FOOT

FramentatiOn
Of Target

Update on trigger

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Goal

- Limited acquisition rate of the experiment $\longrightarrow$ ~1 kHz $\xrightarrow{\text{Fragmentation = 5\%}}$ ~50 Hz

- **Goal** : select interesting events introducing a Trigger on data using TW detector

- 1^{st} trigger: introduce in the MC a threshold in Energy loss on the two central bars of TW

- 2^{nd} trigger: require another hit somewhere in TW when there's a signal from the central bars

- **File** : ^{12}C (200 MeV/u) $\longrightarrow C_2H_4$

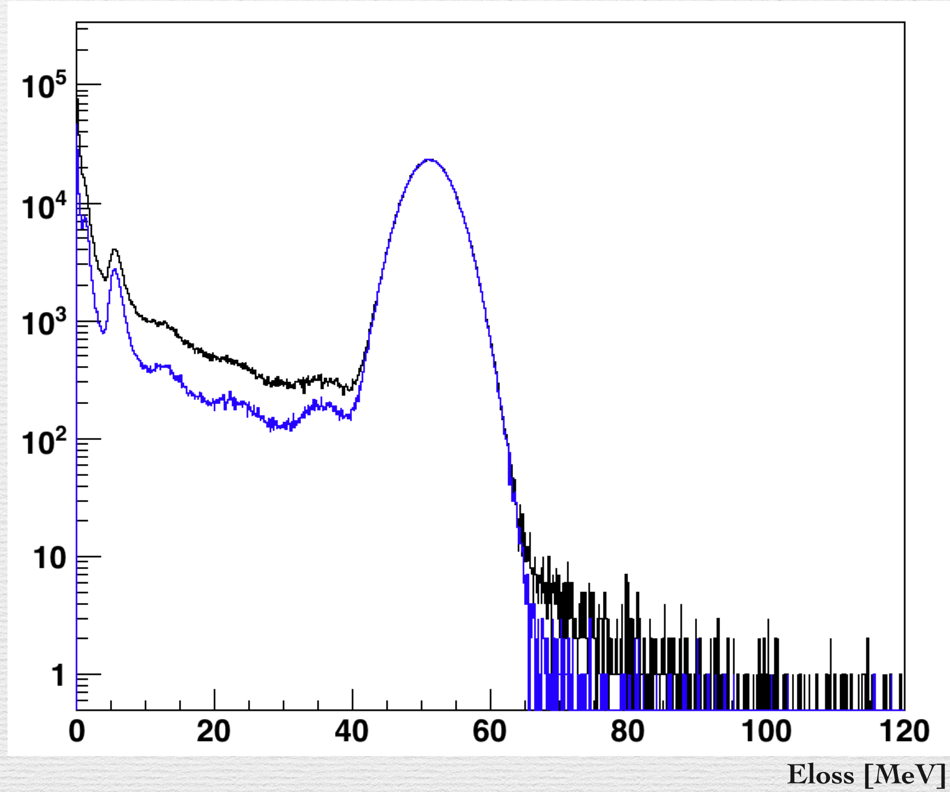
  $2 * 10^6$ events

  Untriggered (all primaries included)

First Trigger implementation

- Untriggerd files are quite different from the triggered ones (lot of background) $\longrightarrow$ to clean the sample:

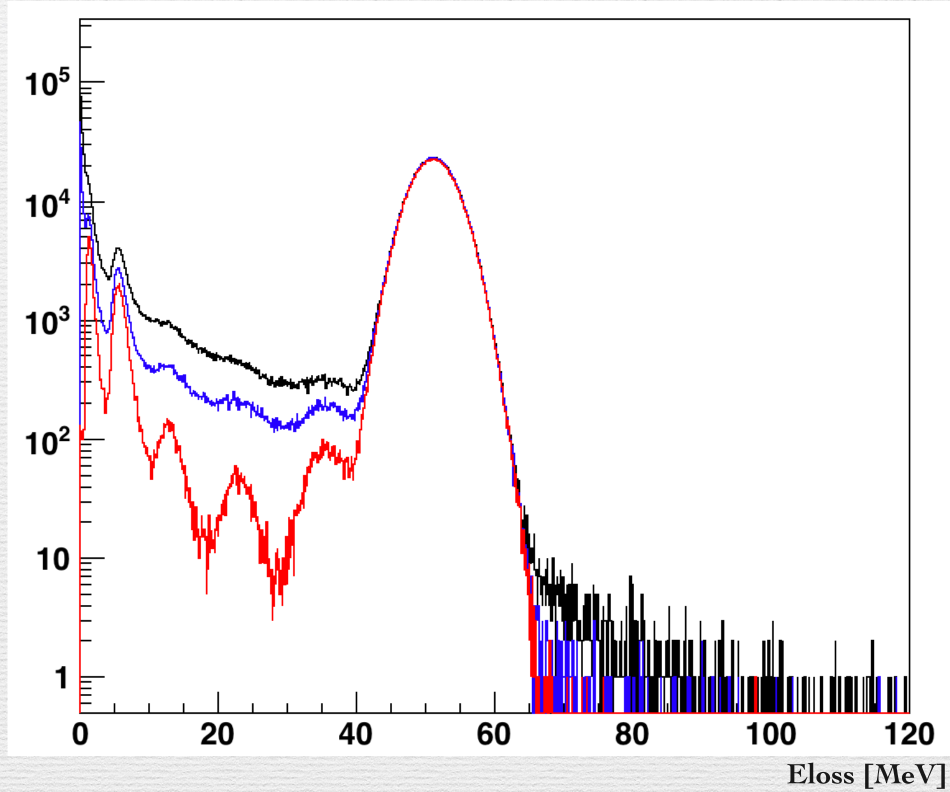
1. No Multi hit



First Trigger implementation

- Untriggerd files are quite different from the triggered ones (lot of background) $\longrightarrow$ to clean the sample:

1. No Multi hit
2. Z <= Z beam



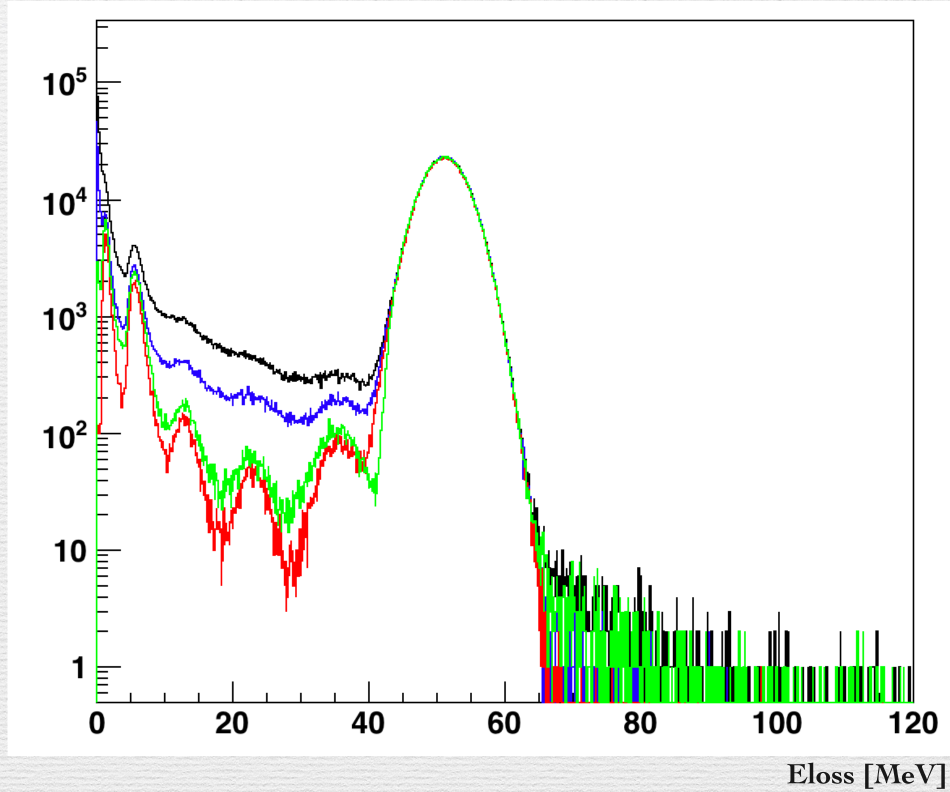
First Trigger implementation

- Untriggerd files are quite different from the triggered ones (lot of background) ⟶ to clean the sample:

  1. No Multi hit

  2. Z <= Z beam

- We have tuned the ZID reconstruction algorithm also for CNAO campaign

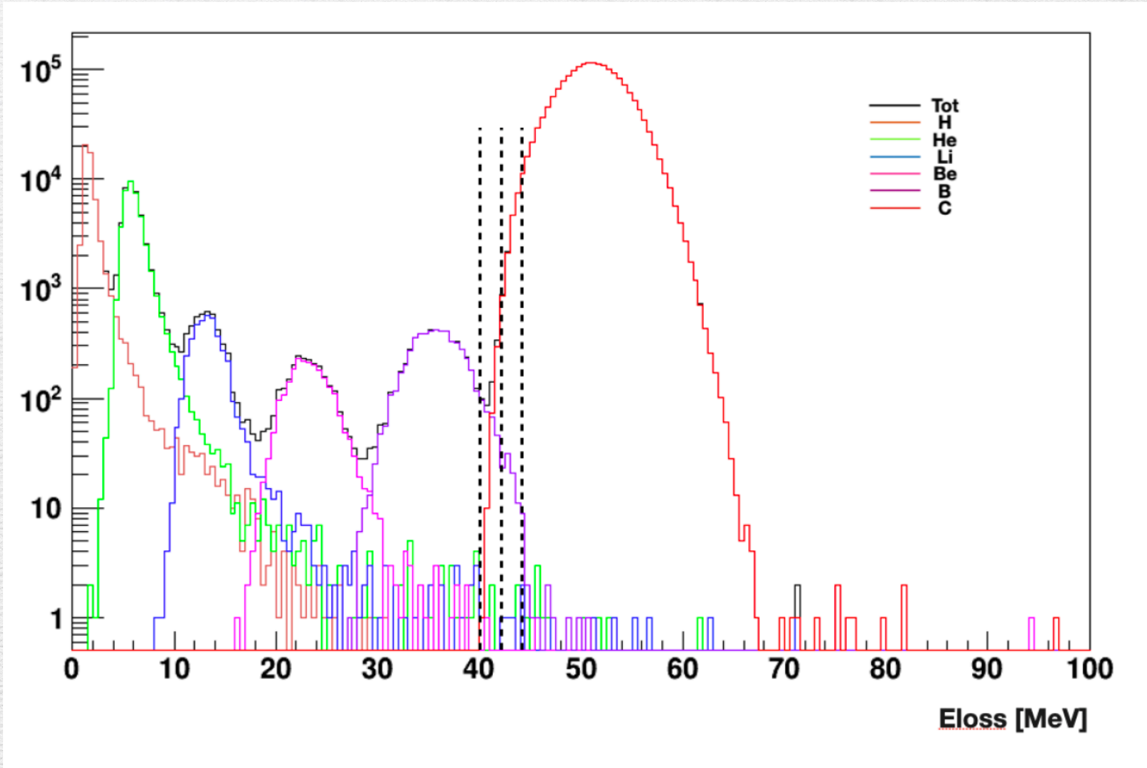


First Trigger implementation

- Starting from these yields we have chosen **3 different** thresholds to study:

1. Eloss = 38 MeV
2. Eloss = 42 MeV
3. Eloss = 46 MeV

We take all fragments arriving on the TW except the ones hitting the bars n° 9 (front and rear) with energy loss (front or rear) above the threshold



First Trigger implementation

- Trigger Efficiencies: ratio for each Z between events selected with TW trigger and MB trigger

$$\frac{Y(Z)_{TW}}{Y(Z)_{MB}}$$

Threshold: 38		Threshold: 42		Threshold: 46	
B	97.32%	B	99.74%	B	100%
C	1.40%	C	1.45%	C	9.33%
$^{10}C+^{11}C$	60.82%	$^{10}C+^{11}C$	60.84%	$^{10}C+^{11}C$	64.40%

Fraction of primaries selected with this TW trigger with respect to the MB trigger

First Trigger implementation

- Trigger Efficiencies: ratio for each Z between events selected with TW trigger and MB trigger

$$\frac{Y(Z)_{TW}}{Y(Z)_{MB}}$$

Threshold: 38	
B	97.32%
C	1.40%
$^{10}C +^{11}C$	60.82%

Threshold: 42	
B	99.74%
C	1.45%
$^{10}C +^{11}C$	60.84%

Threshold: 46	
B	100%
C	9.33%
$^{10}C +^{11}C$	64.40%

- **A choice needs to be taken**: a compromise between the number of fragments we want to take and the bias we'll introduce

First Trigger implementation

- Fragmentation percentage for each fragment:
- using a MB trigger $\longrightarrow$ $\frac{N(Z)}{N_{tot}}|_{MB}$
- using the TW trigger, for each threshold $\longrightarrow$ $\frac{N(Z)}{N_{tot}}|_{TW}$

