NUCLEAR EMULSIONS: STATUS OF THE ANALYSIS

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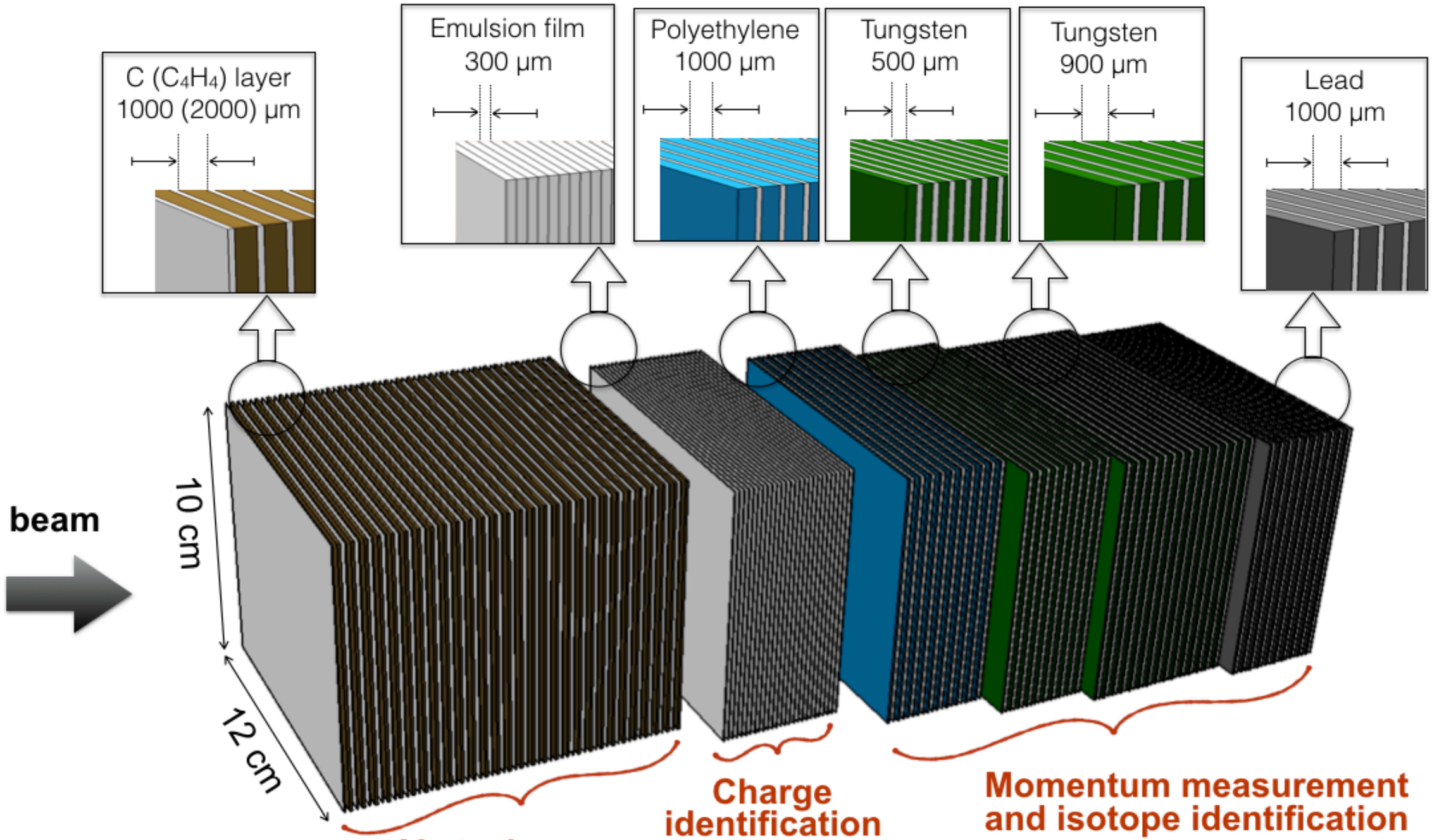
SCANNING STATUS

TARGET \ BEAM	Oxygen 200 MeV/n	Oxygen 400 MeV/n
Carbon	GSI1	GSI3
Polyethylene	GSI2	GSI4

- ➡ 520 emulsions exposed
- ➡ Scanning started on May 7 2019
- ➡ GSI2: completed (120 emulsions)
- ➡ GSI1: completed (120 emulsions)
- ➡ Total: 240/520

- scanning has been interrupted for urgent work in lab for more than one month
- now we have a completely new scanning laboratory
- we resumed the scanning work one week ago

REMINDER OF DETECTOR STRUCTURE



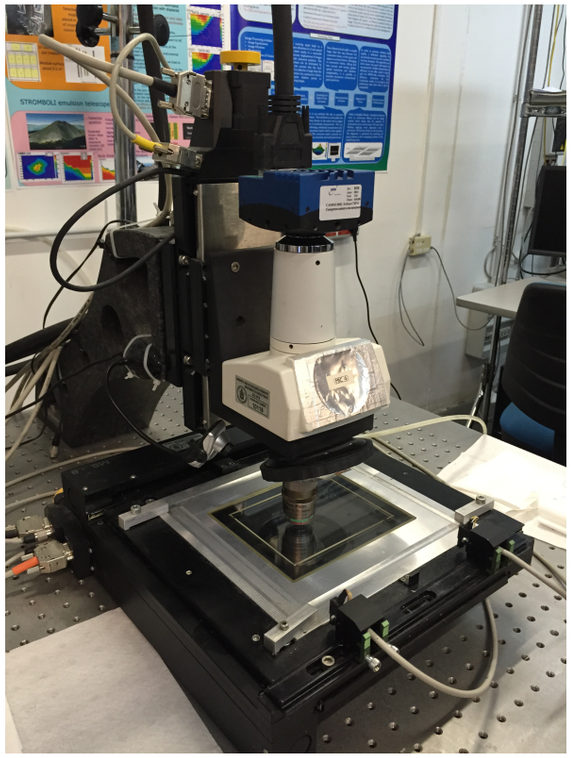
Detector Structure

	Oxygen 200 MeV/n
S1	C2H4 (30x2mm) + 30 emu
S2	Emu (36)
S3	Lexan (10x1mm)+10emu
S4	W (7x0.5mm)+7emu
S5	W (7x0.9mm)+7emu
S6	Pb (20x1mm)+20emu
S7	Pb (9x2mm)+10emu

