

SELECTION CRITERIA FOR EVENTS AND TRACKS

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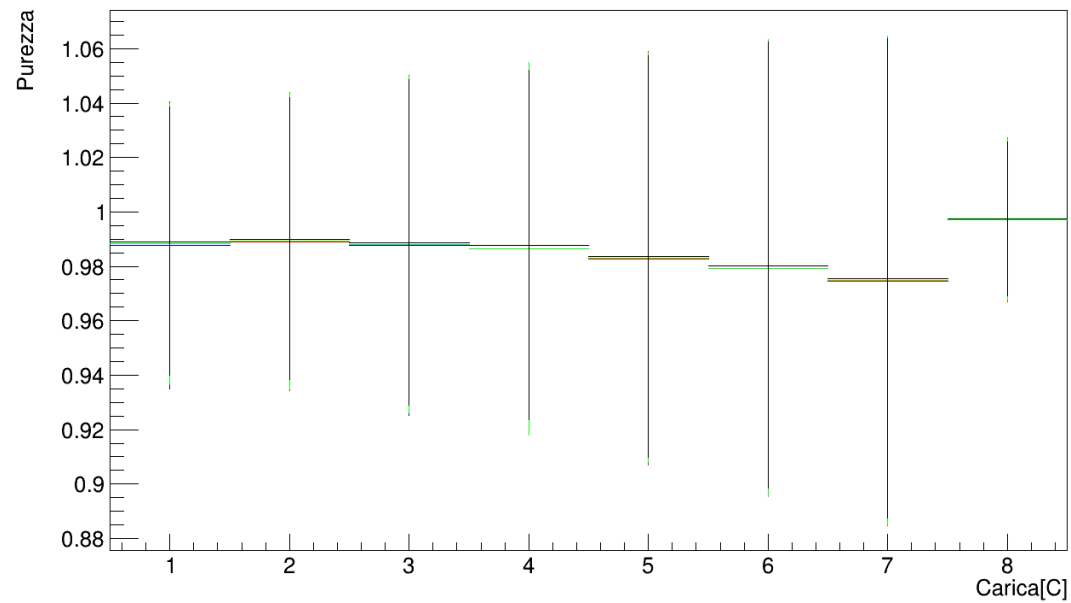
SHORT INTRODUCTION

- The data were taken with the Monte Carlo simulation GSI2021_MC.
- 1000000 data were used for the analysis.
- I used SHOE master branch (updated 27 March).
- I analysed tracks reconstructed by GENFIT.
- Goal of this work:
 - optimization of the choice of the minimum number of global track points
 - study of selection criteria to identify the out of target events and secondary fragmentation tracks only by means of global track parameters.

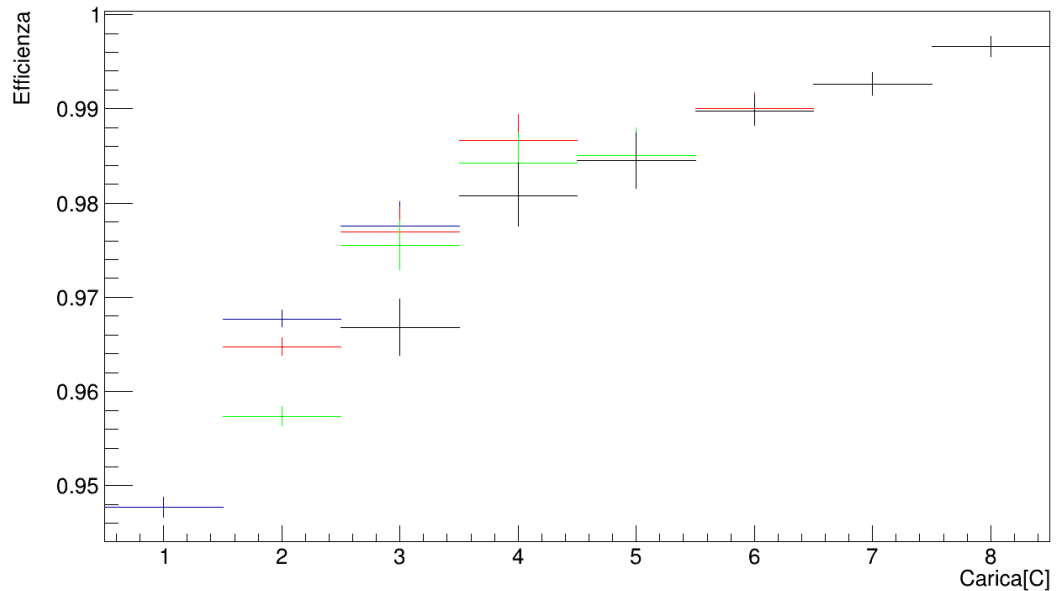
OPTIMIZATION OF THE MINIMUM NUMBER OF GLOBAL TRACK POINTS

- The first aim of the analysis is to find the minimum number of points to be chosen for a track in order to optimize efficiency and purity.
- Efficiency: $\text{Number of reconstructed tracks} / \text{Number of simulated tracks}$
- Purity: $\text{Number of hits of the main MC particle associated to the track} / \text{Total number of hits of the track}$

Purity



Efficiency

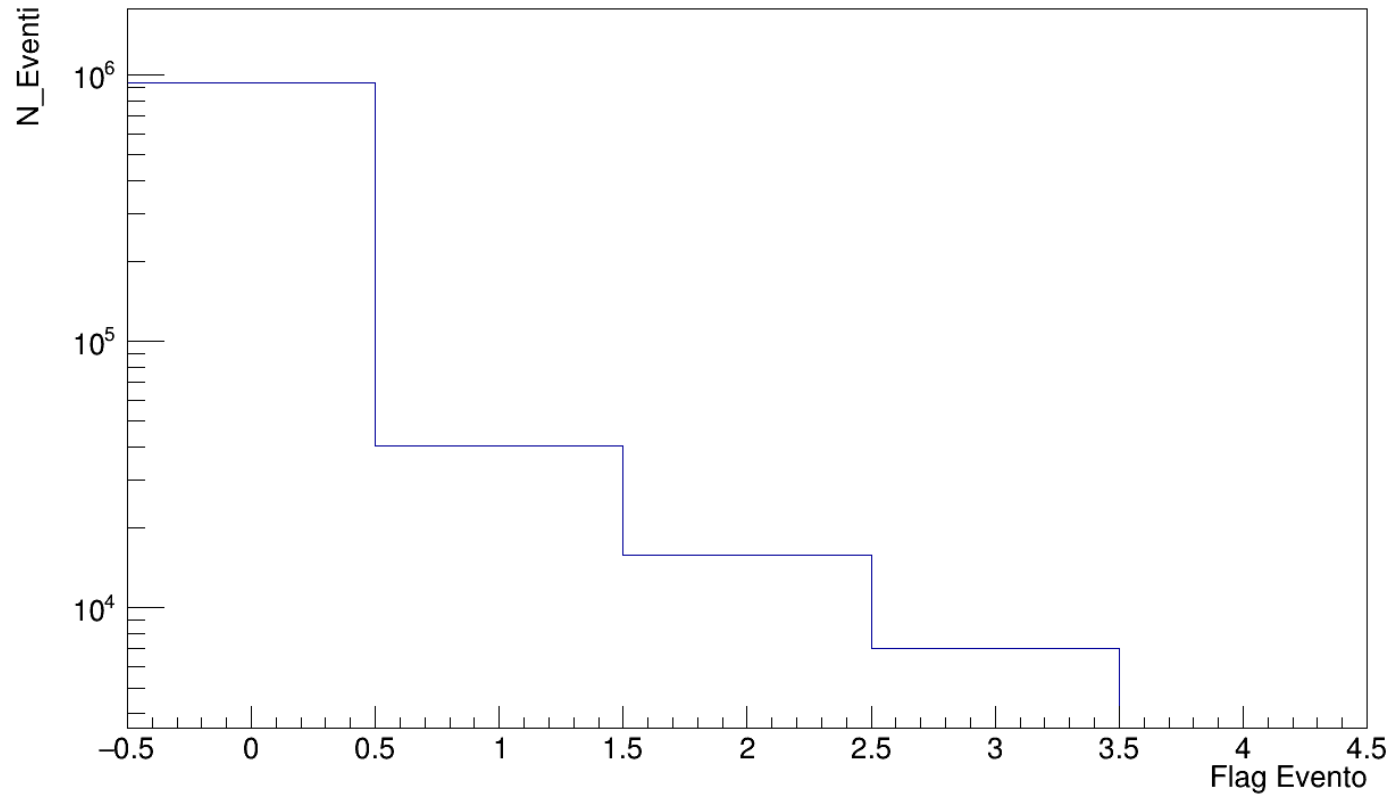


- Blue: 5 points
- Red: 6 points
- Green: 7 points
- Black: 9 points

OPTIMIZATION OF EFFICIENCY AND PURITY

- Purity seems to have no dependency on the choice of points.
- Instead, efficiency is greatly affected, especially for the lower charges.
- From the analysis it has been found that the optimal number of points is: 5 (minimum number of points).
- In all subsequent studies the minimum number of points will be set to 5.