MB trigger	
H	2.78%
He	2.07%
Li	0.21%
Be	0.12%
B	0.29%
C	94.53%

TW trigger	Thr 38 MeV
H	41.12%
He	30.69%
Li	3.11%
Be	1.76%
B	4.13%
C	19.17%

TW trigger	Thr 42 MeV
H	40.91%
He	30.53%
Li	3.09%
Be	1.75%
B	4.21%
C	19.49%

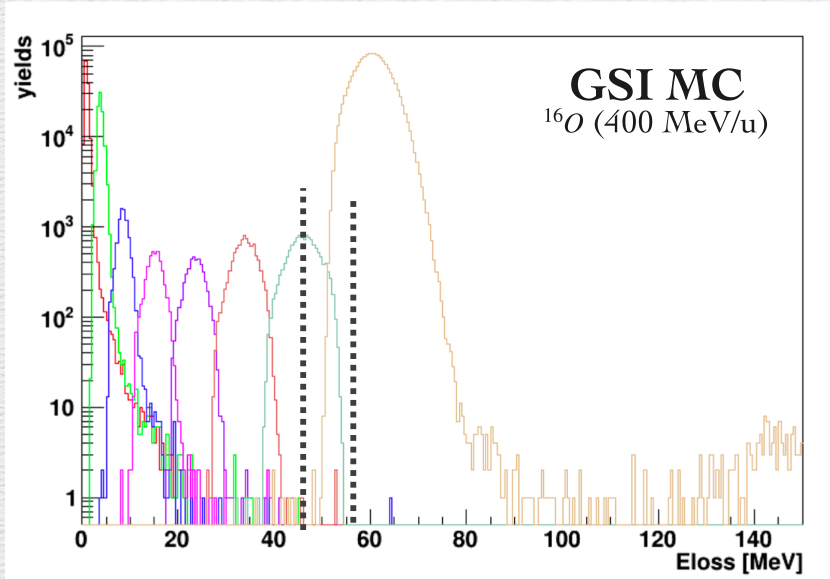
TW trigger	Thr 46 MeV
H	19.44%
He	14.51%
Li	1.47%
Be	0.83%
B	2.00%
C	61.73%

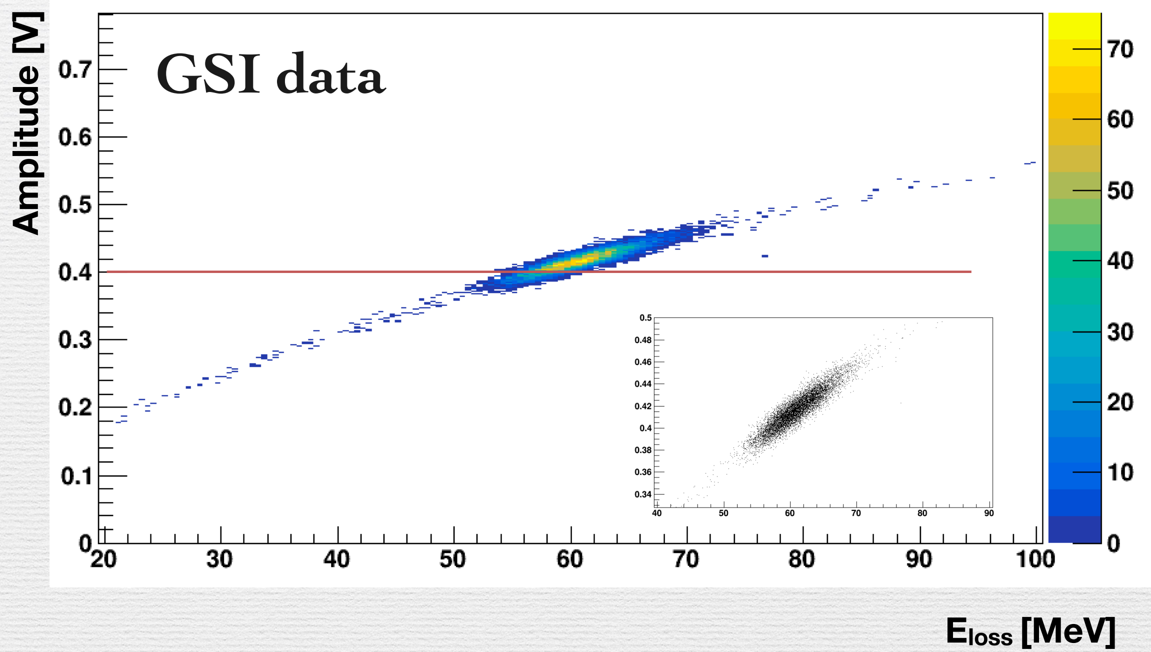
Correlation amplitude vs Eloss

- From the hardware point of view the threshold in E_{loss} has to be translate in a signal amplitude threshold

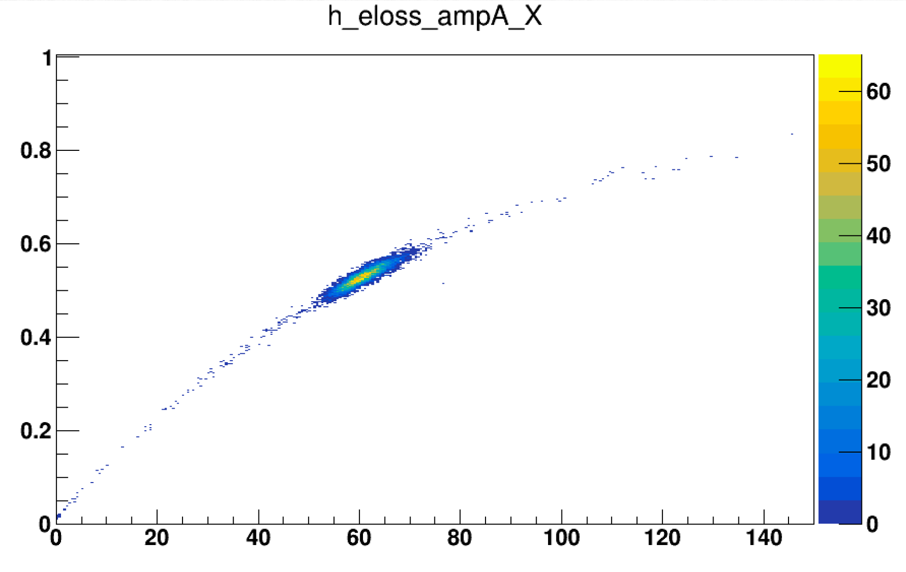
Ex:

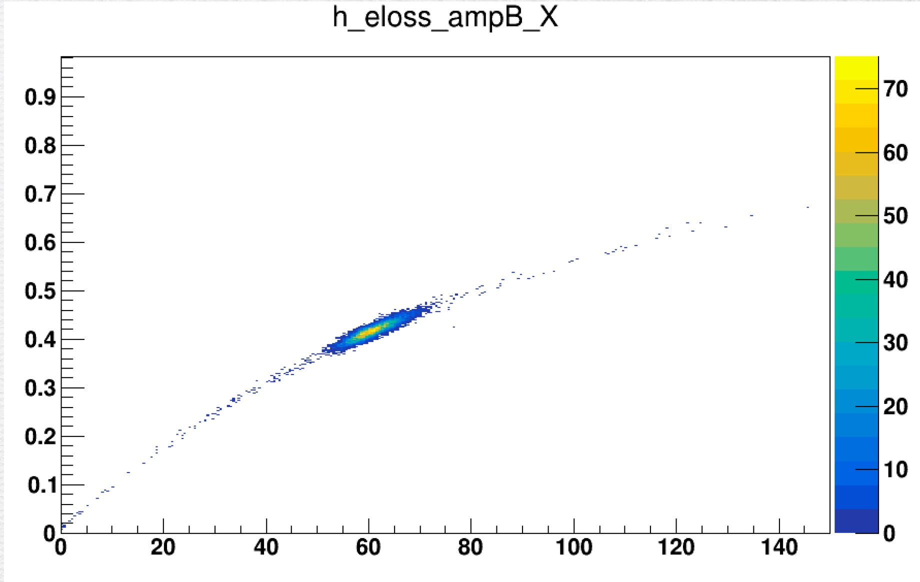
Amp = 0.4 V -> E_{loss} = 54-58 MeV

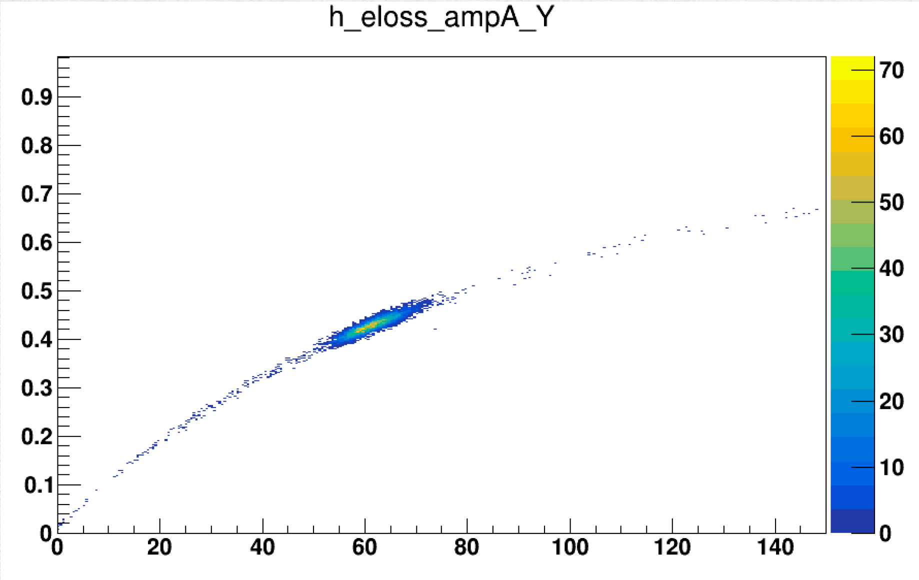


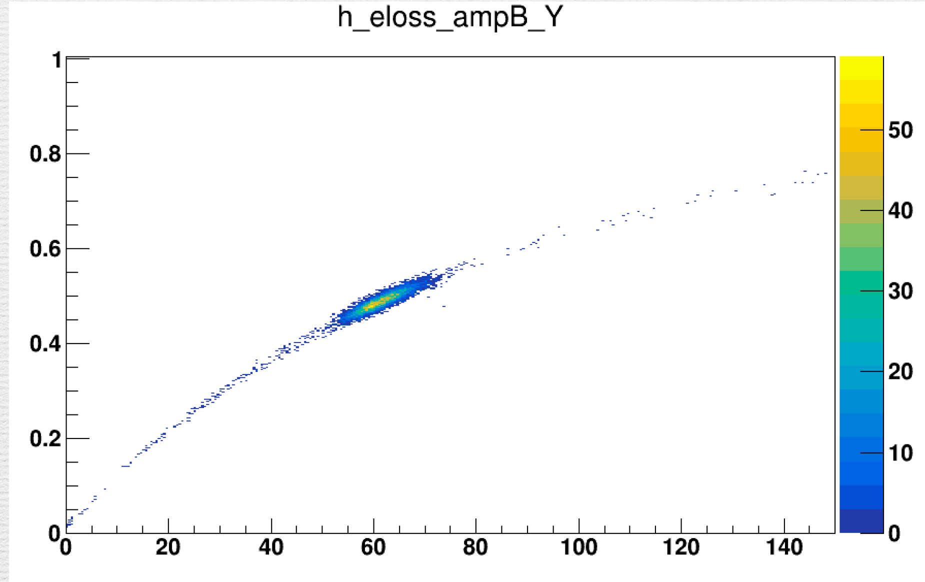


- Fix an amplitude threshold means to take an energy loss range of about 4-5 MeV


h_eloss_ampA_X


h_eloss_ampB_X

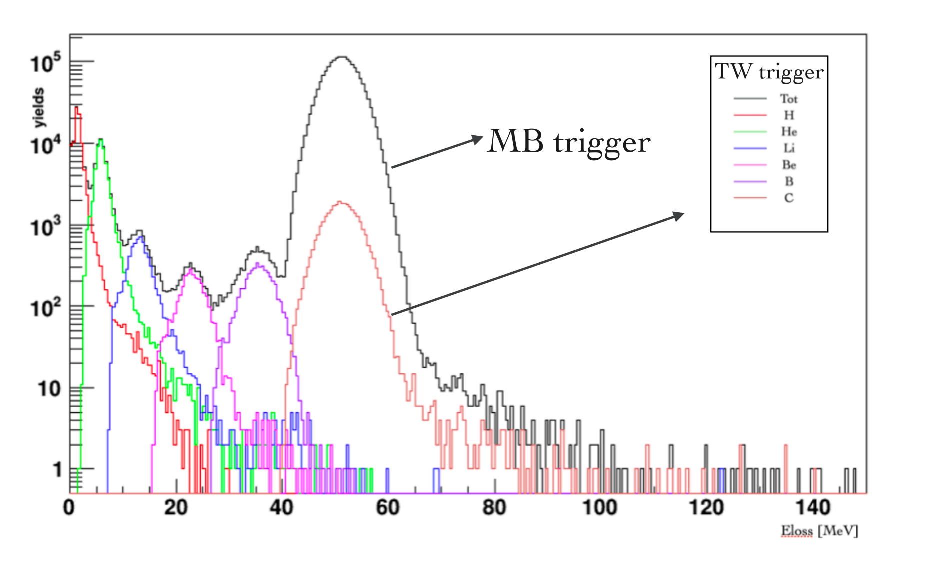

h_eloss_ampA_Y


h_eloss_ampB_Y

Second Trigger implementation

- We count the hits on the central bars (number 9 of the front layer and of the rear layer) only if there is another hit somewhere in the TW

