Preliminary elemental cross sections with GSI data

Riccardo Ridolfi

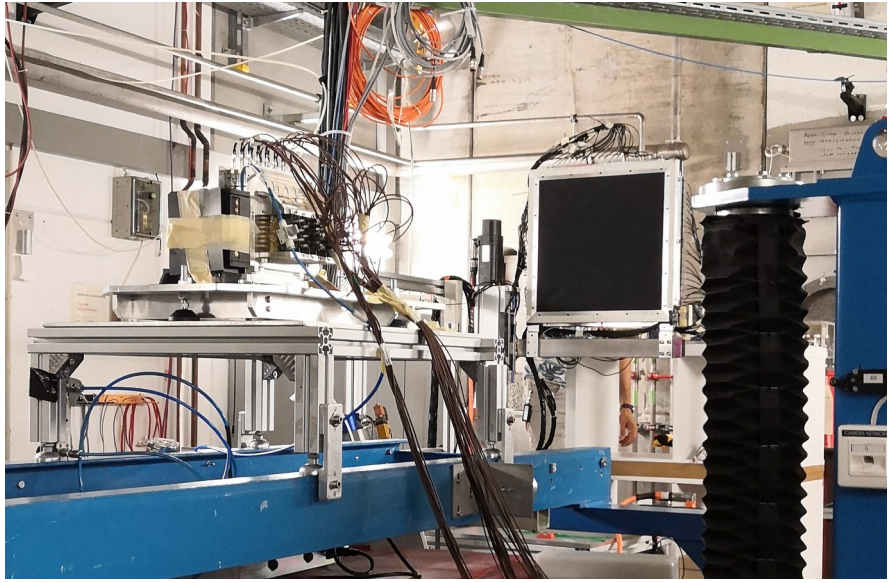
12 January 2021

Cross section measurements

400 MeV/u ^{16}O beam on 5mm Carbon target

Run	Trigger type	Target	Events
4305	MB	C	162102
4306	MB	C	577096
4307	MB	C	513370
4310	Frag + MB	C	1012099
4313	MB	no	57133

Table 6.1: Run list GSI2021.



Cross section measurements

400 MeV/u ^{16}O beam on 5mm Carbon target

With available data total integrated and angle differential cross section are achievable (no kinetic energy)

$$\sigma(Z) = \int_{E_{\min}}^{E_{\max}} \int_{0}^{\theta_{\max}} \left(\frac{\partial^2 \sigma}{\partial \theta \partial E_{\mathrm{kin}}} \right) \mathrm{d}\theta \mathrm{d}E_{\mathrm{kin}} = \frac{Y(Z)}{N_{\mathrm{prim}} \cdot N_{\mathrm{TG}} \cdot \varepsilon(Z)}$$

$$\frac{\mathrm{d}\sigma}{\mathrm{d}\theta}(Z) = \frac{Y(Z,\theta)}{N_{\mathrm{prim}} \cdot N_{\mathrm{TG}} \cdot \Delta\theta \cdot \varepsilon(Z,\theta)}$$

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Align FOOT detectors and estimate **angular acceptance**

Extract fragment yields from TW

Calculate MC efficiencies for fragments

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Cross section measurements

400 MeV/u ^{16}O beam on 5mm Carbon target

In this analysis trackers (VTX & MSD) are not included!

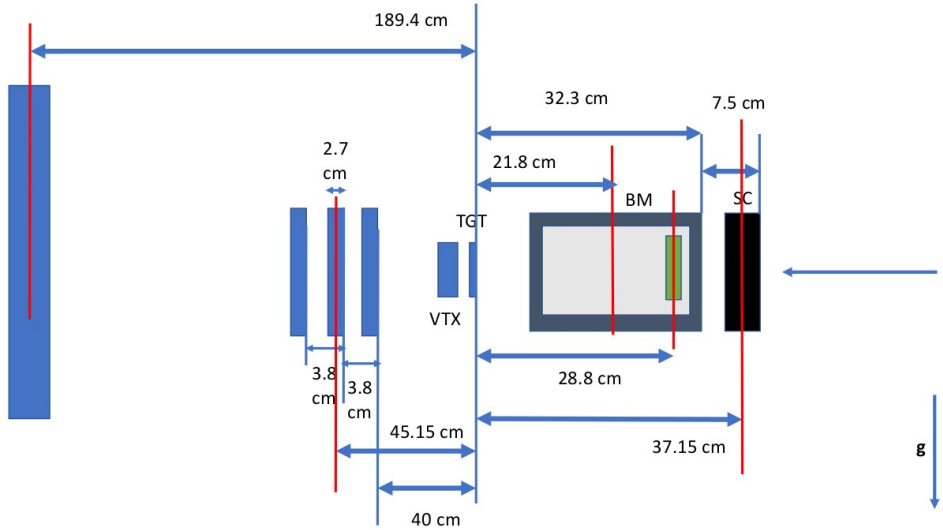
Fragmentation out of target will be estimated with no target runs

Data analysis carried out in GSI VIRGO cluster

Detector alignment

All the geometry was handled by **SHOE** TAGgeotrafo

To align BM and TW projections of beam particles were used



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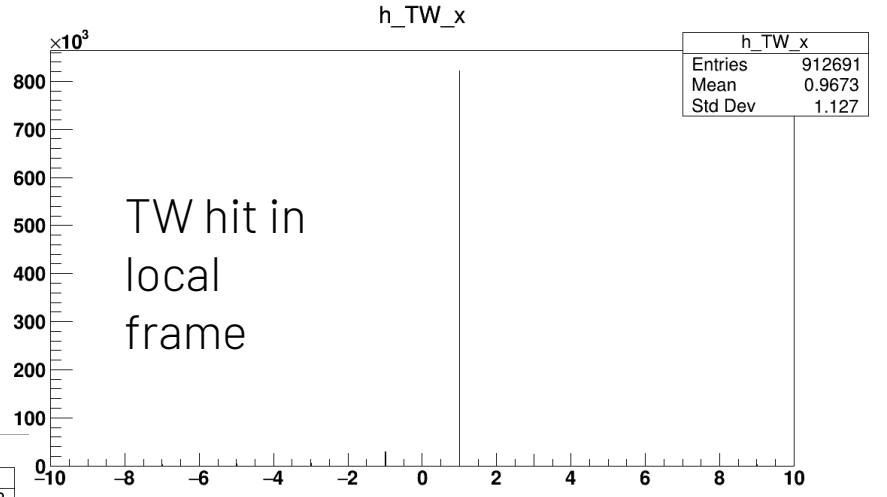

