UPDATE ON THE ANALYSIS OF GSI ^{16}O@200MEV/N DATA TAKING

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Reconstruction improvements

Improvements of detector response in MC description (“MC Reco”)

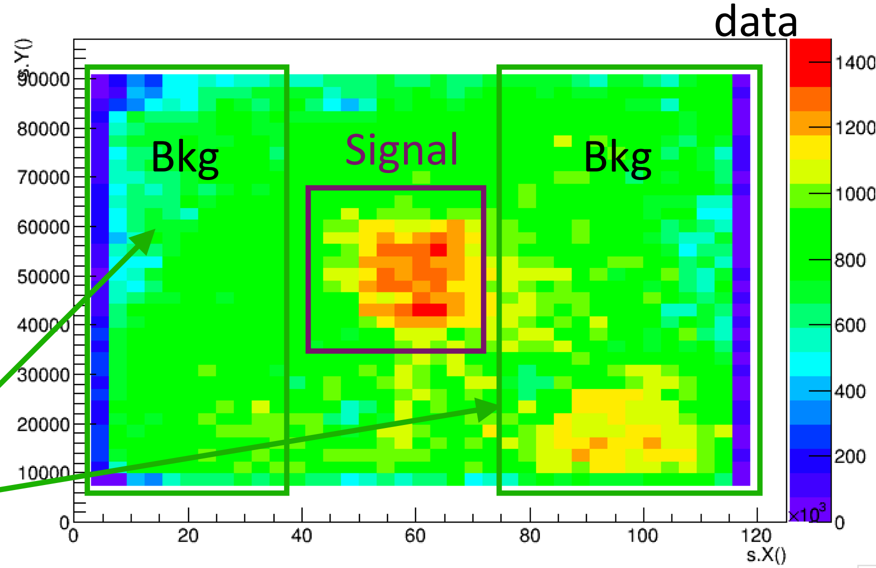
- Efficiencies for cross section measurement is obtained comparing True and Reconstructed Monte Carlo
- Reconstructed Monte Carlo has to reproduce detector response
- Effects considered:
  - angle smearing (Gauss, σ=0.005)
  - data-driven inefficiencies
  - data-driven random background (Optimized)
  - data-driven long cosmic rays background (Optimized)
  - data-driven misalignments **(NEW)**

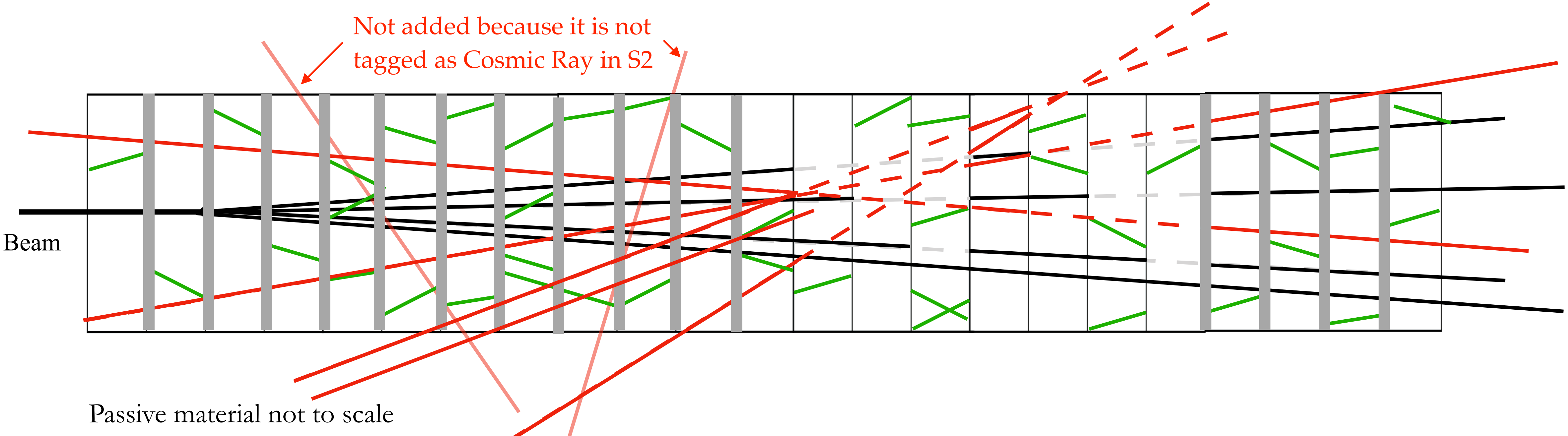
Background in Monte Carlo Simulation

Nuclear emulsions integrate cosmic rays since their production up to their development

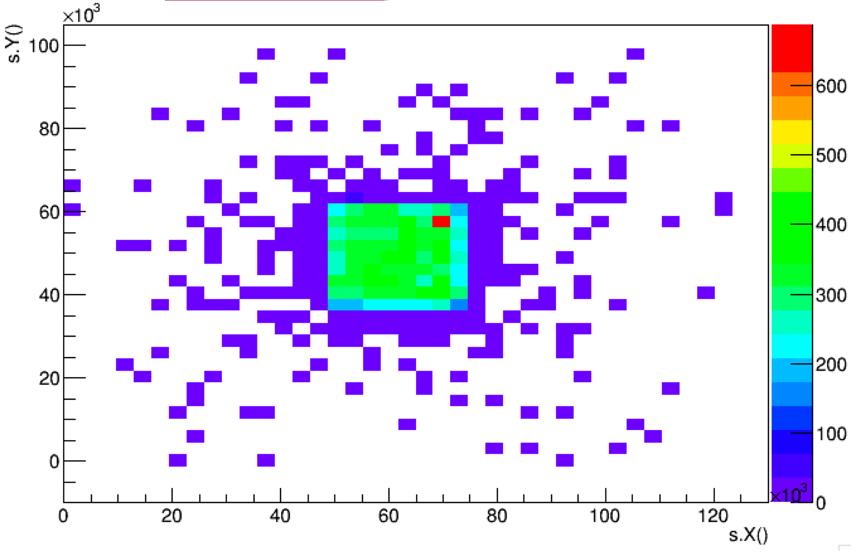
- Basetracks belonging to cosmic rays tagged from Section2 Charge identification analysis in DATA

- Basetracks due to the cosmic rays integrated when brick is not assembled



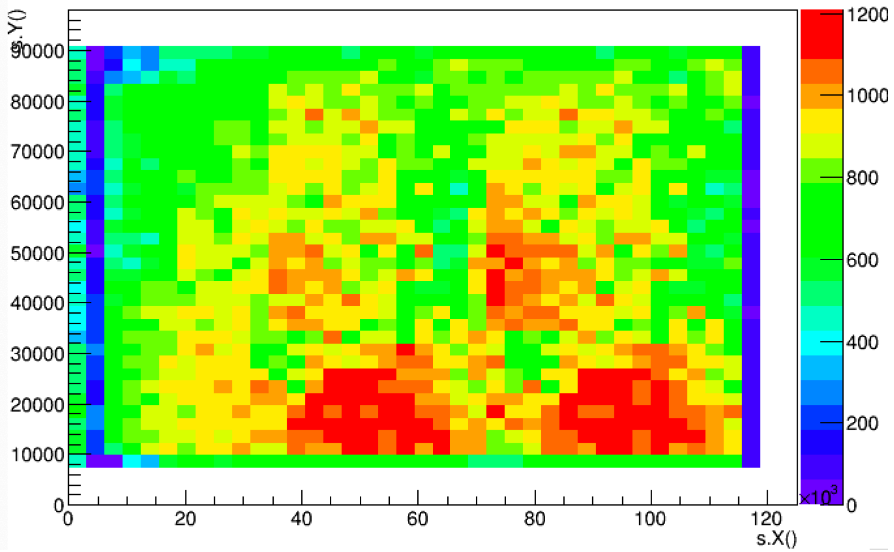


Background in Monte Carlo Simulation



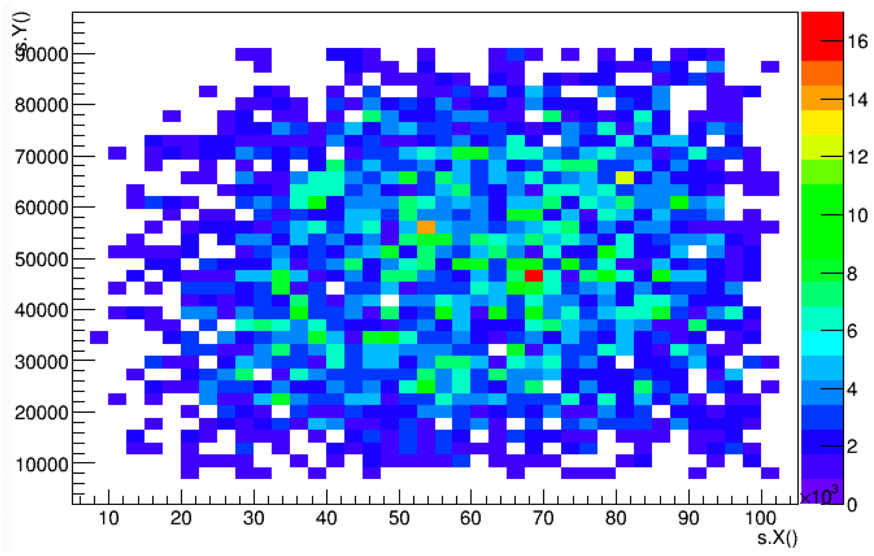
22523 MC Basetracks

+



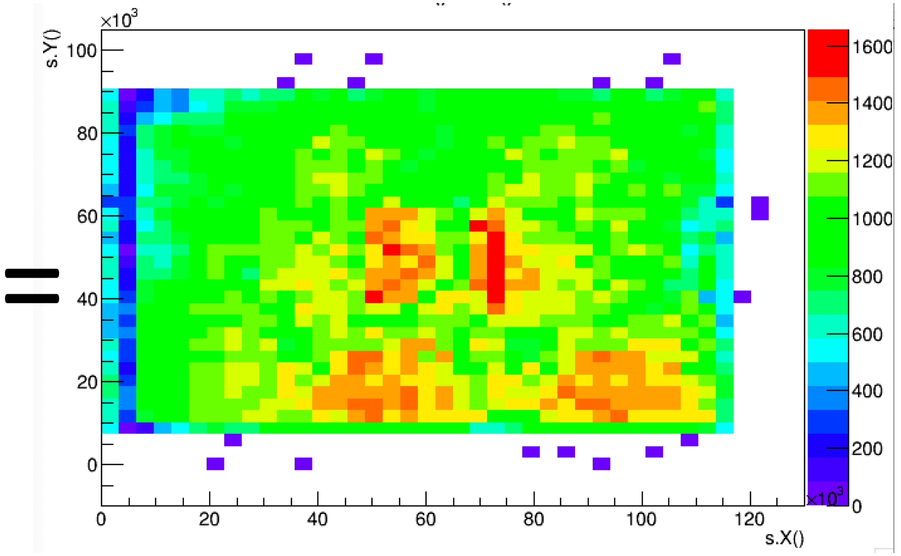
1023915 basetracks from data (region with no signal)

