

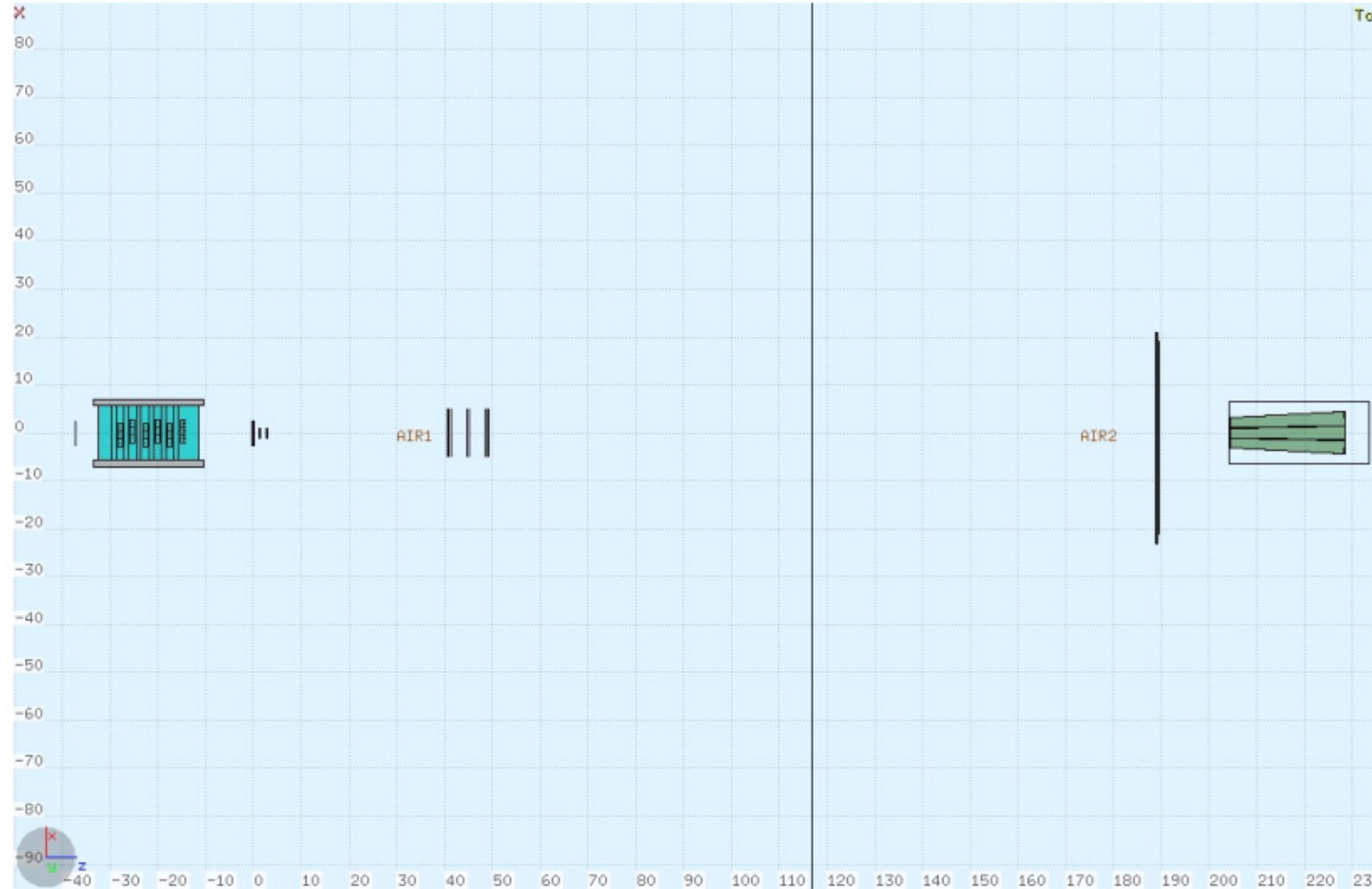


Update on the GSI2021 elemental cross sections

Riccardo Ridolfi

19 April 2023

MC simulation



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 $\sigma_x = 2.3$ mm
 $\sigma_y = 1.5$ mm

Cross section measurement

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

$$\Delta\sigma(Z) = \int_{\beta_{\min}}^{\beta_{\max}} \int_0^{\theta_{\max}} \left(\frac{\partial^2 \sigma}{\partial \theta \partial \beta} \right) d\theta d\beta = \frac{Y(Z)}{N_{\text{prim}} \cdot N_{\text{TG}} \cdot \varepsilon(Z)}$$

Align FOOT detectors and estimate angular acceptance

Extract fragment yields from TW

Calculate MC efficiencies for fragments

Evaluate the beta range from data and put in MC for efficiency calculations

Cross section measurement

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

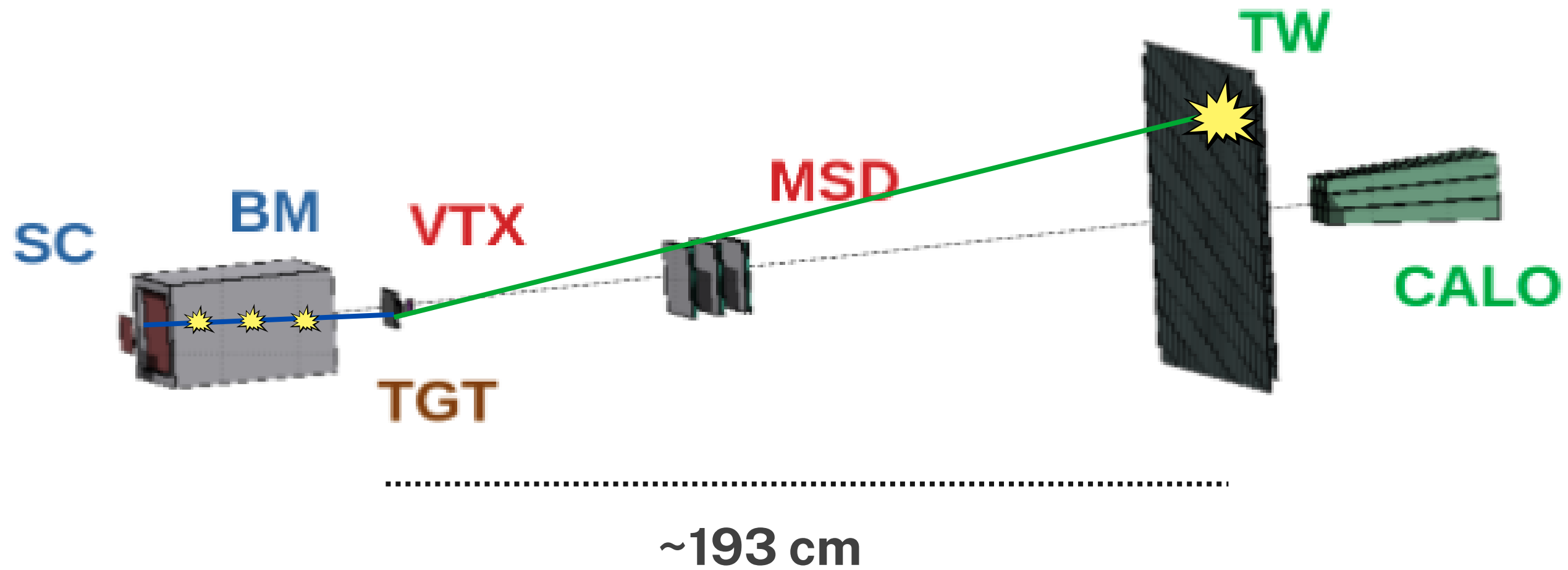
$$\frac{d\sigma}{d\theta}(Z) = \frac{Y(Z, \theta)}{N_{\text{prim}} \cdot N_{\text{TG}} \cdot \Delta\theta \cdot \varepsilon(Z, \theta)}$$

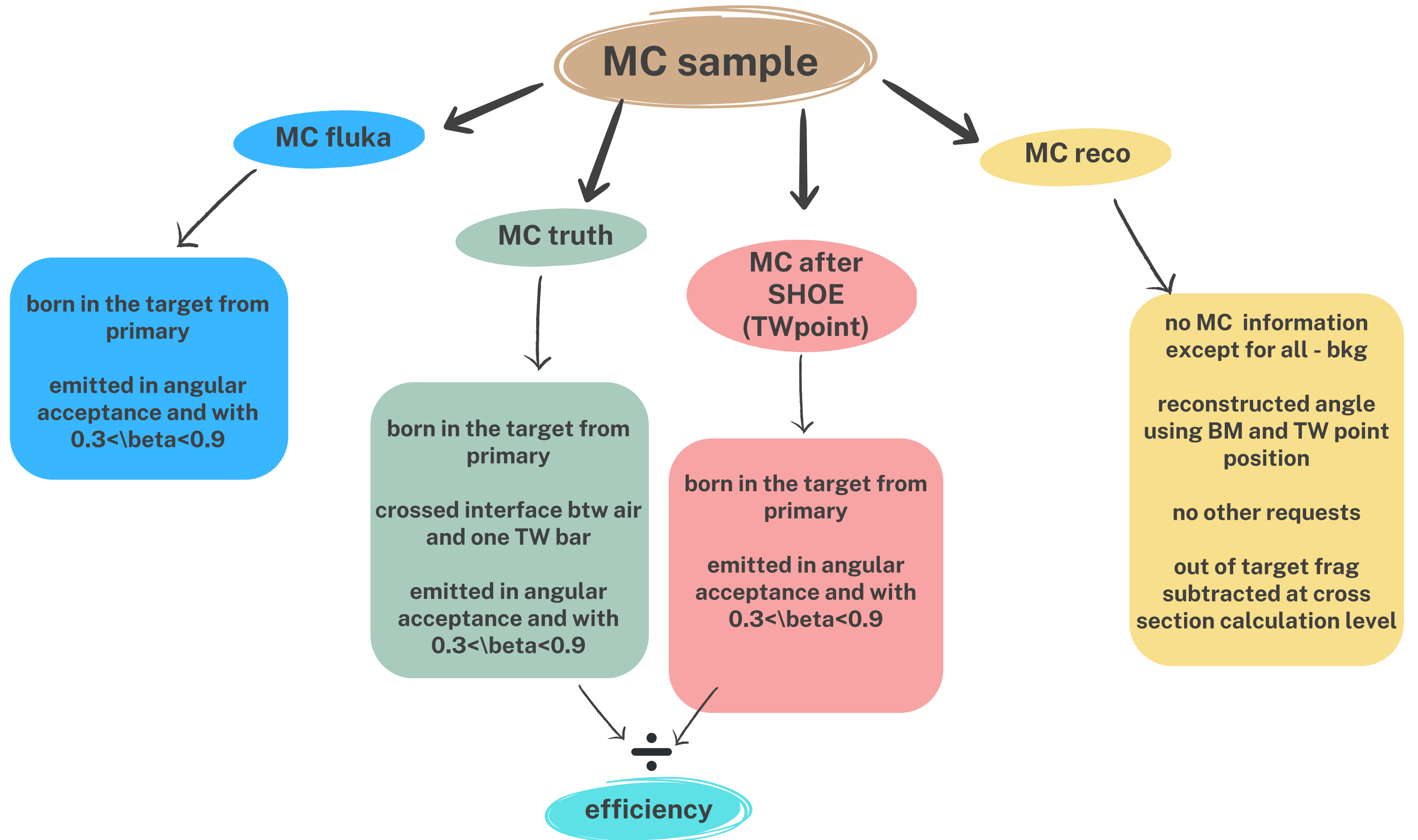
Align FOOT detectors and estimate angular acceptance

