First reconstruction of Carbon@221 MeV/n data (CNAO2023)

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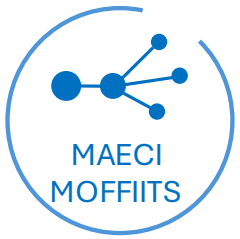
INFN LNGS
Università di Bari "Aldo Moro", INFN Bari

MAECI-MOFFIITS Meeting, 26-28 May 2025



CNAO 2023

CN7

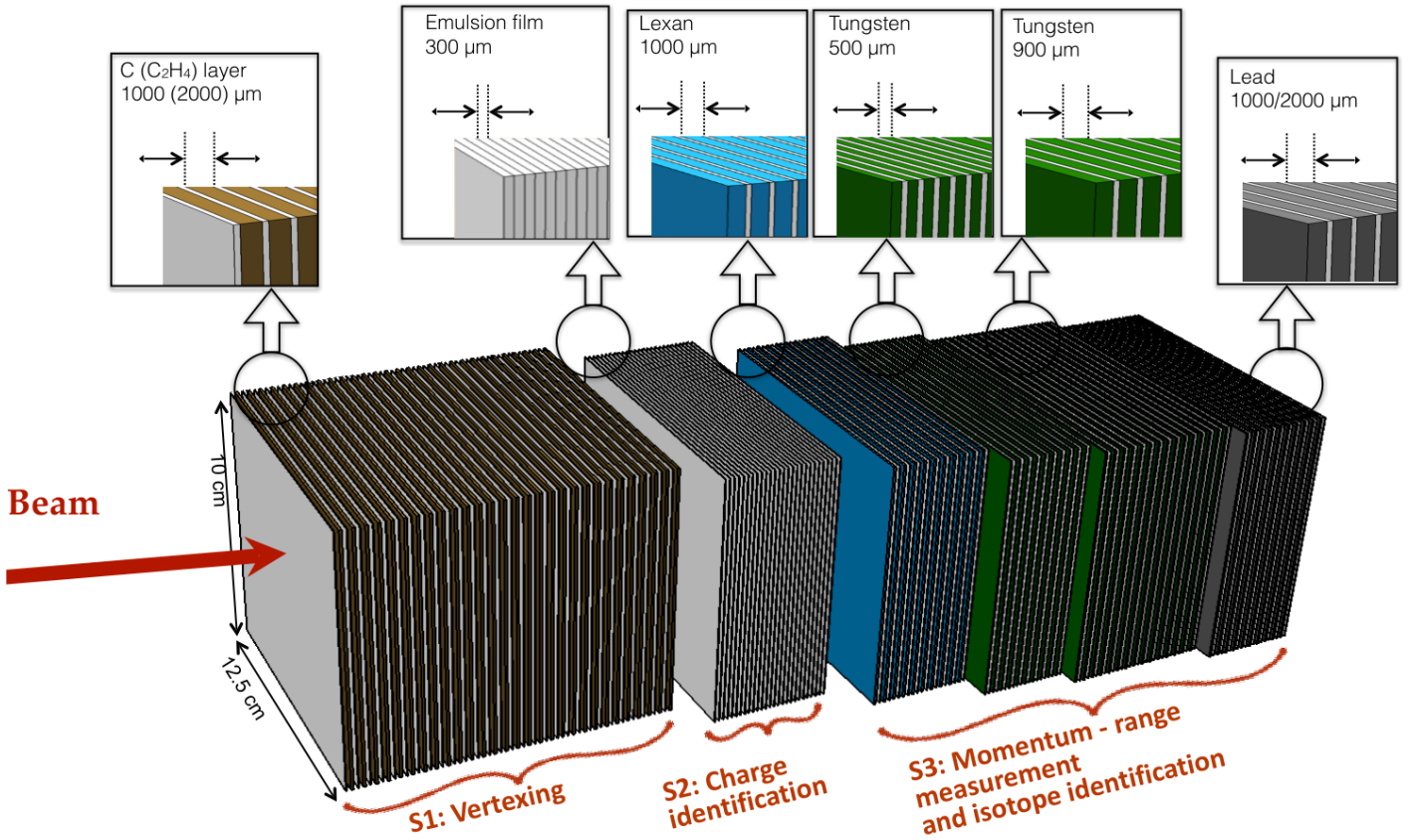
Beam: Carbon ions → Energy: 221 MeV/n

Target: Carbon (C)

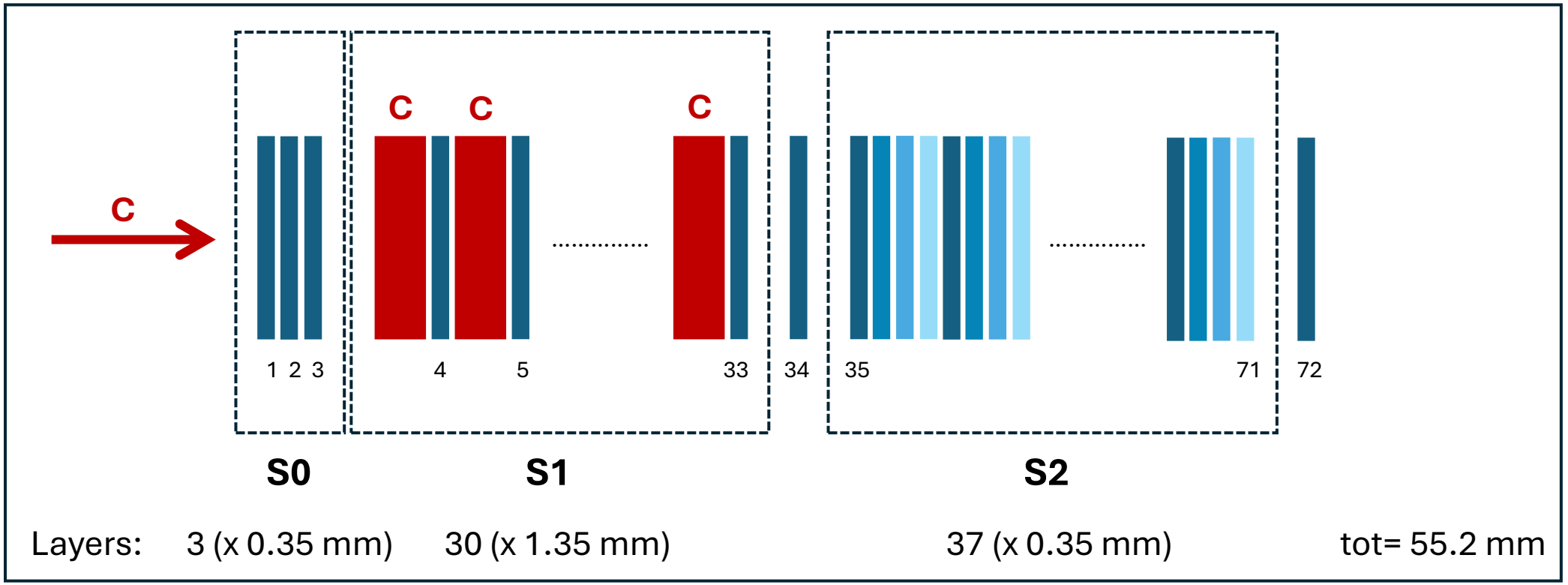
CN8

Beam: Carbon ions → Energy: 221 MeV/n

Target: Polyethylene (C_2H_4)



