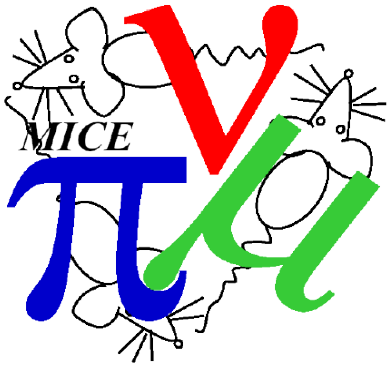
MICE Analysis Status and Plans



C. Rogers,
ASTeC Intense Beams Group
Rutherford Appleton Laboratory

ASTeC

Status

- Analysis of data since CM43
  - Diagnostics
  - Magnets and physics
- Plans
  - Step IV lattice
  - Demonstration of Ionisation Cooling issues

Outline Data Plan

- Commission hardware
- Beam-based alignment of detectors with field off
- Beam-based alignment of magnets with field on
- Understand diagnostics
- Check beam quality through the lattice
- Optics and momentum scans with/without absorber

- First pass analysis should follow data ASAP
- At least two analyses for every (major) measurement

Data taking update

September 21st – 22nd	SSU at 1.5 T
September 25th – 29th	Ckov momentum scan
	Magnetic field remnant study
	Beam polarisation measurement
October 7th	4 T in SSU
October 14th	TOF0 alignment
December 3rd - 7th	FC alignment study
December 13th - 16th	Scattering in Xenon and empty
February 23rd – March 24th	Alignment studies
	Empty absorber data
	Scattering in LiH
	Pionic beamline studies

CM 43 →

Summary of Data Analysis

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Magnet Mapping - Coil Geometries	V. Blackmore	Complete	Complete	N/A	Complete	Complete	Complete	In progress	Not started
Tracker Alignment – least squares	J. Nugent	Complete	Complete	In progress	Complete	Complete	Complete	In progress	Scattering Paper
Tracker Alignment – residuals	F. Drielsma	Complete	Complete	In progress	Complete	Complete	Complete	In progress	MICE Note
PID Detector Alignment	F. Drielsma	Complete	Complete	In progress	Complete	In progress	In progress	In progress	MICE Note
Beamline Commissioning – u/s	V. Blackmore	Complete	Complete	N/A	Complete	Complete	Complete	Complete	MICE Note 476
Beamline Commissioning – d/s	P. Franchini	Complete	Complete	In progress	Complete	In progress	In progress	In progress	Not started
Upstream detector resolution	V. Blackmore	Complete	Complete	Complete	Complete	Complete	Complete	In progress	Emittance Paper
Downstream/global detector resolution	M. Uchida	Complete	Complete	In progress	Complete	In progress	In progress	Not started	Not started
Detector efficiencies	M. Uchida/F. Drielsma	Complete	In progress	In progress	In progress	In progress	In progress	Not started	Not started
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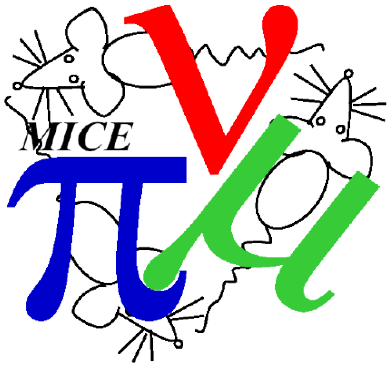
Diagnostics (from physics p.o.v.)



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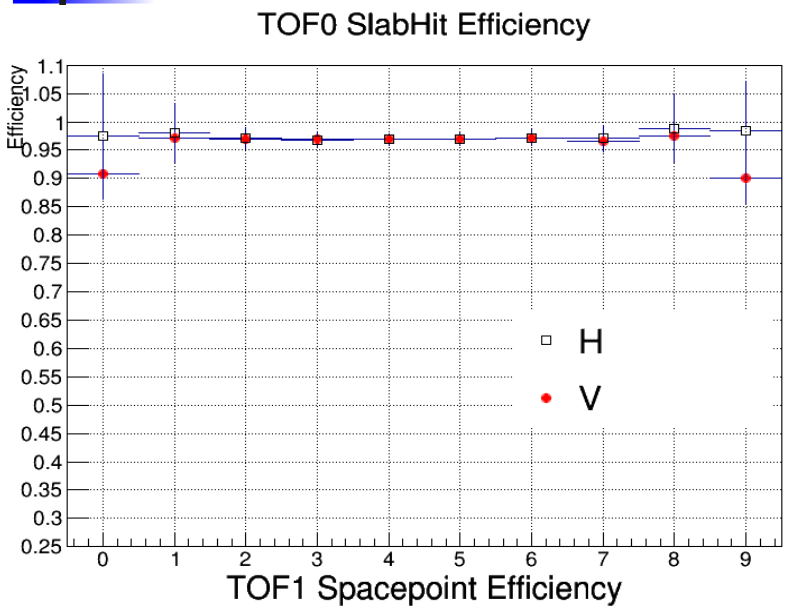
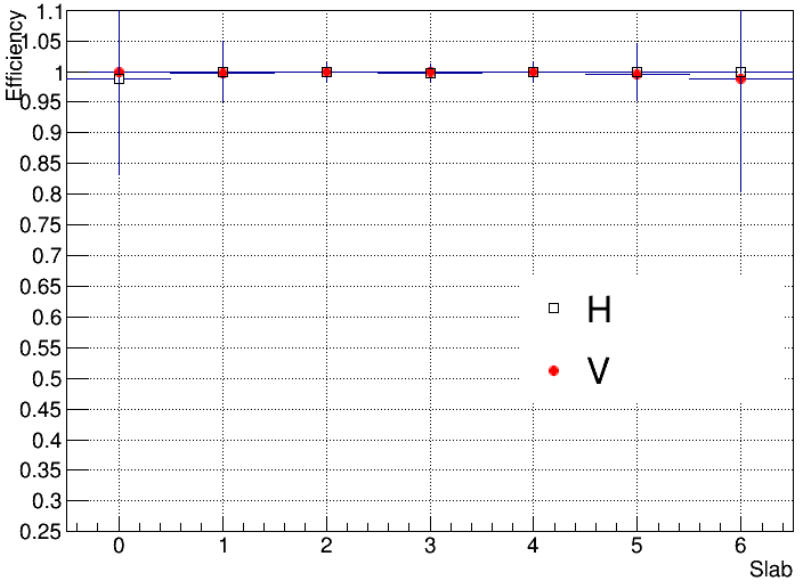
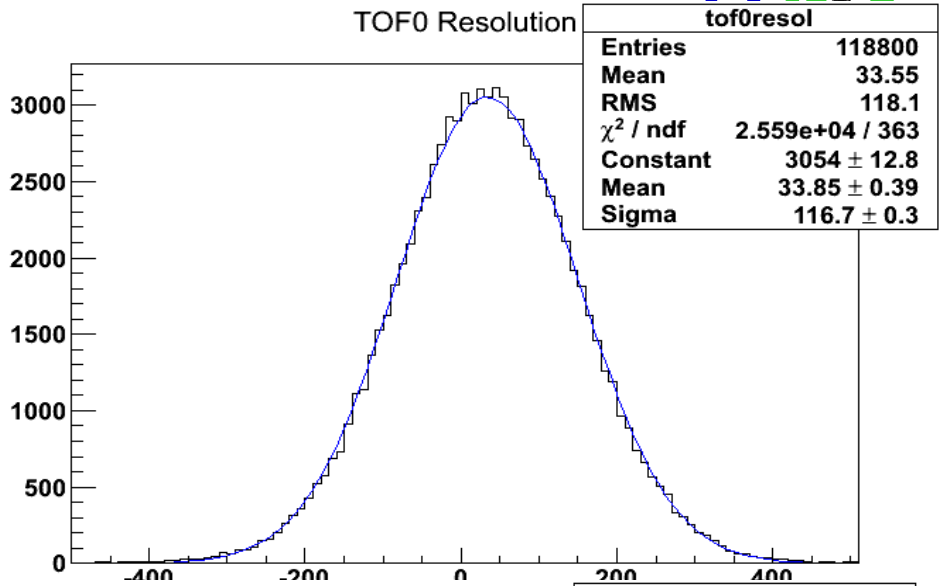
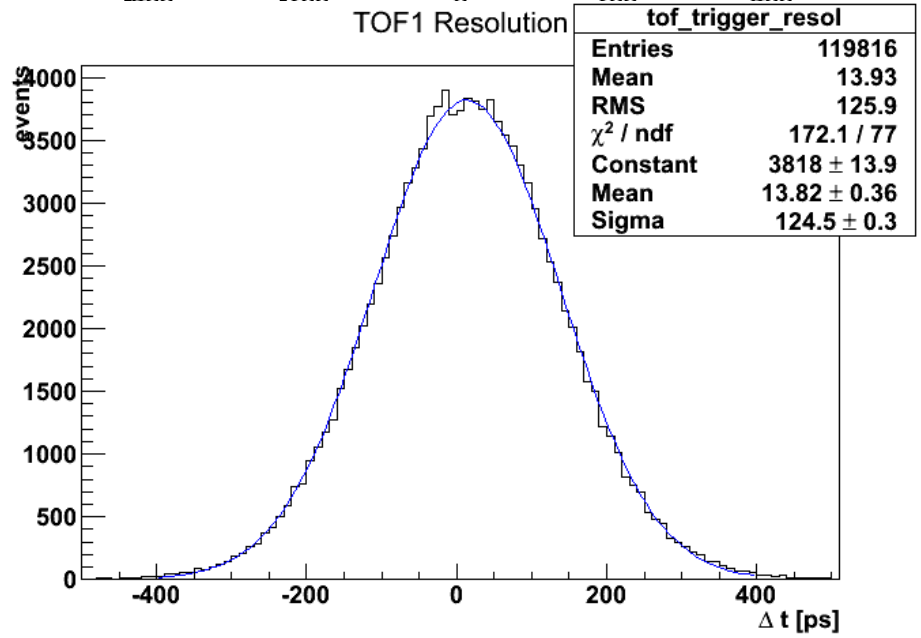
TOF Performance