Events



- 0 = the primary beam does not interact in the target and arrives till the Tof-Wall.
- 1 = the primary beam fragments in the target.
- 2 = the primary beam fragments downstream of the target.
- 3 = the primary beam fragments upstream of the target.

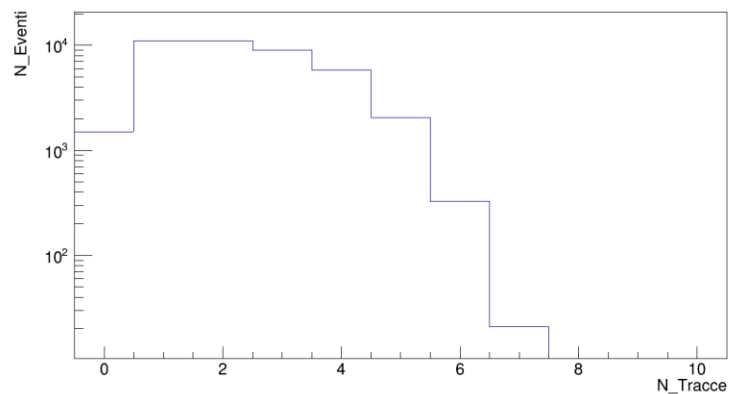
STUDY OF PRIMARY FRAGMENTATION

- The main objective of the study is to identify the events in which the primary beam fragments in the target.
- We can identify the type 0 events, because they are particles that didn't interact, so in the charge and mass reconstruction phase we will find oxygen.

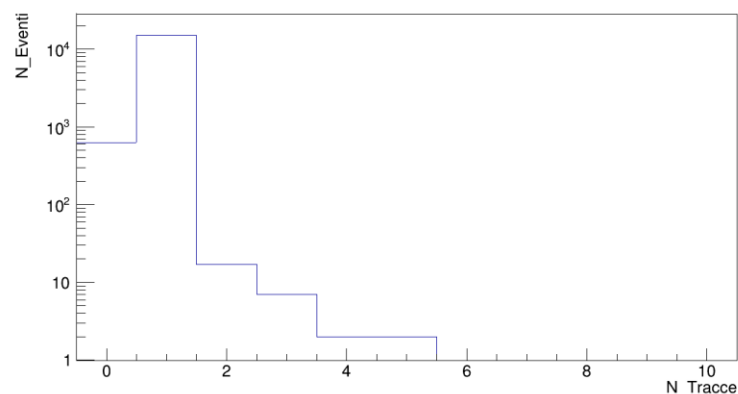
ATTEMPTS TO SEPARATE THE EVENTS

- Firstly we consider only events that have only one BM tracks.
- We tried to project a track constructed using the first two and last two points of the track (excluding the TW point) onto the target. It has failed.
- We analyzed the difference between the number of tracks and the number of TW-points of the events.
- Etc. Etc.
- None of the above attempted methods worked.
- It can be used also the reconstruction information of the single detectors, but in a global analysis, we didn't find a way to separate the events.

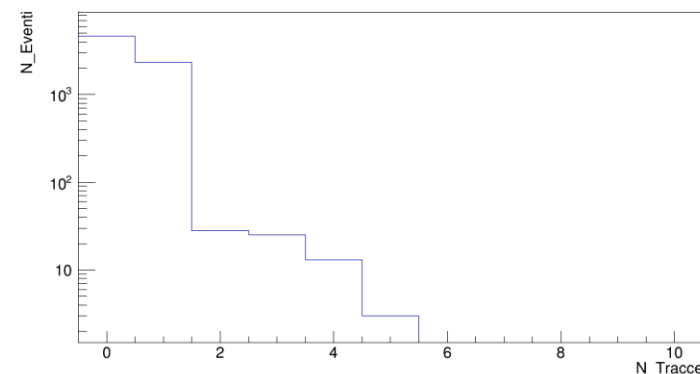
Primary fragments in target



Primary fragments downstream of the target



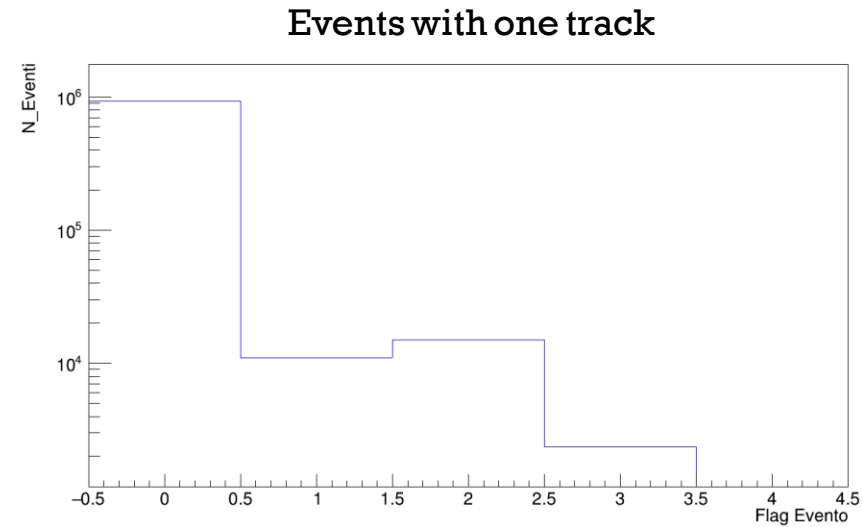
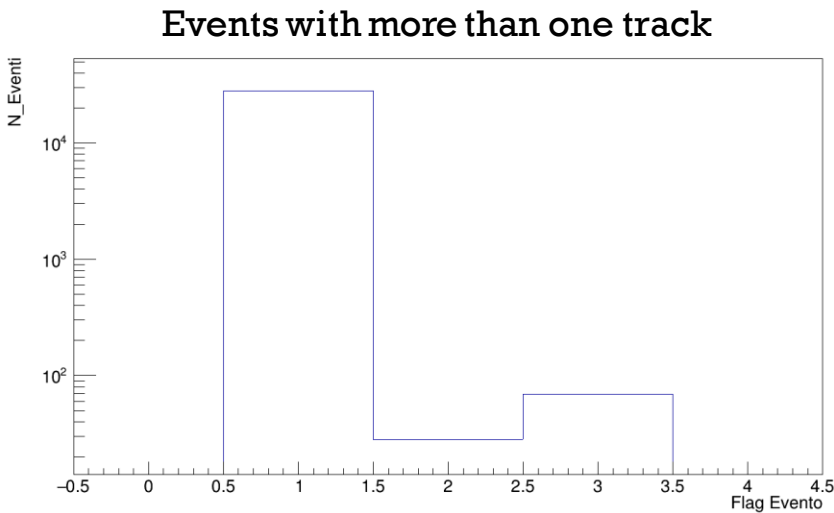
Primary fragments upstream of the target



EVENTS NUMBER OF TRACKS

- We didn't find a good way to separate the signal from the background, but we noticed that the background events are mostly composed by events having only one reconstructed track.

