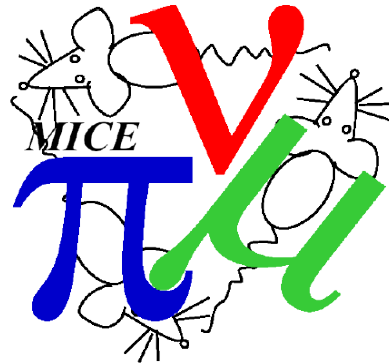




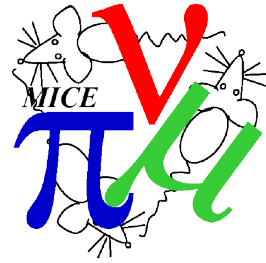
Analysis Report



V. Blackmore, S. Boyd, C. Hunt, S. Middleton, T. Mohayai,
S. Wilbur, **C. Rogers** et al
ASTeC Intense Beams Group
Rutherford Appleton Laboratory



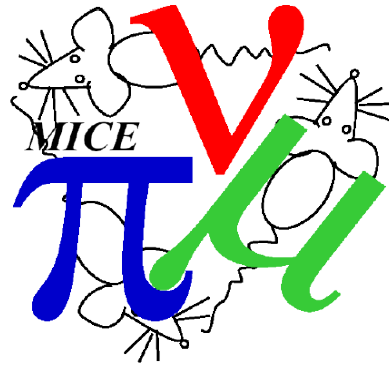
Outline



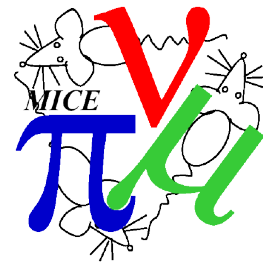
- Report on data analysis of 2015 data
 - Beamline data
 - Field off data
 - Field on data
- Plan for 2015/02
- Caveat
 - All analysis is ongoing and very fresh
 - Limited cross-checks
 - Finding new bugs all the time



Data Analysis from 2015/01

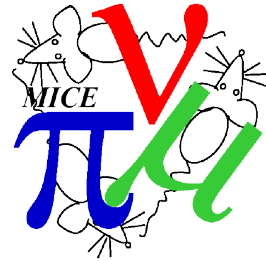


2015 Data ... so far

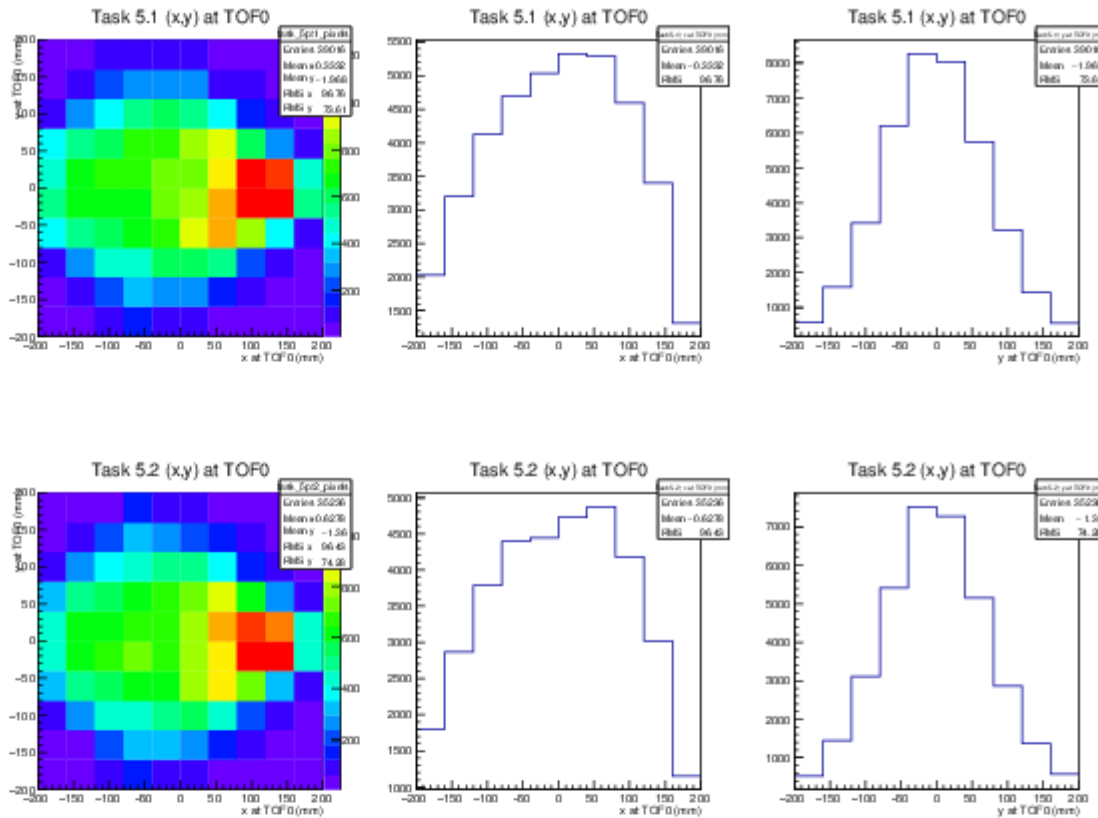


2014/03		Coordinator
March 21 st and 22 nd	TOF calibration Data rate studies	
March 28 th and 29 th	DAQ tests Ckov momentum scan Beamline studies	Lucien Cremaldi Jaroslaw Pasternak
April 19 th and 20 th	TOF2 calibration Beamline studies	Jaroslaw Pasternak
April 26 th and 27 th	Beamline studies	Jaroslaw Pasternak
2015/01a		
June 2 nd	Q123 rate	Jaroslaw Pasternak
June 6 th to June 18 th	Tracker commissioning Online systems debugging	
June 19 th to 27 th	Tracker commissioning Tracker alignment	Melissa Uchida
July 3 rd to 4 th	Tracker alignment	Melissa Uchida
2015/01b		
July 18 th	TOF calibration	
July 22 nd to 23 rd	Tracker half-field test	Chris Rogers

Q123 Scan

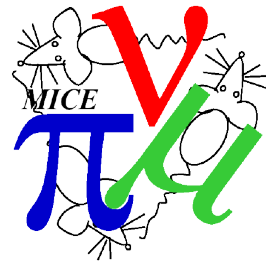


- Nb: Task “5.x” is a set of magnet currents
 - Transverse distributions show little dependence on settings



V. Blackmore

Q123 Scan



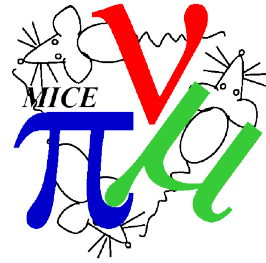
Task	Q1	Q2	Q3	mean x (mm)	rms x (mm)	mean y (mm)	rms y (mm)	total pixels	total spills	pixels/spill	relative to Task 5.1 (%)
5.1	102.4	127.9	89.0	-0.3332	96.76	-1.968	73.61	39016	1002	39	100
5.2	97.3	124.1	86.3	-0.6278	96.43	-1.36	74.28	35236	998	35	90.6
5.3	90.1	118.9	80.1	-1.915	96.17	-1.606	74.54	31263	1000	31	80.3
5.4	95.2	117.7	74.8	-1.605	97.04	-1.182	73.45	31495	1002	31	80.7
5.5	132.6	188.3	89.4	-2.283	95.96	-1.204	74.54	26514	998	27	68.2
5.6	158.3	179.2	198.5	-1.527	95.74	-1.684	73.69	39647	994	40	102.4
5.7	85.97	146.61	117.65	-0.6262	96.83	-1.738	73.81	32547	996	33	83.9
5.8	94.41	140.64	110.90	-0.6582	96.38	-1.746	73.93	35583	1000	36	91.4
5.9	38.18	115.70	110.12	-0.8329	96.99	-1.718	74.65	25669	1001	26	65.9
5.10	87.39	138.82	113.50	-1.486	96.97	-0.9925	74.06	32724	997	33	84.3

