Solenoid Mode Analysis

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22/10/2020 / Collaboration Meeting 57

Solenoid Mode Analysis Review

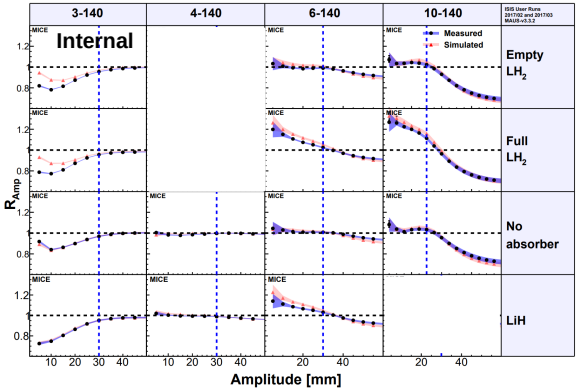
- Analysis of 2017-02-6 solenoid mode data in good shape (ish)
  - Need recommissioning of this MC following SciFiParams_Density discussion, expect better matching of Px, Py distributions after redoing dipole beam tuning
  - Amplitude analysis with systematics for 3,4,6,10-140 & 3-170,200,240 beams

Systematics used:

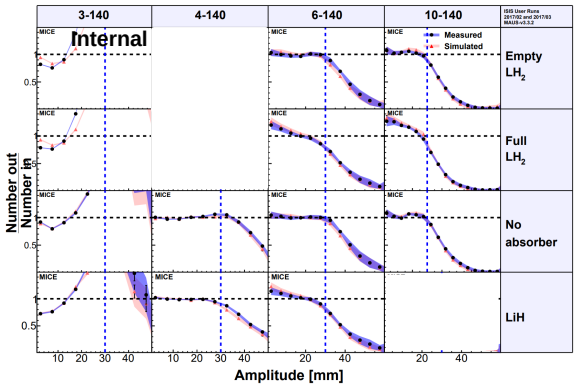
- +3mrad tku/tkd rotation in x
- +3mm tku/tkd position in x
- +3% in SSU/SSD Centre
- +5% in SSU/SSD E1/E2
- +50% (2->3g/cm^3) tracker glue density

2017-02-6 140 MeV beam

CDF Ratios



PDF Ratios

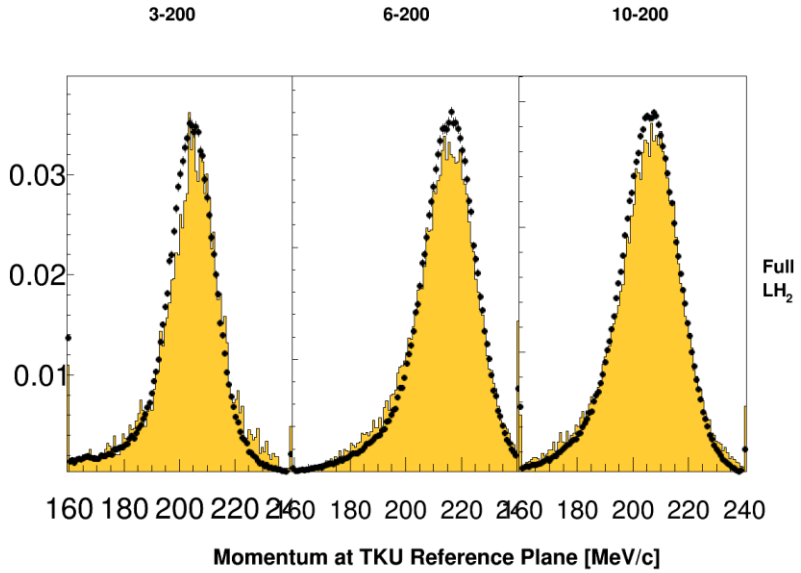


Ready for MC commissioning for other CC tags (dependent on later slides)

Solenoid Mode Analysis Review

Example beam tunes at higher momentum – 200 MeV beam

3-170/200/240 beams appear to be largely unresponsive to D2 changes – anything between D2 +0% and D2 +10% shows good agreement



Solenoid Mode Analysis Updates

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- Canonical angular momentum measurement introduced
- MC Reco vs MC Truth discrepancy noted, single field value in each tracker reco suspected as contributing
- Correction(s) attempted, results mixed

Solenoid Mode Analysis Updates

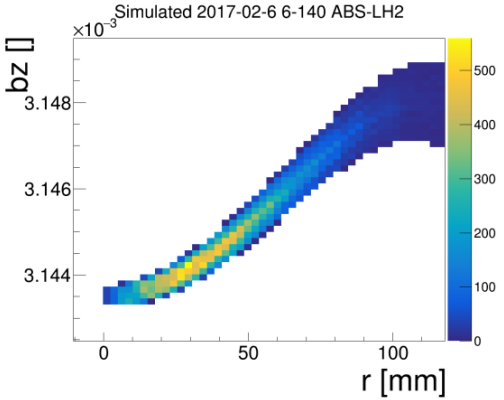
$$\mathrm{L}_{\mathrm{canon}} = xP_y - yP_x + qr\mathrm{A}$$

$L_{field} = qr\mathrm{A}_\phi \approx \frac{qr^2 B_z}{2}$ by paraxial approximation (first order)

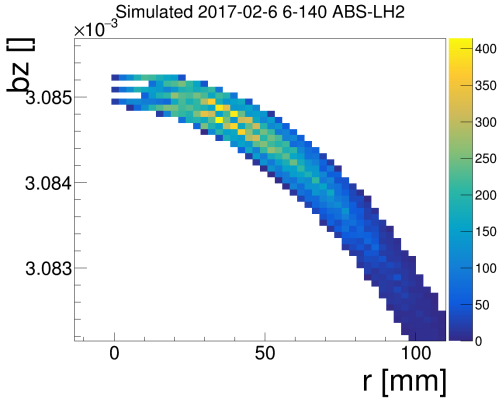
Load particle Bz at reconstructed trackpoint (x,y,z) position from MAUS field geometry

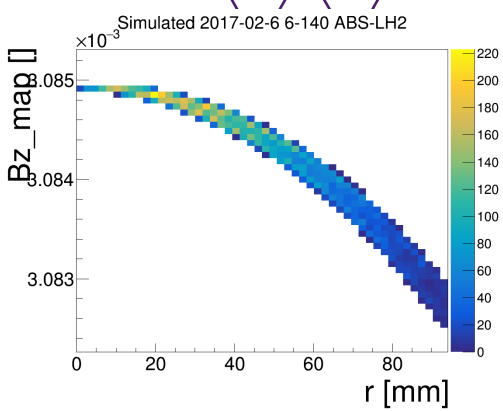
B_z vs r plots – Bz Truth

TKU S1



TKU S2





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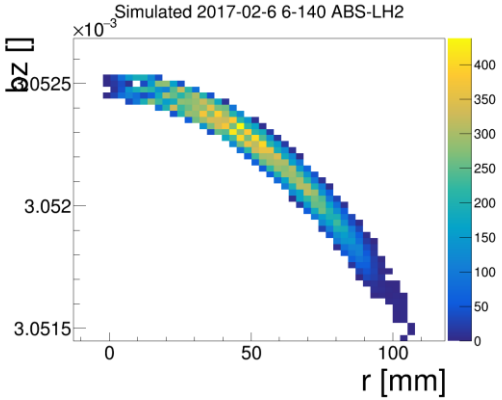
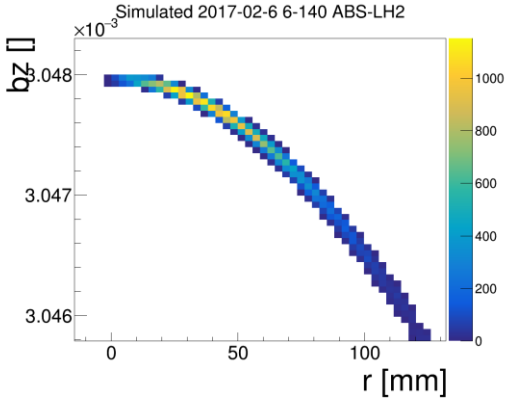
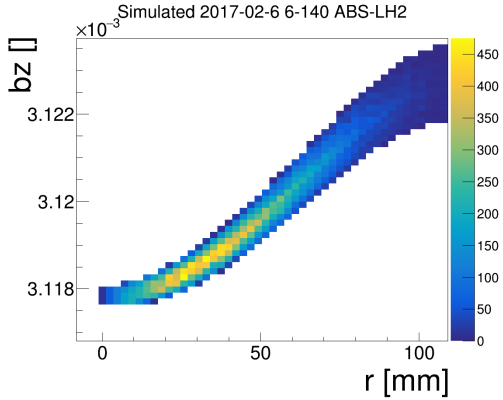


TKU S4

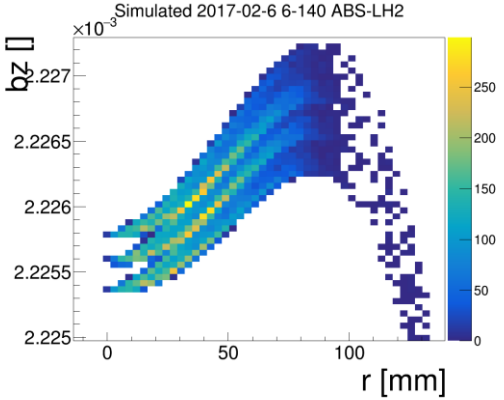


TKU S5



B_z vs r plots – Bz Truth

TKU S1



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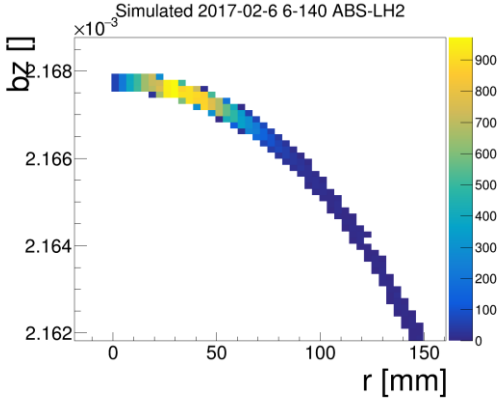

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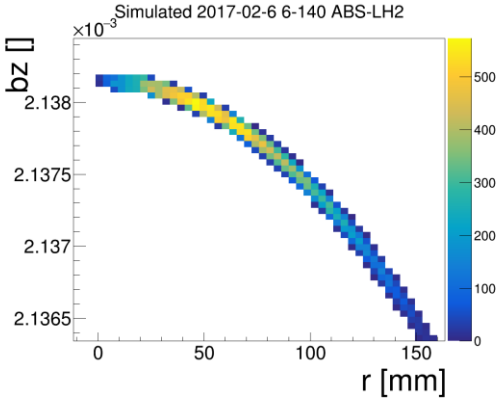
TKU S3



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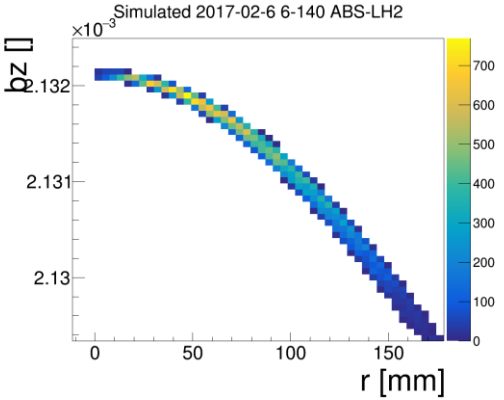

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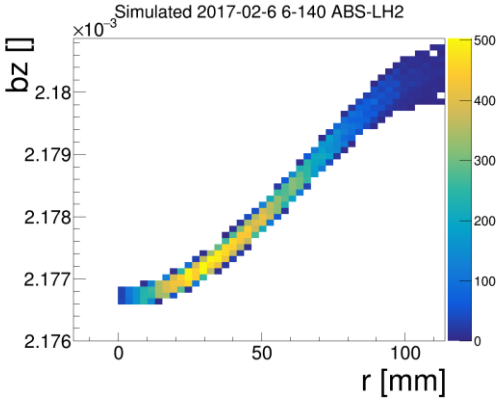

B_z vs r plots – Bz

Truth field vs Reco field from field map

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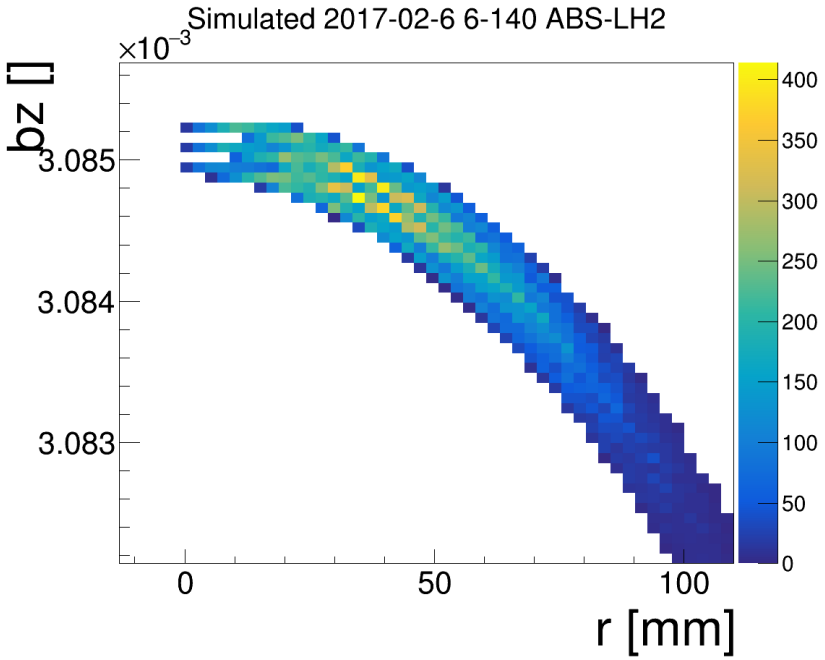
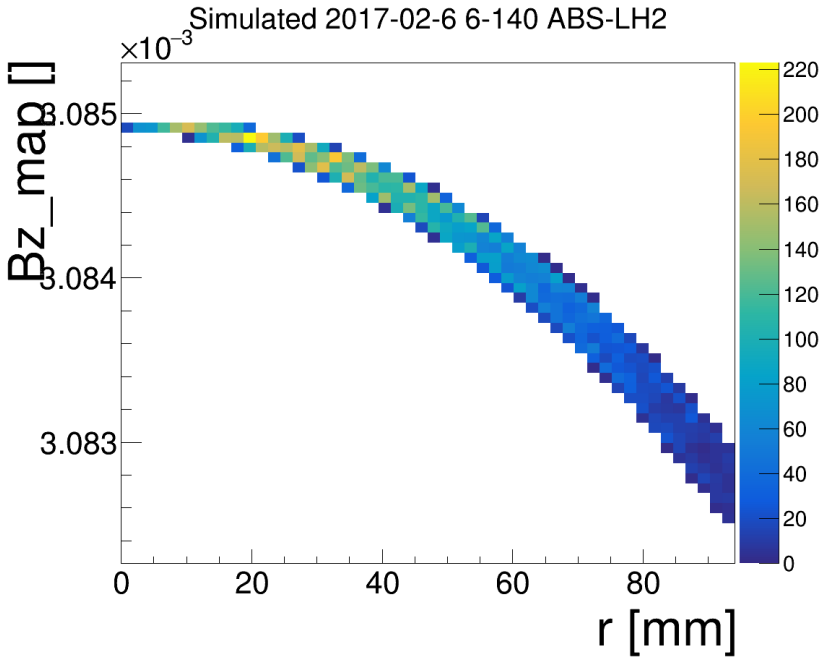
TKU S2 Truth



TKU S2 Reco



B_z vs r plots – Bz

Truth field vs Reco field from field map

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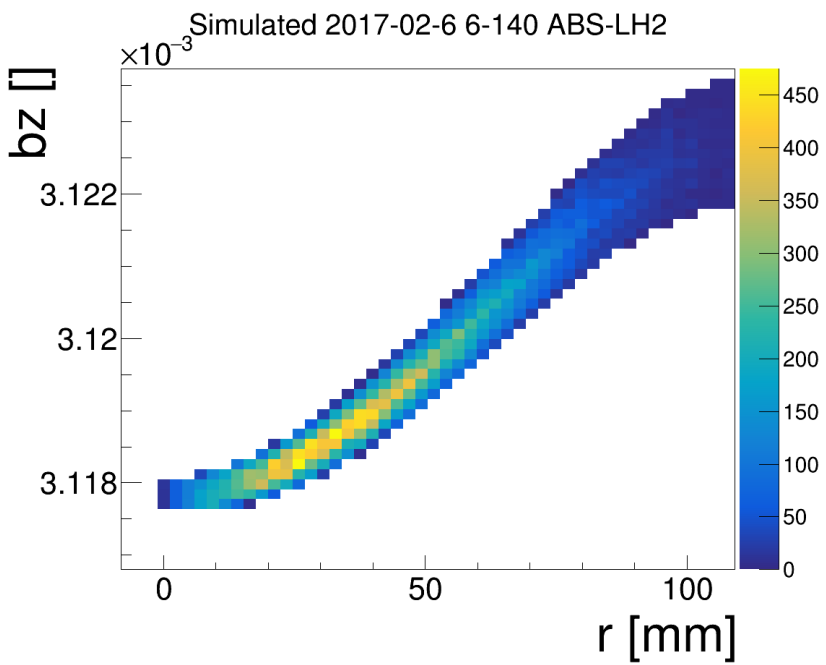
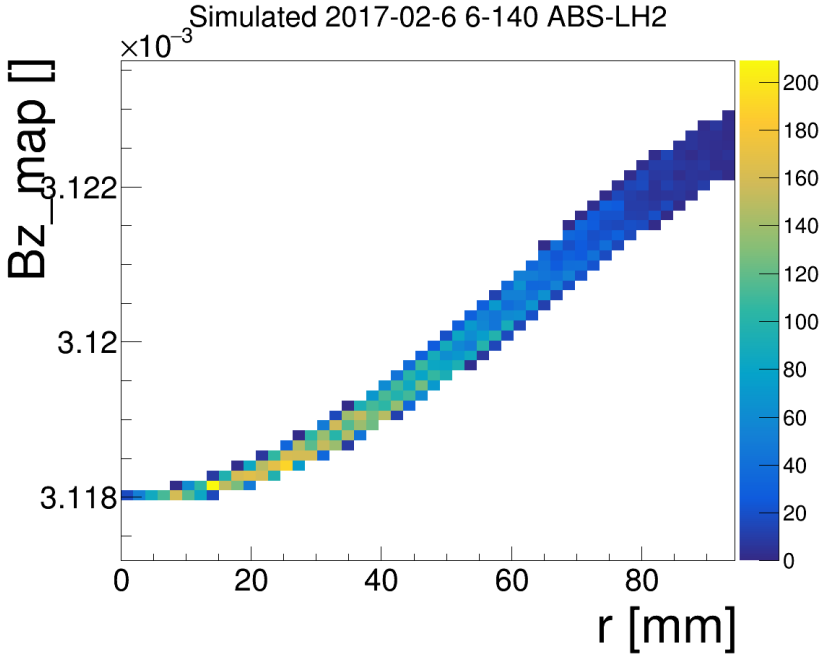
TKU S5 Truth



TKU S5 Reco



Hall Probes

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Looking at extracting “clean” data from hall probe readings to compare fields across each cooling channel tag

Some residual plots, but clearly bad readings mixed in with good.

Have removed HP:66, HP:67, HP:80 as these probes were found to be hanging loose at some inspection date

Not all probes active across all runs

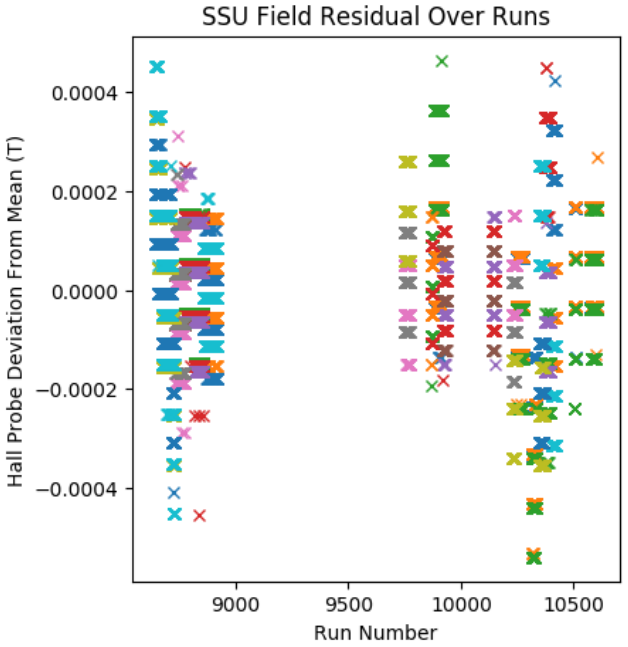
Hall Probe Residuals Per Cooling Channel Tag – Solenoid Mode Runs

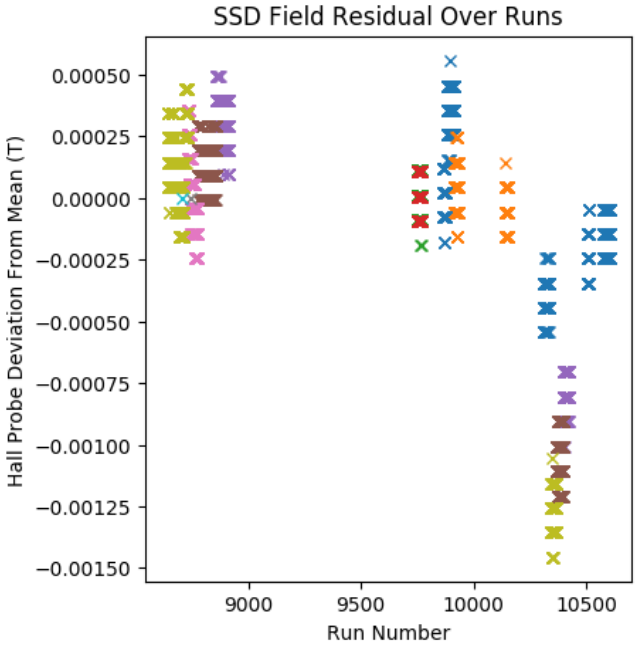
SSU

- MICE-SSU-HP-65:B, 2017-02-6, mean field 3.03983
- MICE-SSU-HP-77:B, 2017-02-6, mean field 3.07293
- MICE-SSU-HP-79:B, 2017-02-6, mean field 3.03774
- MICE-SSU-HP-65:B, 2017-02-5, mean field 3.03988
- MICE-SSU-HP-77:B, 2017-02-5, mean field 3.07295
- MICE-SSU-HP-79:B, 2017-02-5, mean field 3.03802
- MICE-SSU-HP-65:B, 2017-02-2, mean field 3.04185
- MICE-SSU-HP-77:B, 2017-02-2, mean field 3.07389
- MICE-SSU-HP-79:B, 2017-02-2, mean field 3.03984
- MICE-SSU-HP-65:B, 2016-04-2.4a, mean field 3.07551
- MICE-SSU-HP-77:B, 2016-04-2.4a, mean field 3.10748
- MICE-SSU-HP-79:B, 2016-04-2.4a, mean field 3.07315
- MICE-SSU-HP-65:B, 2016-04-1.7, mean field 3.07555
- MICE-SSU-HP-77:B, 2016-04-1.7, mean field 3.10745
- MICE-SSU-HP-79:B, 2016-04-1.7, mean field 3.07316
- MICE-SSU-HP-65:B, 2016-04-1.5, mean field 3.07367
- MICE-SSU-HP-77:B, 2016-04-1.5, mean field 3.10629
- MICE-SSU-HP-79:B, 2016-04-1.5, mean field 3.07137
- MICE-SSU-HP-65:B, 2016-04-1.2, mean field 3.04315
- MICE-SSU-HP-77:B, 2016-04-1.2, mean field 3.07515
- MICE-SSU-HP-79:B, 2016-04-1.2, mean field 3.04081
- MICE-SSU-HP-65:B, M2D-flip-2017-02-5, mean field 3.03955
- MICE-SSU-HP-77:B, M2D-flip-2017-02-5, mean field 3.07269
- MICE-SSU-HP-79:B, M2D-flip-2017-02-5, mean field 3.03771

SSD

- MICE-SSD-HP-72:B, 2017-02-6, mean field 2.12224
- MICE-SSD-HP-72:B, 2017-02-5, mean field 3.02286
- MICE-SSD-HP-72:B, 2017-02-2, mean field 3.00879
- MICE-SSD-HP-73:B, 2017-02-2, mean field 3.05549
- MICE-SSD-HP-72:B, 2016-04-2.4a, mean field 3.04341
- MICE-SSD-HP-72:B, 2016-04-1.7, mean field 3.04241
- MICE-SSD-HP-72:B, 2016-04-1.5, mean field 3.04254
- MICE-SSD-HP-73:B, 2016-04-1.5, mean field 3.057
- MICE-SSD-HP-72:B, 2016-04-1.2, mean field 3.01146
- MICE-SSD-HP-73:B, 2016-04-1.2, mean field 3.057
- MICE-SSD-HP-72:B, M2D-flip-2017-02-5, mean field 2.99558

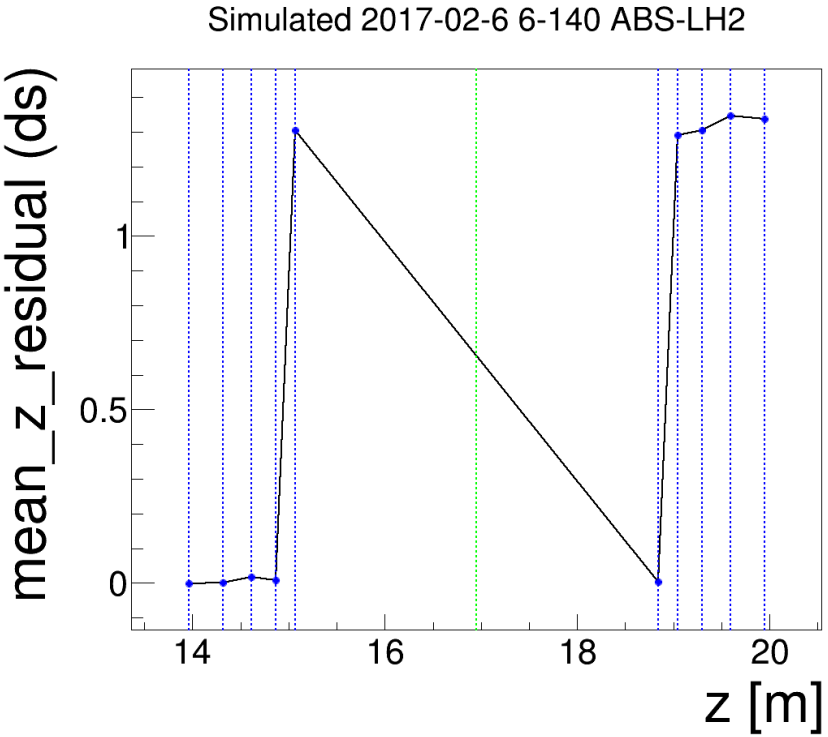


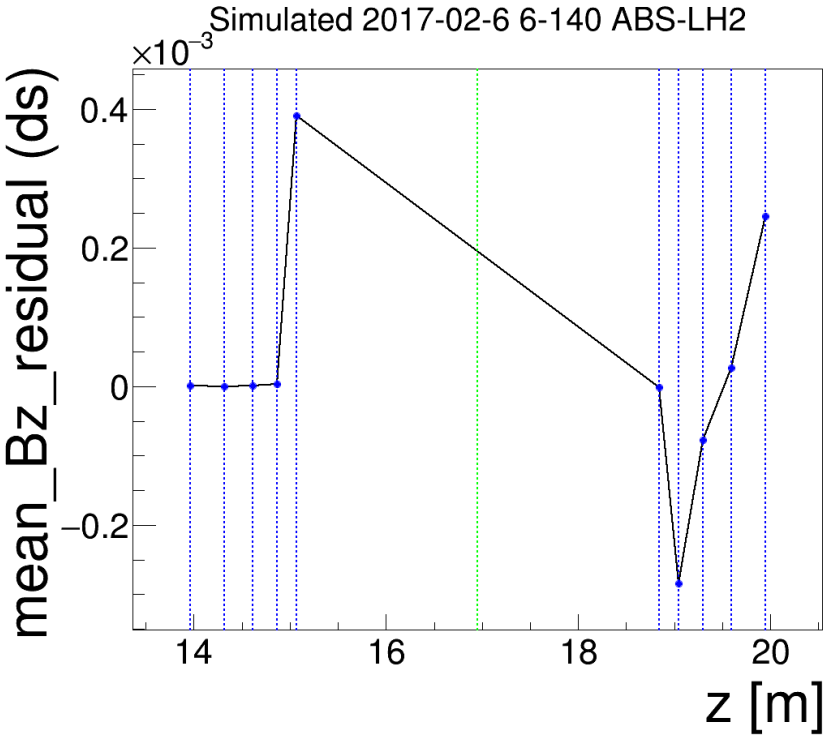


Deviation from mean measured field over one CC setting

Mean Z / Mean Bz

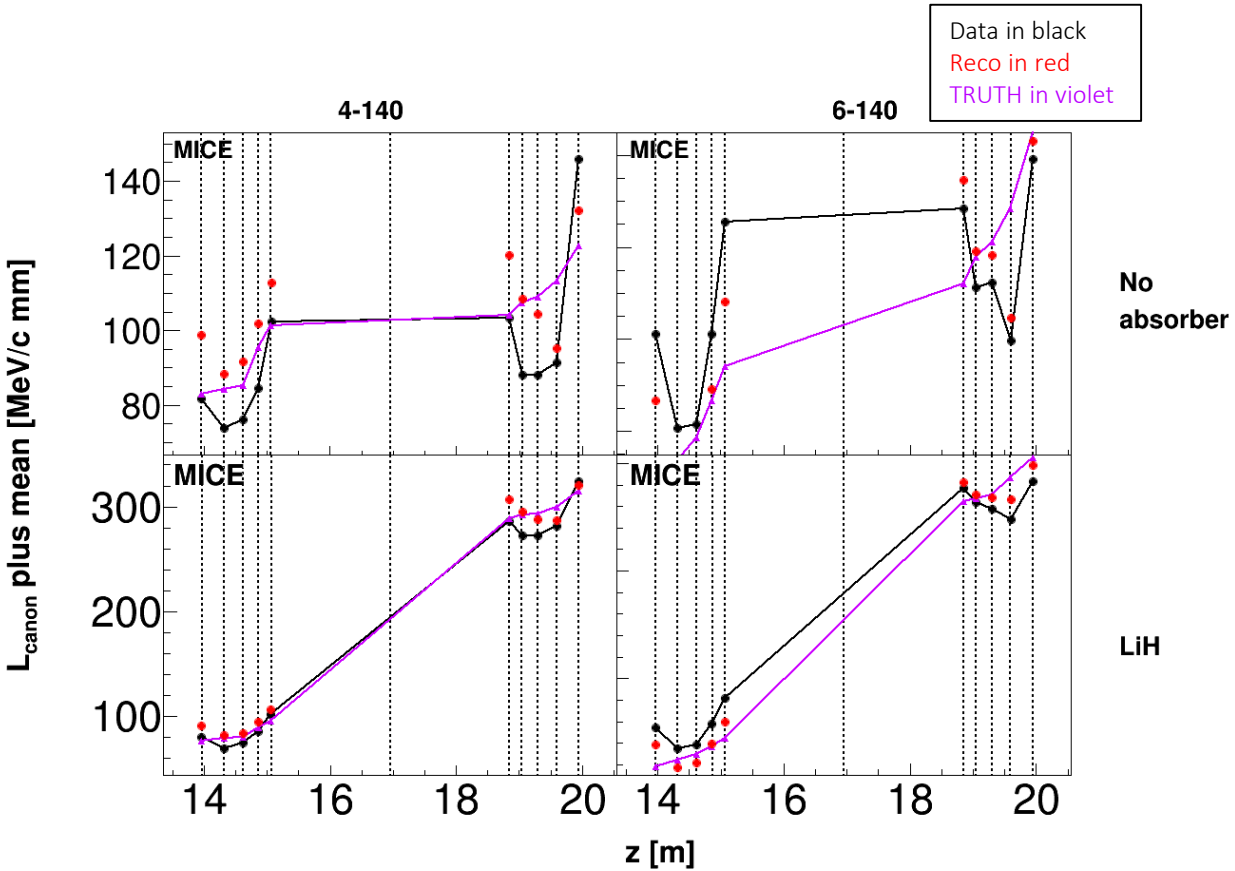
Something buggy this way comes



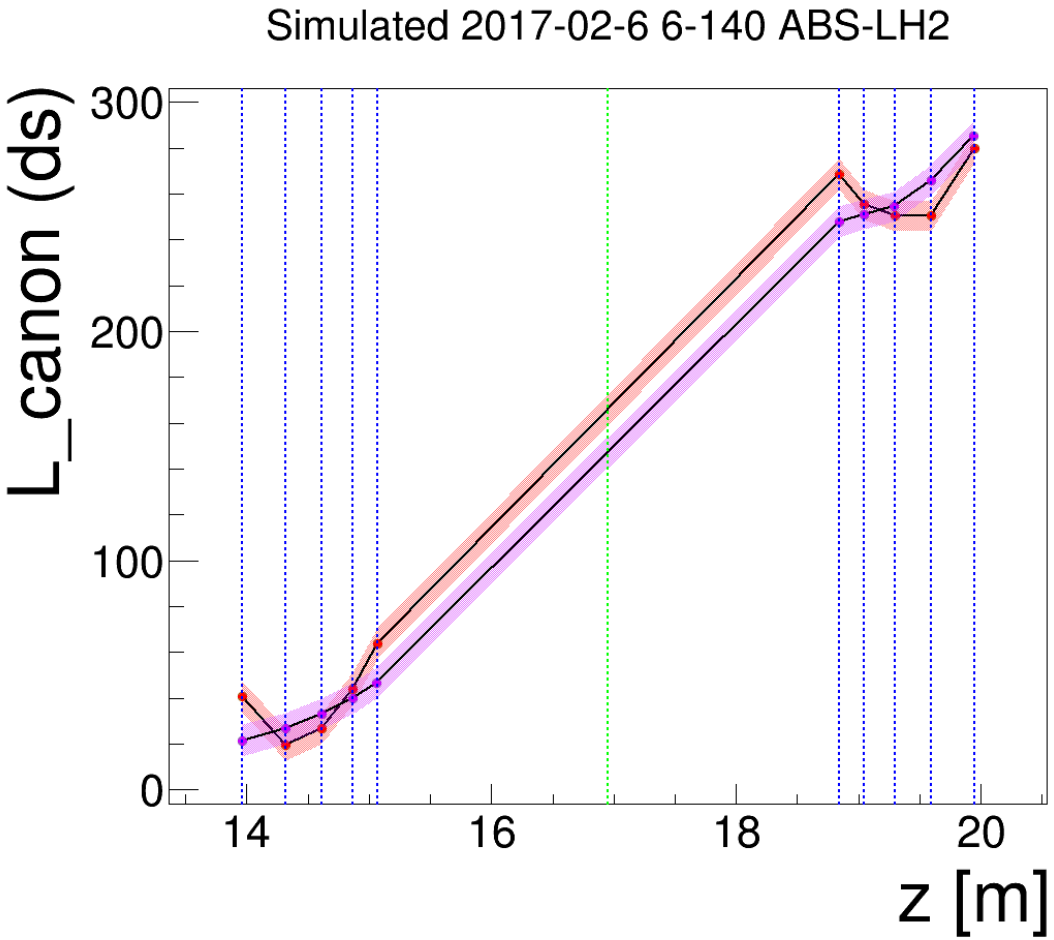


Canonical Angular Momentum – Kinetic + Field Term

The only angular momentum plot I will show with <u>data</u> today



L canon mean



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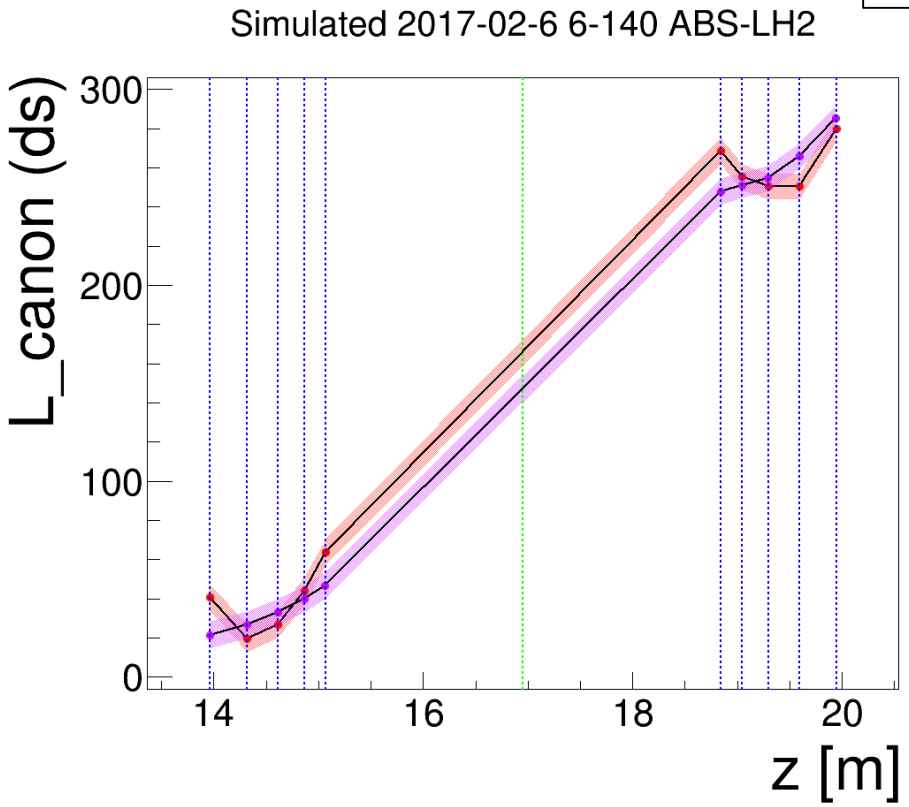
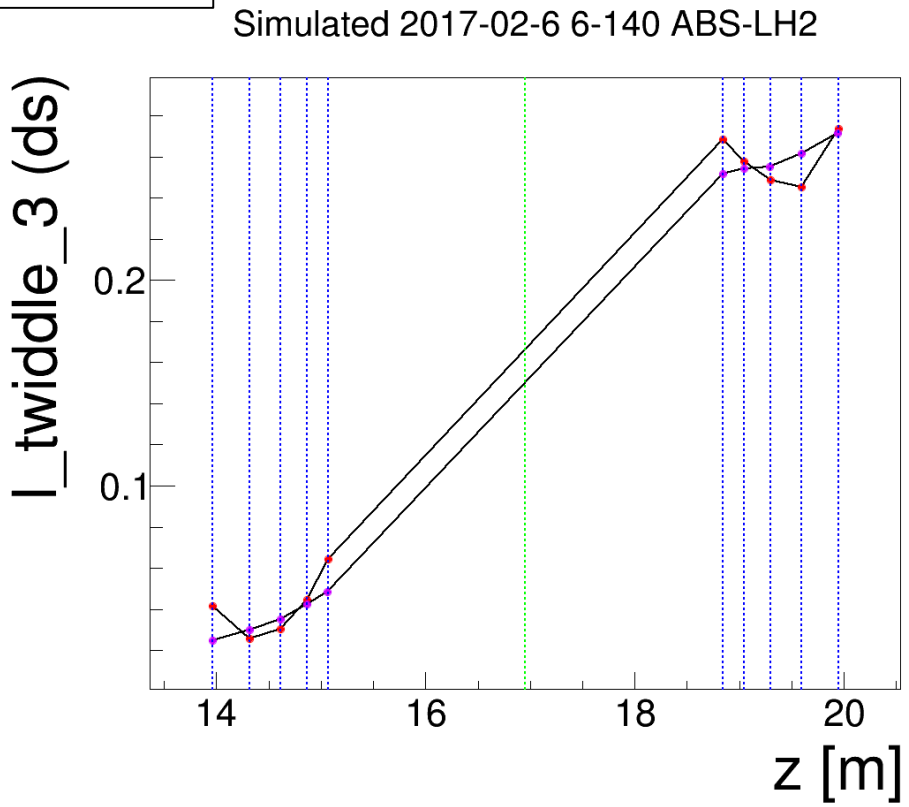
Reco in red
TRUTH in violet

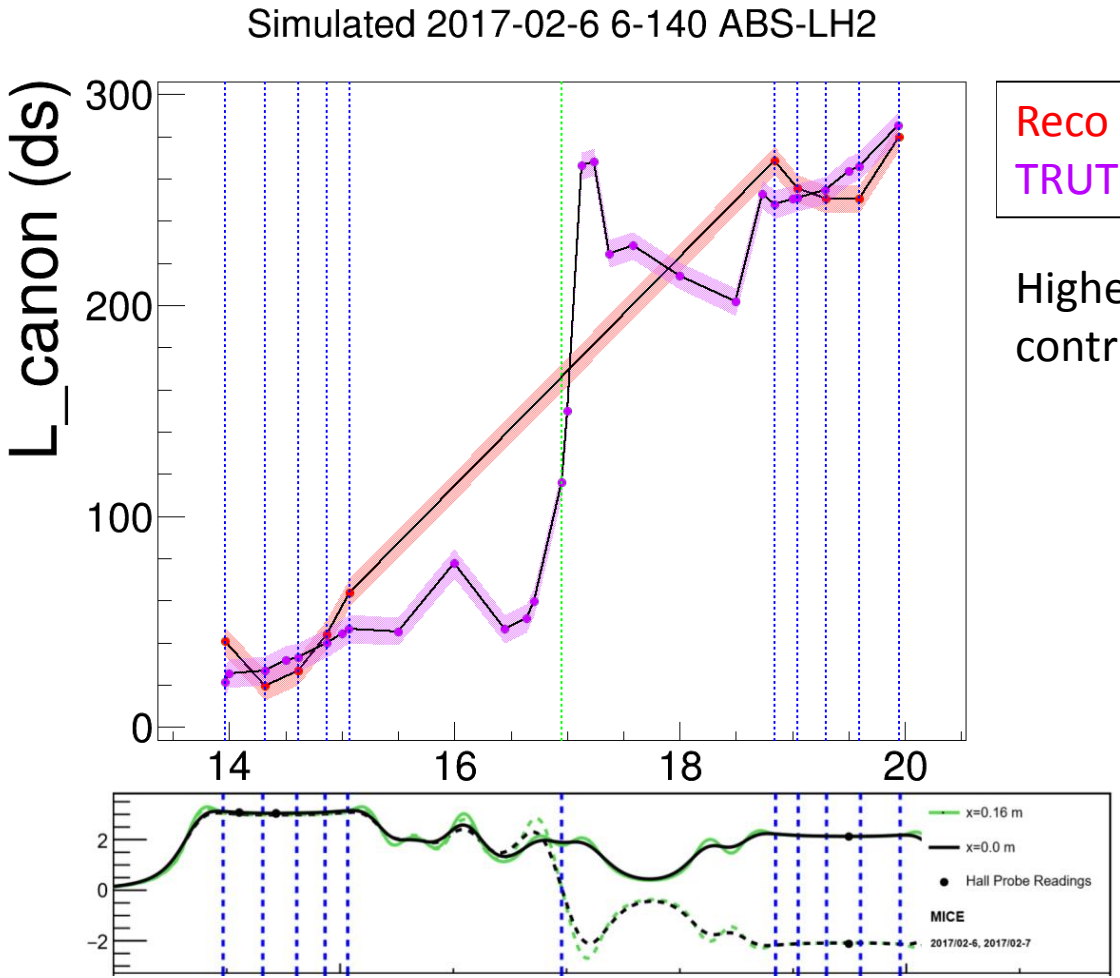
L canon mean

Reco in red
TRUTH in violet





L canon mean with more virtual planes



Reco in red
TRUTH in violet

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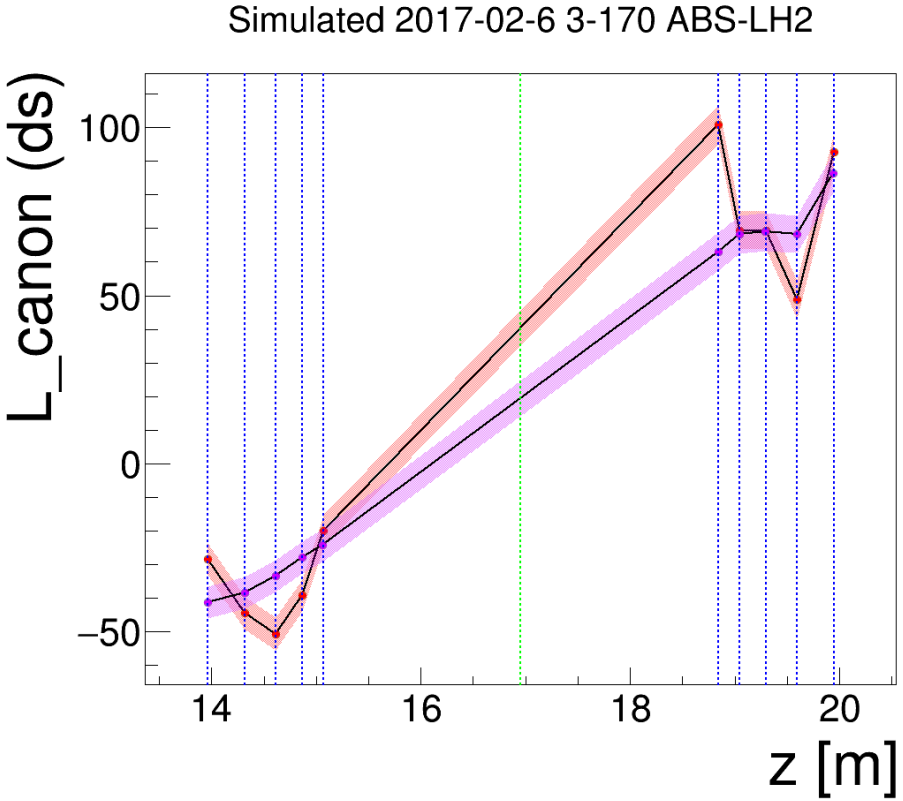
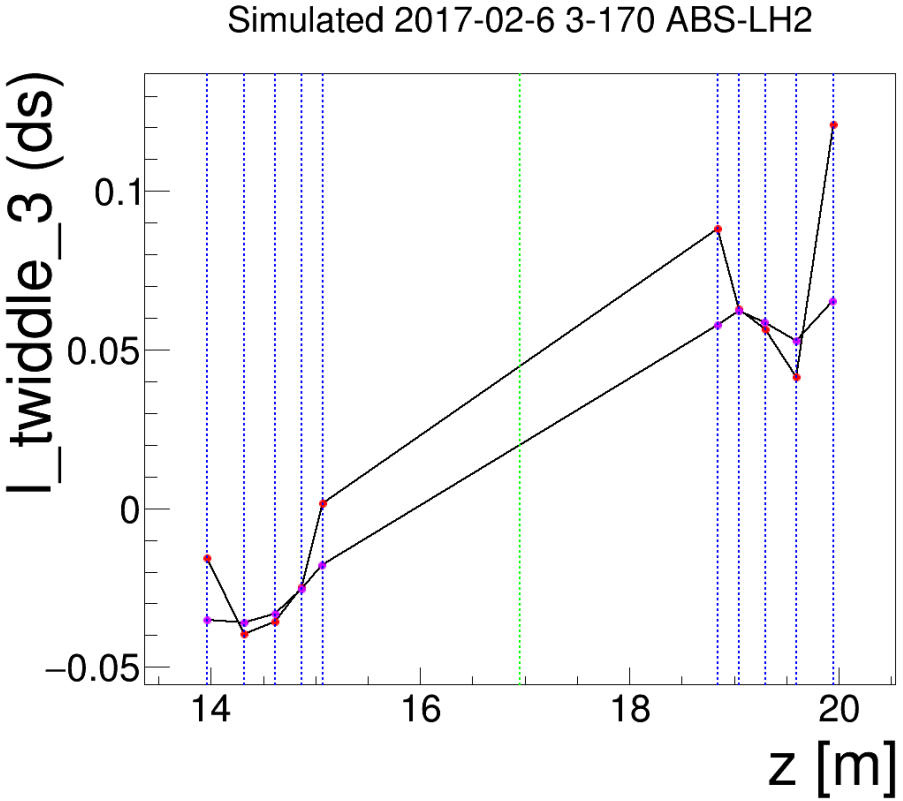
Higher order terms in L_{field} term probably contributing here

$$L_{field} = qr\mathrm{A}_{\phi}$$
$$= q\left(\frac{r^2 B_z}{2} - \frac{r^3}{16}B_z'' + O(r^5)\ldots\right)$$

Higher Momentum Beam

Interesting features in higher momentum beams..