+



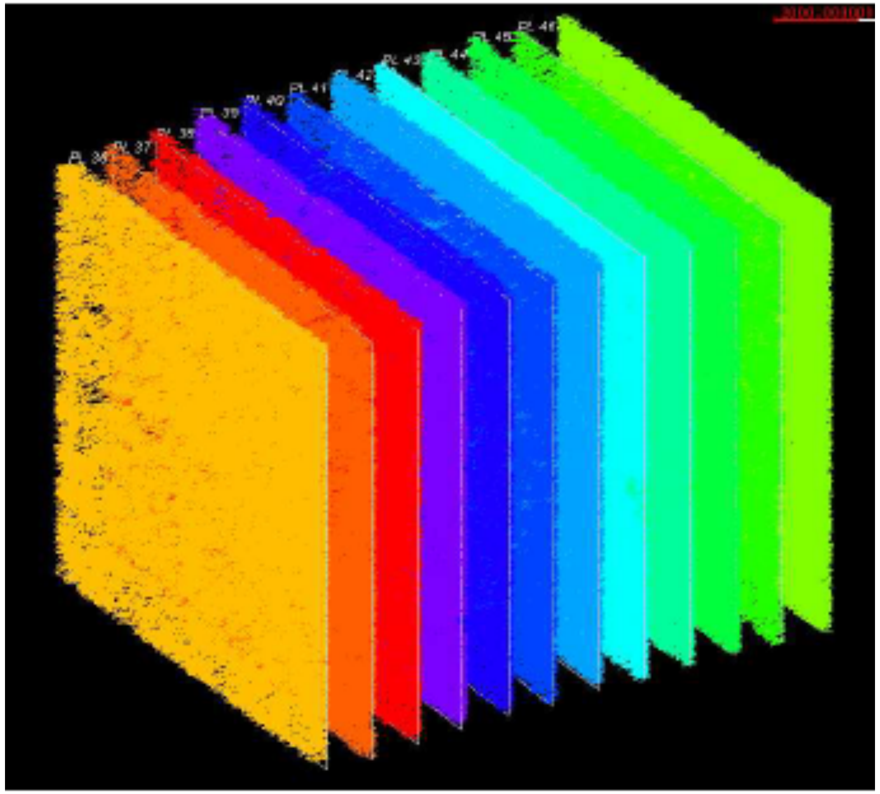
3068 basetracks from data tagged as cosmic rays

=



1049506 Basetracks

Nuclear emulsion films misalignments in MC Reco



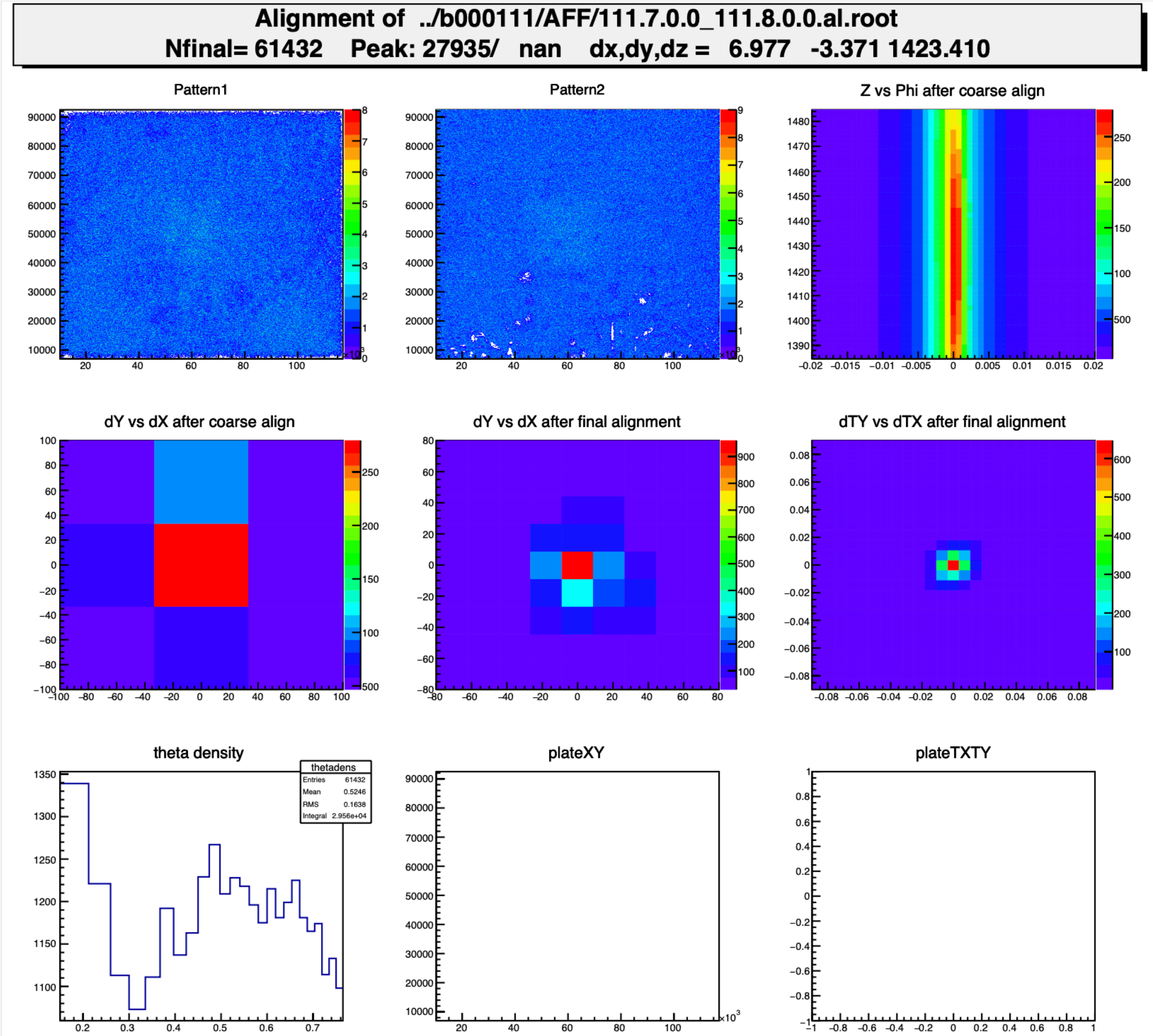
Misalignments were simulated applying a small smearing on XYZ positions → being the smearing random, we had a decrease in tracking efficiency, but we were not really simulating what happens in Data!

NEW way of simulating misalignments in MC Reco:

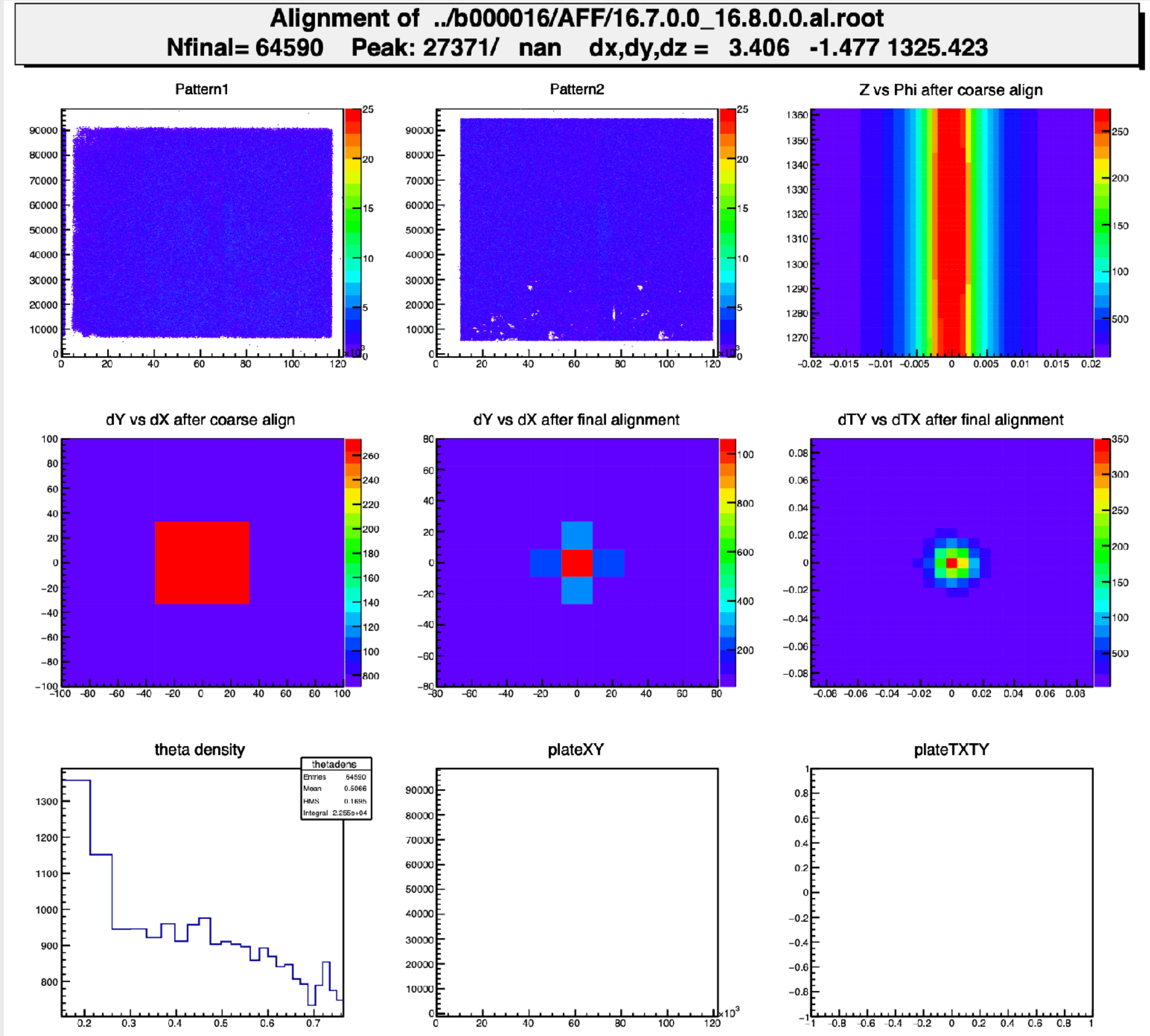
- Rototranslation matrix taken from DATA (same brick-same film)
- Matrix applied to MC Reco basetracks
- Alignment procedure applied to MC Reco as in Data (three steps, same parameters)

Nuclear emulsion films misalignments in MC Reco

DATA



MC RECO



Cross section evaluation

Cross Section Measurement

$$\left.\frac{d\sigma(x)}{dx}\right|_{C\ or\ C_2H_4} = \frac{Y_i(x)}{N_B N_{TG} \Delta x \epsilon^i_{reco}(x)}$$

