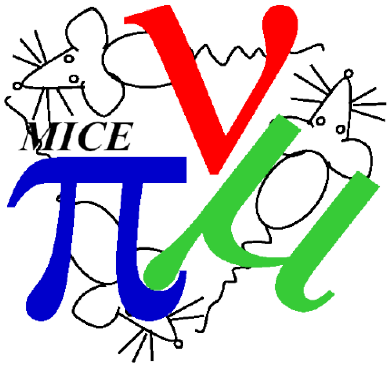
Emittance Evolution

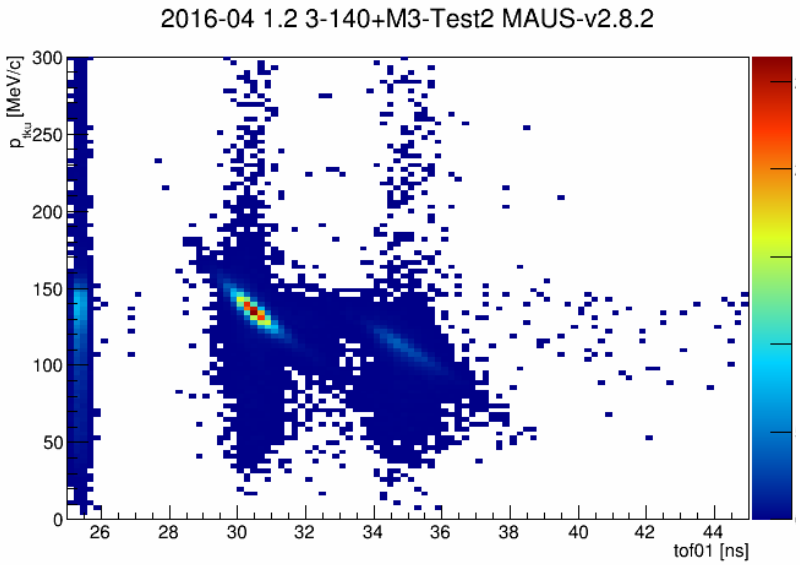


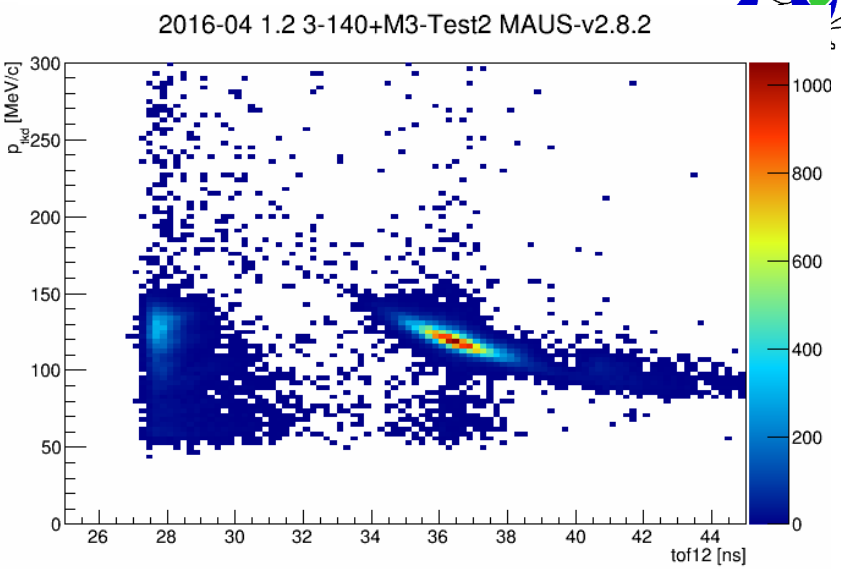
C. Rogers,
ISIS Intense Beams Group
Rutherford Appleton Laboratory

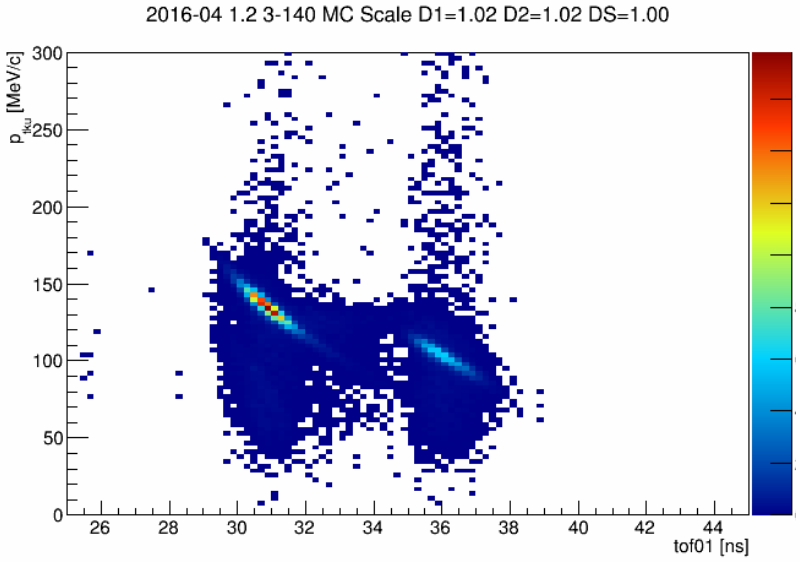
MC + More Plots

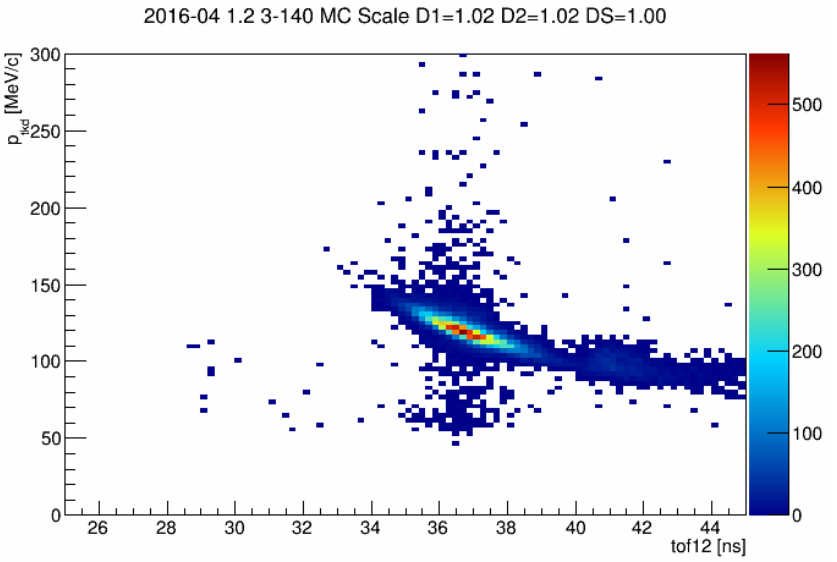
- I have spent some time trying to get the MC right
- I think the main discrepancy is in the pion yield
  - See talk two weeks ago
- It looks hard (i.e. change Dipole by > 10%) to reduce the pion yield significantly
- I don't understand why – this is just pion lifetime!
  - Could dig into Geant4
  - I believe pion → 4 MeV muon uniformly distributed in pion rest frame