L canon Reco vs Truth

Uncorrected distributions in 1D

Reco in black, TRUTH in yellow

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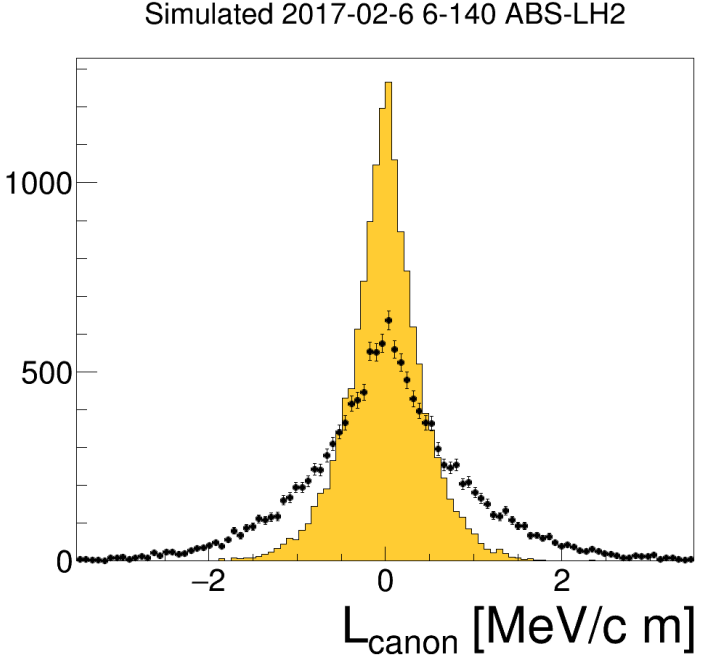
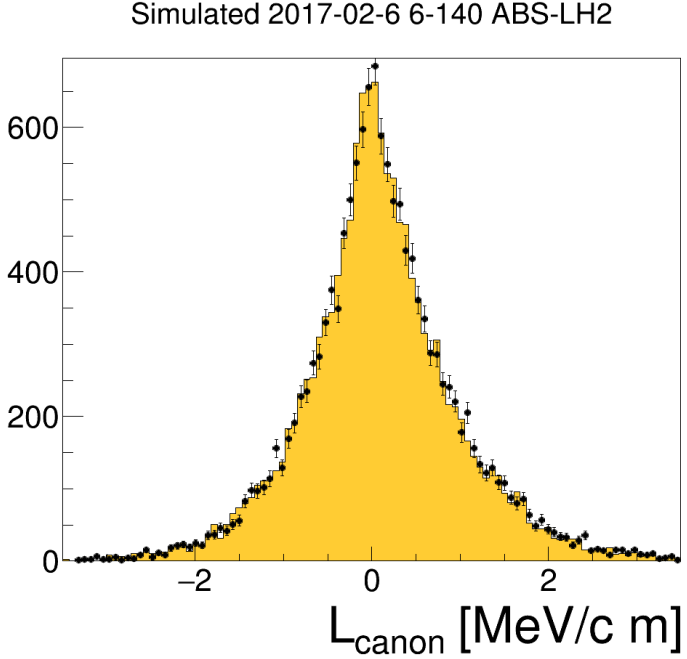
Global through virtual diffuser
us



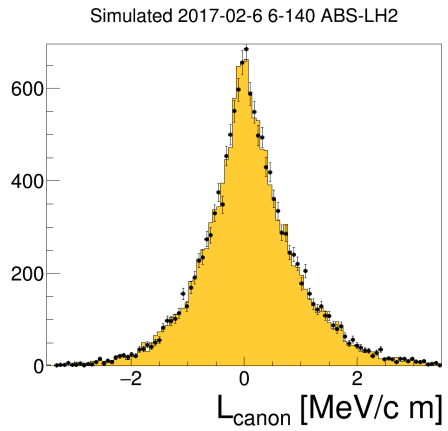
Global through virtual diffuser
ds



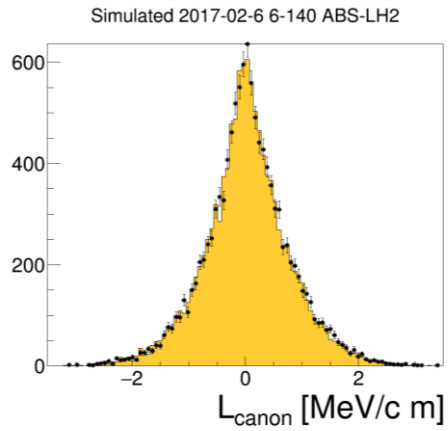
L canon Reco vs Truth

Uncorrected distributions in 1D

Global through virtual diffuser ds



Tku 5



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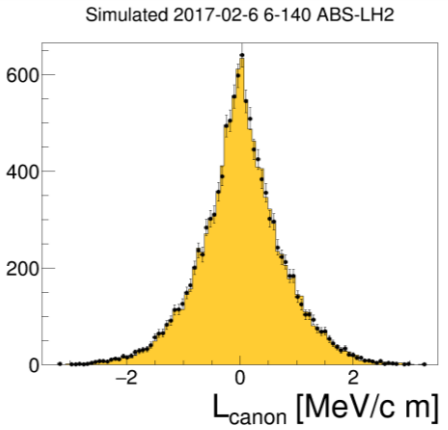
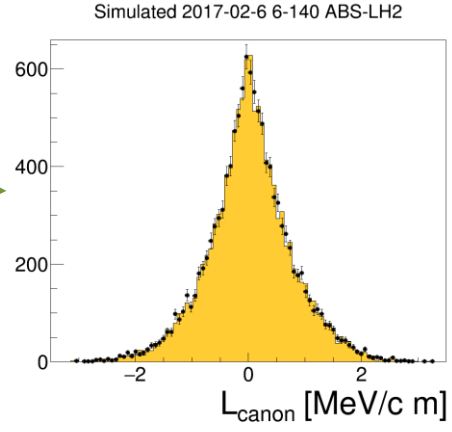
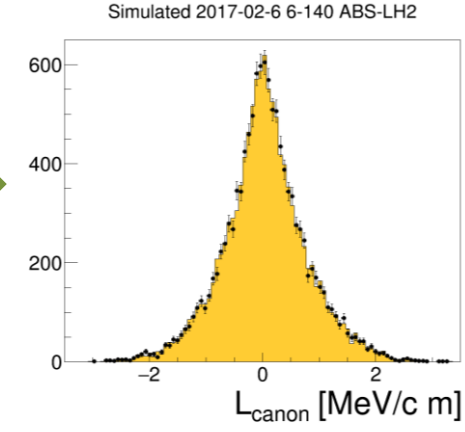


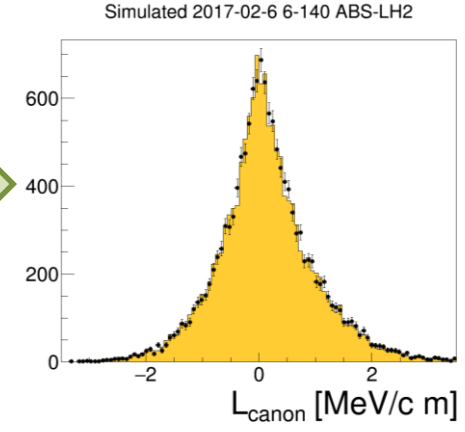
Tku 3



Tku 2

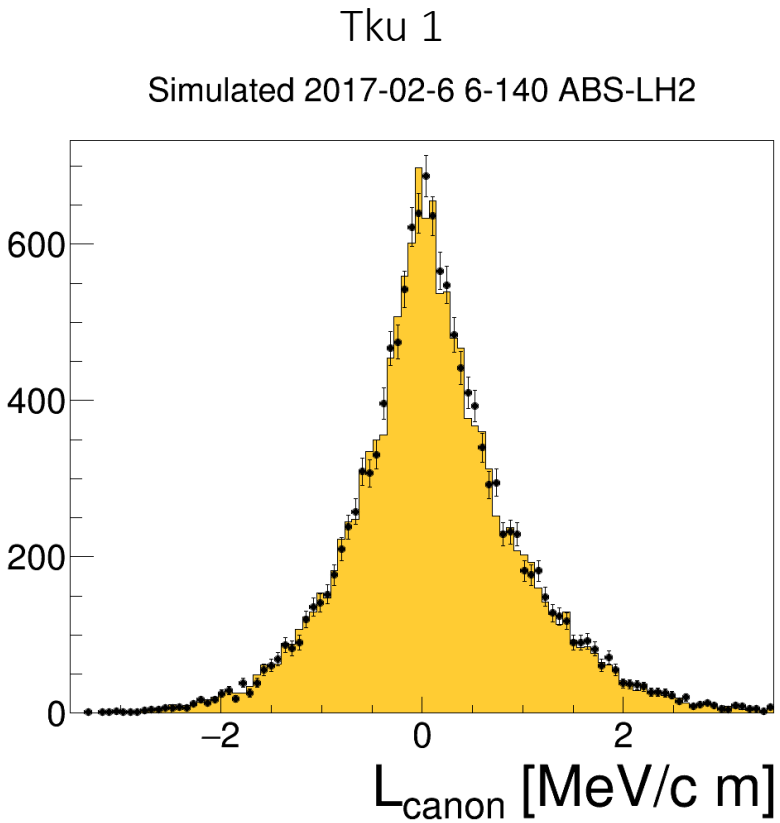


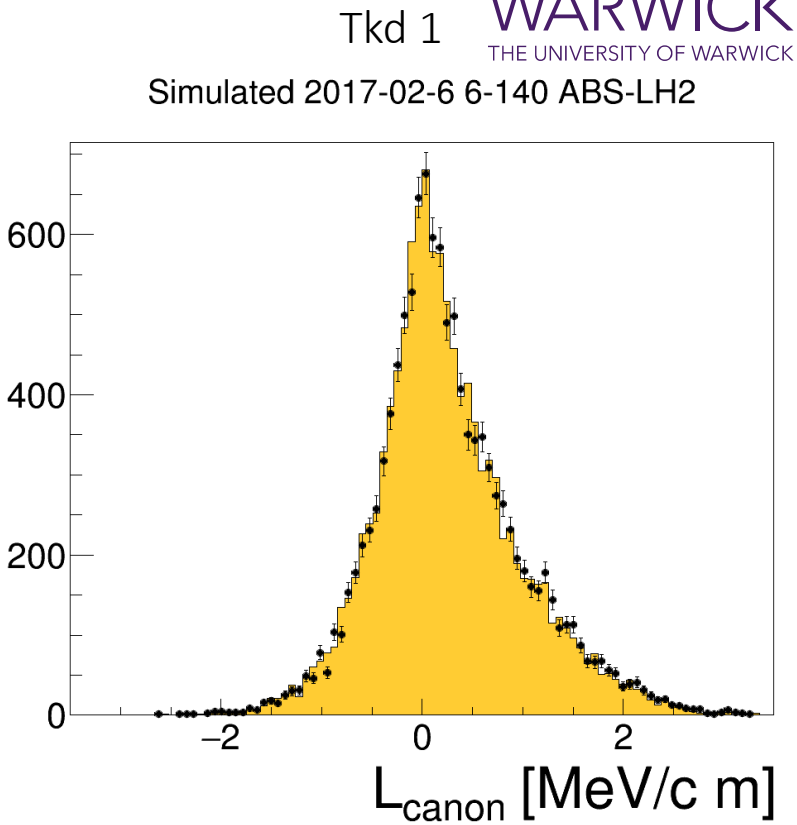
Tku 1



L canon Reco vs Truth

Uncorrected distributions in 1D

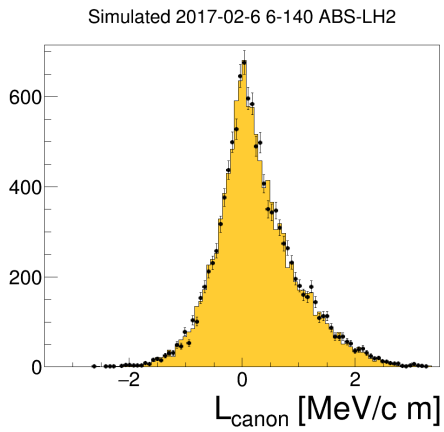




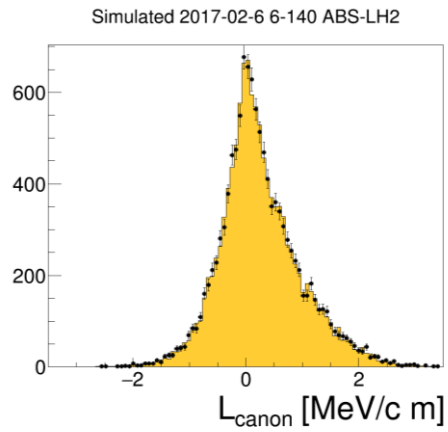
L canon Reco vs Truth

Uncorrected distributions in 1D

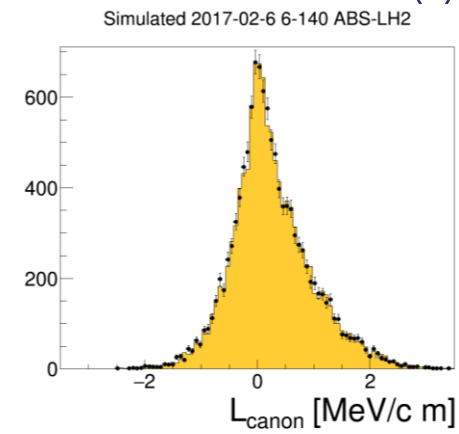
Tkd 1



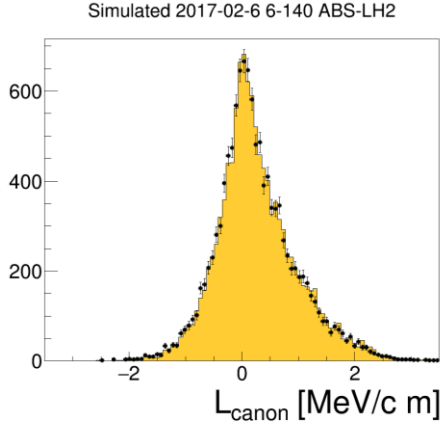
Tkd 2



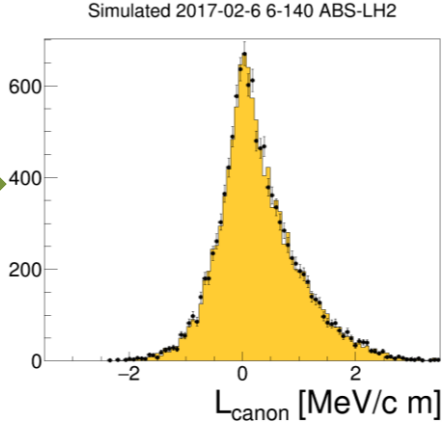
Tkd 3



Tkd 4



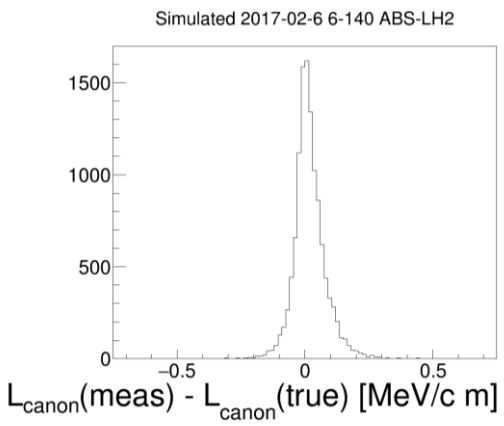
Tkd 5



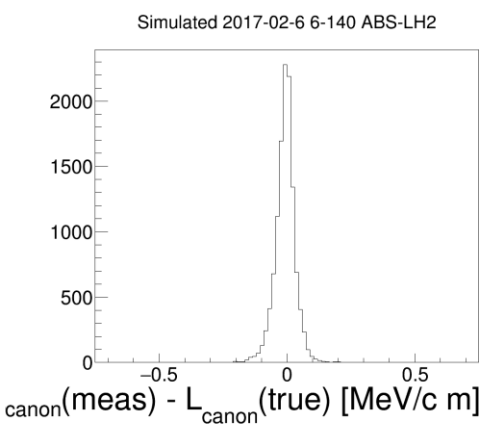
L canon Residuals

1D Distributions – L_canon residual

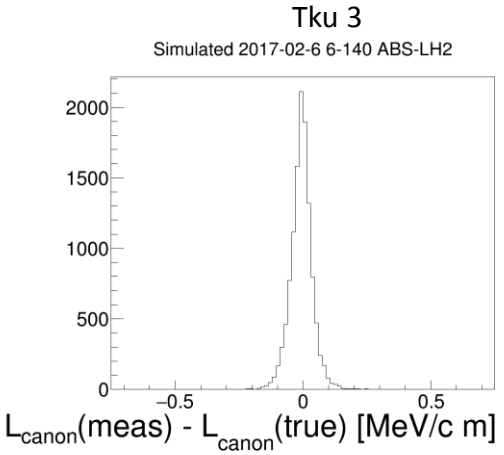
Tku 5



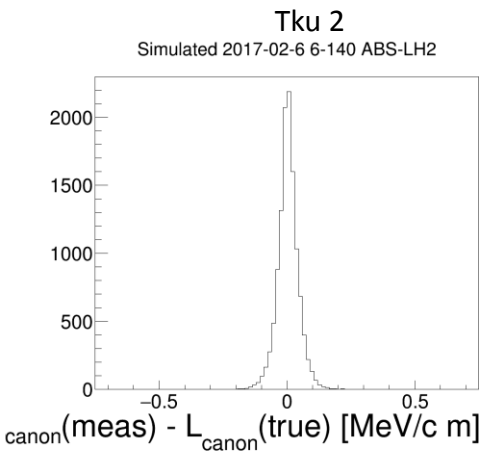
Tku 4



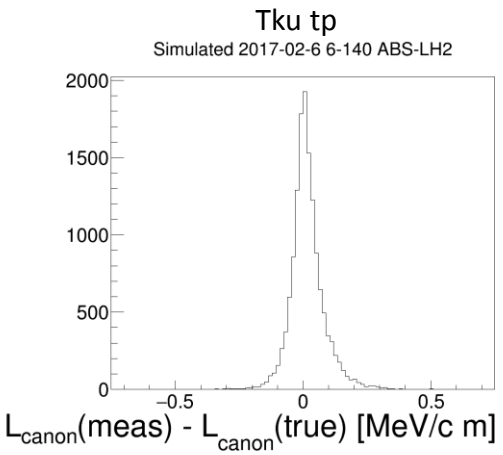
Tku 3



Tku 2



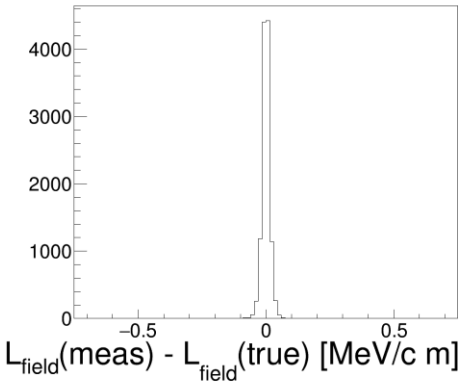
Tku tp



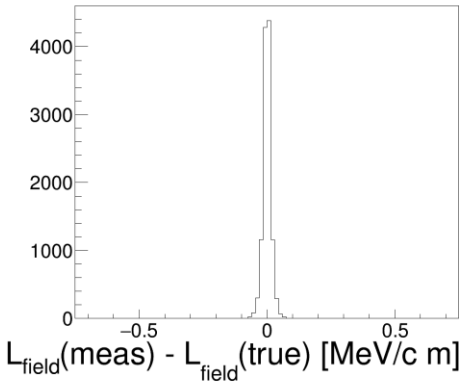
L field Residuals

1D Distributions – L_field residual

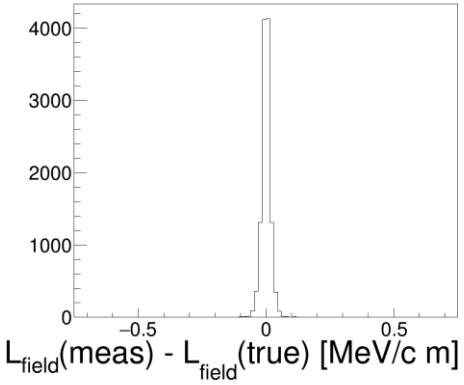
Tku 5



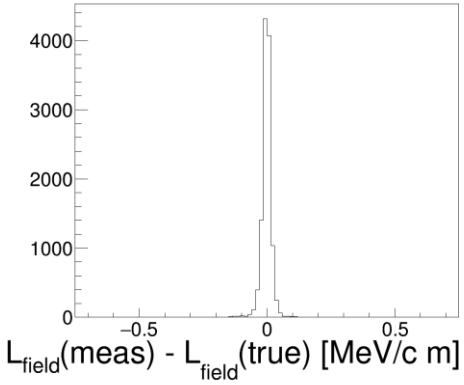
Tku 4



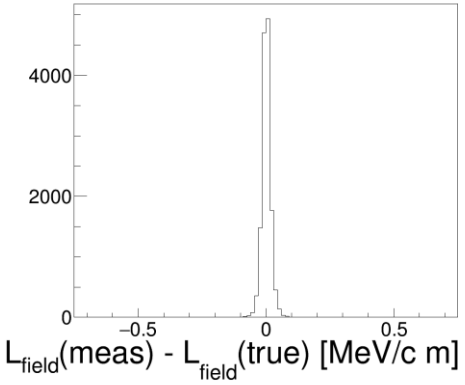
Tku 3



Tku 2

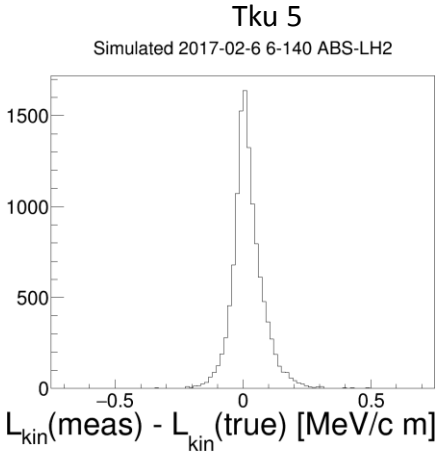


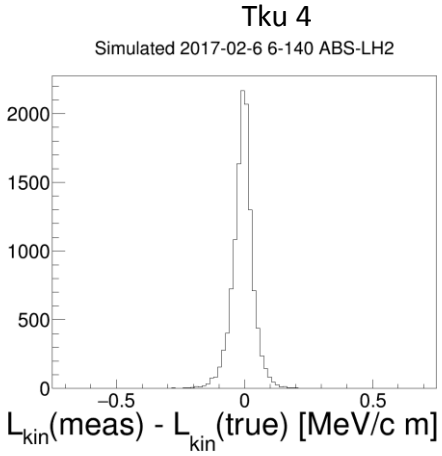
Tku 1

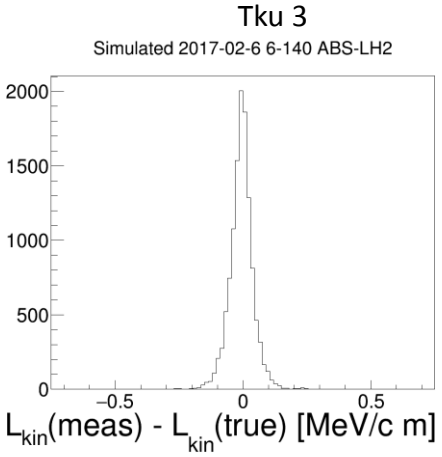


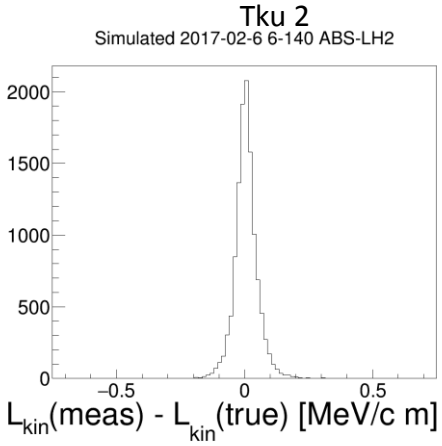
L field Residuals

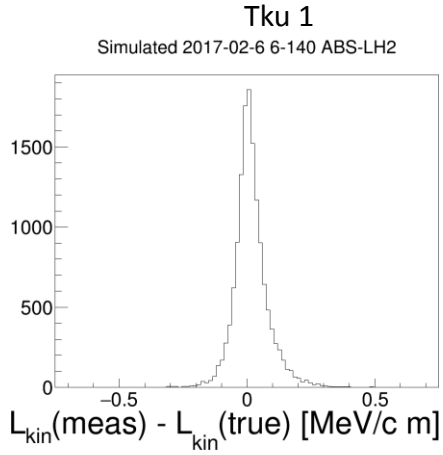
1D Distributions – L_field residual





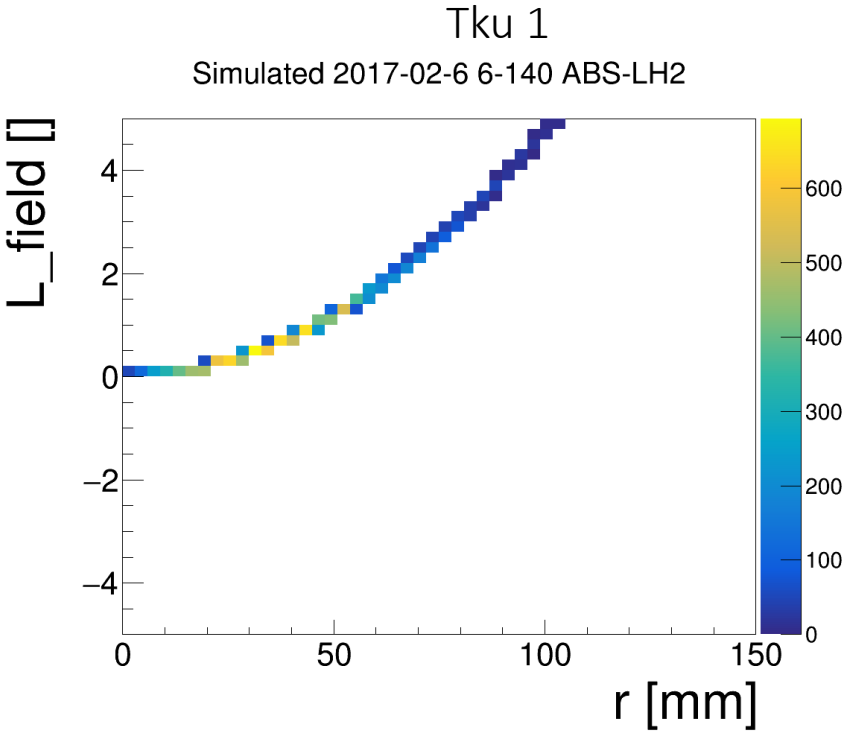


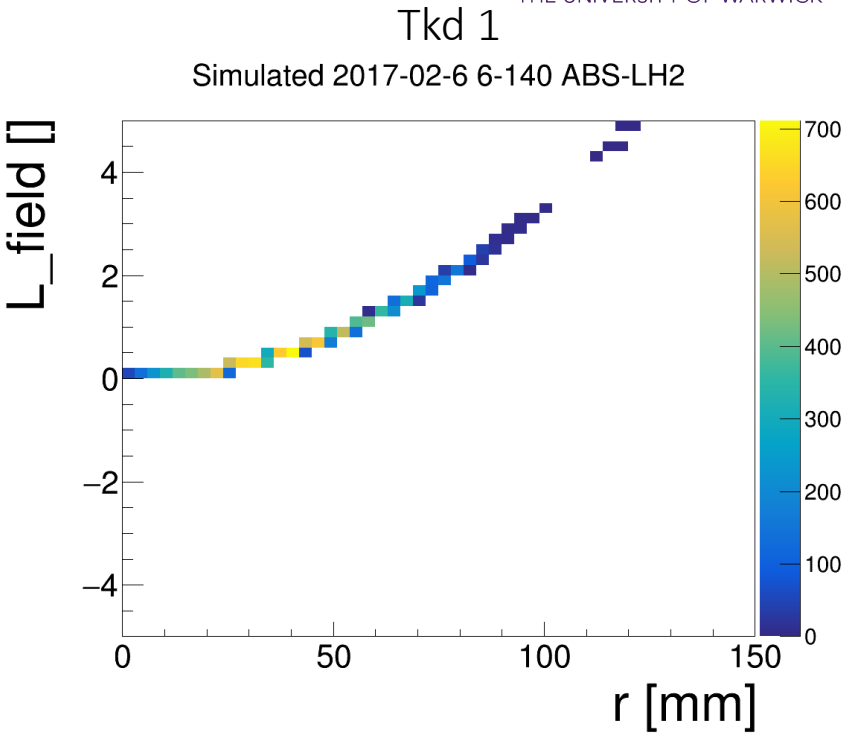




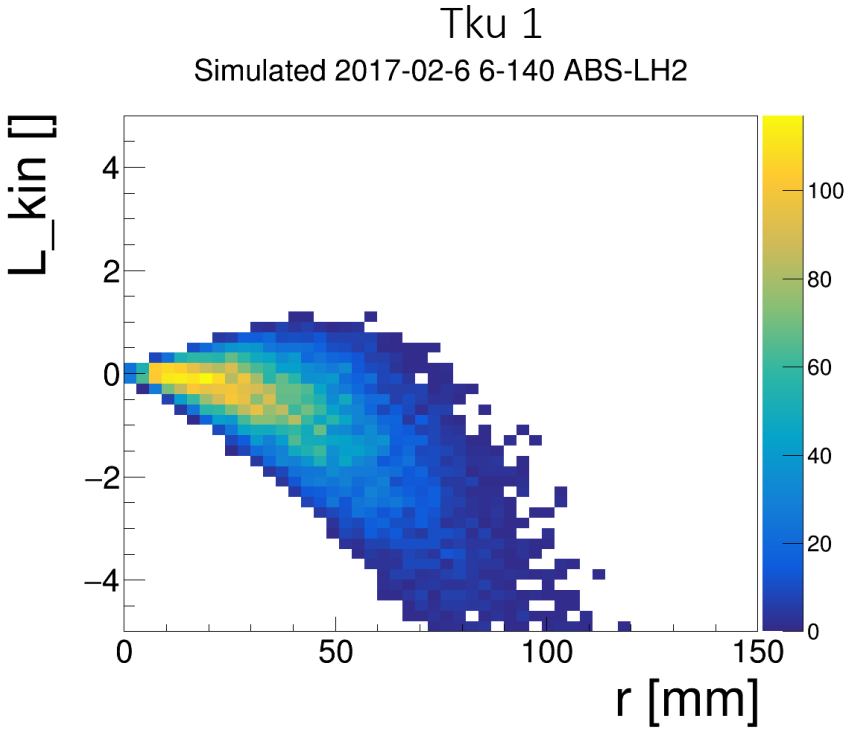
L field vs r plots – ds sample

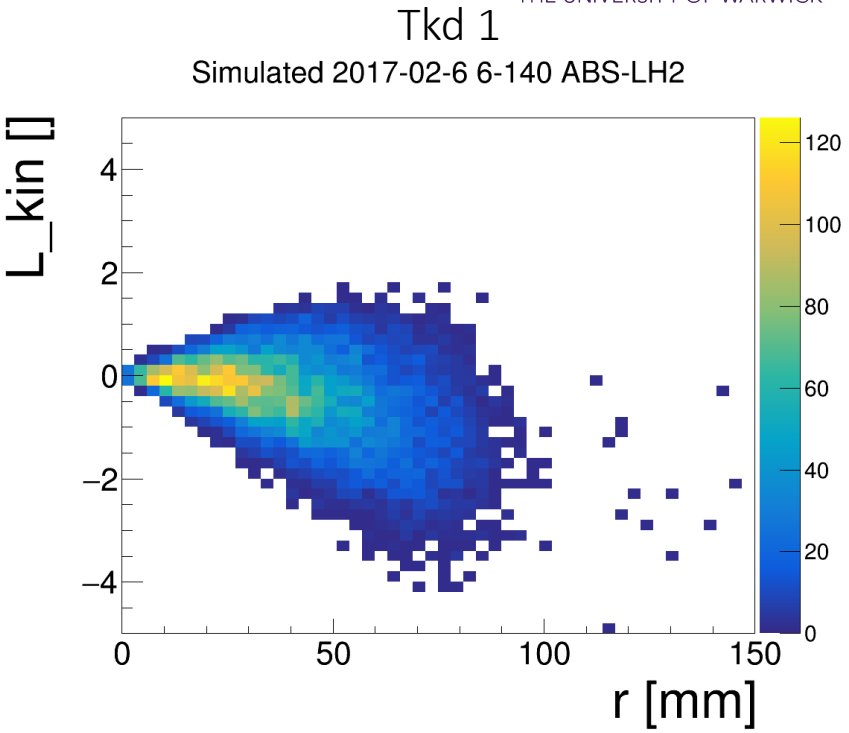
L field follows field maps for x,y,z position of trackpoints



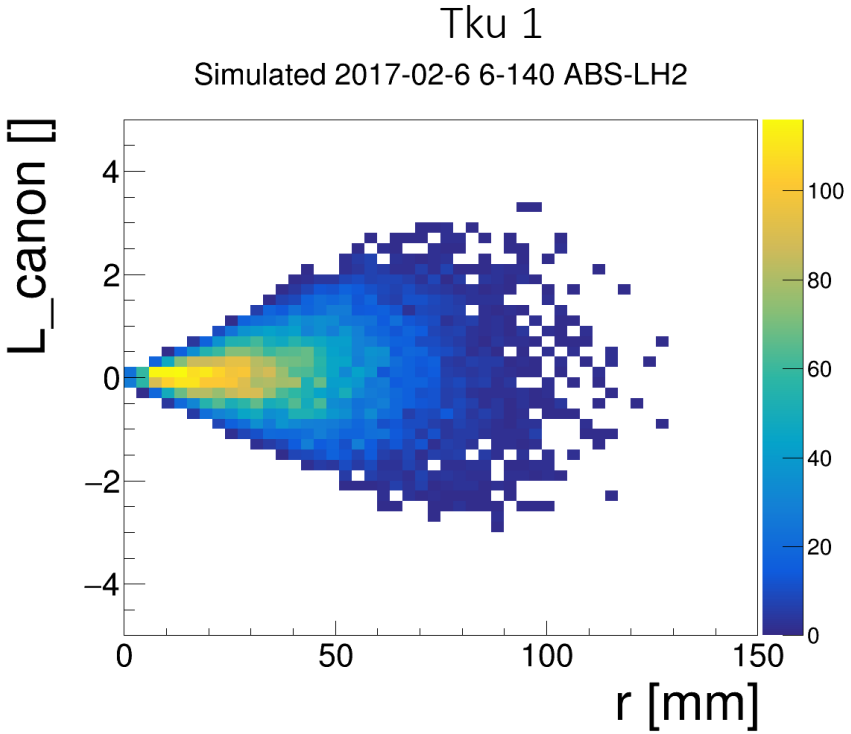


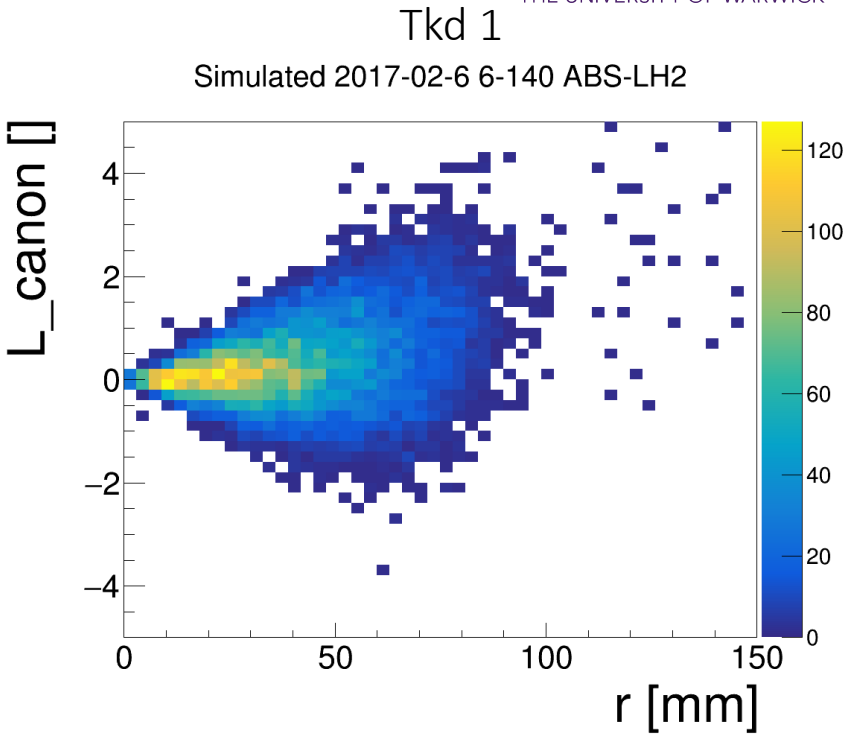
L kin vs r plots – ds sample



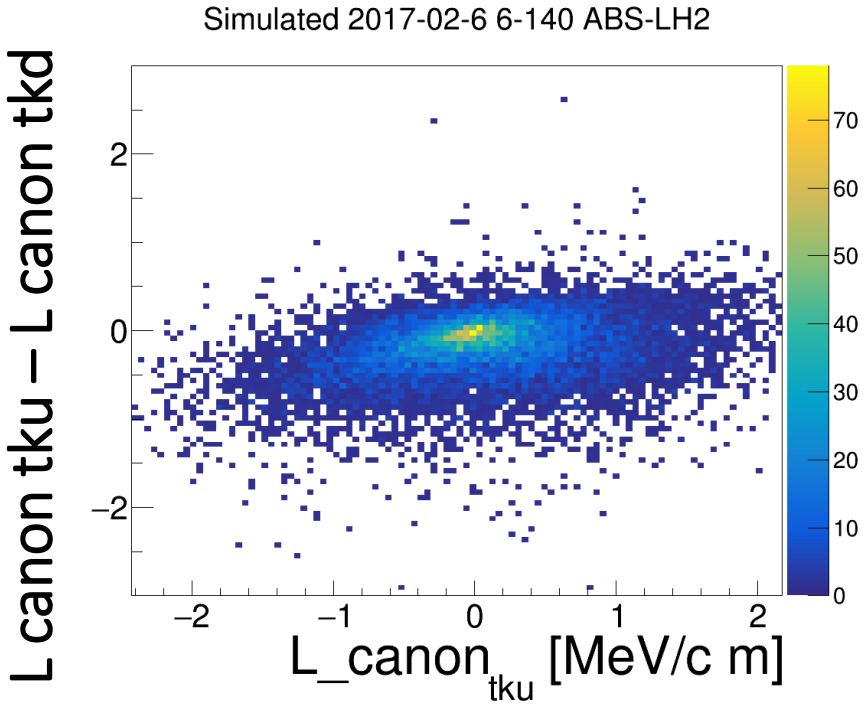


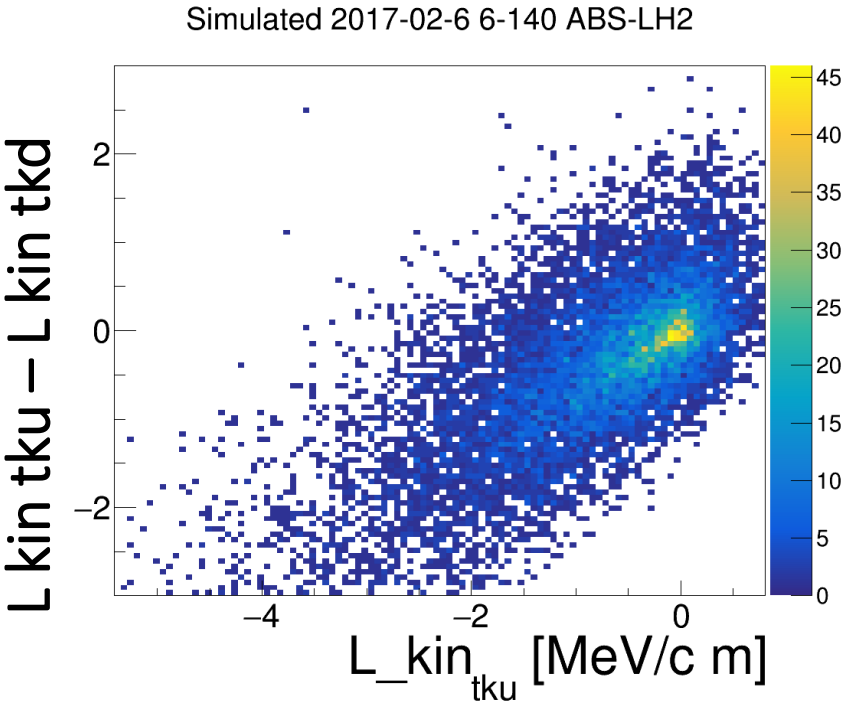
L canon vs r plots



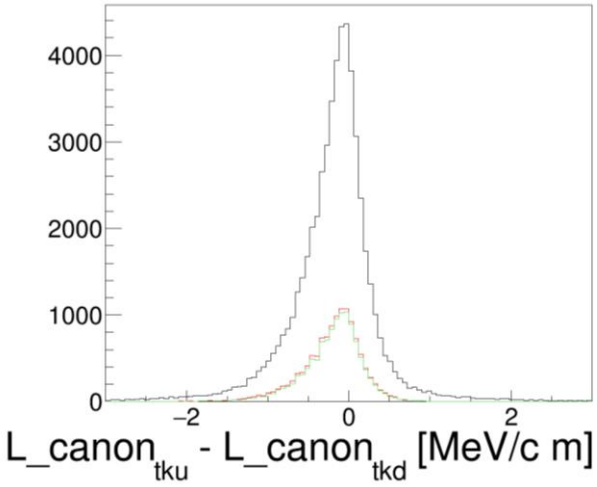


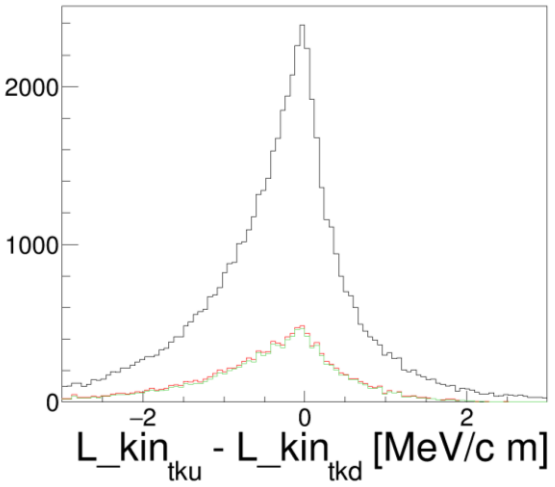
L change across absorber vs L tku

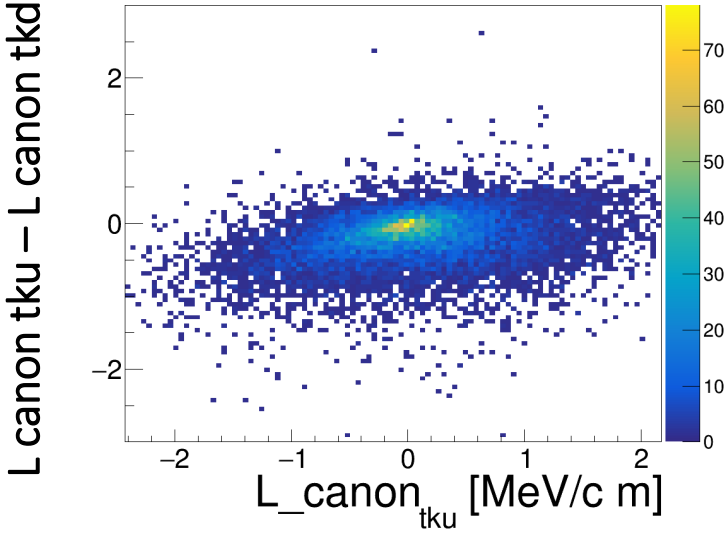


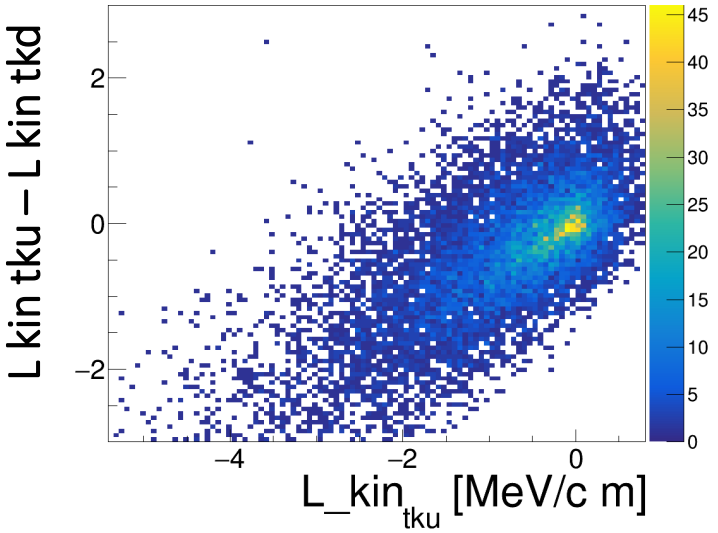


L change across absorber vs L tku







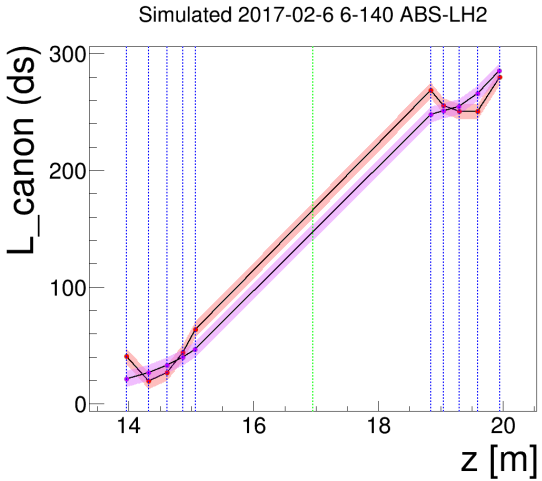


Corrections

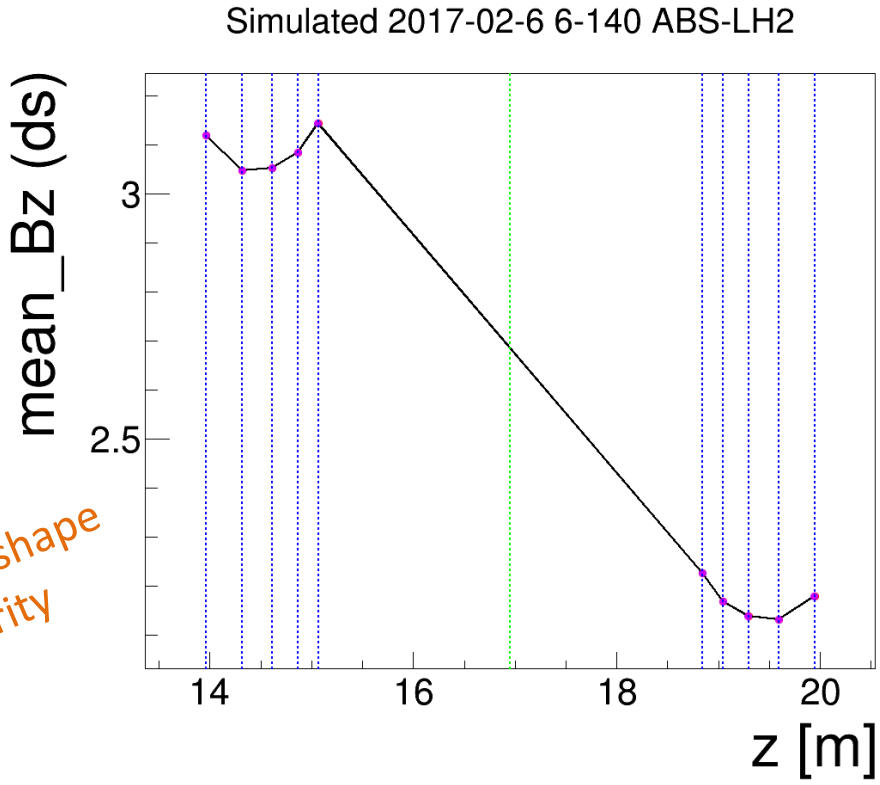
Track Reconstruction in MAUS

MAUS Kalman only sees single value for Bz in track propagation through each tracker

Actual field varies through the tracker O(0.1 T)



Suspicious shape similarity



Equations for Track Propagation

$$x' = x + \frac{p_x}{p_t} R \sin\Delta\theta - \frac{p_y}{p_t} R(1 - \cos\Delta\theta)$$

$$y' = y + \frac{p_y}{p_t} R \sin\Delta\theta + \frac{p_x}{p_t} R(1 - \cos\Delta\theta)$$

$$z' = z + \Delta z$$

$$p'_x = p_x \cos\Delta\theta - p_y \sin\Delta\theta$$

$$p'_y = p_y \cos\Delta\theta + p_x \sin\Delta\theta$$

$$p'_z = p_z;$$

$$R = \frac{p_t}{qB_z}$$

$$\Delta\theta = \frac{cB_z Q \Delta z}{p_z}$$

$$c \approx \frac{0.299 MeV}{cT^{-1}mm^{-1}}$$

Rescaling Correction

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Rescaling correction:

$$R = \frac{p_t}{qB_z}$$

$$\Delta\theta = \frac{cB_z Q\Delta z}{p_z}$$

$$c \approx \frac{0.299MeV}{cT^{-1}mm^{-1}}$$

Assume helix remains the same so $x, x', y, y', R, \Delta\theta$ fixed

→ direction of Pt ($\frac{p_x}{p_t}$ & $\frac{p_y}{p_t}$) remain the same

Px and Py scaled equally:

$$p'_x = \frac{B'_z}{B_z} p_x, \quad p'_y = \frac{B'_z}{B_z} p_y$$

$$\Delta\theta = \frac{cB_z Q\Delta z}{p_z} \rightarrow p'_z = \frac{B'_z}{B_z} p_z$$

New pz looks U-shaped through the trackers, so we leave p_z as is

$$x' = x + \frac{p_x}{p_t} R\sin\Delta\theta - \frac{p_y}{p_t} R(1-\cos\Delta\theta)$$

$$y' = y + \frac{p_y}{p_t} R\sin\Delta\theta + \frac{p_x}{p_t} R(1-\cos\Delta\theta)$$

$$z' = z + \Delta z$$

$$p'_x = p_x\cos\Delta\theta - p_y\sin\Delta\theta$$

$$p'_y = p_y\cos\Delta\theta + p_x\sin\Delta\theta$$

$$p'_z = p_z;$$

Recalculating Correction

Simultaneous eqn correction: Recalculating px, py with new Bz
Residuals on x, x', y, y' order of magnitude lower, keep fixed
Keep pz fixed to calc $\Delta\theta$
Use $R = \frac{p_t}{qB_z}$, $\Delta\theta = \frac{cB_z Q \Delta z}{p_z}$

Solve simultaneous equations for px, py:

$$x' - x = \frac{p_x}{qB_z} sin\Delta\theta - \frac{p_y}{qB_z}(1 - cos\Delta\theta),$$

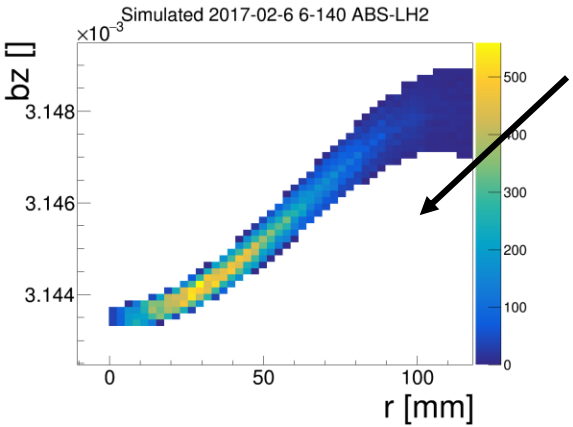
$$y' - y = \frac{p_y}{qB_z} sin\Delta\theta + \frac{p_x}{qB_z}(1 - cos\Delta\theta),$$

- Recalculating with old Bz under/overestimates slightly,
- Recalculating with new Bz gives close to MAUS reco px, py,
  Some values wildly off

MAUS Correction

MAUS uses a single Bz value for track propagation in each tracker, replace with station-to-station average Bz values

Average Bz along central solenoid axis – other choices could be better, beam does not mostly populate r = 0



O(0.1%) field variation in r, so expect small effect

Rescaling Correction

Rescaling Correction

$\mathrm{x}, \mathrm{x}', \mathrm{y}, \mathrm{y}', R, \Delta\theta$ fixed

$\frac{p_x}{p_t}$ & $\frac{p_y}{p_t}$ remain the same

Px and Py scaled equally:

$$p'_x = \frac{B'_z}{B_z}\mathrm{p_x}, \;\; \mathrm{p'_y} = \frac{B'_z}{B_z}p_y$$

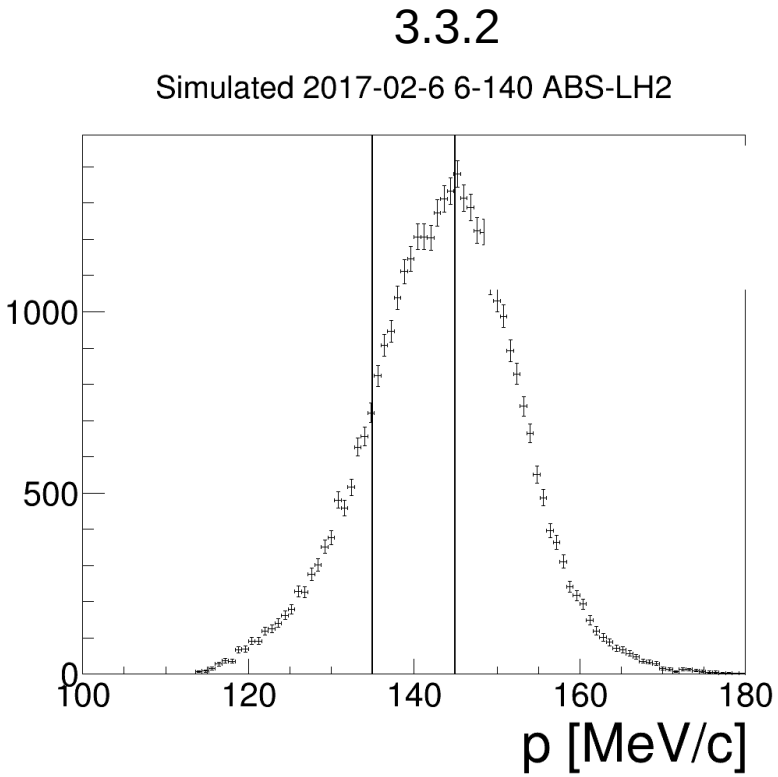
$$\Delta\theta = \frac{cB_zQ\Delta z}{p_z} \rightarrow p'_z = \frac{B'_z}{B_z}p_z$$

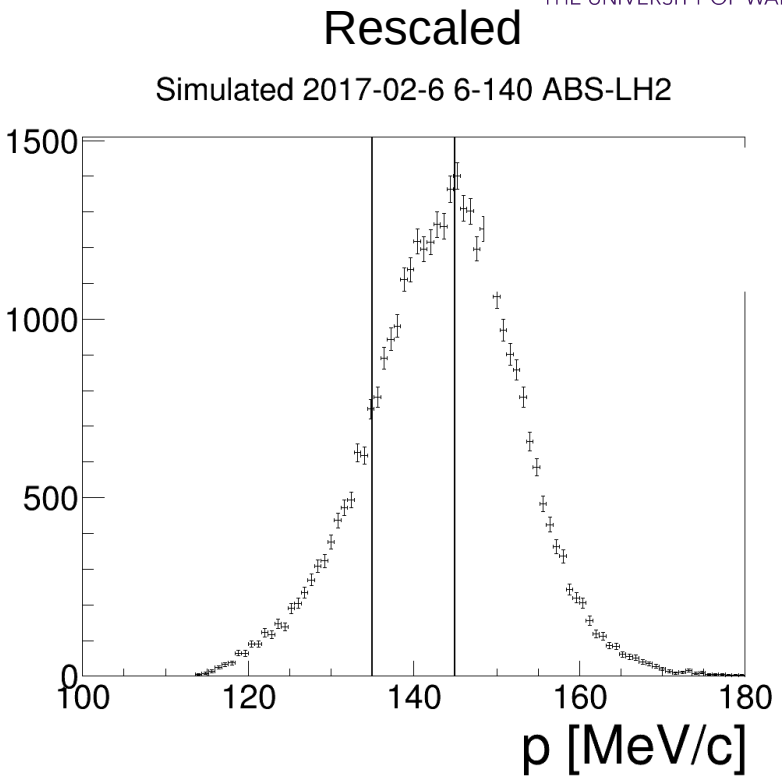
New pz looks U-shaped through the trackers,

