Update on the Analysis of GSI1 ^{16}O (200 MeV on C_2H_4)

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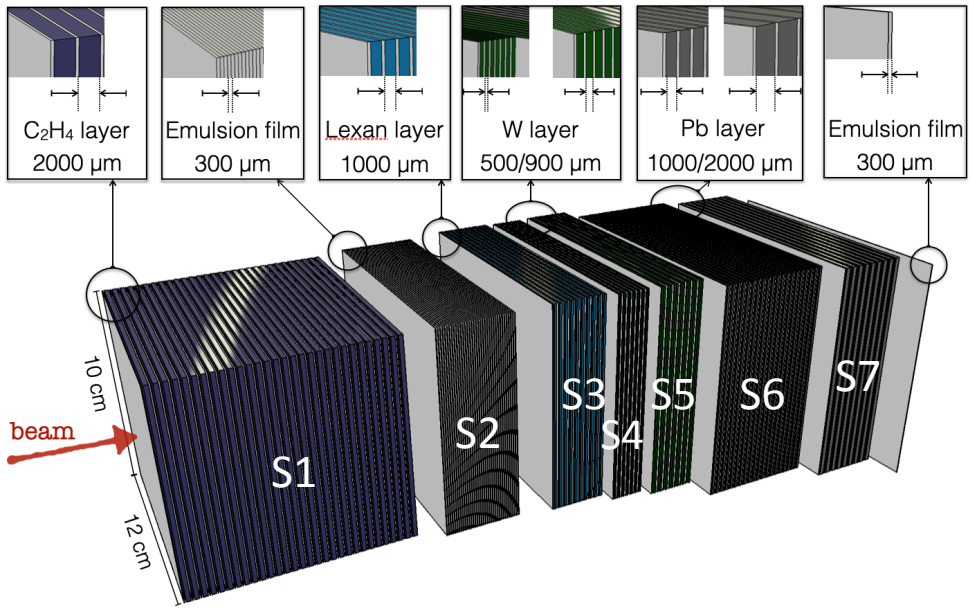
Outline

- Status of the analysis
  - Scanning Progresses
  - Tracks and vertices reconstruction in the whole brick

SCANNING PROGRESSES

Scanning Progress

TARGET \ BEAM	2019 Oxygen 200 MeV/n	2019 Oxygen 400 MeV/n	2020 Carbon 700MeV/n
Carbon	GSI1	GSI3	GSI5
Polyethylene	GSI2	GSI4	GSI6

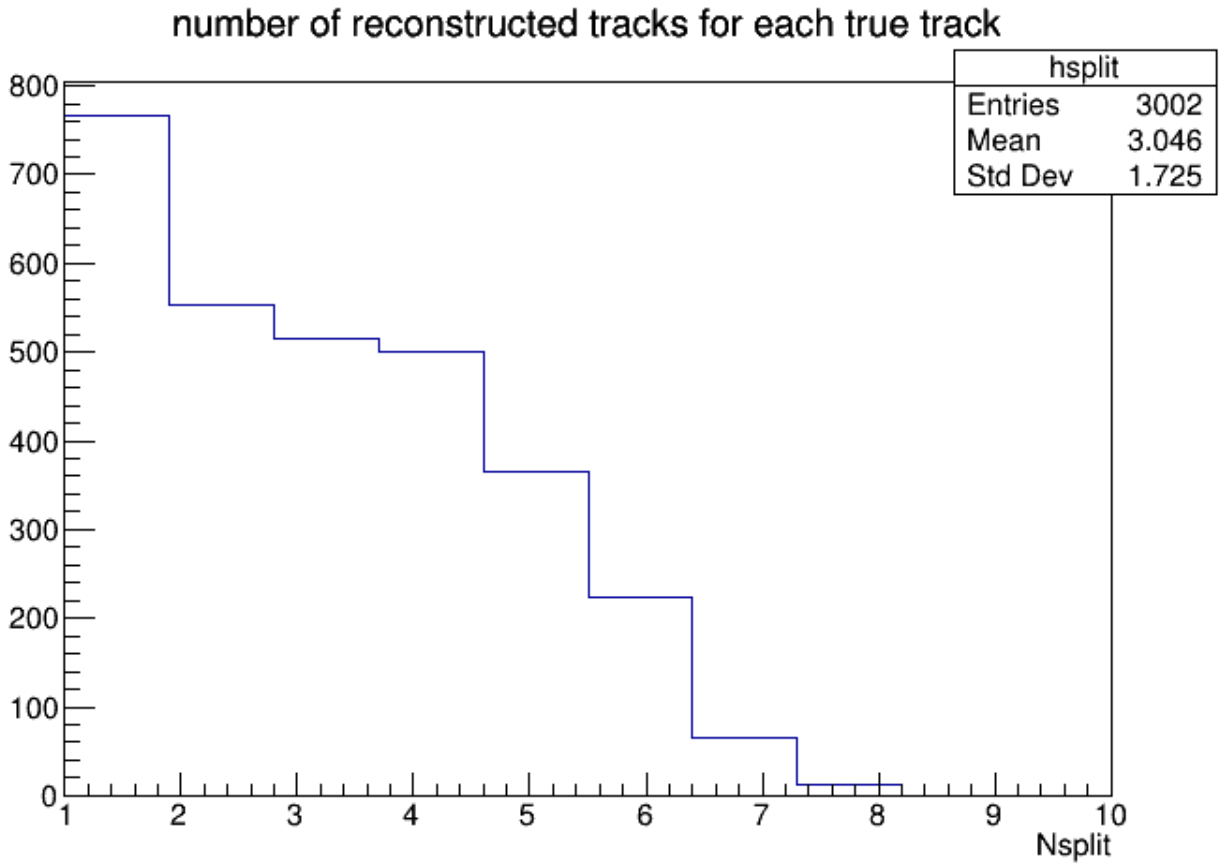


- 2019 (GSI1, GSI2, GSI3, GSI4):
  - scanning: 100%
  - alignment:
    GSI1: 100%
    S1+S2+S3: quality checks completed
    GSI2: 100%
    S1+S2+S3: quality checks completed
    GSI3: 100%
    S1+S2+S3: quality checks on-going
    GSI4: 34%
  - tracking:
    GSI2: S1+S2 completed
  - GSI1: S1-S7: completed
- 2020 (GSI5, GSI6):
  - scanning: 328/328 (100%)

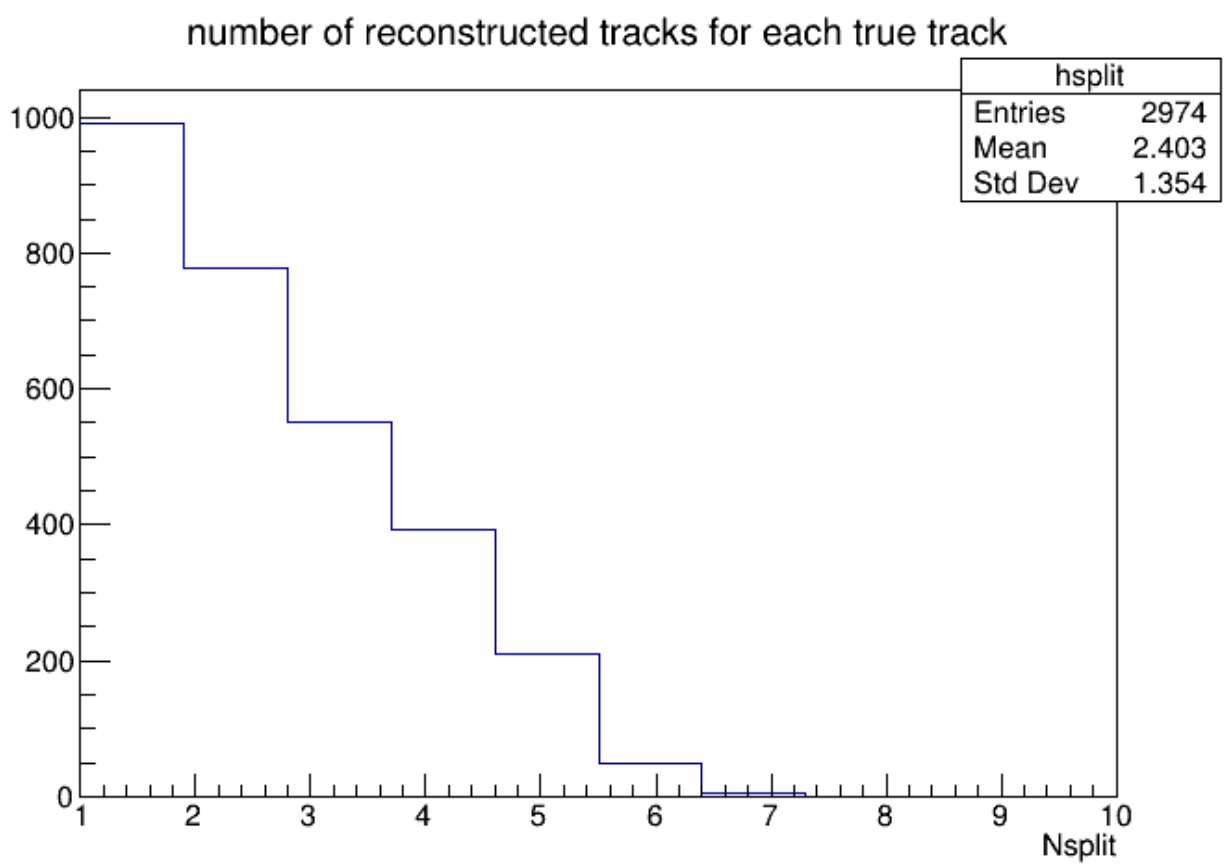
GSI1 (MC) Tracks and Vertices Reconstruction

Tracking

- Tracking for each section (S1 - S7) with appropriate tracking parameters from upstream plate to downstream plate
- Some tracks reaching their end are splitted because of large angle scattering



Tracking in Downstream direction



Tracking in Upstream direction

Tracking

- Track reconstruction is based on Kalman algorithm: going in the upstream→downstream direction improves the reconstruction