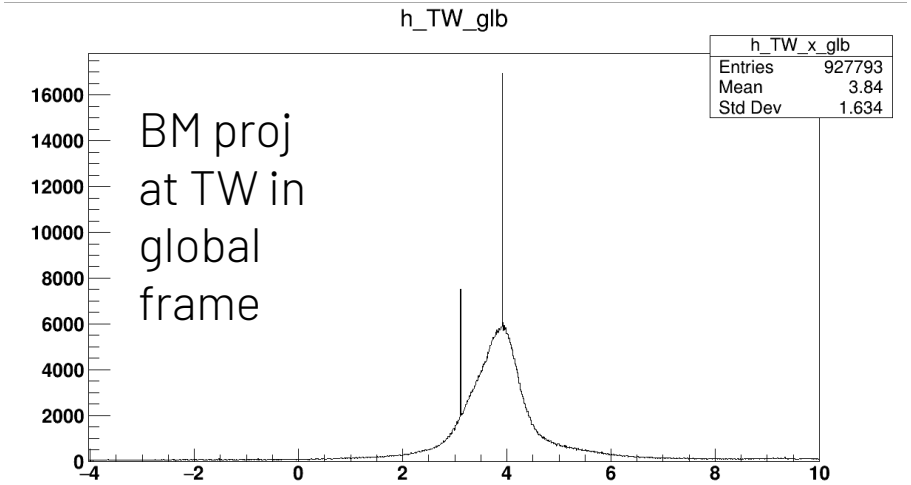

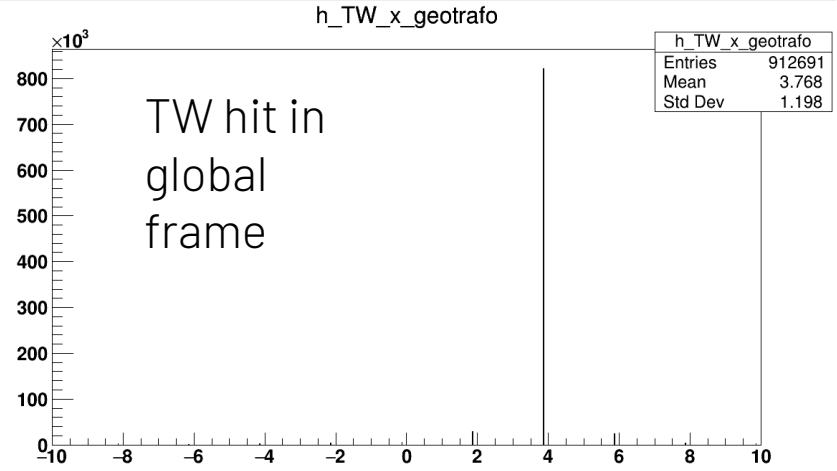

Detector alignment

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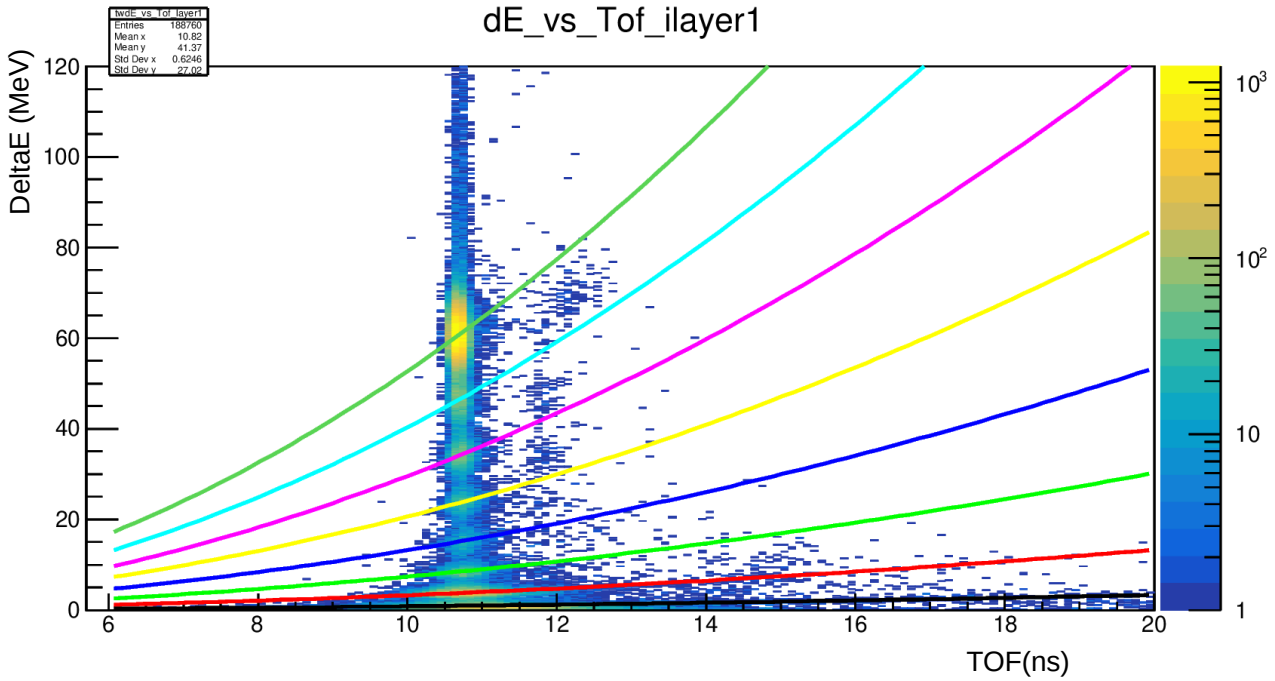
of beam particles were used

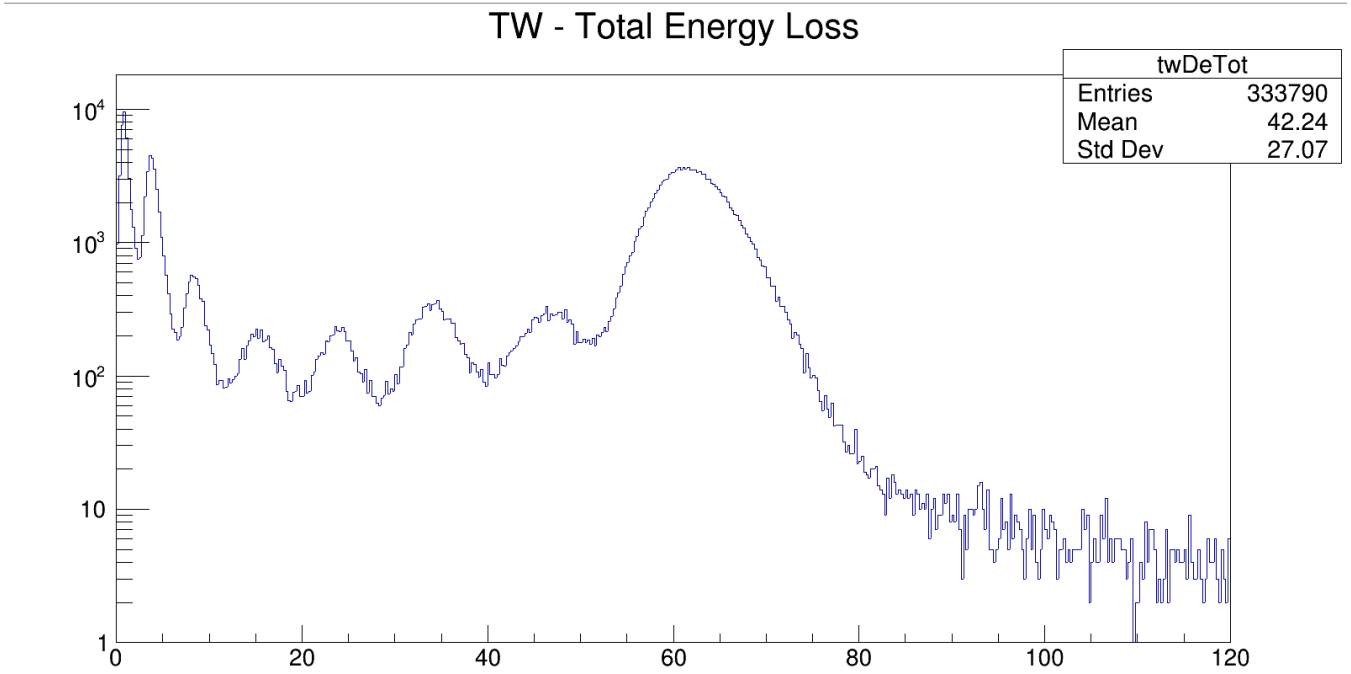
Due to the asymmetric shift of TW
acceptance θ max ≈5°

SHOE output (ZID)



Run 4310 + BB curve implemented in SHOE for 400 MeV/u

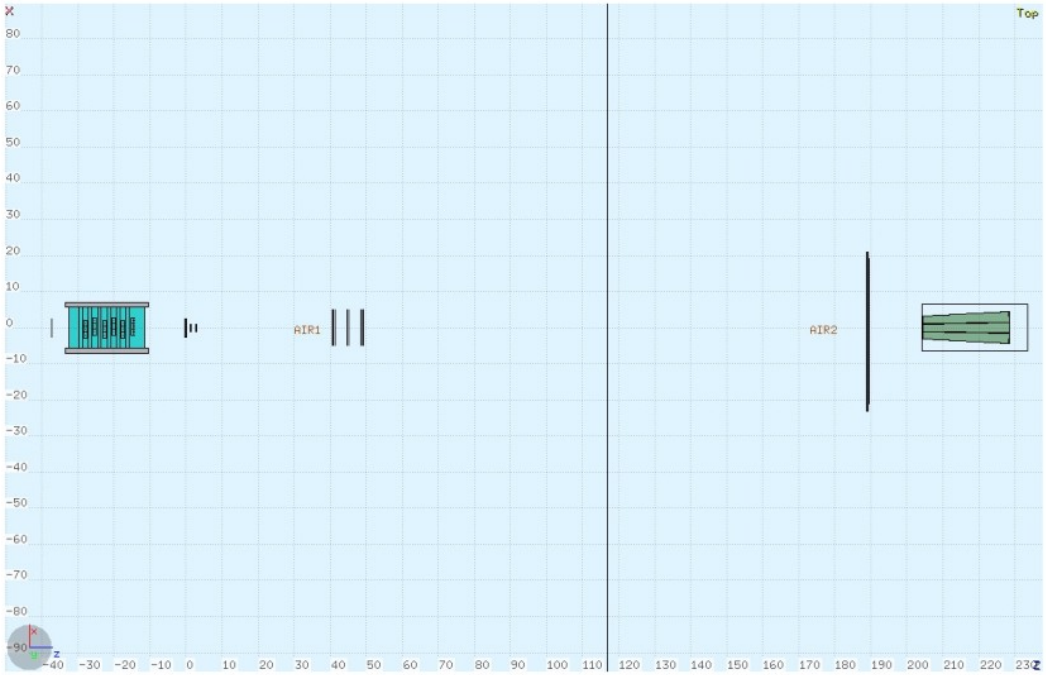
SHOE output (ZID)