so we leave $\mathrm{p_z}$ as is

Rescaling Px, Py

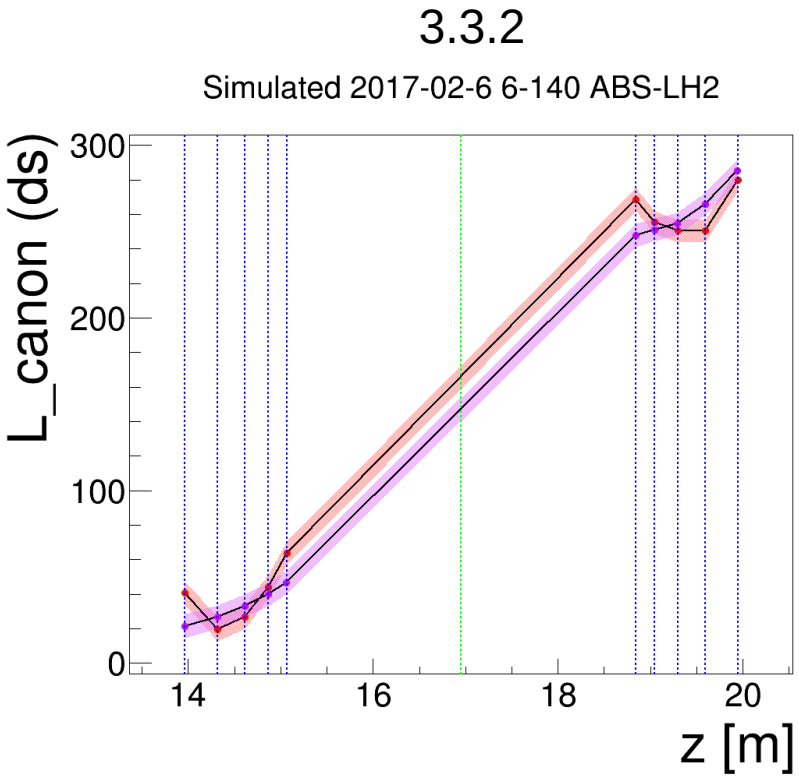
TKU p cut

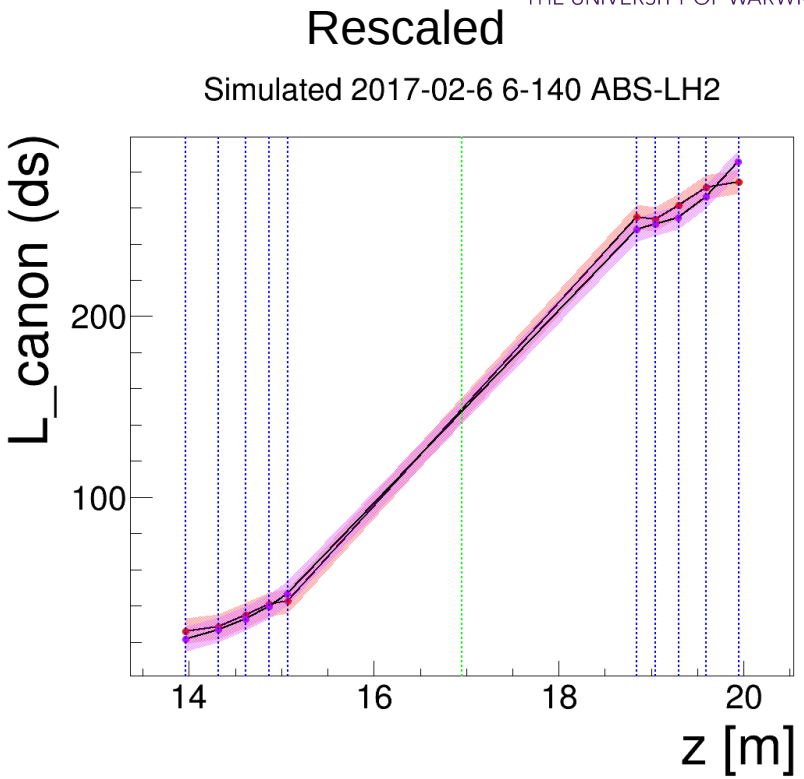




Rescaling Px, Py

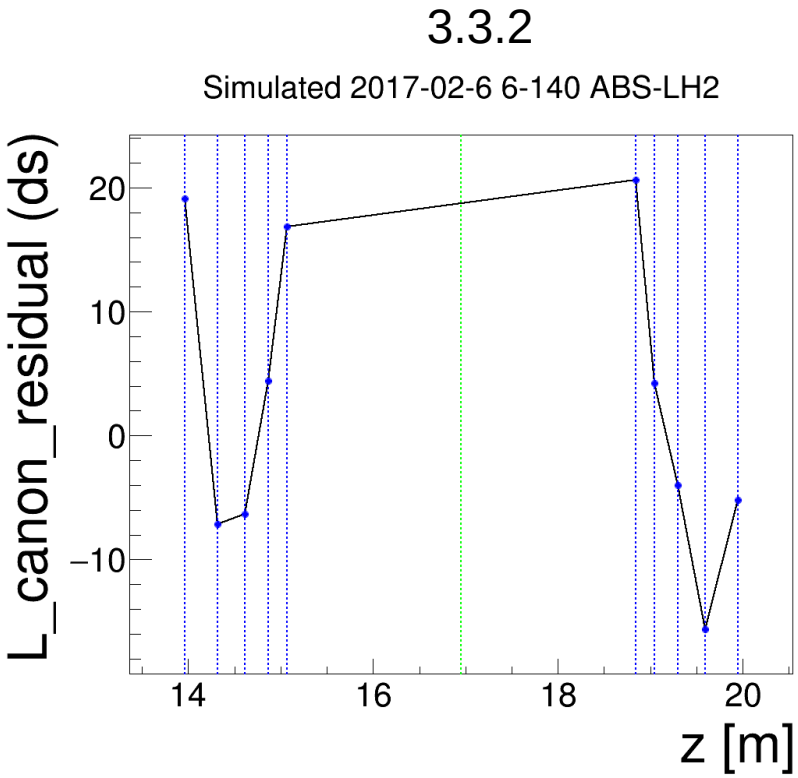
L_canon

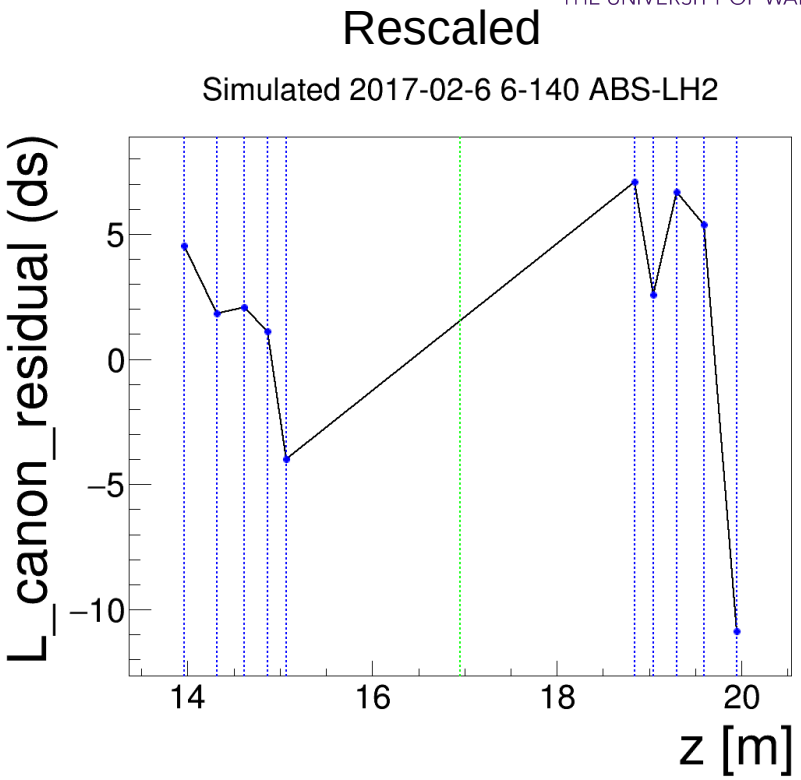




Rescaling Px, Py

L_canon residual

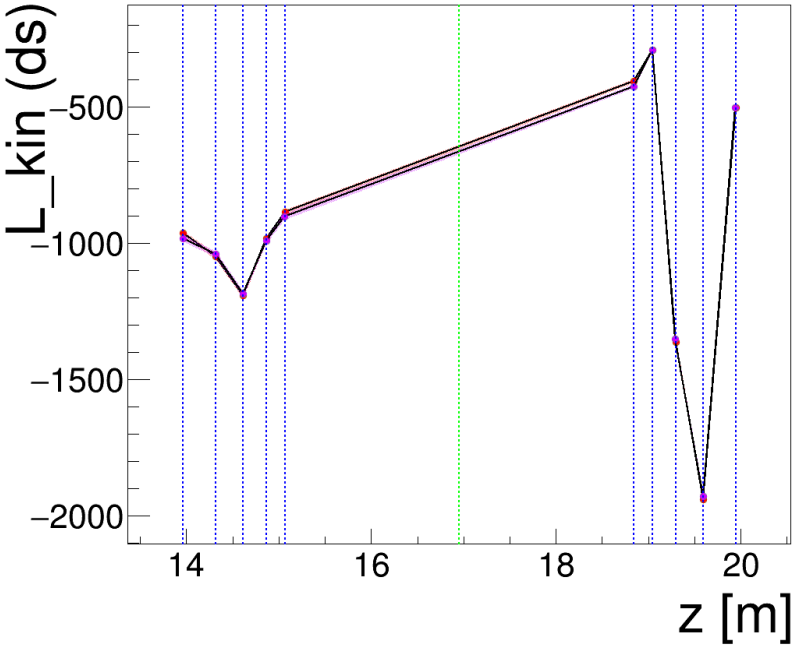




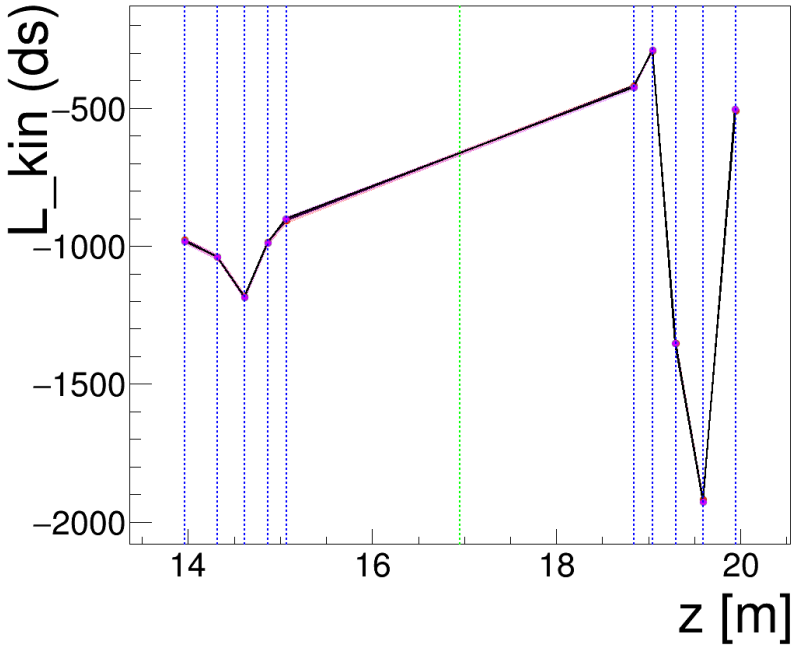
Rescaling Px, Py

L_kin

3.3.2

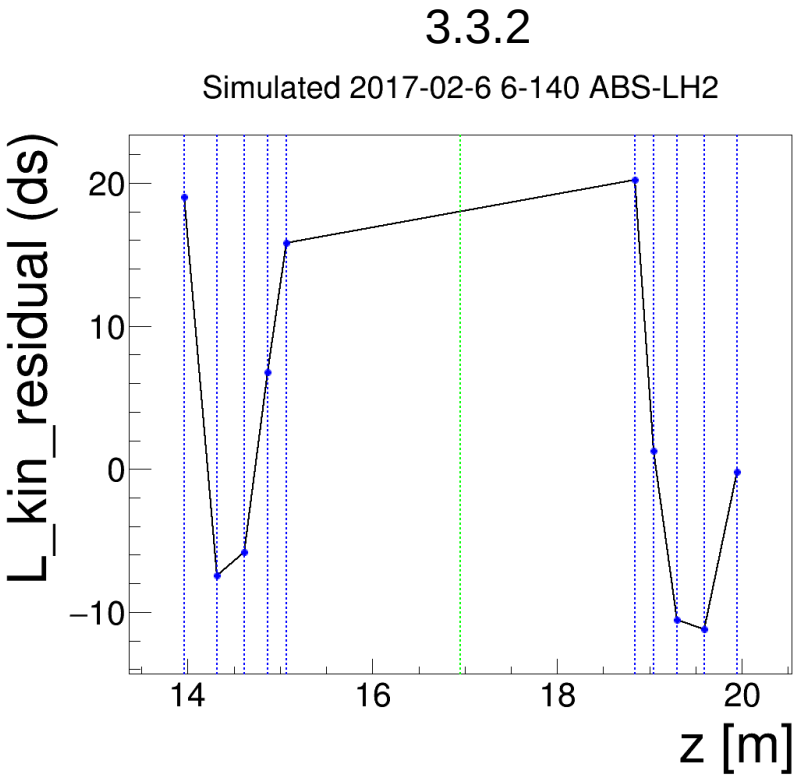


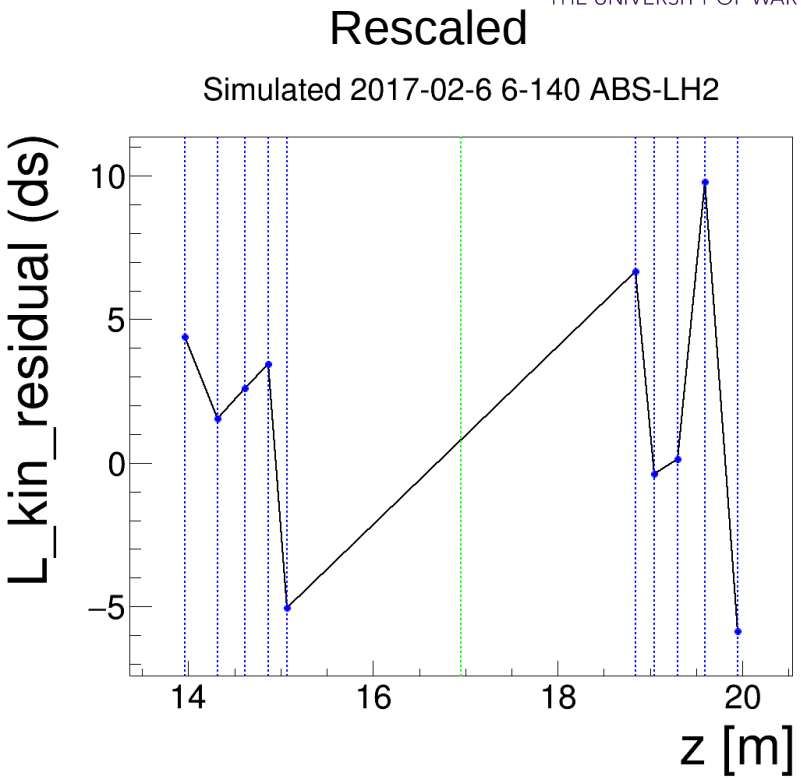
Rescaled



Rescaling Px, Py

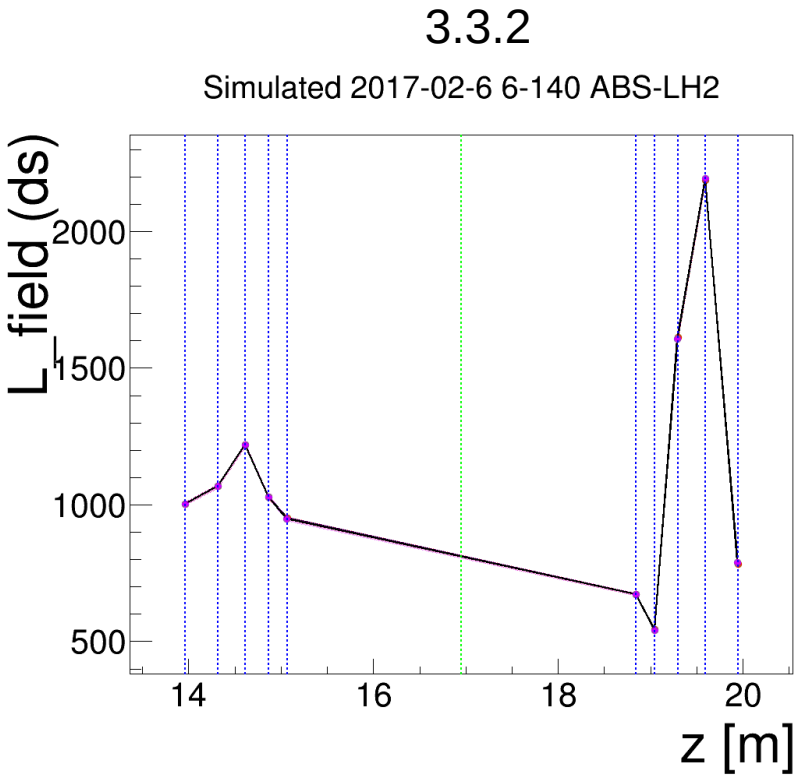
L_kin residual

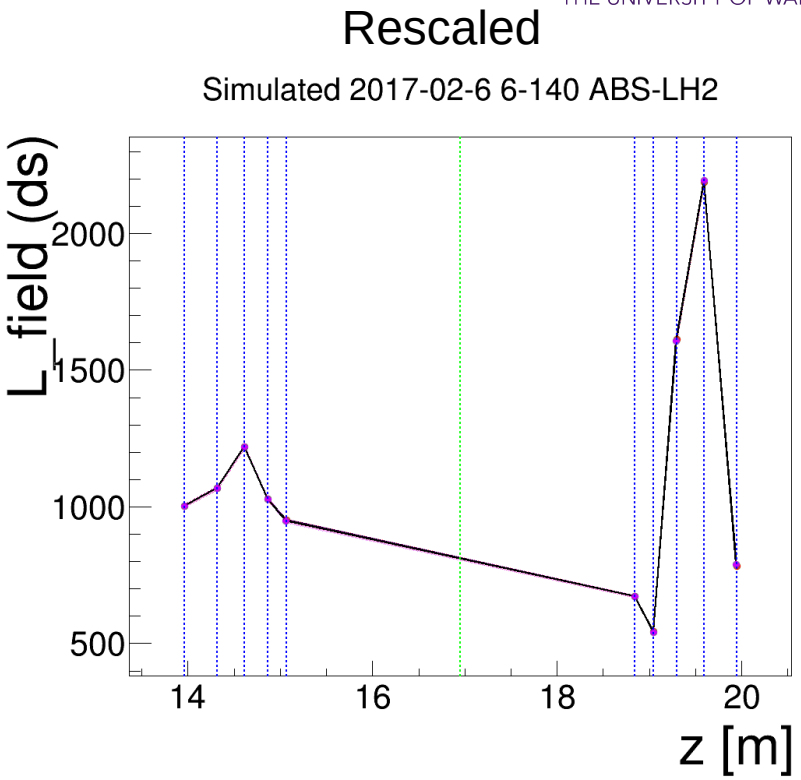




Rescaling Px, Py

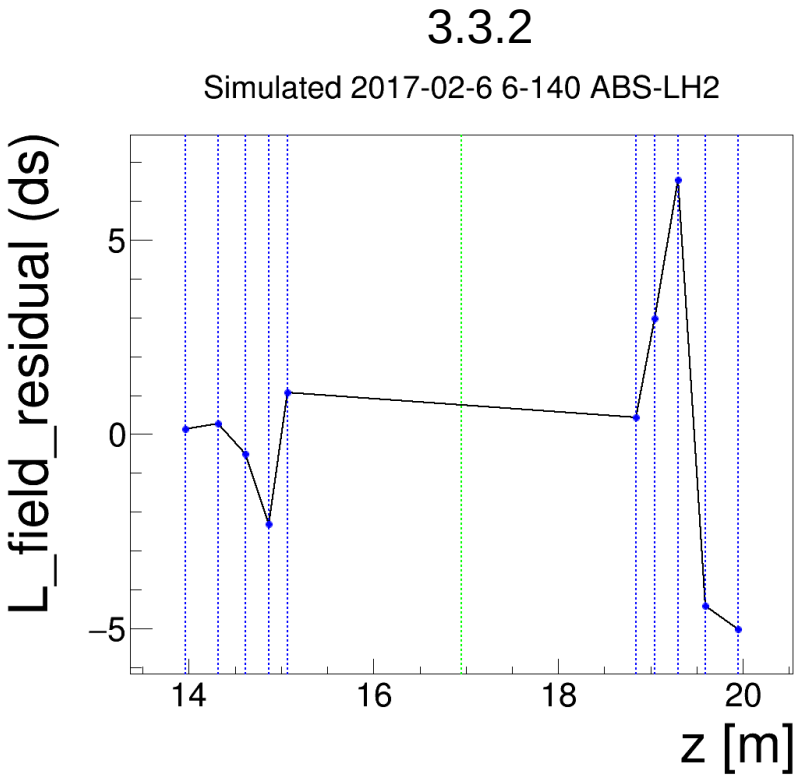
L_field

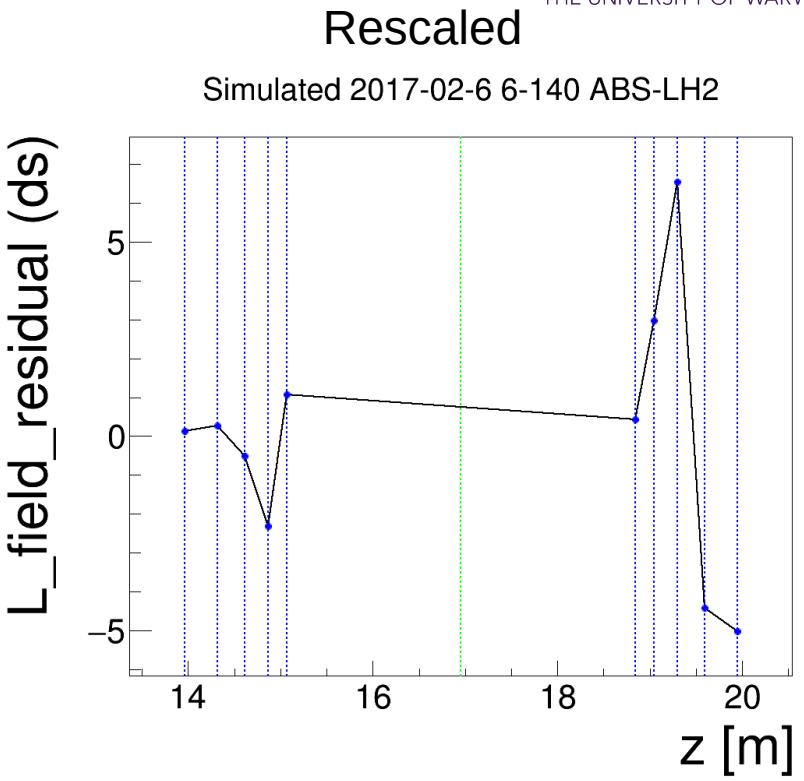




Rescaling Px, Py

L_field residual





L canon Reco vs Truth

Original and corrected distributions in 1D

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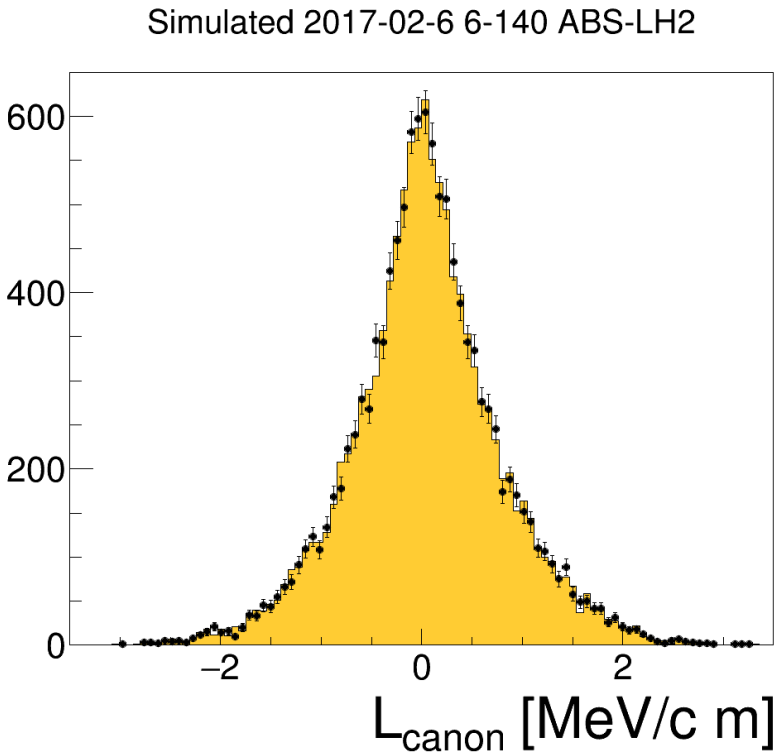
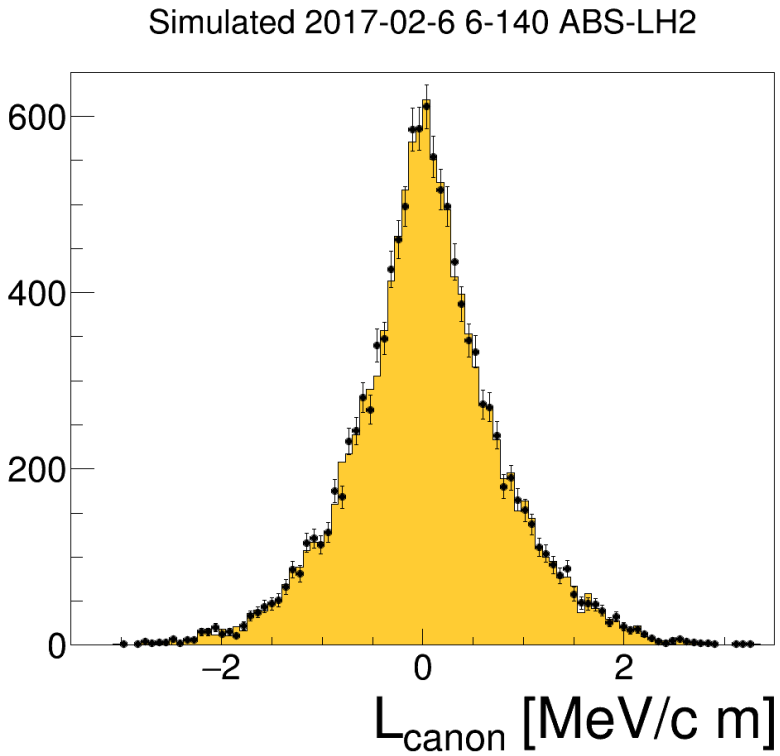
Uncorrected, tku 2



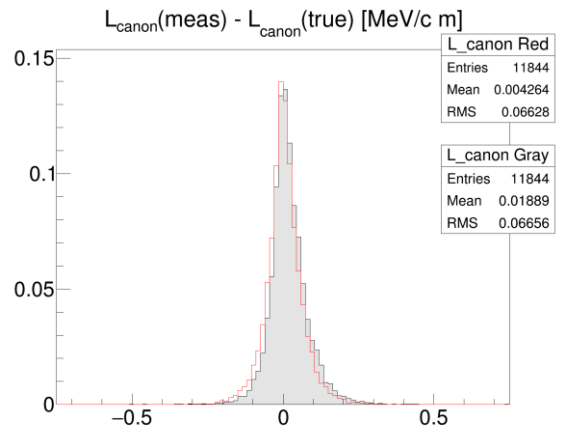
Rescaled, tku 2



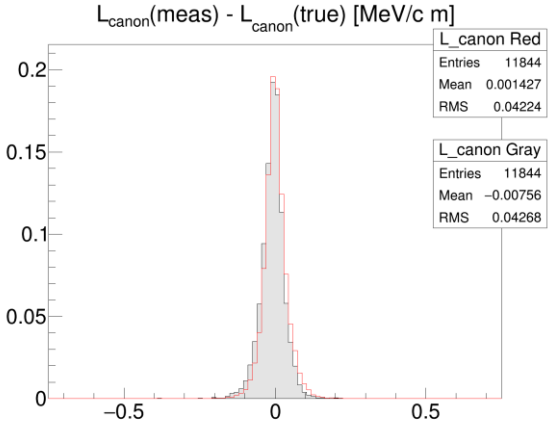
Rescaling Px, Py

L_canon Residuals, TKU

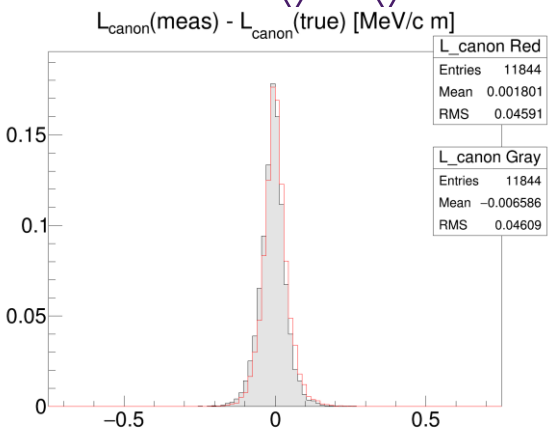
Tku 5



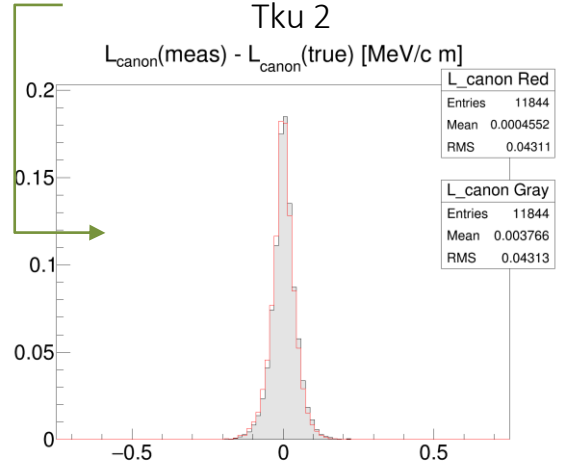
Tku 4



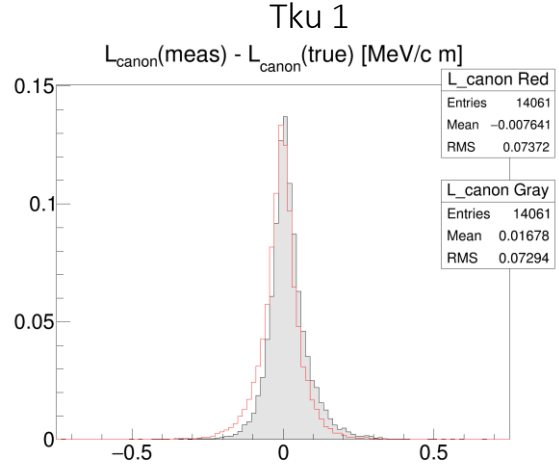
Tku 3



Tku 2



Tku 1

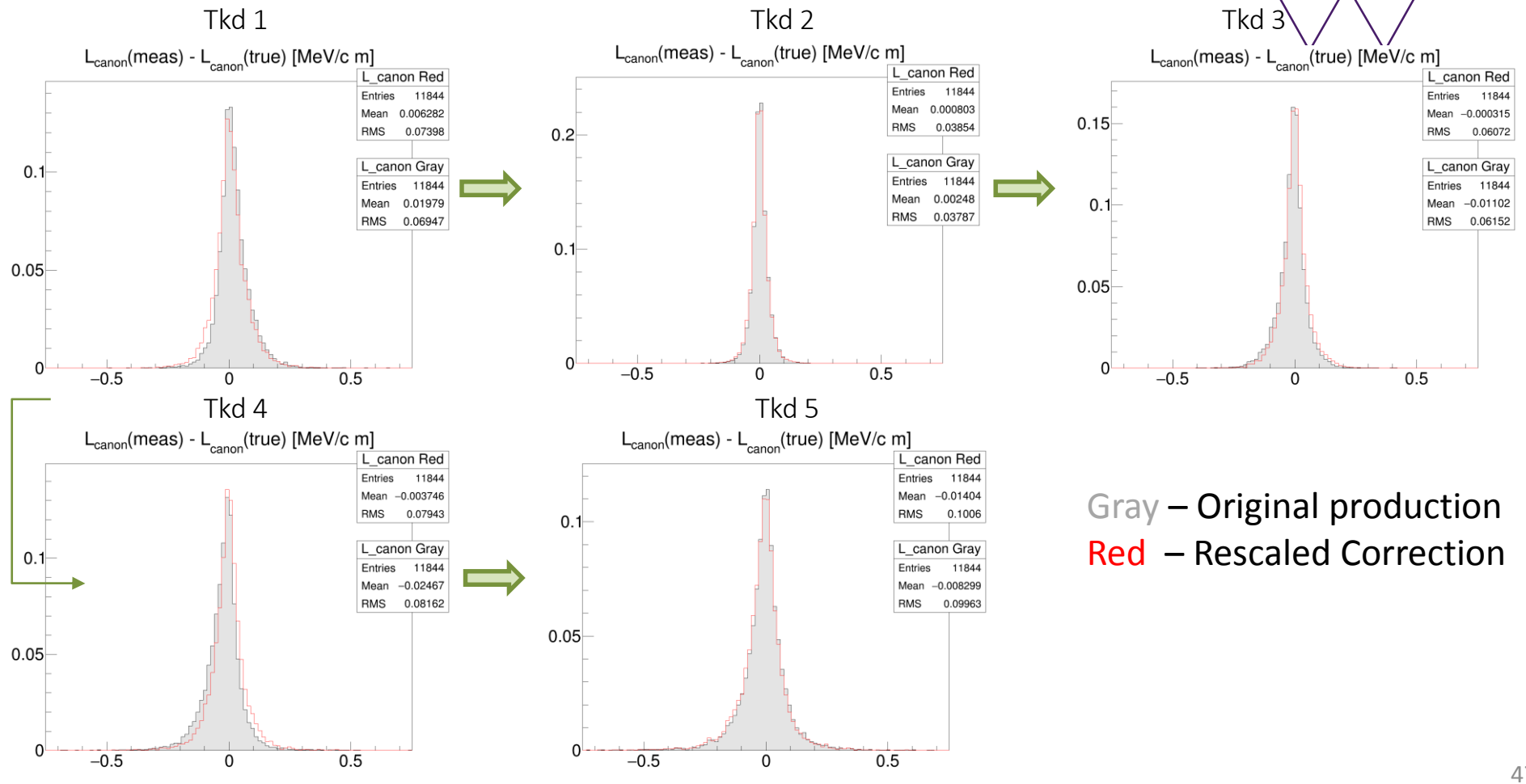


Gray – Original production

Red – Rescaled Correction

Rescaling Px, Py

L_canon Residuals, TKD

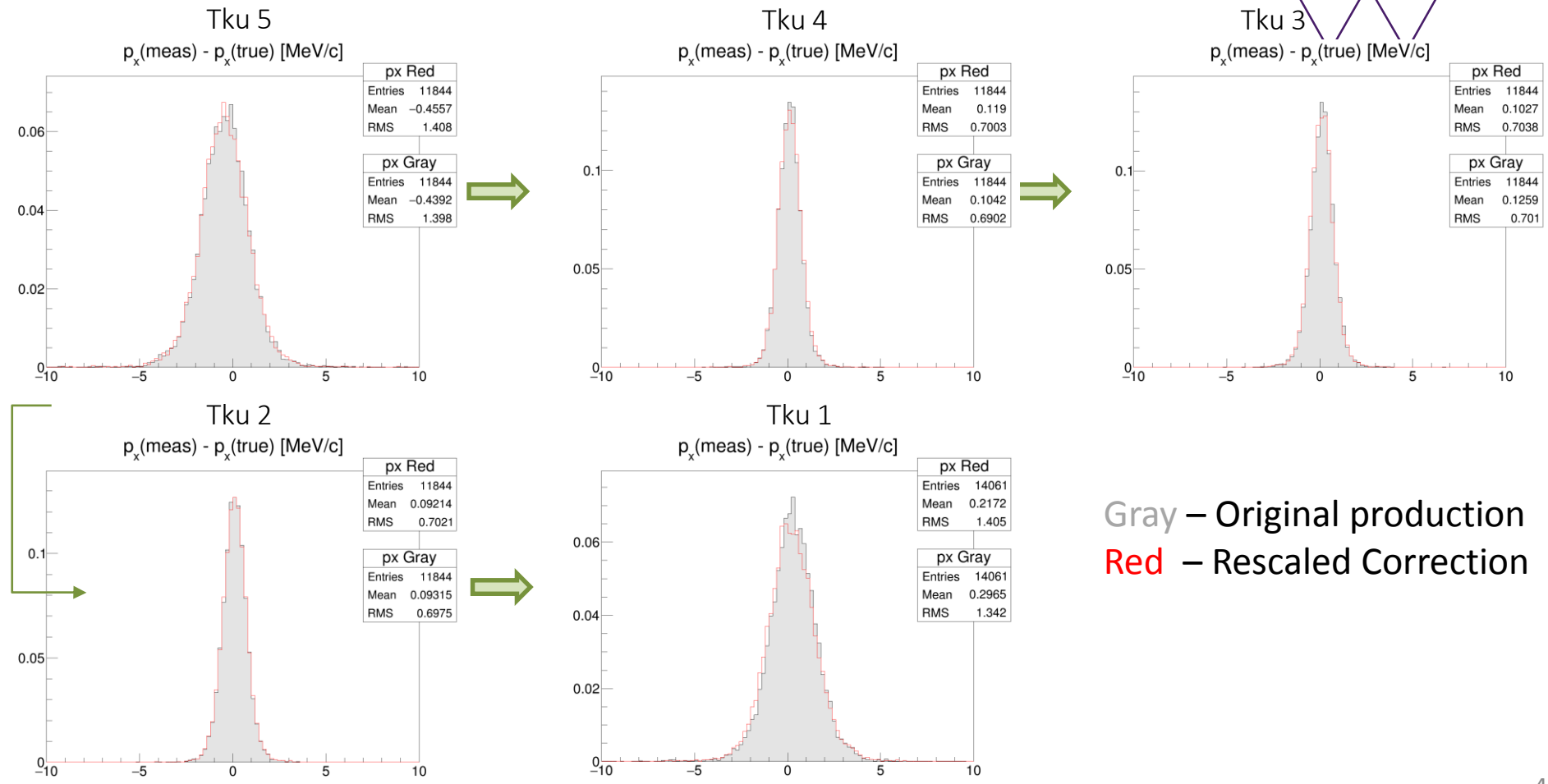


Gray – Original production

Red – Rescaled Correction

Rescaling Px, Py

Px Residuals, TKU

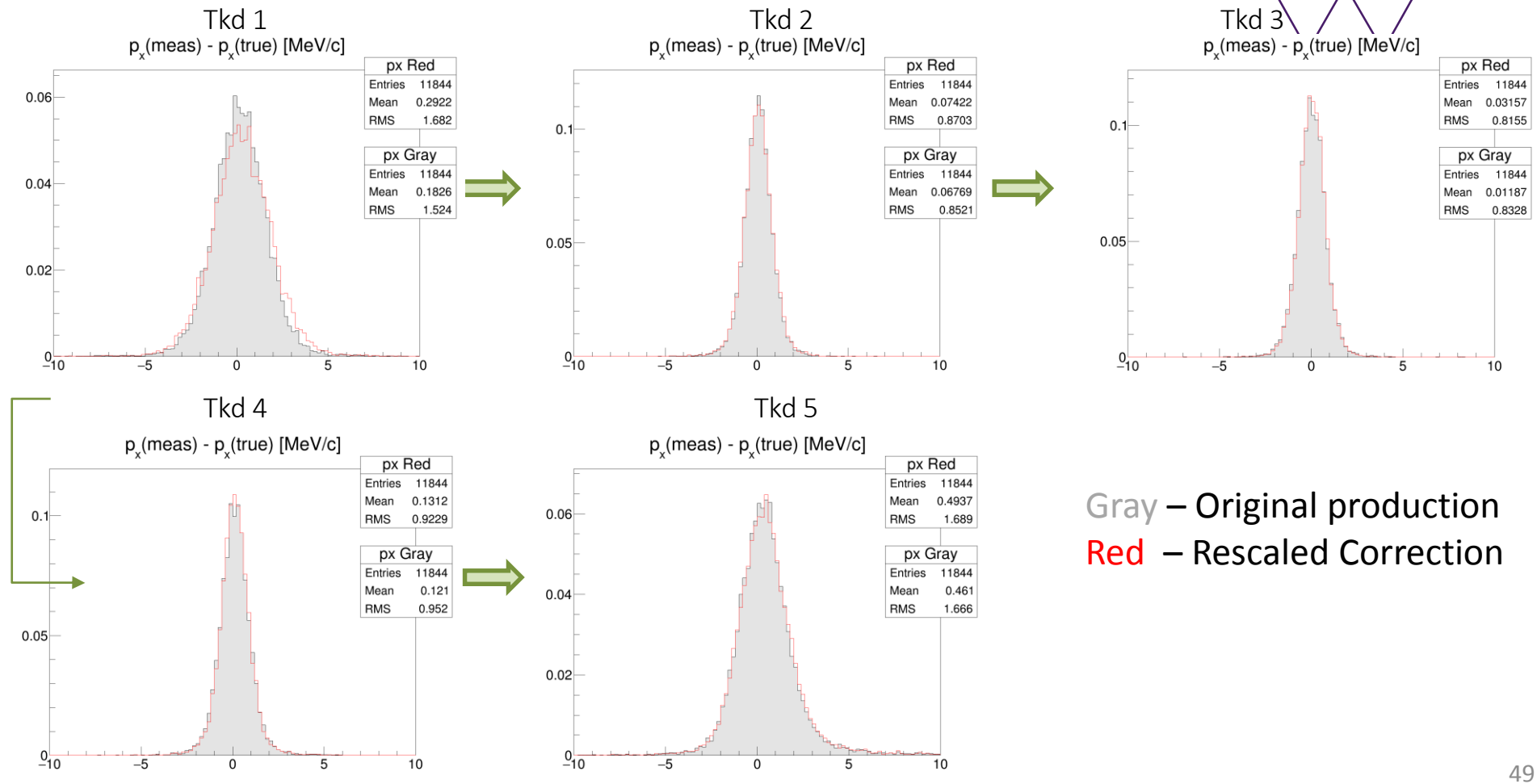


Gray – Original production

Red – Rescaled Correction

Rescaling Px, Py

Px Residuals, TKD

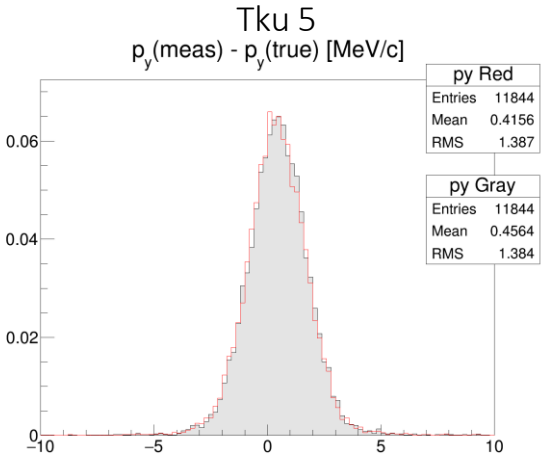


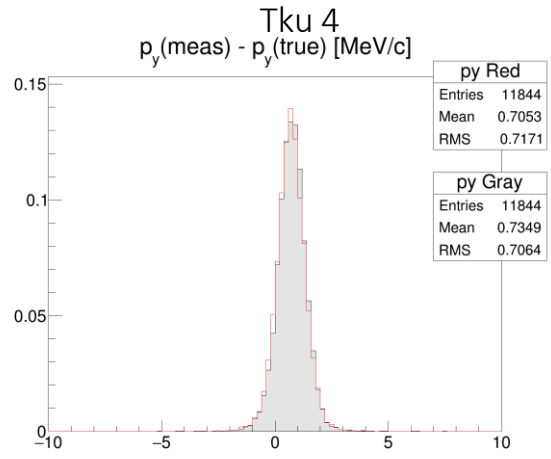
Gray – Original production

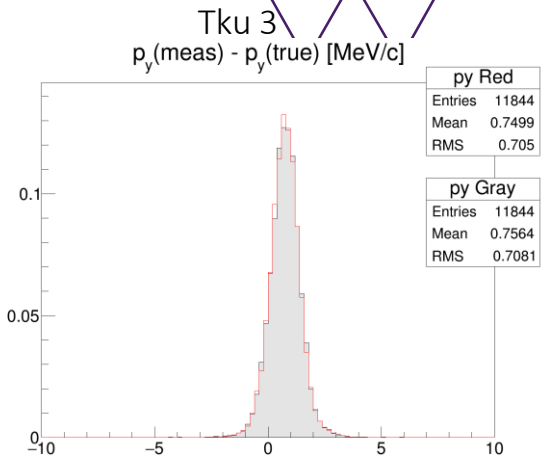
Red – Rescaled Correction

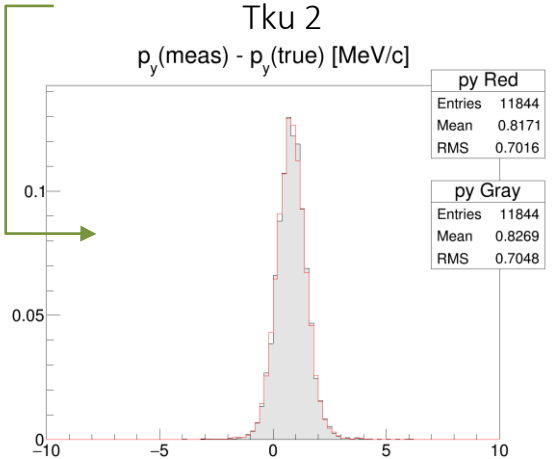
Rescaling Px, Py

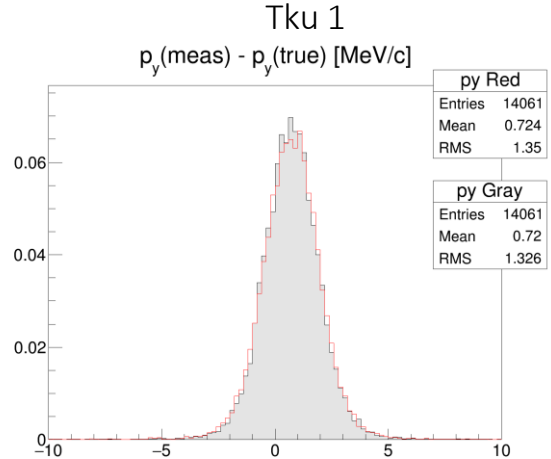
Py Residuals, TKU









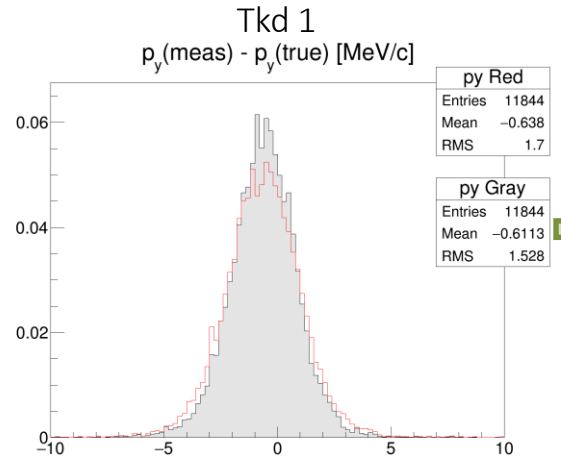


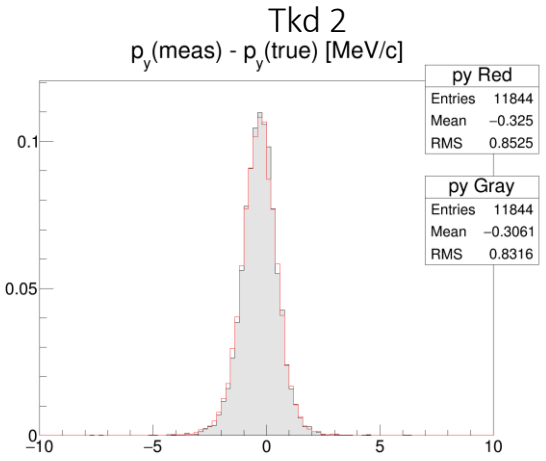
Gray – Original production

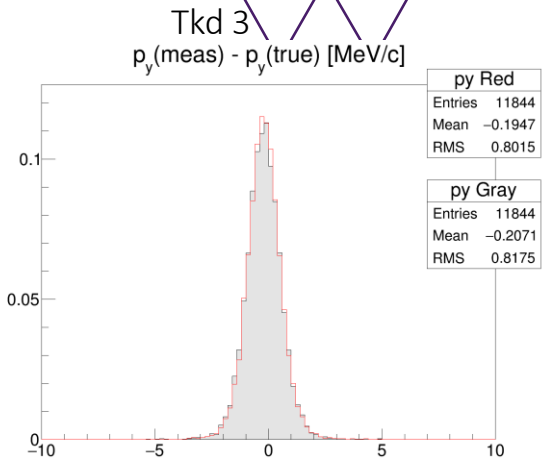
Red – Rescaled Correction

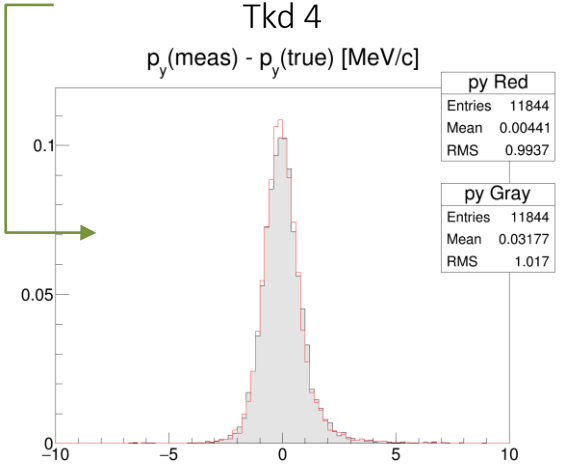
Rescaling Px, Py

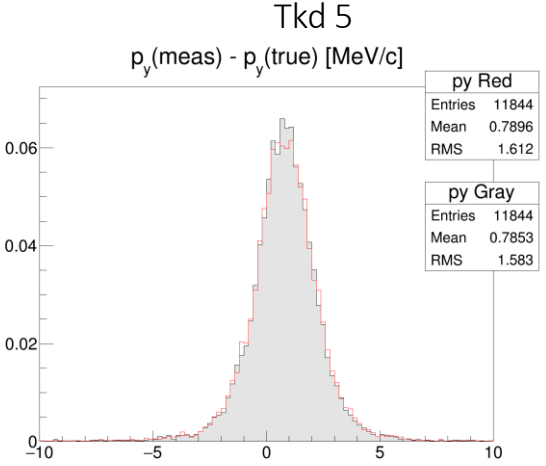
Py Residuals, TKD









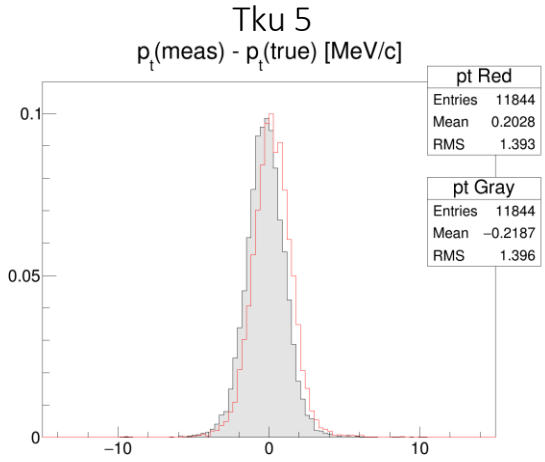


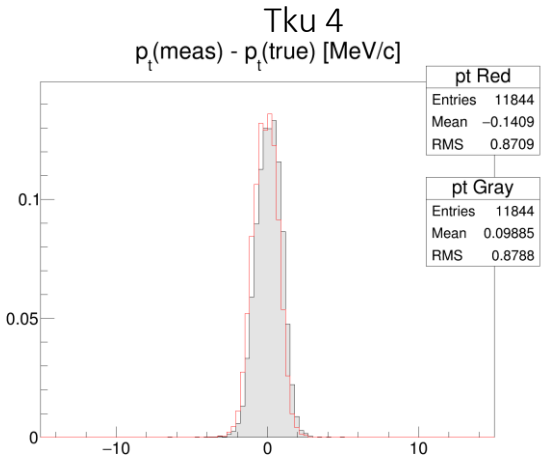
Gray – Original production

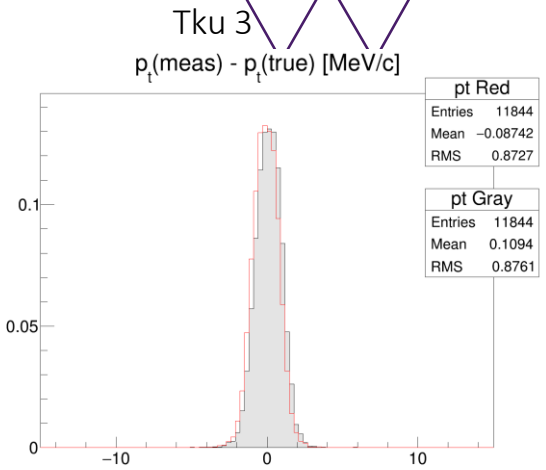
Red – Rescaled Correction

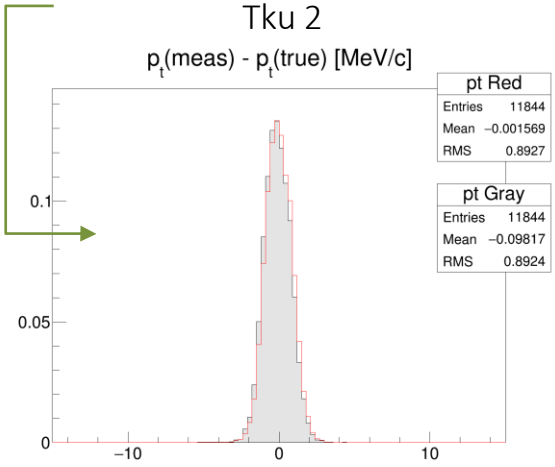
Rescaling Px, Py

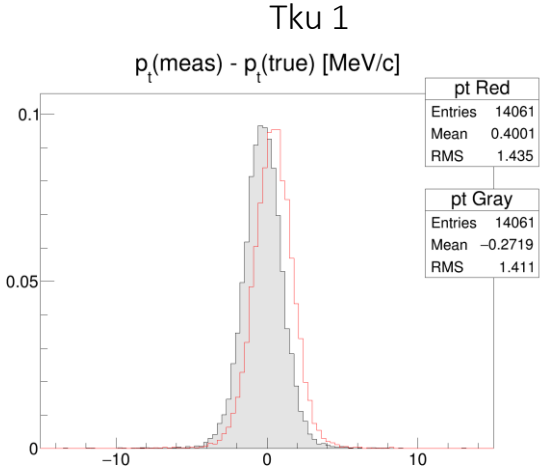
Pt Residuals, TKU









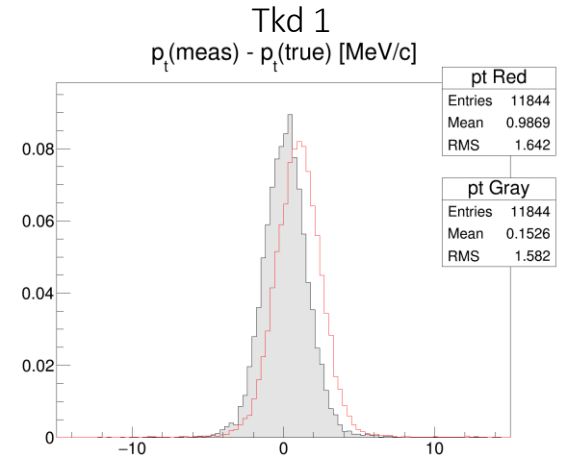


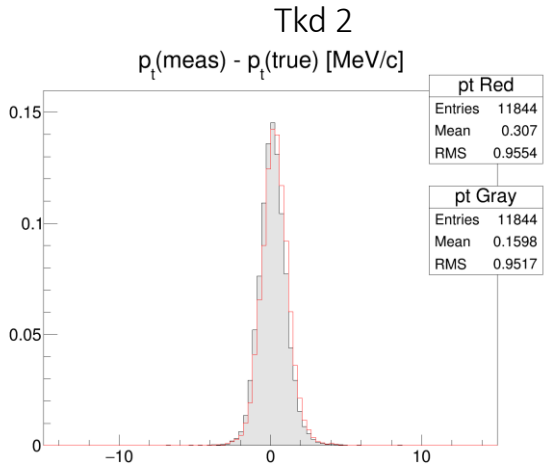
Gray – Original production

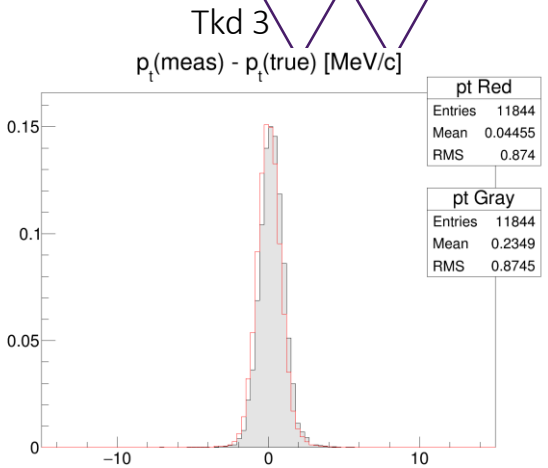
Red – Rescaled Correction

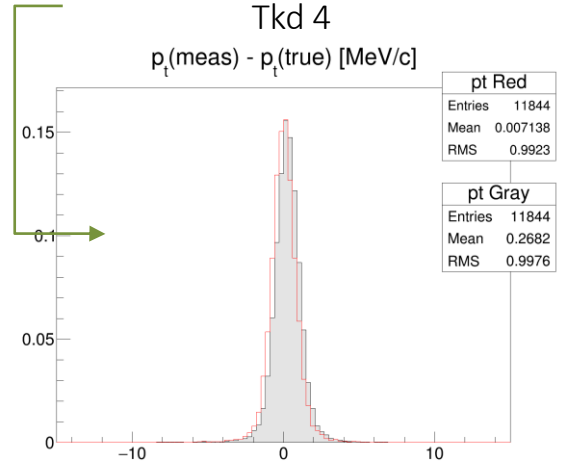
Rescaling Px, Py

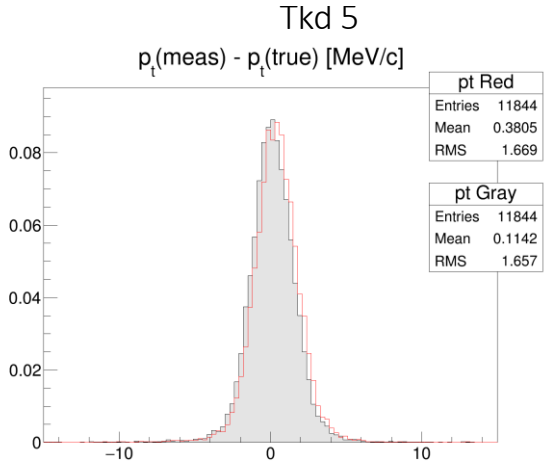
Pt Residuals, TKD









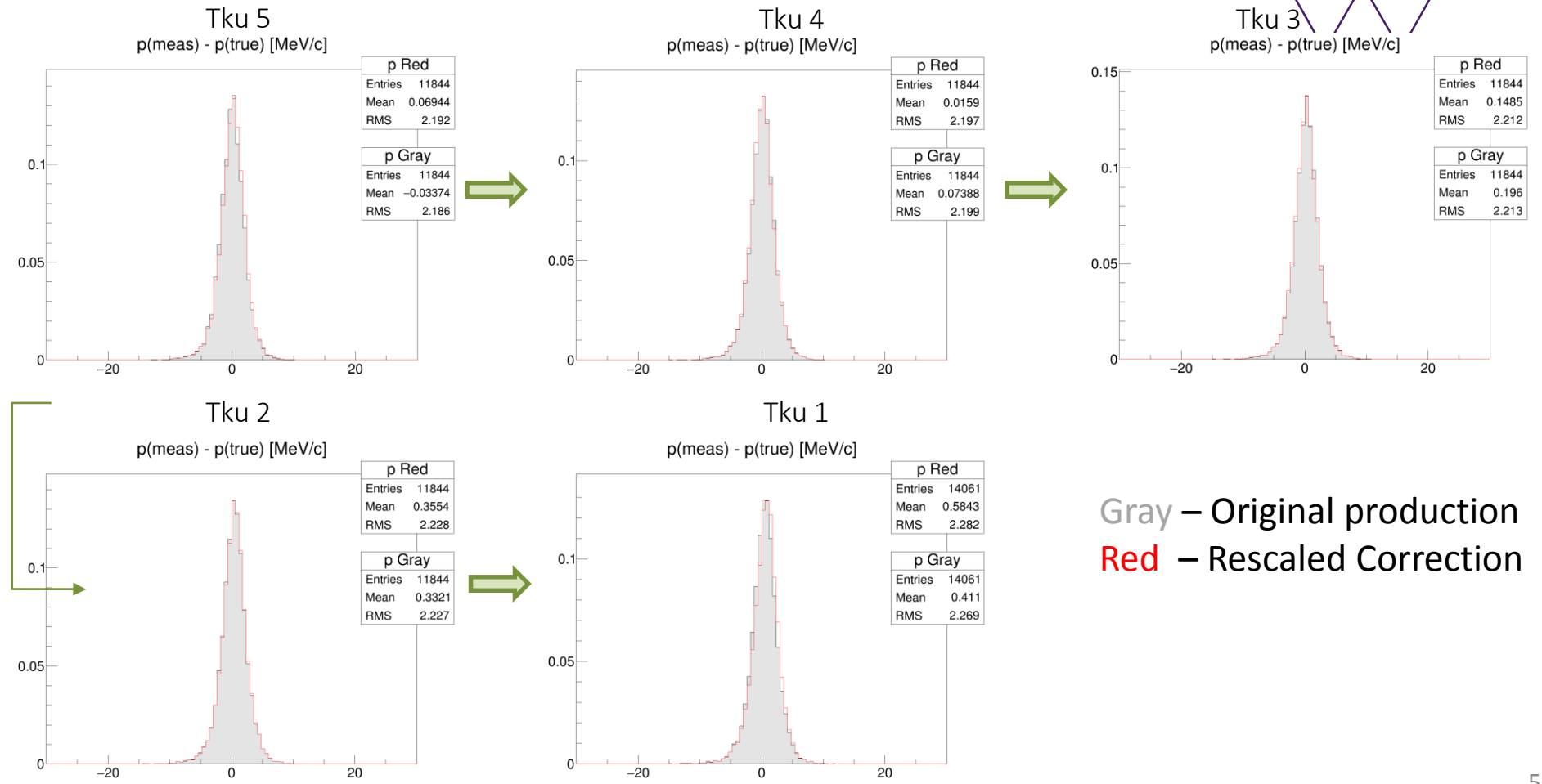


Gray – Original production

Red – Rescaled Correction

Rescaling Px, Py

P Residuals, TKU

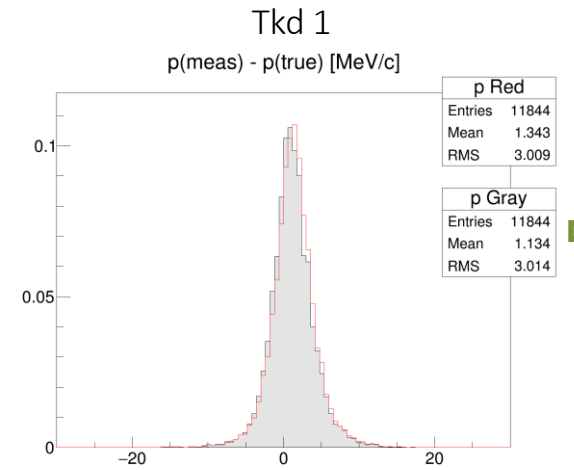


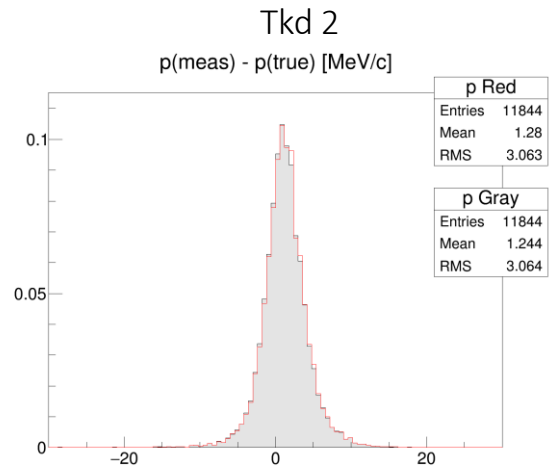
Gray – Original production

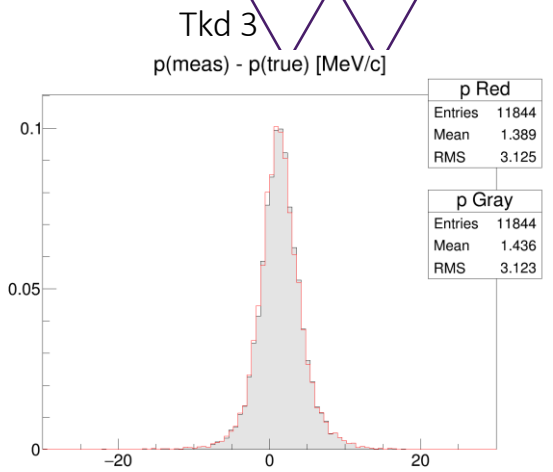
Red – Rescaled Correction

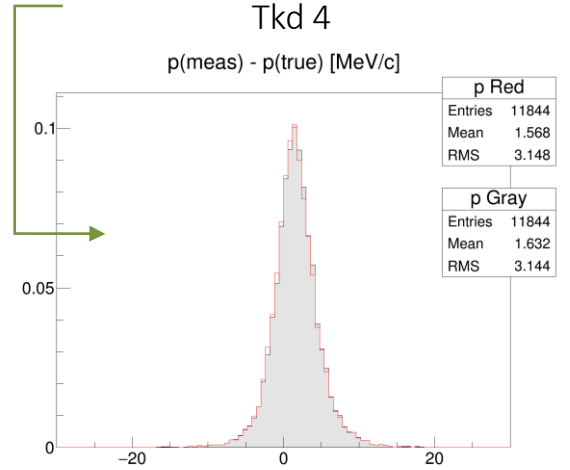
Rescaling Px, Py

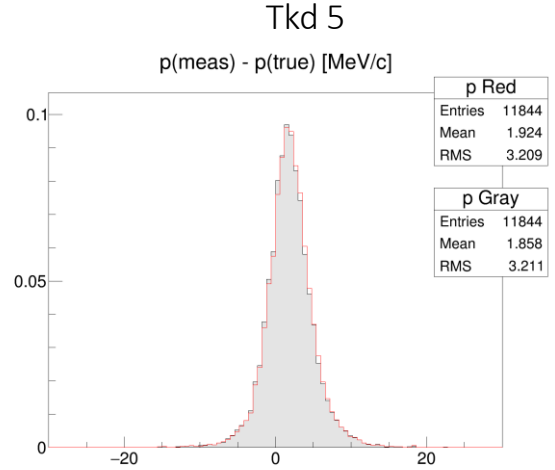
P Residuals, TKD











Gray – Original production

Red – Rescaled Correction

Recalculating Correction

Recalculating Correction

Simultaneous eqn correction: Recalculating px, py with new Bz
Residuals on $\mathrm{x}, \mathrm{x}', \mathrm{y}, \mathrm{y}'$ order of magnitude lower, keep fixed
Keep pz fixed to calc $\Delta\theta$
Use $R = \frac{p_t}{qB_z}$, $\Delta\theta = \frac{cB_z Q \Delta z}{p_z}$

