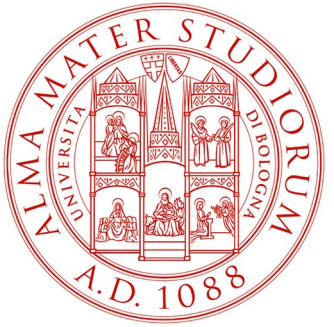


Tracking analysis on full setup

R. Zarrella

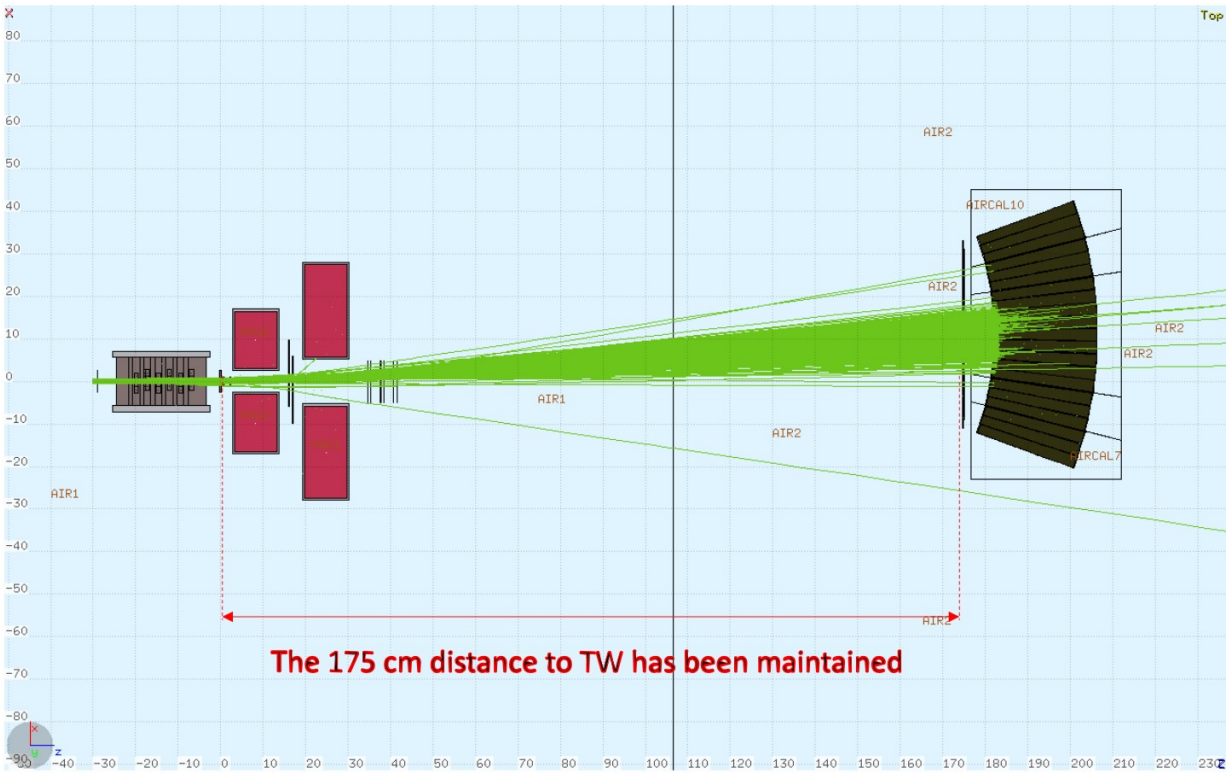
FOOT Physics Meeting 02/2024

12C_200_2023v2

Full setup simulation

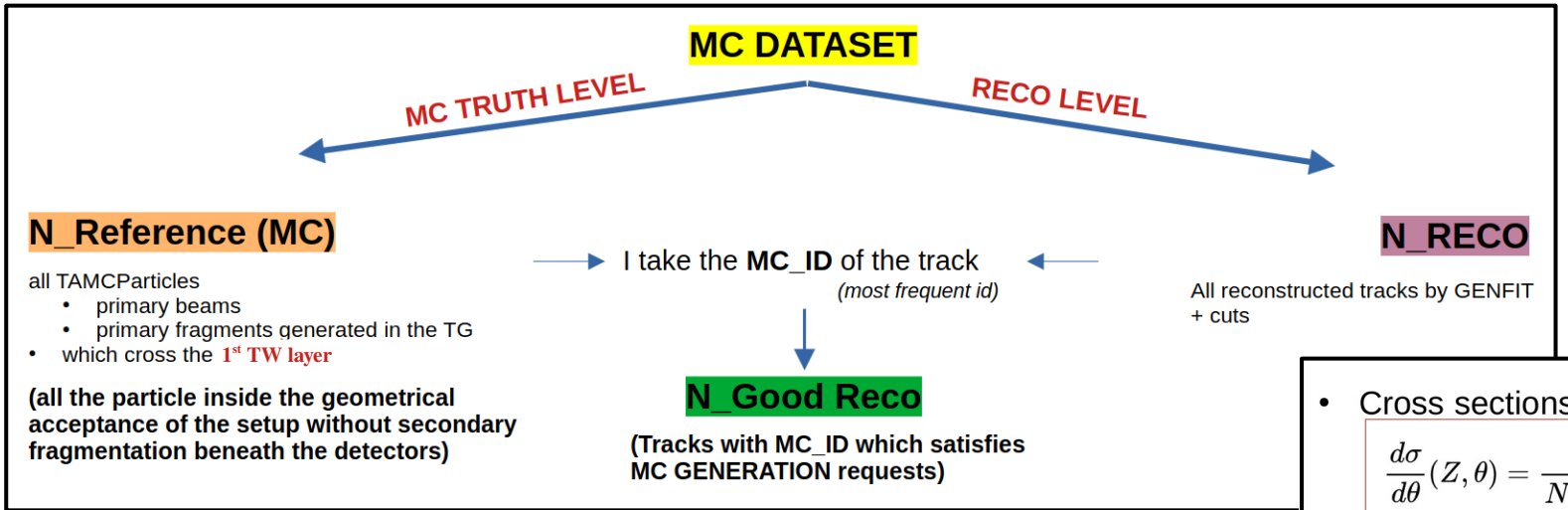
- All detectors in nominal position
- Magnetic field rotated as real one
- TW & CALO at X = +11cm
- ^{12}C @ 200 MeV/u on 5 mm of C
- 10^7 primaries on target

Test of full reconstruction chain with tracking



From Giuseppe & Silvia's presentation @ PM of July

Analysis strategy



From Giacomo's presentation(s)