TKU momentum vs TOF01

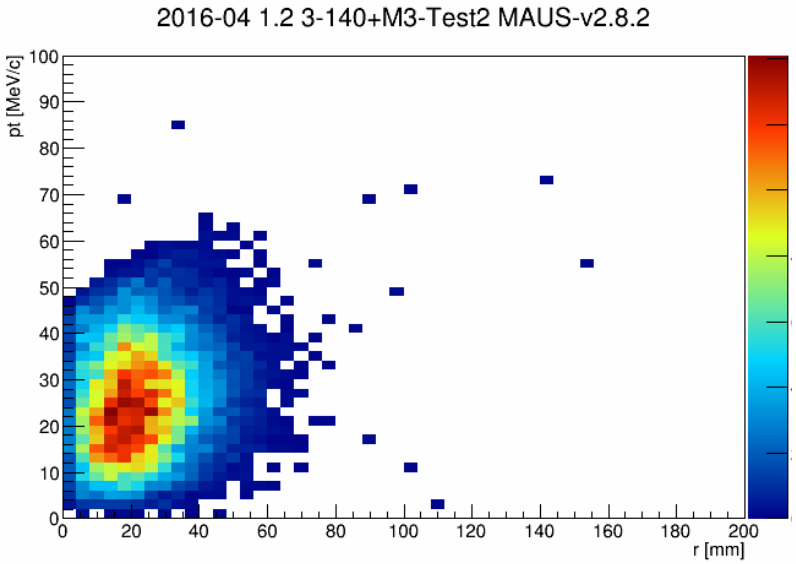


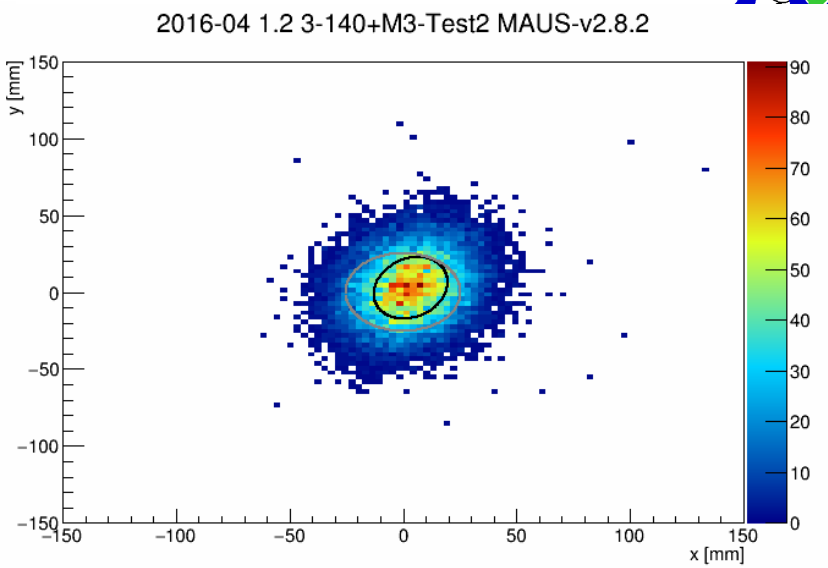


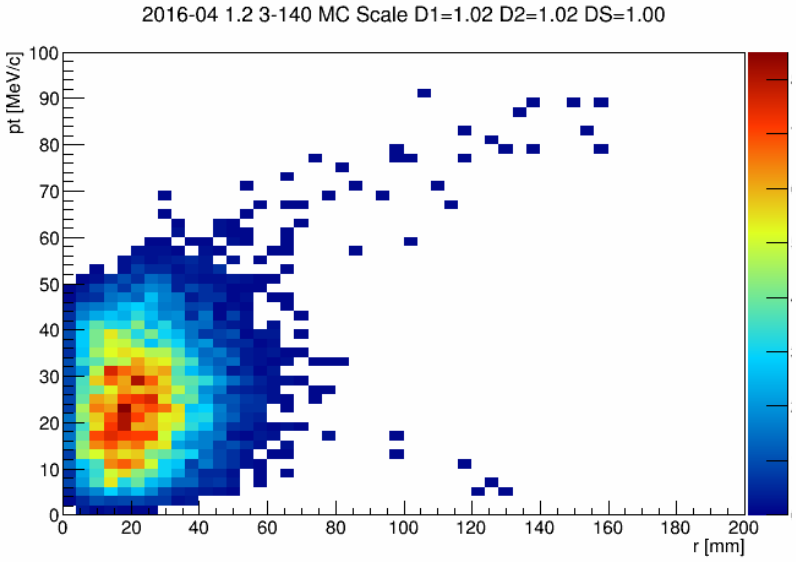


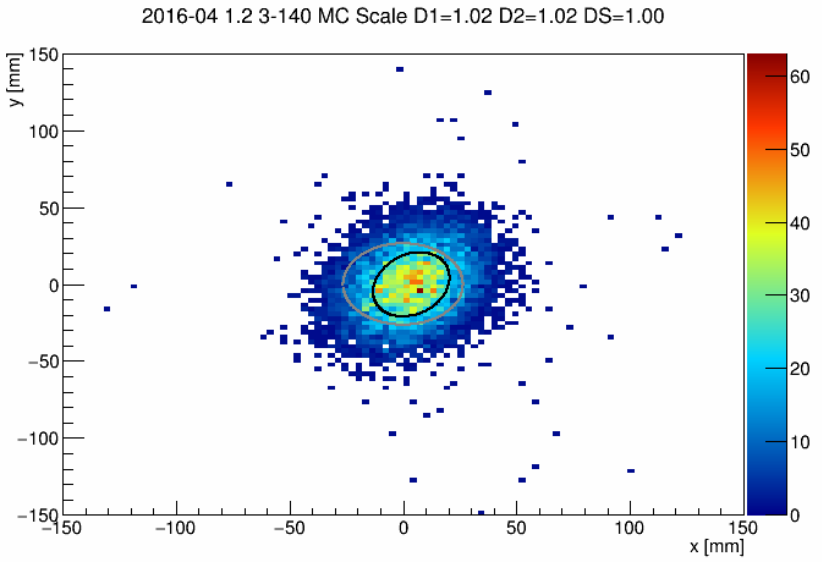


Distribution at TKU st 1 After cuts

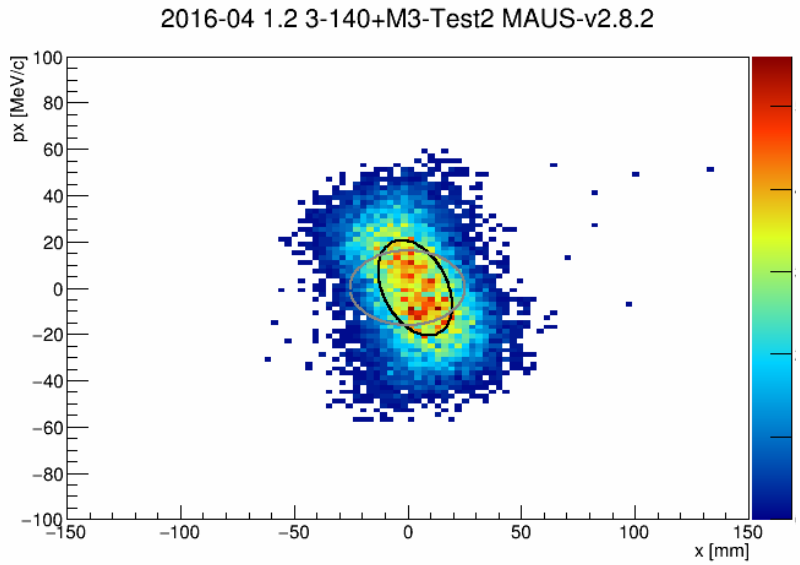


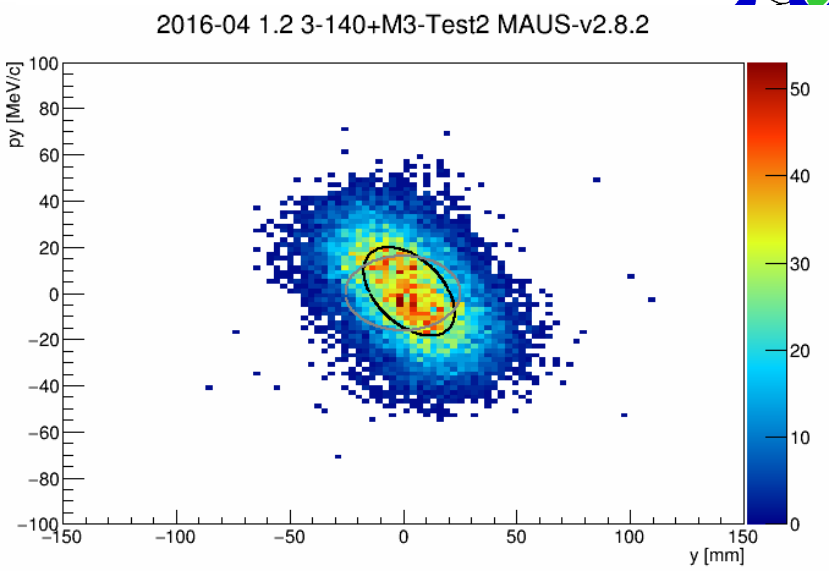


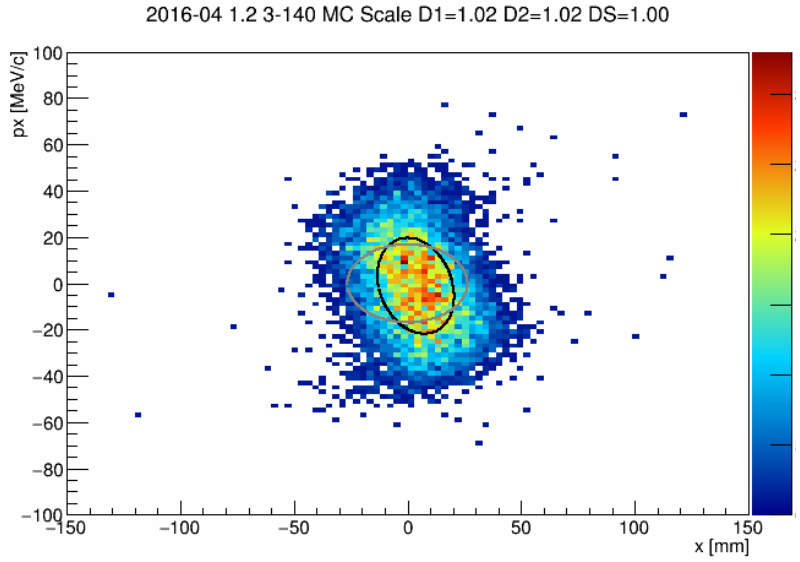


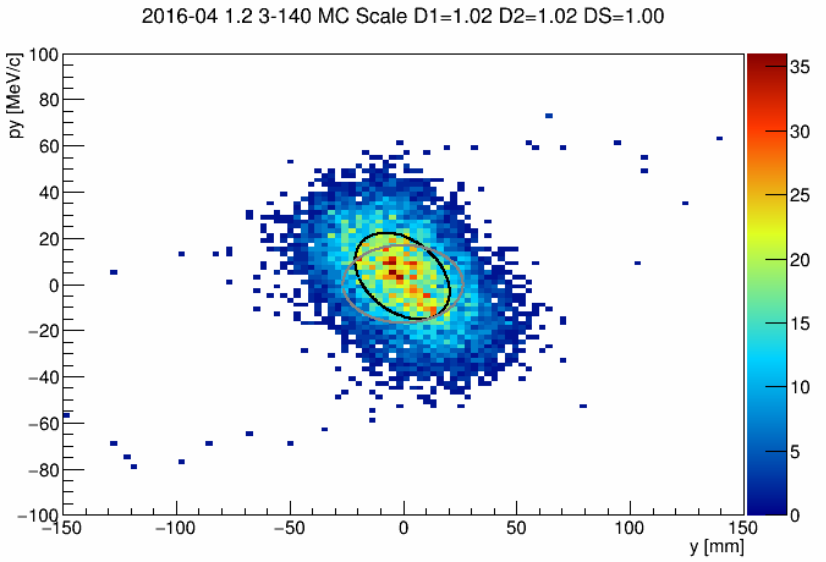


Distribution at TKU st 1 After cuts

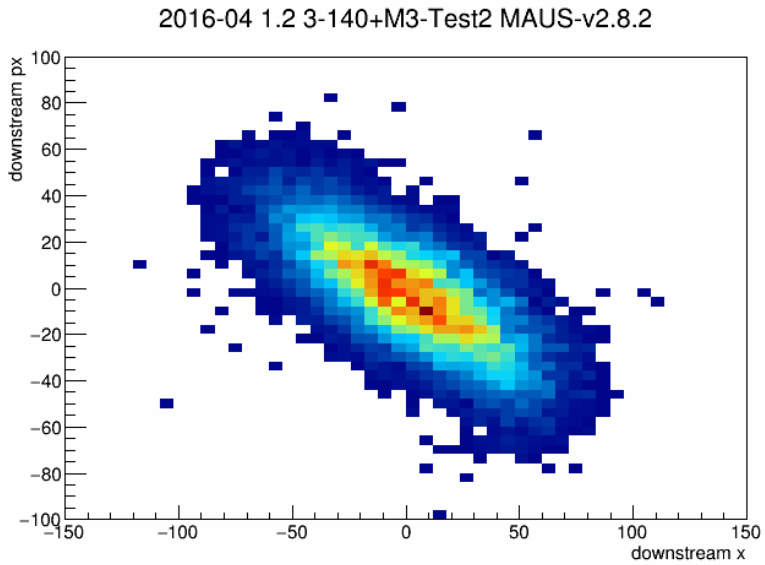


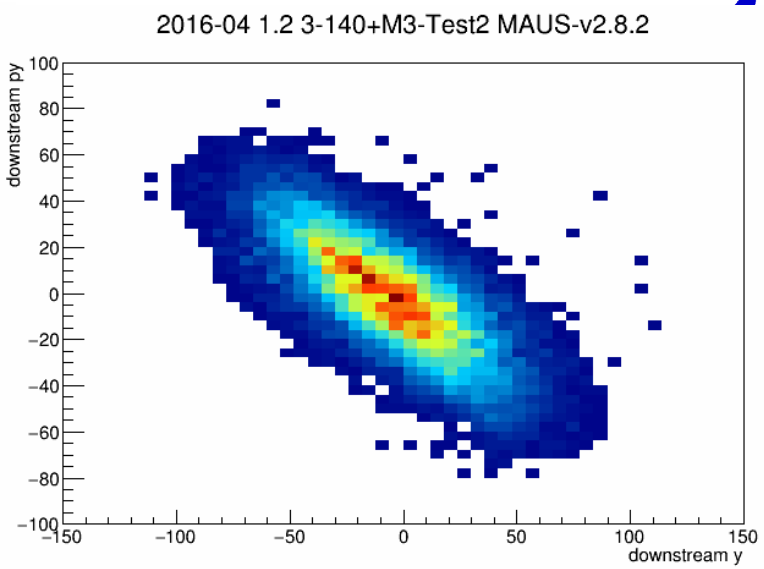


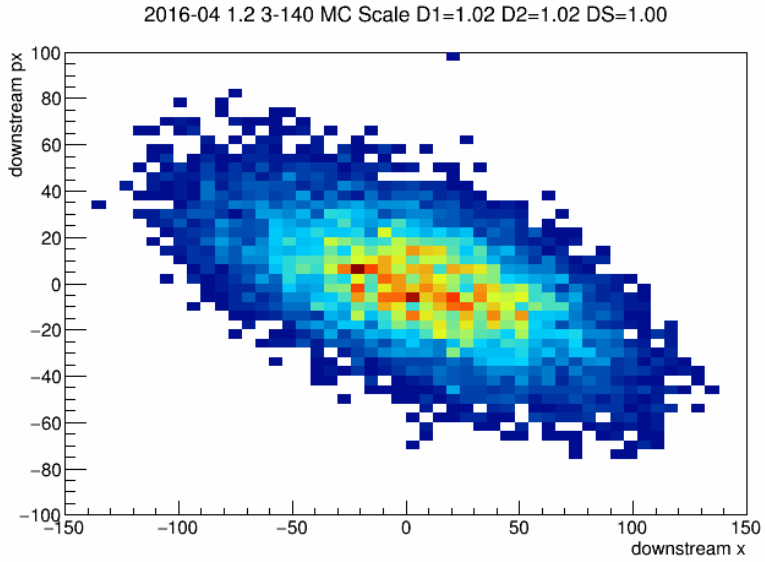


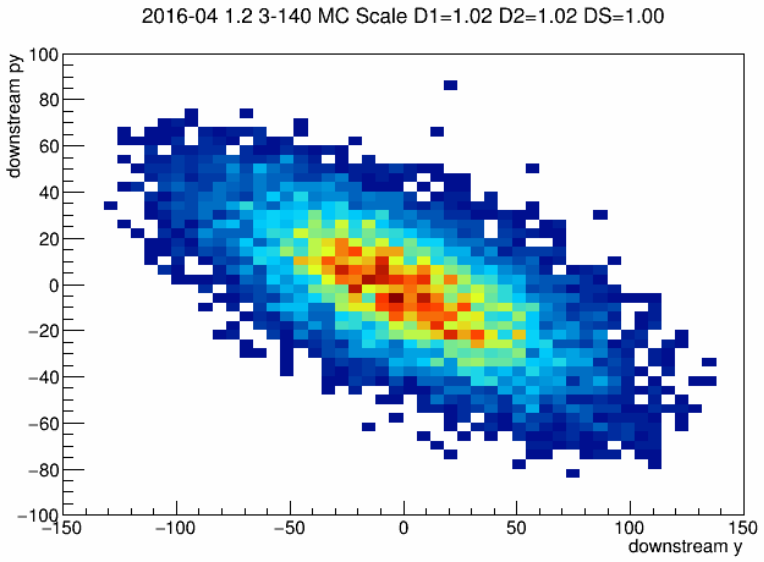