MC Evt 1266 Track 1

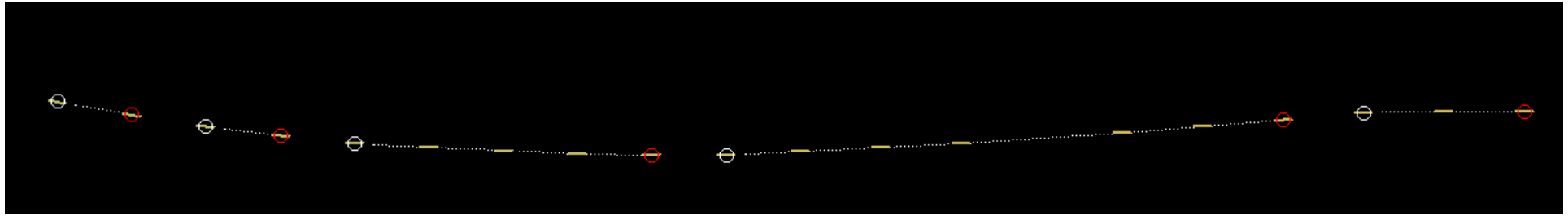


Plate 100 Plate 120

Downstream→Upstream

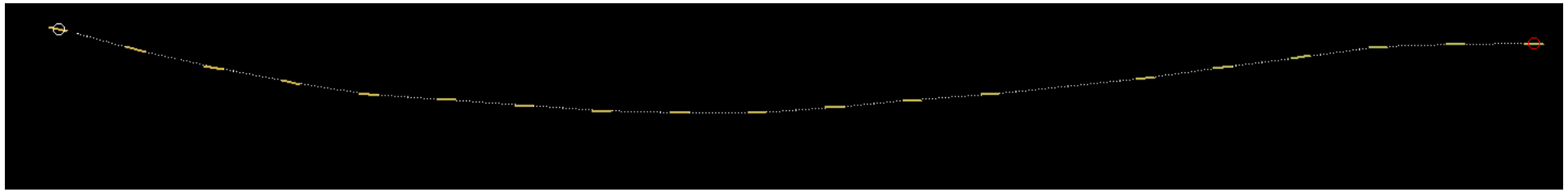


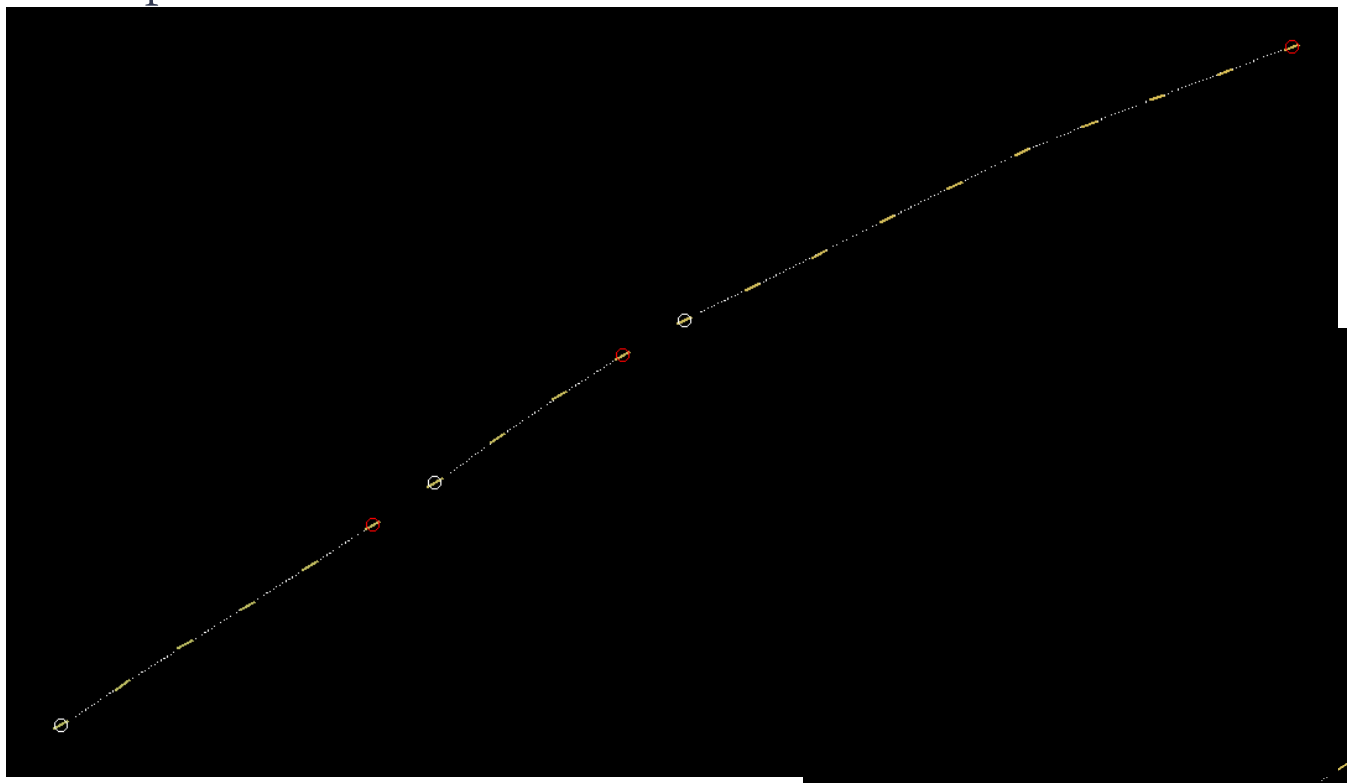
Plate 100 Plate 120

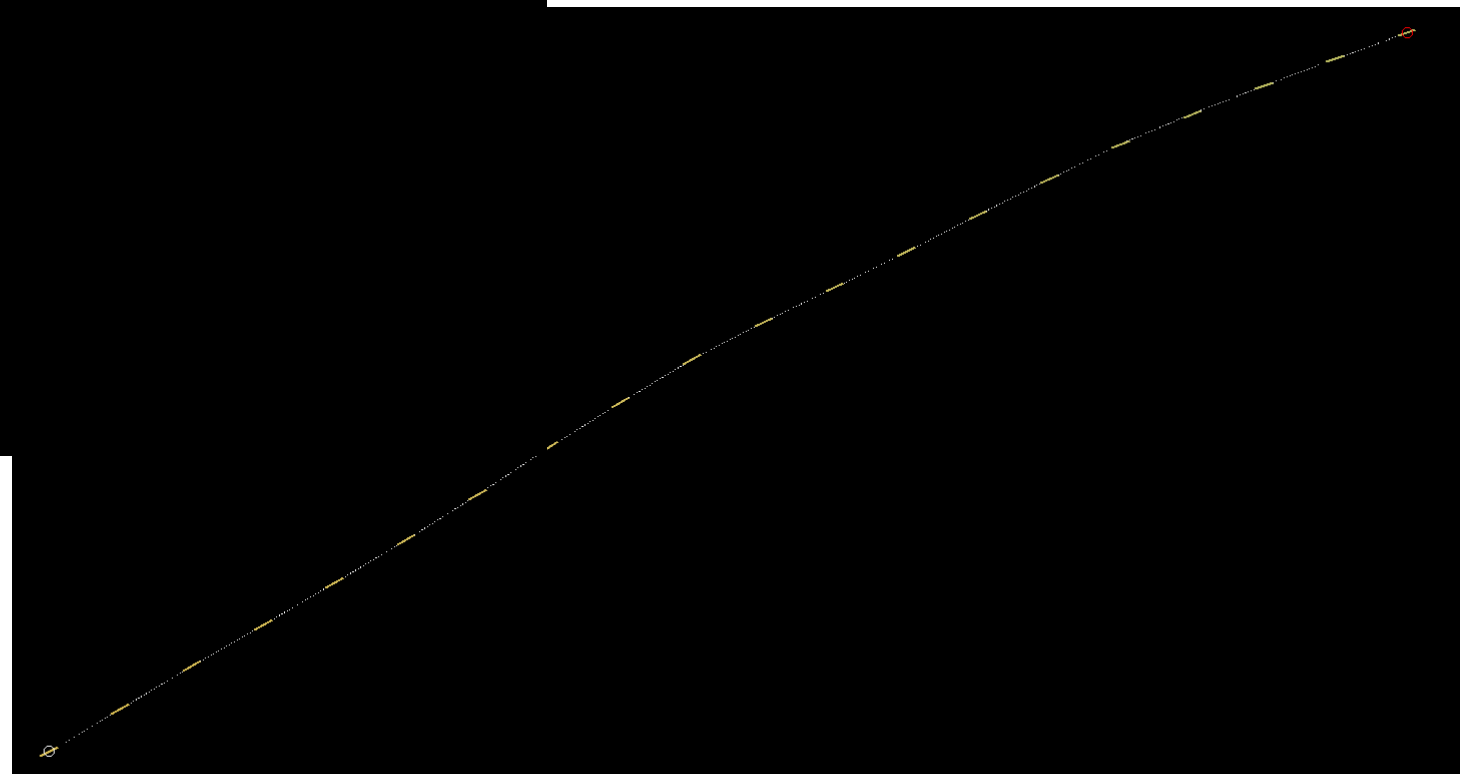
Upstream→Downstream

Tracking

- Track reconstruction is based on Kalman algorithm: going in the upstream→downstream direction improves the reconstruction

MC Evt 1402 Track 1

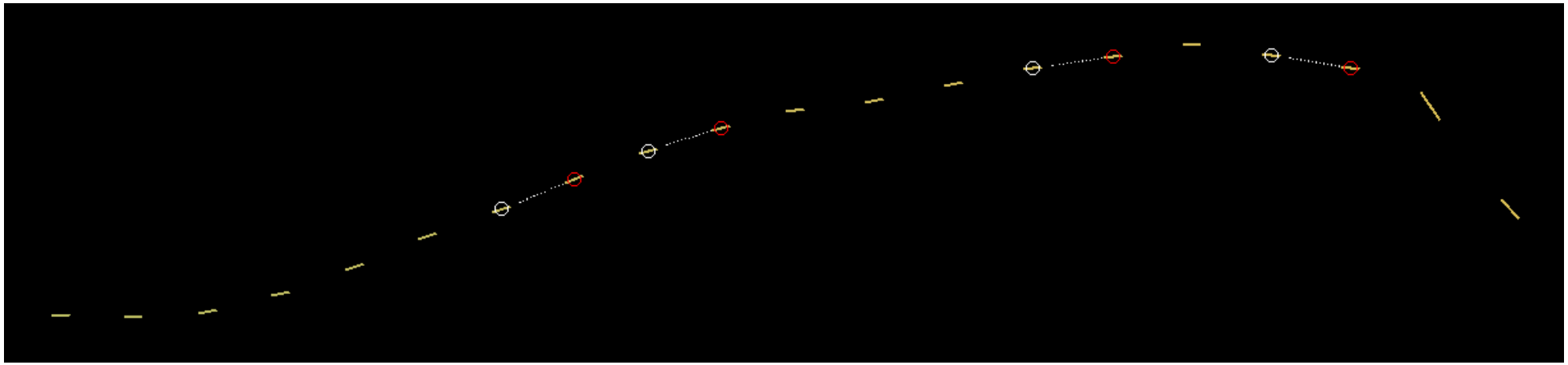




Tracking

- Many cases in which scattering is too large: we'll try to implement a dedicated algorithm to reconstruct this tracks

