GSI2021 Campaign: studying the case by simulation

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Outline

1. The case for a thicker C_2H_4 target
2. Energy loss in detectors and air
3. Background interactions
4. The case of ^{14}O and ^{15}O production

1. The case of a thicker C_2H_4 target

In comparison to our 5 mm thick C target, can we use a thicker C2H4 target without problems, in order to gain time and statistics?

Main issues:

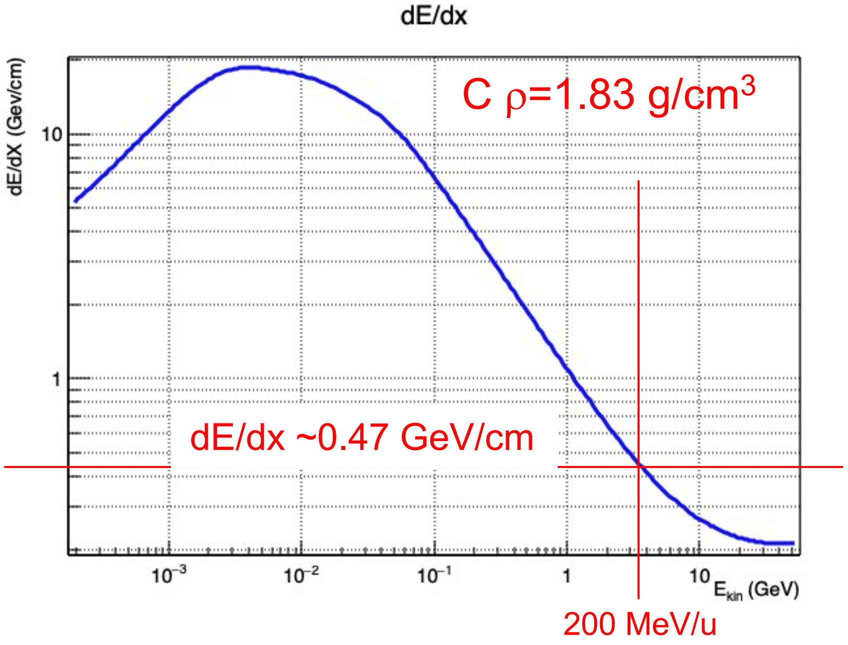
1. Energy loss of primary and secondaries

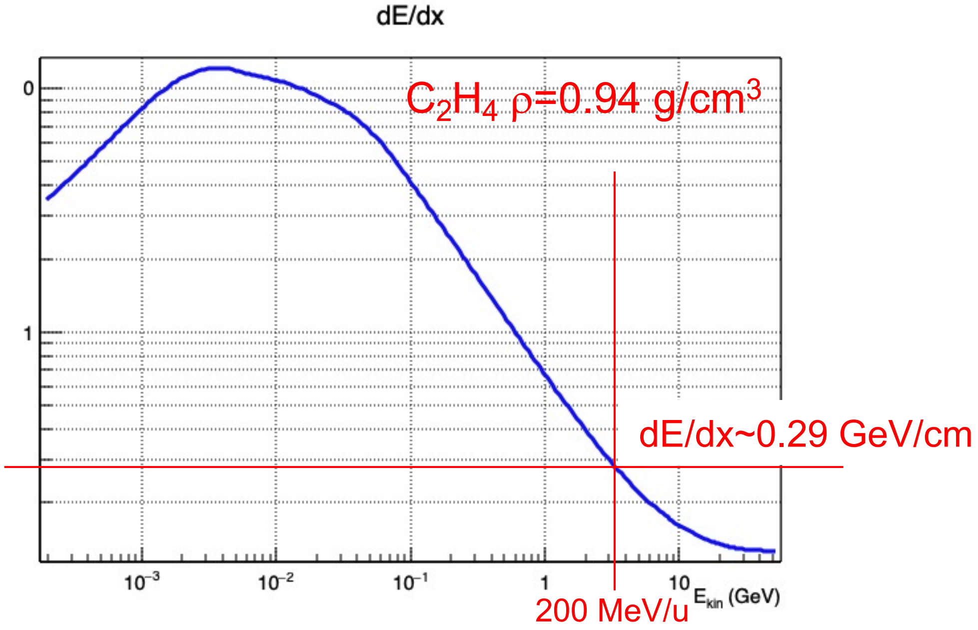
2. Uncertainty in position and time of flight

3. Probability of multiple interactions

Energy Loss of primary

Energy loss of ^{16}O

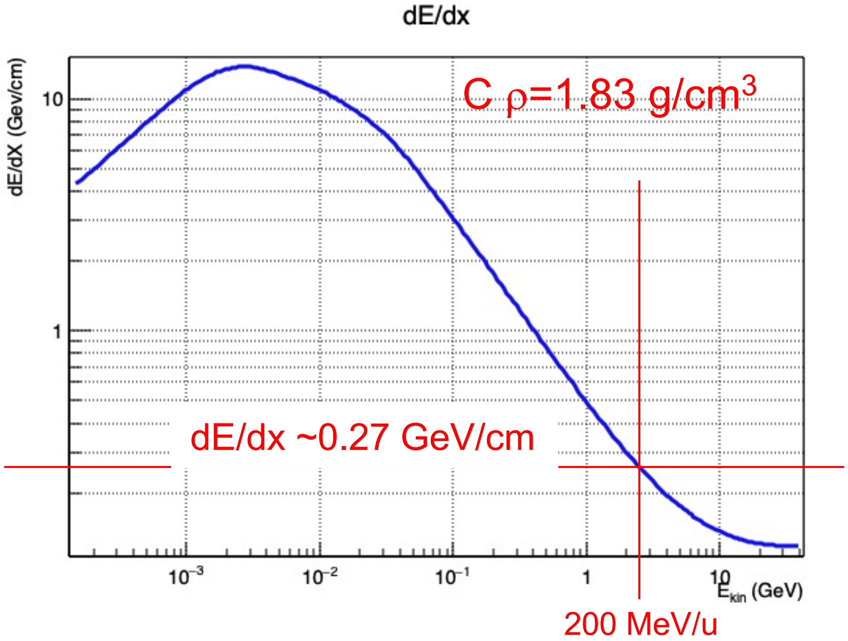


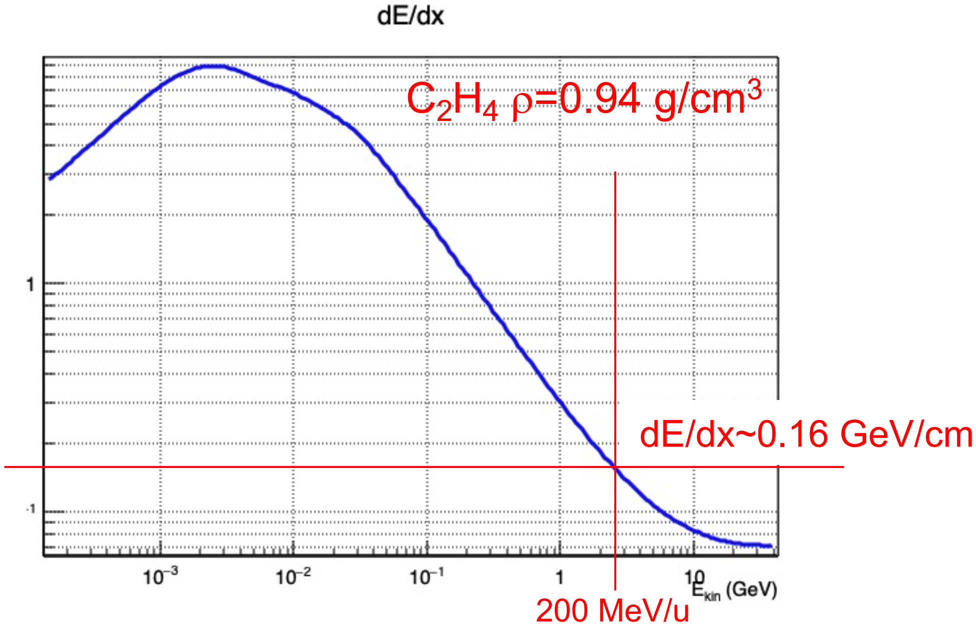


dE/dx (C_2H_4) ~ 0.6 dE/dx (C) *$\rho(C)/\rho(C_2H_4)$ = 0.51 but Z/A(H) = 1 while Z/A(C)= 0.5*