Distribution at TKD st 1 After cuts









Distribution at TKD st 1 After cuts

Reco

means x: 3.38 y: 2.74 px: -0.06 py: 0.65 p: 139.34 z: 15068.88 energy: 174.88

MC

means x: 3.67 y: -0.26 px: -1.09 py: 3.42 p: 139.41 z: 15068.87 energy: 174.94

Reco upstream:

beta	4d	161.14	alpha 4d	0.52	emittance:	4d	2.73
beta	x	118.54	alpha x	0.40	emittance	x:	2.95
beta	y	164.57	alpha y	0.53	emittance	y:	3.22

MC upstream:

beta	4d	159.48	alpha 4d	0.35	emittance:	4d	2.97
beta	x	116.30	alpha x	0.23	emittance	x:	3.22
beta	y	166.53	alpha y	0.39	emittance	y:	3.44

Distribution at TKD st 1 After cuts

MC upstream:

283.67	-77.13	78.27	-102.87
-77.13	428.60	195.56	-32.84
78.27	195.56	434.32	-140.72
-102.87	-32.84	-140.72	349.99

MC downstream:

1922.88	-585.36	208.82	-802.92
-585.36	532.99	660.21	3.00
208.82	660.21	1946.57	-750.89
-802.92	3.00	-750.89	778.73

Reco upstream:

264.80	-122.98	63.25	-113.17
-122.98	422.99	173.34	-31.54
63.25	173.34	401.44	-178.67
-113.17	-31.54	-178.67	367.29

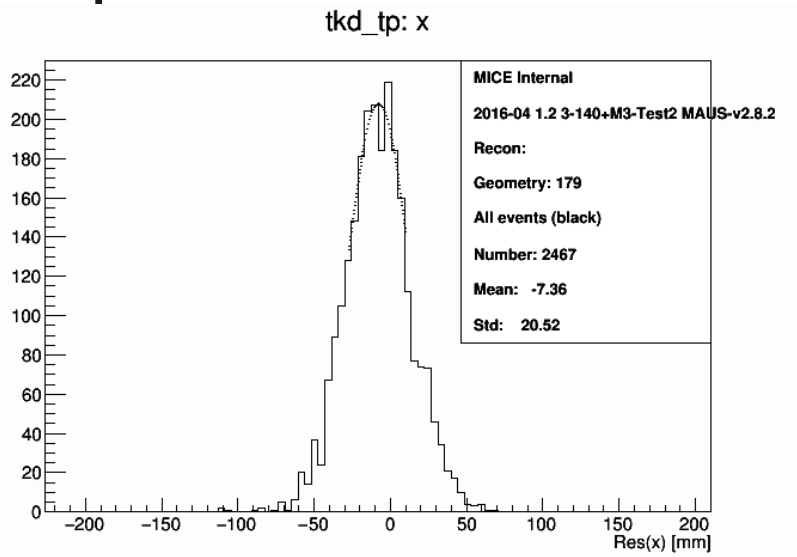
Reco downstream:

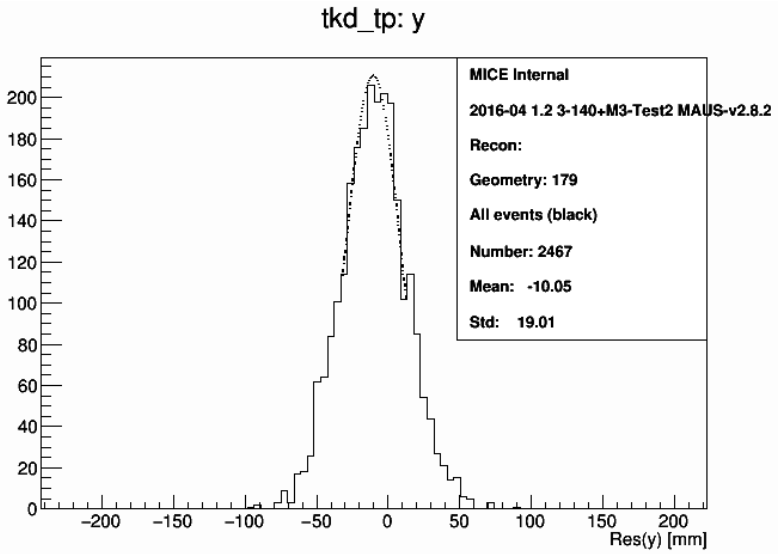
988.79	-513.64	106.82	-389.49
-513.64	506.57	253.93	33.27
106.82	253.93	967.40	-565.14
-389.49	33.27	-565.14	578.05