Extract fragment yields from TW

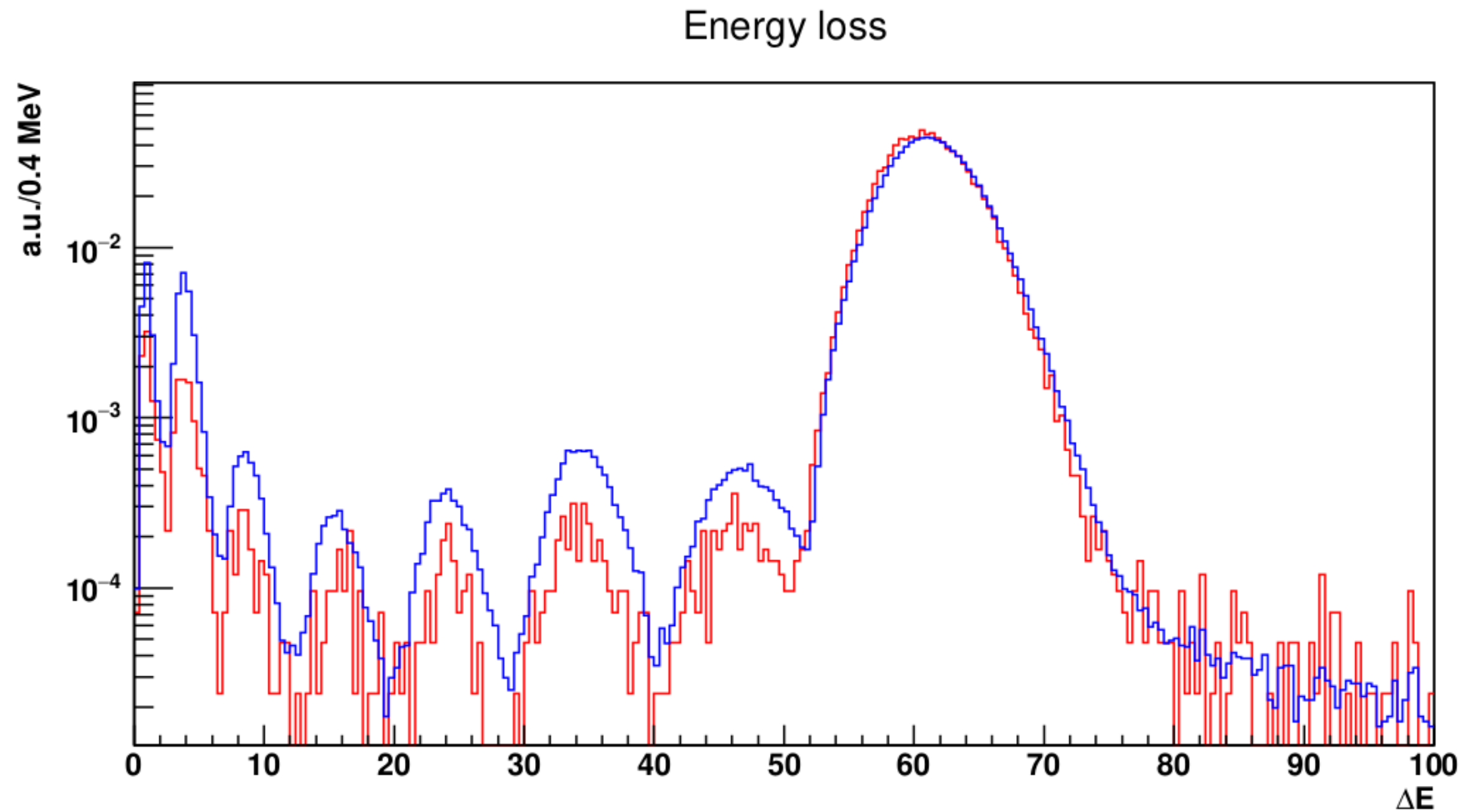
Calculate MC efficiencies for fragments

Angle measurement



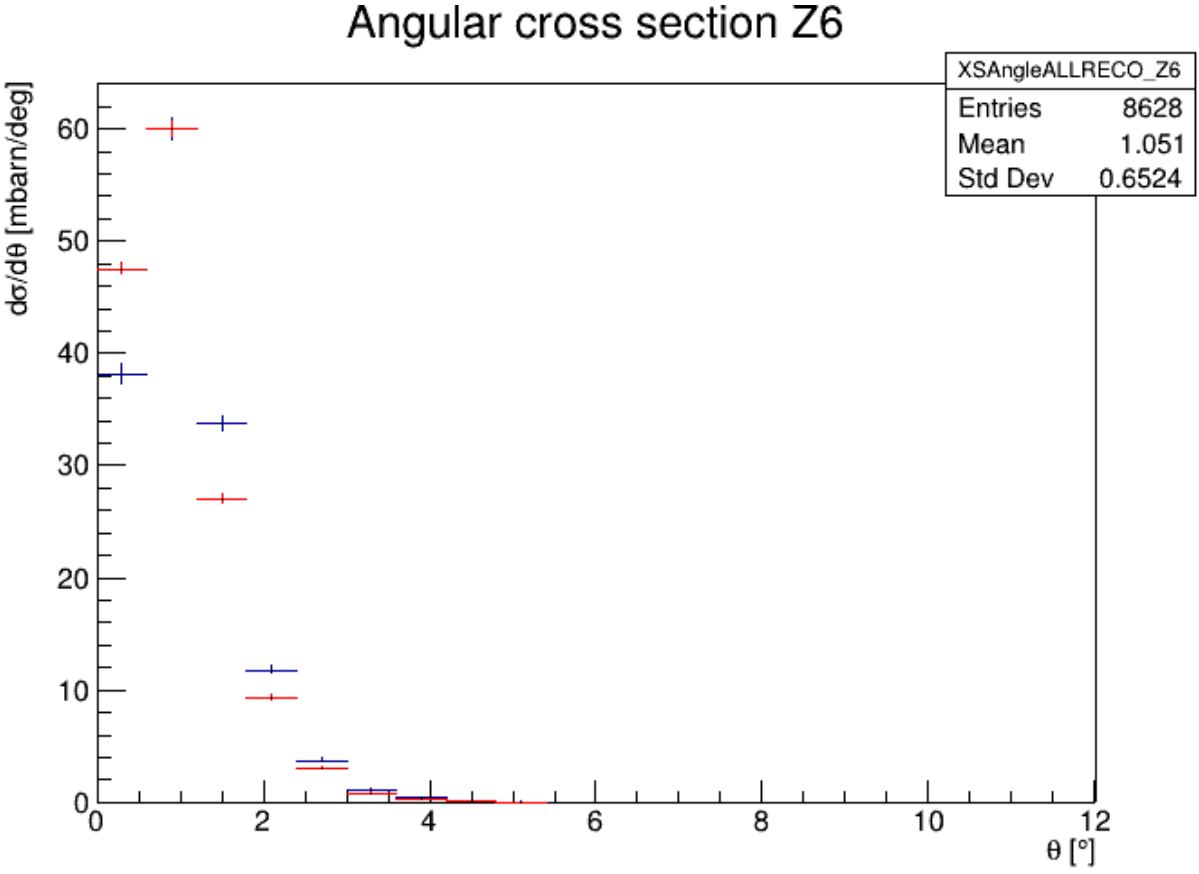
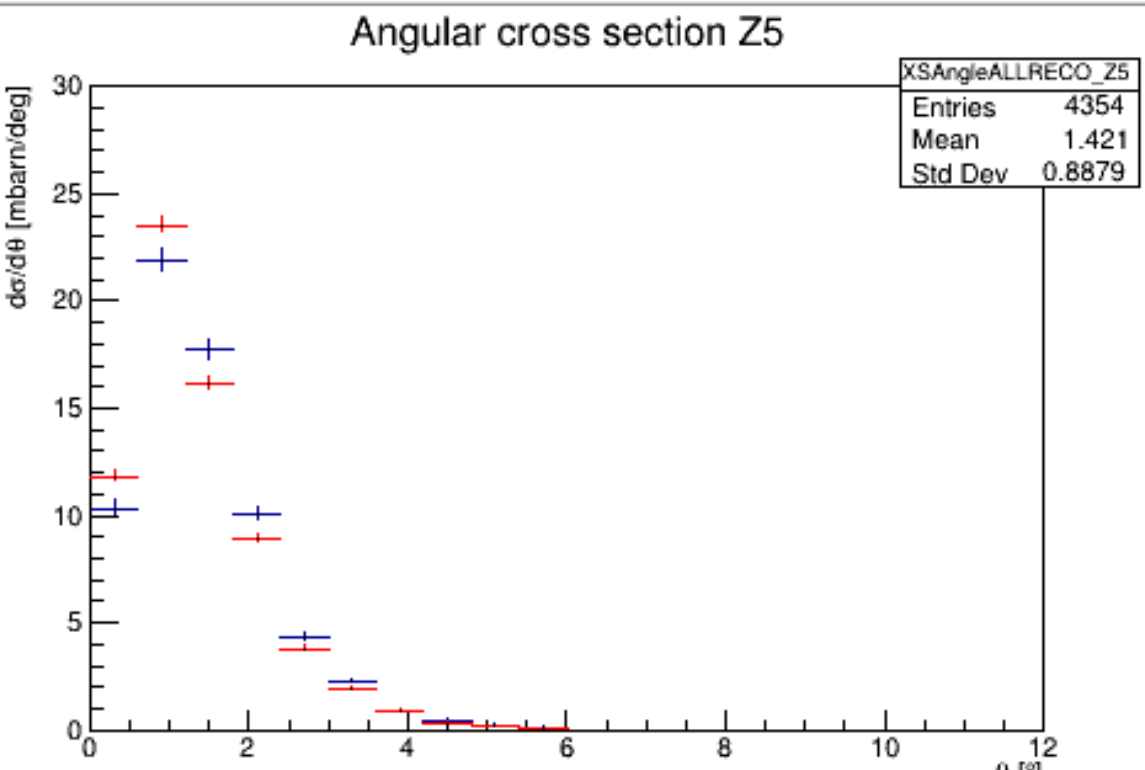
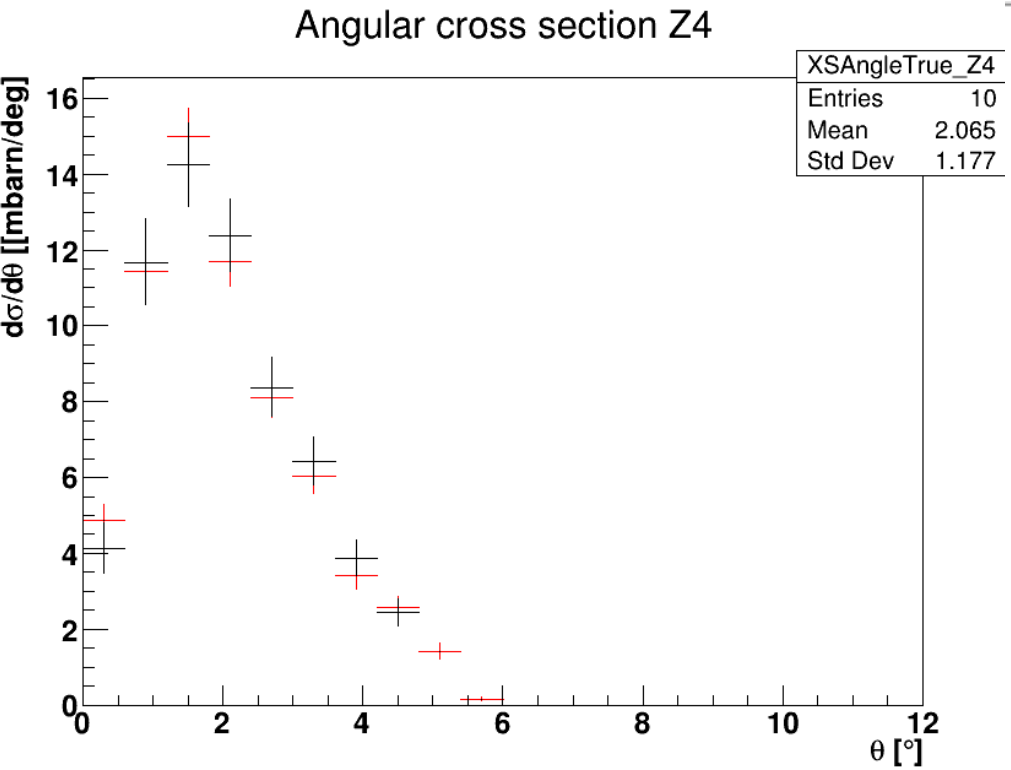
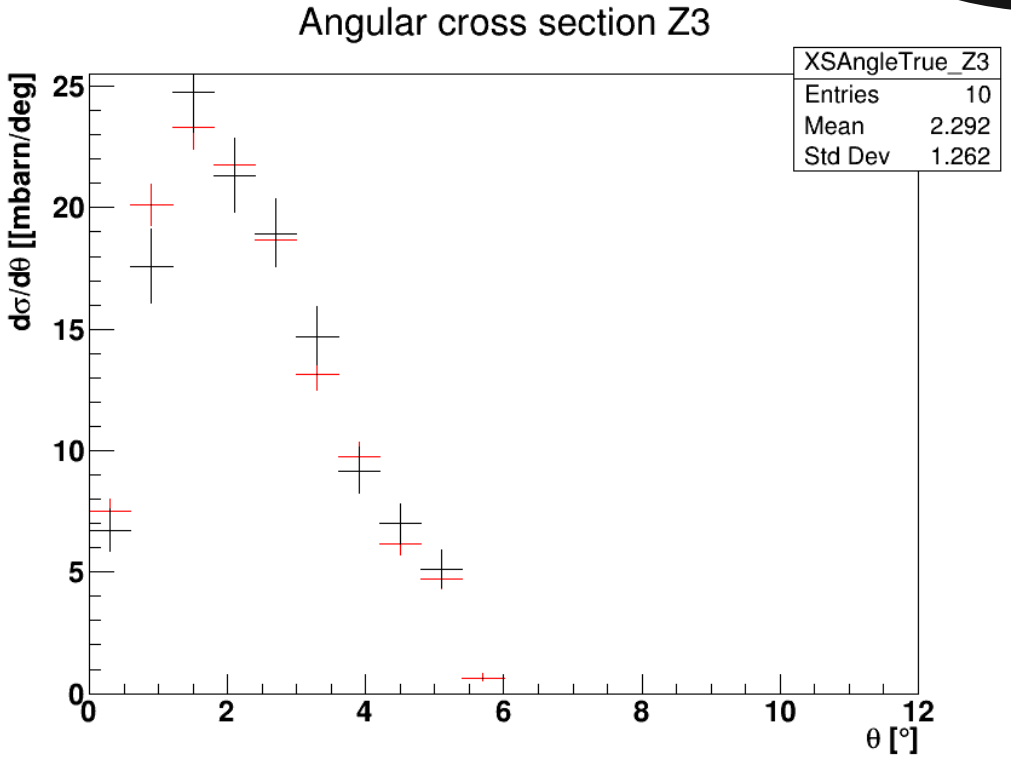
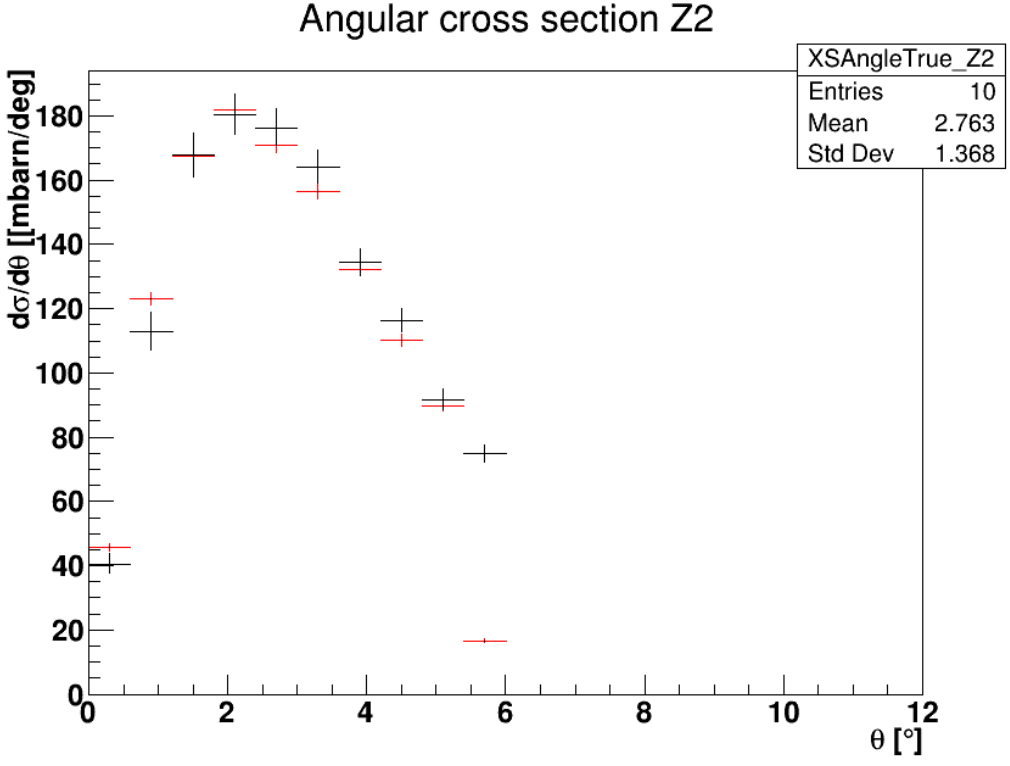
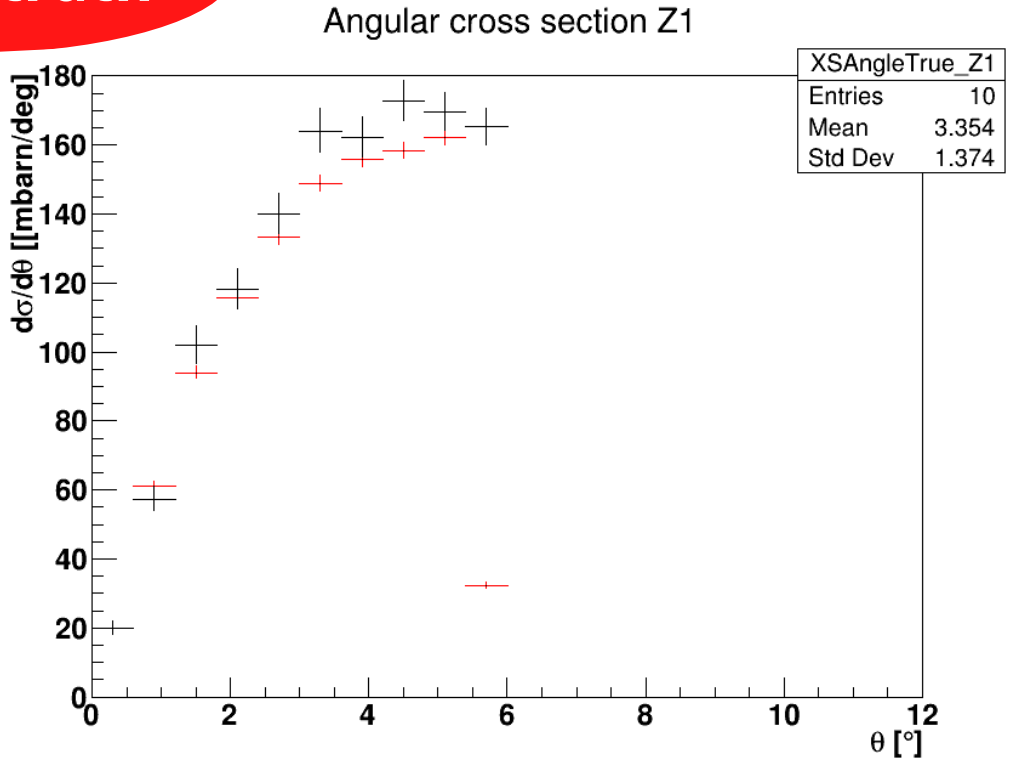


