

Field Off Scattering Studies: Current Status

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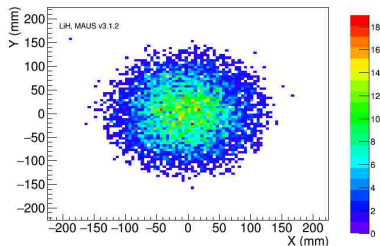
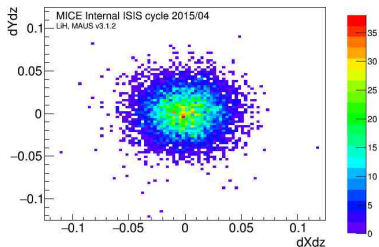
24/1/2019

Job List

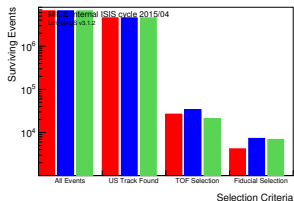
- Update Note - in progress preparing for referee review in next few weeks
 - ▶ Deconvolution algorithm has changed
 - ▶ Selection has been updated

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
 - ▶ Convolved with physics model of scattering in absorber - prediction.
 - ▶ Measure absorber scattering
 - ▶ Gold deconvolution algorithm unfolds absorber scattering distribution
 - ▶ χ^2 comparison between data and prediction
 - ▶ Width of scattering distribution: Θ as a function of P



Selection

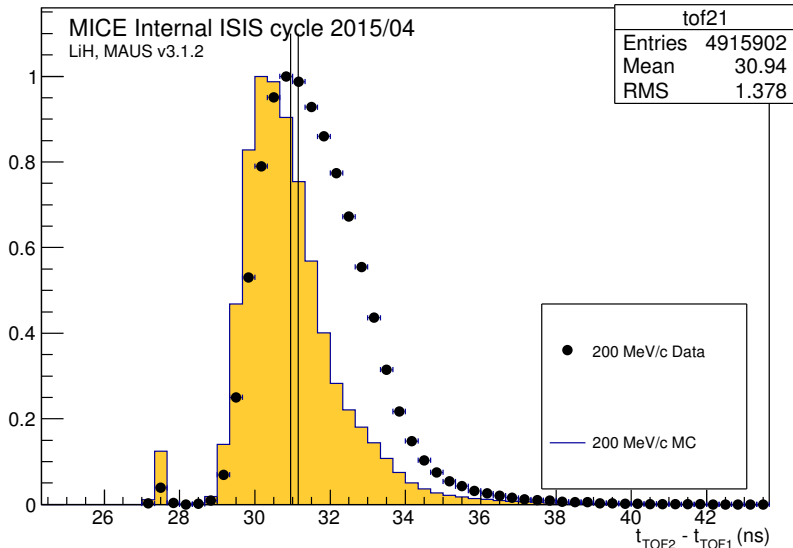


Cuts

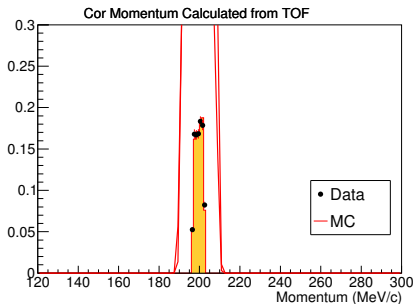
- Require a US track. If a DS track not extant, statistics are set to overflow values.
- Analysis done in 200 ps bins, as shown in TOF plot
- Require projection of US tracks to appear, when 12 mrad radial angle is added, within central 140 mm radius of DS trkr plane 5
- Tracks are projected to the upstream face of the diffuser, if track crosses the diffuser it is rejected
- Tracks must have $\chi^2/\text{NDF} < 4$