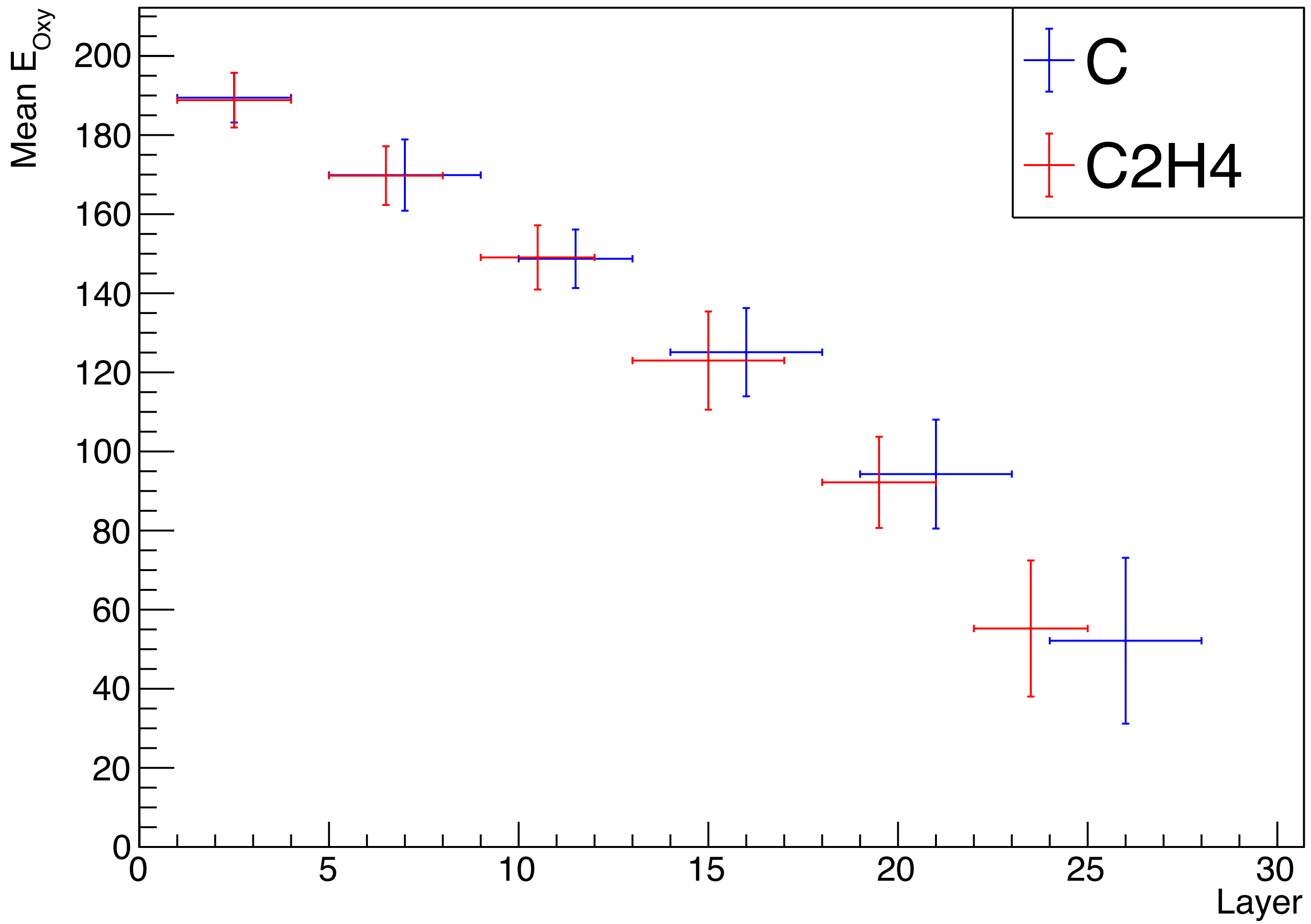
$$\left.\frac{d\sigma(x)}{dx}\right|_{H} = \frac{1}{4}\left(\left.\frac{d\sigma(x)}{dx}\right|_{C_2H_4} - 2\left.\frac{d\sigma(x)}{dx}\right|_{C}\right)$$

- Y_i = # of fragments in the interval Δx
- N_B = # of ions colliding on the target
- N_{TG} = # of particles in the target: $\frac{\rho d N_A}{A}$, with:
  - ρ = target density:
    $\rho_C = 2.26 g/cm^3$
    $\rho_{C_2H_4} = 0.94 g/cm^3$
    $\rho_H = 0.0708 g/cm^3$
  - d = target thickness:
    $d_C = 0.1 cm$ per layer
    $d_{C_2H_4} = 0.2 cm$ per layer
  - $N_A = 6.022 \cdot 10^{23}/mol$
  - A = molar mass:
    $A_C = 12 g/mol$
    $A_{C2H4} = 28 g/mol$
    $A_H = 1 g/mol$
- $\Delta x = x$ bin
- ϵ^i_{reco} = reconstruction efficiency

One detector… many measurements!

$$\left.\frac{d\sigma(x)}{dx}\right|_{C\ or\ C_2H_4} = \frac{Y_i(x)}{N_B N_{TG} \Delta x \epsilon^i_{reco}(x)}$$

- The energy loss within S1 is not negligible
- We divide S1 into sub-sections



C:

- (189 ± 6) MeV/n
- (170 ± 9) MeV/n
- (149 ± 7) MeV/n
- (125 ± 11) MeV/n
- (94 ± 14) MeV/n
- (52 ± 21) MeV/n

C2H4:

- (189 ± 7) MeV/n
- (170 ± 7) MeV/n
- (149 ± 8) MeV/n
- (123 ± 12) MeV/n
- (92 ± 12) MeV/n
- (55 ± 17) MeV/n

H:

- (189 ± 7) MeV/n
- (170 ± 9) MeV/n
- (149 ± 8) MeV/n
- (124 ± 12) MeV/n
- (93 ± 14) MeV/n
- (54 ± 21) MeV/n

The problem of N_B evaluation

$$\left.\frac{d\sigma(x)}{dx}\right|_{C\ or\ C_2H_4} = \frac{Y_i(x)}{N_B N_{TG} \Delta x \epsilon^i_{reco}(x)}$$

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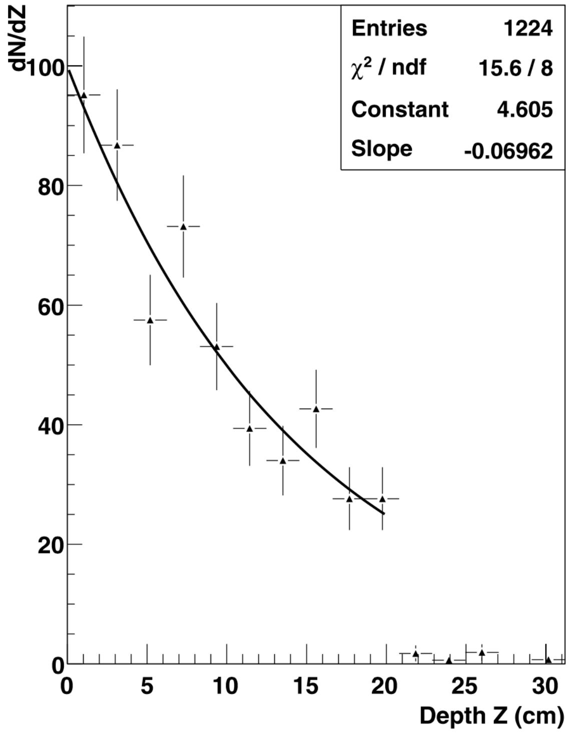
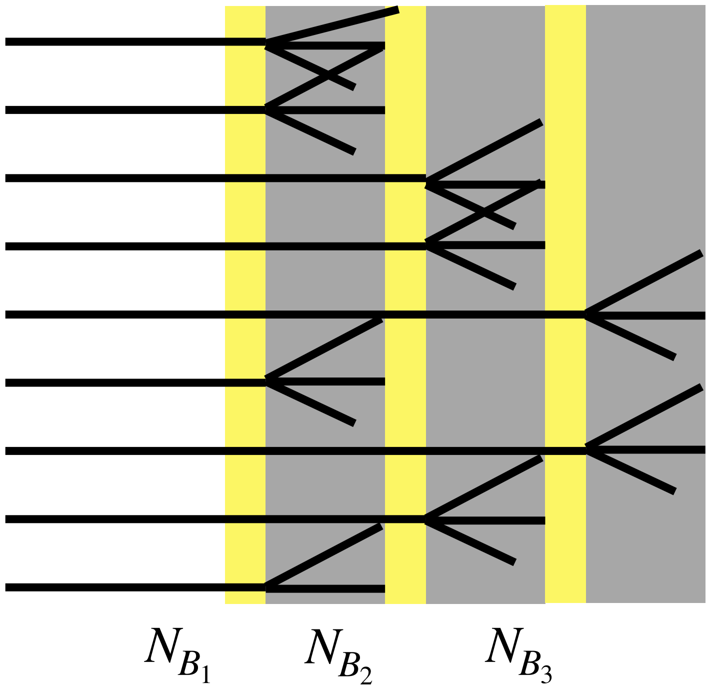


Fig. 2. Fraction of the remnant Carbon beam as a function of the traversed ECC material.

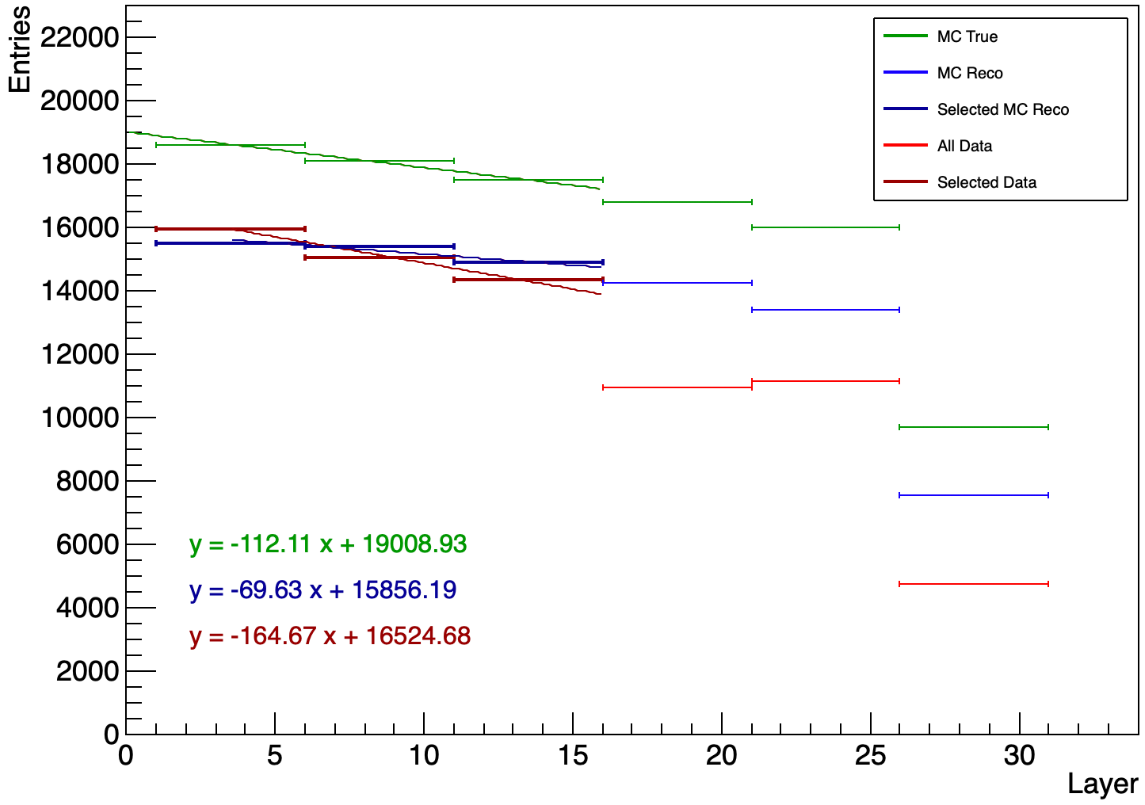


- Each passive material layer can be considered a “new measurement”
- The number of incident beam particle on each layer has to be evaluated and is affected by its efficiency
- New approach: estimation from oxygen tracks