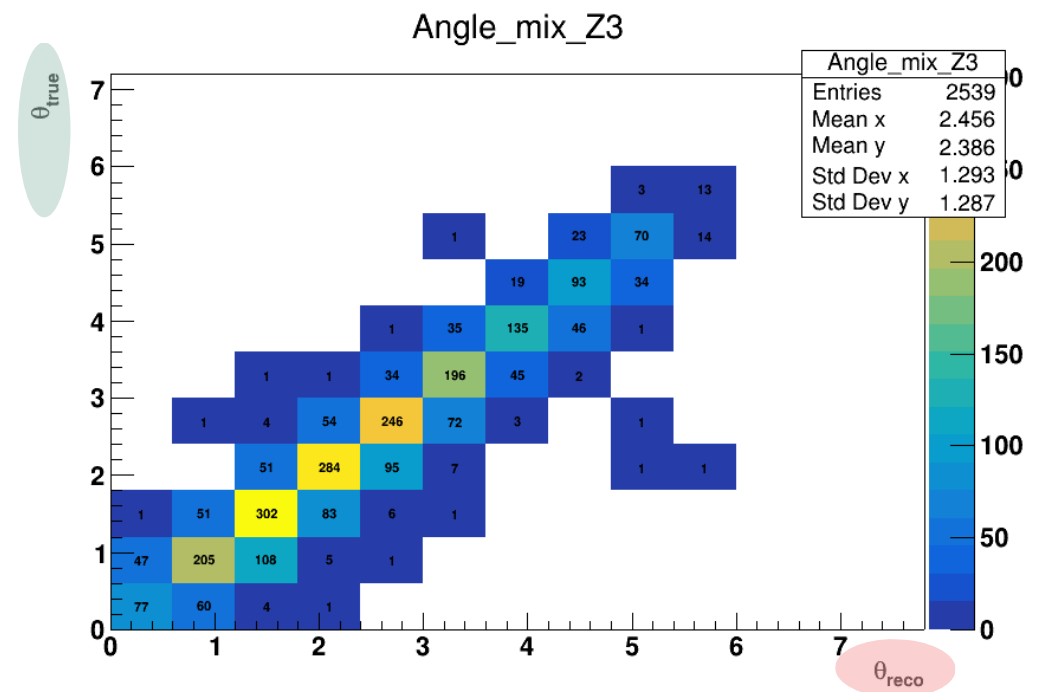
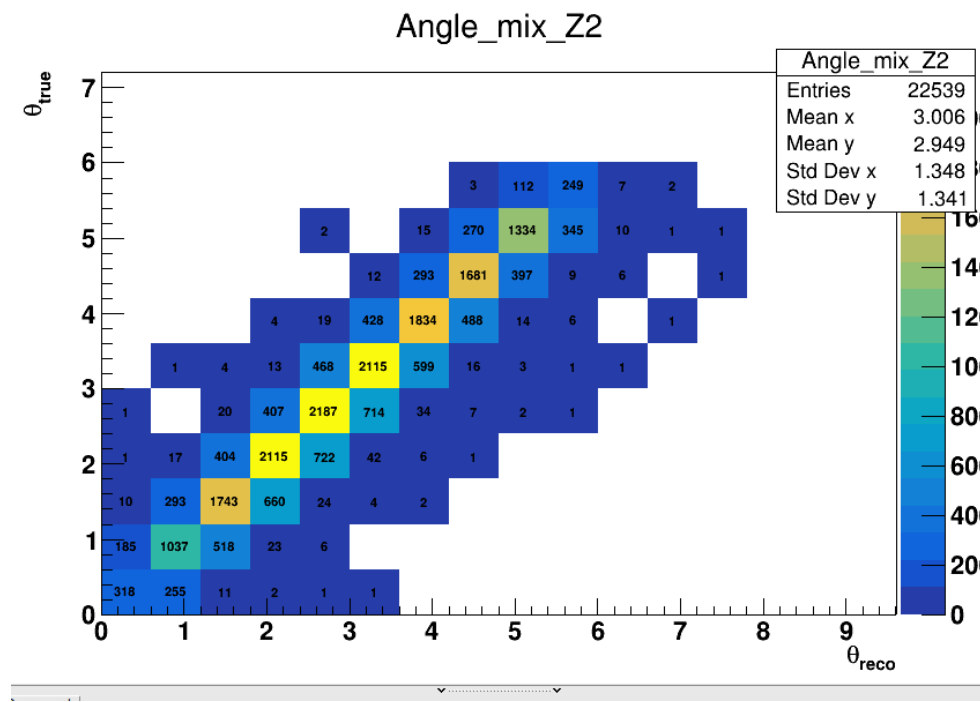
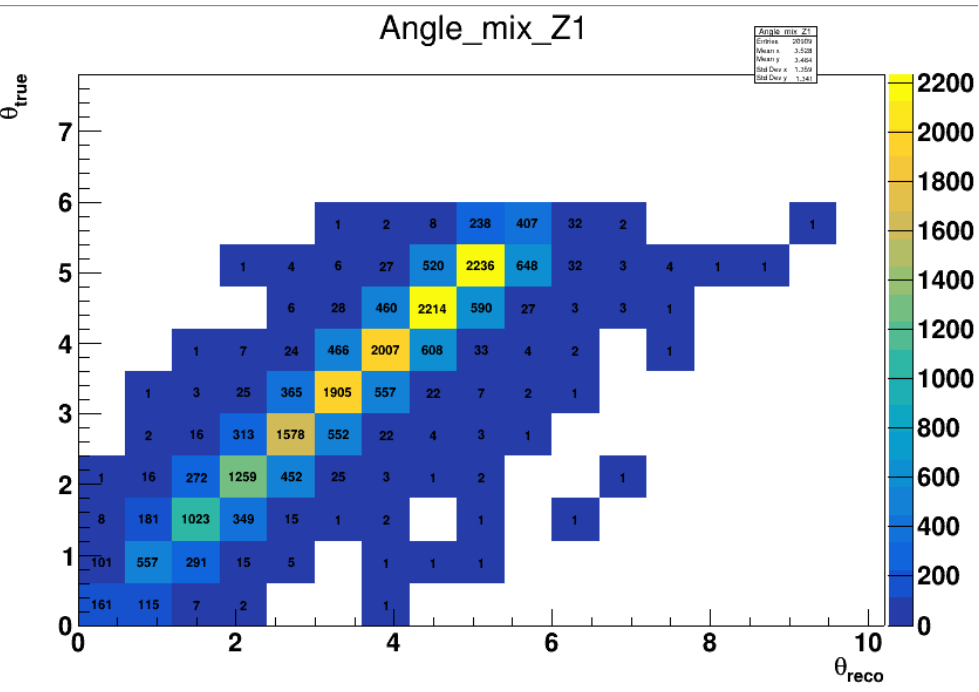
Why background subtraction?



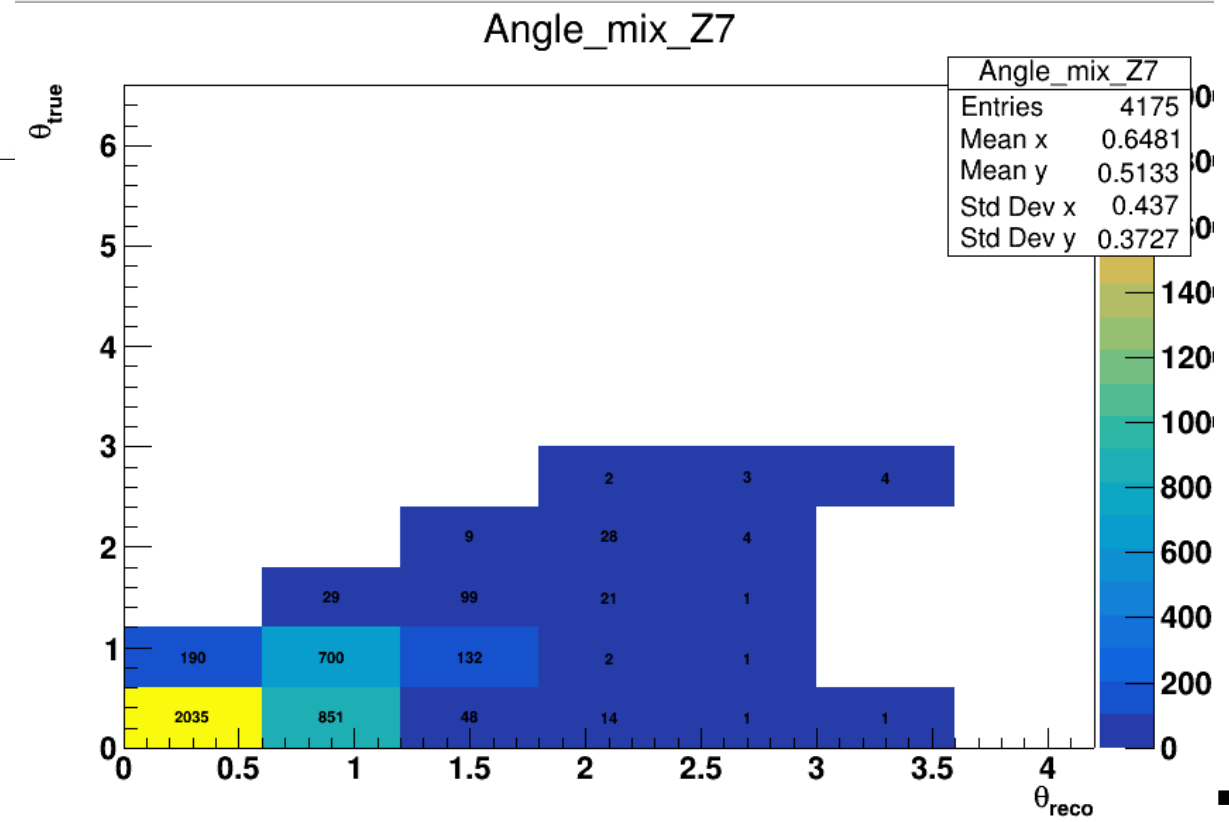
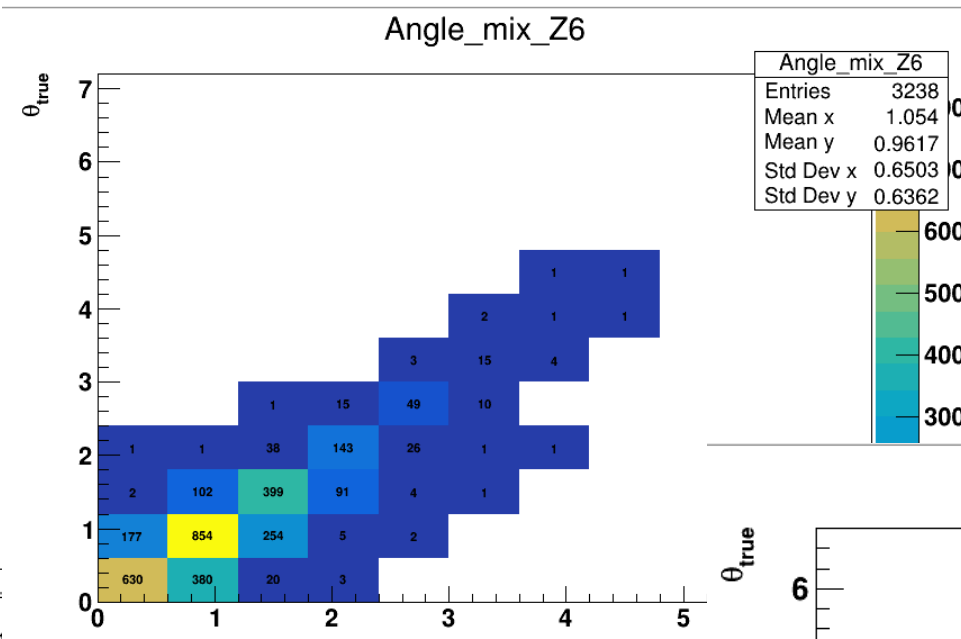
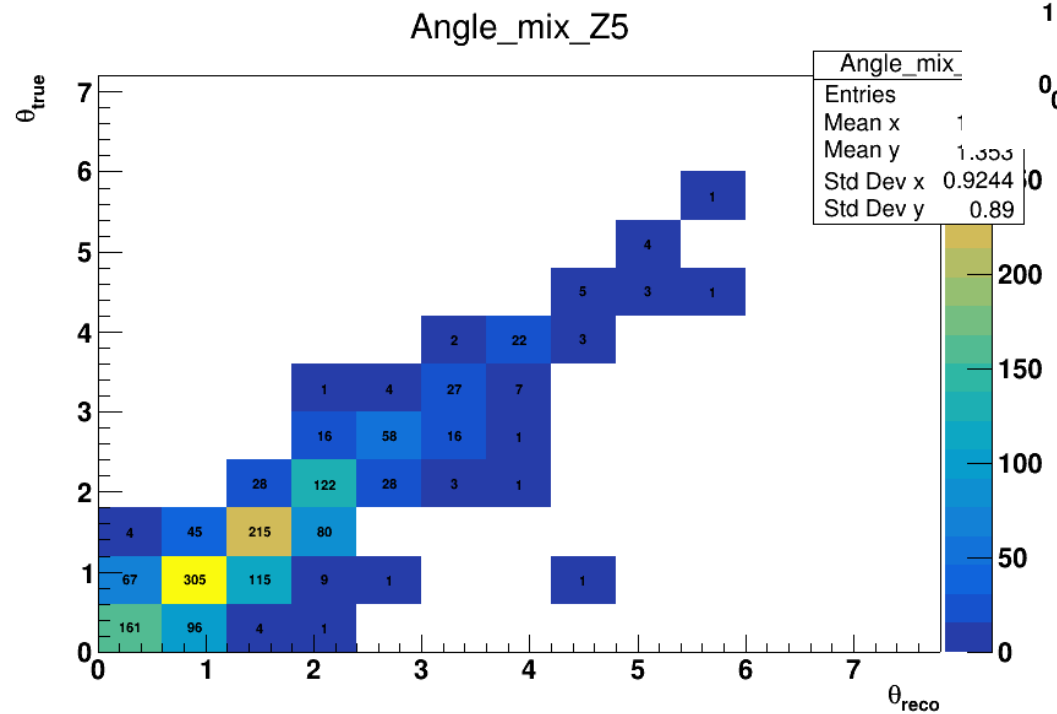
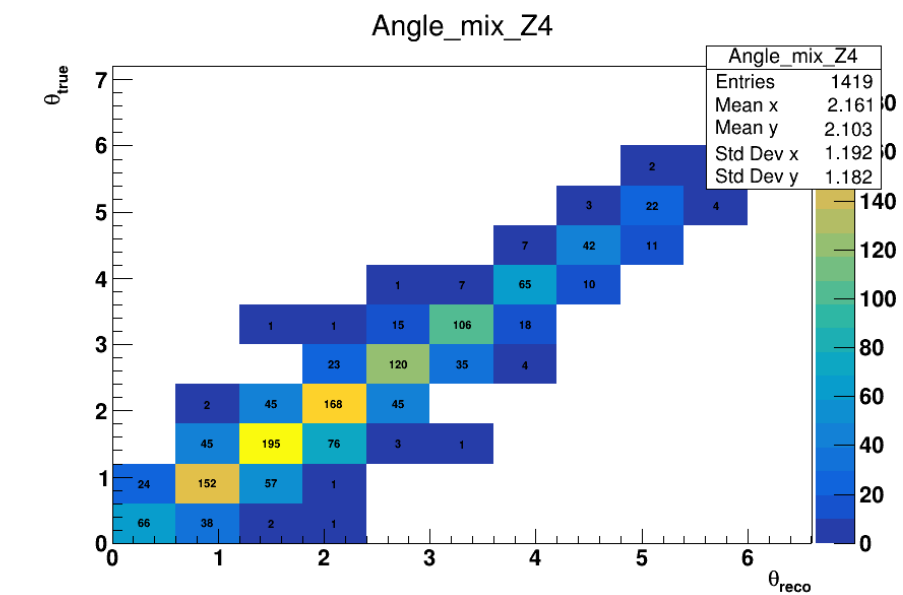
MC truth

