FIRST analysis update

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Analysis of composite target

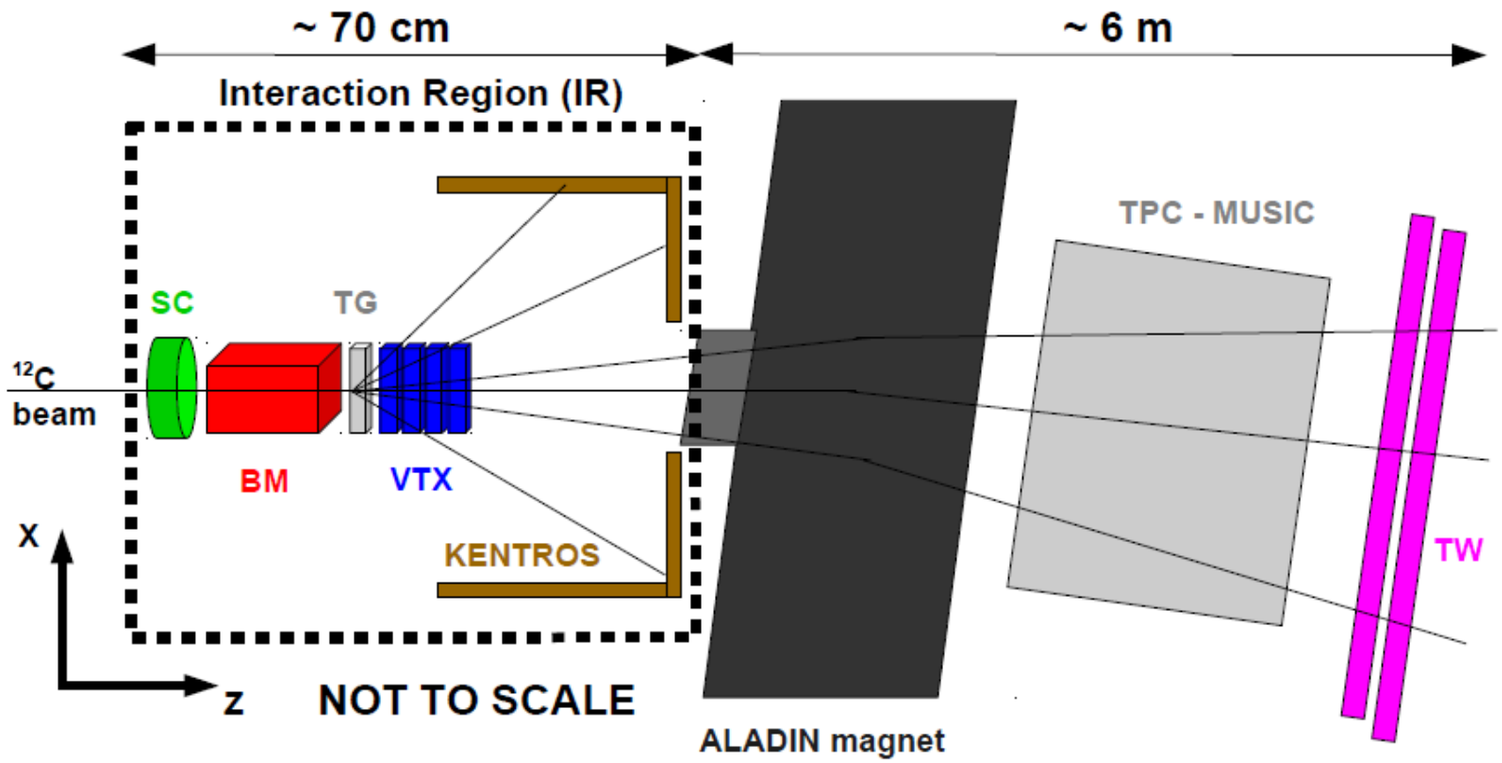
- FIRST graphite target density was measured to be very high $\varrho_{tgt} = 4.2$ g/cm^3 while the typical graphite density is $\varrho_{tgt} = 2.6$ g/cm^3 .
- This evidence triggered further studies on the target composition
- Before finalising the paper for the publication the target was sent to Torino for "further checks": XPS analysis was performed along the z axis (beam) at several "depths" after having cut the target.
- Such analysis discovered the following target composition

element	percentage of atoms (%)
C	34 +/- 3
O	47 +/- 2
Cr	8 +/- 1
La	7 +/- 1
P	2.4 +/- 1.8
Ca	1.3 +/- 0.4

- **The data acquired with such composite target can be used just for the benchmarking with MC cross sections**
- **We switched to the analysis of the data acquired with the gold target**