- Cross sections computed using the formula:

$$\frac{d\sigma}{d\theta}(Z,\theta) = \frac{Y(Z,\theta)}{N_{beam}\, N_{target}\, \Omega_\theta\, \epsilon(Z,\theta)}$$

- Systematical impact studied with the **reco ratio**:

$$reco\ sys = \frac{\sigma_{reco} - \sigma_{MC}}{\sigma_{MC}}$$

- Analysis cuts:
  - $\chi^2 / n_{dof} < 2$
  - $n_{global\ tracks} > 1$
  - **TW point** in one track (at most)
  - $n_{global\ tracks}$ == **TW point**

Same strategy as Giacomo for the analysis but…

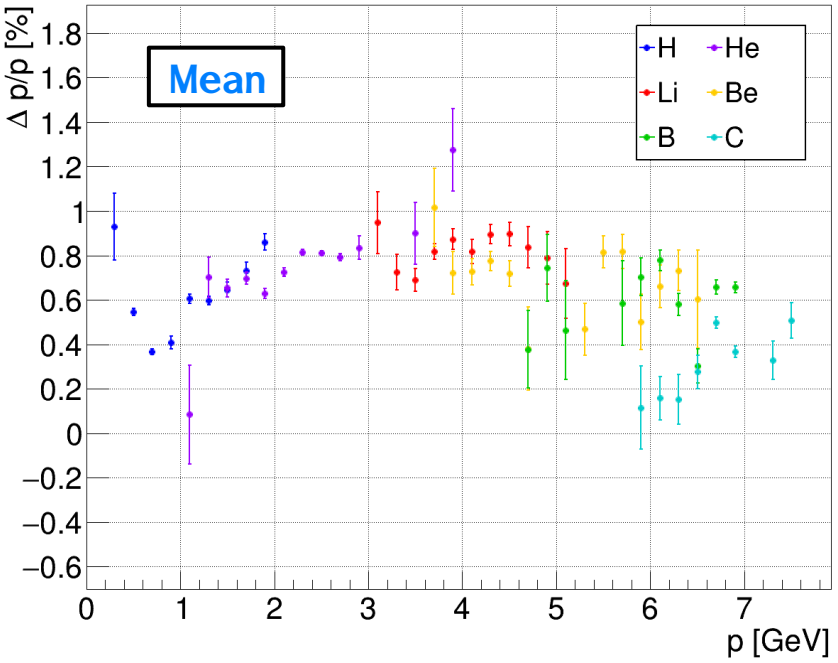
- **Magnetic field is present**
- **Full spectrometer for tracking → VT-IT-MSD-TW**

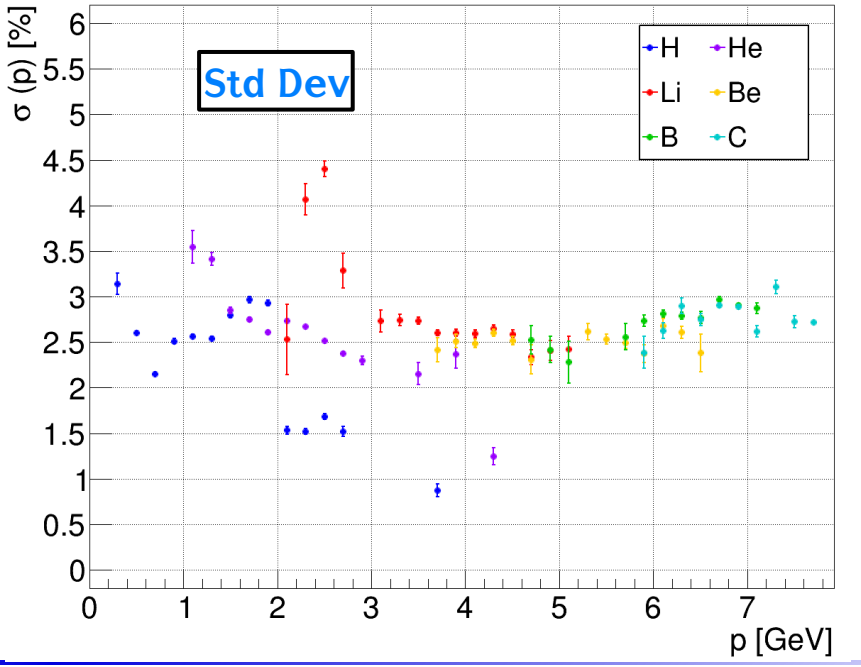
Momentum resolution

$$\frac{\Delta p}{p} = \frac{p_{reco} - p_{MC}}{p_{MC}}$$

(Calculated @ TG-AIR interface)

- **Slight overestimation of p (<1%)**
- **p resolution ~ 2.5% in the whole energy range**





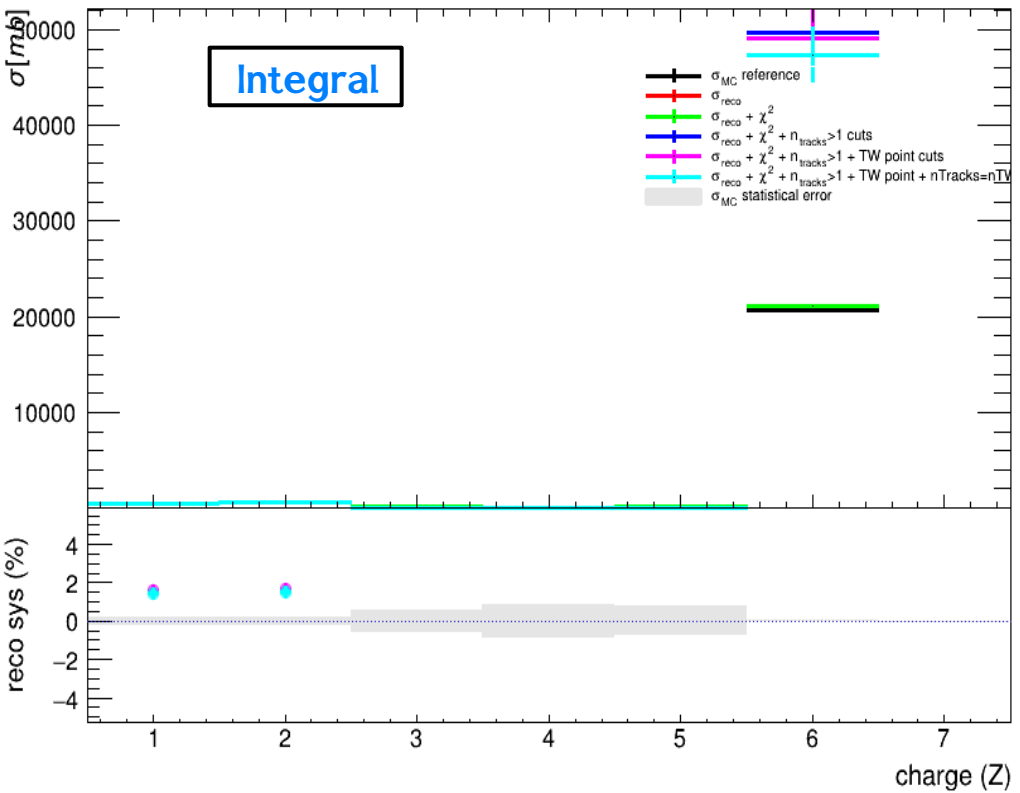
Let's jump to the end! Cross section

Resolution is good!
What about the cross section?