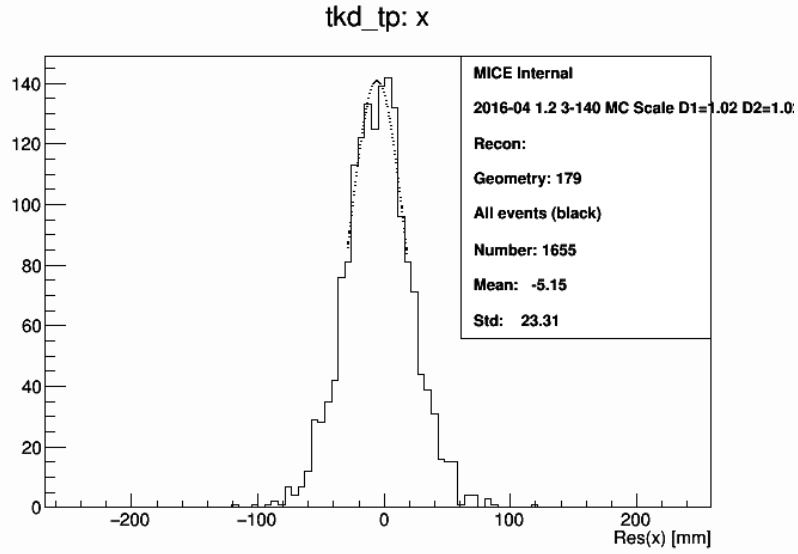
Track extrapolation

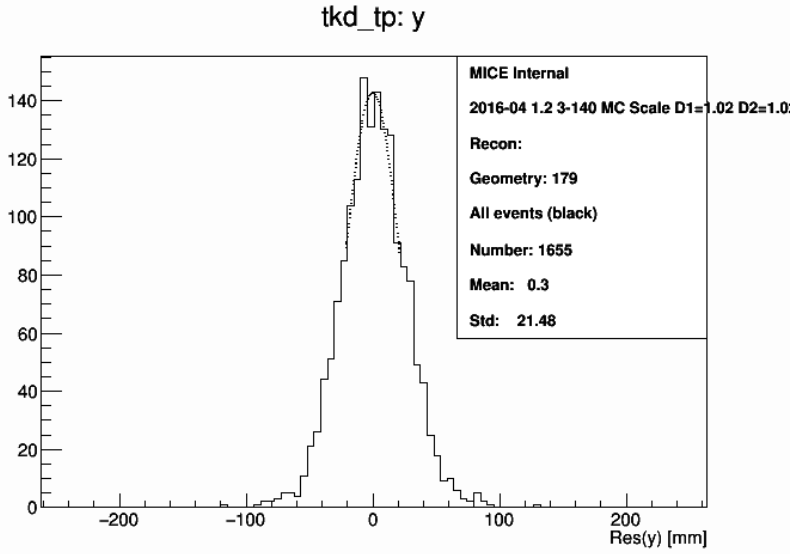
- Track extrapolation is main way to validate reconstruction overall
- Transverse position and momentum offsets can arise from misalignment or misreconstruction
- Longitudinal momentum/time offsets are more likely to arise from misreconstrution
  - Misalignment is second order effect