STUDY OF PRIMARY FRAGMENTATION

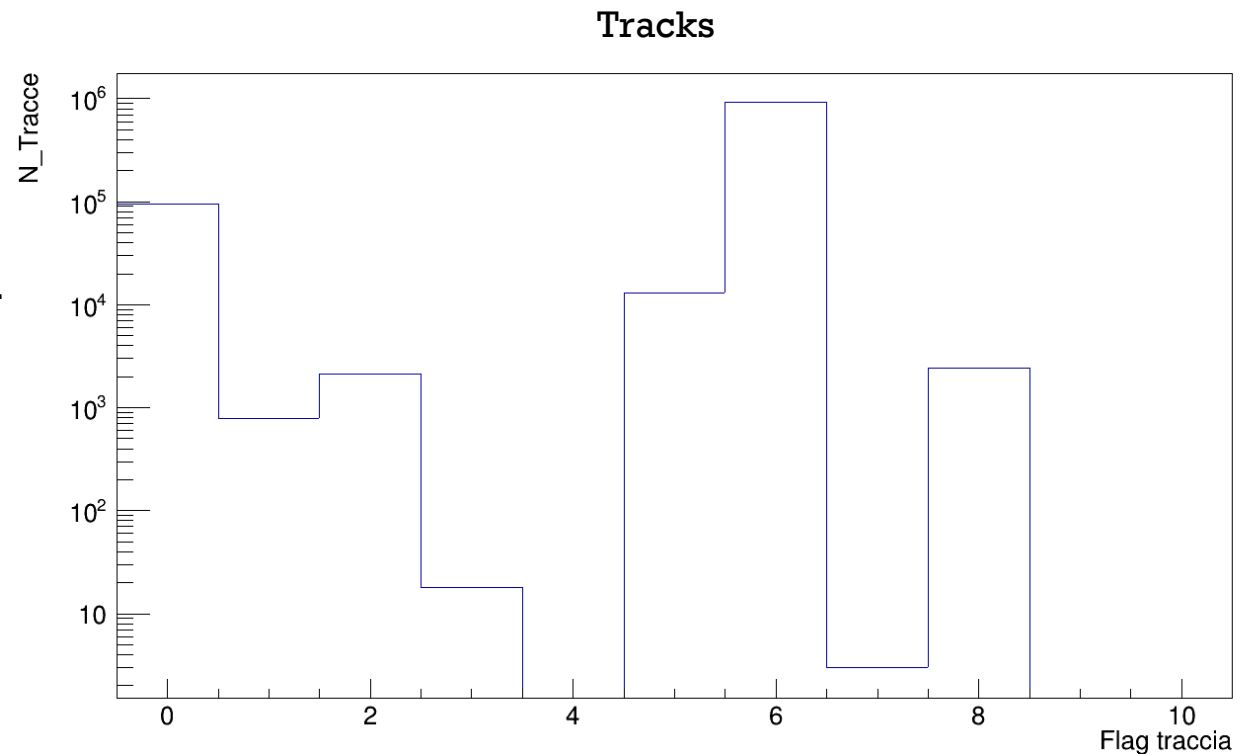


- 0 = the primary beam does not interact in the target and arrives to the Tof-Wall.
- 1 = the primary beam fragments in the target.
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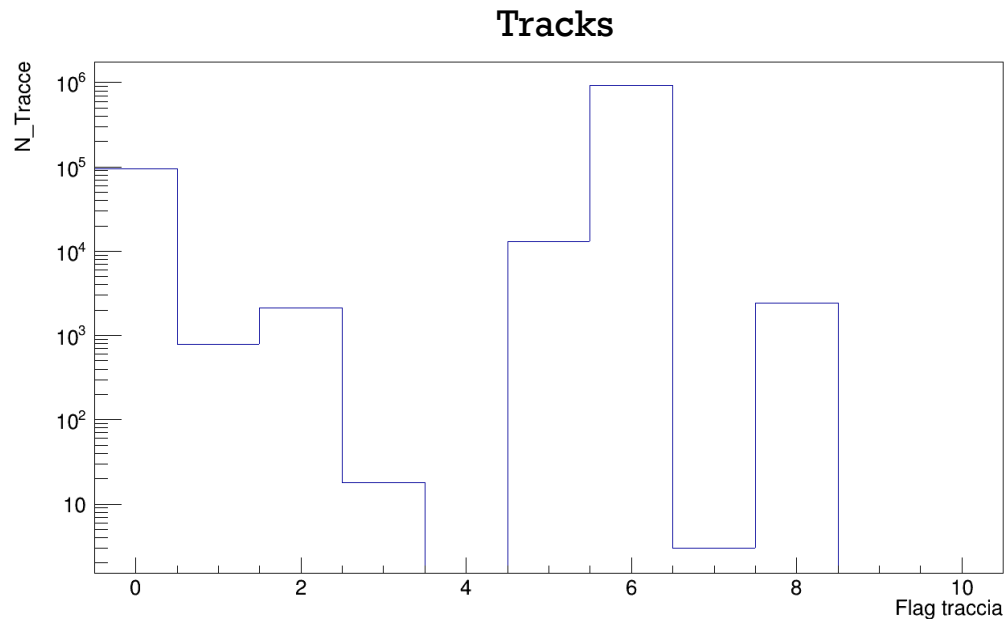
- So we decided to separate the events with more than one track from the ones that have only one track: we have now to understand how to separate the signal tracks from the background tracks.

STUDY OF TRACKS

- We have associated a number to every type of tracks from all the events.
- 0 = secondary generated in target and arriving to Tof-Wall.
- 1 = secondary generated in target, but not arriving to Tof-Wall.
- 2 = secondary not generated in target, but arriving to Tof-Wall.
- 3 = secondary not generated in target and not arriving to Tof-Wall.
- 4 = primary dead in target
- 5 = primary dead downstream of target, but before Tof-Wall.
- 6 = primary arriving to Tof-Wall.
- 7 = primary dead upstream of target.
- 8 = secondary generated upstream of target.



- The aim of this analysis is to find some parameters that separate the signal tracks (type 0) from the background tracks (all the others).
- Types 6 are identifiable, because they are the primary beam that arrives to TW, so they are oxygen.
- Types 8 tracks are a systematic error which, at the Monte Carlo analysis level, cannot be eliminated, as they are particles that behave like primaries. They can be eliminated in the actual experiment using the information of the various detectors taken individually.
- Types 4 and 7 can be ignored.
- Types 3 are only the 0.001% of the types 0, so they can be neglected.
- So we have to separate types 0 from 1-2-5.



STUDY OF TRACKS

0 = secondary generated in target and arriving to Tof-Wall.

1 = secondary generated in target, but not arriving to Tof-Wall.

2 = secondary not generated in target, but arriving to Tof-Wall.

3 = secondary not generated in target and not arriving to Tof-Wall.

4 = primary dead in target

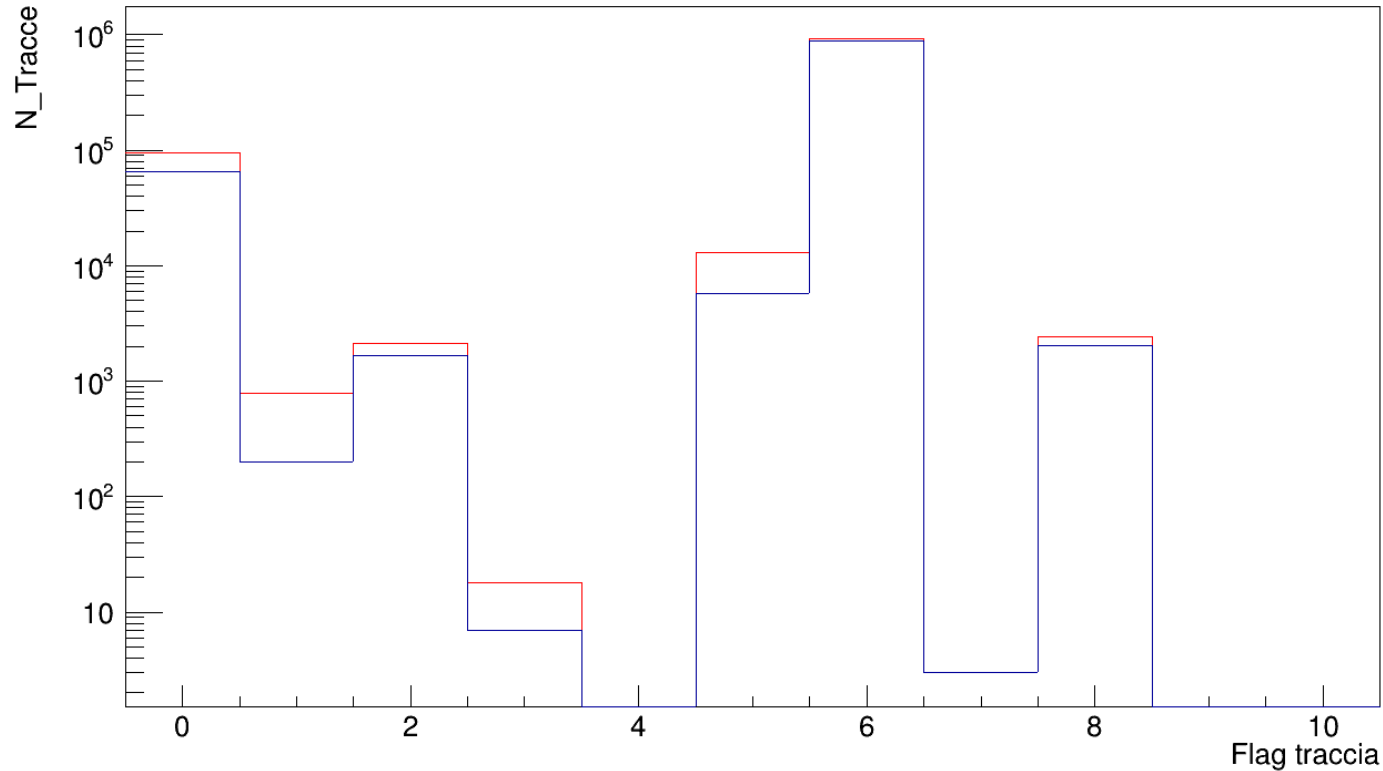
5 = primary dead downstream of target, but before Tof-Wall.

