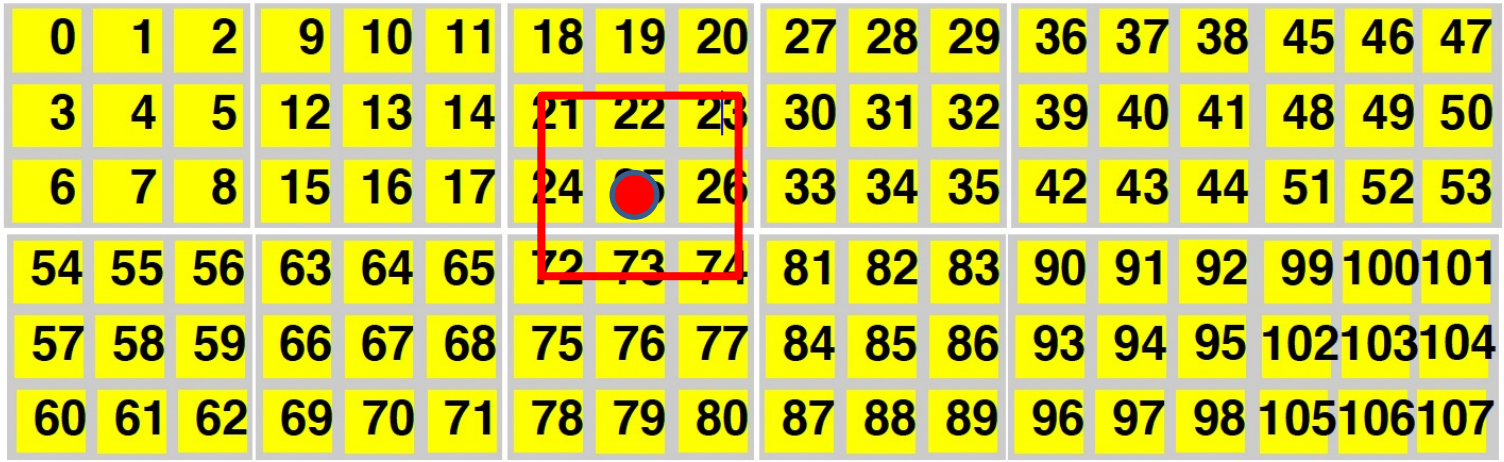
MC Simulation for CNAO2022 campaign

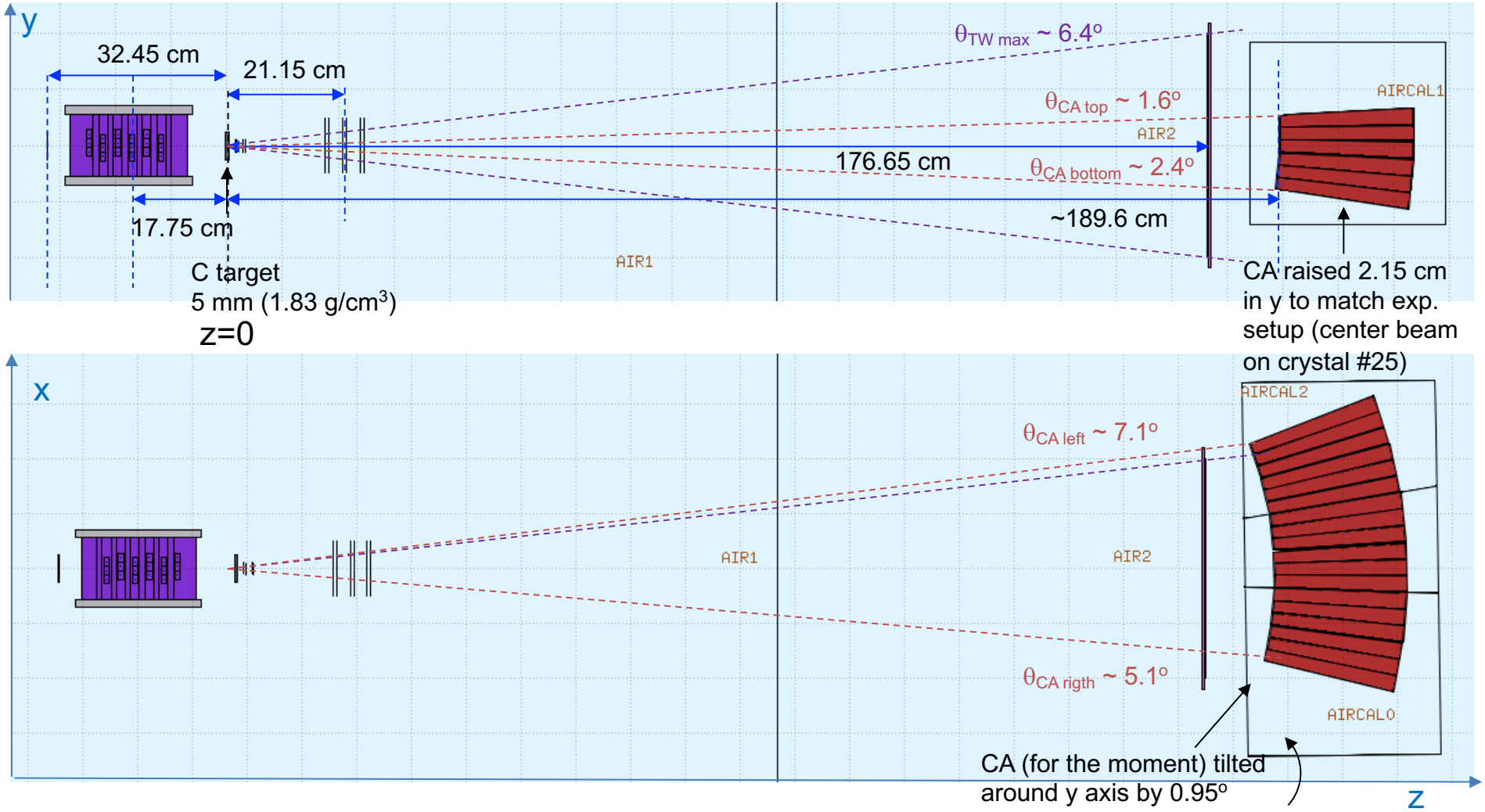
G.B. S.M., INFN-Milano

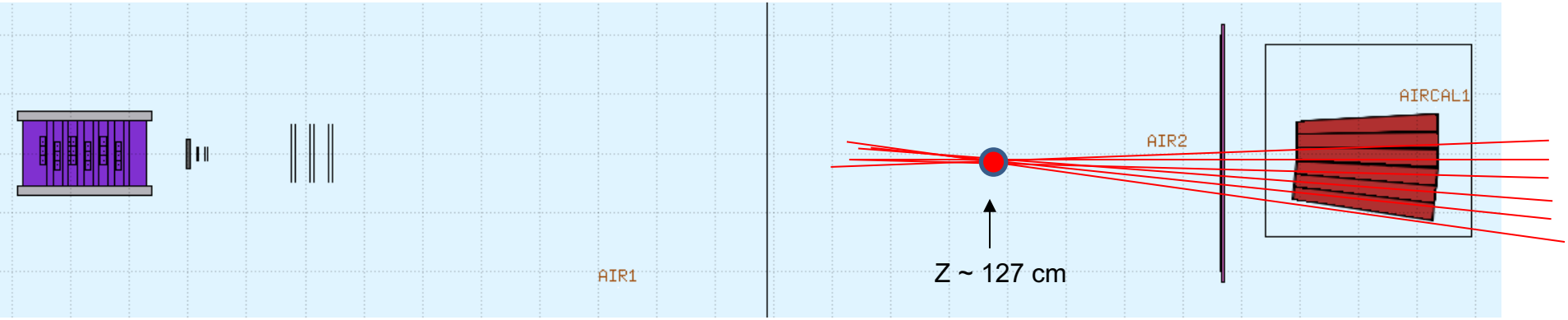
Preparation of simulation campaign

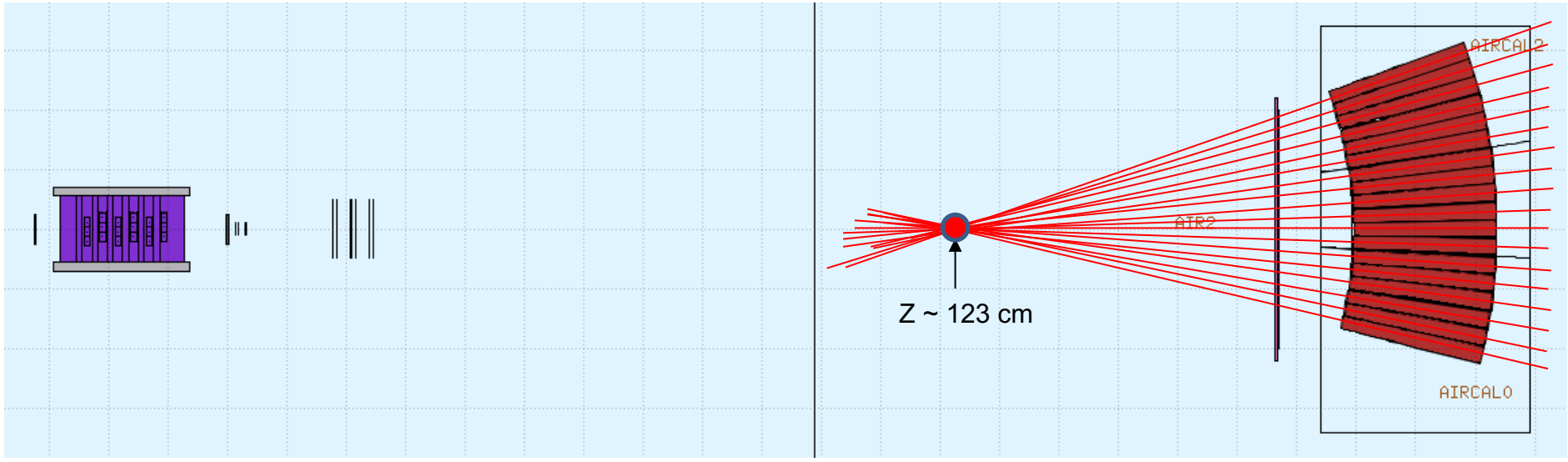
- Campaign is CNAO2022_MC in Shoe Newgeom branch (*Please update)*
- Run 200: November geometry (if still of interest…)
- Run 201: December geometry; built after the geometrical survey as in entry #57 of Elog (http://arpg-serv.ing2.uniroma1.it/elog/FOOTCNAO2022/57). *See also slides presented by G. Traini*
- Beam size X, Y (approximated as independent gaussians) as taken from the preliminary reconstruction of BM exp. Data
- E_k = 200.6 MeV/u
- *The same numbers of geomaps/CNAO2022_MC/FOOT_201.geo have been copied in geomaps/CNAO2022/FOOT_5449.geo*