V. Blackmore

- Essentially no improvement in rate
 - Nb: rate not normalised to e.g. BLM
- No change in beam distribution
 - We are insensitive to these currents

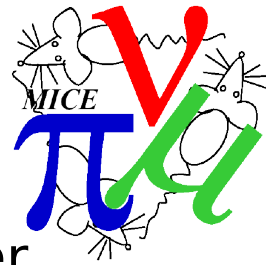


Other Beamline Studies



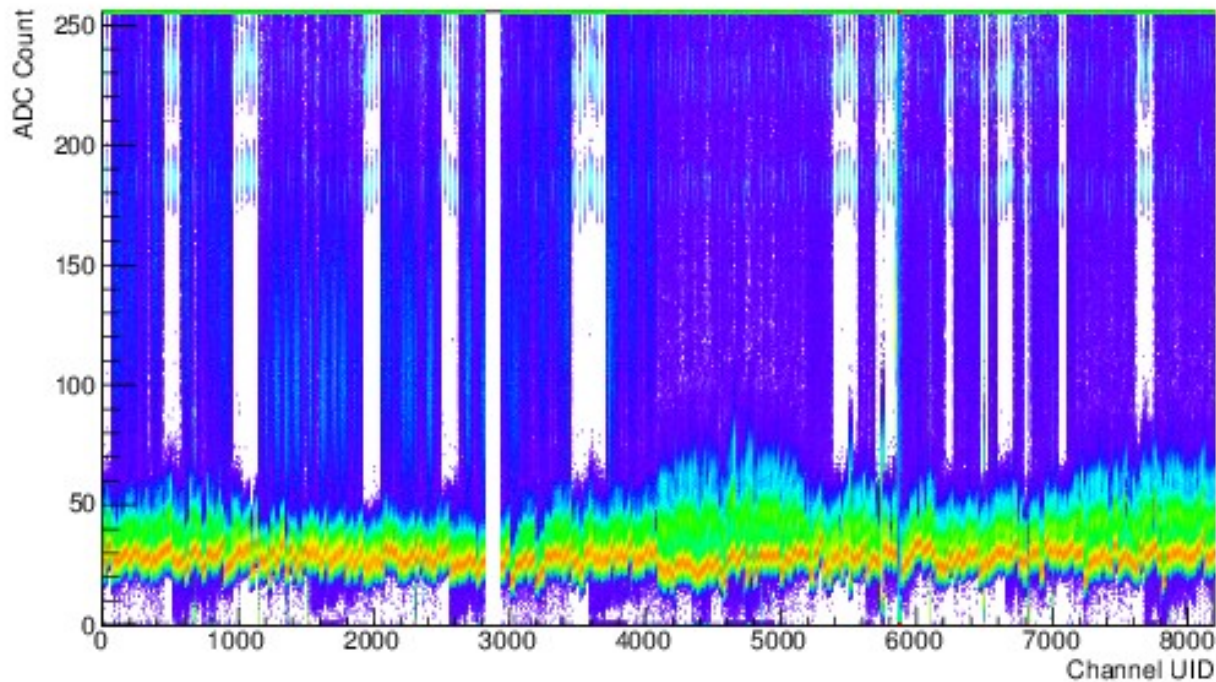
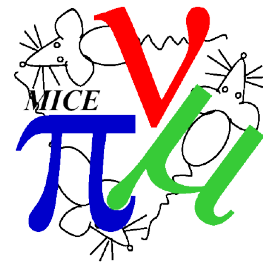
- No further analysis since CM42
 - Analysis is needed
 - Volunteers welcome

Tracker Alignment



- Fire tracks from upstream tracker to downstream tracker
- Aim to find relative position of downstream tracker
- Note
 - Axis of upstream tracker (TKU) defines the geometry
 - Assume TKU is at the surveyed position
 - Place all other elements with respect to that
 - Taking best measurement from survey, beam-based alignment
- Time spent debugging tracker

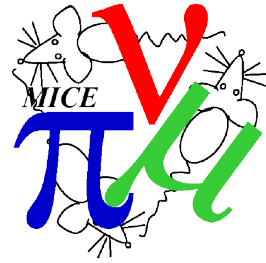
Trip-T error



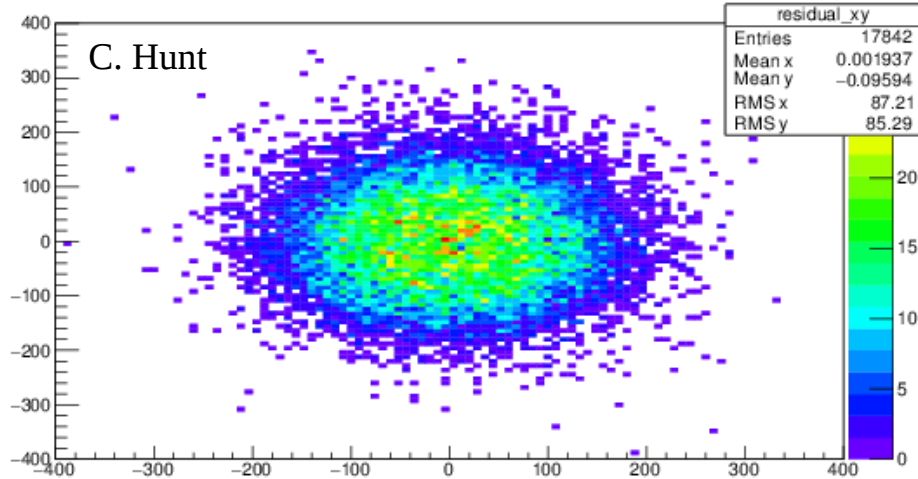
C. Hunt
E. Overton
C. Heidt

- Trip-t saturation error
 - Led to incorrect reconstruction
 - Enough to ruin the entire analysis