Run 4310 + BB curve implemented in SHOE for 400 MeV/u

MC analysis

Updated layout

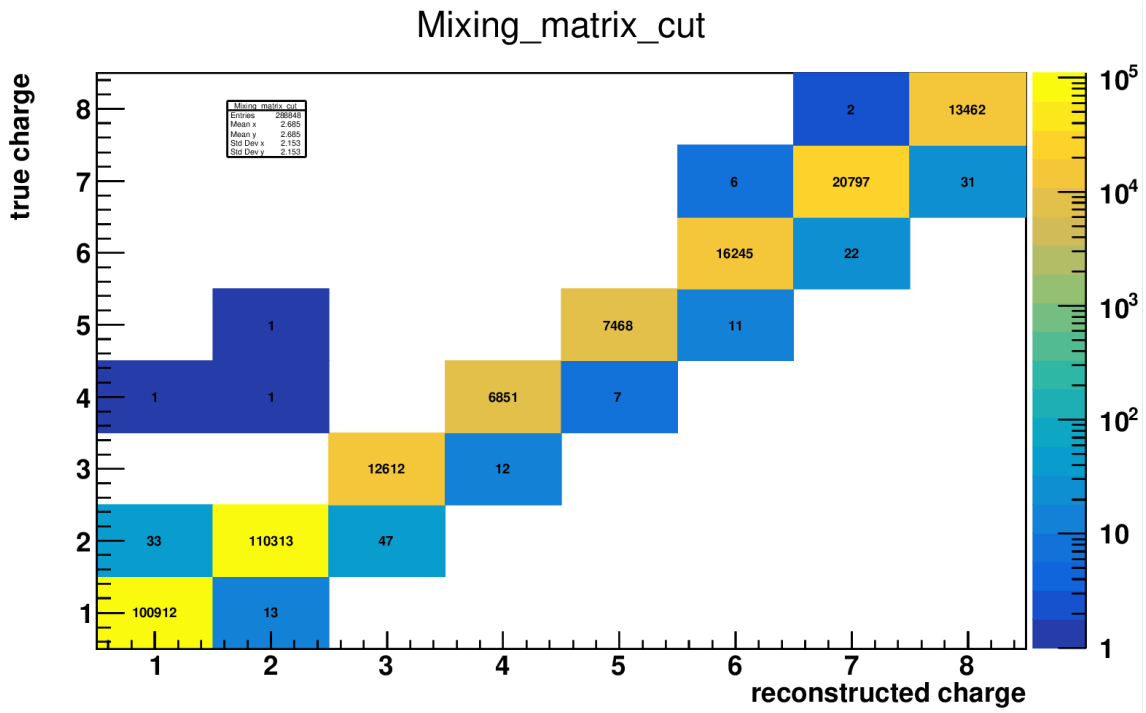


Using just the **newgeom branch**, for the moment, the geometrical layout of GSI2021_MC campaign has been updated according to the survey performed in cave A (as from the document uploaded in the Elog)

We have considered for the moment the case with all detectors centered in the XY plane (400 MeV/u runs)

Gaussian beam with σ_x = 2.3 mm σ_y = 1.5 mm

MC analysis



Only particles with cut in Ekin, produced in target by primary beam inside TW acceptance

No unfolding up to now

MC analysis

$$\varepsilon(Z) = \frac{N_{\mathrm{TW}}(Z) + 1}{N_{\mathrm{track}}(Z) + 2}$$

asking for a good TW point matched to a fragment produced in TG within TW acceptance and kinetic energy between [100,600] MeV/u

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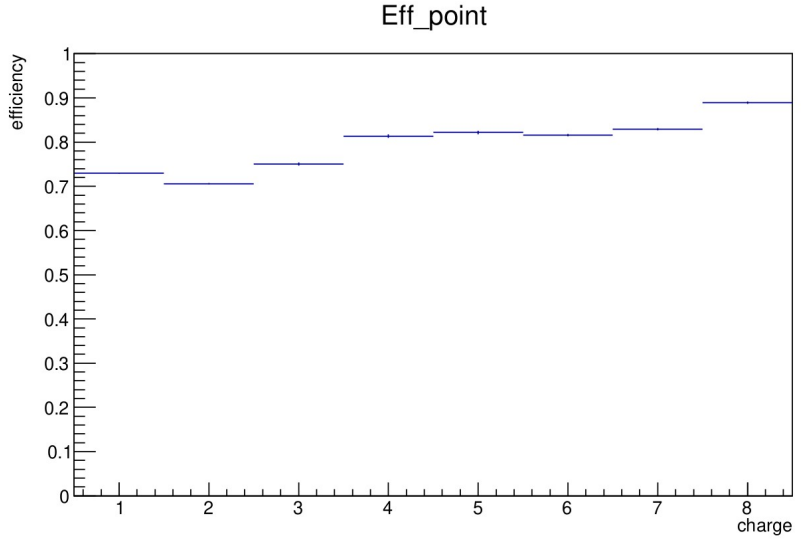
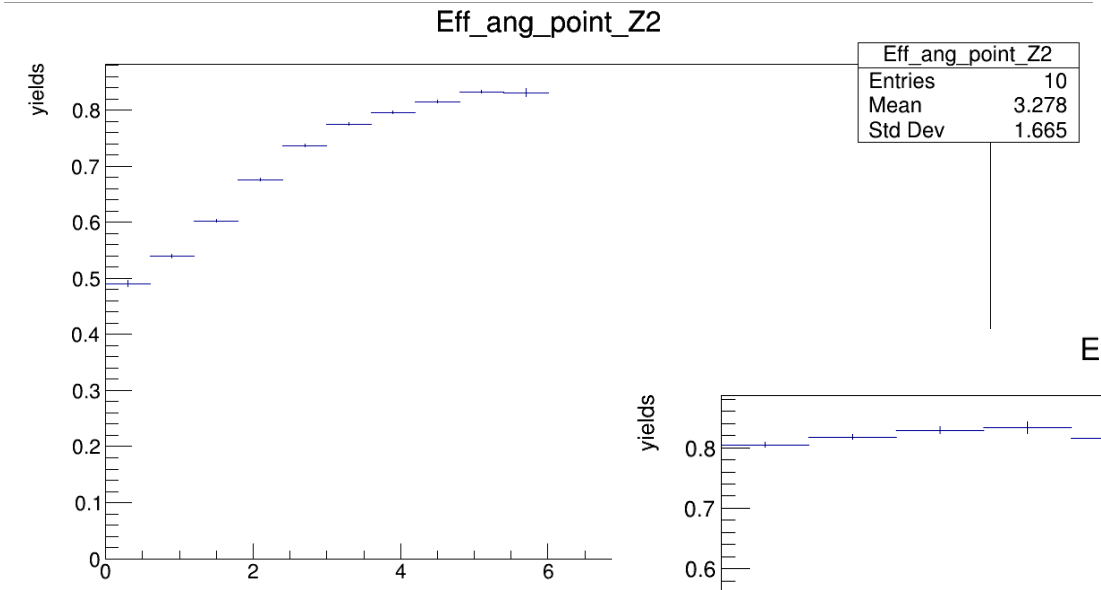
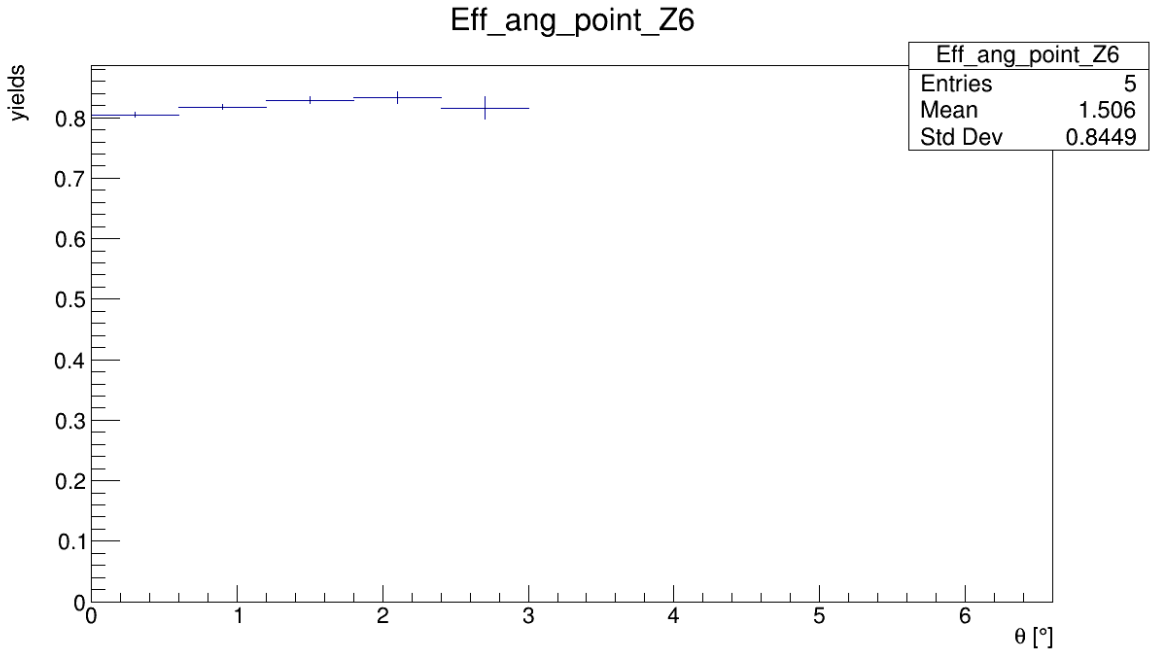
$$\epsilon_{\varepsilon}(Z) = \sqrt{\varepsilon(Z)\frac{N_{\mathrm{TW}}(Z) + 2}{N_{\mathrm{track}}(Z) + 3} - \varepsilon(Z)^2}.$$

