Field Off Scattering Studies: Current Status

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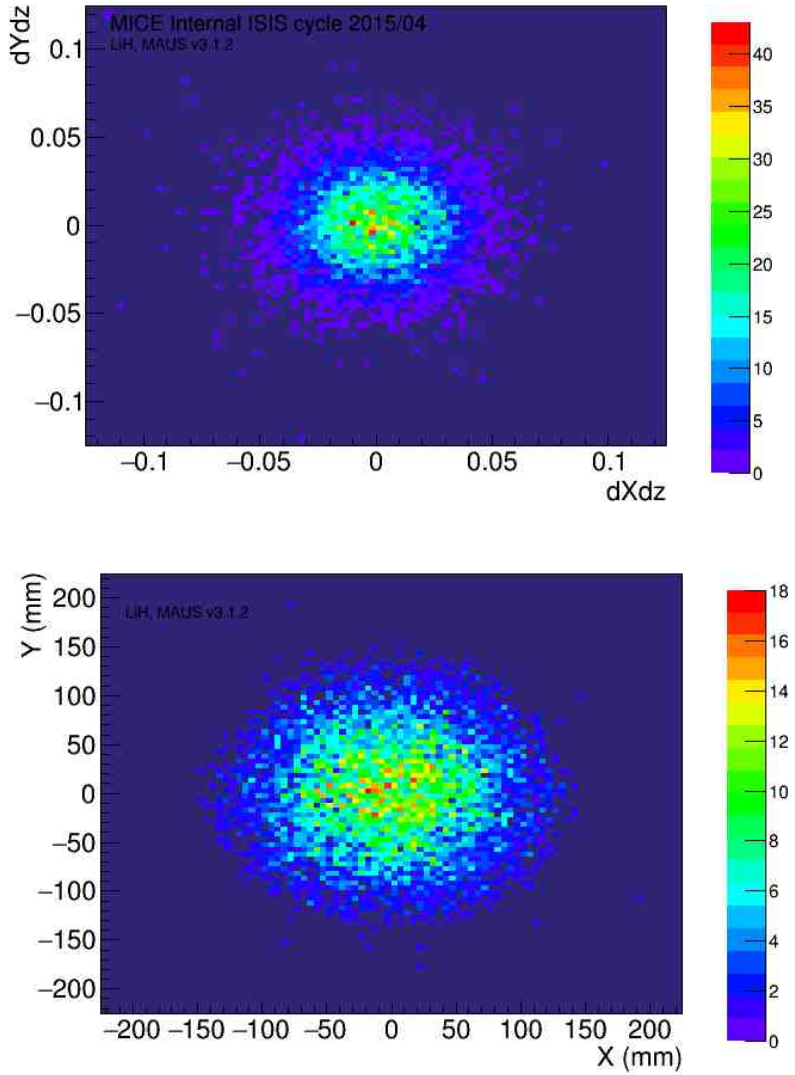
Job List

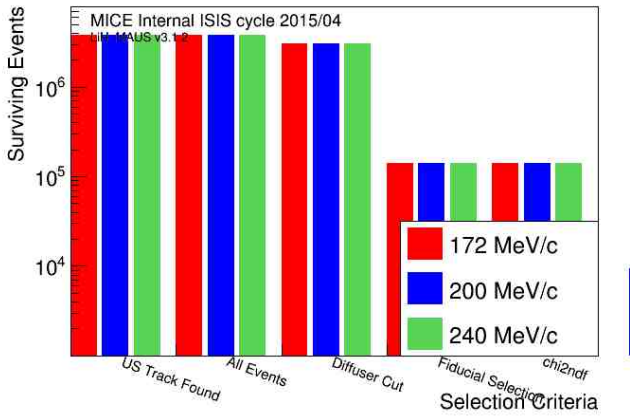
- Actions from referees at CM53 (✓)
- Actions from referees on at last review (✓)

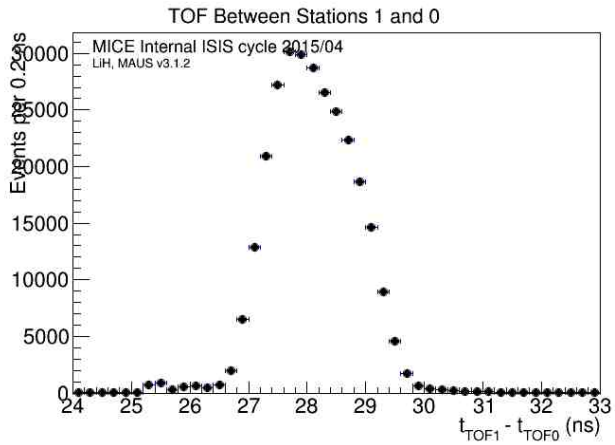
Scattering Data

- Field off data sets were collected in ISIS run periods 2015/03 and 2015/04
- A momentum dependent multiple scattering measurement is made
  - Measure empty channel scattering
  - Measure absorber scattering
  - Gold's algorithm deconvolution unfolds absorber scattering distribution
  - χ^2 comparison between data and model
  - Width of scattering distribution: Θ as a function of P