MC Evt 3477 Track 9

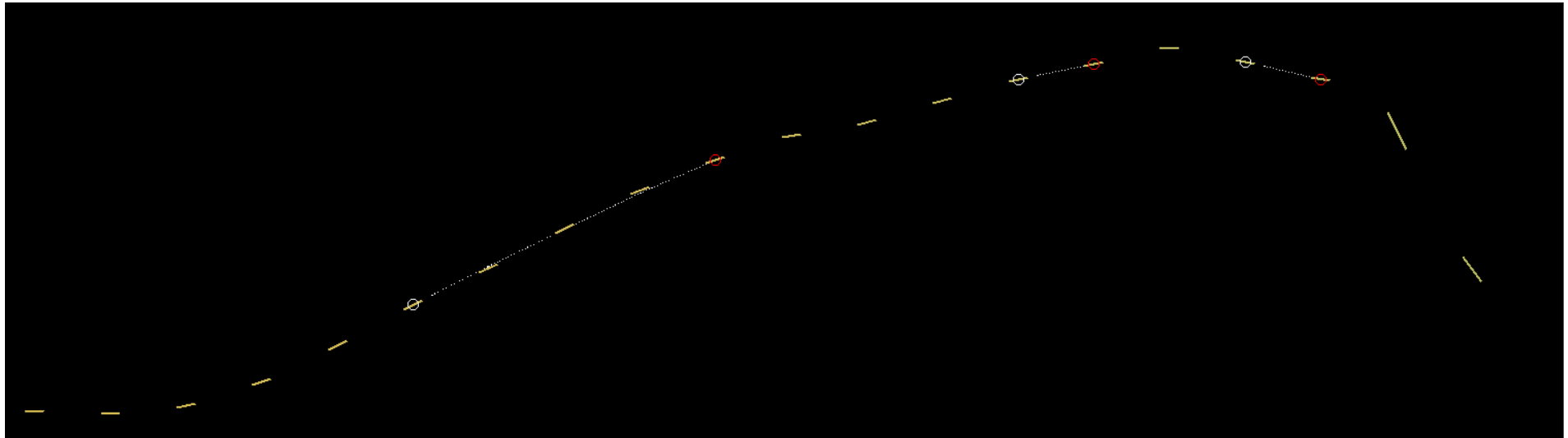


Downstream→Upstream

Plate 100

Plate 120

Plate 120

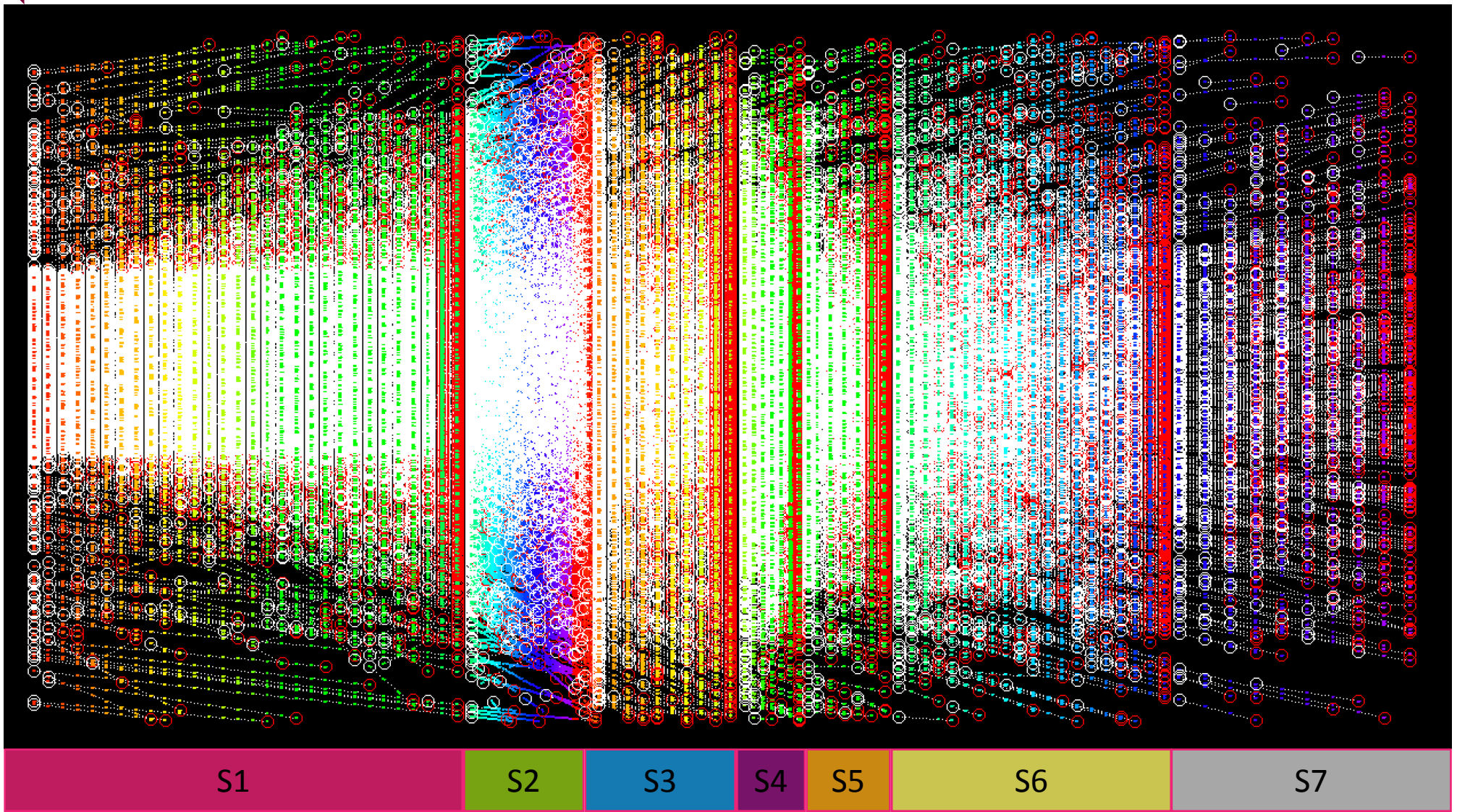


Upstream→Downstream

Plate 100

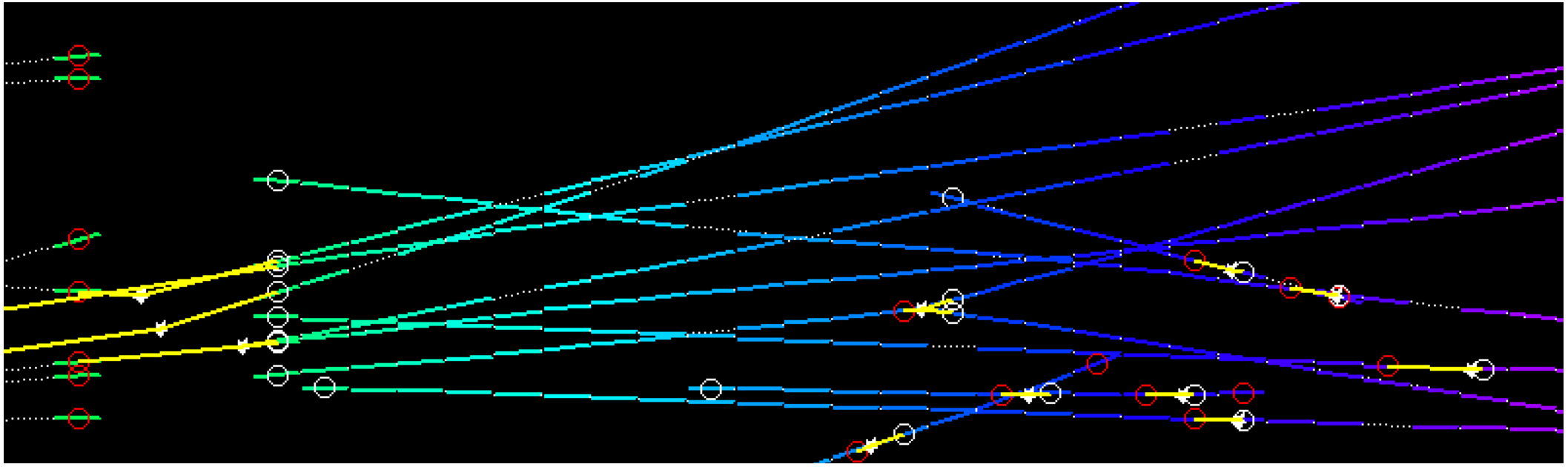
Tracking

- All tracks reconstructed in each section are converted in the same reference system and saved in a unique file