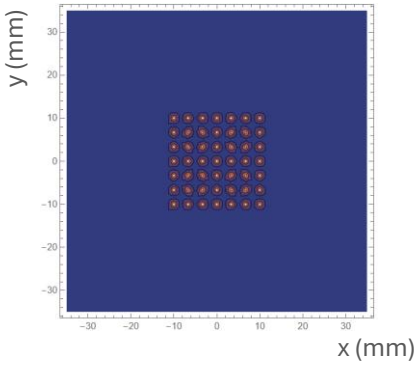
CN7: S0, S1, S2 stacks

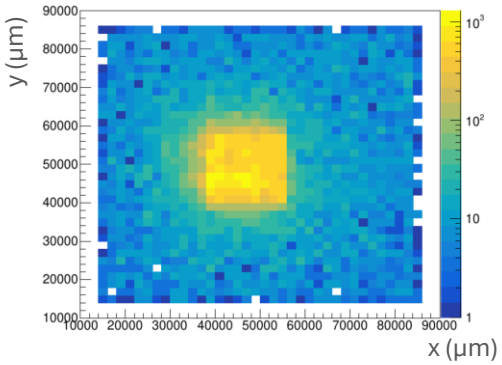


- S0: 3 emulsion films → improves reconstruction of primaries
- S1: 1mm carbon layers – emulsion films
- S2: emulsion films thermally treated → charge identification
- Plate 34 and 72: “buffer” emulsions → helps for stacks merging

Beam Analysis

- Beam desiderata: 49k carbon ions

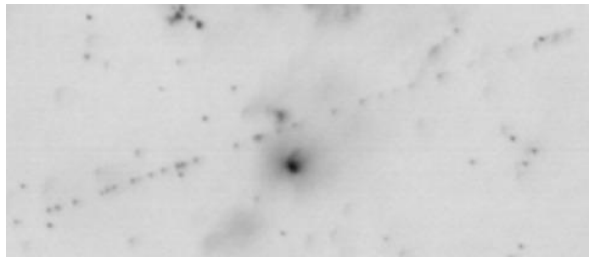




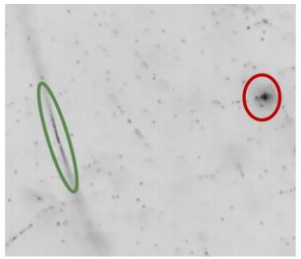
- Scanning with optical microscope:

  - 11x11 filter, optimized for carbons

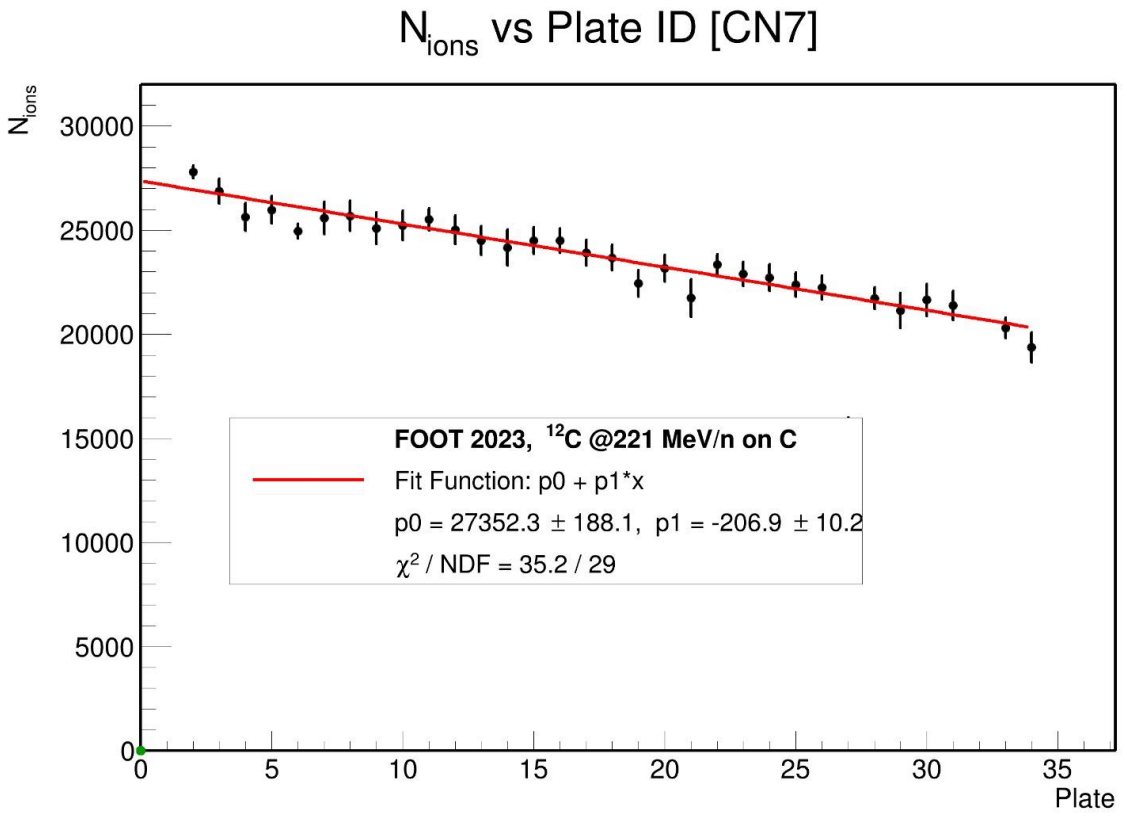
  - 5x5 filter for MIP particles, secondaries