6 = primary arriving to Tof-Wall.

7 = primary dead upstream of target.

8 = secondary generated upstream of target.

Tracks

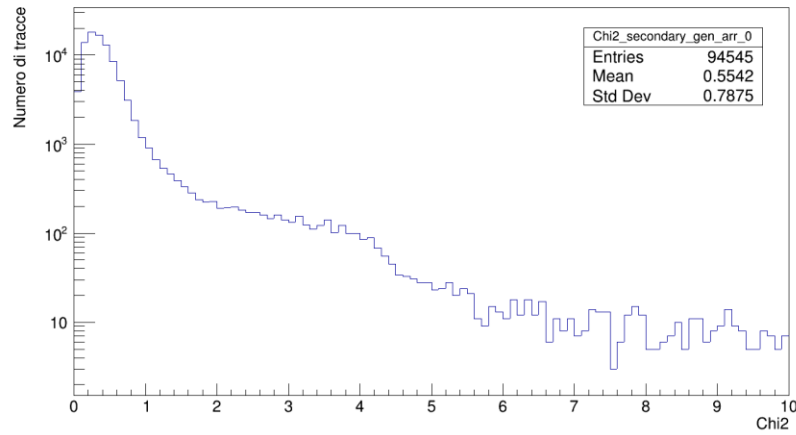


- 0 = secondary generated in target and arriving to ToF-Wall.
- 1 = secondary generated in target, but not arriving to ToF-Wall.
- 2 = secondary not generated in target, but arriving to ToF-Wall.
- 3 = secondary not generated in target and not arriving to ToF-Wall.
- 4 = primary dead in target
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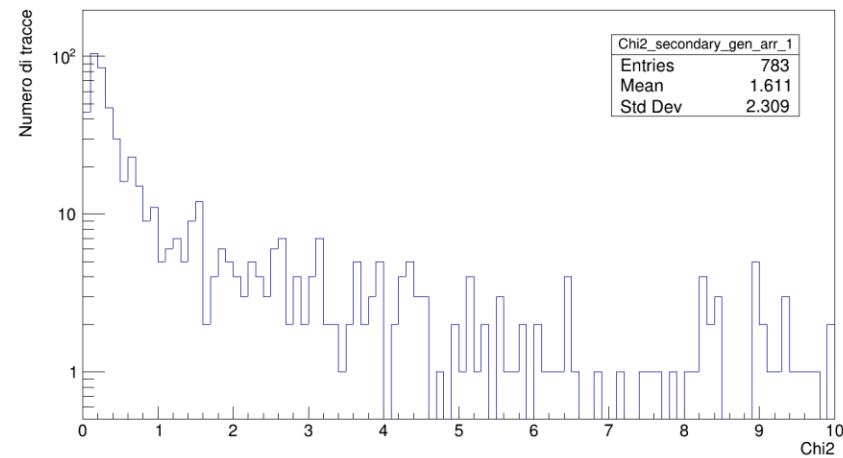
ANALYSIS OF TW-HITS

- A fundamental component to obtain the energy released by particles and the TOF is the measurement of the ToF-Wall point, so each track must have a TW_hit.
- Red = no selection.
- Blue = required TW-hit.

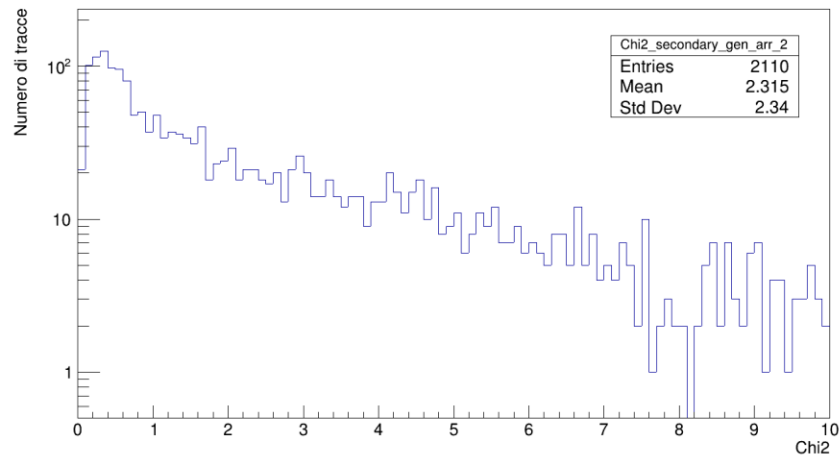
Type 0



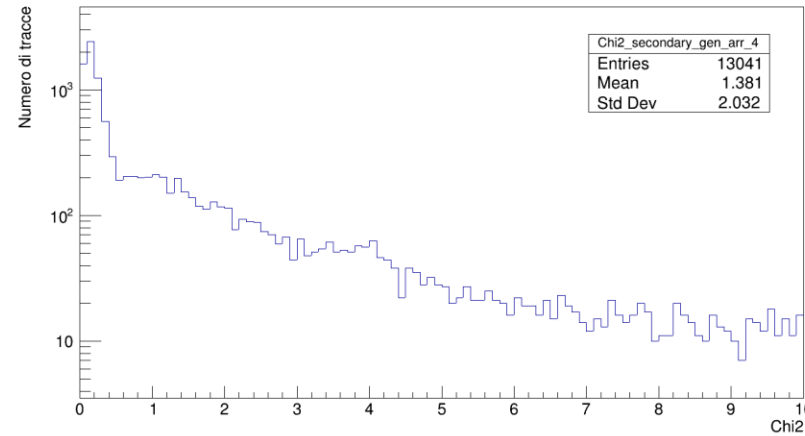
Type 1



Type 2



Type 5



CHI2 CUT

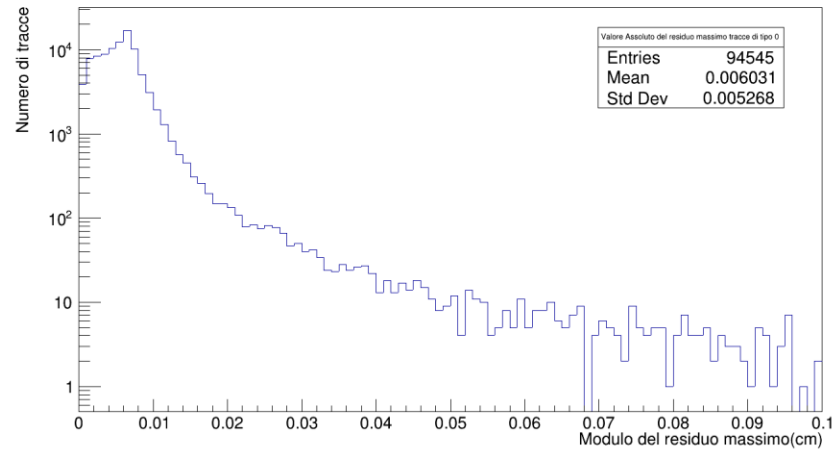
- The cut has been set at $CHI2 < 2$.