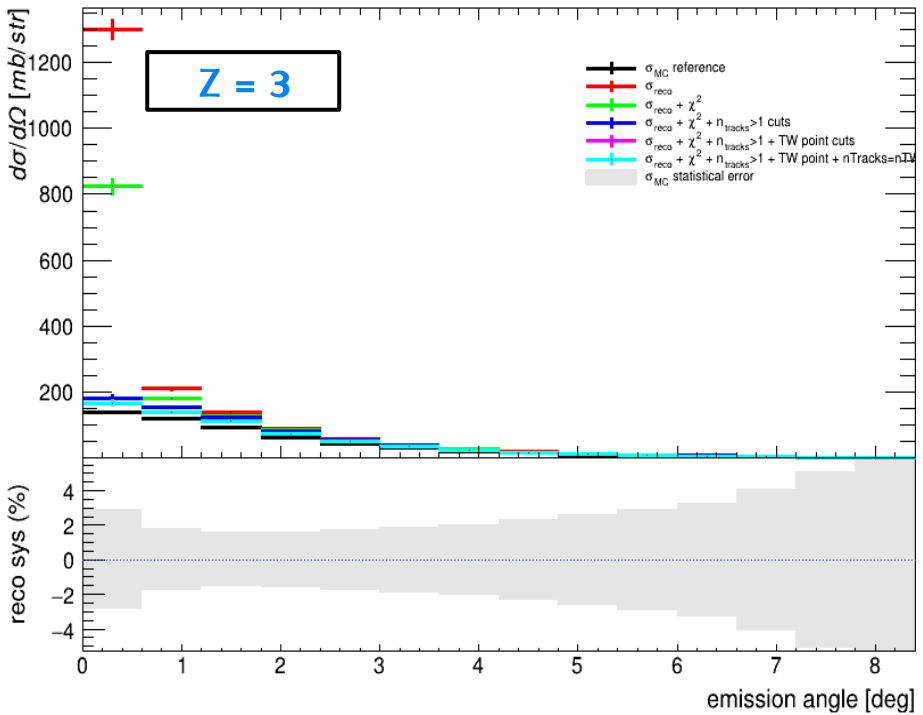
Integral cross section in Z

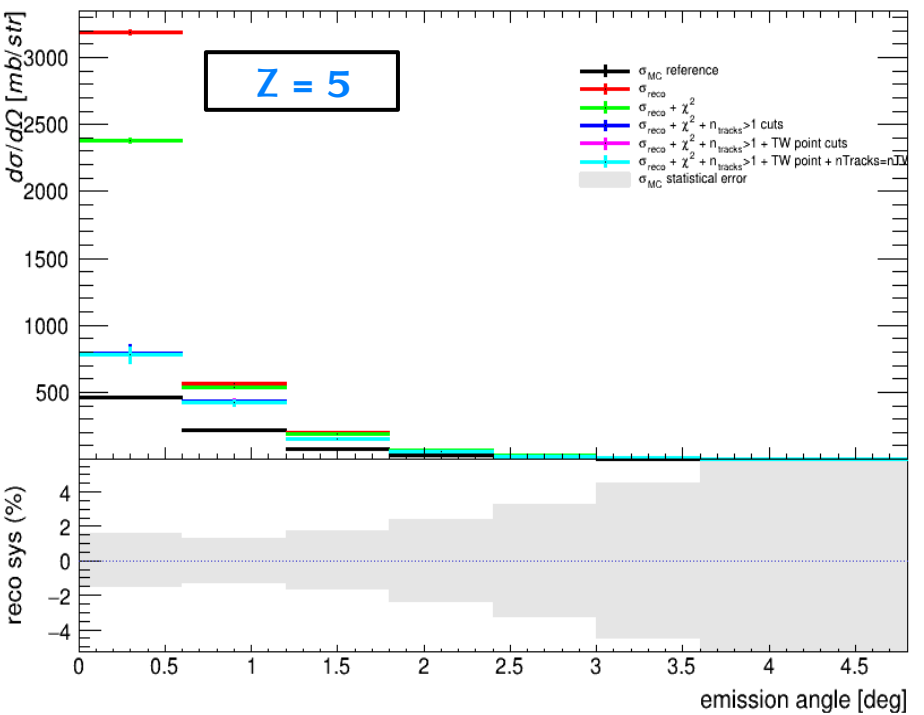
- H and He at 2% level
- All the other are out of the graph...

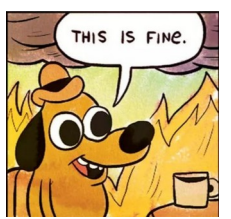
What?



Let's jump to the end! Cross section







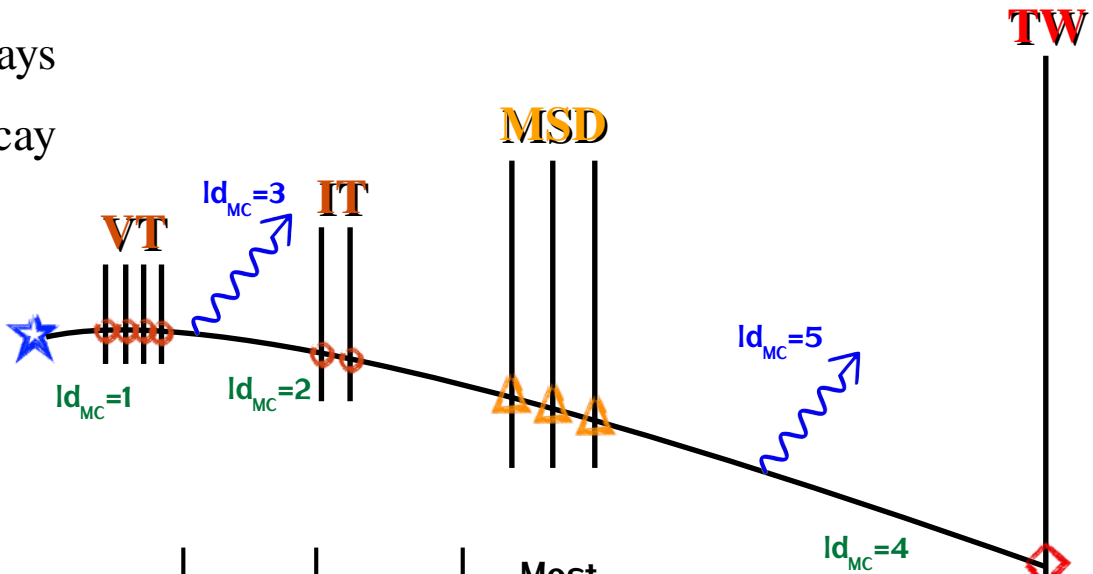
So… apparently nothing is working with B field (?)