Energy Loss of secondaries - 1

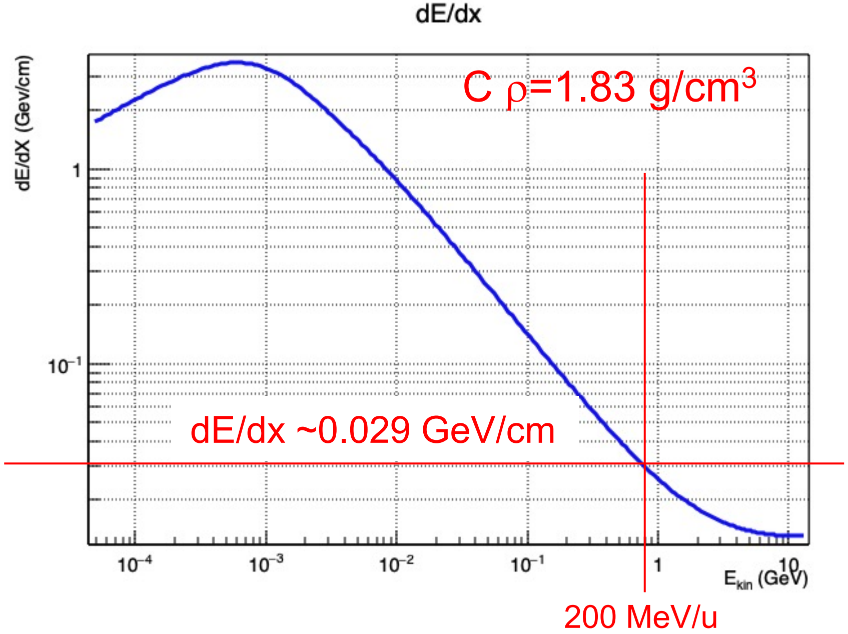
Energy loss of ^{12}C

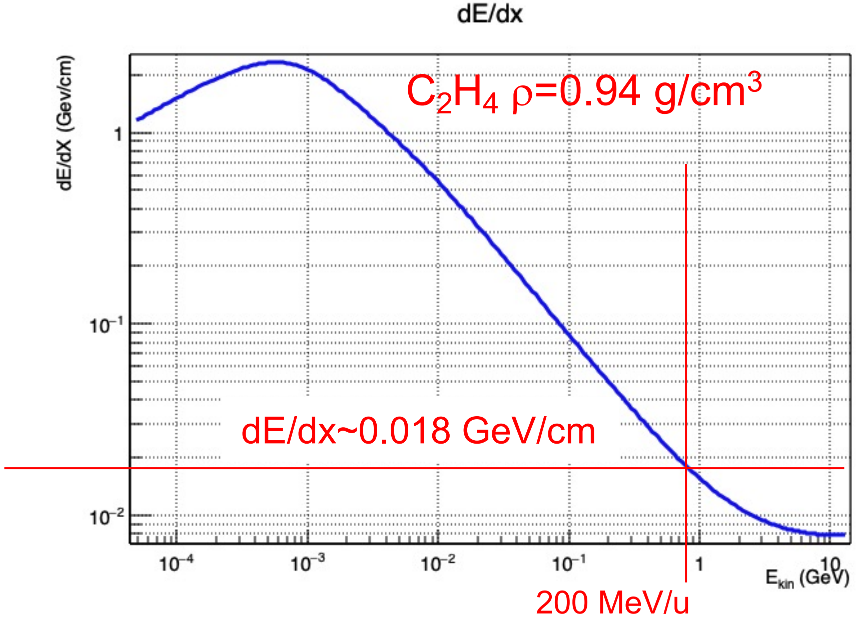




Energy Loss of secondaries - 2

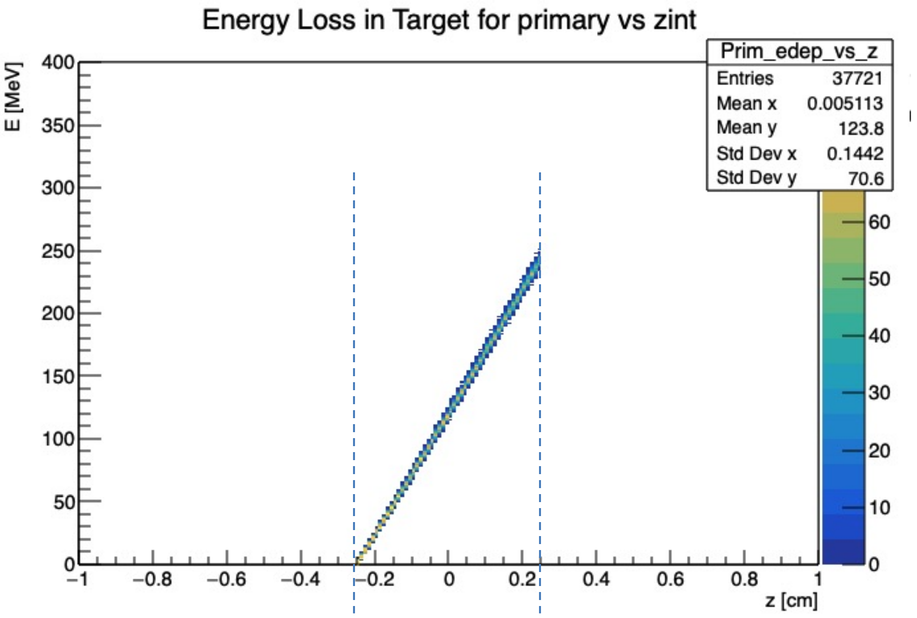
Energy loss of ^4He



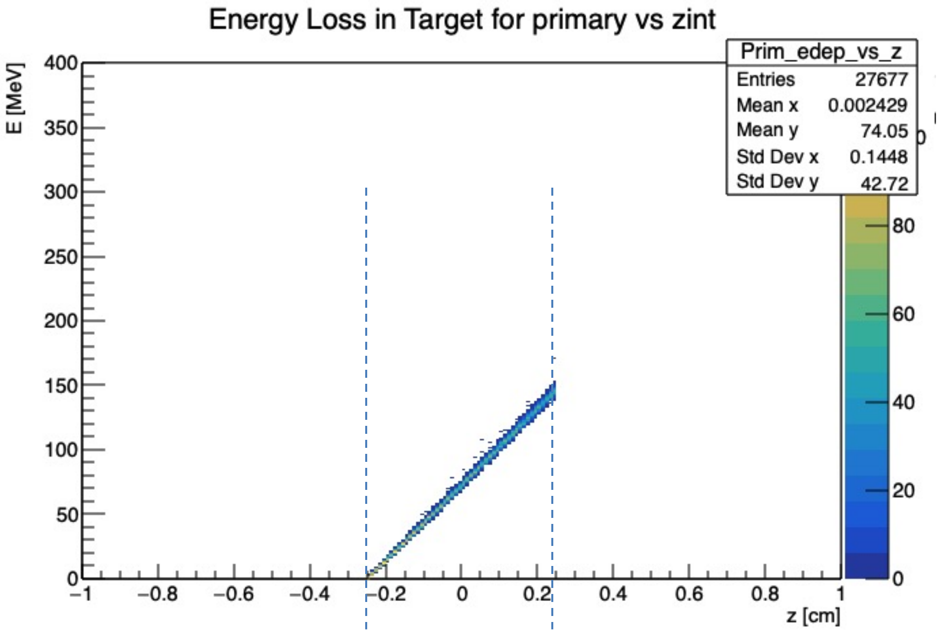


Energy loss of primary in target (^{16}O 200 MeV/u = 3.199 GeV)

C target 5 mm

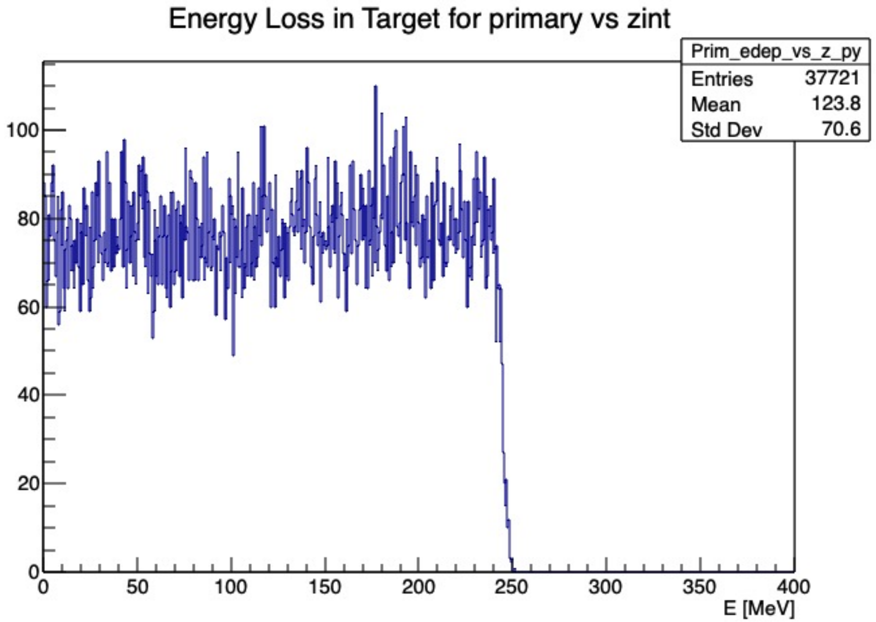


C_2H_4 target 5 mm



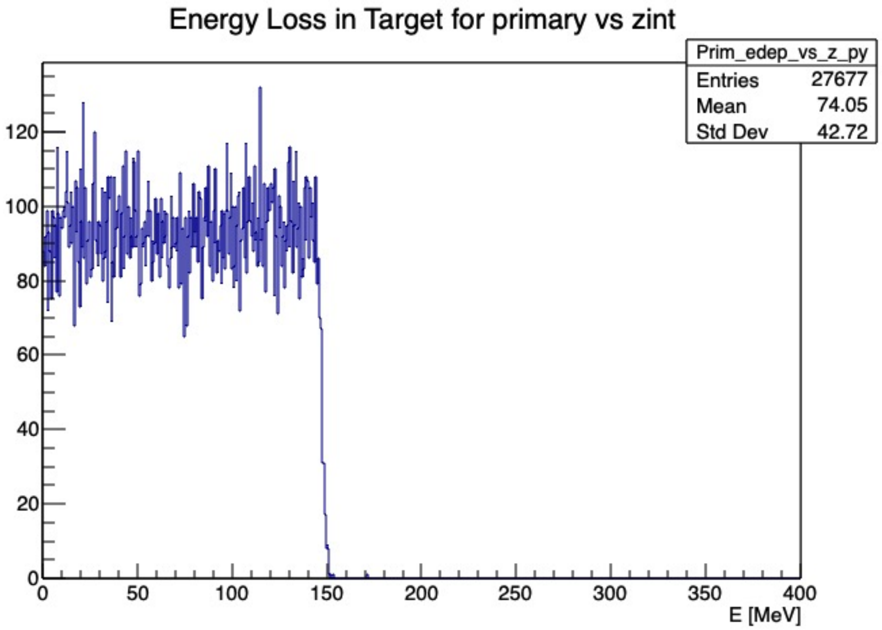
Energy loss of primary in target (^{16}O 200 MeV/u = 3.199 GeV)