- 0 = secondary generated in target and arriving to Tof-Wall.
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- 2 = secondary not generated in target, but arriving to Tof-Wall.
- 5 = primary dead downstream of target, but upstream of the Tof-Wall.

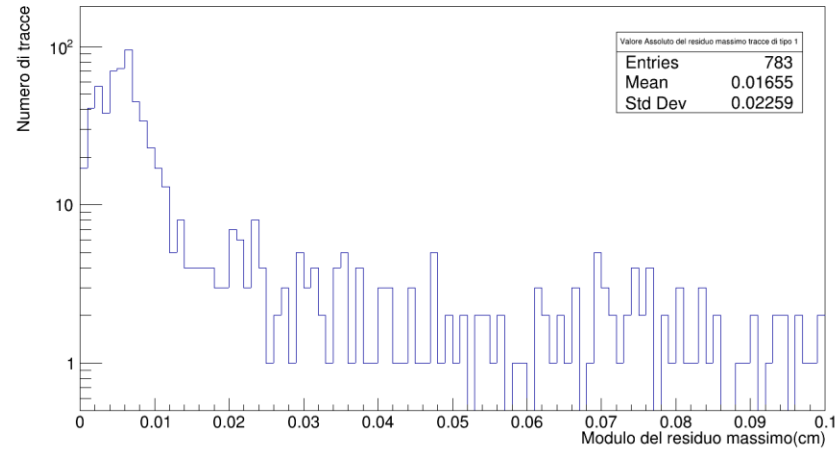
MAXIMUM RESIDUAL CUT

- The residual is the magnitude of the vector difference between the measured point and the fitted point of the track itself.
- The cut has been placed at $\text{Max_res} < 0.01 \text{ cm}$.

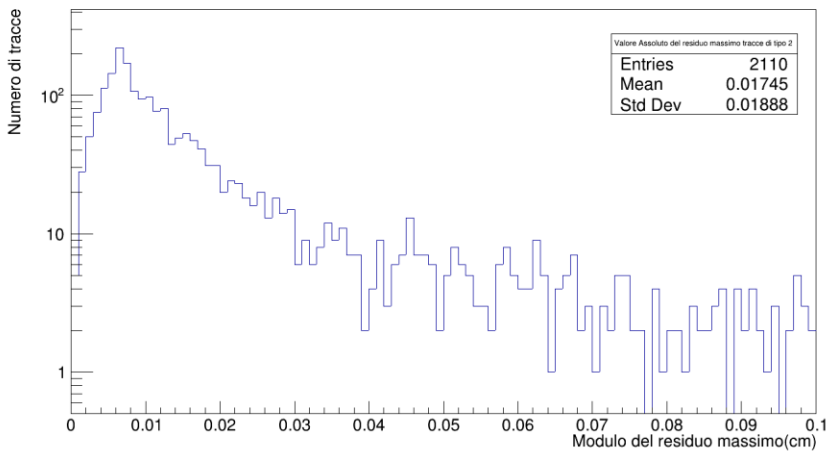
Type 0



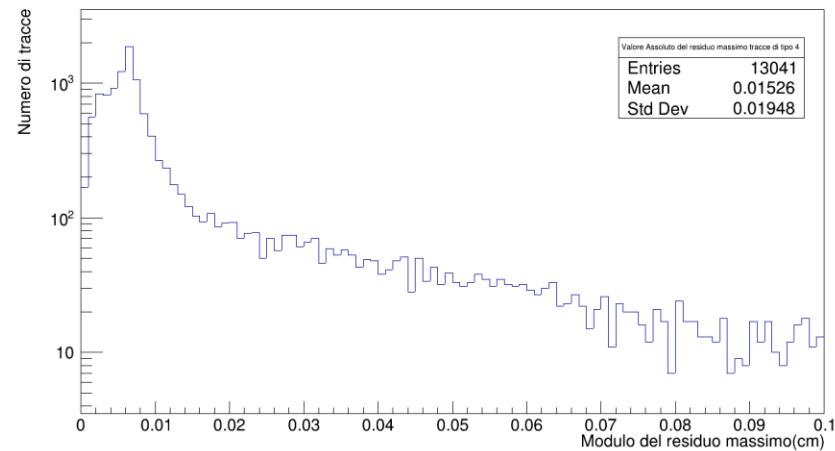
Type 1



Type 2

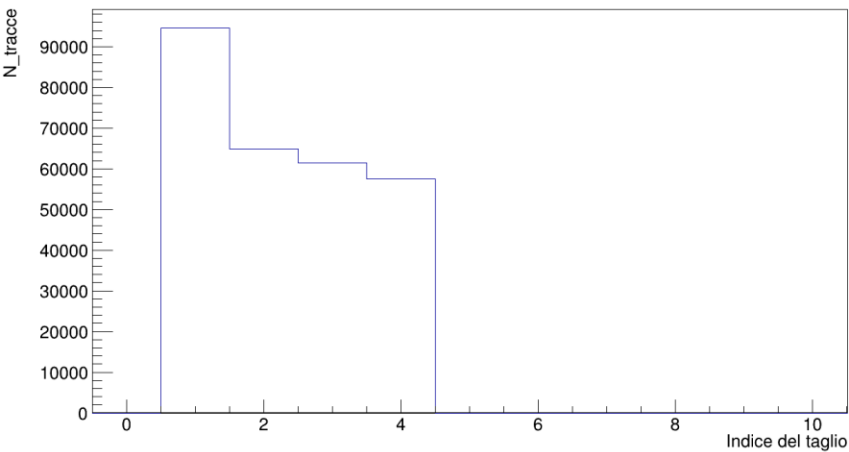


Type 5

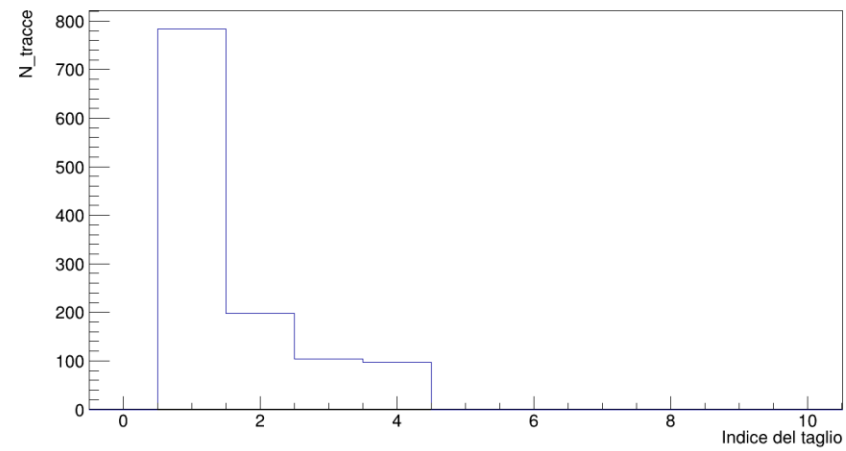


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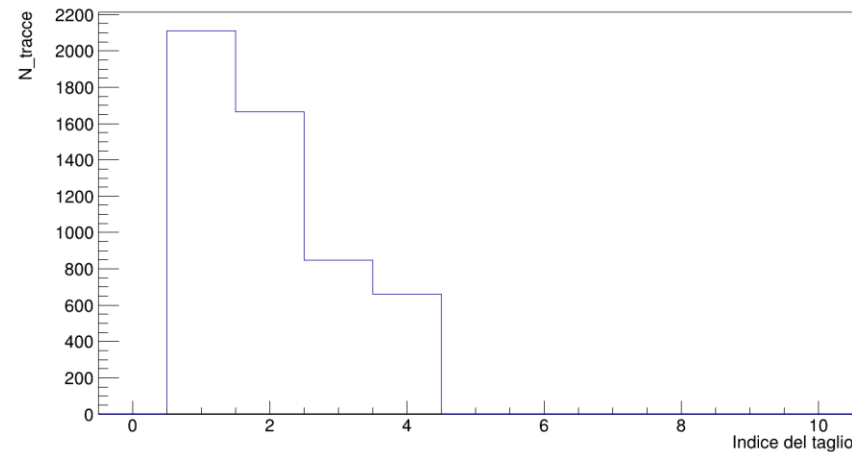
Type 0