11x11 filter

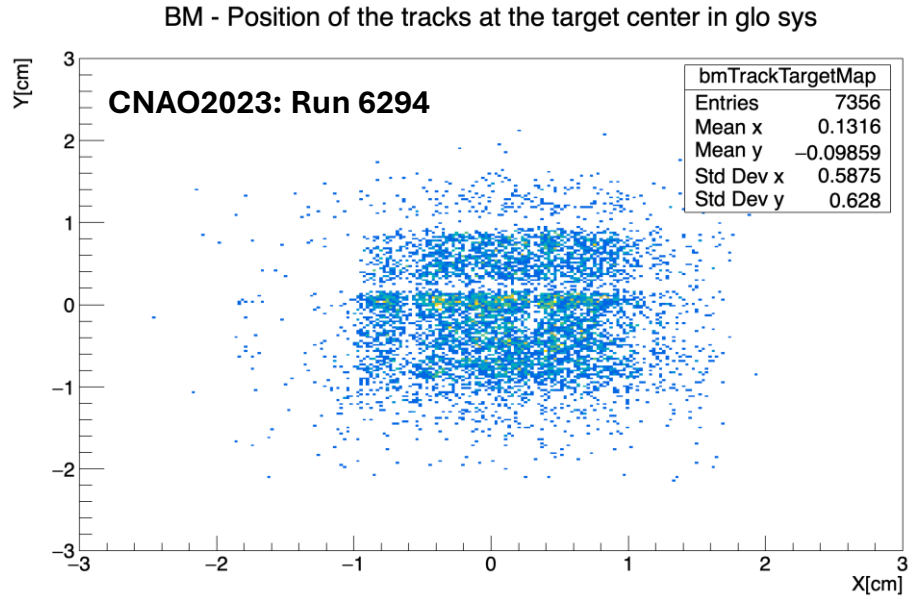


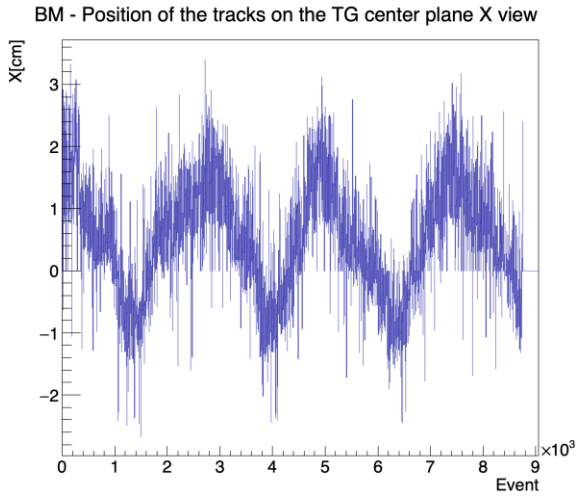
5x5 filter

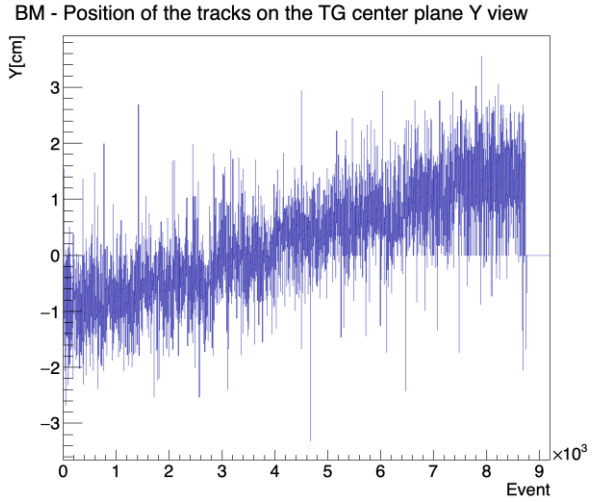


→ ~ 30k possible primaries (C)

Beam measurements for emulsion 12C exposure @ CNAO





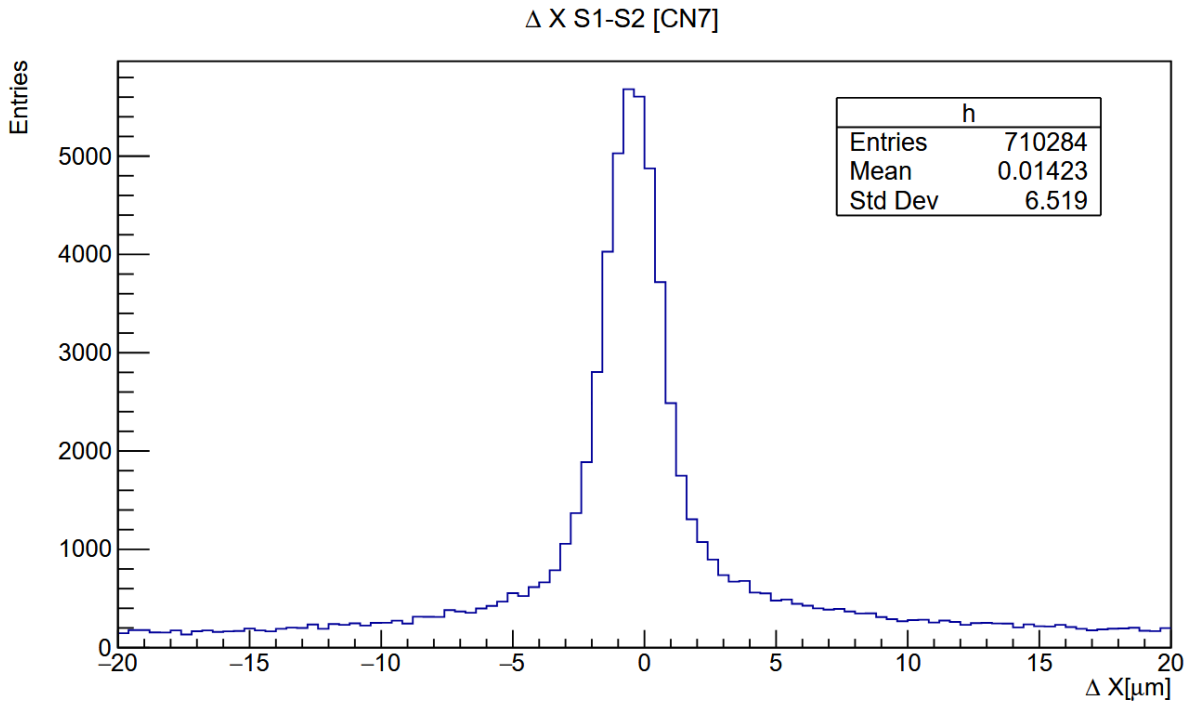


- In CNAO2023 we made two exposures: 6292-6293 and 6294.
- 6292-6293: two runs for the same emulsion brick exposure since the MSD acquisition stopped.
  Run 6292: file not found. Deleted due to msd problems
  Run 6293 in principle with 39k events counted with the scaler placed in the control room, but the margherita majority number of events from the decoded file is of 24k
- Same problem also in run 6294: 49k events from the control room scaler and 30k events from decoded file counting
- The margherita majority trigger signal was the same both for DAQ and for the control room scaler. Probably the latter was not properly set (ripartenze…)
- **We didn't made any cross check between the scaler and the decoded file. In the future we should do it**
- The beam profile and the irradiation pattern was the expected one.
- In CNAO2024 there is only one run with a number of events written on the logbook: run 7071 with 2*10^6 events.
  The number of events counted from the decoded file is 200k… which is the same number written on the Michela's logbook.
  Probably (or hopefully), there is a mistake in the logbook entry.