TKU vs TKD st1

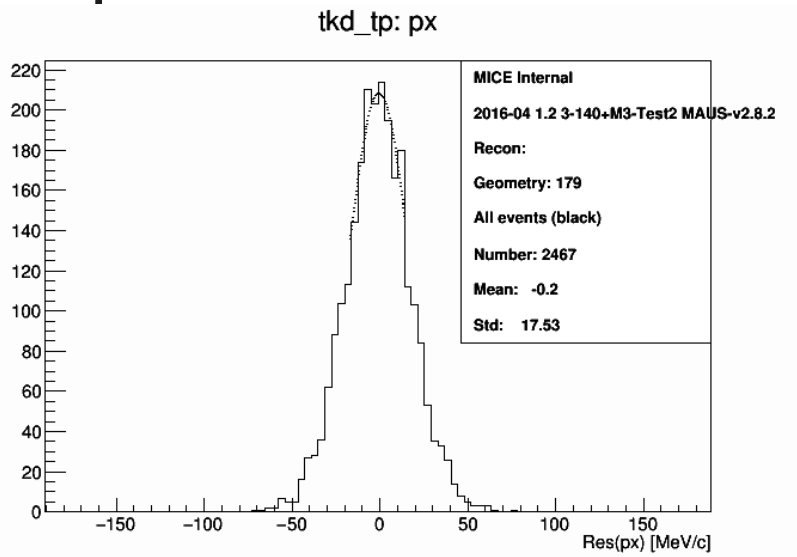


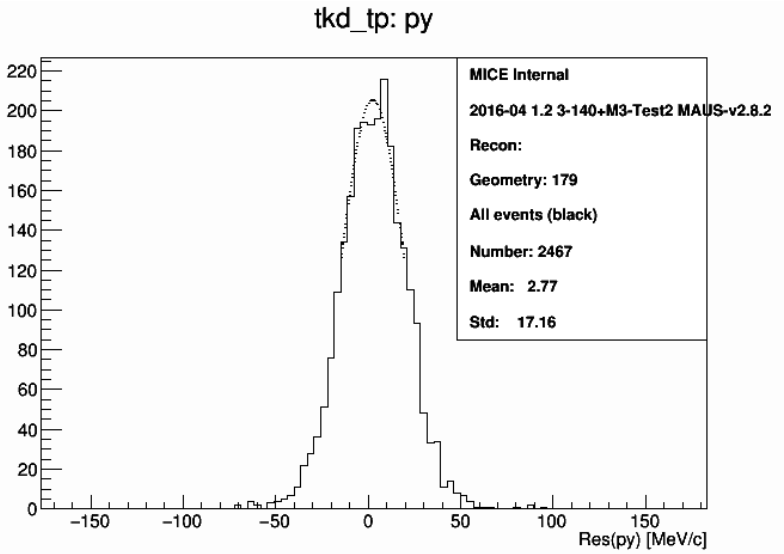


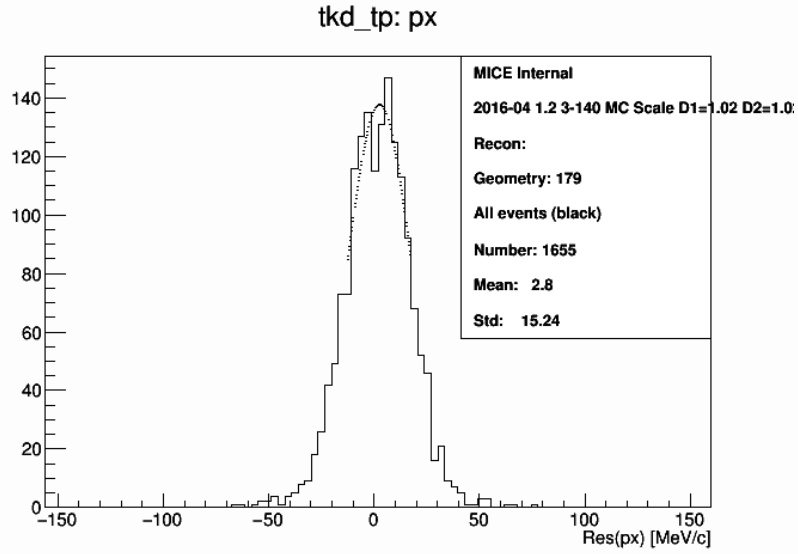


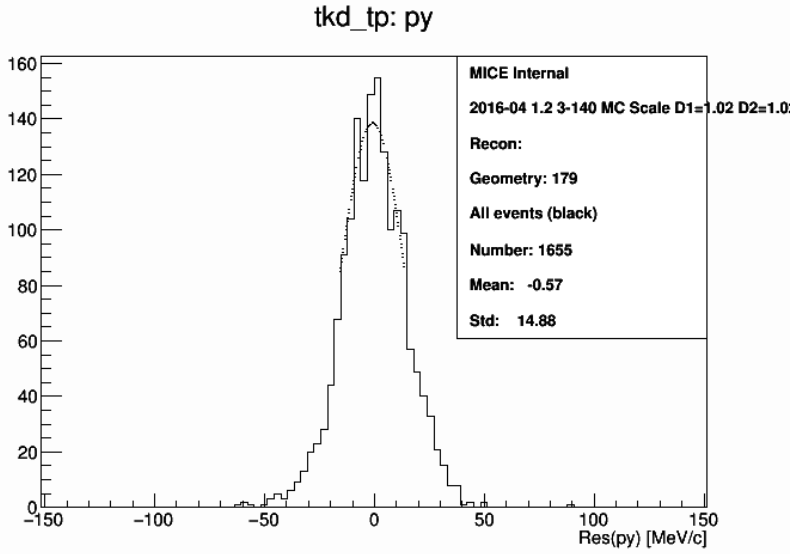


TKU vs TKD st1

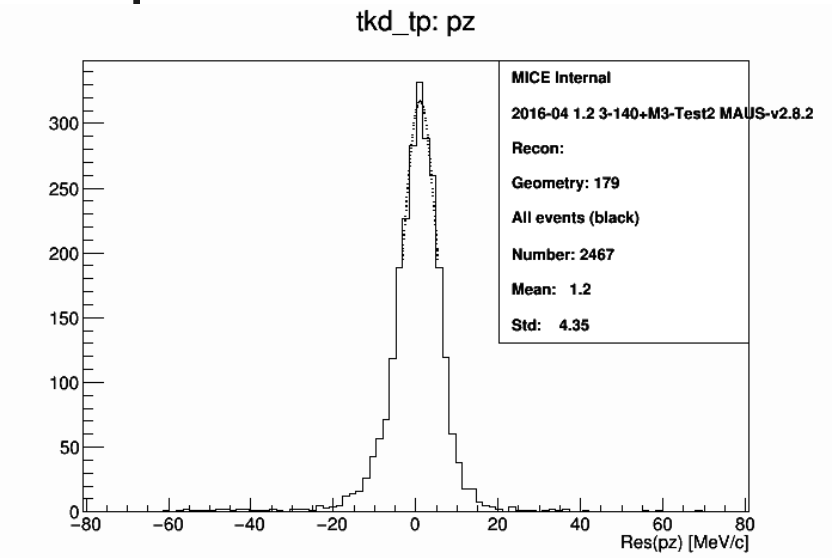


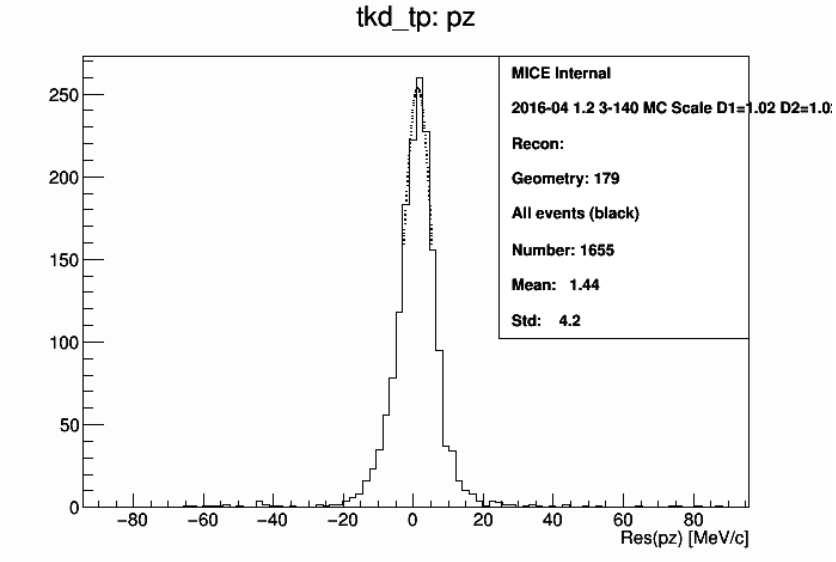






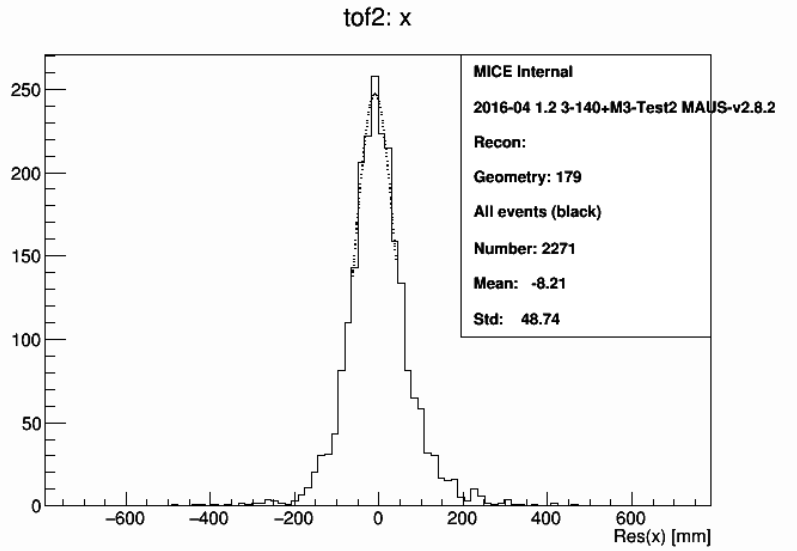
TKU vs TKD st1

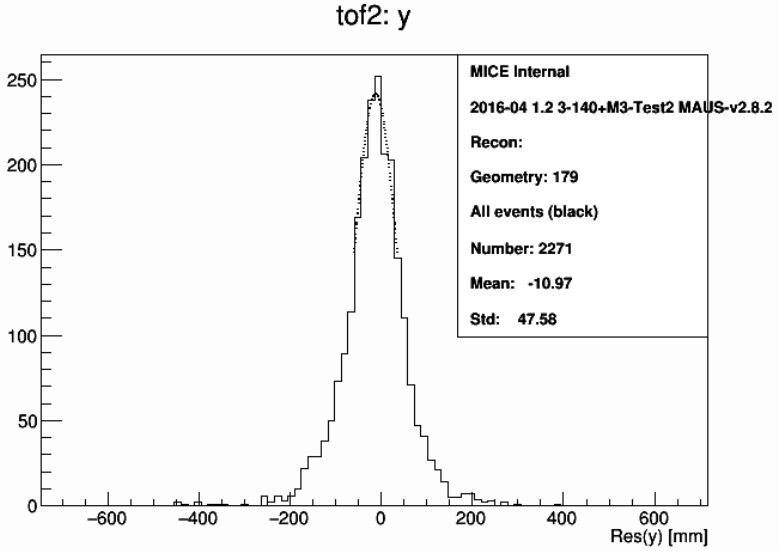


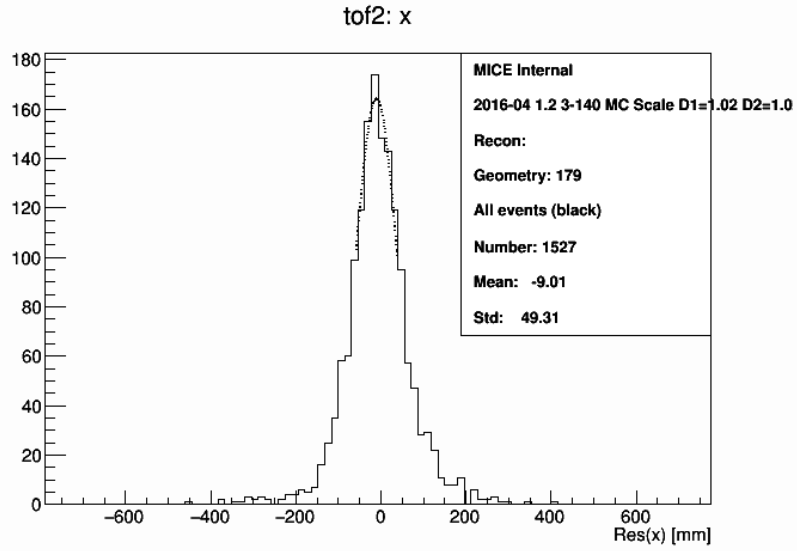


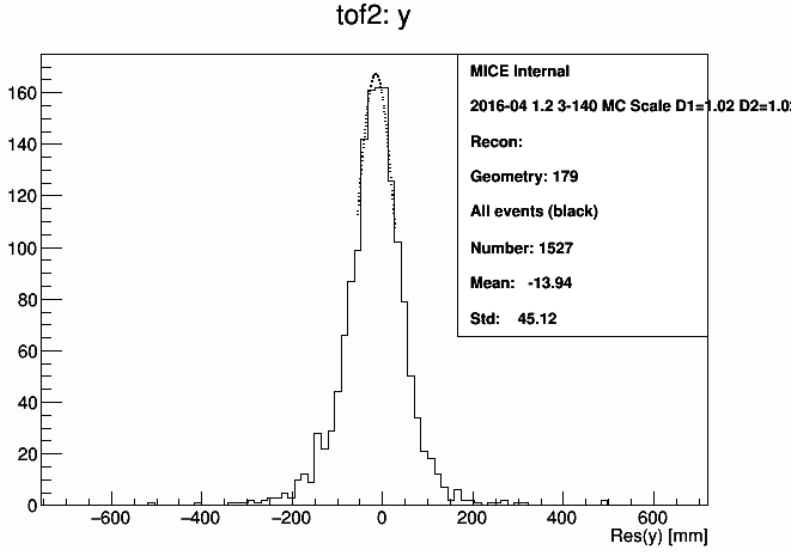
- Query – how can the TKU track extrapolation agree so well when the beam evolution disagrees?

TKU vs TOF2

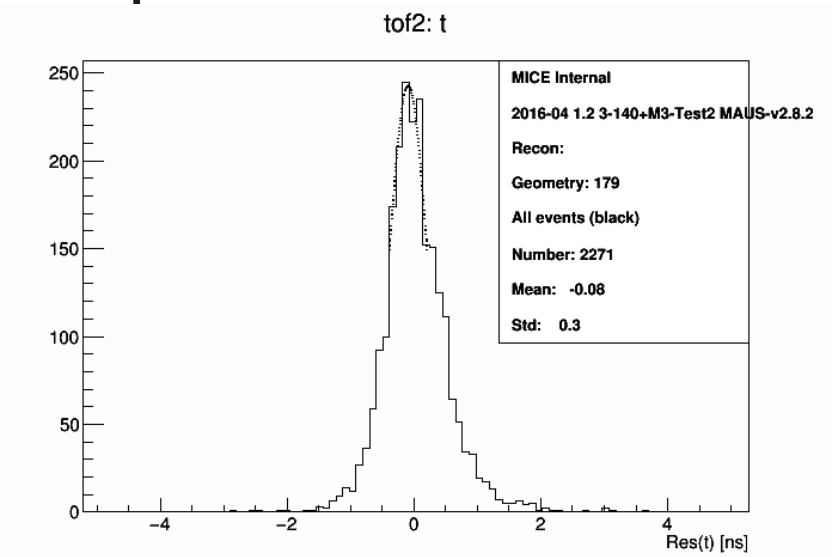

tof2: x
MICE Internal