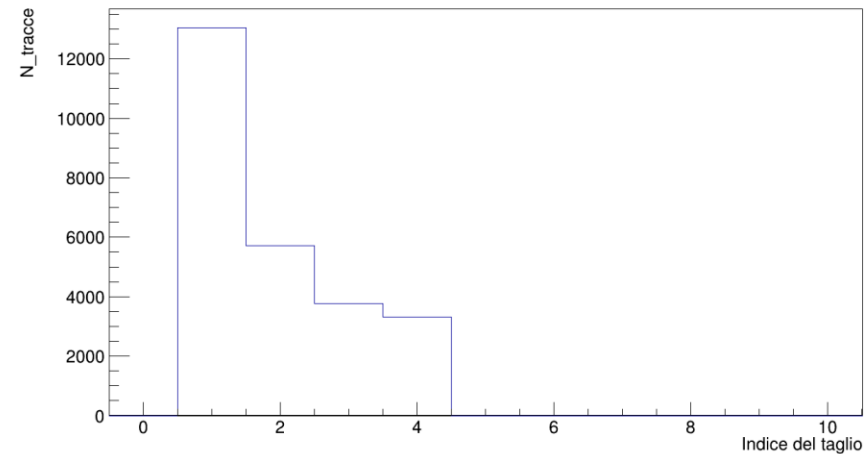
Type 1



Type 2



Type 5

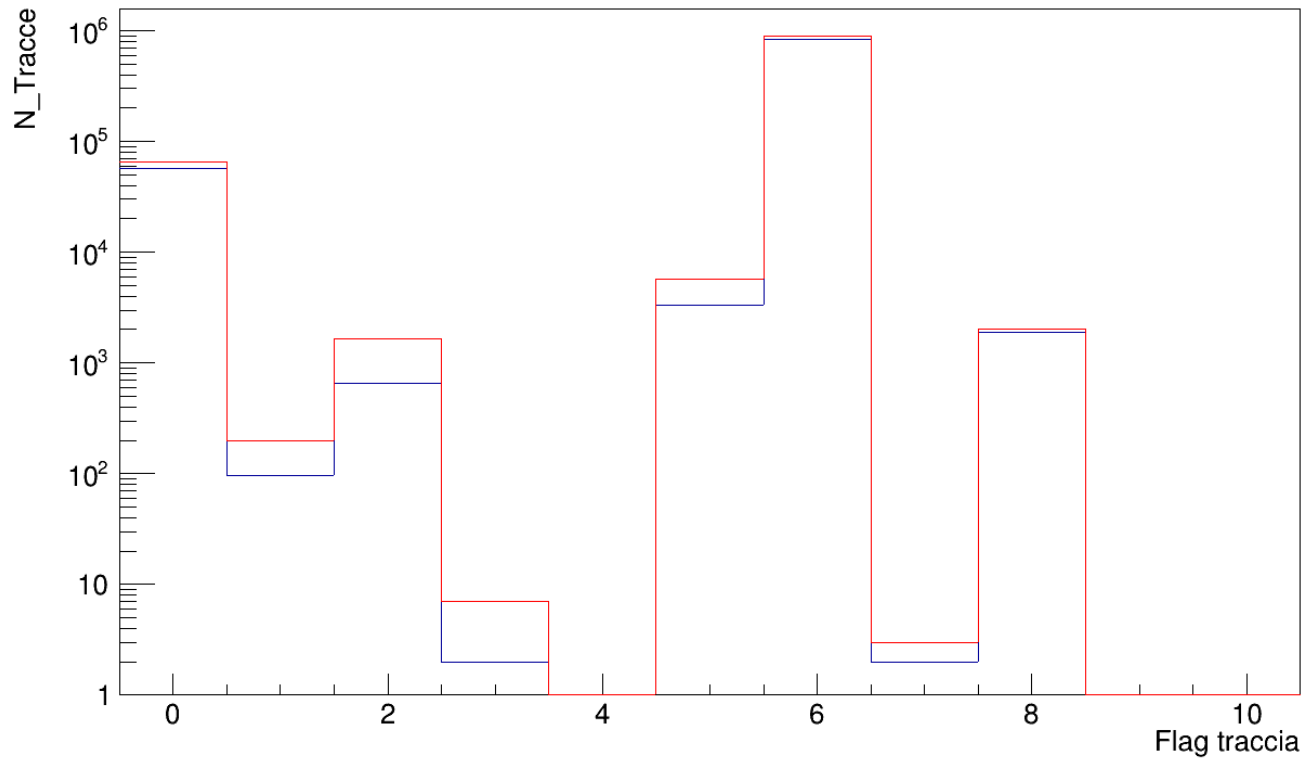


ANALYSES OF THE CUTS FOR EACH KIND OF TRACK

- 0 = secondary generated in target and arriving to Tof-Wall.
- 1 = secondary generated in target, but not arriving to Tof-Wall.
- 2 = secondary not generated in target, but arriving to Tof-Wall.
- 5 = primary dead downstream of target, but upstream of Tof-Wall

- **LEGEND FOR THE X-AXIS**
- 1 = reconstructed tracks.
- 2 = reconstructed tracks with a TW-hit.
- 3 = reconstructed tracks with a TW-hit and $CHI2 < 2$.
- 4 = reconstructed tracks with a TW-hit and $CHI2 < 2$ and $Max_res < 0.01\text{cm}$.

Criteria applied to the tracks



- Tracks with TW-hit (red) and tracks that survived to the cuts (blue).

EFFECT OF THE CUTS

- 0 = secondary generated in target and arriving to Tof-Wall.
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- 3 = secondary not generated in target and not arriving to Tof-Wall.
- 4 = primary dead in target
- 5 = primary dead downstream of target, but before Tof-Wall.
- 6 = primary arriving to Tof-Wall.
- 7 = primary dead upstream of target.
- 8 = secondary generated upstream of target.

TYPE OF TRACKS	NUMBER OF RECONSTRUCTED TRACKS	PERCENTAGE
0	94545	83,75
1	783	0,69
2	2110	1,87
5	13041	11,55
8	2414	2,14
TOT	112893	

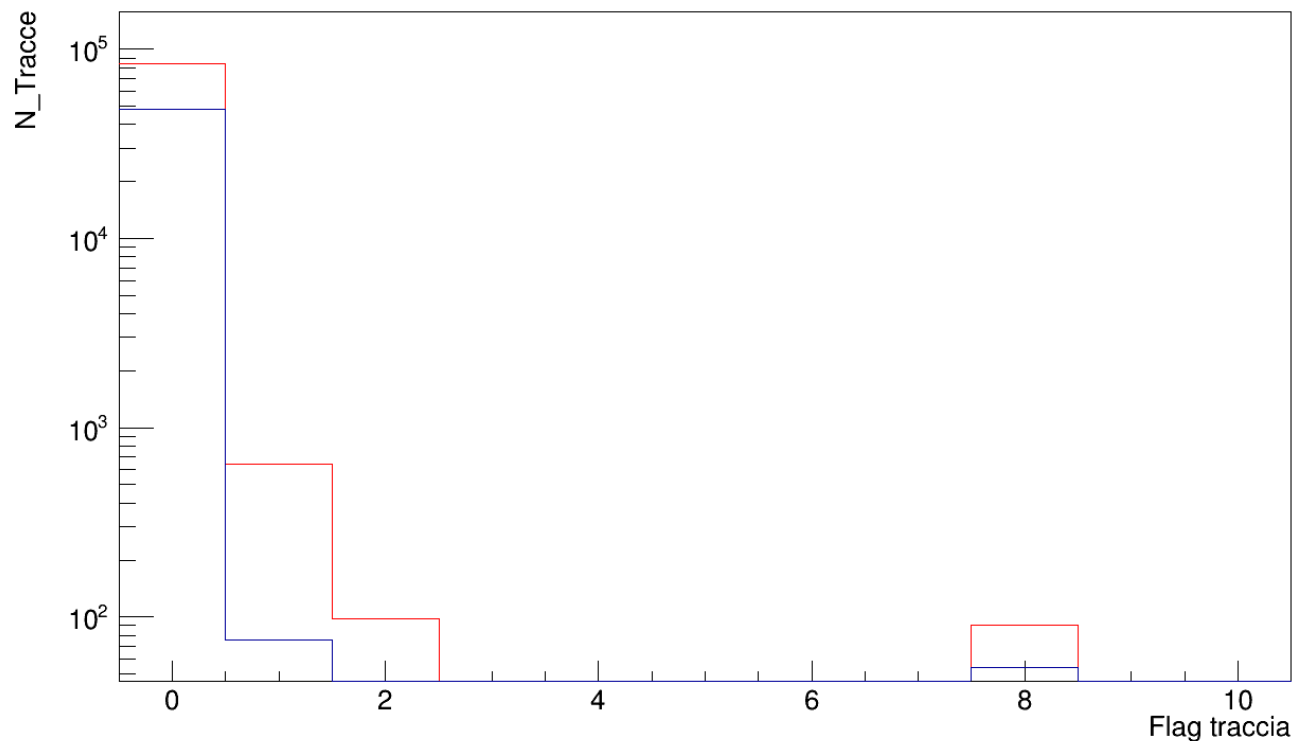
TYPE OF TRACKS	TRACKS WITH TW-HIT	PERCENTAGE
0	64822	87,08
1	198	0,27
2	1665	2,24
5	5722	7,69
8	2036	2,73
TOT	74443	