C target 5 mm



$\Delta E/E$ = 3.9±2.2 %

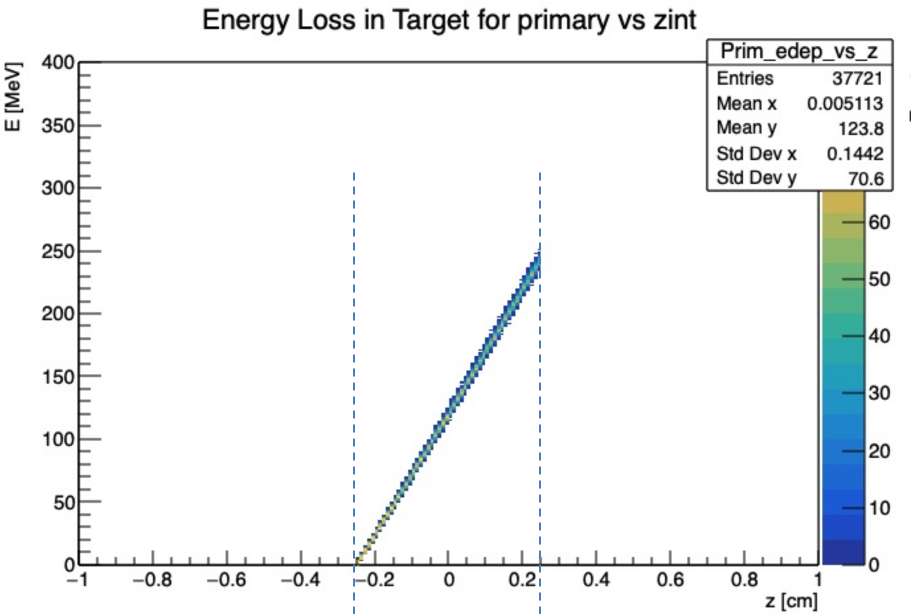
C_2H_4 target 5 mm



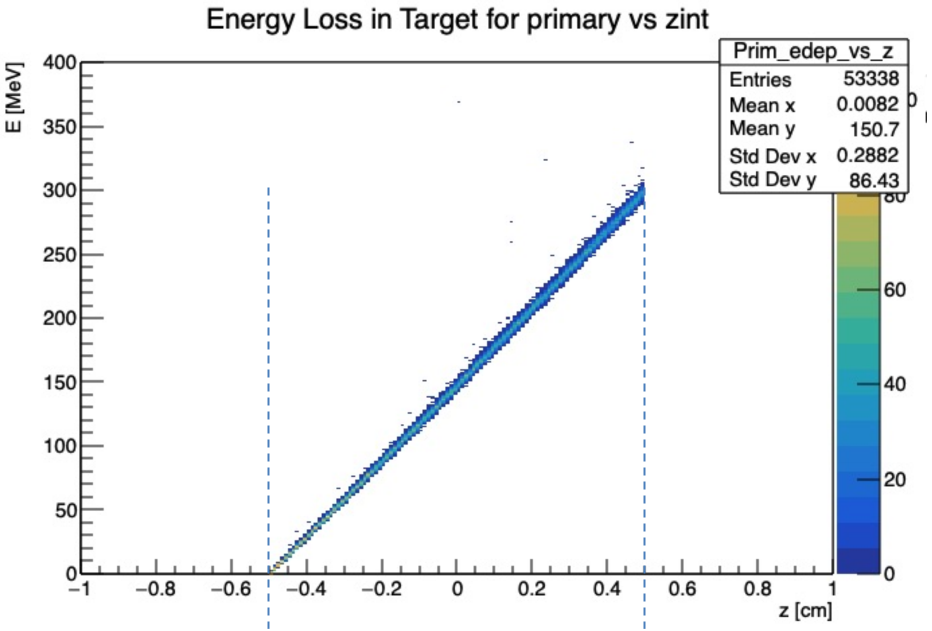
$\Delta E/E$ = 2.3±1.3 %

Energy loss of primary in target (^{16}O 200 MeV/u = 3.199 GeV)

C target 5 mm

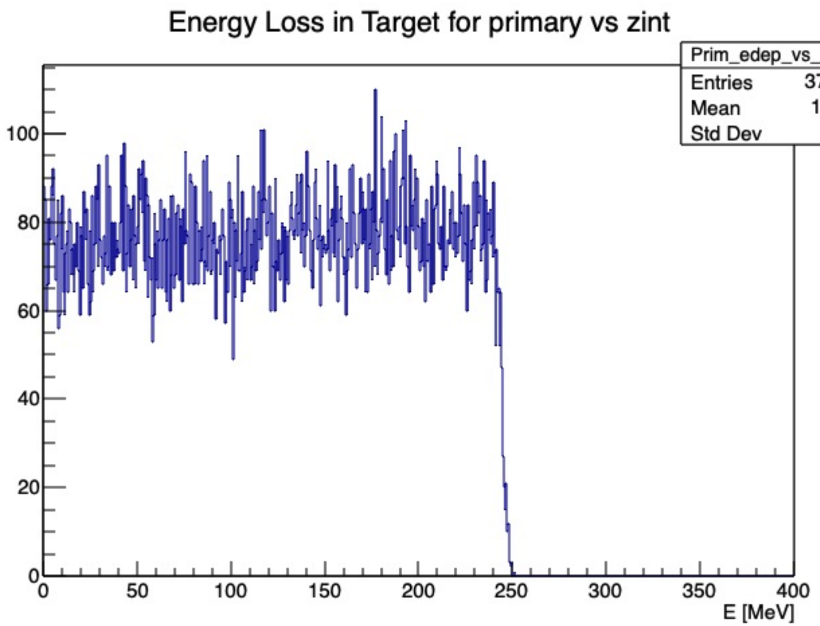


C_2H_4 target 10 mm



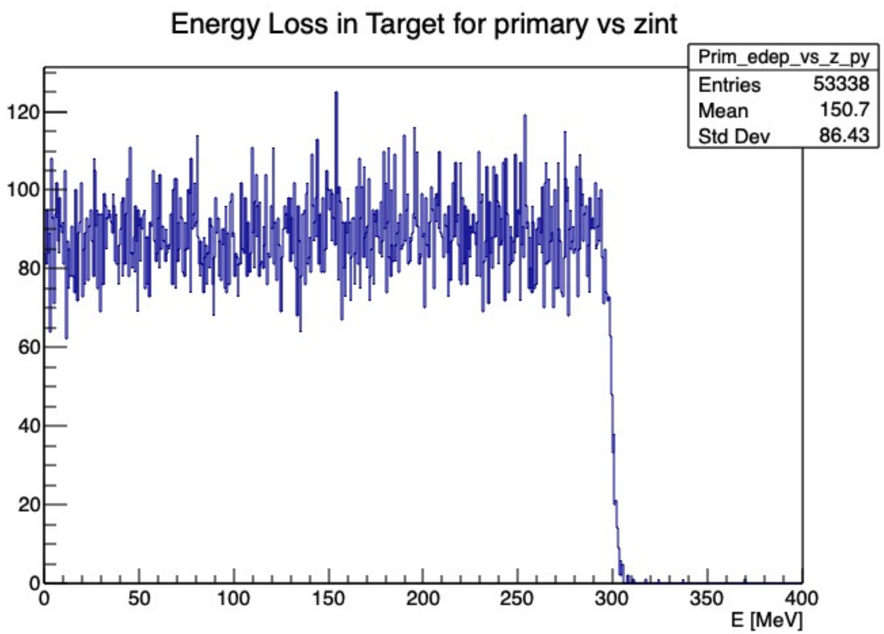
Energy loss of primary in target (^{16}O 200 MeV/u = 3.199 GeV)

