Gold analysis

A. S.

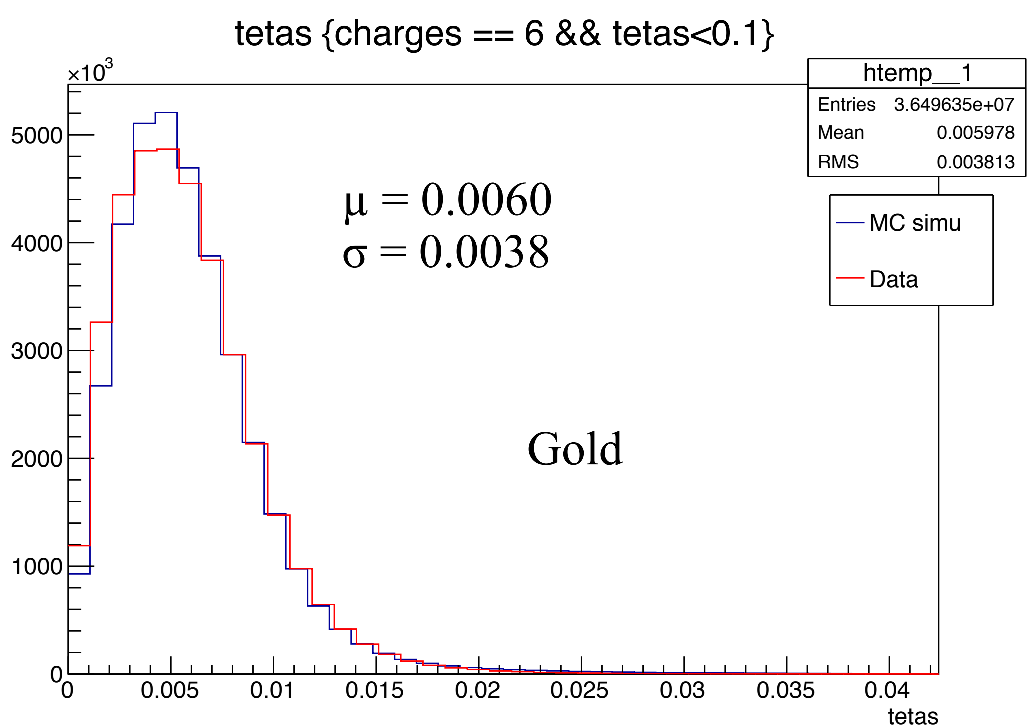
Gold analysis: status

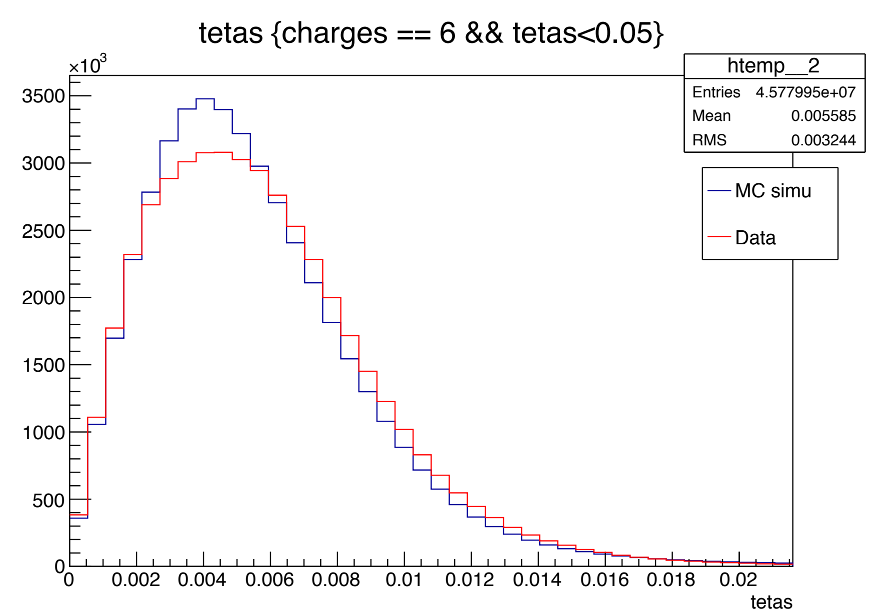
- Target info from R. Plescak $\varrho_{tgt} = 19.2\ g/cm^3$. Purity: 99%. Thickness: 500 μm.
- 4.16 M collisions used for the analysis (~1/6 of the *Crazy* target stat.)
- Performed a full simulation with fluka of the Gold target events:
  - 50 M of events for the full simulation
  - 10 M of events for each biased sample (for efficiency and unfolding machinery)
- Everything is produced/decoded/reconstructed. Most of the syst. checks already done.
- First things to check:
  - MC production quality
  - Target Eloss correction implementation

Beams trough target

- What can we expect about the beam spread?
  - x: 0.05 cm (Au) X_0 Au: ~6.5 g/cm^2 ~ 0.3 cm $\sqrt{x/X_0}$ Au = 0.41
  - β,cp,z = 0.7, 12 GeV, 6
- Beam Spread:
  - Gold = 4.0 mrad

$$\theta_0 = \frac{13.6\ \text{MeV}}{\beta cp}\, z\, \sqrt{x/X_0}\left[1 + 0.038\ln(x/X_0)\right]$$





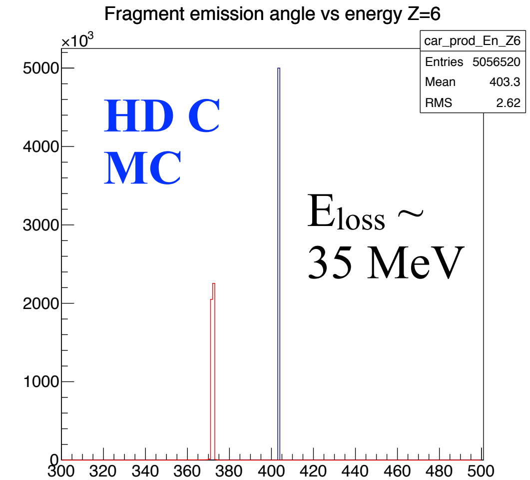
remarkable agreement found

Beams trough target

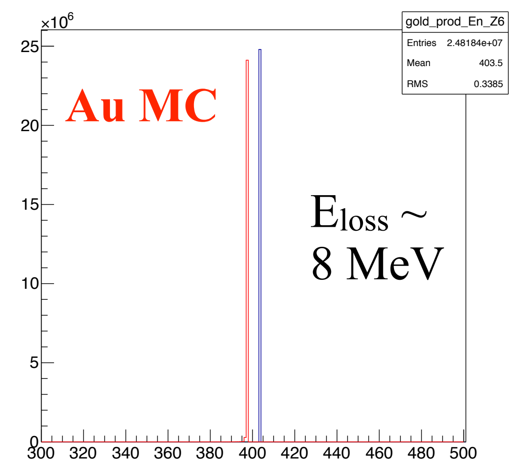
- What can we expect about the beam energy loss in "HD Carbon" and Gold?

$$-\frac{dE}{dx} = K z^2 \frac{Z}{A} \frac{1}{\beta^2} \left[\frac{1}{2} \ln \frac{2m_e c^2 \beta^2 \gamma^2 T_{\max}}{I^2} - \beta^2 - \frac{\delta}{2} \right]$$