Slide by Yunsheng Dong

Merging Stacks

- Linking → Alignment → Tracking of each Stack → Merging of the Stacks
- Merging S1 and S2:



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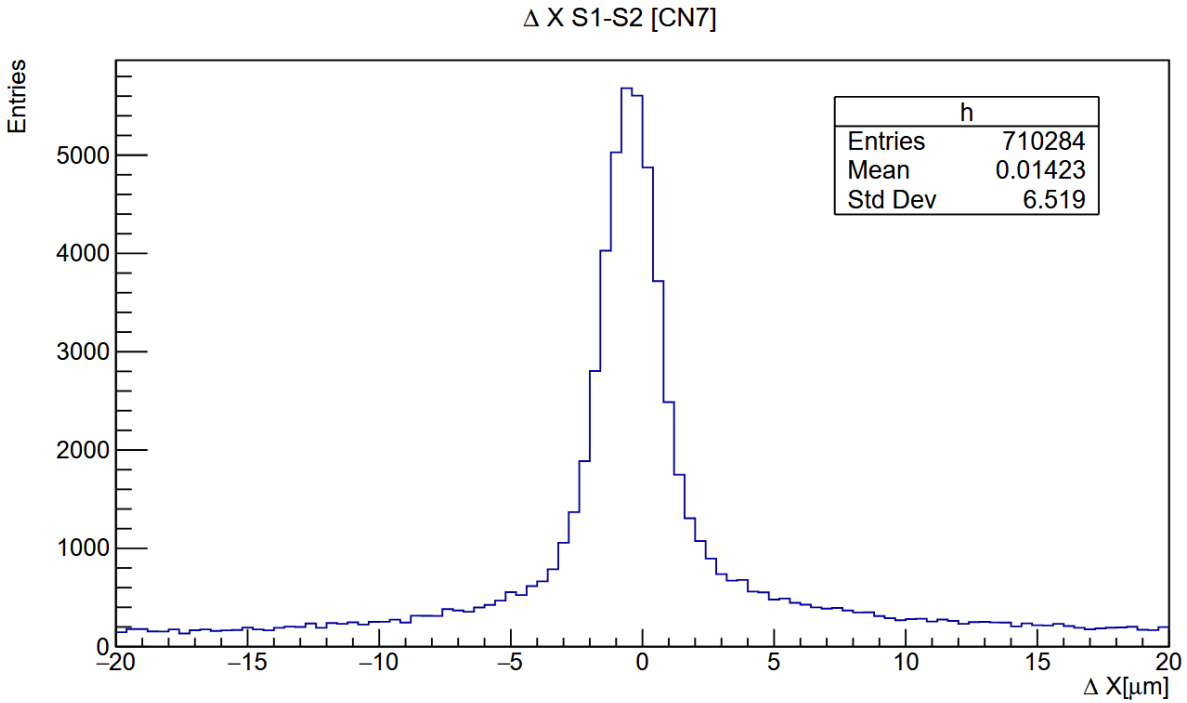
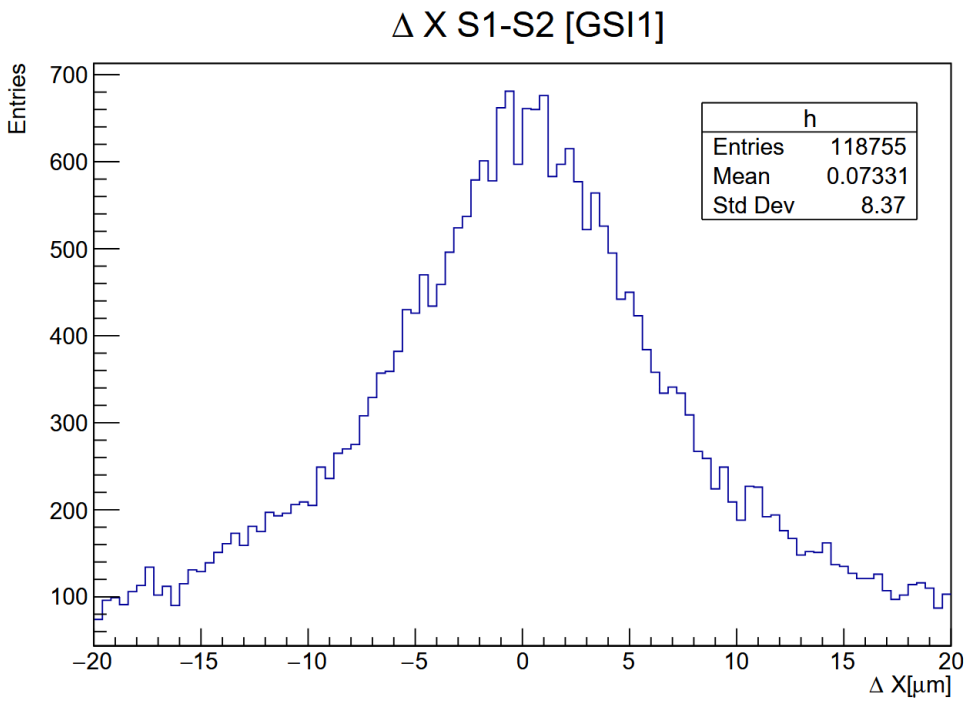
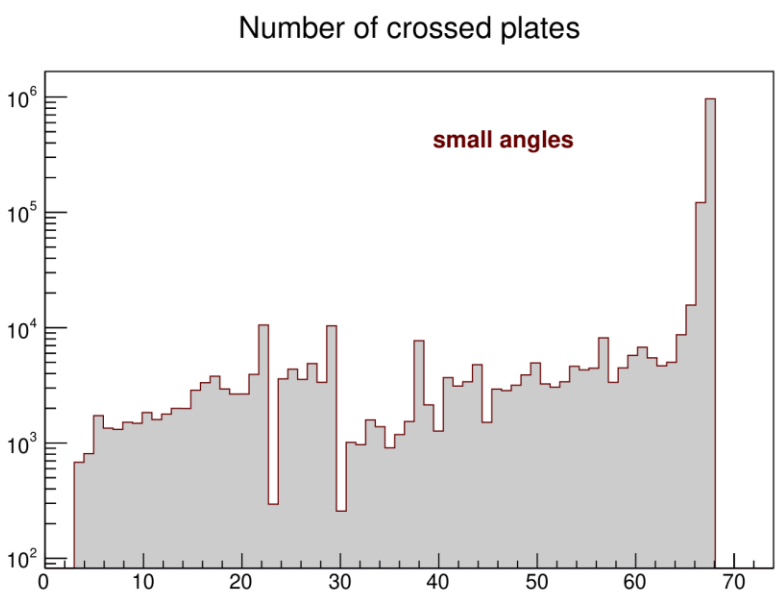