MC reco

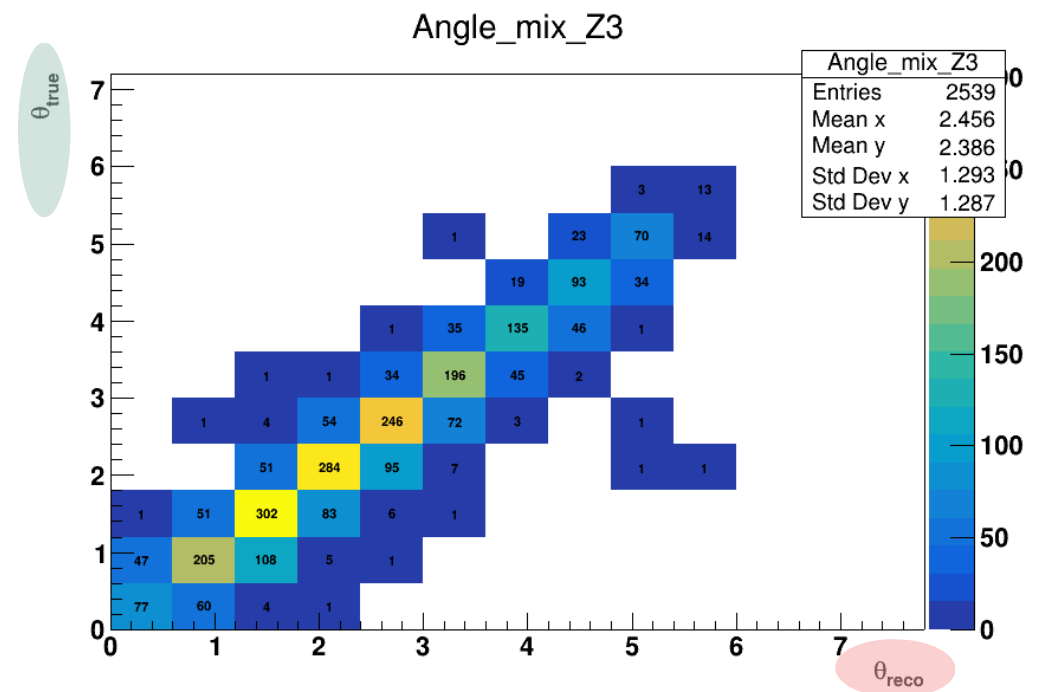
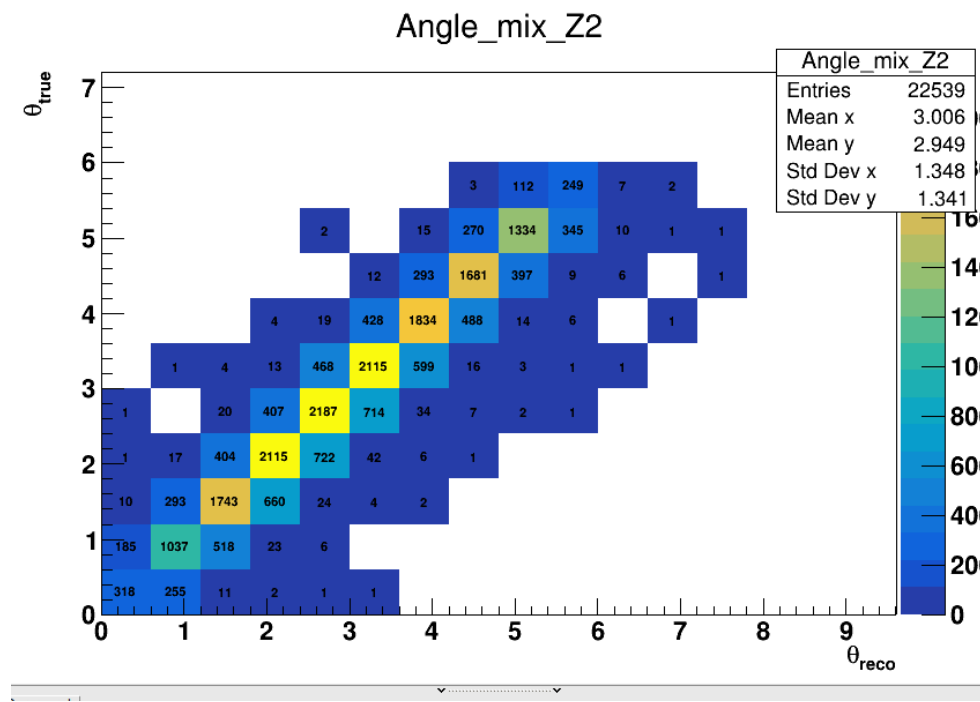
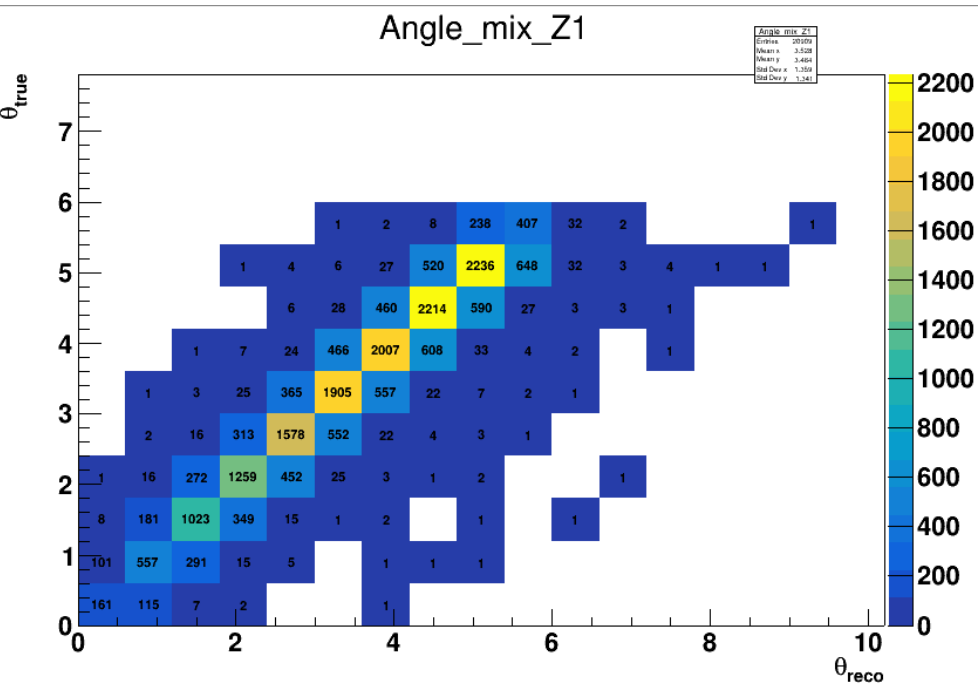




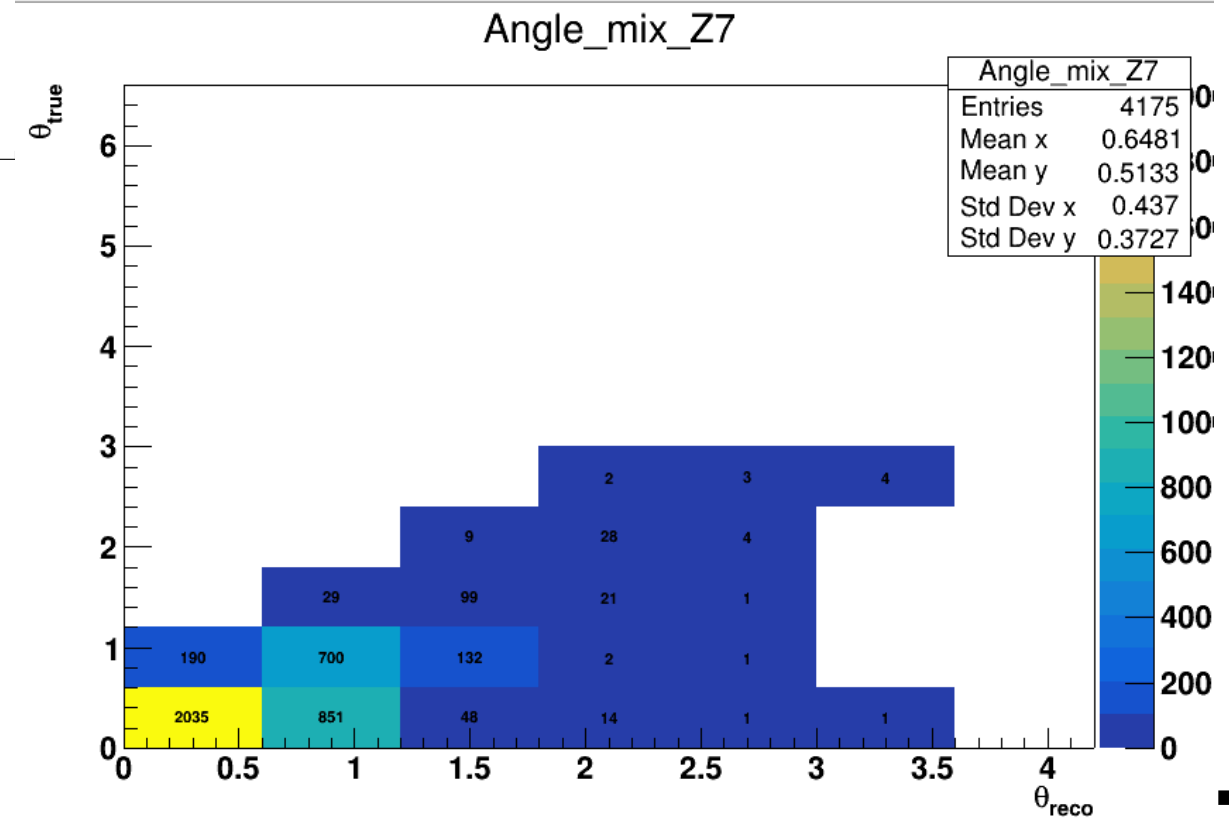
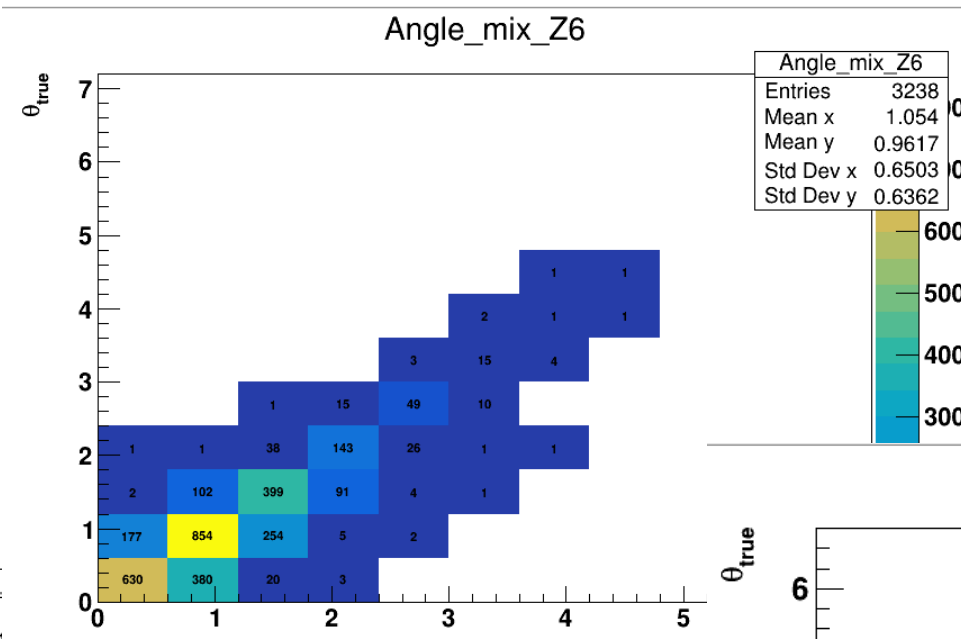
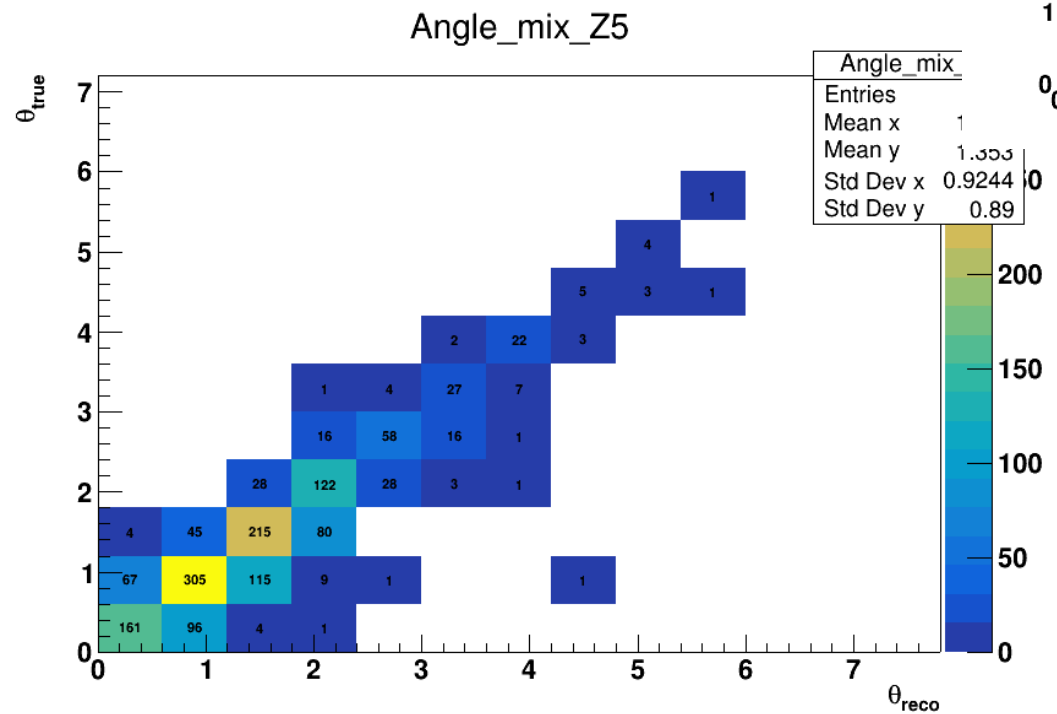
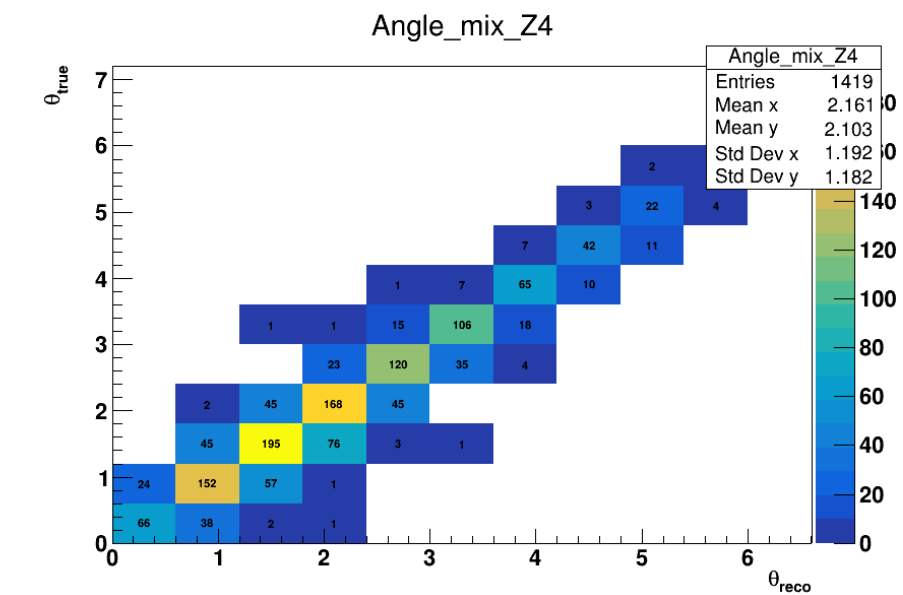
if present
MC after
SHOE
(TWpoint)
take its
reco angle