- The bias we will introduce on the fragments (especially on B) is more significant with respect to the other trigger



Efficiencies	
H	98.06%
He	95.23%
Li	92.19%
Be	85.45%
B	58.09%
C	1.66%

	MB	TW
C	94.53%	16.47%

$\frac{N(Z)}{N_{tot}}\cdot_{MB}$

$\frac{N(Z)}{N_{tot}}|_{TW}$

1^{st} Trigger vs 2^{nd} Trigger

1^{st} trigger:

Efficiencies	Threshold: 46
H	100%
He	100%
Li	100%
Be	100%
B	100%
C	9.33%

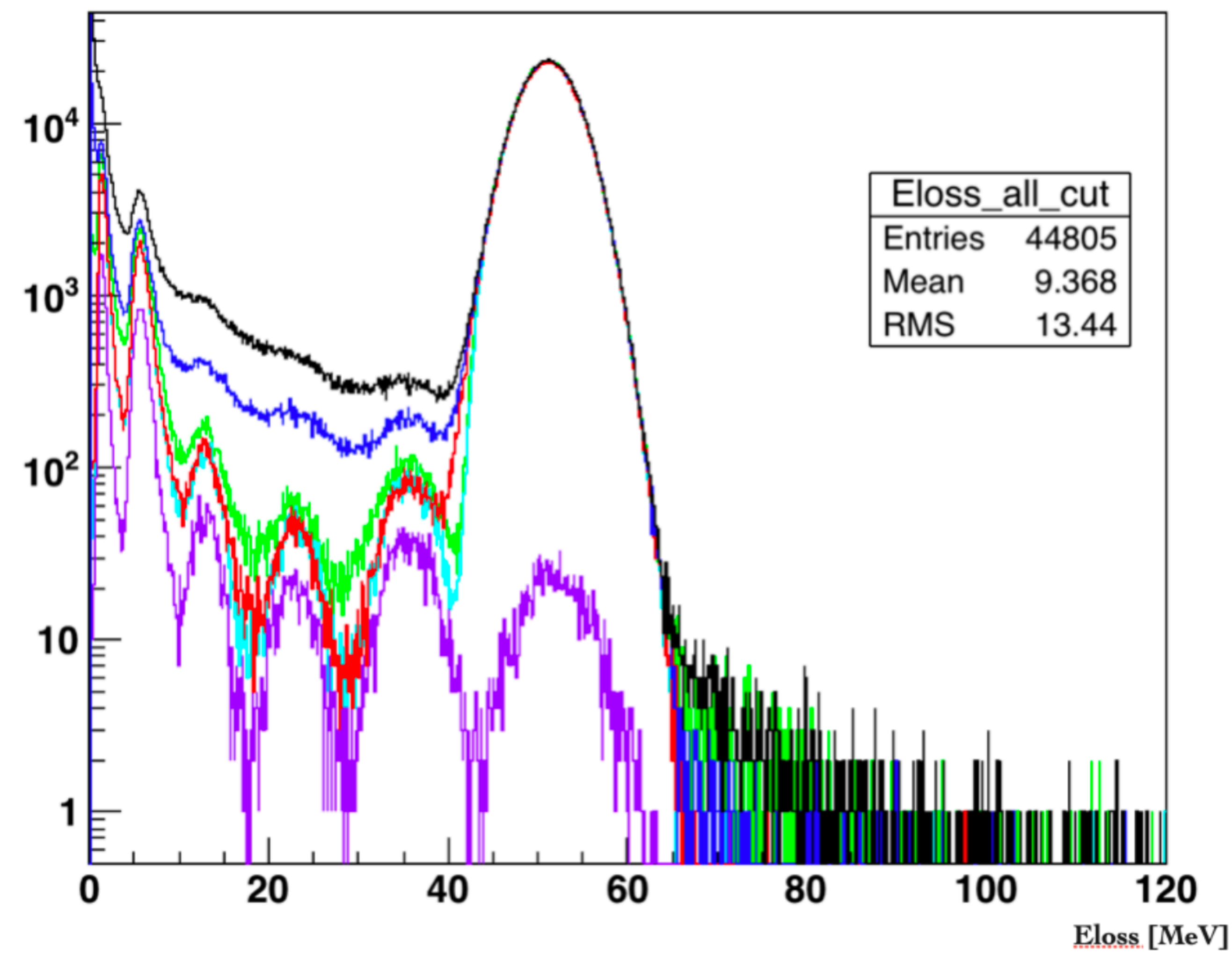
- Very small bias introduced for B (and C fragments)
- Compromise between few % systematics trigger bias and amount of primaries acquired (1%->10%)

2^{nd} trigger:

Efficiencies	
H	98.06%
He	95.23%
Li	92.19%
Be	85.45%
B	58.09%
C	1.66%

- Greater bias (to evaluate properly)
- Low amplitude thresholds have to be set to remove noise (in order not to take as good events primary+noisy hit somewhere in TW)

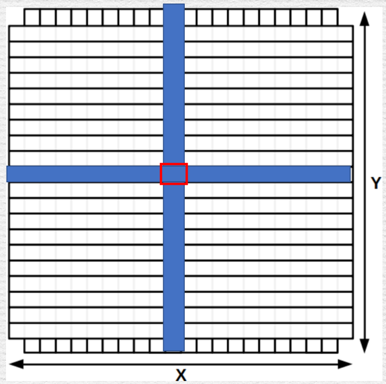
SPARE SLIDES

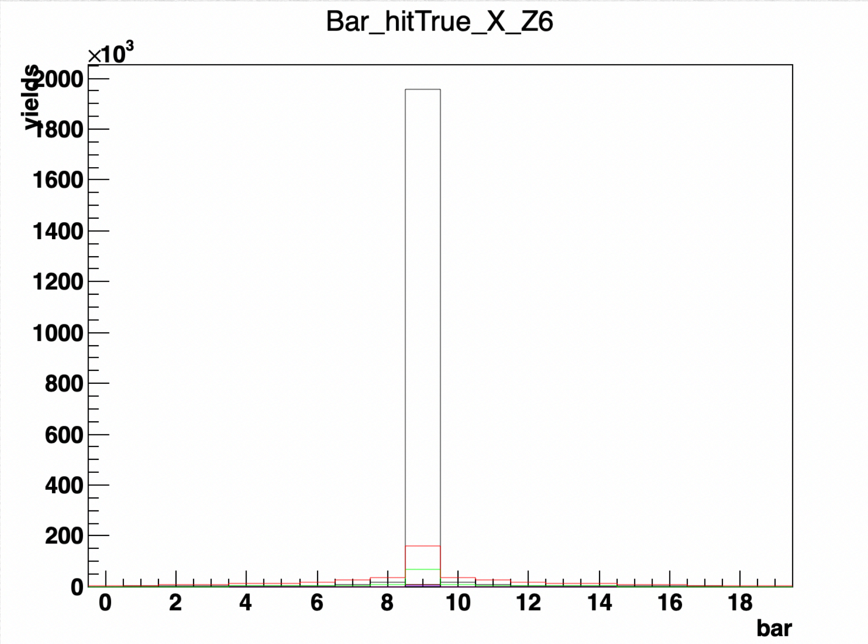


Eloss_all_cut
Entries 44805
Mean 9.368
RMS 13.44
10^4
10^3
10^2
10
1
0
20
40
60
80
100
120
Eloss [MeV]

MB trigger vs TW trigger

- We want to compare the **Minimum Bias** trigger to the one in which we introduce a veto using the central bars (n° 9) of the **Tof Wall**



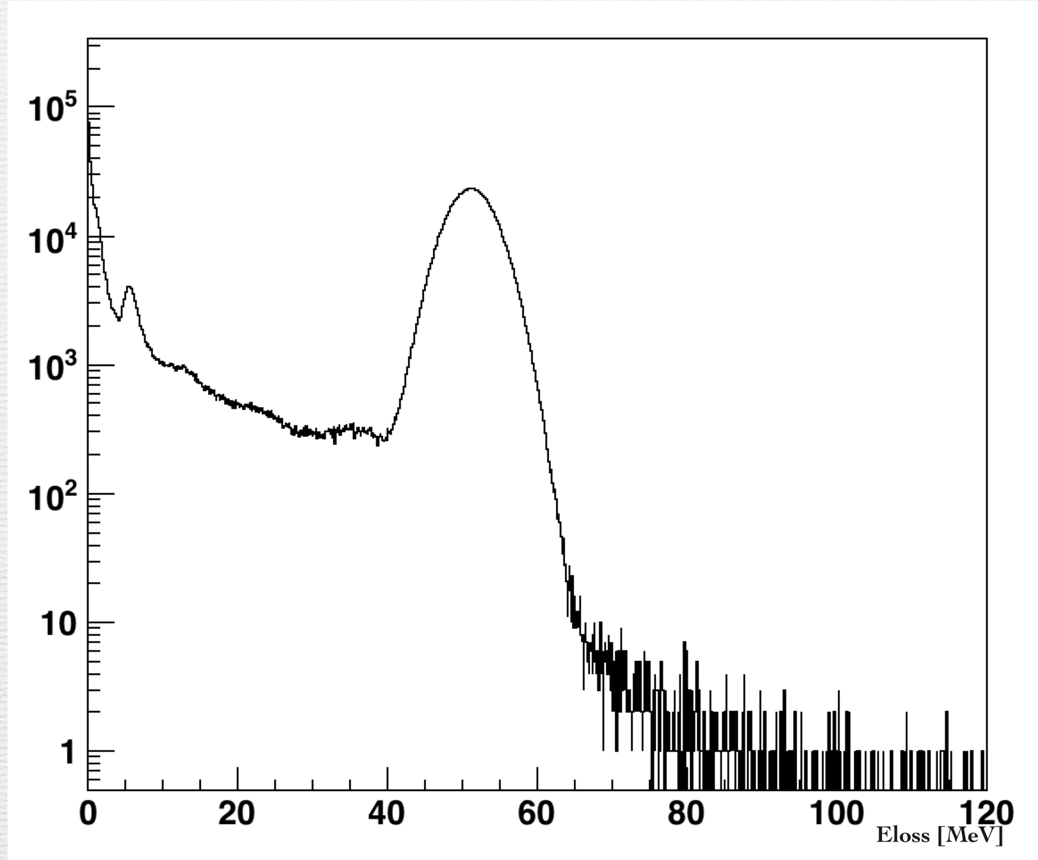


Cut away most of the primary ions

Yields of Energy Loss

- Untriggerd files are quite different from the triggered ones (lot of background)

- Looking at the Energy Loss yields, in order to clean our sample, we make some cuts:



Yields of Energy Loss

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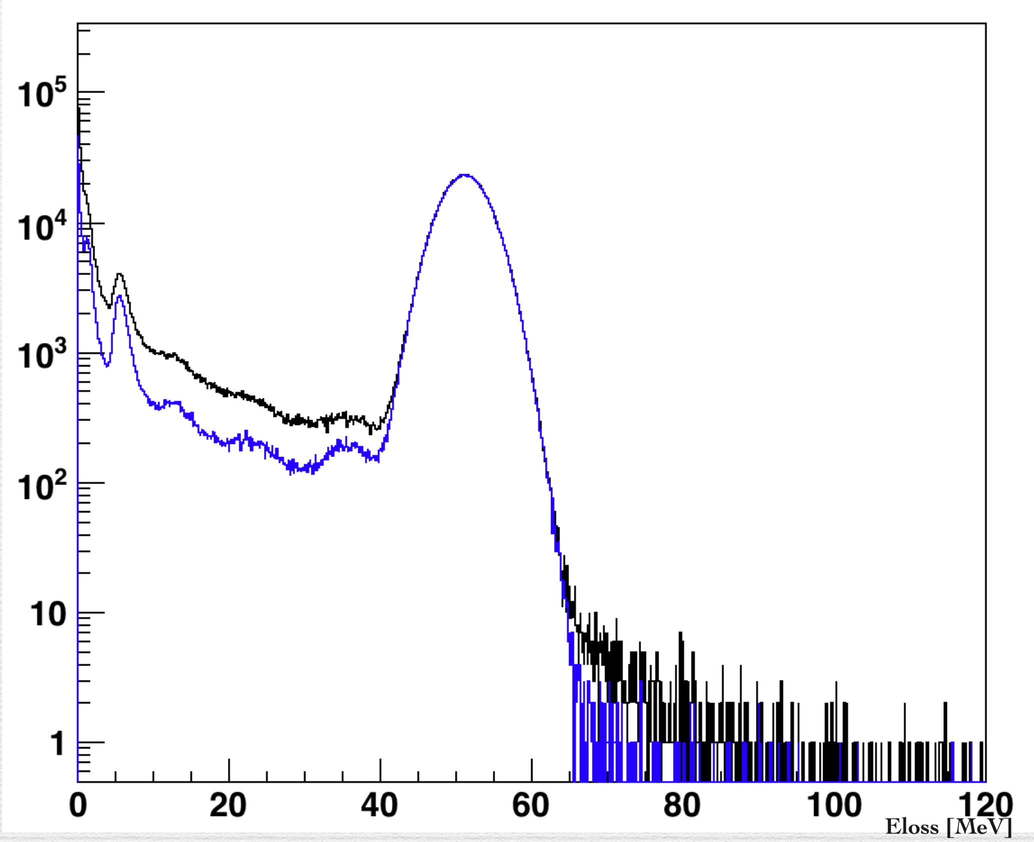
  1. No Multi hit