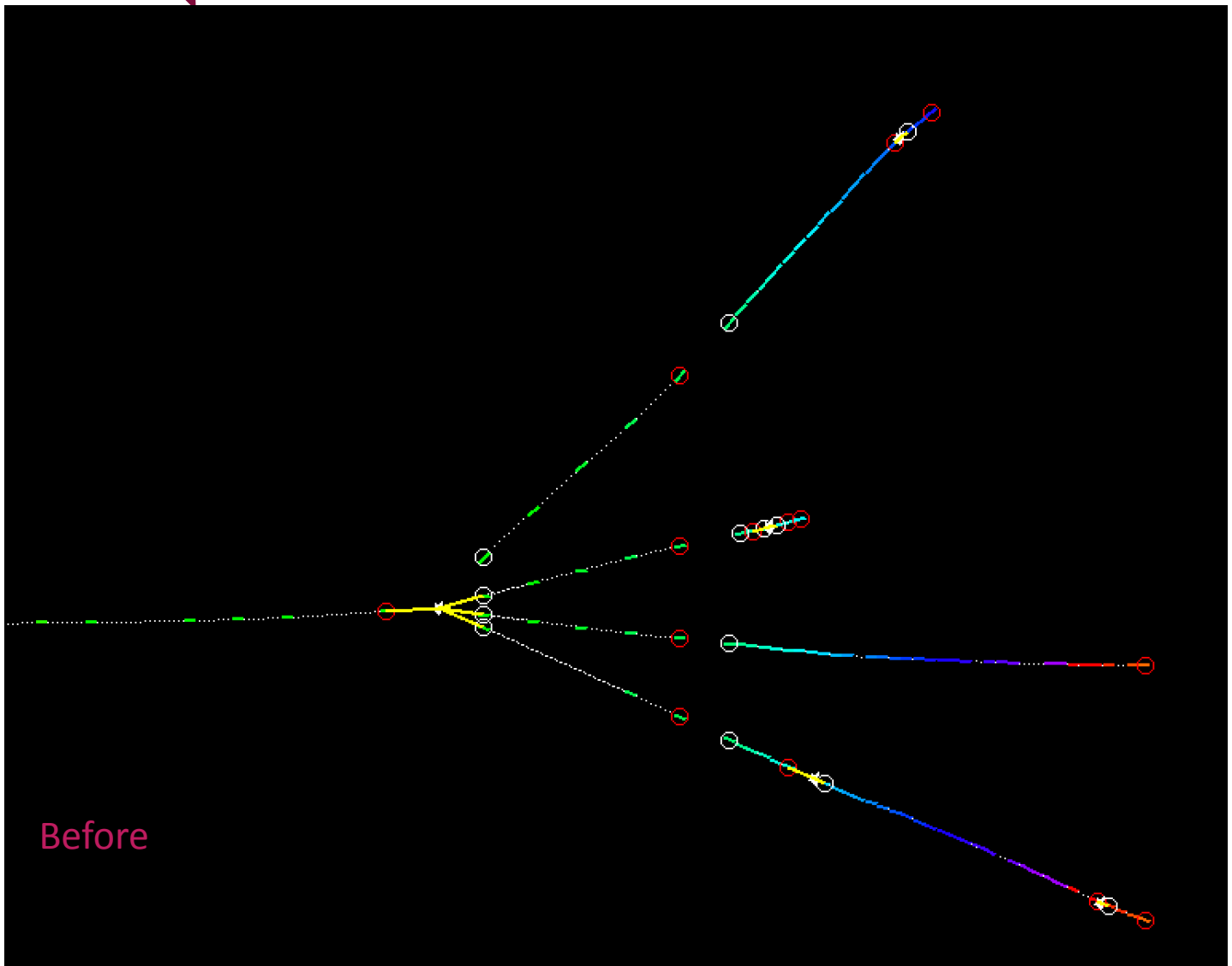
Vertexing + Tracks merging

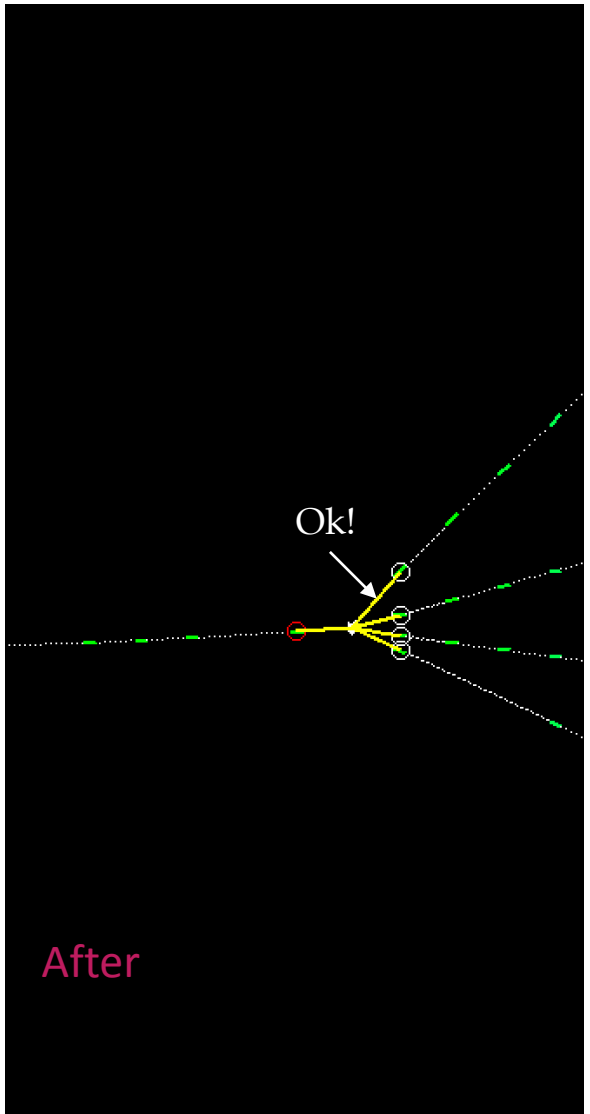
- Exclusion of cosmic rays tracks (based on sharp cut:
  $\text{nseg} = 2$ & $\theta \geq 0.2\text{rad}$ & $\text{mean volume}_{S1} \leq 13687 * \theta + 13781$) $\Rightarrow$ more than 93% of tracks selected are background
- Interaction vertices search in S1
- Only point-tale vertices search in S2…S7 (aim: merge 2prong back-to-back vertices into one track)



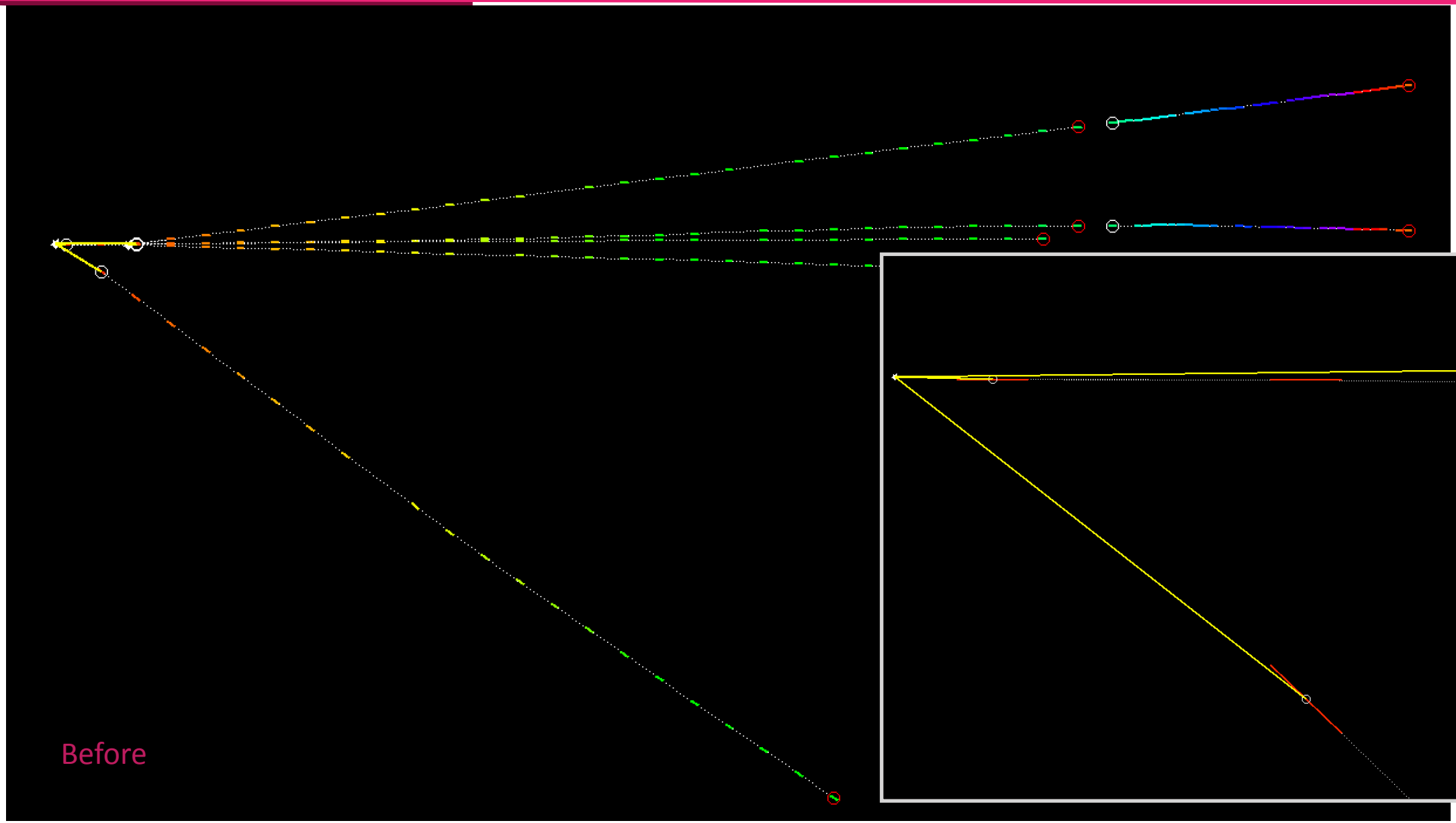
MC 2312 - After “vertex improving”

- Vertices topologies are improved with dedicated procedures (as shown in previous meeting)

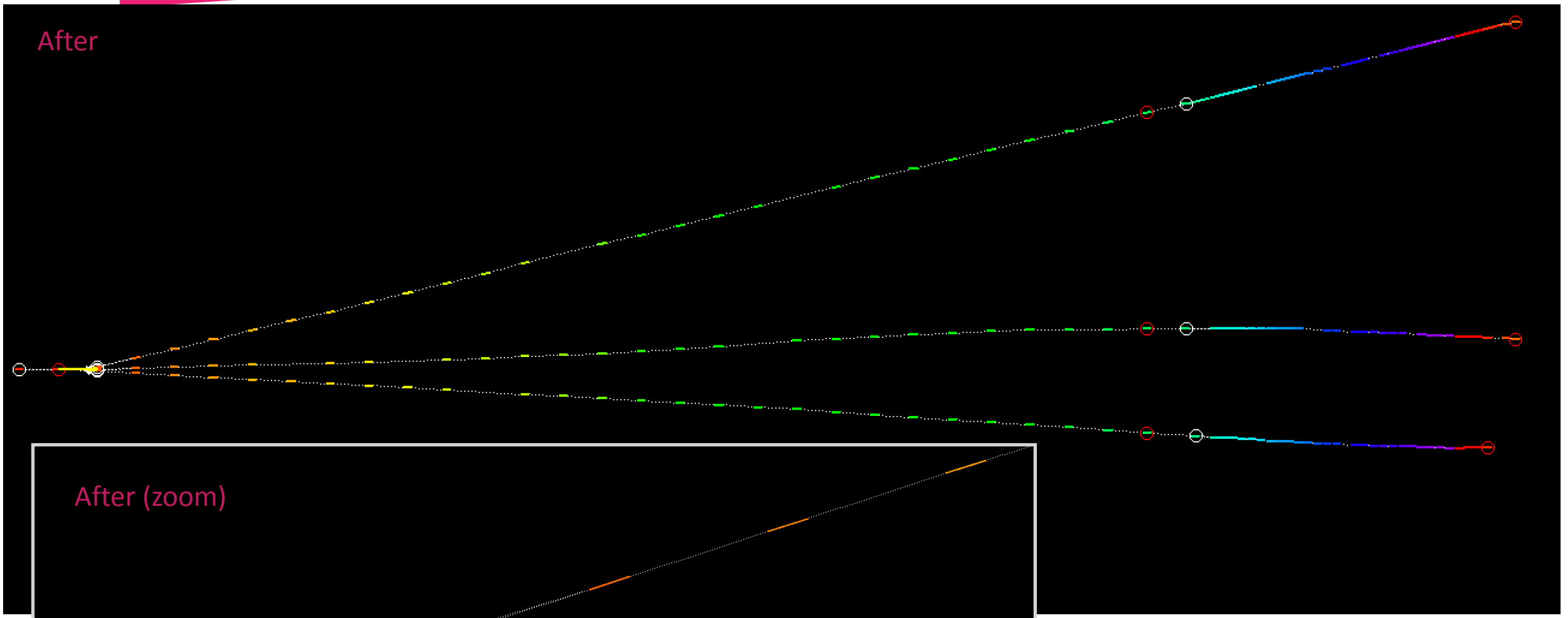




MC 1881 - before “vertex improving”