Cut plot

TOF Between Stations 2 and 1

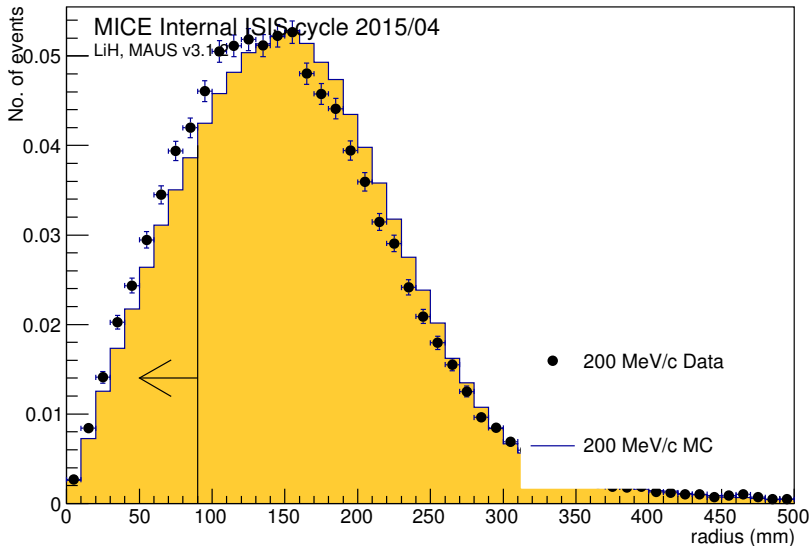


MC Data comparison

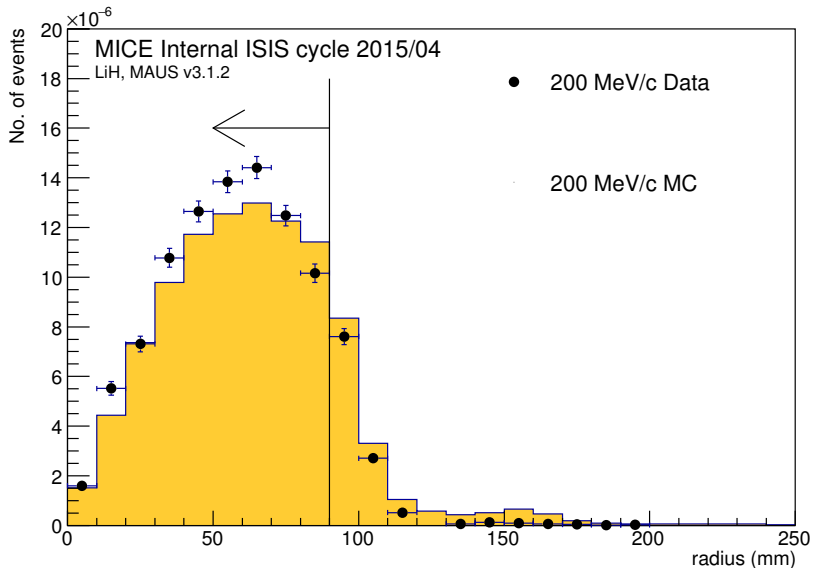


- 200 MeV/c case
- Compare MC recon and data

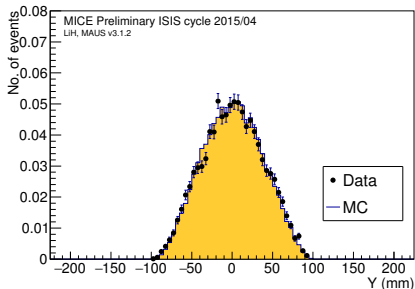
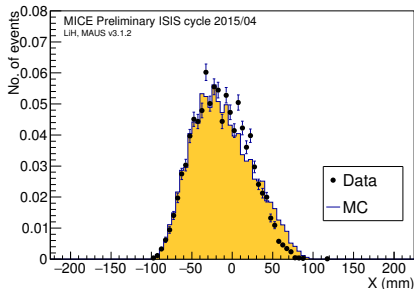
Cut plot