2016-04 1.2 3-140+M3-Test2 MAUS-v2.8.2
Recon:
Geometry: 179
All events (black)
Number: 2271
Mean: -8.21
Std: 48.74
Res(x) [mm]

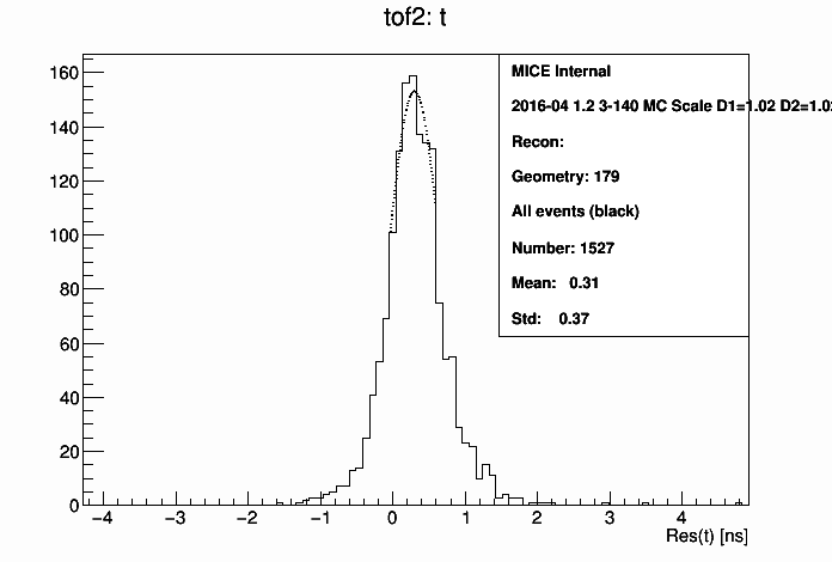

tof2: y
MICE Internal
2016-04 1.2 3-140+M3-Test2 MAUS-v2.8.2
Recon:
Geometry: 179
All events (black)
Number: 2271
Mean: -10.97
Std: 47.58
Res(y) [mm]


tof2: x
MICE Internal
2016-04 1.2 3-140 MC Scale D1=1.02 D2=1.0
Recon:
Geometry: 179
All events (black)
Number: 1527
Mean: -9.01
Std: 49.31
Res(x) [mm]

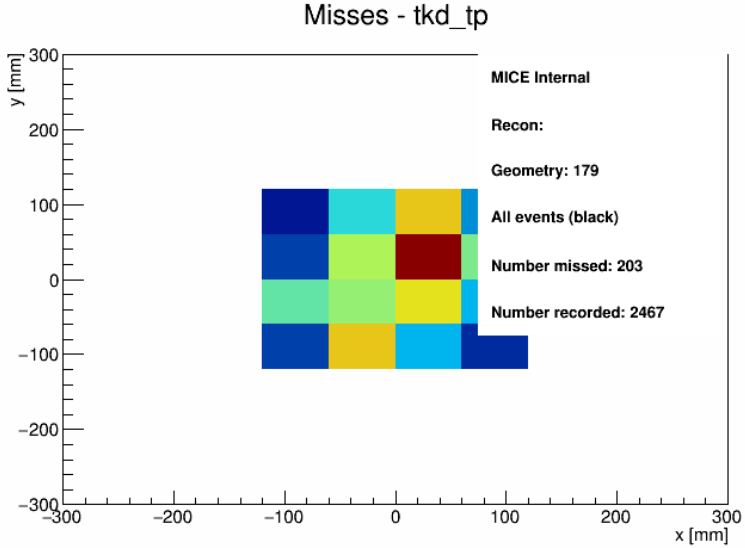

tof2: y
MICE Internal
2016-04 1.2 3-140 MC Scale D1=1.02 D2=1.0
Recon:
Geometry: 179
All events (black)
Number: 1527
Mean: -13.94
Std: 45.12
Res(y) [mm]