TYPE OF TRACKS	TRACKS SURVIVED THE CUTS	PERCENTAGE
0	57453	90,57
1	97	0,15
2	661	1,04
5	3323	5,24
8	1904	3,00
TOT	63438	

PERCENTAGE

- Tables that shows the percentages of the different types of secondaries.
- 0 = secondary generated in target and arriving to Tof-Wall.
- 1 = secondary generated in target, but not arriving to Tof-Wall.
- 2 = secondary not generated in target, but arriving to Tof-Wall.
- 5 = primary dead downstream of target, but before Tof-Wall.
- 8 = secondary generated upstream of target.

Track in events with more than one track



- Reconstructed tracks with TW-hit (red) and tracks that survived to the cuts (blue).
- 43% of the type 0 tracks is lost and the remaining background is the 0.4%

TRACKS ANALYSIS IN EVENTS WITH MORE THEN ONE TRACK

0 = secondary generated in target and arriving to ToF-Wall.

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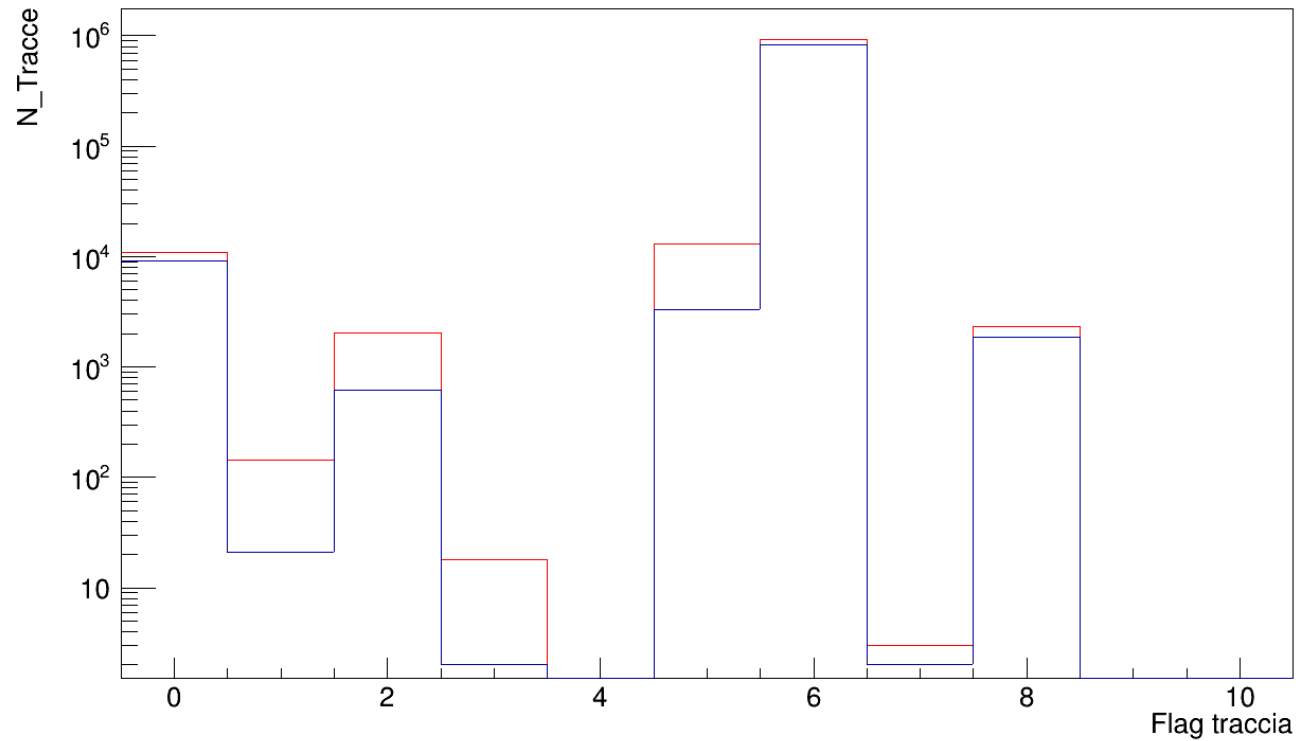
5 = primary dead downstream of target, but before ToF-Wall.

6 = primary arriving to ToF-Wall.

7 = primary dead upstream of target.

8 = secondary generated upstream of target.

Track in events with one track



- Reconstructed tracks with TW-hit (red) and tracks that survived to the cuts (blue).
- 17% of the type 0 tracks is lost and the remaining background is the 38.7%

TRACKS ANALYSIS IN EVENTS WITH ONE TRACK

0 = secondary generated in target and arriving to Tof-Wall.

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2 = secondary not generated in target, but arriving to Tof-Wall.

3 = secondary not generated in target and not arriving to Tof-Wall.