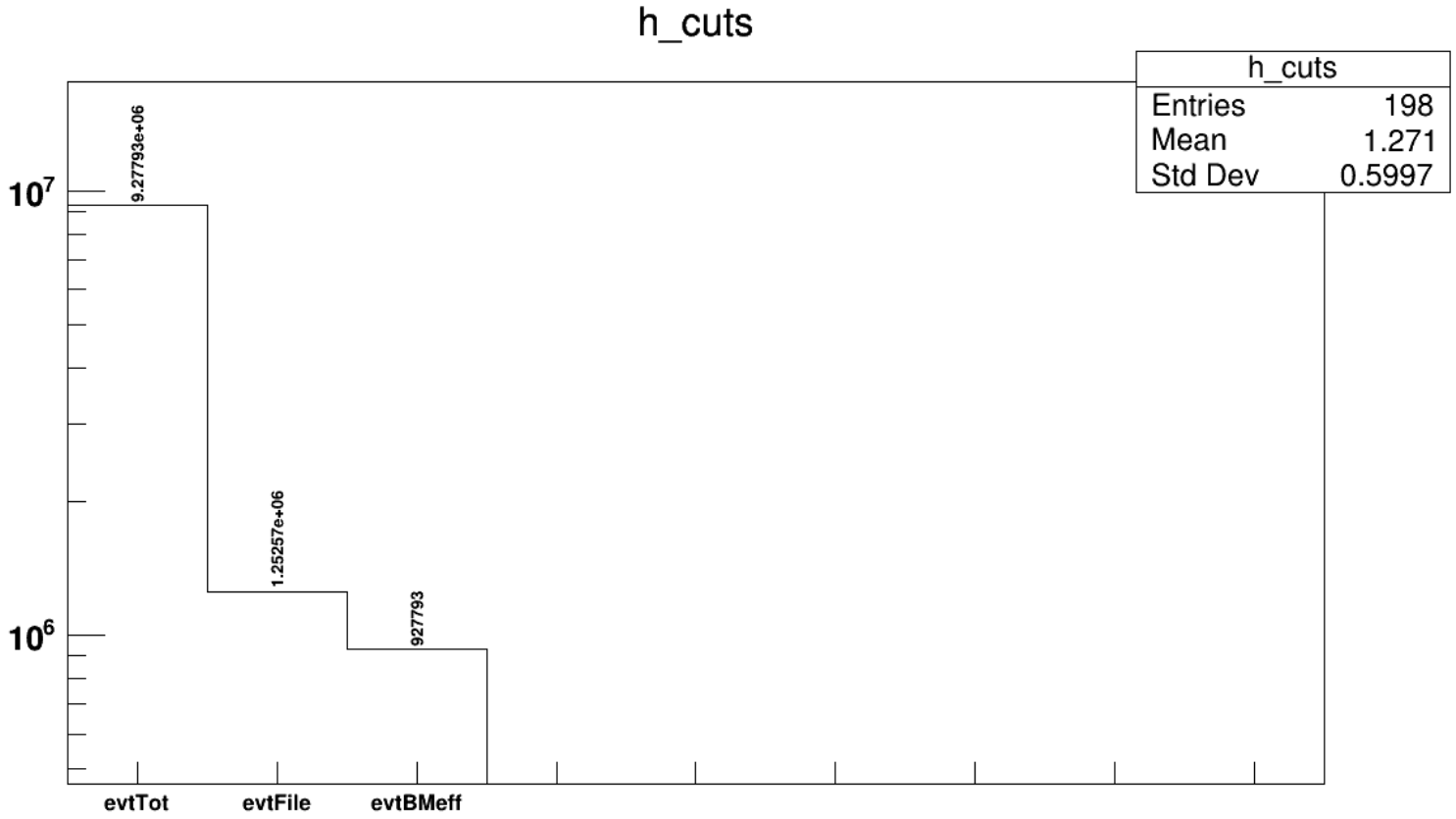


MC analysis

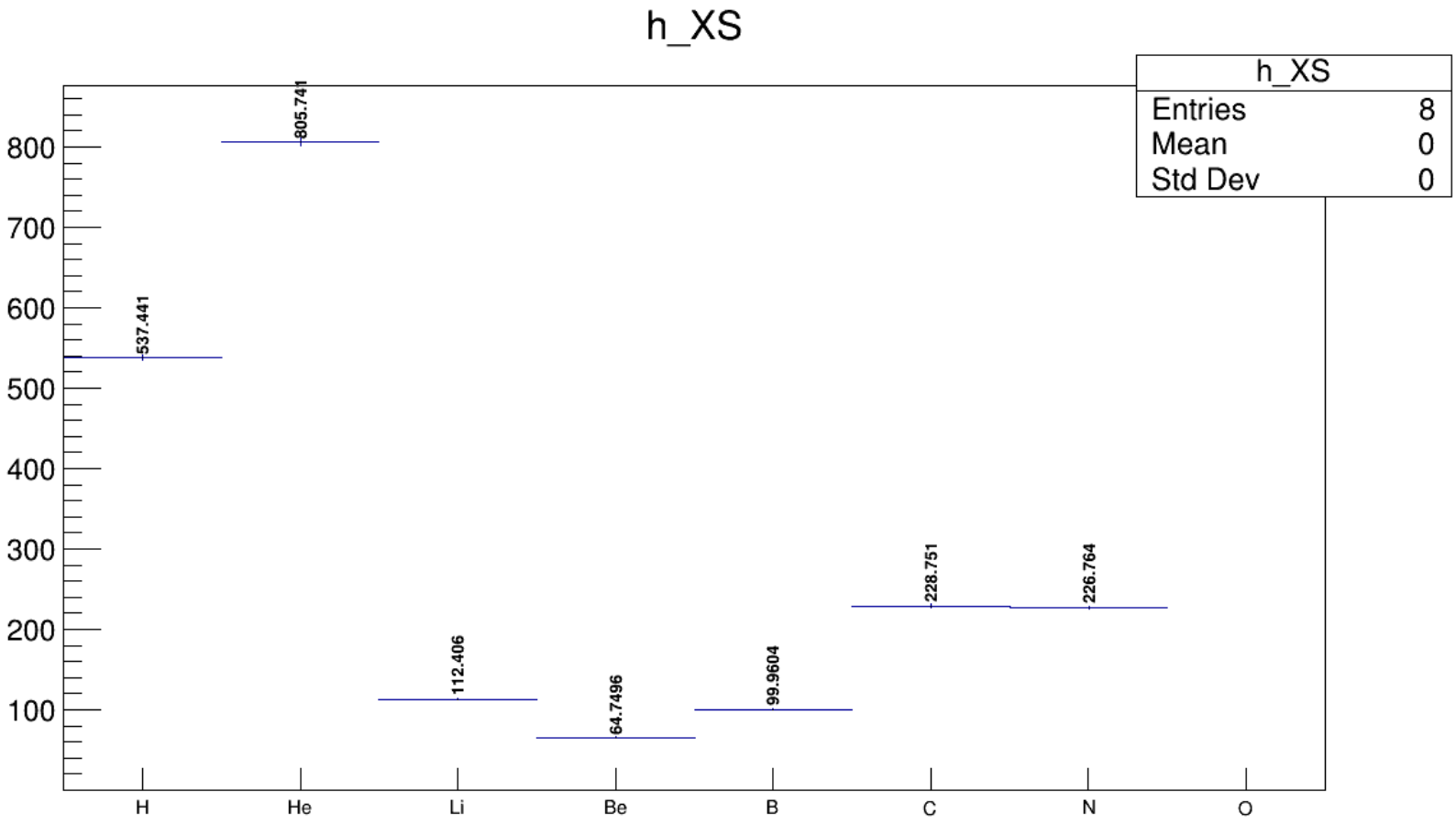

Eff_ang_point_Z2
Eff_ang_point_Z2
Entries 10
Mean 3.278
Std Dev 1.665
yields
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
2
4
6


Eff_ang_point_Z6
Eff_ang_point_Z6
Entries 5