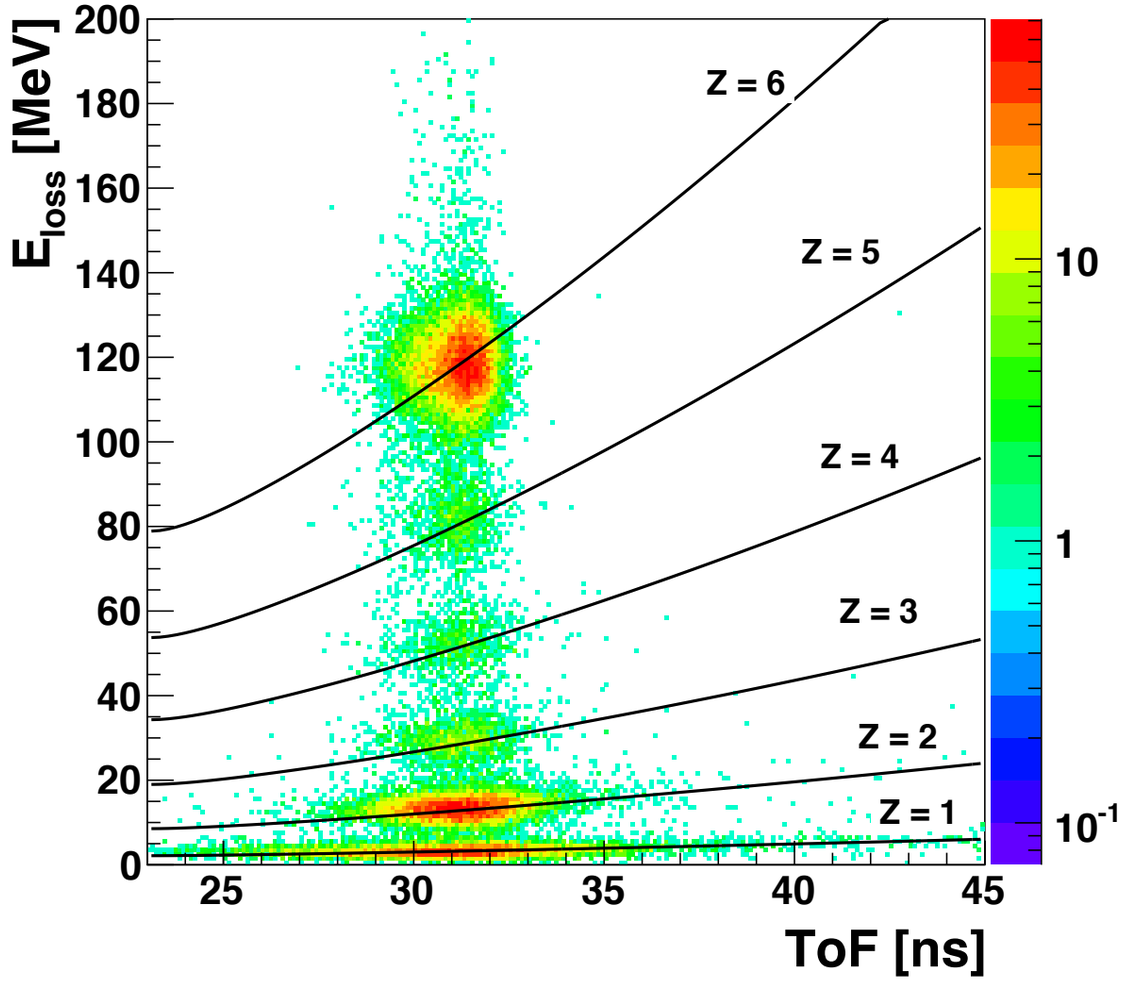
Gold analysis

- **Same analysis strategy, the only difference is the target and collected statistics**
  - Target info: $\varrho_{tgt} = 19.2$ g/cm^3. Purity: 99%. Thickness: 500 μm
  - 4.16 M collisions used for the analysis (~1/6 of the composite target statistic)
- Produced a full simulation with FLUKA of the Gold target events (50 M of events)
- A dedicated MC simulation (biased MC) has been developed for efficiency and unfolding machinery, producing fragments from the centre of the target with flat E_{kin} spectrum, within the angular acceptance of the magnet (10 M of events for each fragment)



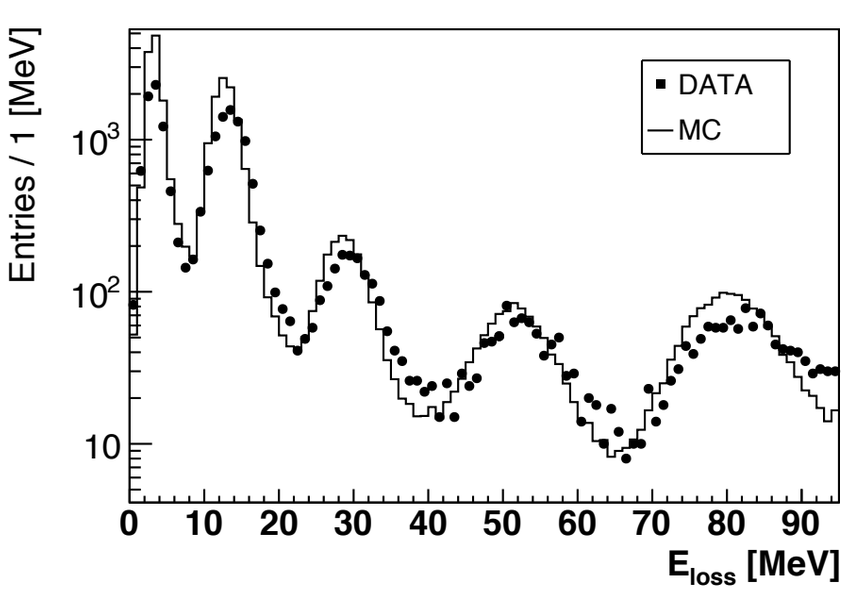
FIRST apparatus

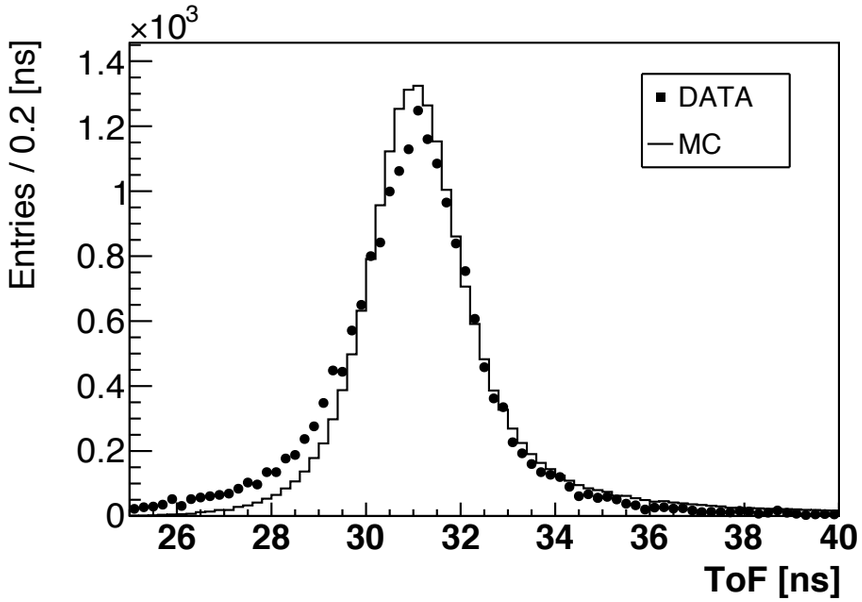
Charge identification with gold target
(small angle analysis < 6 degree)