then
MC truth



if present
MC after
SHOE
(TWpoint)
take its
reco angle



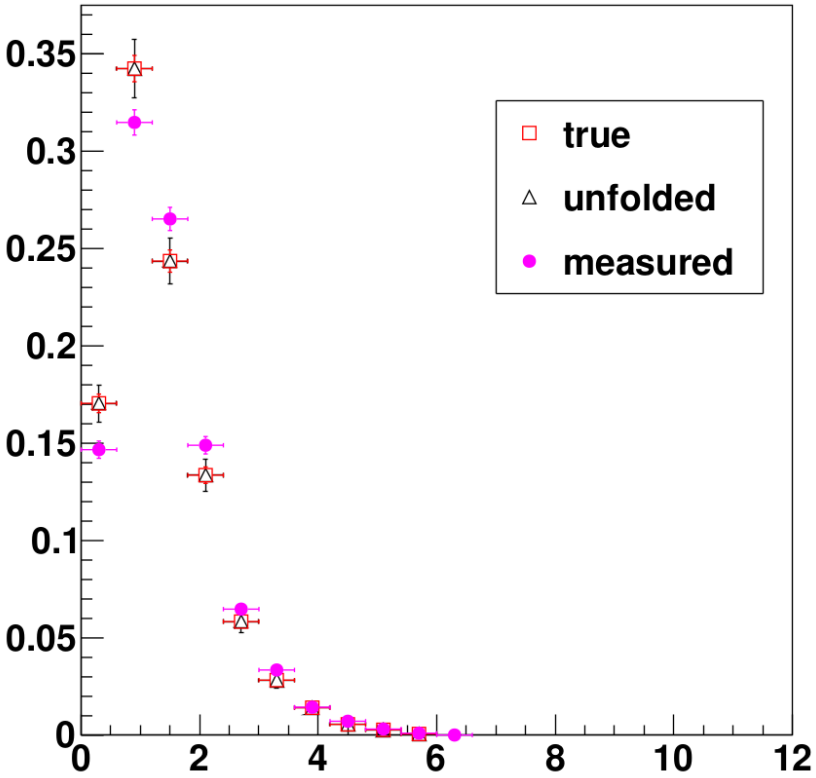
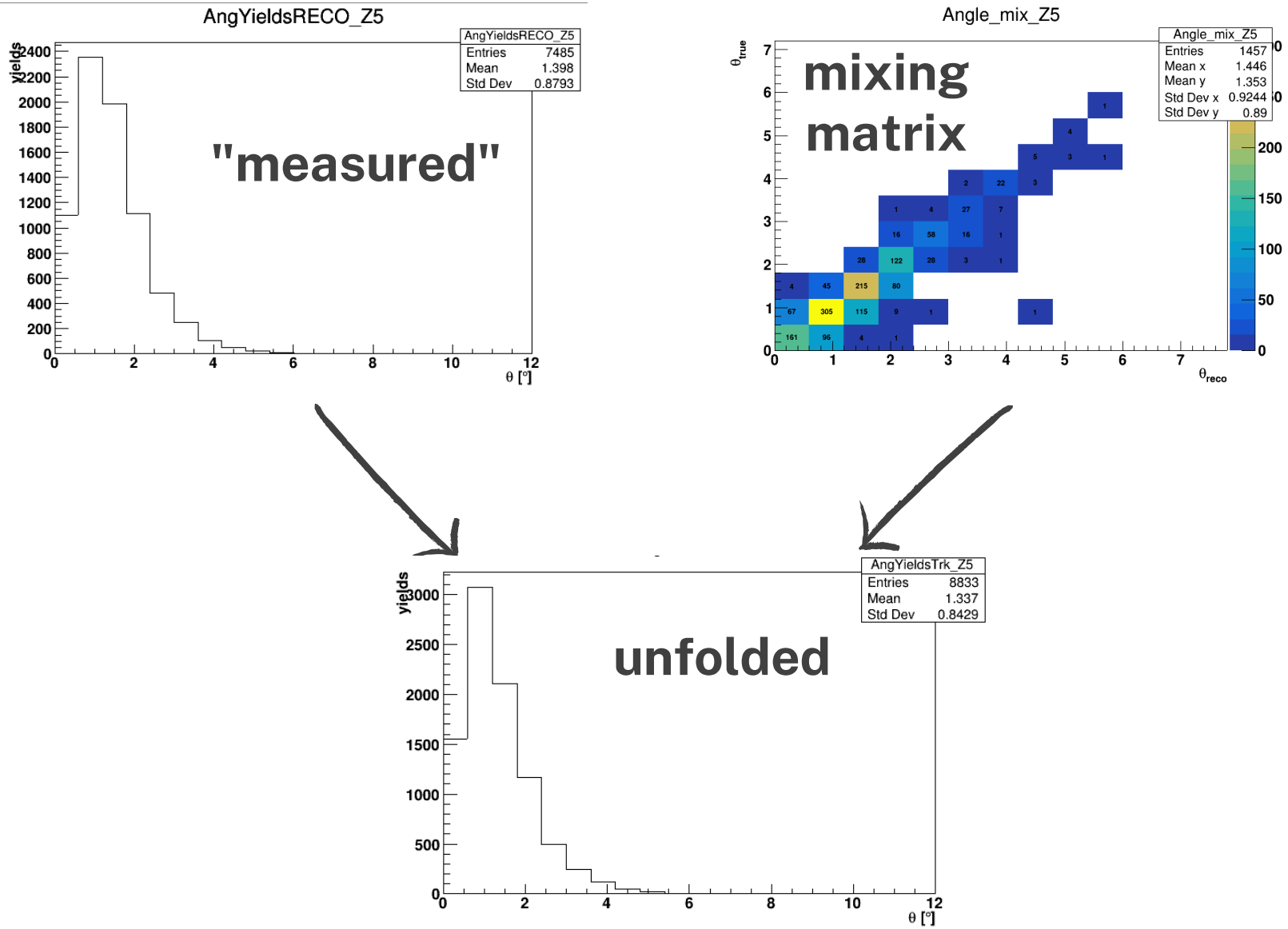
then
MC truth
unfolding is
needed!

TUnfold, an algorithm for correcting migration effects in high energy physics

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Abstract

TUnfold is a tool for correcting migration and background effects in high energy physics for multi-dimensional distributions. It is based on a least square fit with Tikhonov regularisation and an optional area constraint. For determining the strength of the regularisation parameter, the L-curve method and scans of global correlation coefficients are implemented. The algorithm supports background subtraction and the propagation of statistical and systematic uncertainties, in particular those originating from limited knowledge of the response matrix. The program is interfaced to the ROOT analysis framework.