CA back view


0 1 2 9 10 11 18 19 20 27 28 29 36 37 38 45 46 47
3 4 5 12 13 14 21 22 23 30 31 32 39 40 41 48 49 50
6 7 8 15 16 17 24 25 26 33 34 35 42 43 44 51 52 53
54 55 56 63 64 65 72 73 74 81 82 83 90 91 92 99 100 101
57 58 59 66 67 68 75 76 77 84 85 86 93 94 95 102 103 104
60 61 62 69 70 71 78 79 80 87 88 89 96 97 98 105 106 107


y
32.45 cm
21.15 cm
17.75 cm
C target
5 mm (1.83 g/cm3)
z=0
θTW max ~ 6.4°
θCA top ~ 1.6°
θCA bottom ~ 2.4°
176.65 cm
~189.6 cm
AIR1
AIR2
AIRCAL1
CA raised 2.15 cm
in y to match exp.
setup (center beam
on crystal #25)
x
θCA left ~ 7.1°
θCA rigth ~ 5.1°
AIRCAL2
AIRCAL0
CA (for the moment) tilted
around y axis by 0.95°
z


AIR1
AIR2
AIRCAL1
Z ~ 127 cm


AIR2
AIRCAL2
AIRCAL0
Z ~ 123 cm

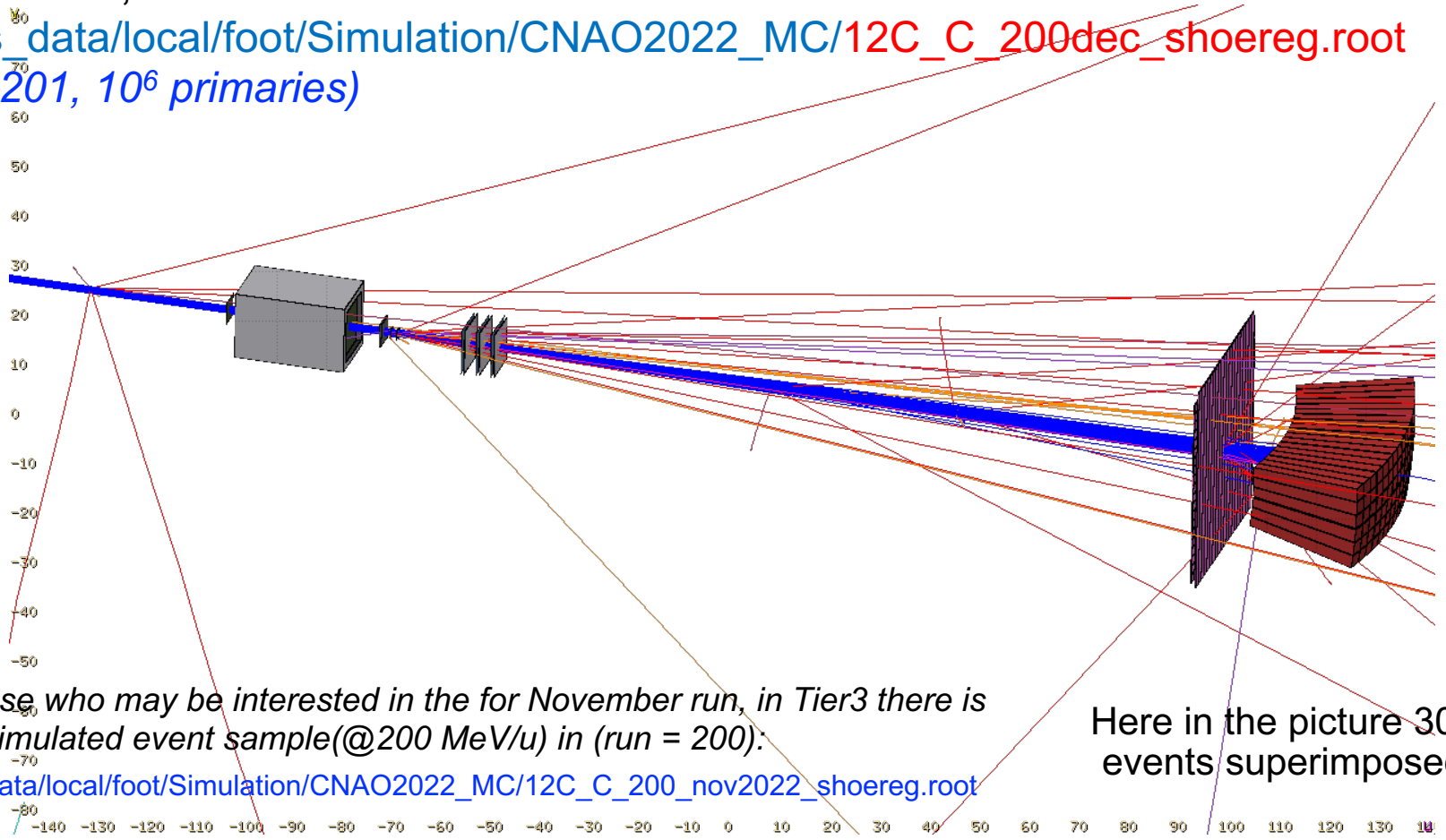
Technical issues recently solved:

Mismatch between simulation and reconstruction in the management of rotation angles in geometry (Y. Dong, R. Zarrella)

As in the past, there are details missing:

- Frames and printed circuit boards around VTX, MSD…
- Cardboard wrapping of TW
- Wrapping of crystals
- Tyvec foil in front of calorimeter
- …