Selection

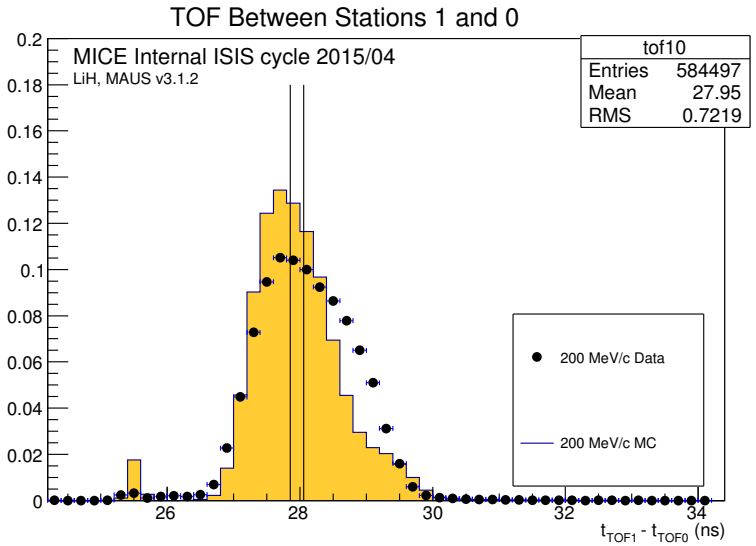


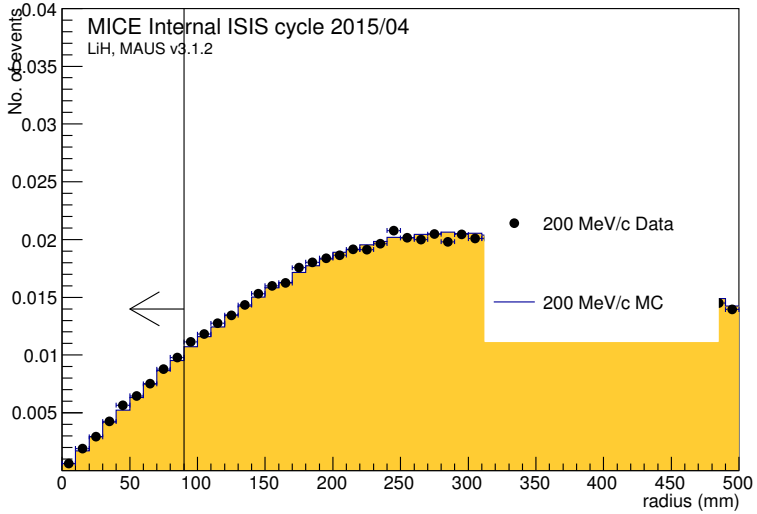


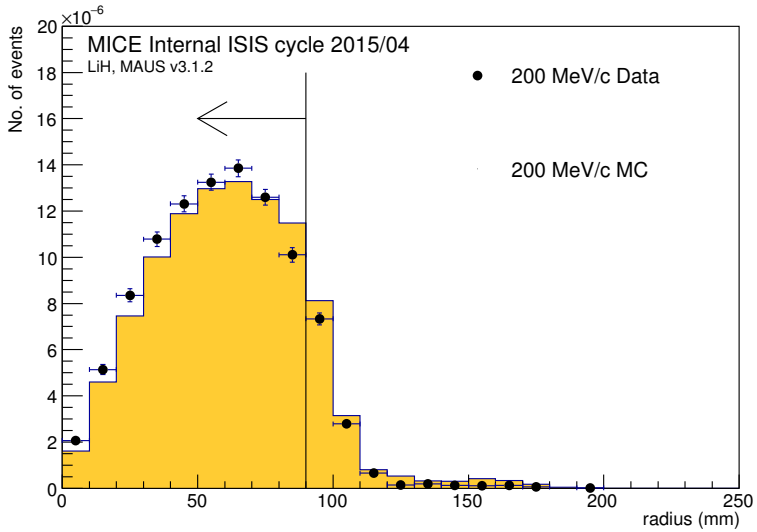
Selection

- Require a US track. If a DS track not extant, statistics are set to overflow values
- Require projection of US tracks to appear, within central 90 mm radius of DS trkr plane 5
- Tracks are projected to the upstream face of the diffuser, if track radius is greater than 90 mm rejected
- χ^2 less than 4 US & DS
- Analysis done in 200 ps bins, as shown in TOF plot