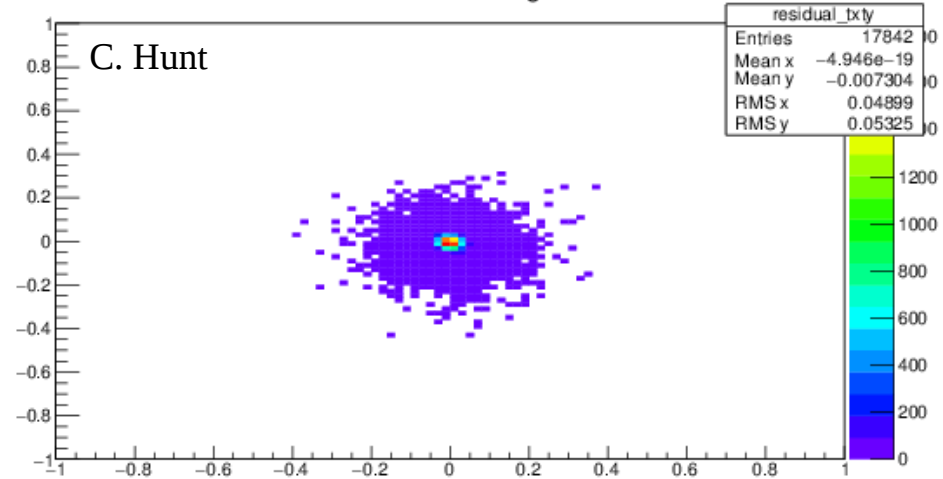
Tracker Rotation



Residuals in Position

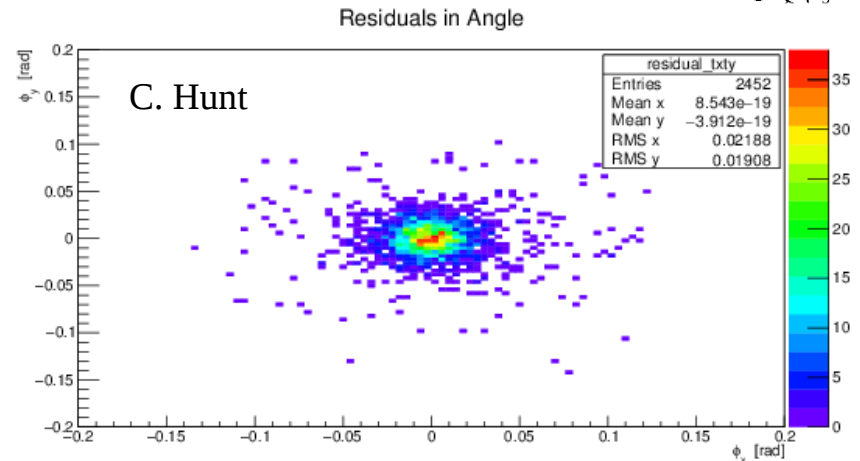
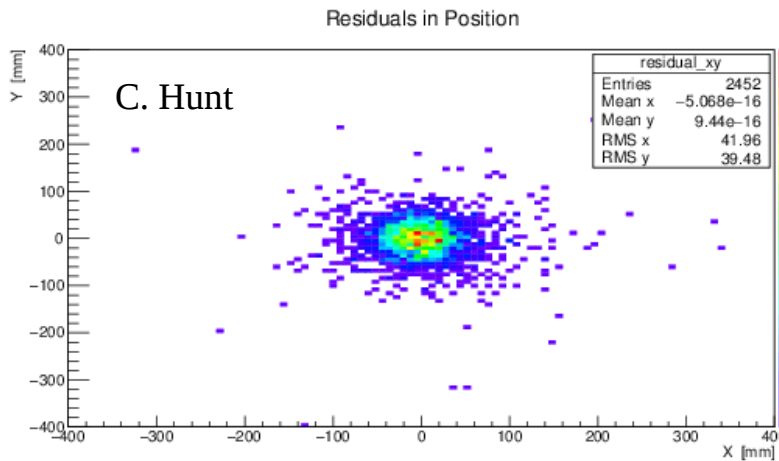
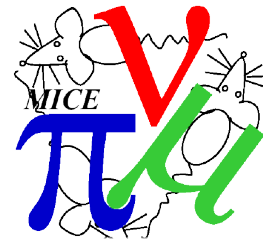


Residuals in Angle



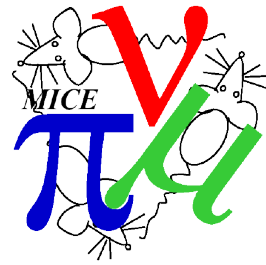
- Tracker rotation error
 - Potentially a mapping bug?
 - Rotation by ~ 120 degrees + reflection
- PDG back of envelope estimate
 - RMS x should be ~ 30 mm, not 90 mm
 - RMS x' should be ~ 7 mrad, not 50 mrad

Repaired tracker rotation

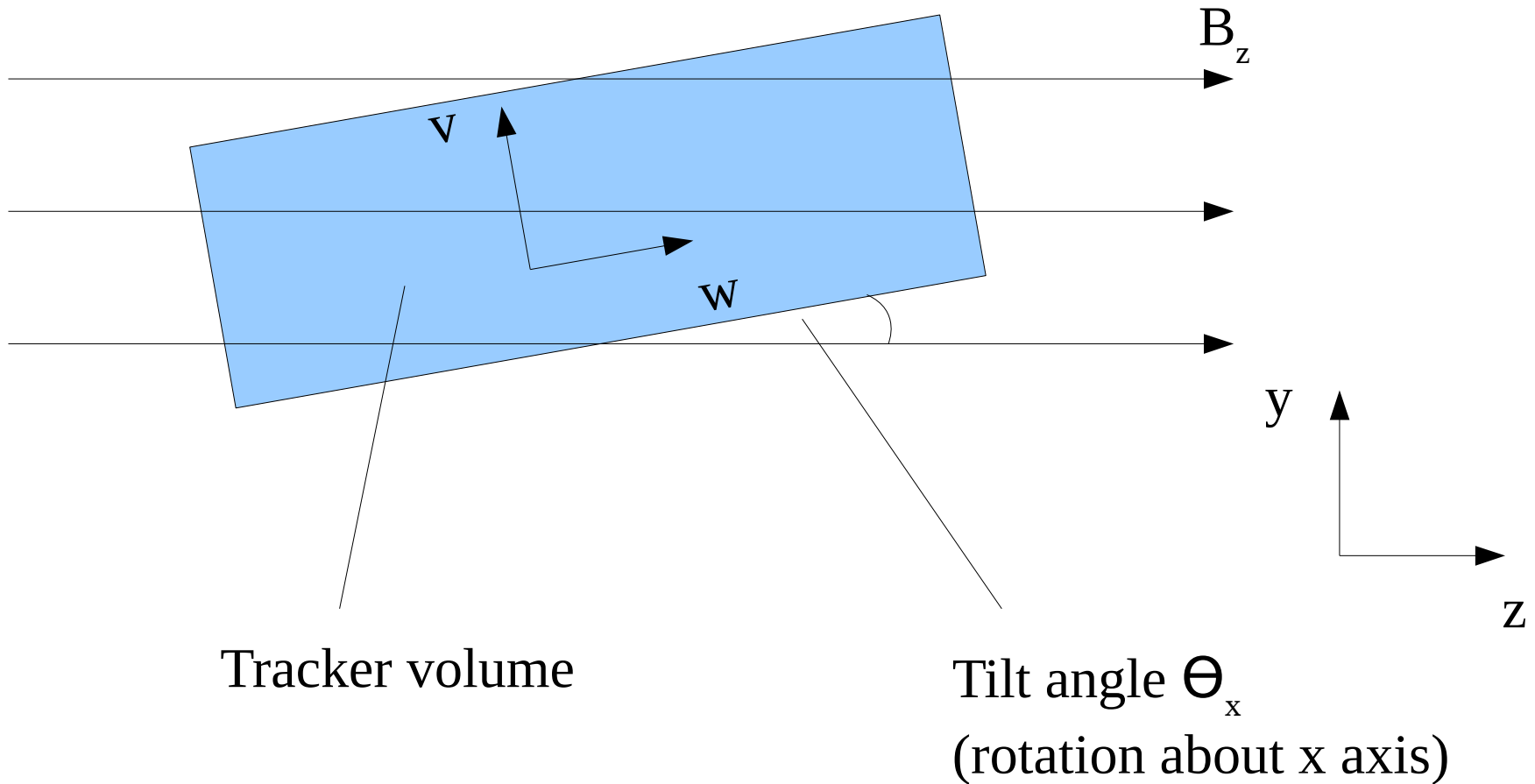


- With rotation fixed, residuals look better
 - Still a bit larger than expected
 - Air in various volumes
 - Work in progress
 - Nb: means have been subtracted
- Misalignments are credible
 - O(mrad) in x, y
 - O(mm) in x
 - O(cm) in y
 - Need cross-checks