The problem of γ-decay

Any γ-decay changes the MC Id of a particle! (*see Giuseppe's talk later*)

- **Breaks any control on MC information along the track!**
- Fragments produced in excited state can emit γ-rays
- FLUKA update introduced in-flight prompt γ-decay
  (please correct me if I'm wrong!)
- Much less relevant for GSI2021_MC
  (Primary? Energy?)

Recursive check of "mother" particle when γ-decay happens

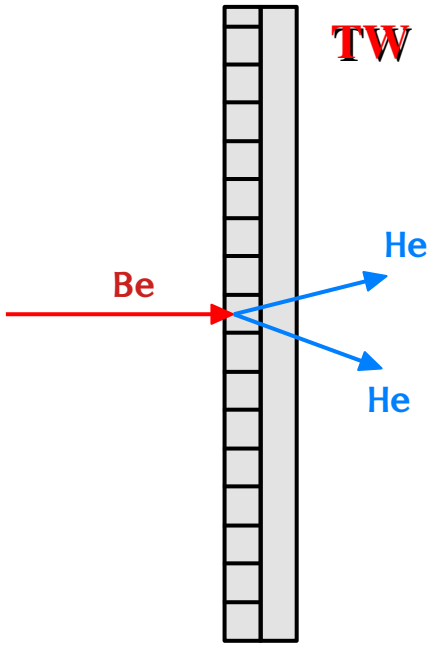


	At TG	At TW	Most frequent
Track Id_{MC}	1	4	2

The problem of TW fragmentations

Change of MC Id inside the TW

- **Breaks some controls on MC Z information along the track!**
- Can become quite a mess...
- Mostly leads to wrong Z association in efficiency calculation



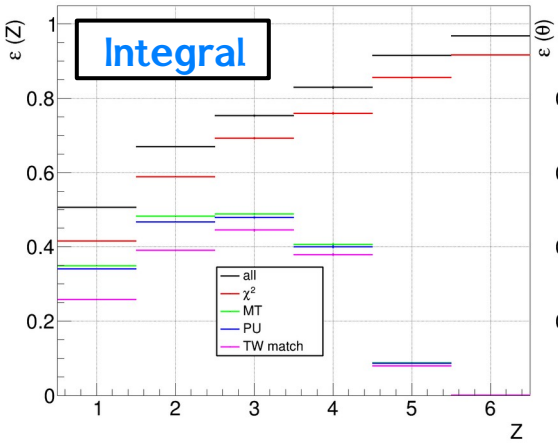
$$\frac{dE}{dx} \propto Z^2$$

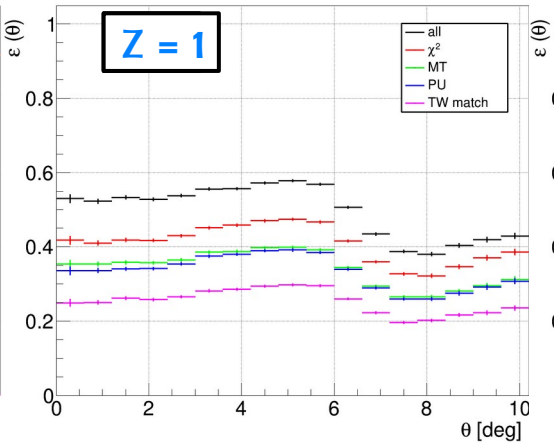
$$2(2^2) = 8 \sim 3^2$$

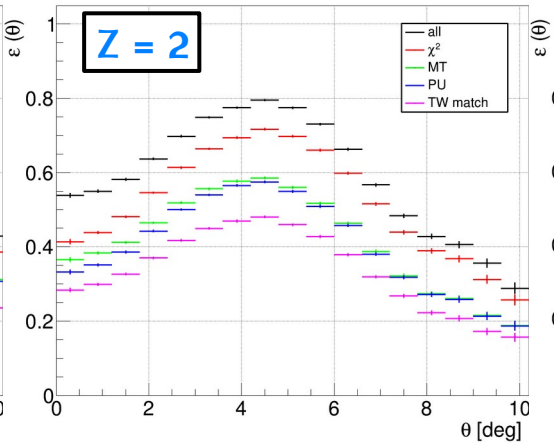
- **Recursive check of "mother" particle when TW-frag happens**
- **Now accounted for in efficiency**

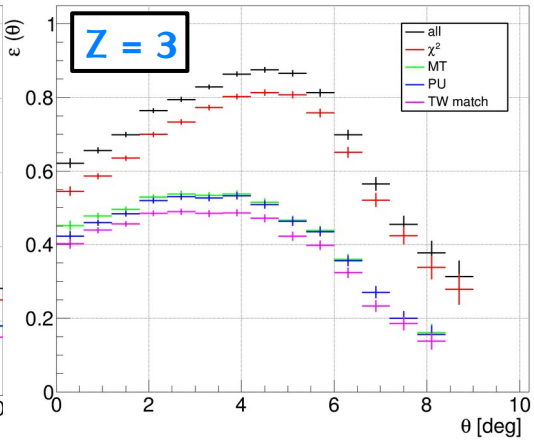
	MC at TG	MC at TW-in	MC at TW-out	MC TWpoint	Reco TW
Z	4	4	2	2	3