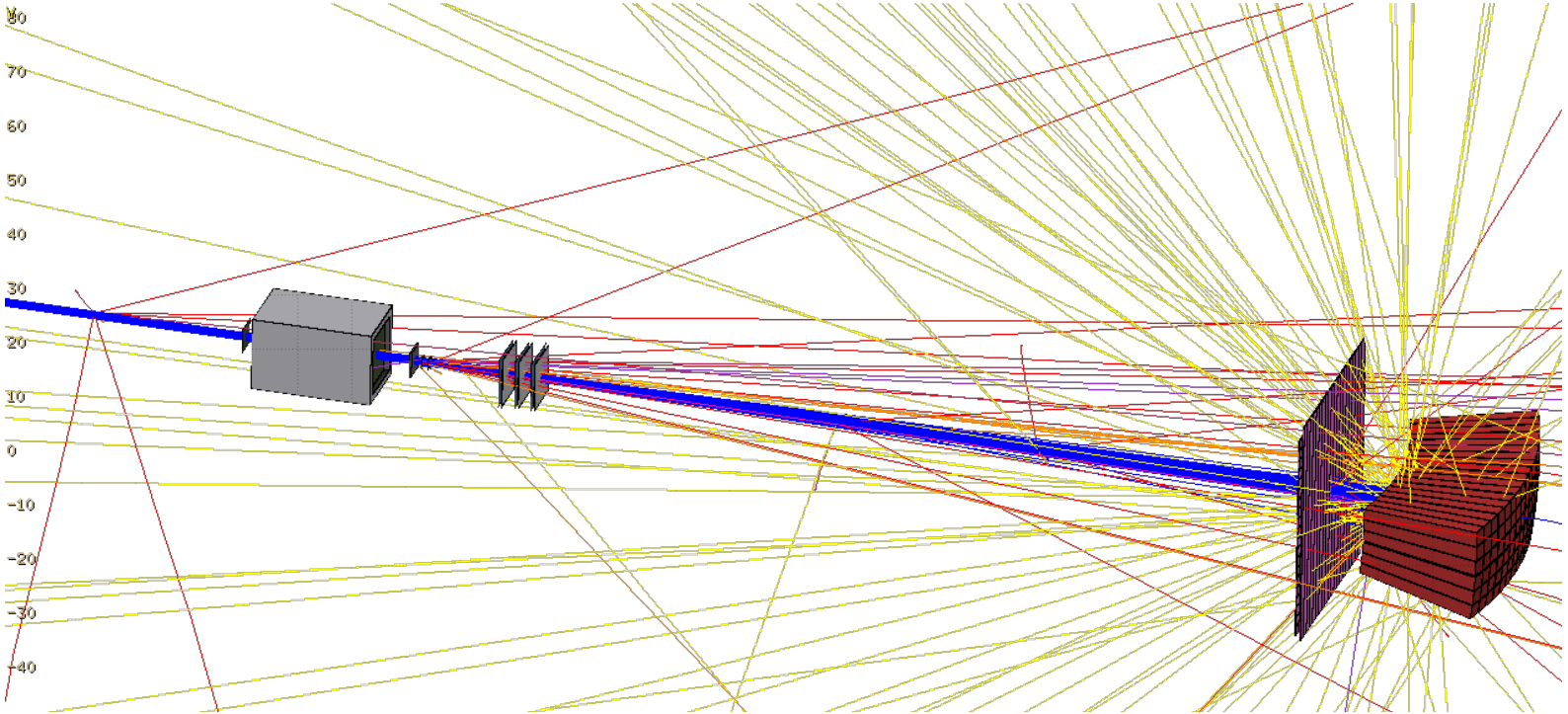
First batch of simulated events with Dec. Geometry available for first tests, alignement, reconstruction etc. in tier3:
/gpfs_data/local/foot/Simulation/CNAO2022_MC/12C_C_200dec_shoereg.root
(run 201, 10^6 primaries)



For those who may be interested in the for November run, in Tier3 there is a 10^6 simulated event sample(@200 MeV/u) in (run = 200):
/gpfs_data/local/foot/Simulation/CNAO2022_MC/12C_C_200_nov2022_shoereg.root