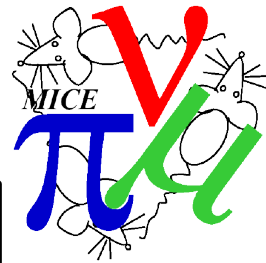
Tracker to Solenoid Alignment



- Aim is to measure the tracker tilt angle wrt solenoid field



Archiver Magnet Currents



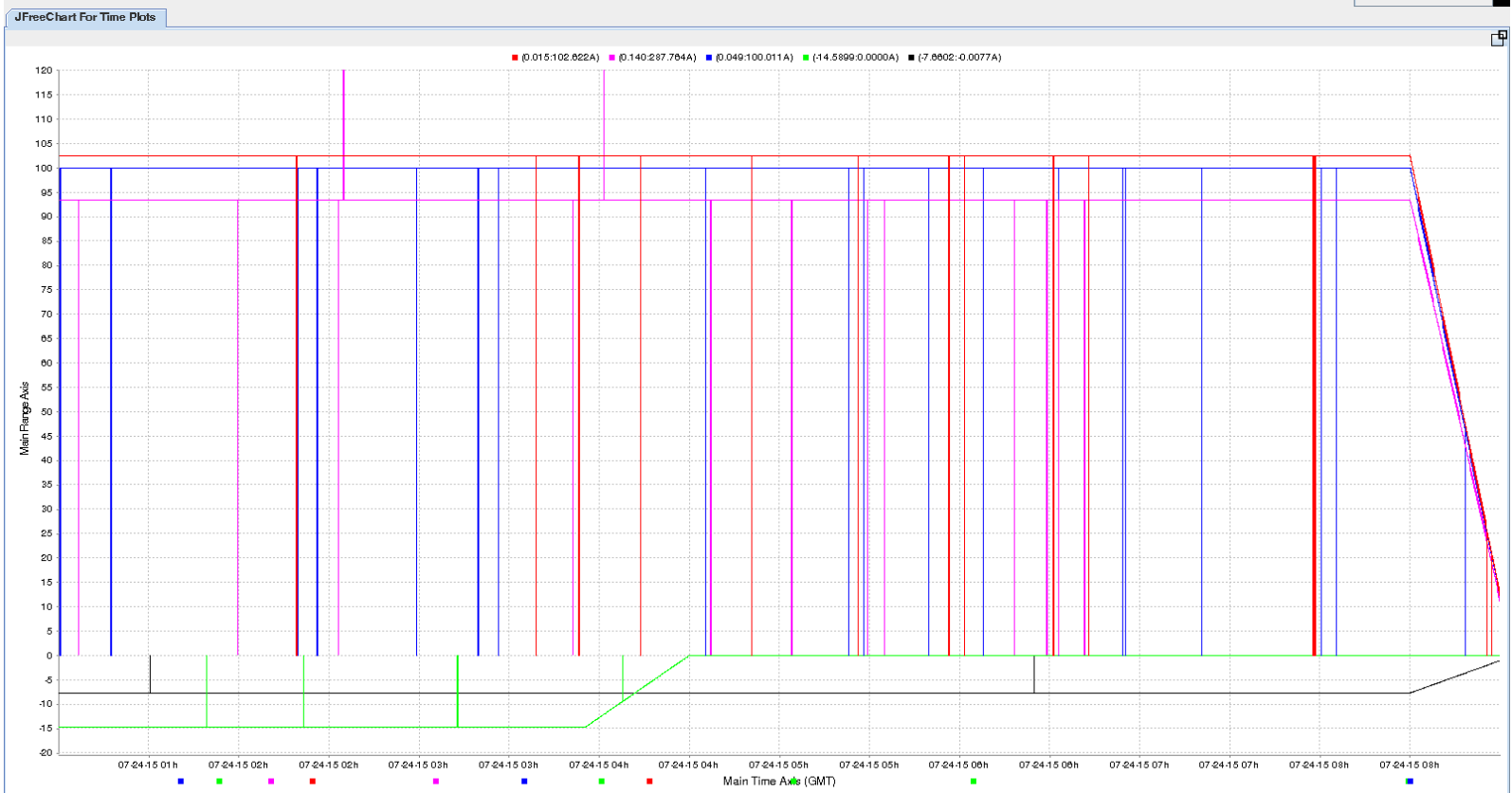
Run Number	Start Date	End Date
7288	2015-07-24 01:19:36.0	2015-07-24 04:01:15.0
7289	2015-07-24 04:05:11.0	null
7290	2015-07-24 06:05:25.0	2015-07-24 08:16:27.0

File Edit View Tools Window Help

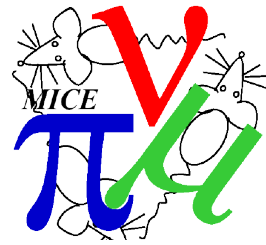
MICE-SSD-TRIM-02.IMAG

MICE-SSD-MATCH-01.IMAG
MICE-SSD-MATCH-02.IMAG
MICE-SSD-CNTR-01.IMAG
MICE-SSD-TRIM-01.IMAG
MICE-SSD-TRIM-02.IMAG

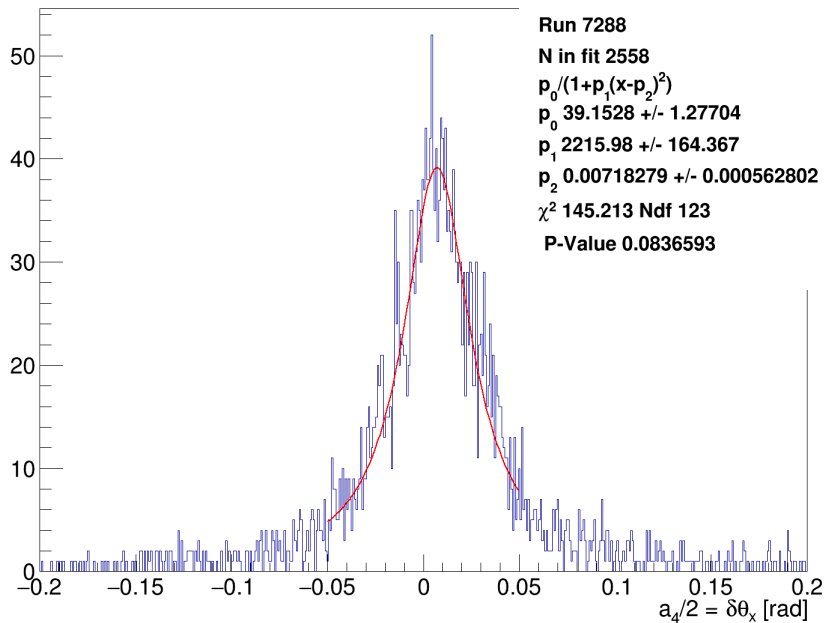
Max 120
Min -20
Type normal left
 Keep Ranges
Plot