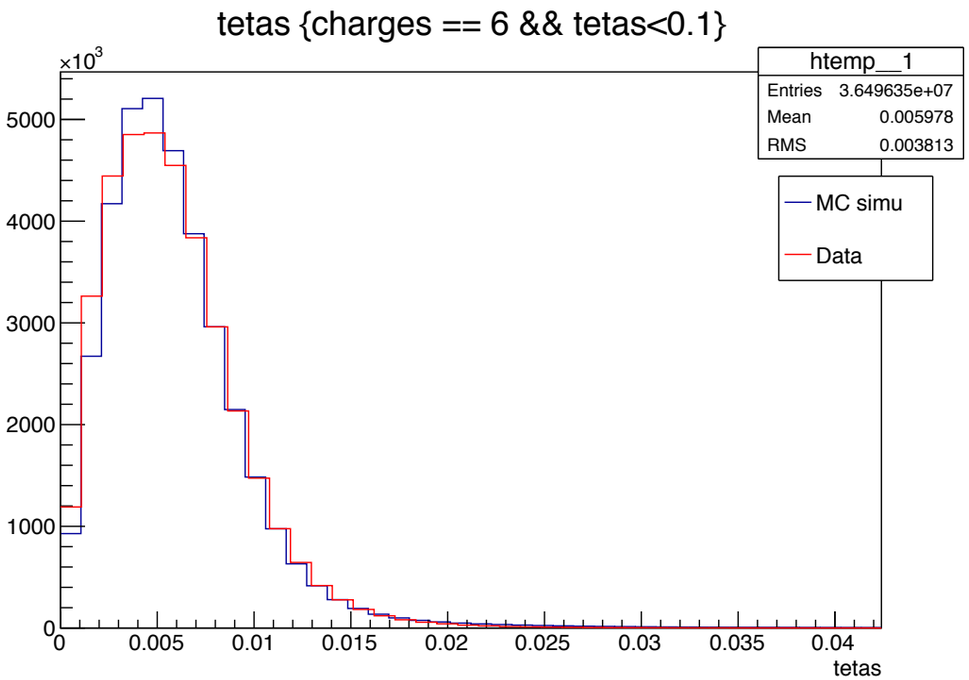
Data MC comparison

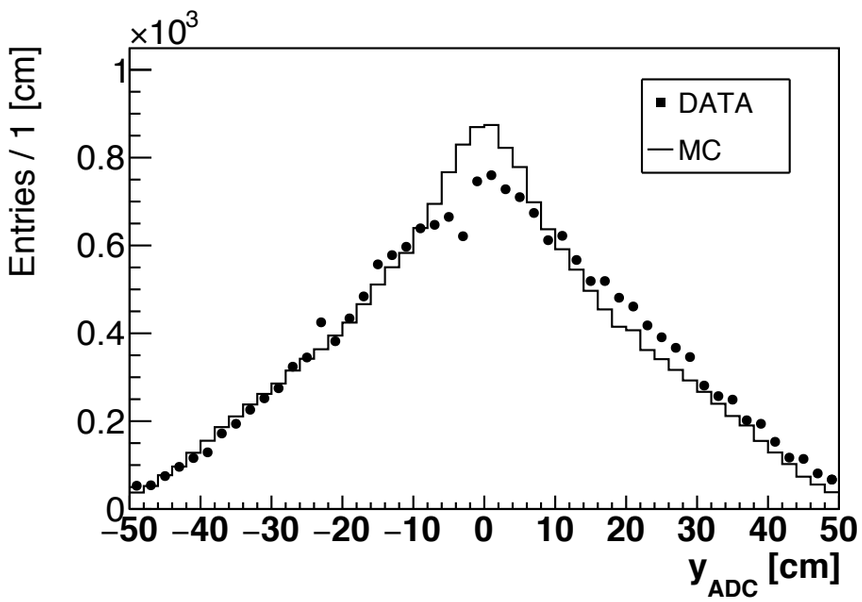
- The comparisons of E_{loss}, ToF and Y coordinate measured from the TW detector for DATA and MC events have been obtained for fragmented events (tracks associated to a reconstructed vertex >1)





Multiple scattering from target



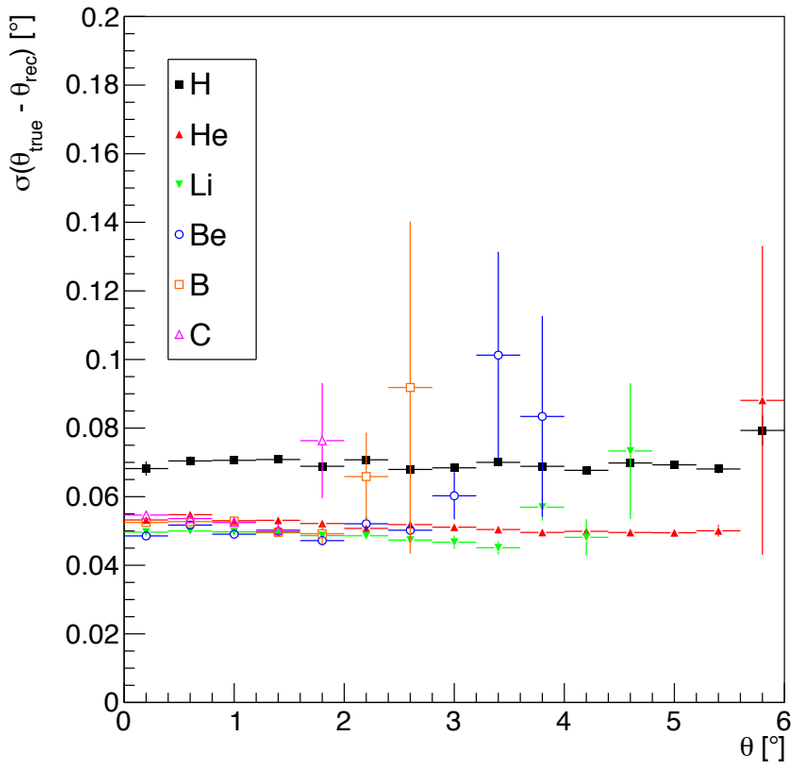


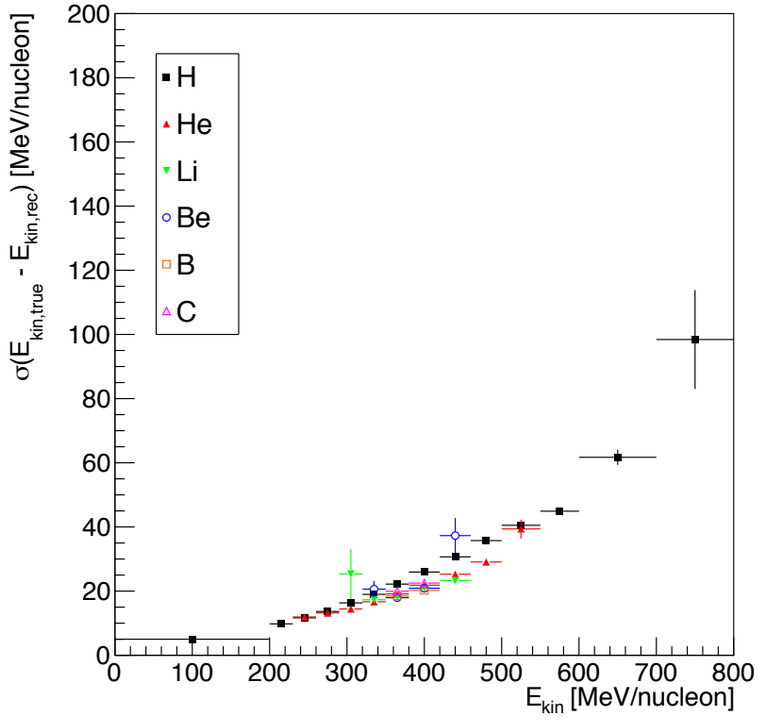
Analysis checks

- Everything is produced/decoded/reconstructed. Most of the systematic checks already done.
- Tracking efficiencies and resolutions nearly independent on the target as expected: depend only on the tracking AFTER the target (similar to the ones obtained with composite target)

- Since the E_{kin} resolution increase as a function of fragment E_{kin} we need to unfold the spectrum

