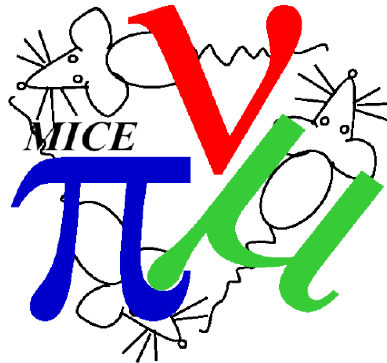




# Physics Coordinator Report

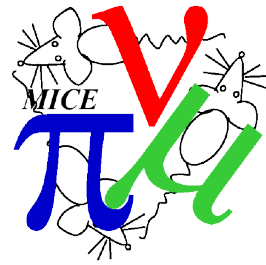
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C. Rogers,  
ASTeC Intense Beams Group  
Rutherford Appleton Laboratory

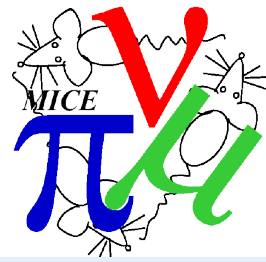


# Physics Coordinator Report



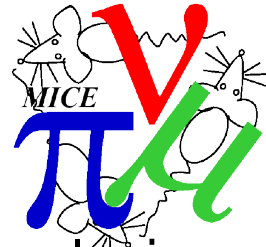
- Step IV analysis status
  - Analysis “dashboard”
  - Physics shifter
  - Data taking plan and status for 2015/01
  - Data taking plan for 2015/02
- Summary of presentations
  - Beamline commissioning
  - Alignment
  - Quality of transported beam and cooling channel optics
  - Measurement of energy loss and beam polarisation
  - Batch production, xboa, data rate

# Status of Planning for Step IV (1)



Measurement	Coordinator	Principle of Measurement	Laptop Studies	Batch MC & Analysis	Final Run Settings	Data Taking	First Analysis & Data Checks	Final Analysis	Publication
<b>Step IV</b>									
<b>Magnet Mapping</b>	V. Blackmore	Complete	Complete	N/A	Complete	Complete	Complete	In progress	Not started
<b>Detector alignment</b>	M. Uchida	In progress	Not started	In progress	Complete	In progress	In progress	Not started	Not started
<b>Detector resolution</b>	M. Uchida	In progress	Not started	In progress	Not started	Not started	Not started	Not started	Not started
<b>Detector efficiencies</b>	M. Uchida	In progress	Not started	In progress	Not started	Not started	Not started	Not started	Not started
<b>PID measurement</b>	C. Pidcott	In progress	Not started	Not started	Not started	Not started	Not started	Not started	Not started
<b>Magnet alignment</b>	C. Rogers	In progress	In progress	Not started	Not started	Not started	Not started	Not started	Not started
<b>Beam quality</b>	C. Hunt	Complete	In progress	Not started	Not started	Not started	Not started	Not started	Not started
<b>First emittance reduction</b>	C. Rogers	Complete	In progress	Not started	Not started	Not started	Not started	Not started	Not started
<b>Full emittance reduction</b>	Unassigned	Complete	In progress	Not started	Not started	Not started	Not started	Not started	Not started
<b>Non-linear optics</b>	R. Ryne	Complete	In progress	Not started	Not started	Not started	Not started	Not started	Not started
<b>MCS - field off</b>	John Nugent	In progress	In progress	Not started	Not started	Not started	Not started	Not started	Not started
<b>MCS - field on</b>	Celeste Pidcott	In progress	In progress	Not started	Not started	Not started	Not started	Not started	Not started
<b>Energy loss</b>	Rhys Gardner	In progress	In progress	Not started	Not started	Not started	Not started	Not started	Not started
<b>Energy loss</b>	Dimitrije Maletic	In progress	In progress	Not started	Not started	Not started	Not started	Not started	Not started
<b>Emittance exchange/wedge</b>	Pavel Snopok	In progress	In progress	Not started	Not started	Not started	Not started	Not started	Not started
<b>Beam polarisation</b>	Sophie Middleton	Complete	Complete	In progress	Complete	Complete	Complete	In progress	In progress
<b>Step I</b>									
<b>EMR</b>	F. Drielsma	Complete	Complete	N/A	Complete	Complete	Complete	In progress	In progress
<b>Pion contamination</b>	J. Nugent	Complete	Complete	N/A	Complete	Complete	Complete	In progress	In progress