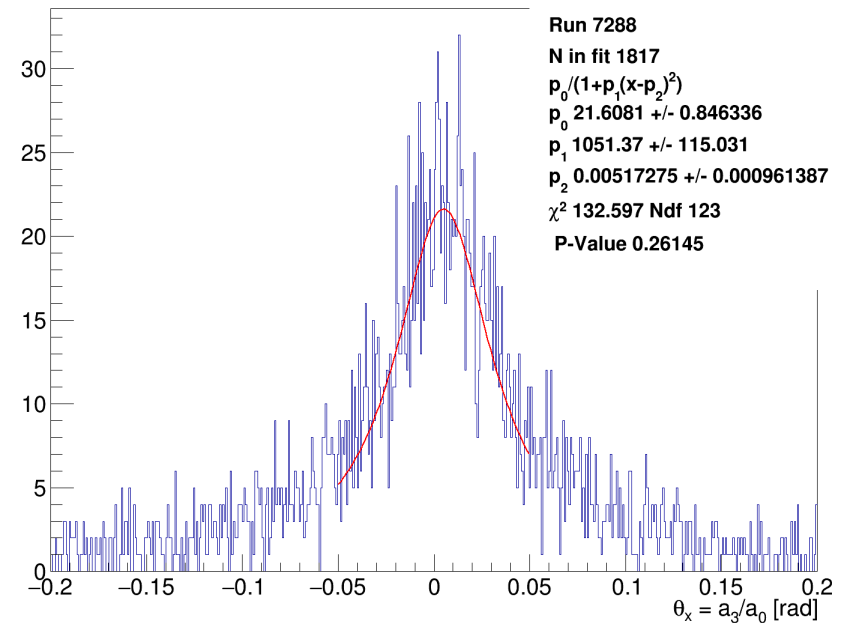
Tracker to Solenoid Alignment - x



TKD uw θ_x

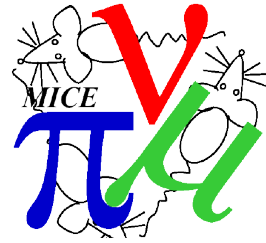


TKD w θ_x

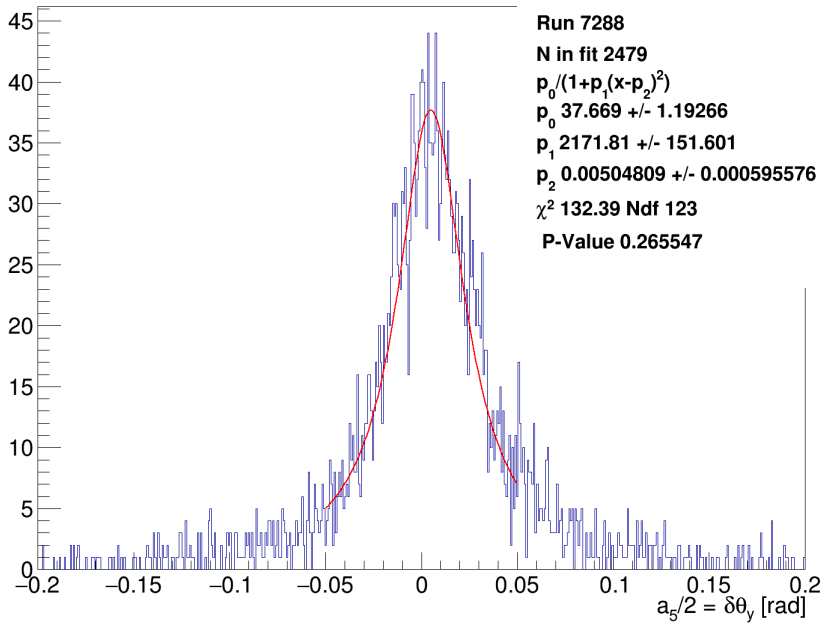


- Two different ways to calculate angle
- Output is pretty consistent
- But reconstruction of angle in each plane cannot be done simultaneously
 - i.e. fit is underconstrained

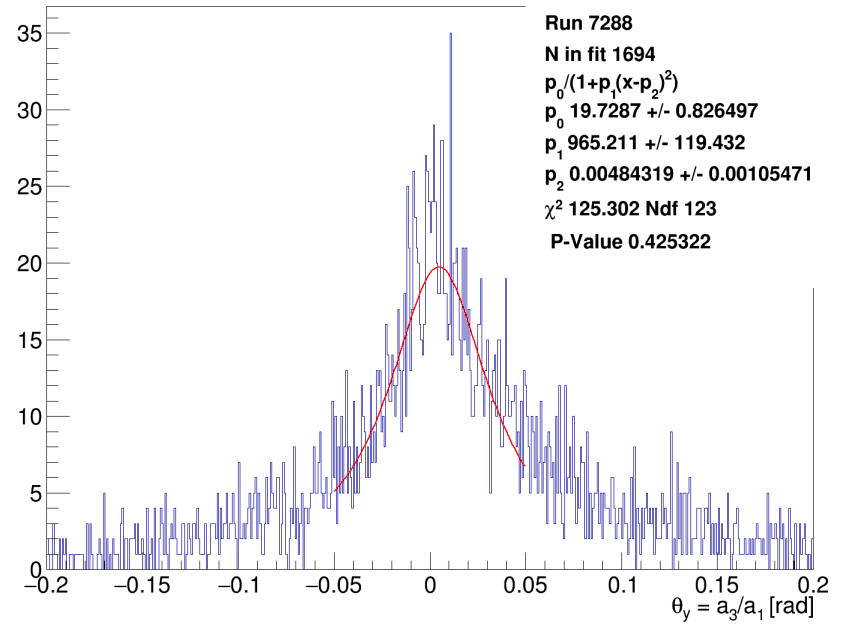
Tracker to Solenoid Alignment -y



TKD vw θ_y

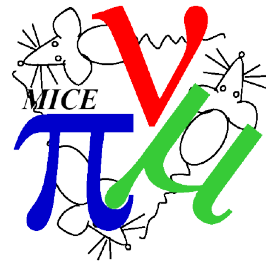


TKD w θ_y

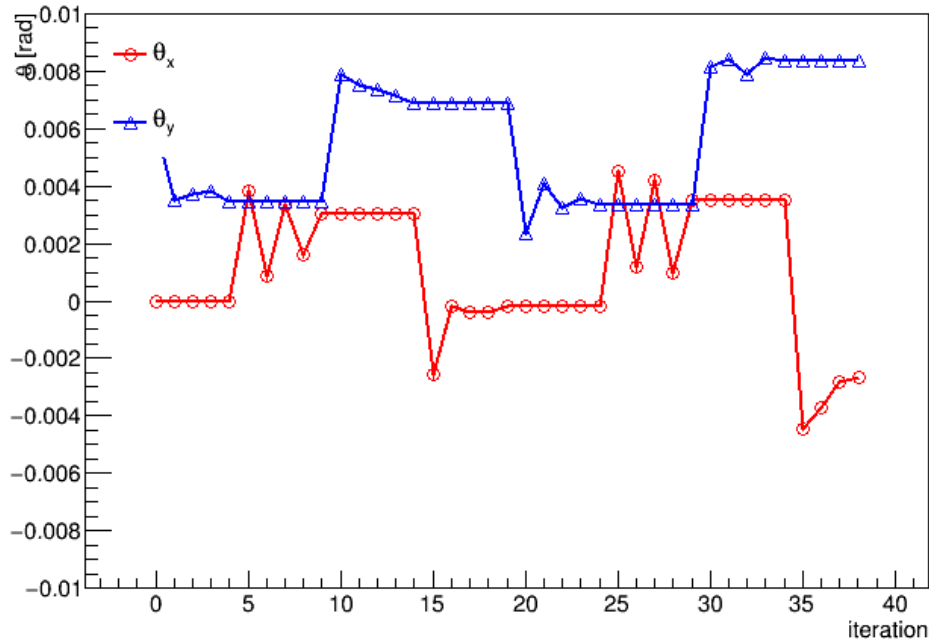


- Calculate θ_y

Convergence Search

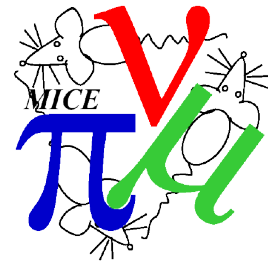


run_logs/run_10_serial5.log

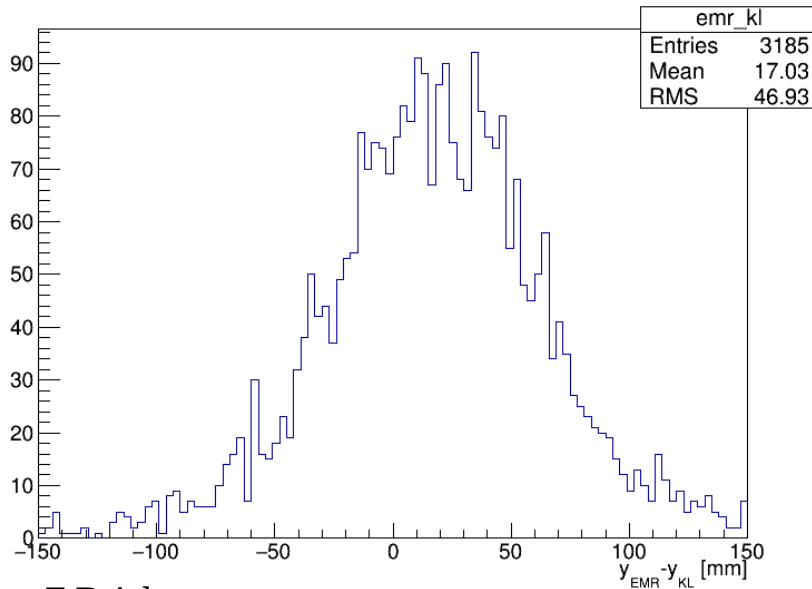


- Repeat 4 times
 - Repeat 5 times for x
 - Run fit, calculate angle
 - Rotate space points into estimated solenoid frame
 - Repeat 5 times for y
 - Run fit, calculate angle
 - Rotate space points into estimated solenoid frame
- Looks bimodal – check with MC (sign error?)