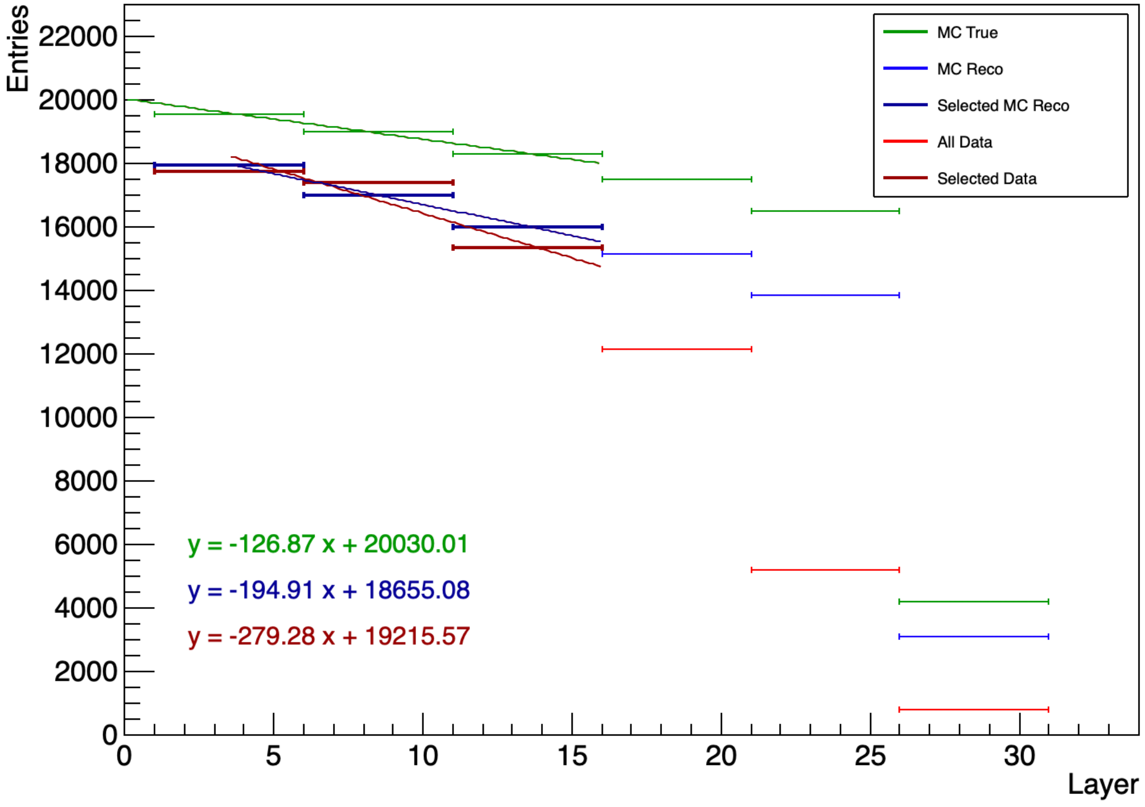
The problem of N_B evaluation

- Oxygen: tracks with $\tan\theta \leq 0.03$ rad
- Missing basetracks in a track filled to recover inefficiencies
- For fit only layers up to 15 have been considered (larger inefficiencies for data after)
- N_B of a specific film evaluated from the fit and corrected for efficiency