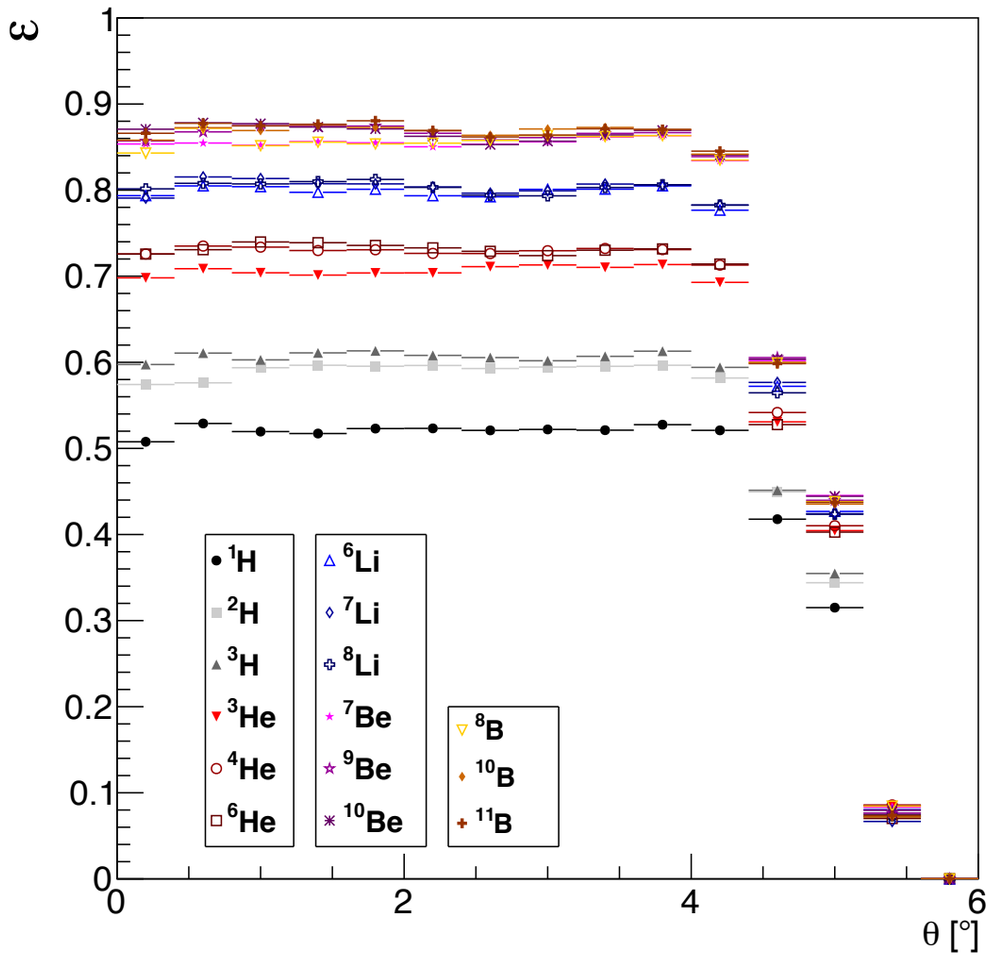
- Used the RooUnfold Tool with Bayesian approach