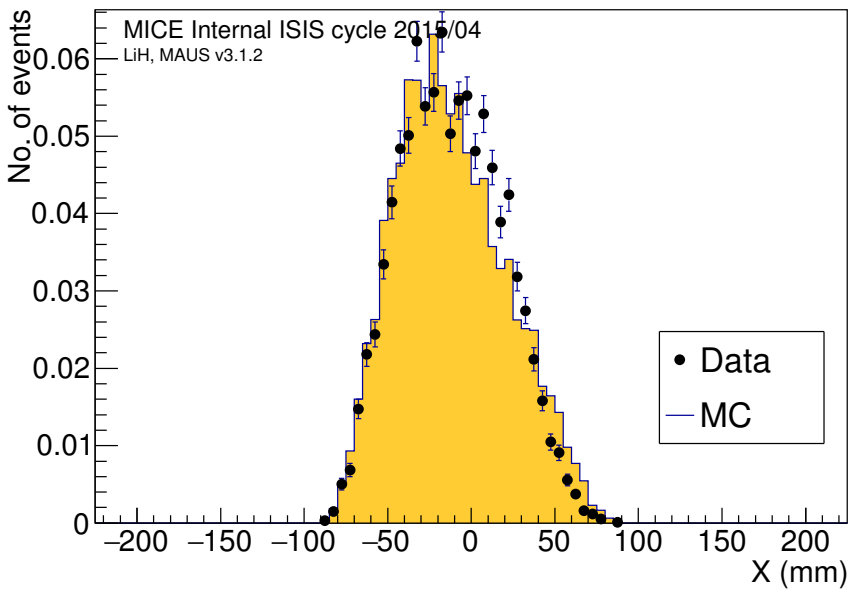
Cut plot

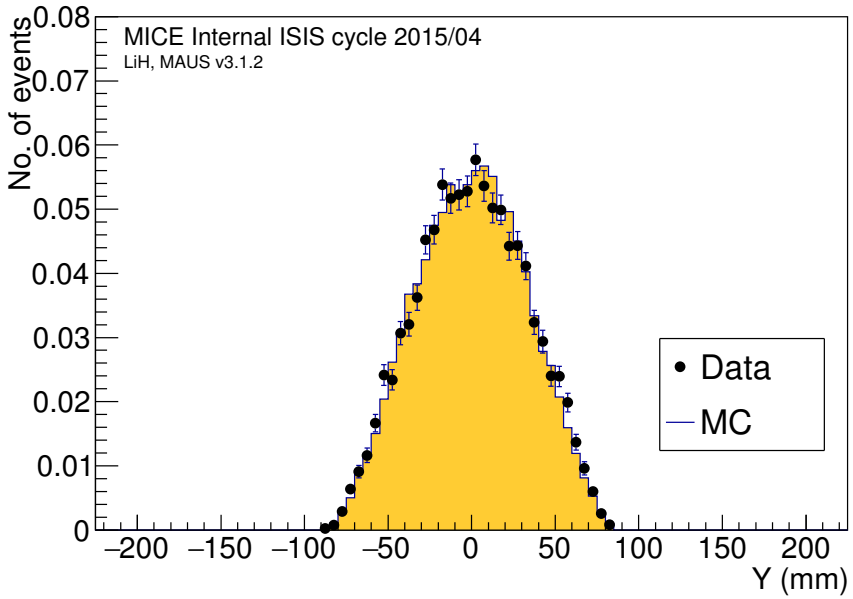

TOF Between Stations 1 and 0
MICE Internal ISIS cycle 2015/04
LiH, MAUS v3.1.2
tof10
Entries 584497
Mean 27.95
RMS 0.7219
200 MeV/c Data
200 MeV/c MC
$t_{TOF1} - t_{TOF0}$ (ns)


MICE Internal ISIS cycle 2015/04
LiH, MAUS v3.1.2
No. of events
200 MeV/c Data
200 MeV/c MC
radius (mm)


MICE Internal ISIS cycle 2015/04
LiH, MAUS v3.1.2
No. of events
200 MeV/c Data
200 MeV/c MC
radius (mm)