# Physics shifter – Hall of Heroes



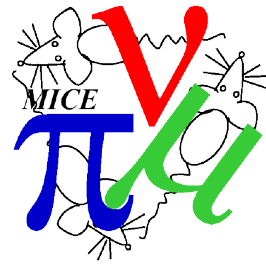
- Physics shifter job is to check the data meets goals of analysis
- ## 2014/03

Days	Shifter	Measurement	Measurement Coordinator	Report
25-26 April	Ryan Bayes	Beamline precommissioning	Jaroslaw Pasternak	<a href="#">2015-04-27_physics_shift_report</a>
18-19 April	Chris Rogers	Beamline precommissioning	Jaroslaw Pasternak	<a href="#">2015-04-20_physics_shift_report</a>
11-12 April	Victoria Blackmore	Beamline precommissioning	Jaroslaw Pasternak	Run cancelled
28-29 March	Ryan Bayes	Beamline precommissioning	Jaroslaw Pasternak	<a href="#">2015-03-30 Physics shifter report</a>
21-22 March	Chris Rogers	TOF Calibration	None	<a href="#">2015-03-23 Physics shifter report</a>

## 2015/01a

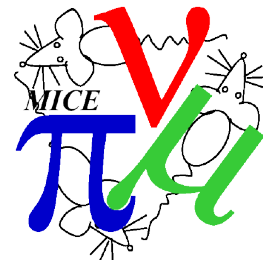
Days	Shifter	Measurement	Measurement Coordinator	Report
2-6 June	Ryan Bayes	Q1-3 scan	J. Pasternak	<a href="#">2 June</a>
7-11 June	Paolo Franchini	TOF calibration	J. Pasternak	<a href="#">12 June</a>
12-16 June	Chris Heidt	TOF calibration and Tracker Timing		
17-21 June	Chris Rogers	Tracker Timing	E. Overton	<a href="#">physics_shift_2015-06-17</a>
		Tracker Timing, TOF Calib		<a href="#">physics_shift_2015-06-18</a>
22-26 June	Paolo Franchini			
27 June - 1 July	Francois Drielsma			
2 - 4 July	Francois Drielsma			
14 - 18 July				
19 - 23 July				
24 - 24 July				

# Physics shifter - Gripes



- Physics shifter relies on offline reconstruction
  - MAUS is too difficult to run over multi-GB files locally
- Physics shifter needs support from measurement coordinator
  - Measurement coordinator needs to supply analysis tools e.g. analysis scripts
  - Ideal if physics shifter is already involved in the analysis
    - Hard to organise when the data taking is a “moving target”

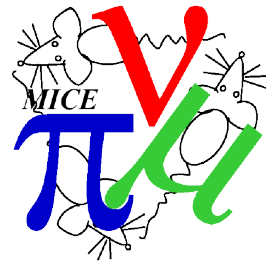
# Status run 2015/01



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	25
Beamline Pre-commissioning	4	SS	1	01a	12/06/15	16/06/15	25
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	25
Alignment to Other Detectors	1	Done	1	01a	26/06/15	27/06/15	25
Beam-Based Alignment 1	7	Done	1	01a	27/06/15	04/07/15	0
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	0
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	0
Optics Validation	21	Done	3	01b	20/07/15	27/07/15	0

- % done is Rogers “thumb in the air”
- Not doing too badly compared to “baseline/optimistic” run plan

# Plan for run 2015/02

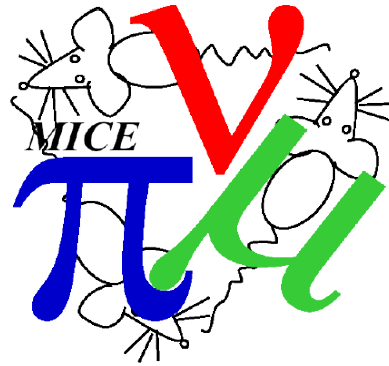


- Uncertainties
  - Not clear how much field-on data we will get from 2015/01
  - Will IH2 system be available?
- Aims
  - Finish beam-based magnet alignment outstanding
  - Beta function scan at 200 MeV/c
  - Momentum scan at 420 mm
  - Phase advance scan
  - Field-off Multiple Coulomb Scattering measurement
  - Any other special energy loss/MCS measurement
  - Emittance scan at 200 MeV/c
  - Emittance momentum matrix
- I think this needs a bit more detail...
  - Optics settings are in progress