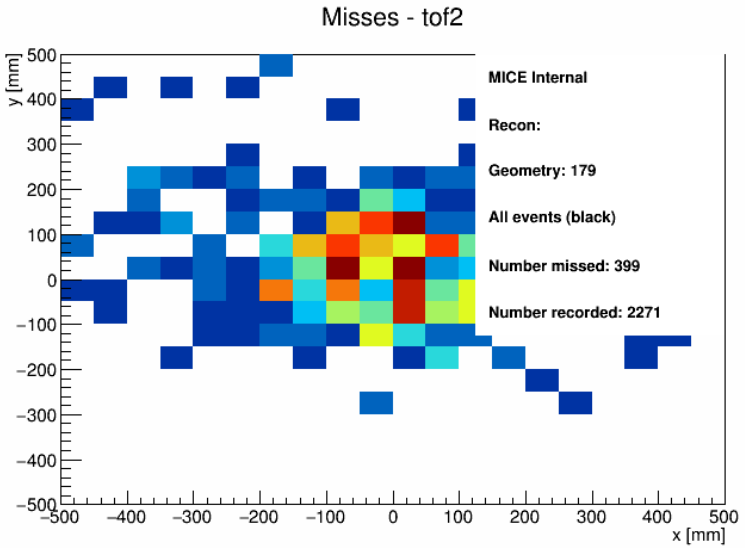
TKU vs TOF12

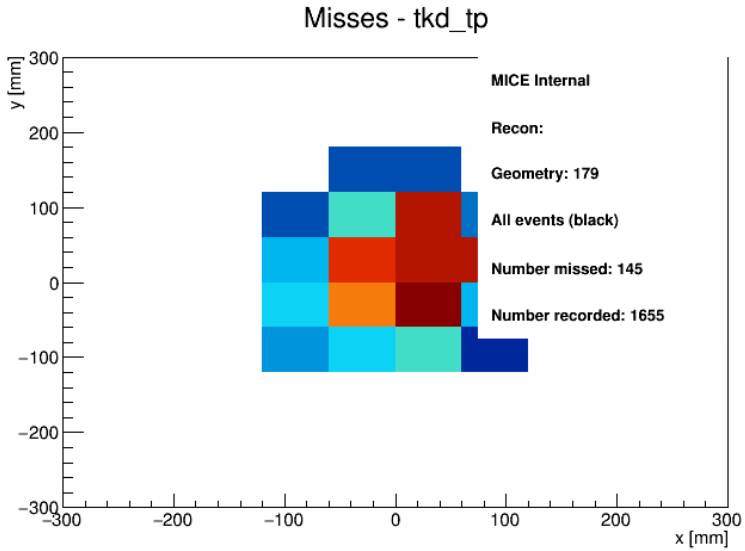

tof2: t
MICE Internal
2016-04 1.2 3-140+M3-Test2 MAUS-v2.8.2
Recon:
Geometry: 179
All events (black)
Number: 2271
Mean: -0.08
Std: 0.3
Res(t) [ns]

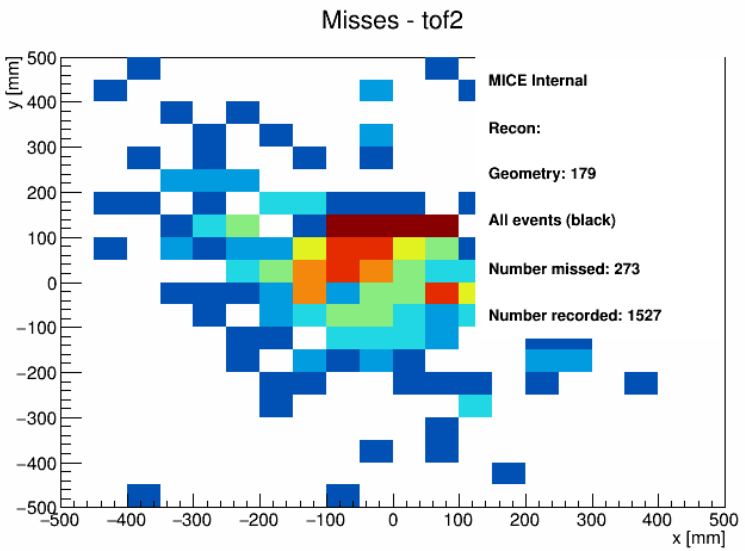

tof2: t
MICE Internal
2016-04 1.2 3-140 MC Scale D1=1.02 D2=1.0
Recon:
Geometry: 179
All events (black)
Number: 1527
Mean: 0.31
Std: 0.37
Res(t) [ns]

Misses/Inefficiency

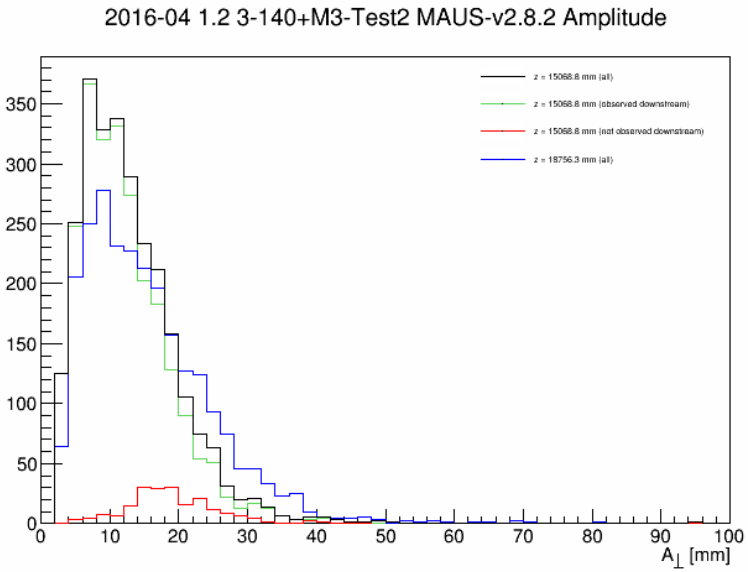


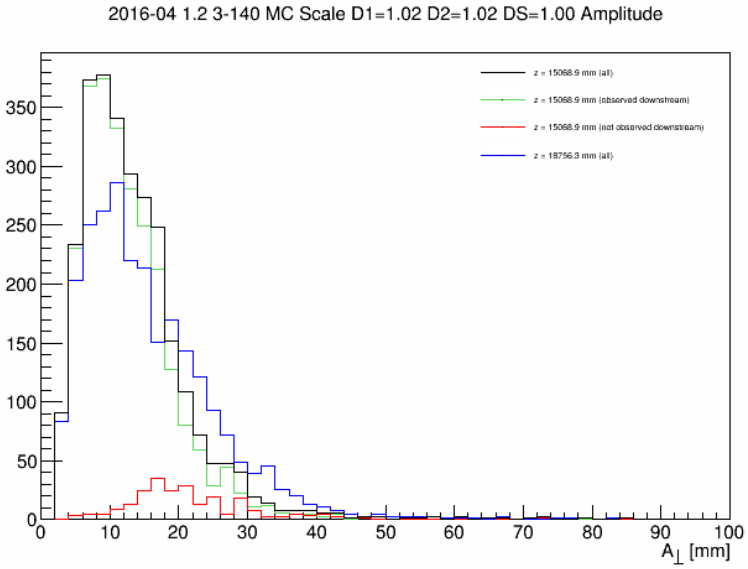






Measured Amplitude Change





Measurement Uncertainty

- Bias on the measured x/px/y/py phase space and transmission
  - Intrinsic detector resolution (scattering and spatial resolution)
    - Resolution estimated TKU
    - Need to add TOFs and TKD
    - Need to tie into amplitude calculation U/S and D/S
  - Detector efficiency
    - Use MC
  - Magnetic field in reconstruction region
    - Assign 1 % uncertainty in magnetic field => 1 % uncertainty in momentum
    - Need to re-reconstruct an existing MC varying this parameter?
    - What about alignment of tracker to Bz?
      - Propose trying position uncertainty of 10 mm (from JHC analysis)
      - Propose trying rotation uncertainty of 1 mrad? 10 mrad?
      - Nb: we MC in one field; and recon in another
  - Statistical uncertainty
    - Poisson statistics? Straight forward to implement

Measurement Uncertainty

- Bias on the model of the channel
  - Alignments
  - Absorber material
  - Other material budget
  - *Biases the simulation*
- For IPAC; prefer not to present the simulated performance
  - Is this acceptable?

Job List – for IPAC

- Resolutions for TKD (and TOF)
- Inefficiency for TKD (and TOF2)
- Reconstruction uncertainty for TKD
- Discrepancy between MC and Data in TKD
- PID cut
- Get track extrapolation from production reco
- Tidy up amplitude routines
- Add downstream sampling
- Fix TOF efficiency
- MC Uncertainty...