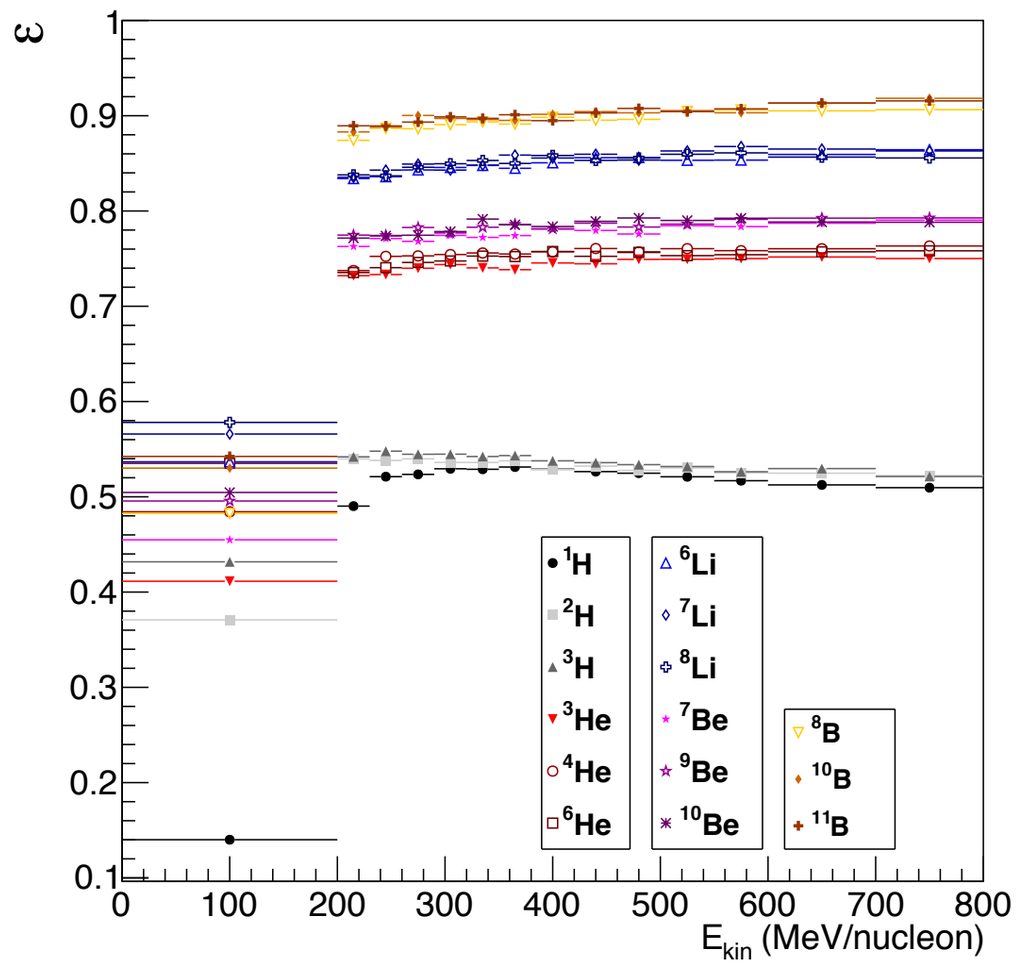




Tracking efficiencies

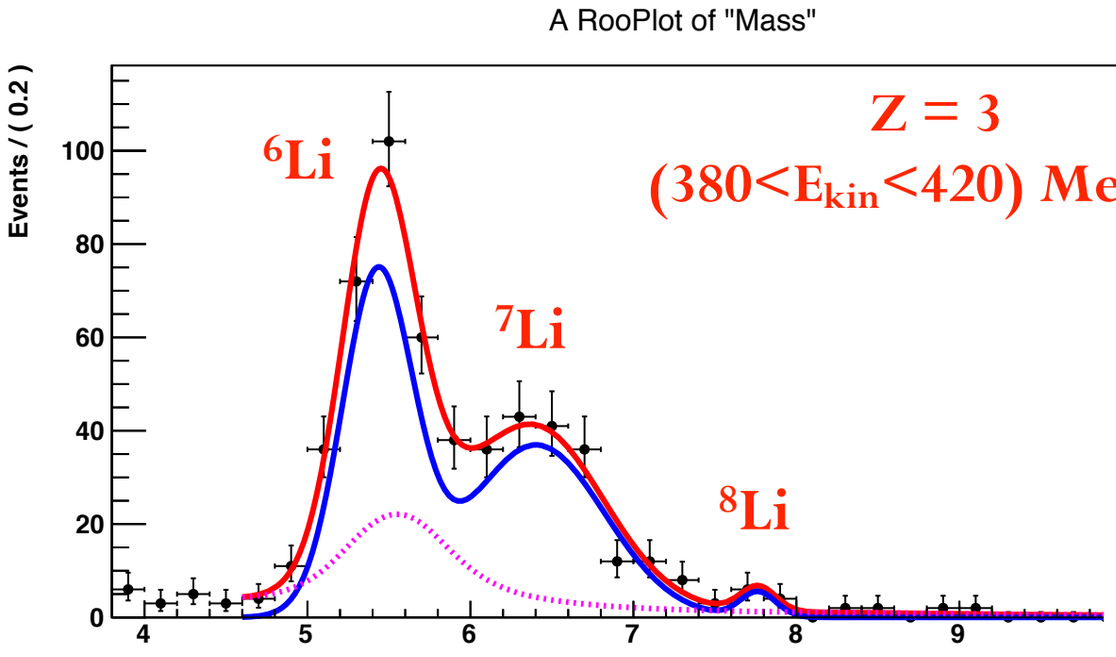
- Tracking efficiencies evaluated for each fragment produced in the interaction of the ^{12}C beam with gold target
- Tracking efficiencies (shape) from biased sample rescaled to match the mean efficiency measured on the full simulation sample





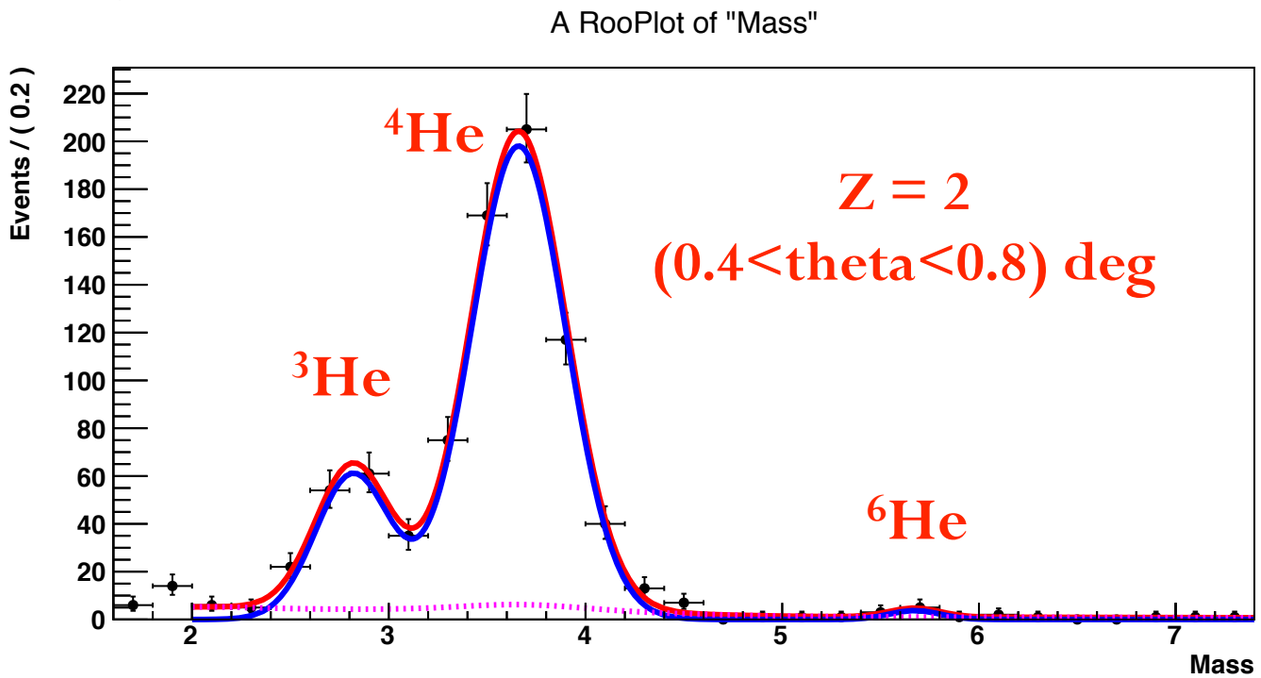
Mass fits examples

- For fragments with high Z low statistic on the tails: larger statistical errors



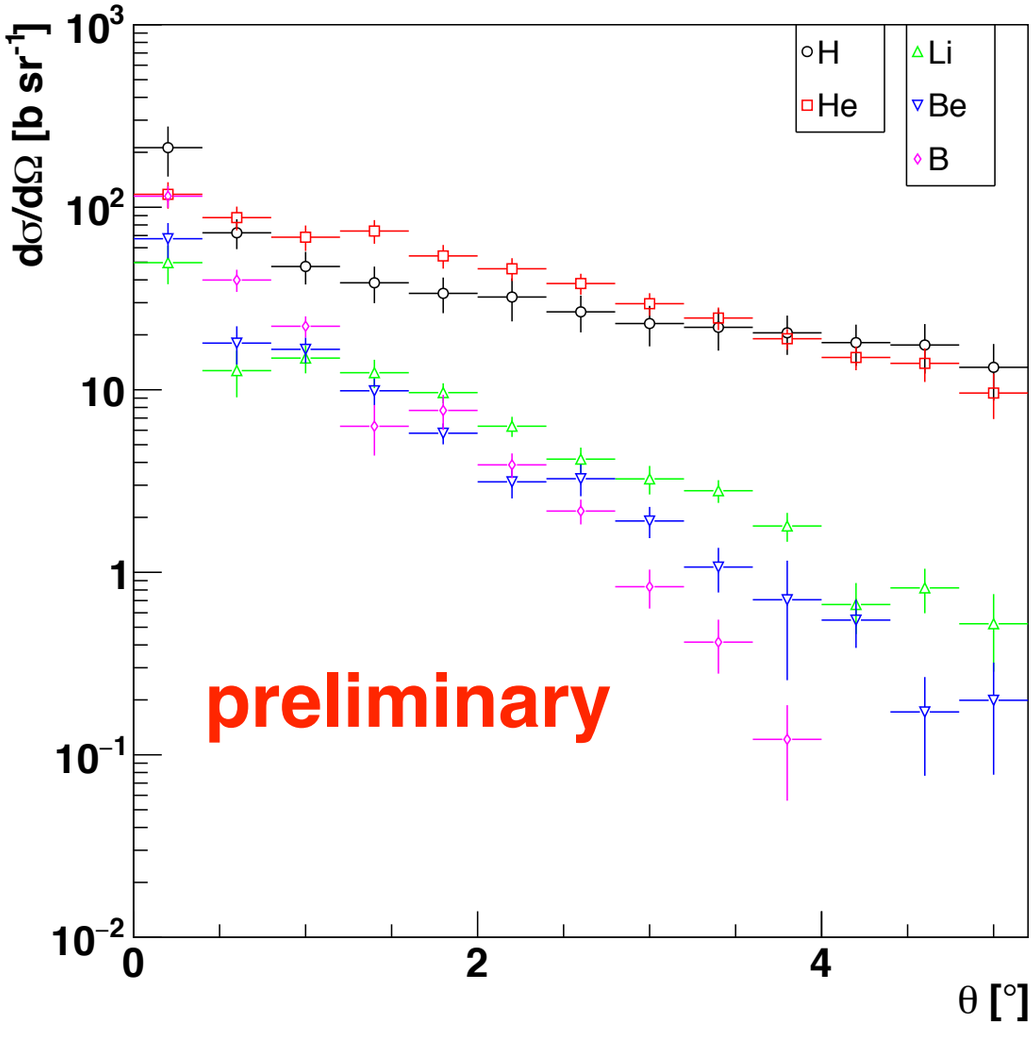
$$\frac{d\sigma_i}{d\Omega}(\theta) = \frac{Y_i(\theta)}{N_C \times N_{TG} \times \Delta\Omega \times \epsilon^i_{trk}(\theta)}$$