C target 5 mm



$\Delta E/E = 3.9 \pm 2.2$ %

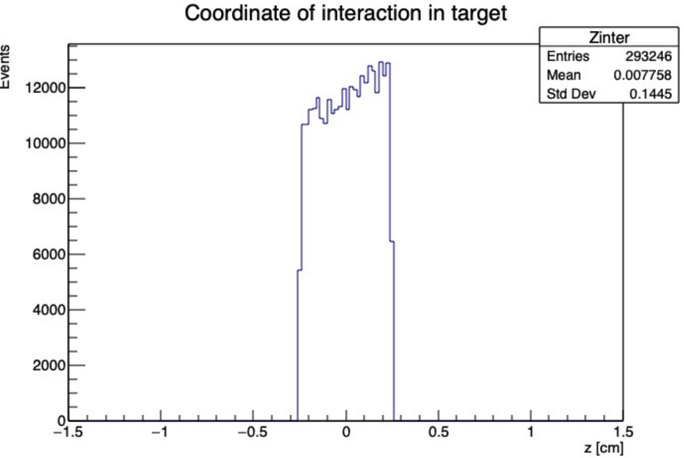
C_2H_4 target 10 mm



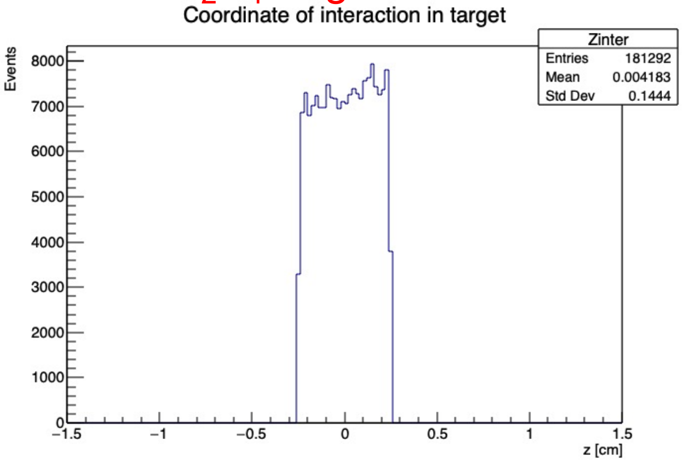
$\Delta E/E = 4.7 \pm 2.8$ %

Depth of primary interaction in target

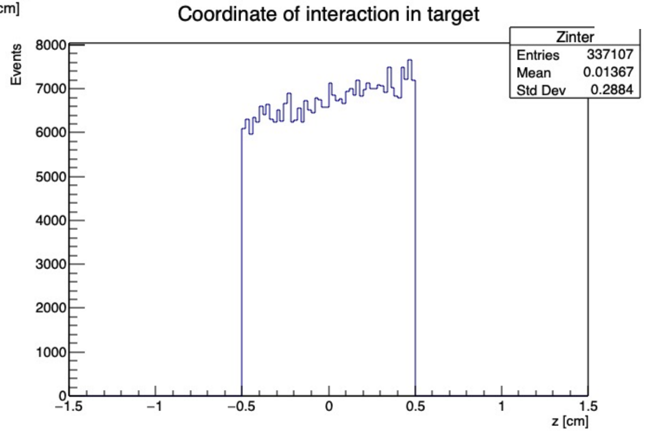
C target 5 mm



C_2H_4 target 5 mm



C_2H_4 target 10 mm

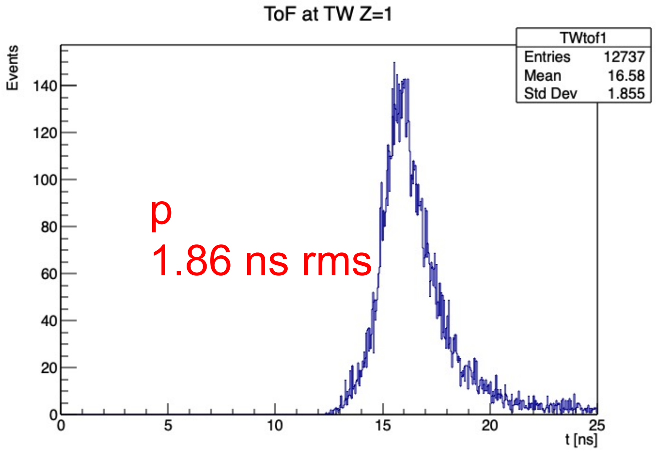


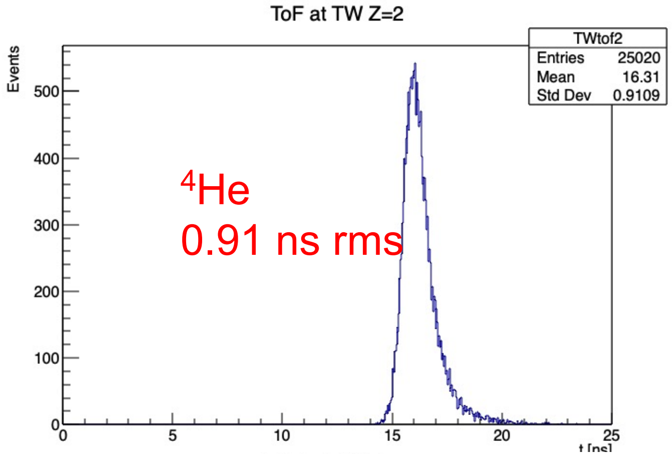
The deeper is the interaction point:
- the lower is primary energy
- the higher is σ

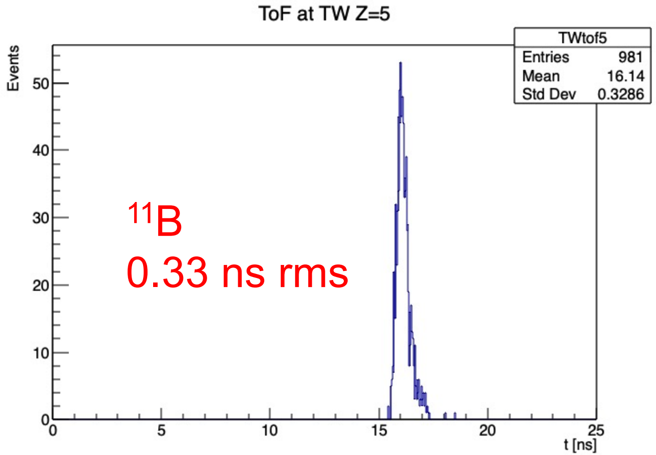
In principle, backtracing from VTX allows to determine the depth of interaction with accuracy << 1mm

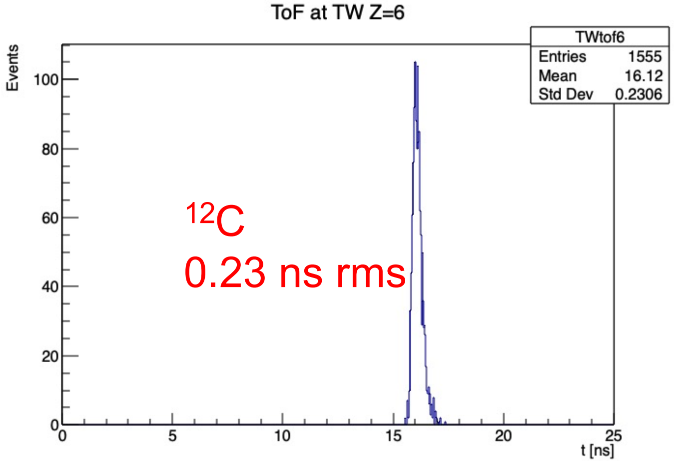
ToF fluctuations at TW for different (Z,A) (^{16}O 200 MeV/u)

C target 5 mm



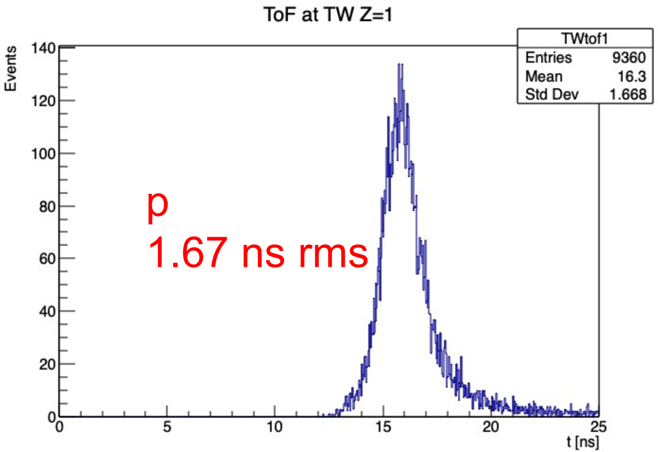


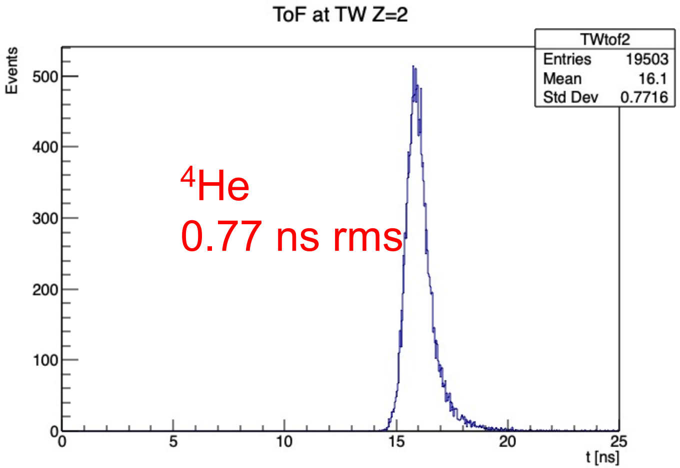


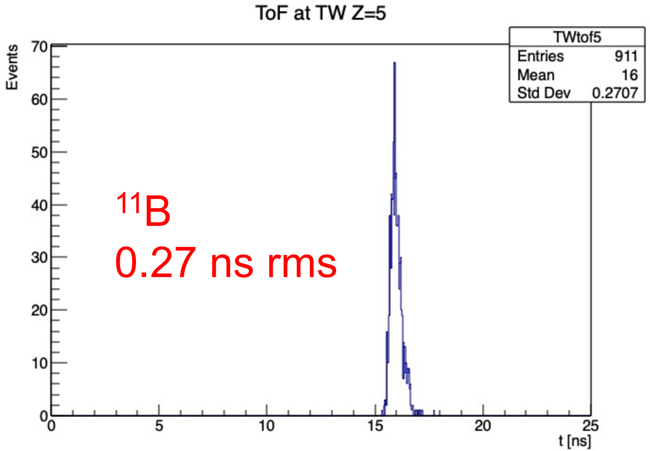


ToF fluctuations at TW for different (Z,A) (^{16}O 200 MeV/u)