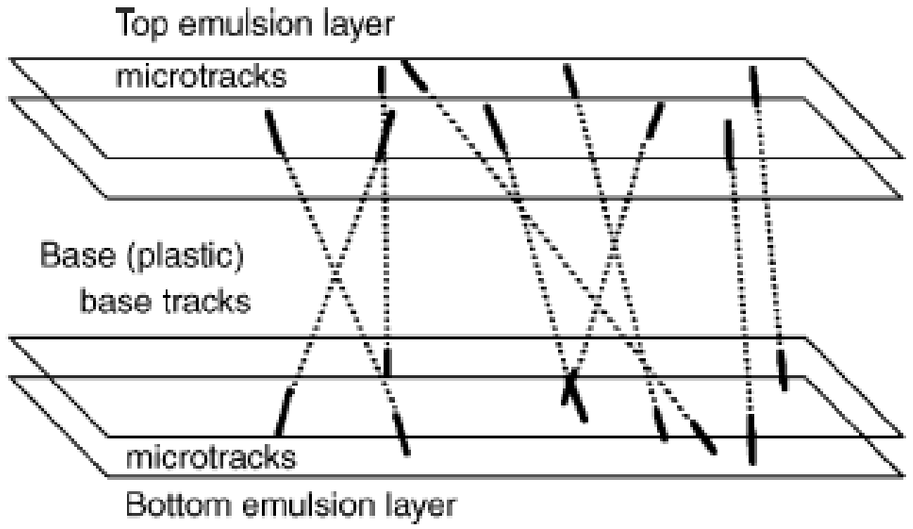
4

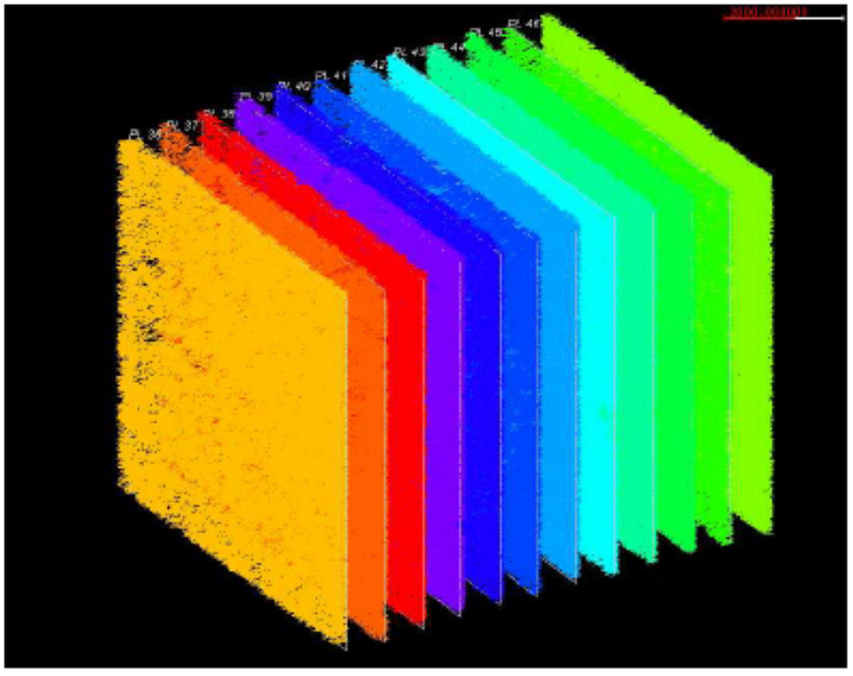
From Scanning to Reconstruction

1. Scanning

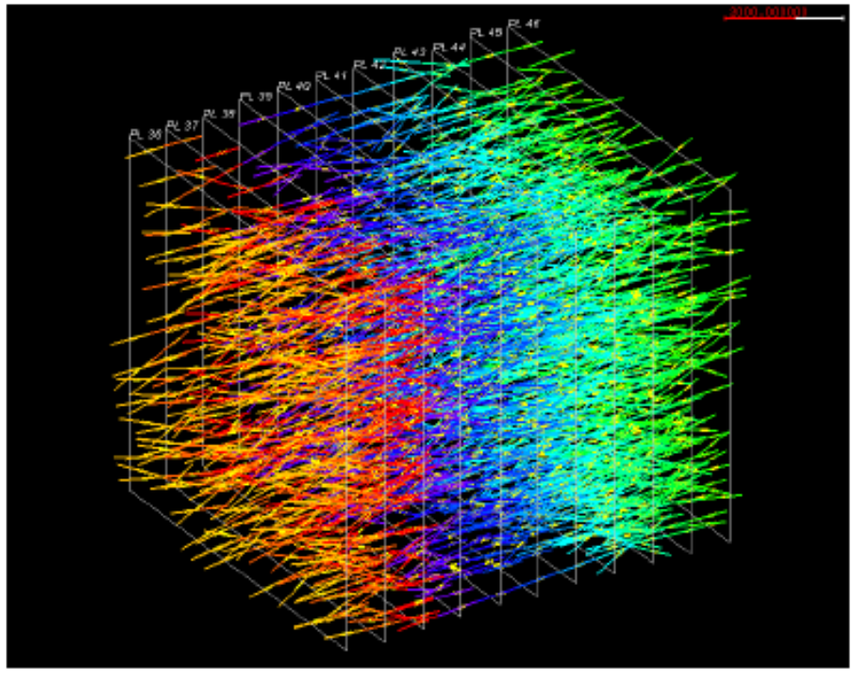


2. Linking Microtracks into Basetracks

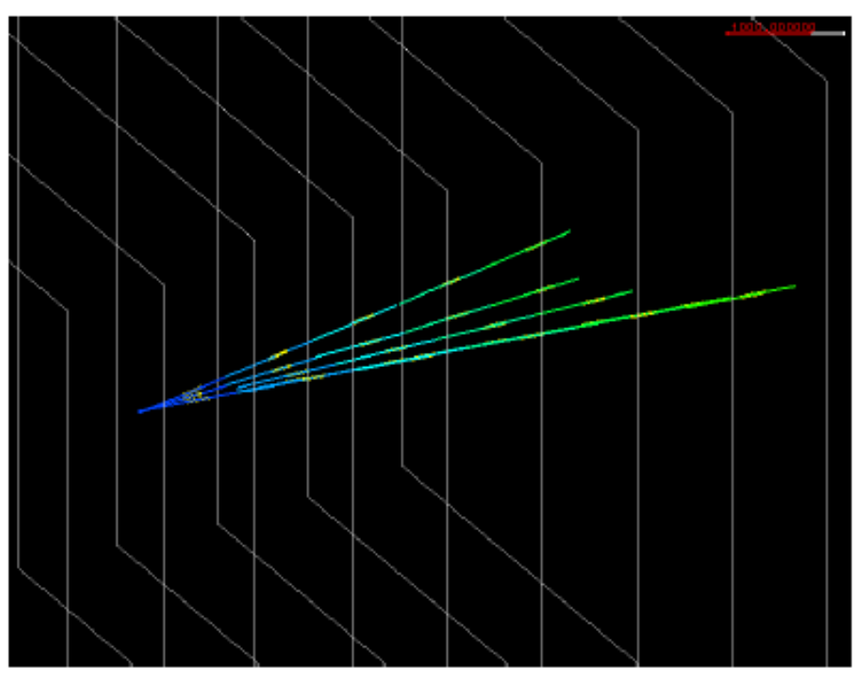




3. Alignment Between Plates



4. Tracking Reconstruction



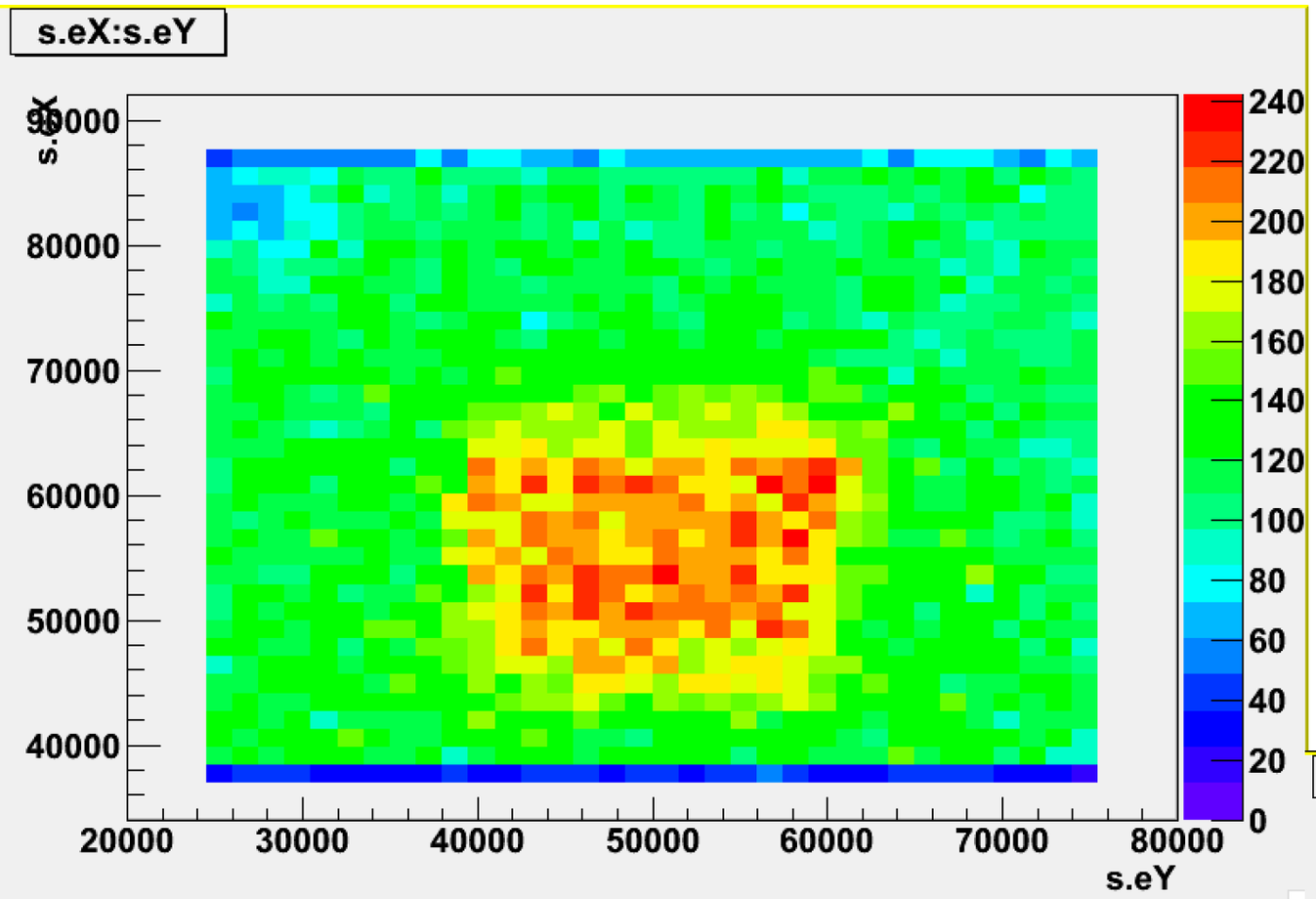
5. Vertexing Reconstruction

GSI2 Analysis Status

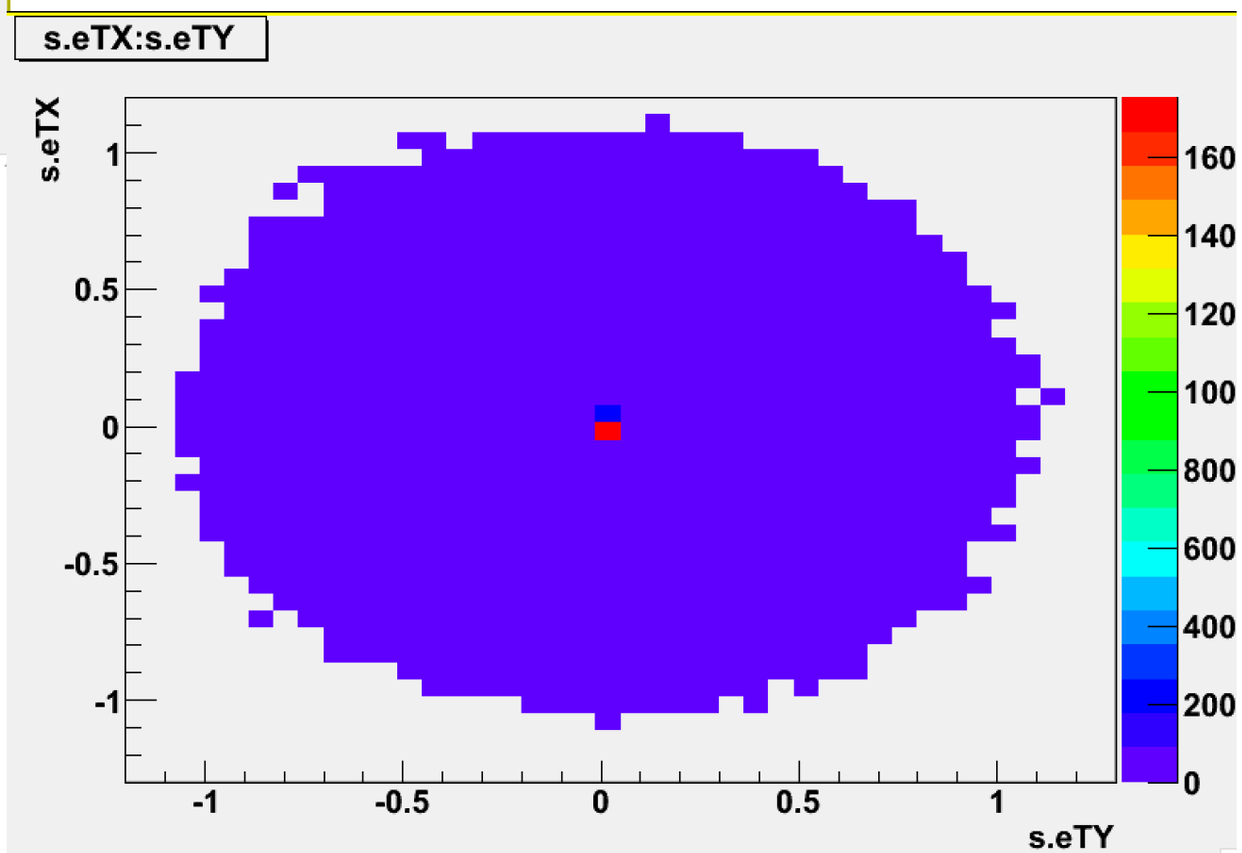
	Scanning	Linking	Alignment	Tracking	Vertexing
S1	✔	✔	✔	✔	✔
S2	✔	✔	✔	✔	/
S3	✔	✔	✔	✔	/
S4	✔	✔	✔	to be done	/
S5	✔	✔	✔	to be done	/
S6	✔	✔	✔	to be done	/
S7	✔	✔	✔	to be done	/

6

OXYGENS ON EMULSION #1

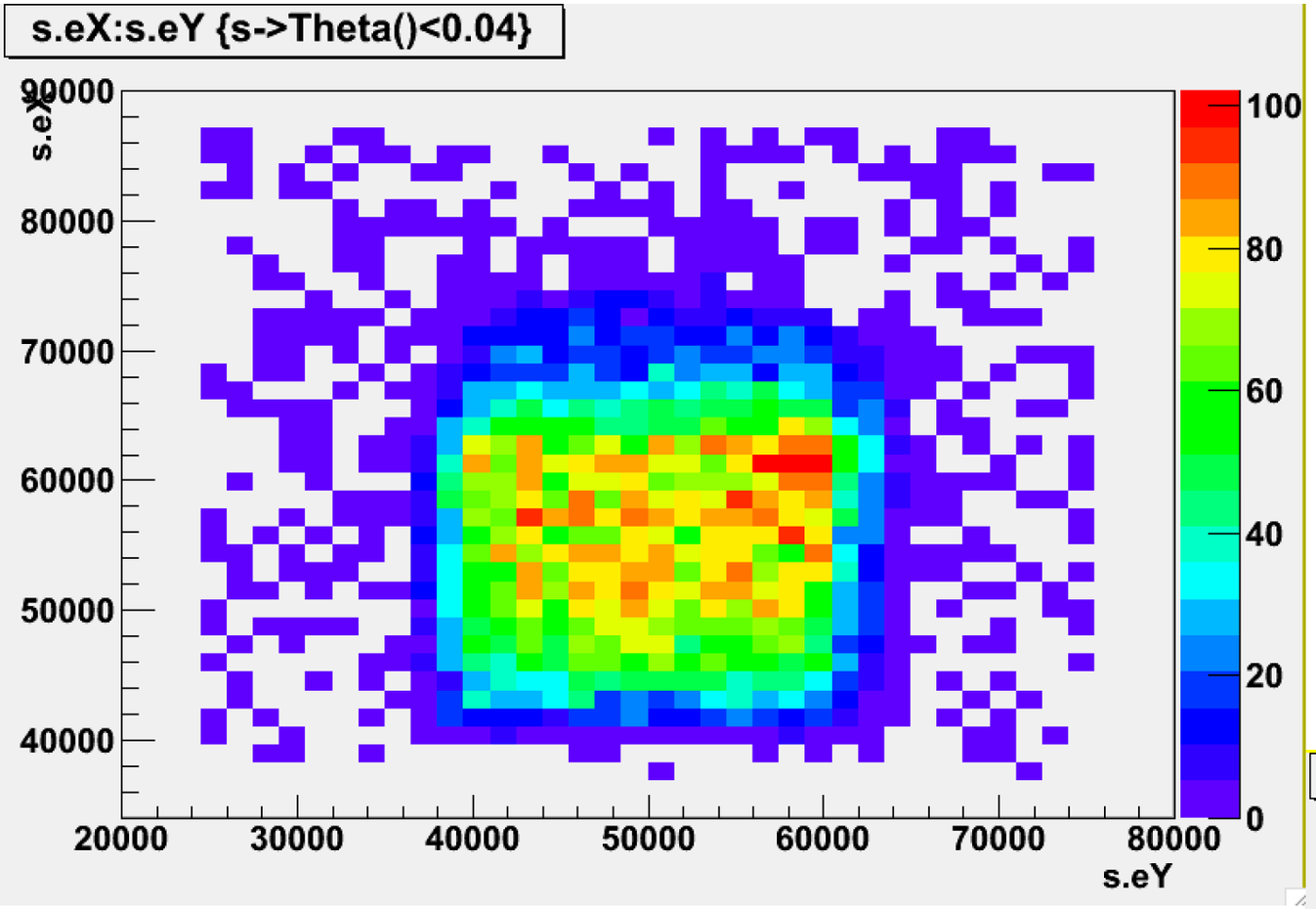


ALL BASETRACKS
(NO CUTS)

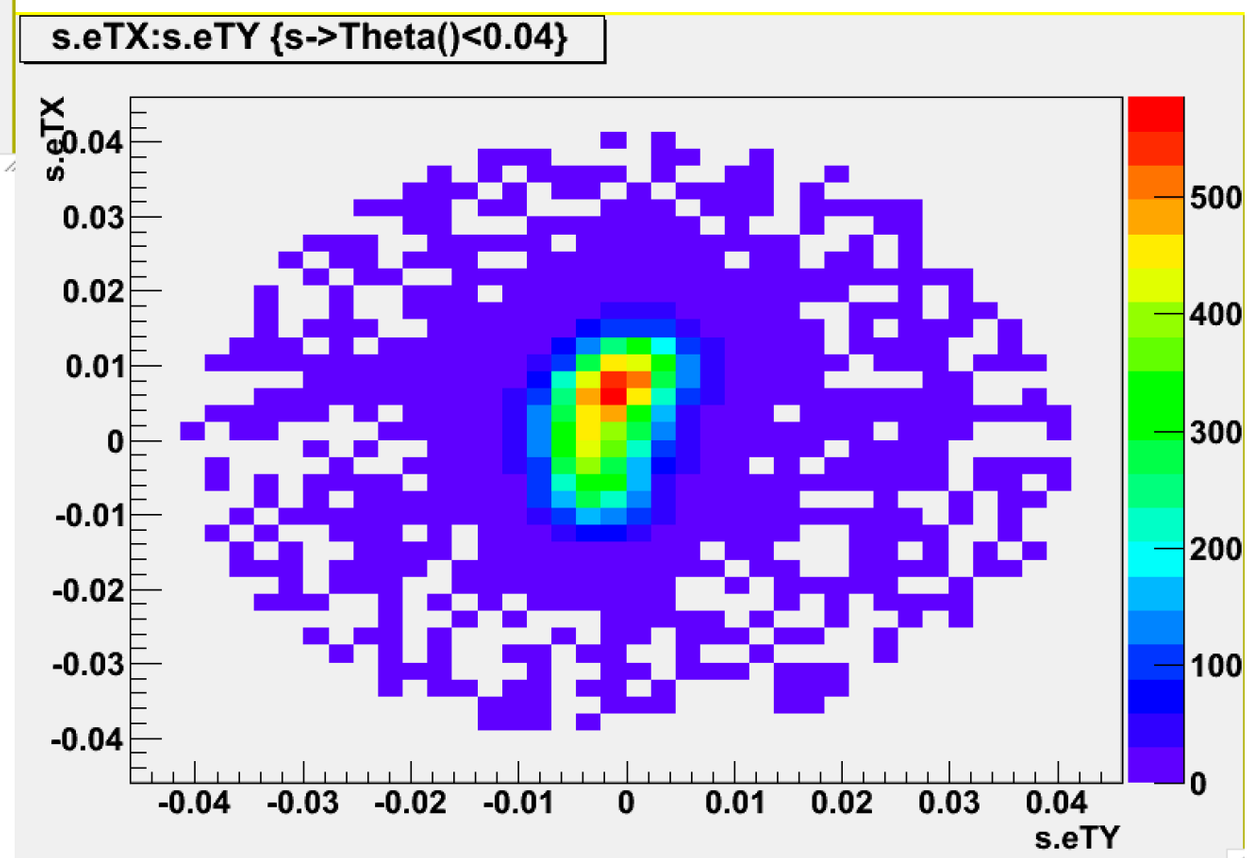


Oxygens on Emulsion #1

Theta<0.04



Oxy Beam: 19375
Counting: 19397!!



MONTECARLO SIMULATION

- Beam: 10k Oxygen @200 MeV/n, Rectangular Shape 3x3, Isotropic distribution

- Same detector structure (but **no thermal treatment** simulated in S2)

- No cosmic rays or background were simulated

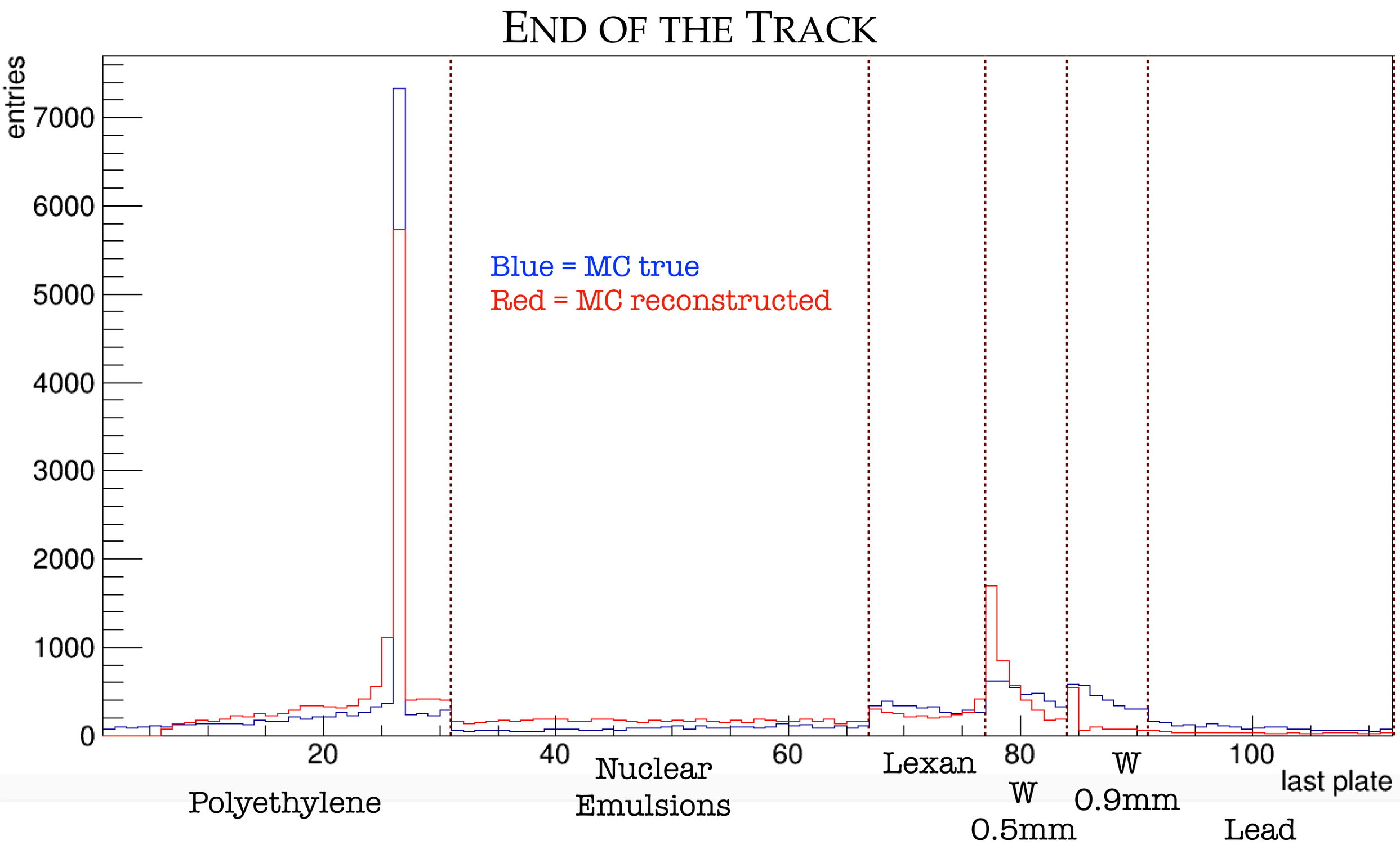
- Montecarlo Simulation was converted into the raw data files format and underwent the tracking reconstruction with official software used in OPERA (FEDRA)

- **Flat** efficiency was set at 90% efficiency as a temporary value (see later)

- 4 mrad smearing was applied on angles (data driven)