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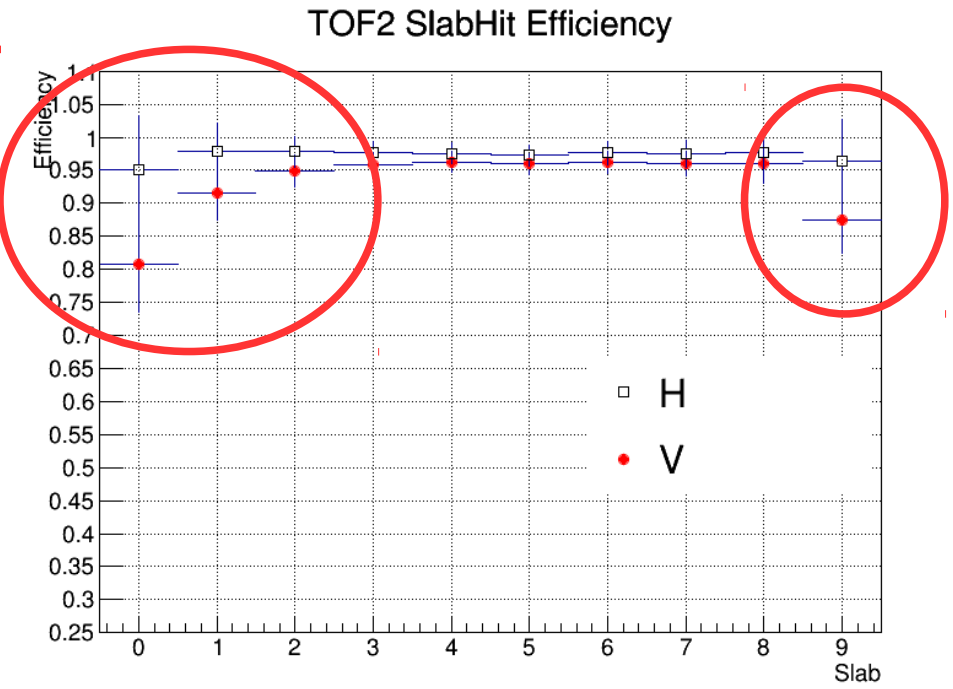
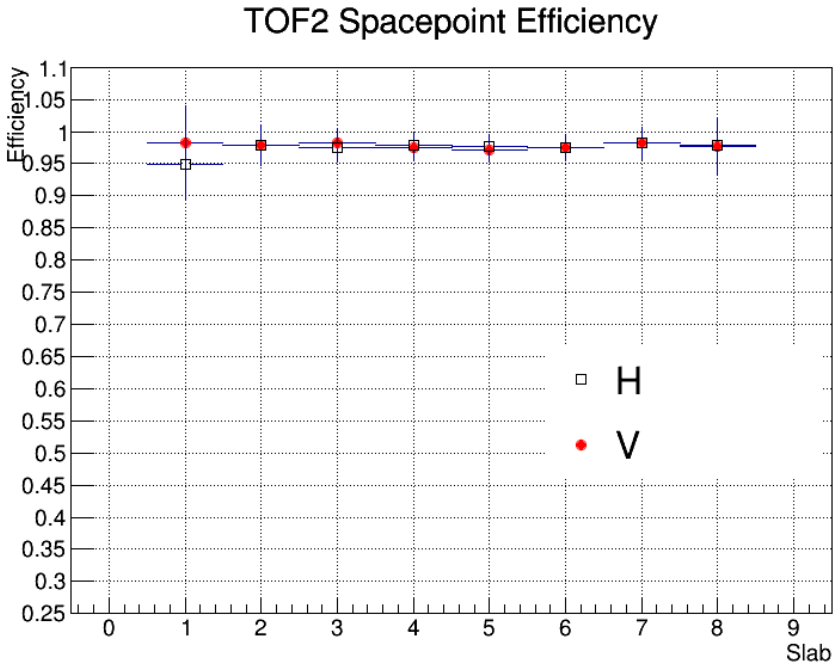
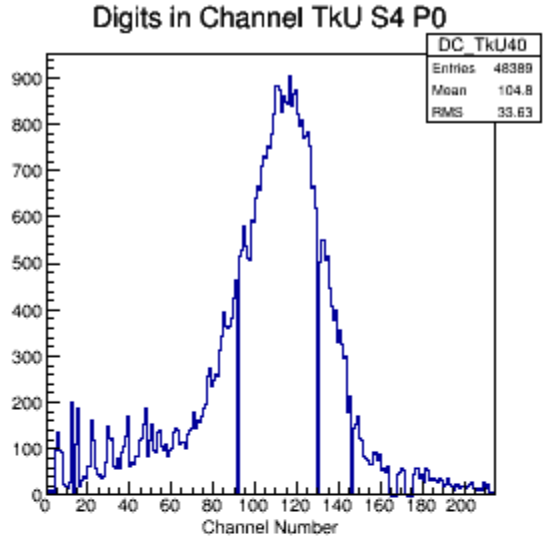
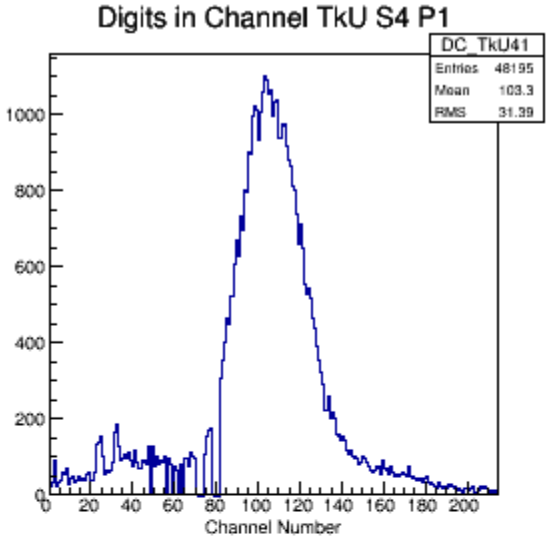
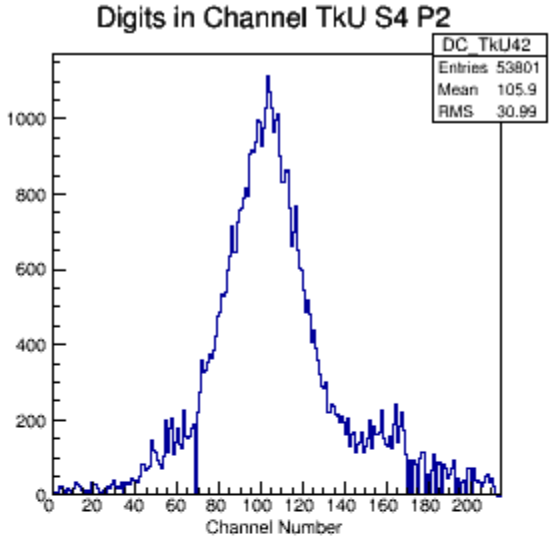