Yields of Energy Loss

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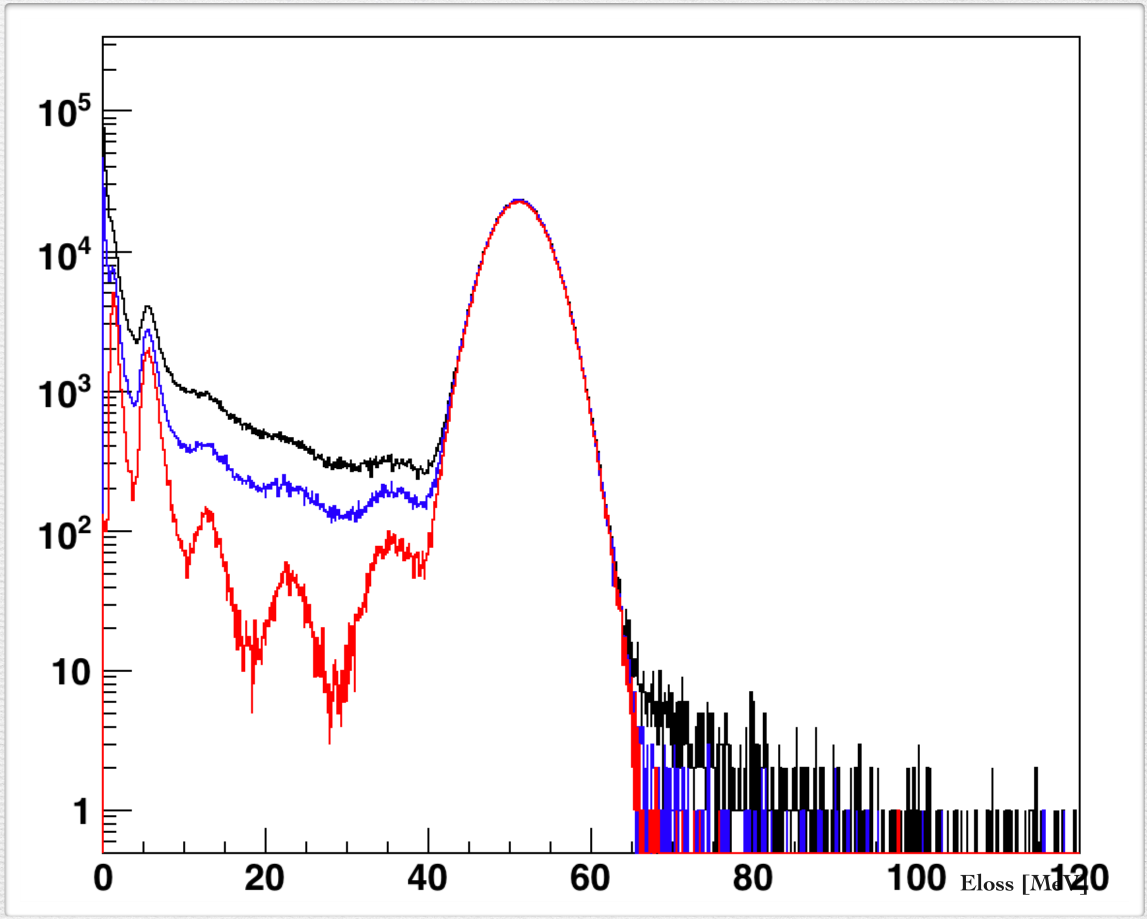
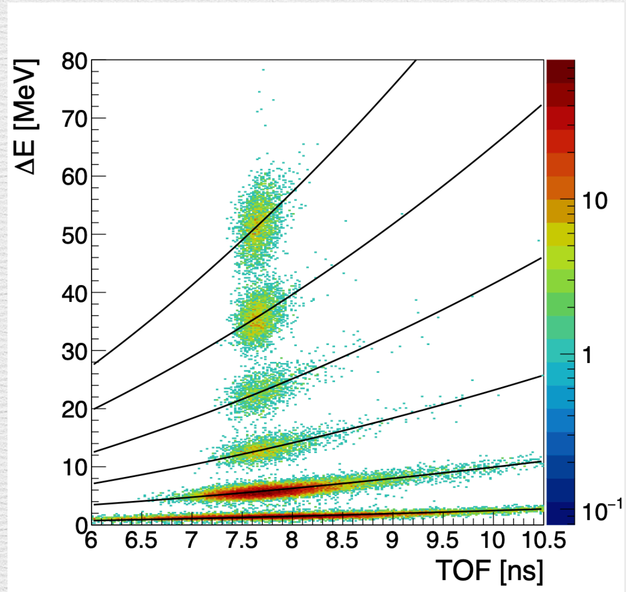
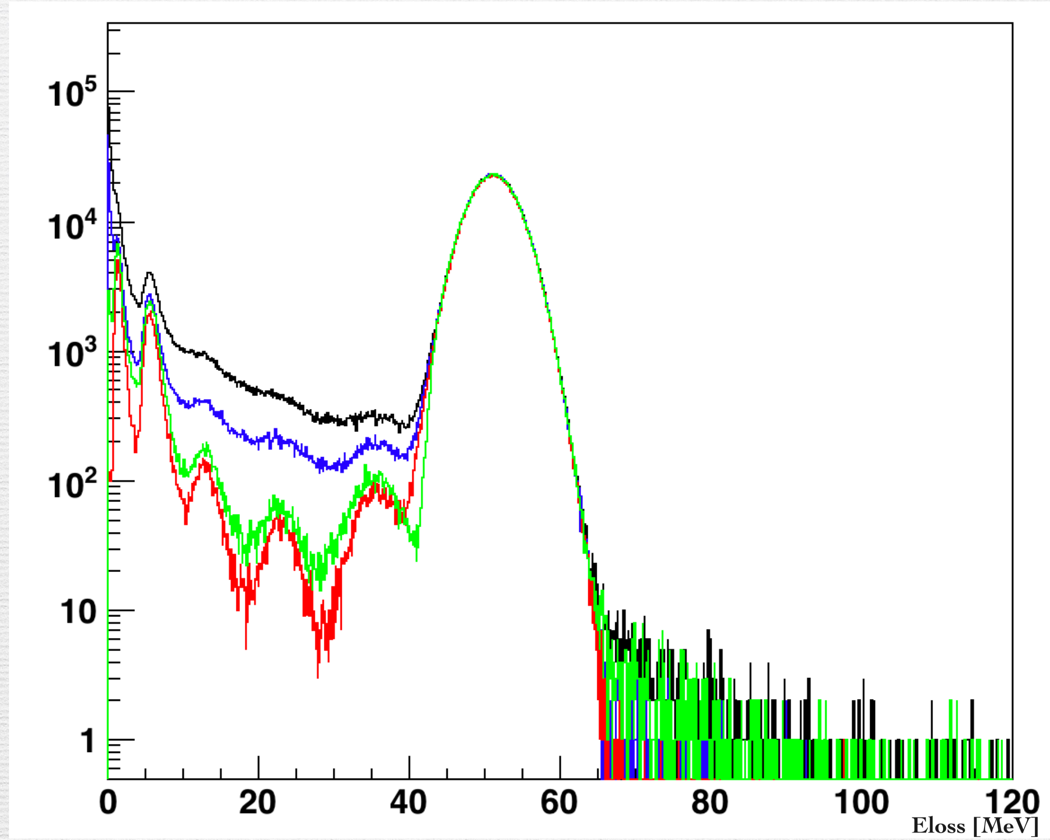
    2. Z <= Z beam



Yields of Energy Loss

3. We have tuned the charge reconstruction algorithm also for CNAO campaign as already done for other campaigns in shoe [GSI, full geo: 12C_200, 16O_200]

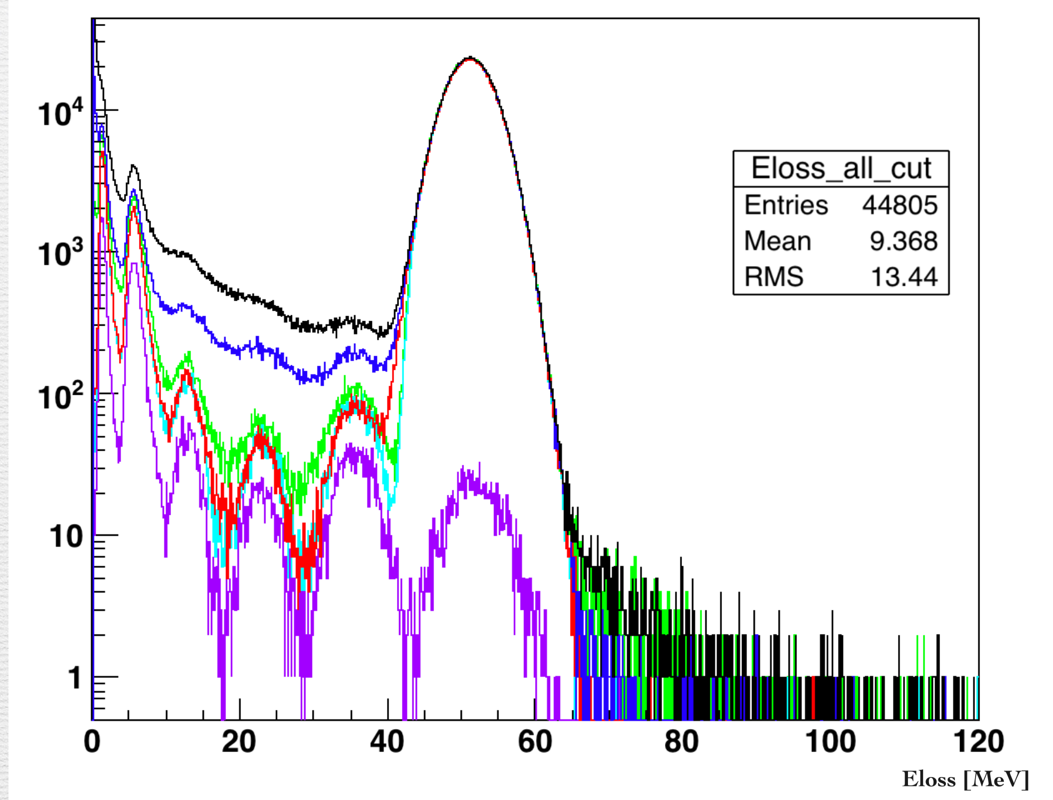




Yields of Energy Loss

- Requiring for Zrec all the primary fragments produced in the TG arriving on the TW we obtain these distributions

This tells us the primary fragmentation is $\boxed{\sim 2.2\%}$



Yields of Energy Loss

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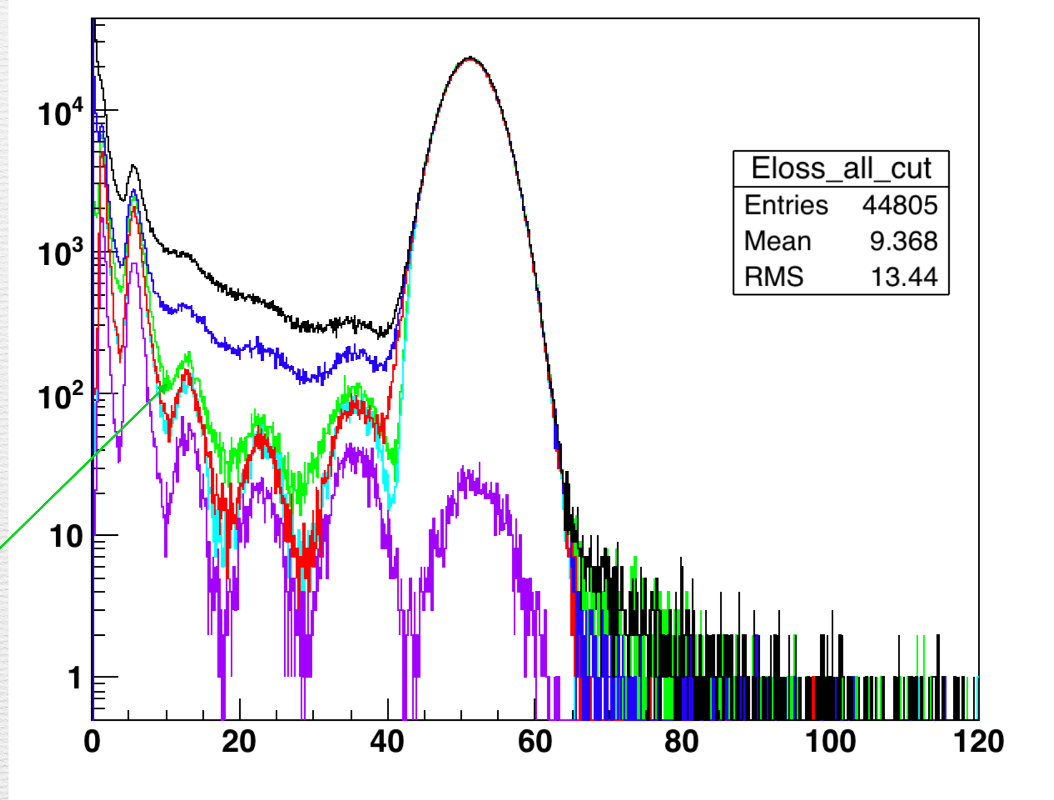
- For this study we decide to take the more data-like situation