Mean 1.506
Std Dev 0.8449
yields
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
1
2
3
4
5
6
θ [°]

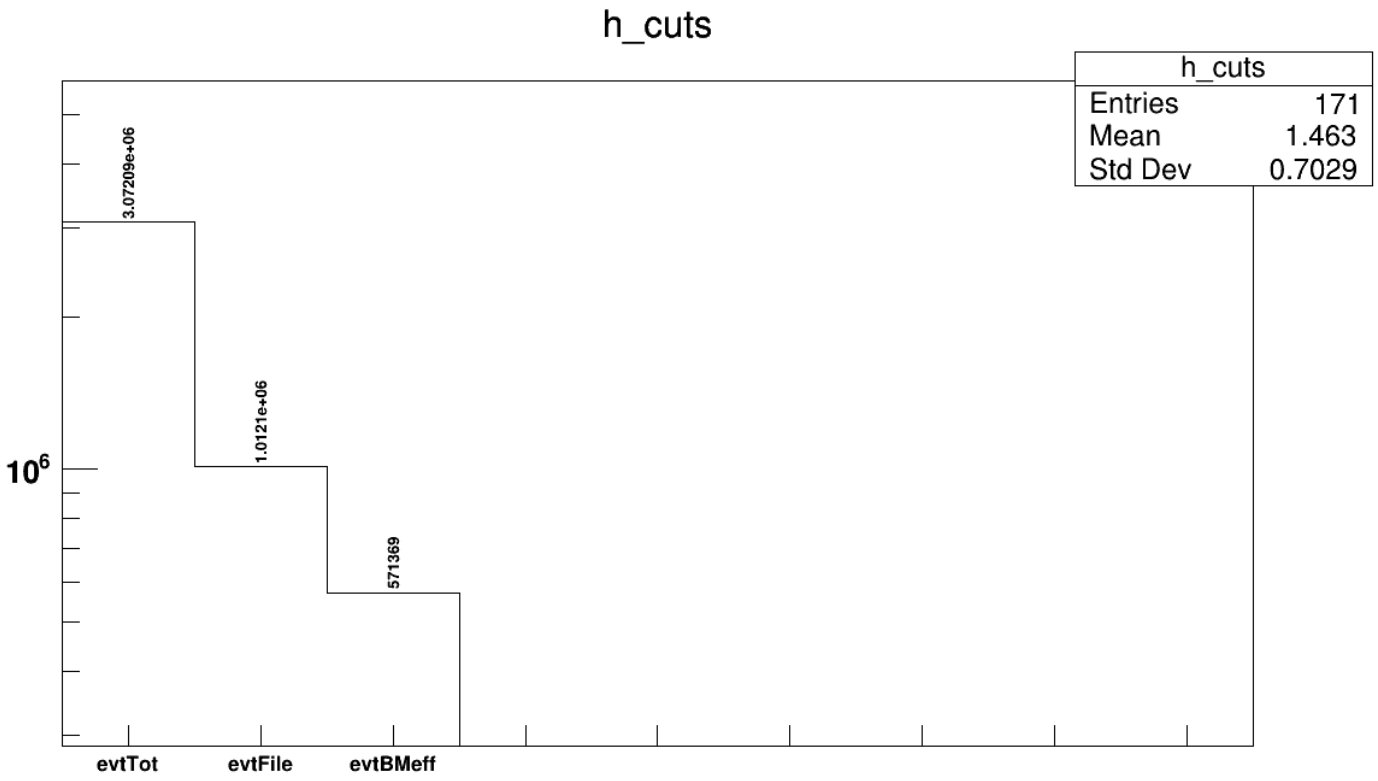
Cross section measurement MB (4305-6-7)



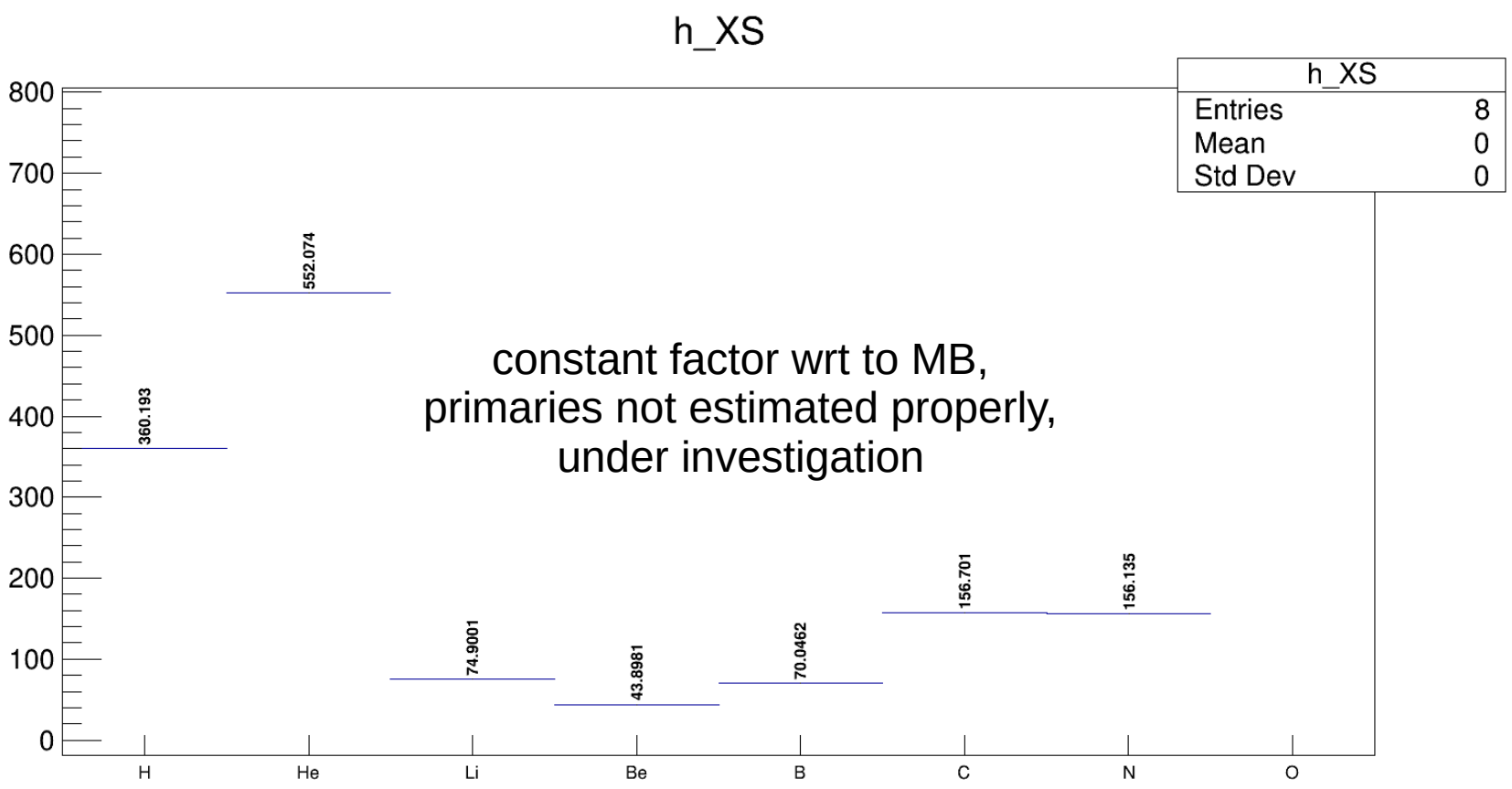
Cross section measurement MB (4305-6-7)