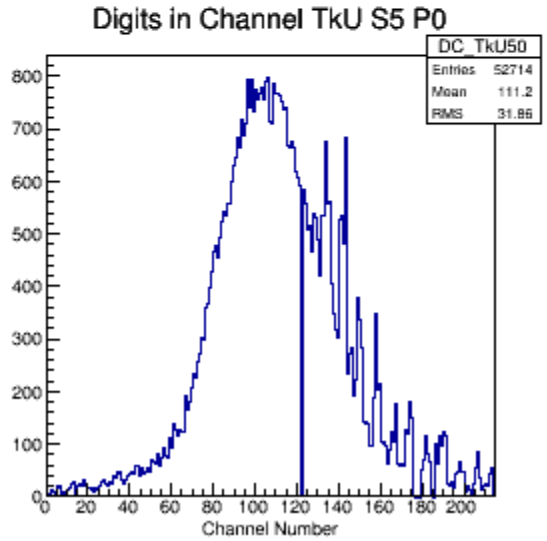


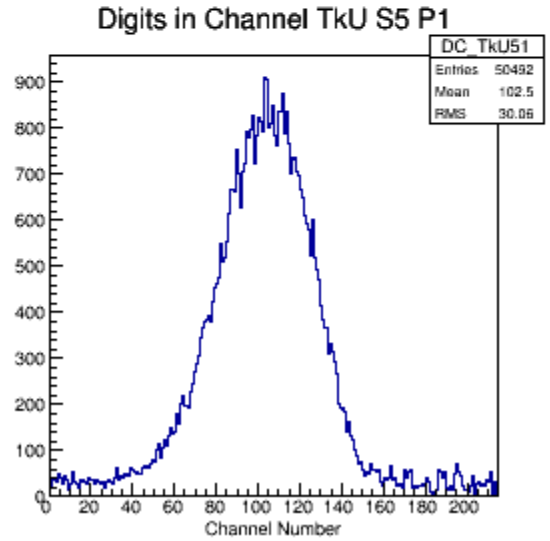
Tracker Performance

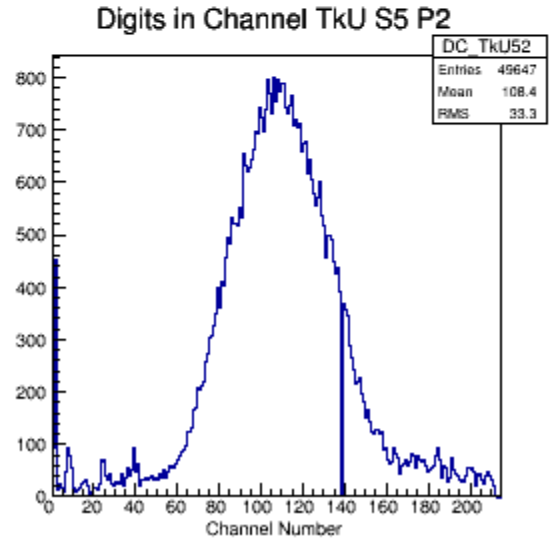












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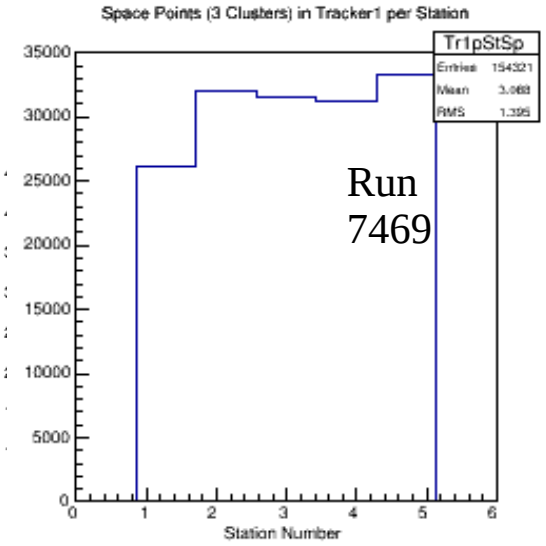
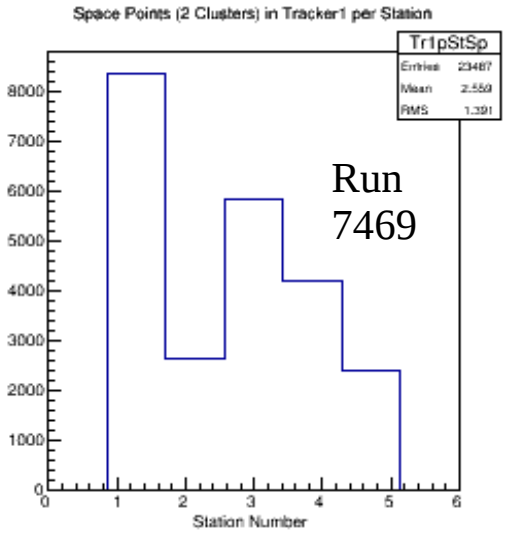
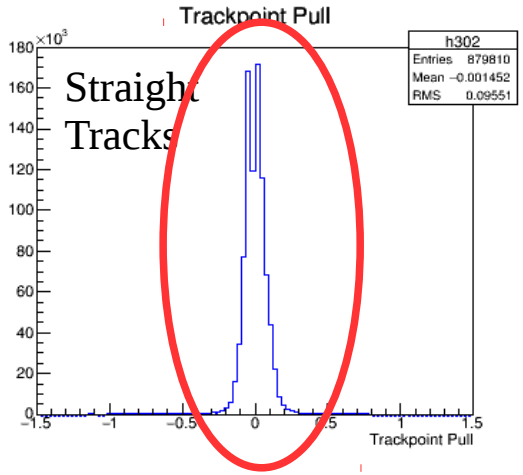
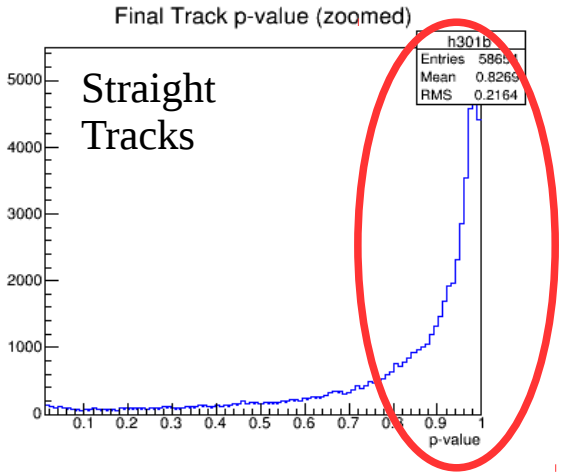
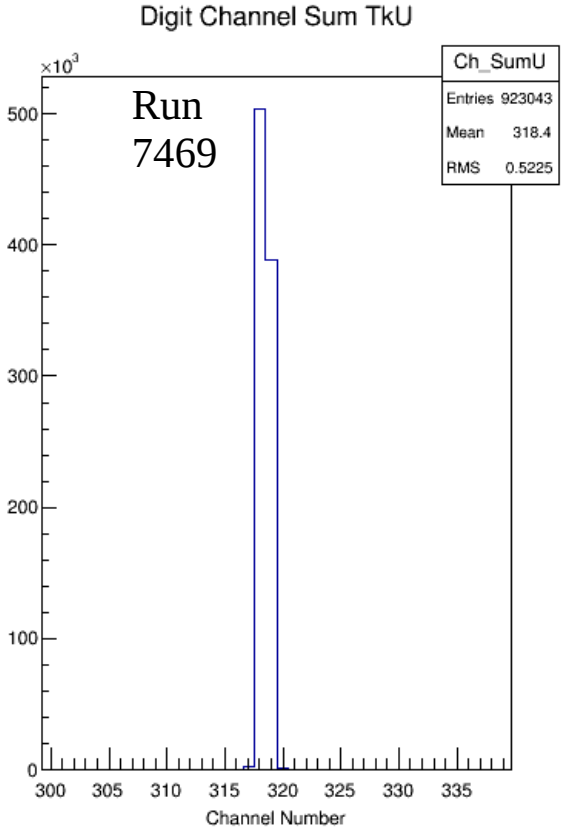