GSI1

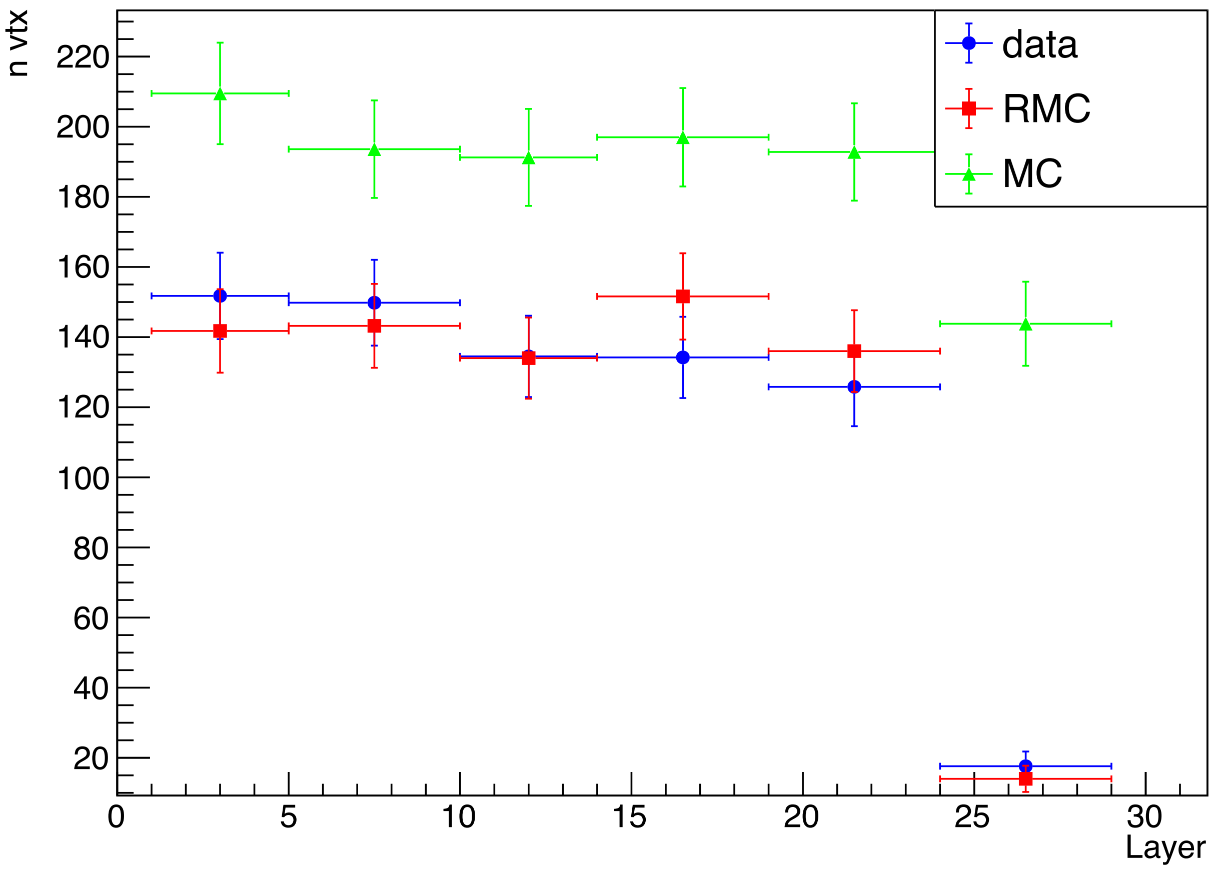


GSI2

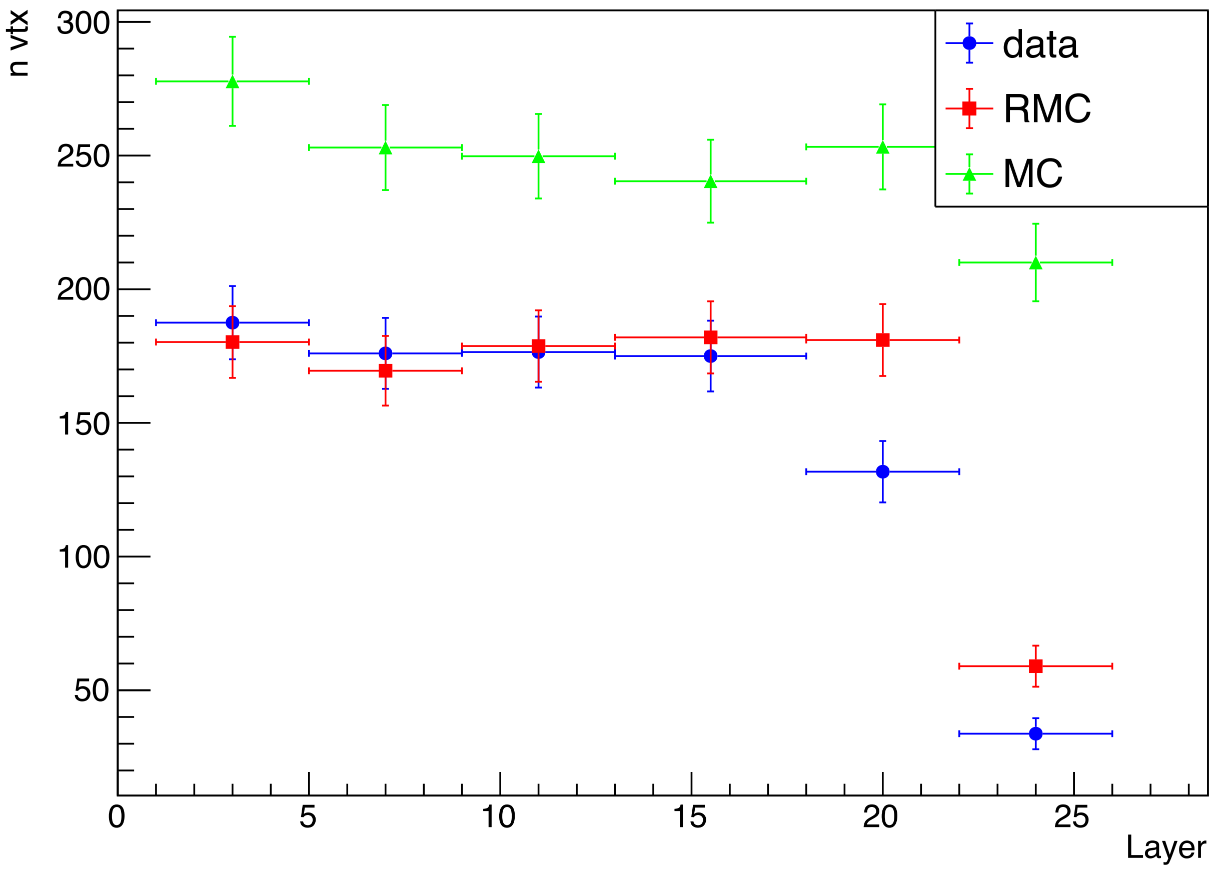


Number of vertices per layer

GSI1



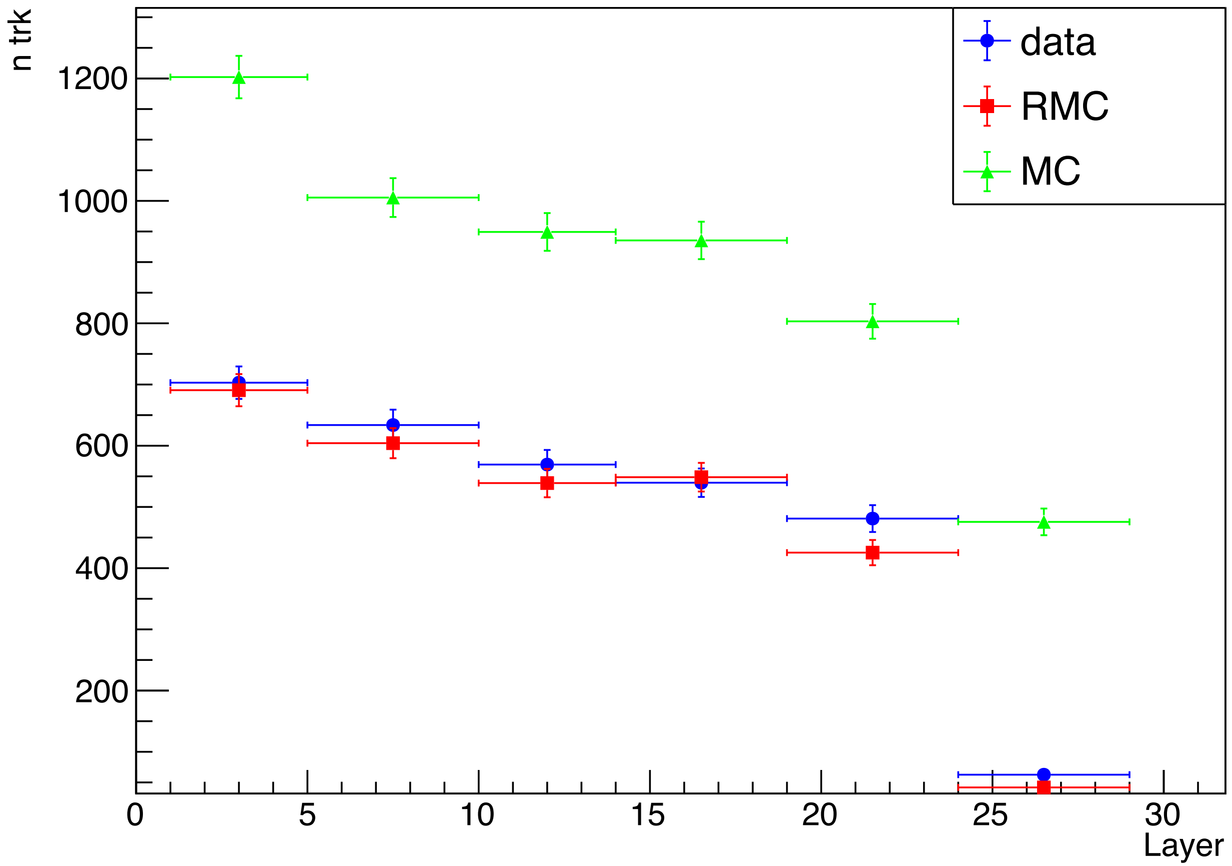
GSI2



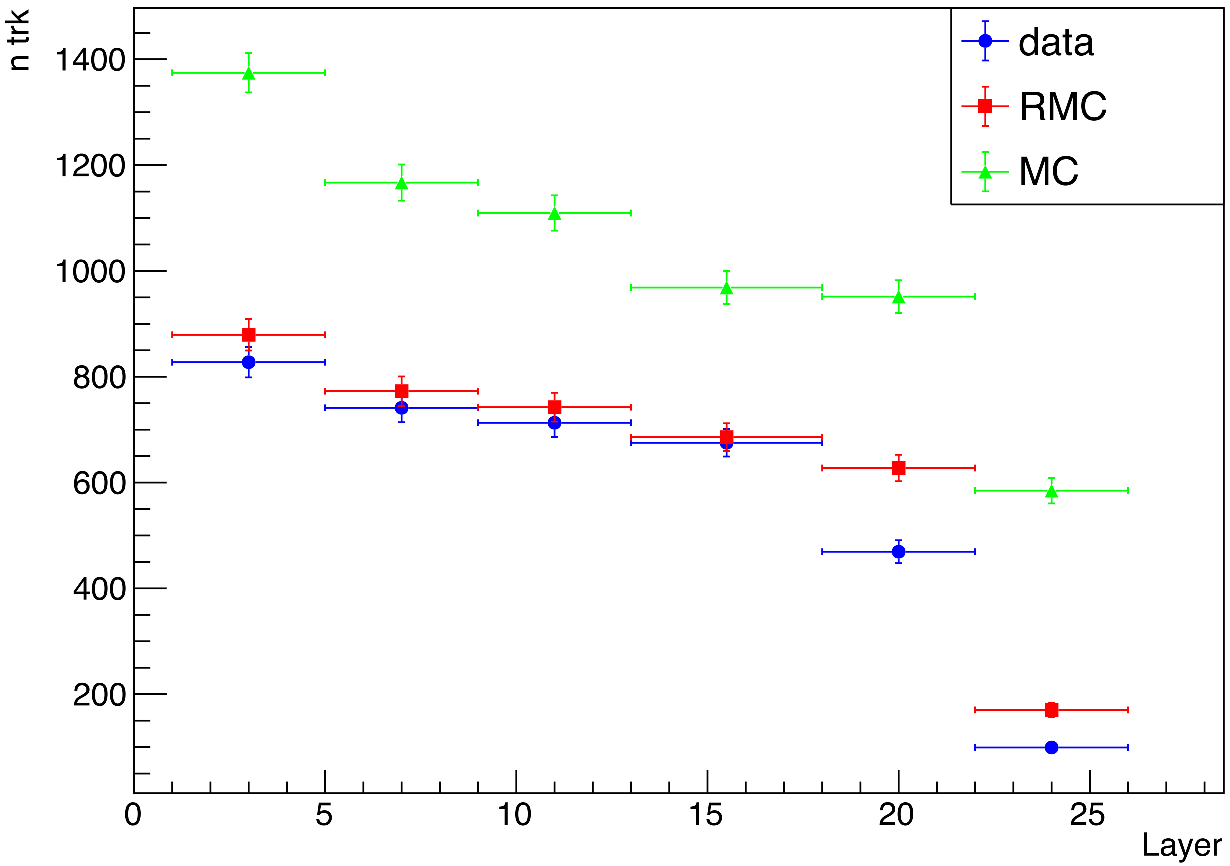
- Data-driven inefficiencies overestimated after new misalignment procedure

Number of fragments per layer

GSI1



GSI2



- Data-driven inefficiencies overestimated after new misalignment procedure

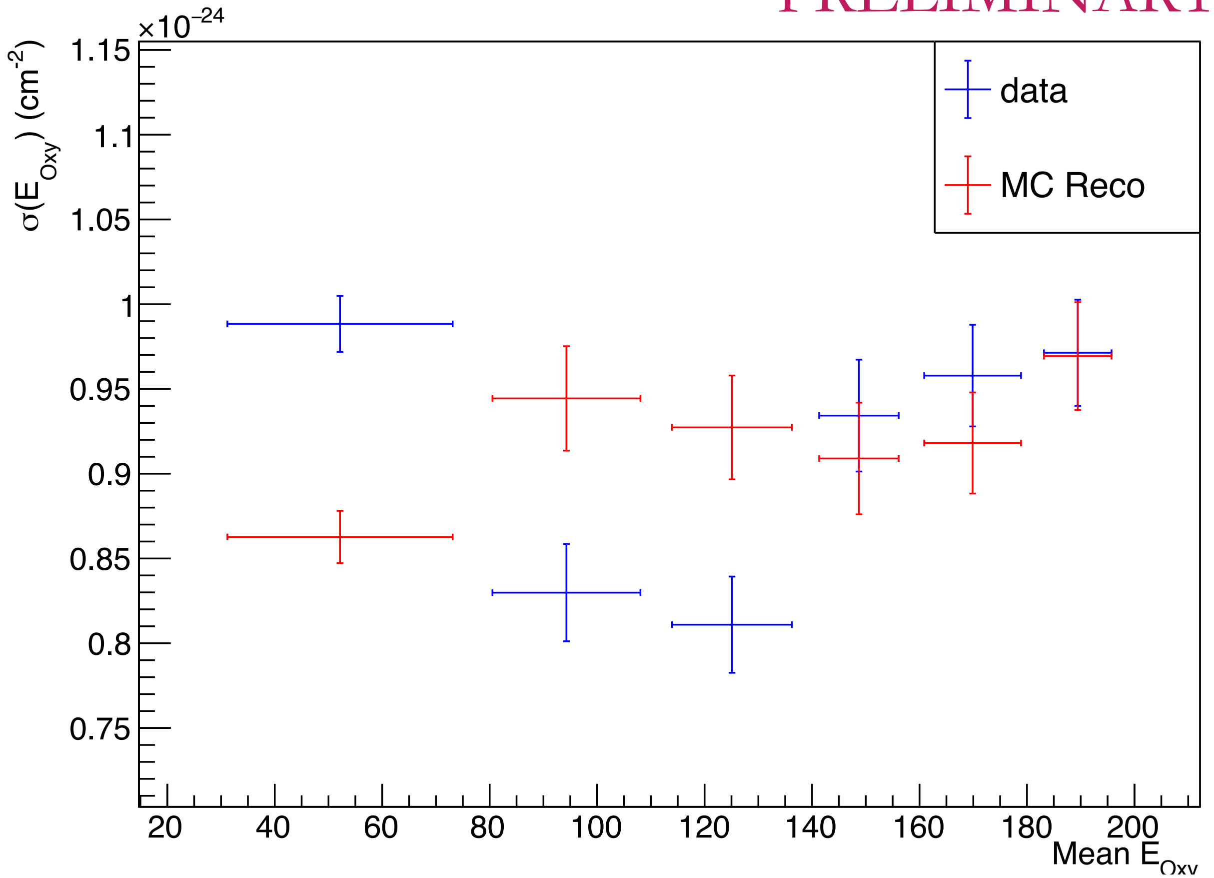
Closure test?

$$\left.\frac{d\sigma(x)}{dx}\right|_{C\ or\ C_2H_4} = \frac{Y_i(x)}{N_B N_{TG} \Delta x \epsilon^i_{reco}(x)}$$

- How to evaluate efficiencies? At the moment: $\epsilon = \frac{Y_{i_{MCReco}}}{Y_{i_{MCTrue}}}$
- We cannot evaluate efficiency from MC event by event (no trigger, no time stamp for emulsions…)
- Comparison of integrated cross section at Z=3 and $\theta < 10°$ with electronic detector setup
- Comparison with literature
- Other ideas?