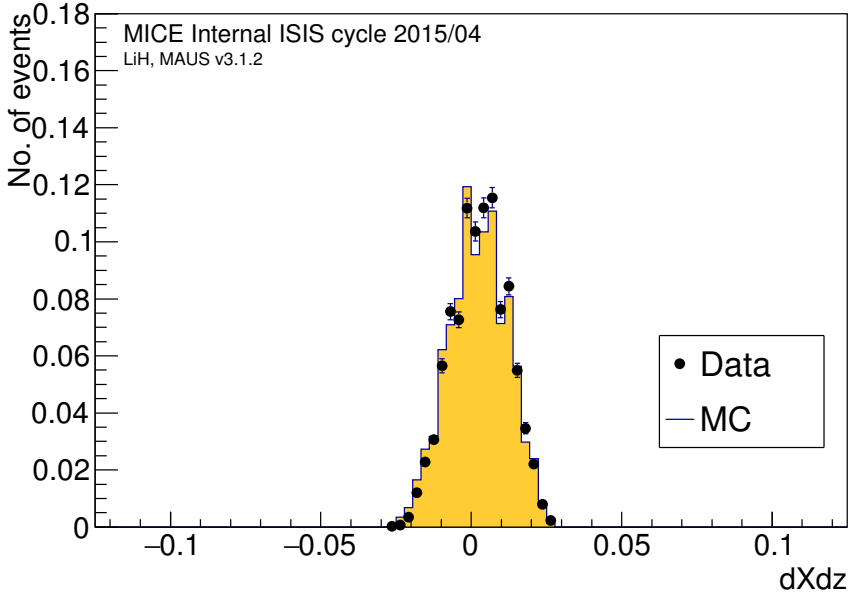
MC Data comparison

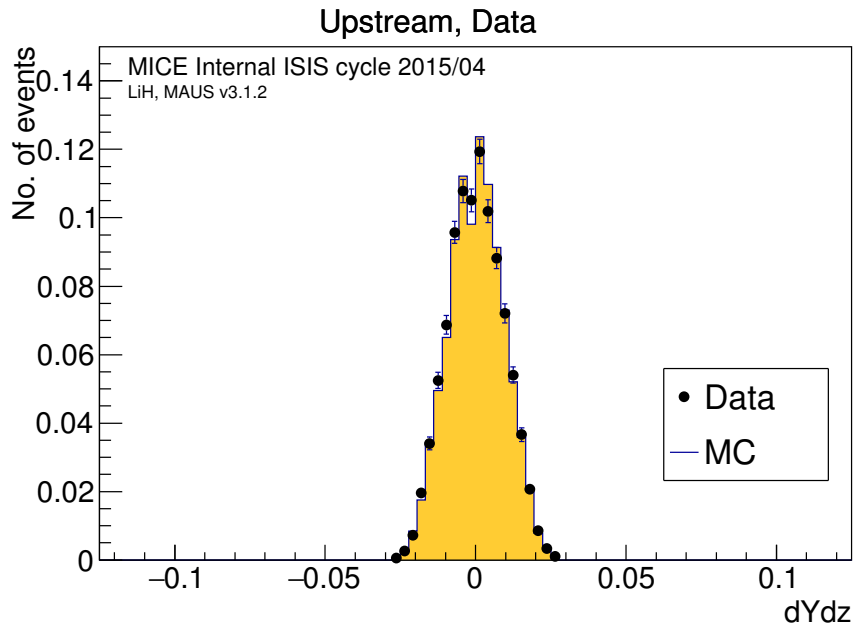




- 200 MeV/c case
- Compare MC recon and data

MC Data comparison





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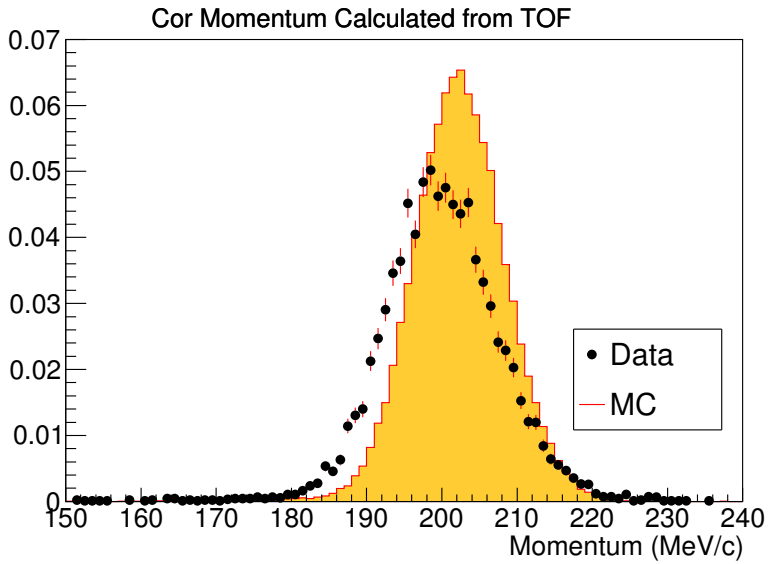
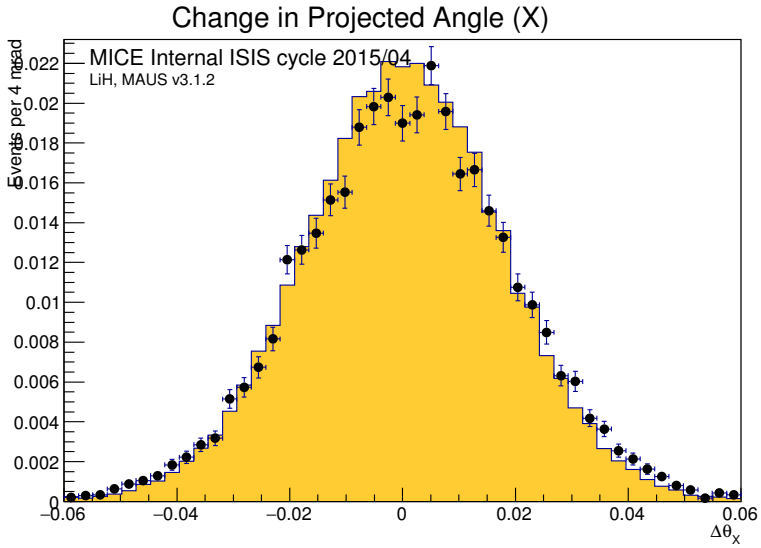
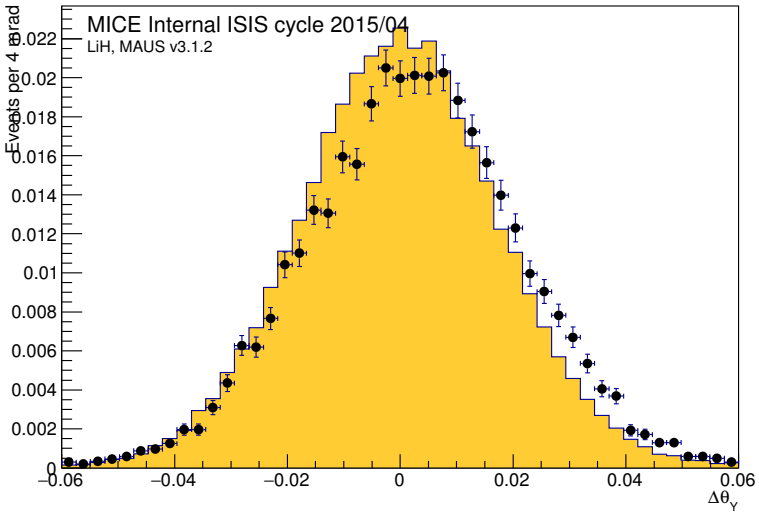
MC Data comparison