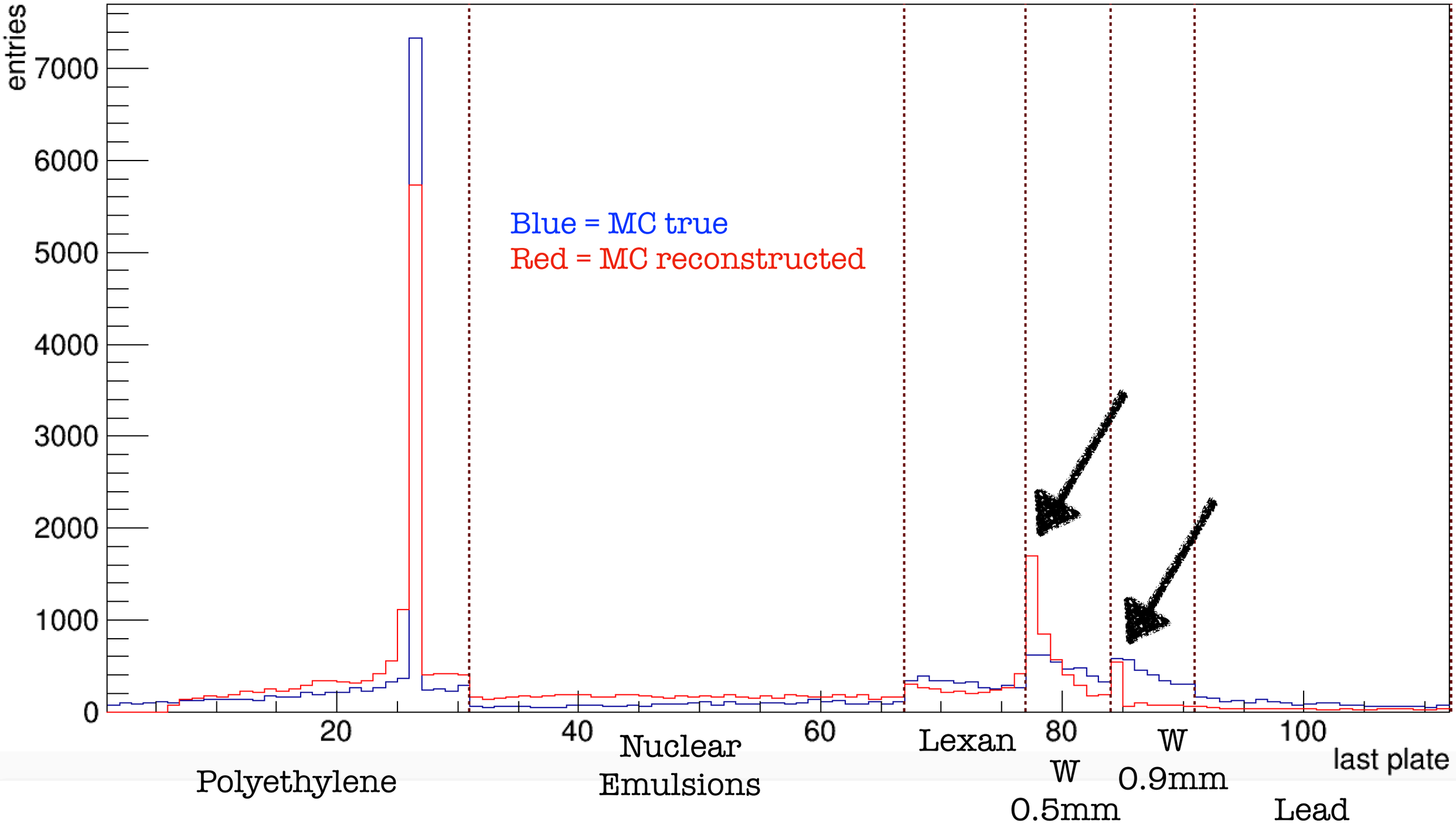
- No misalignment was simulated

TRACKING VALIDATION WITH MONTECARLO

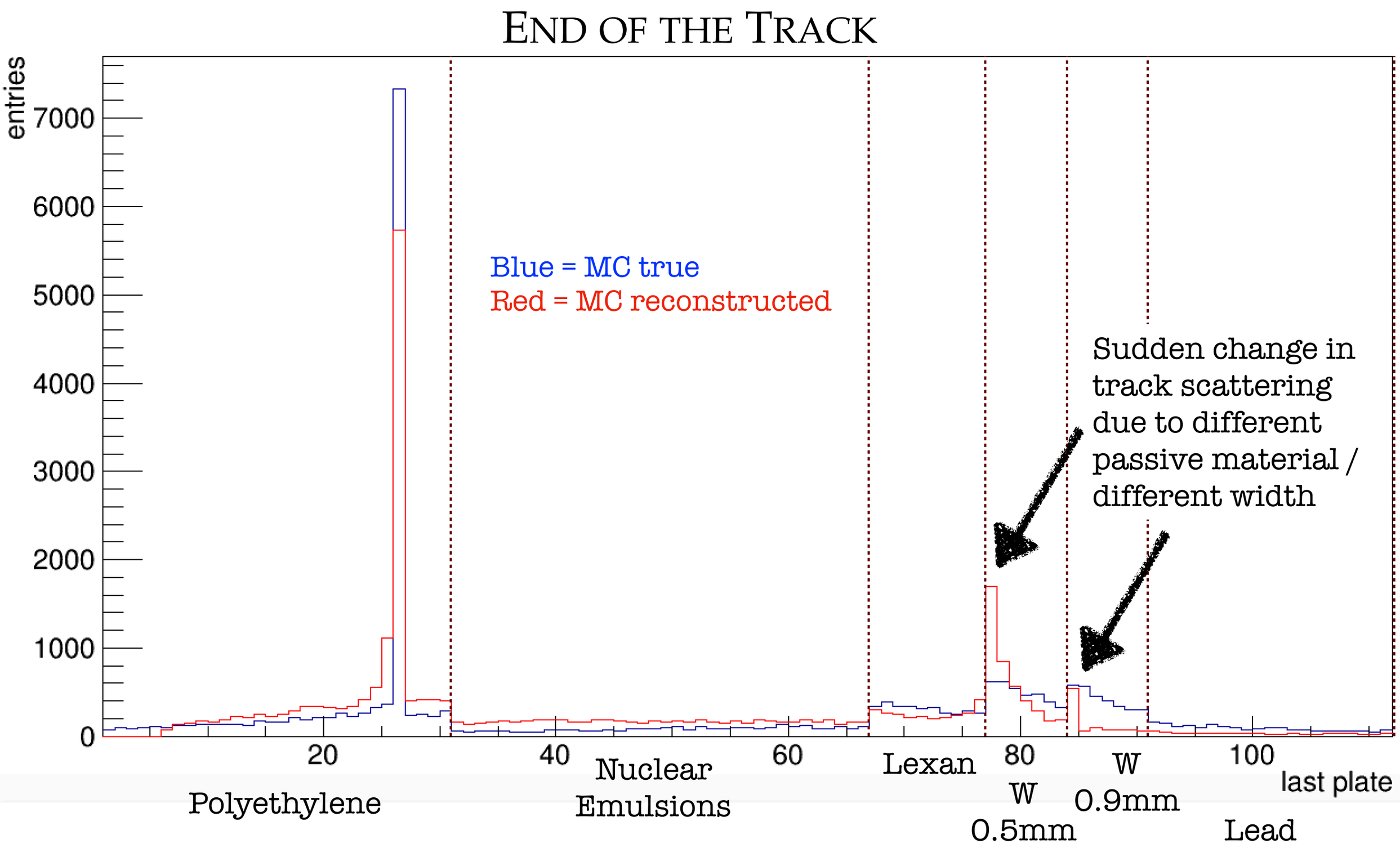


TRACKING VALIDATION WITH MONTECARLO

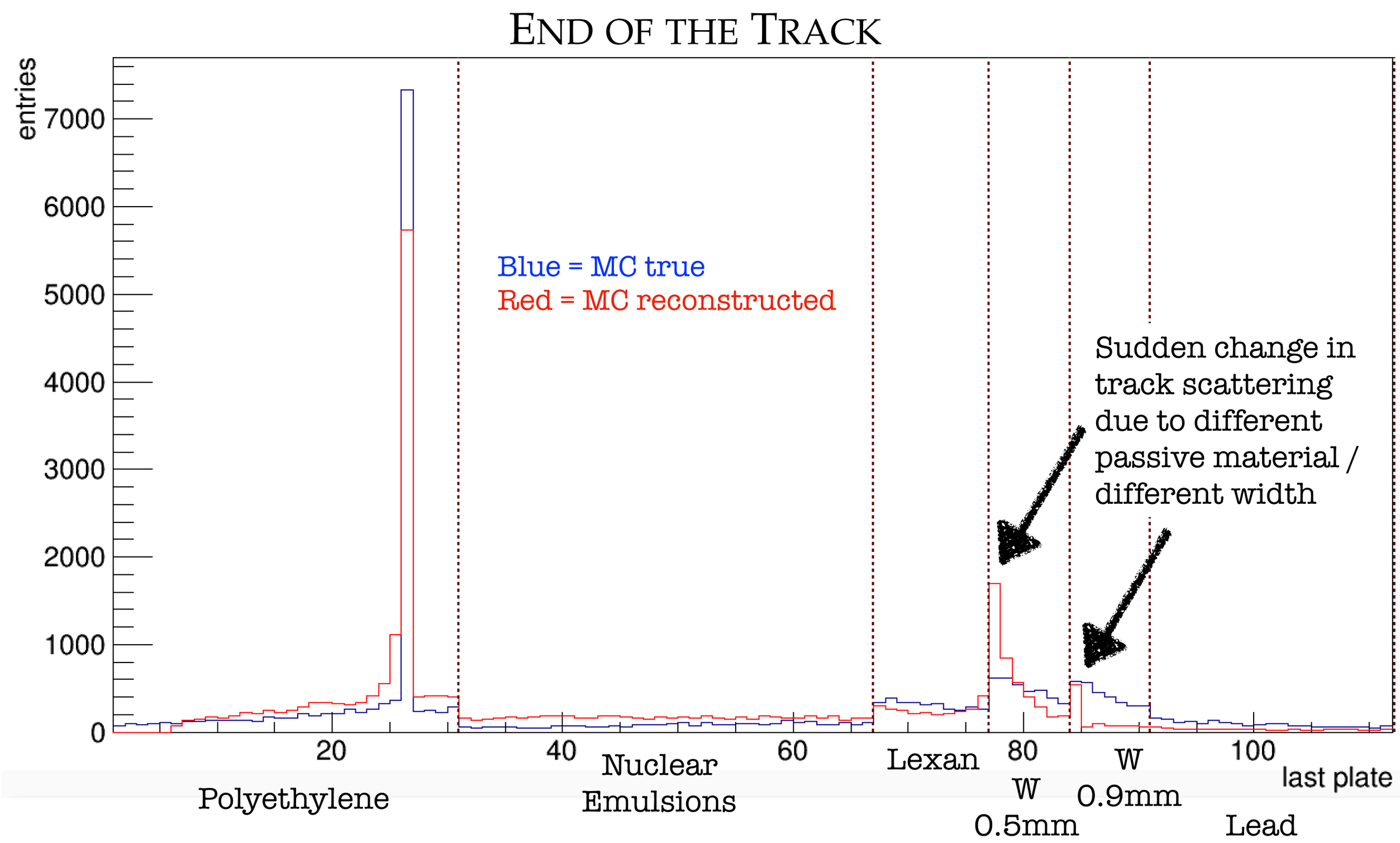
END OF THE TRACK



TRACKING VALIDATION WITH MONTECARLO

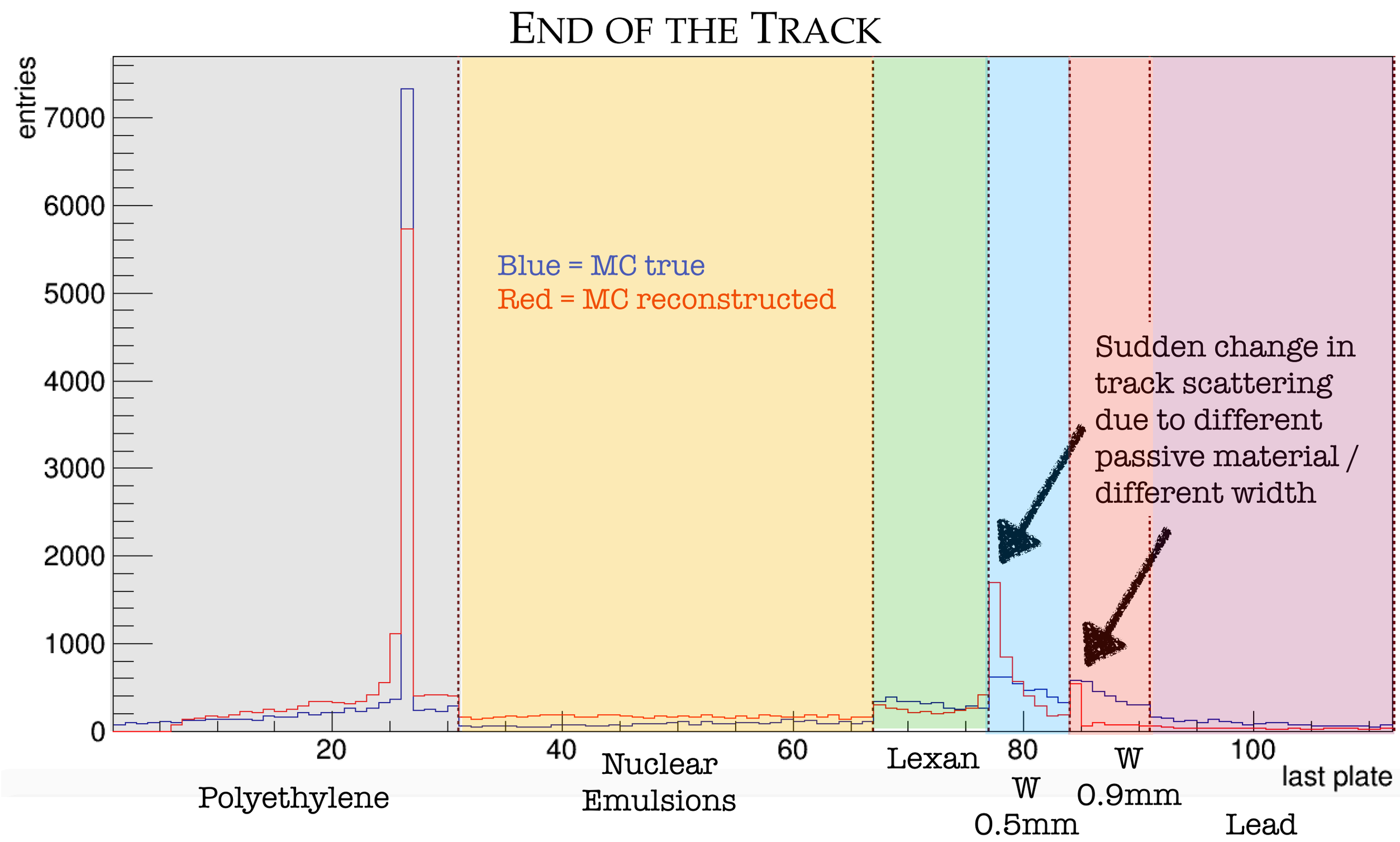


Tracking Validation with Montecarlo



- A dedicated tracking should be done for each section
- Necessity to implement an algorithm to merge the tracks from different tracking

Tracking Validation with Montecarlo



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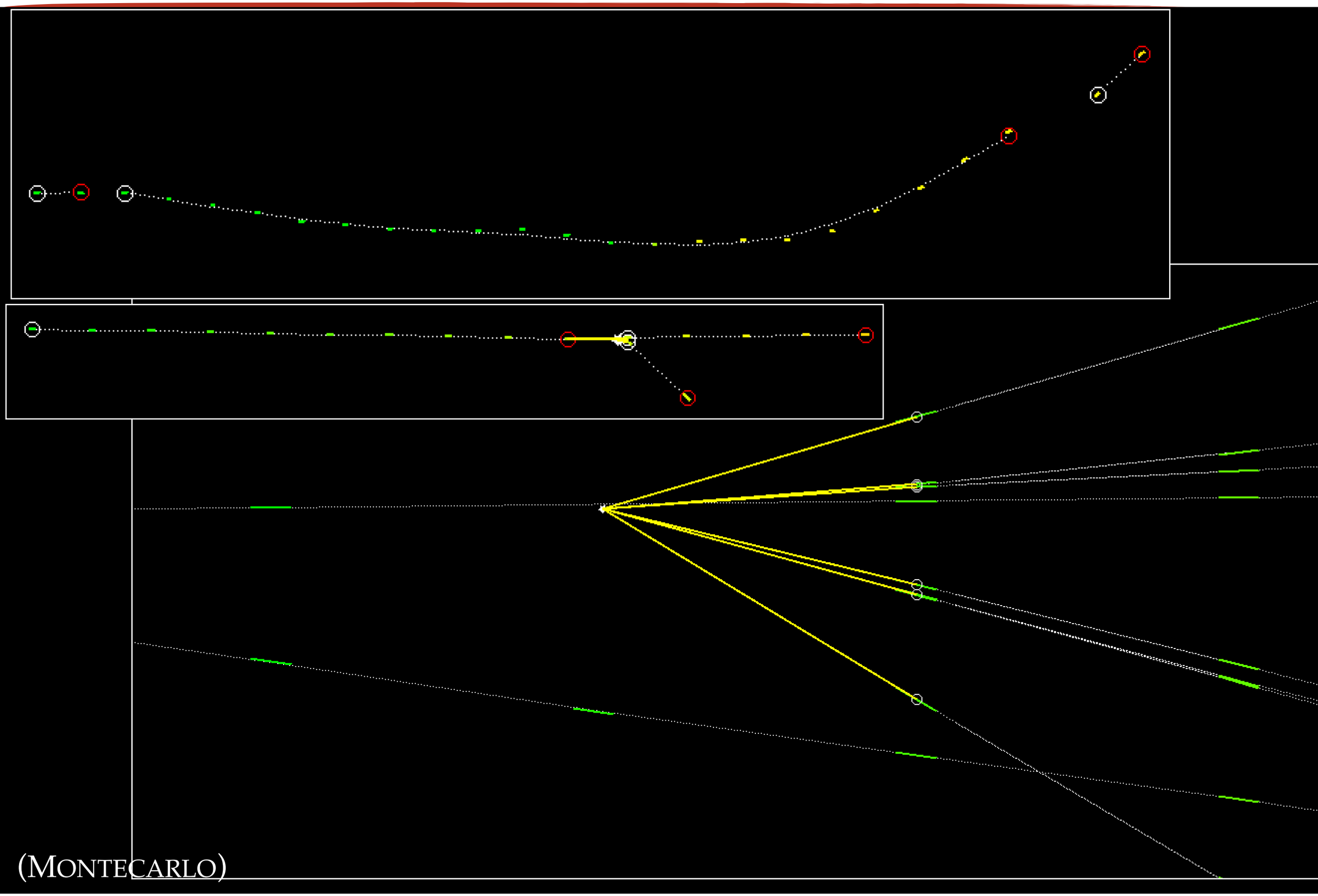
Examples of Tracking Issues



(MonteCarlo)

Efficiency Plate by Plate (All Tracks)

Plate Id	Nseg	Nseg expected	Eff_plate all tracks	Eff_plate OXY
1	6426	6426	100.00%	100.00%
2	6357	7469	85.11%	85.23%
3	12798	13526	94.62%	94.44%
4	13409	14878	90.13%	90.00%
5	14337	15609	91.85%	91.72%
6	14132	16105	87.75%	87.72%
7	13067	16487	79.26%	78.39%
8	15048	16625	90.51%	90.45%
9	15194	17017	89.29%	89.18%
10	15719	17245	91.15%	91.24%
11	15570	17355	89.71%	89.42%
12	15583	17342	89.86%	89.66%
13	14492	17068	84.91%	84.98%
14	14811	16831	88.00%	87.64%
15	13348	16651	80.16%	77.90%

Plate Id	Nseg	Nseg expected	Eff_plate all tracks	Eff_plate OXY
16	14741	16711	88.21%	87.80%
17	12406	16016	77.46%	75.82%
18	13589	16185	83.96%	81.85%
19	14569	16956	85.92%	85.20%
20	14129	16797	84.12%	83.37%
21	10631	15761	67.45%	59.35%
22	12550	15155	82.81%	80.26%
23	10681	12833	83.23%	80.26%
24	9037	10230	88.34%	88.53%
25	7311	8038	90.96%	90.68%
26	6886	7279	94.60%	96.16%
27	5525	6393	86.42%	78.18%
28	5880	6362	92.42%	93.85%
29	5839	6262	93.24%	93.26%
30	5686	6208	91.59%	92.34%

$$\mathrm{Eff}_{plate} = \frac{\text{Number of basetracks found}}{\text{Number of passing tracks}}$$

Efficiency can be further improved
Optimization still on-going

12

Efficiency Plate by Plate (All Tracks)

Plate Id	Nseg	Nseg expected	Eff_plate all tracks	Eff_plate OXY
1	6426	6426	100.00%	100.00%
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$$\mathrm{Eff}_{plate} = \frac{\text{Number of basetracks found}}{\text{Number of passing tracks}}$$