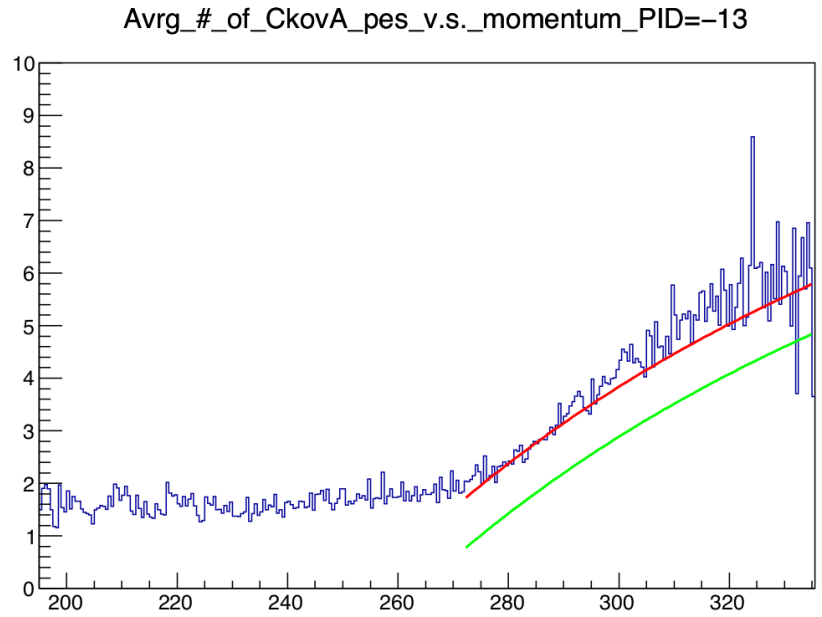


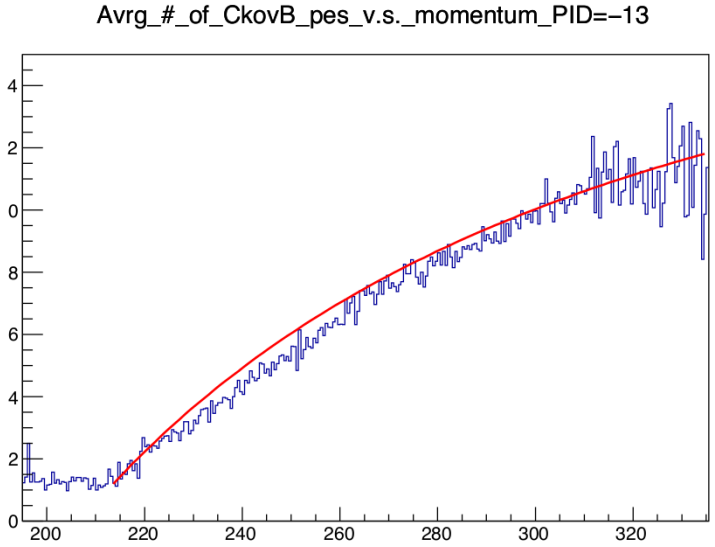




- Also: Need to finish efficiency analysis

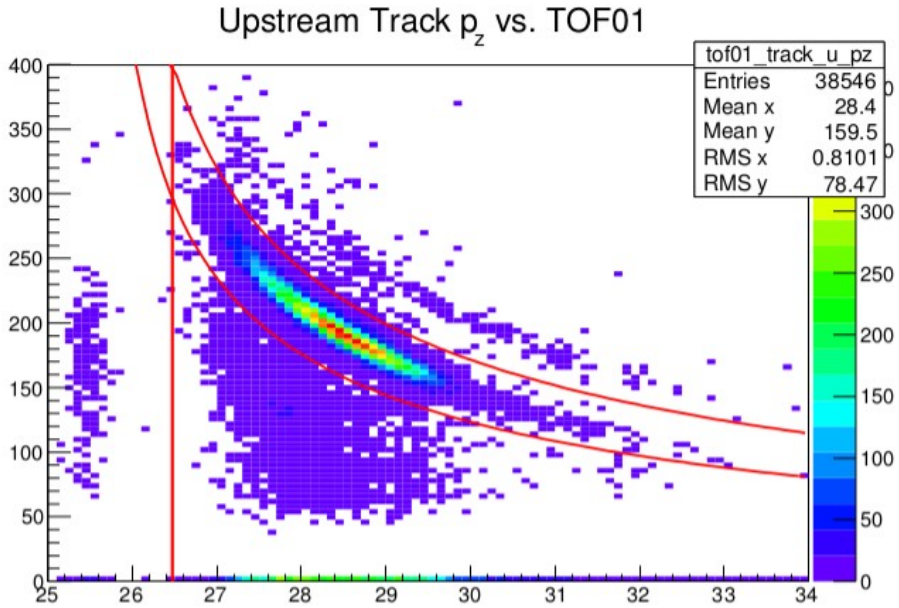
Ckov

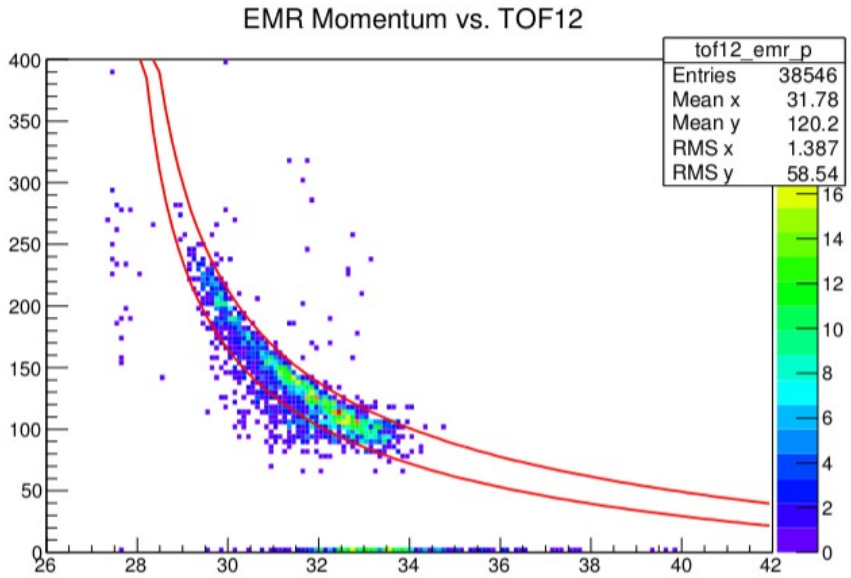


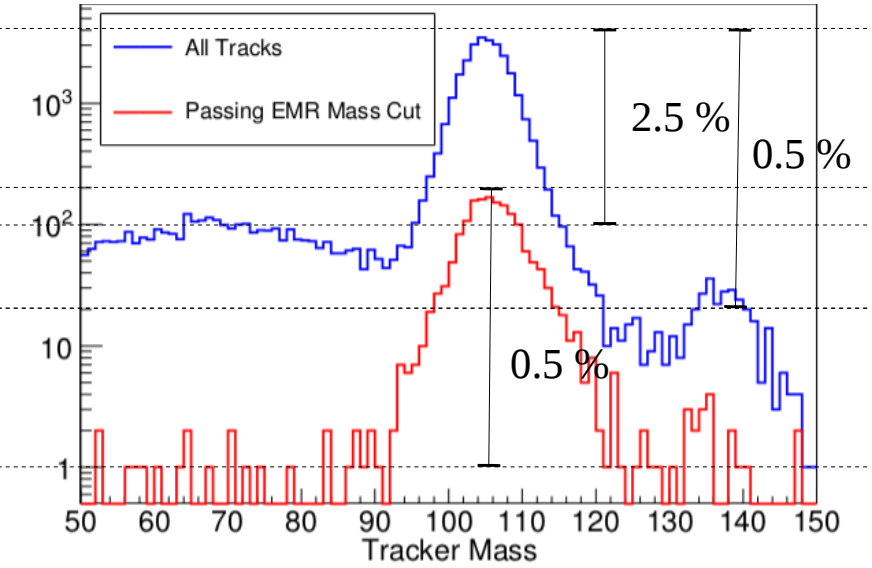


- Resolved issue with turn on point in CkovA and B
- Light yield has gone up in CkovA

Cut based PID – (Run 7469)