Total reaction cross section on C

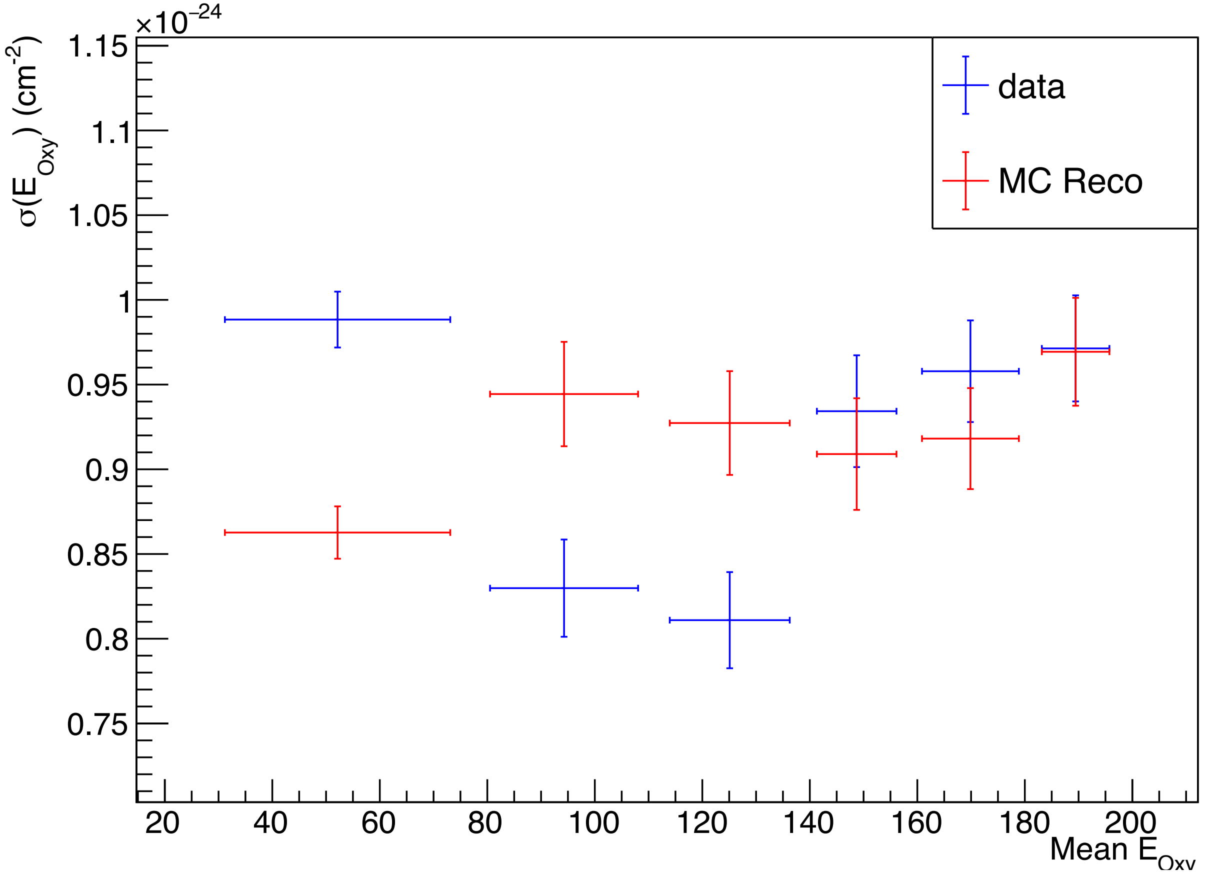
PRELIMINARY



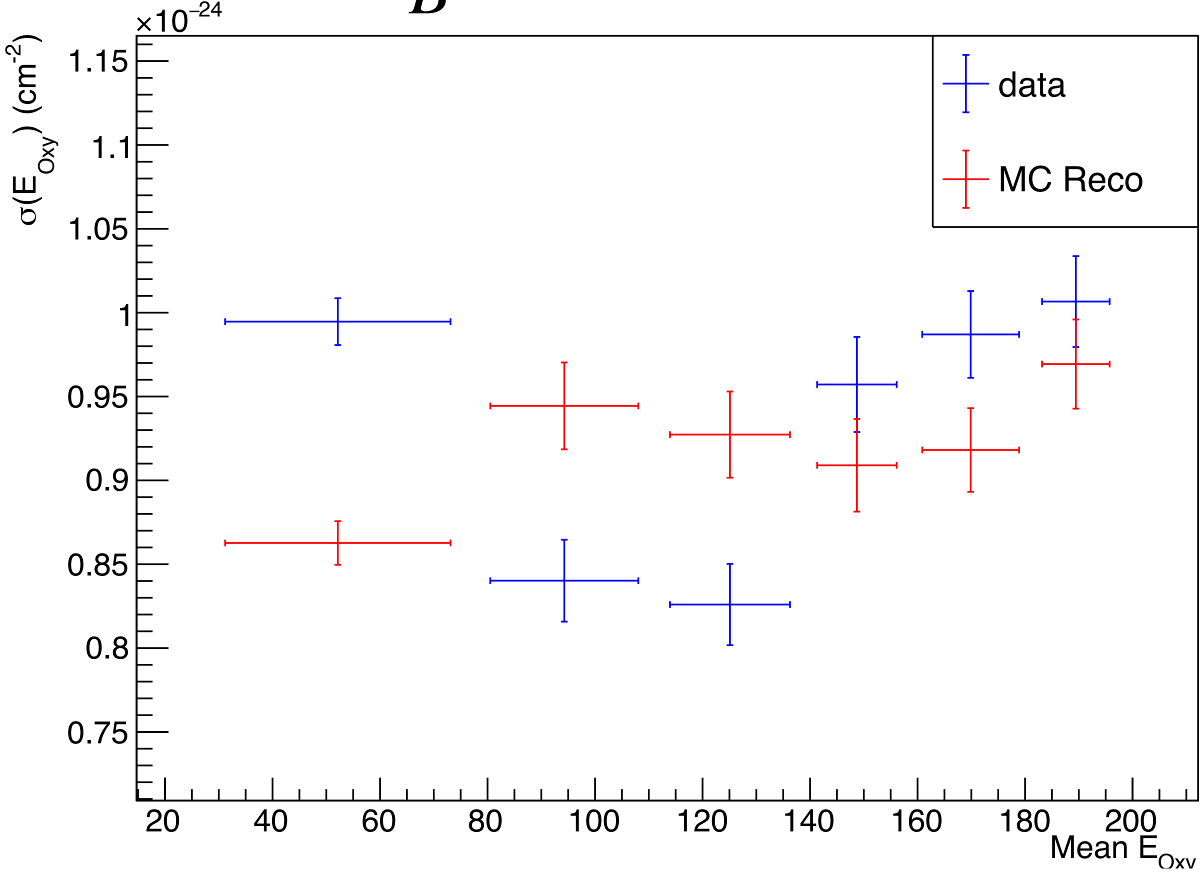
$$Y_i = \#\ \text{of vertices}$$

	Projectile Ekin (MeV/n)	Cross section
Yamaguchi 2011	288	852 ±17
Zeitlin 2011	290	863 ±20
Zeitlin 2011	400	842 ±22