Efficiency can be further improved
Optimization still on-going

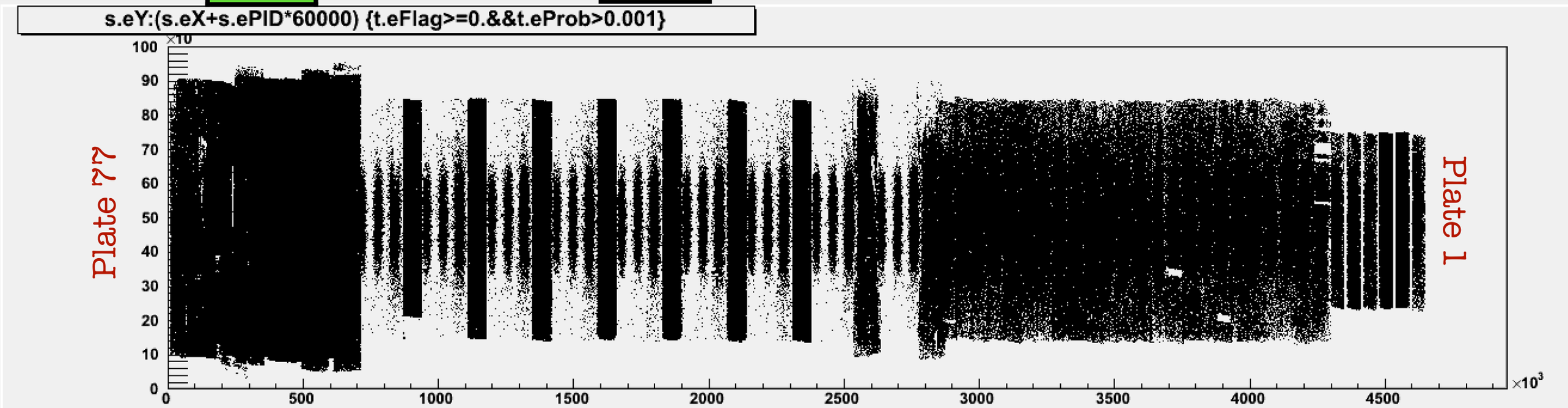
12

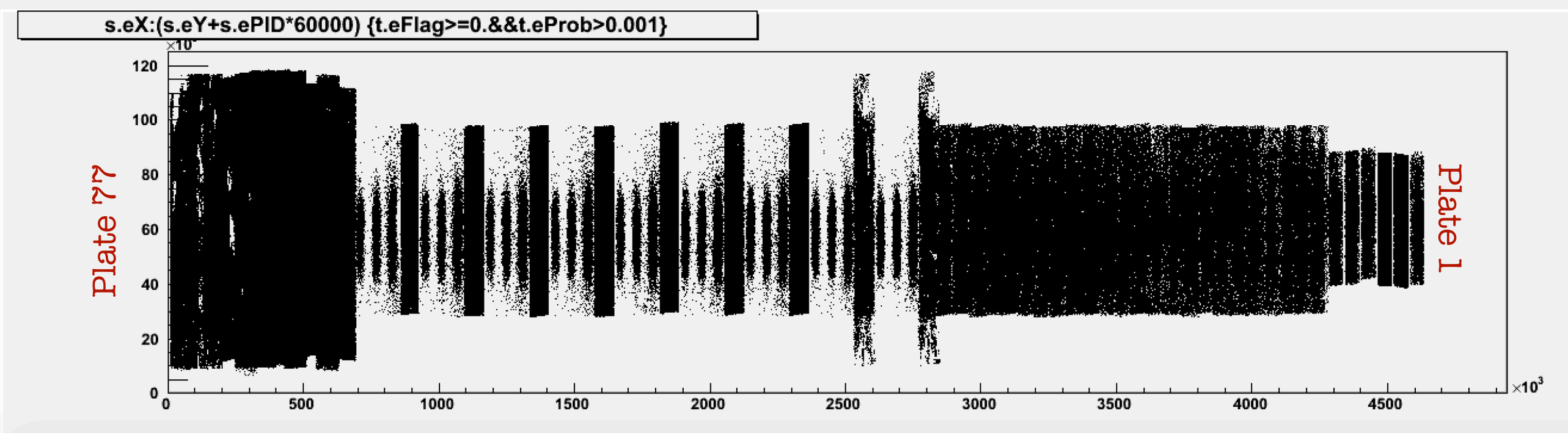
TRACKS' SEGMENTS IN EACH LAYER

S3

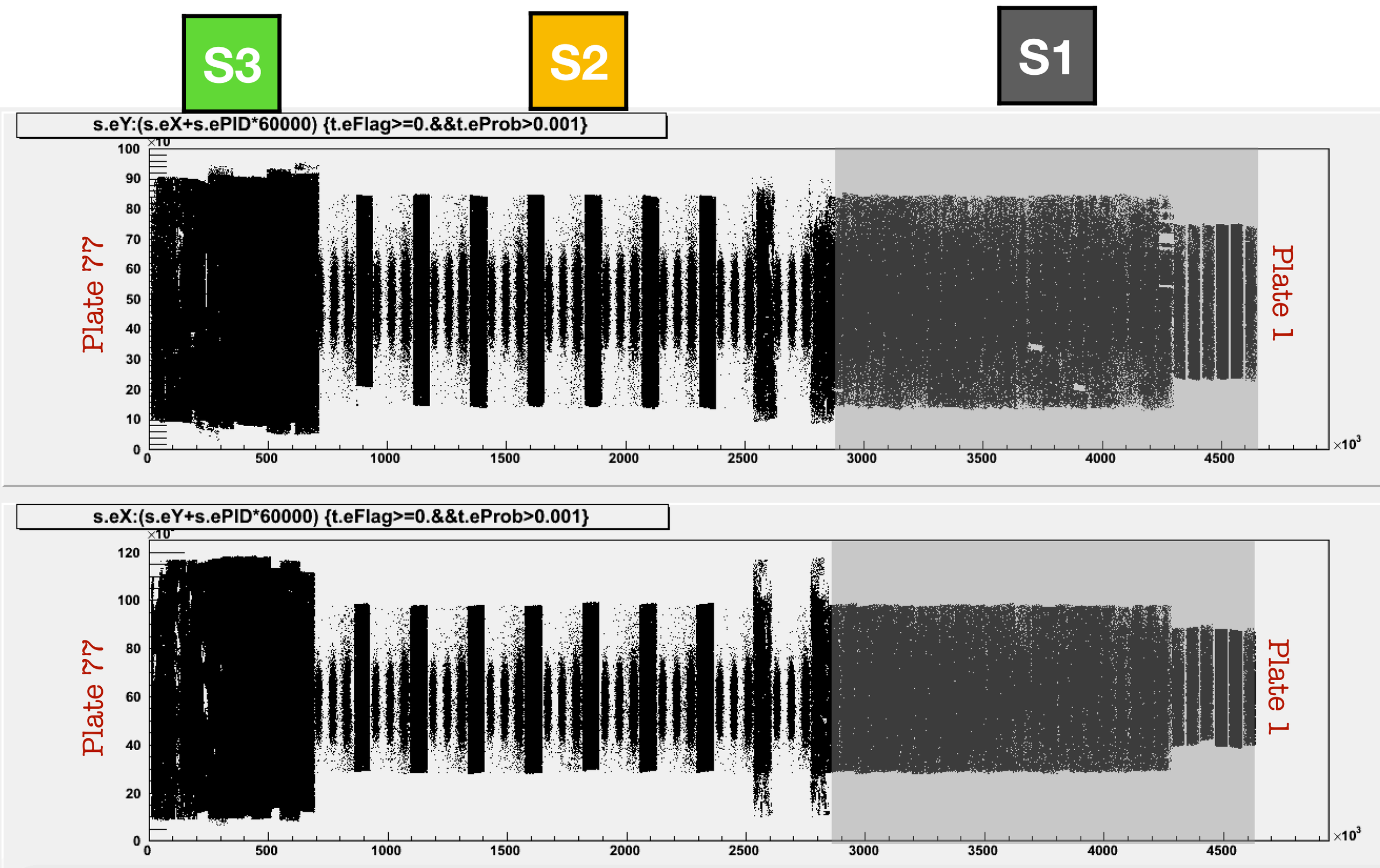
S2

S1





TRACKS' SEGMENTS IN EACH LAYER

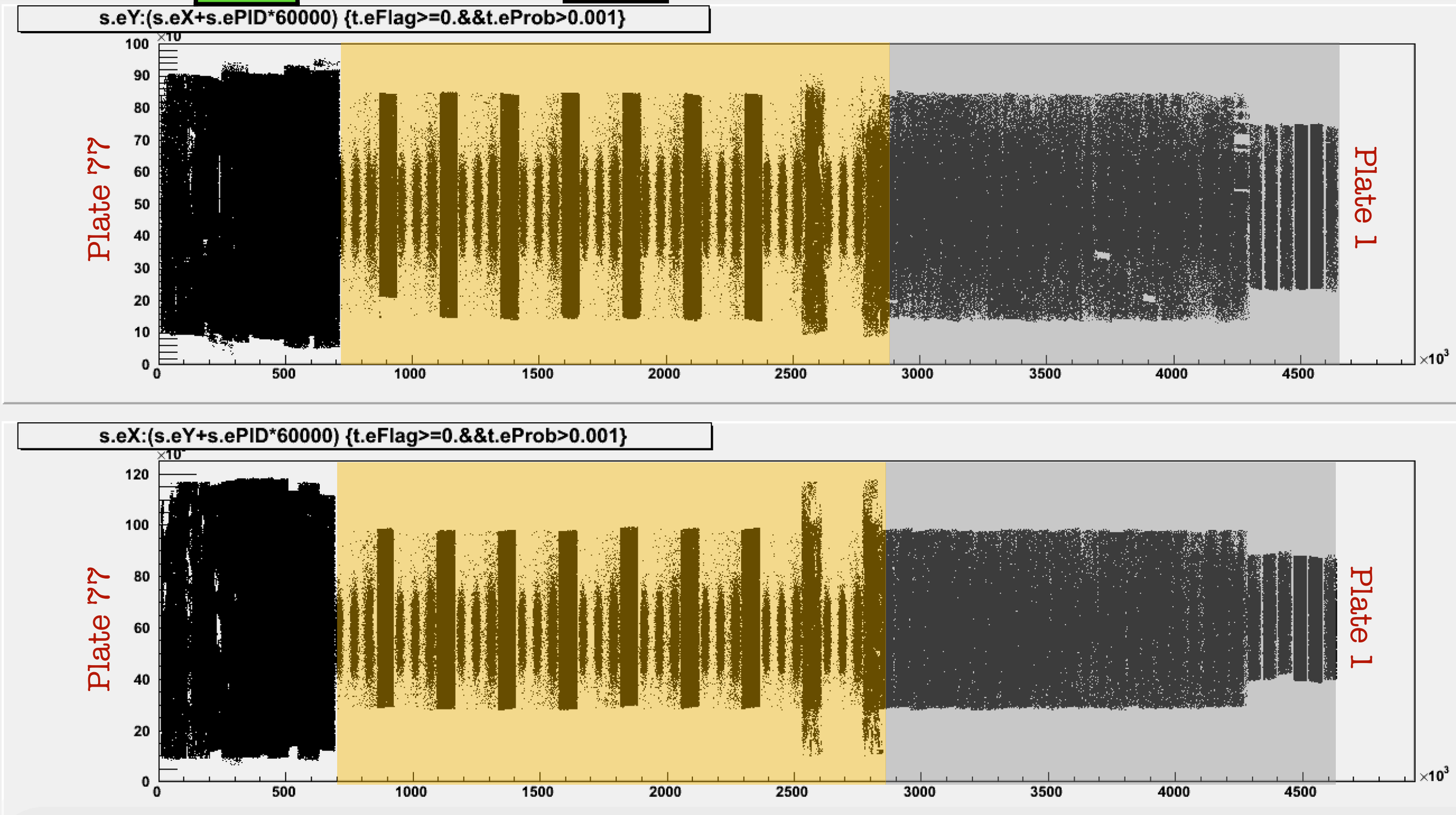


TRACKS' SEGMENTS IN EACH LAYER

S3

S2

S1

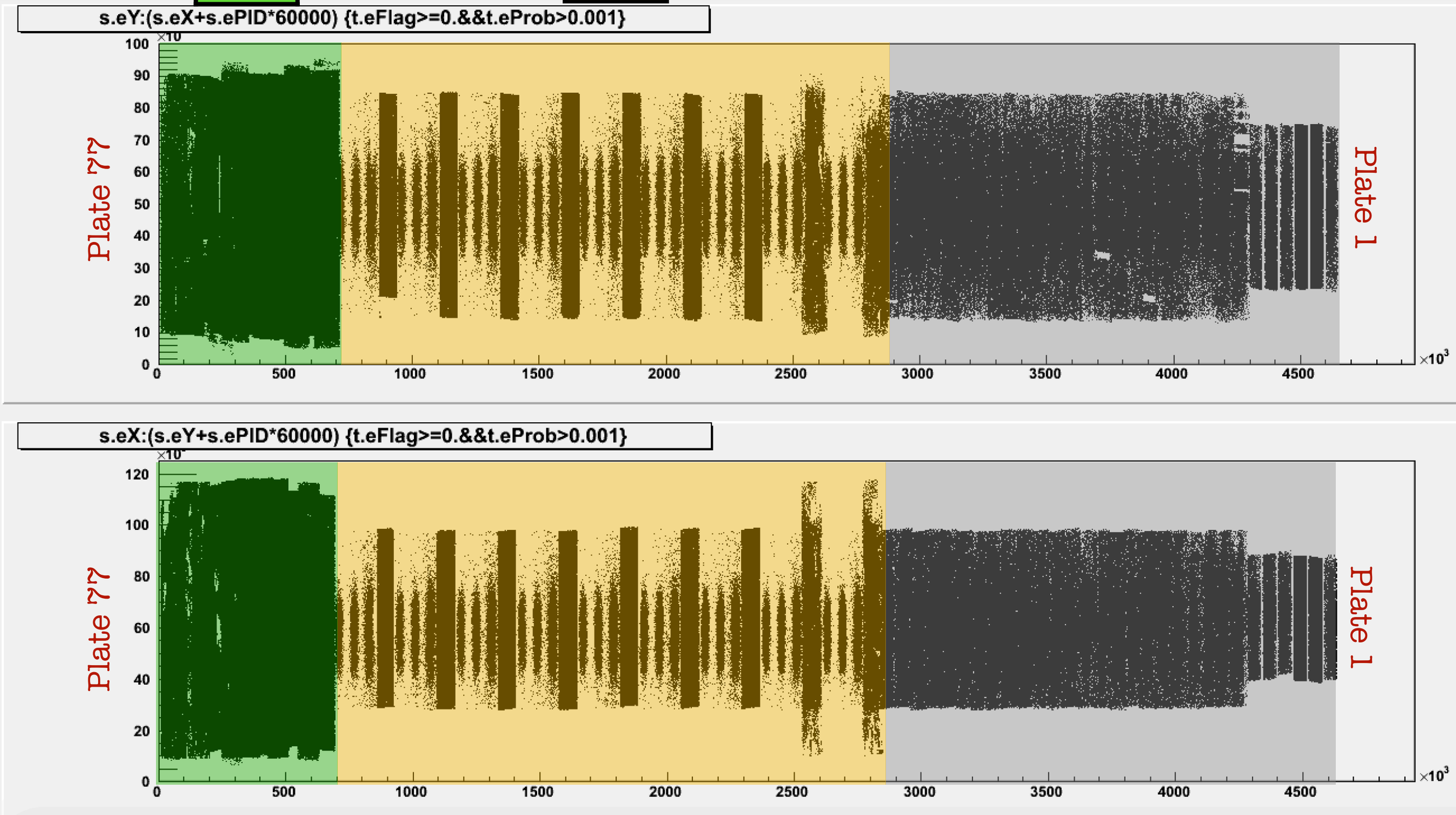


TRACKS' SEGMENTS IN EACH LAYER

S3