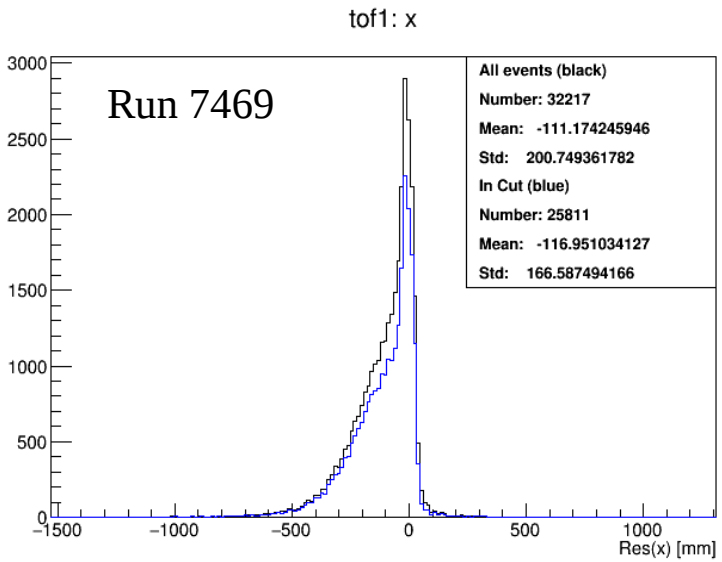


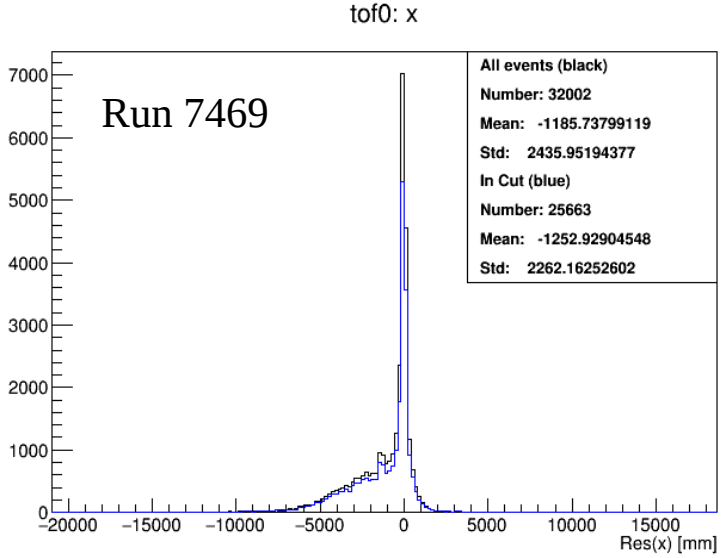


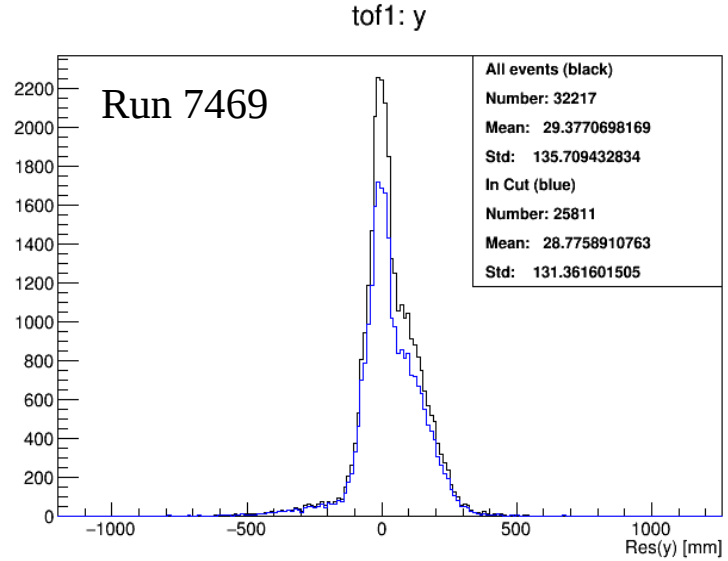


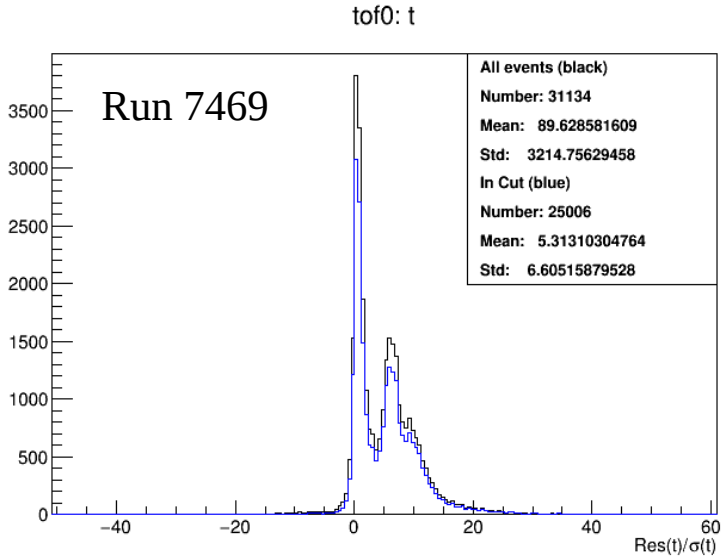
- EMR mass cut
- Tracker mass cut
- Not clear that the two cuts are consistent
  - Can we be quantitative about this?
- Need to prove, conclusively, source of low mass “shoulder”

Track extrapolation/consistency

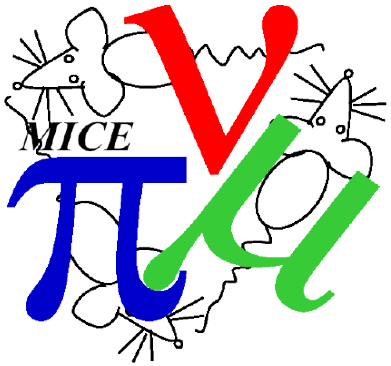








Magnets and Physics Data Analysis



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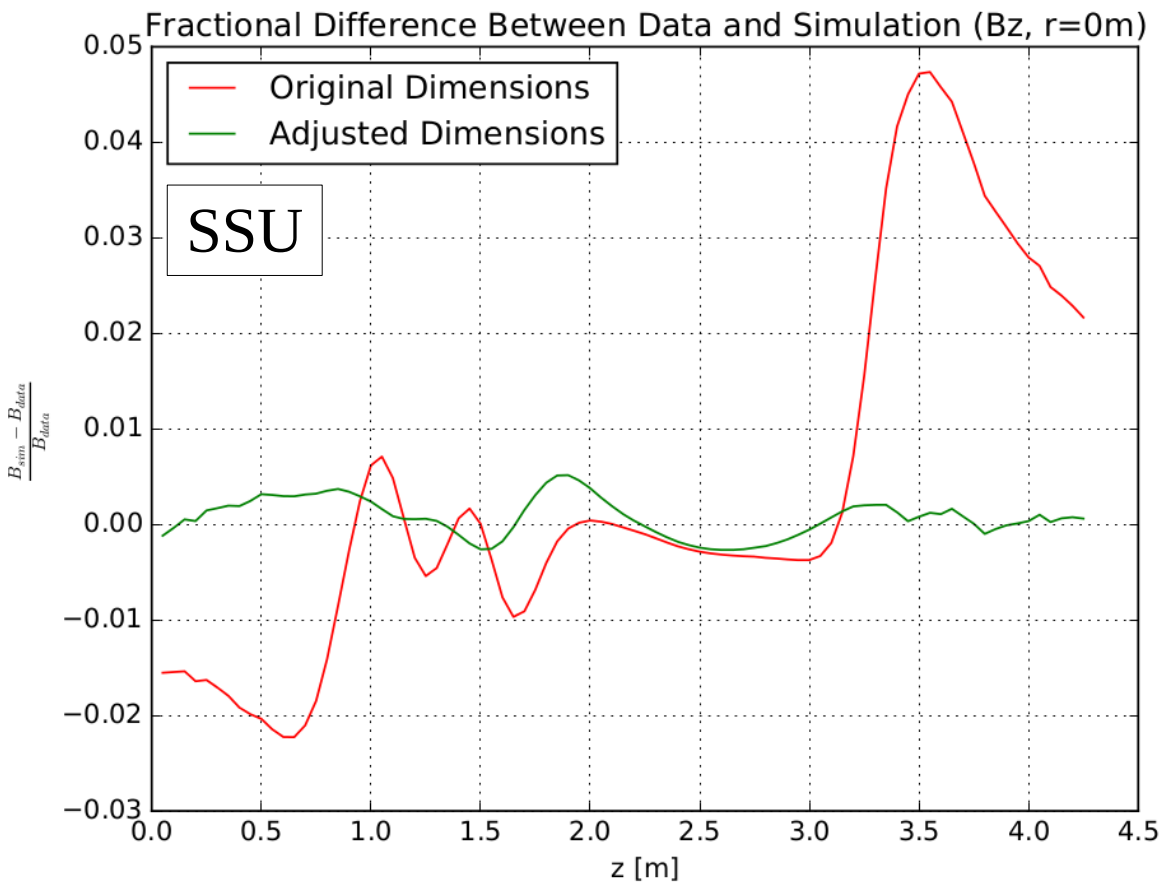
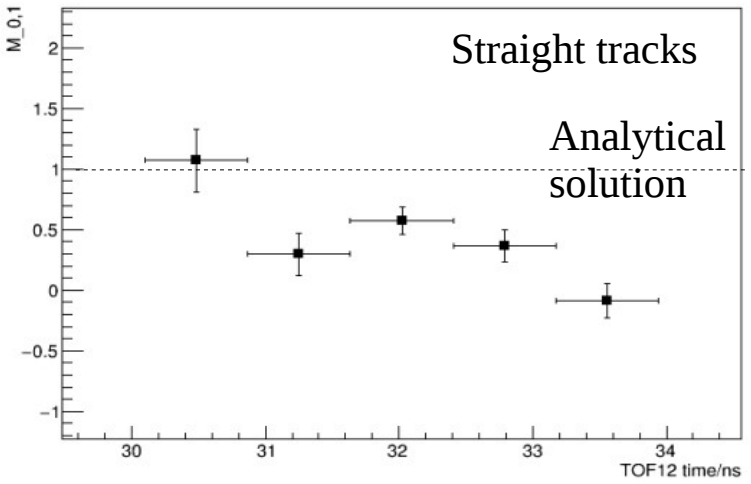
Field mapping analysis

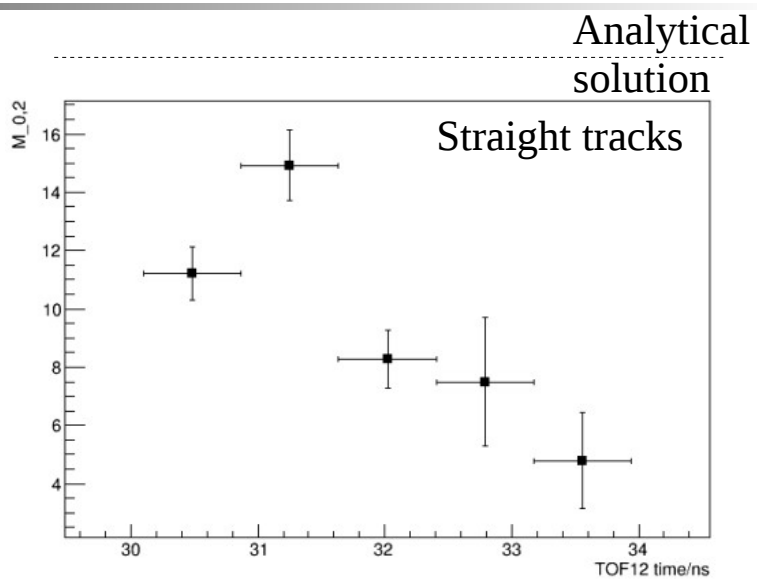


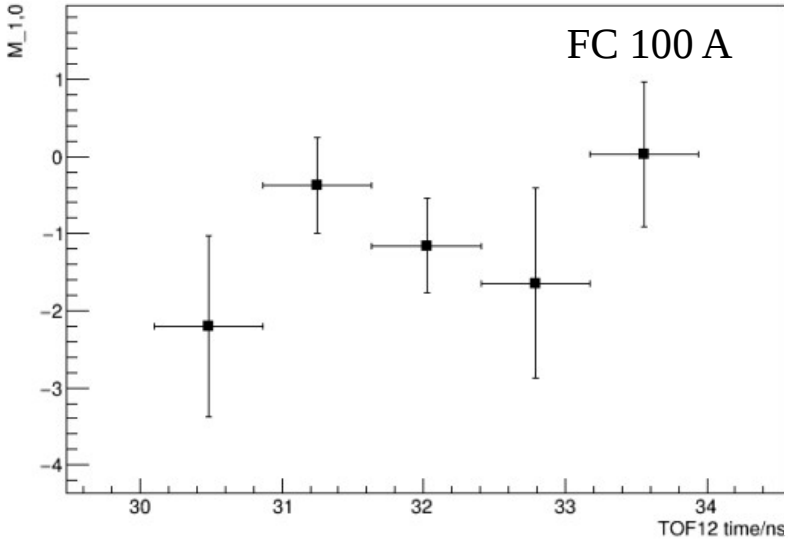
Coil	Original Centre [m]	Centre position from fit [m]
M1	0.925	0.920
M2	1.363	1.357
E1	1.761	1.757
CC	2.509	2.502
E2	3.257	3.247