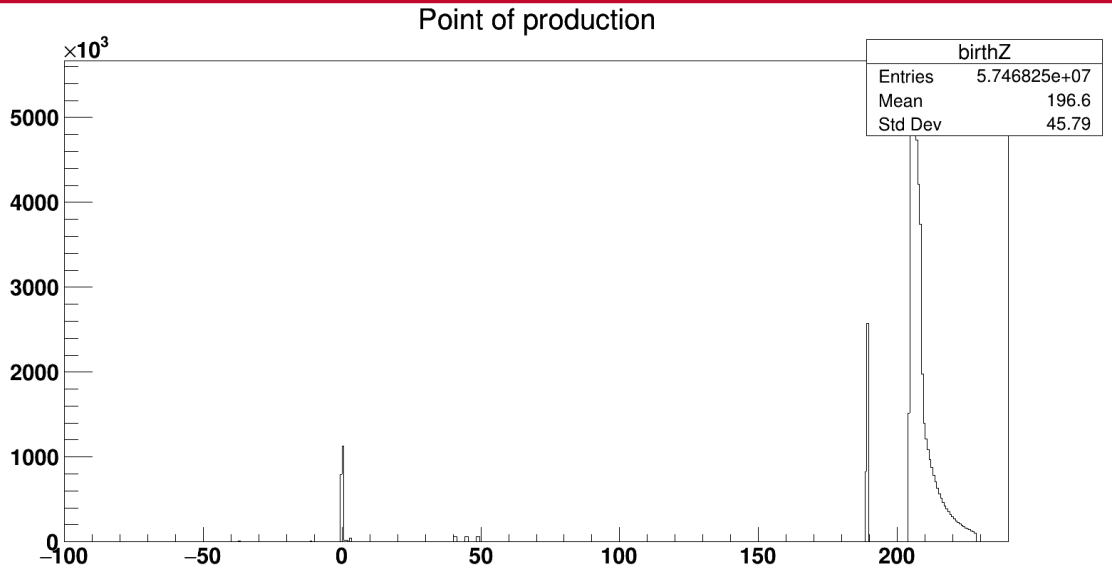
Cross section measurement frag (4310)

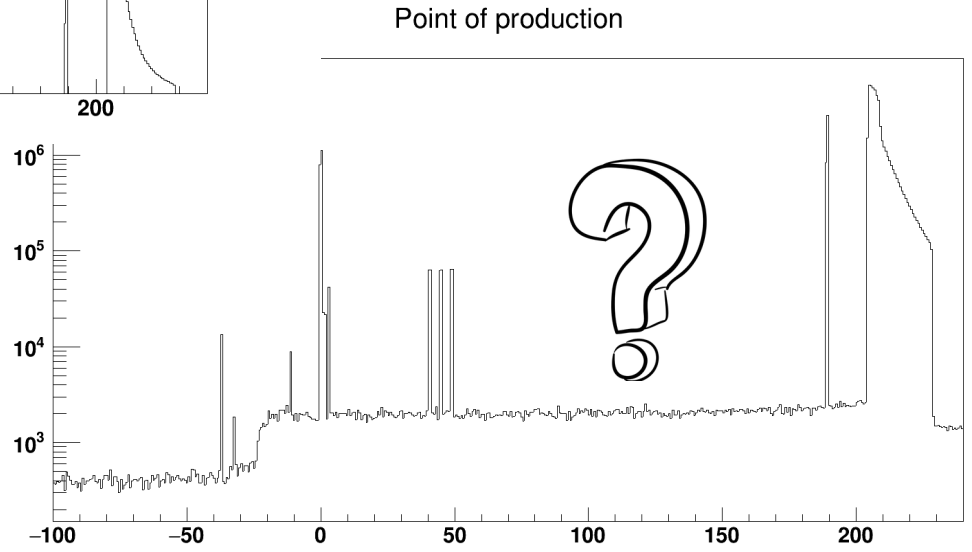


Cross section measurement frag (4310)

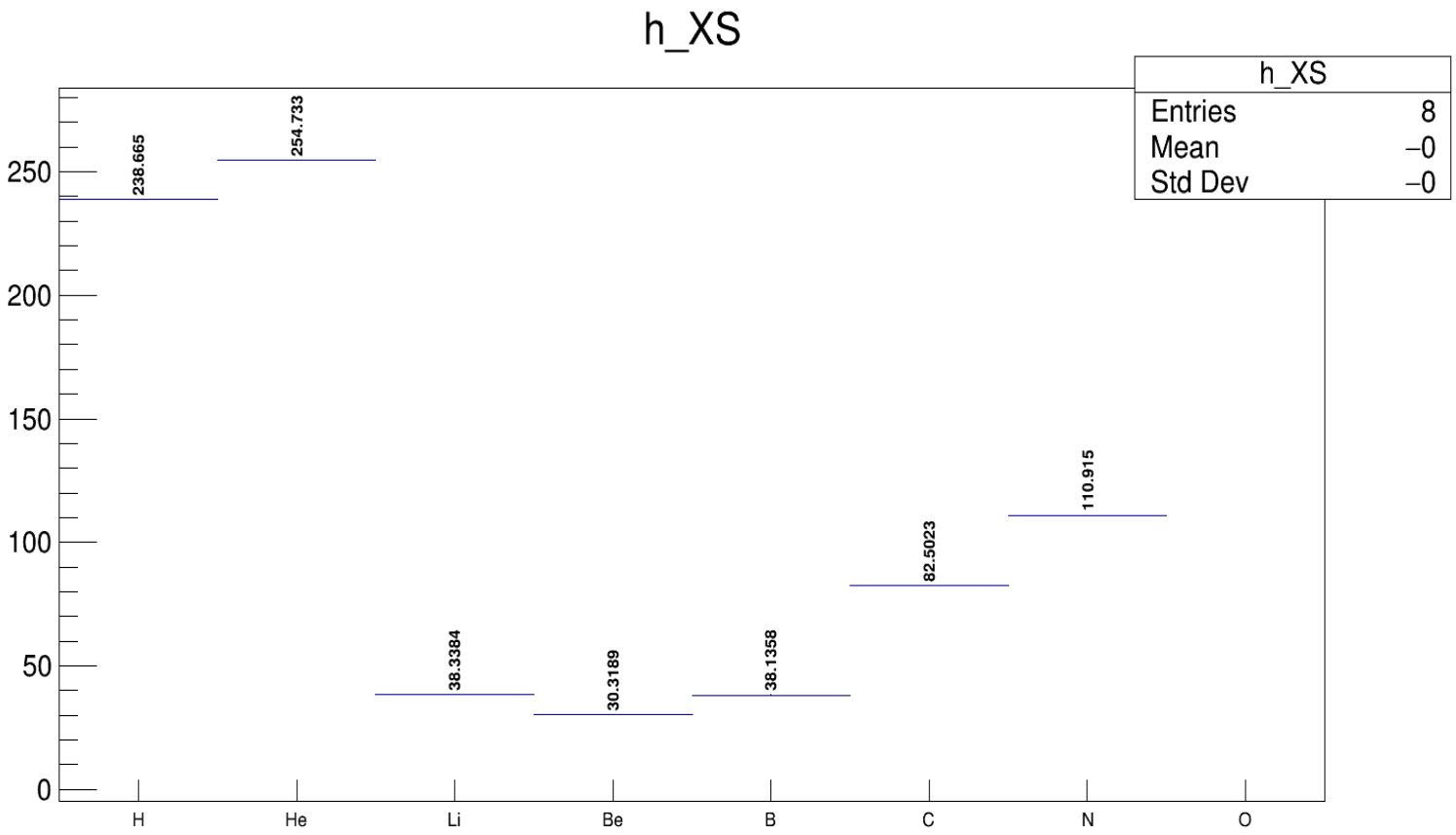


Background subtraction





Cross sections (no target, 4313)