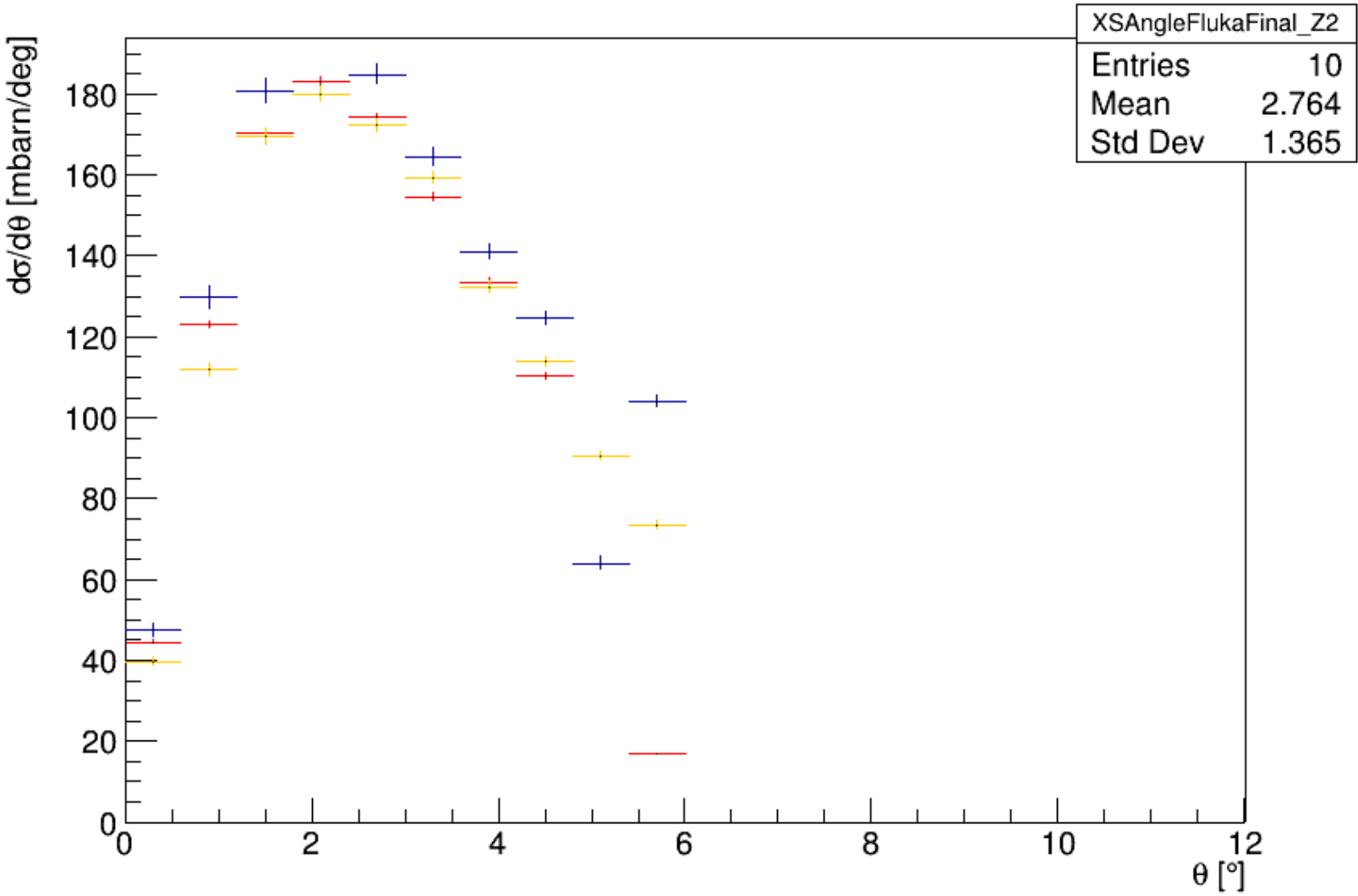


MC reco
before
unfolding

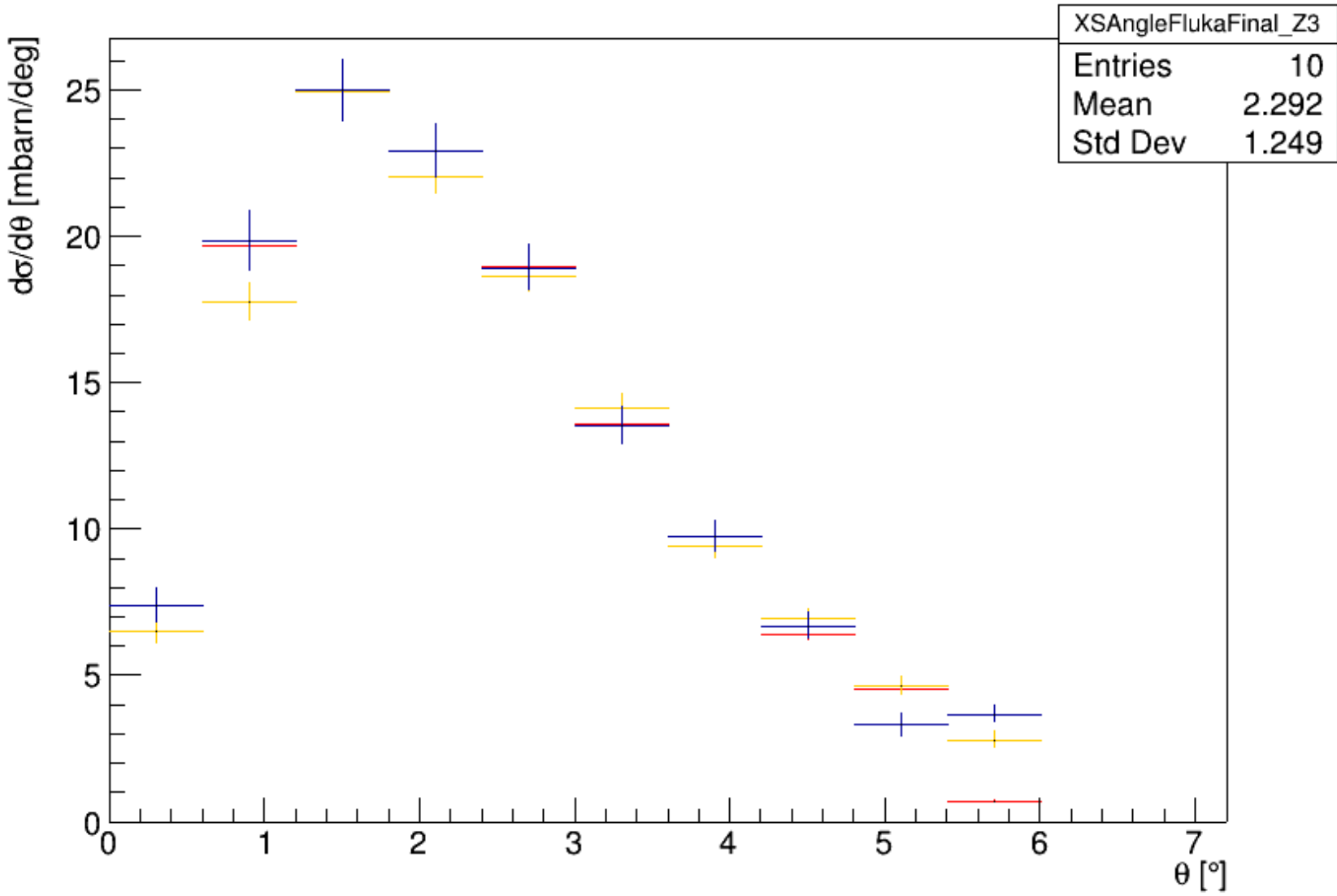
MC fluka

MC reco
after
unfolding

Angular cross section Z2



Angular cross section Z3

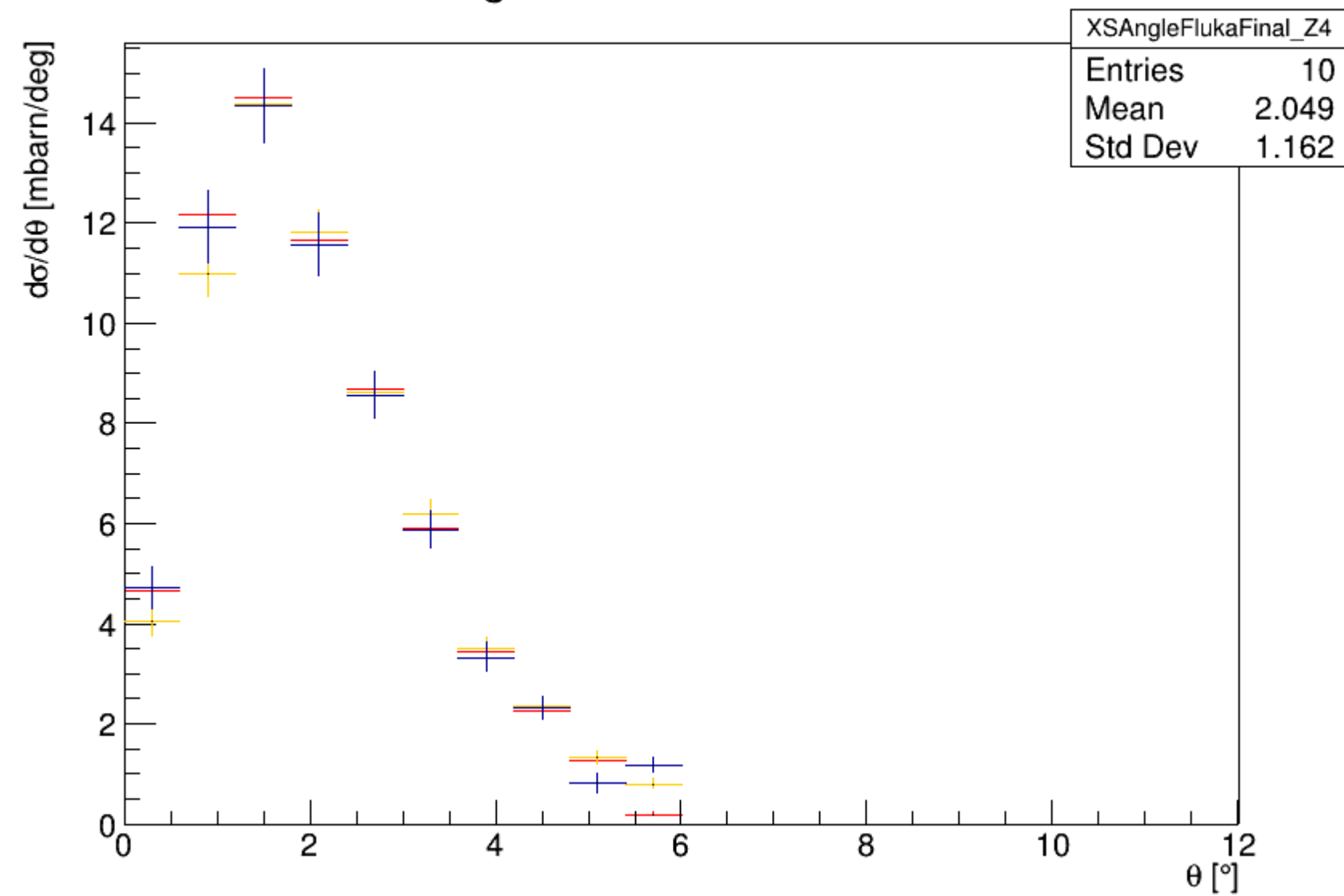


MC reco
before
unfolding

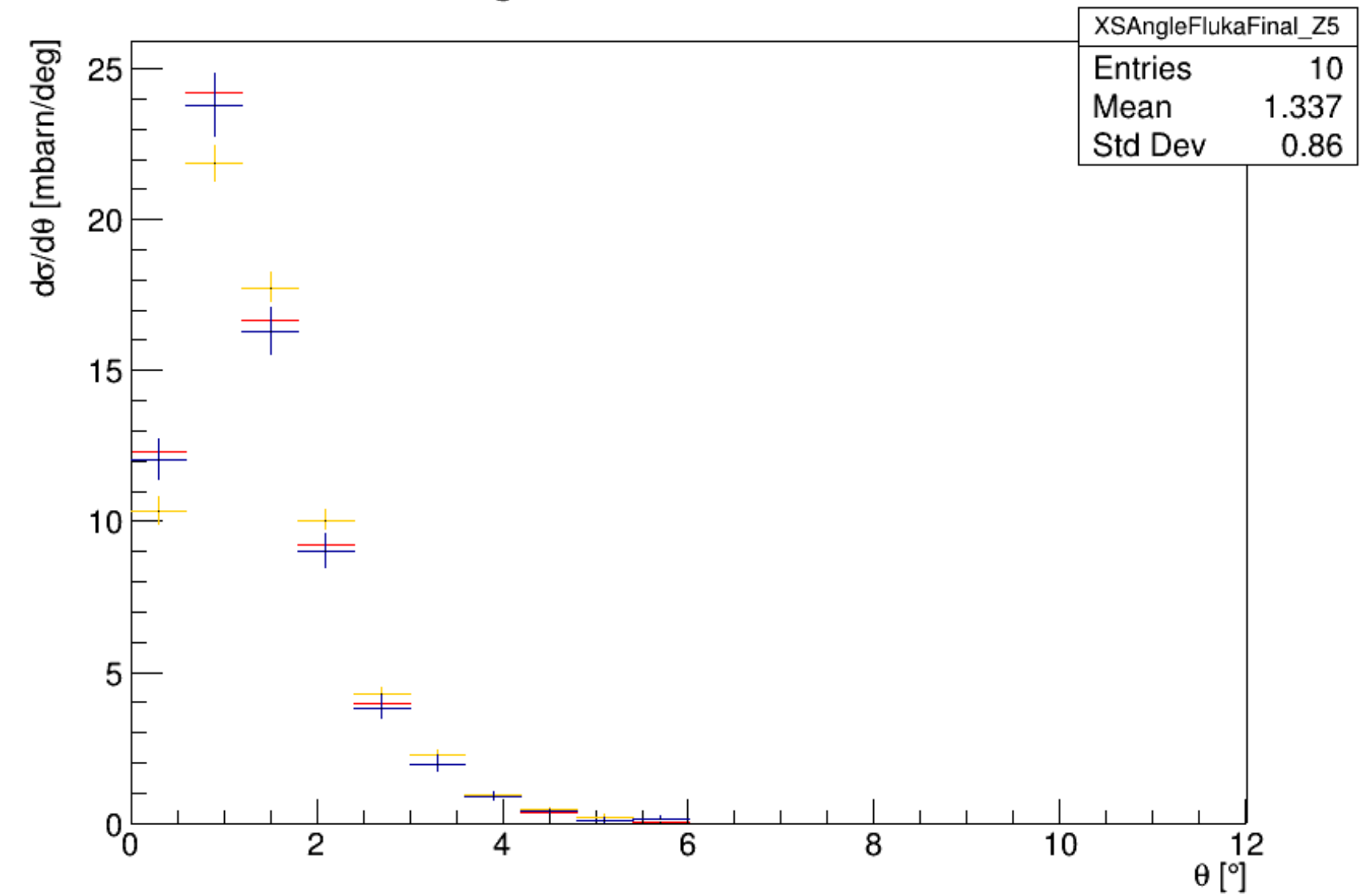
MC fluka

MC reco
after
unfolding

Angular cross section Z4



Angular cross section Z5

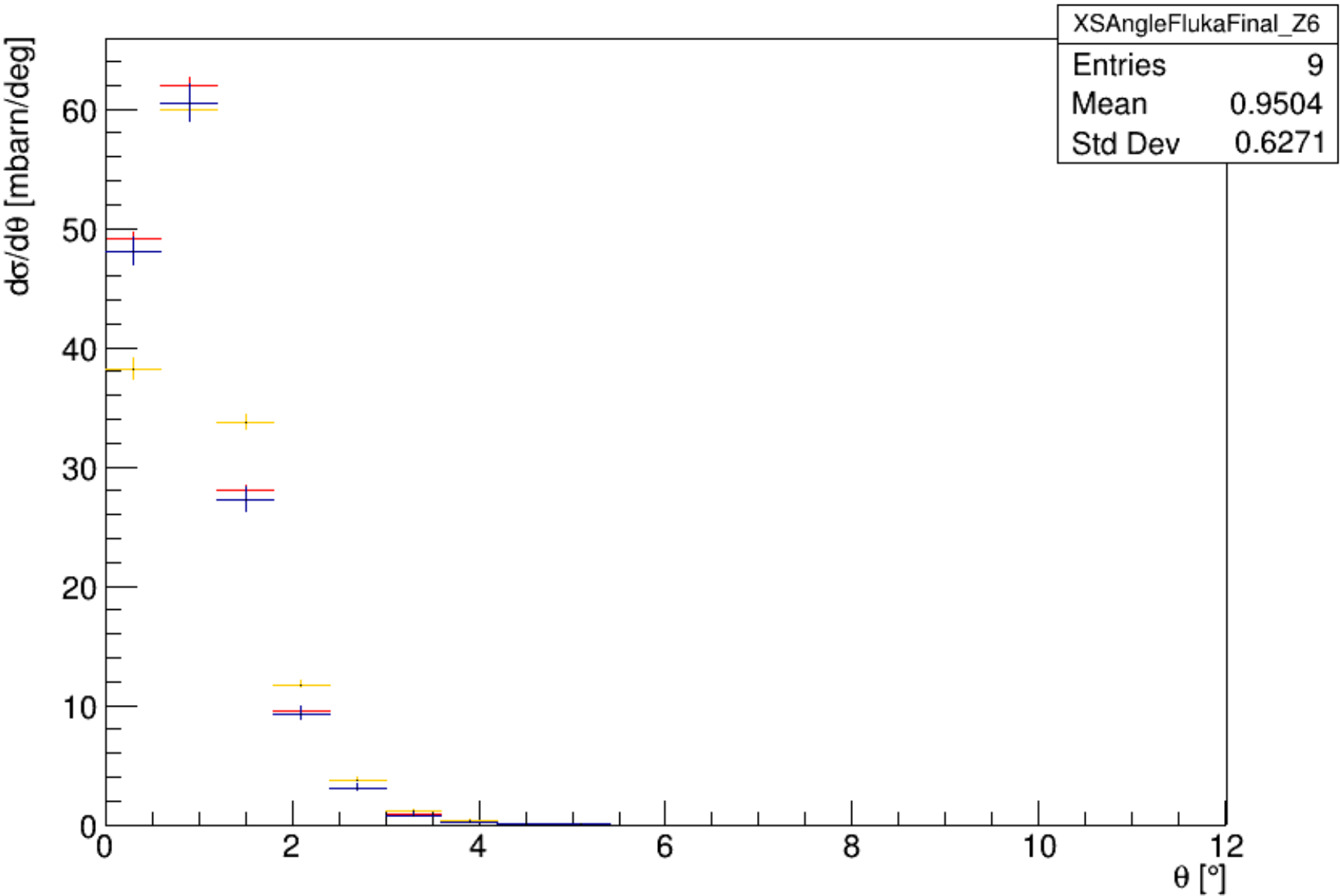


MC reco
before
unfolding

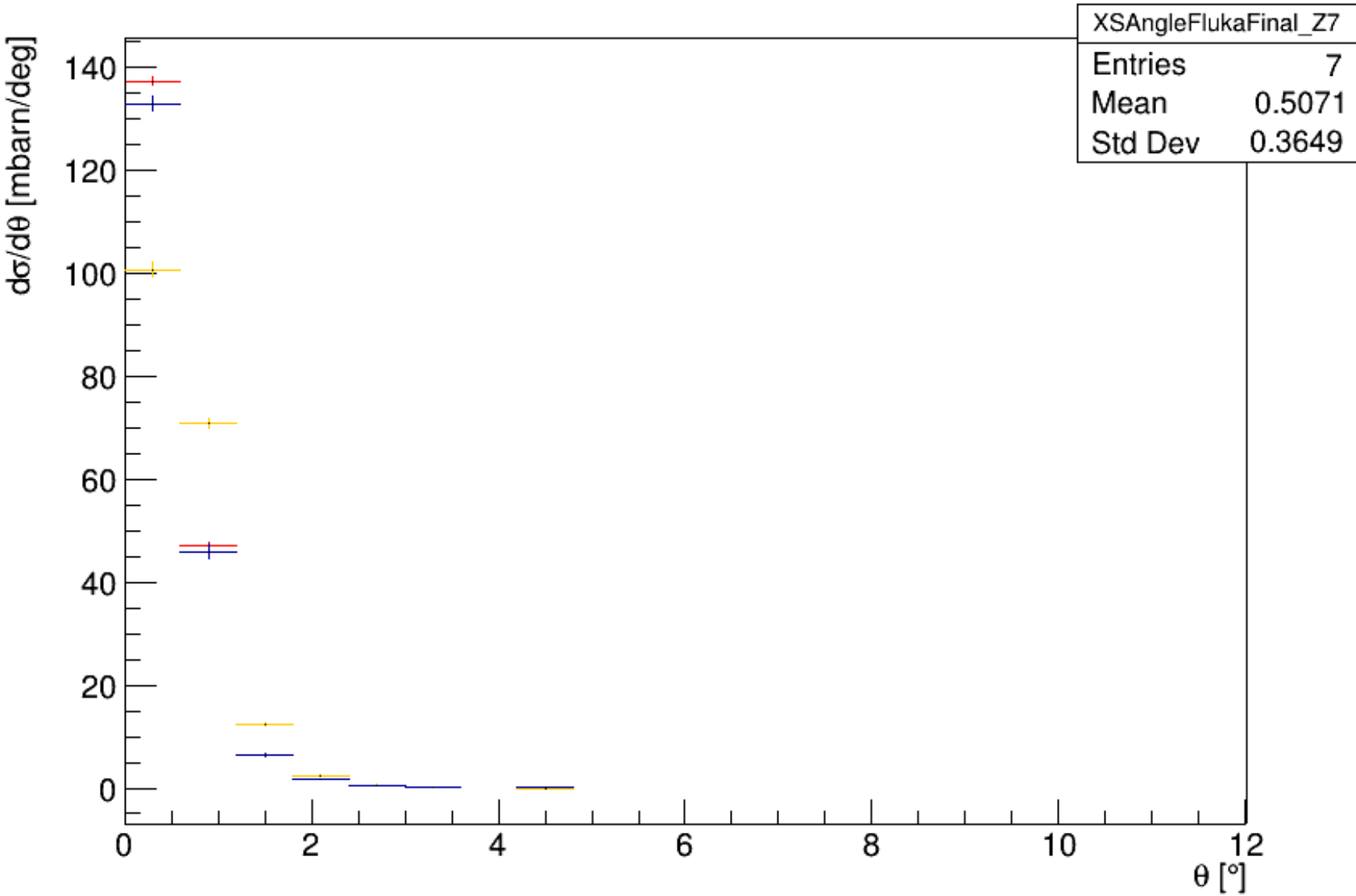
MC fluka

MC reco
after
unfolding

Angular cross section Z6



Angular cross section Z7



The background subtraction strategy (+ unfolding) seems to behave well also with angle differential cross sections!

$$\Delta\sigma(Z) = \frac{1}{N_{\text{TG}} \cdot \varepsilon(Z)} \left(\frac{Y^{\text{sig}}(Z)}{N_{\text{prim}}^{\text{sig}}(Z)} - \frac{Y^{\text{bkg}}(Z)}{N_{\text{prim}}^{\text{bkg}}(Z)} \right)$$