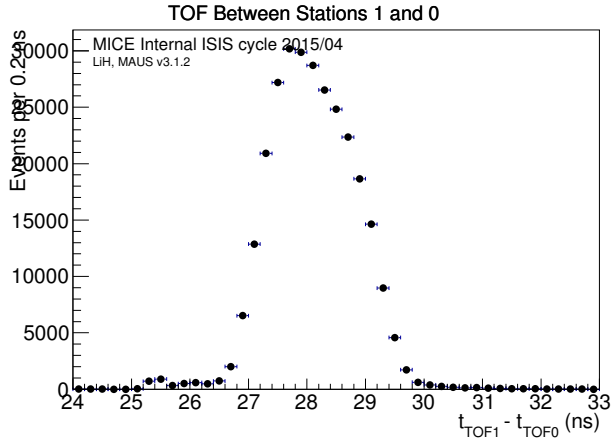


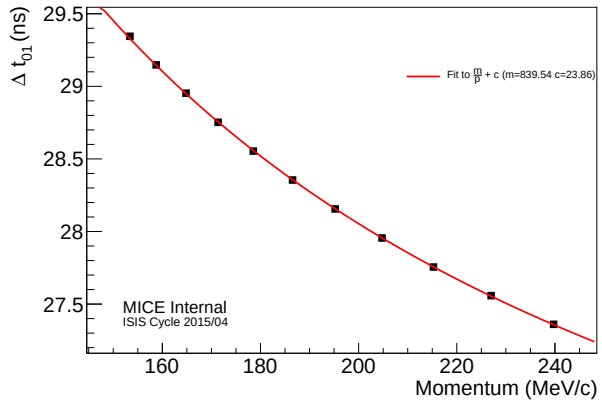


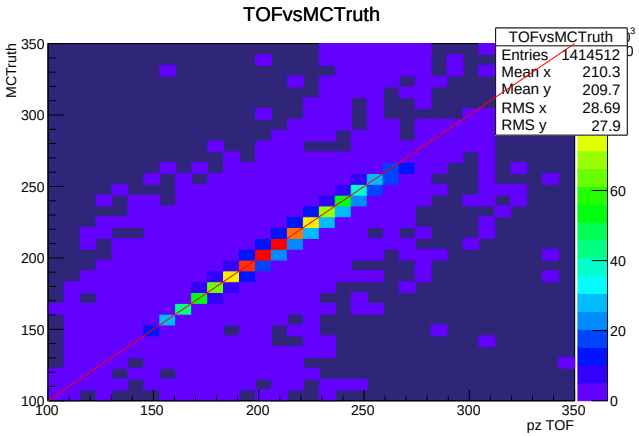


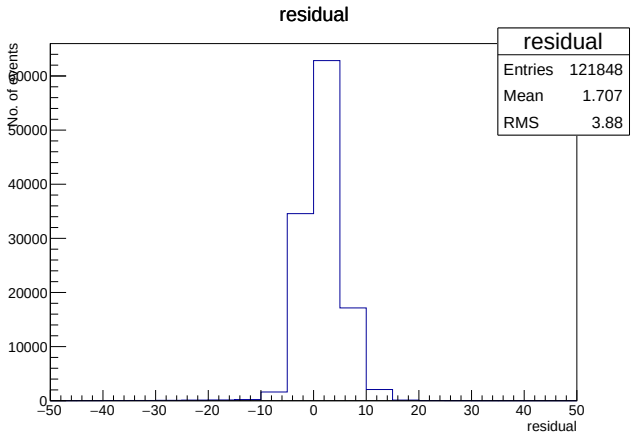
- 200 MeV/c case
- Compare MC recon and data