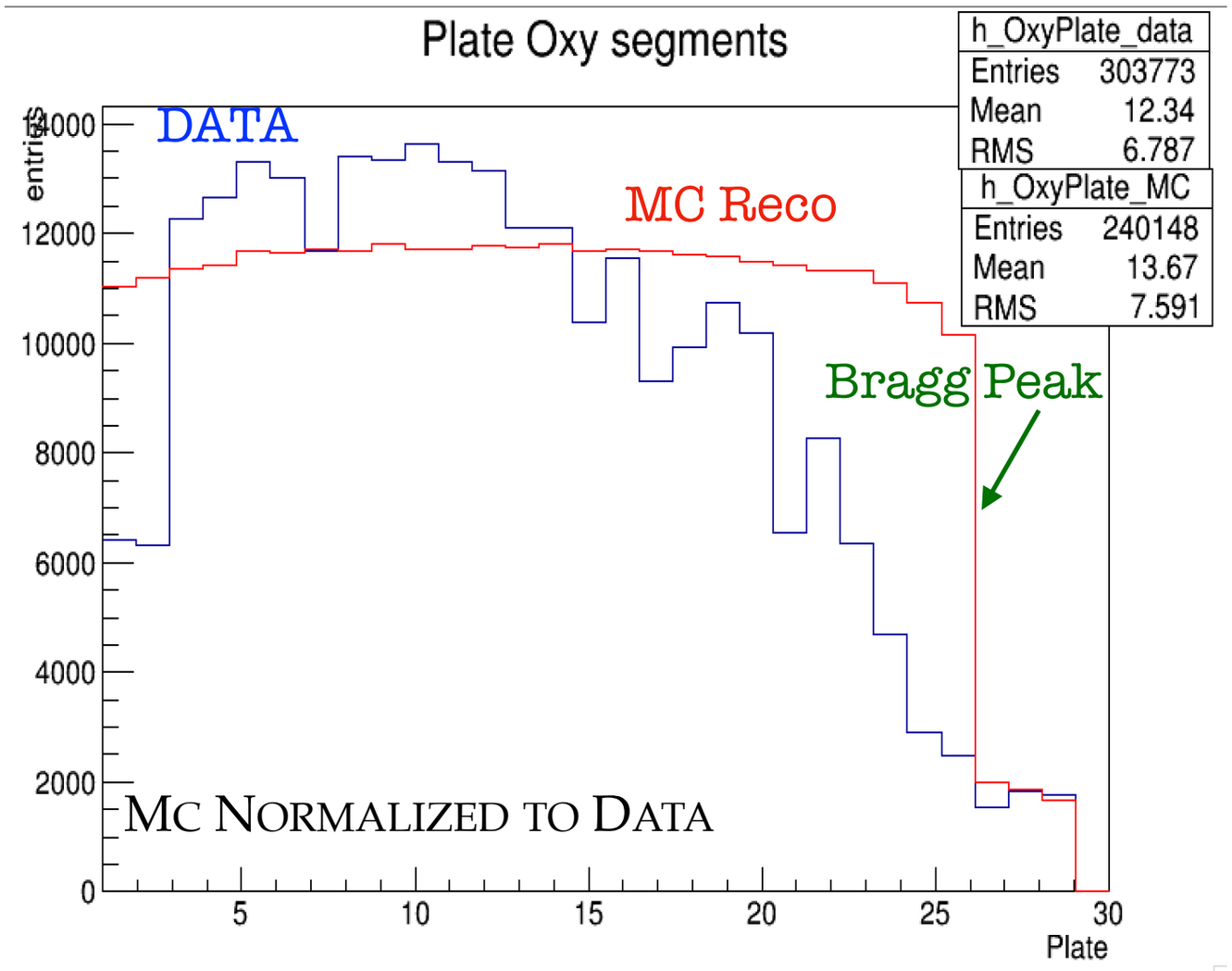
S2

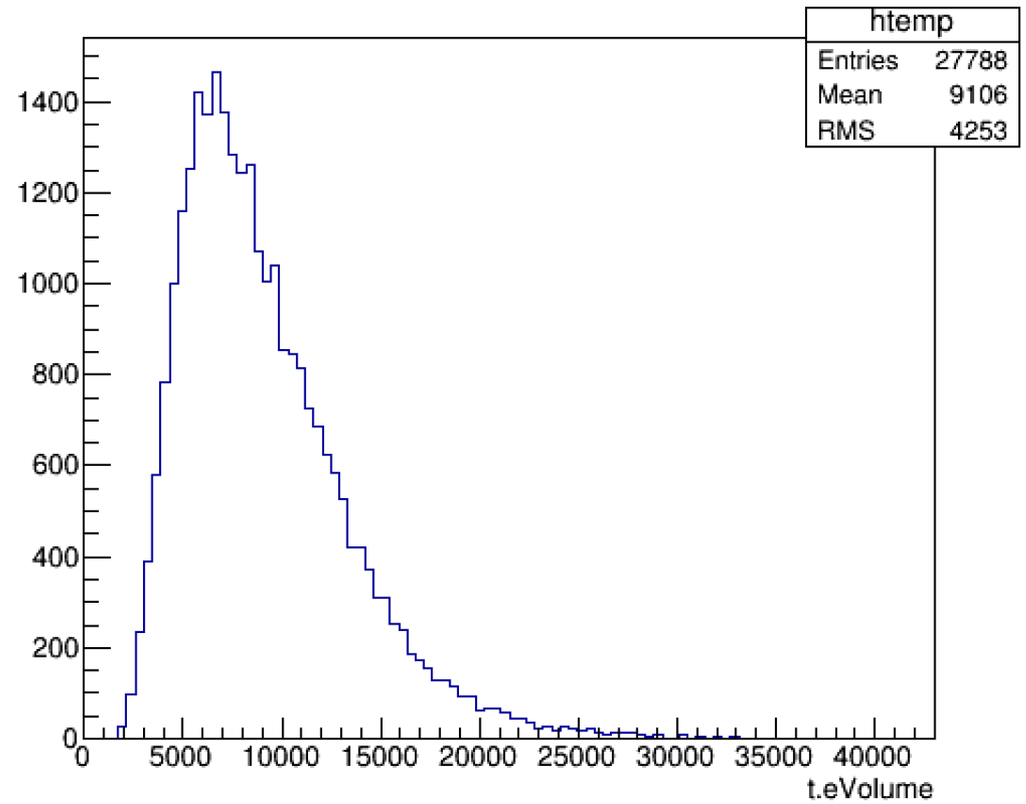
S1

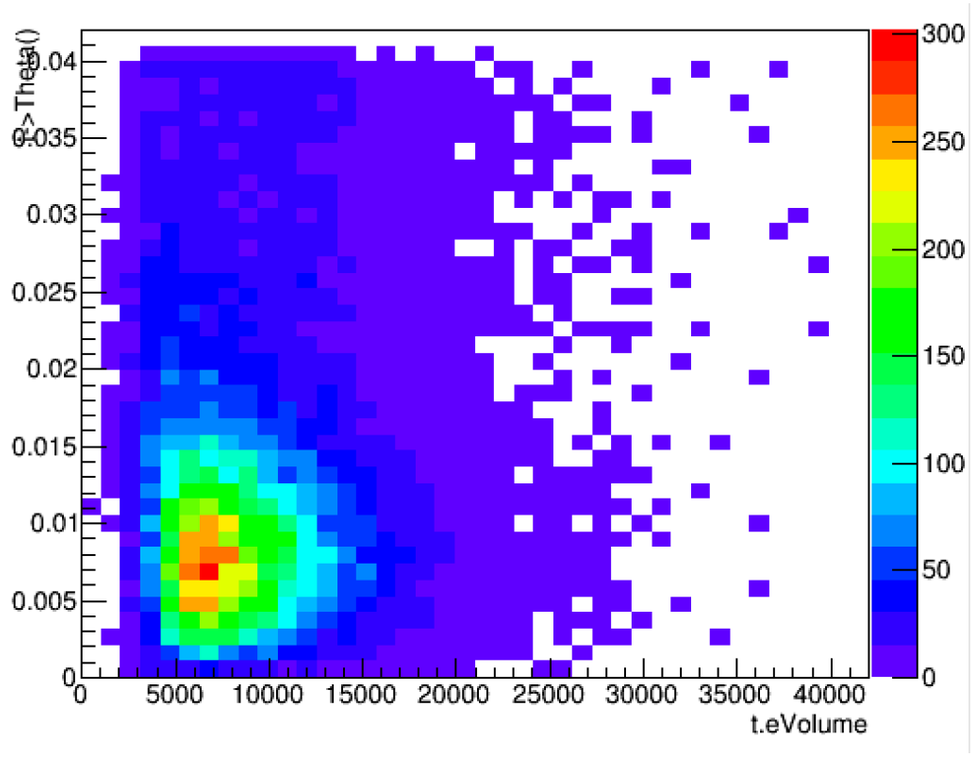


OXYGEN SEGMENTS PLATE BY PLATE

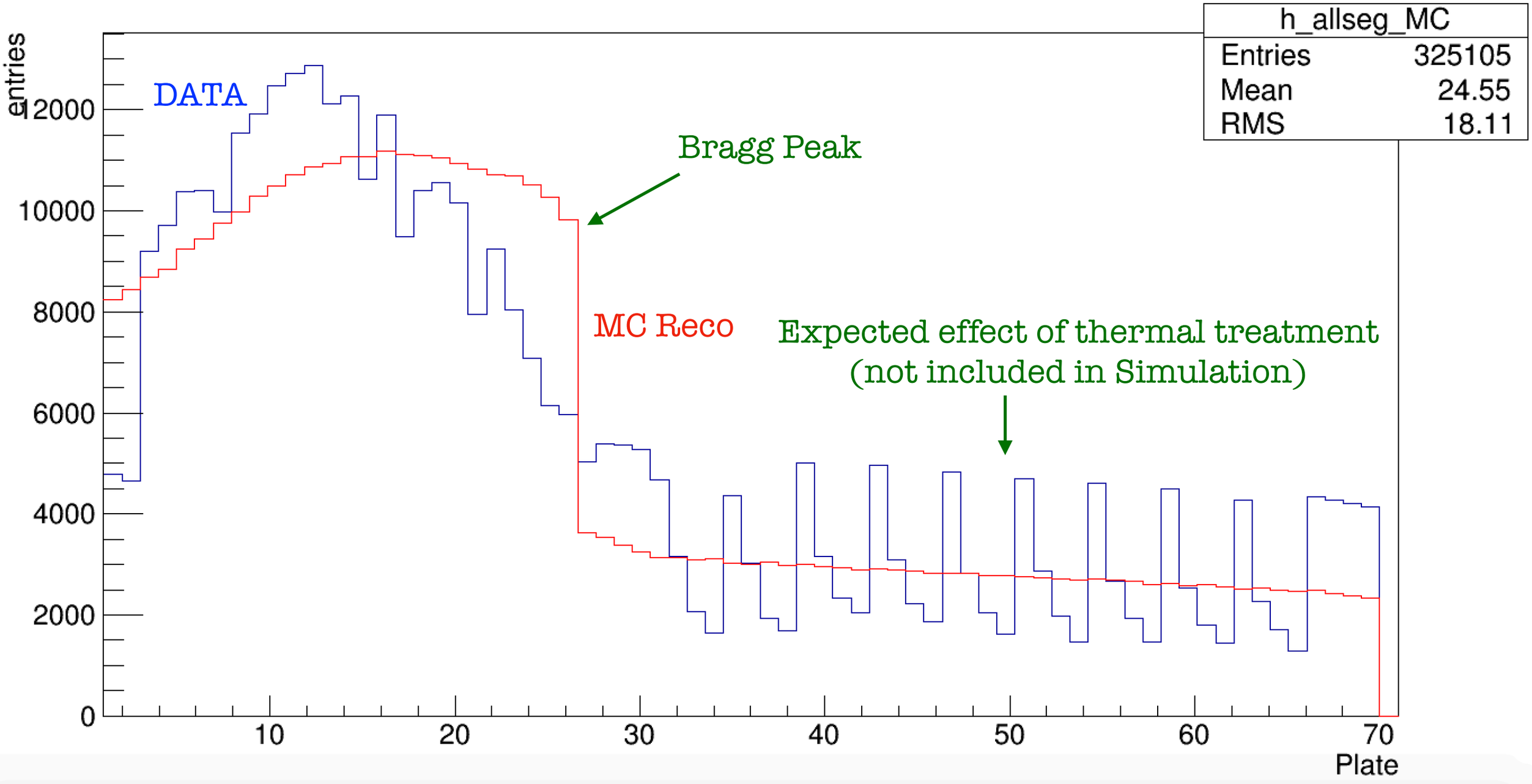
SEGMENT WITH THETA<0.04 BELONGING TO TRACKS WITH AT LEAST 4 SEGMENTS





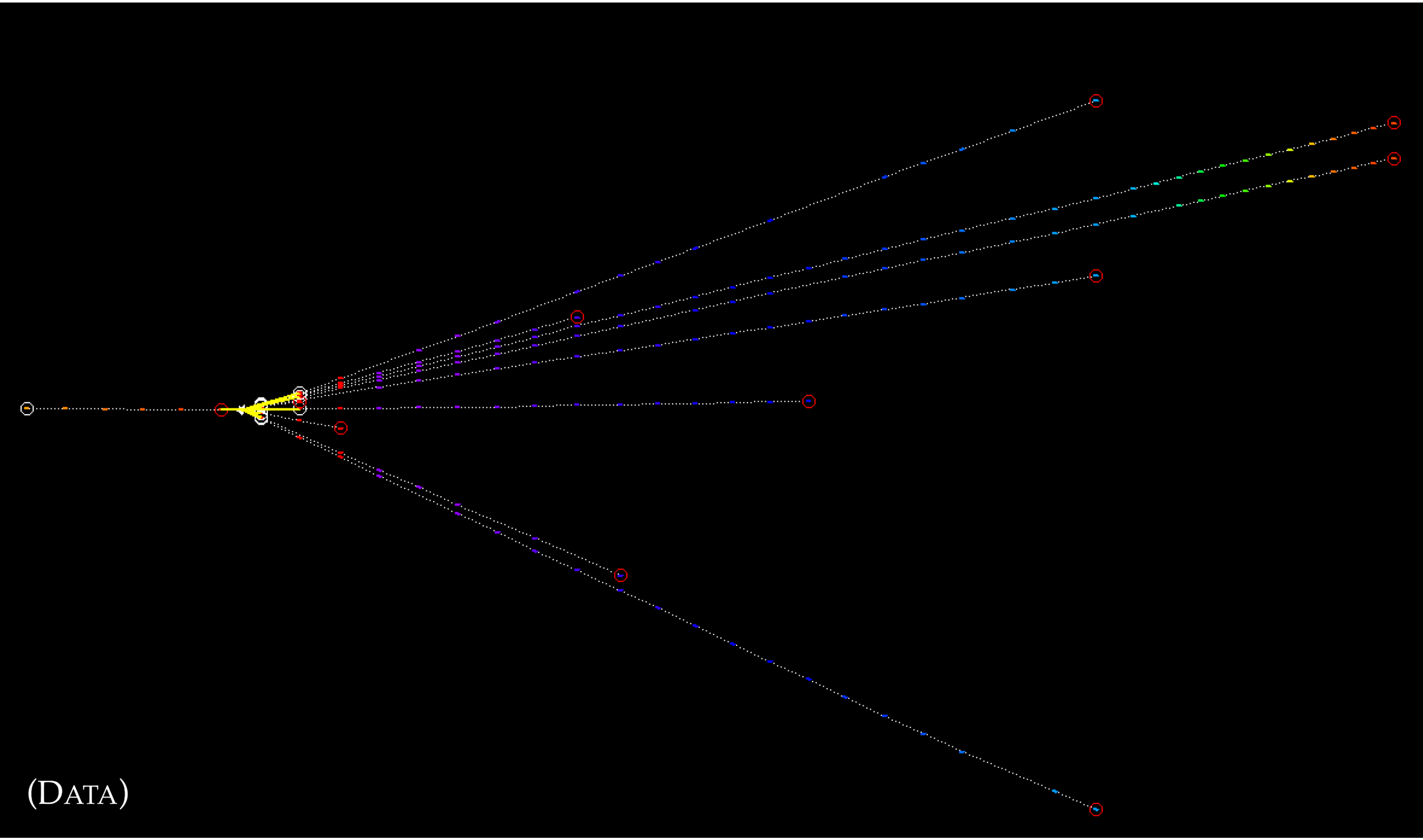


ALL SEGMENTS PLATE BY PLATE



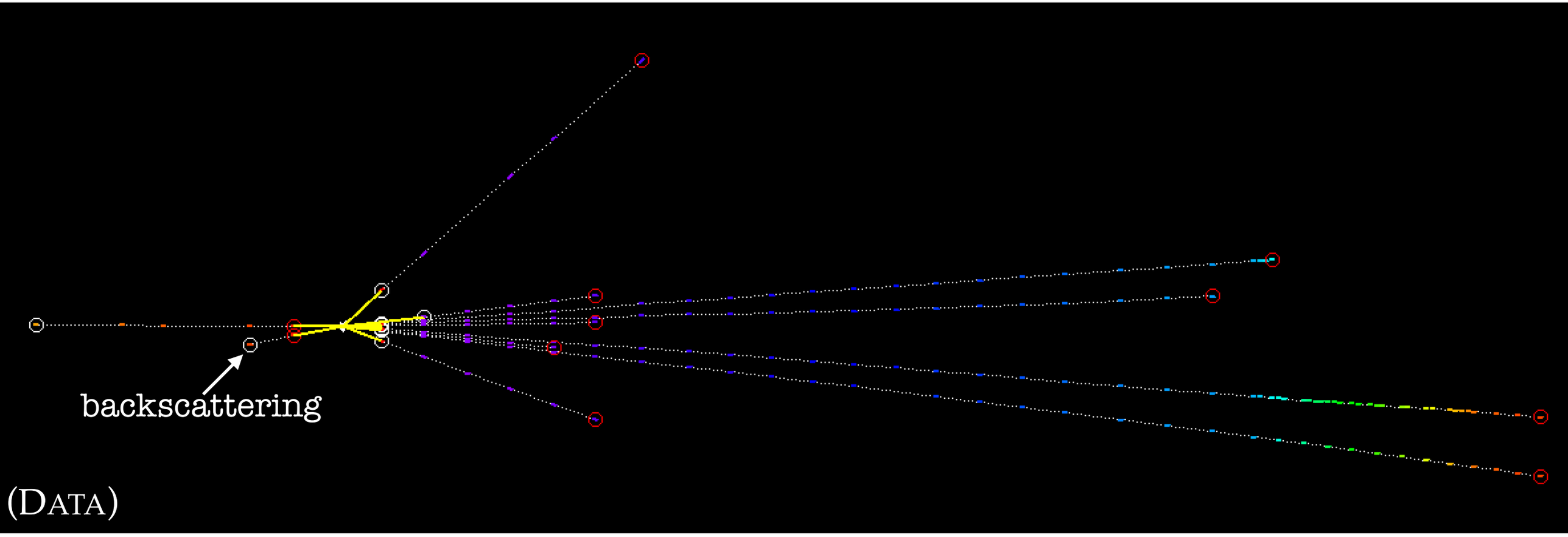
MC NORMALIZED TO DATA

Example of a Vertex with High Multiplicity



(Data)

