MCS in LH_2, Field-off

Content

- Systematic uncertainty evaluation using MC for US Tracker parameters (position, direction)

  - In parameter spaces with ranges proportional to MC/Data offsets
  - To assess if beamline magnet scaling is necessary
  - Or include in systematics

- TOF10 distribution and Momentum Pz

**Example, 170MeV/c Empty**

Source of uncertainty

Differences between distributions of parameters X,Y,dX/dz,dY/dz in MC Rec. and Data in selected beam are observed in most configurations. These should effect measured scattering due to differing beam positions in:

- Tracker volume (reconstruction efficiency, asymmetric beam loss)

- LH2 absorber (LH2 Path length)

... The size of the effect is assessed.

170MeV/c Empty, Tracker parameters US_X

170MeV/c Empty, Tracker parameters US_dXdz
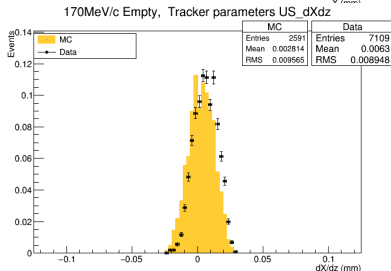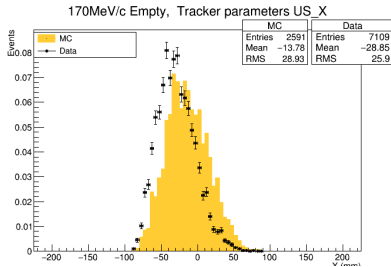
US tracker, ref. plane

Configuration	Mean			
	X	Y	dX	dY
170MeV/c Empty Data	-28.85 ± 0.3072	0.6512 ± 0.3511	0.0063 ± 0.0001061	0.0001015 ± 0.000108
170MeV/c Empty MC Rec.	-13.78 ± 0.5683	-3.372 ± 0.6364	0.002814 ± 0.0001879	0.0009539 ± 0.0001923
170MeV/c Empty MC Truth	-13.8 ± 0.5687	-3.376 ± 0.6367	0.003314 ± 0.0002532	-0.004793 ± 0.0002556
170MeV/c Full Data	-28.34 ± 0.2981	1.35 ± 0.3337	0.006381 ± 0.0001028	-0.0002352 ± 0.0001038
170MeV/c Full MC Rec.	-13.08 ± 0.5836	-3.194 ± 0.6457	0.002813 ± 0.0001898	0.001009 ± 0.0001954
170MeV/c Full MC Truth	-13.11 ± 0.584	-3.162 ± 0.645	0.003179 ± 0.0002567	-0.00508 ± 0.0002657
200MeV/c Empty Data	-2.458 ± 0.439	0.004072 ± 0.4167	-0.0002688 ± 0.0001256	-1.25e-05 ± 0.0001096
200MeV/c Empty MC Rec.	-0.9516 ± 0.7157	-5.432 ± 0.6811	-0.0003786 ± 0.0002104	0.002134 ± 0.0001762
200MeV/c Empty MC Truth	-0.9895 ± 0.7181	-5.393 ± 0.6812	0.0001874 ± 0.000247	-0.003805 ± 0.0002305
200MeV/c Full Data	-2.544 ± 0.4276	0.8684 ± 0.4028	-0.0002074 ± 0.0001215	-0.0002647 ± 0.0001065
200MeV/c Full MC Rec.	-2.022 ± 0.7117	-6.227 ± 0.6817	0.0003276 ± 0.0002029	0.002173 ± 0.0001837
200MeV/c Full MC Truth	-1.916 ± 0.7154	-6.269 ± 0.6846	0.000483 ± 0.0002461	-0.003859 ± 0.0002316
240MeV/c Empty Data	-13.85 ± 0.5078	2.136 ± 0.4506	0.004391 ± 0.0001541	4.442e-05 ± 0.0001269
240MeV/c Empty MC Rec.	-7.256 ± 0.5156	-8.406 ± 0.4653	0.00218 ± 0.000159	0.002039 ± 0.0001303
240MeV/c Empty MC Truth	-7.25 ± 0.5158	-8.429 ± 0.4649	0.002641 ± 0.0001889	-0.004002 ± 0.0001621
240MeV/c Full Data	-12.92 ± 0.4026	1.552 ± 0.3545	0.004525 ± 0.0001214	-0.0002201 ± 9.723e-05
240MeV/c Full MC Rec.	-6.678 ± 0.519	-9.19 ± 0.4665	0.001933 ± 0.0001595	0.001719 ± 0.0001304
240MeV/c Full MC Truth	-6.725 ± 0.5194	-9.212 ± 0.4659	0.002298 ± 0.0001884	-0.004266 ± 0.0001695

Estimation method

Transverse position parameters

- The residual between the mean of distributions of parameters X & Y in MC Rec. and Data selected beam are used to set the parameter space in which the incident beam is scanned across.
    - Initially this range is exaggerated (2×) to see the behaviour of the effects.

Directional parameters

... Similarly but

- Discrepancy in $UST_{\frac{dX}{dZ}}$ translates to a rotation of $\frac{dX}{dZ}$ rad for P(x,y,z) around Y axis
- Discrepancy in $UST_{\frac{dY}{dZ}}$ translates to a rotation of $\frac{dY}{dZ}$ rad for P(x,y,z) around X axis

- A new beam is written for each scan point across this range and is simulated through the corresponding geometry.
- MCS analysis of the simulations provides scattering distribution for each scan point.
- RMS, Kurtosis & Skewness of the above scattering distributions will show the significance of the systematic effect.
- ... and each distribution measured with UST tracker parameters within an appropriate parameter range will be used to calculate bin error.