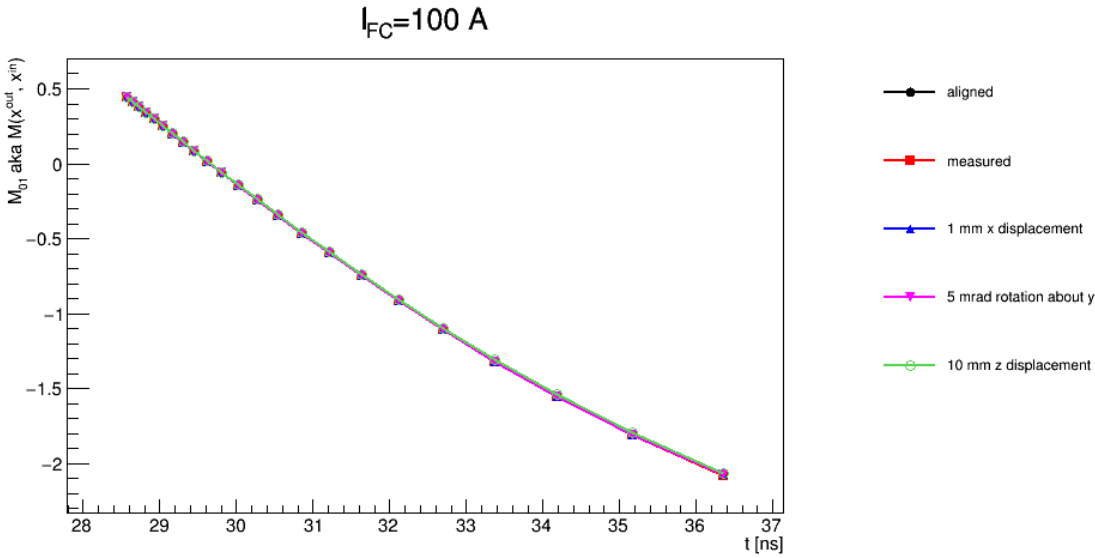
- Optimised coil positions
- Now looking at adjusting coil aspect ratio

Magnet alignment (Transfer Matrix)

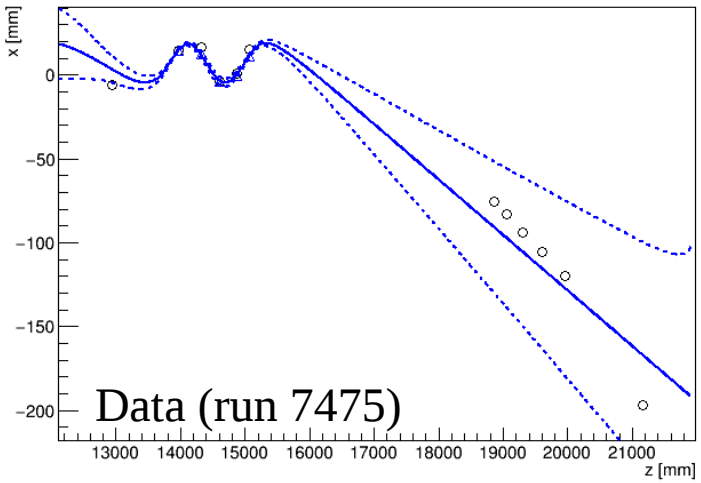


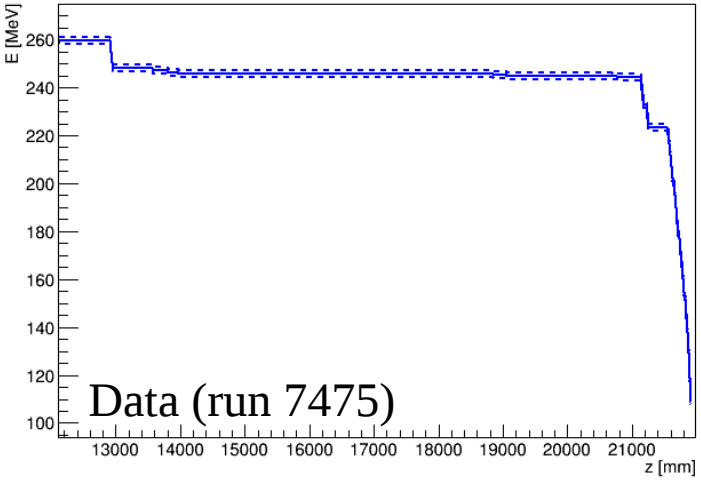






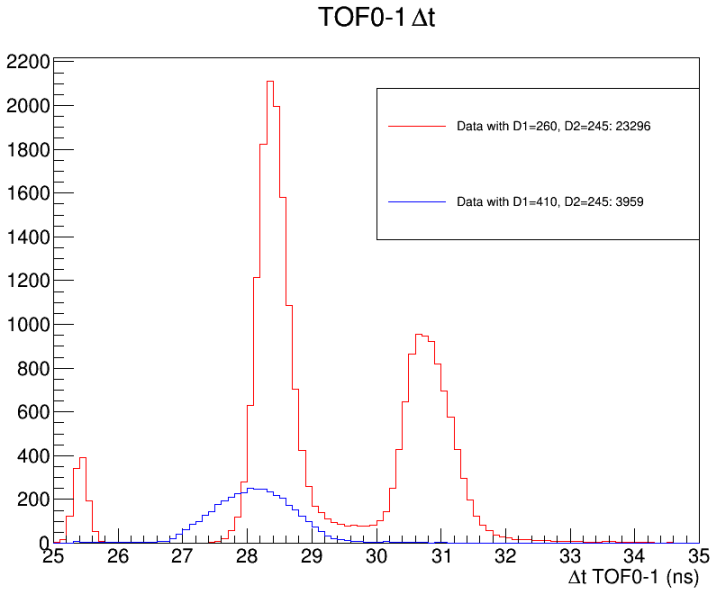
Magnet alignment (Residuals)

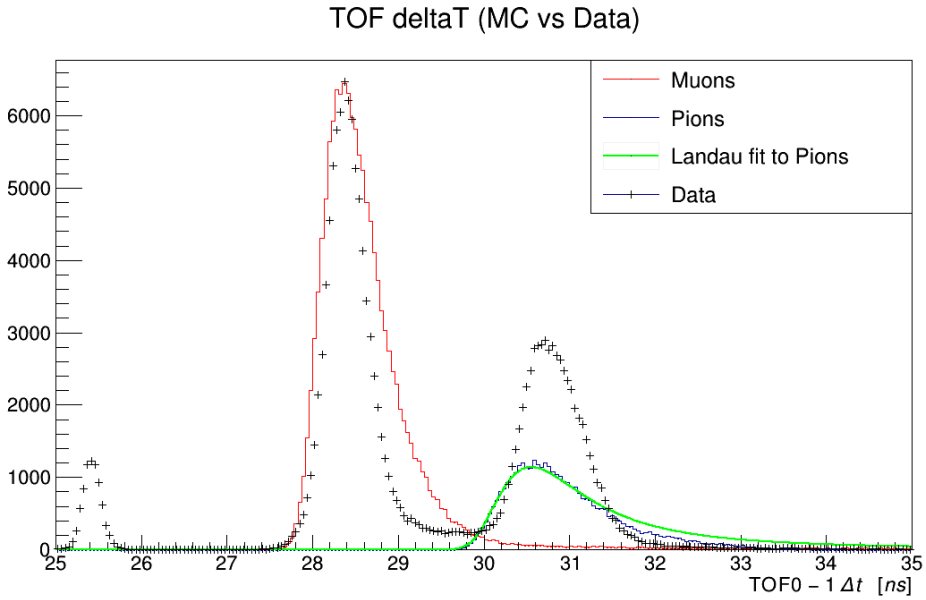




- Developed algorithm to extrapolate tracks, and errors between detectors
- Fitting using Minuit implemented
  - But slow
- Fitting using Kalman fits in development
- Aim is to wiggle the magnets and attempt to improve combined fit