Here in the picture 300 events superimposed

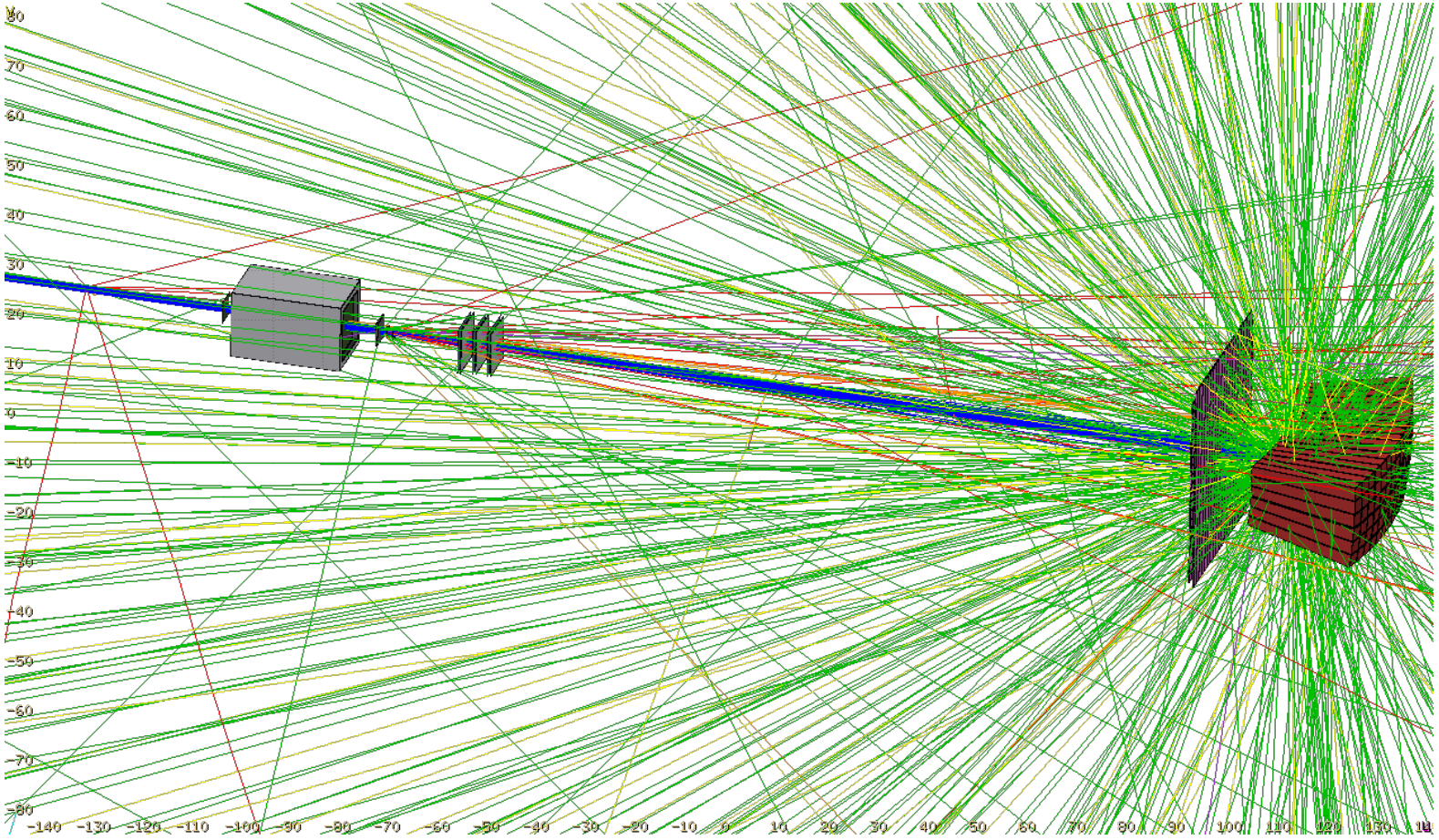
300 events + photons (E_{cut} > 500 keV)



Notice: this simulation includes (few) δ-rays and photons with 500 keV energy cut (for a fragment with ~200 MeV/u Ekin $T_{max}(\delta)$ ~ 1.22 MeV)

Exception: δ-ray production has been inhibited in BGO (while photons are allowed)

300 events + photons (E_{cut} > 500 keV) + neutrons



No. of interactions for 1 milion of primaries

No. of interactions in Air: 11011 Before TG: 3233 After TW: 435

No. of interactions in STC: 1436
No. of interactions in BMN: 1277
No. of interactions in TGT: 36506 (3.65%)
No. of interactions in VTX: 1206
No. of interactions in MSD: 5301
No. of interactions in TWL: 30284

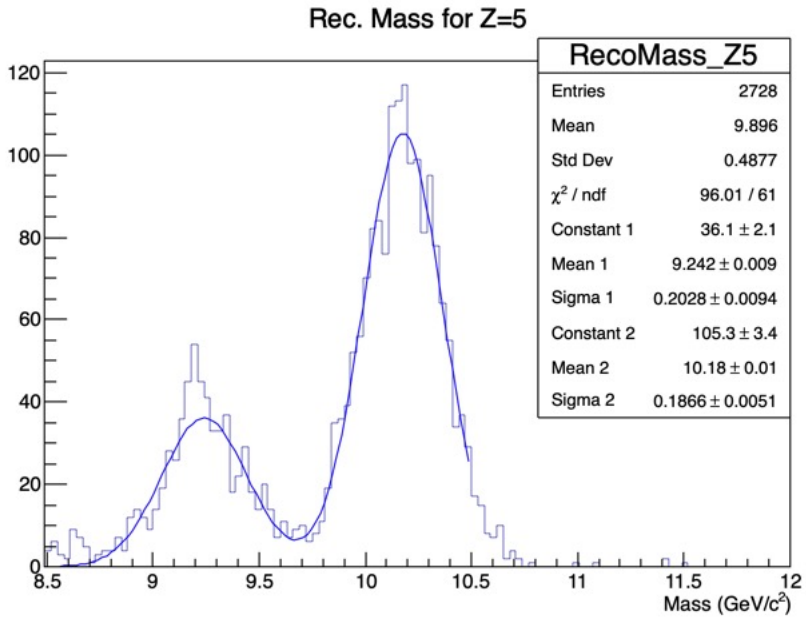
No. of int. in TWL ~ No. of int. in TGT
ρ_{TWL} = 0.94 g/cm^3 ρ_{TGT} = 1.83 g/cm^3
6 mm 5 mm
It seems that proportionally there are more interactions in the TWL.
Maybe because the cross section is higher after the energy loss along the path?

No. of primaries interacting before target is 5946

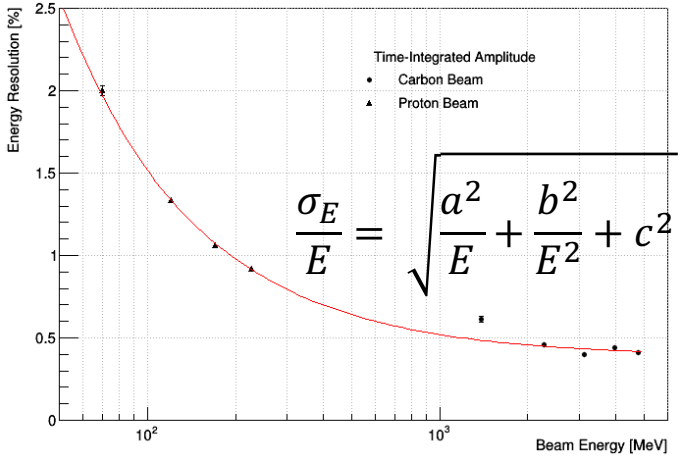
We have to pay attention to interactions in TW while attempting to use the calorimeter to identify isotopes produced in target: Tracking is essential. Beyond primaries, also fragments from target reinteract in TW.