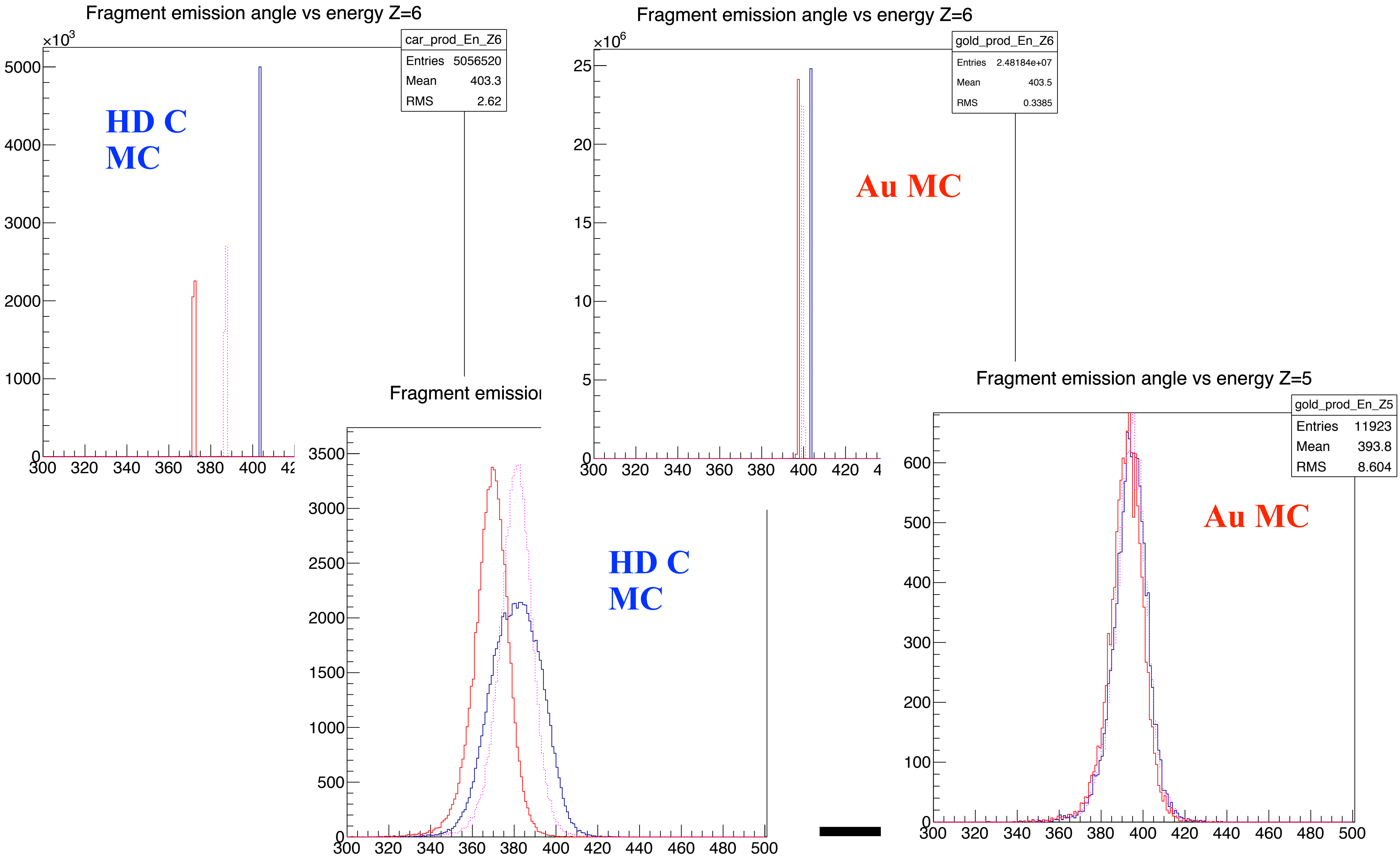
  - Same beam properties: β, γ, z
  - Different target properties (Δx, Z/A, I, T_{max}, $\boldsymbol{\delta}$):
  - Δx: 0.05 cm (**Au**) ; 0.8 cm (**HD C**)
  - ϱ: 19.3 (**Au**); 4.2 (**HD C**)
  - Z/A:
    - C: Z = 6; A = 12.011
    - Au: Z = 79; A = 196.966569



- Total Energy loss, ignoring the [] terms:
  - Carbon E_{loss} in HD C tgt 37.9 (in MeV) for $\beta = 0.7$
  - Carbon E_{loss} in Au tgt 8.7 (in MeV) for $\beta = 0.7$