OPEN ACCESS

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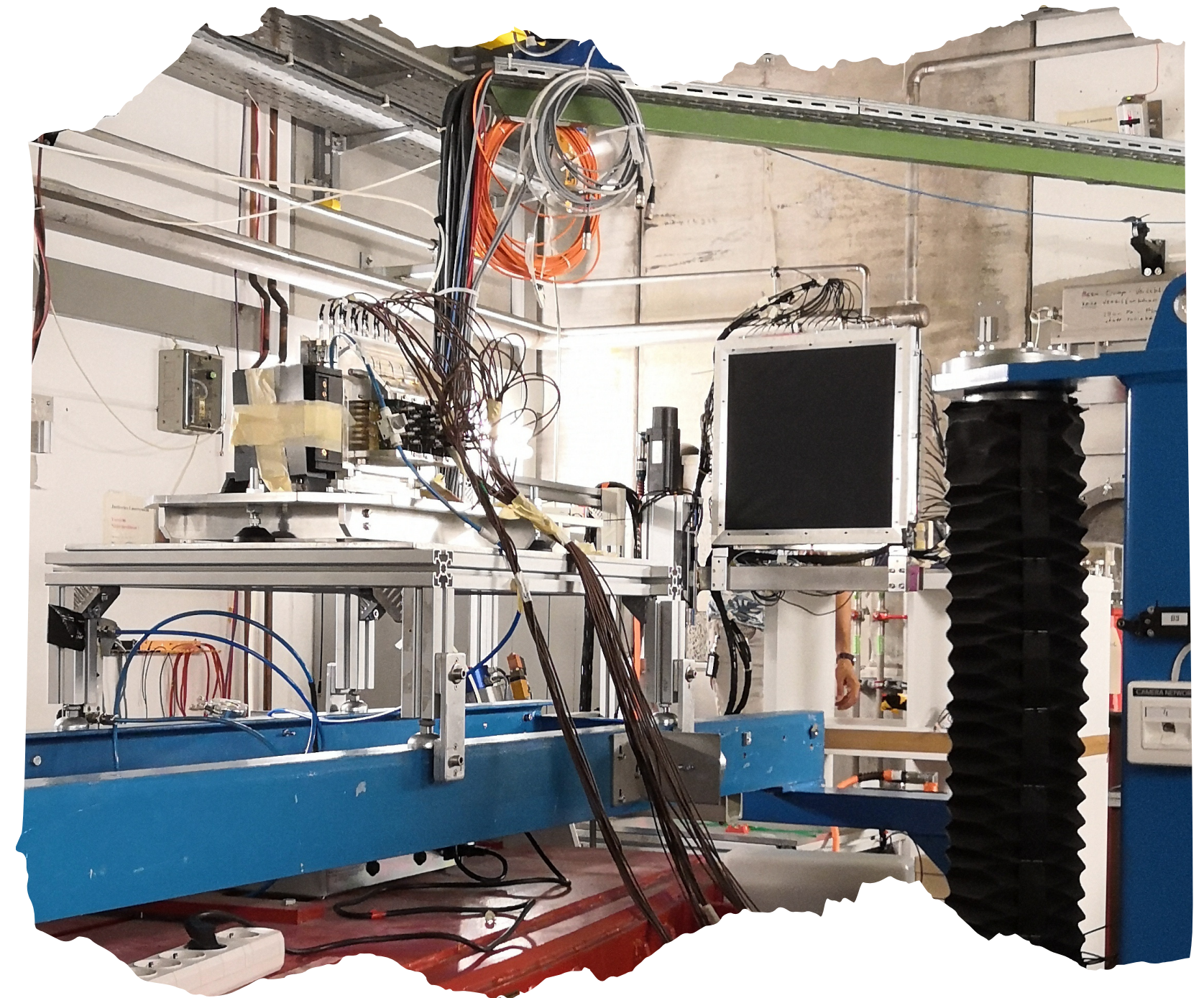
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Elemental fragmentation cross sections for a ^{16}O beam of 400 MeV/u kinetic energy interacting with a graphite target using the FOOT ΔE -TOF detectors

Let's look at the data!

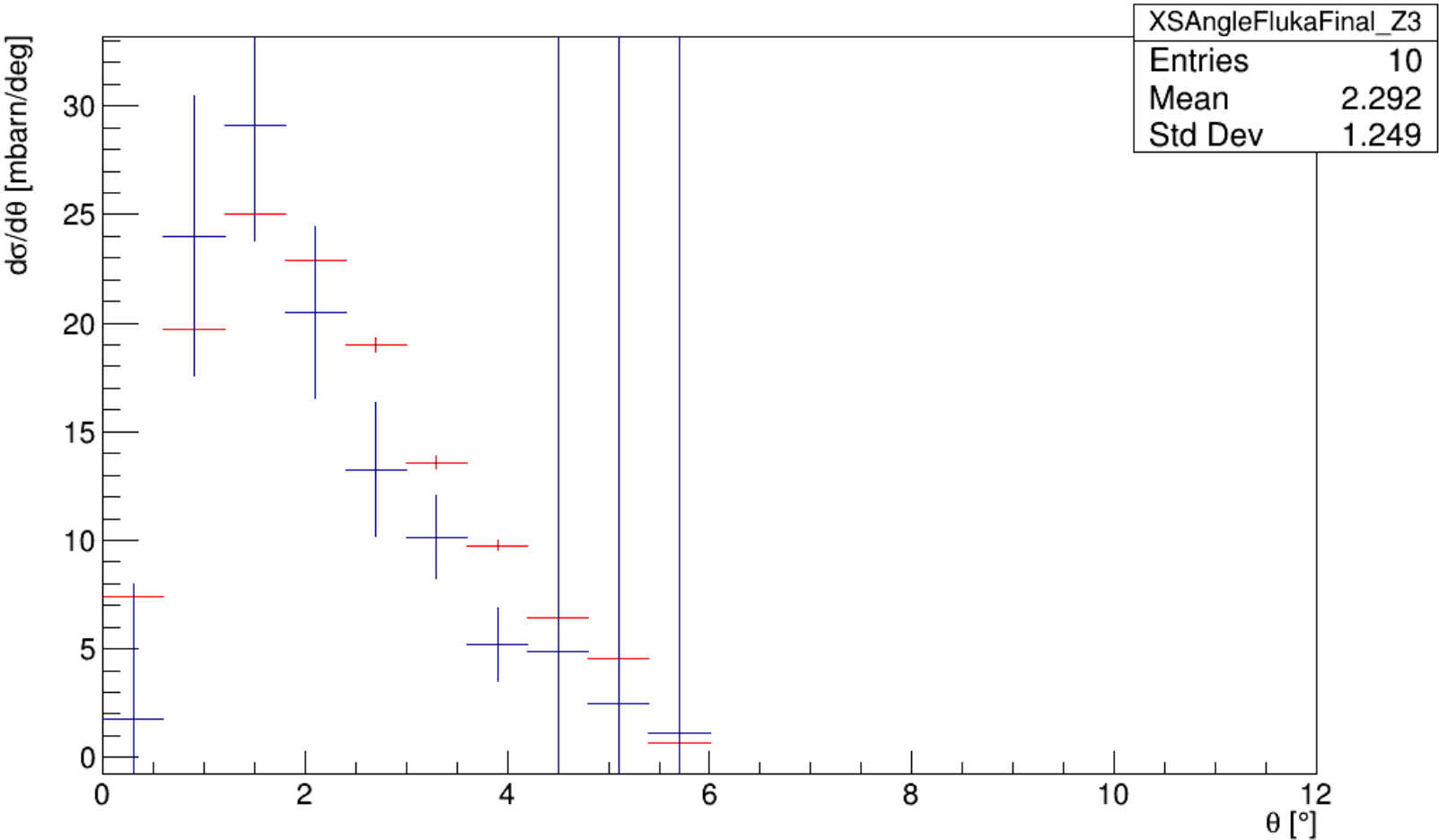
400 MeV/u ^{16}O beam on 5mm Carbon target

Run	Trigger type	Target	Events
4305	MB	C	162102
4306	MB	C	577096
4307	MB	C	513370
4308	Frag + MB	C	510169
4309	Frag + MB	C	531812
4310	Frag + MB	C	1012099
4313	MB	no	57133

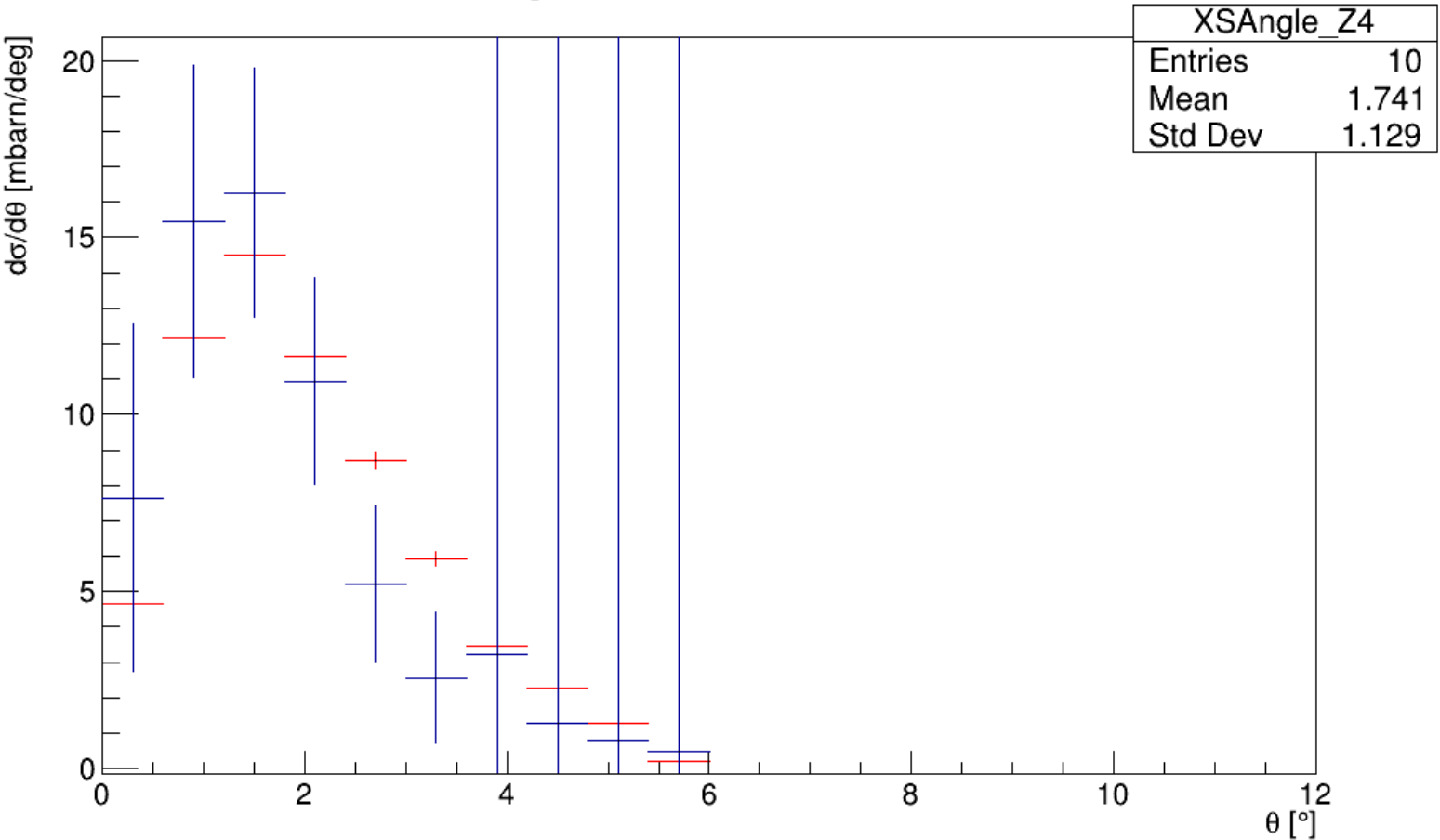


Let's look at the data (preliminary)!