4 = primary dead in target

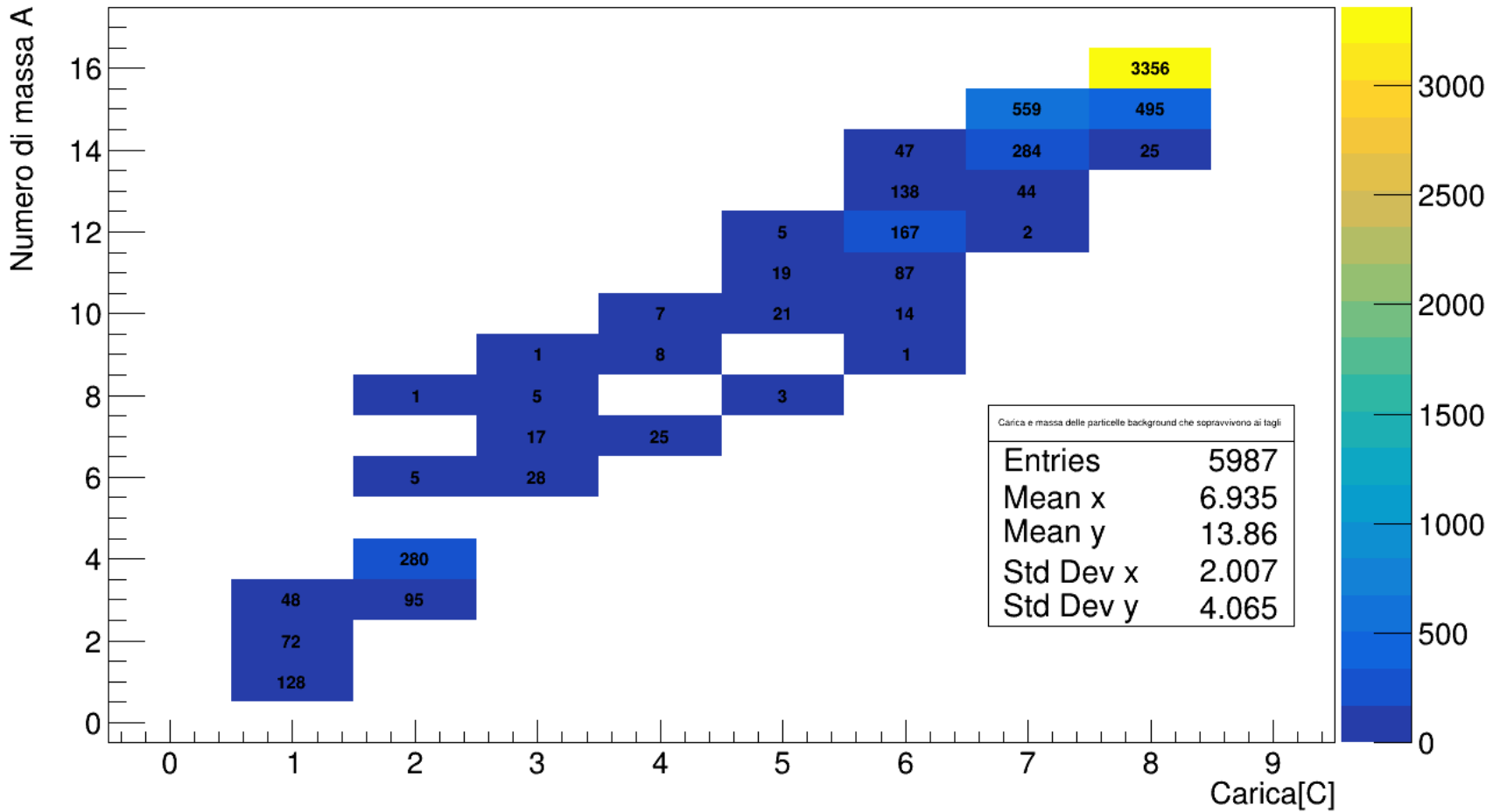
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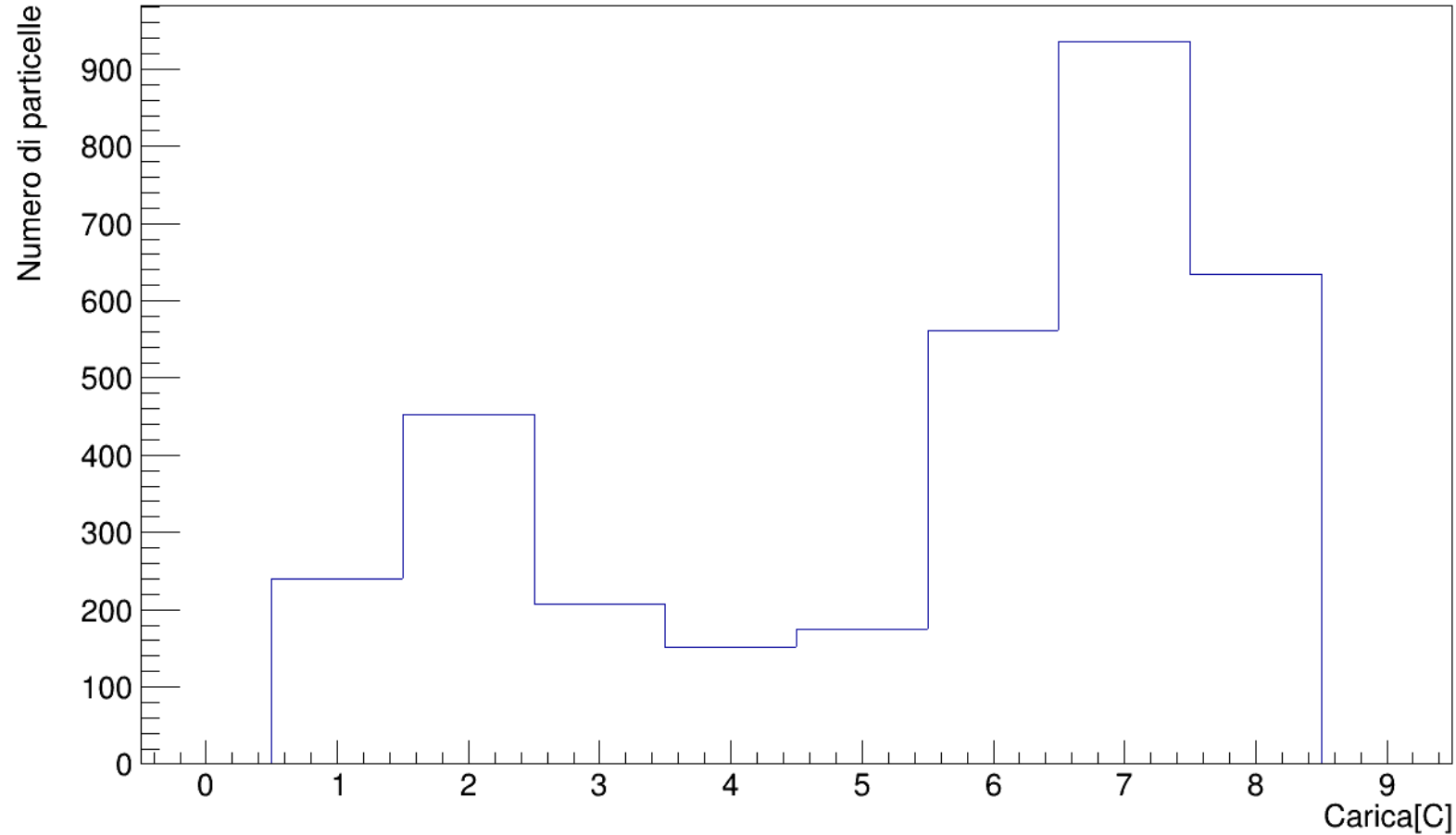
Charge and mass of the background MainMc-Track-Id particle, that survived the cuts.



SURVIVED PARTICLES

- Charge and mass of the background MainMc-Track-Id particle, that survived the cuts.
- A lot of them are oxygen (type 5), because is the primary that fragments after the target.
- This tracks can be distinguished for example using the difference between the cluster size of the MSD's layers.

TW reconstructed charge of background tracks that survived the cuts and have oxygen as Main-Mc-Track-Id particle.



SURVIVED PARTICLES

- TW-charge associated to the track that survived the cuts and that has oxygen as MainMc-Track-Id particle.
- We can try to split them combining the TW charge and the cluster size of the msd.

CONCLUSIONS

- The minimum number of points in the tracks has been optimized by evaluating efficiency and purity:
 - minimum number of hits: 5
 - the purity does not vary changing this number,. Purity $\sim 0.98-0.99$
 - the efficiency is higher for a low number of points. Efficiency $\sim 0.95-1$
- Track selection criteria to identify secondary fragmentation:
 - request of a tw hit, $\chi^2 < 2$ and maximum residual < 0.01 . The tw hit request is the strongest cut
 - survival fraction of tracks born in target that arrive till the TW: TWhit request: 69%; all the cuts: 61%
 - survival fraction of background tracks: TWhit request: 52%, all the cuts: 33%
- There are two families of events:
 - Multi track events: only 0.4% of background events passes the selection criteria
 - Single track events: 38.7% of background events passes the selection criteria
- The tracks that survive the cuts are those in which the primary fragments into an isotope or a heavy particle: such tracks could be identified with information from the various sub detectors.

BACK UP

TYPE OF TRACKS	NUMBER OF RECONSTRUCTED TRACKS	TRACKS WITH TW-HIT	%_RIMASTA
0	94545	64822	68,56
1	783	198	25,29
2	2110	1665	78,91
5	13041	5722	43,88
8	2414	2036	84,34

TYPE OF TRACKS	NUMBER OF RECONSTRUCTED TRACKS	TRACKS SURVIVED THE CUTS	%_RIMASTA
0	94545	57453	60,77
1	783	97	12,39
2	2110	661	31,33
5	13041	3323	25,48
8	2414	1904	78,87

TYPE OF TRACKS	TRACKS WITH TW-HIT	TRACKS SURVIVED THE CUTS	%_RIMASTA
0	64822	57453	88,63
1	198	97	48,99
2	1665	661	39,70
5	5722	3323	58,07
8	2036	1904	93,52

PERCENTAGE

- Tables that shows the percentages of the different types of secondaries.

DEAD POSITION TYPE 4