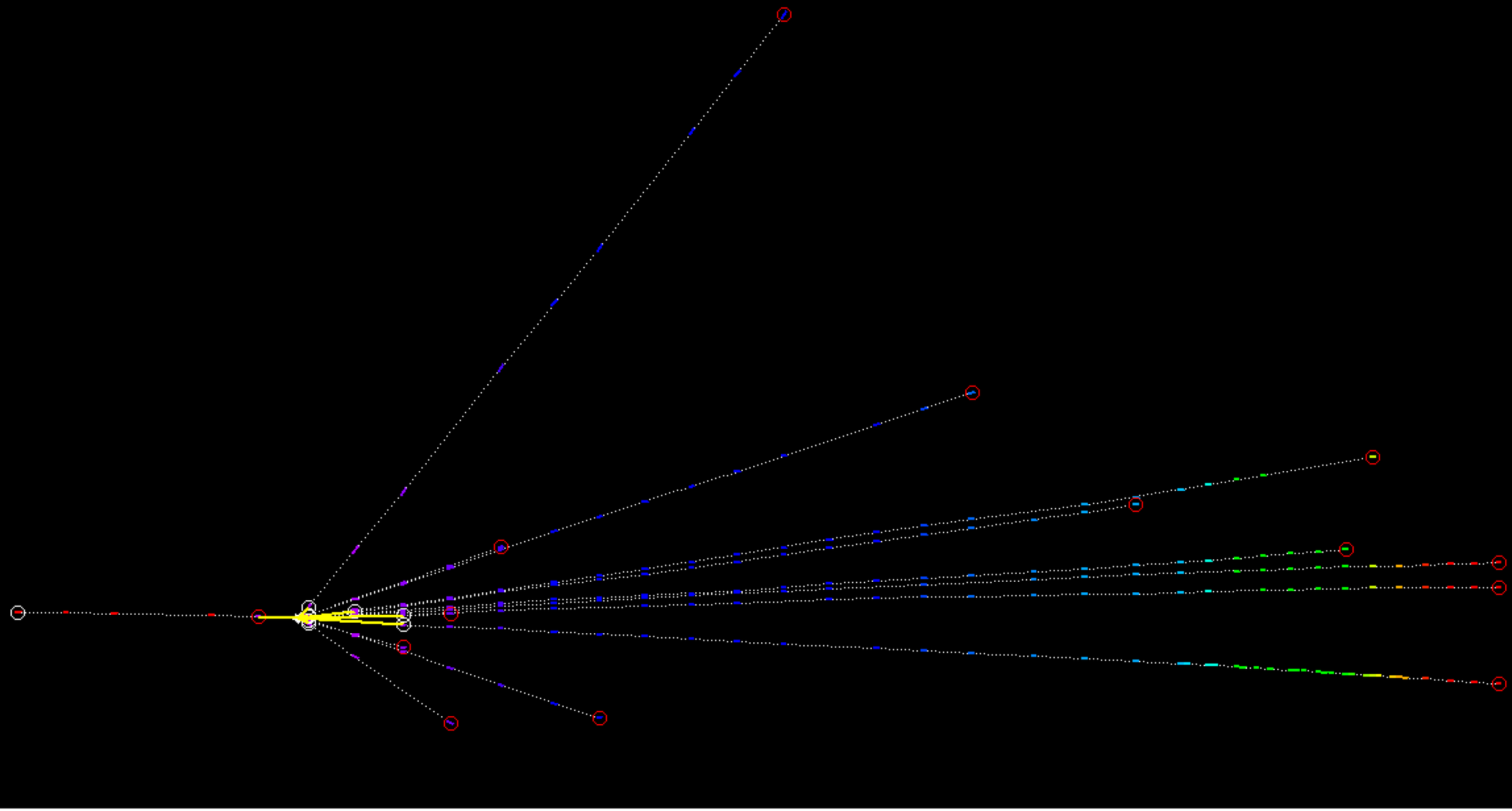
Example of a Vertex with High Multiplicity



(Data)

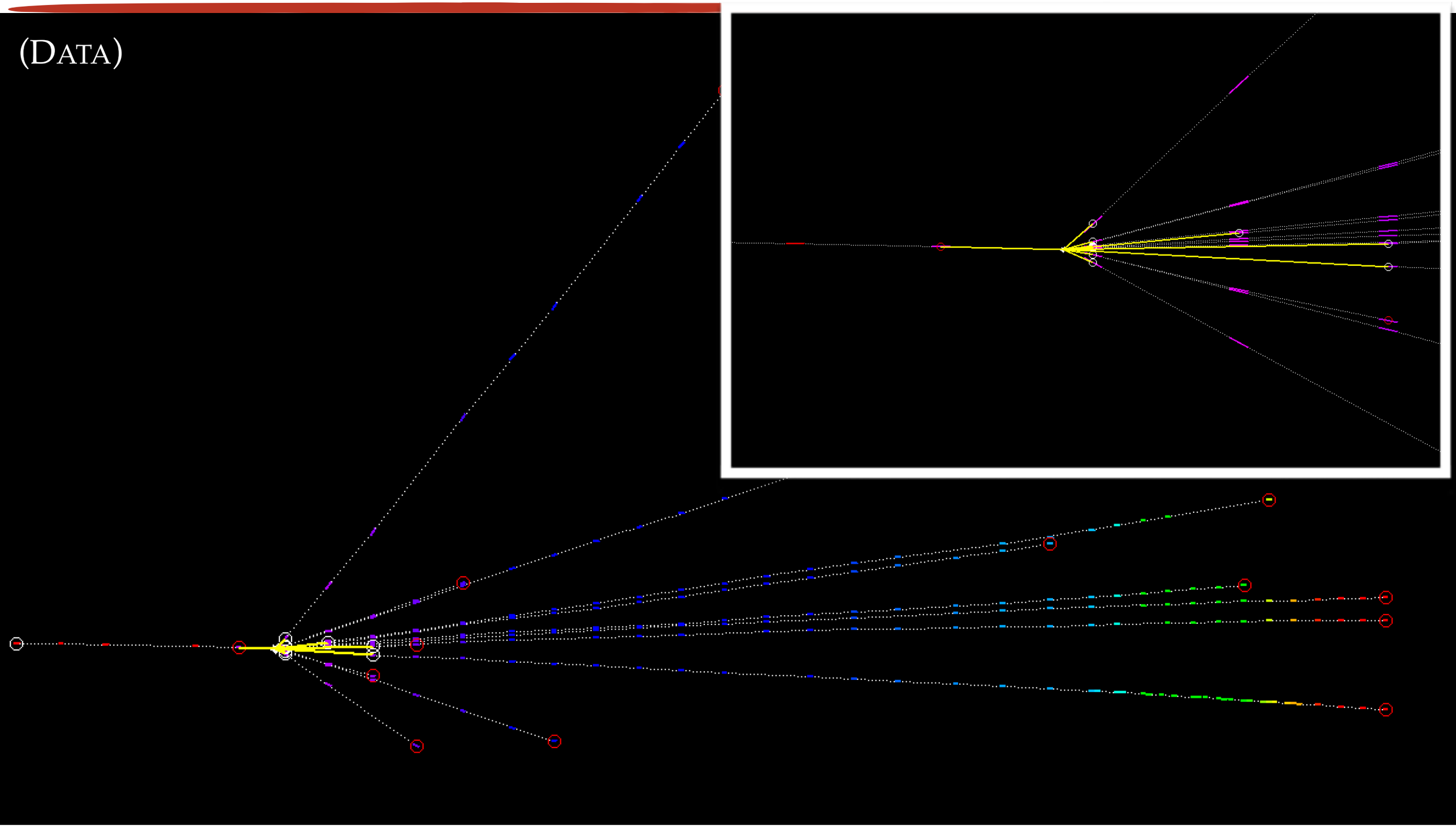
Example of a Vertex with High Multiplicity

(Data)



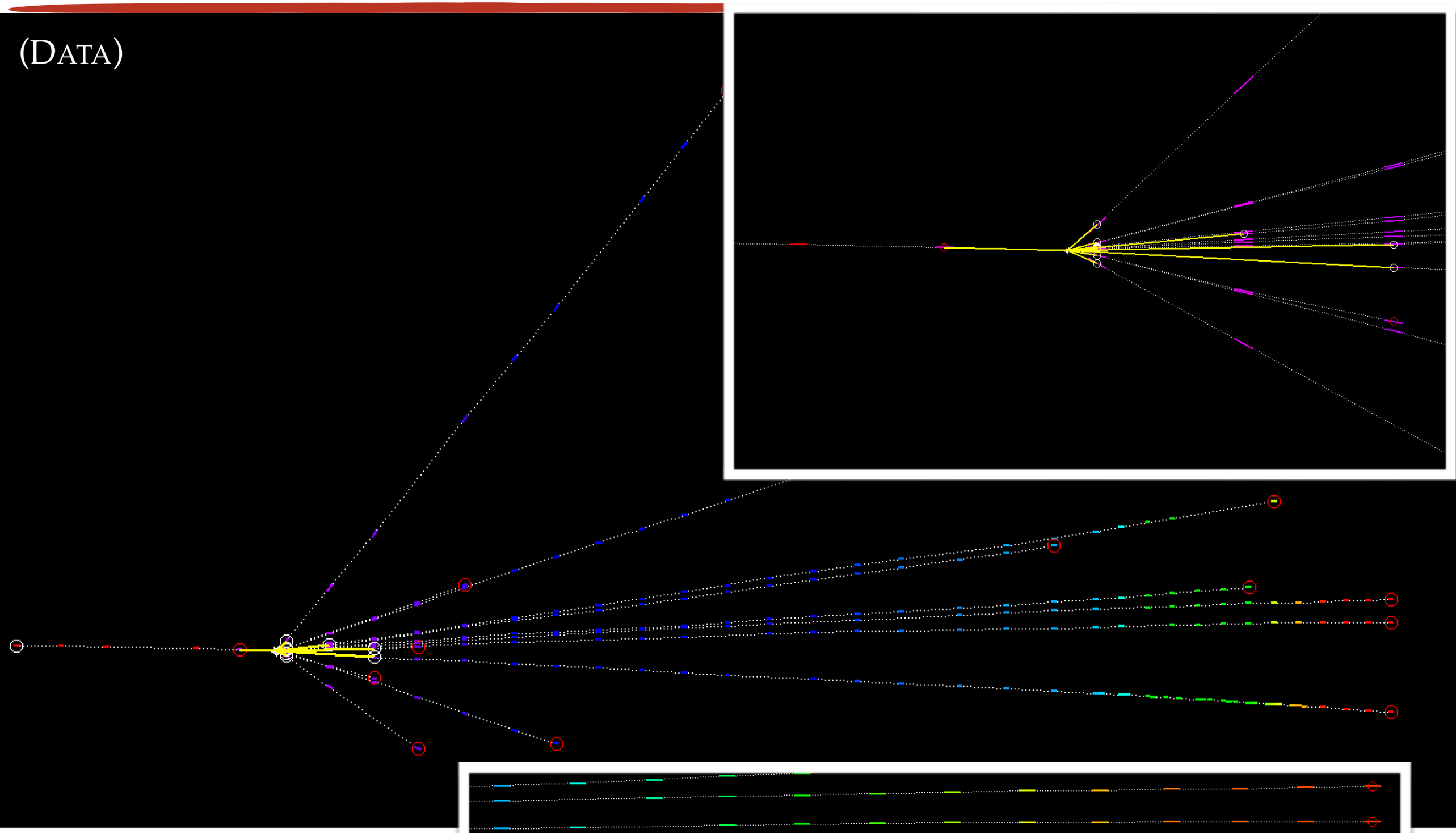
Example of a Vertex with High Multiplicity

(Data)

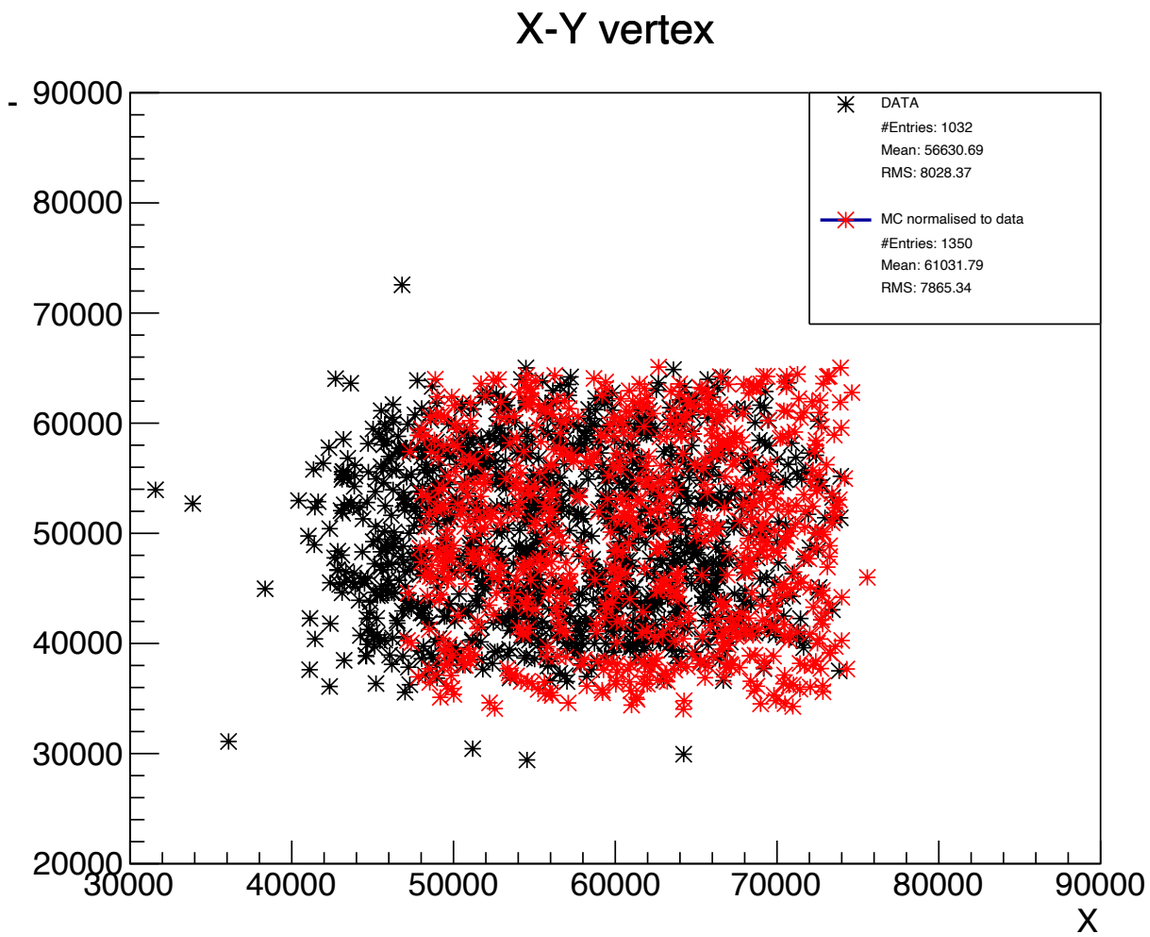


Example of a Vertex with High Multiplicity

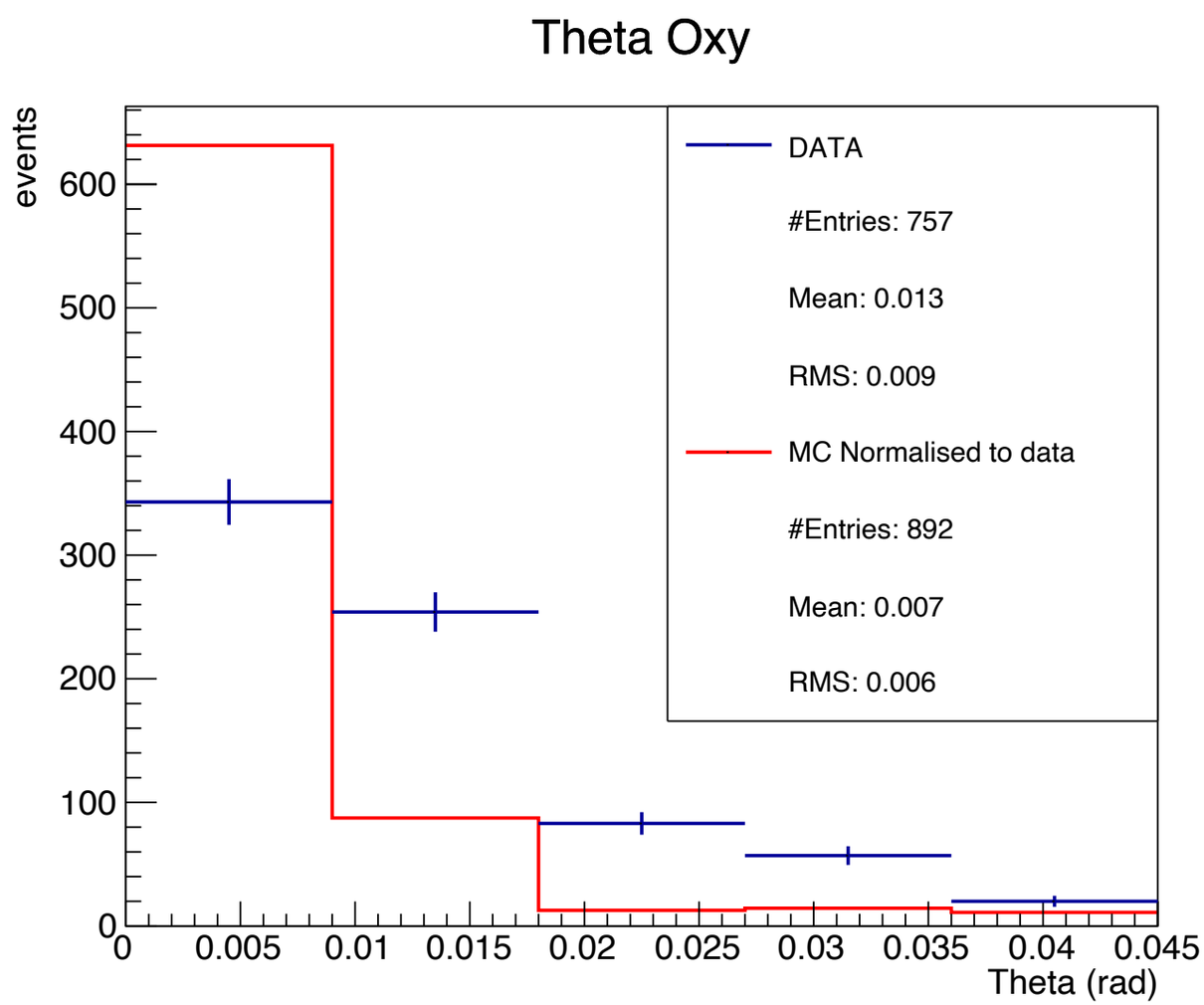
(Data)