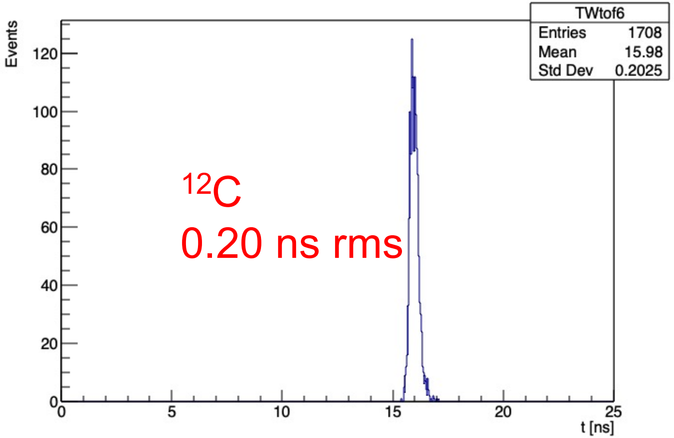
C_2H_4 target 5 mm





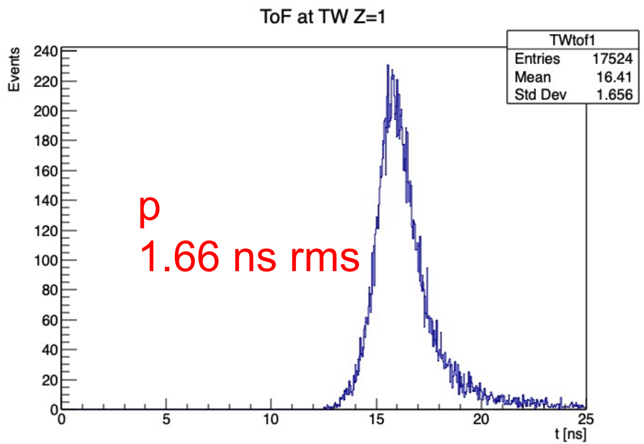


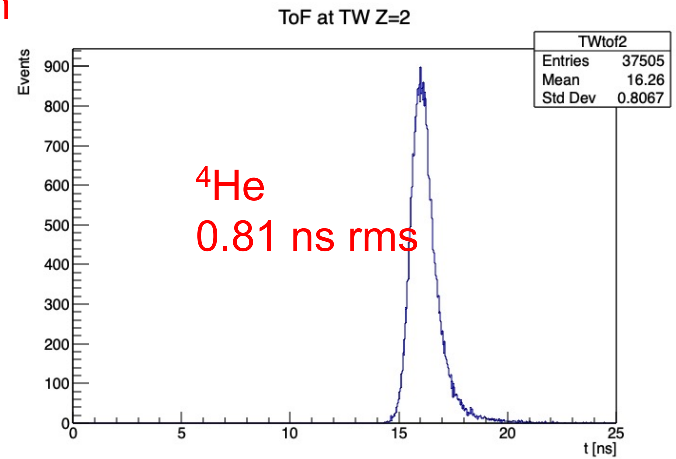
Fluctuations are slightly reduced with respect to the case of the 5 mm C target

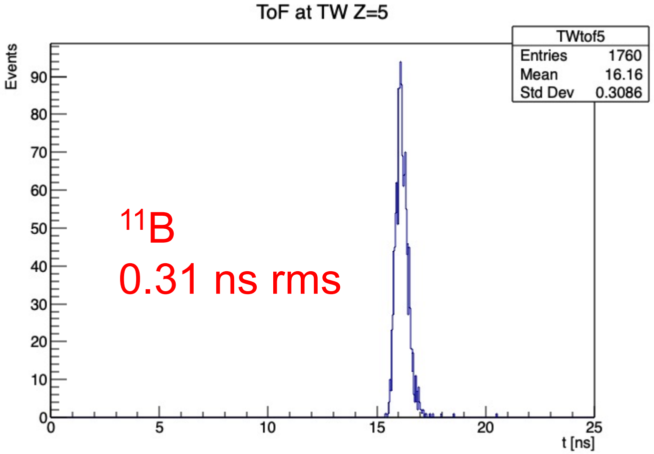


ToF fluctuations at TW for different (Z,A) (^{16}O 200 MeV/u)

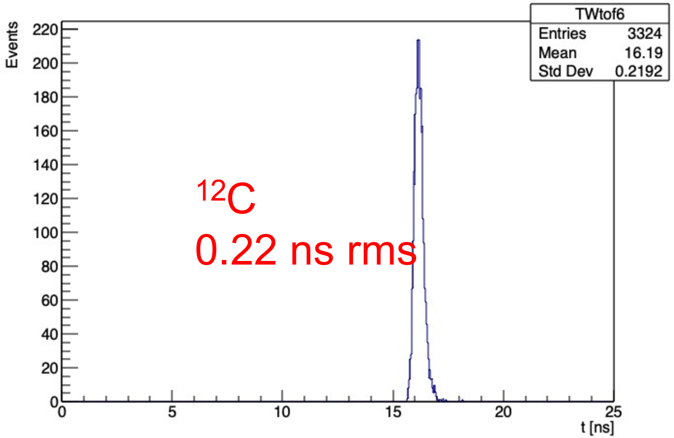
C_2H_4 target 10 mm







Fluctuations are comparable to the case of the 5 mm C target



1. Conclusions

1) There are no appreciable cons in using a thicker C_2H_4 target

2) Actually, using 5 mm for both C and C_2H_4 targets resulted in a somewhat unbalanced situation

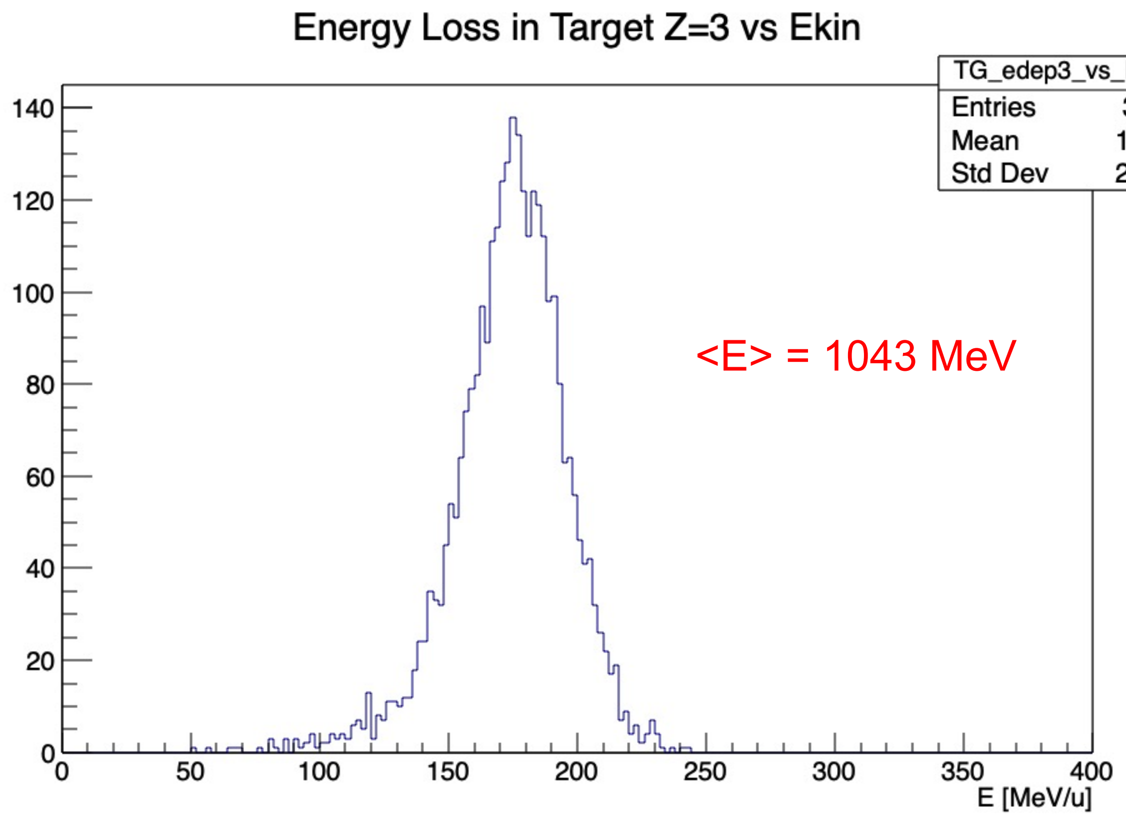
2. Energy Loss in Detectors and Air

1. In the GSI2021 detector configuration, the reconstruction of A is mainly based on the combination of ToF and Energy in calorimeter.