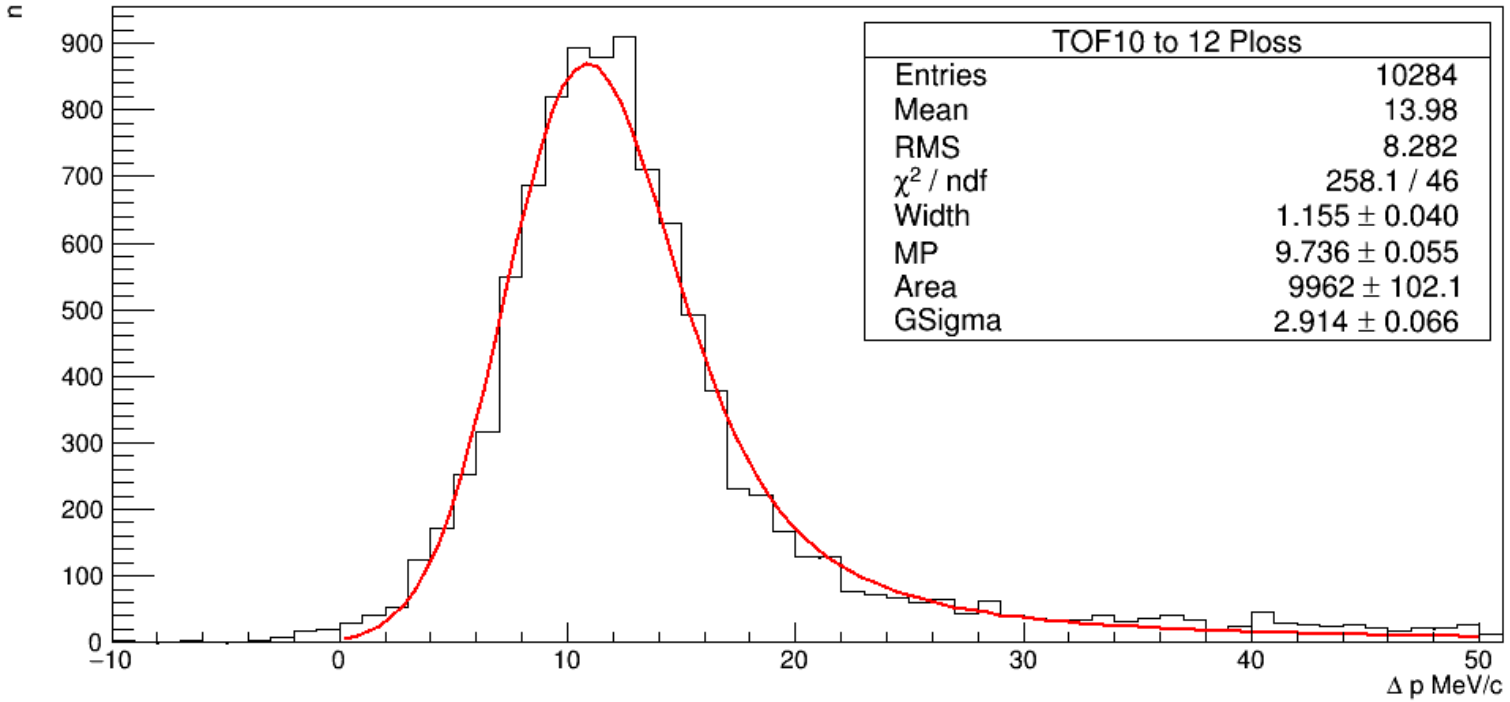
Pionic Beamline





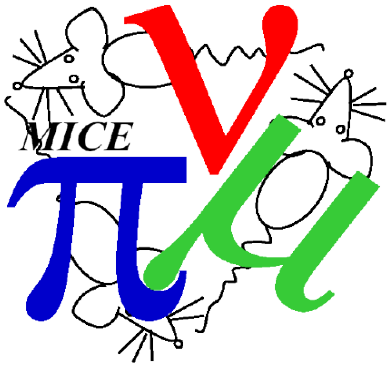
- Use of a pion beamline gives very good rate
- MC studies indicate very good purity from simple TOF cut
- Looks very promising
- Need to reoptimise beamline optics

TOF-based Energy Loss



- Compare TOF01 to TOF12
- Infer an energy loss
- Need to determine details of analysis technique and unfolding algorithm

Future Plans



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Step IV Lattice – no M1D

variable	flip, 140	flip, 200	flip, 200 ($x_4 \leq 185$)	flip, 240	sol, 140	sol, 200	sol, 240
x_1	0.83	0.72	0.72	0.80	0.80	0.77	0.89
x_2	142.56	168.13	233.49	251.62	132.76	249.89	222.69
x_3	125.55	261.81	262.59	150.98	205.79	276.14	146.06
x_4	180.83	221.55	184.91	126.80	65.21	86.61	64.09
x_5	-191.34	-233.37	-237.68	-244.00	223.01	208.29	161.48
x_6	-0.73	-0.74	-0.74	-0.70	0.73	0.74	0.70
$\Delta\epsilon/\epsilon_i$	-7.4%	-4.0%	-3.5%	-2.2%	-4.6%	-3.5%	-2.3%
T	92%	92%	93%	90%	91%	92%	90%

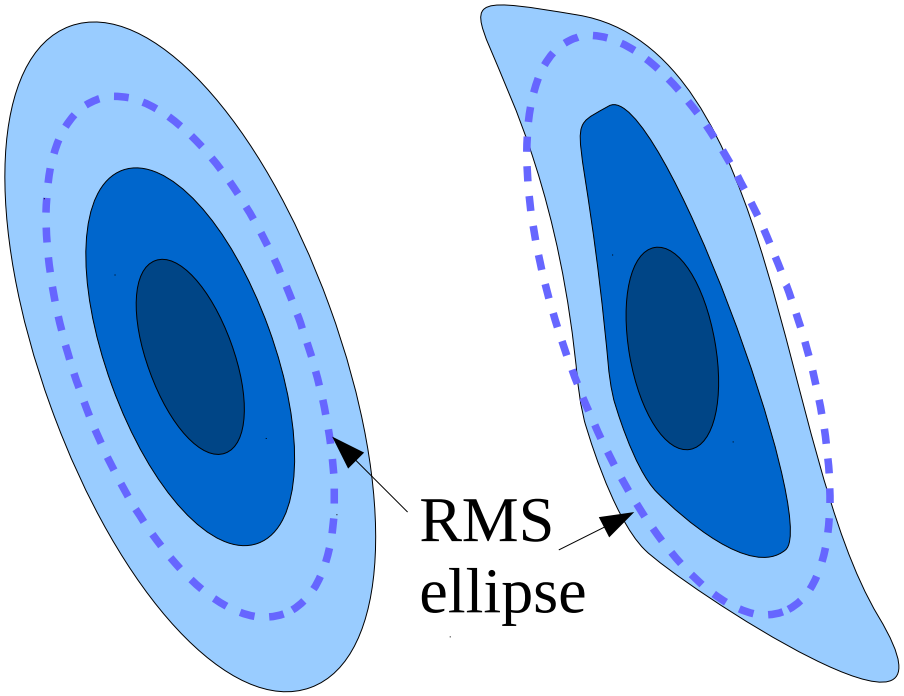
Step IV Lattice – no M1D or M2D

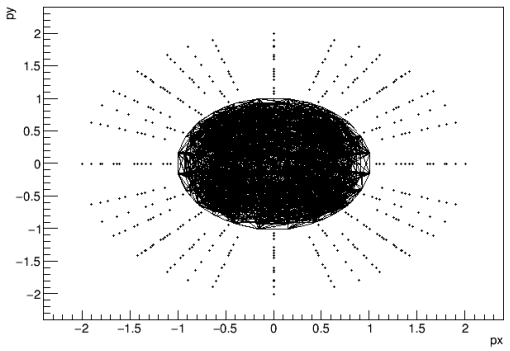
variable	flip, 140 (low T)	flip, 140 (high T)	flip, 200 (low T)	flip, 200 (high T, low x_4)	sol, 140 (low T, no high T)	sol, 200 (high T)	sol, 240 (high T)
x_1	0.71	0.77	0.89	0.70	0.65	0.76	0.65
x_2	80.00	169.49	153.19	125.73	172.39	236.83	158.43
x_3	158.14	208.96	251.15	133.93	242.20	135.21	132.32
x_4	172.05	118.23	224.99	88.85	56.15	55.98	64.11
x_5	0	0	0	0	0	0	0
x_6	-0.56	-0.53	-0.5	-0.51	0.57	0.54	0.57
$\Delta\epsilon/\epsilon_i$	12.8%	6.8%	6.3%	1%	8.2%	2.6%	2.7%
T	72%	80%	74%	85%	73%	82%	80%

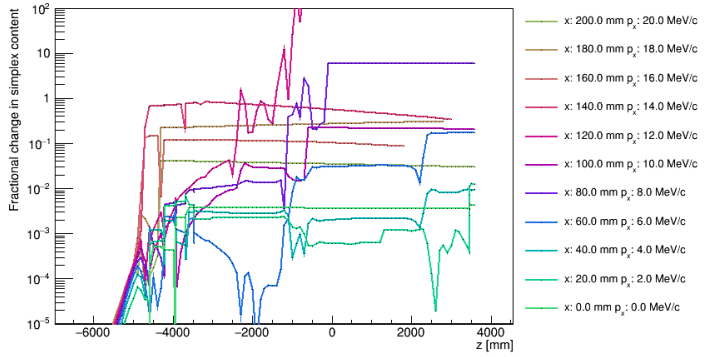
Step IV Lattice – no M2D

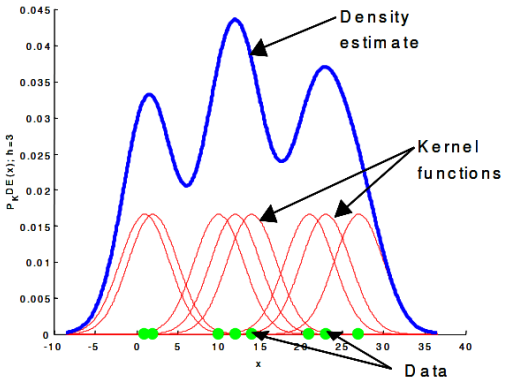
variable	flip, 140 (low T)	flip, 140 (high T)	flip, 200 (low T)	flip, 200 (high T, low x_4)	sol, 140 (low T, no high T)	sol, 200 (high T)	sol, 240 (high T)
x_1	0.71	0.77	0.89	0.70	0.65	0.76	0.65
x_2	80.00	169.49	153.19	125.73	172.39	236.83	158.43
x_3	158.14	208.96	251.15	133.93	242.20	135.21	132.32
x_4	172.05	118.23	224.99	88.85	56.15	55.98	64.11
x_5	0	0	0	0	0	0	0
x_6	-0.56	-0.53	-0.5	-0.51	0.57	0.54	0.57
$\Delta\epsilon/\epsilon_i$	12.8%	6.8%	6.3%	1%	8.2%	2.6%	2.7%
T	72%	80%	74%	85%	73%	82%	80%