Particle Identification Detectors Alignment

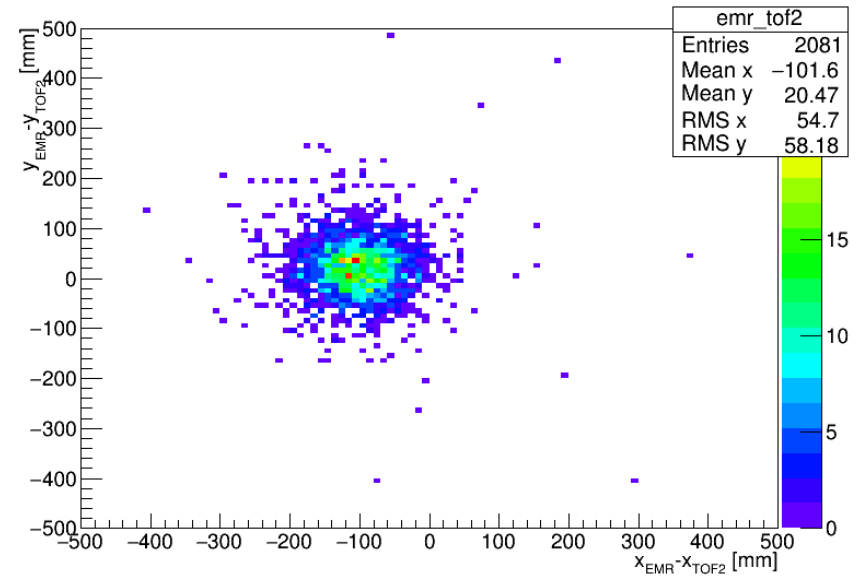


EMR-KL residuals



F Drielsma

EMR-TOF2 residuals

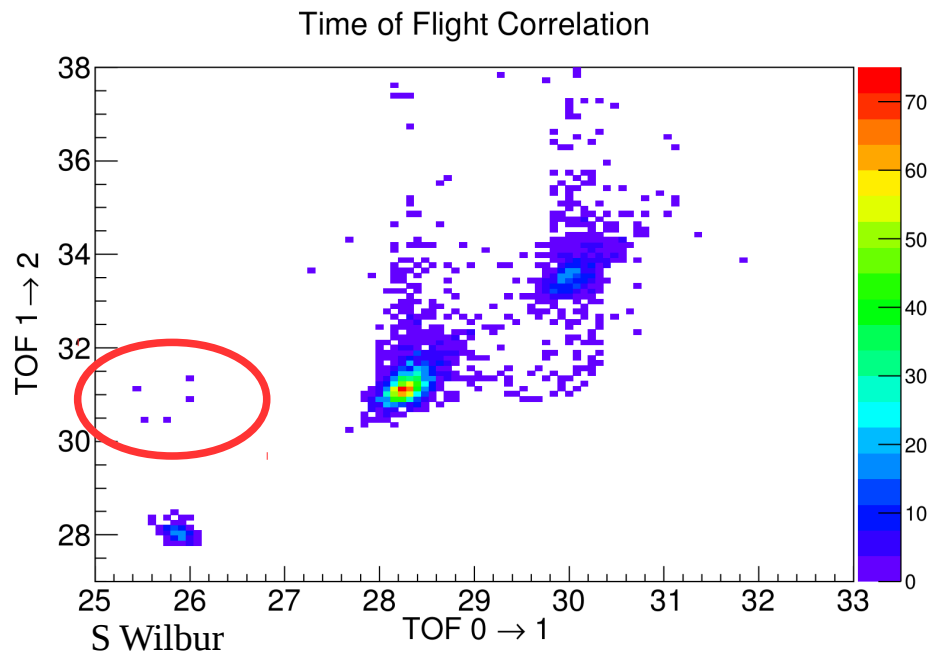
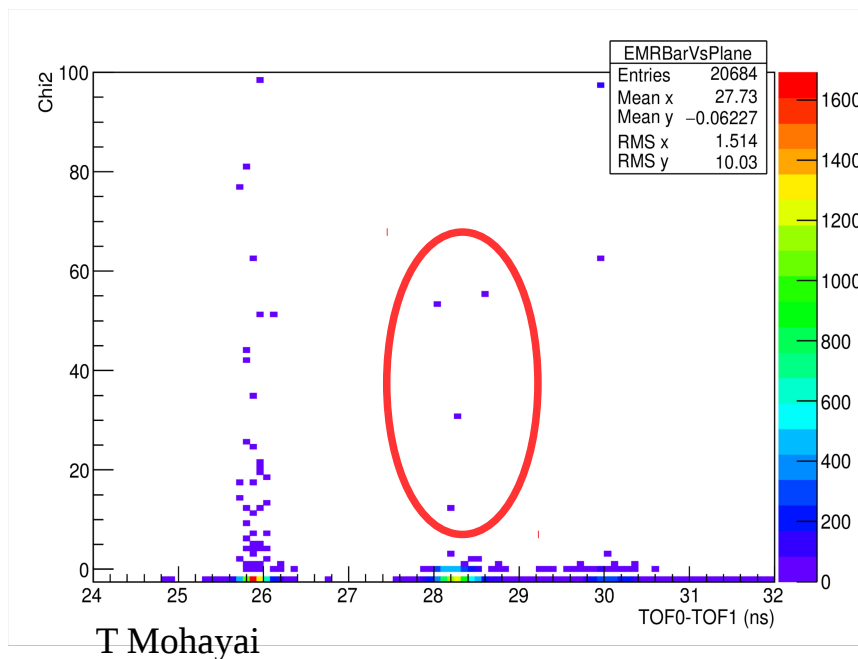
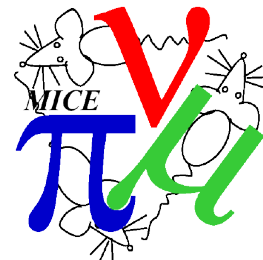


F Drielsma

- Throw tracks from EMR
- Look at where they arrive in KL, TOF2
- Compatible with survey (but need to cross-check)
 - In particular, EMR is translated in x by ~ 10 cm

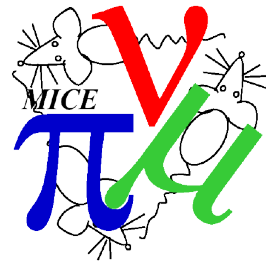
Particle Identification Detectors

Cut-Based PID



- Note a few electron-like tracks in muon TOF01
 - Muon decays?
 - **Breaking** - incorrect time window calibration in EMR recon
- Note electron-like tracks in TOF01, that become muon-like tracks in TOF12
- Await full log-likelihood PID from MAUS