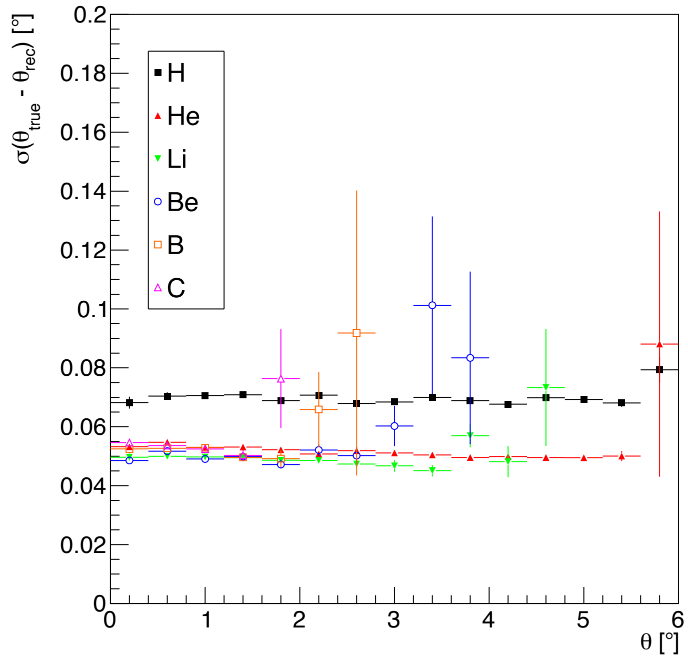
Eloss correction…

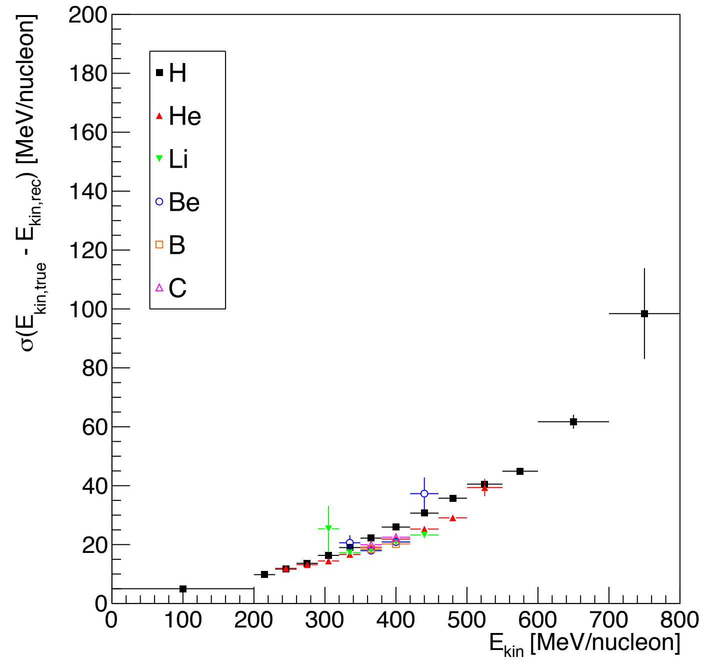


ation

Angle/Ekin resolution

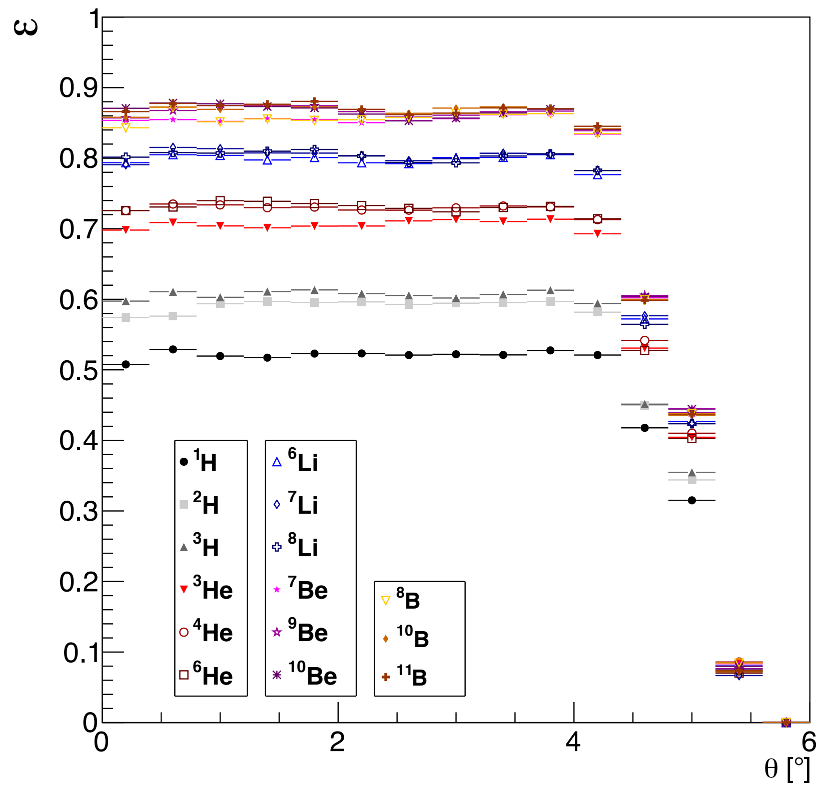
- Preliminary results are similar to what we got with 8 mm of super heavy Carbon… (as expected)
  - Should be nearly independent of the target: depends only on the tracking (actually is only vtx!) AFTER the tgt

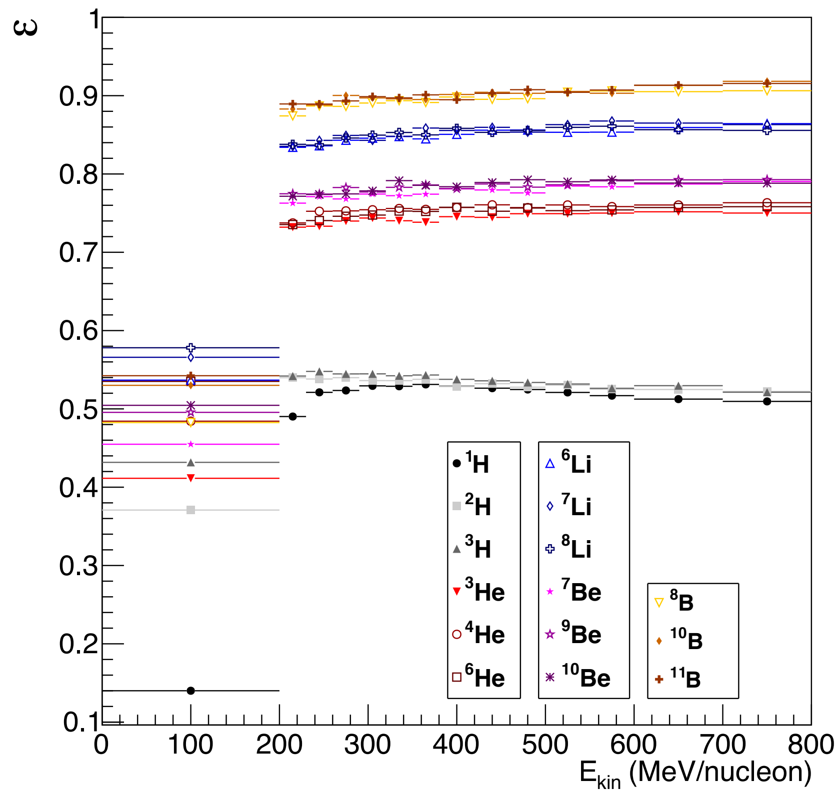




Gold: efficiencies

- Tracking efficiencies (shape) from biased sample
  - (rescaled to match the mean efficiency measured on the full simulation sample) **this part has to be re-checked on last MC**

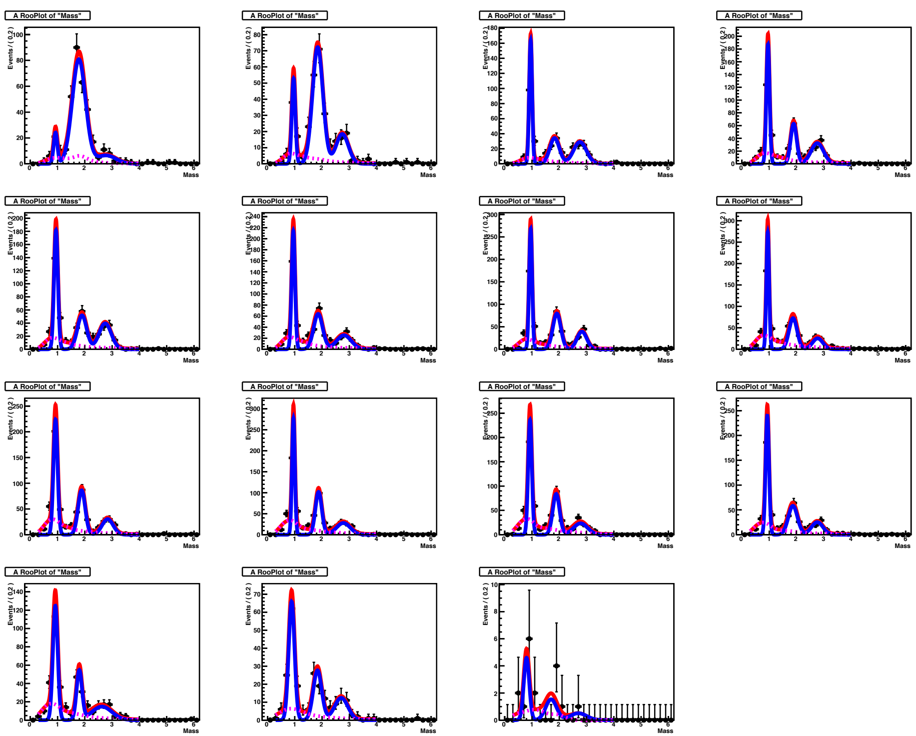




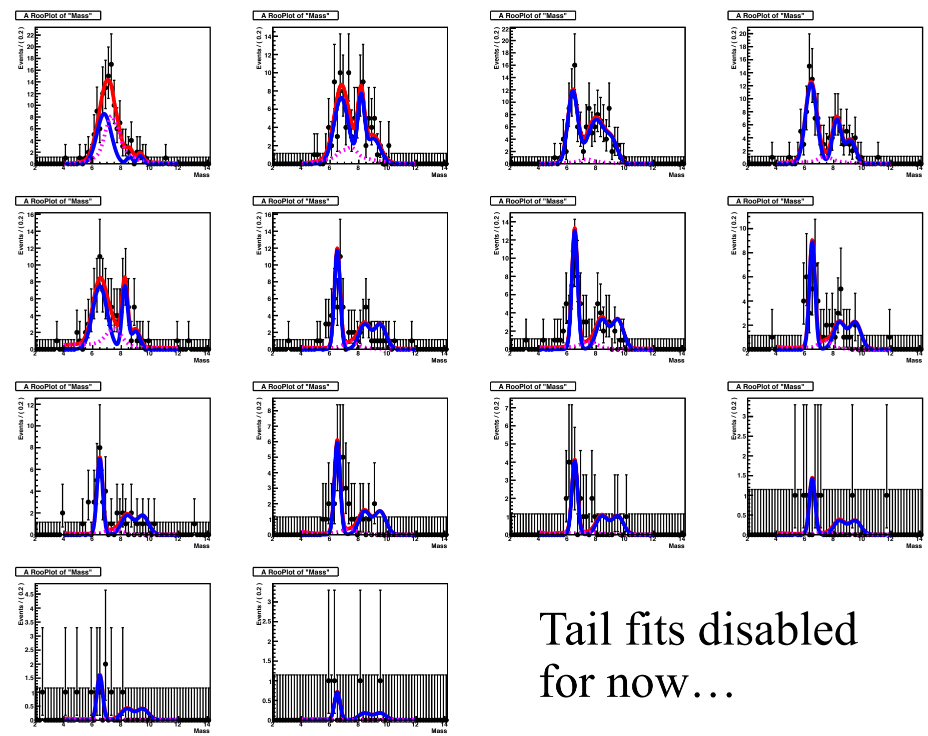
Fit / yields

- Tuned for CrLaO3 target: looks fine also for Au (Toppi tuning performed on raw data fits to solve some instabilities in the tails)