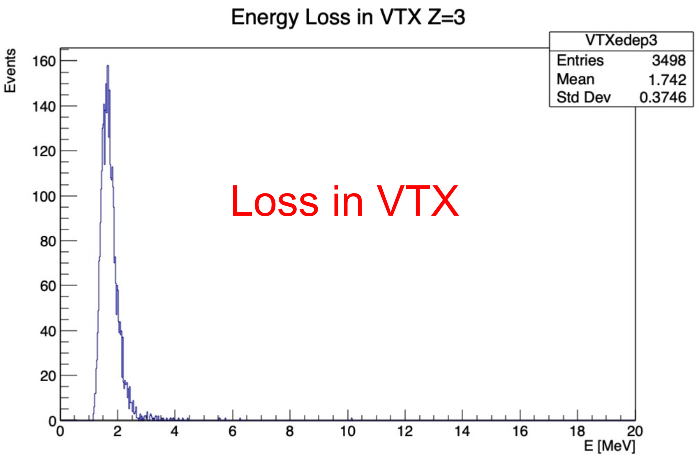
2. Energy loss of secondaries in detectors elements and in air, from target to Calo, may bias the value of reconstructed A (see Aafke’s talk)

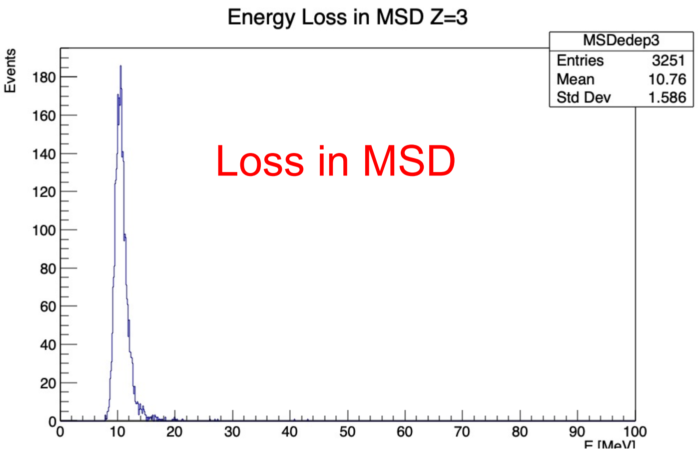
3. MC can be used to study the needed corrections

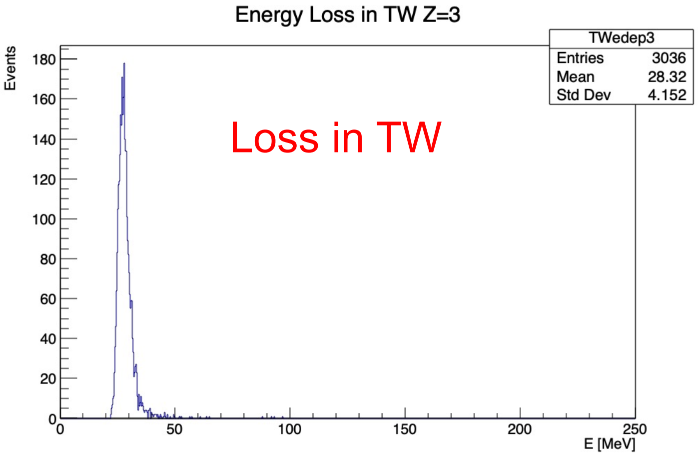
Example 1: Z=3 A=6. Energy at generation