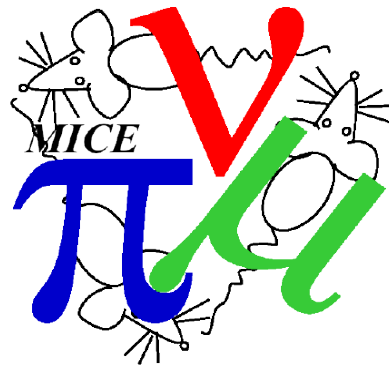
Monte Carlo



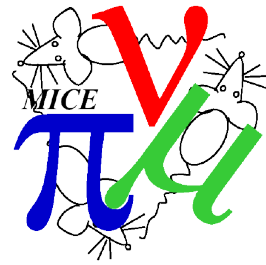
- Would very much like to validate all the analysis against MC
 - Very useful for validating analysis when looking for small effects
 - e.g. relatively small tilt angles, etc
- Batch MC is getting there
 - Clearing final snags



Plan for 2015/02

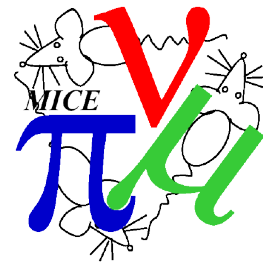


Plan for 2015/02



- Guidance
 - Prepare a plan for data taking in second half of 2015/02
 - Prepare a plan for no data taking in 2015/02
- Prepare a “shopping list” for magnet commissioning down times
 - Not many of those
- User run dates
 - 2015/02 ... 8 Sept 2015 to 16 Oct 2015
 - 2015/03 ... 3 Nov 2015 to 18 Dec 2015
 - 2015/04 ... 16 Feb 2016 to 25 Mar 2016
 - ~~2016/01 ... 12 Apr 2016 to 20 May 2016~~

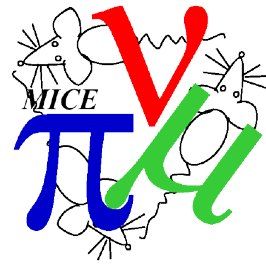
Status run 2015/01



Task	Number of Shifts	Magnets	Shifts Per Day	ISIS	Start Date	End Date	% Done 22/6/15
TOF Calibration and Ckov Commissioning	2	SS	1	01a	02/06/15	04/06/15	75
Tracker Hardware Commissioning	6	SS	1	01a	04/06/15	10/06/15	75
Tracker Validation	2	SS	1	01a	10/06/15	12/06/15	50
Beamline Pre-commissioning	4	SS	1	01a	12/06/15	16/06/15	50
EMR Commissioning 1	1	SS	1	01a	16/06/15	17/06/15	0
ISIS Maintenance Day	0	FC	0	Maintenance	17/06/15	18/06/15	
EMR Commissioning 2	3	FC	1	01a	18/06/15	21/06/15	0
EMR Commissioning 3	2	CT	1	01a	21/06/15	23/06/15	0
Complete magnet training	0	CT	0	01a	23/06/15	25/06/15	
Tracker External Alignment	1	Done	1	01a	25/06/15	26/06/15	50
Alignment to Other Detectors	1	Done	1	01a	26/06/15	27/06/15	50
Beam-Based Alignment 1	7	Done	1	01a	27/06/15	04/07/15	20
ISIS Machine Physics	0	Done	0	Machine Physics	04/07/15	14/07/15	
Beam-Based Alignment 2	2	Done	3	01b	14/07/15	14/07/15	20
Validation of Track Matching	1	Done	3	01b	14/07/15	15/07/15	0
Validation of Particle Identification	2	Done	3	01b	15/07/15	15/07/15	0
Beamline Commissioning	15	Done	3	01b	15/07/15	20/07/15	20
Optics Validation	21	Done	3	01b	20/07/15	27/07/15	0

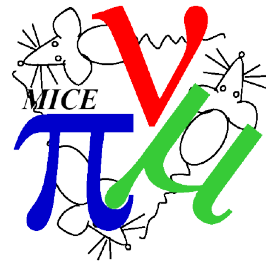
- % done is Rogers “thumb in the air”

Prioritised Shopping List



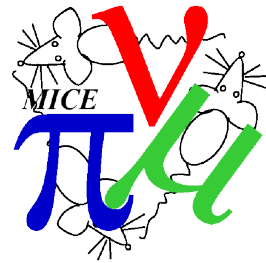
- 1) Tracker timing
- 2) TOF calibration
- 3) Tracker efficiency/validation
- 4) Ckov momentum scan
- 5) Ckov HV scan
- 6) EMR muon depth vs momentum
- 7) More EMR polarisation data

Running in 2015/02



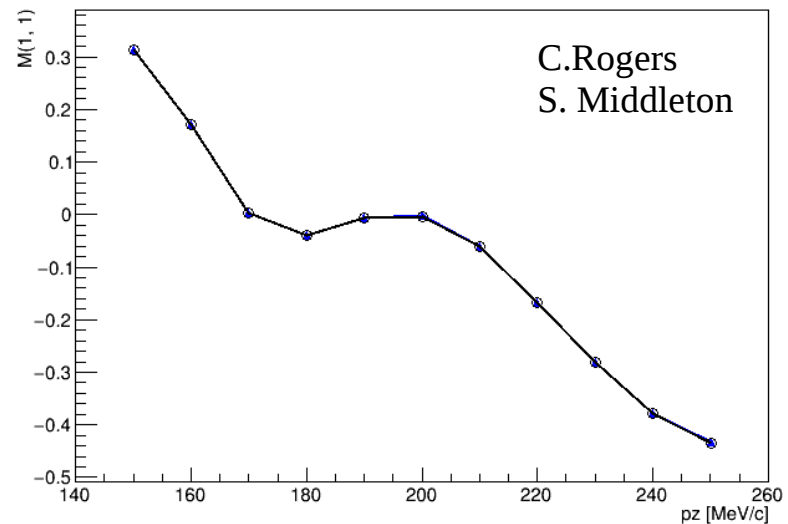
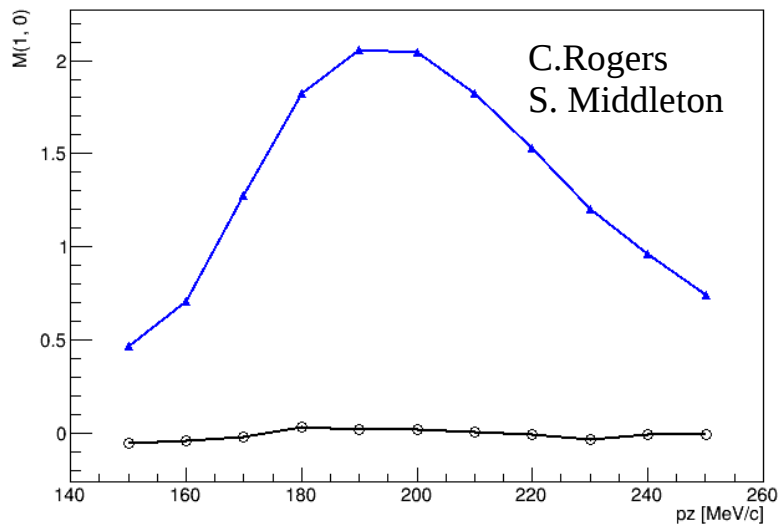
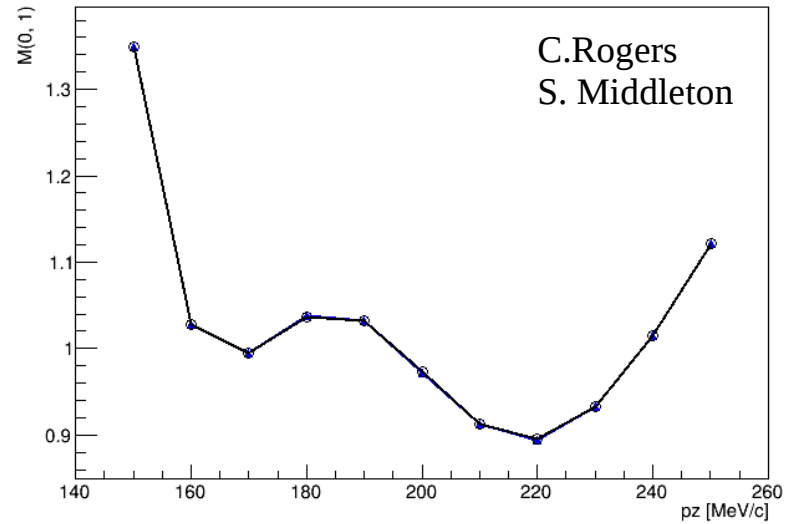
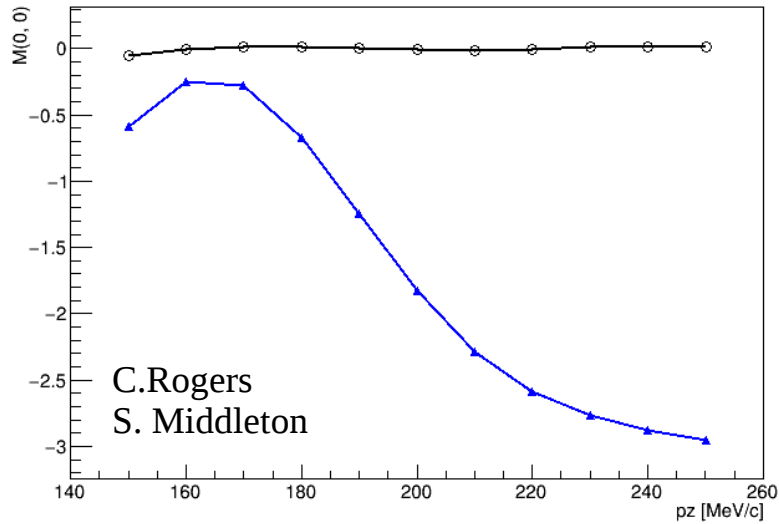
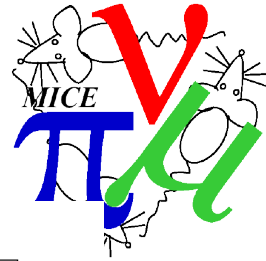
- Assume
 - First 3 weeks of 2015/02 are used up in magnet commissioning
 - Tracker commissioning and TOF calibration are finished
 - Data taking starts 28th September (still realistic?)
- 19 days of data taking
- Two tasks
 - Beam-based magnet alignment
 - (Cooling channel) optics validation
 - Beamline commissioning if time
- Consider “solenoid mode” to be the nominal setting