Eloss [MeV]

Thresholds

- Starting from these yields we have chosen **3 different** thresholds to study:

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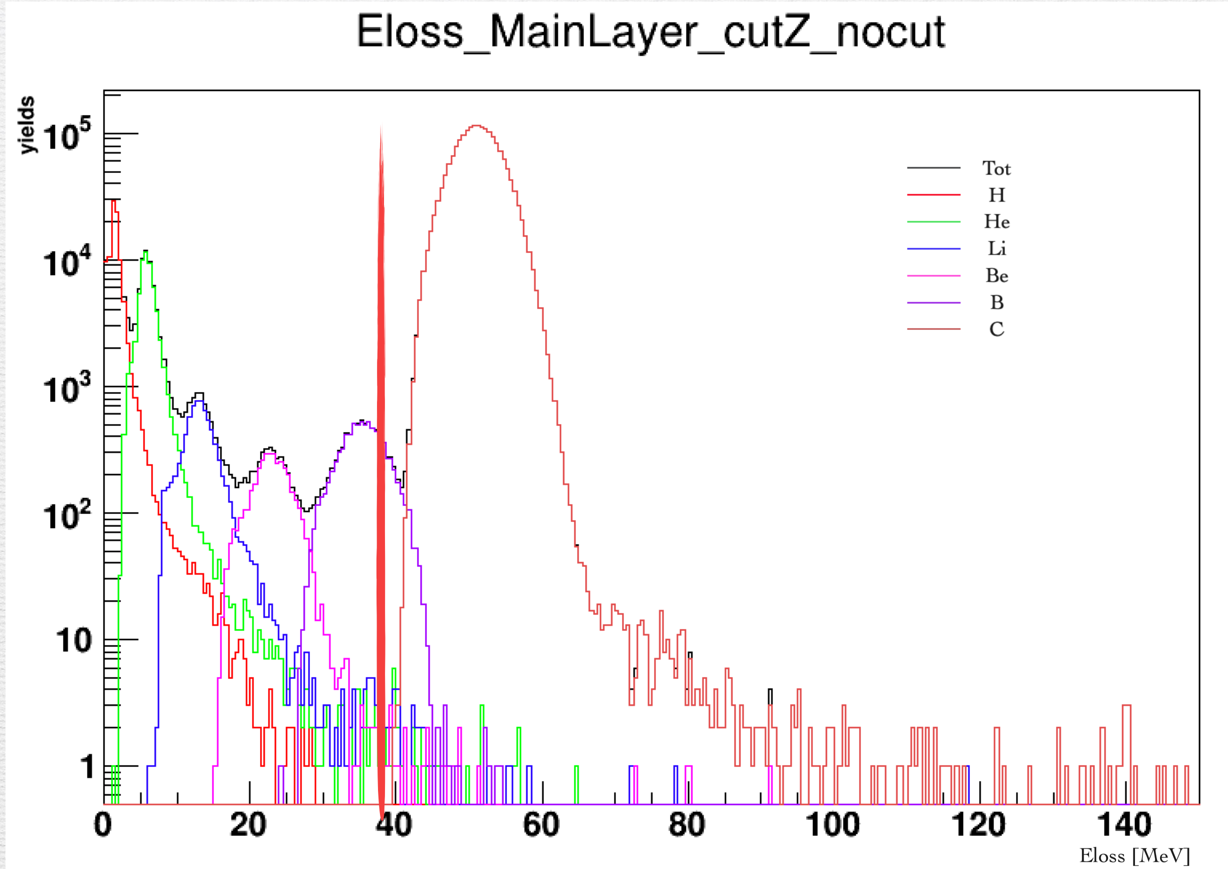

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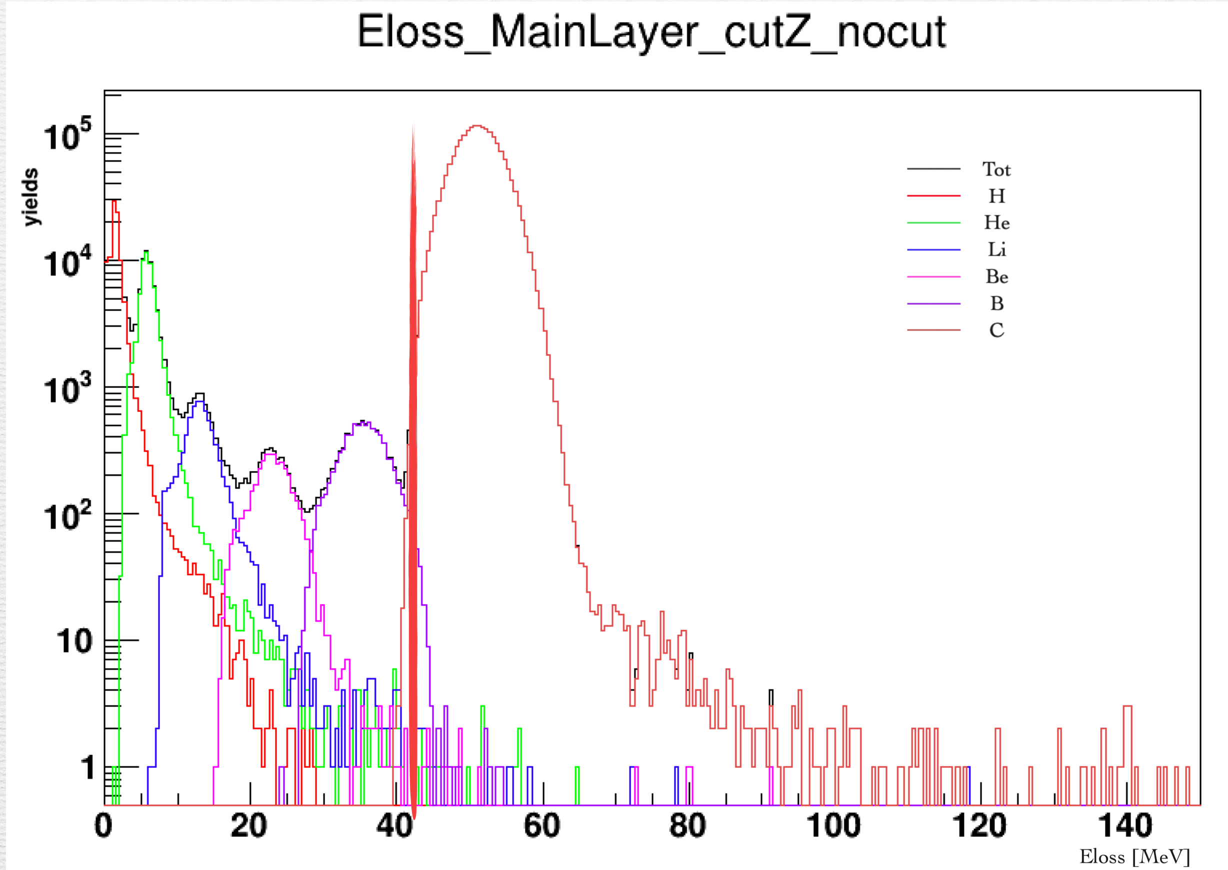

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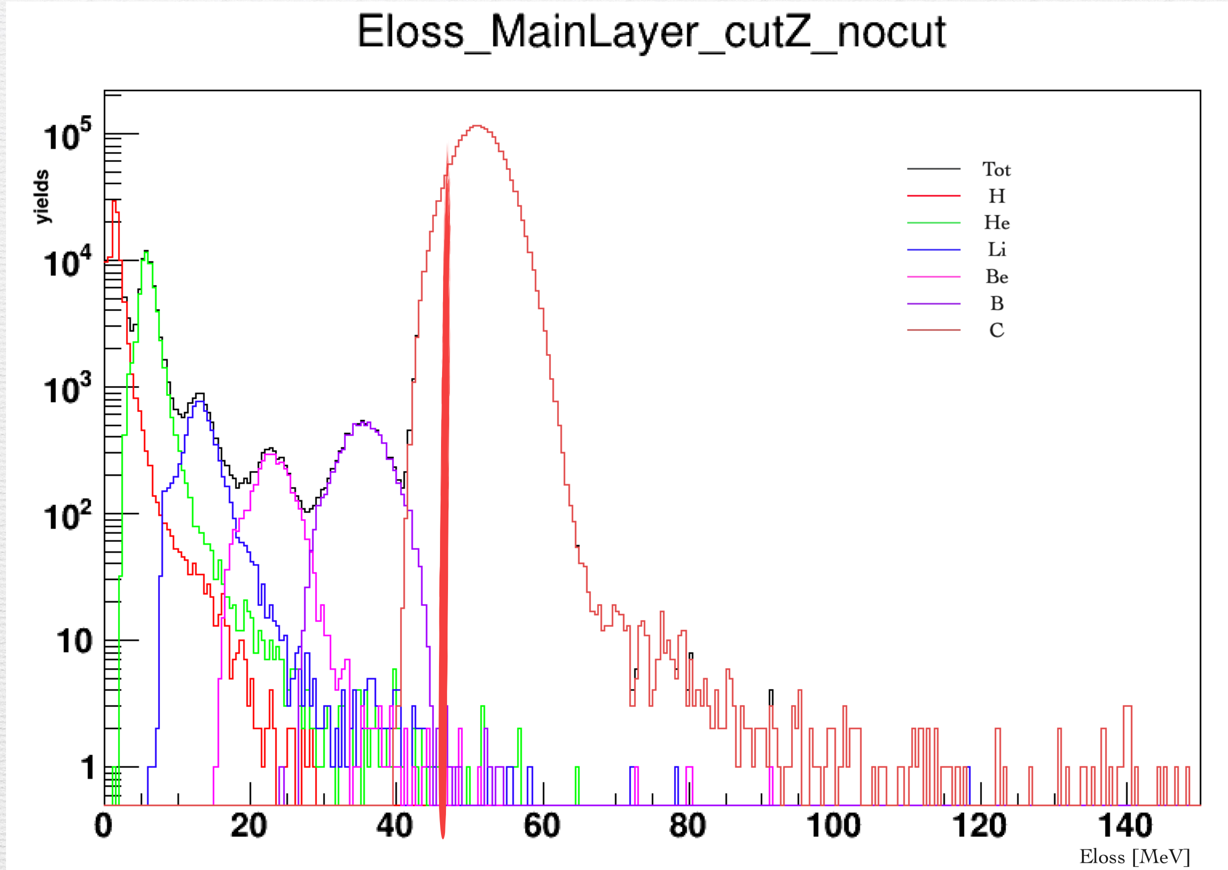
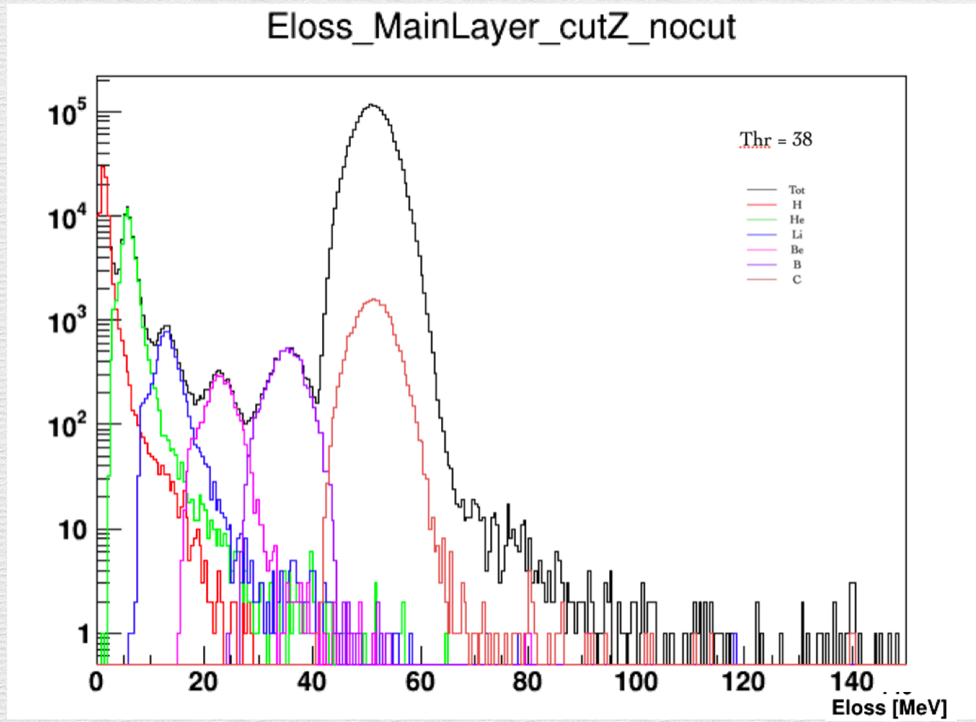