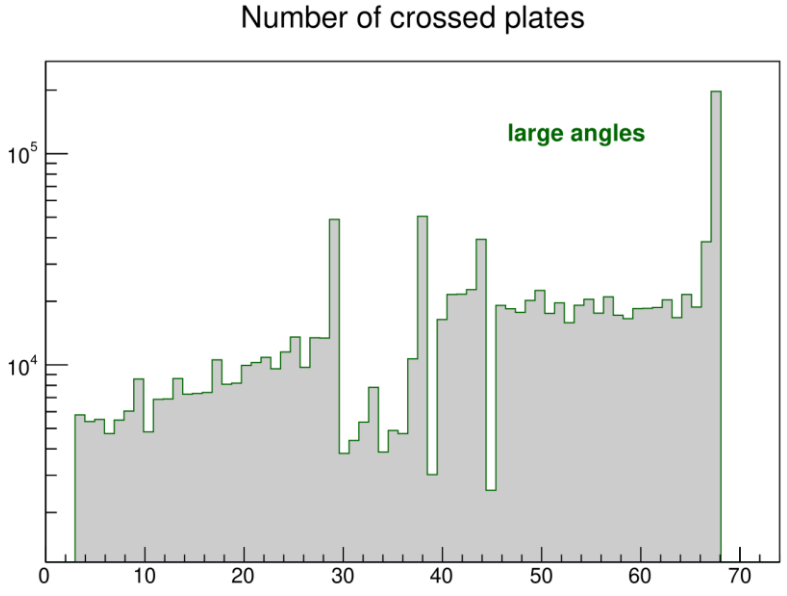
GSI1 2019

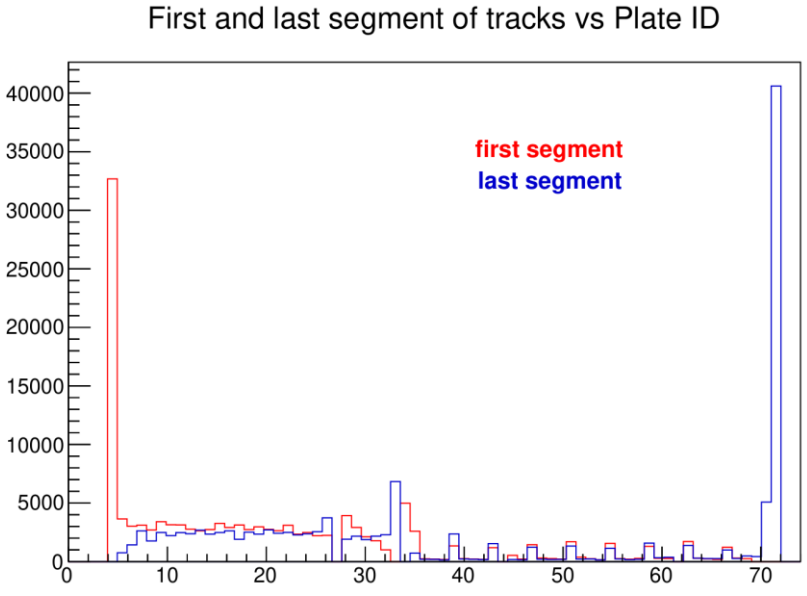


→ “buffer” emulsion helped !!!