Z = 1



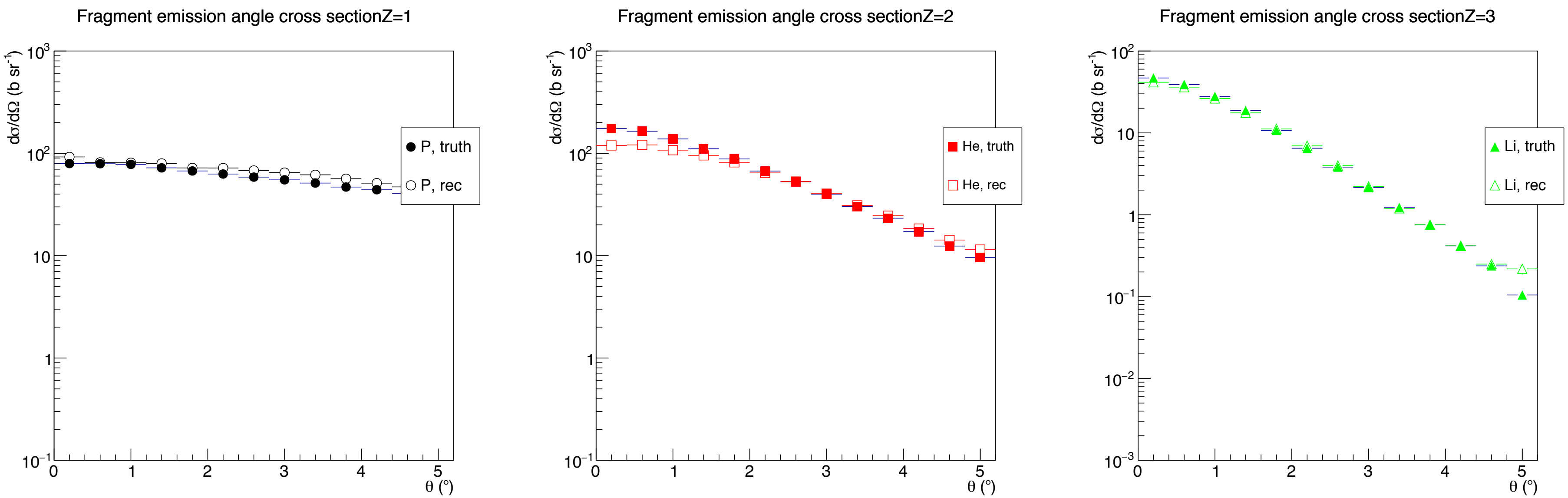
Z = 4

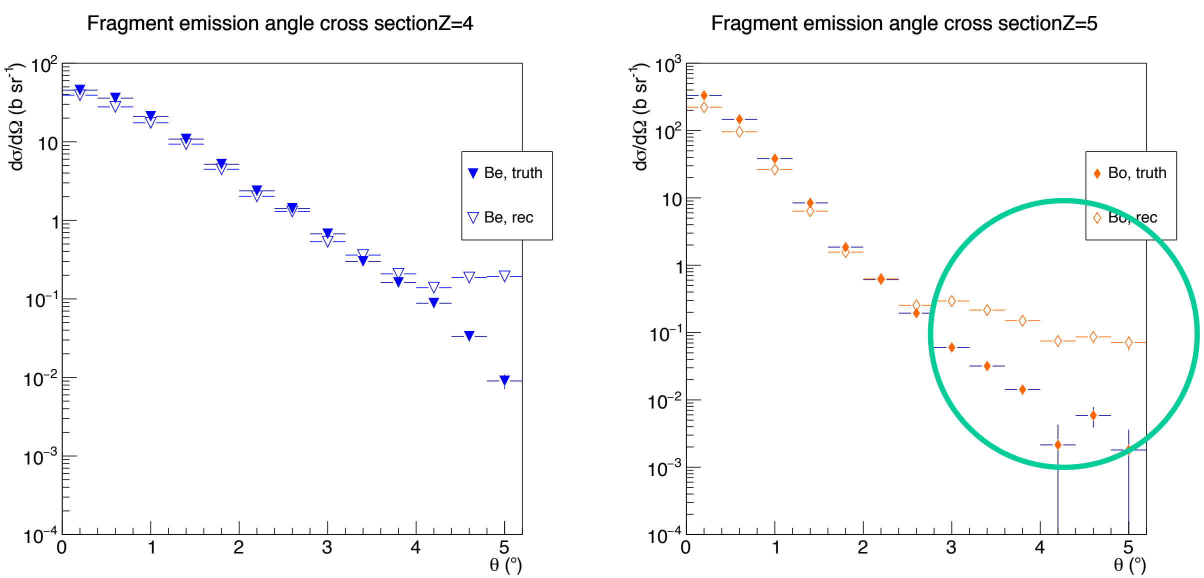


Tail fits disabled for now…

MC results (true Xsec)

- First of all: check the MC. Plot shows true vs reconstructed XS.



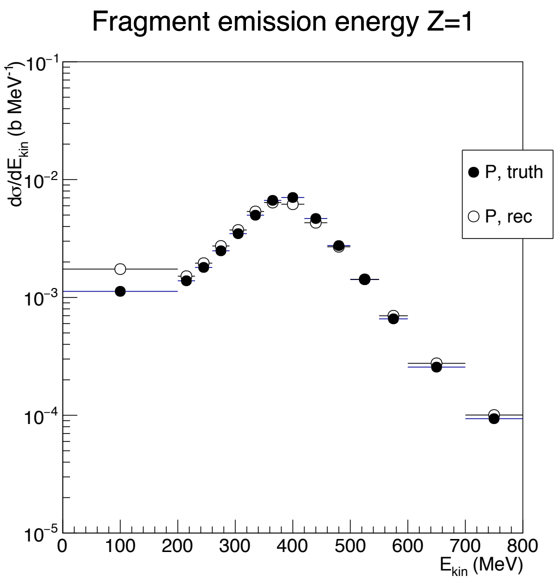


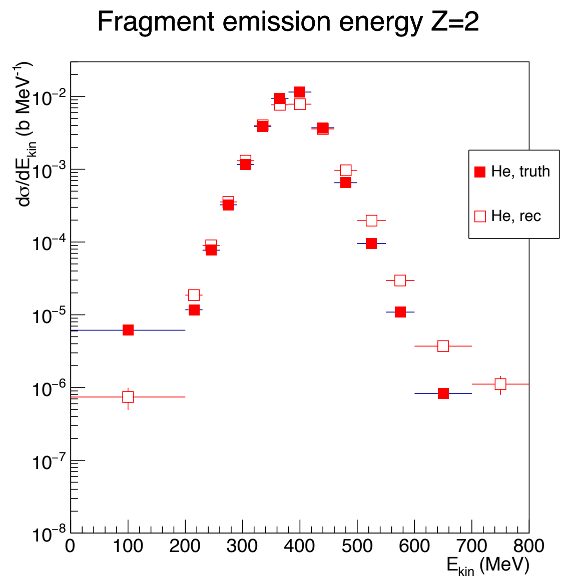
Remaining differences are likely to be related to the efficiency evaluation methods and are anyway taken into account in the systematics…