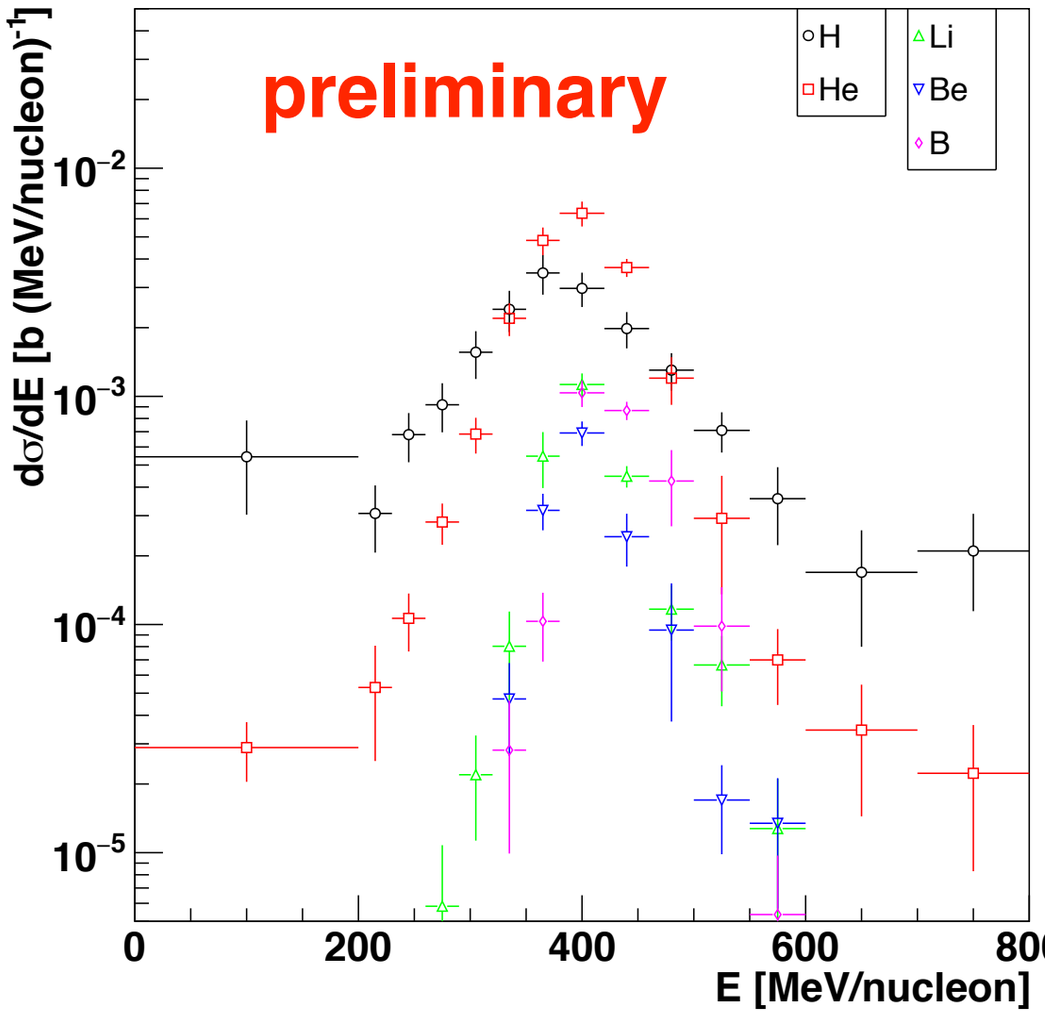
$$\frac{d\sigma_i}{dE_{kin}}(E_{kin}) = \frac{Y_i(E_{kin})}{N_C \times N_{TG} \times \Delta E_{kin} \times \epsilon^i_{trk}(E_{kin})}$$



Gold results

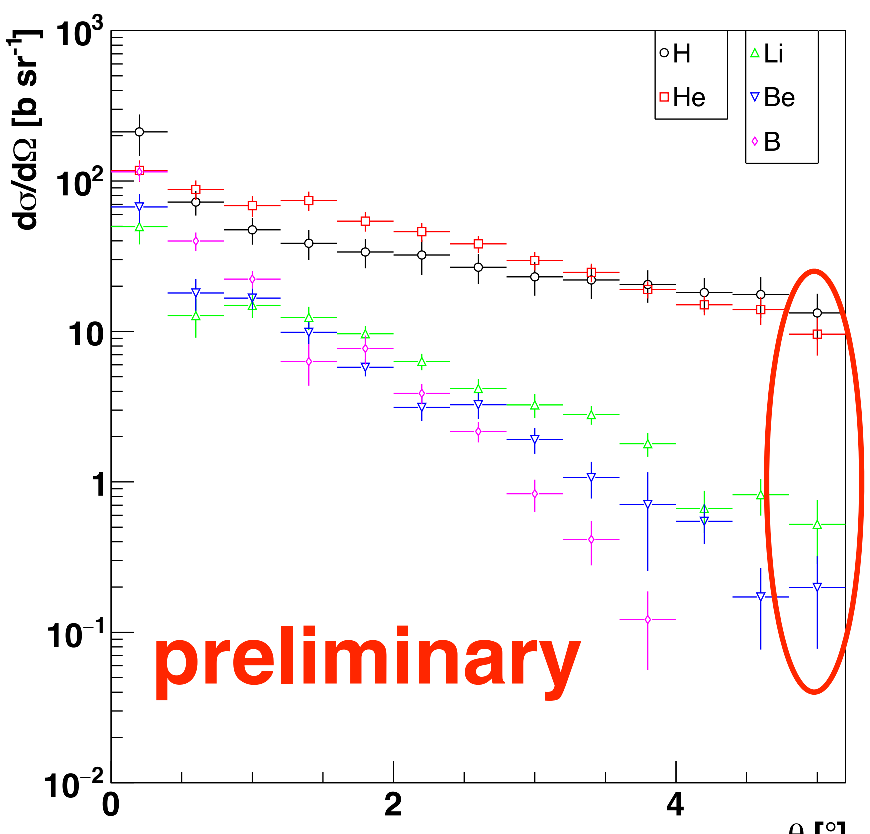
- Full analysis results:
  - systematics studies are yet to be finalised
  - energy cross sections have been unfolded
  - mass fits tuning is being finalised