Cross sections

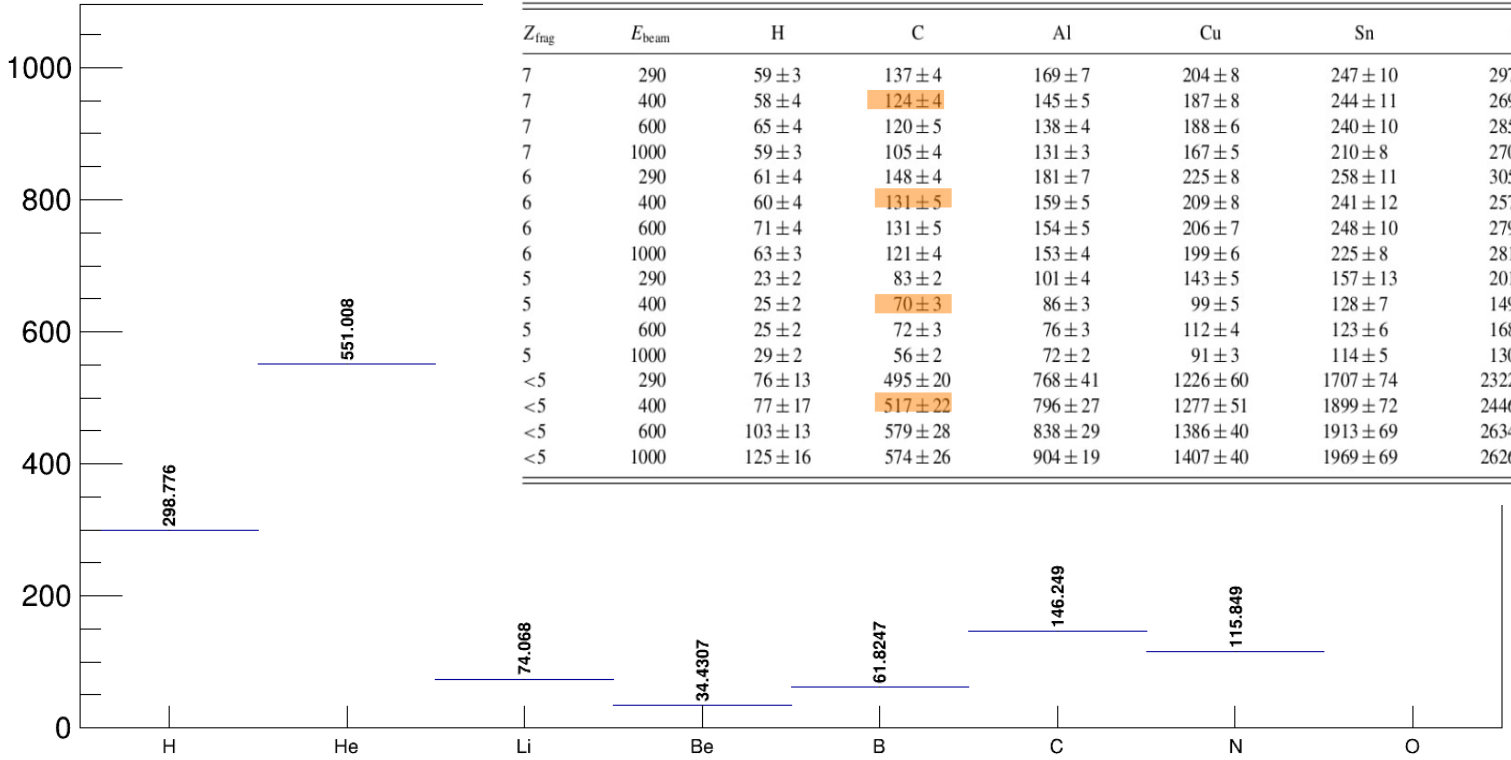
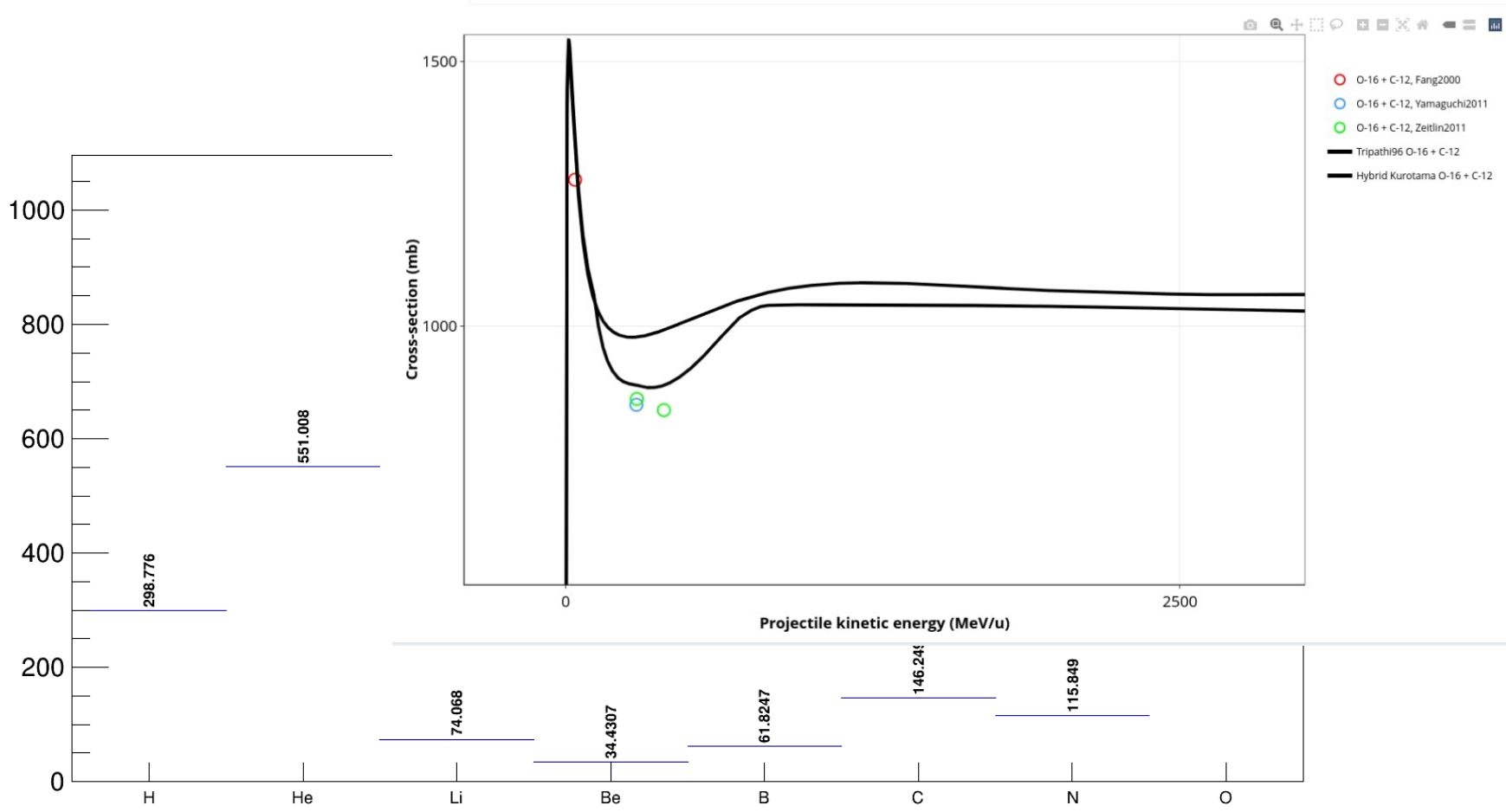