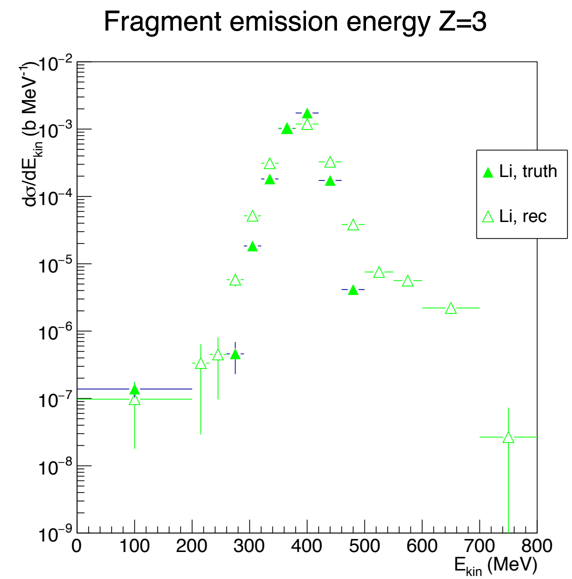
Fit related problems

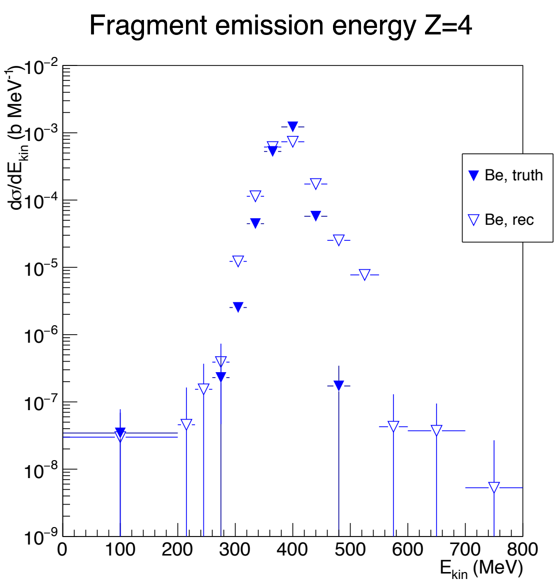
MC results (true Xsec) II

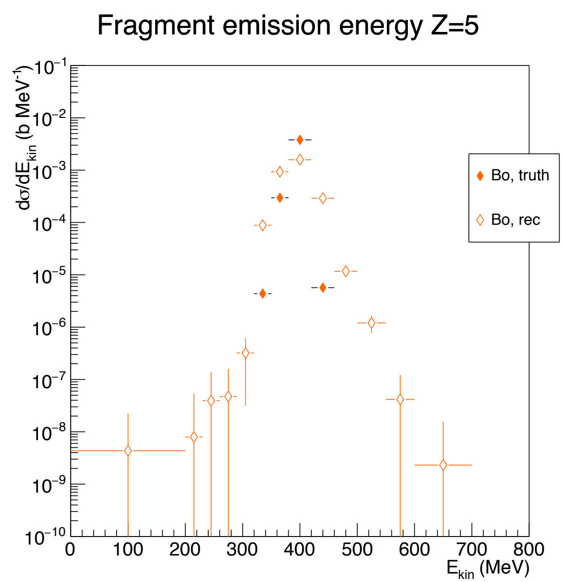
➡ First of all: check the MC. Plot shows true vs reconstructed XS.







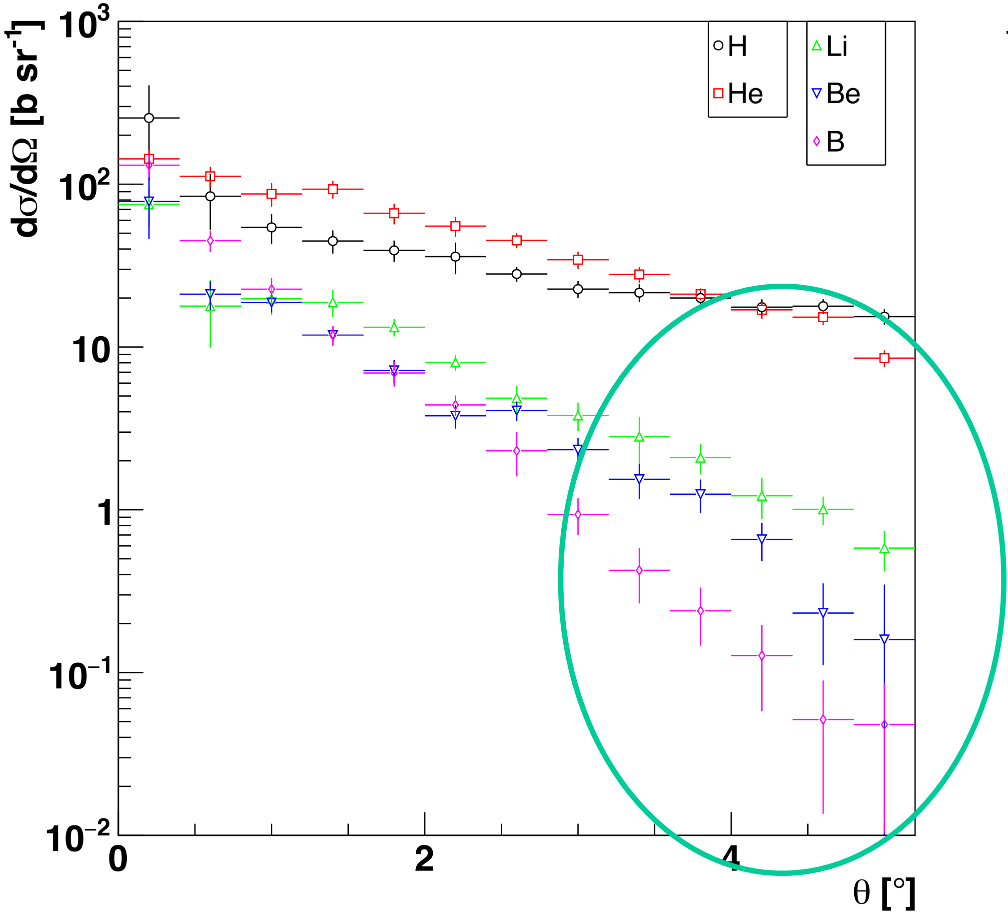


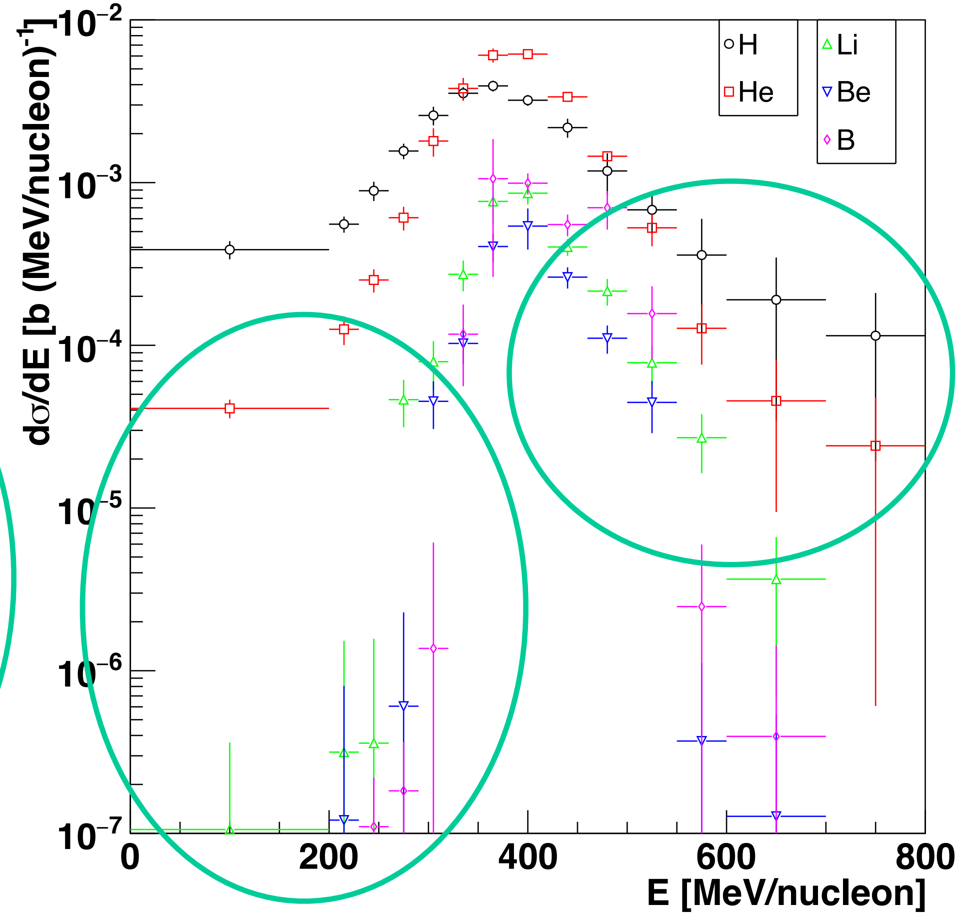


Spectra have not yet been unfolded. The tails, of course, are the ones less know and with a large systematics related to the fitting of small stat bins. Efficiencies have to be re-checked!