Mass Identification in this simulation (after Shoe Genfit reconstruction, simplified Calo clustering)

$$M = \frac{E_k}{(\gamma - 1)}$$

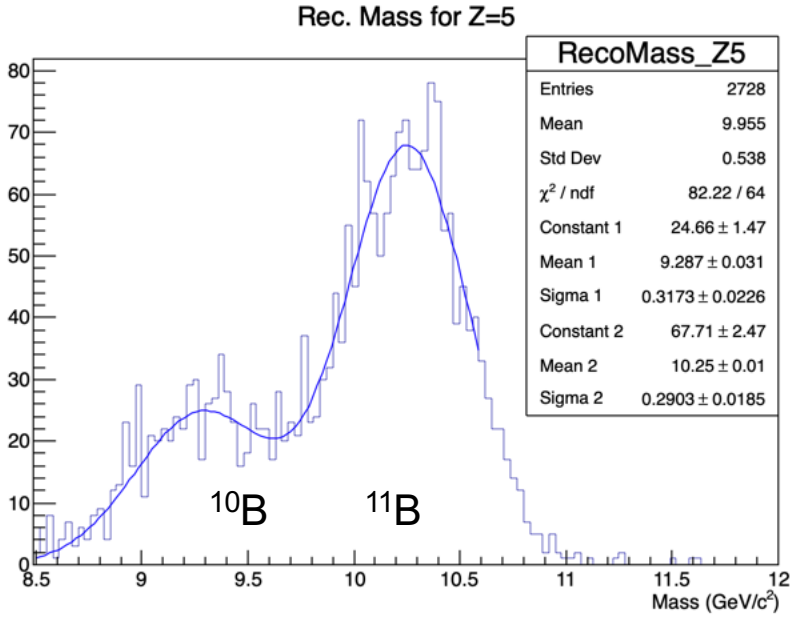


Ideal resolution and perfect intercalibration of crystals



Mass Identification in this simulation (after Shoe Genfit reconstruction)

$$M = \frac{E_k}{(\gamma - 1)}$$

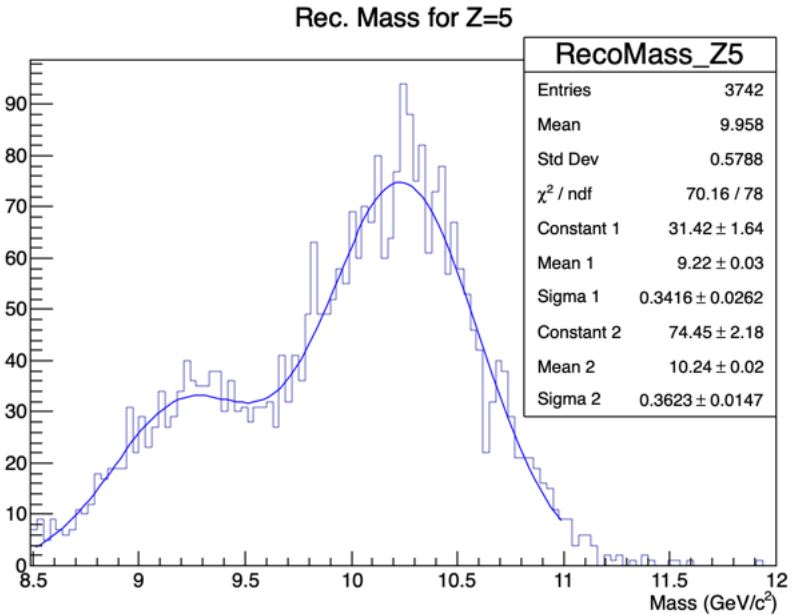


Ideal resolution but imperfect intercalibration of crystals (2% level)

A database of fake uncalibration factors (generated by means of a gaussian with 2% rms) has been introduces while processing MC events

Mass Identification in this simulation (after Shoe Genfit reconstruction)

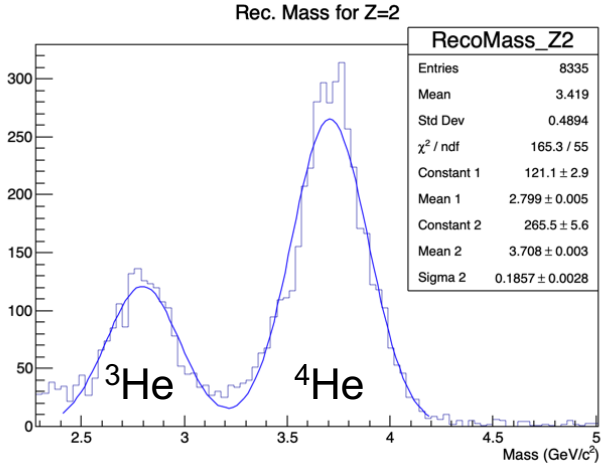
$$M = \frac{E_k}{(\gamma - 1)}$$



2% constant resolution (~4 times worse than ideal resolution) and imperfect intercalibration of crystals (2% level)