VERTICES RECONSTRUCTION

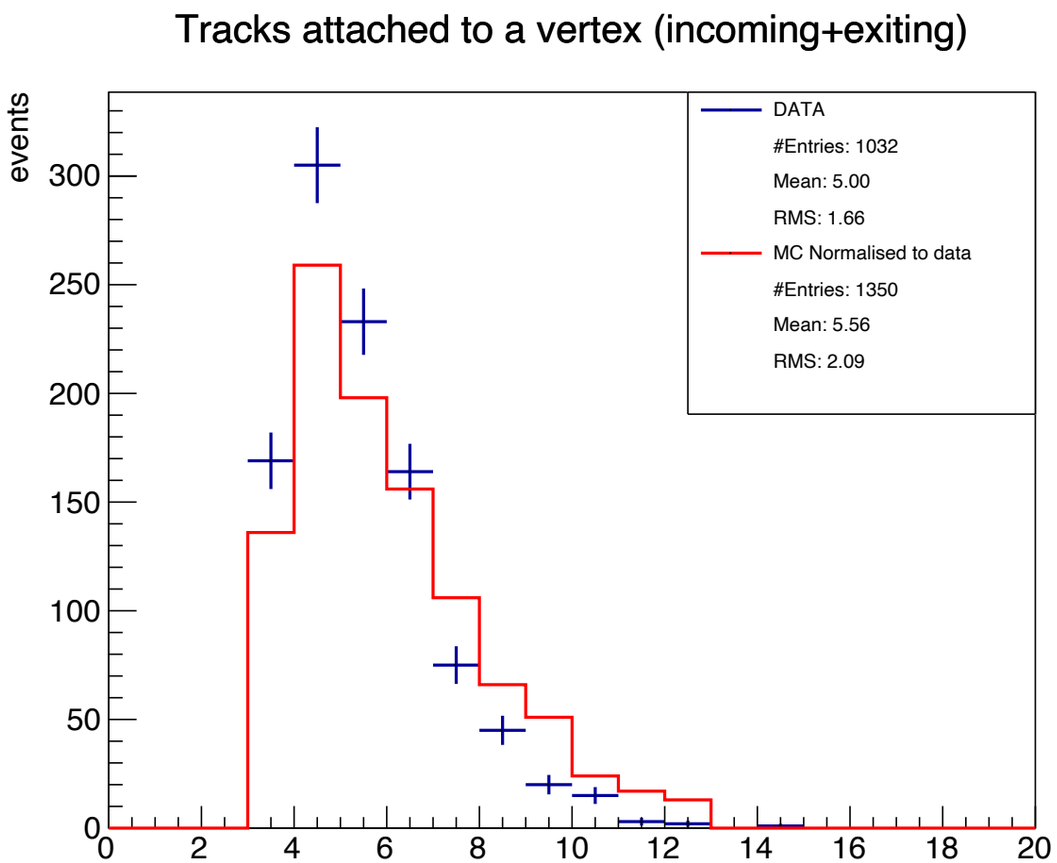


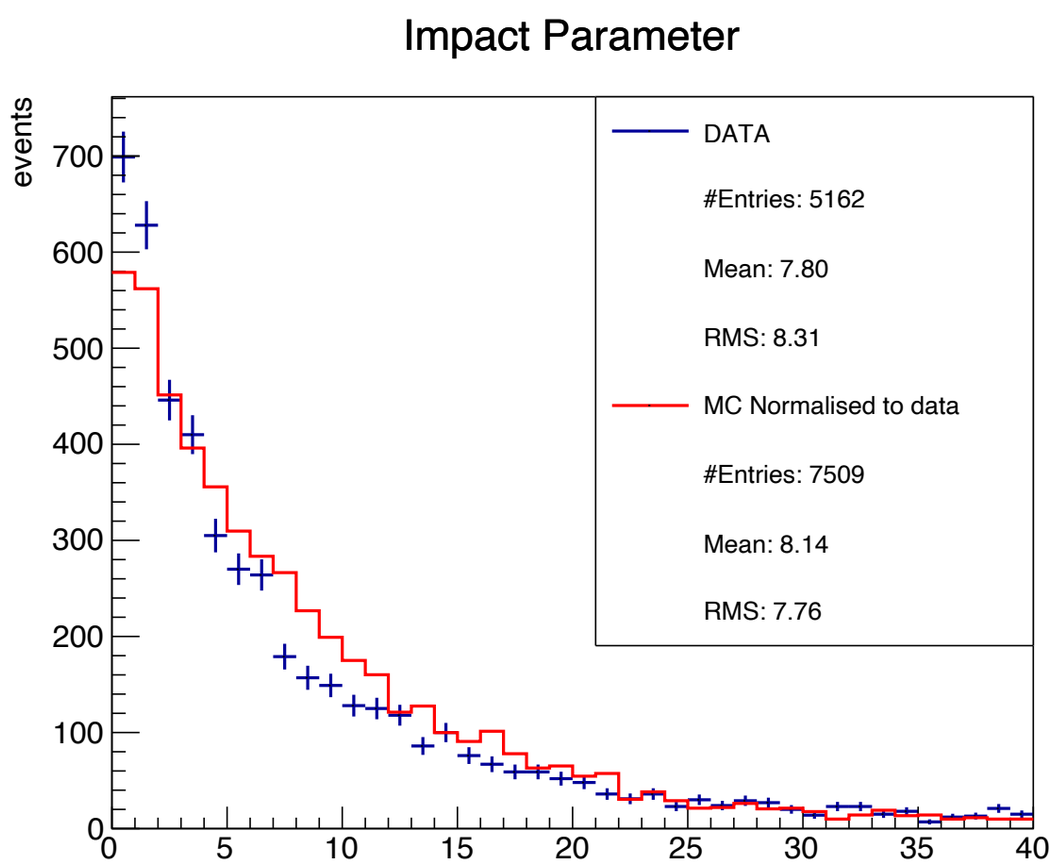
- Simulation beam: (3x3)cm
- Data spot: (2.5x2.5)cm