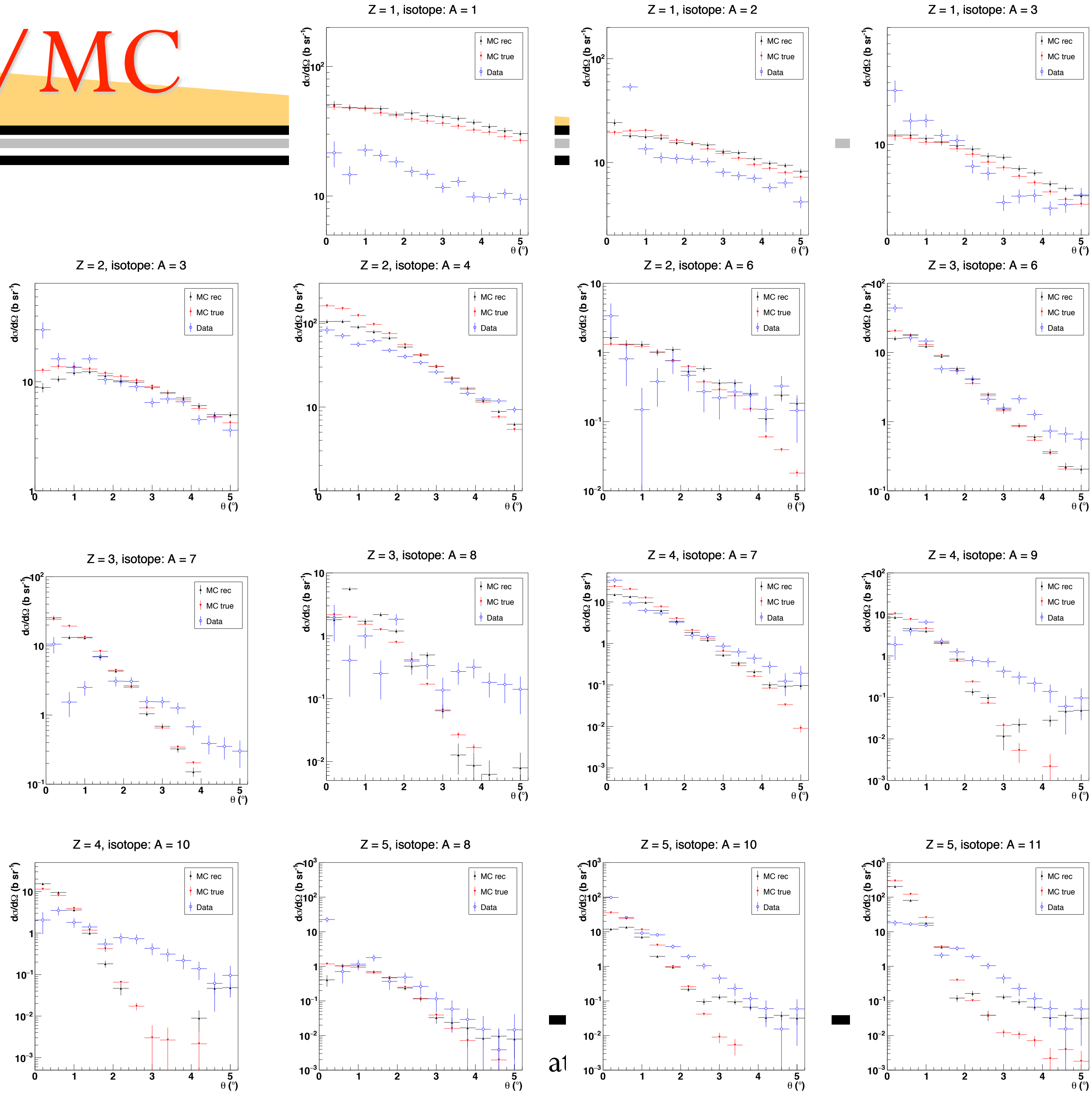
Preliminary results

➡ Full analysis results (some systematics still missing) + fit tuning not yet done (tail fits for now should not be trusted!)