Solve simultaneous equations for px, py:

$$x' - x = \frac{p_x}{qB_z} sin\Delta\theta - \frac{p_y}{qB_z}(1 - cos\Delta\theta),$$

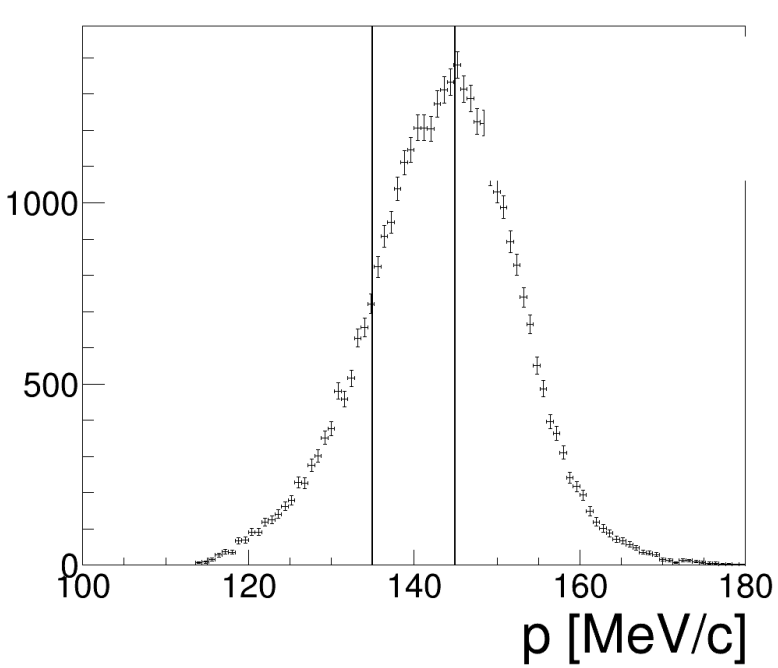
$$y' - y = \frac{p_y}{qB_z} sin\Delta\theta + \frac{p_x}{qB_z}(1 - cos\Delta\theta),$$

Only updating values for stations 1-4
S5 in TKU & TKD is unchanged - apologies

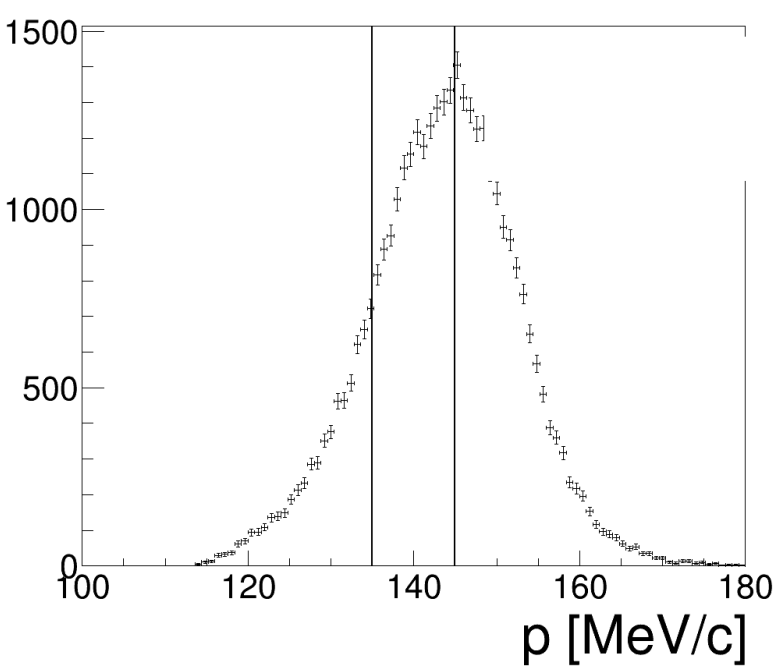
Recalculating Px, Py

TKU p cut

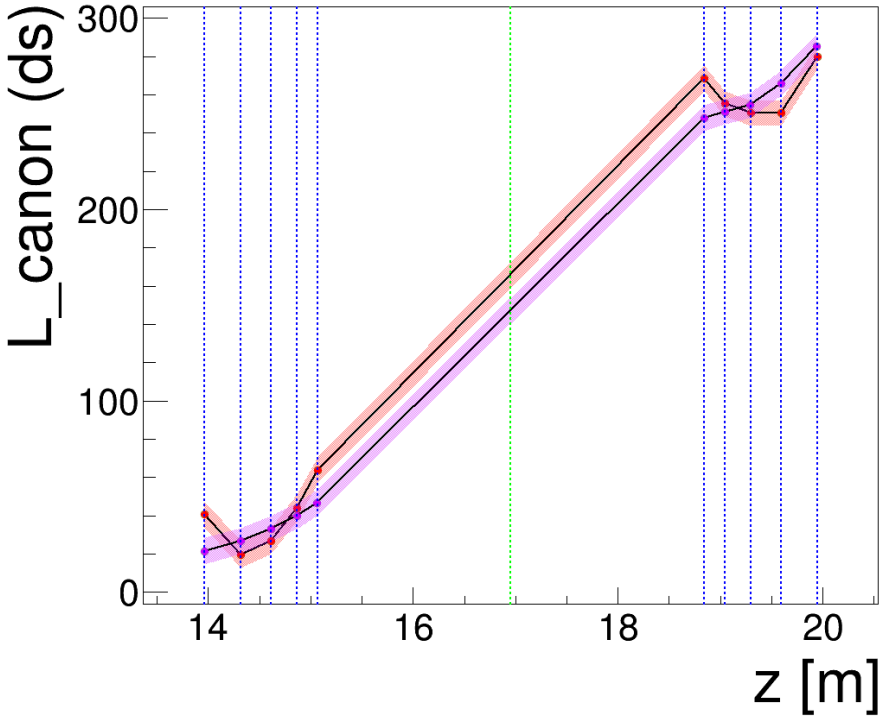
3.3.2

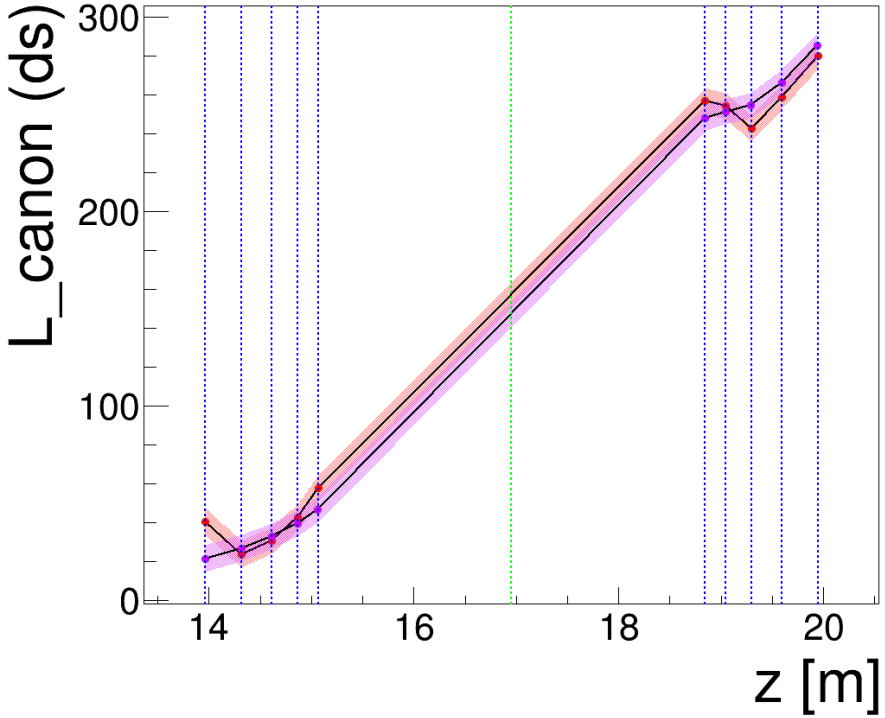


Recalculated



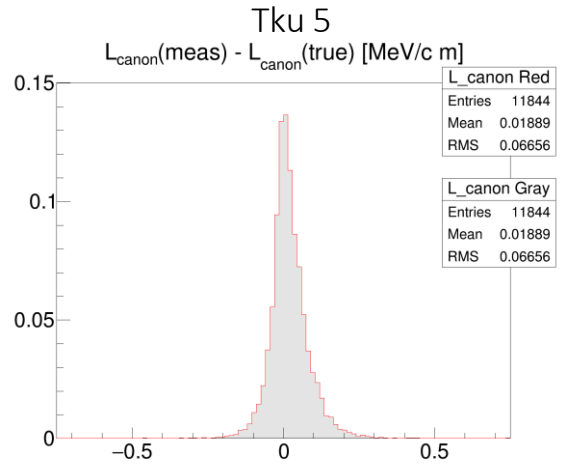
Recalculating Px, Py
L canon mean

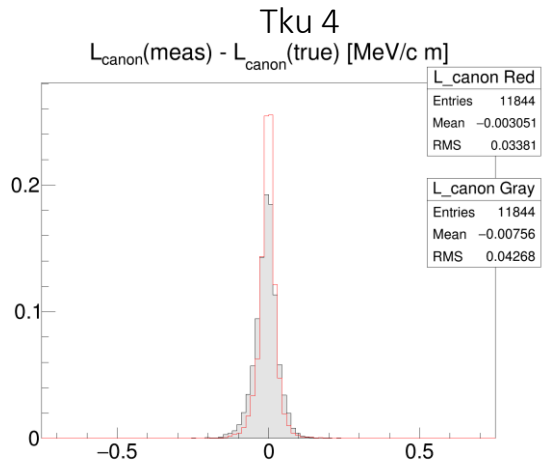


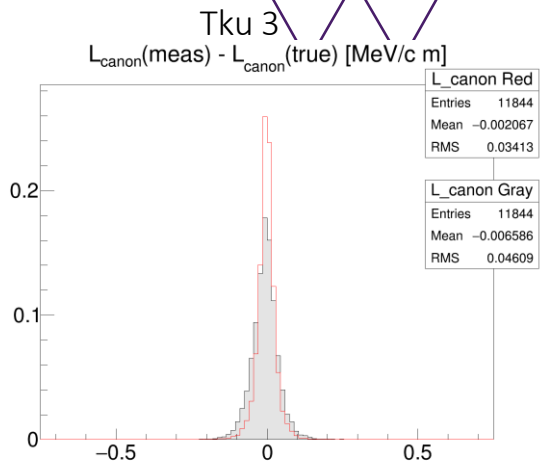


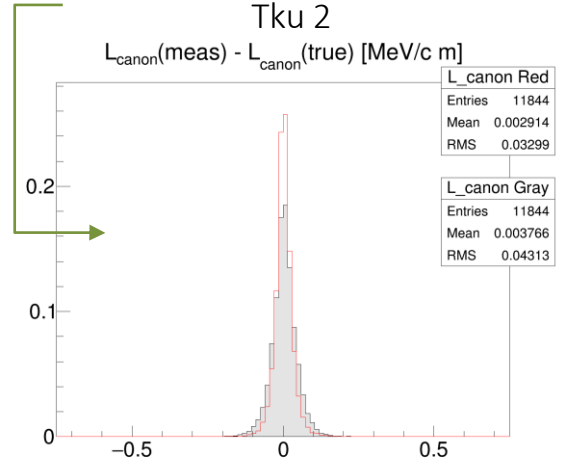
Recalculating Px, Py

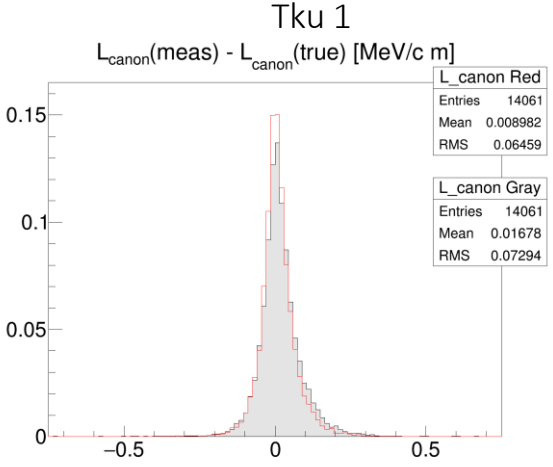
L_canon Residuals, TKU









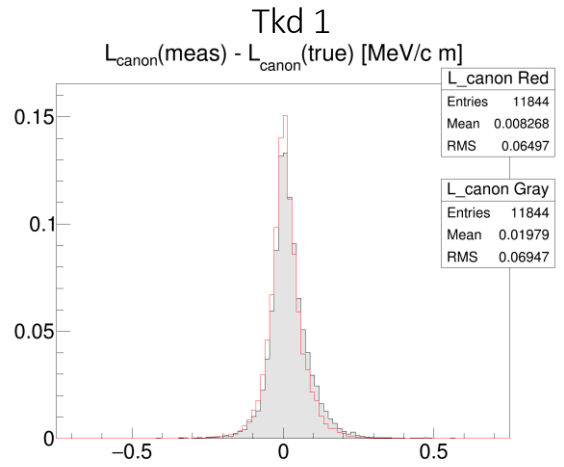


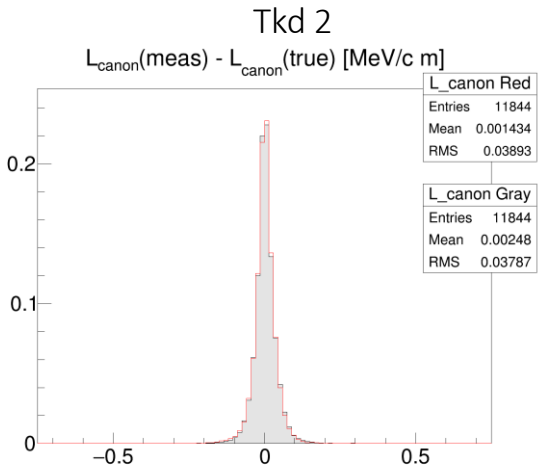
Gray – Original production

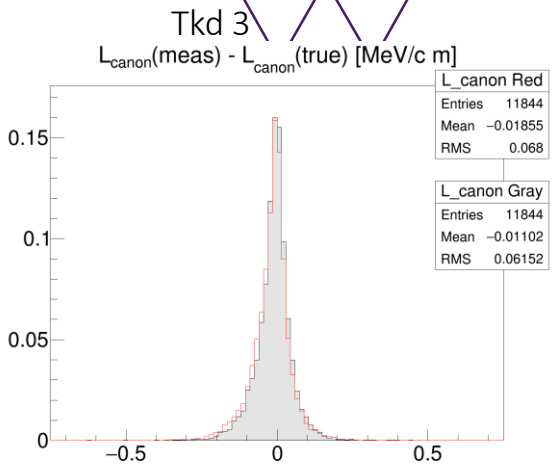
Red – Recalculated Correction

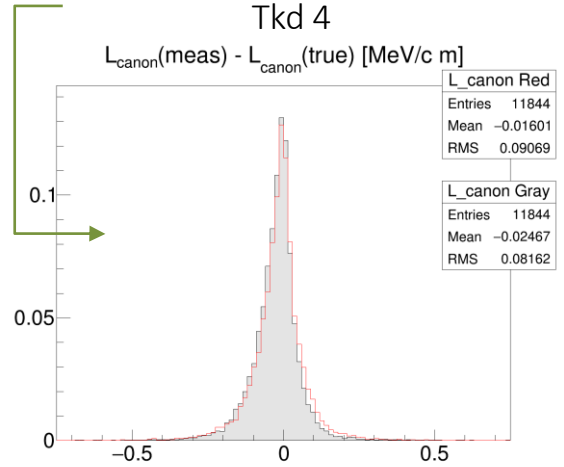
Recalculating Px, Py

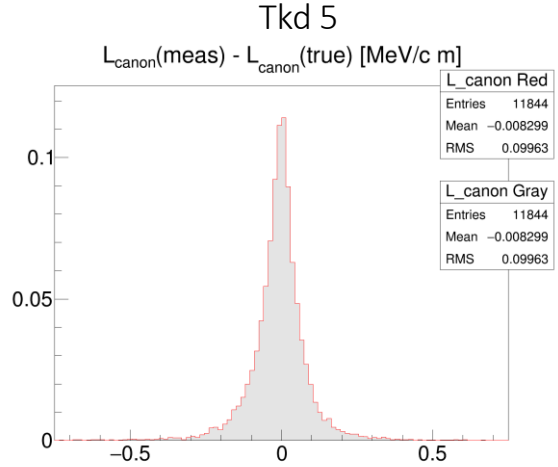
L_canon Residuals, TKD









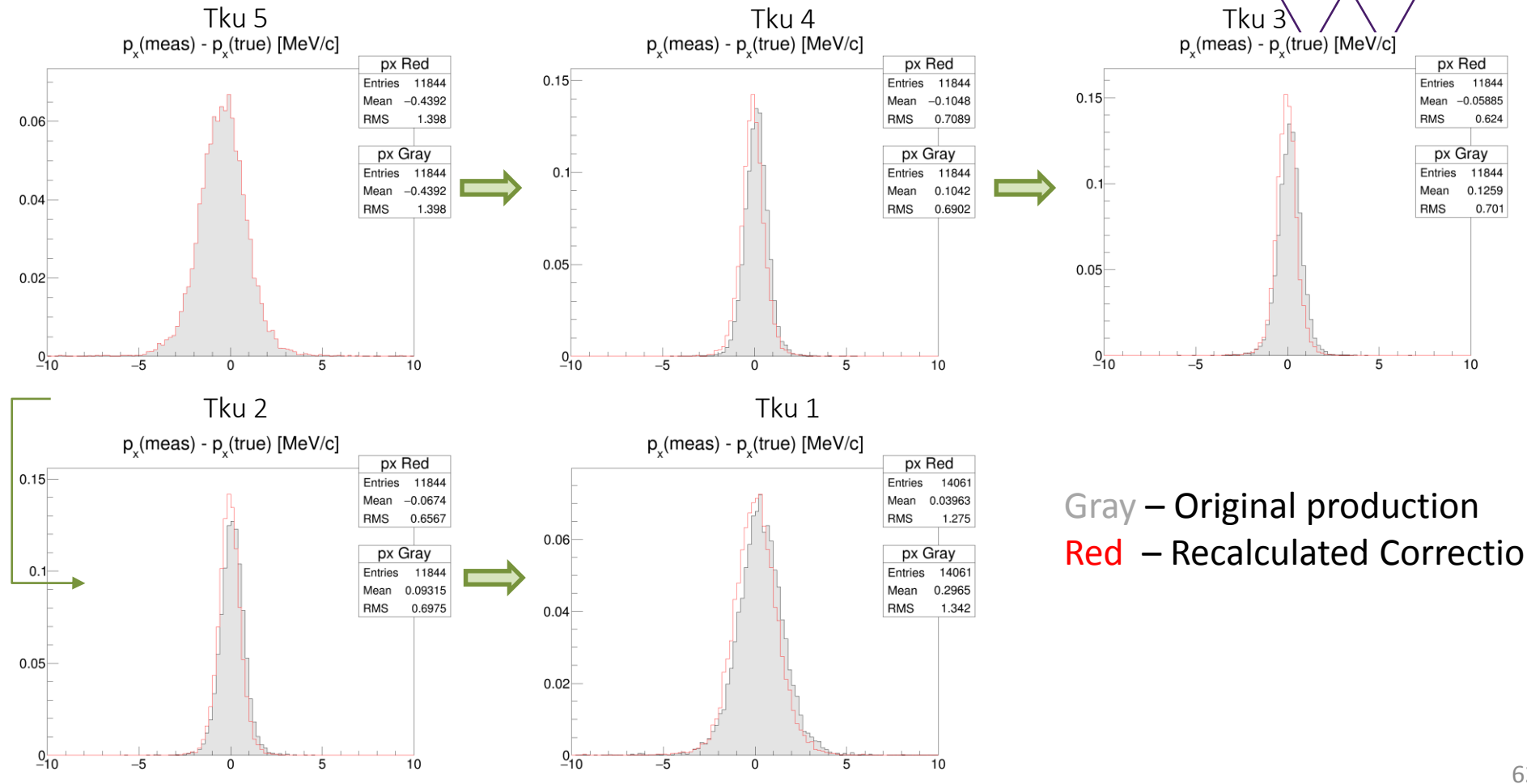


Gray – Original production

Red – Recalculated Correction

Recalculating Px, Py

Px Residuals, TKU

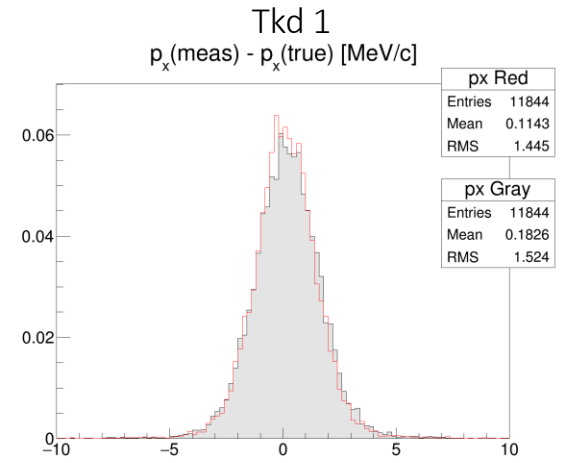


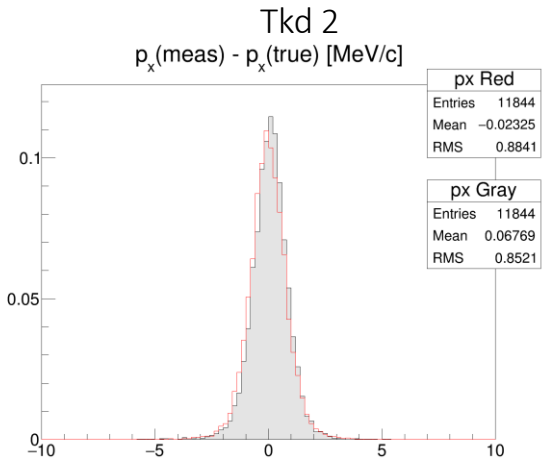
Gray – Original production

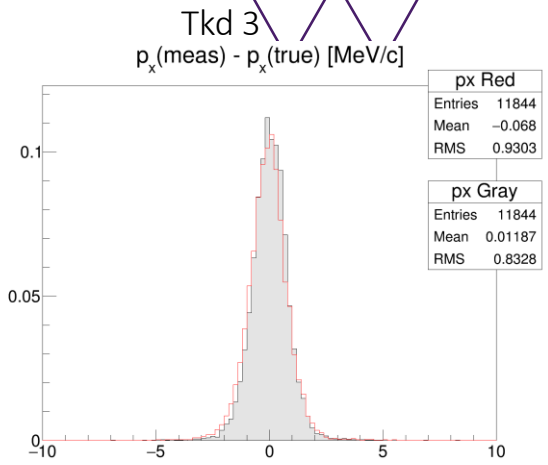
Red – Recalculated Correction

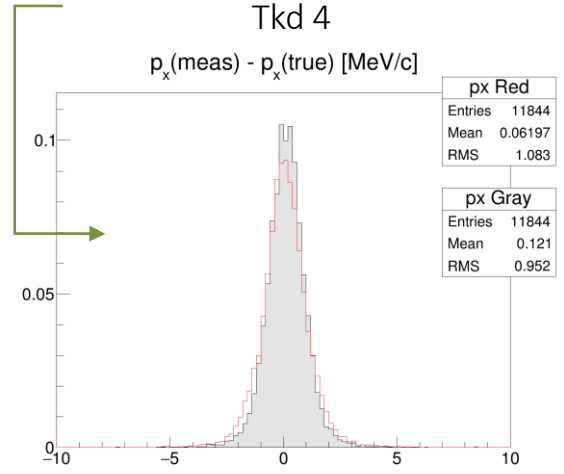
Recalculating Px, Py

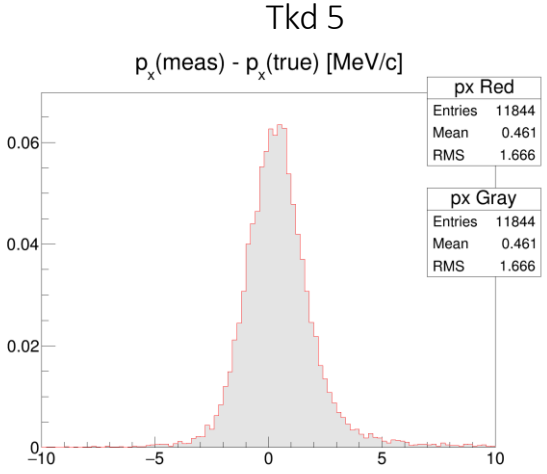
Px Residuals, TKD









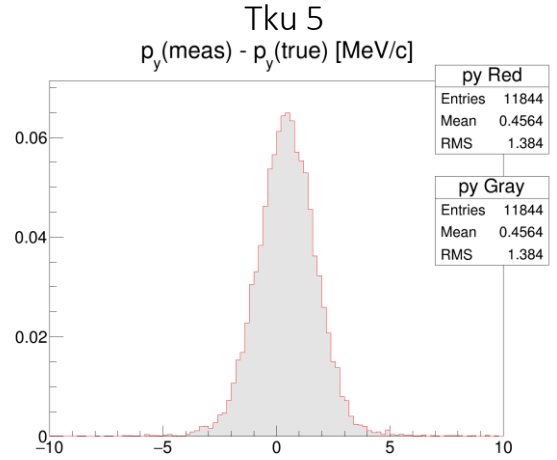


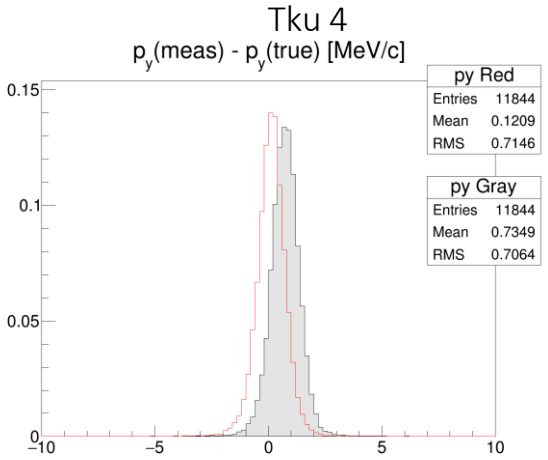
Gray – Original production

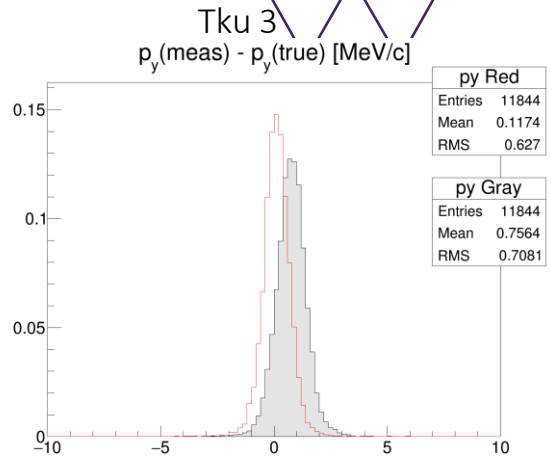
Red – Recalculated Correction

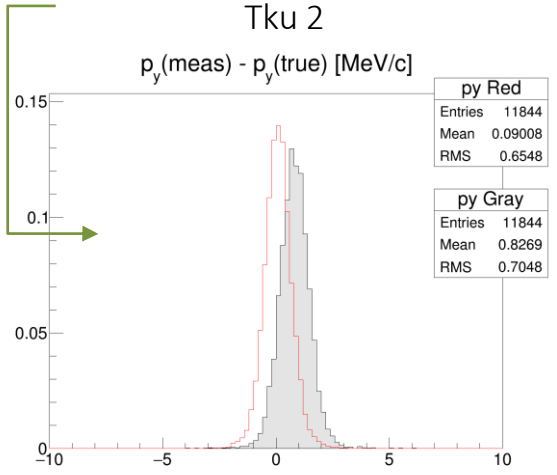
Recalculating Px, Py

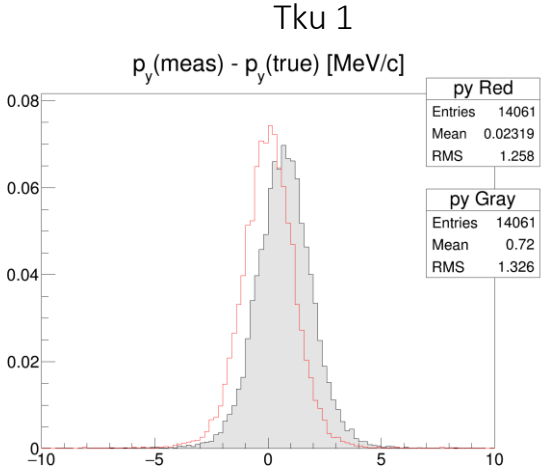
Py Residuals, TKU









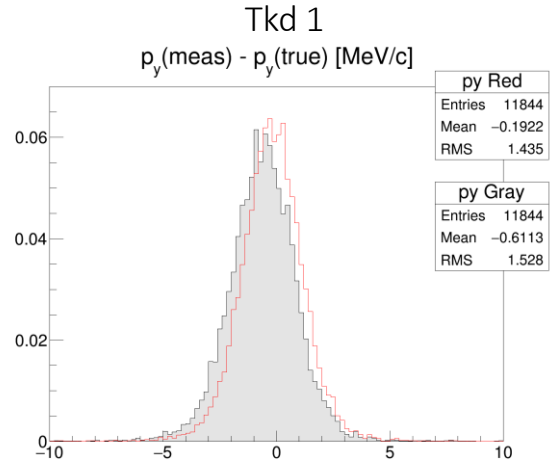


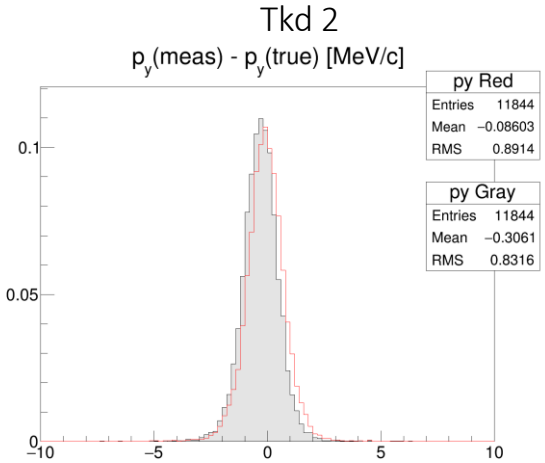
Gray – Original production

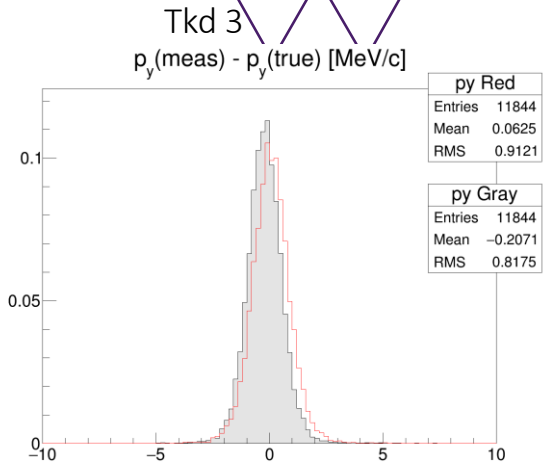
Red – Recalculated Correction

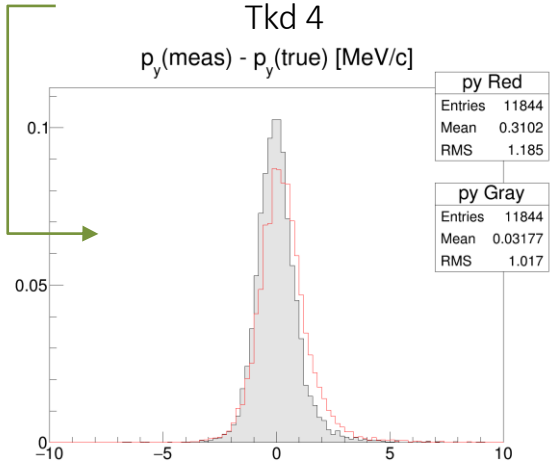
Recalculating Px, Py

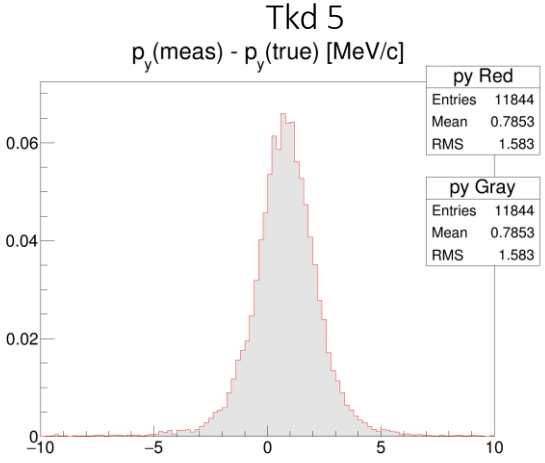
Py Residuals, TKD









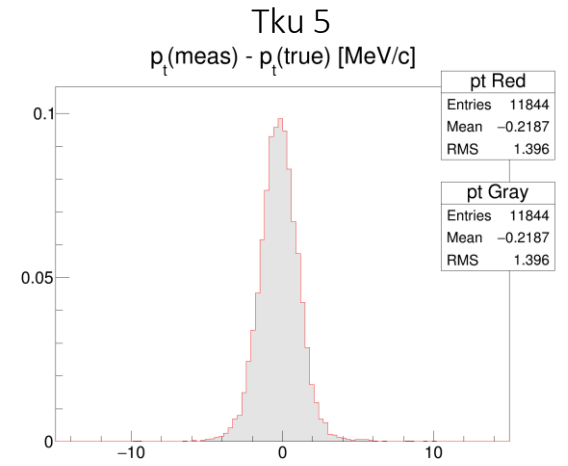


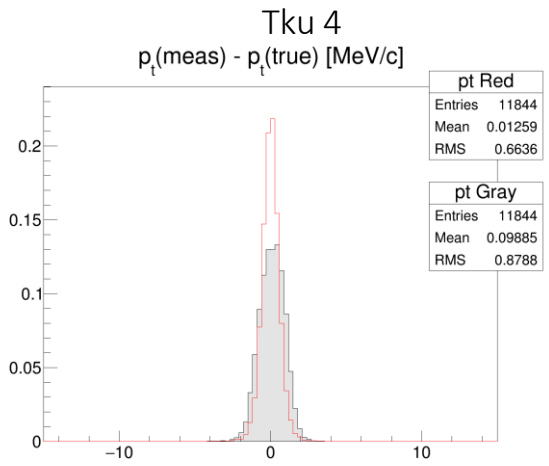
Gray – Original production

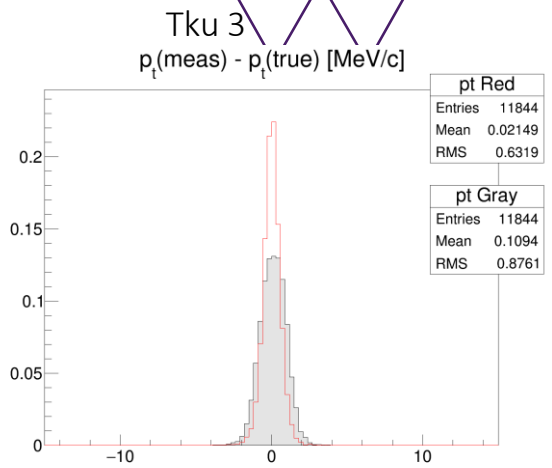
Red – Recalculated Correction

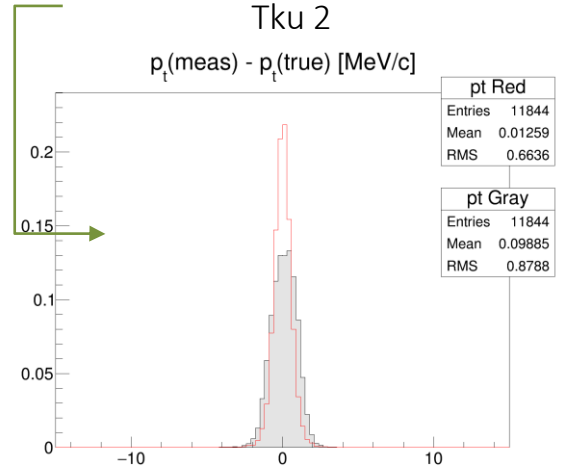
Recalculating Px, Py

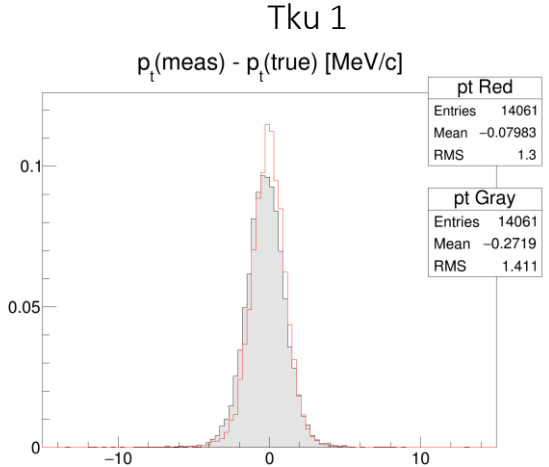
Pt Residuals, TKU









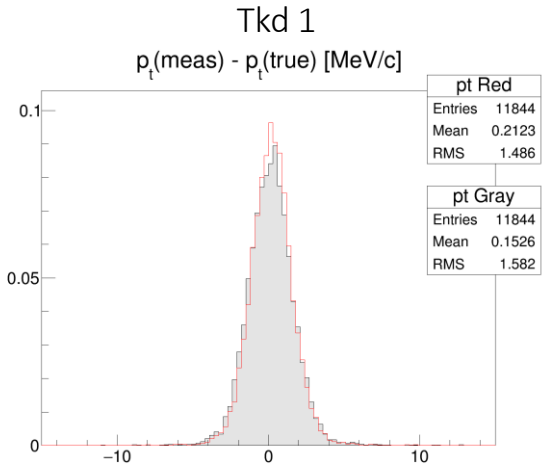


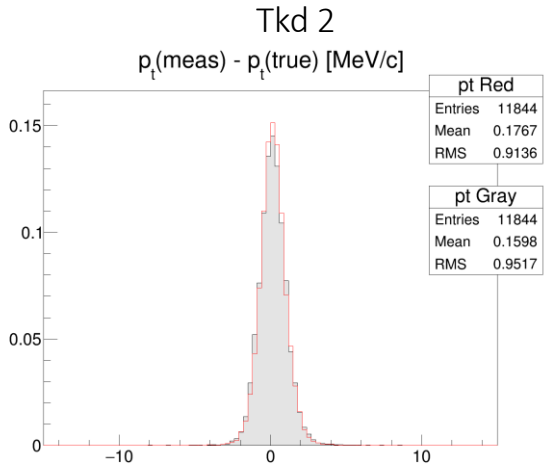
Gray – Original production

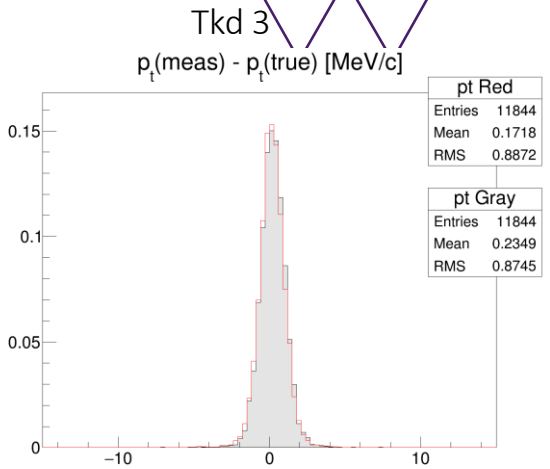
Red – Recalculated Correction

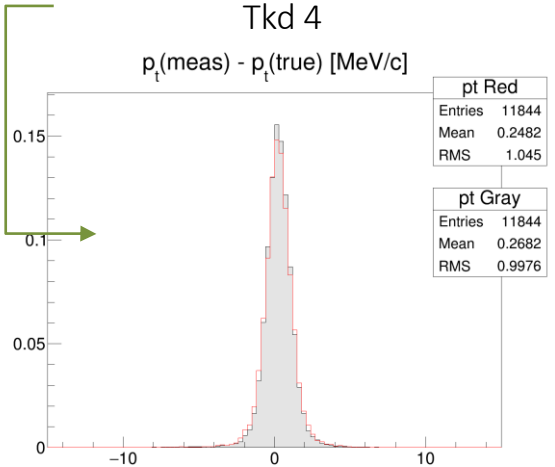
Recalculating Px, Py

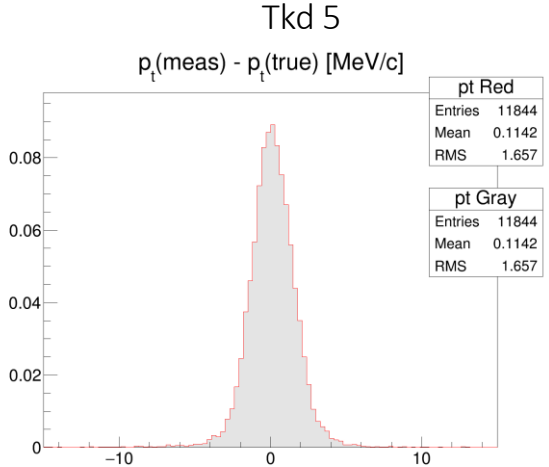
Pt Residuals, TKD









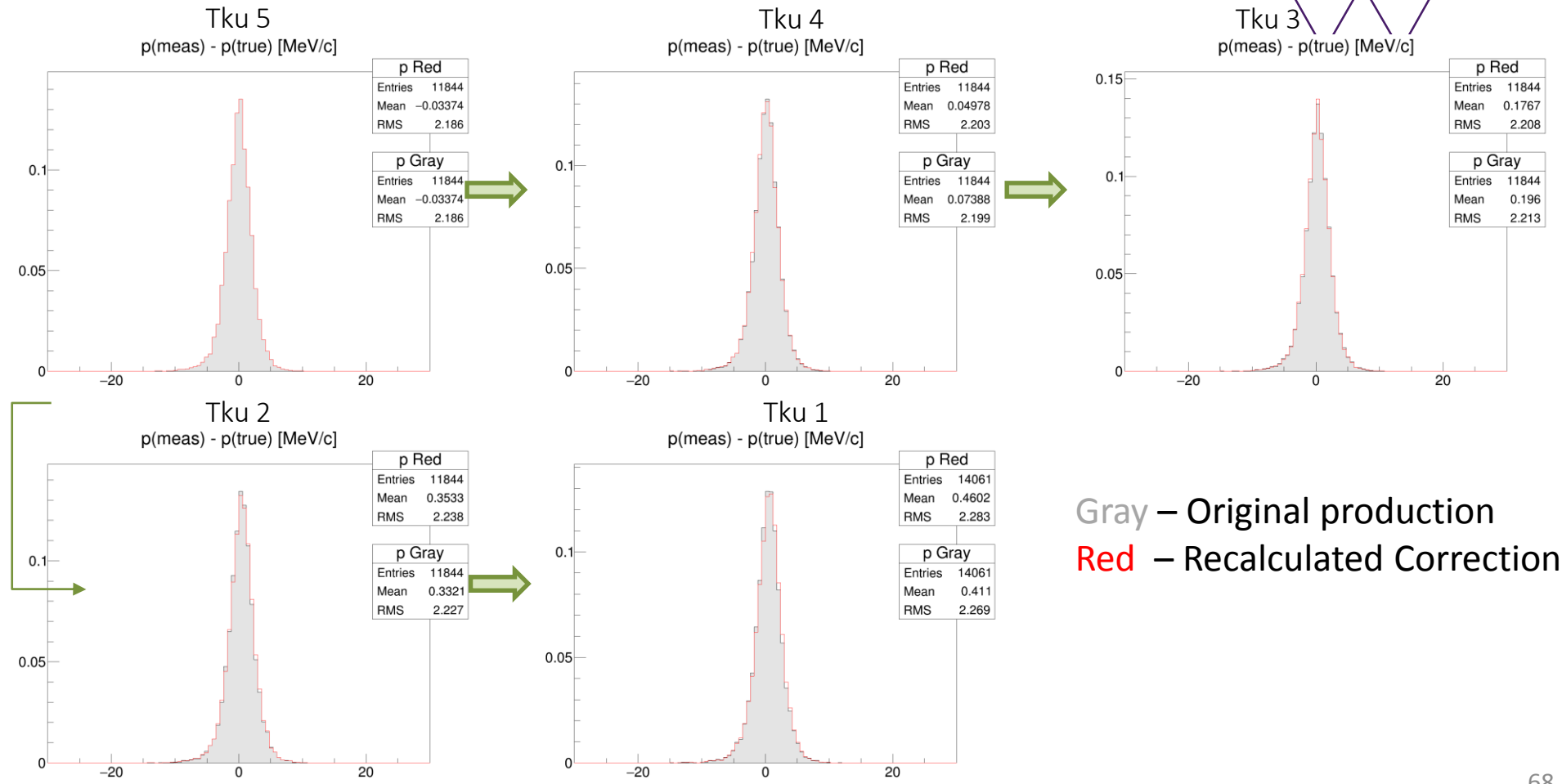


Gray – Original production

Red – Recalculated Correction

Recalculating Px, Py

P Residuals, TKU

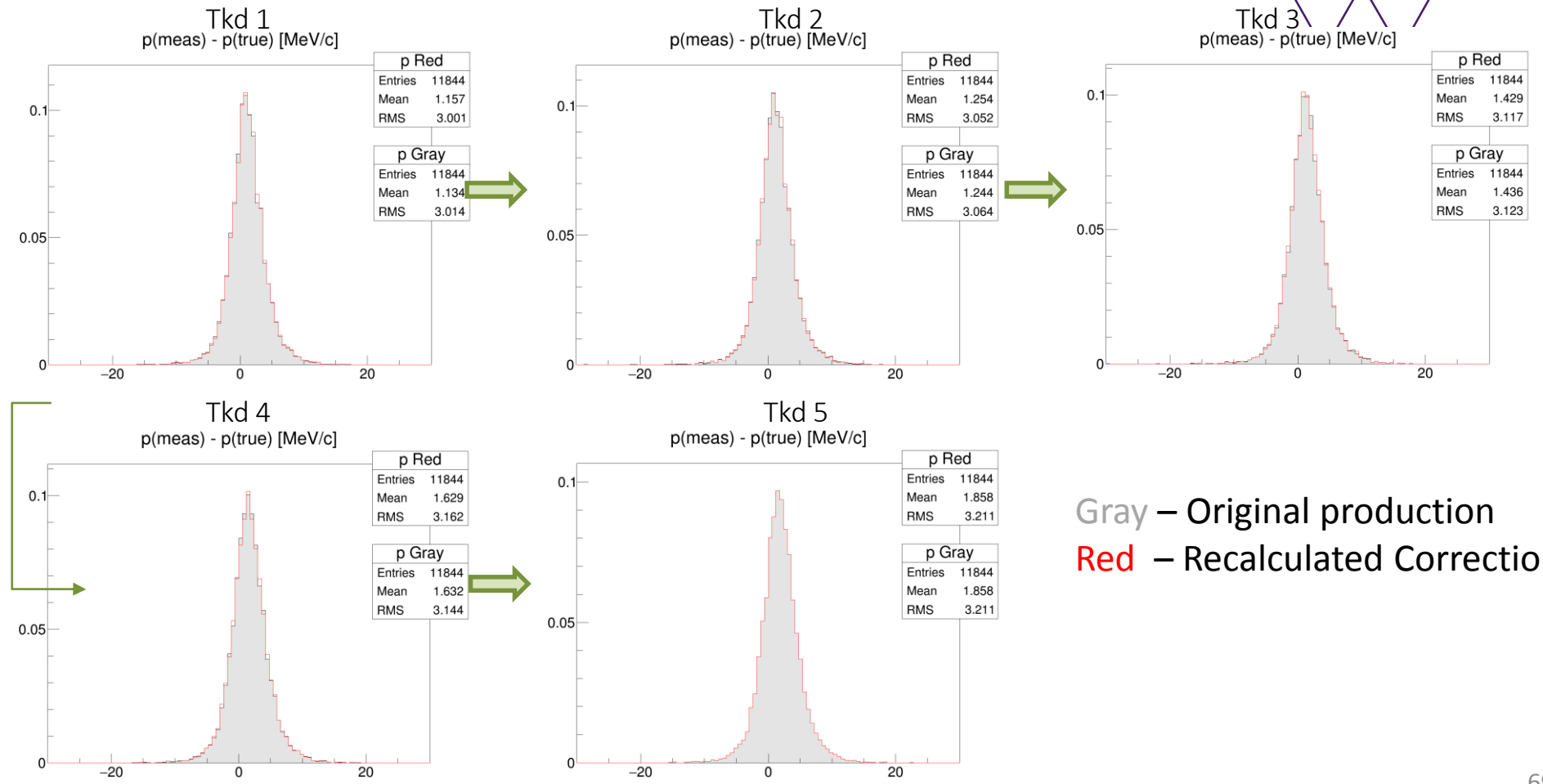


Gray – Original production

Red – Recalculated Correction

Recalculating Px, Py

P Residuals, TKD



Gray – Original production

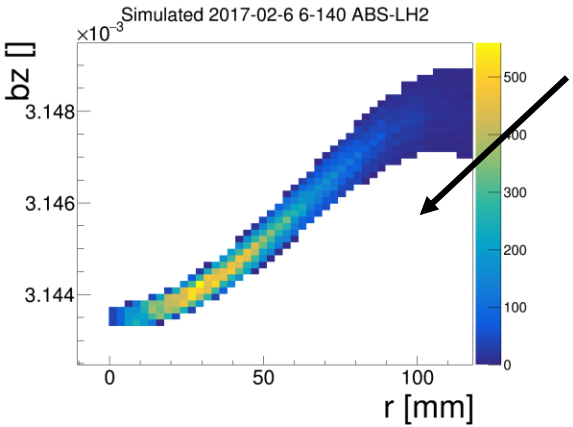
Red – Recalculated Correction

MAUS Correction

MAUS Correction

MAUS uses a single Bz value for track propagation in each tracker, replace with station-to-station average Bz values

Average Bz along central solenoid axis – other choices could be better, beam does not mostly populate r = 0