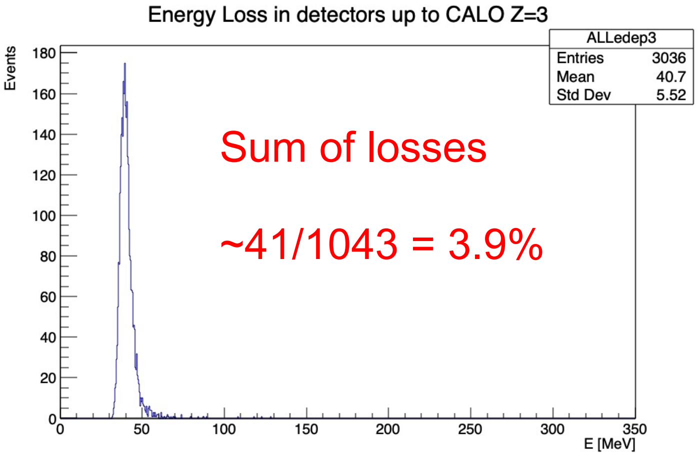


Z=3 A=6. Energy loss in detectors

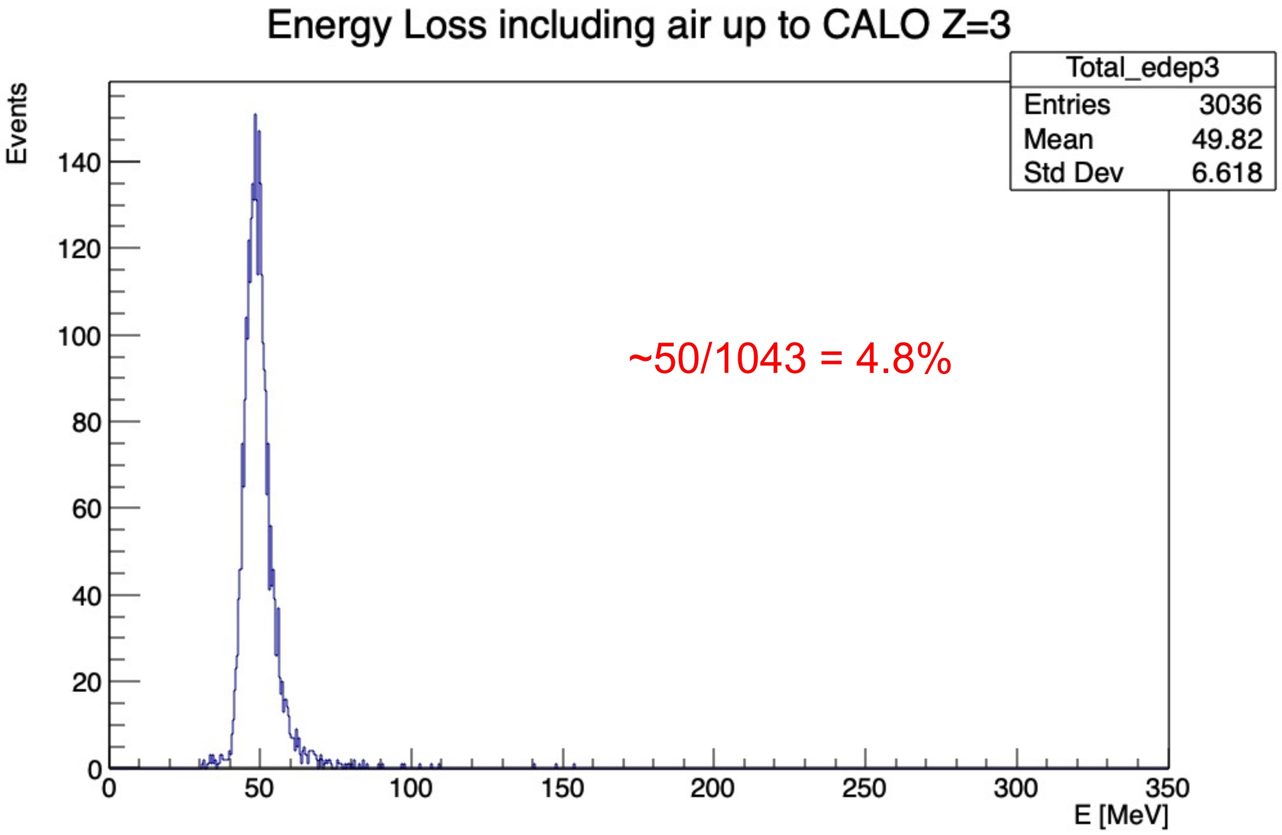




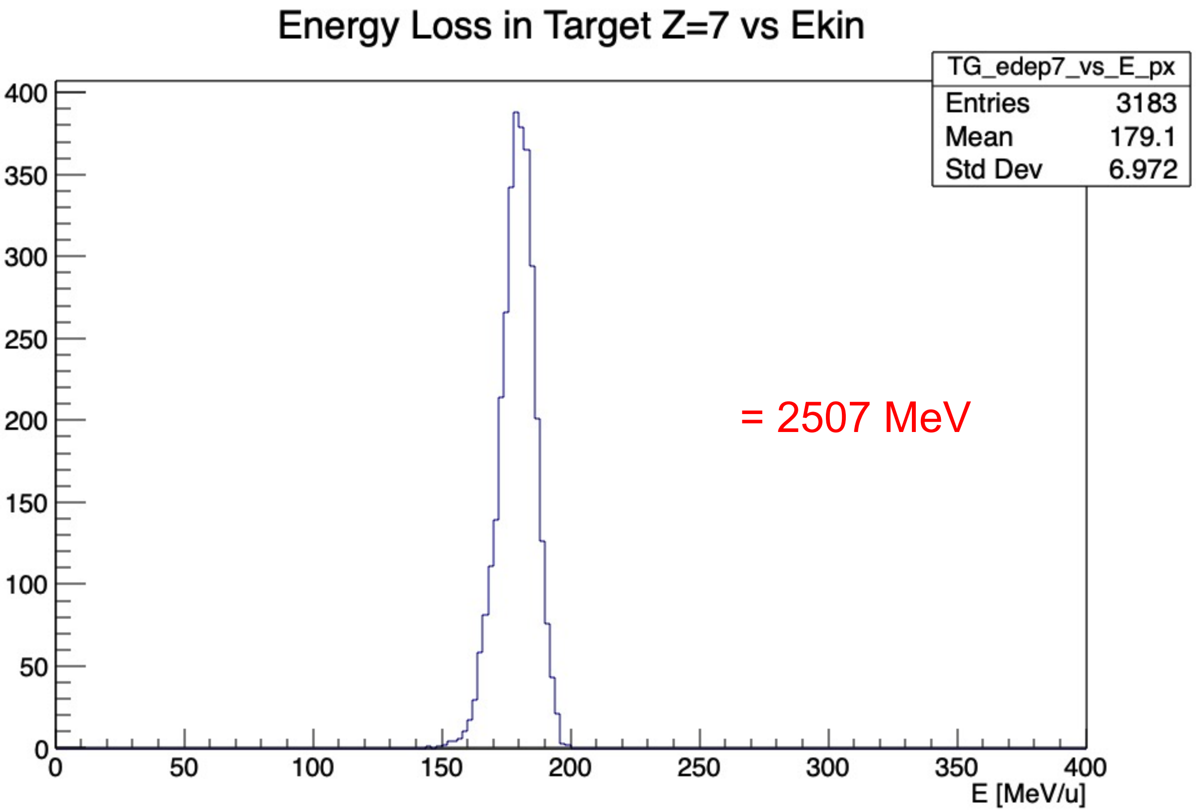




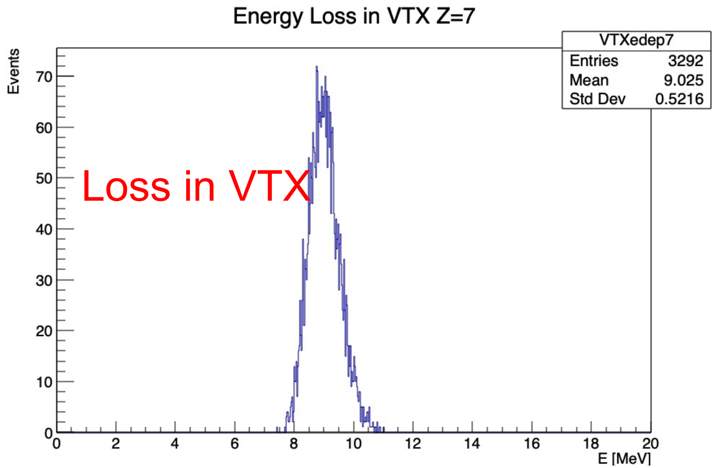
Z=3 A=6. Energy loss in detectors + air

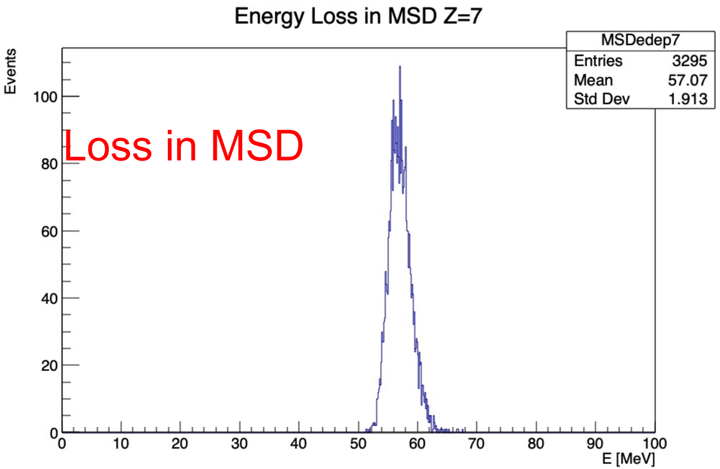


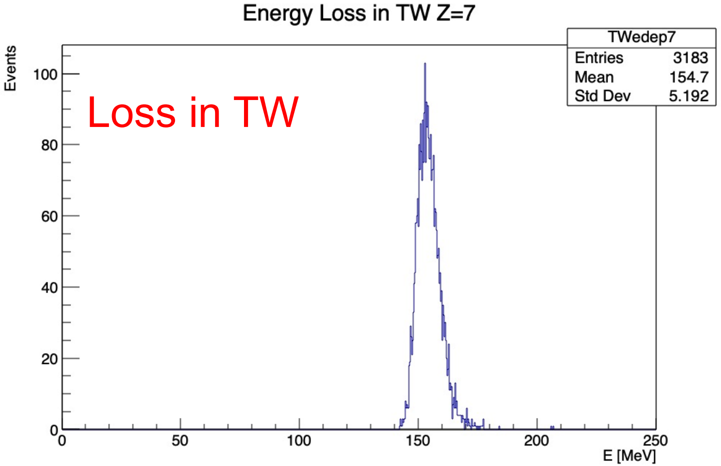
Example 2: Z=7 A=14. Energy at generation

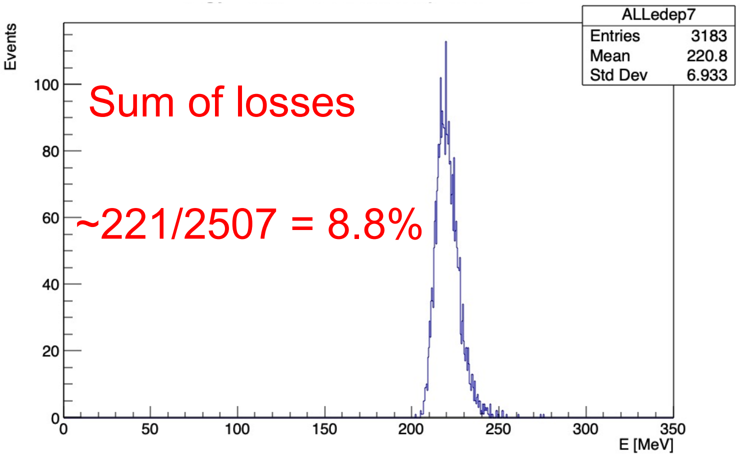


Z=7 A=14. Energy loss in detectors

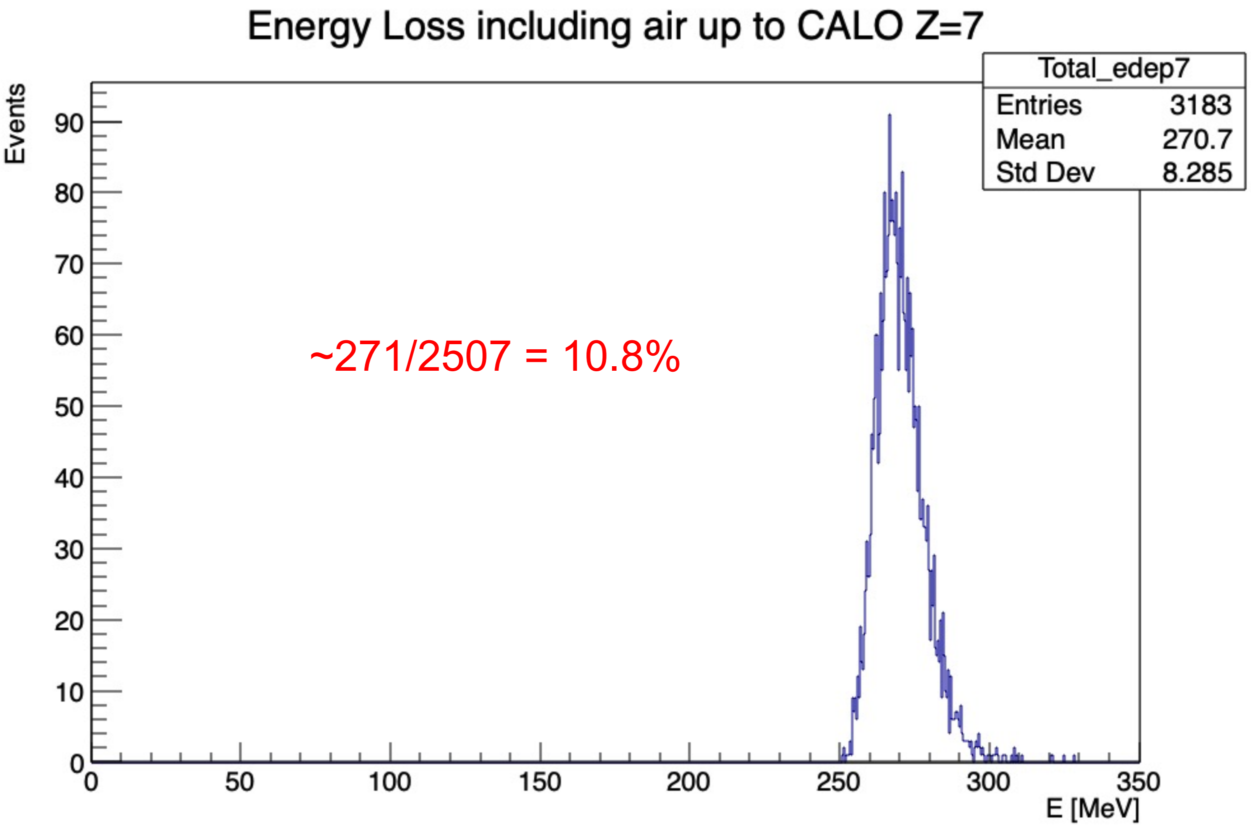








Z=7 A=14. Energy loss in detectors + air



2. Conclusions

1. The higher is Z, the higher is the energy loss in detectors and air (both in absolute and percentage)

2. The energy loss in air is not negligible

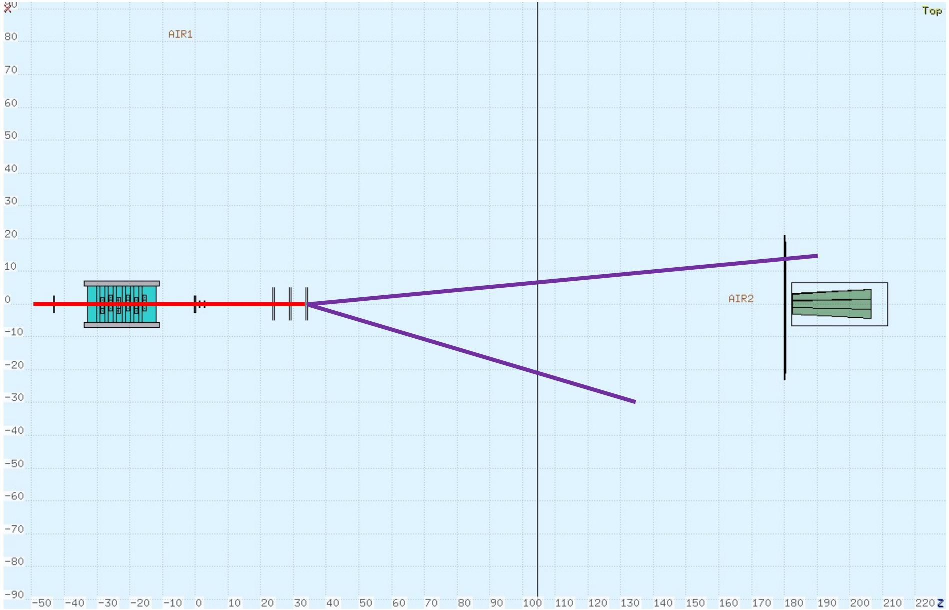
3. Background Interactions

^{16}O 200 MeV/u TARGET C UNTRIGGERED

Primary interacts with the following rates:

Total no. of Processed Events: 10^6

No. of interactions in Air:	6471
No. of interactions in STC:	597
No. of interactions in BM:	467
No. of interactions in TARGET:	14688
No. of interactions in VTX:	417
No. of interactions in MSD:	3005
No. of interactions in TOF WALL:	35980
No. of interactions in CAL:	109670



5mm C target ~ 0.92 g/cm^2

180 cm of air ~ 0.23 g/cm^2

VTX+MSD = 1.1 mm Si ~ 0.25 g/cm^2

6 mm scint. ~ 0.6 g/cm^2

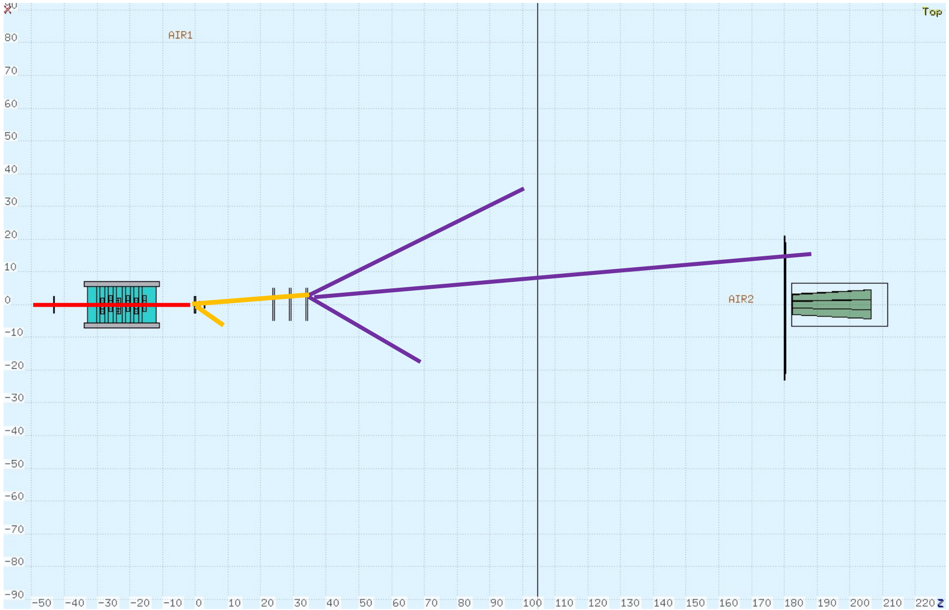
Reinteractions of secondaries produced in target-1

^{16}O 200 MeV/u TARGET C_2H_4 TRIGGERED

Total no. of Processed Events: 27677

No. of Events with interactions in TARGET, with secondaries arriving at the TW: 12408

No. of re-interactions in Air:	24
No. of re-interactions in STC:	0
No. of re-interactions in BMN:	0
No. of re-interactions in TARGET:	0
No. of re-interactions in VTX:	1
No. of re-interactions in MSD:	20
No. of re-interactions in TOF WALL:	204
No. of re-interactions in CAL:	1259



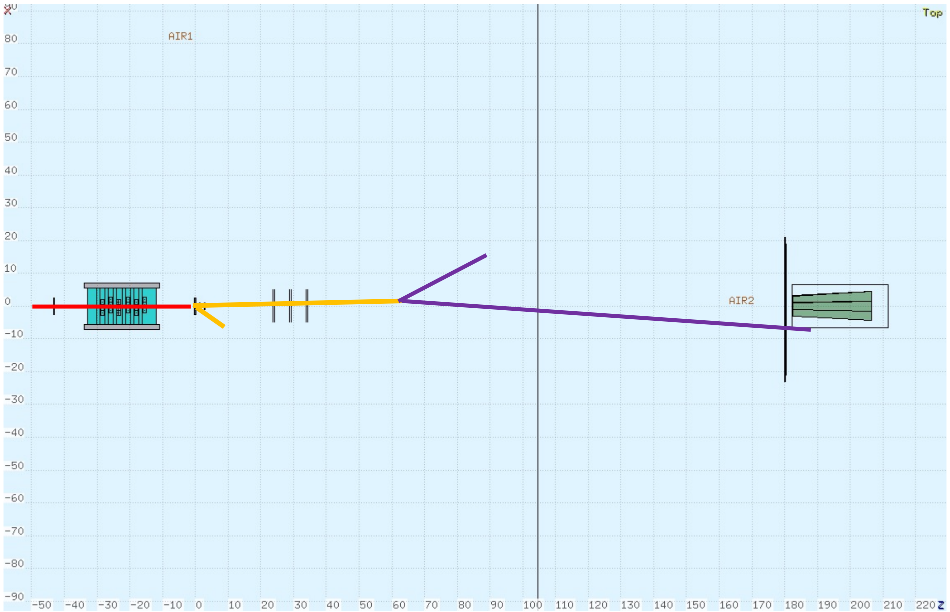
Reinteractions of secondaries produced in target-2

^{16}O 400 MeV/u   TARGET C_2H_4 TRIGGERED

Total no. of Processed Events: 27900

No. of Events with <u>interactions in TARGET</u>, with <u>secondaries arriving at the TW</u>: 16651

No. of re-interactions in Air:	35
No. of re-interactions in STC:	0
No. of re-interactions in BMN:	0
No. of re-interactions in TARGET:	0
No. of re-interactions in VTX:	4
No. of re-interactions in MSD:	15
No. of re-interactions in TOF WALL:	240
No. of re-interactions in CAL:	2993



3. Conclusions

1) The importance of off-target interactions was already pointed out in the analysys of GSI2019.

2) The main difference in 2021 will be the presence of the MSD.

3) Being both VTX and MSD active detectors, we should be able to remove a relevant fraction of “dangerous” situations.

4. The case of ^{15}O production

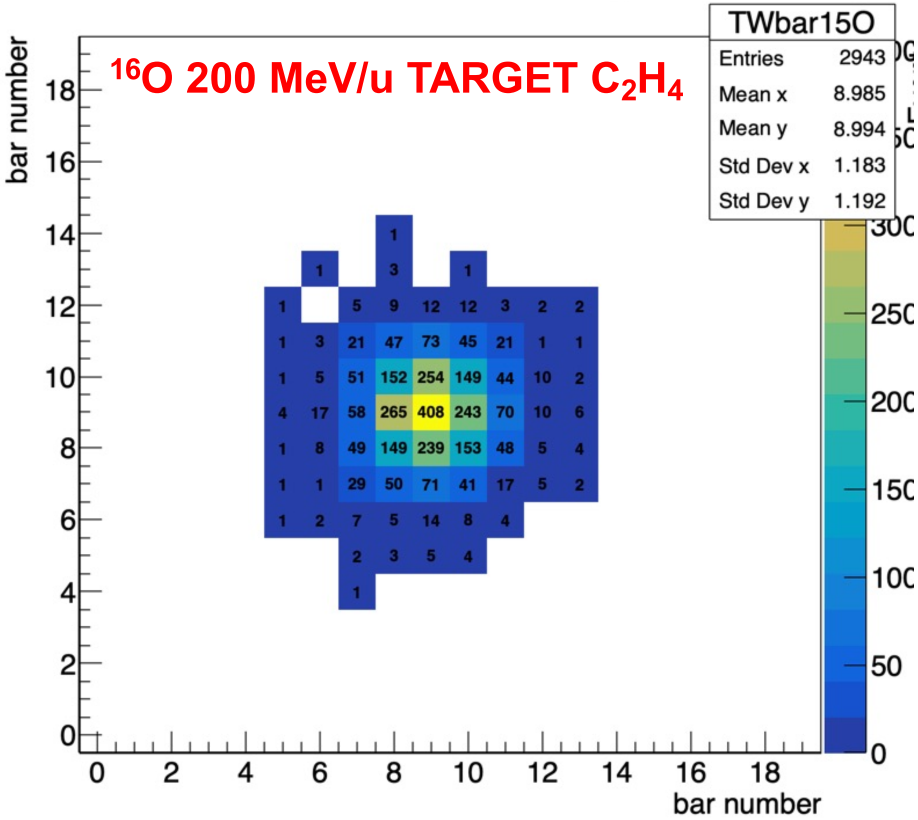
1. It's an intersting case when considering therapy applications (production of an important β^+ emitter)

2. Difficult to study: energy deposition is practically indistiguishable from that of the non-interacted ^{16}O primary

3. Are we going to lose the possibility of detecting this channel by using a fragmentation trigger?

^{15}O production at TW

Bar number of Layer 1 vs Bar number of Layer 2



408 cases out of 2943 (13.8%) hit the central bar in both the 1st and 2nd layer

At 400 MeV/u this occurs in 926 cases out of 2796 (33%)

1. Do we care?

2. Can we distinguish ^{15}O or (^{14}O) from ^{16}O in A reconstruction?

We have not yet any conclusions for this issue at this time.