Data / MC



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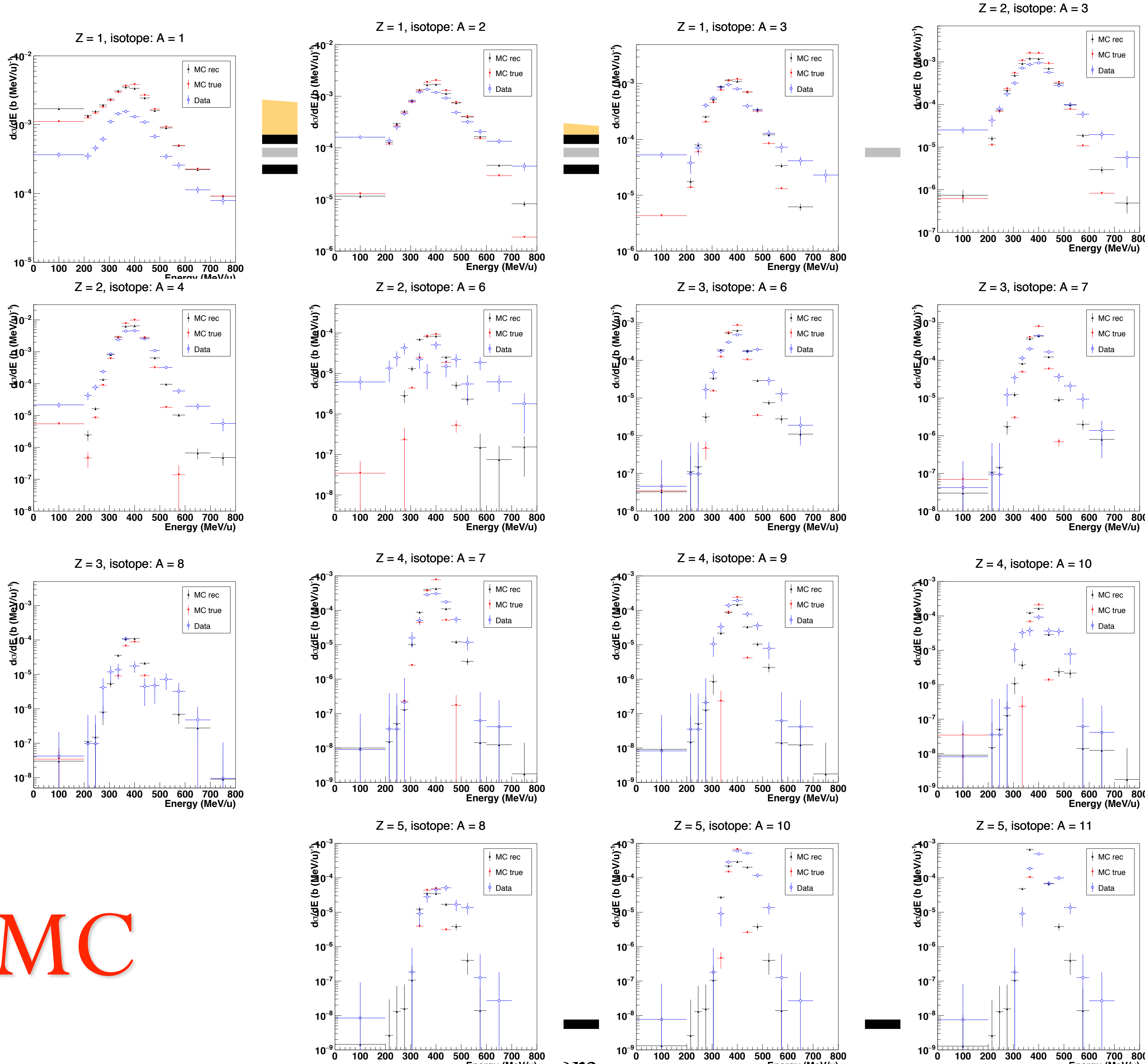
Z = 1, isotope: A = 2
Z = 1, isotope: A = 3
Z = 2, isotope: A = 3
Z = 2, isotope: A = 4
Z = 2, isotope: A = 6
Z = 3, isotope: A = 6
Z = 3, isotope: A = 7
Z = 3, isotope: A = 8
Z = 4, isotope: A = 7
Z = 4, isotope: A = 9
Z = 4, isotope: A = 10
Z = 5, isotope: A = 8
Z = 5, isotope: A = 10
Z = 5, isotope: A = 11
MC rec
MC true
Data
dσ/dΩ (b sr^{-1})
θ (°)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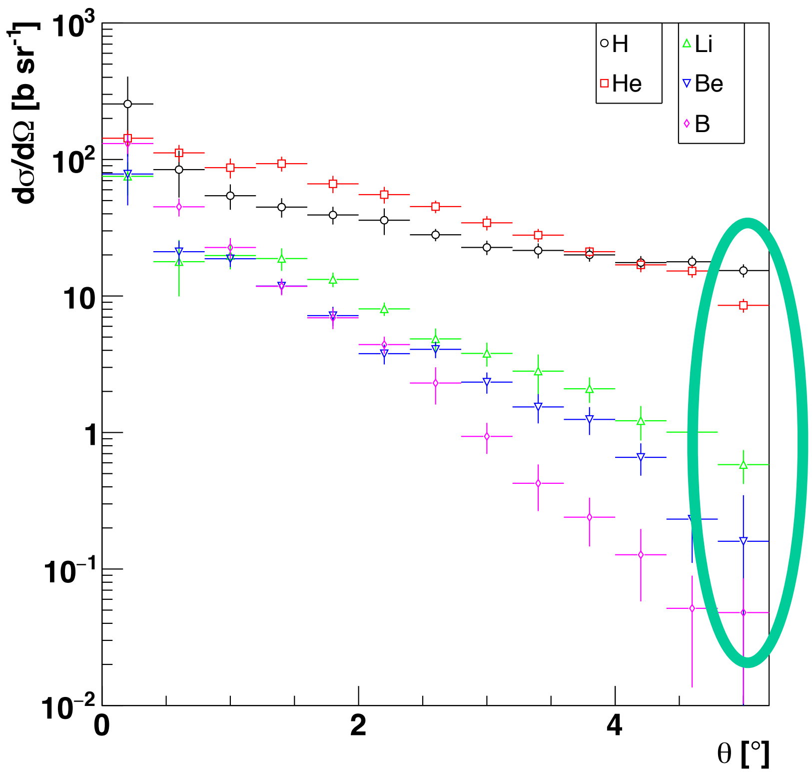
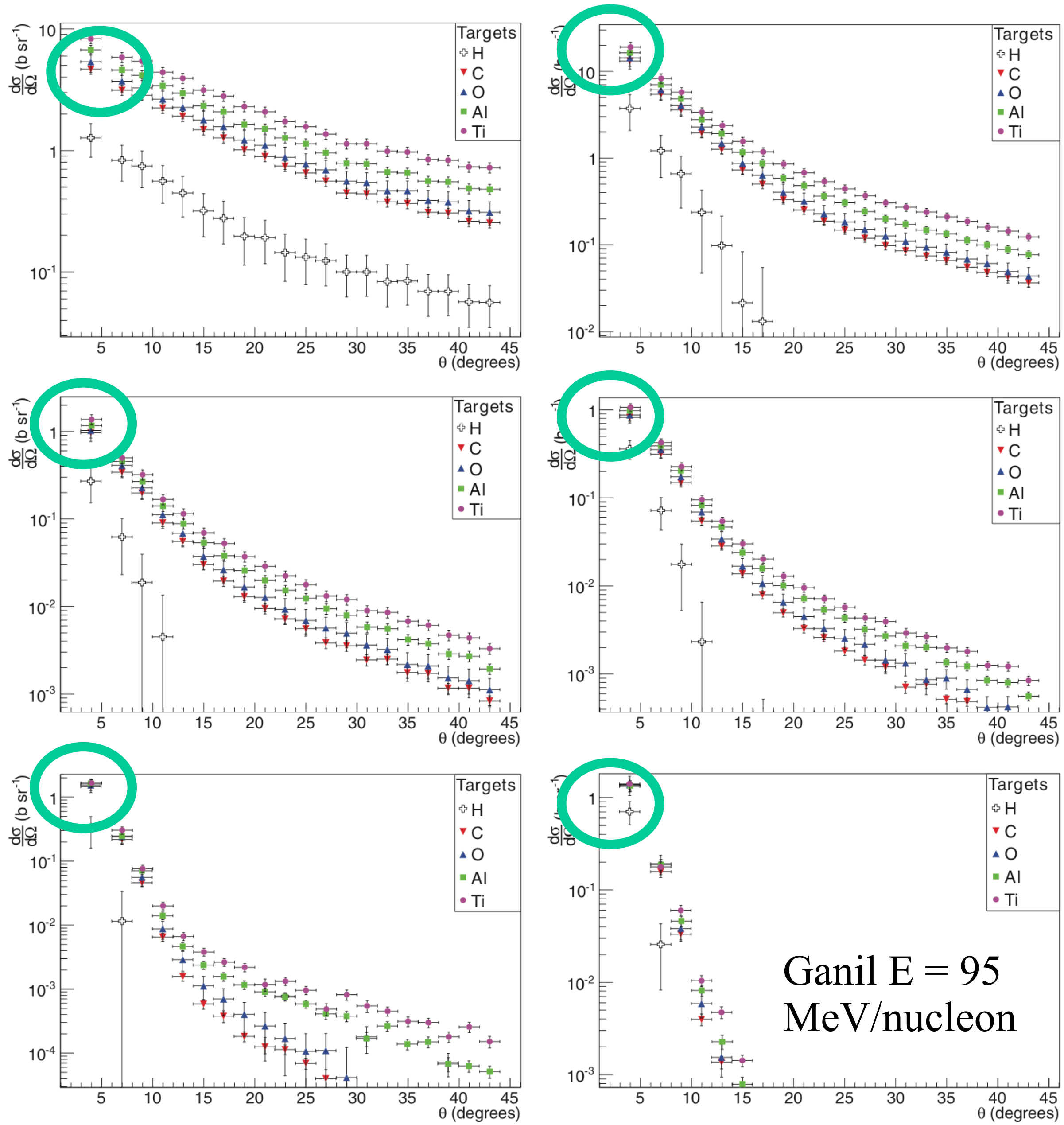
Z = 1, isotope: A = 2
Z = 1, isotope: A = 3
Z = 2, isotope: A = 3
Z = 2, isotope: A = 4
Z = 2, isotope: A = 6
Z = 3, isotope: A = 6
Z = 3, isotope: A = 7
Z = 3, isotope: A = 8
Z = 4, isotope: A = 7
Z = 4, isotope: A = 9
Z = 4, isotope: A = 10
Z = 5, isotope: A = 8
Z = 5, isotope: A = 10
Z = 5, isotope: A = 11
MC rec
MC true
Data
dσ/dE (b (MeV/u)$^{-1}$)
Energy (MeV/u)

Data/MC

X chk with Ganil (Ti : A = 22)

- extrapolation at 5° can be used to check order of magnitude: check last bin from FIRST against first bin from Ganil (Ti)