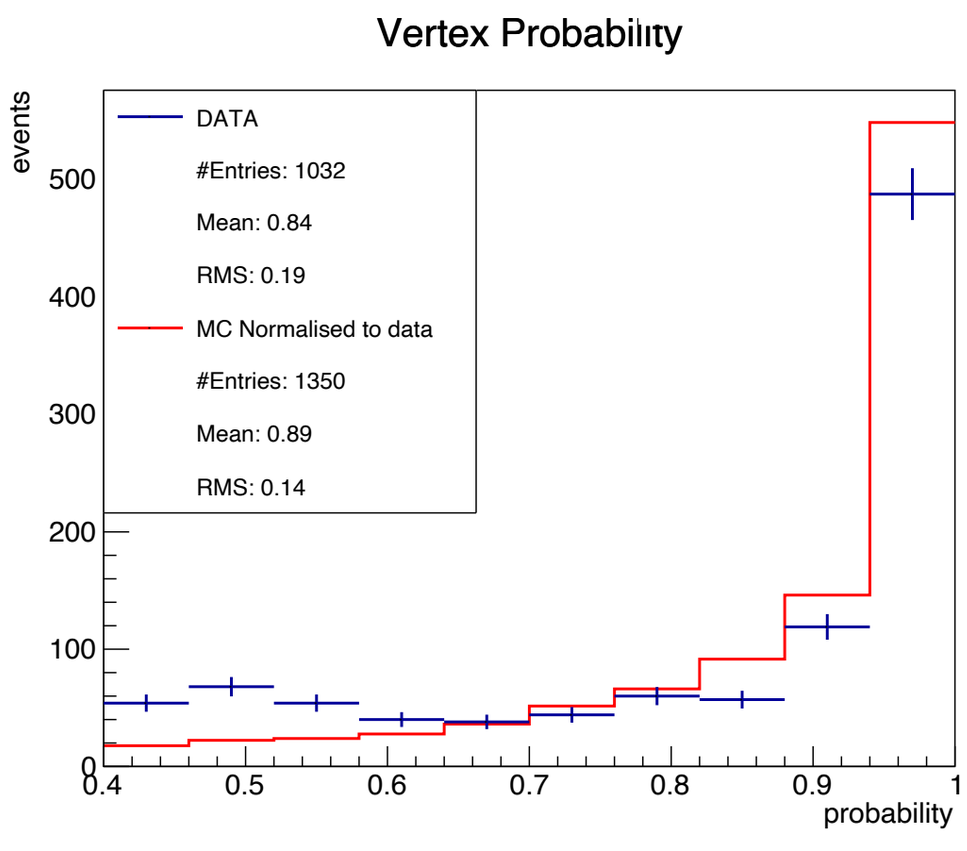


- The angle of simulated Oxygen beam should have a larger smearing

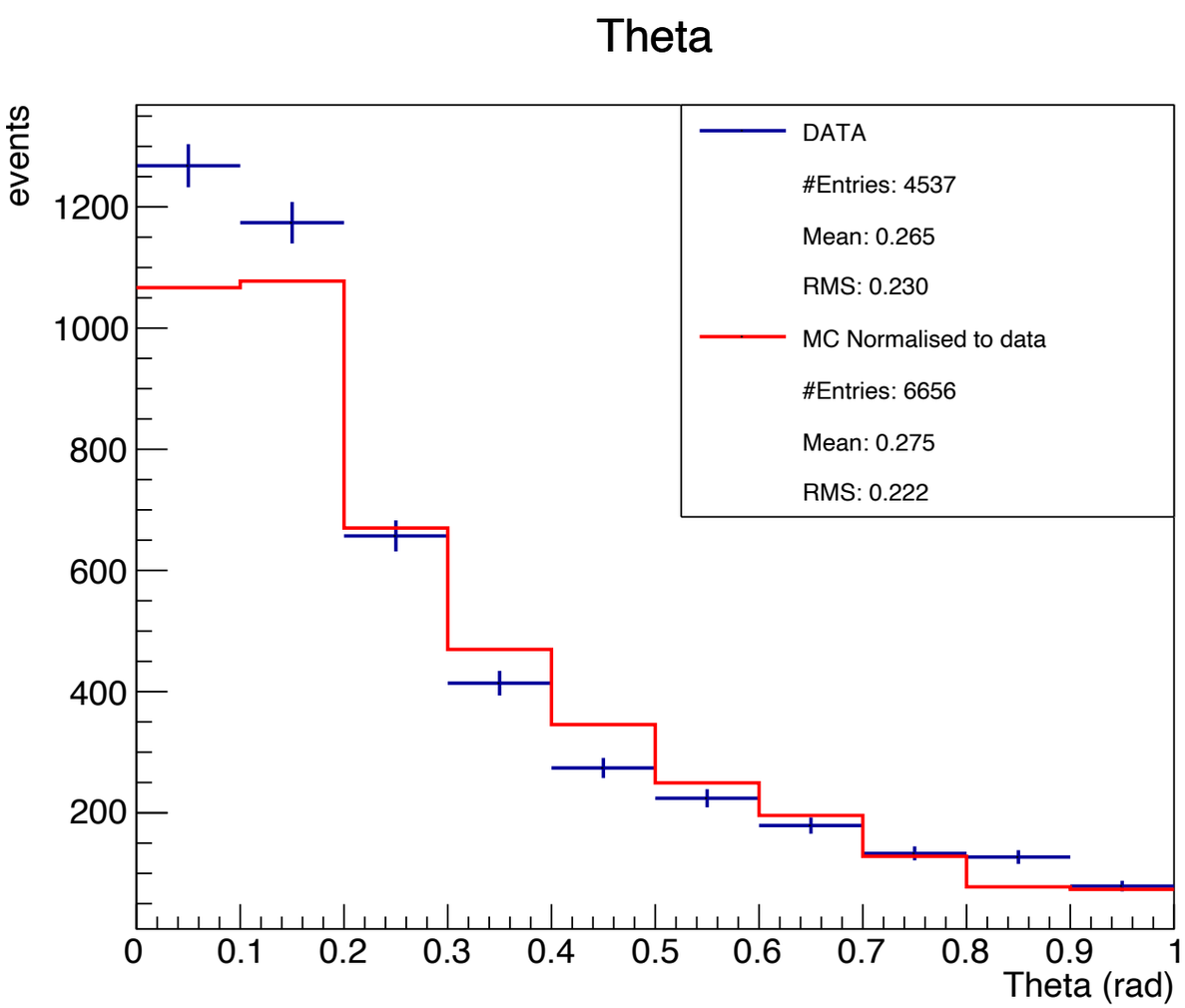
VERTICES CHARACTERISTICS

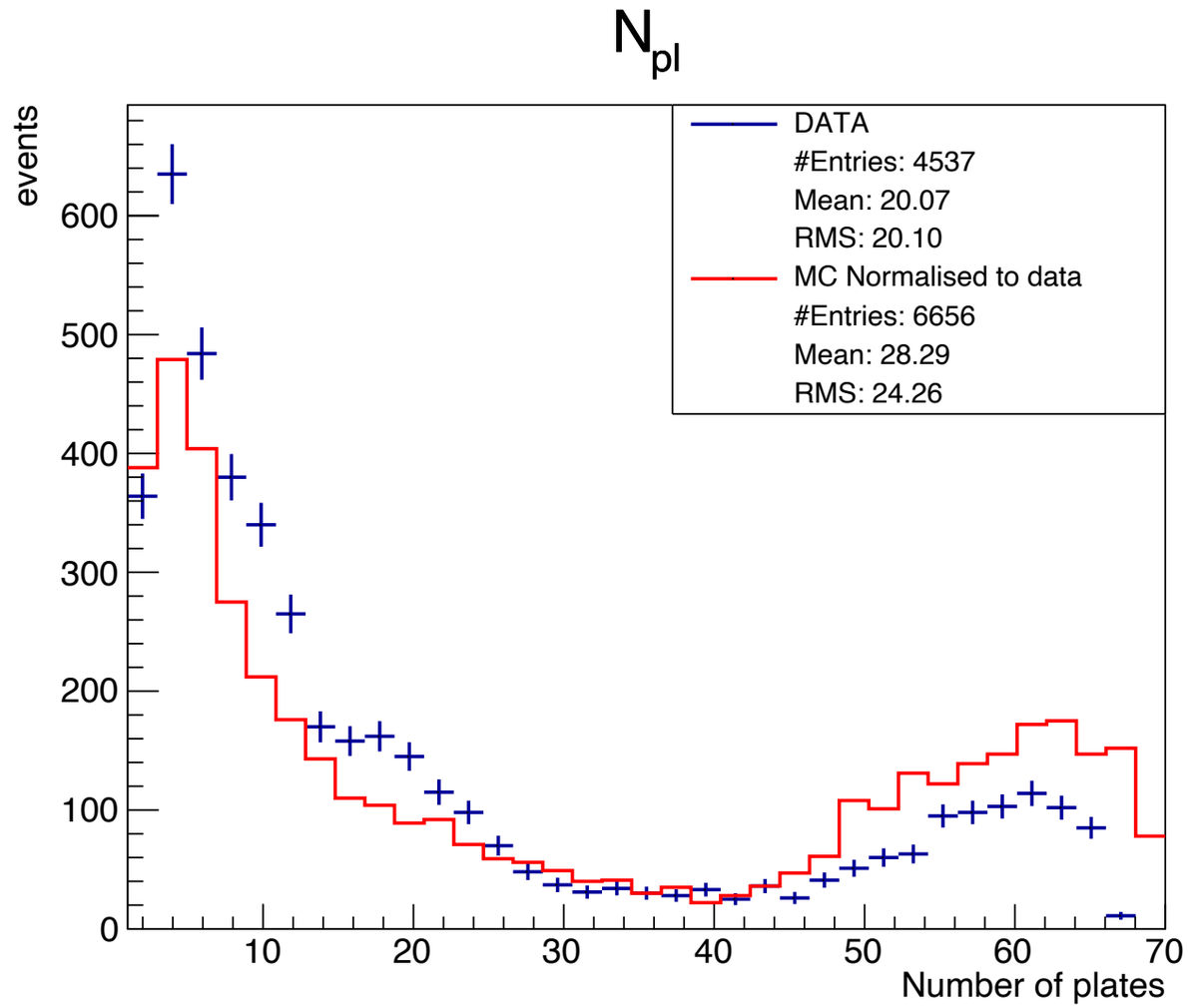






DAUGHTERS CHARACTERISTICS

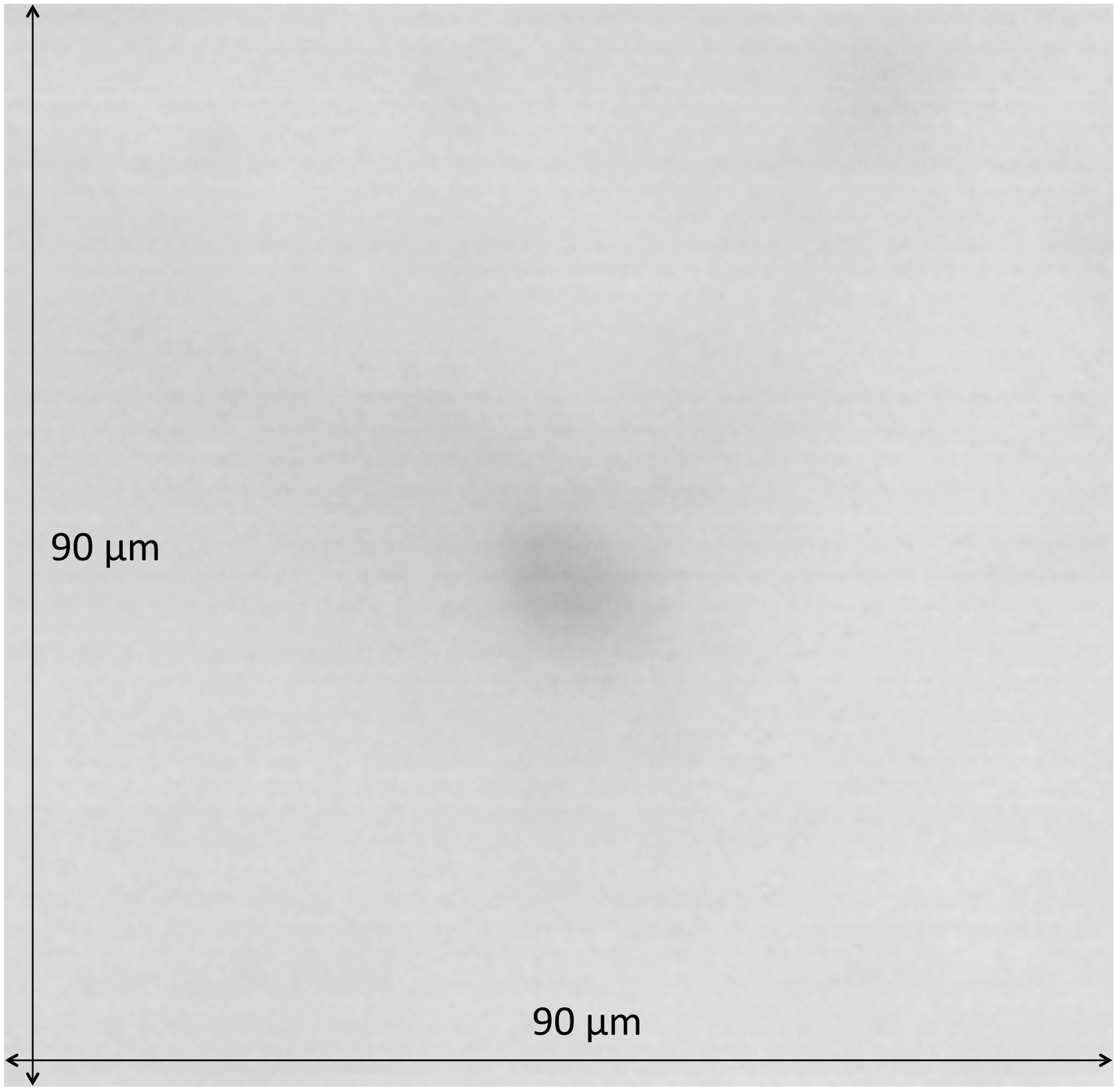




- Particles' charge identification: see next talk by B. Capone

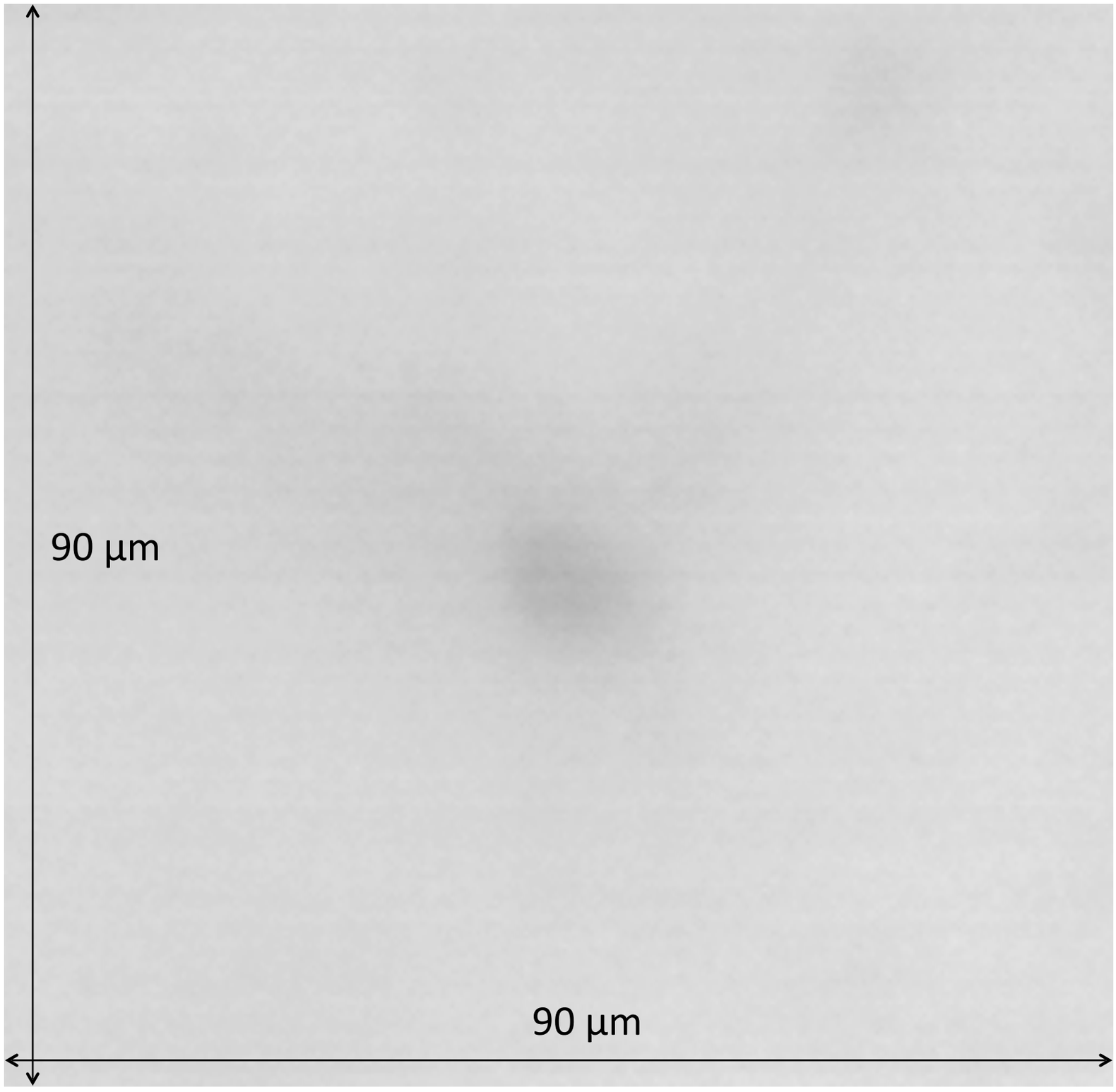
New Idea for High Ionising Particle Acquisition

Oxygen ion track in emulsion



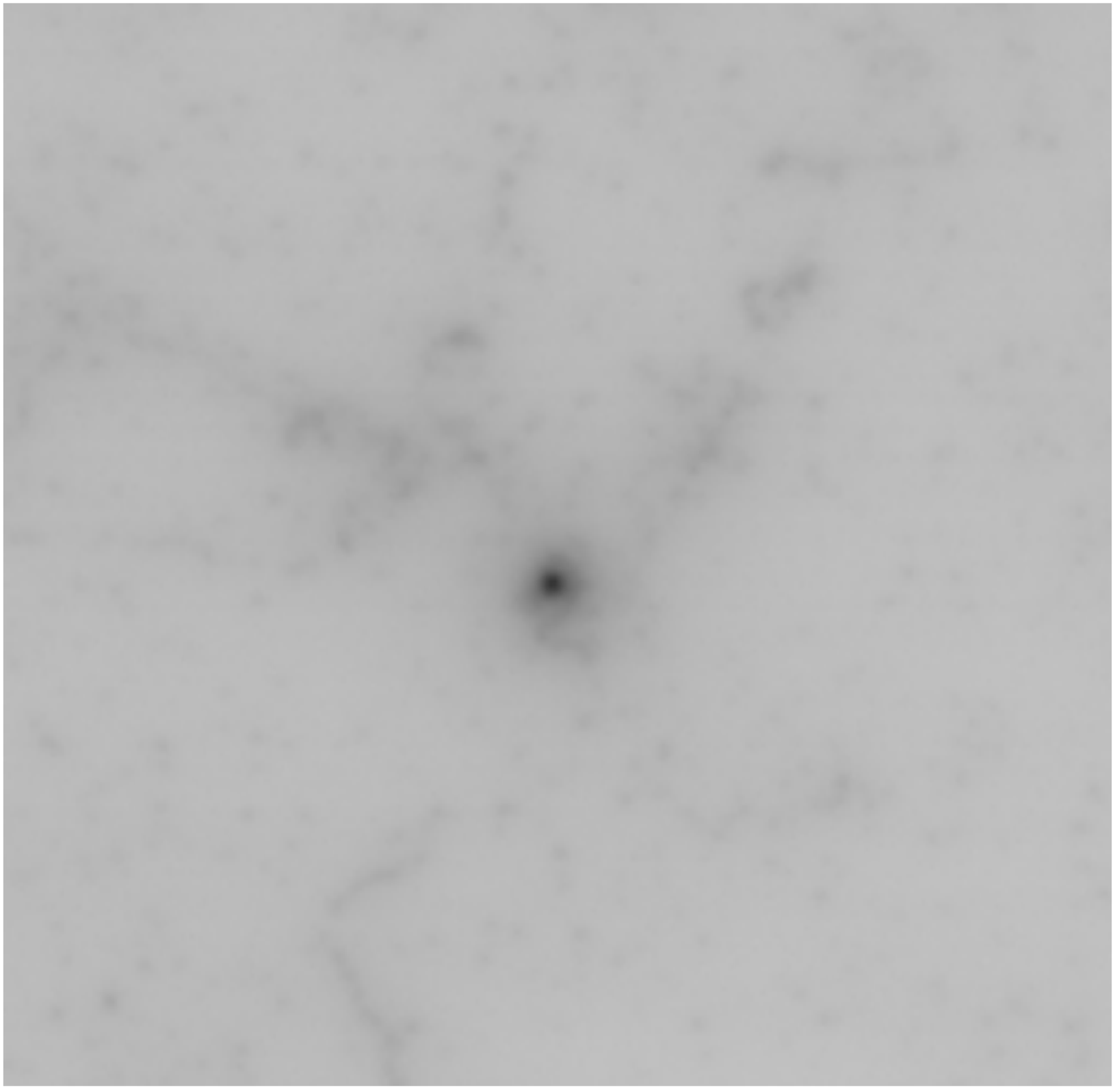
New Idea for High Ionising Particle Acquisition

Oxygen ion track in emulsion

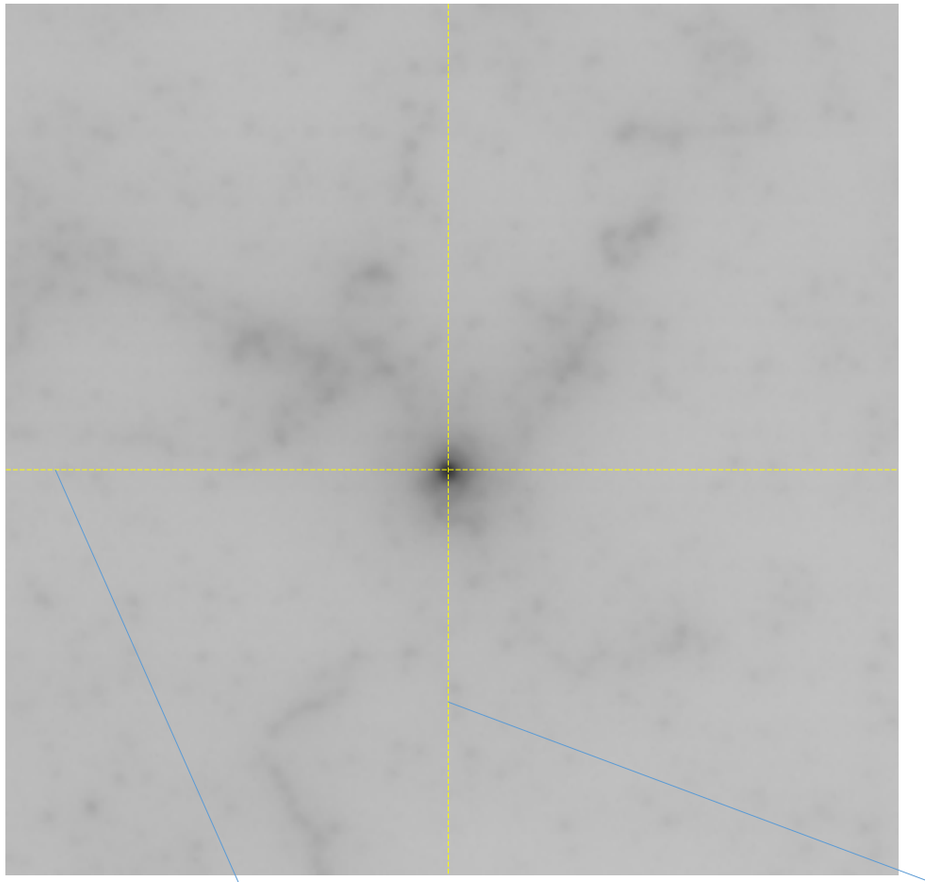


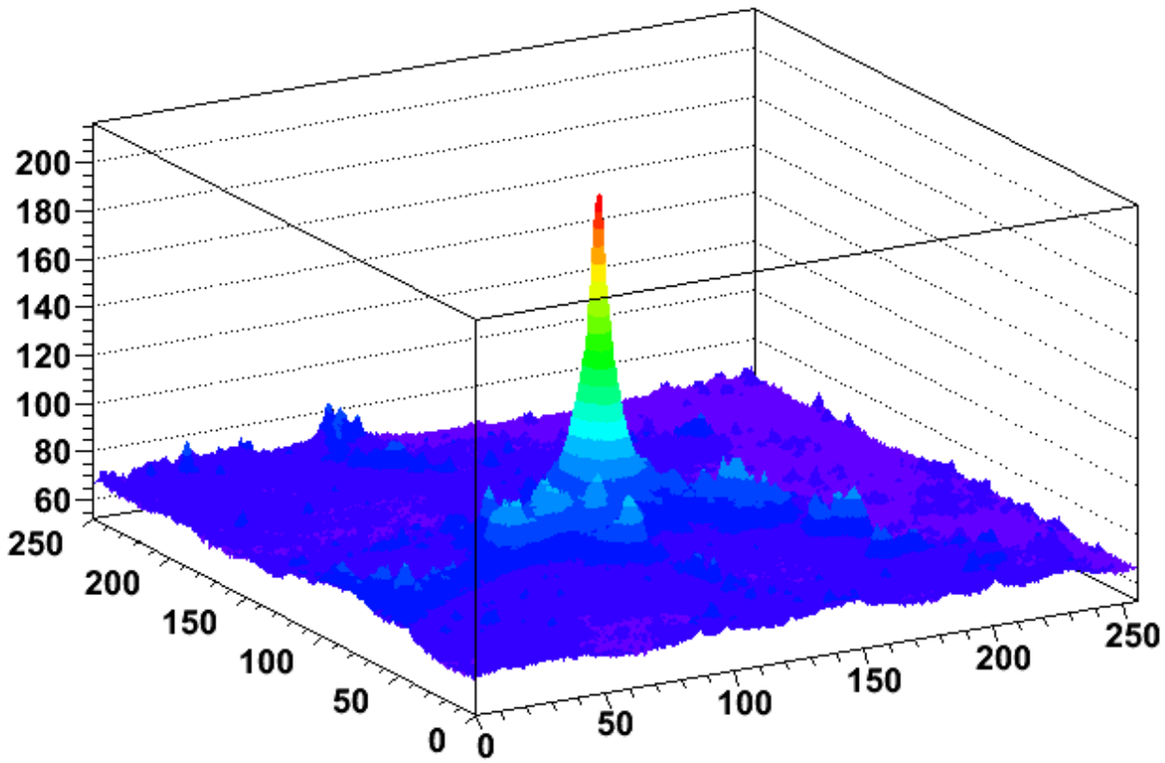
New Idea for High Ionising Particle Acquisition

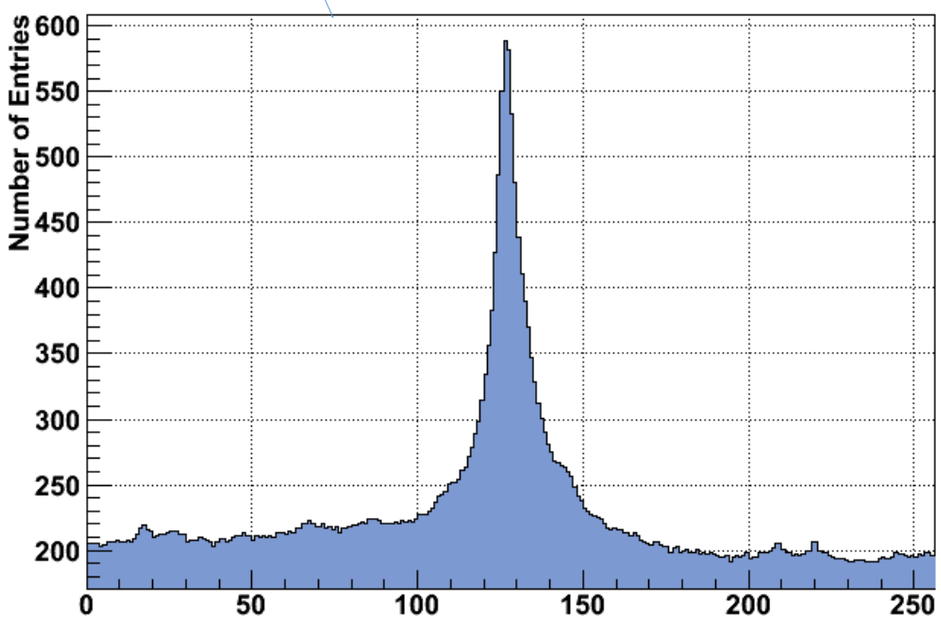
Average Image

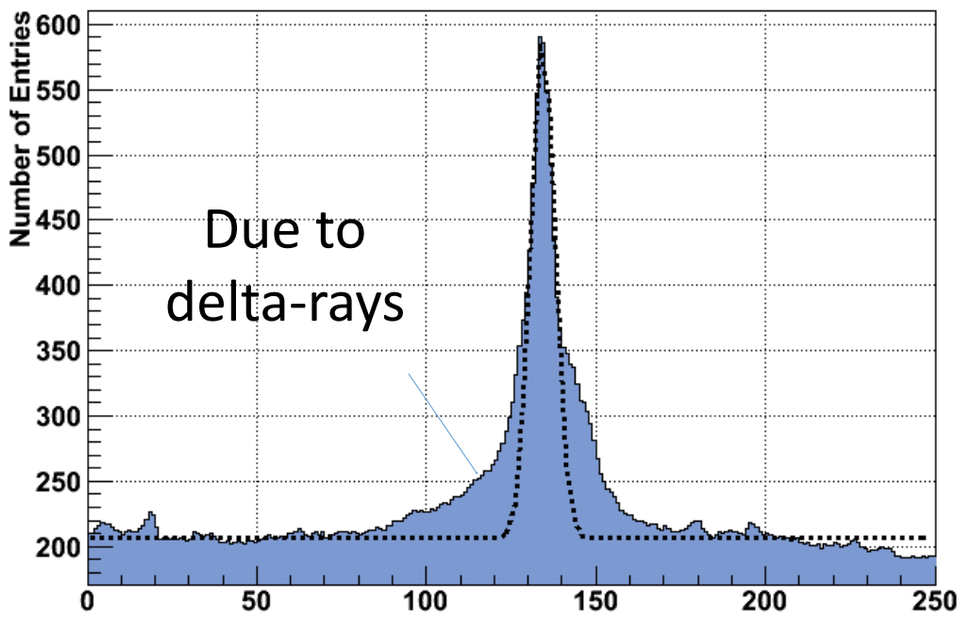


New Idea for High Ionising Particle Acquisition









Next Steps

- Scanning of GSI3 and GSI4 emulsions
- Linking and alignment of GSI1 plates already started
- Improve scanning efficiency: new approach for images acquisition dedicated to high ionizing particles
- Improve tracking efficiency: the optimization of the algorithms used in OPERA is not sufficient to face all the issues faced.
  New algorithms are needed.
- Visual inspection of reconstructed vertices to better understand interactions characteristics and validate the analysis
- Mass identification by momentum (MCS) and range measurements in S3…S7