Cut plot

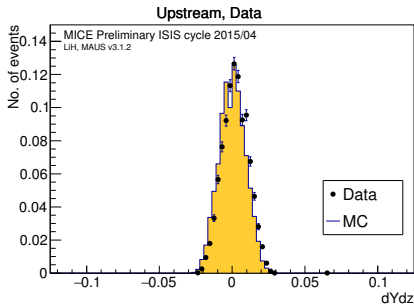
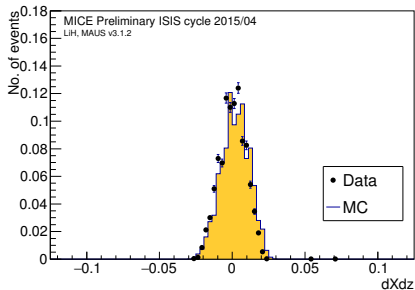


MC Data comparison



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

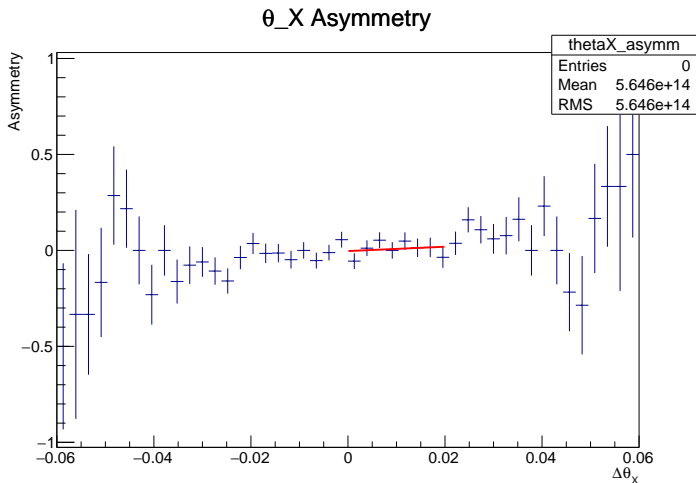
MC Data comparison



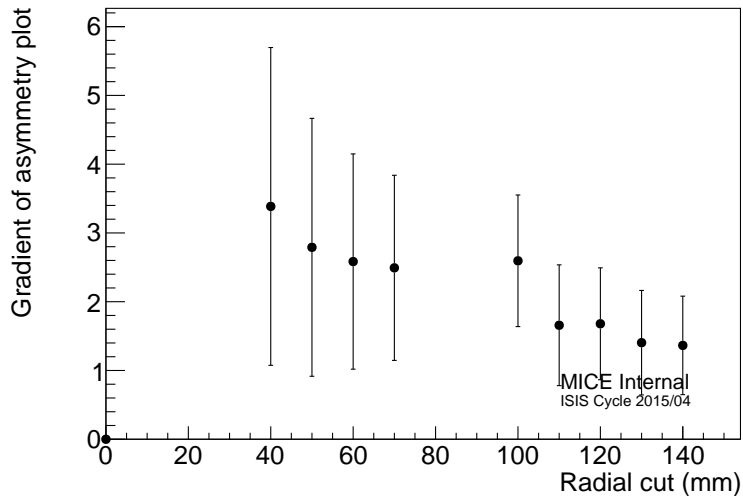
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Asymmetry plot (LiH)

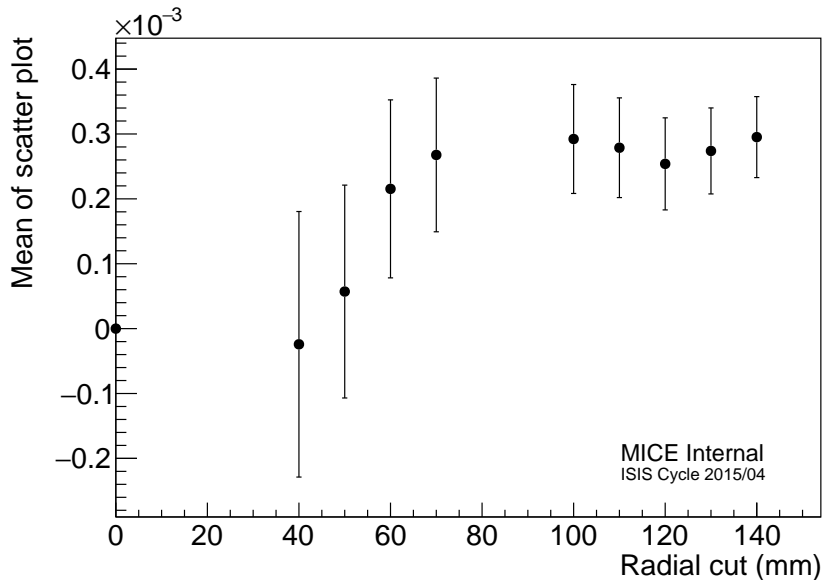
$$A_i = \frac{h_1 - h_2}{h_1 + h_2} \quad (1)$$