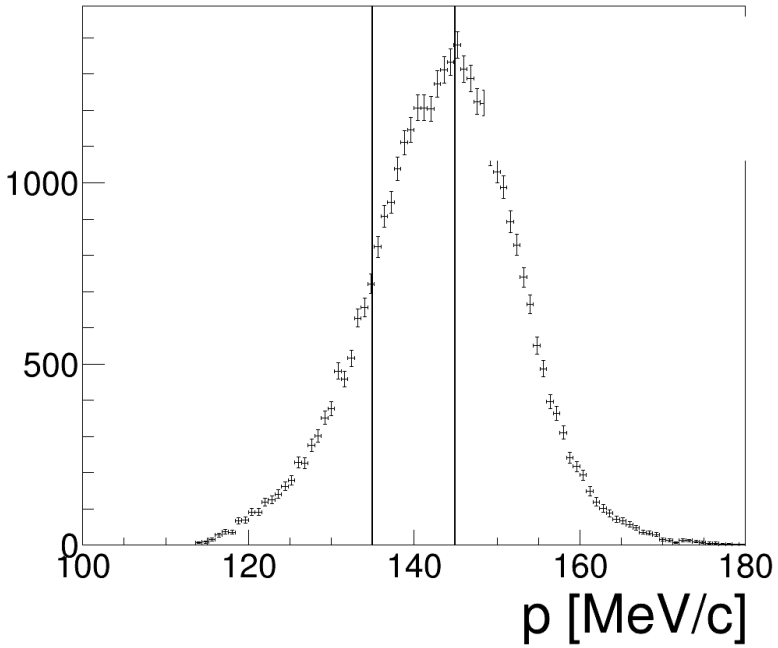


O(0.1%) field variation in r, so expect small effect

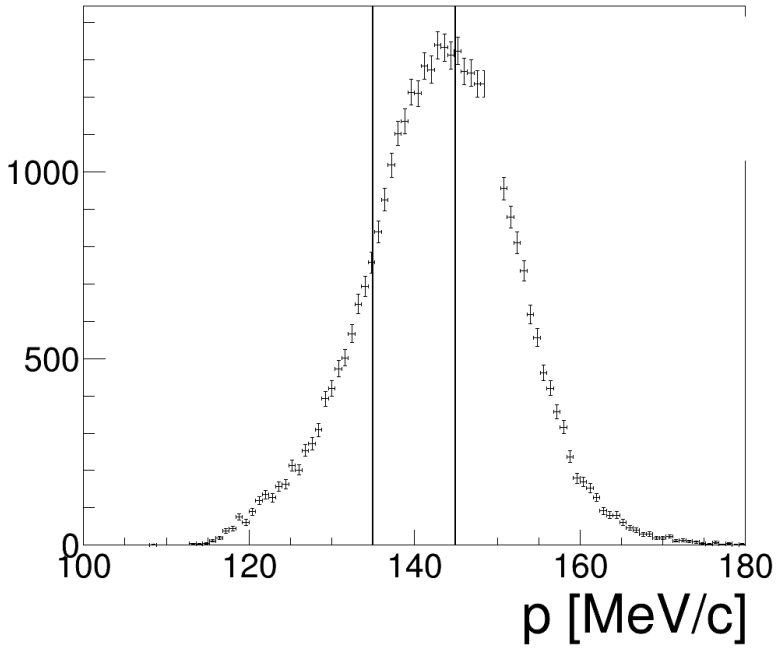
MAUS Correction

TKU p cut

3.3.2



3.3.5

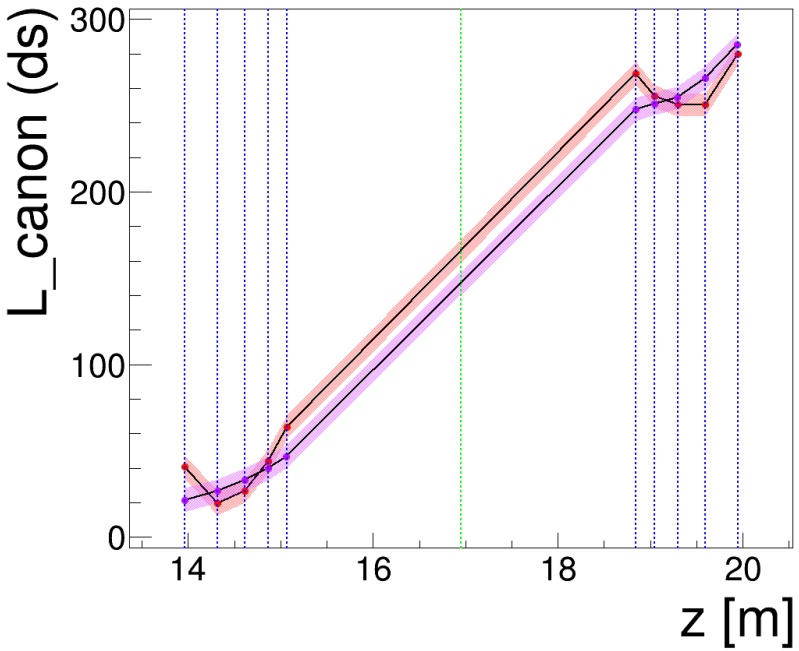


MAUS Correction

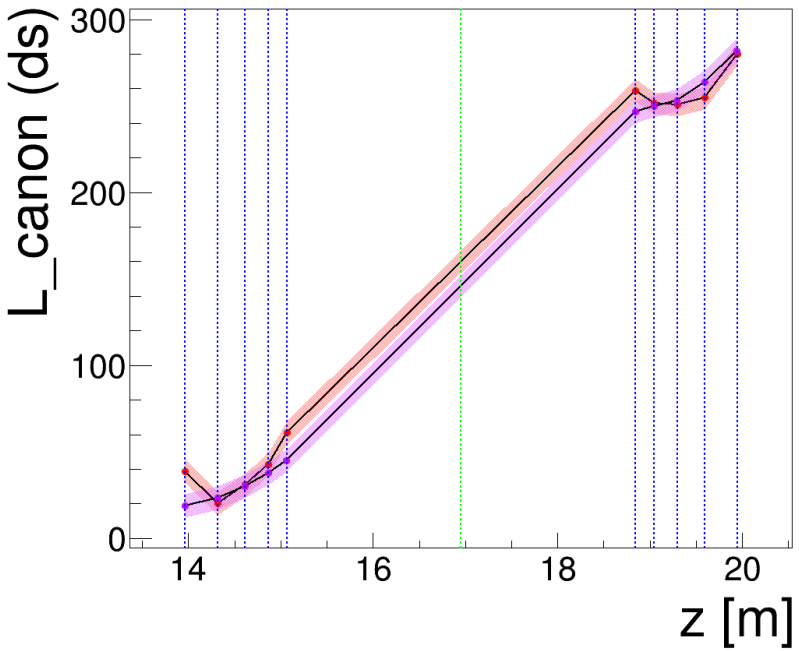
L_canon

WARWICK
THE UNIVERSITY OF WARWICK

3.3.2



3.3.5



L_canon residual

WARWICK
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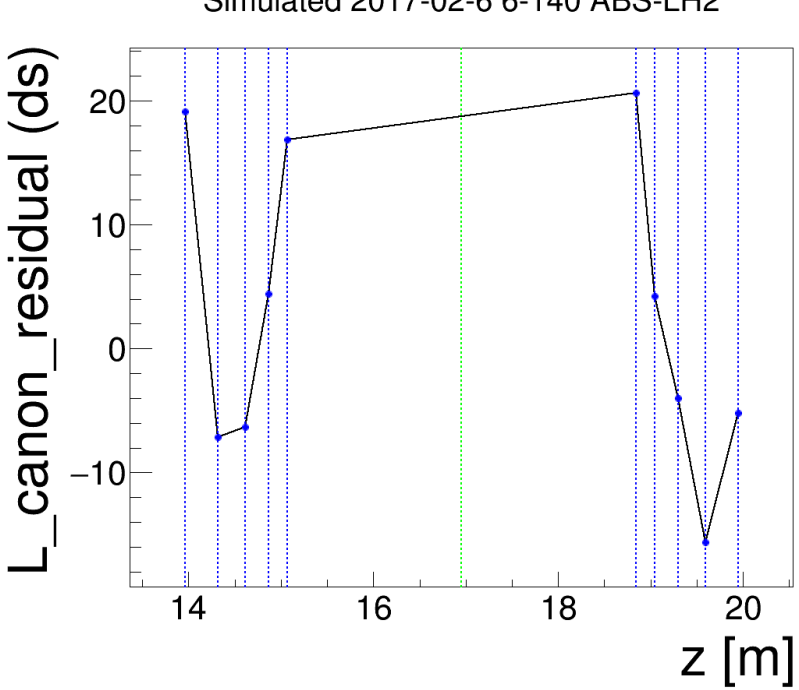
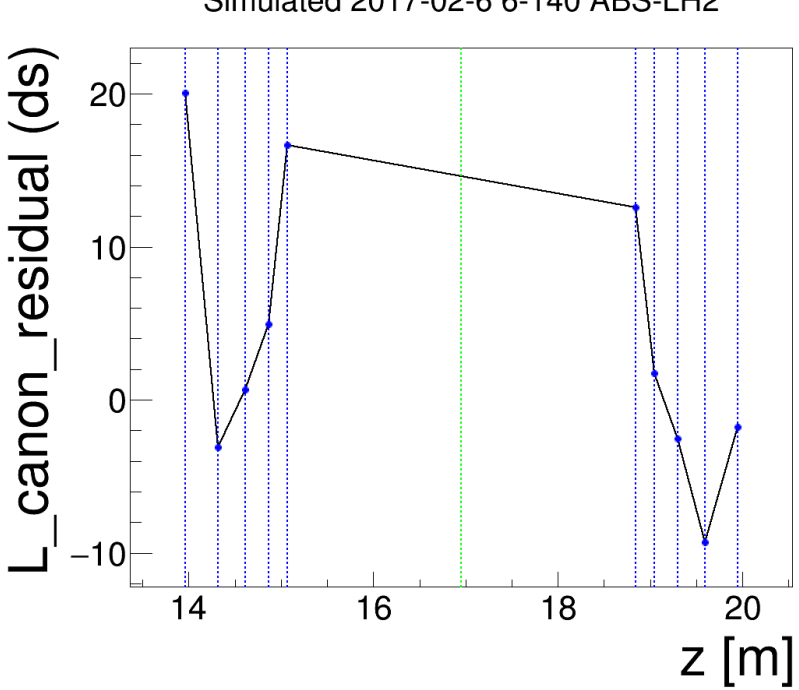
3.3.2



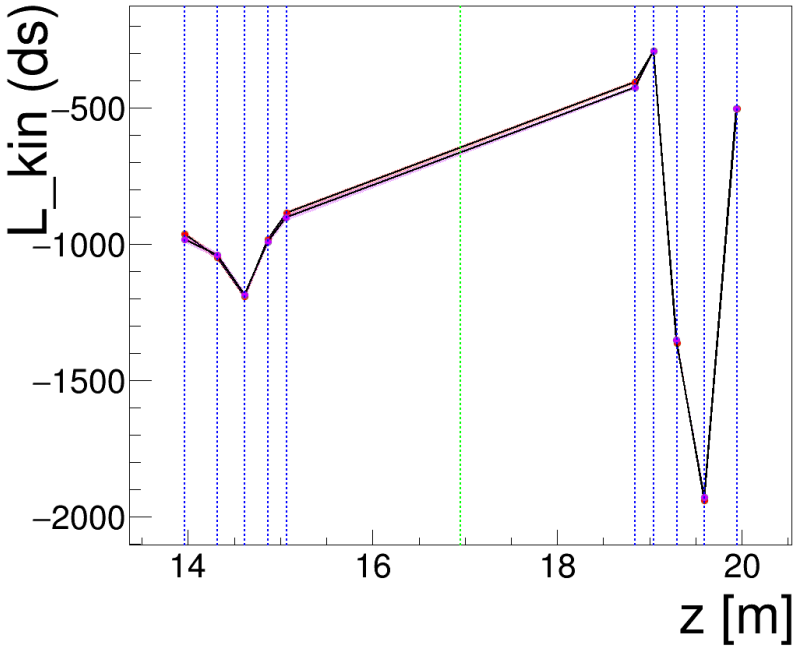
3.3.5



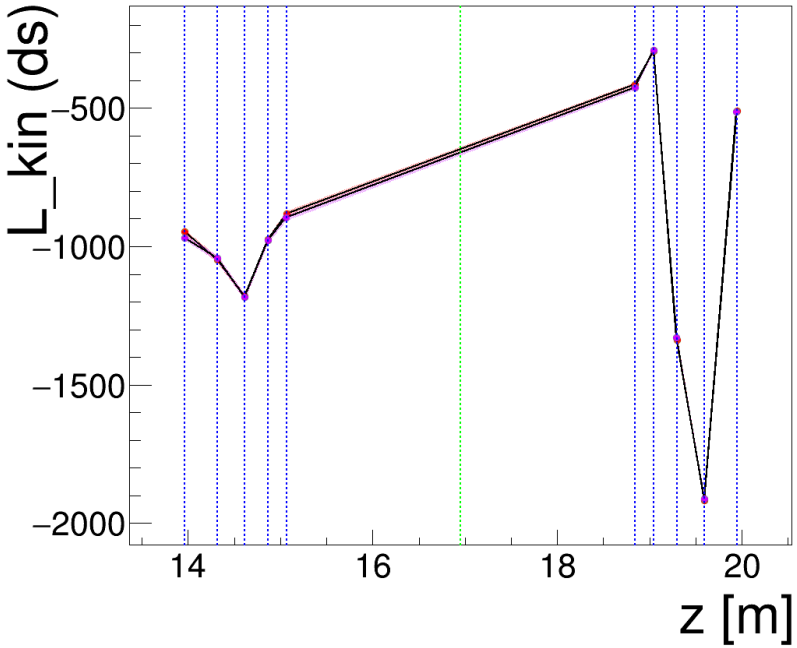
MAUS Correction

L_kin

3.3.2



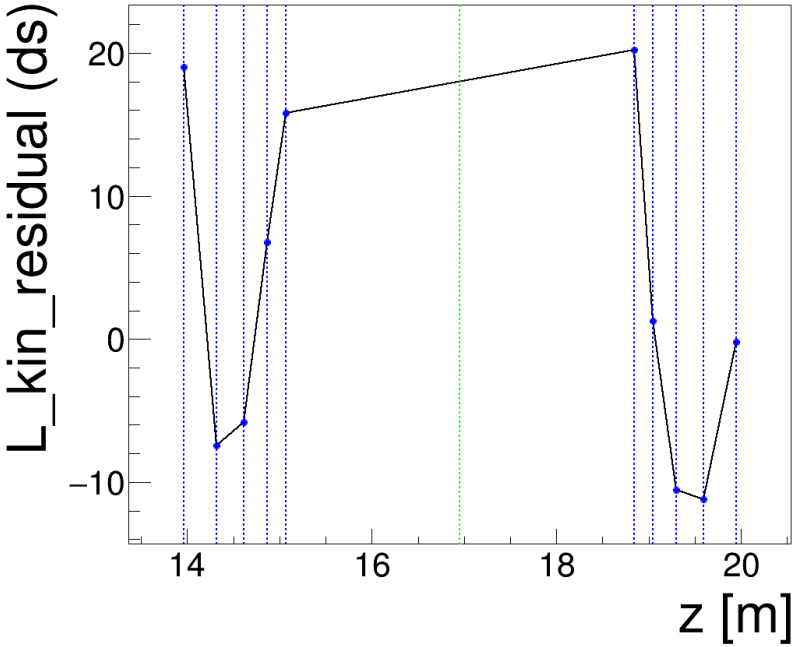
3.3.5



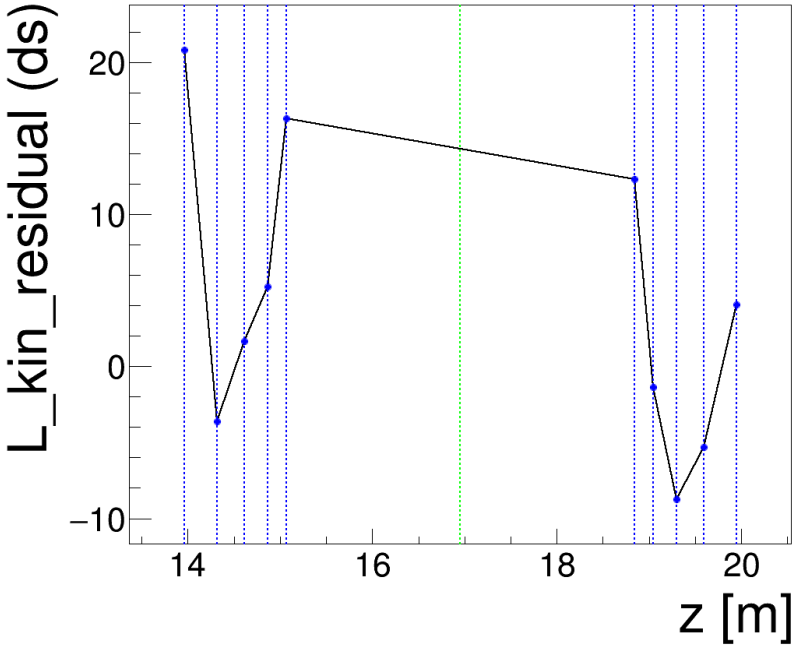
L_kin residual

WARWICK
THE UNIVERSITY OF WARWICK

3.3.2



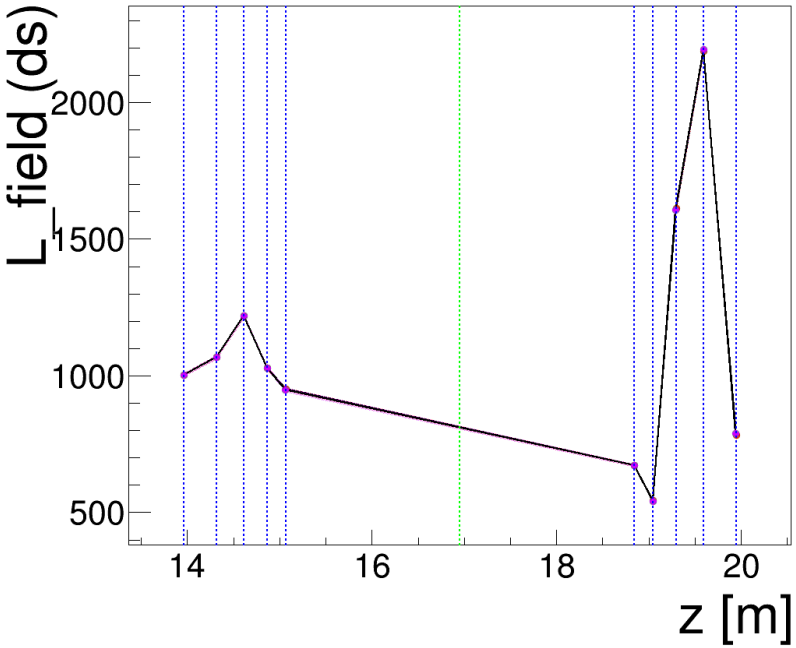
3.3.5



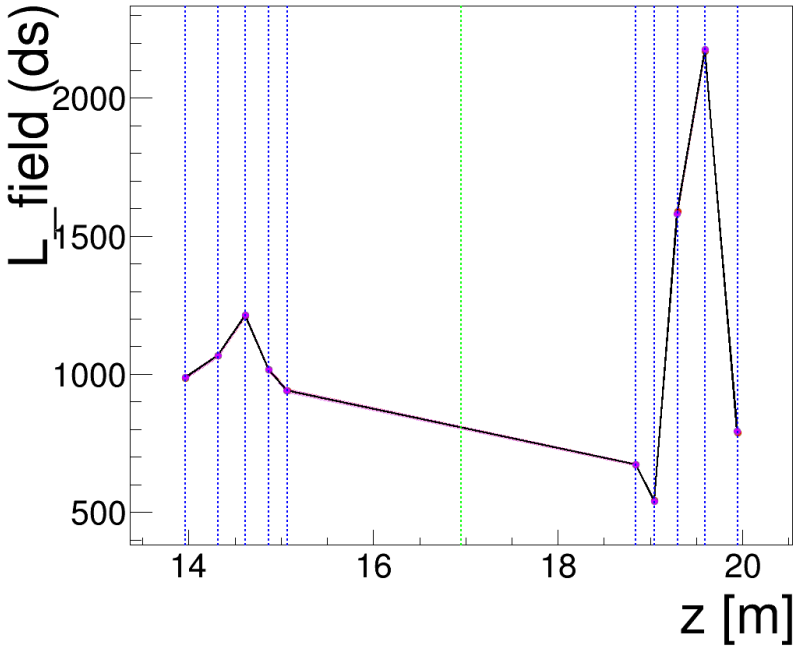
MAUS Correction

L_field

3.3.2



3.3.5



L_field residual

WARWICK
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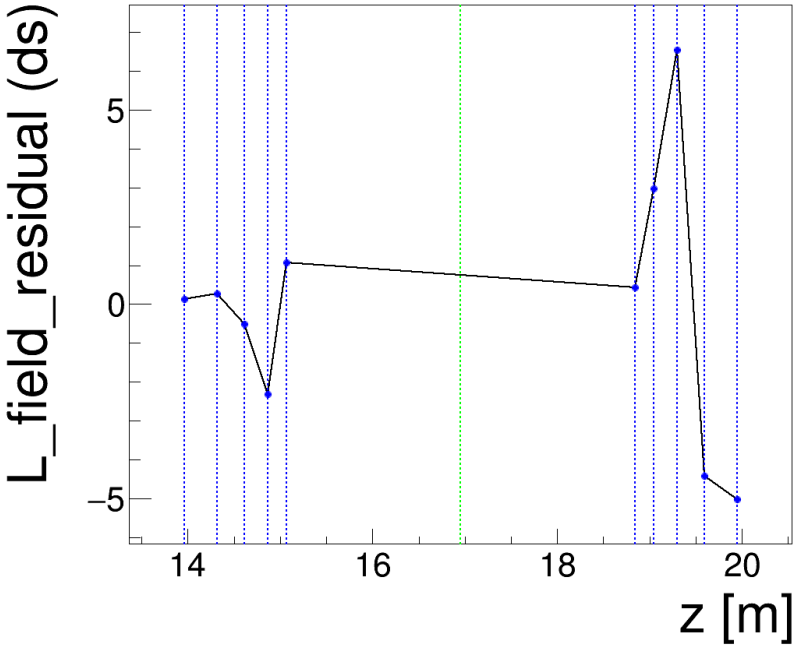
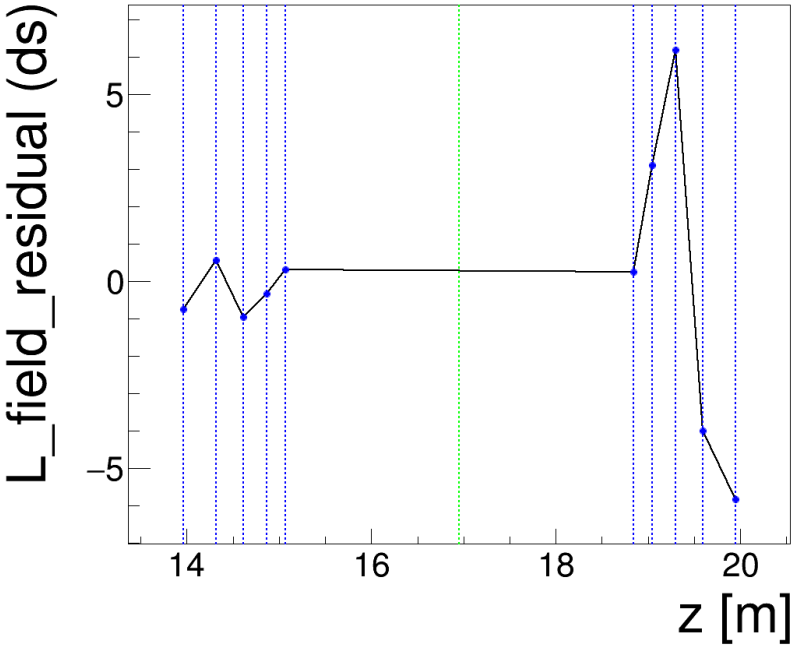
3.3.2



3.3.5



MAUS Correction

Chi2 - all

WARWICK
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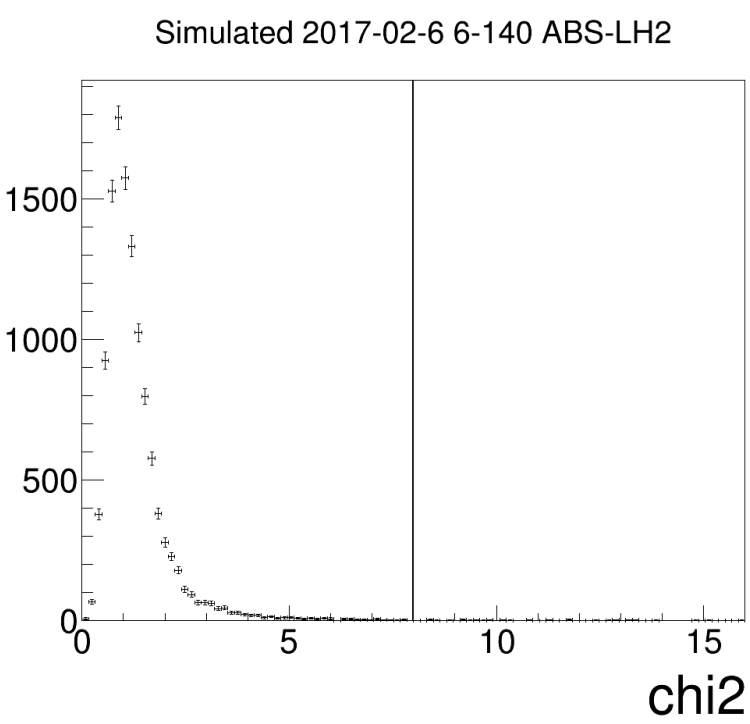
3.3.2



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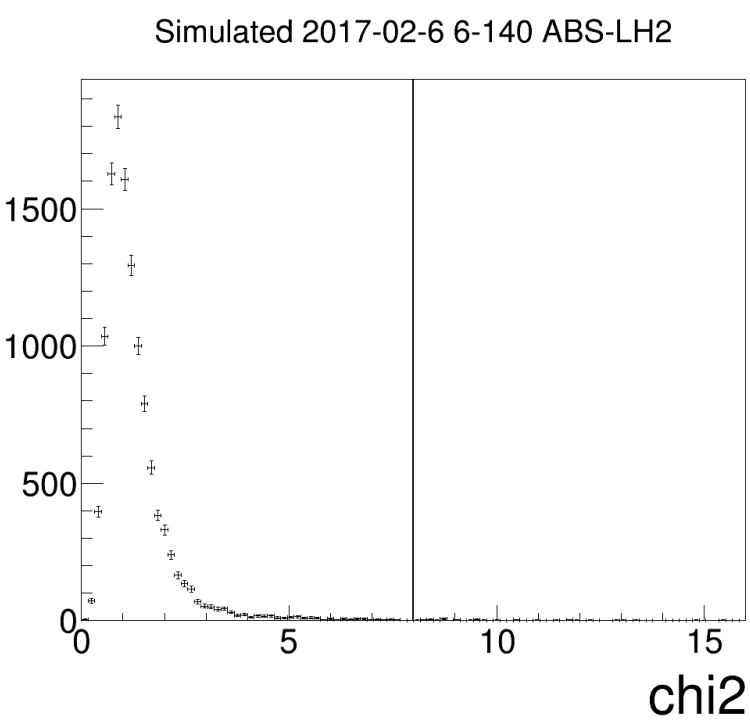
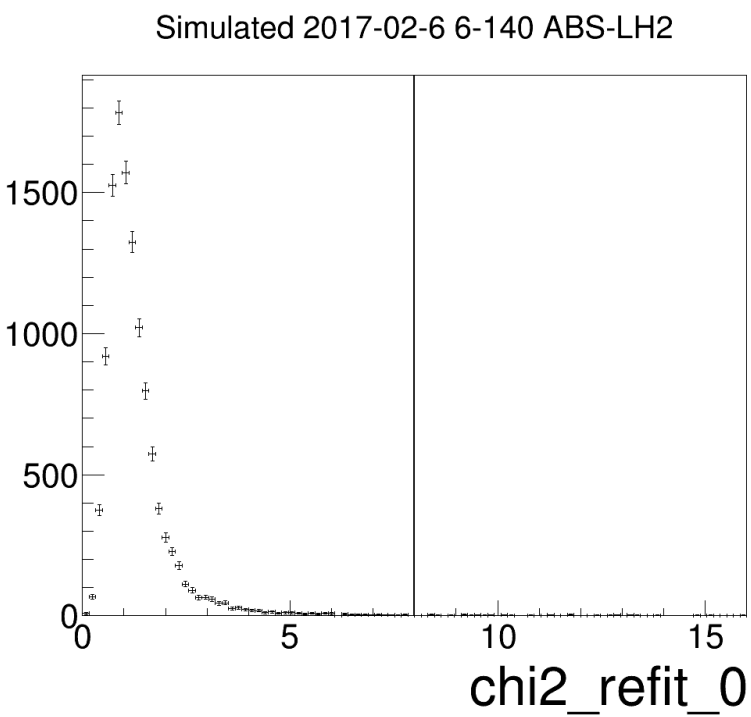


MAUS Correction

Chi2 - refit 0

WARWICK
THE UNIVERSITY OF WARWICK

3.3.2



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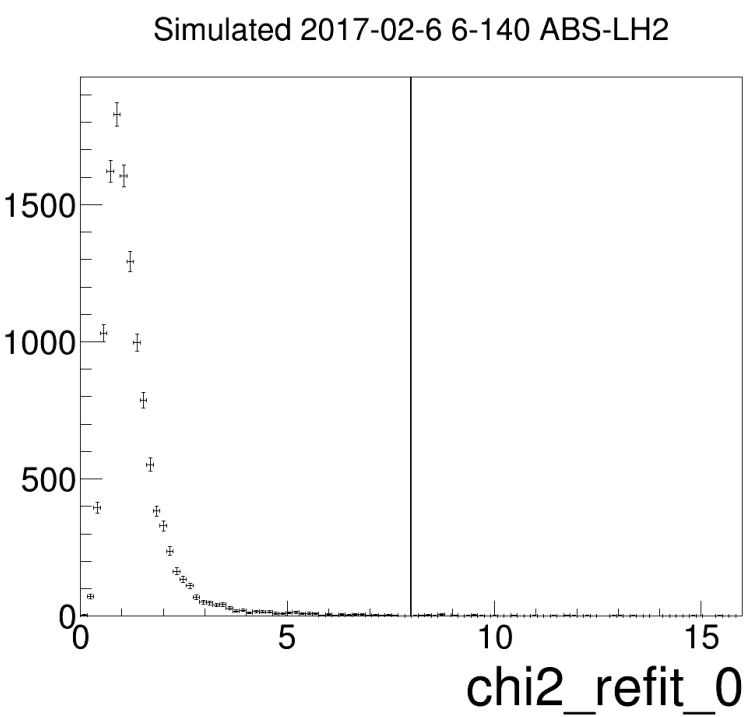

MAUS Correction

Chi2 - refit 1

WARWICK
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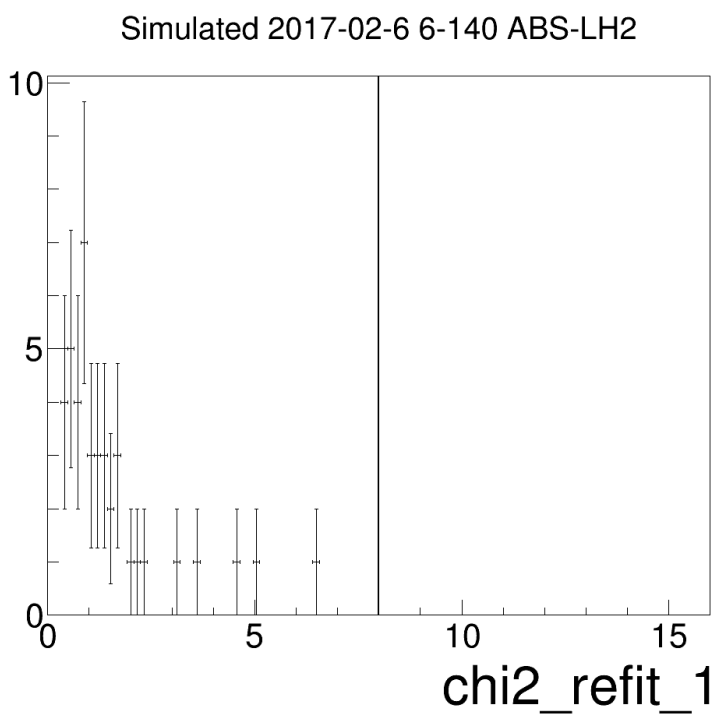
3.3.2



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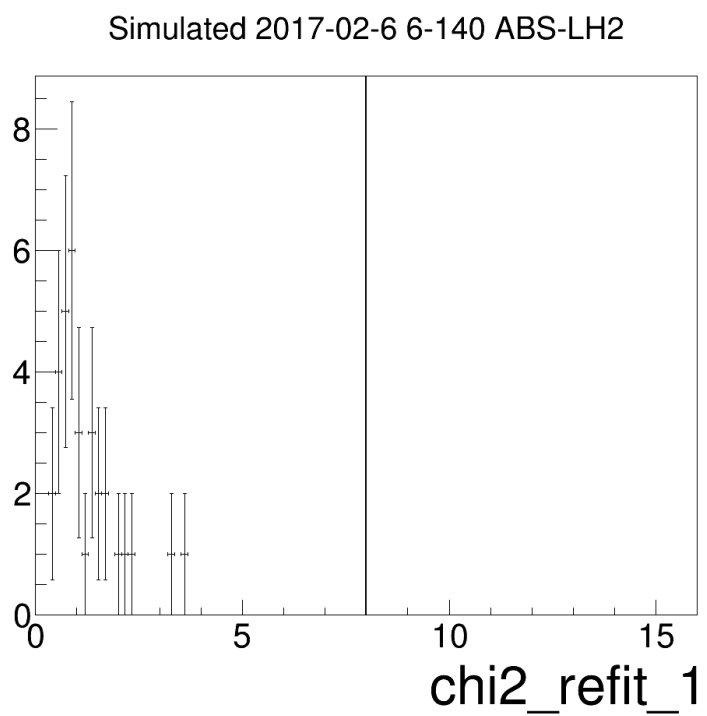
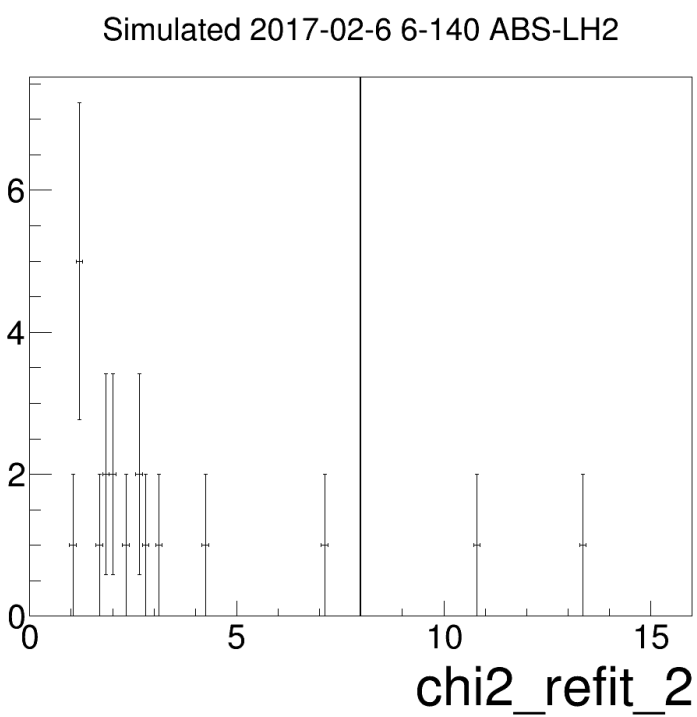


MAUS Correction

Chi2 - refit 2

WARWICK
THE UNIVERSITY OF WARWICK

3.3.2



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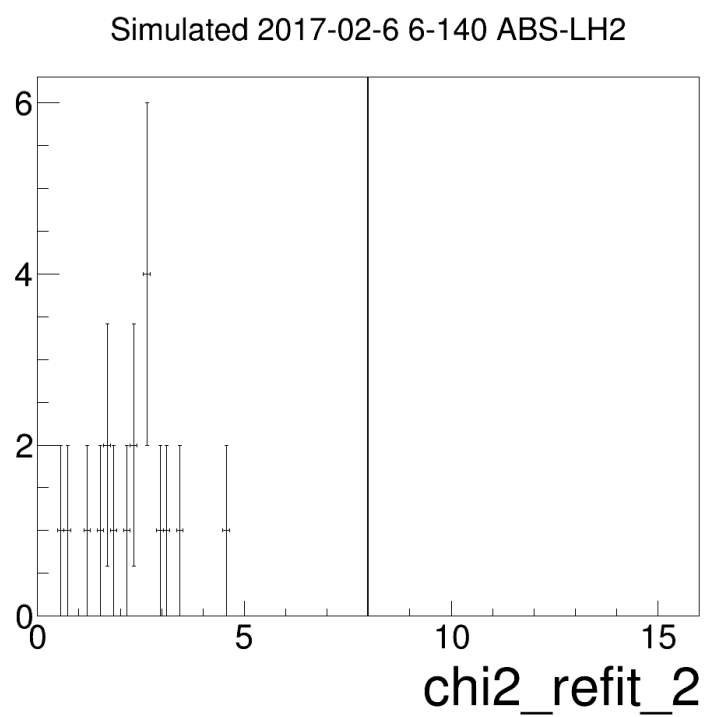
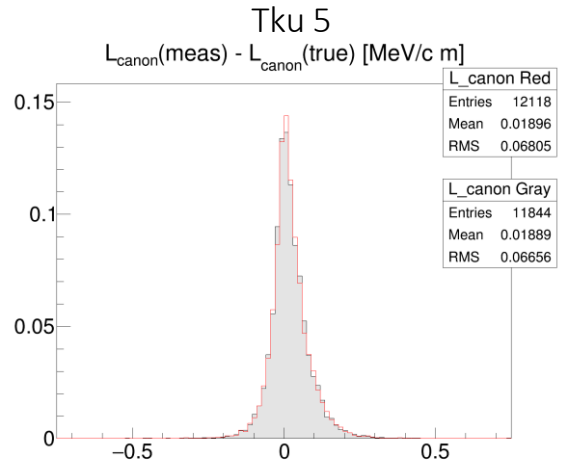
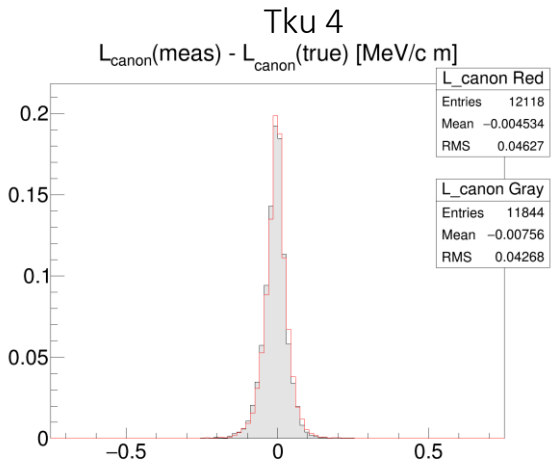
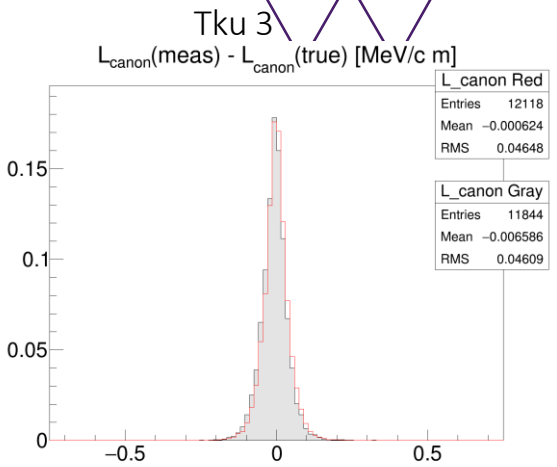