Total reaction cross section on C



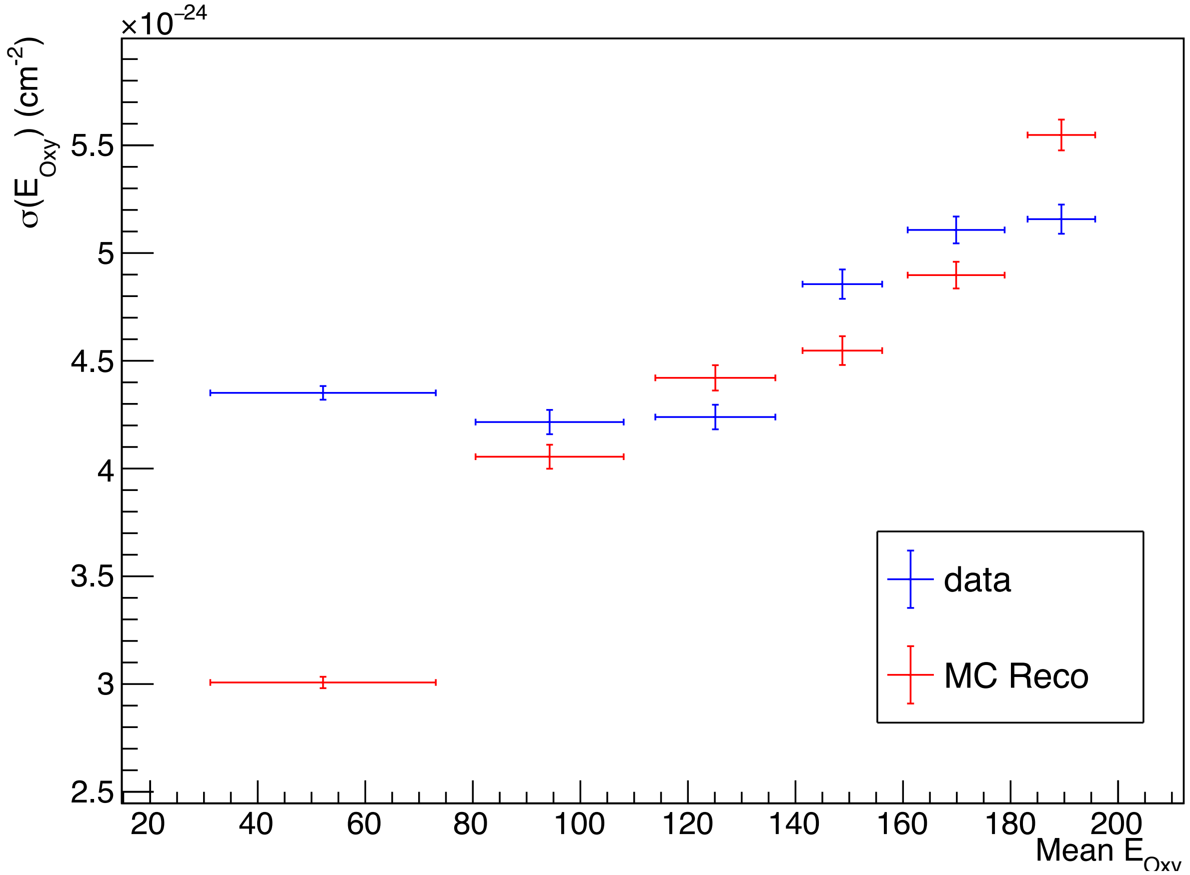
N_B from MC True



$Y_i = \#$ of vertices

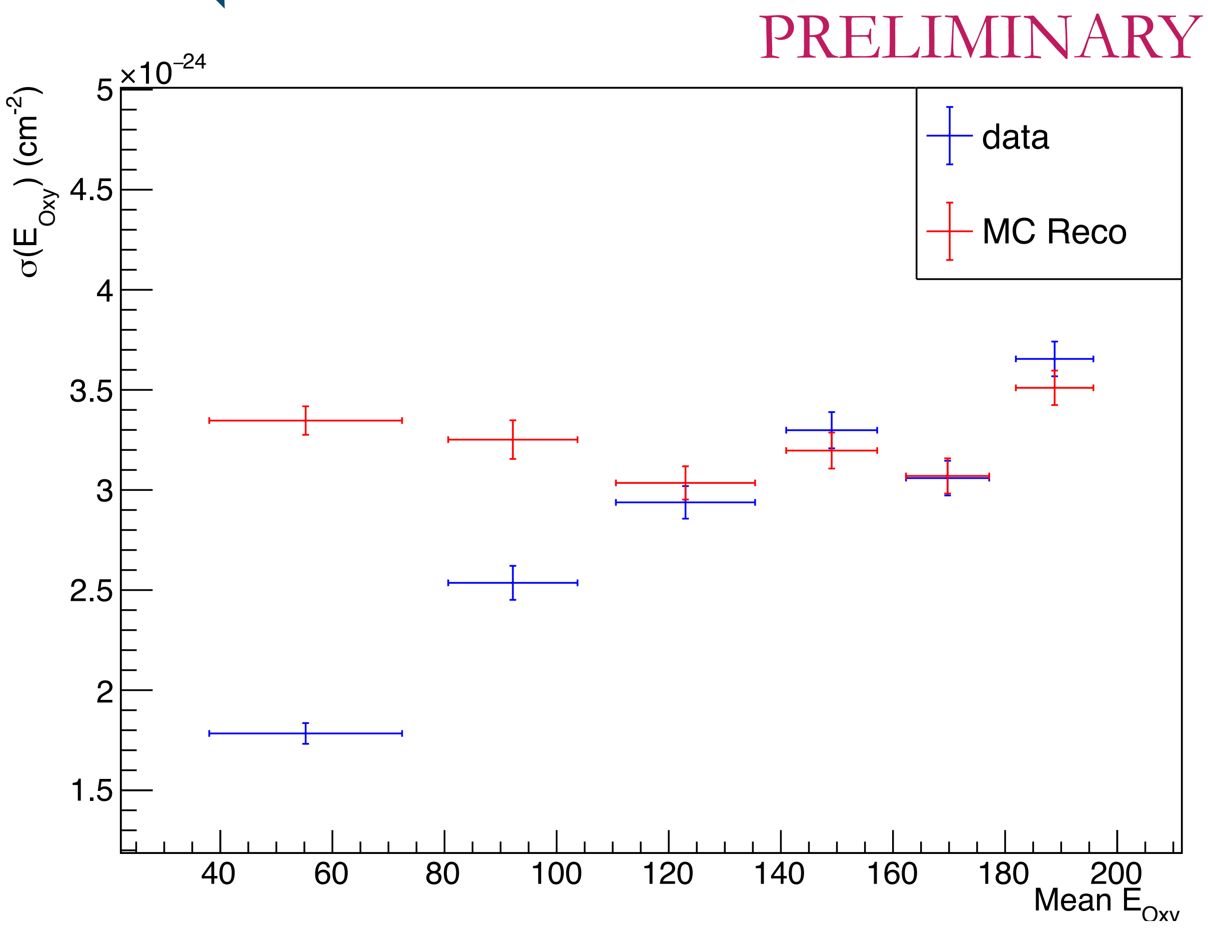
Total production cross section on C

PRELIMINARY



$$Y_i = \#\ \text{of fragments}$$

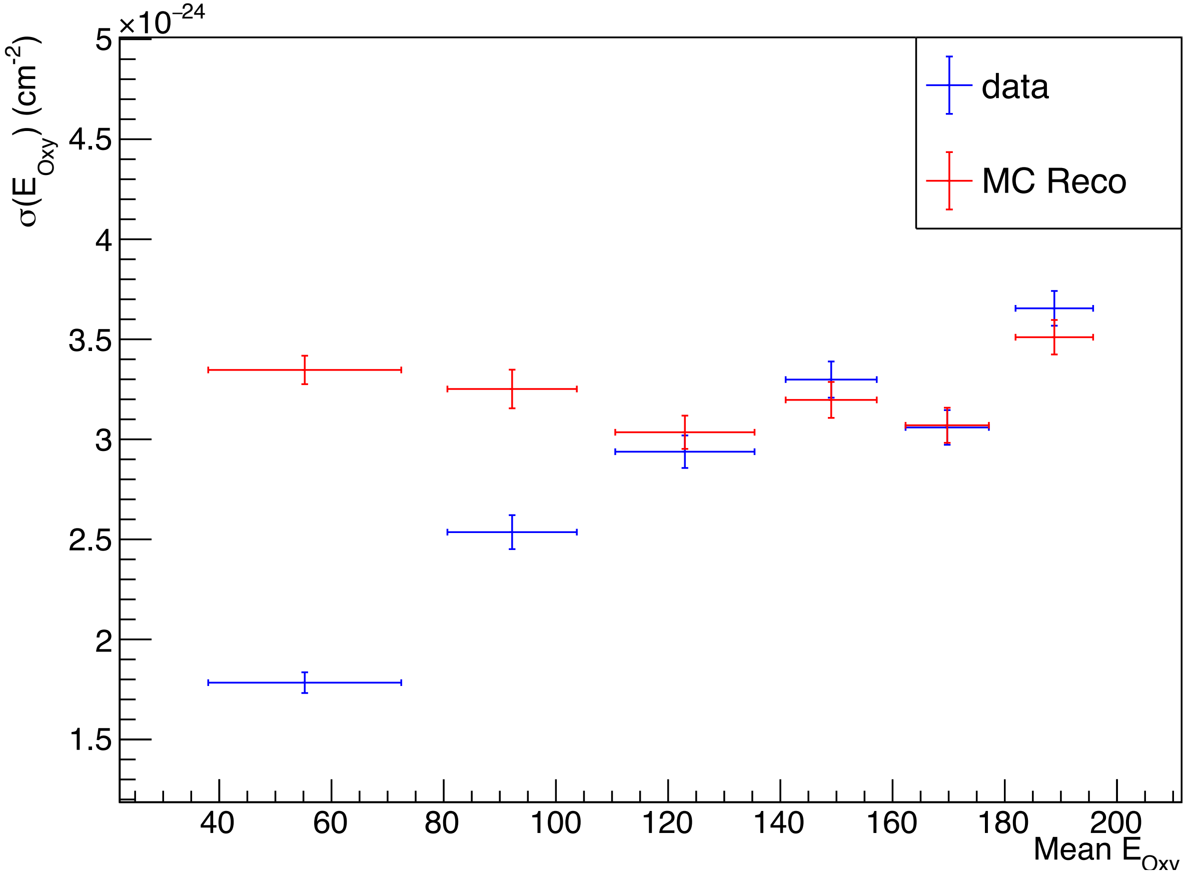
Total reaction cross section on C_2H_4



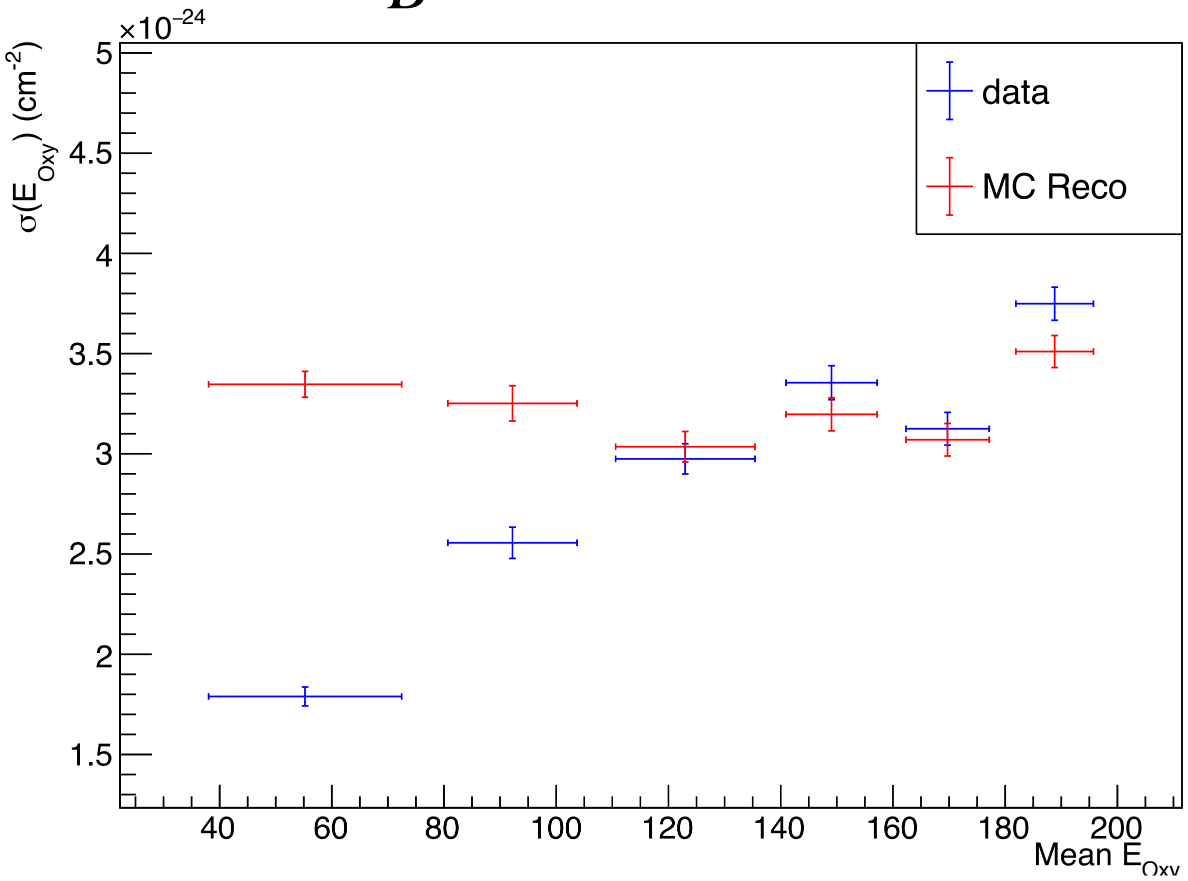
$$Y_i = \#\text{ of vertices}$$

	Projectile Ekin (MeV/n)	Cross section on CH_2
Webber 1990	441	1260 ±13
Webber 1990	591	1316 ±13
Webber 1990	669	1328 ±13