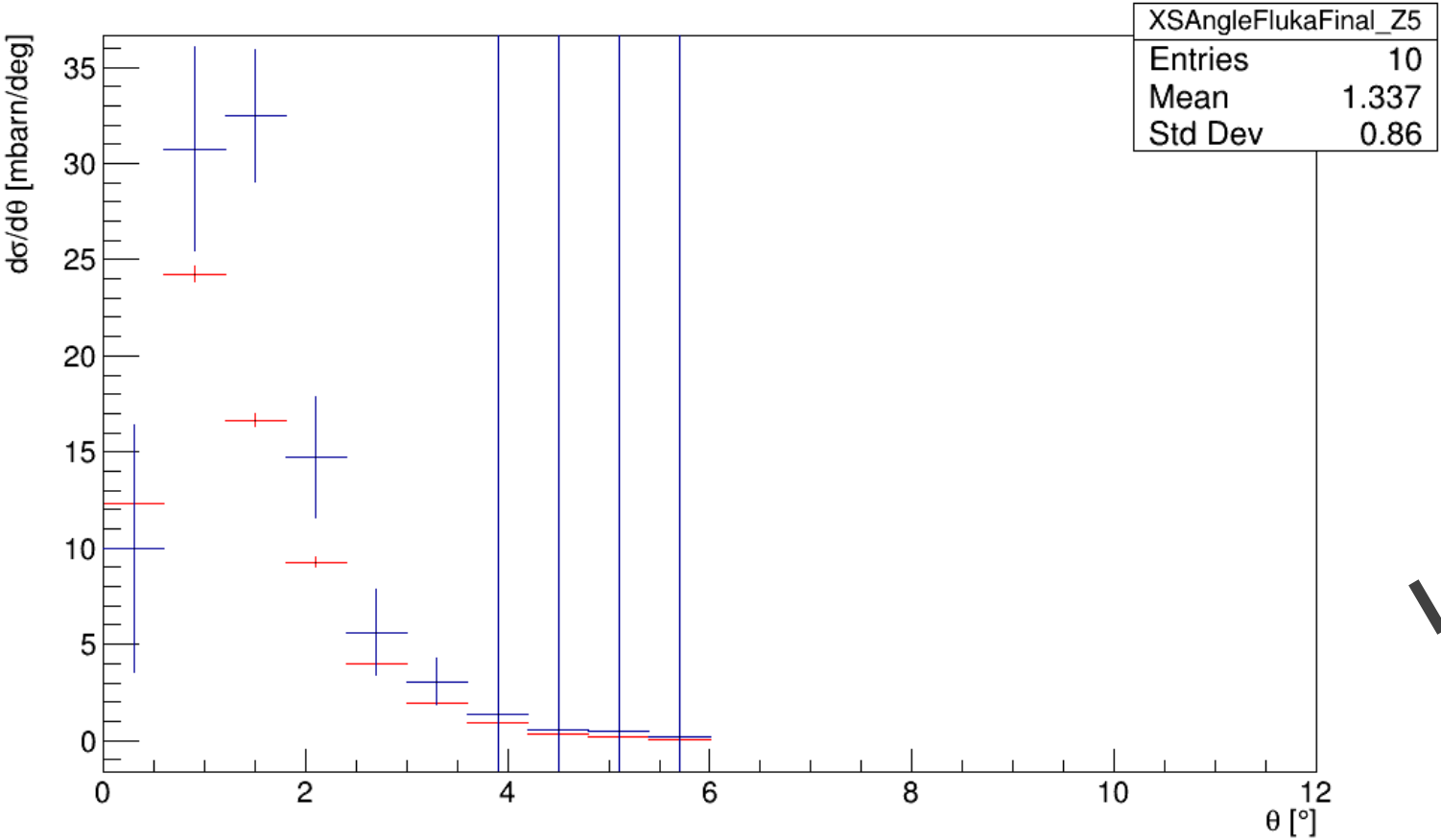
Angular cross section Z3



Angular cross section Z4

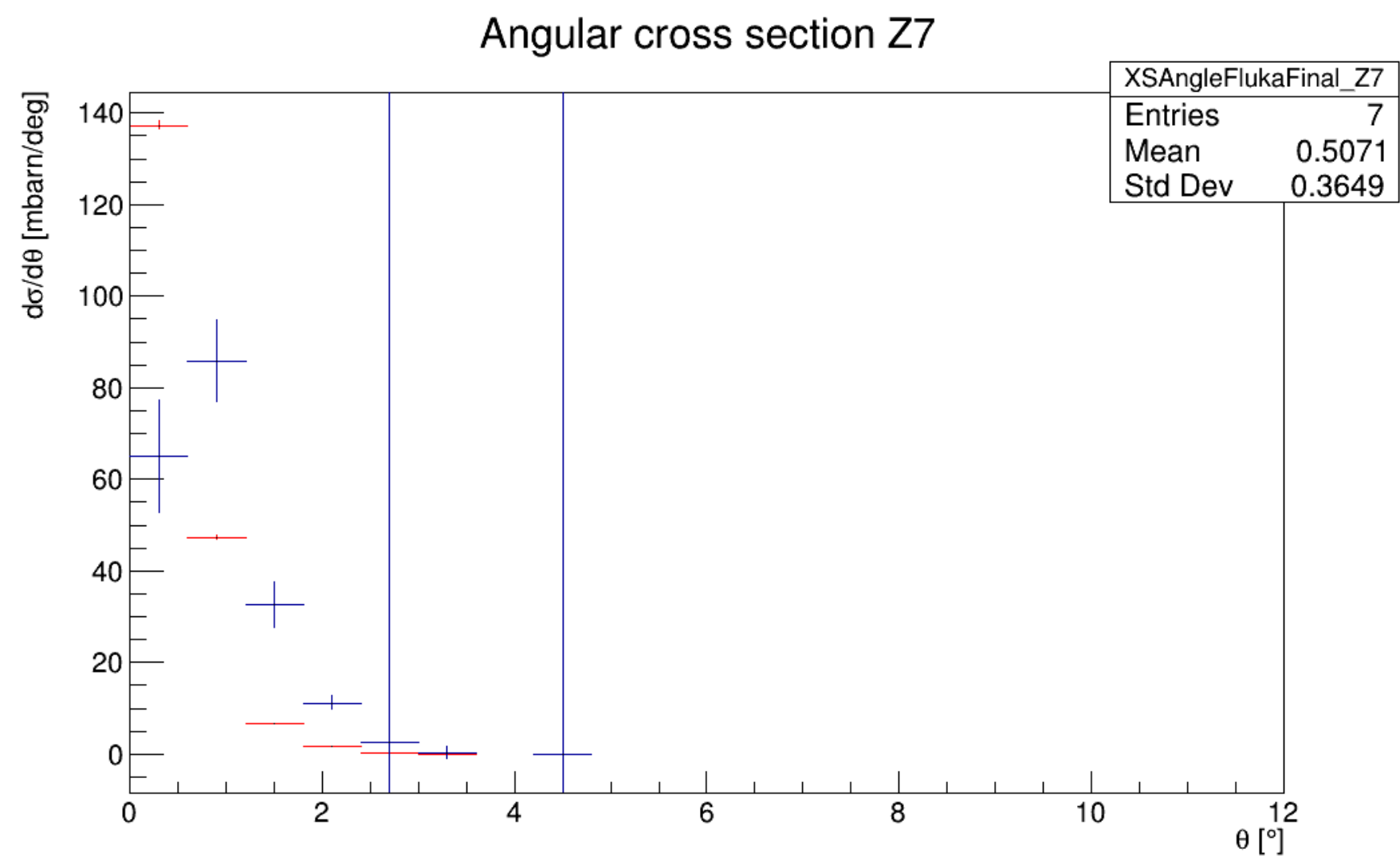
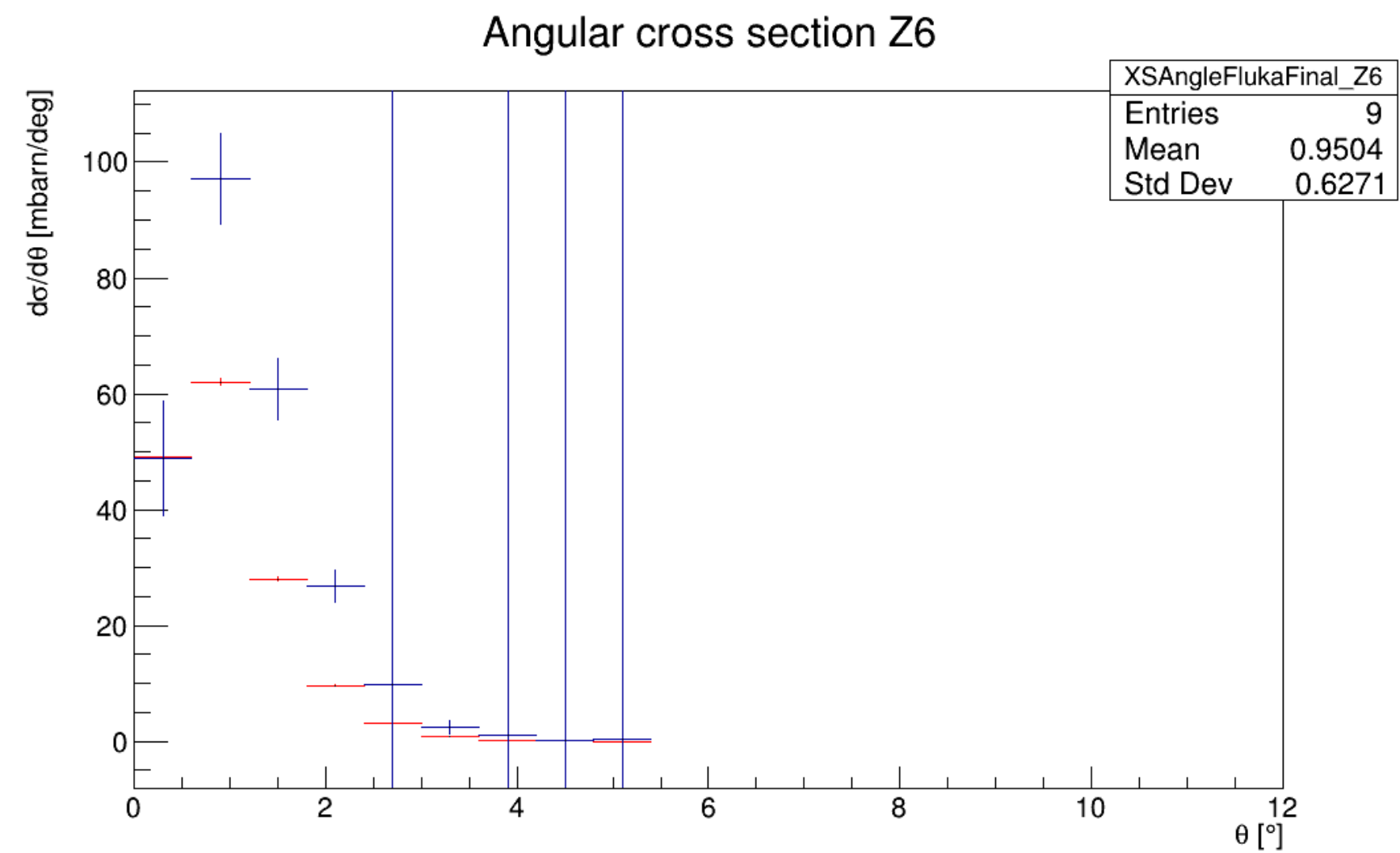


Angular cross section Z5



Look at values not at error bars

Let's look at the data (preliminary)!

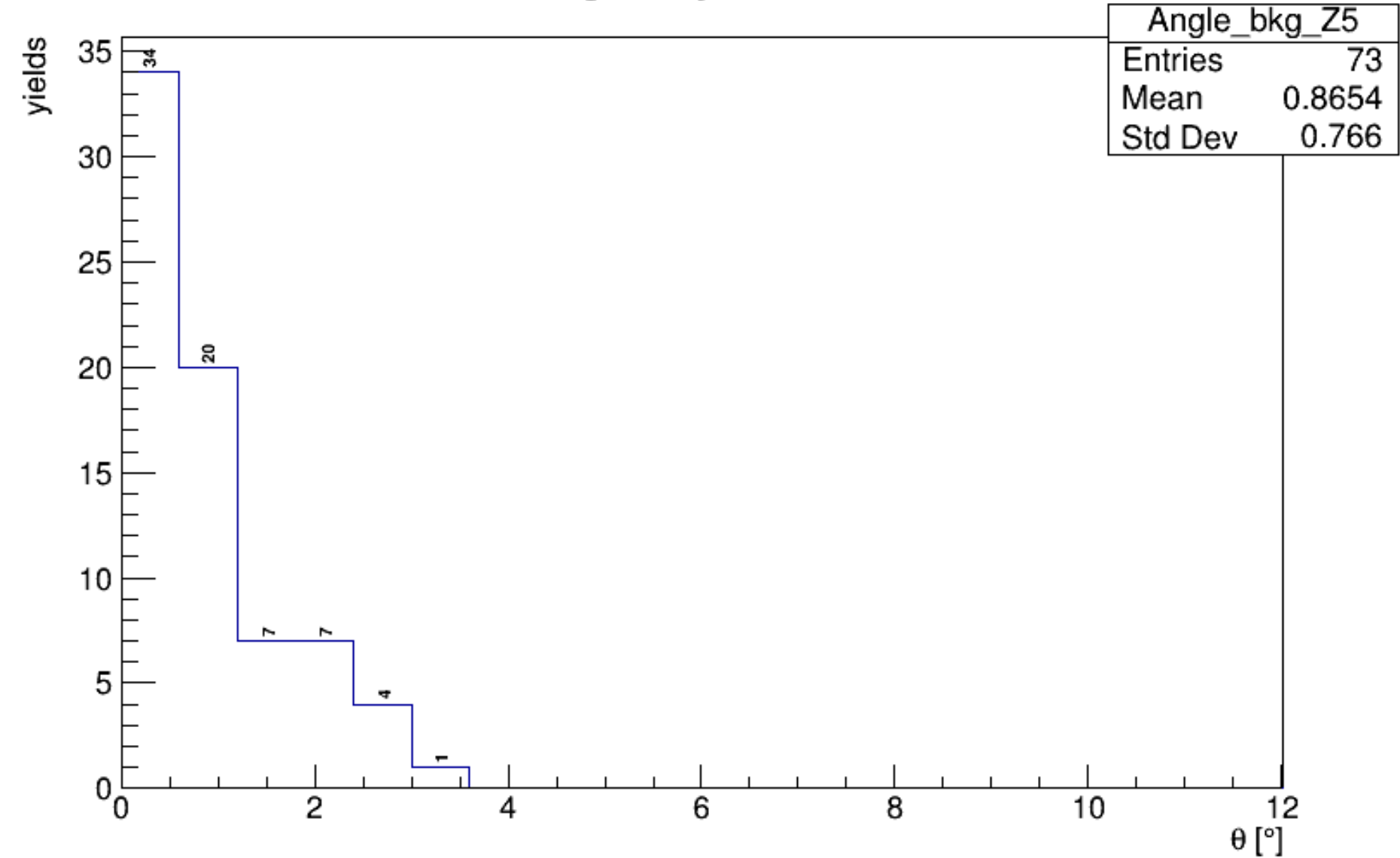


Look at values not at error bars

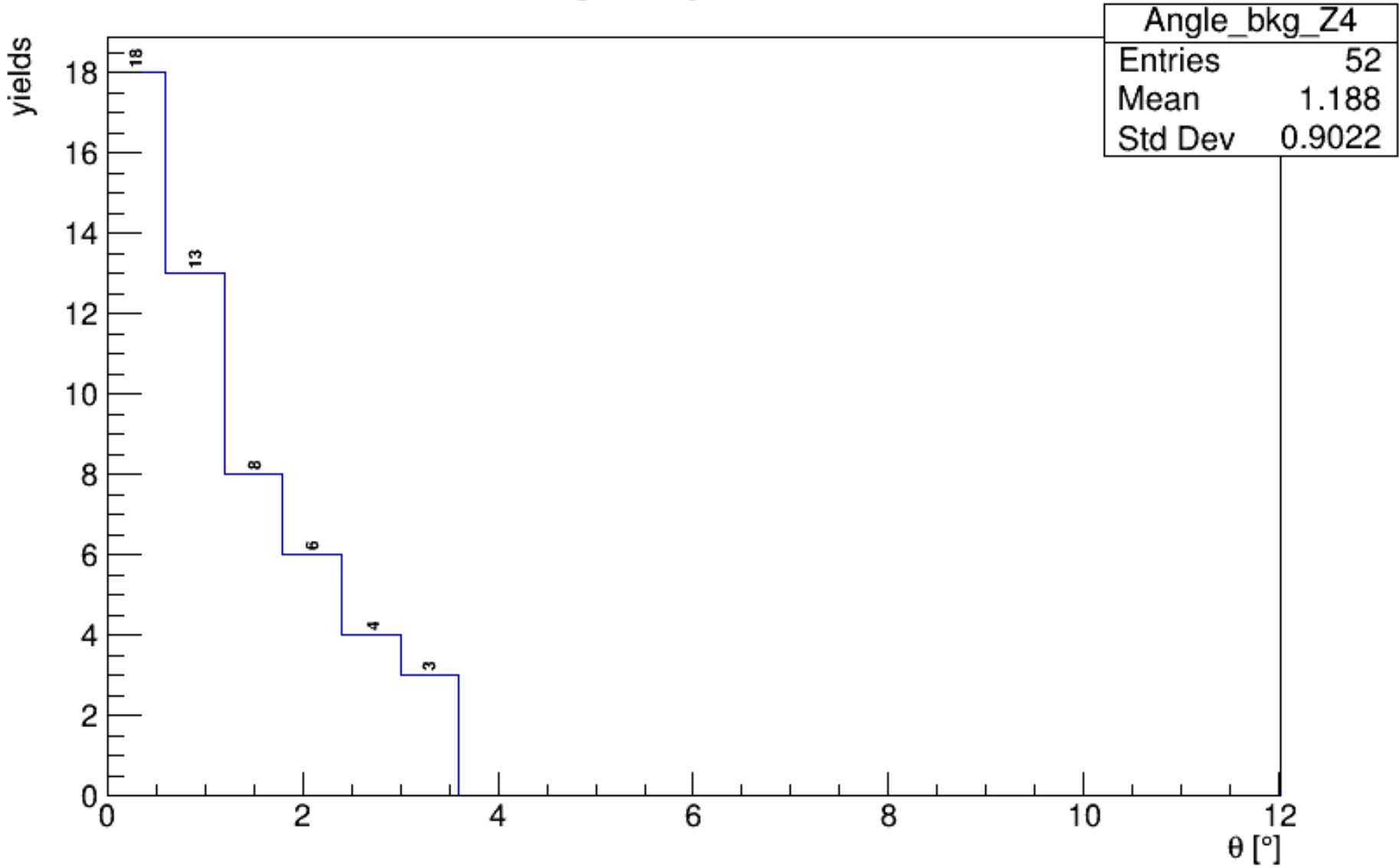
Very few background sample for 400 MeV/u Oxygen...

11	Carbon target	MargaritaMajorit	400	Carbon 5 mm	1,252,568		VTX in data
12	Carbon target &	Fragmentation	400	Carbon 5 mm	2,054,080		VTX in data
20	Alignment	MargaritaMajorit	400	no target	57,133		VTX in data

Angular yields Z5



Angular yields Z4



Conclusions

Background subtraction strategy seems to work also for angle differential cross sections

Very few statistics for background, real impact to final results to be understood soon

Possible strategy to enlarge background sample (GSI2019, MC validation)

Checks on detector alignment in data to be performed