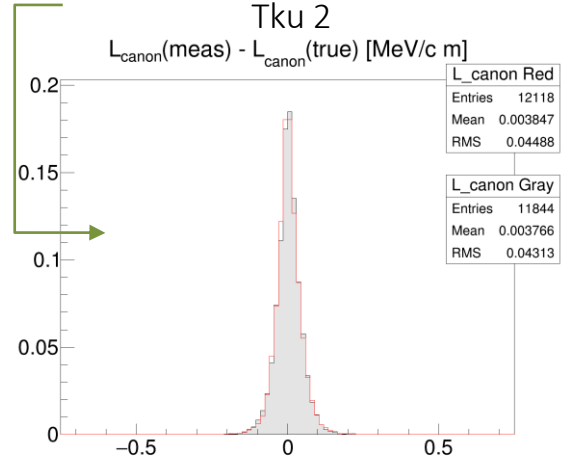
MAUS Correction

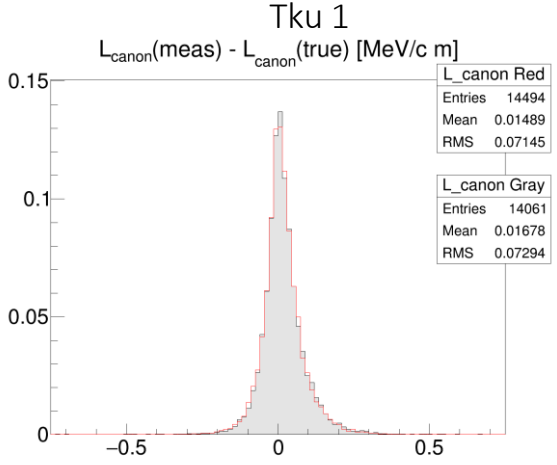
L_canon Residuals, TKU









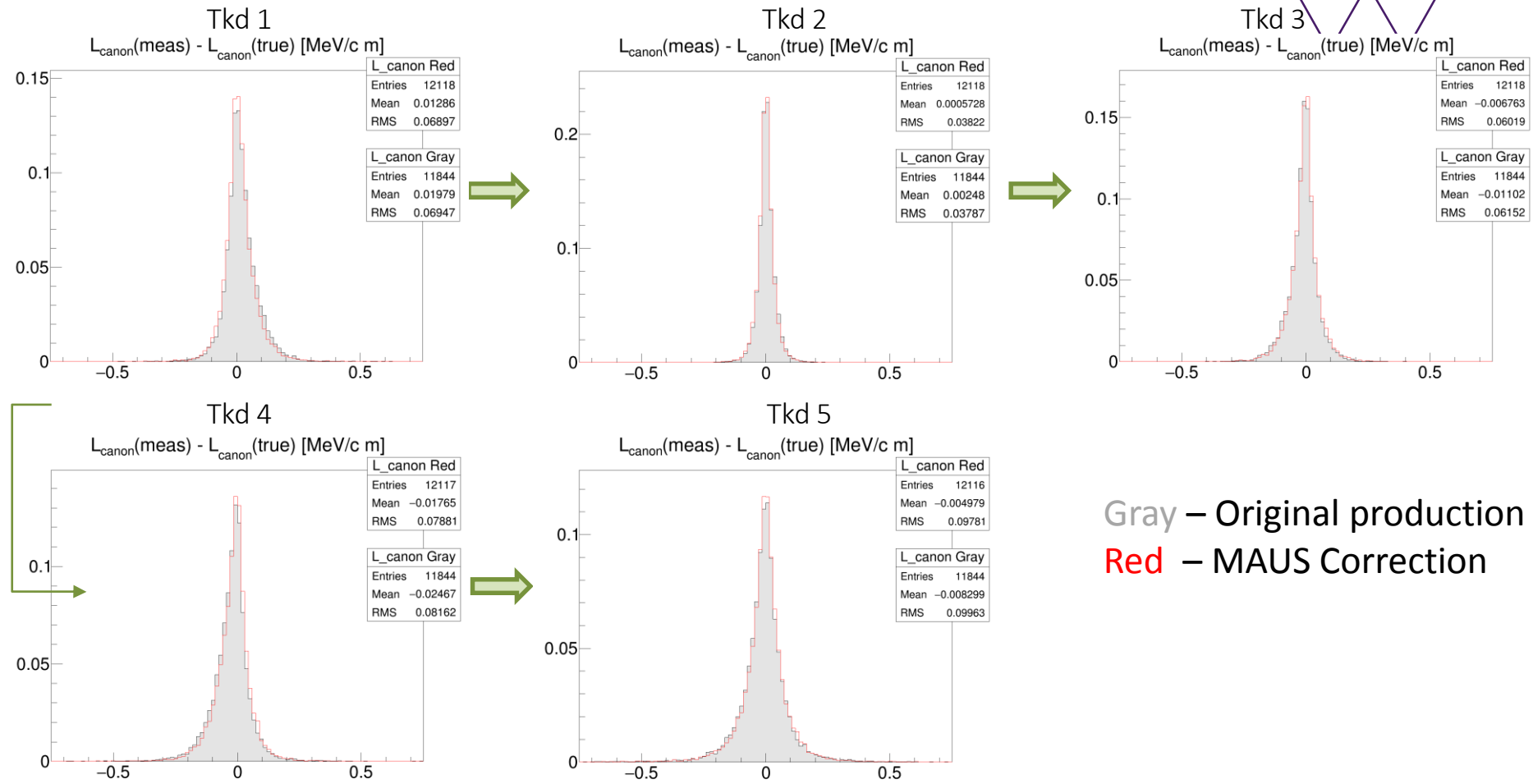


Gray – Original production

Red – MAUS Correction

MAUS Correction

L_canon Residuals, TKD

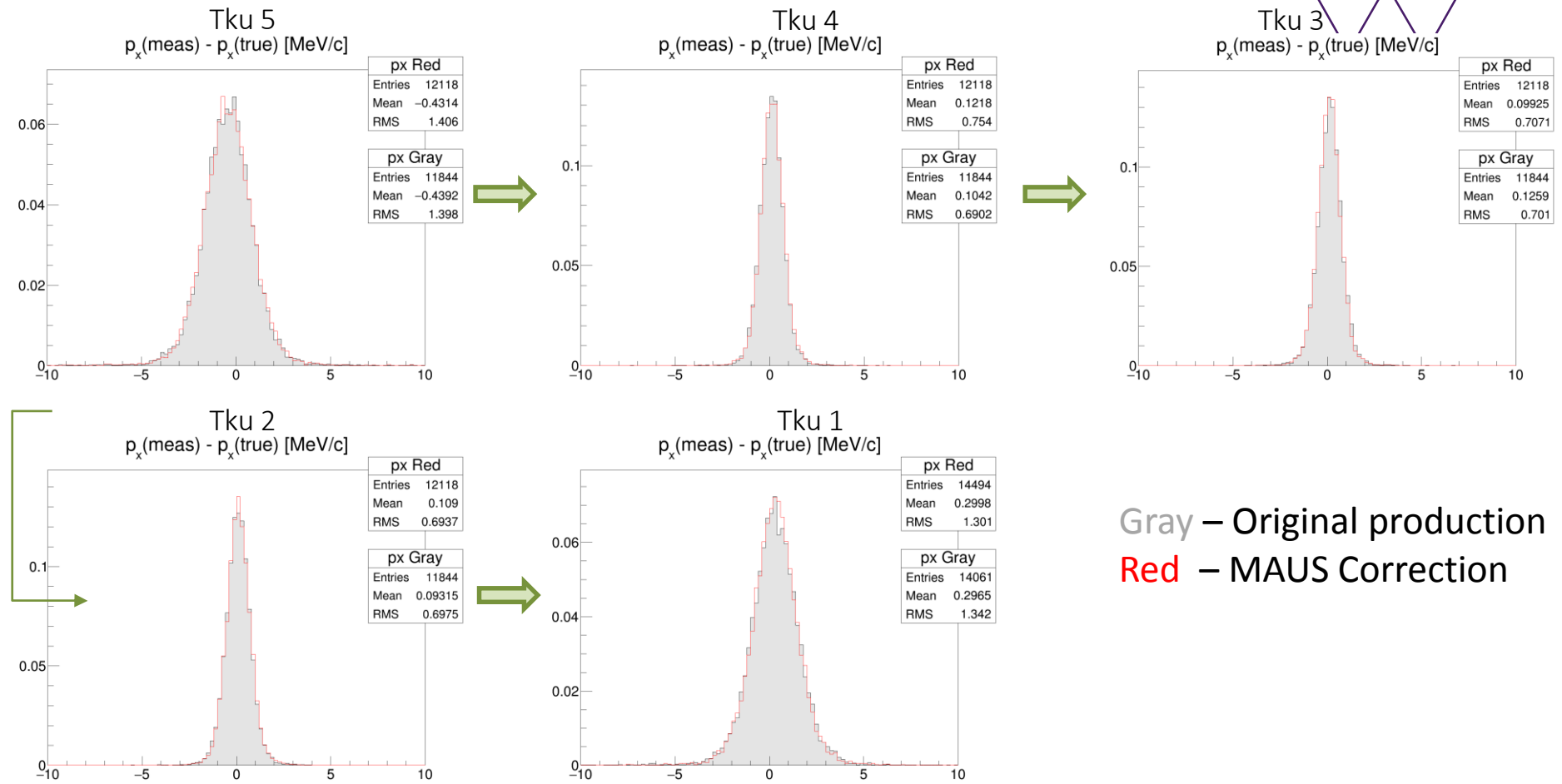


Gray – Original production

Red – MAUS Correction

MAUS Correction

Px Residuals, TKU



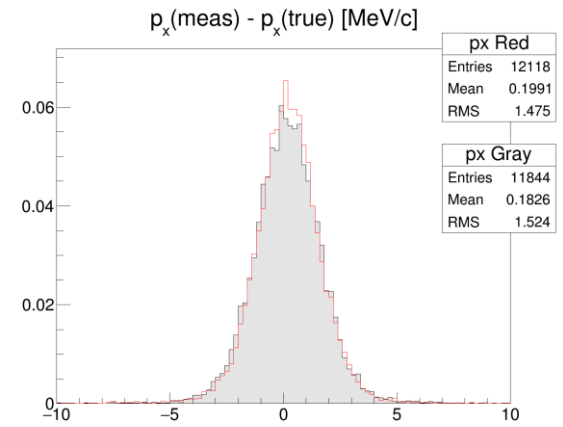
Gray – Original production

Red – MAUS Correction

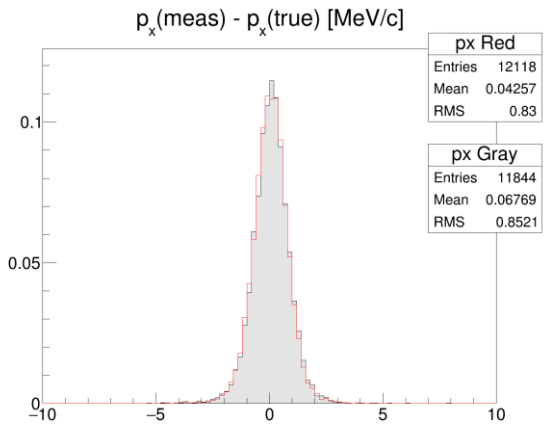
MAUS Correction

Px Residuals, TKD

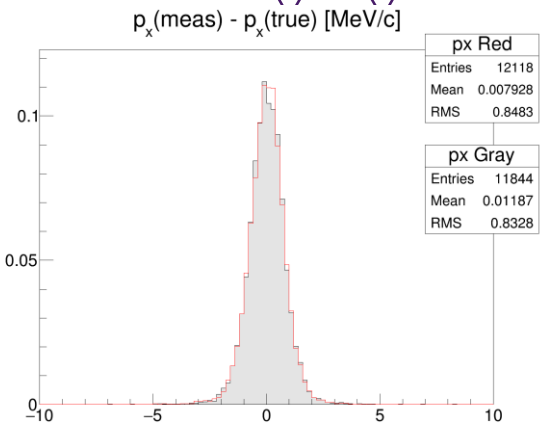
Tkd 1



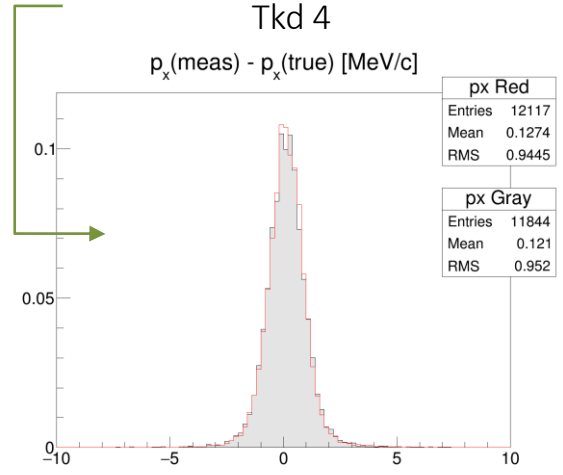
Tkd 2



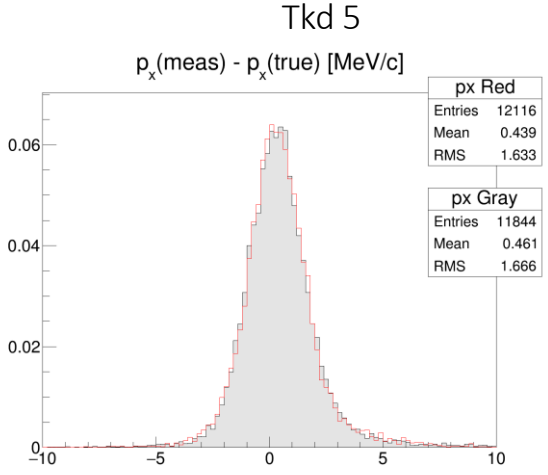
Tkd 3



Tkd 4



Tkd 5

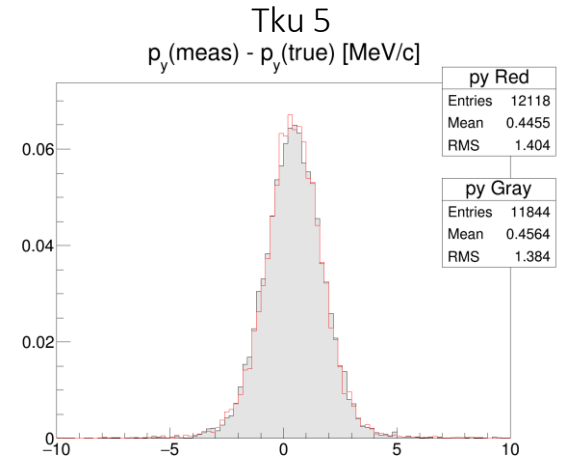


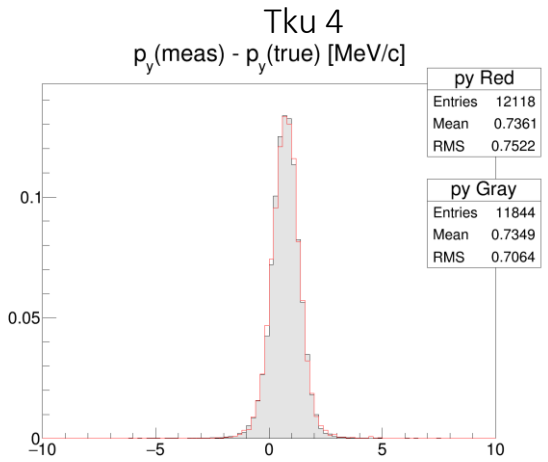
Gray – Original production

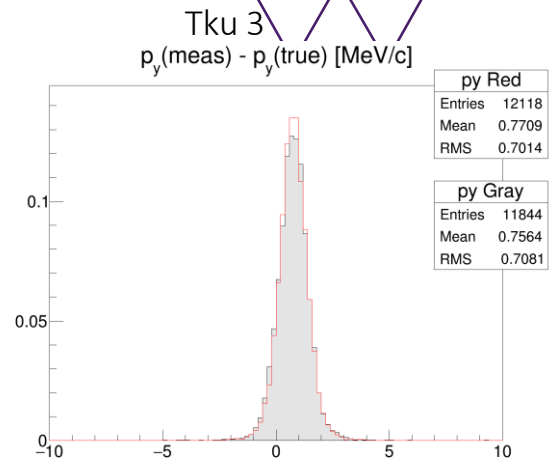
Red – MAUS Correction

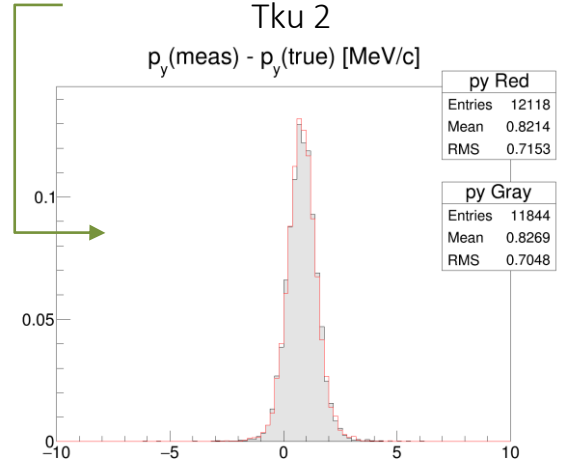
MAUS Correction

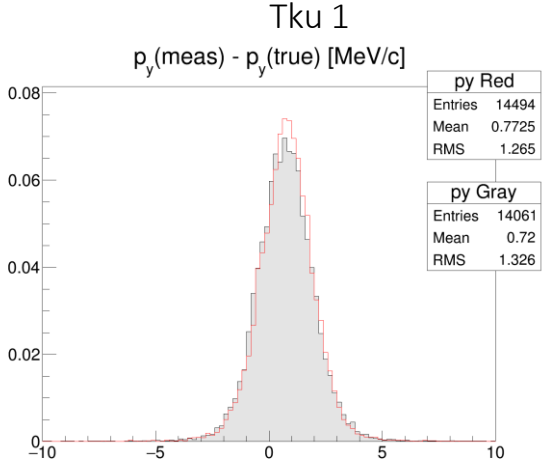
Py Residuals, TKU









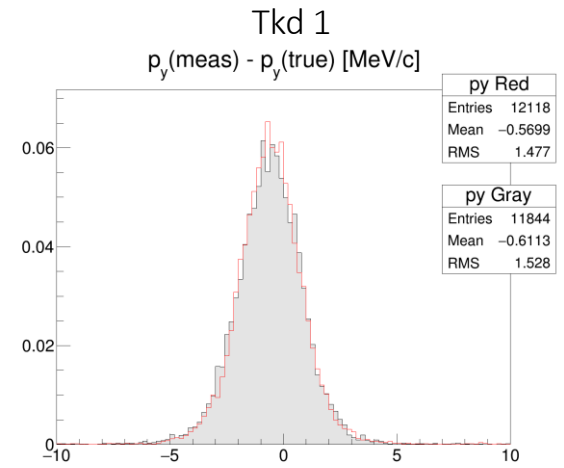


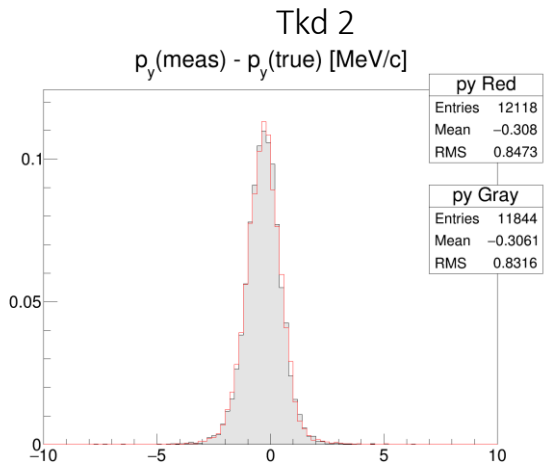
Gray – Original production

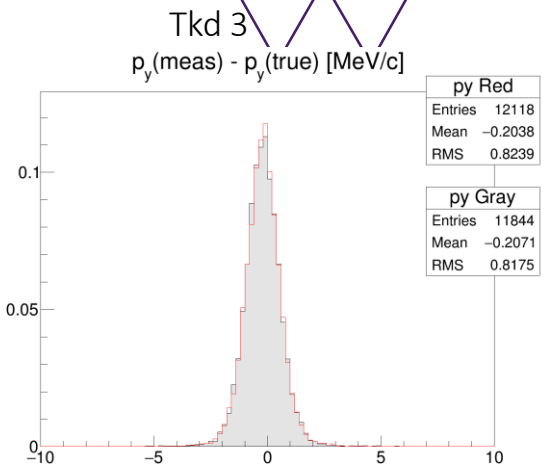
Red – MAUS Correction

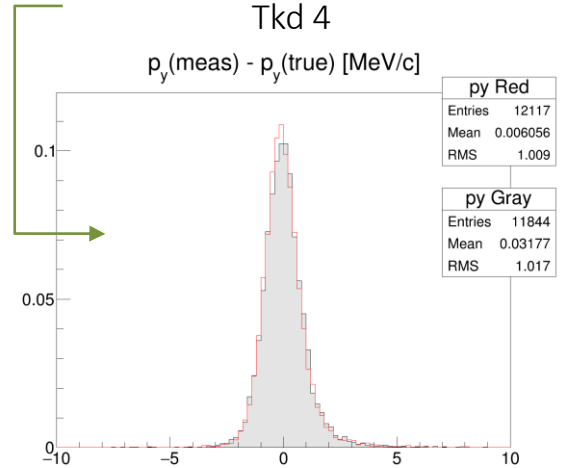
MAUS Correction

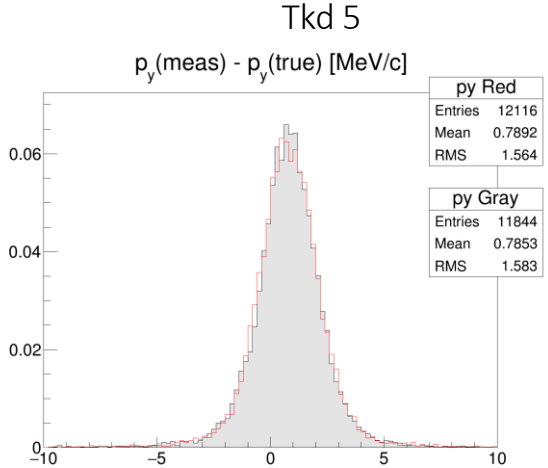
Py Residuals, TKD









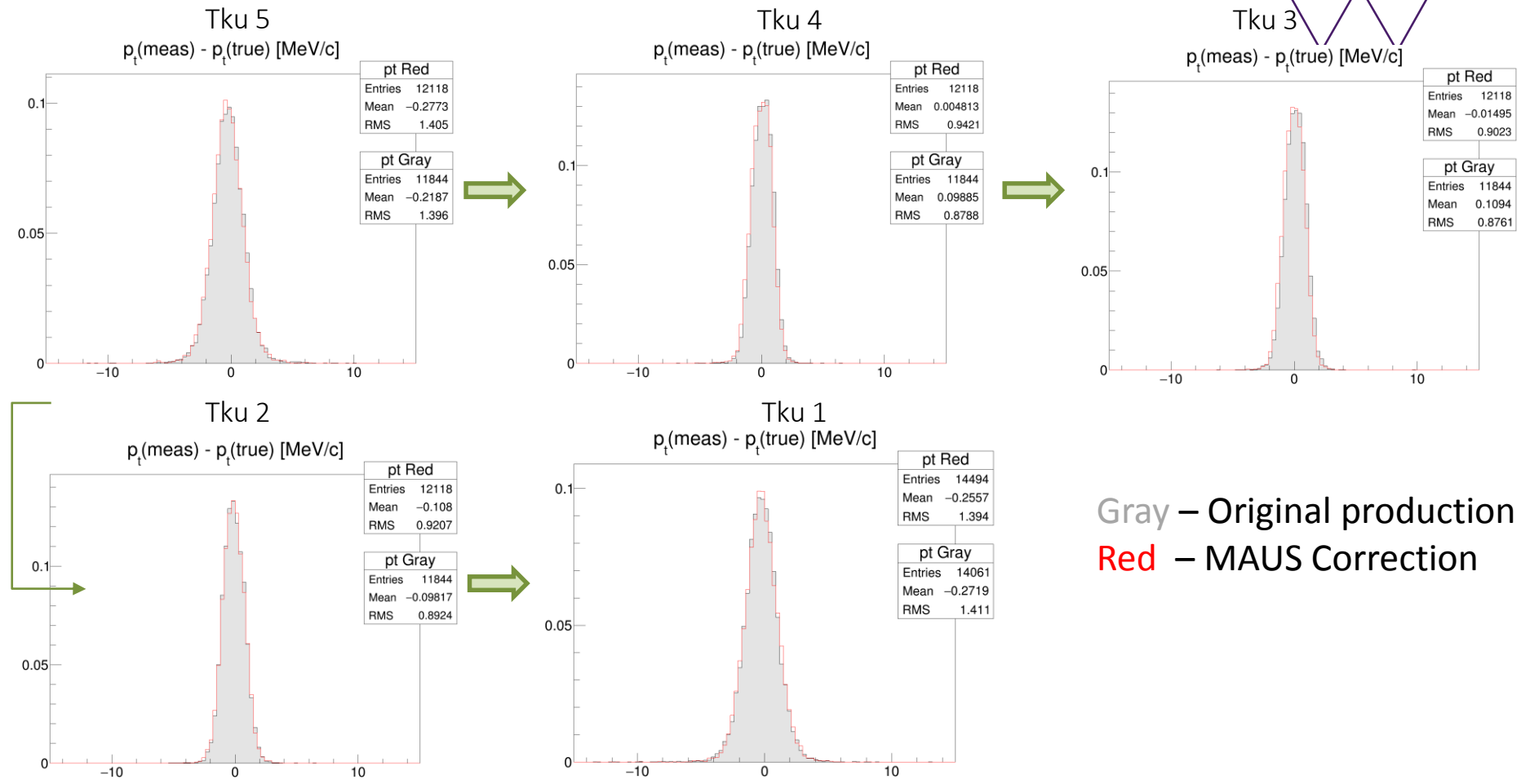


Gray – Original production

Red – MAUS Correction

MAUS Correction

Pt Residuals, TKU

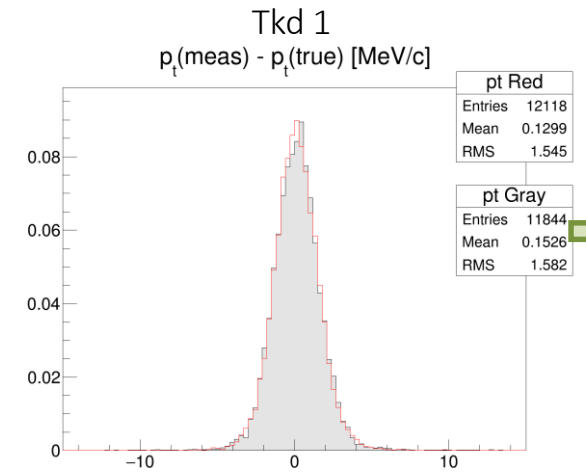


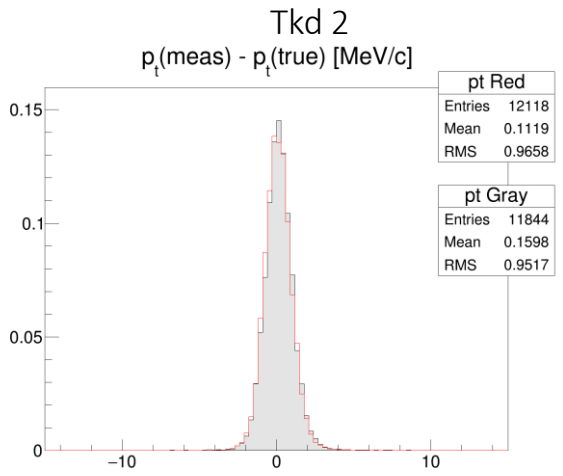
Gray – Original production

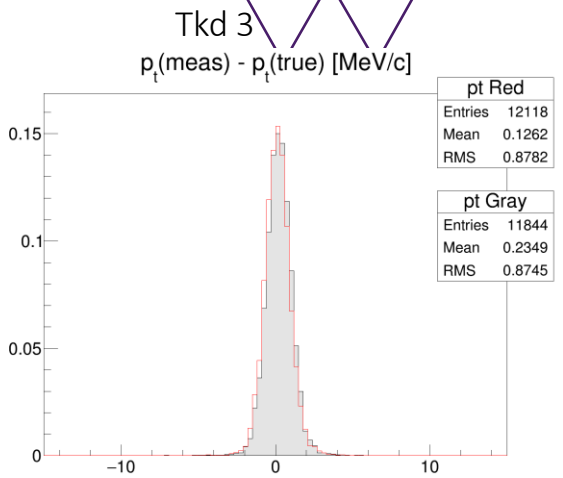
Red – MAUS Correction

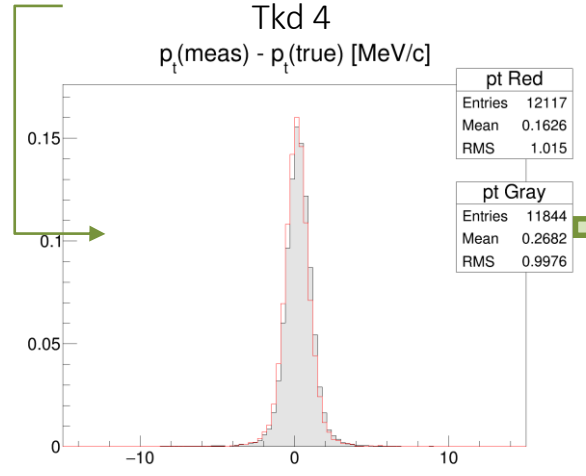
MAUS Correction

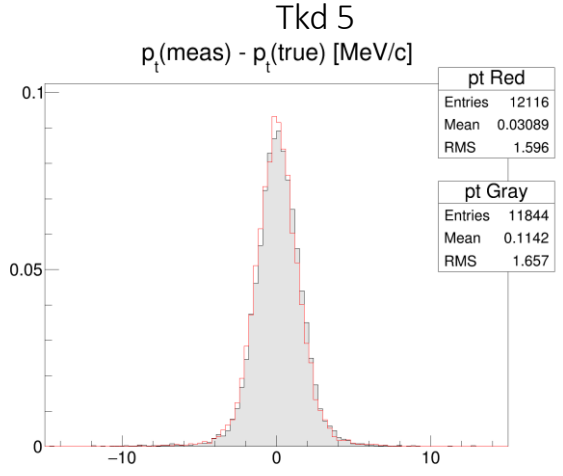
Pt Residuals, TKD









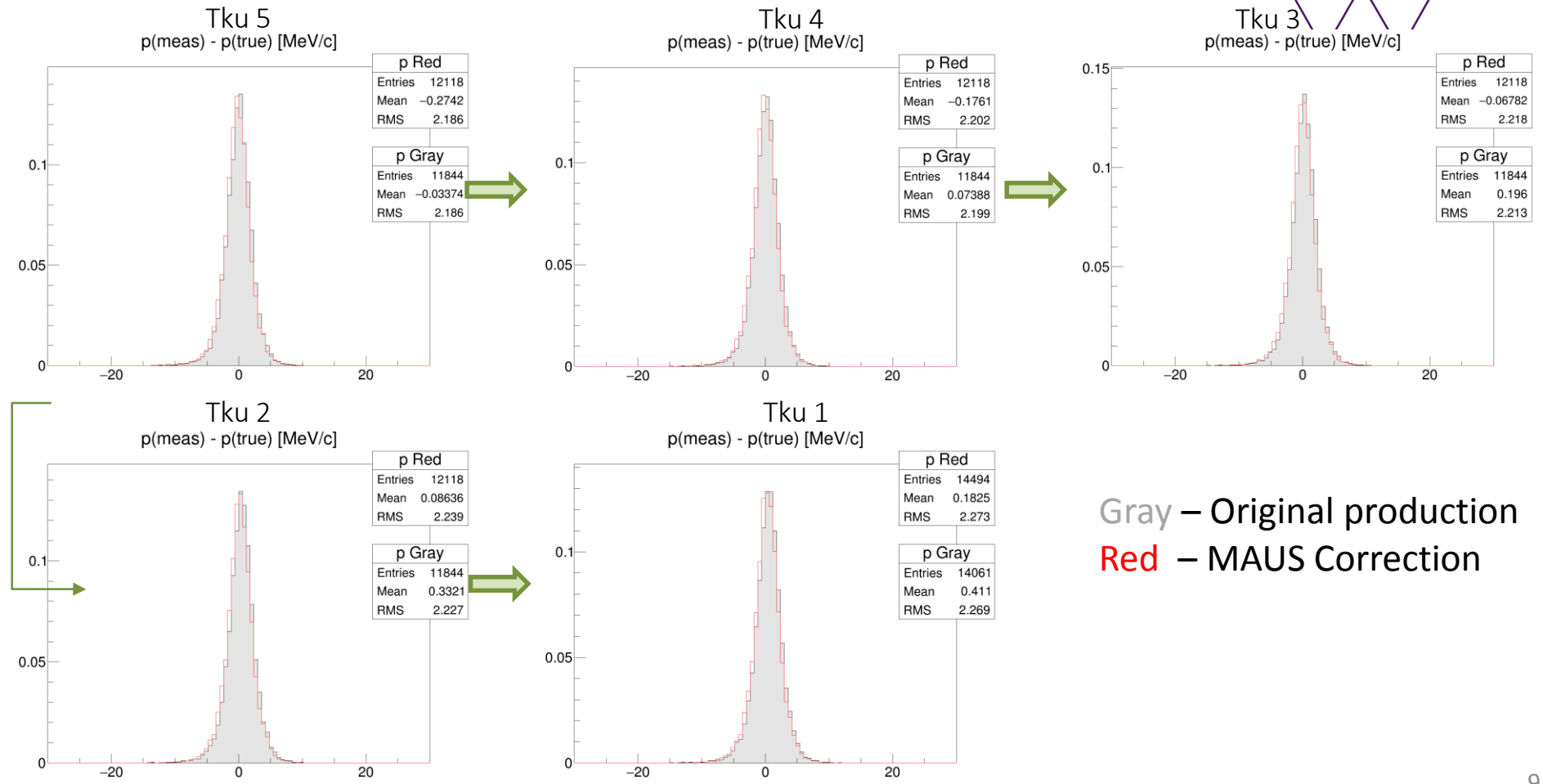


Gray – Original production

Red – MAUS Correction

MAUS Correction

P Residuals, TKU

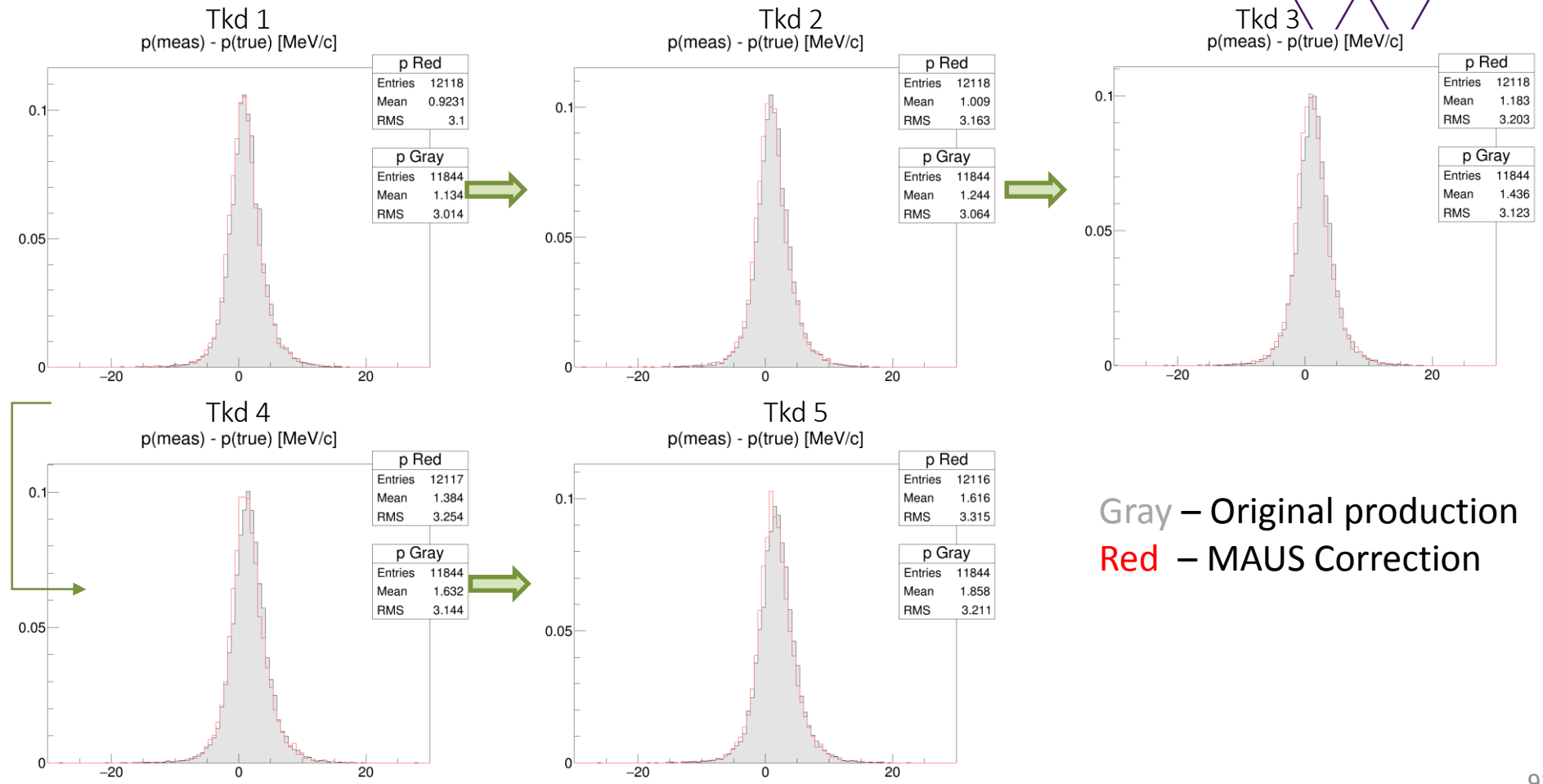


Gray – Original production

Red – MAUS Correction

MAUS Correction

P Residuals, TKD

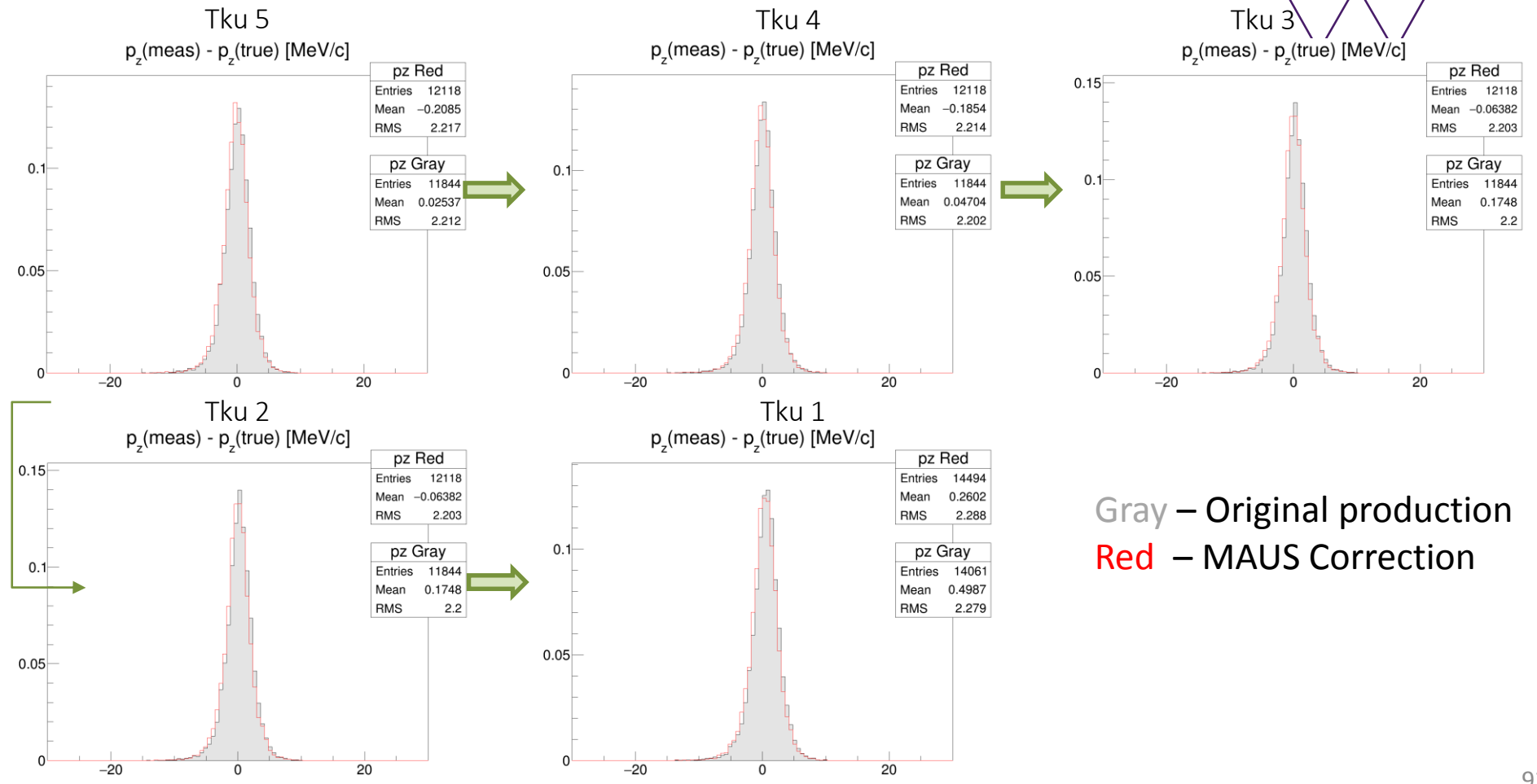


Gray – Original production

Red – MAUS Correction

MAUS Correction

Pz Residuals, TKU

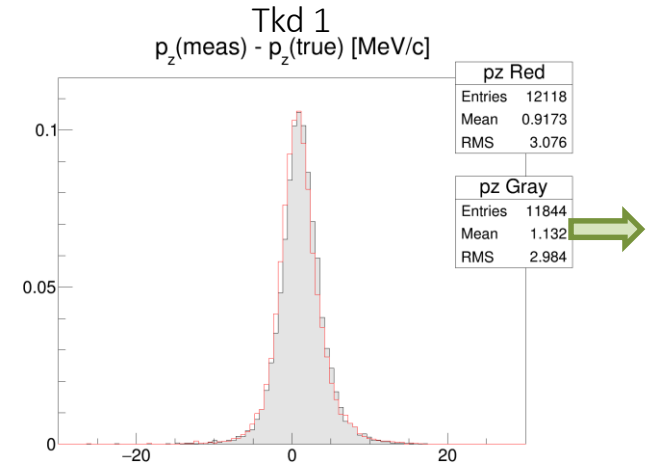


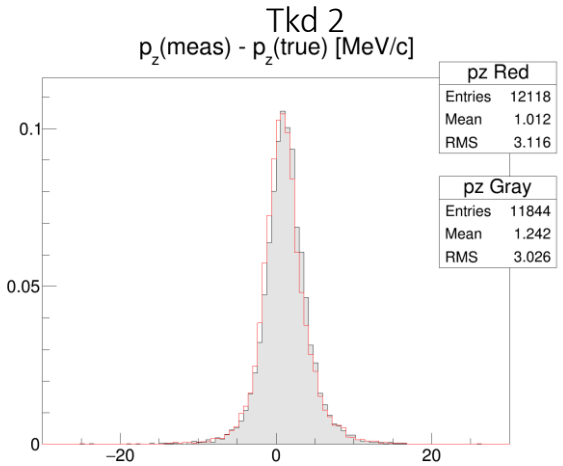
Gray – Original production

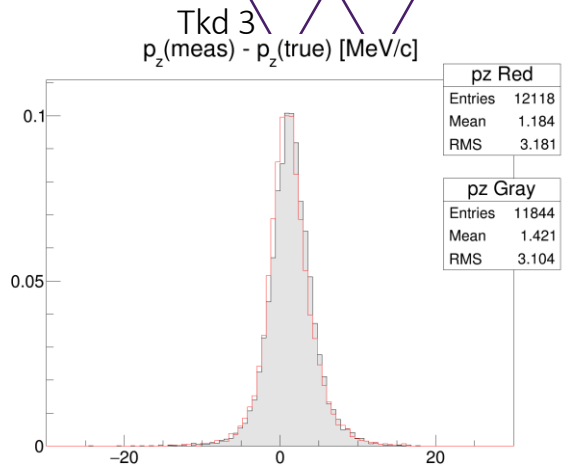
Red – MAUS Correction

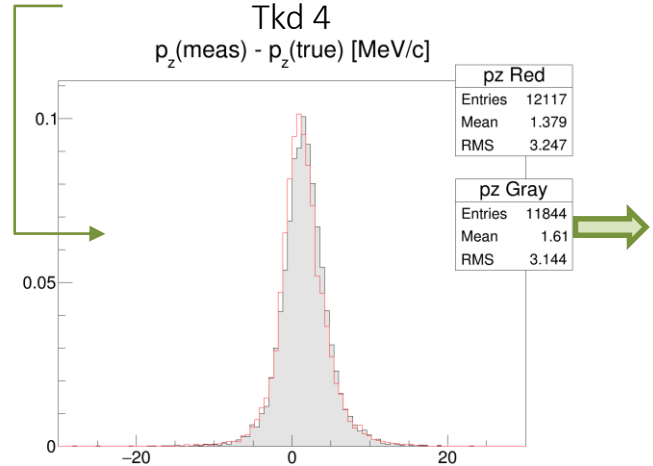
MAUS Correction

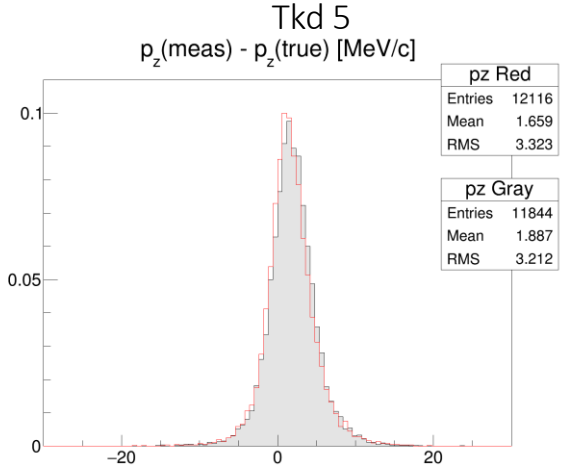
Pz Residuals, TKD











Gray – Original production

Red – MAUS Correction

Corrections Summary

Rescaling correction and MAUS correction both keep residual rms ~similar

MAUS Correction improves all Pz residuals, but not entirely

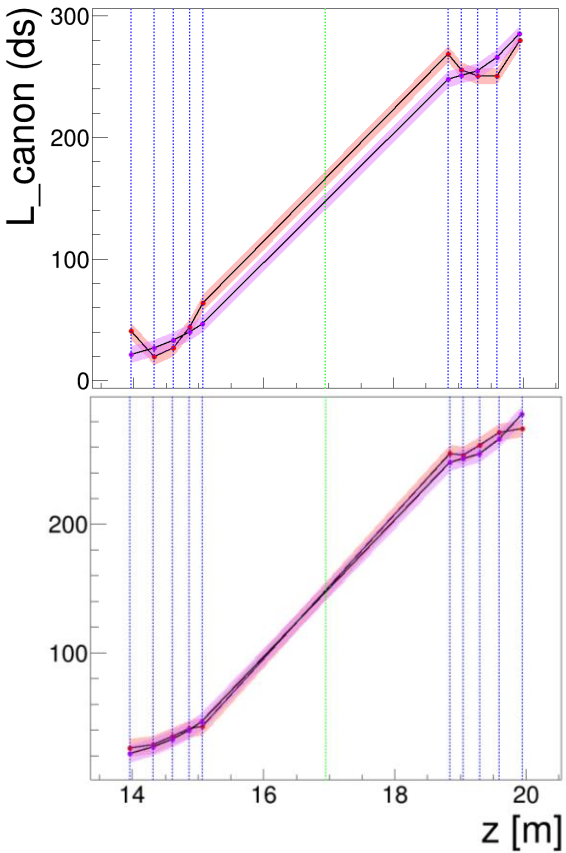
Recalculating Px,Py “undoes” Kalman – Some residual distributions much better (sharper peaks around 0)! Others worse..

Post-corrections use field at x,y,z position of particle trackpoint
Field variation with r is small, but significant?
Could even do an average field along track path in post-correction

Corrections

MAUS 3.3.2 No Correction

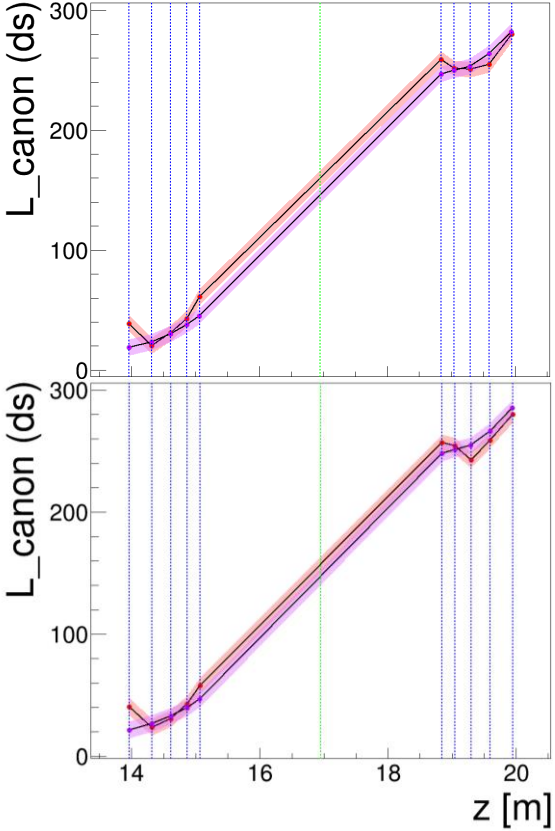
Simulated 2017-02-6 6-140 ABS-LH2



MAUS 3.3.2 Rescaling Correction

MAUS 3.3.5 Correction

Simulated 2017-02-6 6-140 ABS-LH2



MAUS 3.3.2 Recalculated Correction

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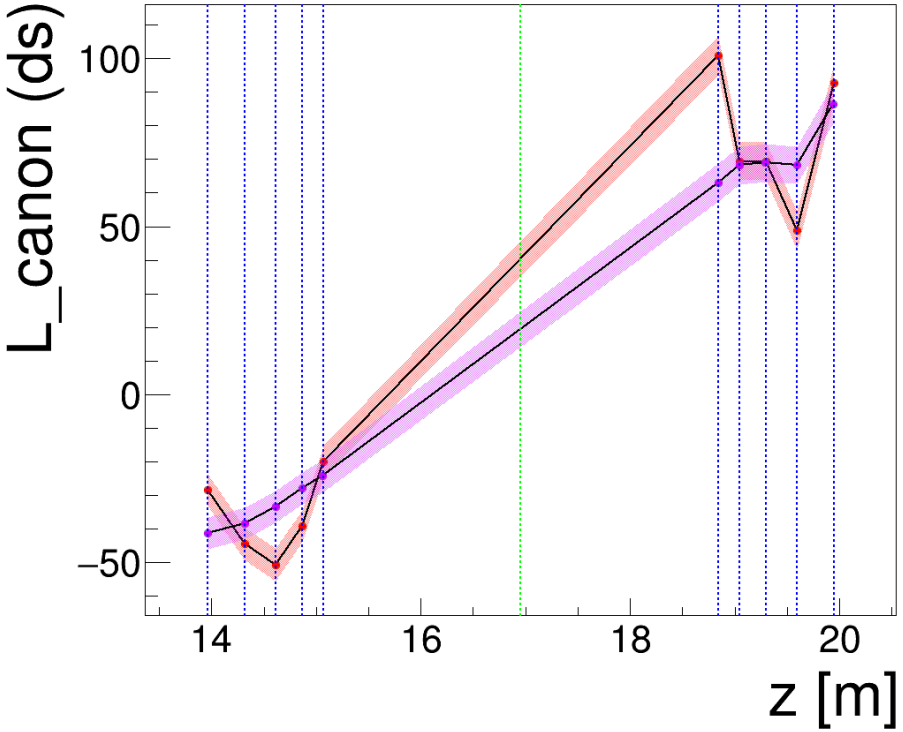
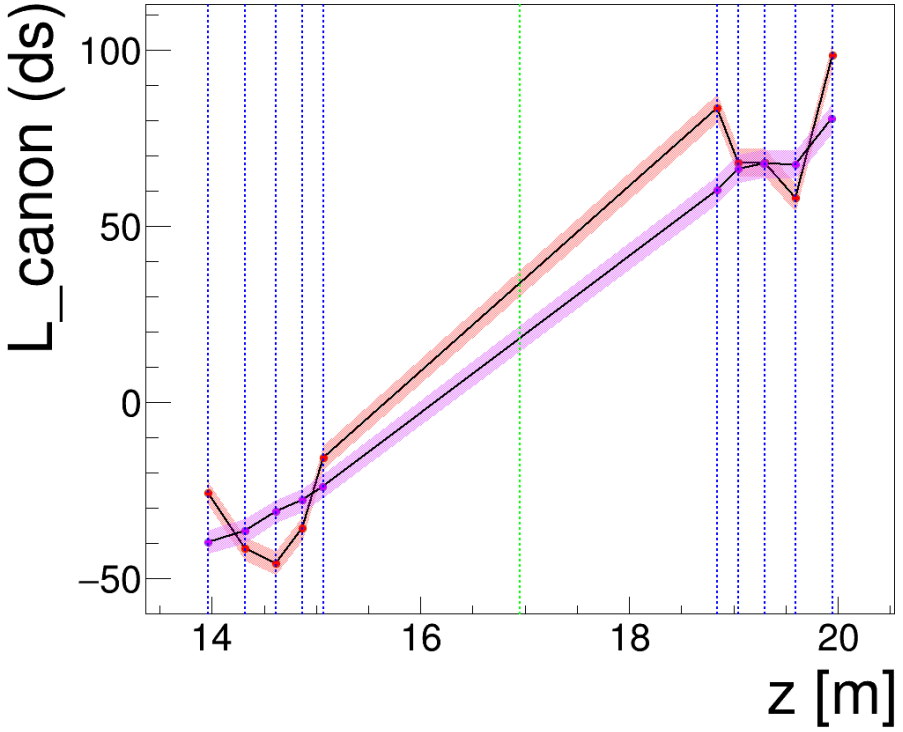
Higher Momentum Beam

Interesting features in higher momentum beams not resolved with MAUS correction

MAUS 3.3.2 No Correction
Simulated 2017-02-6 3-170 ABS-LH2



MAUS 3.3.5 Correction
Simulated 2017-02-6 3-170 ABS-LH2



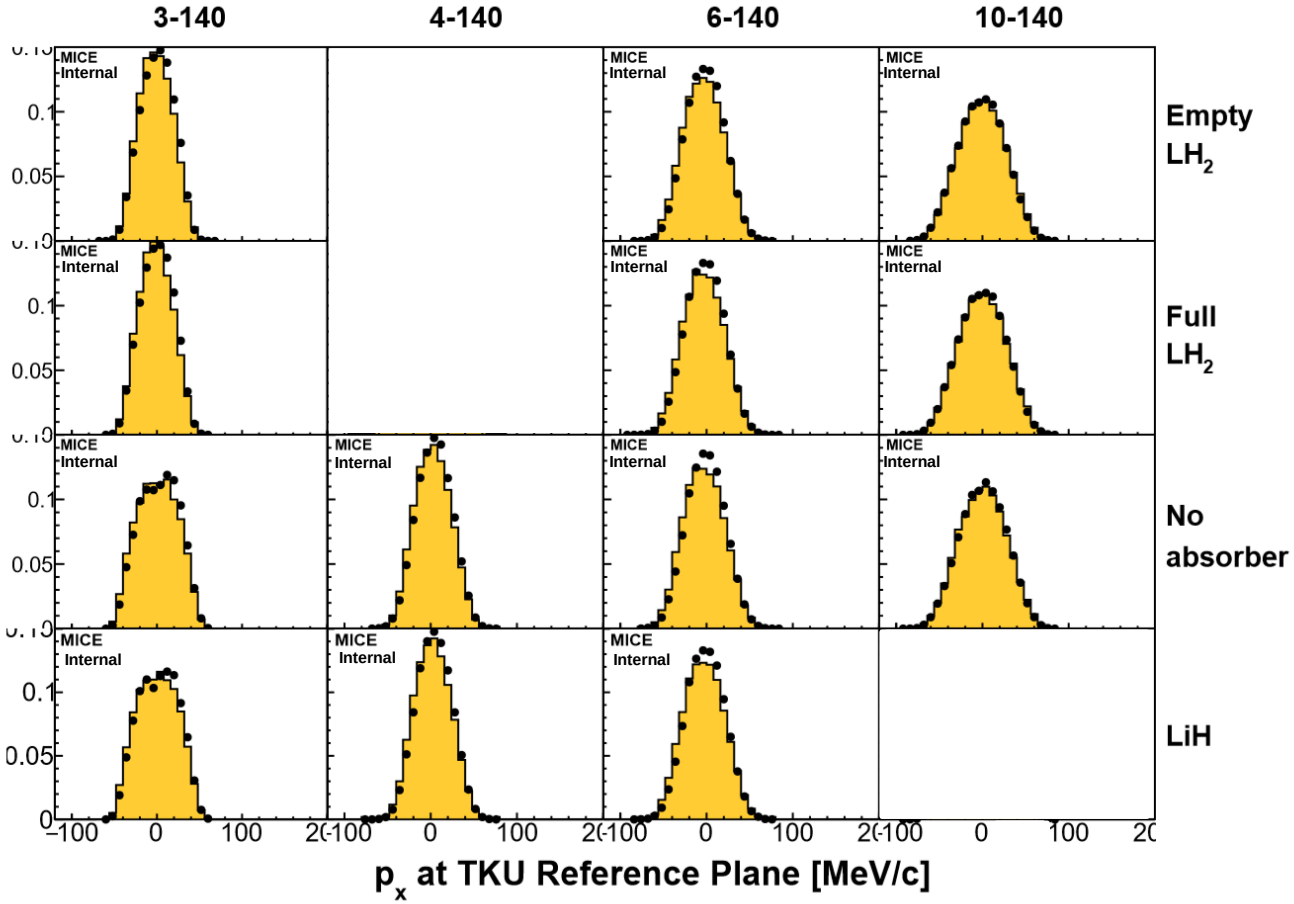
Summary

Dipole current tuning is in reasonable state for MC production over most beam settings (4,6,10-170,200), 240 MeV needs looking at -> Have been holding off MC production dependent on correction implementation..

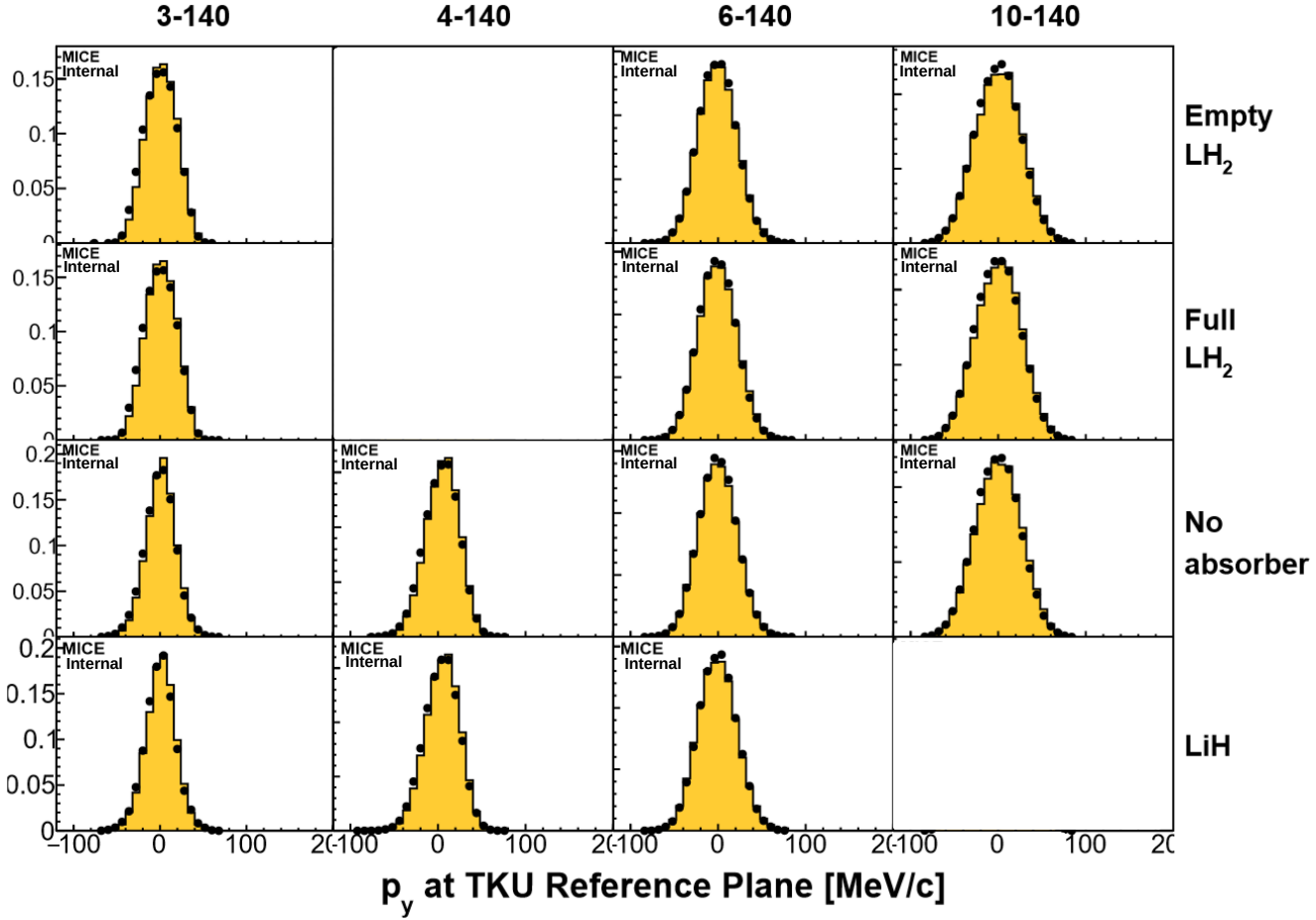
Canonical angular momentum change across the absorber and through stations looks reasonable in truth for 140 MeV beam, some effects seen in reco
Higher momentum needs some investigation

Backup

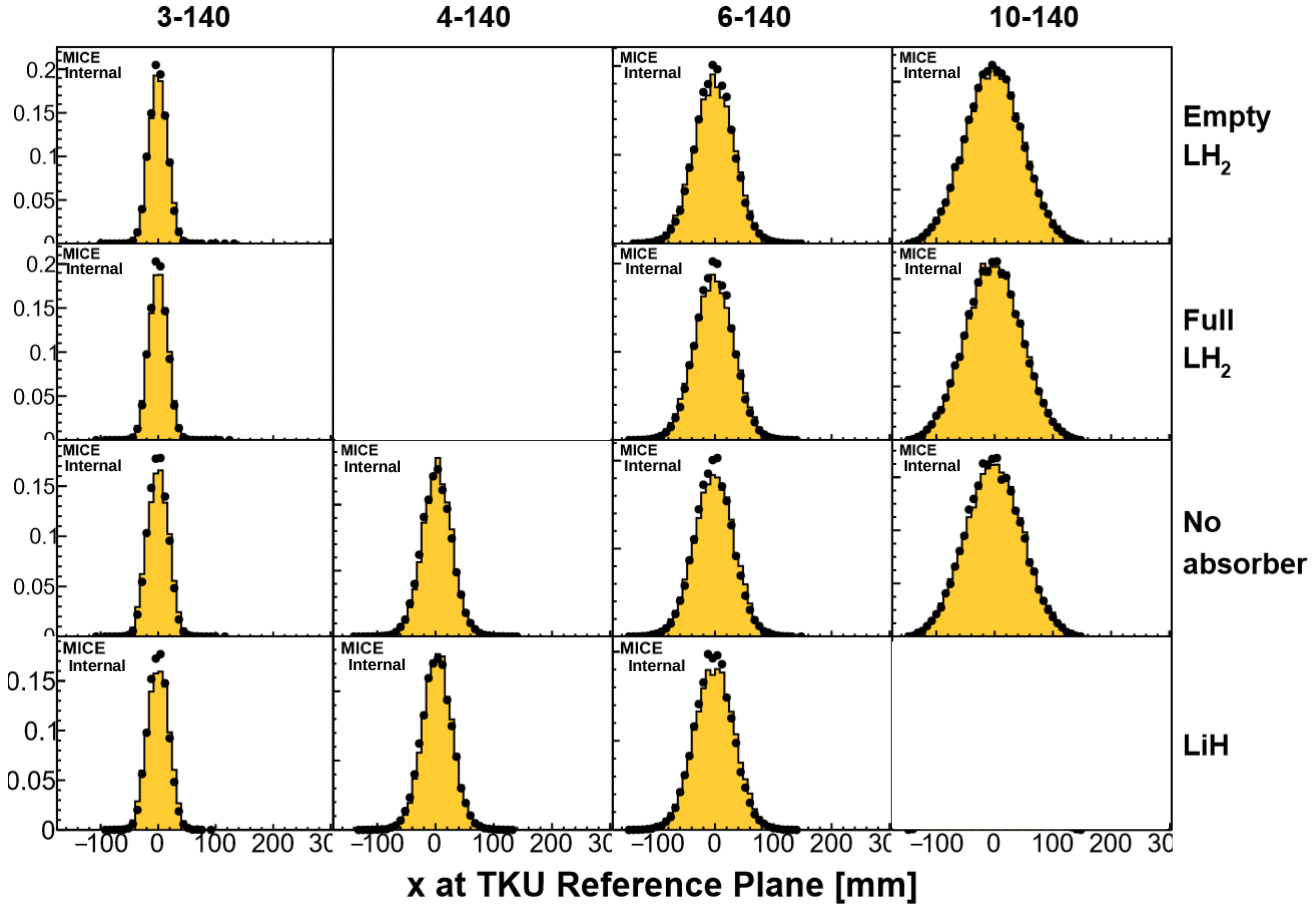
TKU Px comparisons



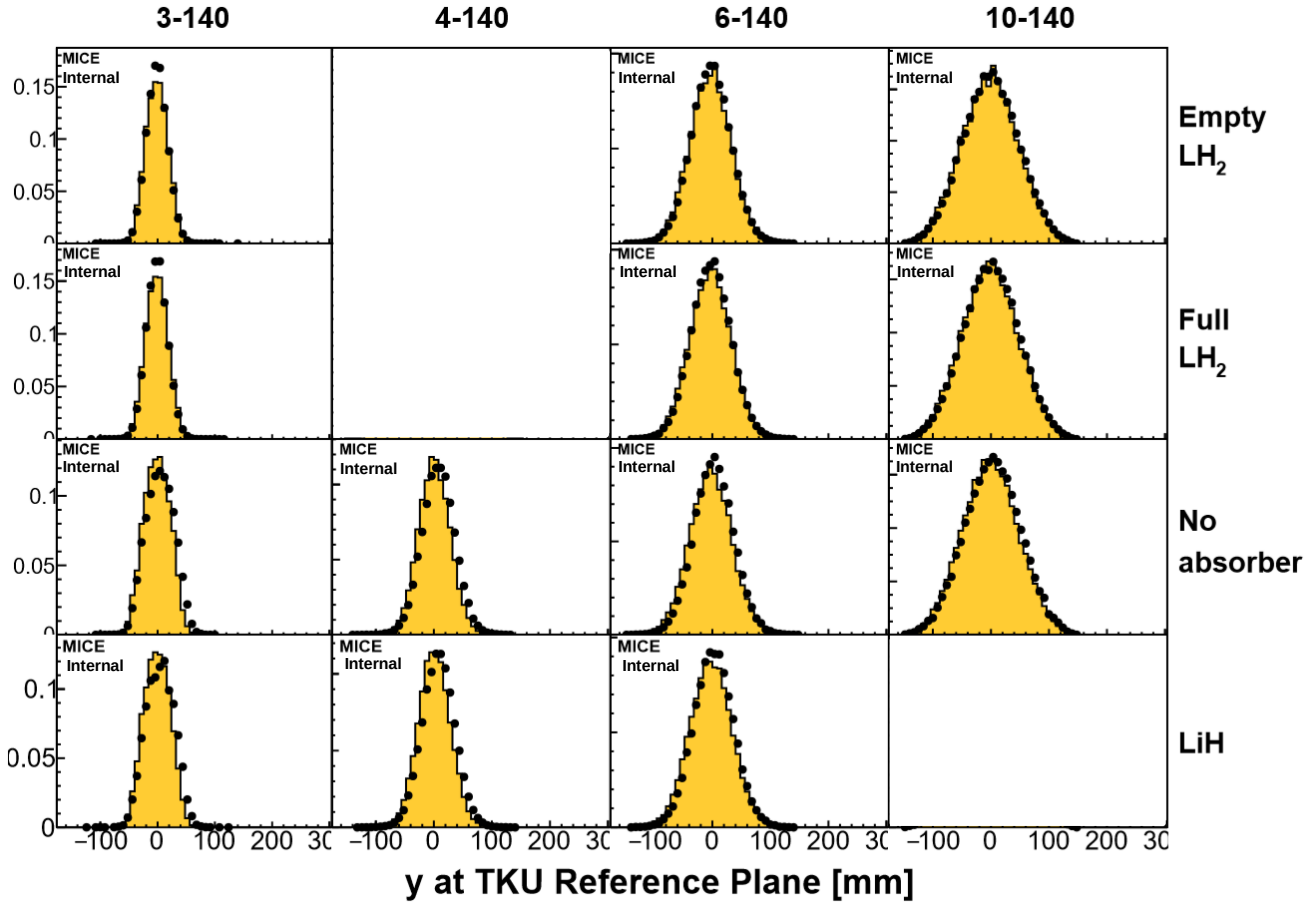
TKU Py comparisons



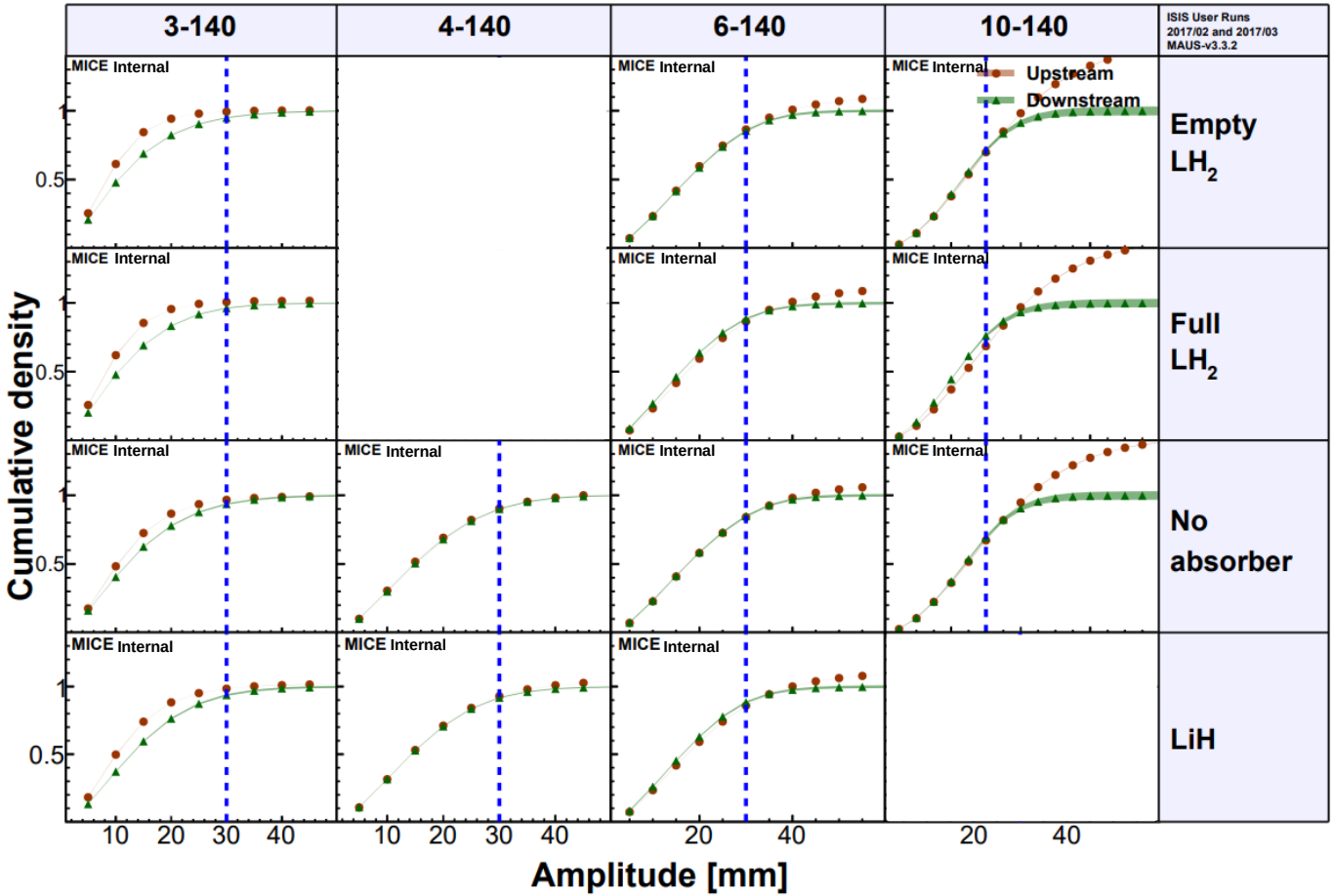
TKU x comparisons



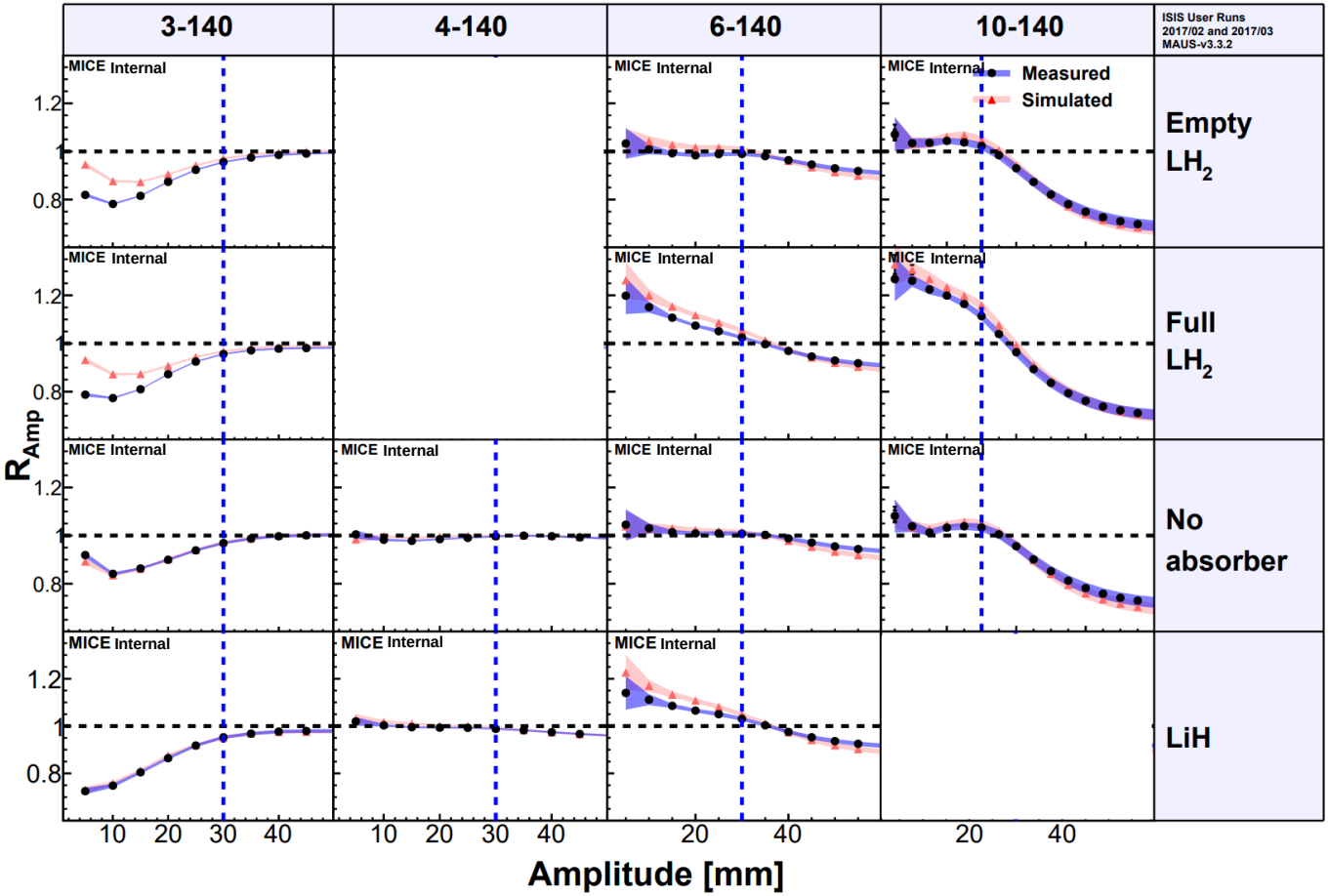
TKU y comparisons



CDFs - Data


3-140
4-140
6-140
10-140
ISIS User Runs
2017/02 and 2017/03
MAUS-v3.3.2
MICE Internal
Upstream
Downstream
Empty LH2
Full LH2
No absorber
LiH
Cumulative density
Amplitude [mm]