Tracks Reconstruction







small angles

Tan(θ) < 0.035

nseg ≥ 4

large angles

Tan(θ) ≥ 0.035

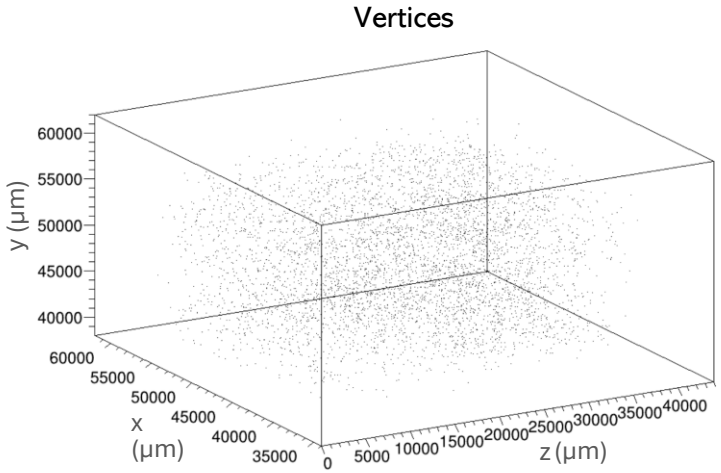
nseg ≥ 4

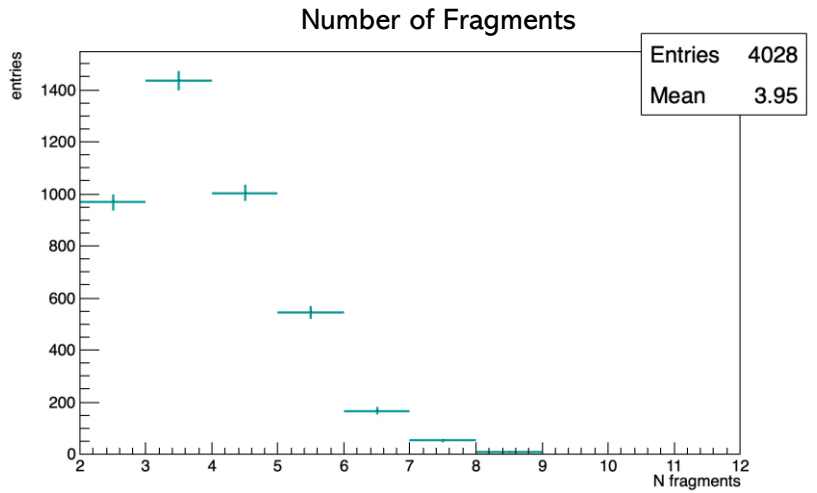
Vertexing

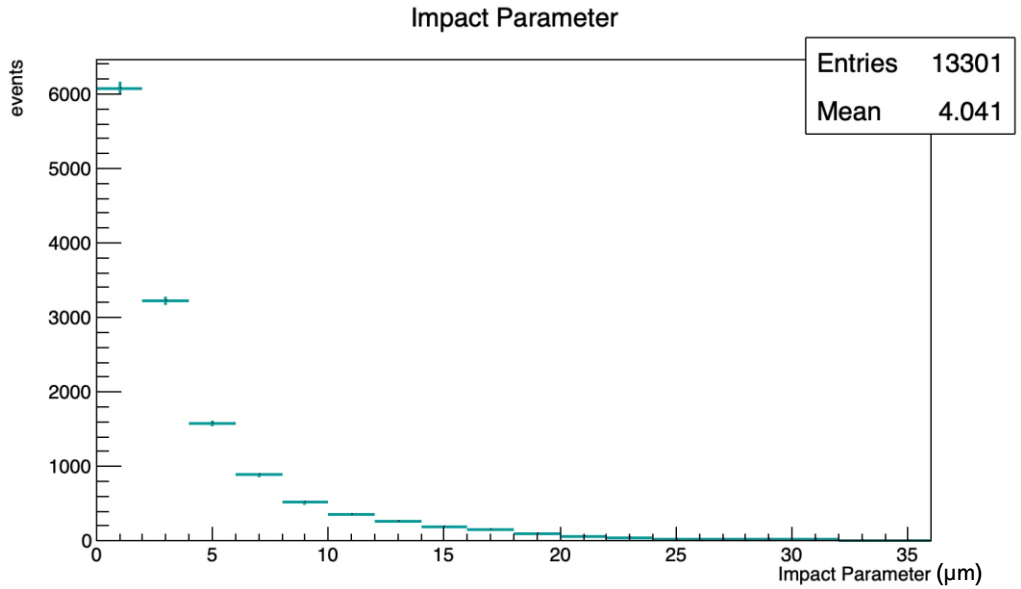
Preliminary vertices in S1:

- an interaction must produce at least two visible fragments
- at least one secondary track reaching S2
- at least two tracks associated with a vertex must have at least 3 base-tracks
- maximum impact parameter = 30 μm