TW Trigger

The TW trigger is performed $\longrightarrow$ We take all fragments arriving on the TW except the ones hitting the bars n° 9 (front and rear) with energy loss (front or rear) above the threshold

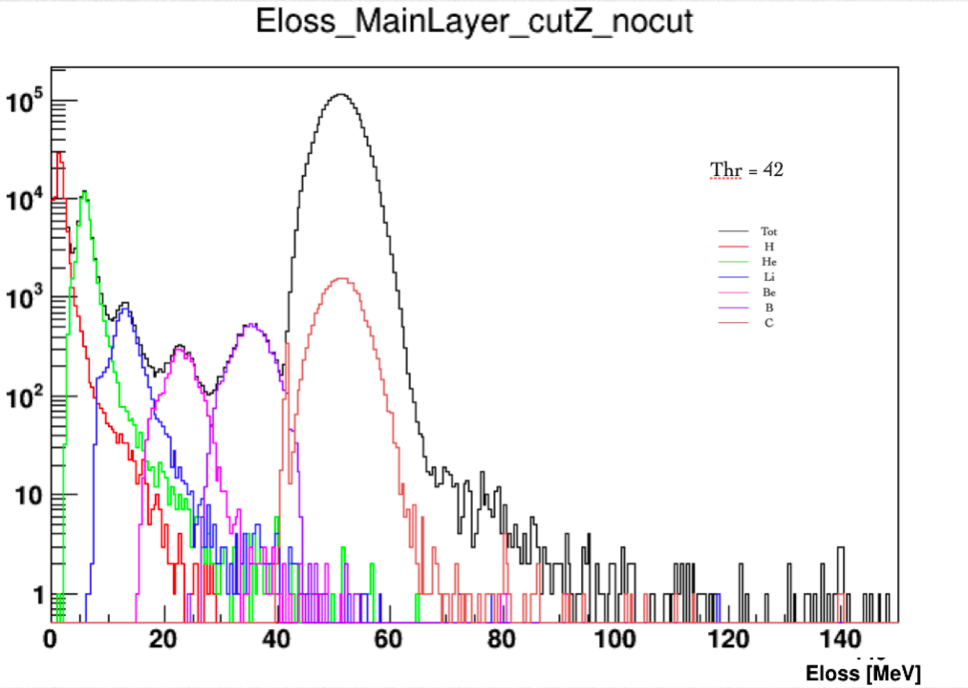


The ratio between the events in MB trigger and the events in TW trigger tells us what we are selecting

$$\frac{TW}{MB}\Big|_{Zrec} = 0.085215$$

TW Trigger

The TW trigger is performed → We take all fragments arriving on the TW except the ones hitting the bars n° 9 (front and rear) with energy loss (front or rear) above the threshold

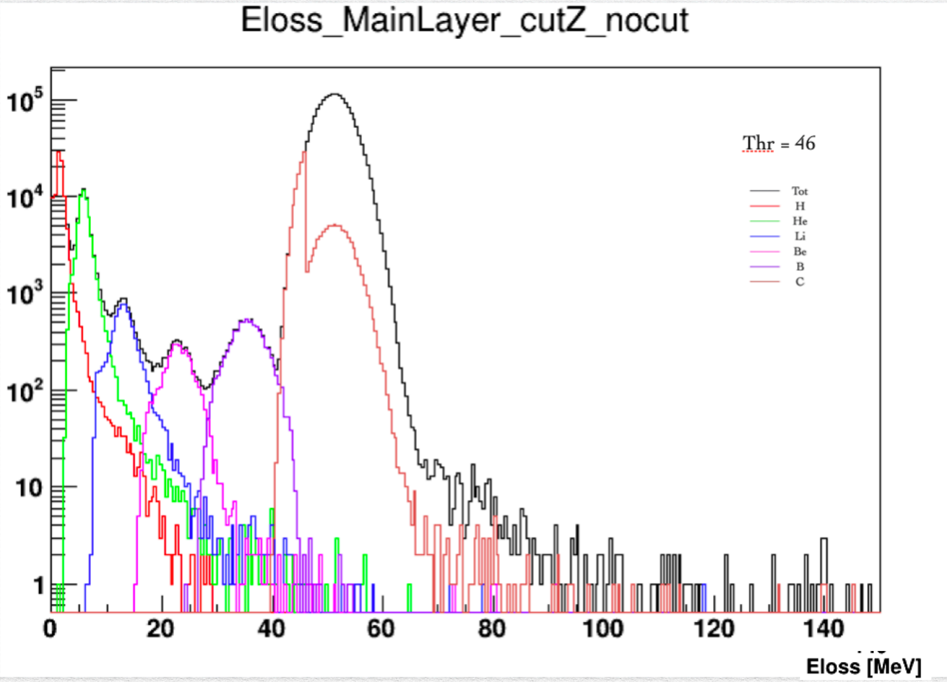


The ratio between the events in MB trigger and the events in TW trigger tells us what we are selecting

$$\frac{TW}{MB}\Big|_{Zrec} = 0.085638$$

TW Trigger

The TW trigger is performed → We take all fragments arriving on the TW except the ones hitting the bars n° 9 (front and rear) with energy loss (front or rear) above the threshold



The ratio between the events in MB trigger and the events in TW trigger tells us what we are selecting

$$\frac{TW}{MB}\Big|_{Zrec} = 0.159727$$

TW Trigger

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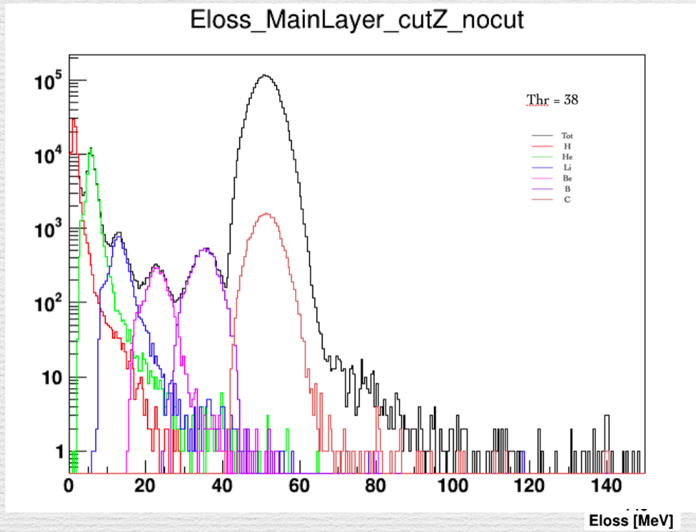

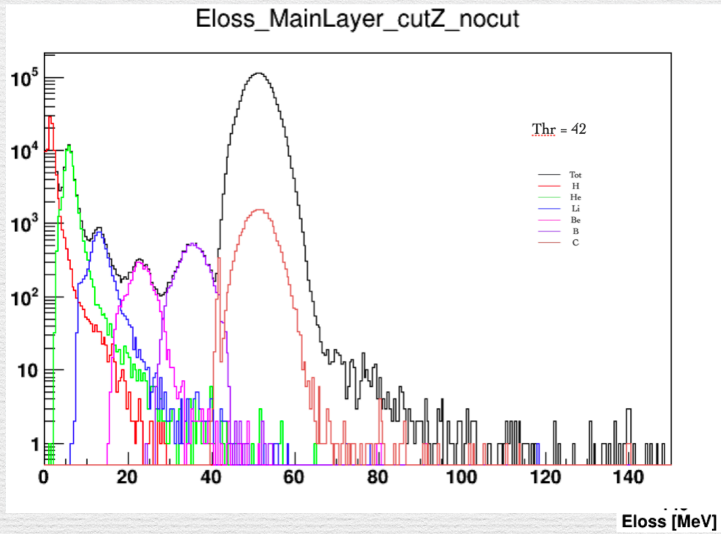

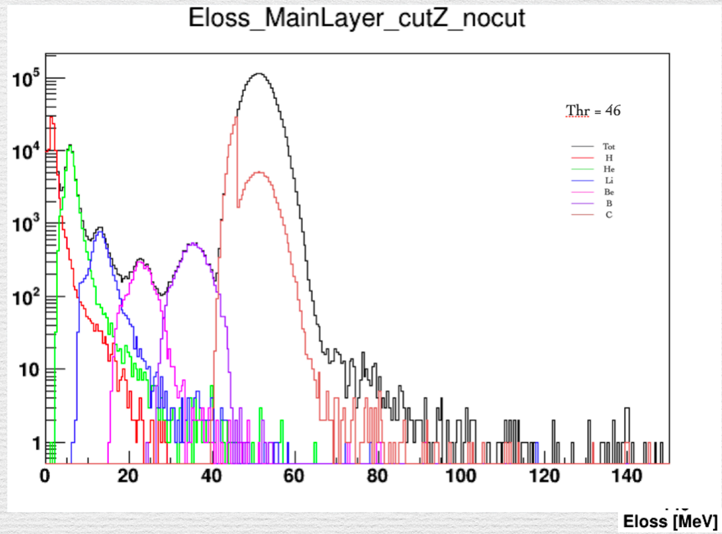

TW Trigger

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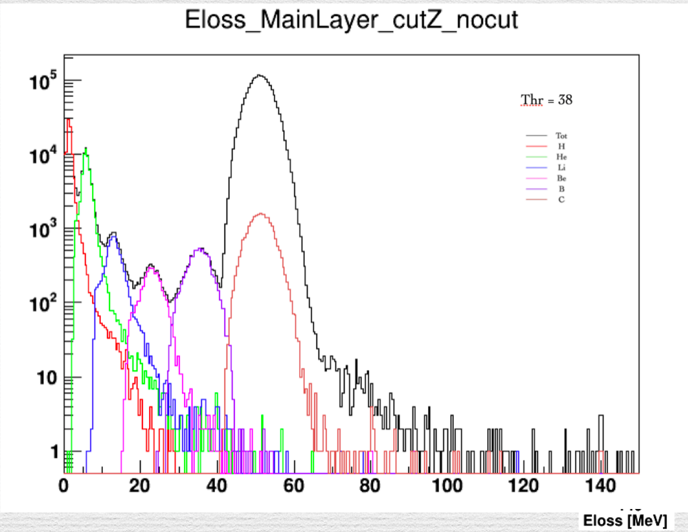
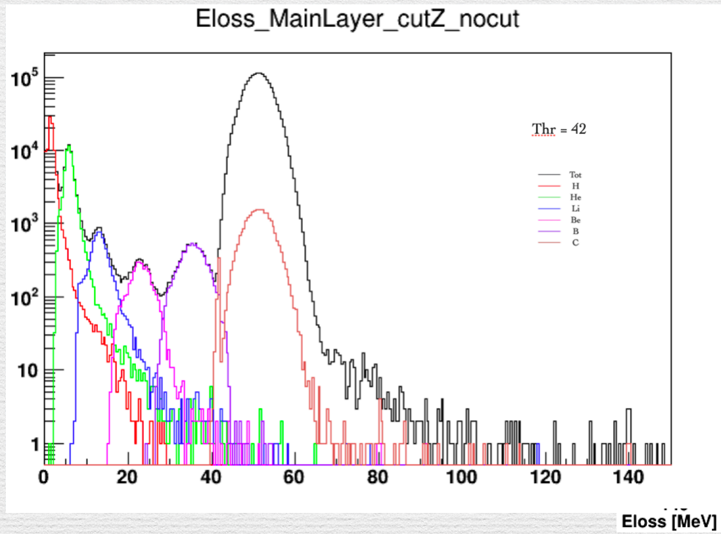
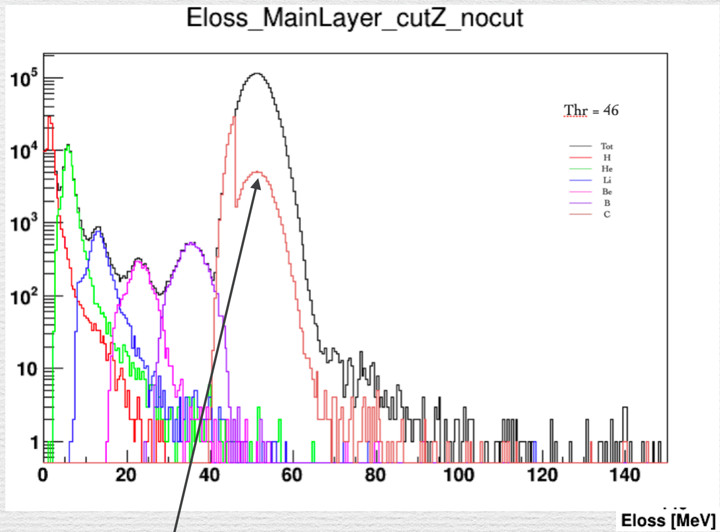