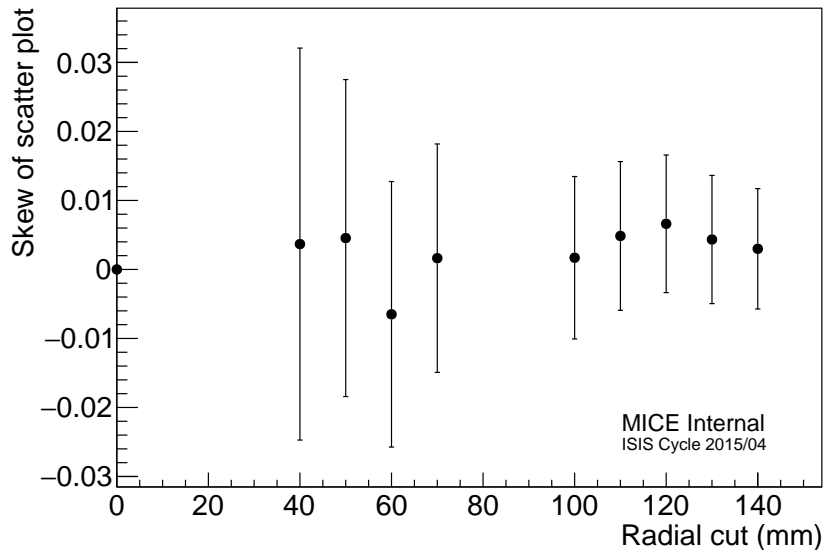
Asymmetry scan



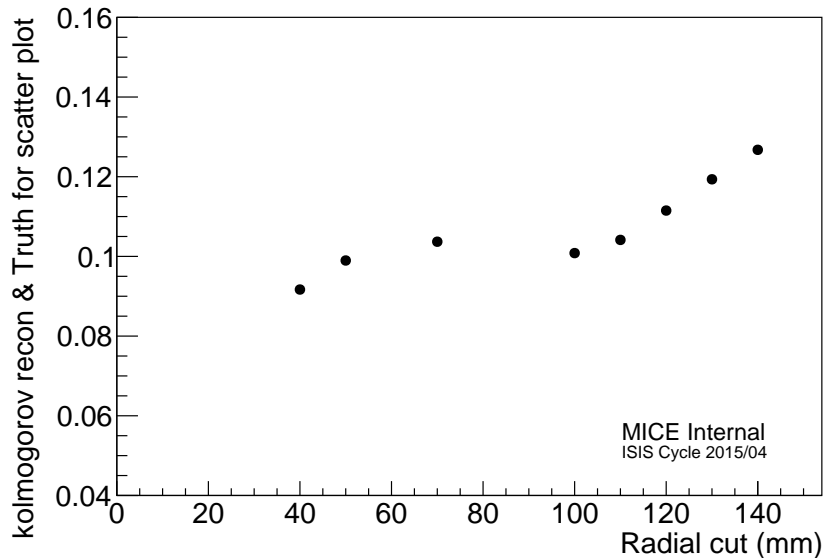
Mean scan



Skew scan

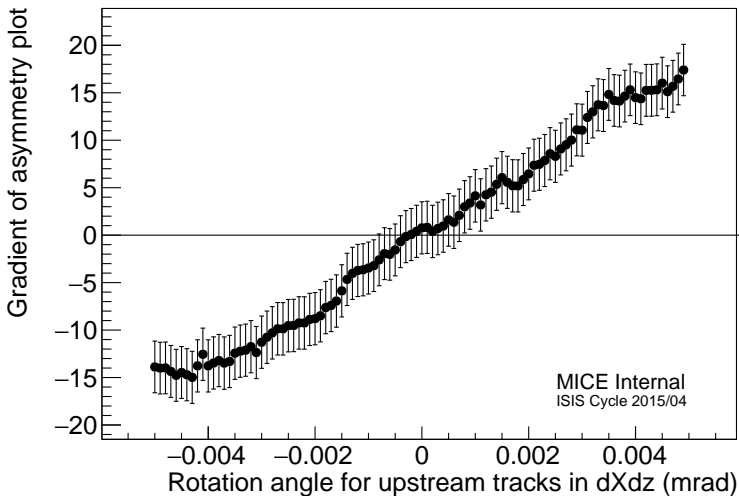


Kolmogorov scan