Non-linear beam optics



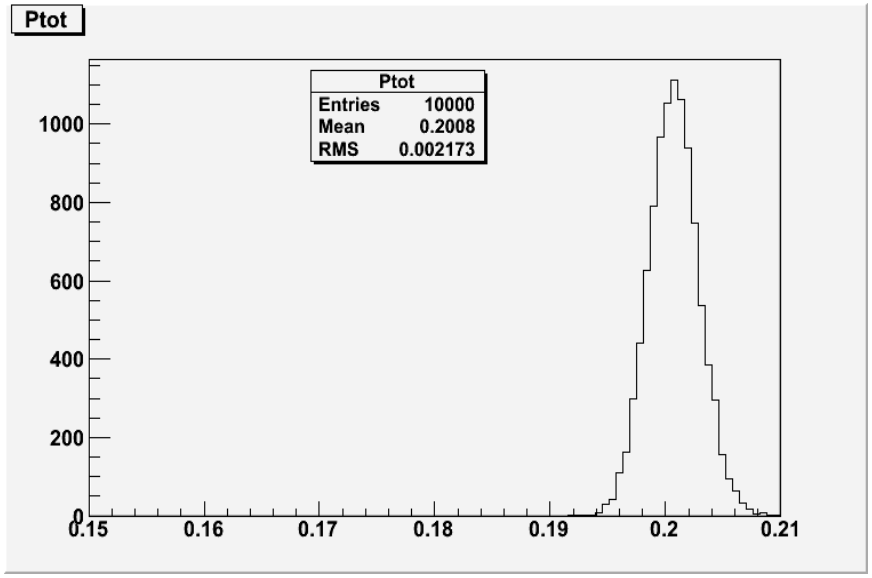


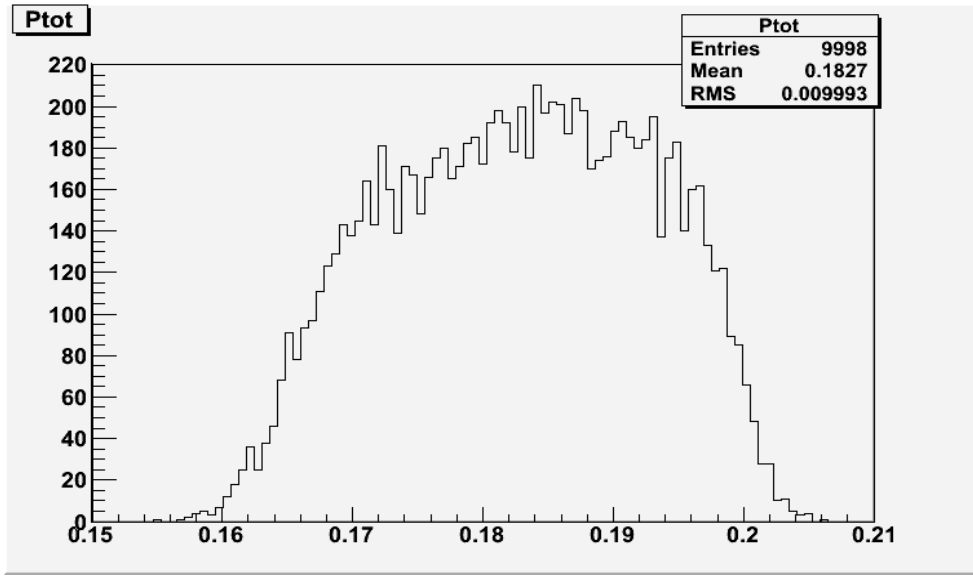




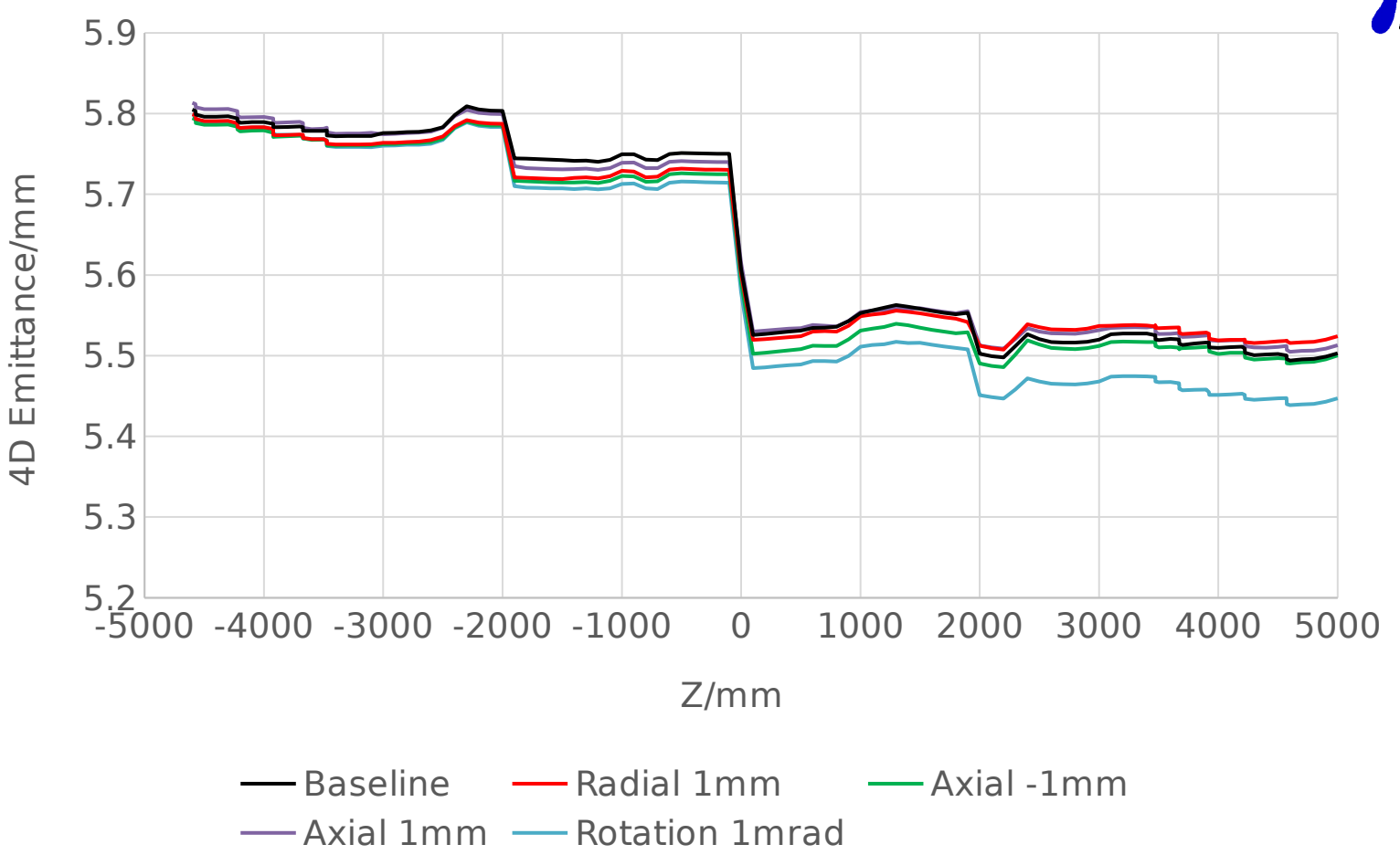
Wedge Absorber

z(cm)	P_z MeV/c	ε_x (mm)	ε_y	ε_L (mm)	σ_E MeV	6-D ε increase
0	**200**	3.04	2.99	2.90	1.82	1.0
6	193	1.44	3.02	6.82	3.86	1.13
12	182	**0.76**	3.00	14.27	8.63	1.23





Demo Alignment and Tolerances



- Trying to get the sample selection right
- Philosophical questions about what constitutes an “error”

Demo Descope Options

- US funding for SSD repair is looking uncertain
- UK STFC has asked us to present options for descope (last week)
- I have a list – but no assessment of feasibility

Demo Descope Options

1) Only use 1 RF power supply
2) Use existing SSD; probably install a tracker station upstream of M1 which we use as reconstruction plane
   - Consider acquiring backup magnet system in case of SSD failure (e.g. quad triplet)
3) Use plastic *secondary* absorbers
   - Not much cost saving
4) Stop at Step IV
5) Seek a lattice for SSU, FC, RF, SSD
6) Consider “quarter lattice” - stop demo at FCD
   - Install tracker around FCD
   - Apertures?
   - Resolutions?

Analysis Workshop

- RAL, CR10 in Atlas building
- Thursday April 28th

Coming up...

- In this session:
  - “Emittance paper” - Victoria Blackmore
  - “(Xenon) scattering paper” - John Nugent
  - “Demonstration of Ionisation Cooling Paper” - JB Lagrange
  - “Detector alignment” - F Drielsma
- Over to Victoria...