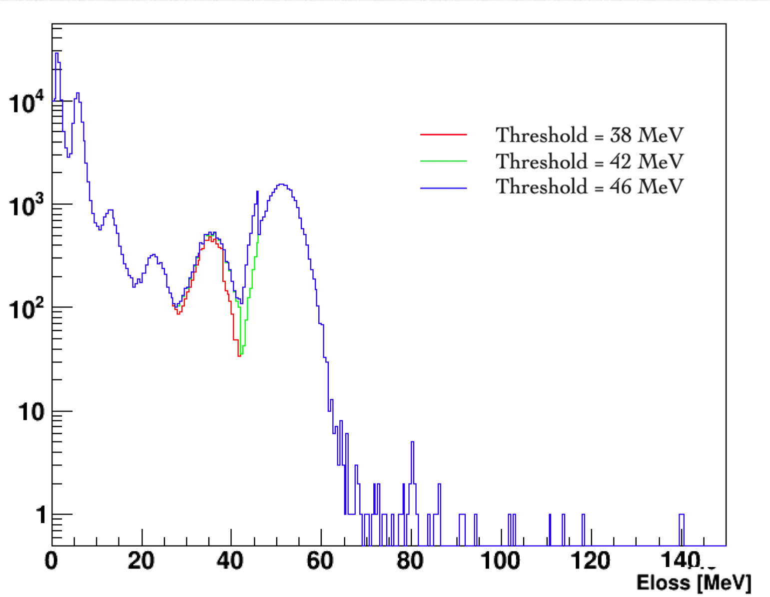
Increase of 1%

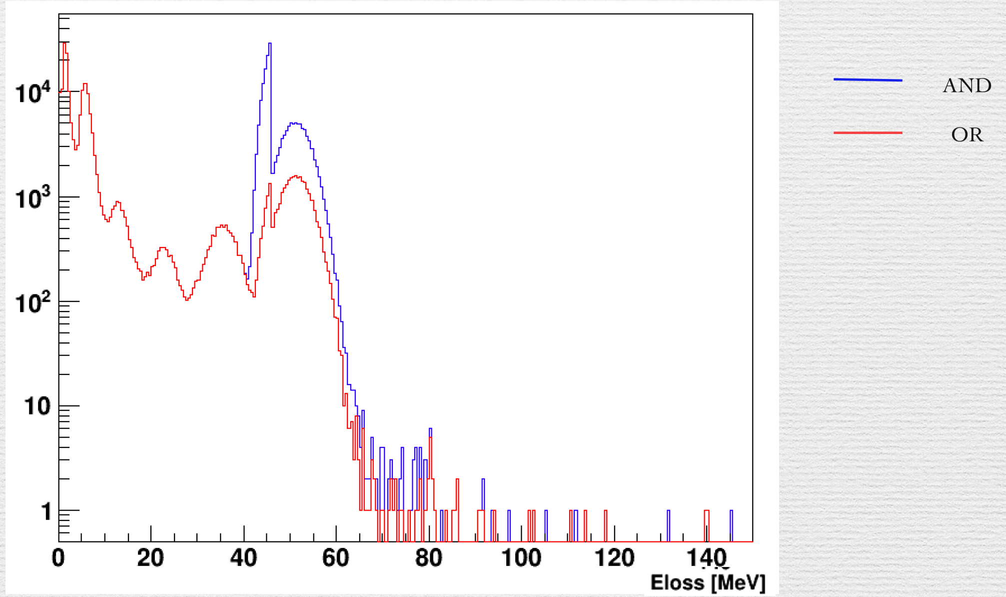
TW Trigger

- The algorithm requires :
  -not bars °9-9
  -not eloss of both layers > threshold

→ This means we're taking also the events in which one of the eloss > threshold (more entries)

- Requiring eloss front OR eloss rear < threshold the entries remains the same.
  Both choices are valid and have pro and cons





First Trigger implementation

- Using the distributions we can calculate the fragmentation percentage for each fragment using a MB trigger:

$$\frac{N(Z)}{N_{tot}}\Big|_{MB} \qquad \frac{N(Z)}{N_{tot}}\Big|_{TW}$$

- …and using the TW trigger, for each threshold:

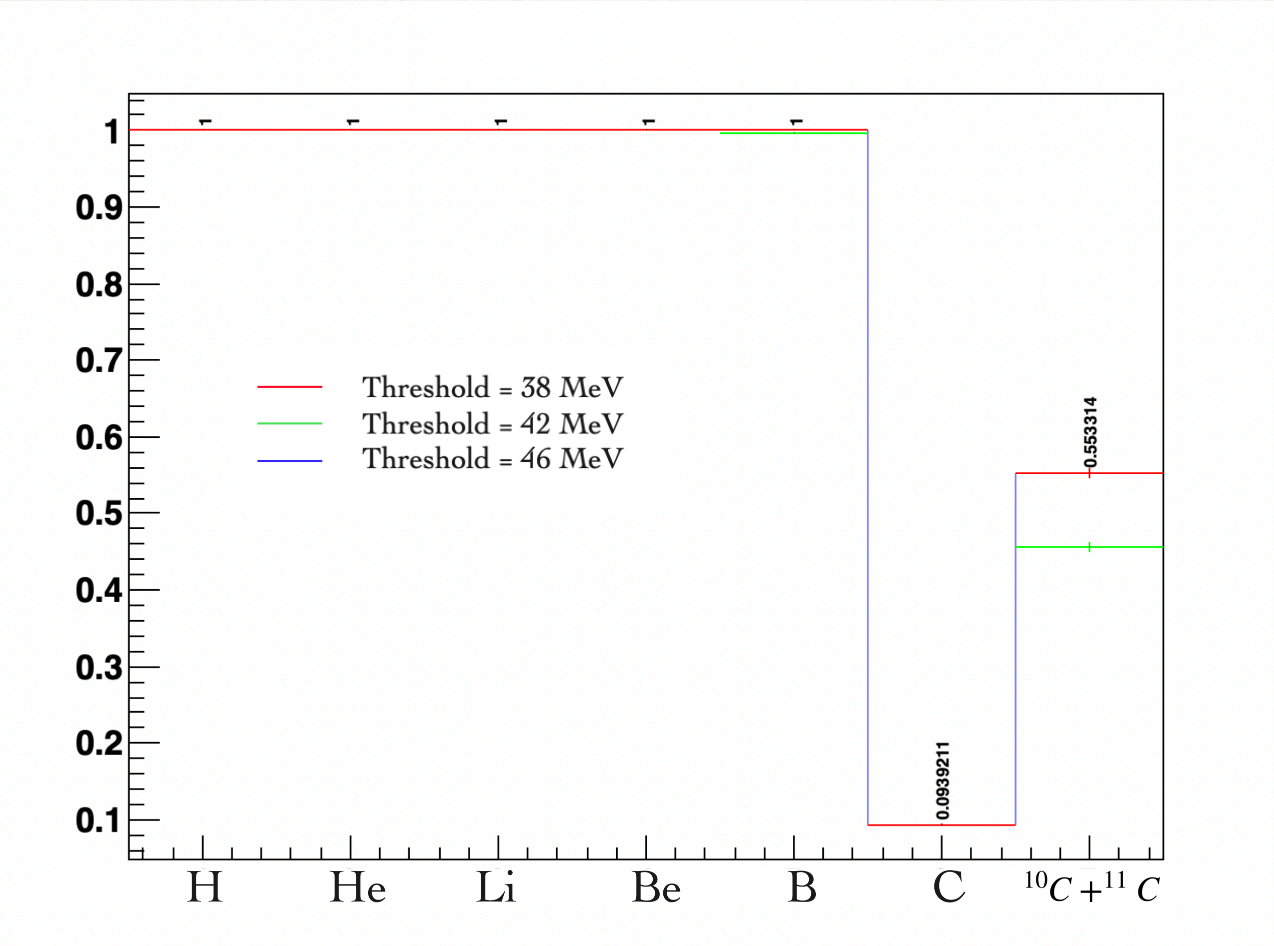
MB	
H	4.60%
He	2.87%
Li	0.38%
Be	0.19%
B	0.41%
C	91.54%
Total Fragments	8.74%

Threshold: 38	
H	47.39%
He	29.55%
Li	3.94%
Be	1.95%
B	4.01%
C	13.15%
Total Fragments	86.64%

Threshold: 42	
H	47.19%
He	29.41%
Li	3.93%
Be	1.94%
B	4.15%
C	13.37%
Total Fragments	86.39%

Threshold: 46	
H	26.96%
He	16.81%
Li	2.24%
Be	1.11%
B	2.38%
C	50.49%
Total Fragments	49.78%

Trigger efficiency



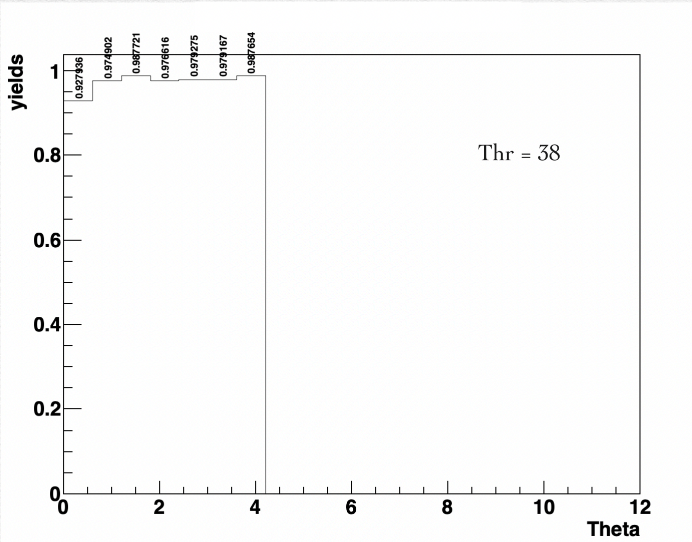
- Trigger efficiency: for each charge we calculate the ratio between the number of fragments with TW trigger and the number of fragments with MB trigger

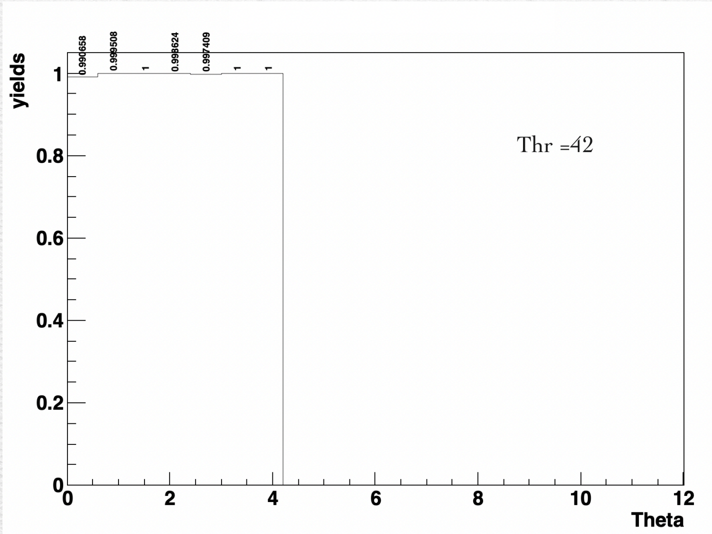
$$\frac{Y(Z)_{TW}}{Y(Z)_{MB}}$$

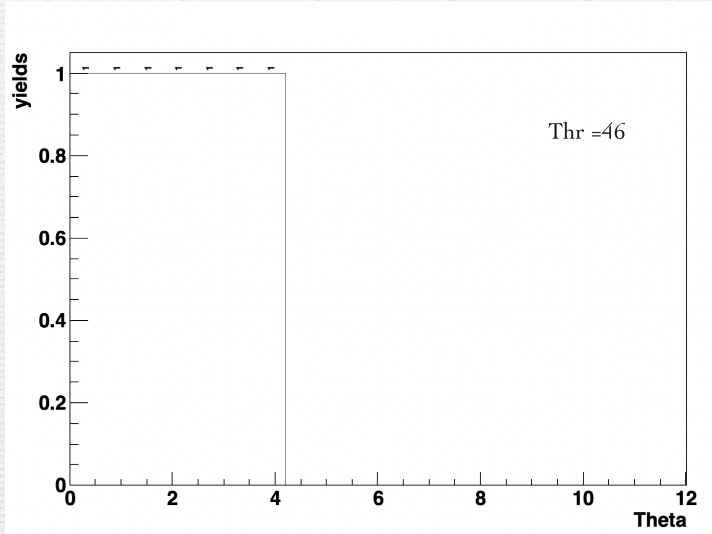
Sum of fragments with charge = 6 and baryon number = 10-11