Momentum Correction

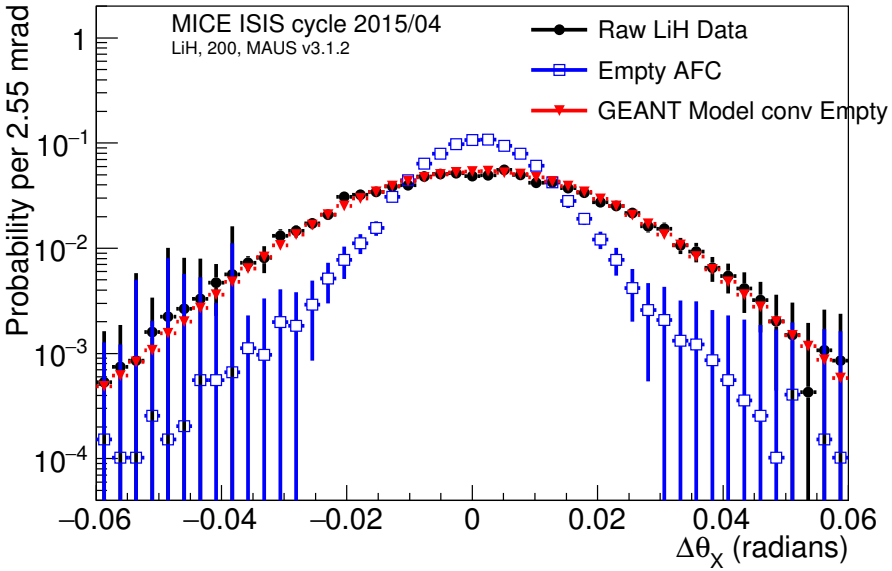


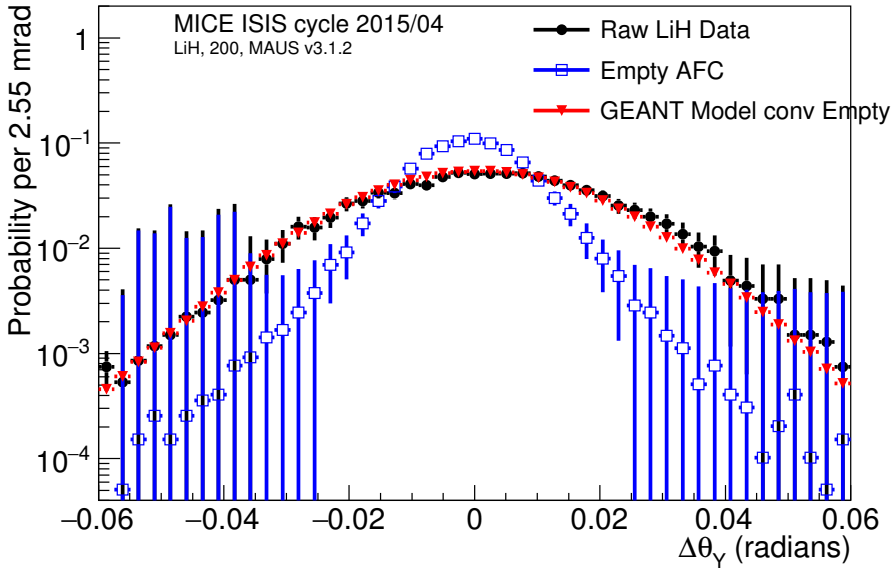




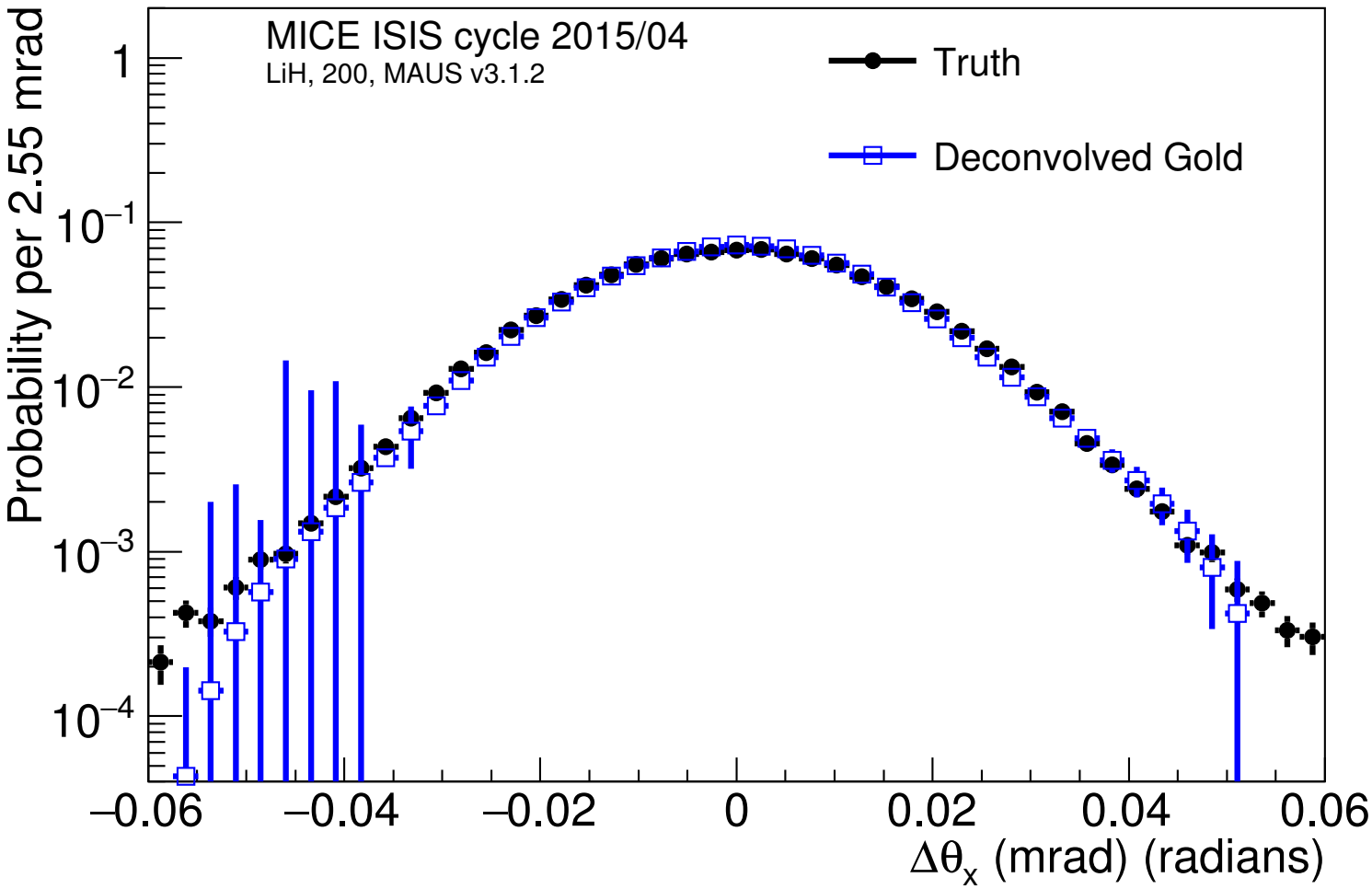