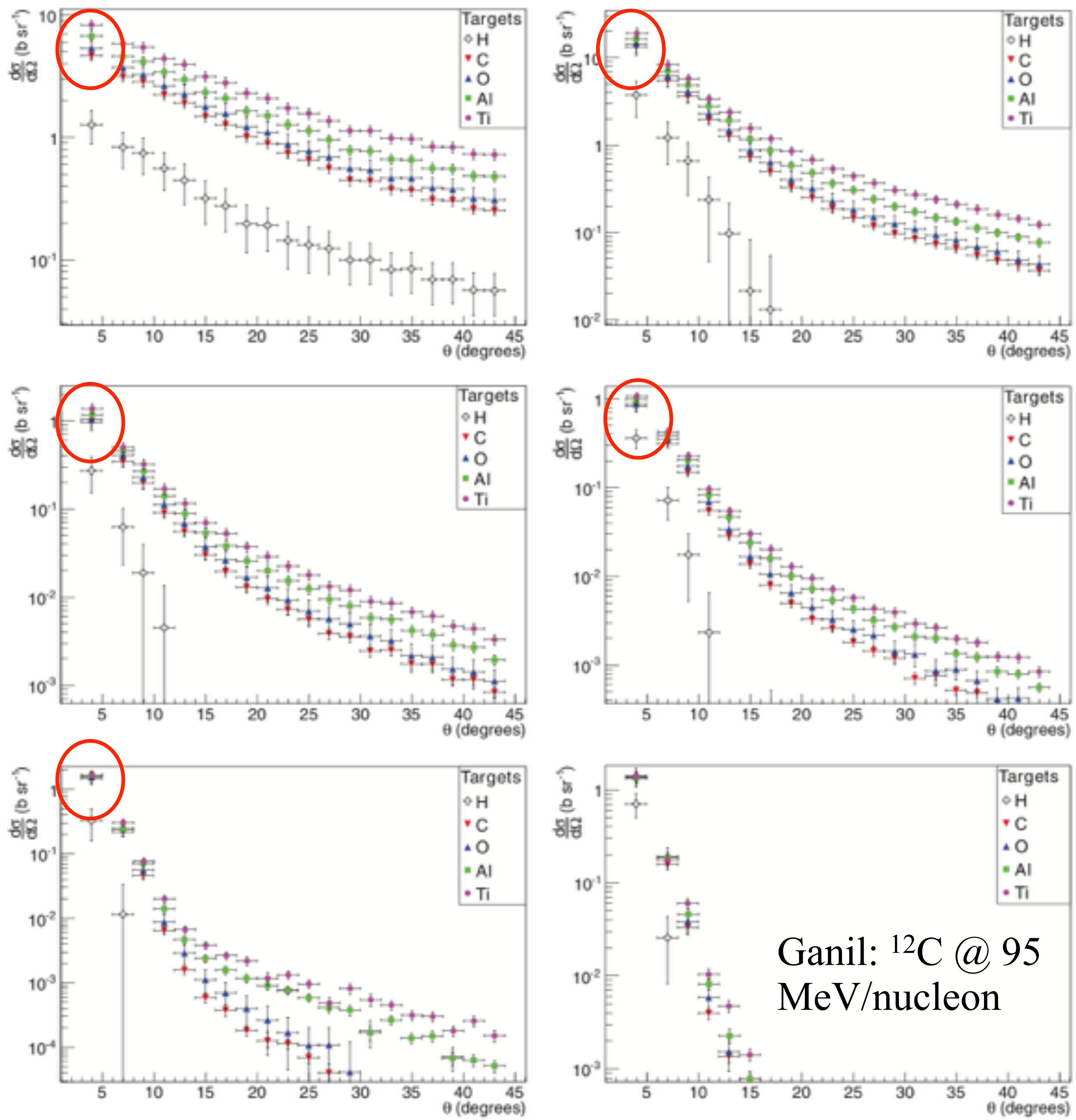




Comparison with Ganil

- Obtained the first fragmentation cross section for C+Au in the low angle range (<6 deg)
- extrapolation at 5° can be used to check order of magnitude: check last bin from FIRST against first bin from Ganil (Ti)