TOF10 and Momentum

TOF10 Distribution and electron peak correction

- An offset was observed between data/MC in the TOF10 distribution
- An accepted routine is to shift both distributions so that $\langle \beta_e \rangle = 1$ or $TOF10_e = 25.492ns$
- This was done by locating the center of the maximum bin in each case,
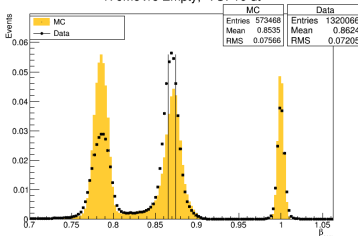- It has been improved by using the mean of a fitted Gaussian function
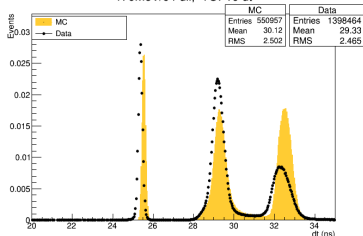

Data, run 10173 (170MeV/c)

Peak at = 25.3657 ns

MC (170MeV/c)

Peak at = 25.5382 ns
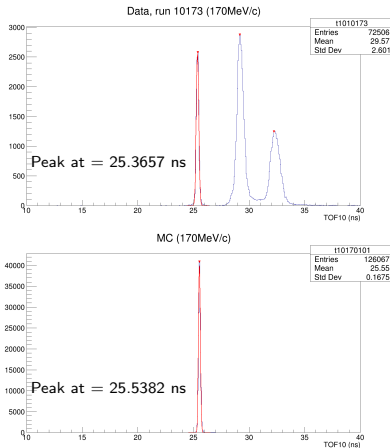
Resulting correction, 170MeV/c
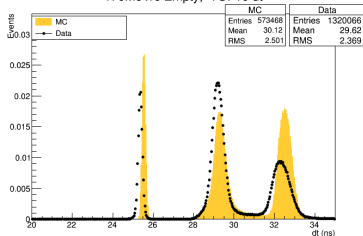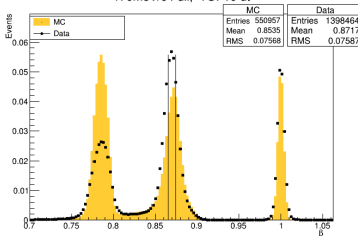
Resulting correction, 200MeV/c
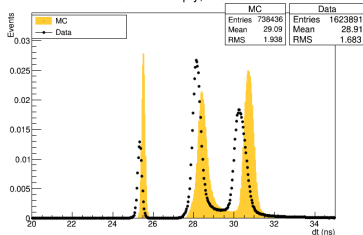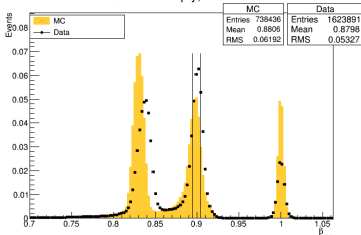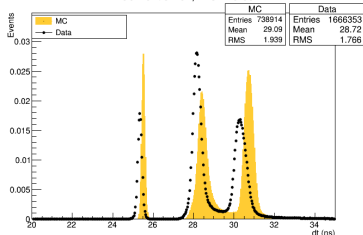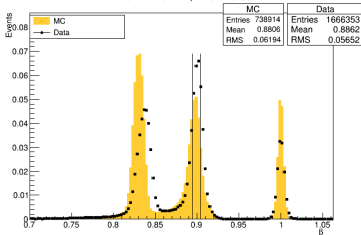
Resulting correction, 240MeV/c
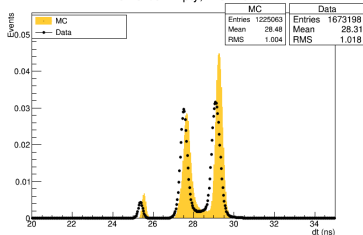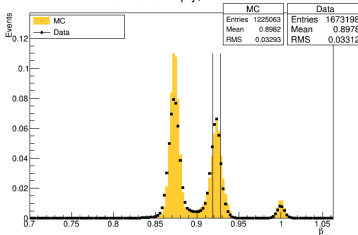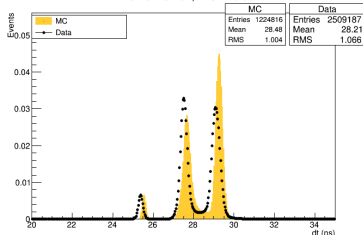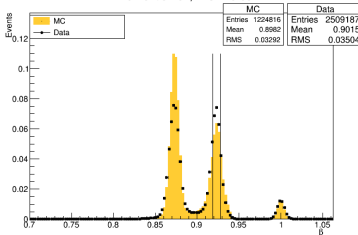
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Conclusions

- US Tracker parameters data/MC offset

  - Code in the bug stopped the simulations overnight so results will be presented next year.
  - Simulation processing code has been written that will be useful for calculation of uncertainty due to other sources

- Momentum Pz

  - New correction method aligns e-peaks perfectly in all data-sets but muon/pion peaks still appear offset
  - Similarly with the US Tracker parameters uncertainty calculation, the momentum (Pz) will be scanned across a parameter space proportional to the discrepancies seen between data/MC.
  - Uncertainty significance will decide if beam-line magnet scaling is necessary or effect is included in error calculation