Forward convolution



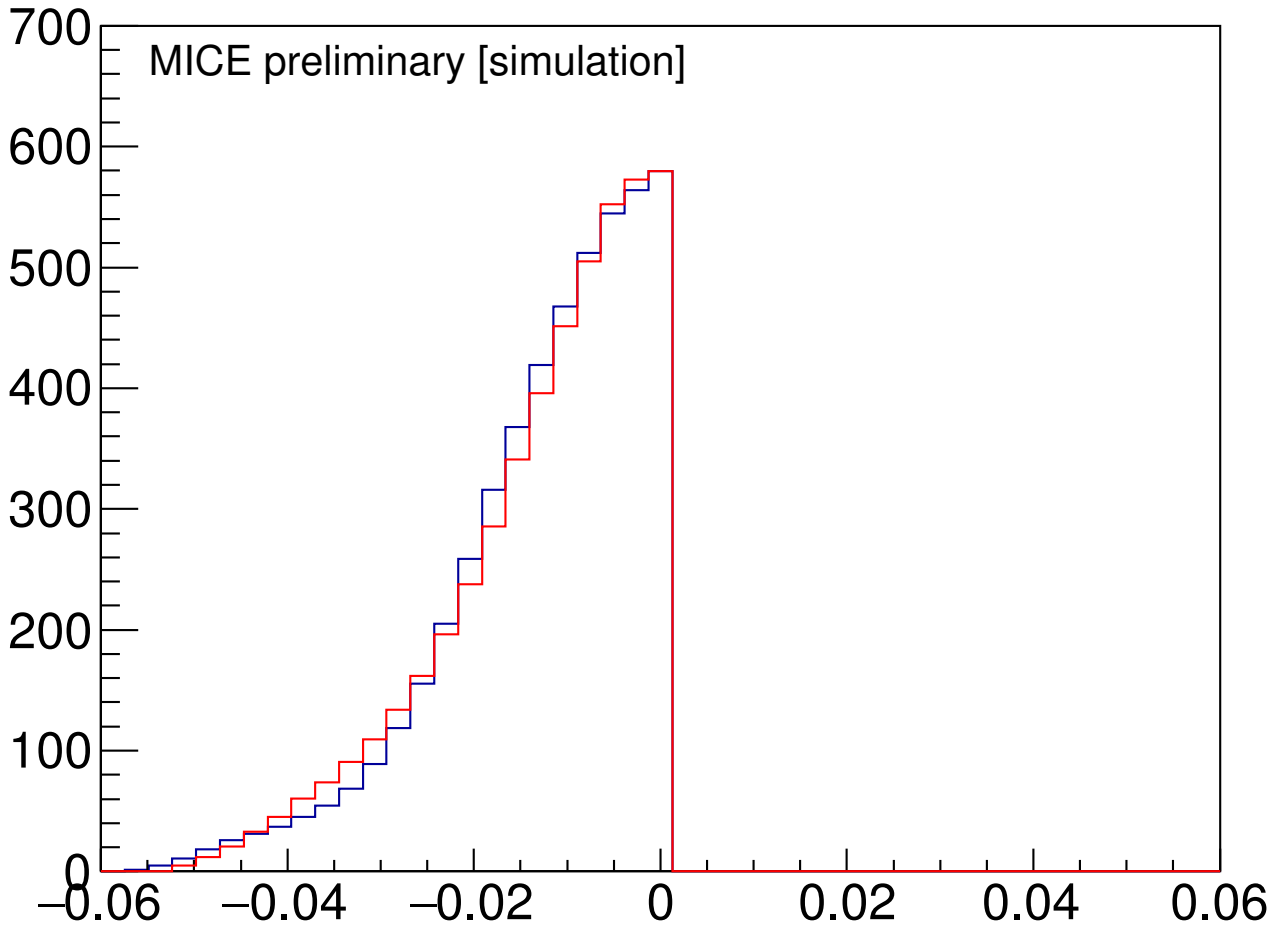


MC Data comparison



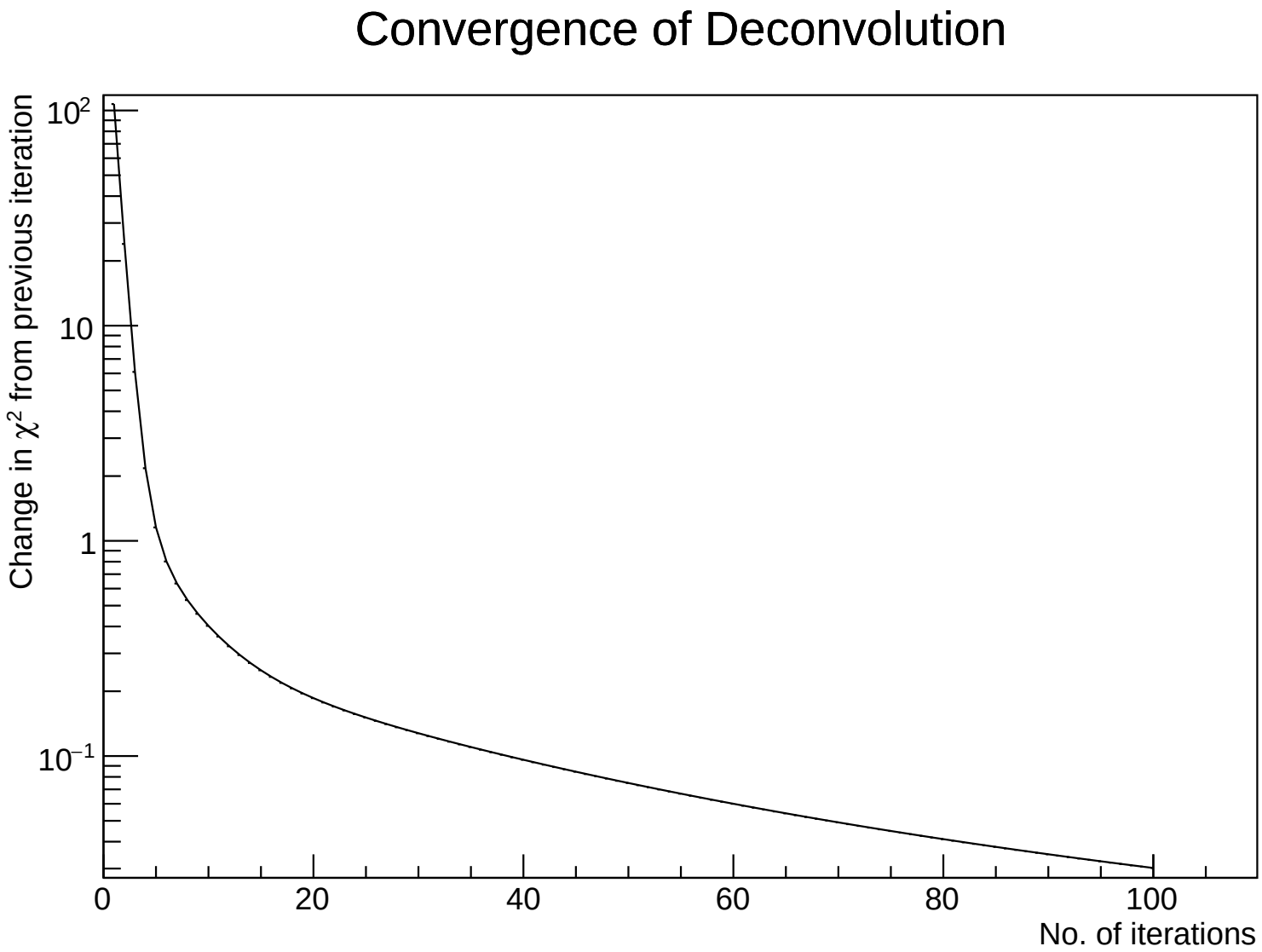
- 200 MeV/c case
- Compare MC recon and data