CDF Ratios



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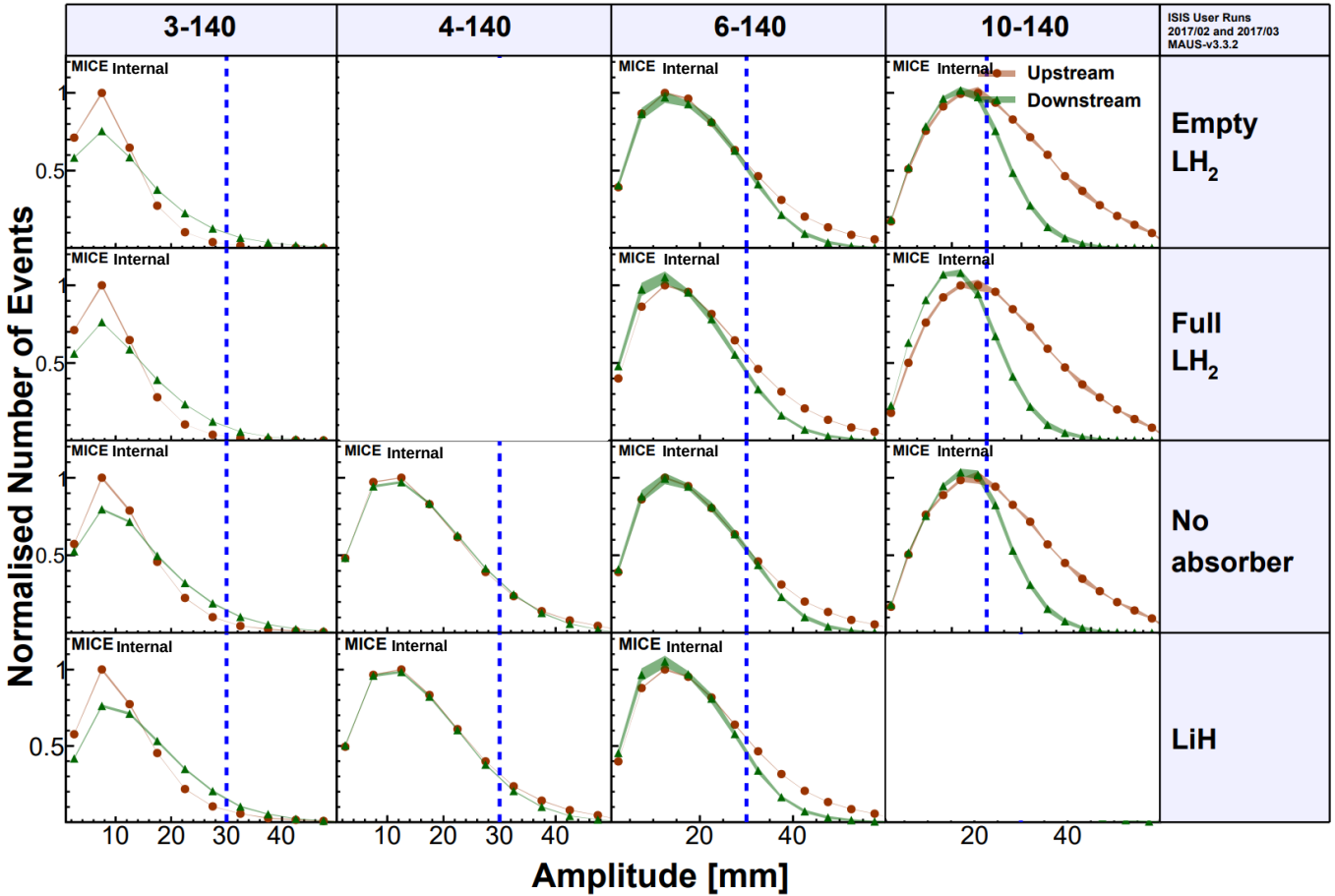
PDFs - Data



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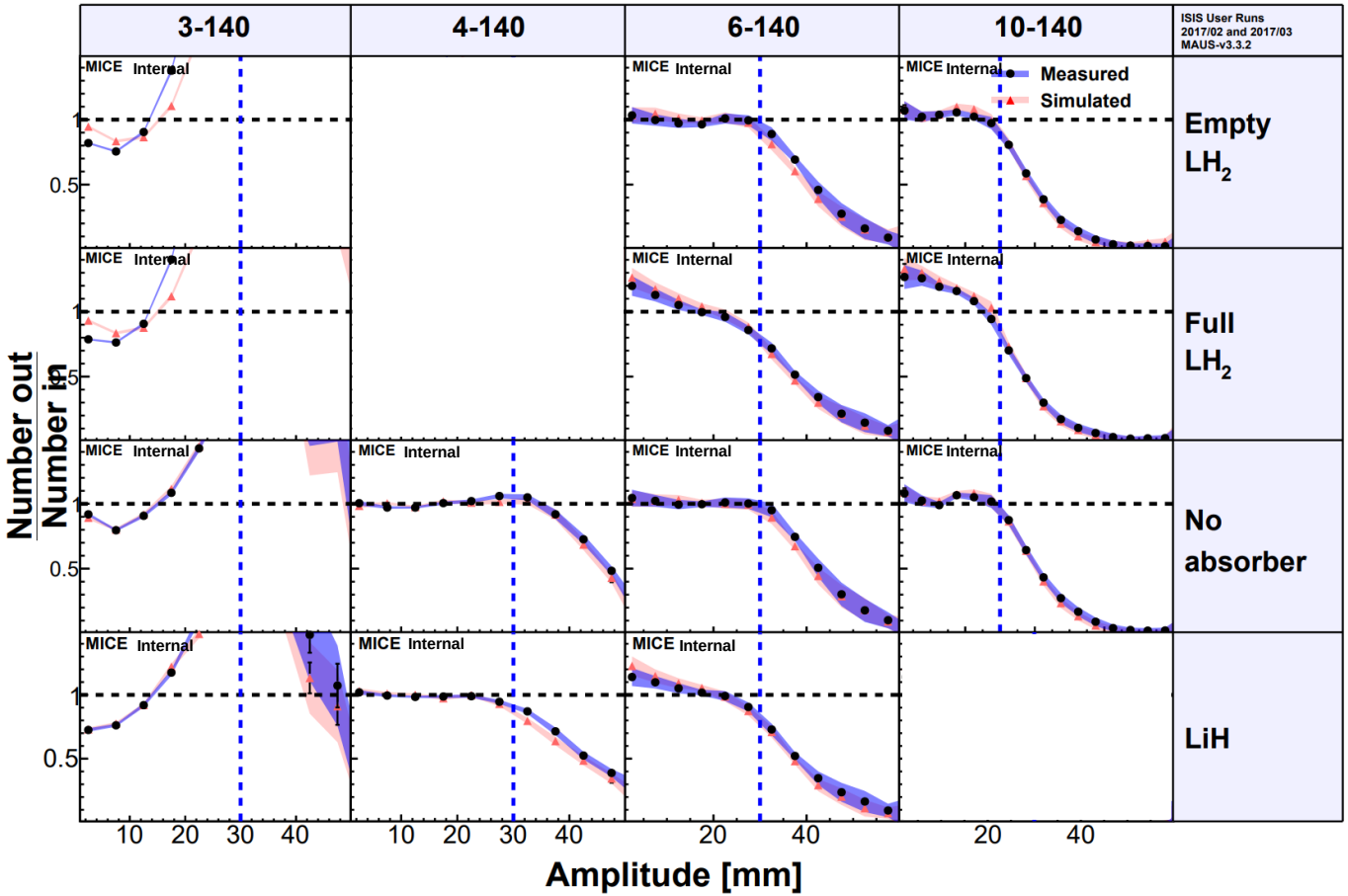
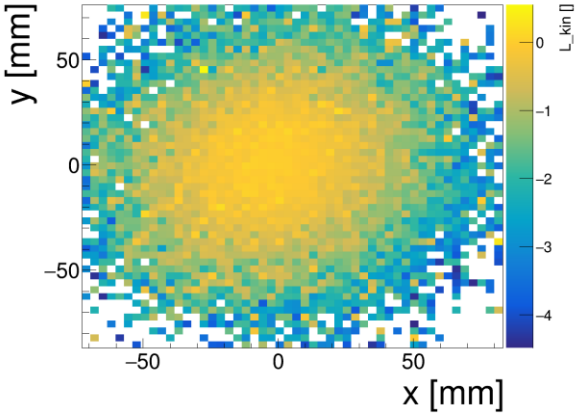
PDF Ratios

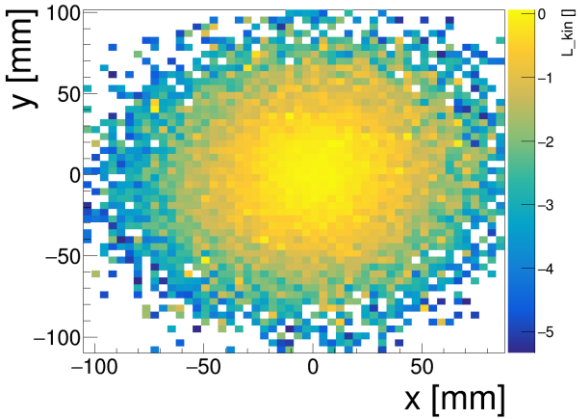

3-140
4-140
6-140
10-140
ISIS User Runs
2017/02 and 2017/03
MAUS-v3.3.2
MICE Internal
Measured
Simulated
Empty LH2
Full LH2
No absorber
LiH
Number out / Number in
Amplitude [mm]

L kin vs x-y plots

Tku 5



Tku 4



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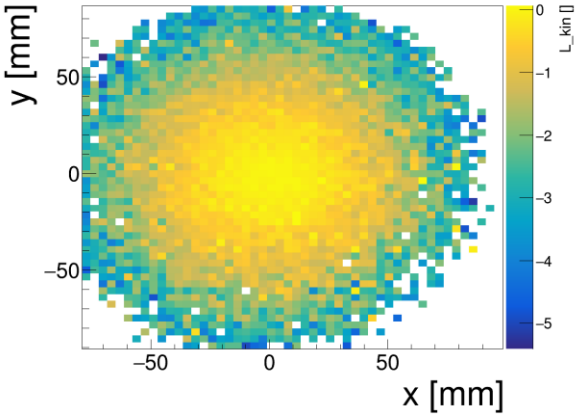
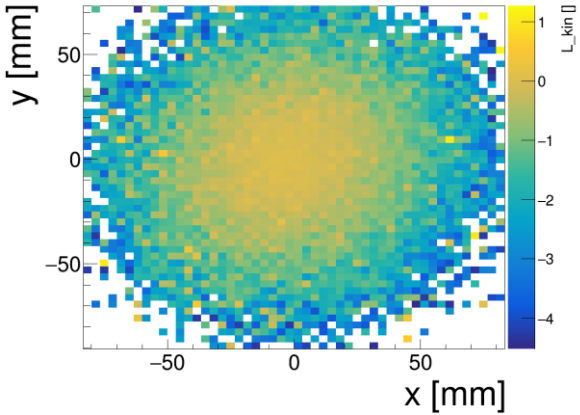
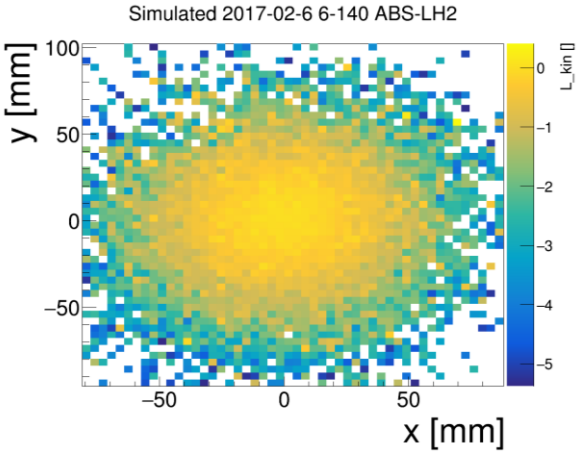


Tku 2



Tku 1



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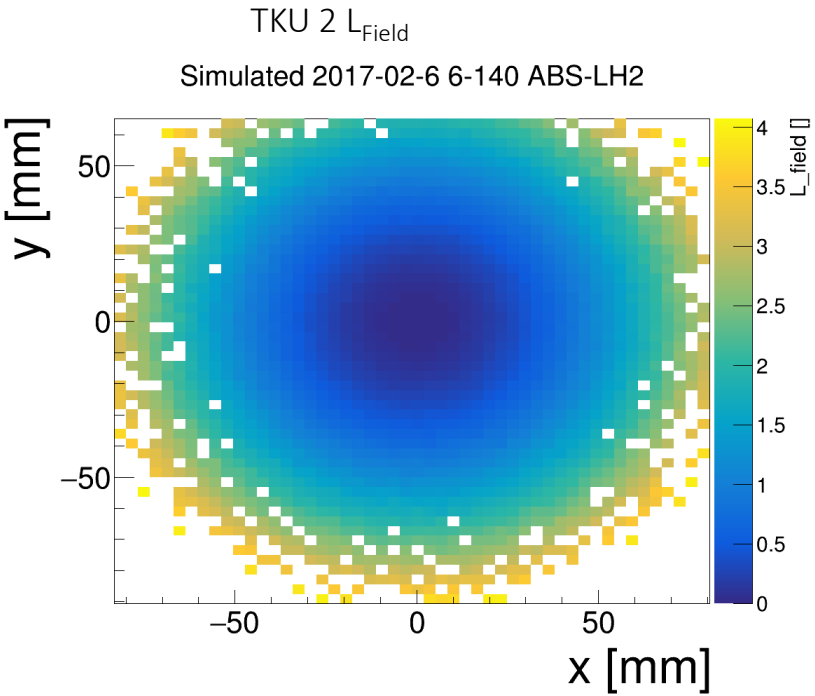
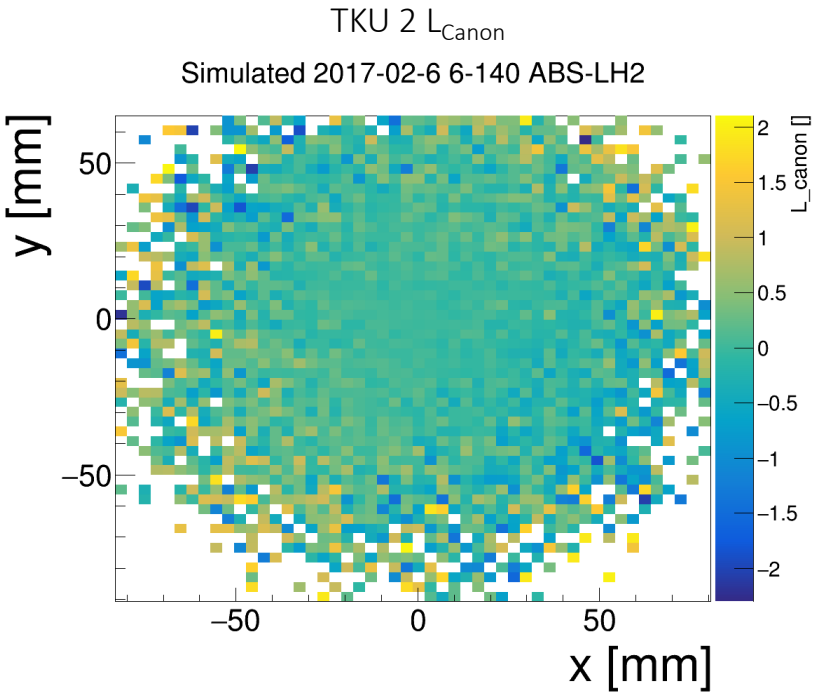
Different z scales, can combine if interest

L canon, L field vs x-y plots





Equations for Track Propagation

$$x' = x + \frac{p_x}{p_t} R \sin\Delta\theta - \frac{p_y}{p_t} R(1 - \cos\Delta\theta)$$

$$y' = y + \frac{p_y}{p_t} R \sin\Delta\theta + \frac{p_x}{p_t} R(1 - \cos\Delta\theta)$$

$$z' = z + \Delta z$$

$$p'_x = p_x \cos\Delta\theta - p_y \sin\Delta\theta$$

$$p'_y = p_y \cos\Delta\theta + p_x \sin\Delta\theta$$

$$p'_z = p_z;$$

$$R = \frac{p_t}{qB_z}$$

$$\Delta\theta = \frac{cB_z Q \Delta z}{p_z}$$

$$c \approx \frac{0.299 MeV}{cT^{-1}mm^{-1}}$$

L canon Reco vs Truth

Original and rescaled distributions in 1D

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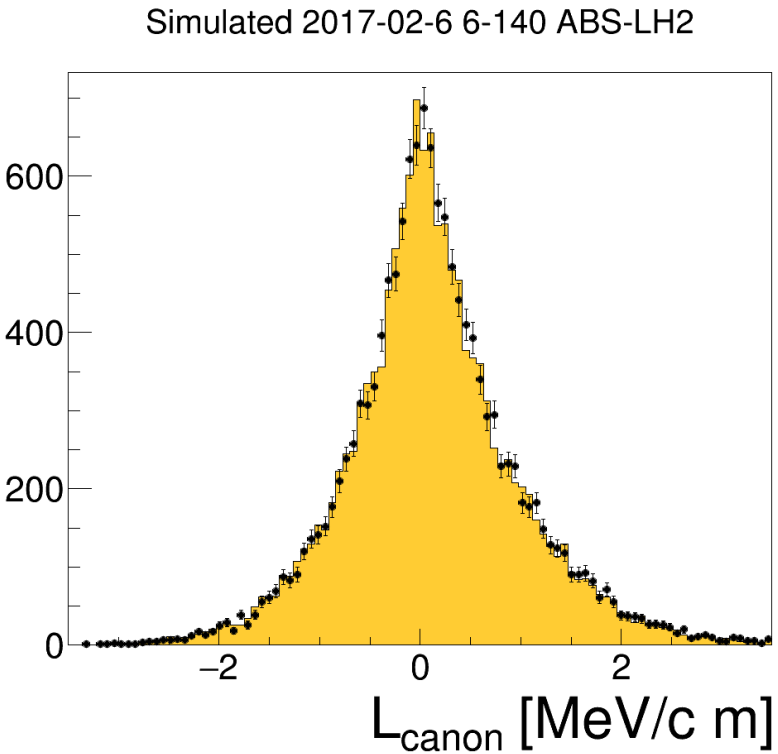
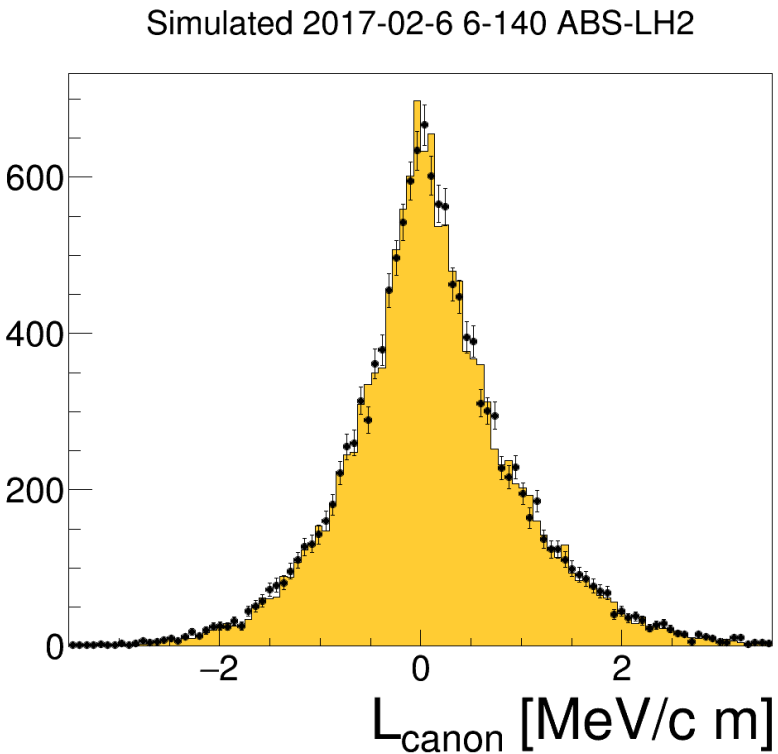
Uncorrected, tku tp



Rescaled, tku tp



1D Distributions – L_canon – tku_tp

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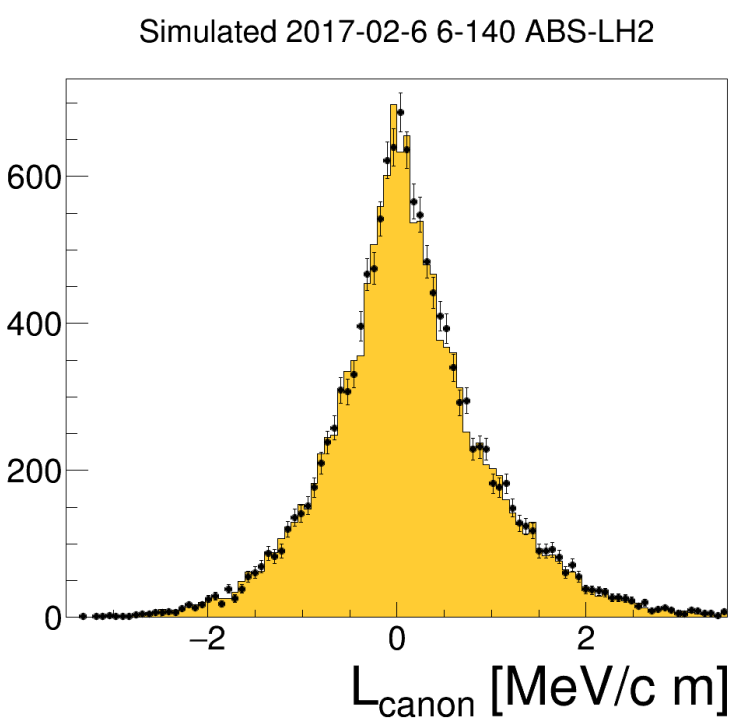
3.3.2



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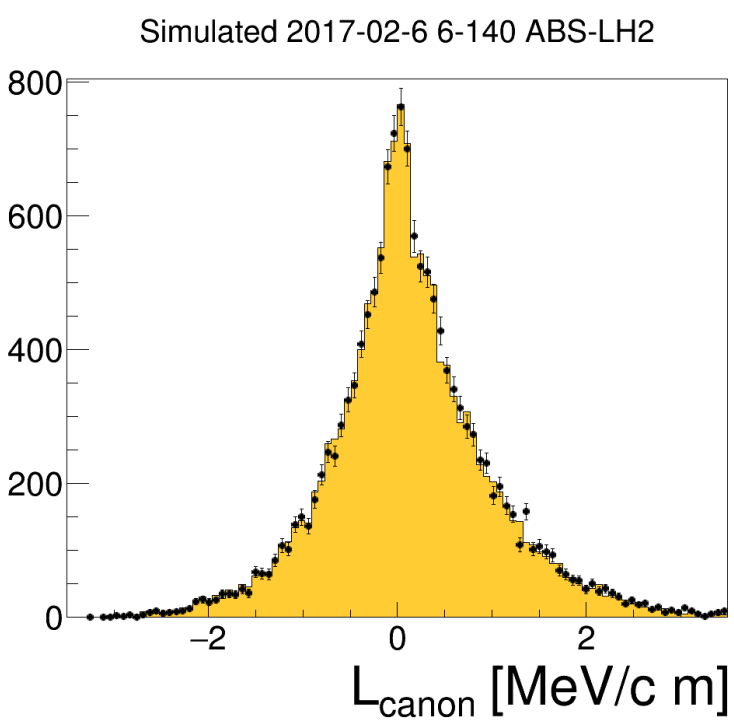

1D Distributions – L_canon – tku_2

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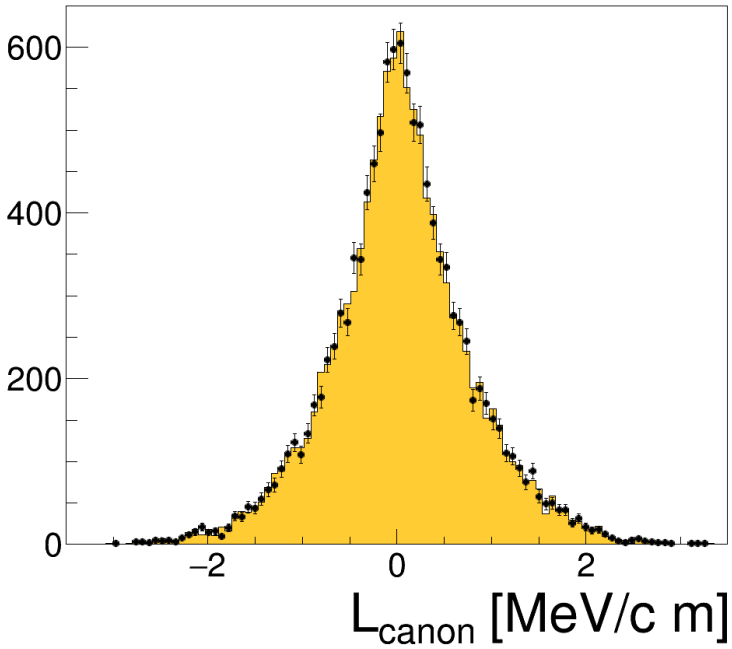
3.3.2



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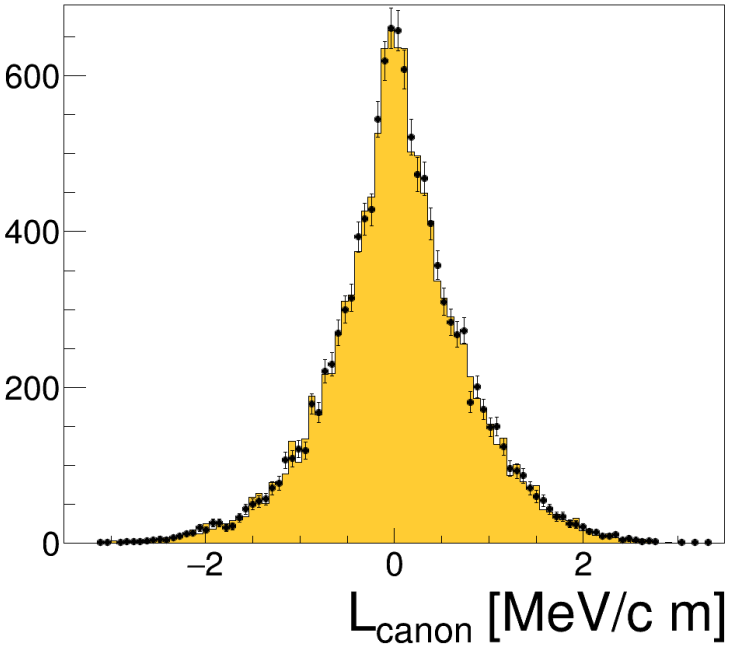

MAUS Correction

1D Distributions – L_canon – tku_3

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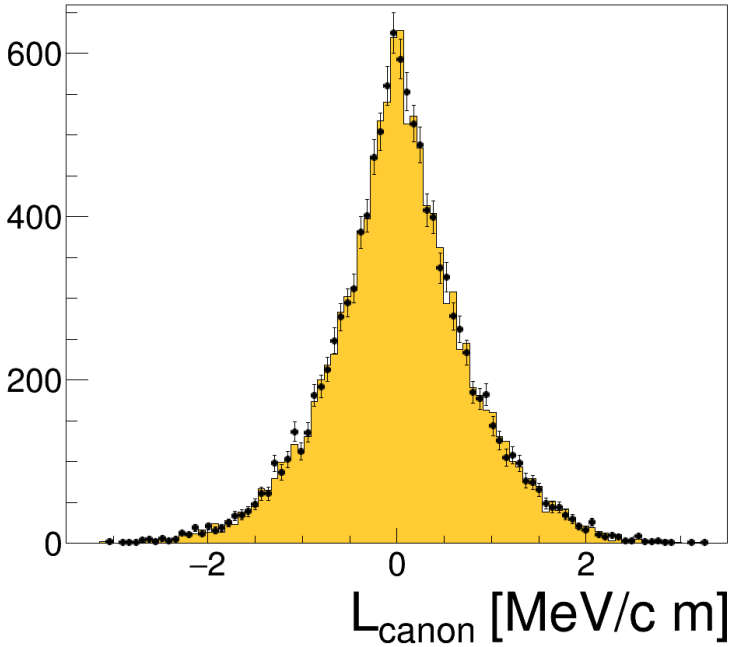
3.3.2



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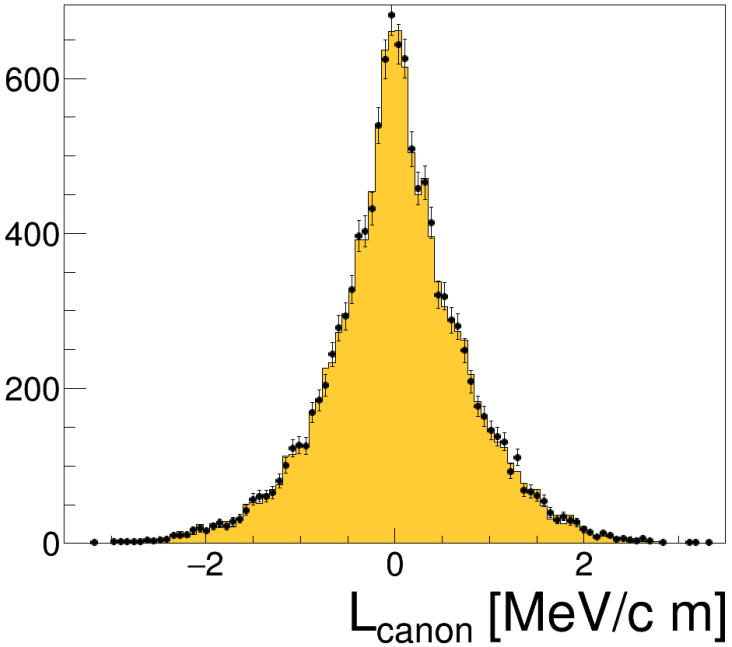

MAUS Correction

1D Distributions – L_canon – tku_4

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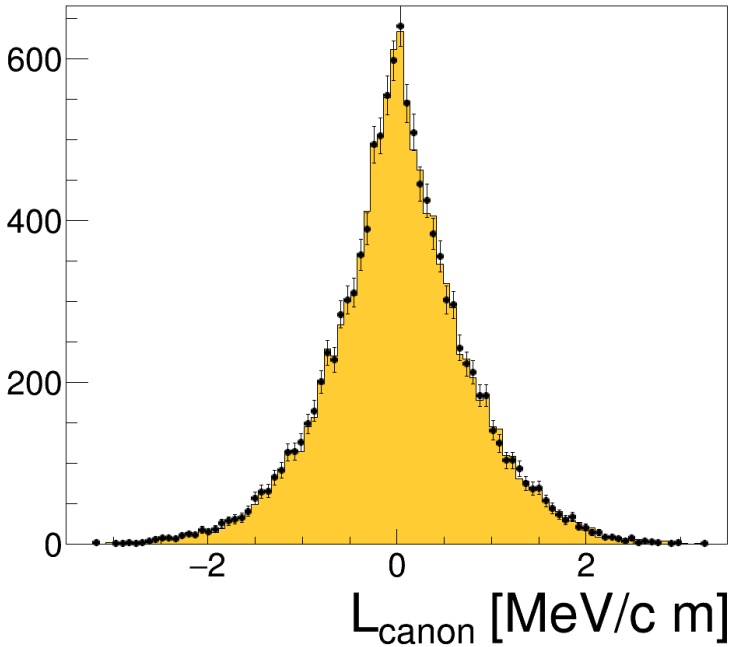
3.3.2



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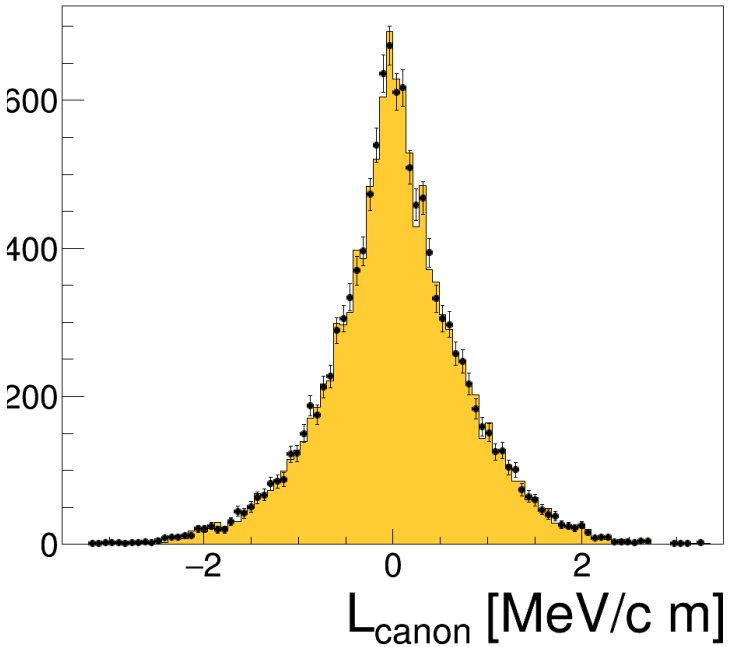

1D Distributions – L_canon – tku_5

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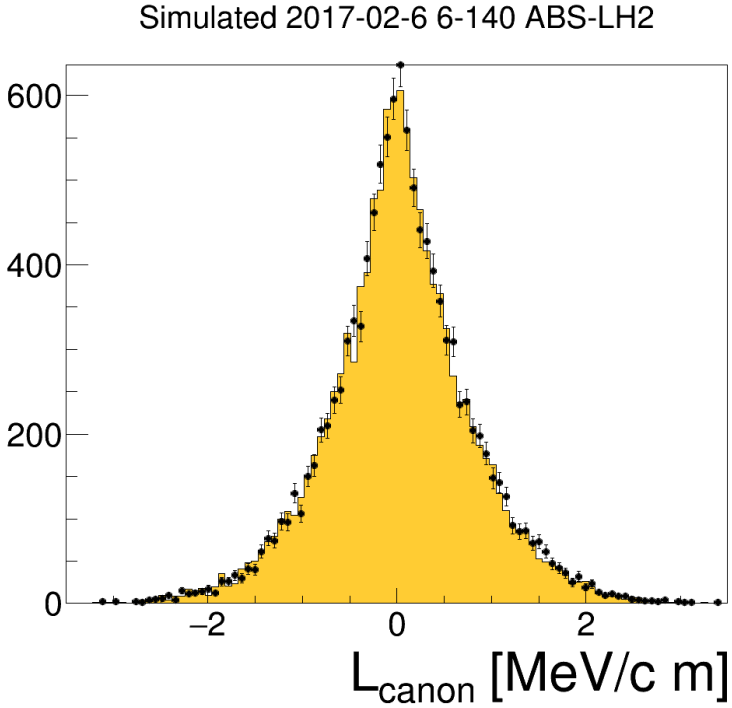
3.3.2



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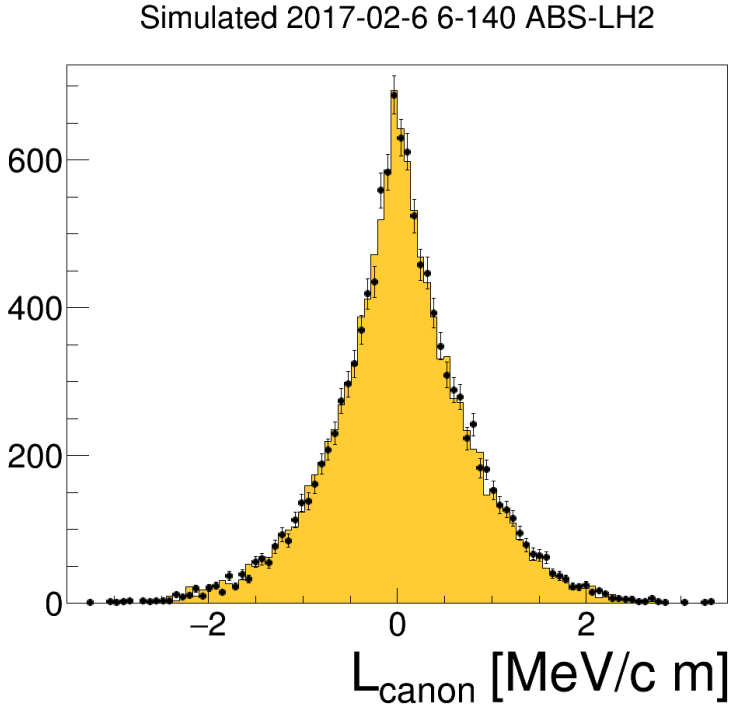

1D Distributions – L_canon – tkd_tp

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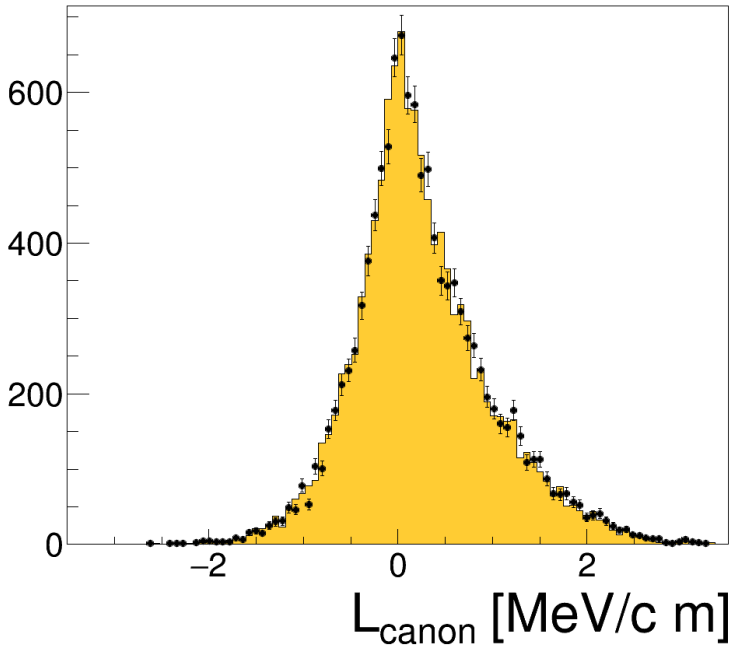
3.3.2



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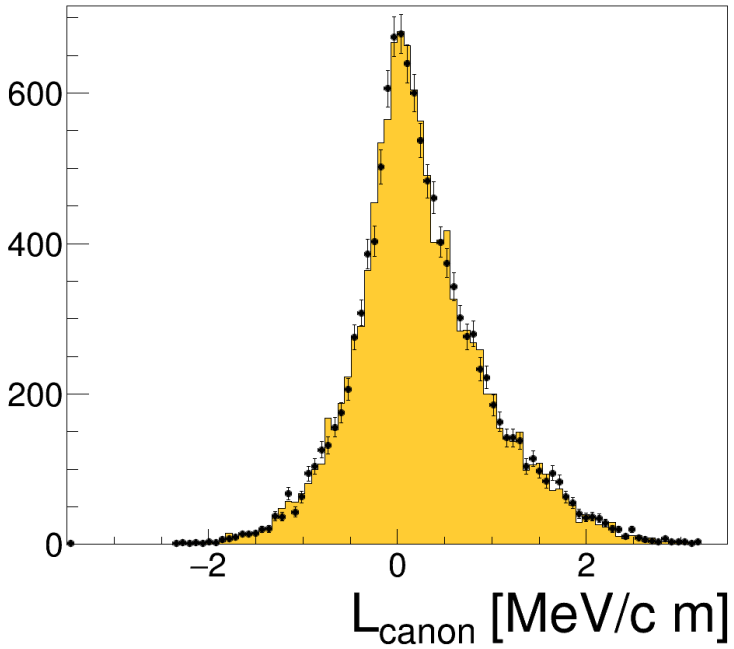

1D Distributions – L_field tku_tp

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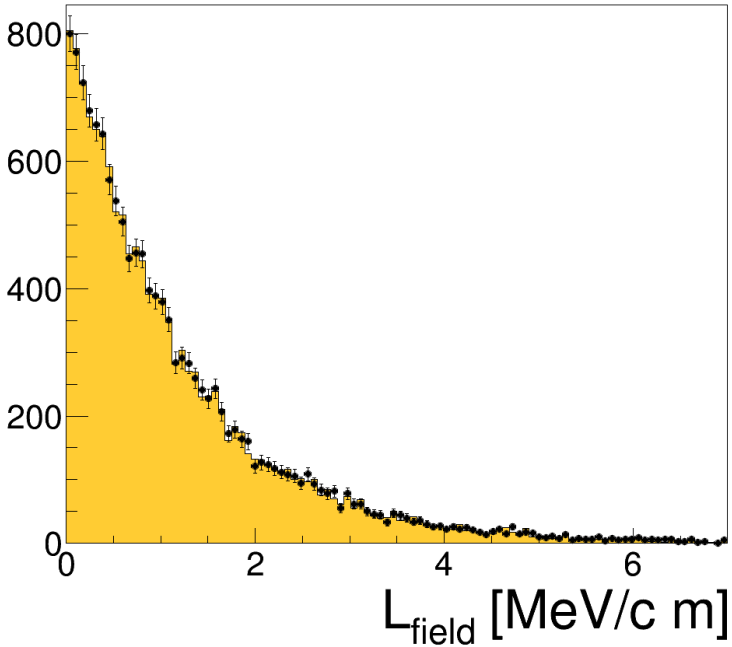
3.3.2



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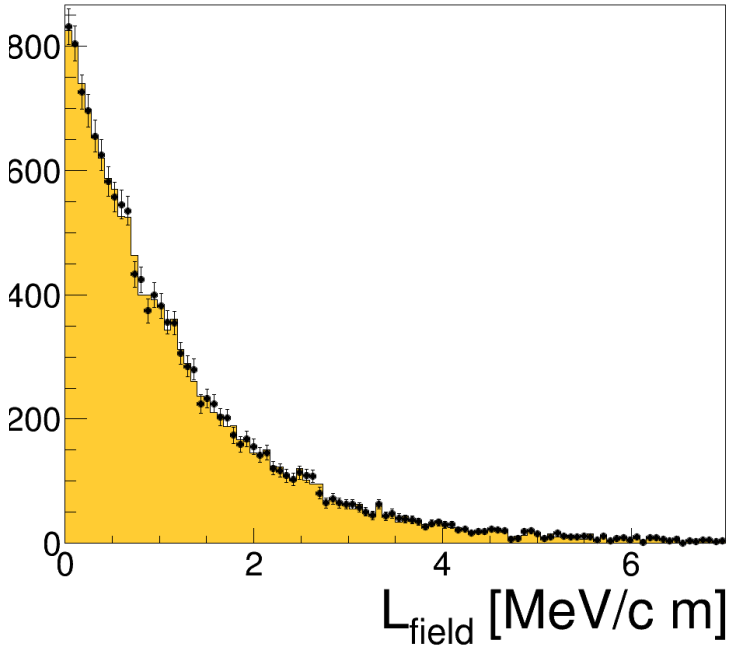

1D Distributions – L_field tku_3

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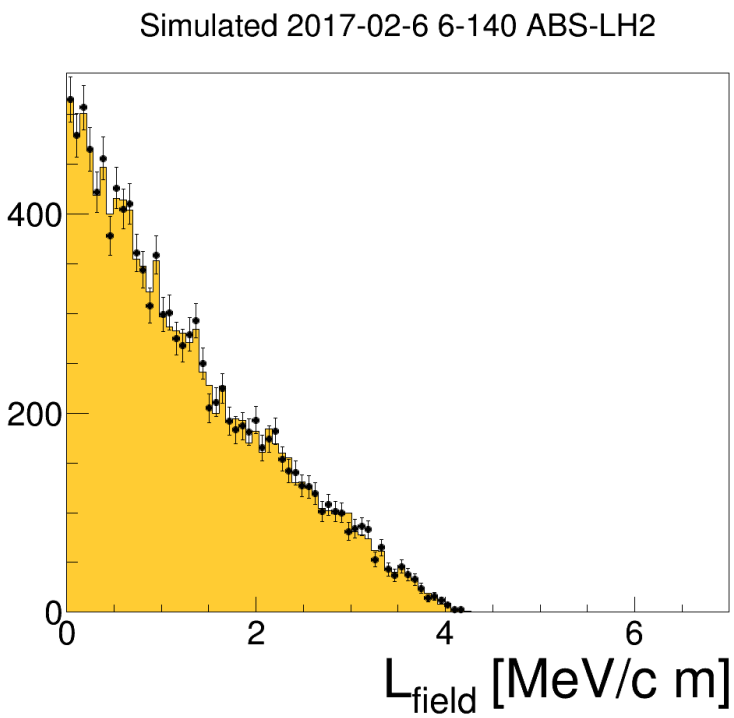
3.3.2



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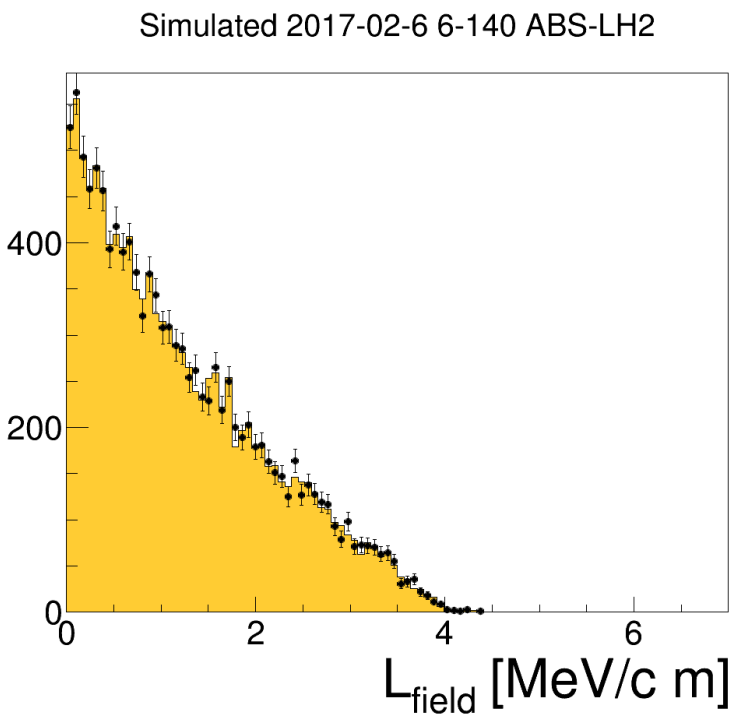

1D Distributions – L_kin tku_tp

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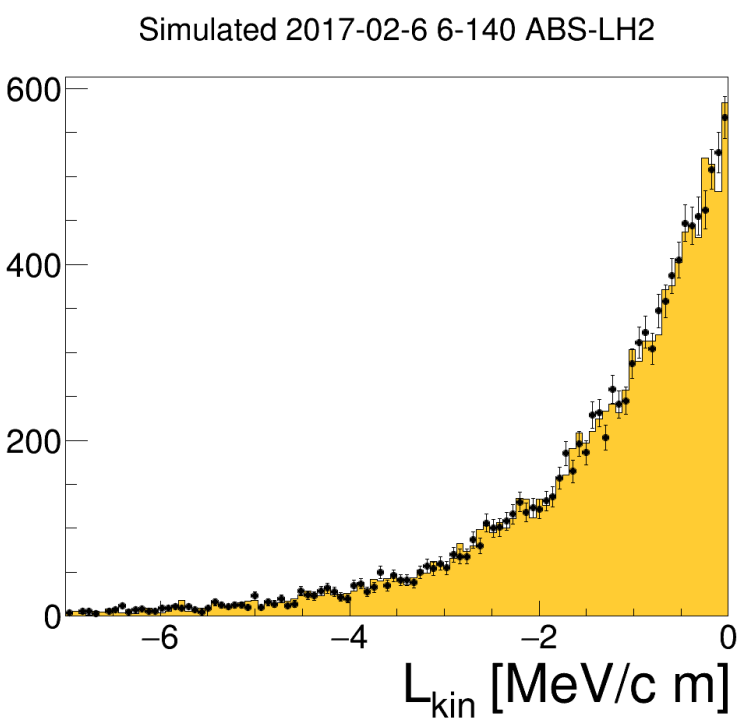
3.3.2



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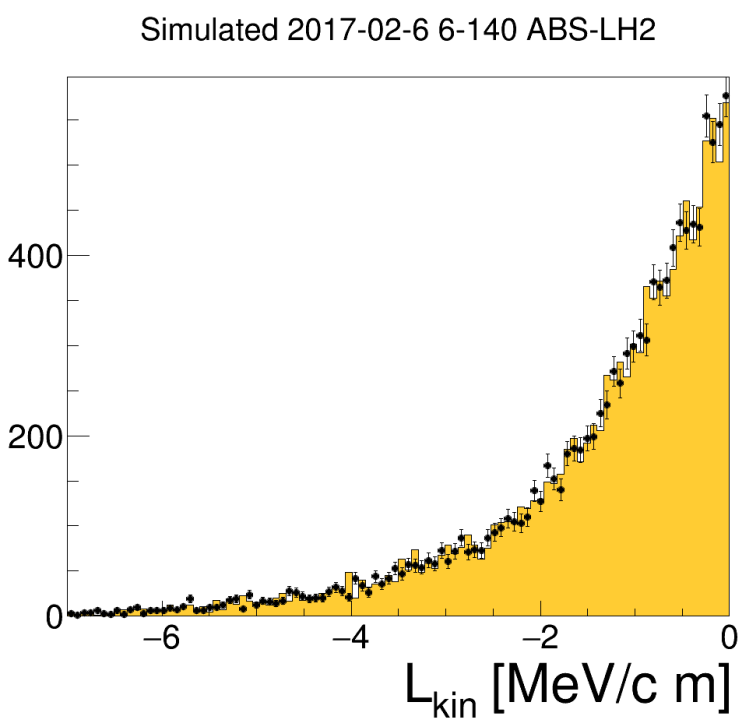

1D Distributions – L_kin tku_3

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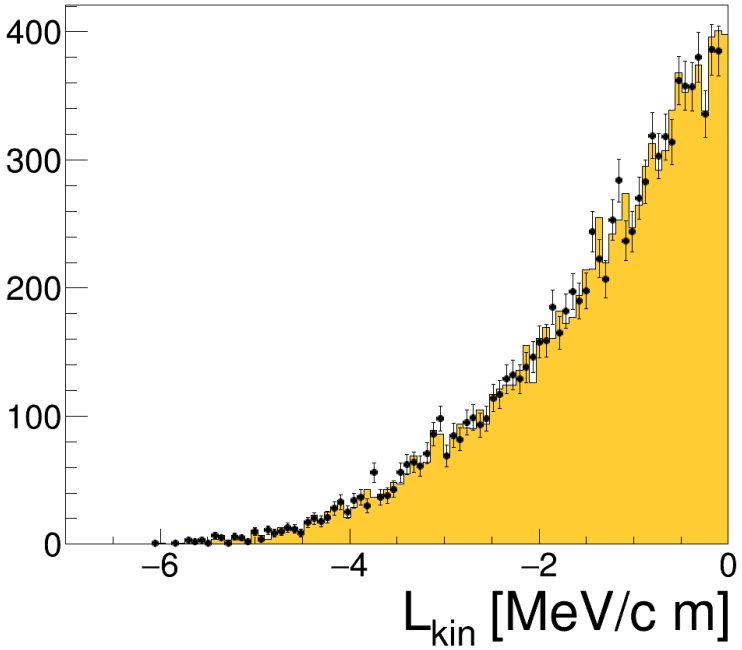
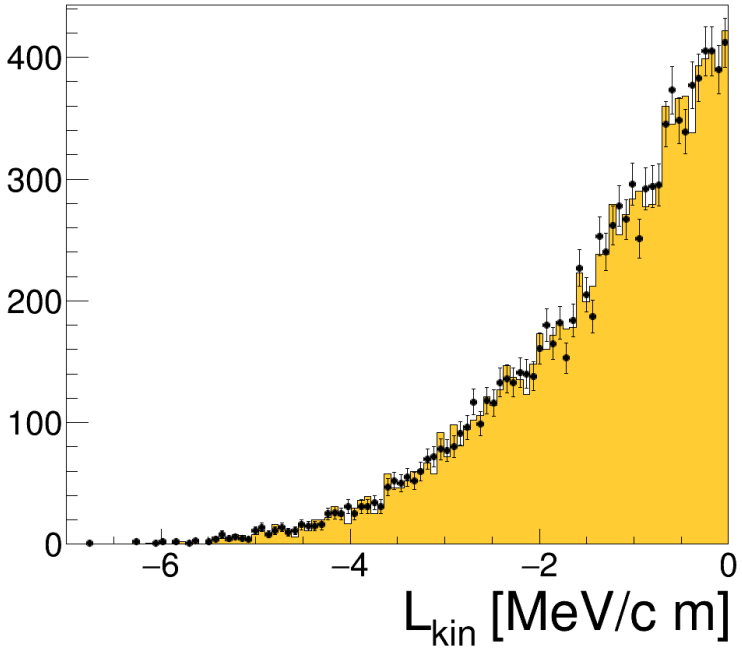
3.3.2