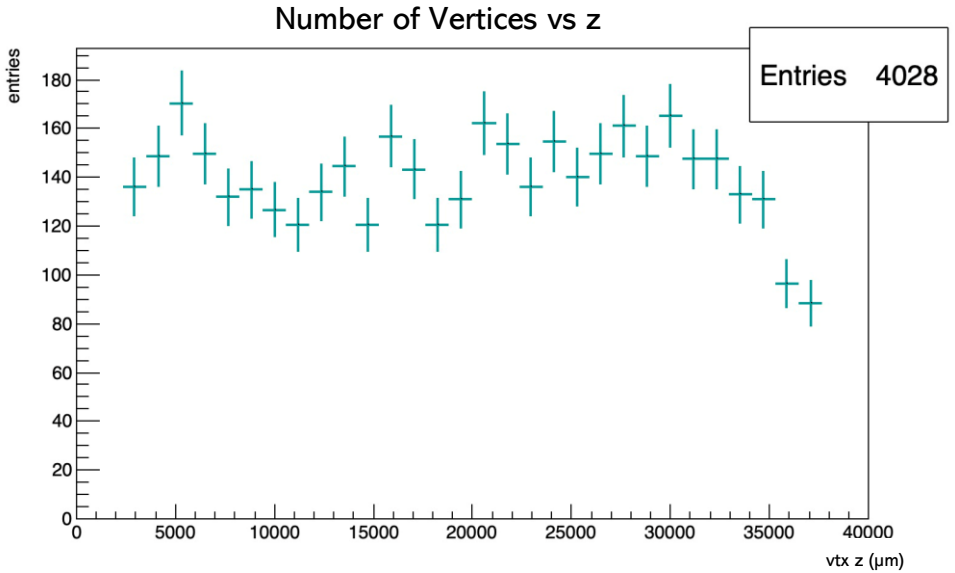
→ parameters optimization on-going

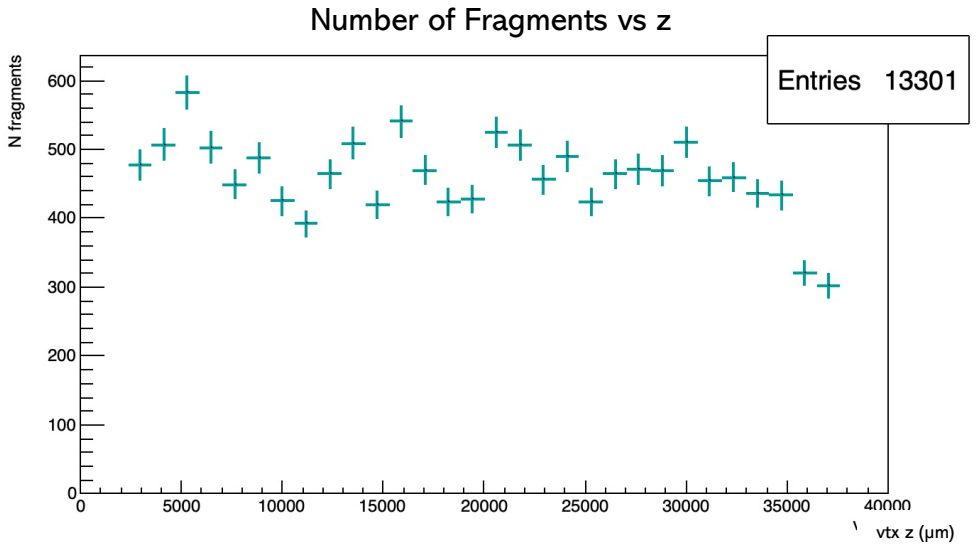


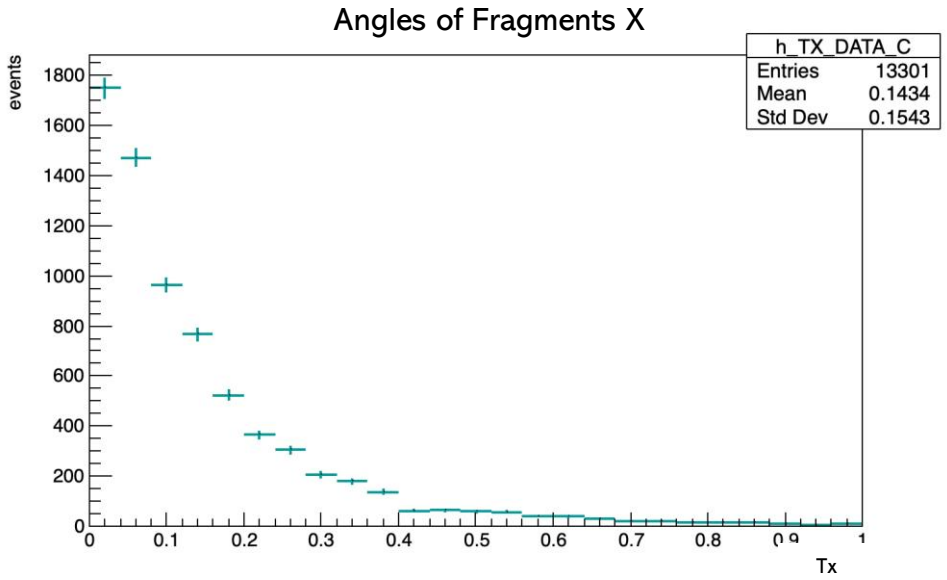


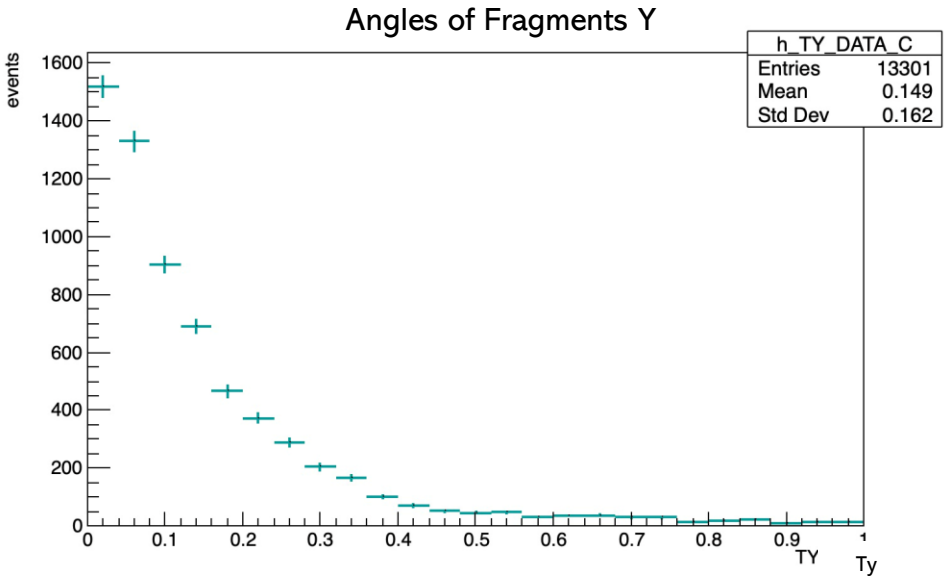


Vertexing


Number of Vertices vs z
Entries 4028
entries
vtx z (μm)

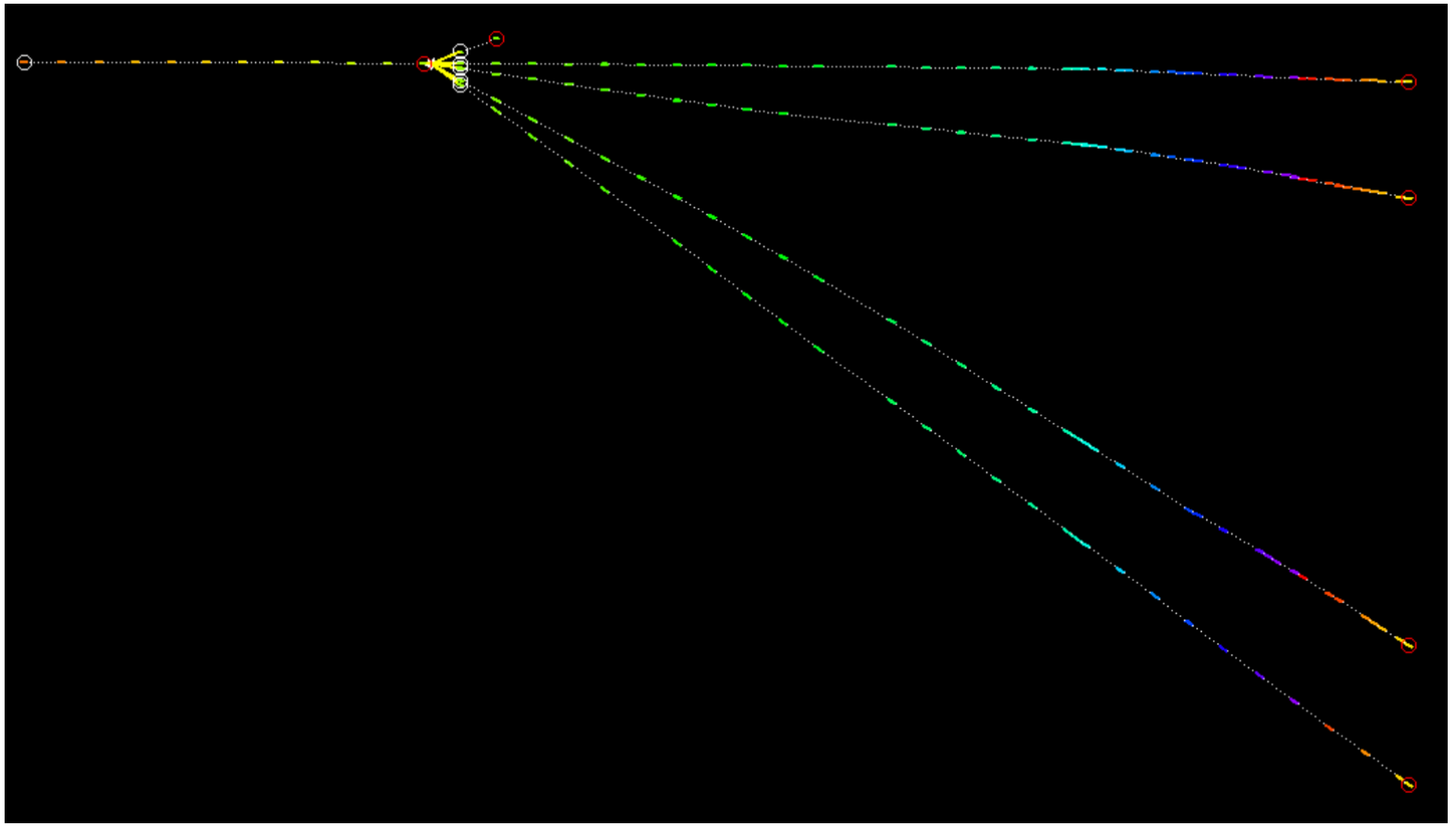

Number of Fragments vs z
Entries 13301
N fragments
vtx z (μm)