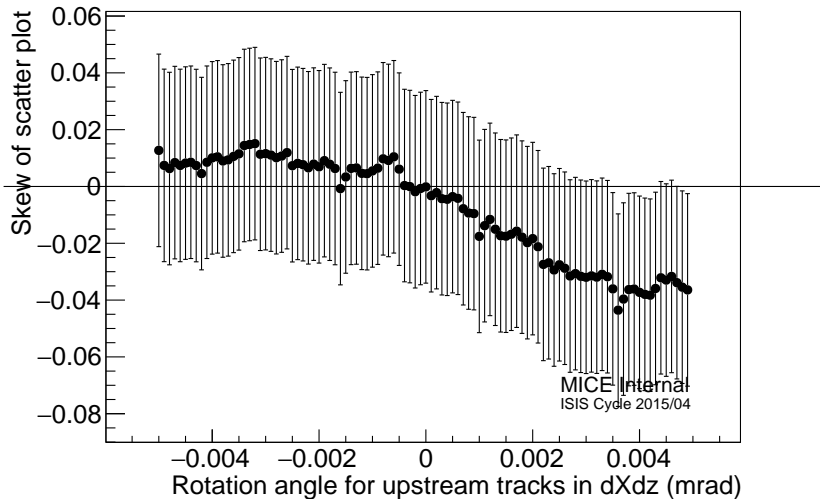
Rotate upstream track

Choose to cut at 90 mm for fiducial volume, look at data

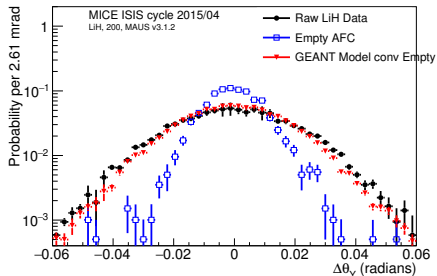
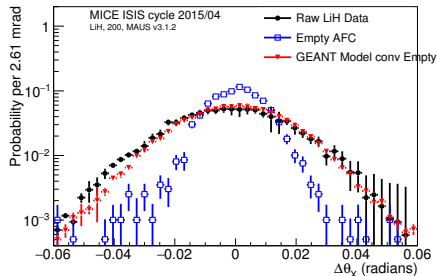