TCC

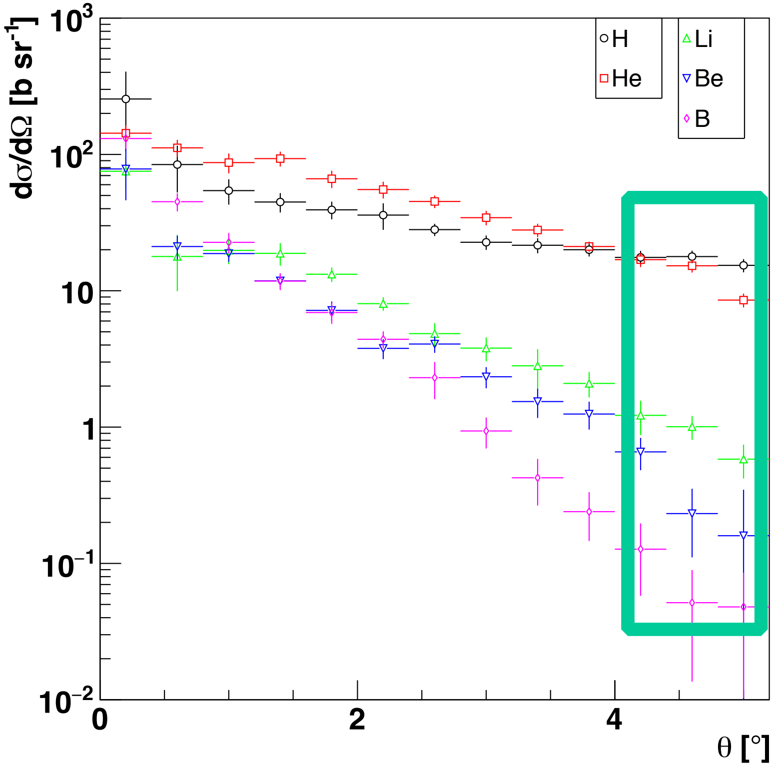
- There is no published TCC info available, but from Ganil, summing up the production cross section for fragments, for titanium (A=22) and energy 95 MeV/u we get that the total is ~ 10 b (there it seems to be a plateau in the values of the x-sections from Ganil data at high A values)
- From FIRST, Gold (A = 79), computed from Marco we have:
  - Using the tracking to count carbons (cleanup sample requiring only 1 track, with correct Z) : σ = (50.55 +- 0.17 (stat)) b
  - Using the TW only to count carbons (larger stat BUT no tracking/no cleanup of the event is performed) σ = (27.9 +- 0.1 (stat)) b
  - **preliminary result shows that we are higher than Ganil, as expected.**

Other CS measurements?

- Difficult to find absolute value cross section measurements for C on Au.
  - Nuclear Physics A 709 (2002) 392–414 .. 12C @ 22 MeV! Studies intermediate mass fragments models. Mean number of fragments is studied against models, no absolute X-sec given. [useless]
  - Phy. Rev. C. Eyal (1973) 12C @ 125 MeV on gold. Access only to B, Be and Li results with integration performed at large detection angles.
  - Harold, 1961 C on Au at 10 MeV/nucleon. Absolute Xsection of α particles available for comparison at large angles.

Eyal , 1973; Harold 1961

- X-Section, large angles
  - Our result seems compatible with order of magnitude extrapolation from low angles….



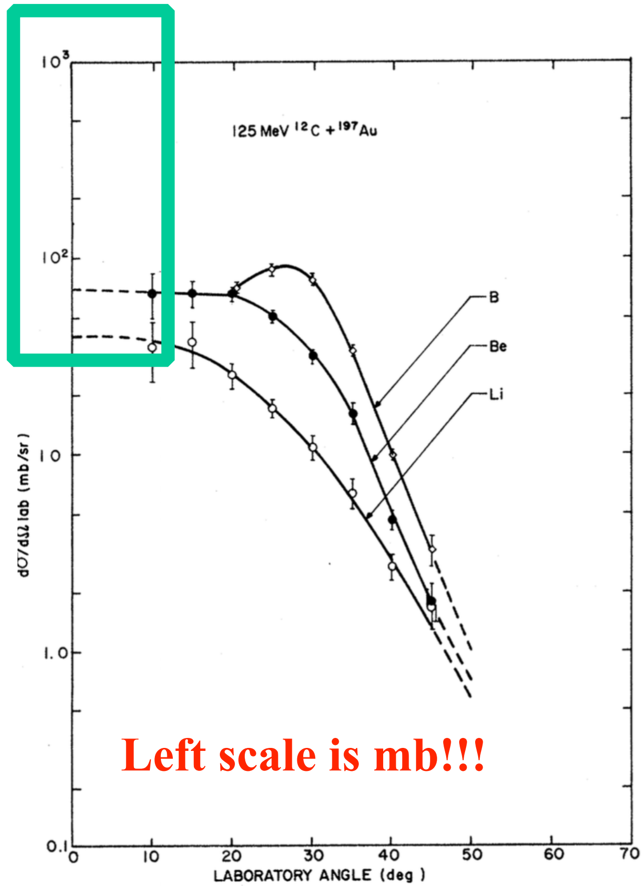
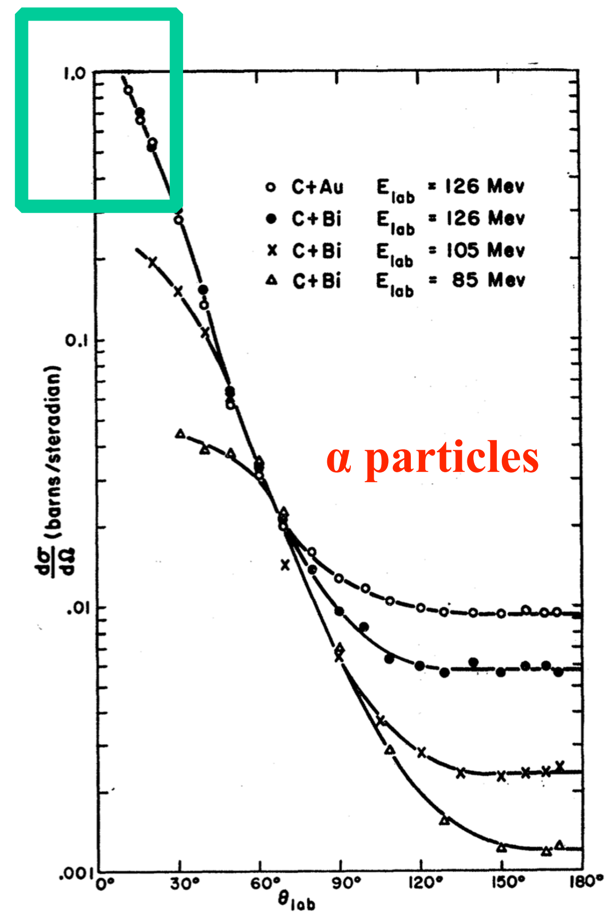


FIG. 8. Angular distribution of light fragments formed in the reaction 125-MeV $^{12}C + ^{197}Au$.



Conclusions

- The "gold" data analysis is nearly done:
  - we just need to finalize the fit tuning, the unfolding procedure and efficiency systematics checks 2 weeks of work at most. **Then we will have in our hands all is needed to publish a data-only paper.**
- We are also nearly ready to complete the draft 0 of a "gold only paper":
  - We need to rewrite the introduction focusing on space related applications and maybe some help from our "nuclear" friends is needed on order to understand how to best write down the analysis aim/impact
  - Then we replace the plots of the Data/MC comparison and the cross section measurements and we are done.
- Adding the MC comparison is a TRICKY business. See next slide
- We should also decide if it is anyway worth to go for a publication in PRC or we should target a different journal… And we need to decide now.

The MC business

- We need to evaluate carefully the impact of publishing the data without any MC OR we need to evaluate the impact of trying to convince Fluka to allow us to publish:
  - From Fluka license [http://www.fluka.org/fluka.php?id=license&mm2=3]: "Publication of any results of comparisons of specific internal physics models extracted from FLUKA with permission under section 6 with data or with other codes or models is subject to prior written permission."
  - http://www.fluka.org/fluka.php?id=FLUKASingle-UserLicenseAgreementFAQ&mm2=3 specifies explicitly what is not allowed:
    - Comparison of FLUKA results with particle production data from thin target experiments
    - Comparison of FLUKA results with data on ion beam fragmentation in thin or thick targets