Total reaction cross section on C_2H_4



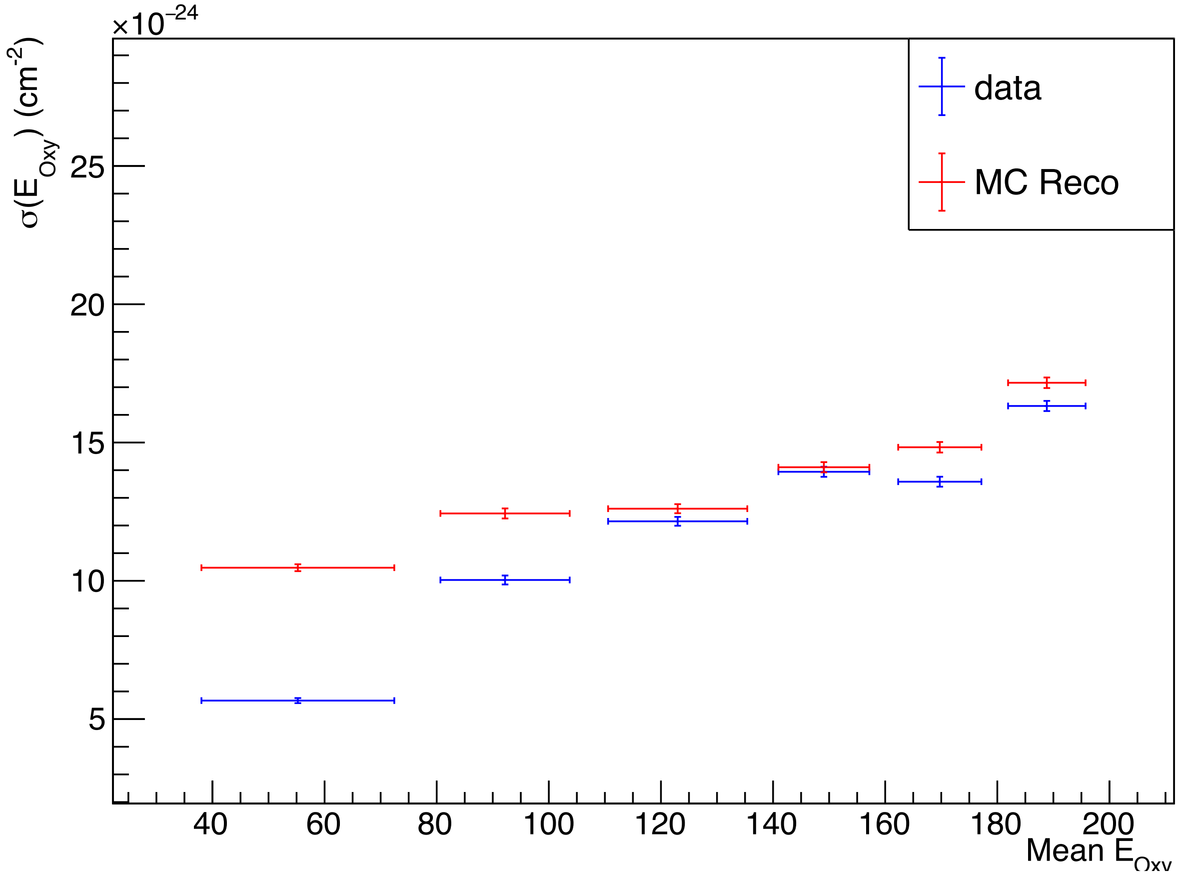
N_B from MC True



$Y_i = \#$ of vertices

Total production cross section on C_2H_4

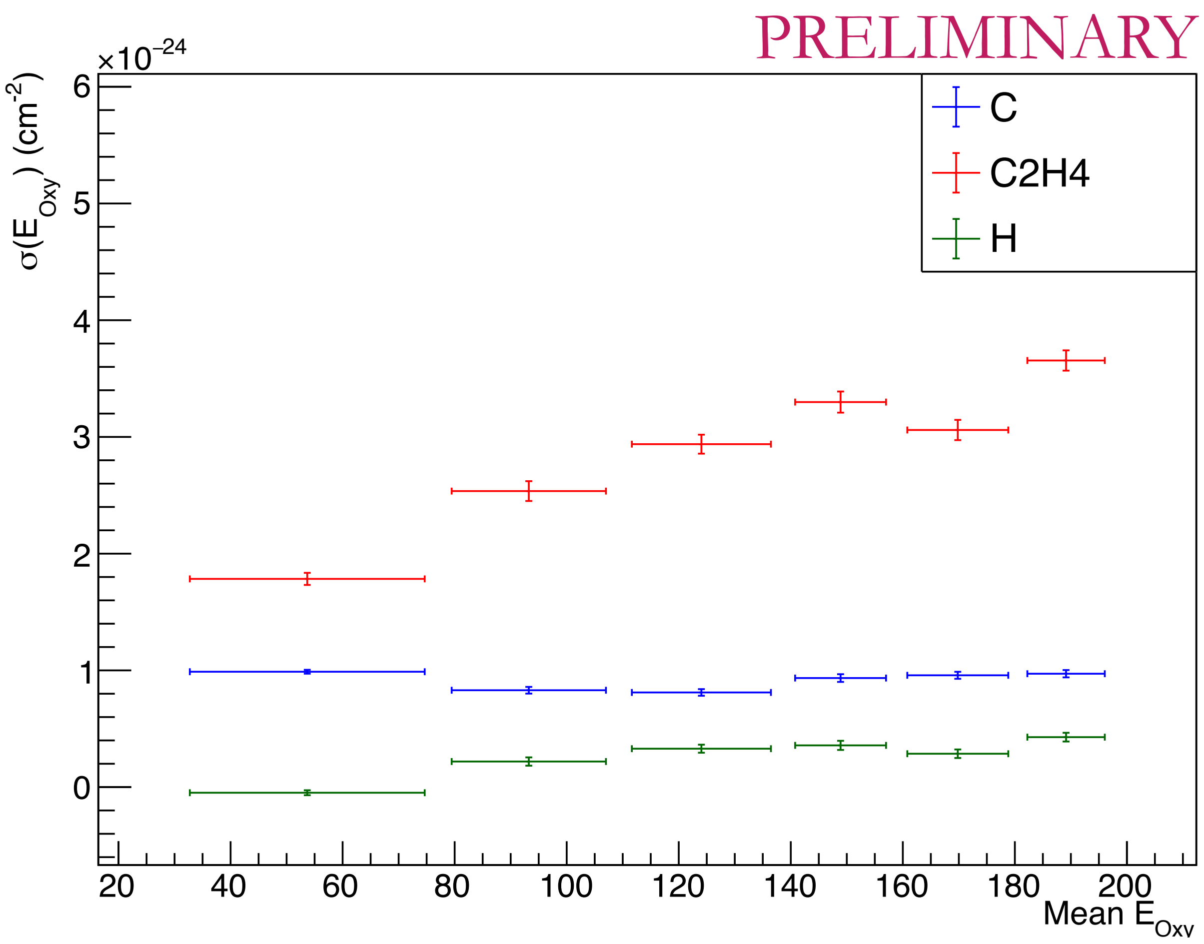
PRELIMINARY



$Y_i = \#$ of fragments

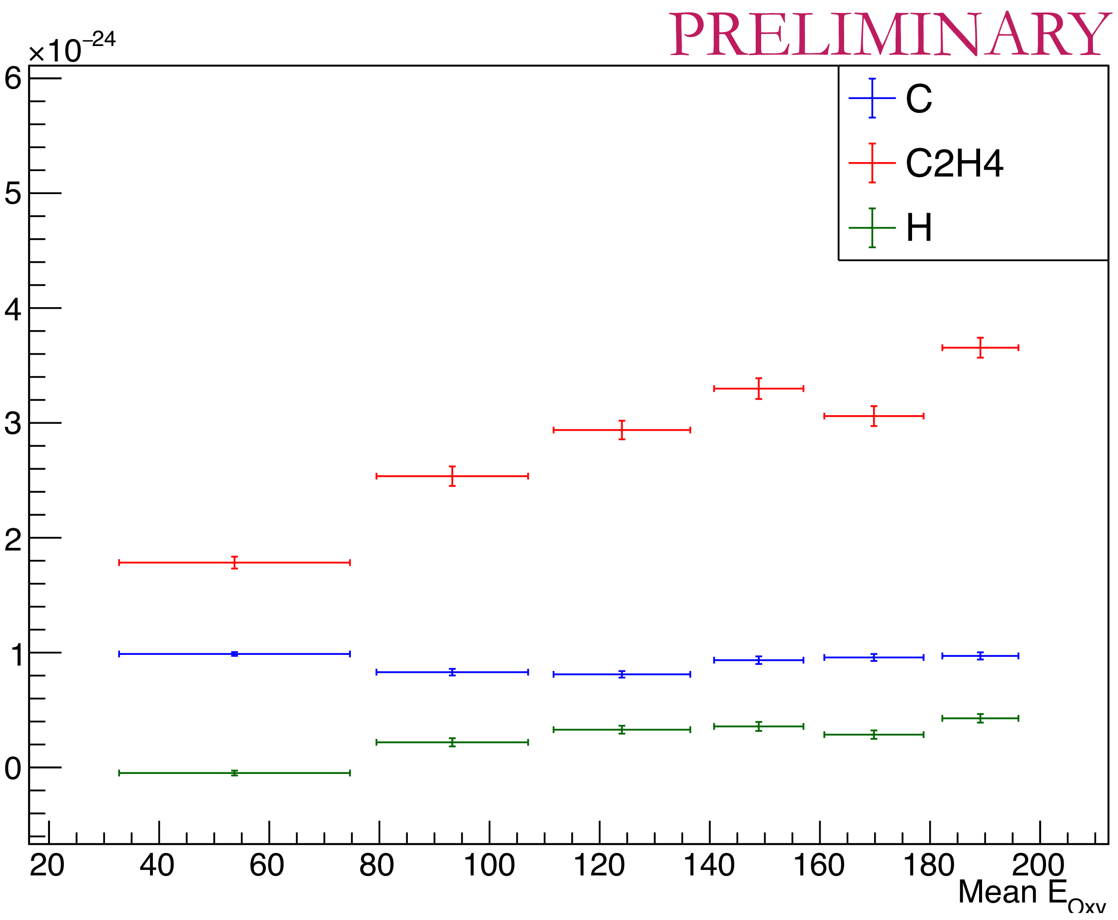
Integrated cross section H

Total reaction cross section



$Y_i = \#$ of vertices

Total production cross section



$Y_i = \#$ of fragments

New paper!

New paper accepted!

Charge identification of fragments produced by interaction of ^{16}O beam at $200 MeV/n$ and $400 MeV/n$ on C and C_2H_4 target

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Your manuscript is accepted - 1327202 Inbox ×

Frontiers in Physics Editorial Office 09:22 (7 hours ago)
to giuliana.galati

Dear Dr Galati,

Please read this email in full as it contains important information related to the publication of your article.

I am pleased to inform you that your manuscript "Charge identification of fragments produced in 16 O beam interactions at 200M eV /n and 400M eV /n on C and C 2 H 4 targets" has been approved for production and accepted for publication in Frontiers in Physics, section Nuclear Physics.
Proofs are being prepared for you to verify before publication. We will also perform final checks to ensure your manuscript meets our criteria for publication (https://www.frontiersin.org/about/review-system#ManuscriptQualityStandards).

The title, abstract and author(s) list you provided during submission is currently online and will be replaced with the final version when your article is published. Please do not communicate any changes until you receive your proofs.

Conclusions

- Improvements:
  - MC description of detector response (“MC Reco”): background + misalignments
  - TO DO: Re-evaluation of data-driven inefficiencies (now overestimated)

Oxygen @ 200 MeV/n on C and C_2H_4

  - Comparison between MC True, MC Reco and DATA improved
  - Estimation of the number of incoming oxygens in each S1 “sub-section”
  - Integrated Cross section evaluation at different energies

To do:

  - Closure test?
  - Differential cross sections (charge / theta)
  - Final checks and new publication soon

- **New paper on charge measurement ACCEPTED!**

THANK YOU!

BACK UP SLIDES

Detector Structure