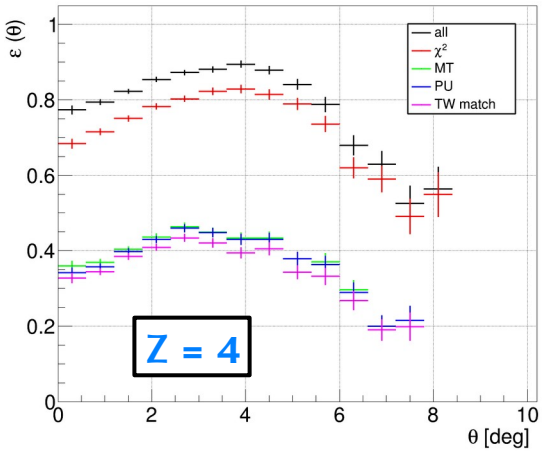
Tracking efficiency

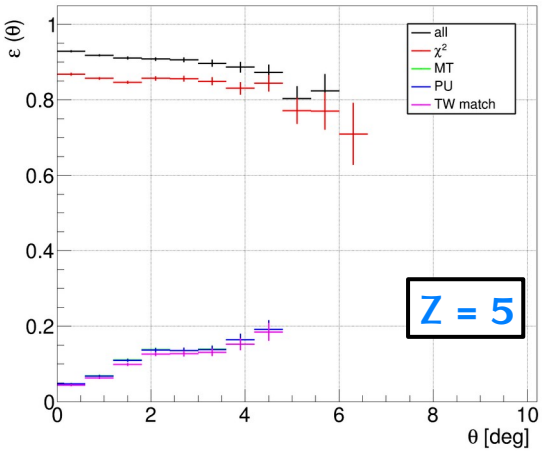








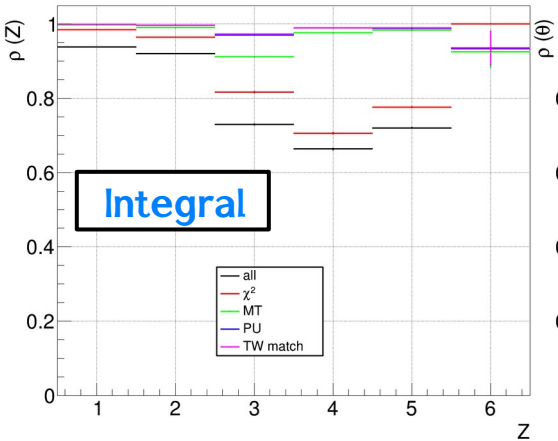


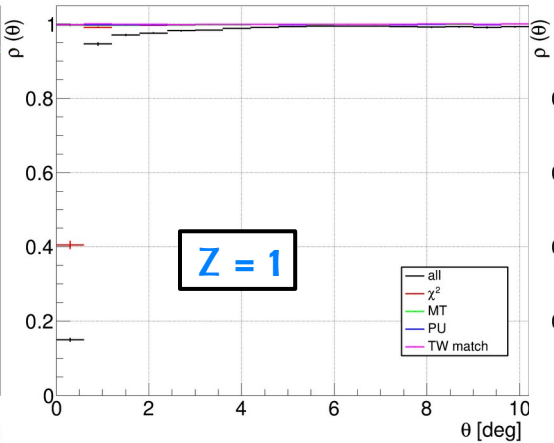


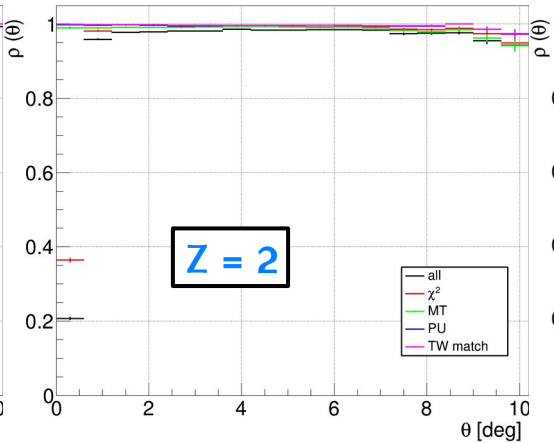
$$\varepsilon = \frac{N_{good}}{N_{ref}}$$

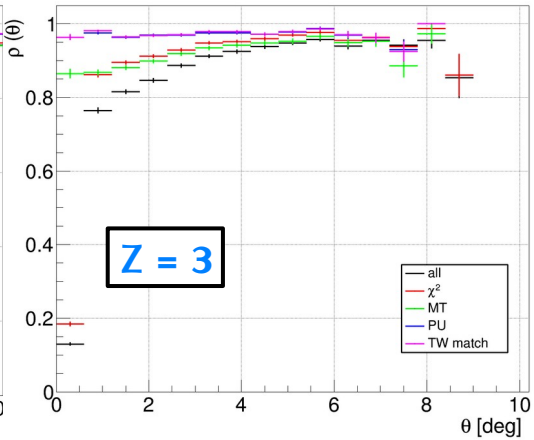
Efficiency is (correctly) lowered by the cuts, and...