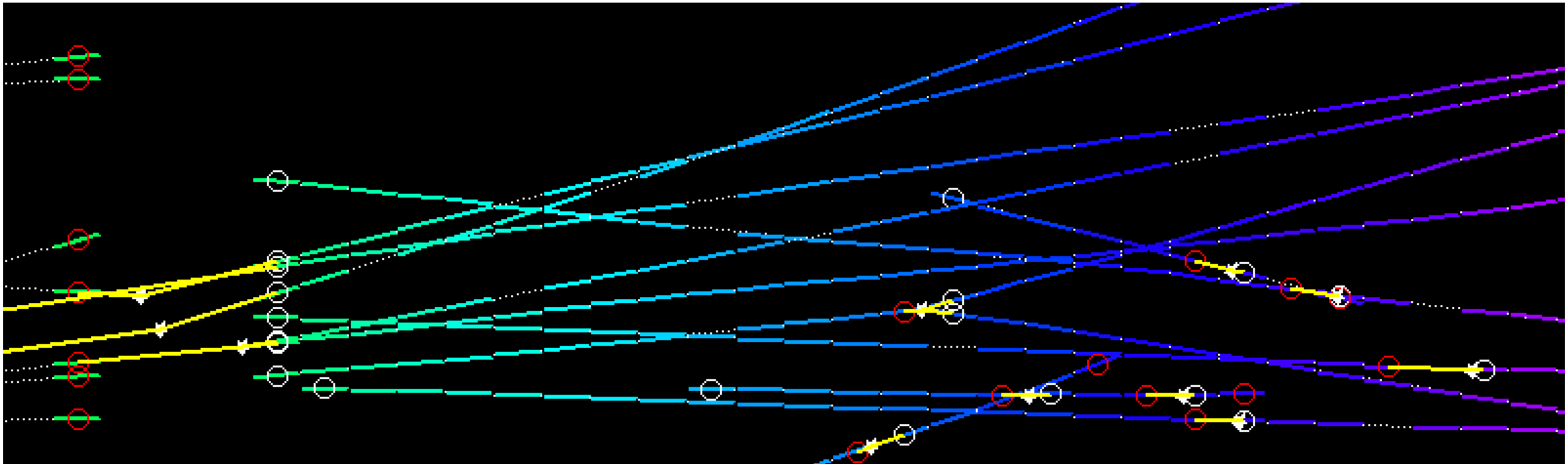


MC 1881 - After “vertex improving” and tracks merge



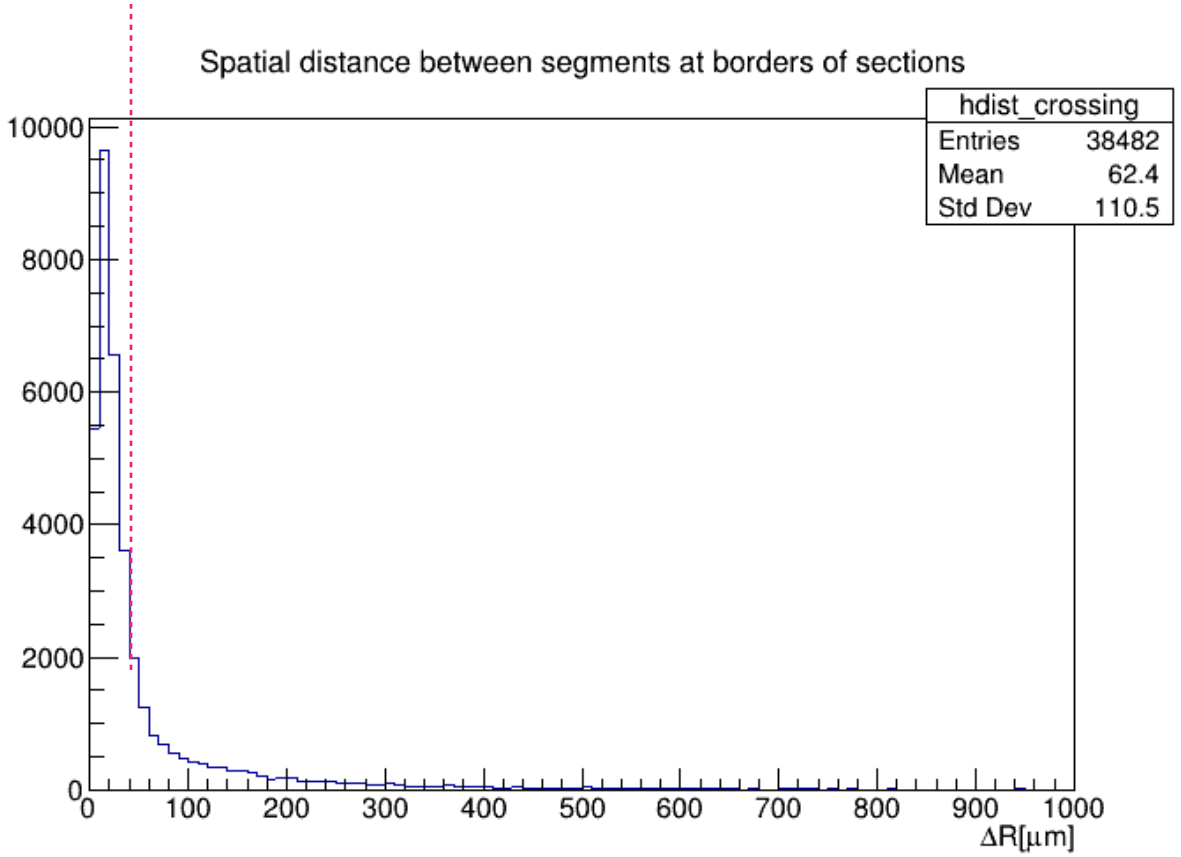
Tracks merging

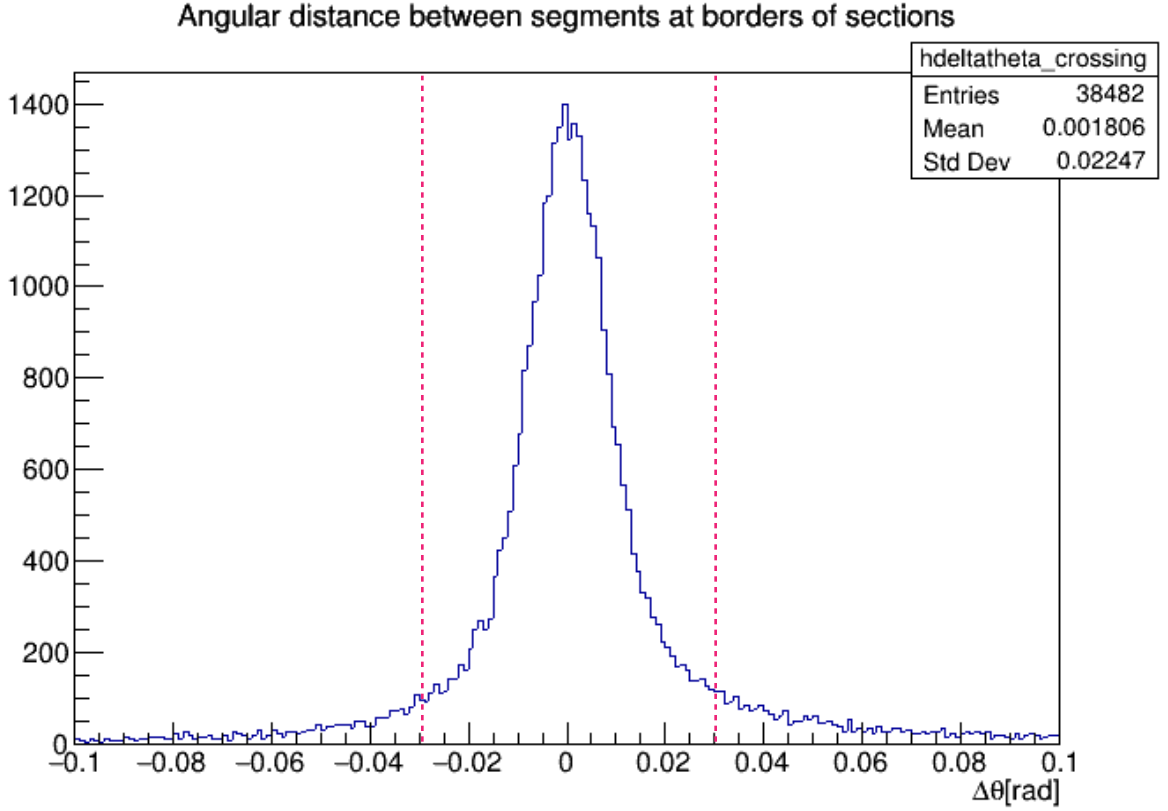
- Not all “pieces of tracks” form a 2 prong back-to-back vertex
- A dedicated Track follow down has been implemented to find the next track’s segment (match according to position and angle)



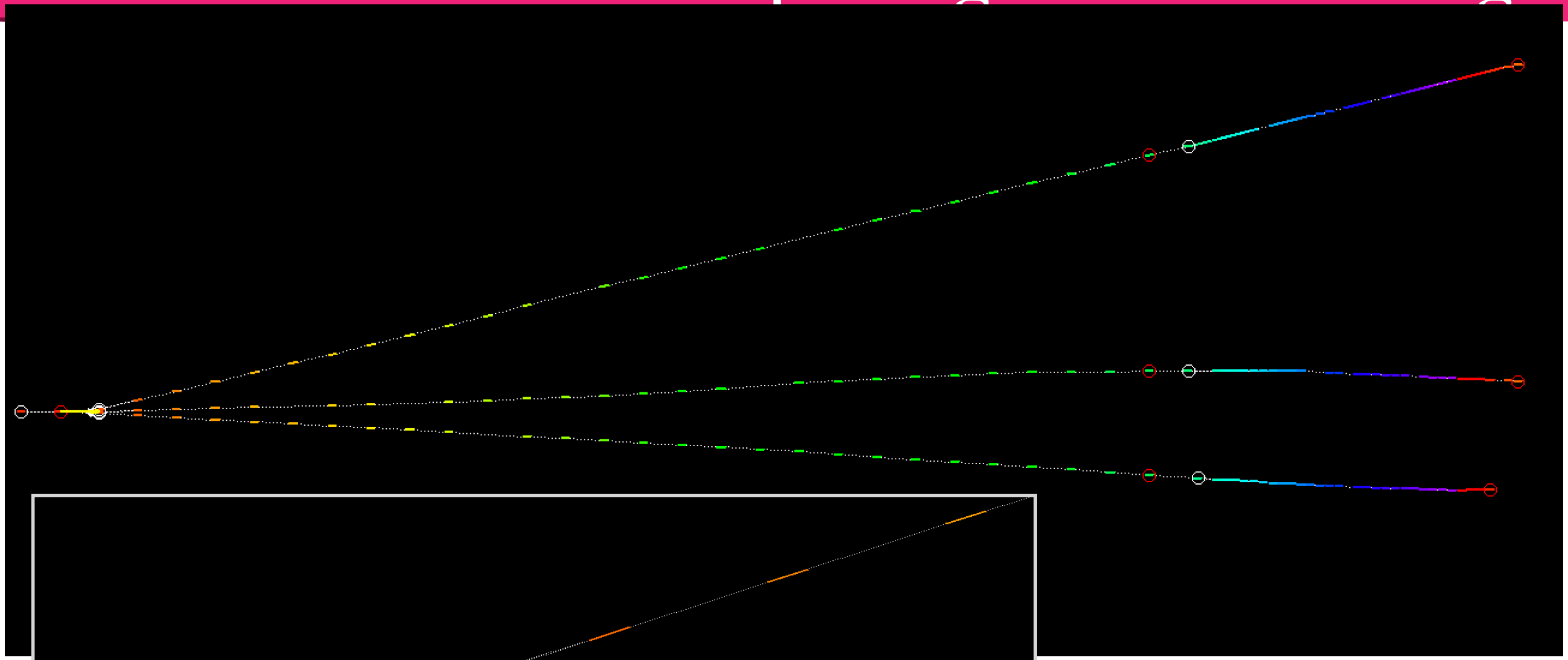
Tracks merging cuts

- Track follow down to find the next track's segment (match according to position and angle)