Ratio in Angle

- Efficiencies in angle and kinetic energy for each threshold: B

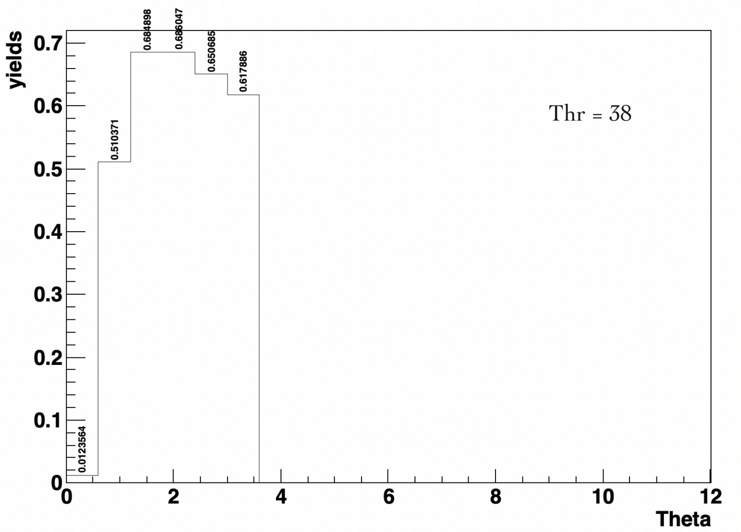


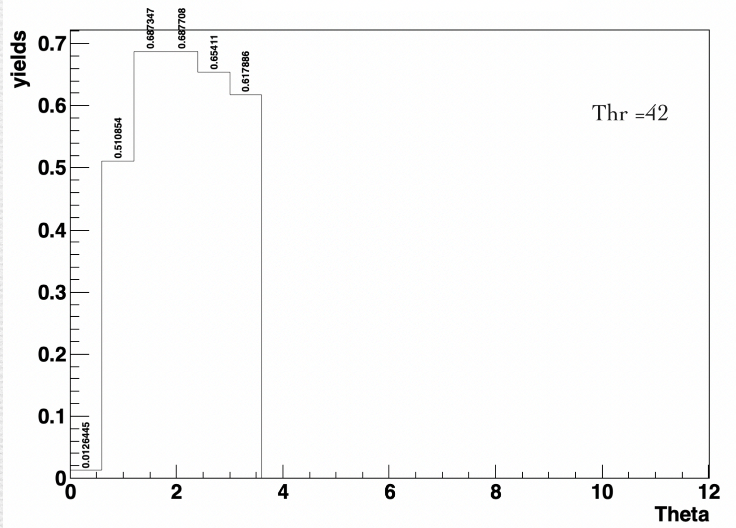


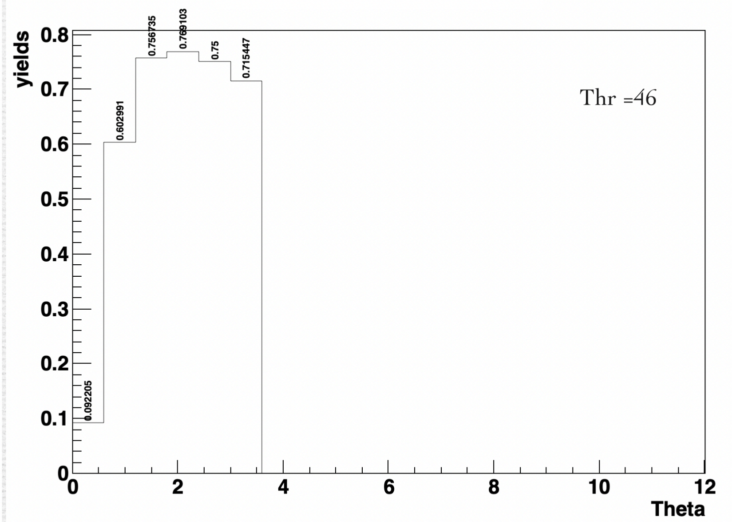


Ratio in Angle

- Efficiencies in angle and kinetic energy for each threshold: C

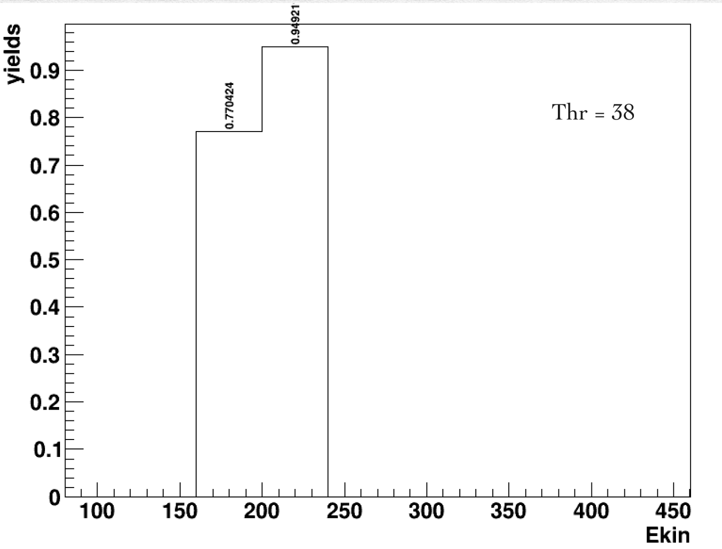


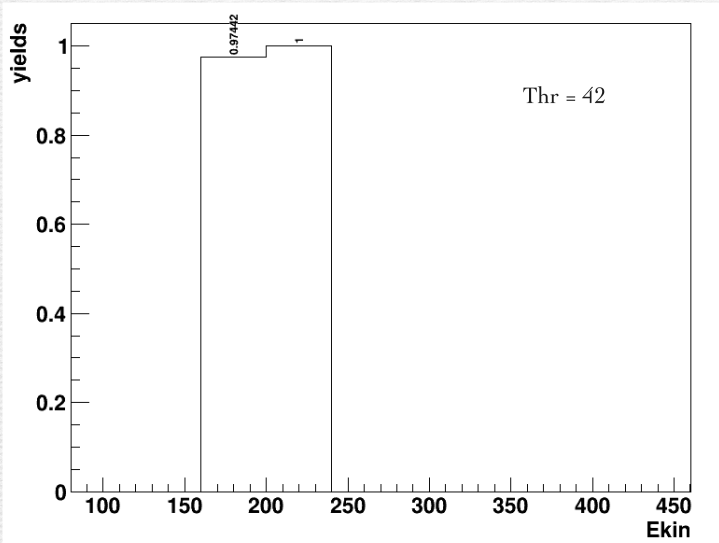


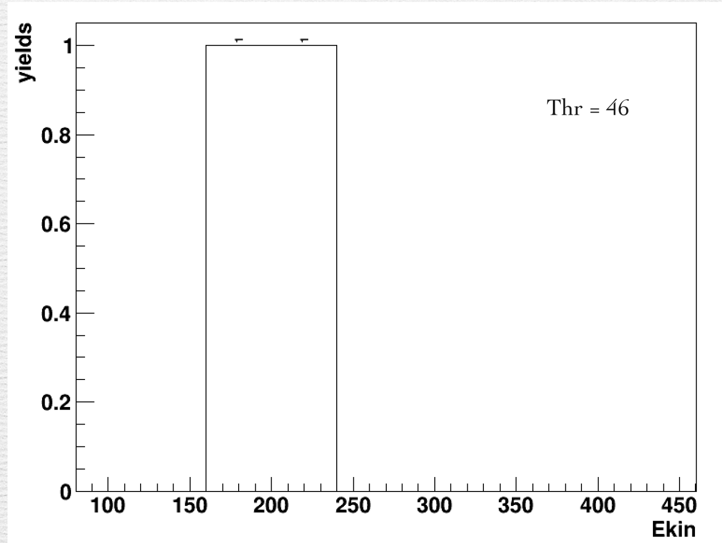


Ratio in Ekin

- Efficiencies in angle and kinetic energy for each threshold: B

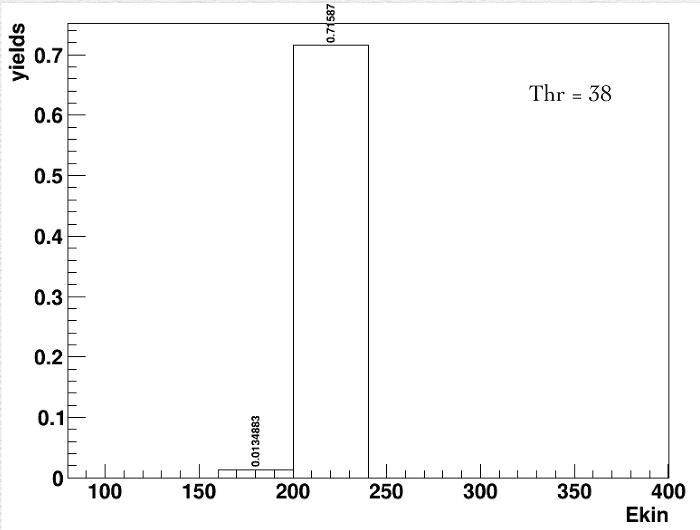


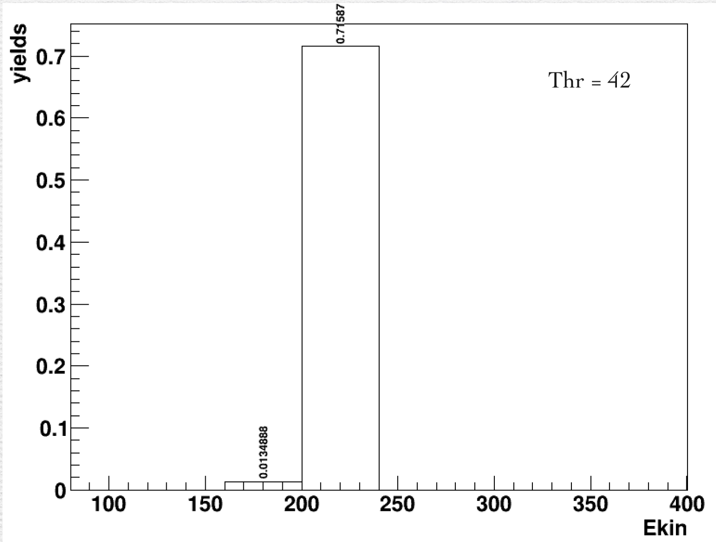


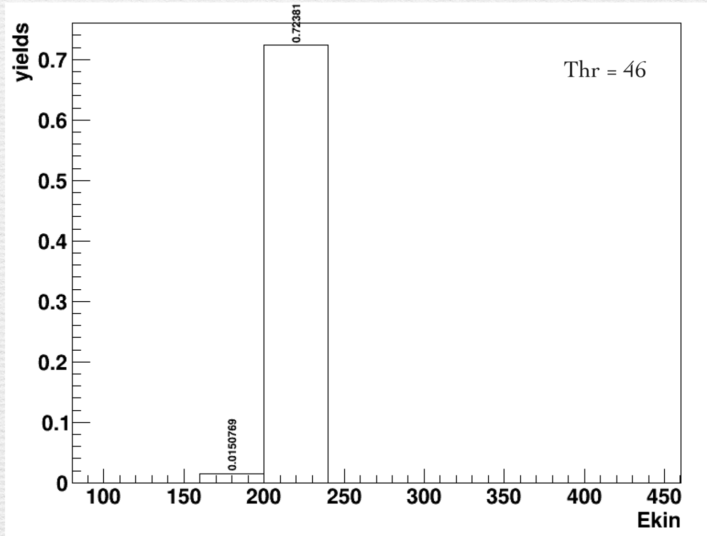


Ratio in Ekin

- Efficiencies in angle and kinetic energy for each threshold: C







Other steps to think about…

1. Scaling of cross section measurement

$$\sigma_{TW} = \frac{N_{TW}^{trigg}}{N_{prim}} \frac{Y_{TW}(Z)}{N_{TW}^{trigg}} \frac{1}{\epsilon_{trigg}} \cdot const$$

$$\sigma_{MB} = \frac{Y_{MB}(Z)}{N_{TW}^{trigg}} \cdot const$$

Scaling factor

Trigger efficiency

2. Studies of C fragmentation in this two channels using the Calorimeter and try different trigger implementations (e.g. with another hit somewhere on the TW) :

$$^{12}C -> ^{11}C + n \qquad ^{12}C -> B + p$$

TW Trigger OR

- Using the distributions we have calculated the fragmentation percentage for each fragment using a minimum bias trigger and using the TW trigger, for each threshold:

MB	
H	0.04604
He	0.028705
Li	0.003831
Be	0.001895
B	0.004068
C	0.915454
Total Fragments	0.087442

$$\frac{N(Z)}{N_{tot}}\Big|_{MB}$$

$$\frac{N(Z)}{N_{tot}}\Big|_{TW}$$

Threshold: 38	
H	0.477890
He	0.297905
Li	0.039757
Be	0.019664
B	0.03224
C	0.13254
Total Fragments	0.867247

Threshold: 42	
H	0.473782
He	0.295344
Li	0.039416
Be	0.019495
B	0.040556
C	0.131407
Total Fragments	0.866458

Threshold: 46	
H	0.466091
He	0.290550
Li	0.038776
Be	0.019179
B	0.041166
C	0.144237
Total Fragments	0.853515

TW Trigger OR Ztrue

- Using the distributions we have calculated the fragmentation percentage for each fragment using a minimum bias trigger and using the TW trigger, for each threshold:

MB	
H	0.026388
He	0.019016
Li	0.001892
Be	0.001112
B	0.002696
C	0.948895
Total Fragments	0.053098

$$\frac{N(Z)}{N_{tot}}\Big|_{MB}$$

$$\frac{N(Z)}{N_{tot}}\Big|_{TW}$$

Threshold: 38	
H	0.412271
He	0.297097
Li	0.029553
Be	0.017371
B	0.037336
C	0.206374
Total Fragments	0.81350

Threshold: 42	
H	0.41039
He	0.295742
Li	0.02941
Be	0.017291
B	0.041674
C	0.205485
Total Fragments	0.814303

Threshold: 46	
H	0.399400
He	0.287822
Li	0.028630
Be	0.016828
B	0.040810
C	0.226510
Total Fragments	0.792773

Correlation amplitude vs eloss

- **File** : ^{16}O (400 MeV)

Untriggered (all primaries included)

1. Eloss = 50 MeV
2. Eloss = 52 MeV
3. Eloss = 54 MeV