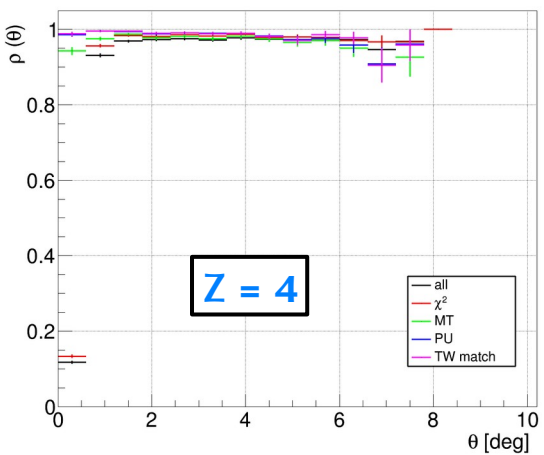
Tracking purity

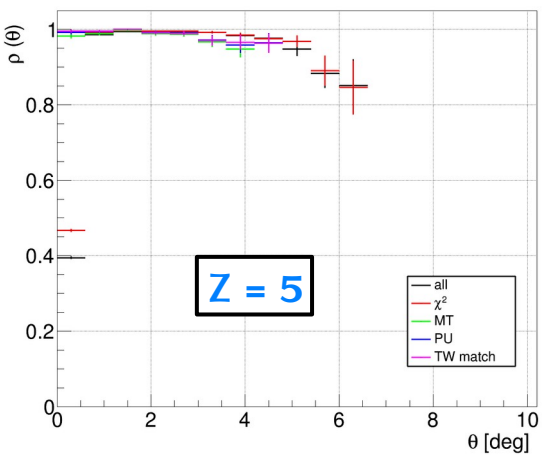








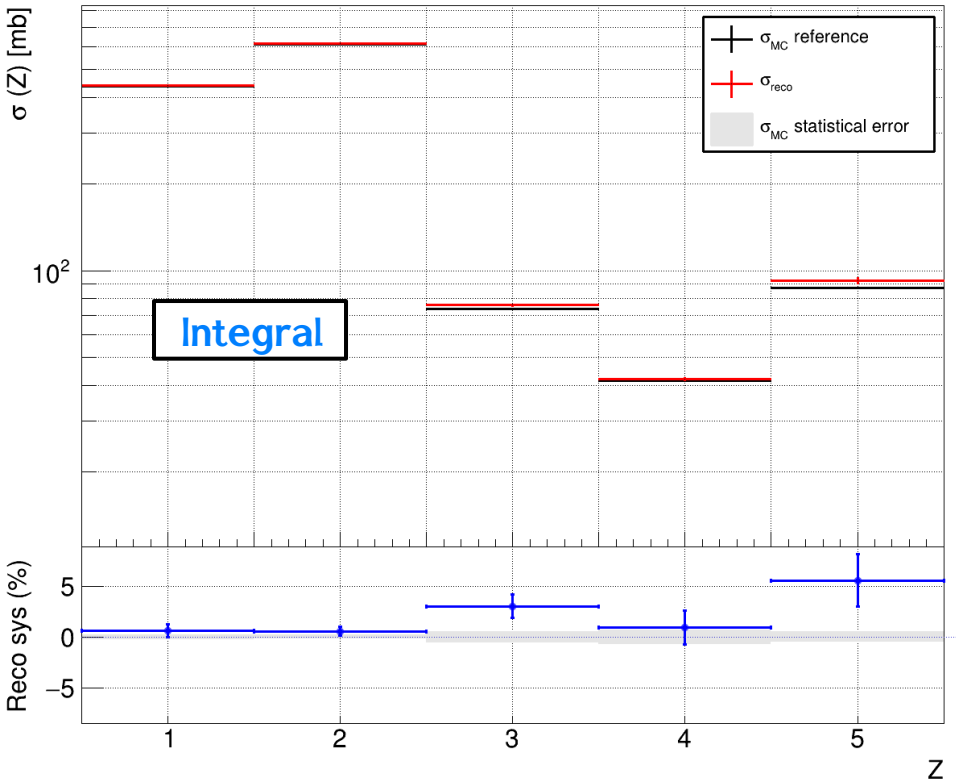


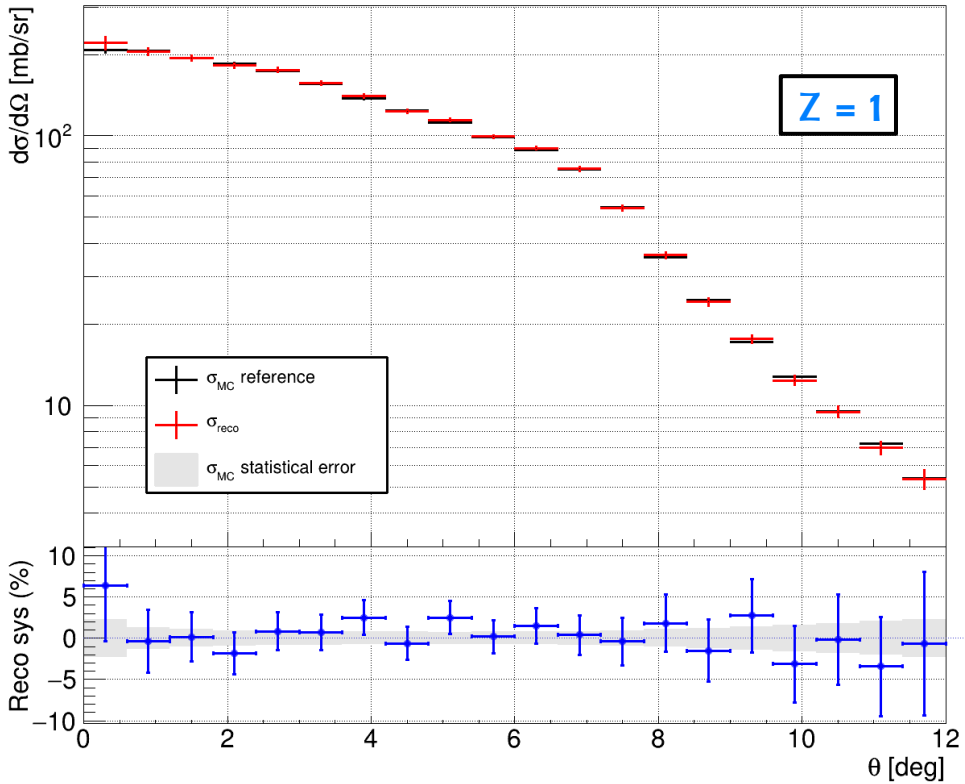


$$\varrho = \frac{N_{reco}\,(Z = Z_{mfp})}{N_{reco}}$$

Purity is close to 100% for all Z and all angles after the cuts!