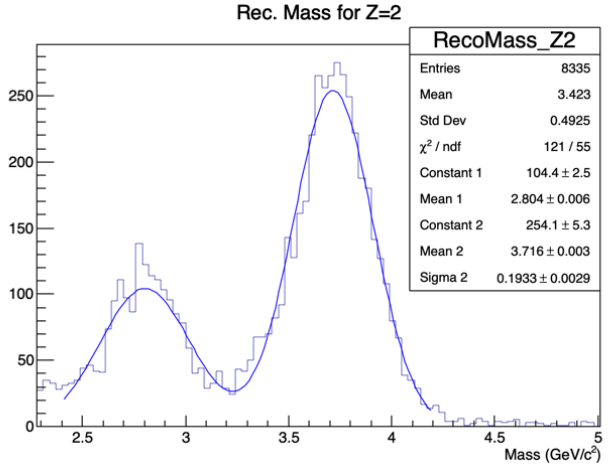
➔The issue of intercalibration seems to have more importance than energy resolution fluctuations

Same analysis for the Z=2 case

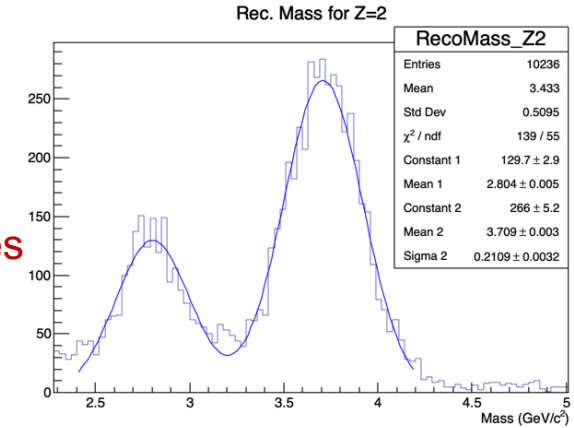


Ideal resolution and perfect intercalibration of crystals

Remember that for low Z the ToF resolution applied to MC TW points in SHOE is still pessimistic!



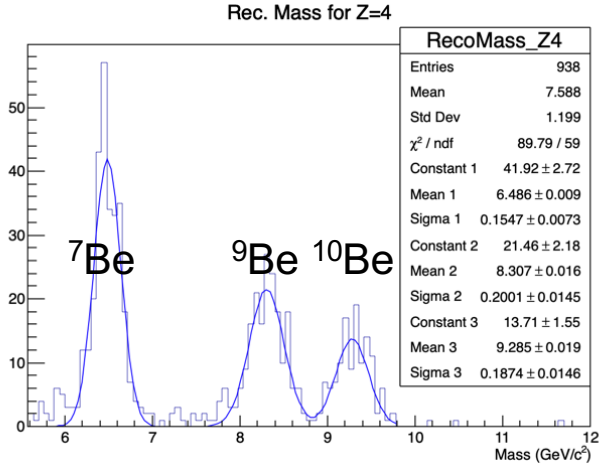
Ideal resolution but imperfect intercalibration of crystals (2% level)



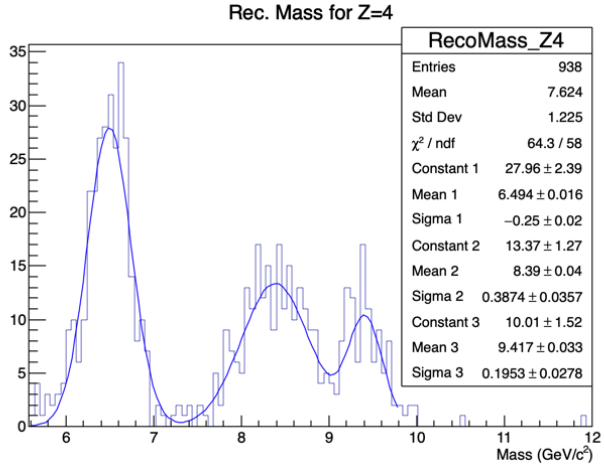
➔ Apparently, for low Z isotopes the issues of resolution and intercalibration should have a much lower impact

2% resolution and imperfect intercalibration of crystals (2% level)

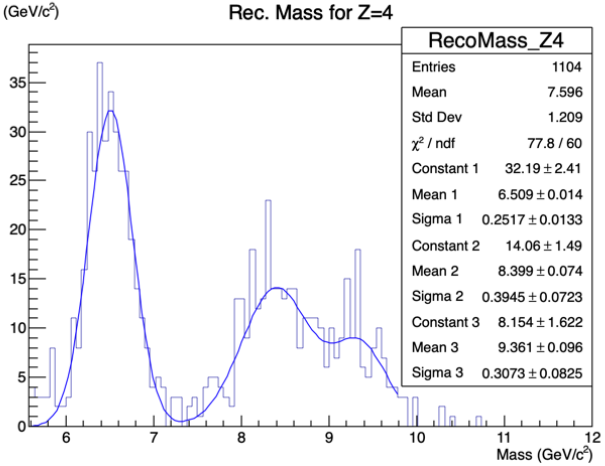
Same analysis for the Z=4 case



Ideal resolution and perfect intercalibration of crystals

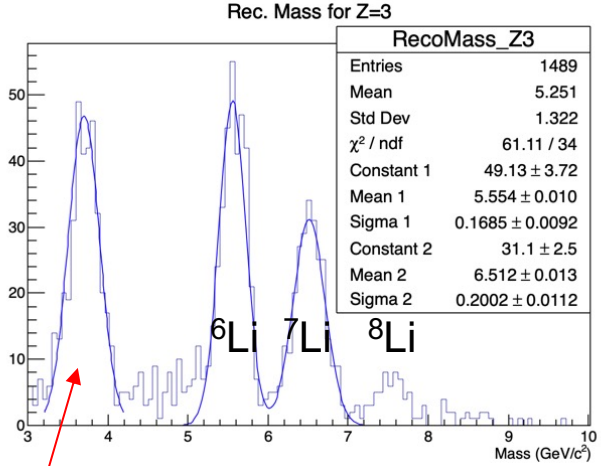


Ideal resolution but imperfect intercalibration of crystals (2% level)