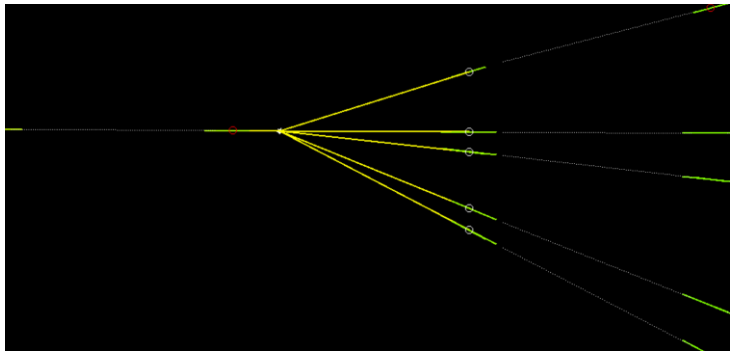

Angles of Fragments X
h_TX_DATA_C
Entries 13301
Mean 0.1434
Std Dev 0.1543
events
Tx


Angles of Fragments Y
h_TY_DATA_C
Entries 13301
Mean 0.149
Std Dev 0.162
events
TY
Ty

Display Vertices

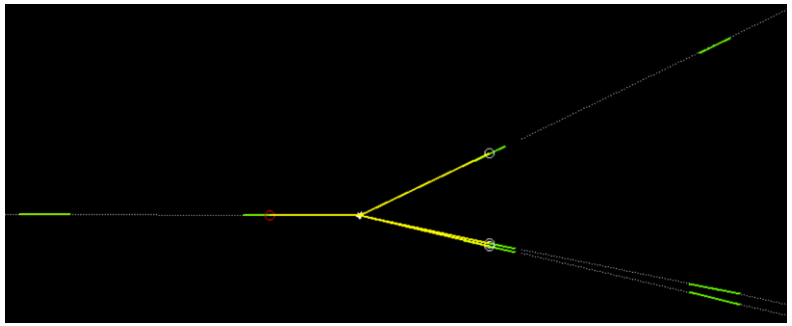
- Vertex ID: 4518
- Location: S1 between plate 14 and 15

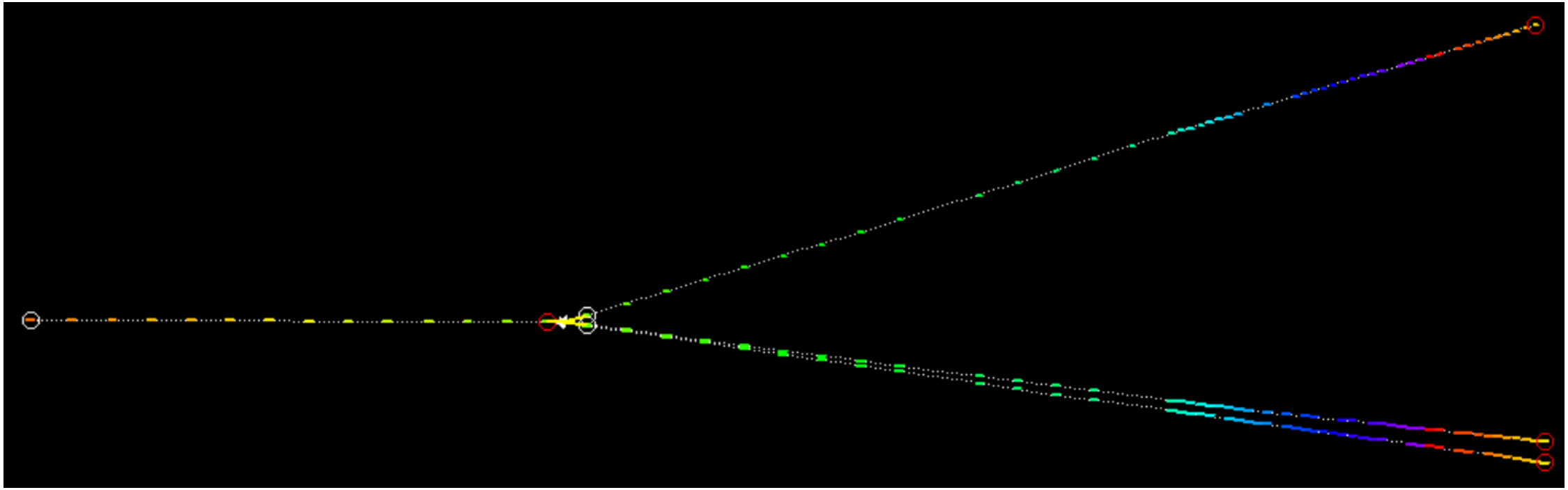




Display Vertices

- Vertex ID: 67
- Location: S1 between plate 17 and 18





Conclusions

- Analysis of CNAO 2023 Carbon@221 MeV/n on Carbon Target data STARTED
- Less statistics: 49k → 30k beam particle
- Optimization of alignment, tracking and vertexing parameters ON GOING

NEXT:

- Vertices characterization
- Charge identification
- Alpha clustering
- Cross section measurement

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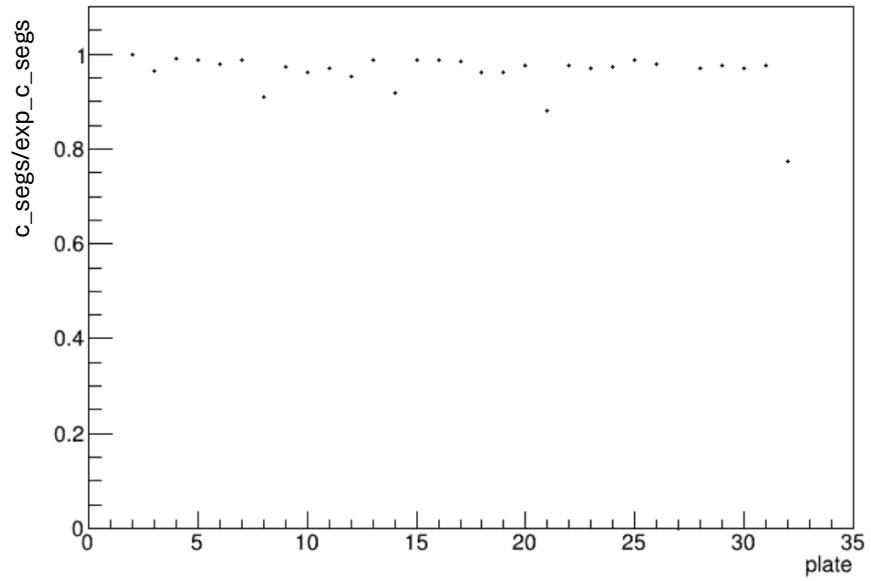
→ Thank you !!!

Backup slides

Efficiency

- Efficiency obtain from small angle tracks (beam) and from large angles tracks

c_segs/exp_c_segs:plate



segs/exp_segs:plate