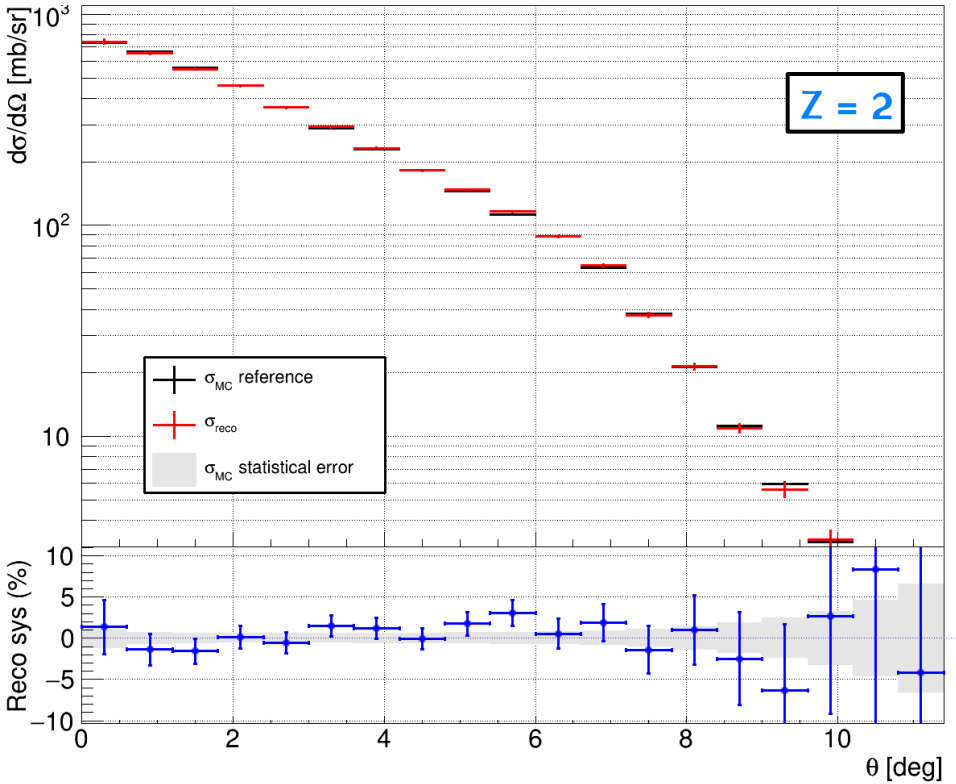
Cross section reconstruction

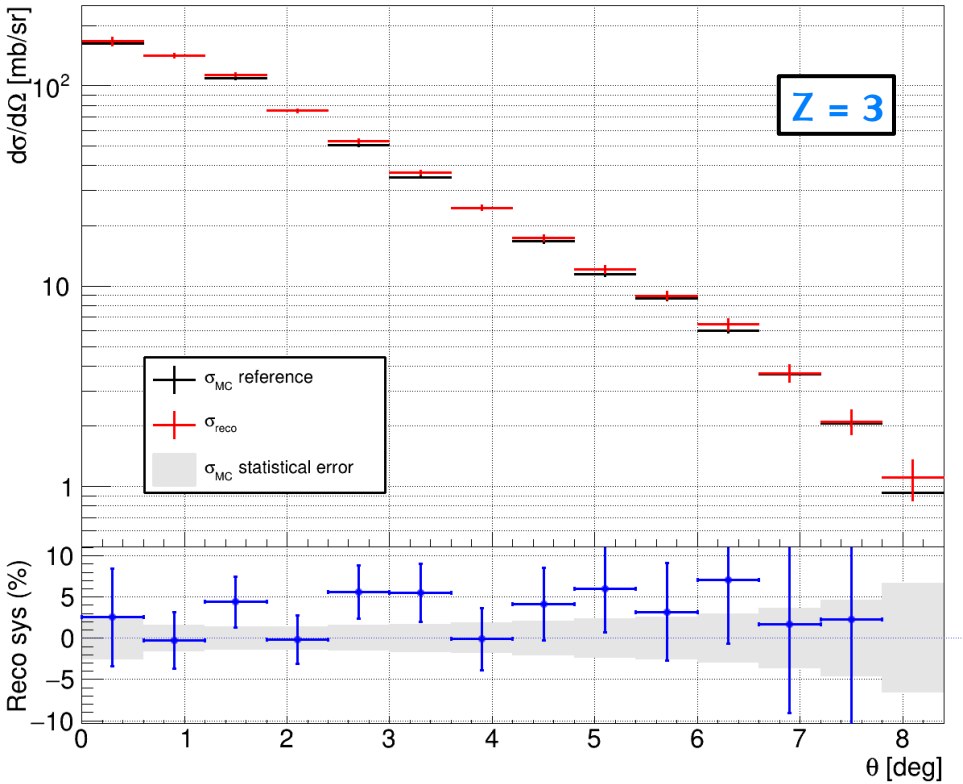




- Integral cross section is now @ 5% level!
- Z = 1 compatible over all angular range