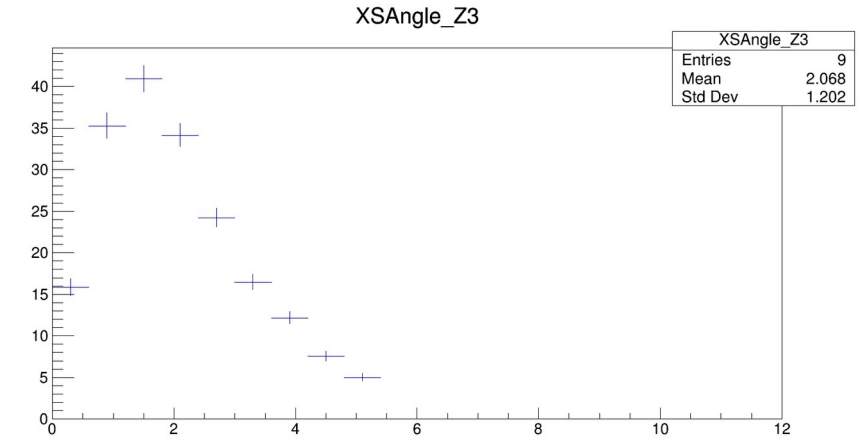
TABLE VII. Fragment production cross section for ^{16}O beams on elemental targets. Beam energies at extraction are shown, in units of MeV/nucleon. All cross sections are in mb.

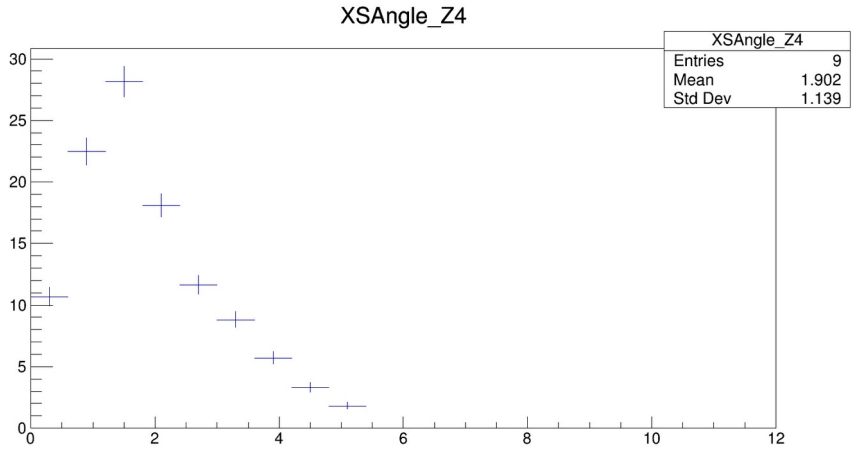
Z_{frag}	E_{beam}	H	C	Al	Cu	Sn	Pb
7	290	59 ± 3	137 ± 4	169 ± 7	204 ± 8	247 ± 10	297 ± 15
7	400	58 ± 4	124 ± 4	145 ± 5	187 ± 8	244 ± 11	269 ± 10
7	600	65 ± 4	120 ± 5	138 ± 4	188 ± 6	240 ± 10	285 ± 14
7	1000	59 ± 3	105 ± 4	131 ± 3	167 ± 5	210 ± 8	270 ± 13
6	290	61 ± 4	148 ± 4	181 ± 7	225 ± 8	258 ± 11	305 ± 15
6	400	60 ± 4	131 ± 5	159 ± 5	209 ± 8	241 ± 12	257 ± 10
6	600	71 ± 4	131 ± 5	154 ± 5	206 ± 7	248 ± 10	279 ± 14
6	1000	63 ± 3	121 ± 4	153 ± 4	199 ± 6	225 ± 8	281 ± 13
5	290	23 ± 2	83 ± 2	101 ± 4	143 ± 5	157 ± 13	201 ± 11
5	400	25 ± 2	70 ± 3	86 ± 3	99 ± 5	128 ± 7	149 ± 6
5	600	25 ± 2	72 ± 3	76 ± 3	112 ± 4	123 ± 6	168 ± 9
5	1000	29 ± 2	56 ± 2	72 ± 2	91 ± 3	114 ± 5	130 ± 7
<5	290	76 ± 13	495 ± 20	768 ± 41	1226 ± 60	1707 ± 74	2322 ± 118
<5	400	77 ± 17	517 ± 22	796 ± 27	1277 ± 51	1899 ± 72	2446 ± 74
<5	600	103 ± 13	579 ± 28	838 ± 29	1386 ± 40	1913 ± 69	2634 ± 112
<5	1000	125 ± 16	574 ± 26	904 ± 19	1407 ± 40	1969 ± 69	2626 ± 112

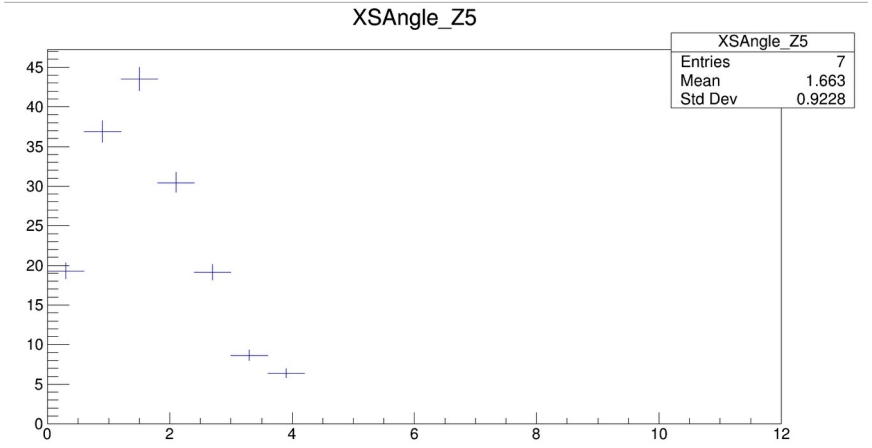
Cross sections

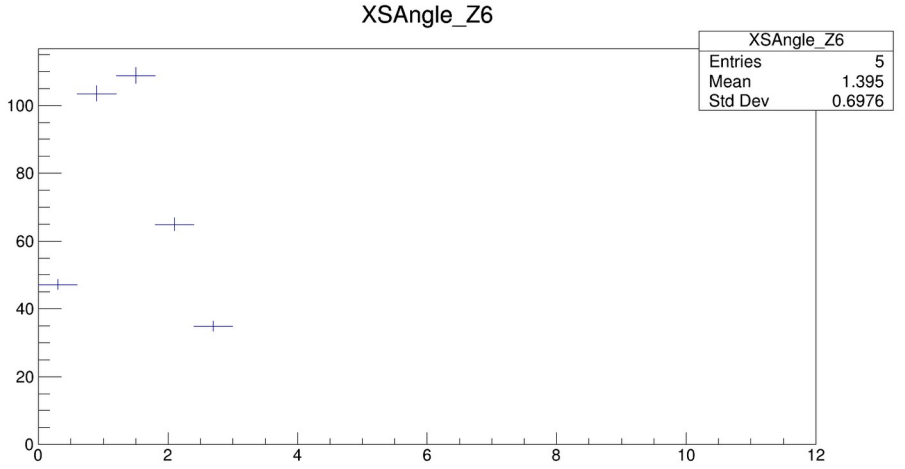


Very preliminary angular raw cross section









Conclusions

Very preliminary elemental cross sections with 400 MeV/u ^{16}O beam on 5mm Carbon target were shown

No trackers included

Difference between fragmentation and MB runs under investigation

Low-Z cross sections seem to be too high

Comments and help are welcome! (but after 31st Jan)

Thanks for your attention!