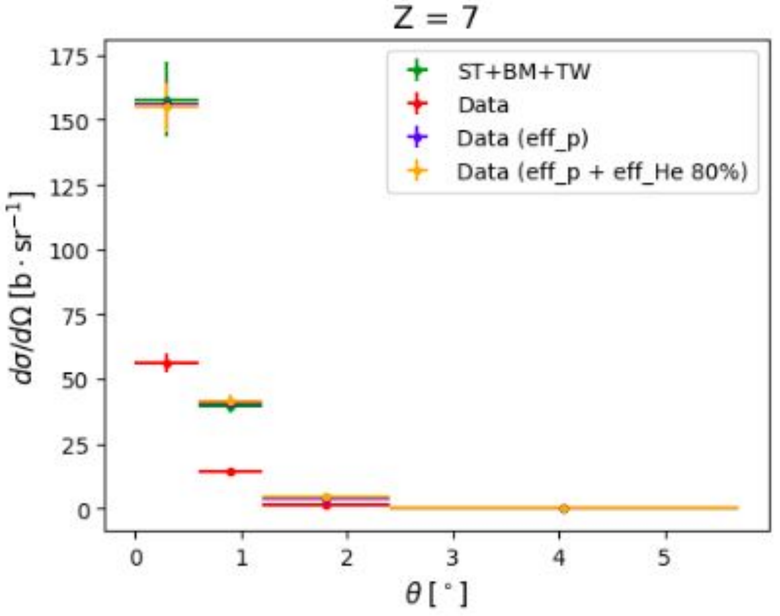

Z = 2
ST+BM+TW
Data
Data (eff_p)
Data (eff_p + eff_He 80%)
$d\sigma/d\Omega$ [b · sr^{-1}]
θ [°]


Z = 3
ST+BM+TW
Data
Data (eff_p)
Data (eff_p + eff_He 80%)
$d\sigma/d\Omega$ [b · sr^{-1}]
θ [°]


Z = 4
ST+BM+TW
Data
Data (eff_p)
Data (eff_p + eff_He 80%)
$d\sigma/d\Omega$ [b · sr^{-1}]
θ [°]


Z = 5
ST+BM+TW
Data
Data (eff_p)
Data (eff_p + eff_He 80%)
$d\sigma/d\Omega$ [b · sr^{-1}]
θ [°]


Z = 6
ST+BM+TW
Data
Data (eff_p)
Data (eff_p + eff_He 80%)
$d\sigma/d\Omega$ [b · sr^{-1}]
θ [°]


Z = 7
ST+BM+TW
Data
Data (eff_p)
Data (eff_p + eff_He 80%)
$d\sigma/d\Omega$ [b · sr^{-1}]
θ [°]