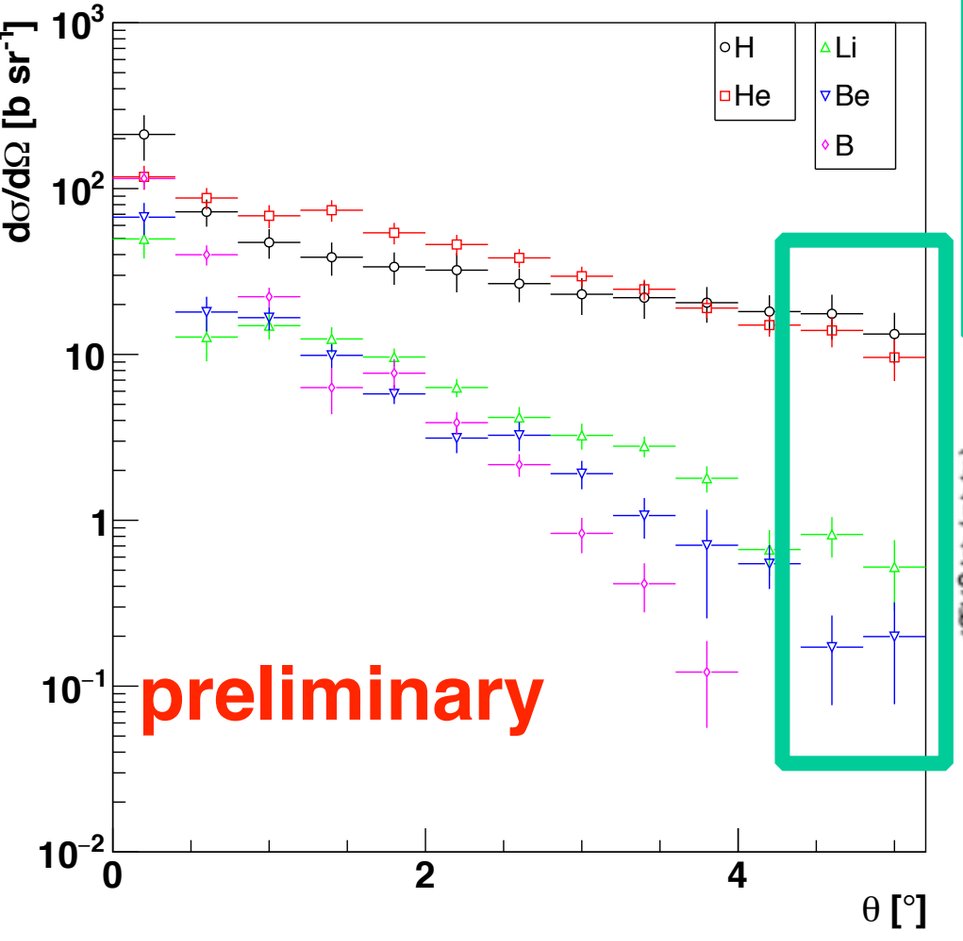


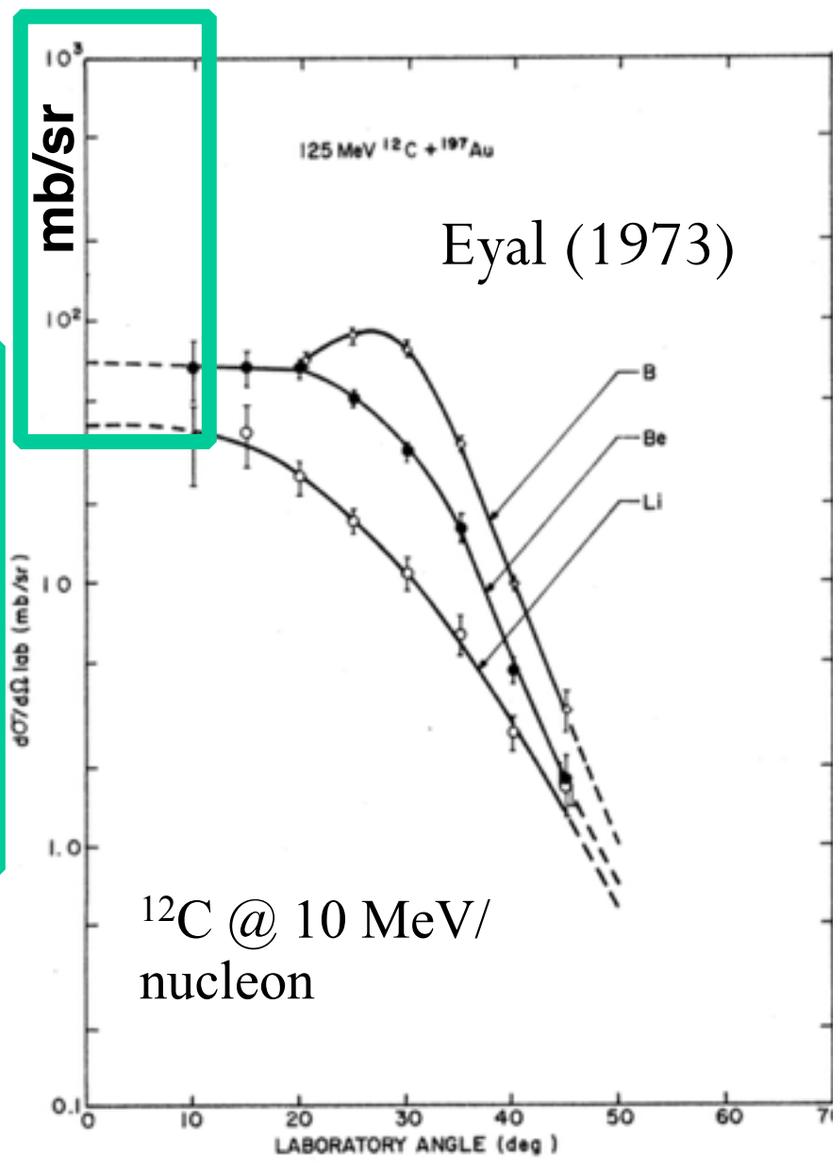


Ganil: ^{12}C @ 95 MeV/nucleon

Comparison with other (old) data

- X-Section, large angles (> 10 deg.)
  - Our result seems compatible with order of magnitude extrapolation from low angles…





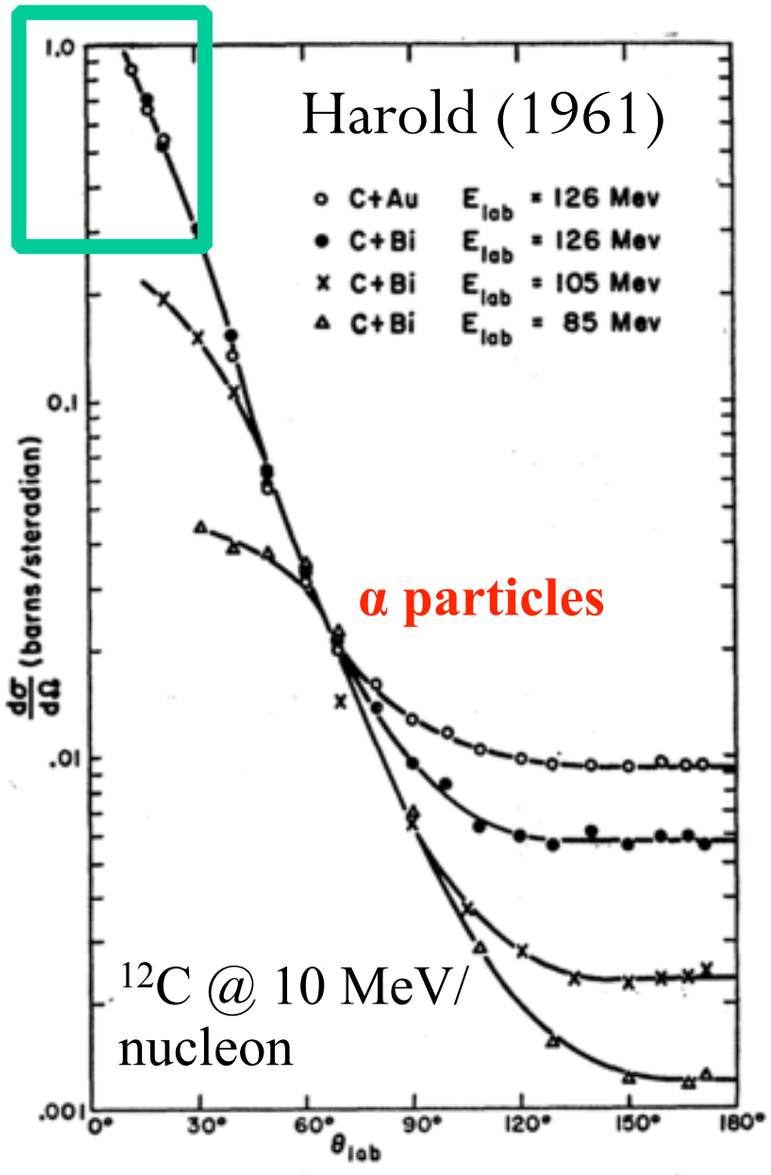


FIG. 8. Angular distribution of light fragments formed in the reaction 125-MeV $^{12}C + ^{197}Au$.

Conclusions

- The "gold" data analysis is well advanced:
  - we just need to finalize the fit tuning and the systematics studies **before the paper submission to PRC**
  - **Preliminary checks on already published data are showing a good agreement with FIRST results**

- We are also working on the benchmarking of our cross sections with FLUKA MC.
  - Preliminary results are promising
- Composite target studies will follow shortly in order to evaluate the feasibility of a MC benchmarking publication.