Beam-based Magnet Alignment

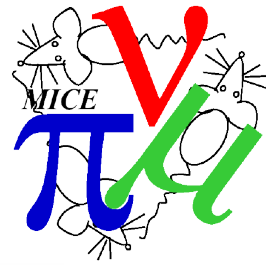


- Set SSU at nominal currents, FC and SSD to 0
 - Project from SSU to SSD
 - Use p_z from SSU
 - Complementary analyses
 - Find the tilt angle and displacement of SSU that minimises residuals
 - Projecting from SSU to SSD
 - Find the tilt angle and displacement of SSU that reproduces the momentum dependence of the transfer matrix
- Repeat for FC and SSD, and for all modules powered together
 - 4 settings
 - 140, 200, 240 MeV/c at each setting
 - Assume one day per setting
 - ~ 30k good muons, based on 2015/01

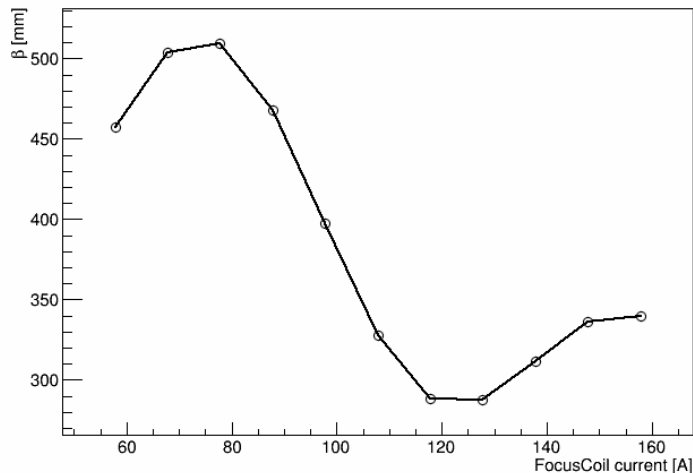
Beam-based Magnet Alignment



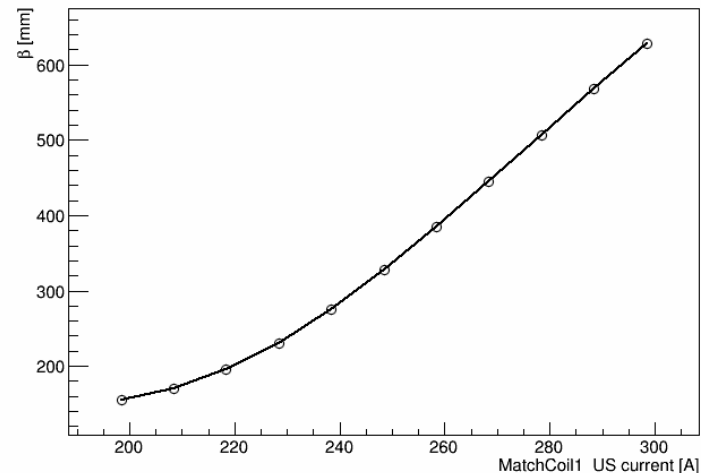
Optics validation



β at $z = 1800$ mm

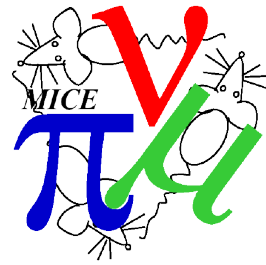


β at $z = 1800$ mm



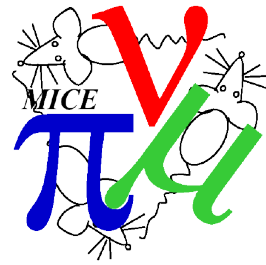
- For the optics validation
 - Scan currents on each coil pack
 - Examine optical beta function dependence on current at downstream tracker
 - Examine transfer matrix dependence on current at downstream tracker
- Nb: plots are illustrative, some currents are not possible

Optics validation (cont)



- If there are major deviations
 - Determine the field strength dependence on current offline
 - Reoptimise the currents offline
 - No plans to optimise currents online
 - Try again...
- Assume 1 day per current scan
 - 7 coil packs => 7 days

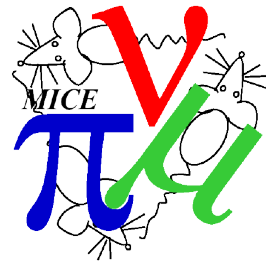
Optics validation



- Beam-based alignment of magnets – 4 days
- Optics validation – 7 days
- If there is time left over
 - MICE Muon Beamline commissioning?
 - Optics validation in flip mode?
 - LH₂ fill and ionisation cooling?

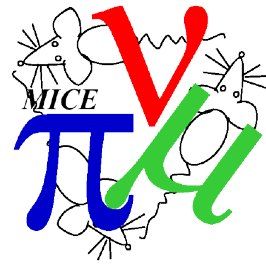


2015/03



- If we complete the 2015/02 tasks outlined above
 - Now need to squeeze “no absorber” and IH_2 data into 2015/03
 - 2015/04 is entirely devoted to LiH
 - May involve compromising on statistics in some cases
- If we do not complete the 2015/02 tasks outlined above
 - 2015/03 gets very tight
 - May have to consider installing LiH during 2015/04
 - ... or running into 2016/01

Final Thoughts



- Hope that the magnet team have a speedy commissioning
- We are eager to push particles through those magnets!