MC Data comparison - mirror



- 200 MeV/c case
- Compare MC recon and data

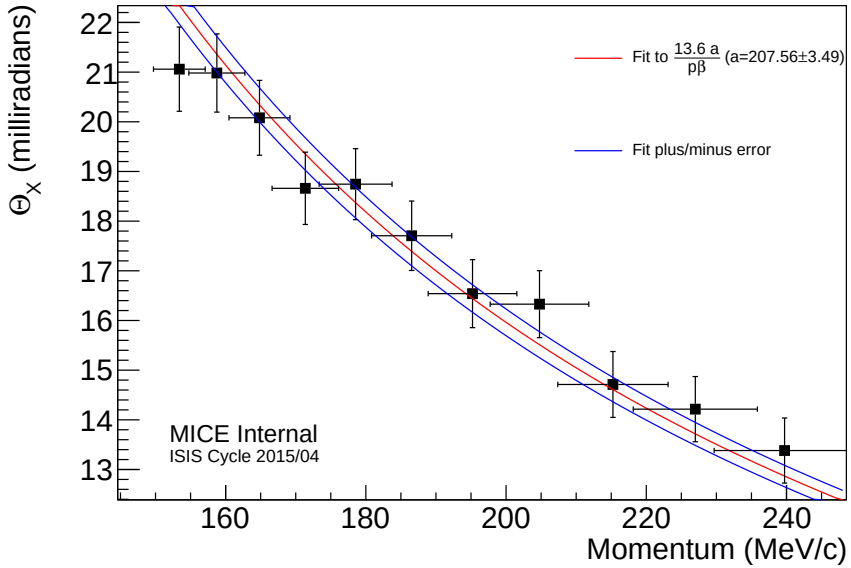
Convergence

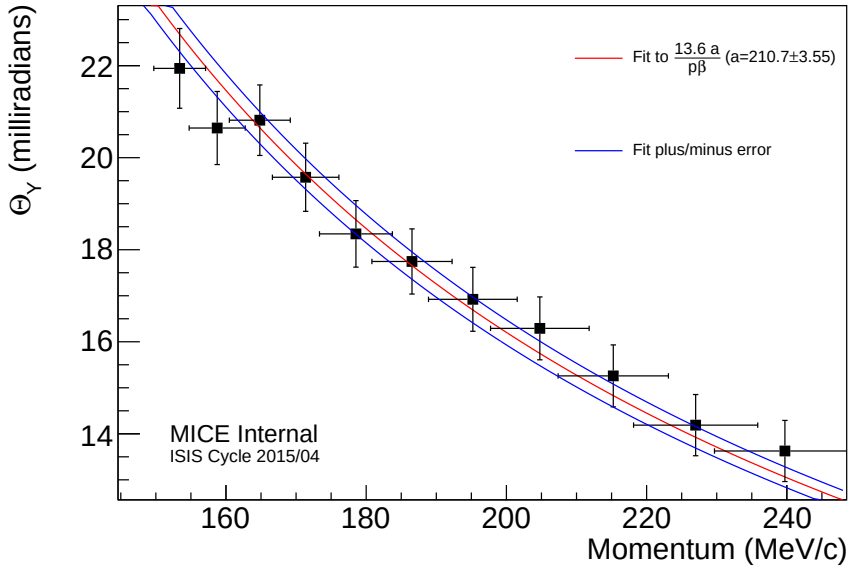


Systematic Errors

- Several sources have been considered
  - Alignment uncertainties
  - TOF uncertainties
  - Fiducial volume uncertainties
    - ★ pion contamation - studied in MC
    - ★ Angle defintion
- TOF systematic affects the momentum scale and is the dominant systematic
- All systematics are combined and included in final result

Θ as a Function of Momentum





- Scan across the entire momentum range and measure scattering in both projections in each bin
- Comparison with PDG formula is made and the fit is made for $a = \sqrt{\frac{z}{X_0}}(1 + 0.038 \ln \frac{z}{X_0})$

Job List

- Circulate updated version of Note

Selection

Selection	Description	μ Beams, LiH abs. 172	200	240
TOF1 trigger	At least two raw TOF slab hits exist and at least one in each TOF plane.	1.	1.	1.
Upstream track selection	There is one US track and at most one track in the DS tracker (If there is no DS track $\theta_X = \theta_Y = 45^\circ$).	66.84 %	68.05 %	74.15%
TOF timing selection	Select muons from run at the target momentum.	4.1 %	5.42 %	7.77 %
Fiducial selection	For projected US tracks $\sqrt{x^2+y^2} < r_0$ at plane 5 of DS tracker, where $x = x_0 + (\frac{dx}{dz} + a_0 \cos\phi)\Delta z$, $y = y_0 + (\frac{dy}{dz} + a_0 \sin\phi)\Delta z$, and $\phi = \tan^{-1}\frac{dy/dz}{dx/dz}$. $r_0 = 150$ mm and $a_0 = 0.012$ assumed.	0.09 %	0.19 %	0.41 %
Diffuser cut	US tracks are projected to the diffuser position any track within the radius of the diffuser annulus is rejected	0.07 %	0.16 %	0.36 %

Scattering Data

Scattering Angle Definitions

- In the top diagram both the solid vectors are in the plane of the square i.e. the plain of the board. The y-axis is coming out of the board
- If both the up- and downstream vector were in the same plane then the subtraction of the simple projected angle would be sufficient
- The bottom figure is a side on view of the top figure. If the up- and downstream vectors are in two different planes then a more consider apporach is required as detailed in `http://www.ppe.gla.ac.uk/~jnugent/Projected-angles.pdf` by John Cobb