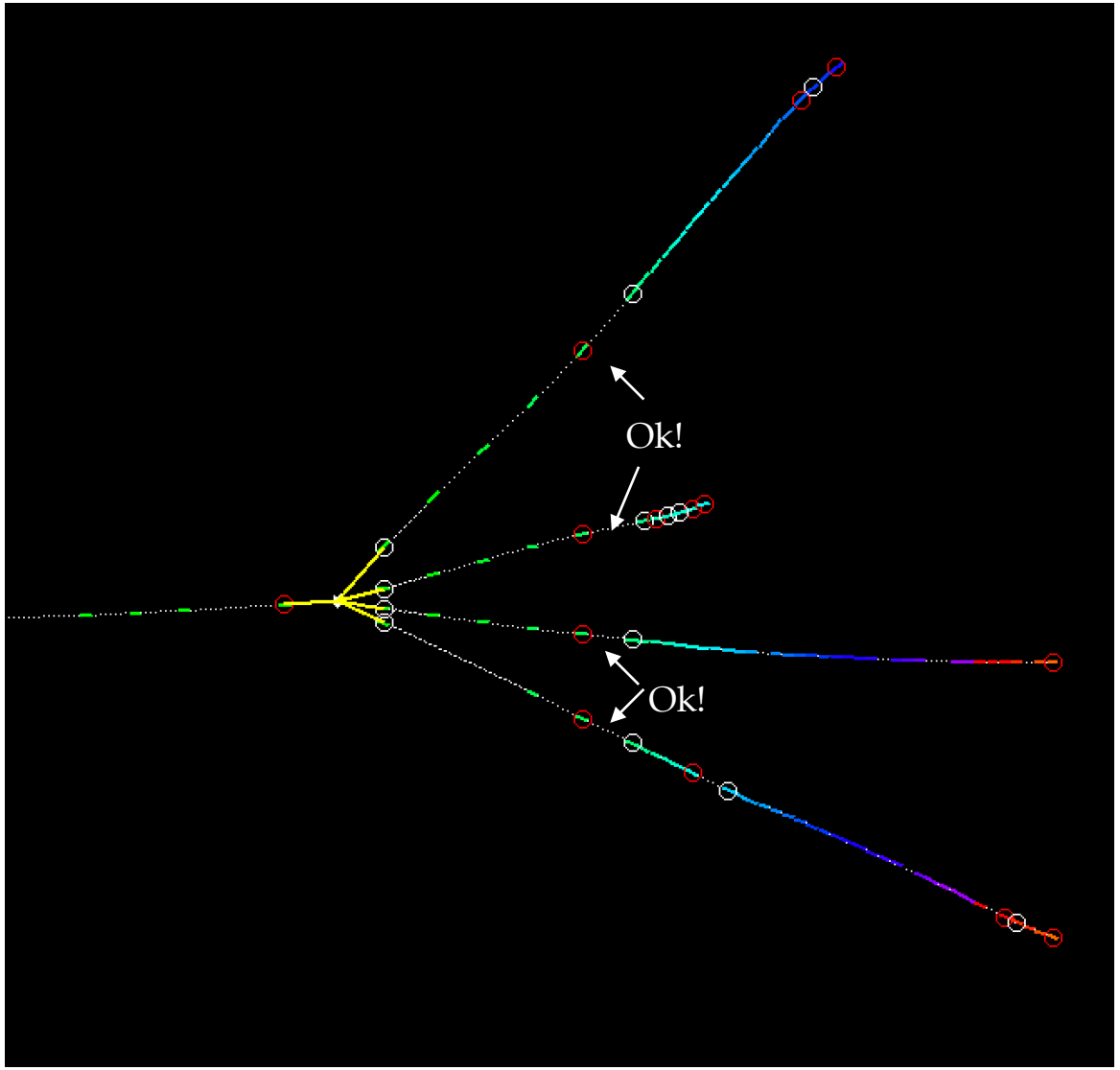
MC 1881 - After “vertex improving” and tracks merge



MC 2312 - After “vertex improving” and tracks merge

- Tracks merge: parametrisation of maximum $\Delta\theta$ according to the number of missing segments:

  0.03rad +0.01rad*(Δlayer – 1)

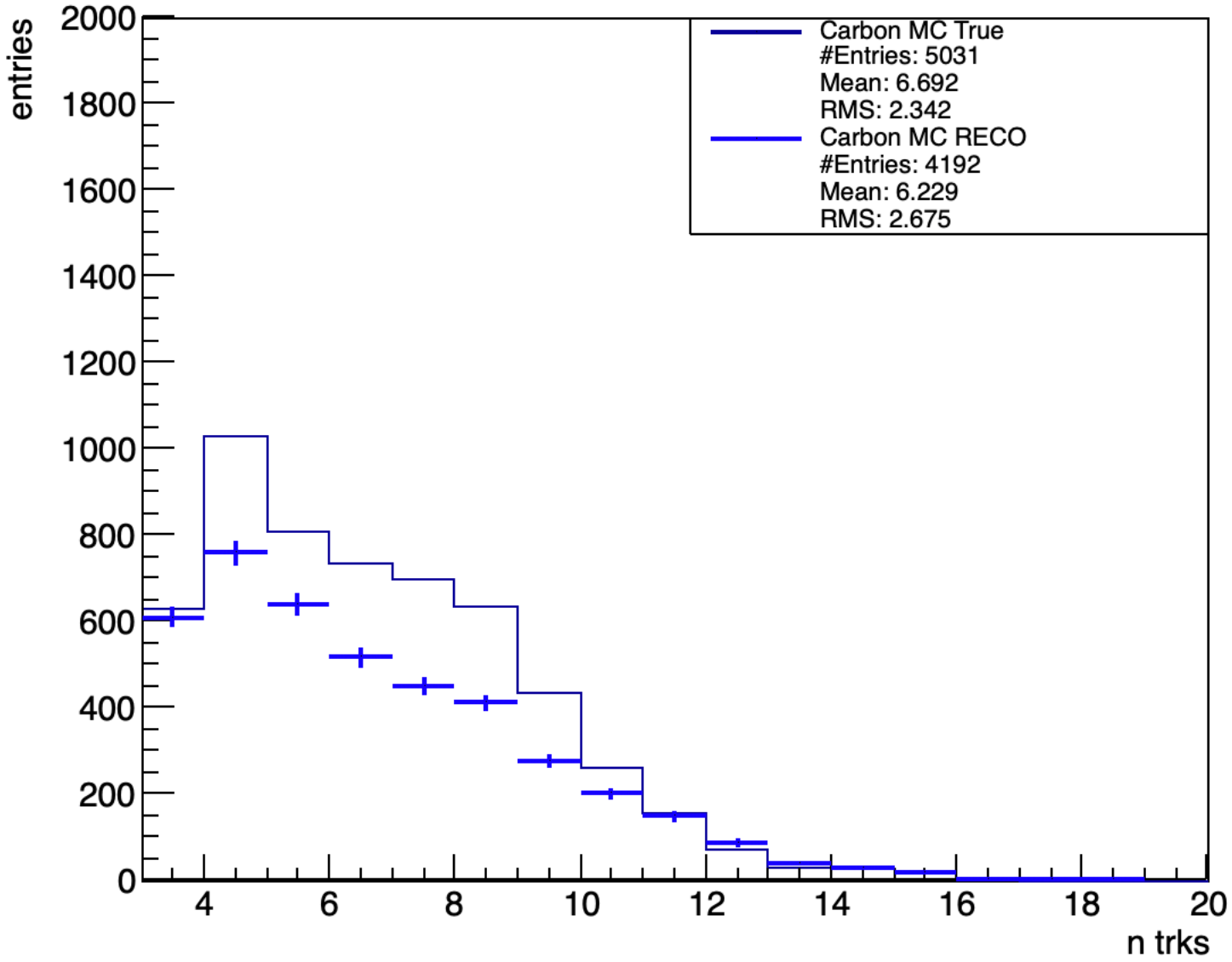


Some results on “improved” vertices (MC)

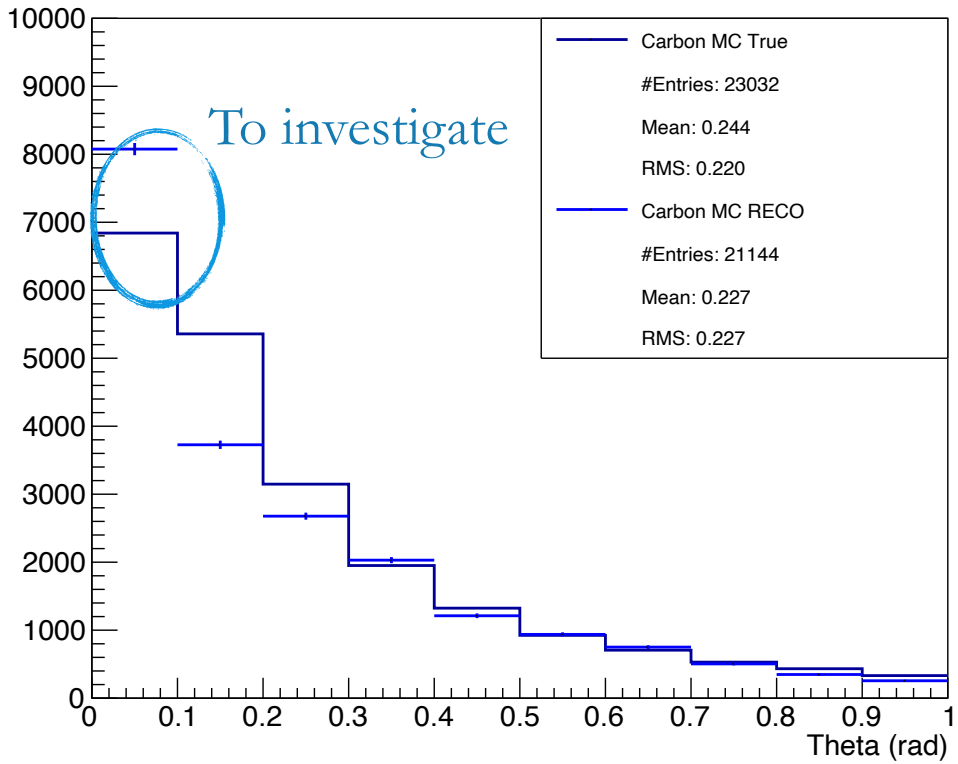
PRELIMINARY

	GSI1 Reco	correctly
Starting from	26616	
fake vertices splitted (to be improved)	6650	1375 (20.7%)
Beam added	1029	
Extra Daughters found	3182	
2 Prong vertices deleted	11802	11722 (99.3%) [20 of which background]
tracks merged	14979	14497 (96.8%)
n≥3	4192	MC true: 5031