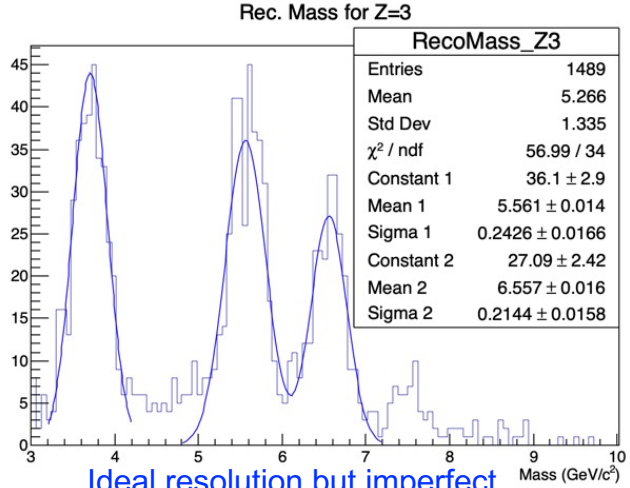
2% resolution and imperfect intercalibration of crystals (2% level)

Same analysis for the Z=3 case

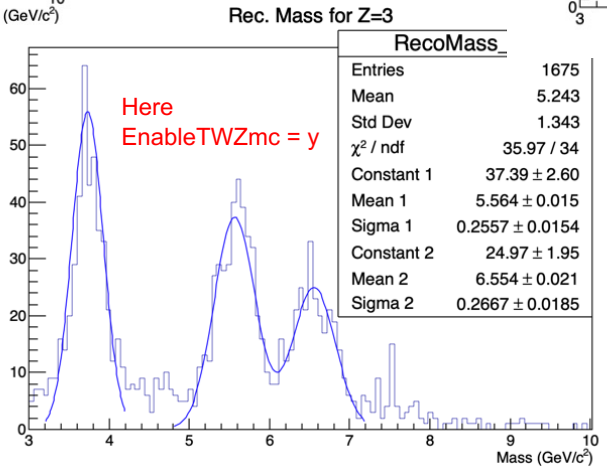


Ideal resolution and perfect intercalibration of crystals

4He… with wrong charge assignment

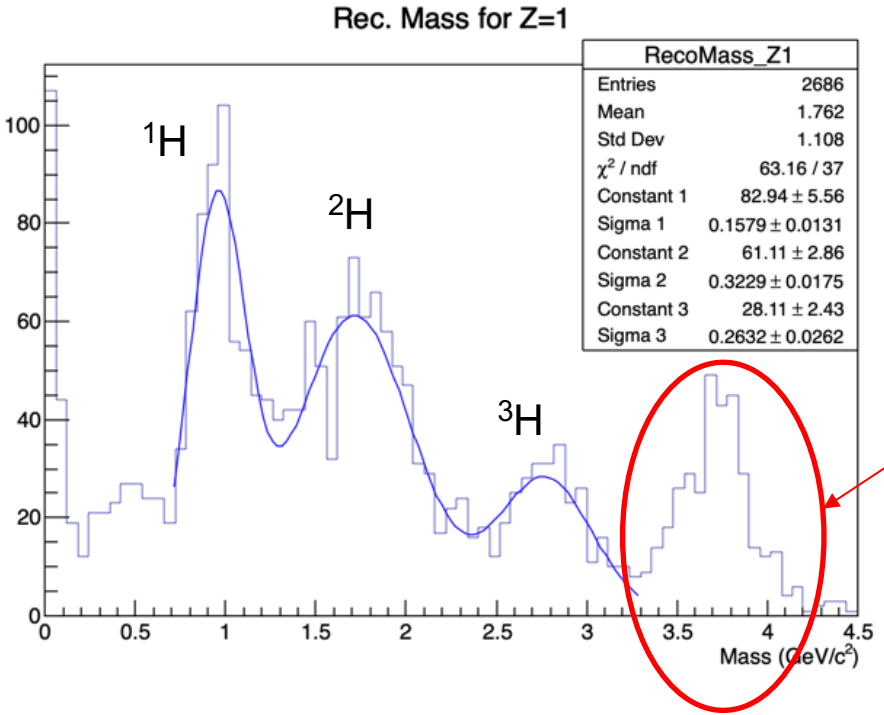


Ideal resolution but imperfect intercalibration of crystals (2% level)



2% resolution and imperfect intercalibration of crystals (2% level)

The case of Z=1



2% resolution and imperfect intercalibration of crystals (2% level)

Wrong Z assignment ?!

These are clearly ^{4}He to which Z=1 has been assigned in reconstruction (or probably bad association of TW to Calo cluster)

Therefore there could be also ^{3}He under the ^{3}H peak.

We are afraid that the same consideration applies also to other charges…

Conclusions

- The campaign CNAO2022_MC in Shoe Newgeom branch has been produced
- A first batch of simulated data is available for initial studies
- Geometry and other details has probably to be corrected after alignment checks etc. to be performed on real experimental data
- This preliminary sample predicts that, in case we succeed to have a sufficiently good track reconstruction and Calo calibration, we shall have enough stastistics to demonstrate our capability of isotope identification
- A large production will be performed only after we shall reach a higher degree of confidence on the geometry of the setup, beam width etc. (δ-ray cut will be lowered)
  ➔ For this purpose we hope to receive feedback from other FOOT colleagues!