3.3.5

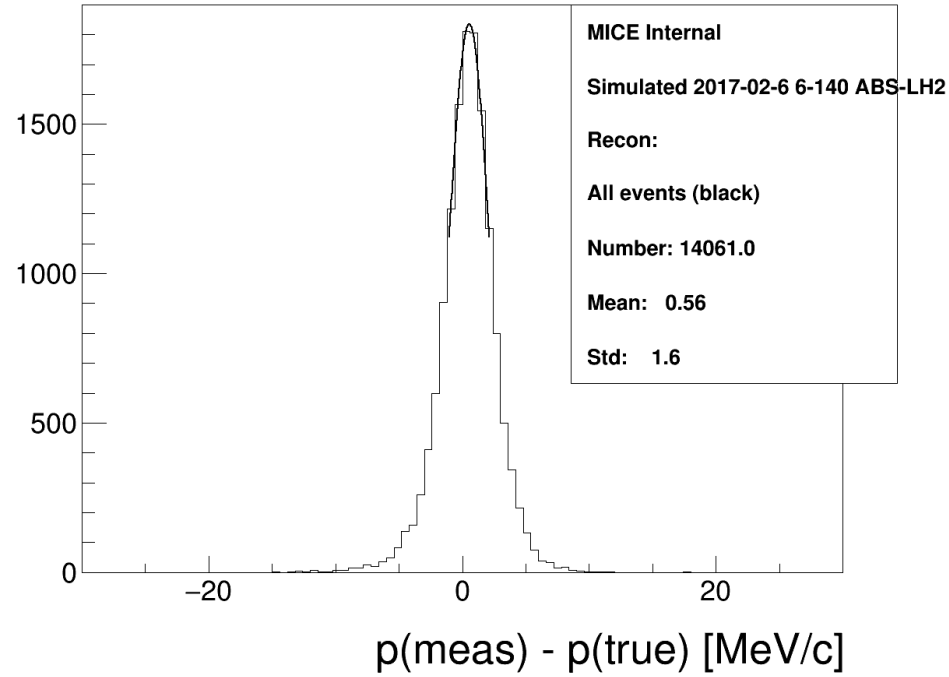


MAUS Correction

P mc residuals

Tku tp

3.3.2



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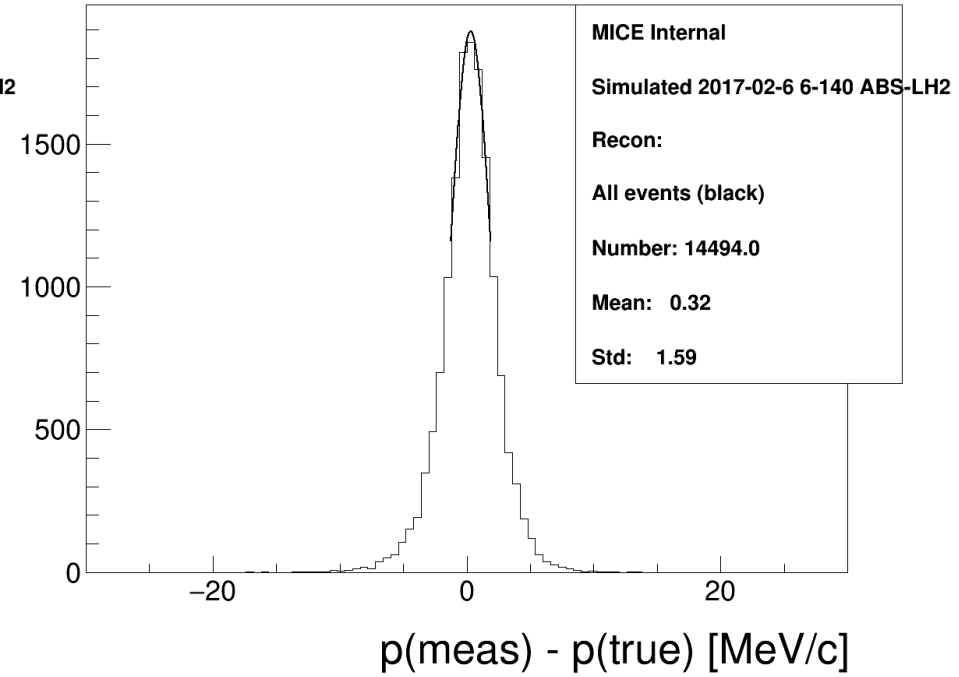
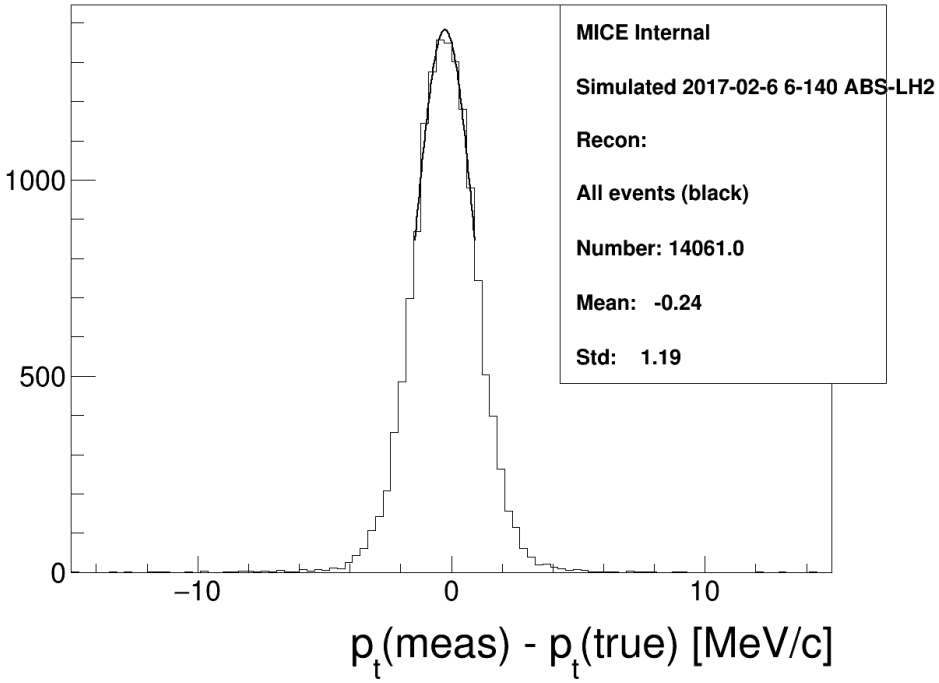


MAUS Correction

Pt mc residuals

Tku tp

3.3.2



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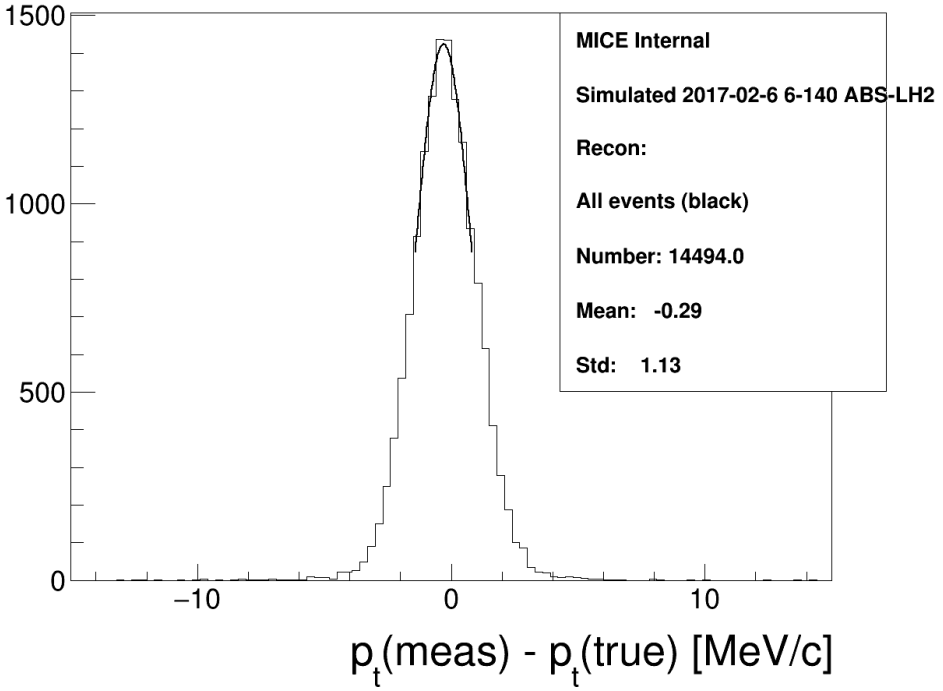
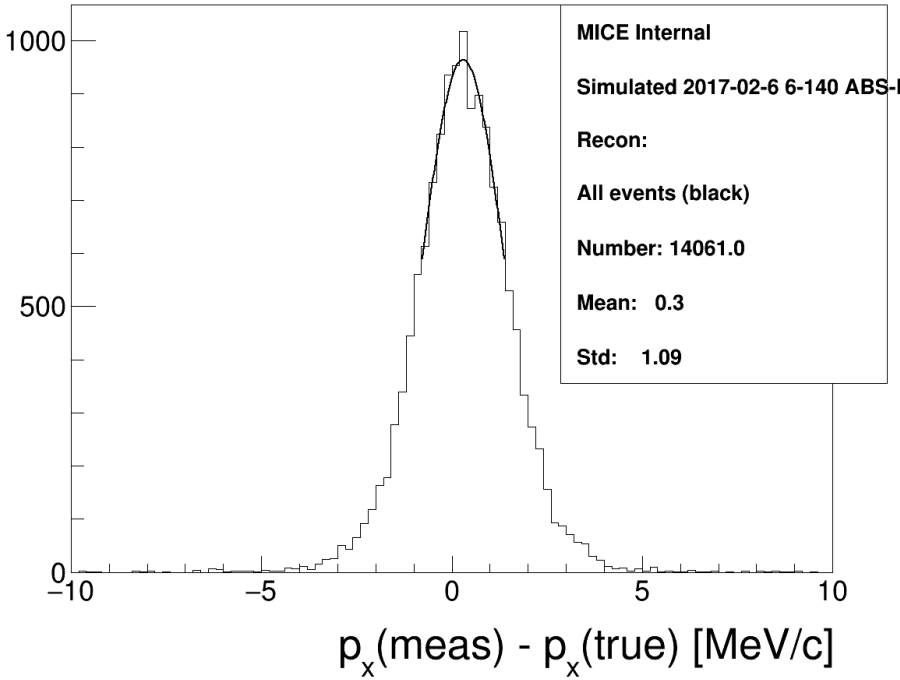


MAUS Correction

Px mc residuals

Tku tp

3.3.2



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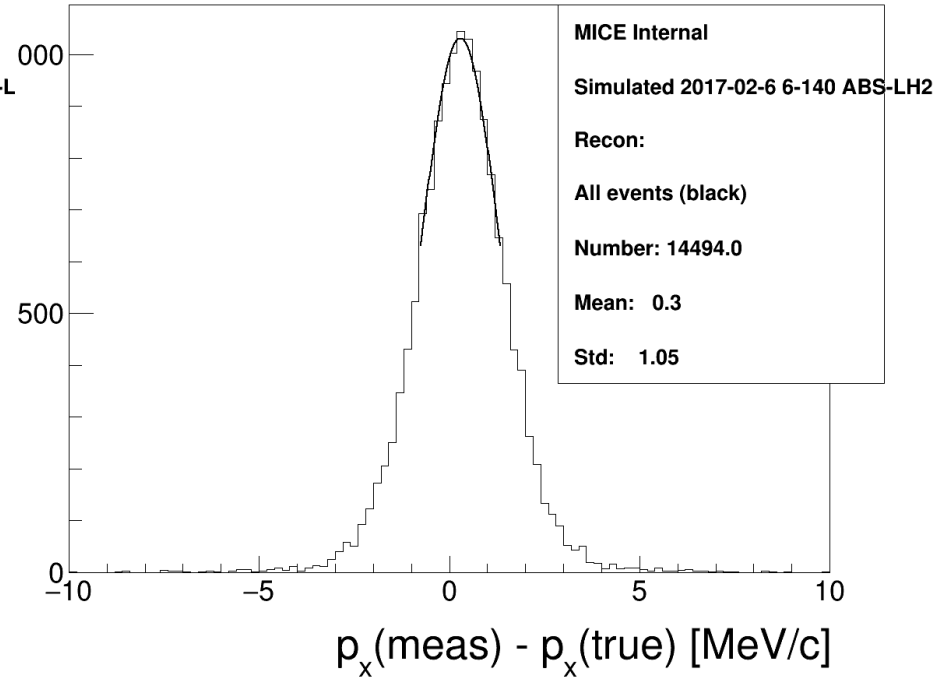
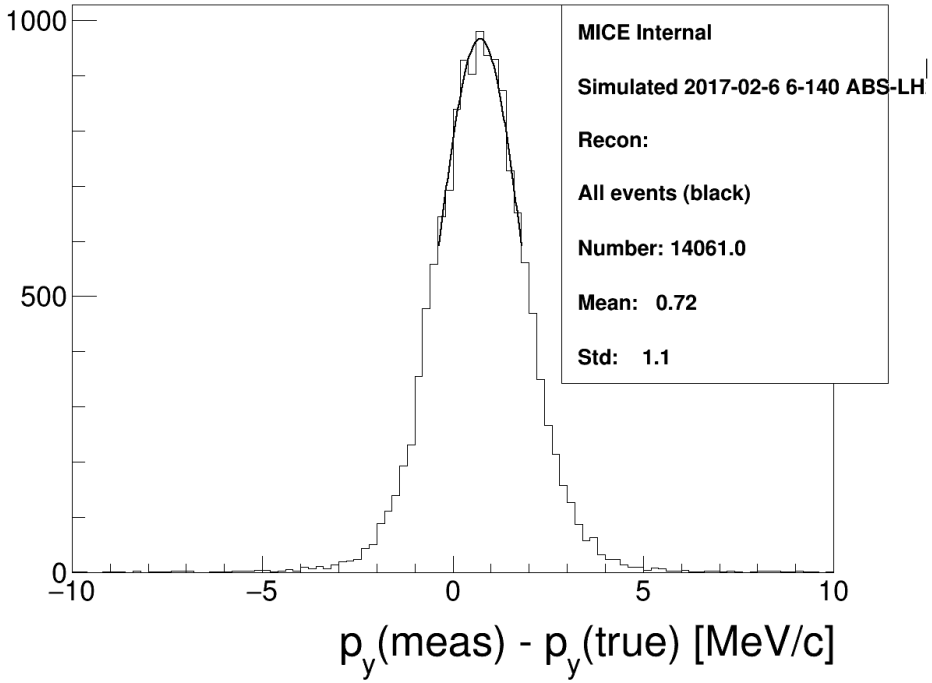


MAUS Correction

Py mc residuals

Tku tp

3.3.2



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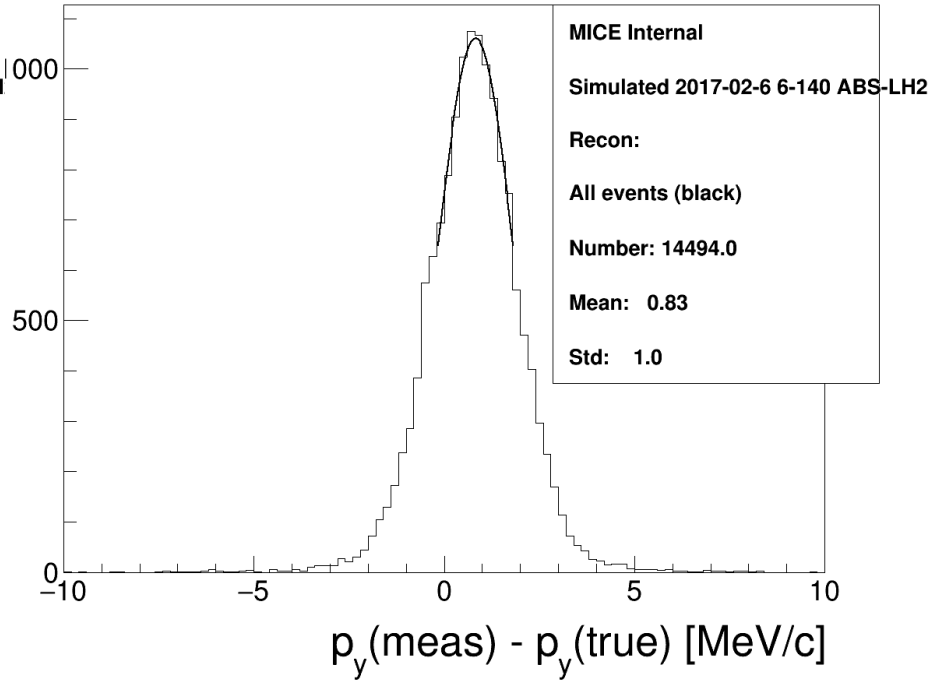
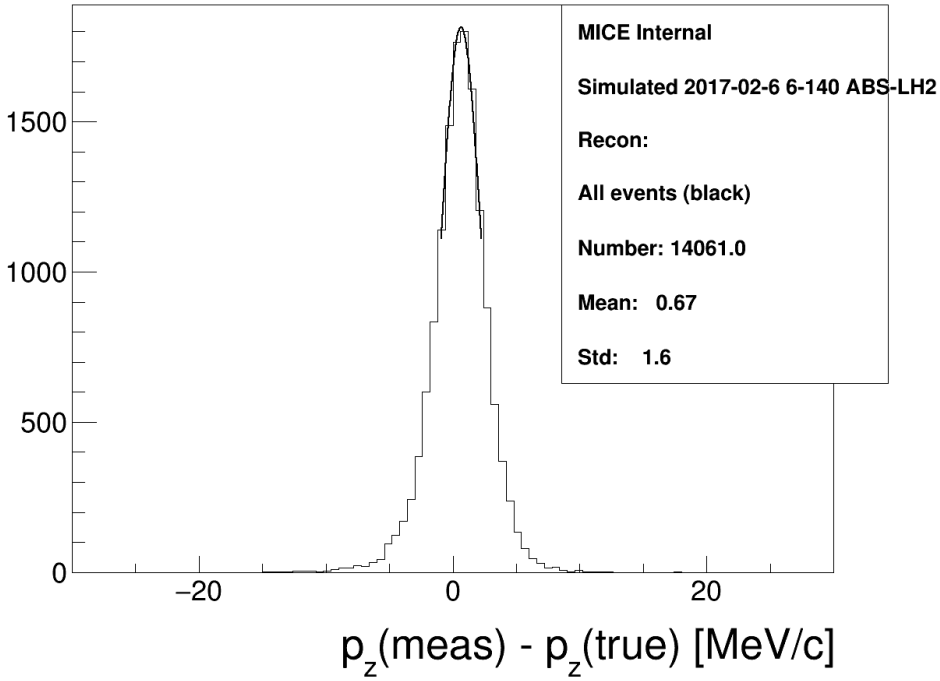


MAUS Correction

Py mc residuals

Tku tp

3.3.2



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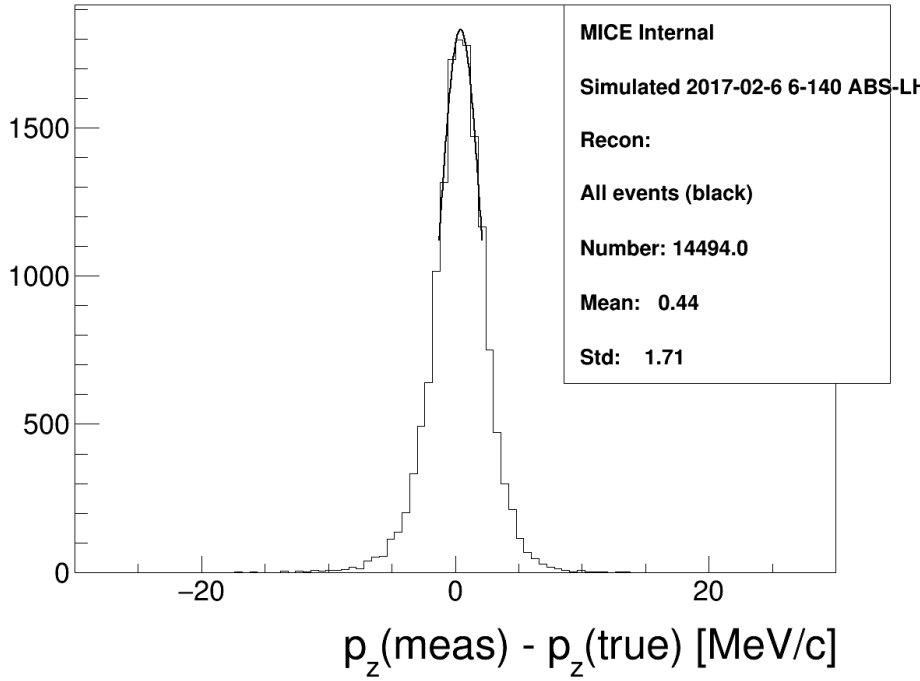
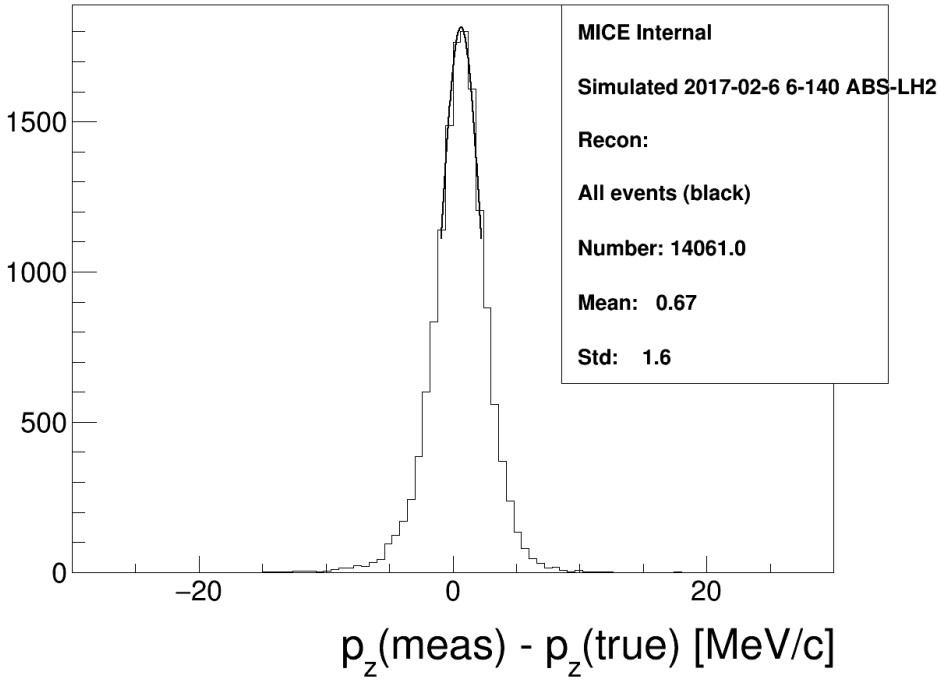


MAUS Correction

Pz mc residuals

Tku tp

3.3.2



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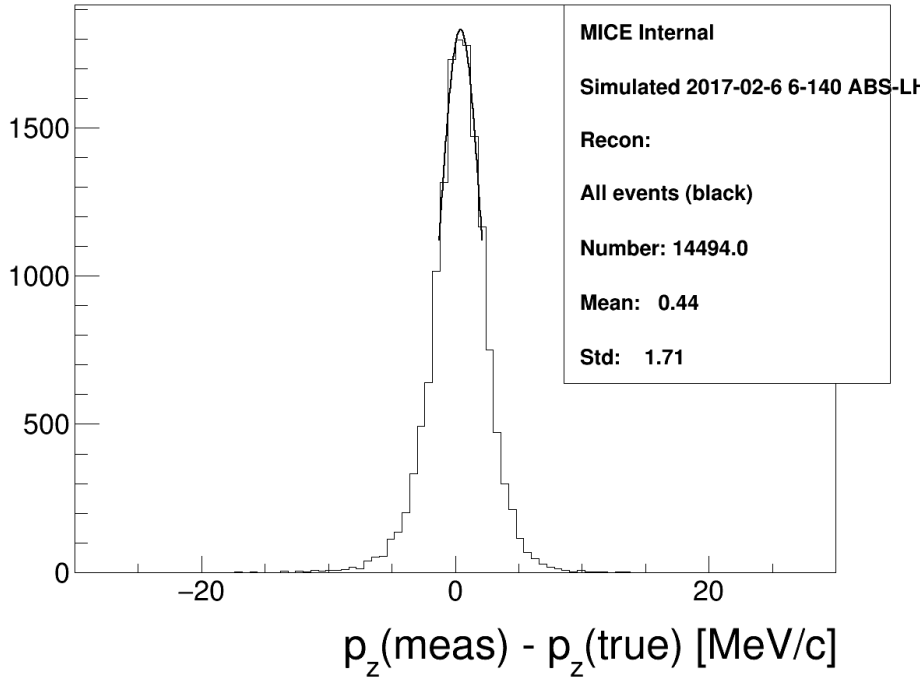
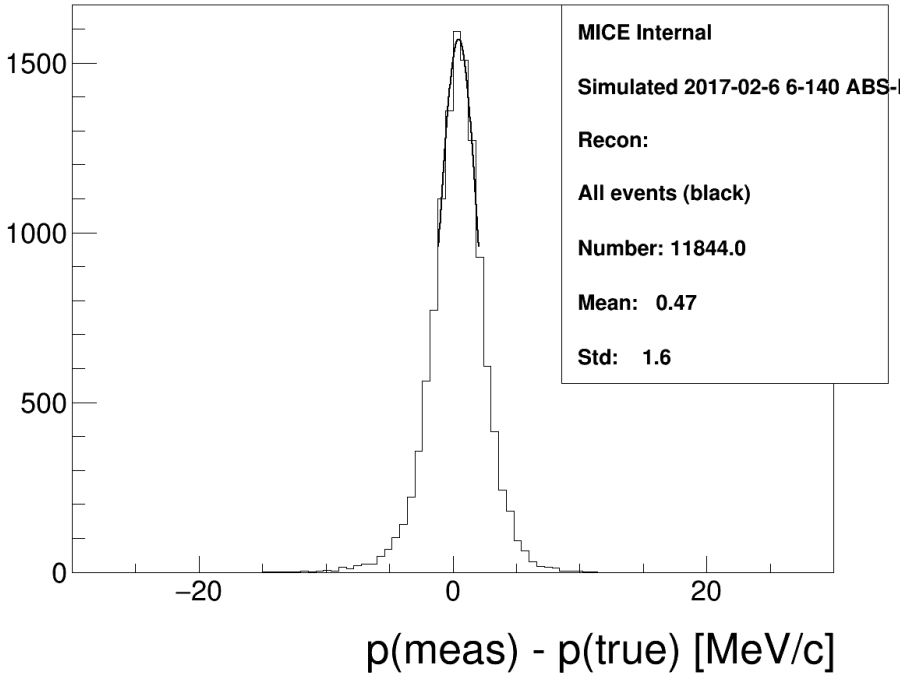


MAUS Correction

P mc residuals

Tku 2

3.3.2



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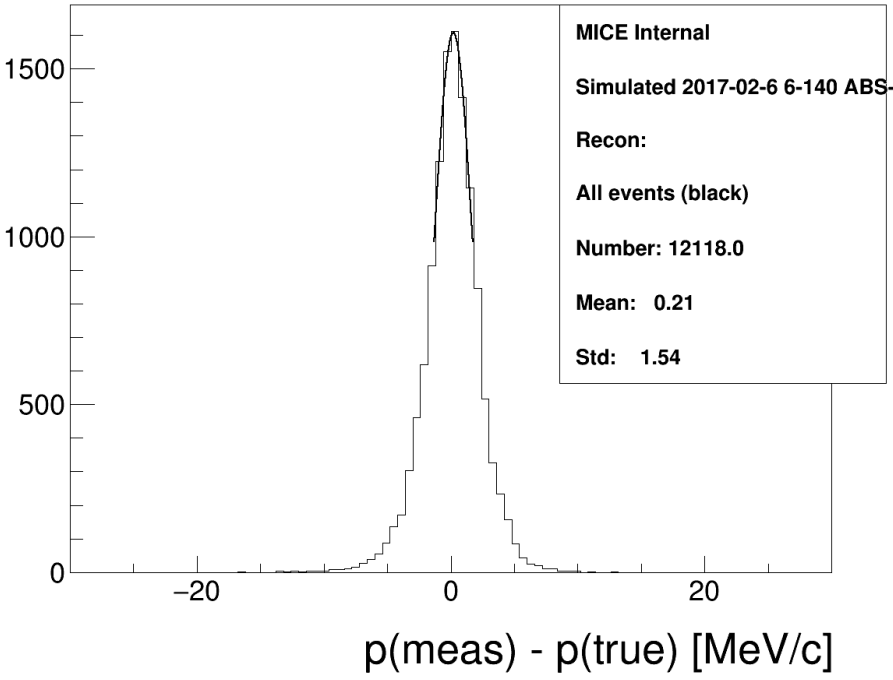
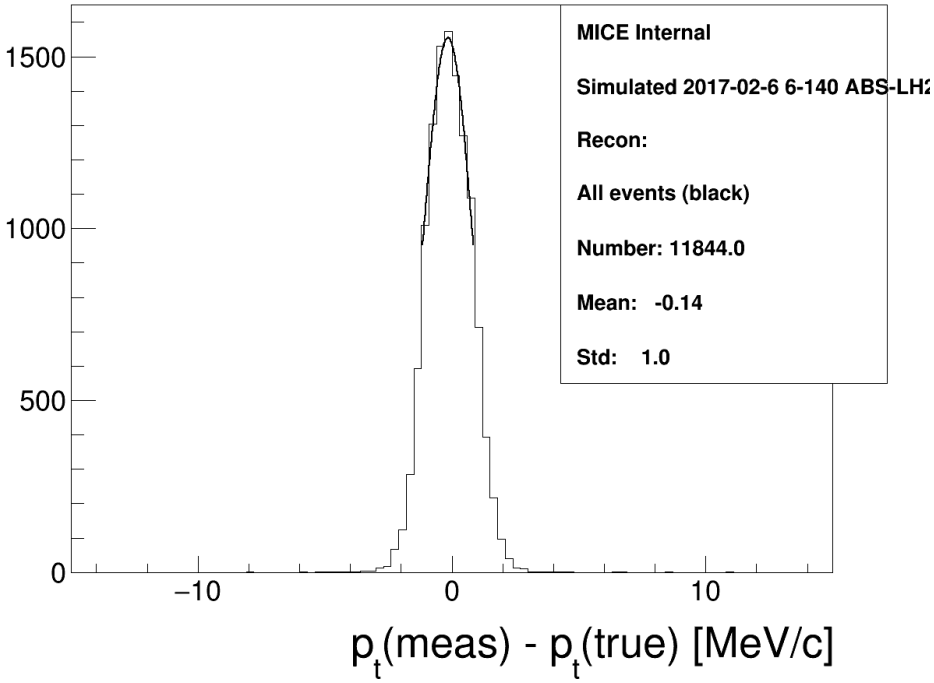


MAUS Correction

Pt mc residuals

Tku 2

3.3.2



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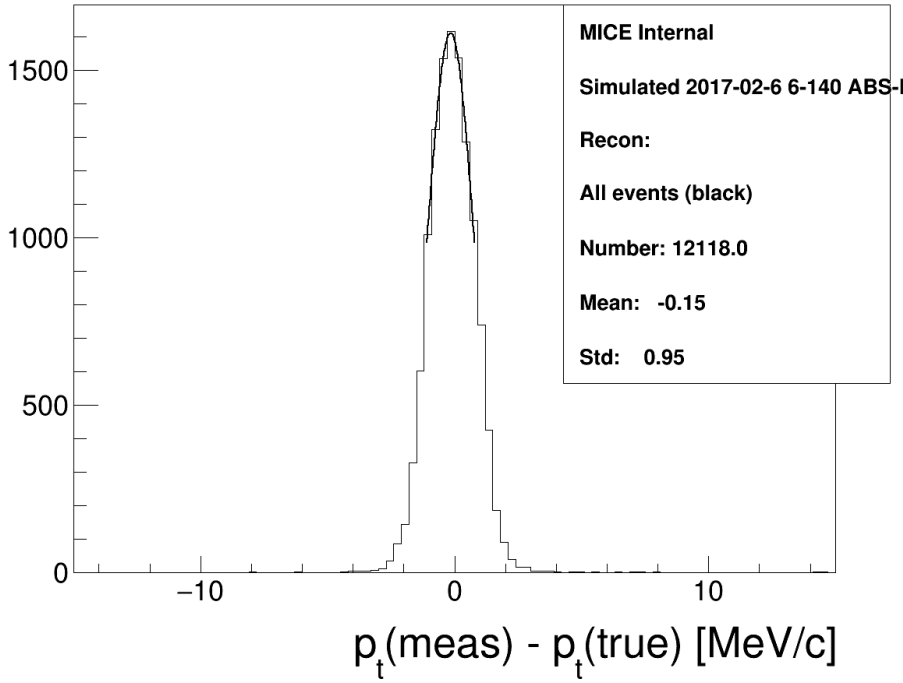
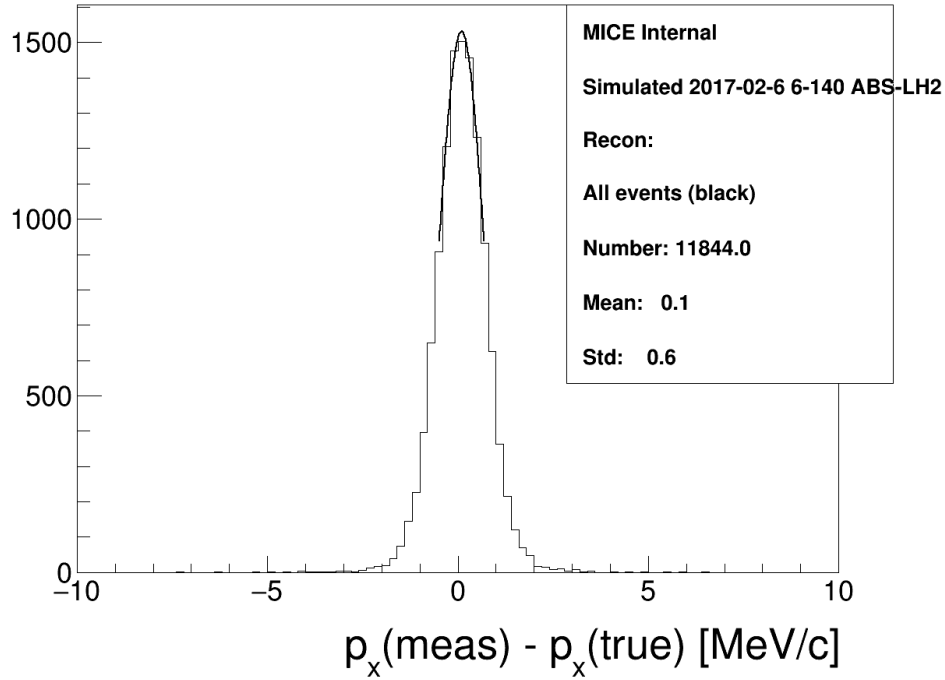


MAUS Correction

Px mc residuals

Tku 2

3.3.2



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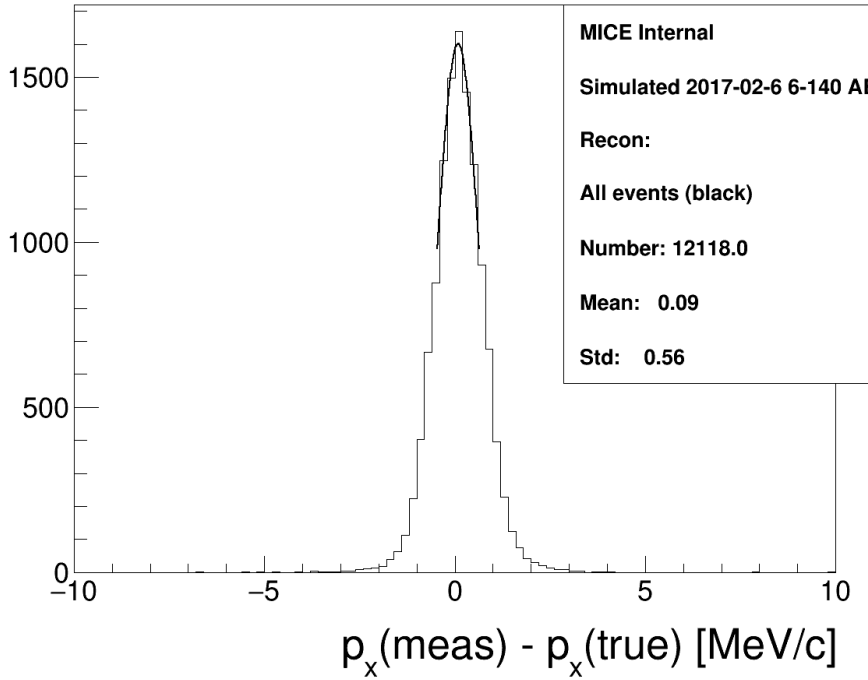
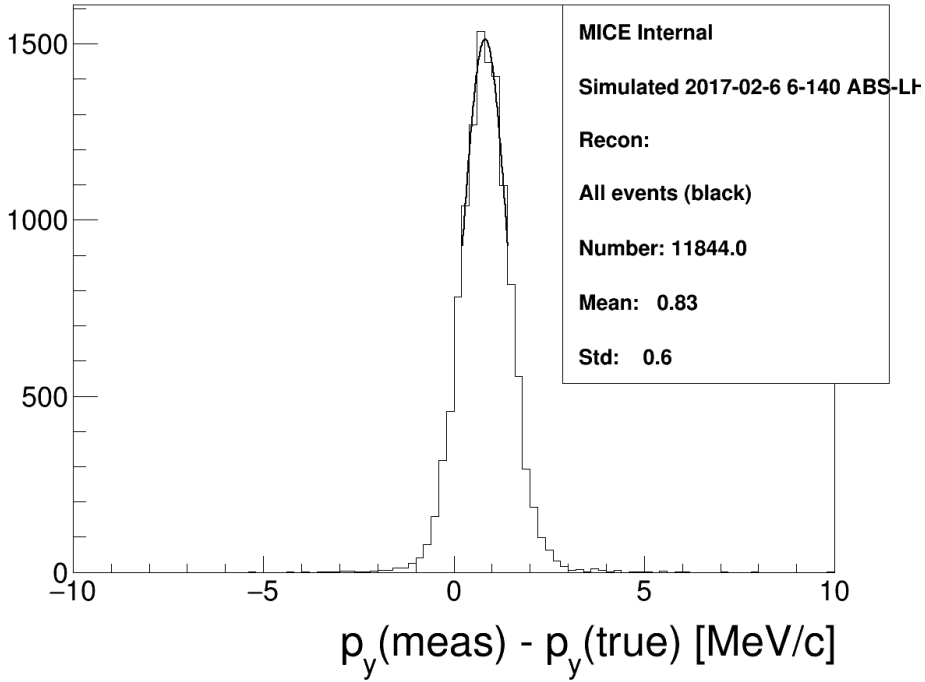


MAUS Correction

Py mc residuals

Tku 2

3.3.2



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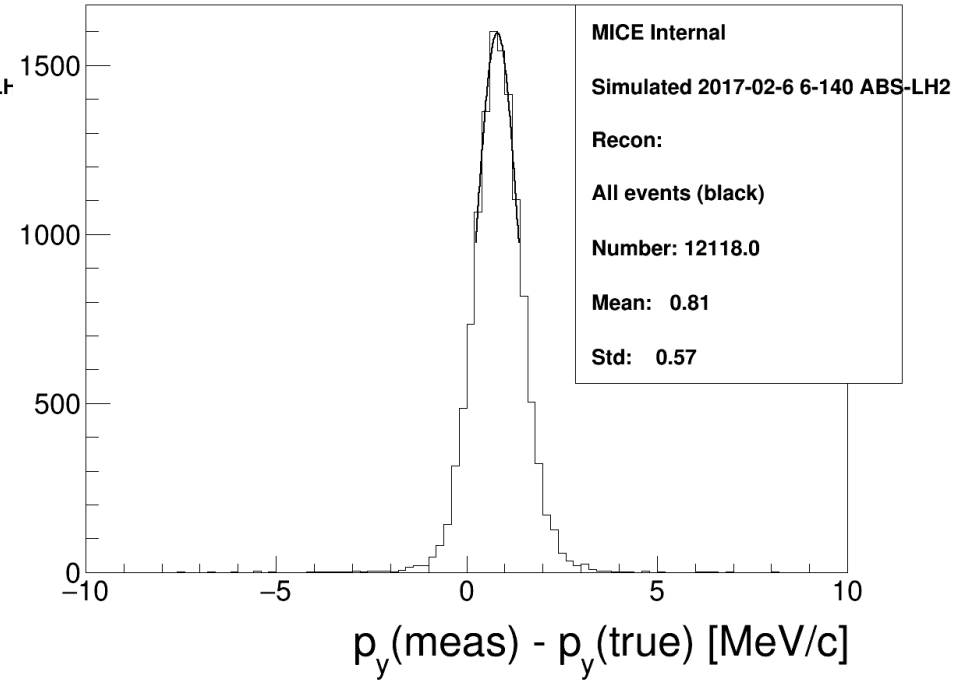
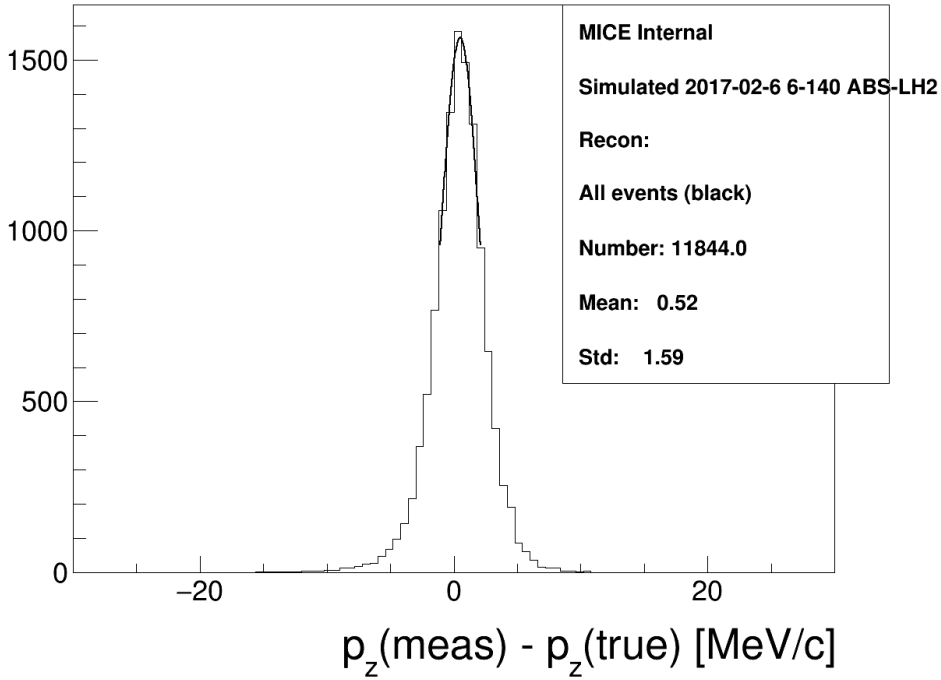


MAUS Correction

Py mc residuals

Tku 2

3.3.2



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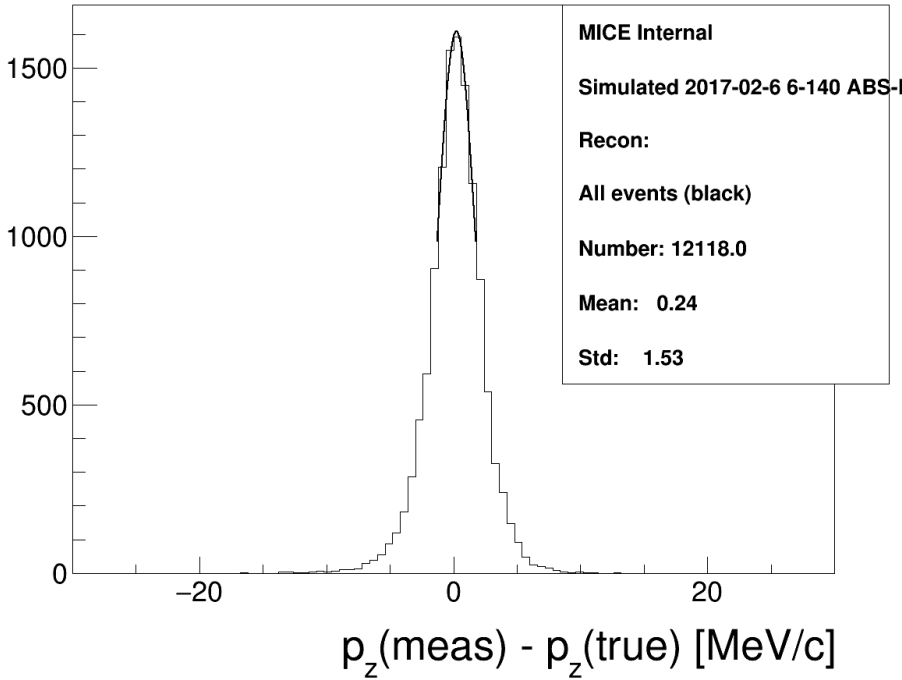
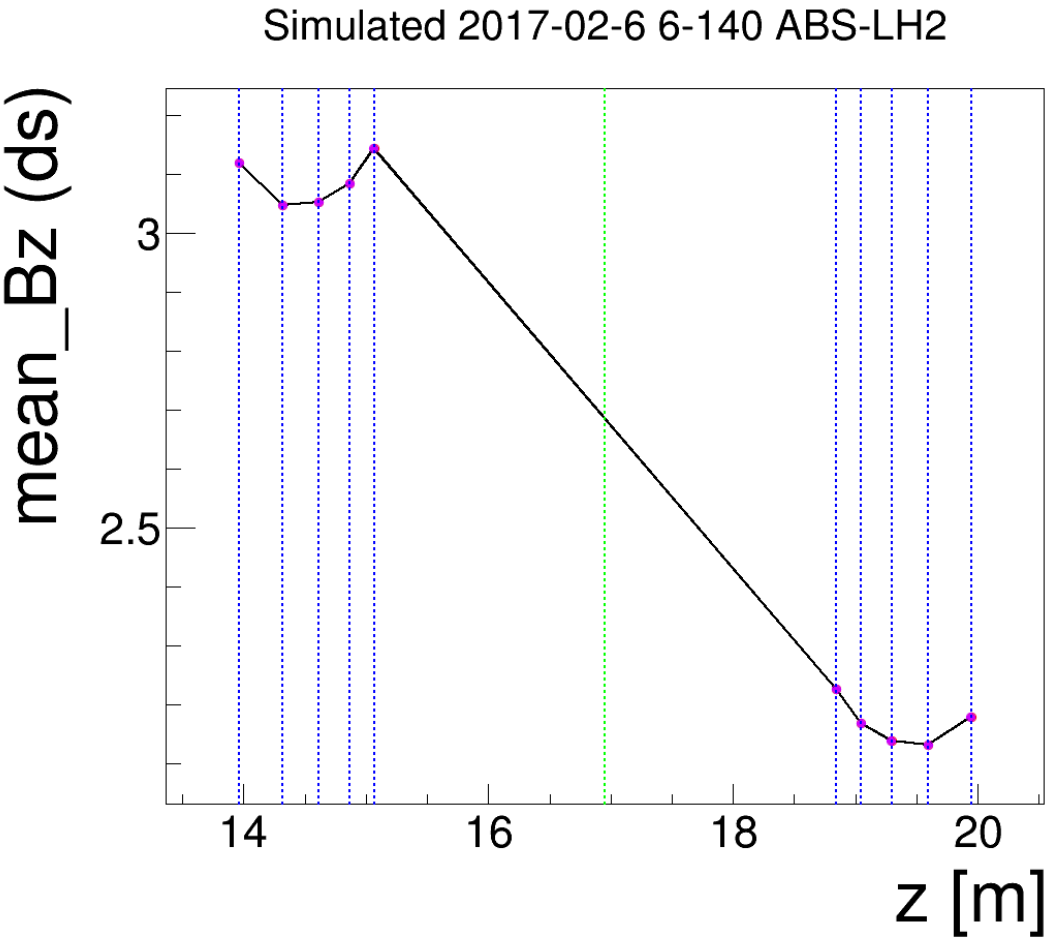


Mean Bz



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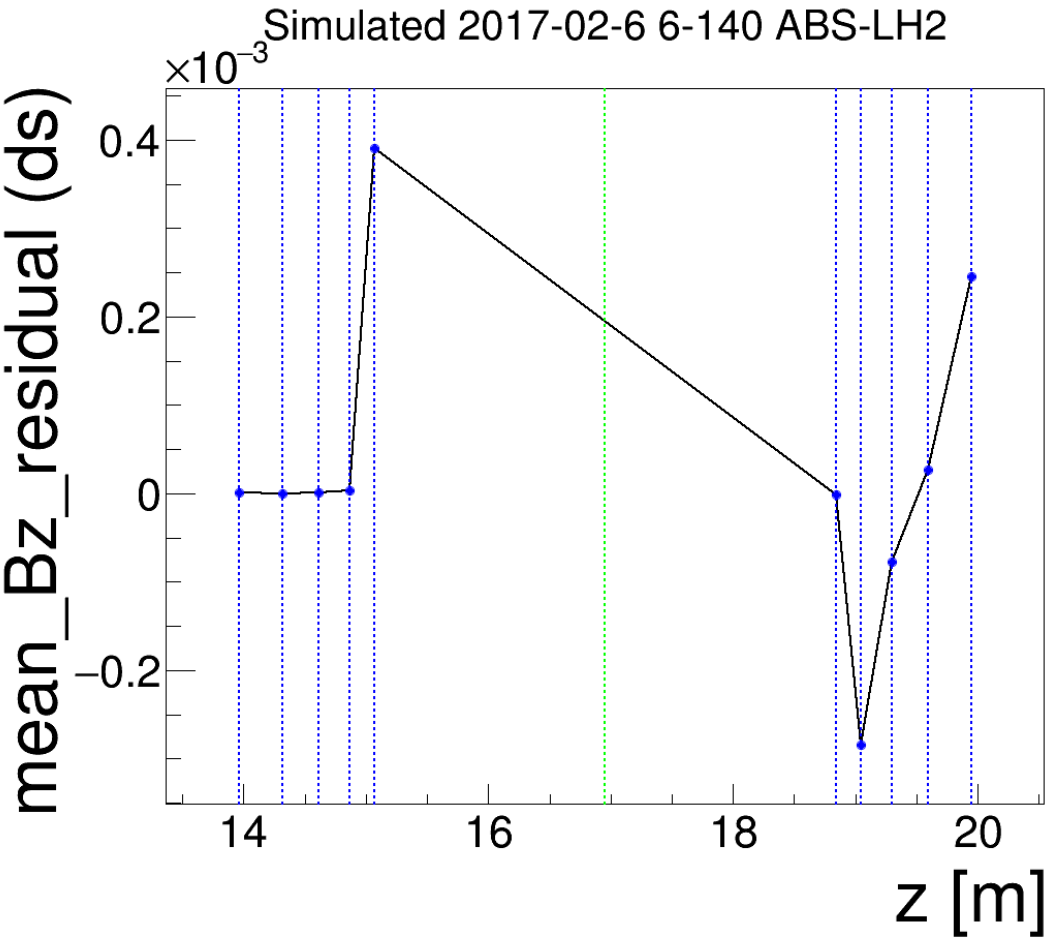
Mean Bz Residual



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MAUS Correction

Mean xPy Residual

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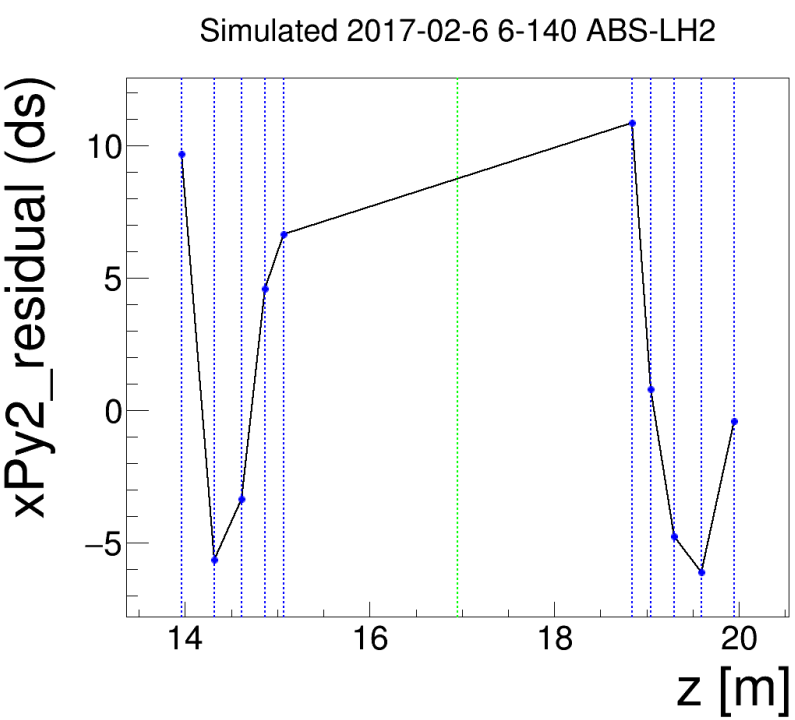
3.3.2



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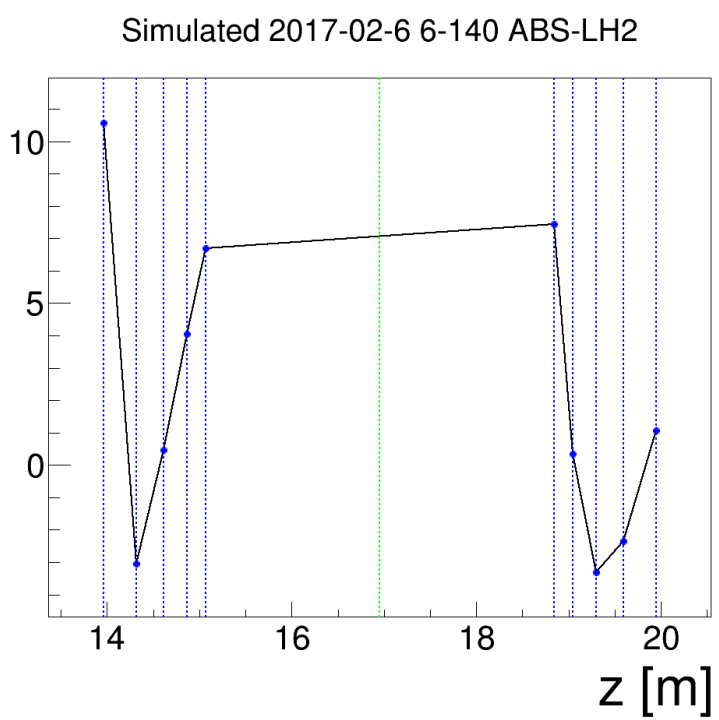

MAUS Correction

Mean yPx Residual

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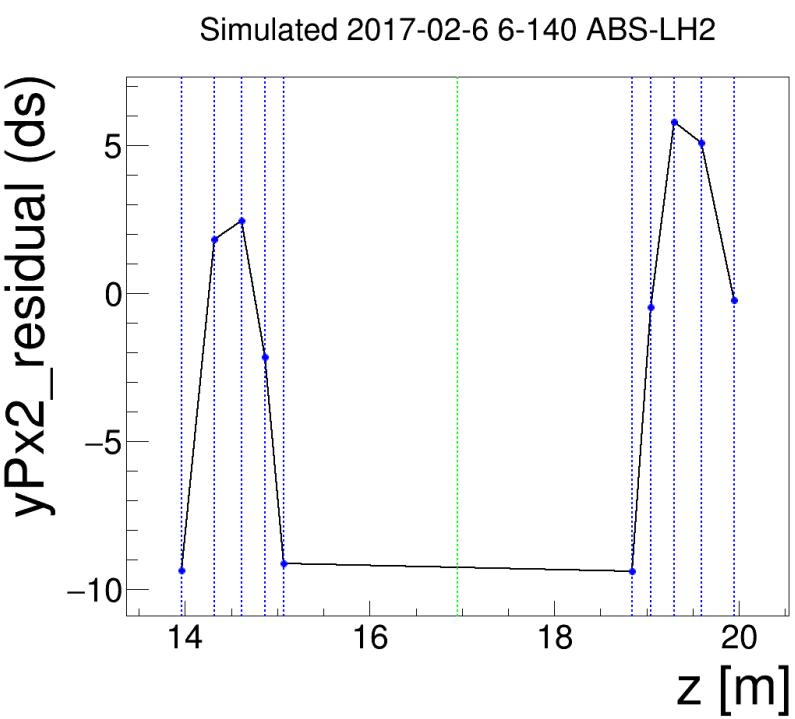
3.3.2



3.3.5