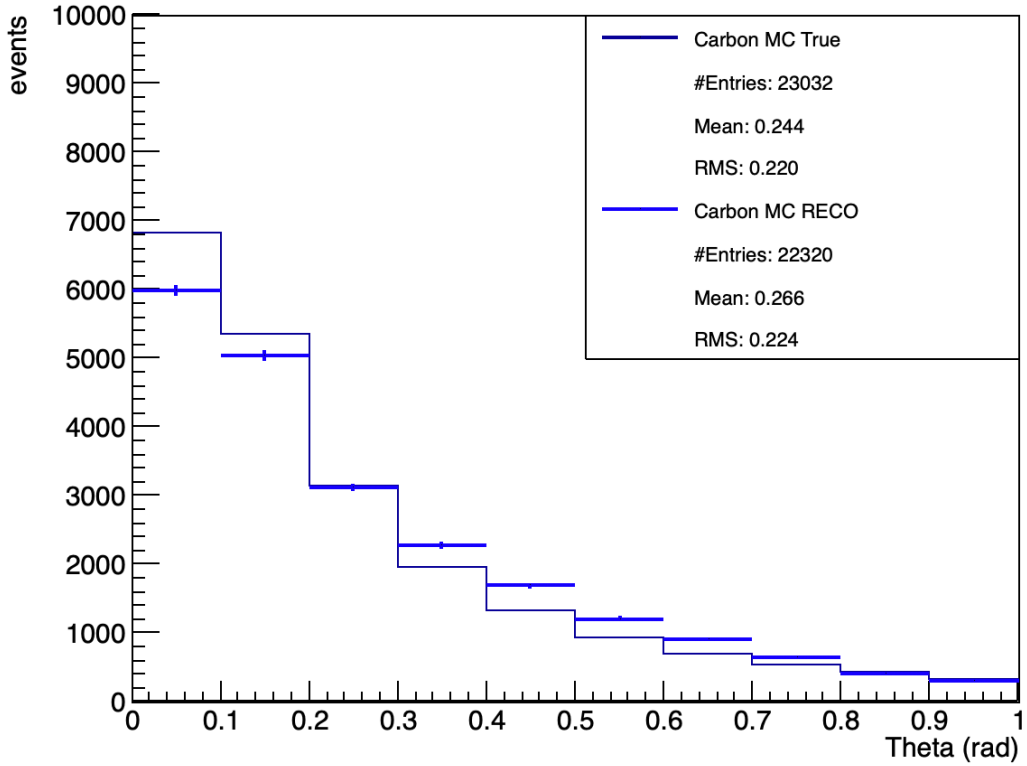
MC True vs Reconstructed: Vertices Multiplicity



MC True vs Reconstructed: Daughters angular distributions



General Meeting 26/05/2021



New

Conclusions

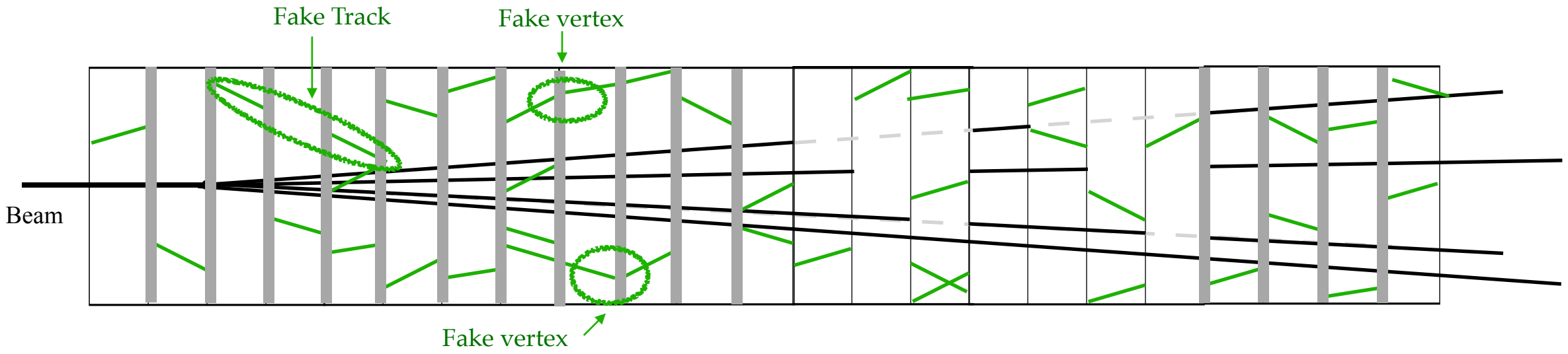
- Efforts for good tracking of S3-S7: still space to improve → next step will be momentum measurement
- Vertices reconstruction further improved → next step will be cross section measurement

THANK YOU!

Back up slides

Background in Monte Carlo Simulation

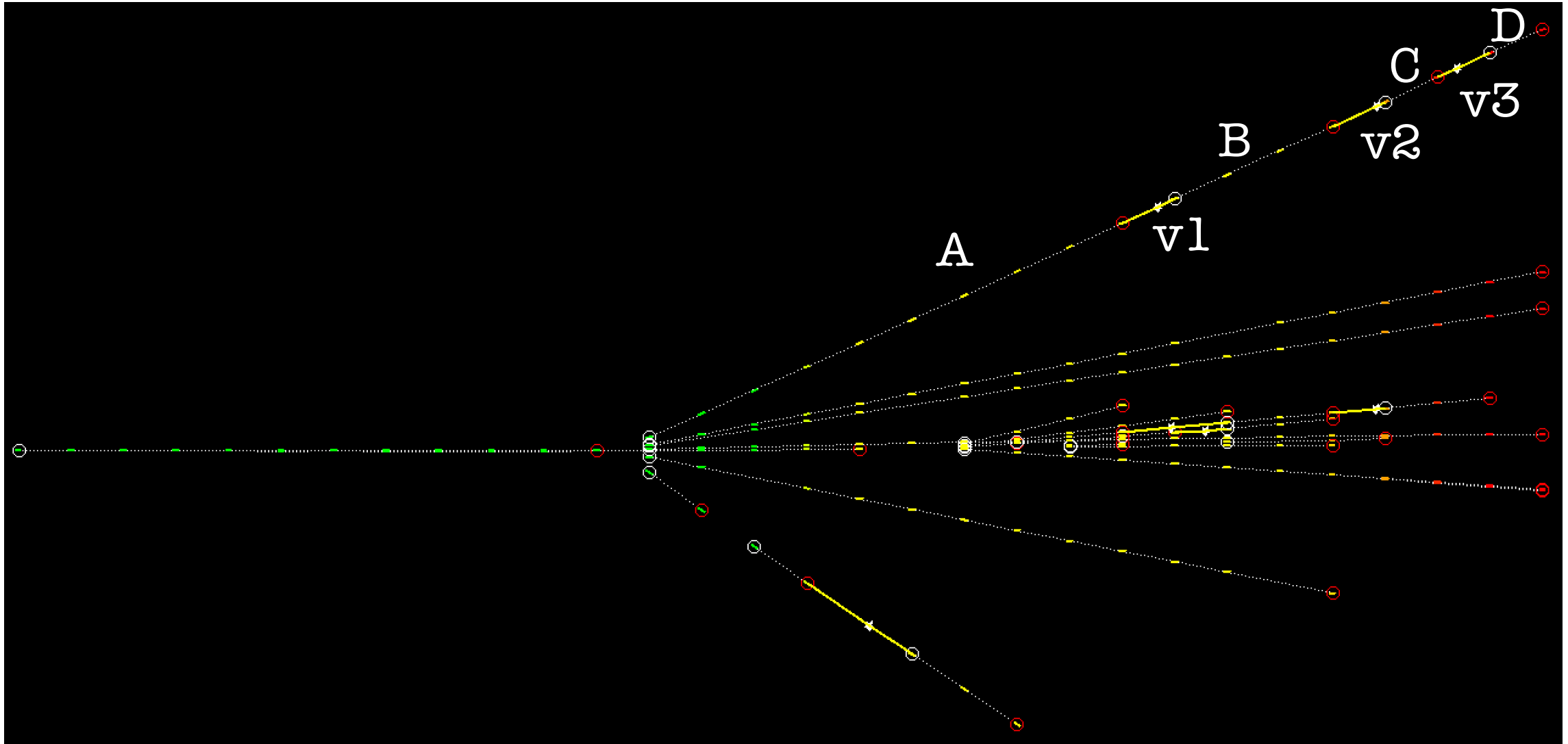
- Nuclear emulsions integrate cosmic rays since their production up to their development
- Before and after brick assembling nuclear emulsions are are are piled up without passive material in a different order with respect to the brick one. The segments due to the cosmic rays integrated during this period, therefore, should not form any track, apart from combinatorial associations (tracks 2 or 3 segments long)



Passive material not to scale

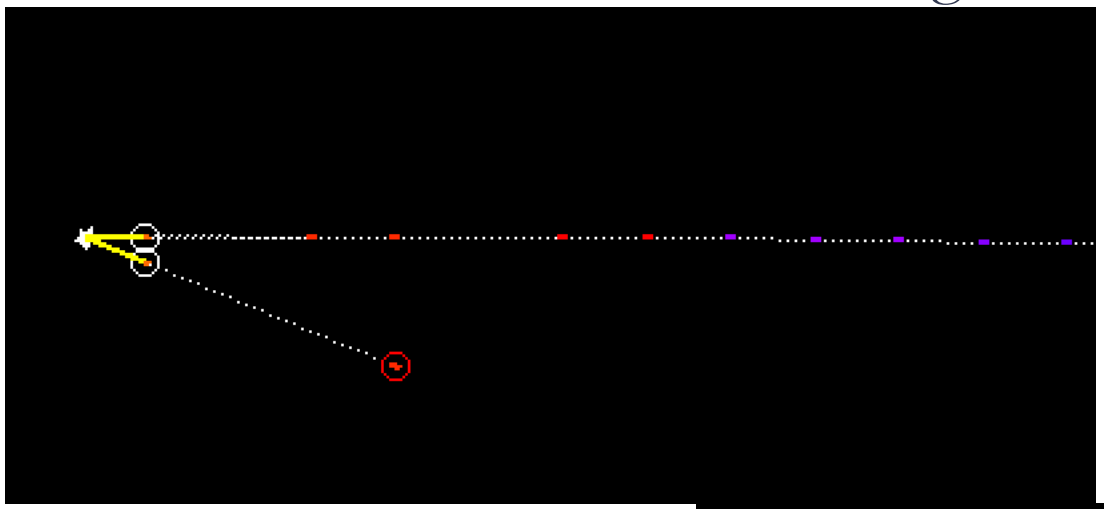
Vertexing improvements

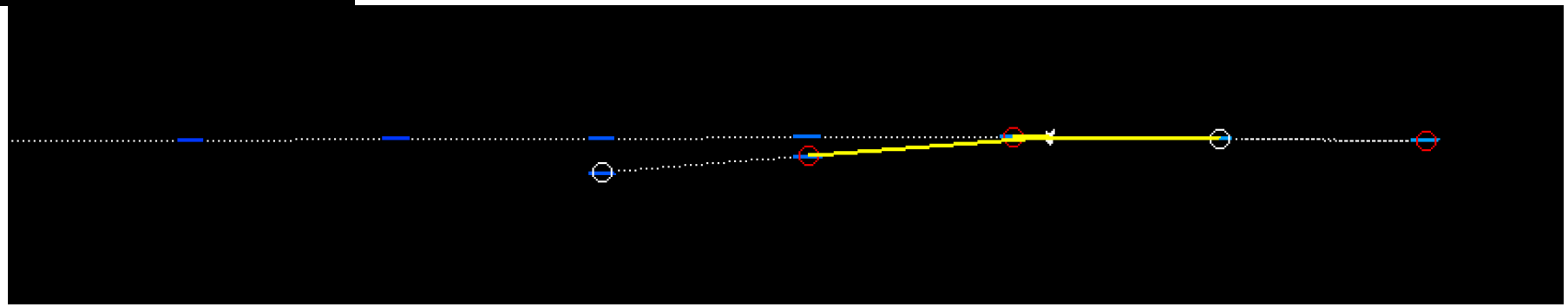
1) 2-prongs back-to-back vertices, formed due to more stringent tracking parameters, are reattached in the same track