Rotate upstream track

Choose to cut at 90 mm for fiducial volume, look at data

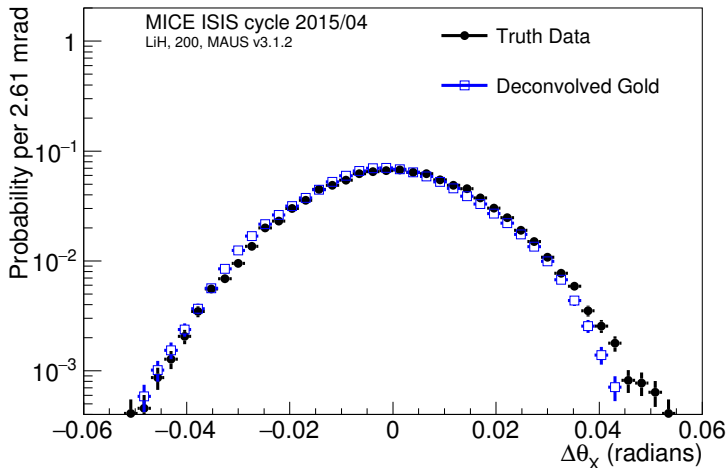


Forward convolution



Update model to Moliere or latest MC production

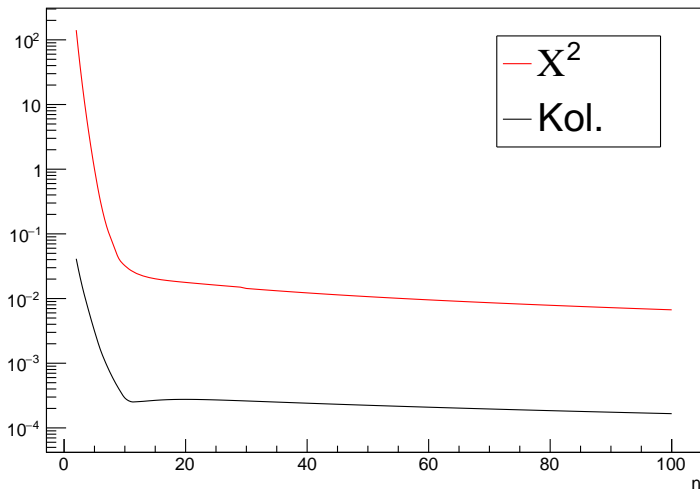
MC Data comparison



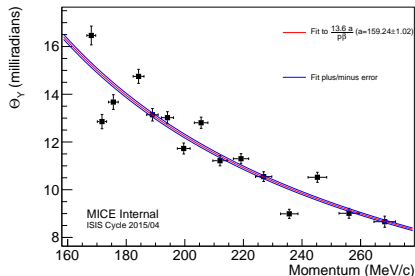
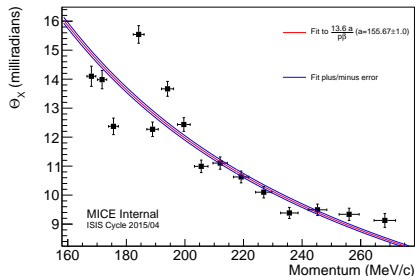
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Convergence

χ^2 and Kolmogorov tests for n and $n-1$ iterations of deconvolution of θ_x



Θ as a Function of Momentum



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

Job List

- Continue updating Note
- Meet with referees at CM53

Selection

Selection	Description	μ Beams, LiH abs.		
		172	200	240
Upstream track selection	There is one US track and at most one track in the DS tracker (If there is no DS track $\theta_X = \theta_Y = 45^\circ$).	69.13 %	69.13 %	69.13 %
TOF timing selection	Select muons from run at the target momentum.	3.76 %	4.22 %	3.05 %
Fiducial selection	For projected US tracks $\sqrt{x^2 + y^2} < r_0$ at plane 5 of DS tracker, where $x = x_0 + (\frac{dx}{dz} \Delta z)$, $y = y_0 + (\frac{dy}{dz} \Delta z)$ and $r_0 = 140$ mm.	0.1 %	0.17 %	0.19 %
Diffuser cut	US tracks are projected to the diffuser position any track outwith 90 mm (the radius of the diffuser annuli) is rejected	0.09 %	0.16 %	0.26 %
χ^2 of track is less than 4	0.09 %	0.16 %	0.26 %	

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 approach is required as detailed in <http://www.ppe.gla.ac.uk/~jnugent/Projected-angles.pdf> by John Cobb