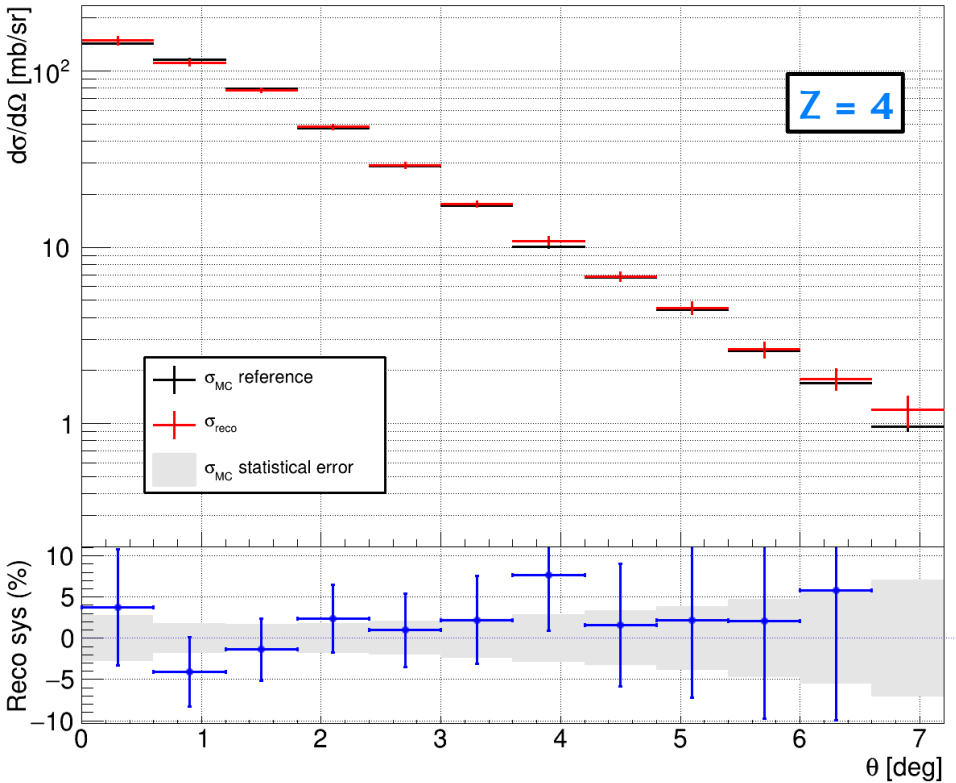
Cross section reconstruction

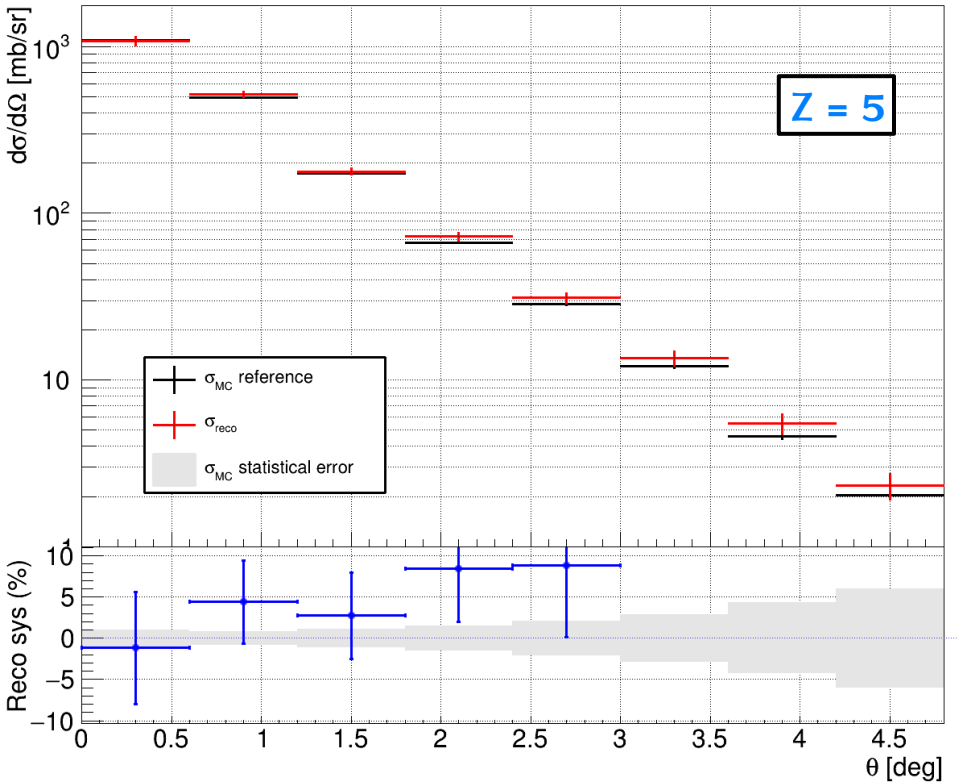




- Z = 2 compatible over all angular range
- Z = 3 slightly overestimated but @ ~5%

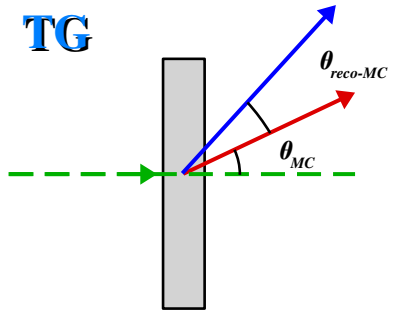
Cross section reconstruction

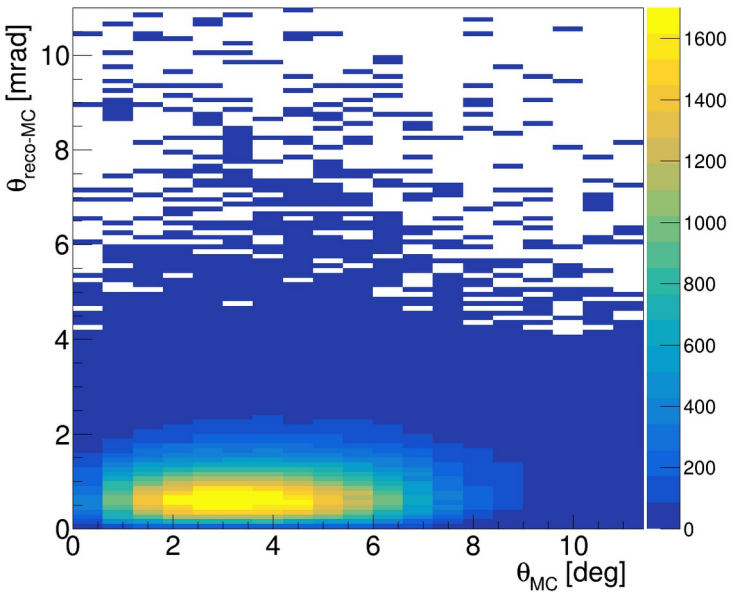


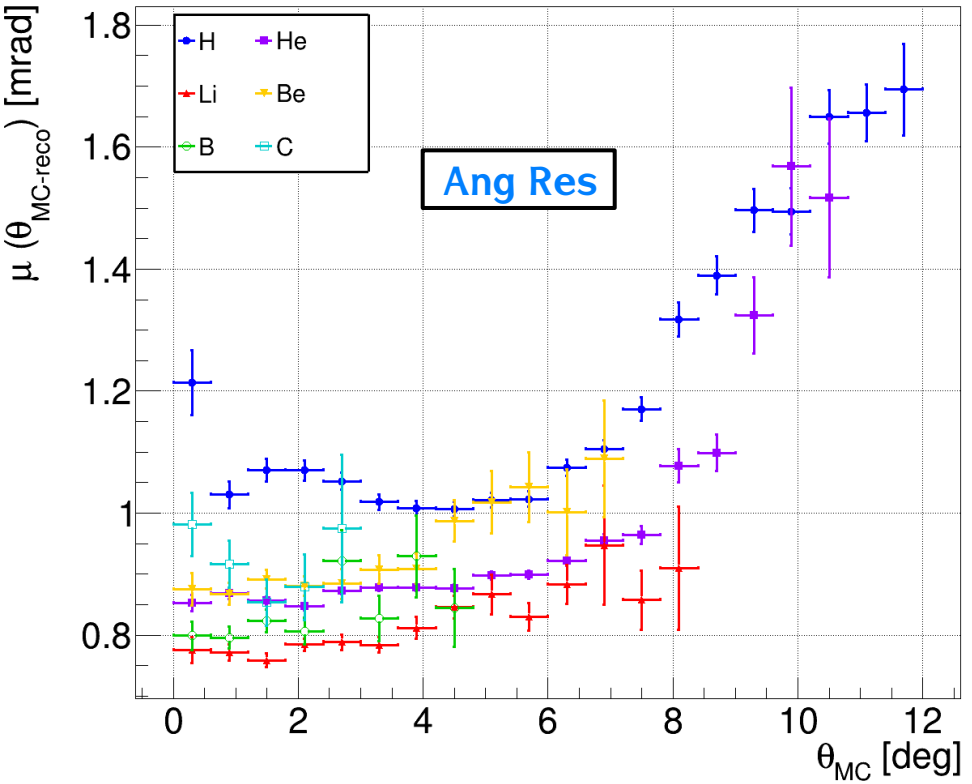


- Z = 4 compatible over all angular range
- Z = 5 slightly overestimated but @ ~5% up to 3°

Bonus: angular resolution







Angular resolution of 1 mrad up to 8°

Conclusions

Global reconstruction on MC simulation of full setup

- **Momentum resolution at the level of 2.5%**
- Handled counting errors coming from γ-decays and TW fragmentations
- **Reconstructed cross section compatible with MC**
  - ✔ Within statistical uncertainties for most ions
  - ✔ At the level of 5% for Li and B (up to 3°)
- **Angular resolution at the level of mrad**
- Need to perform the same exercise on CNAO2023 (very similar)
- **Still many information missing!** *(e.g. Z from MSD, Ek from CA)*

Need for configuration/calibration files to move to experimental campaigns