Vertexing improvements

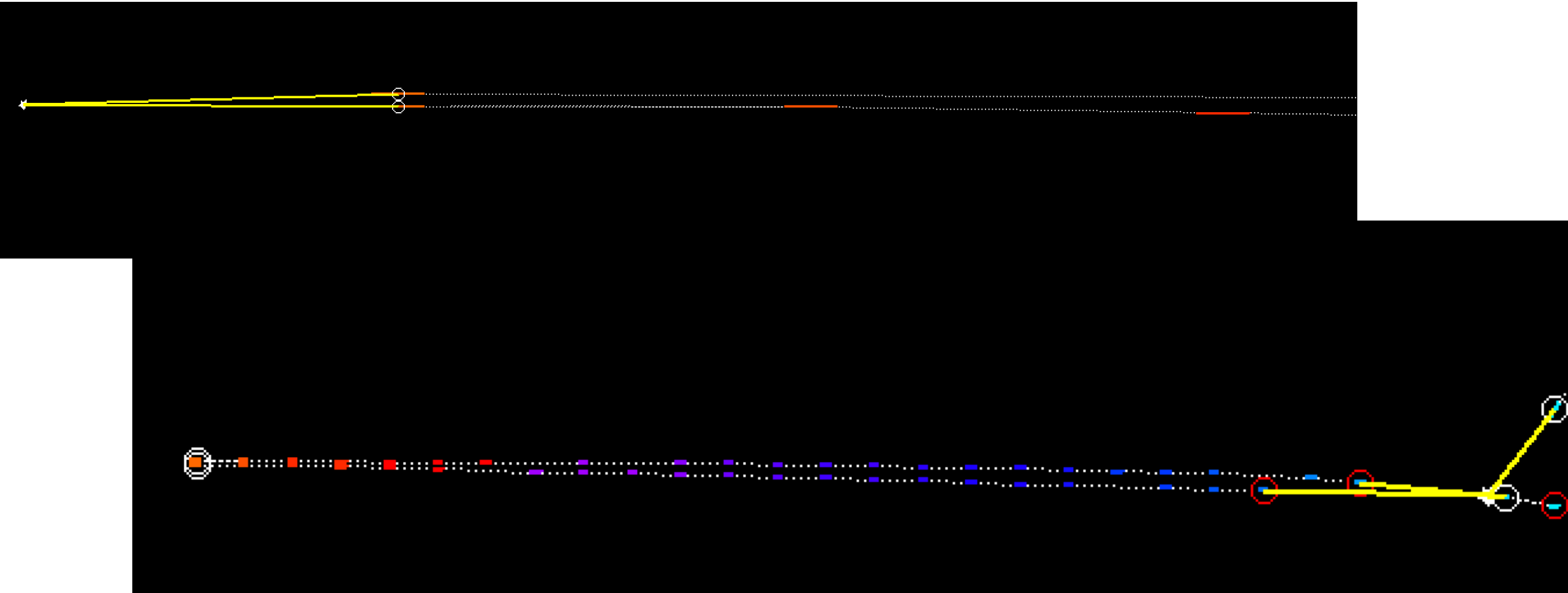
2) 2-prongs fake vertices made of one or two short tracks (n≤3)
3) 3-prongs fake vertices made of a short (n≤3) large angle track attached to an oxygen track which was split into two pieces. Short track discarded and long track becomes a a single track





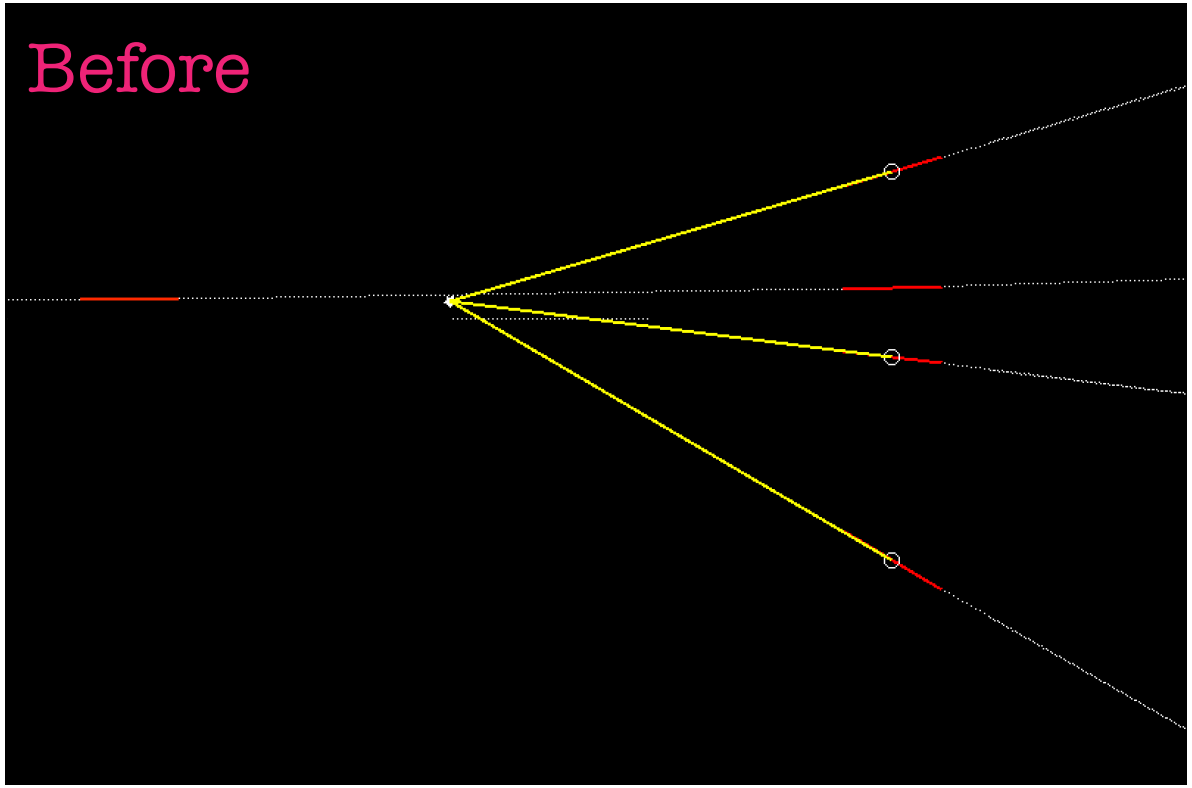
Vertexing improvements

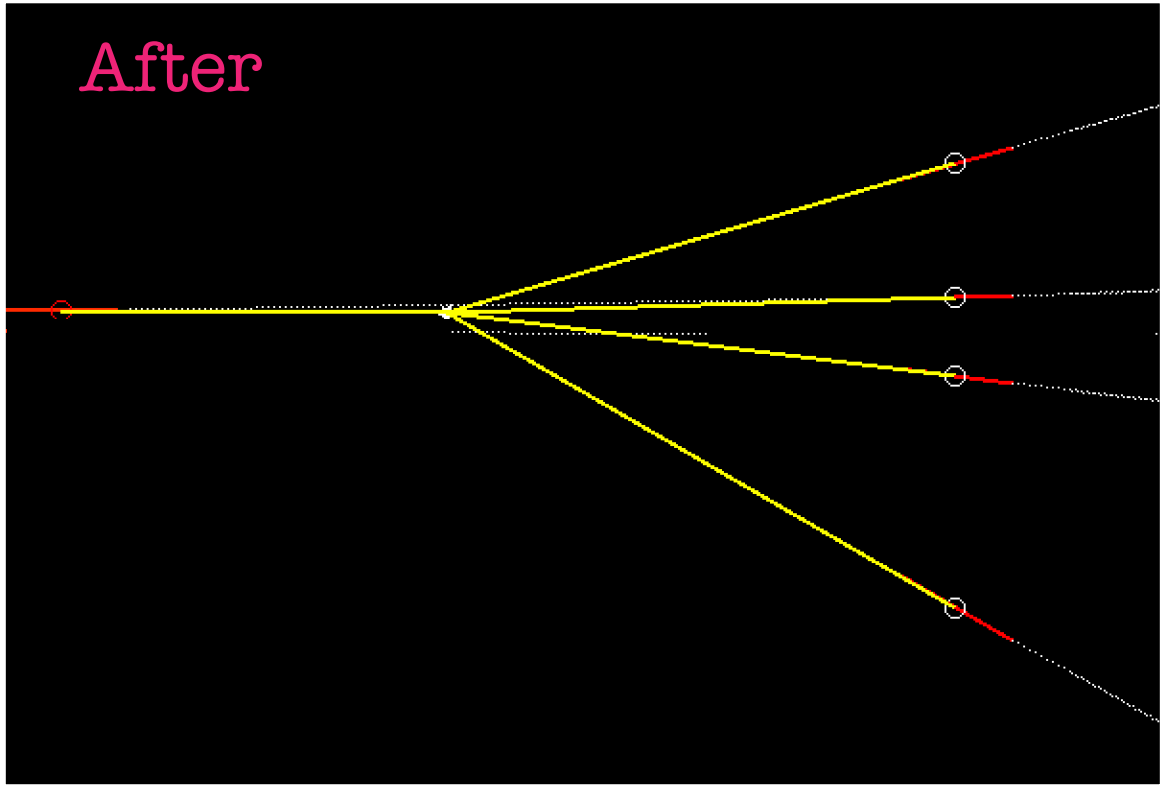
4) Vertices made of two oxygen tracks discarded
5) Two oxygens entering the same vertex: the one with largest impact parameter is removed



Vertexing - improvements

6) Vertices without oxygen track: beam track is reconstructed as penetrating due to very similar angle of a daughter track. The correct topology is restored
7) Search for extra daughters





Vertexing - improvements

8) Oxygen going into nitrogen with the emission of a proton.
Due to very similar angle Oxygen and Nitrogen are reconstructed as one track. Search for protons with small impact parameter to the beam track which go beyond the Bragg Peak.