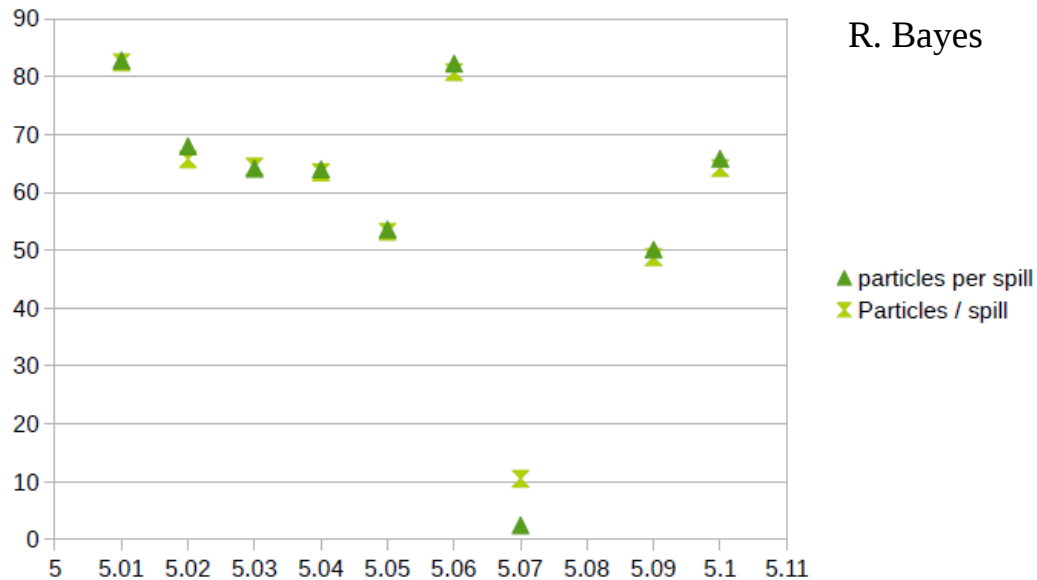
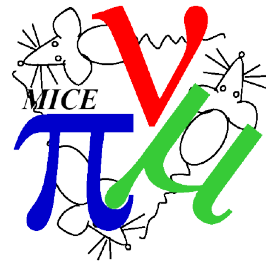
# Summary of Presentations

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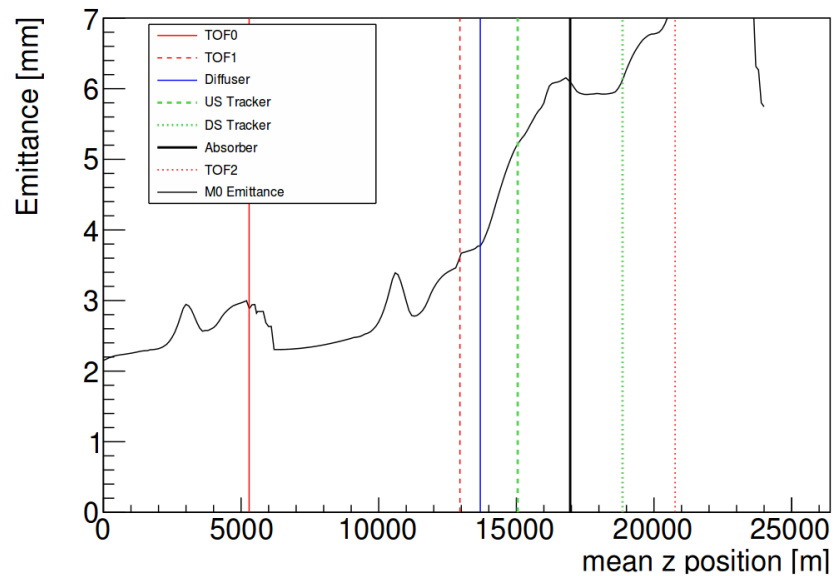
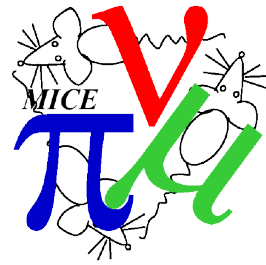


# Beamline Pre-Commissioning (J Pasternak)



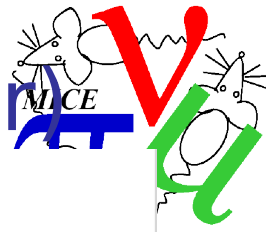
- Described three data taking periods
- 19<sup>th</sup> April Q123 scan without DS
  - Failed due to scalars disconnected
- 25<sup>th</sup> – 26<sup>th</sup> April Step I settings test
  - Awaiting analysis
- 2<sup>nd</sup> June Q123 scan with DS
  - Showed no improvement in rate at TOF0

# Batch Production and Physics Block Challenge (R. Bayes)

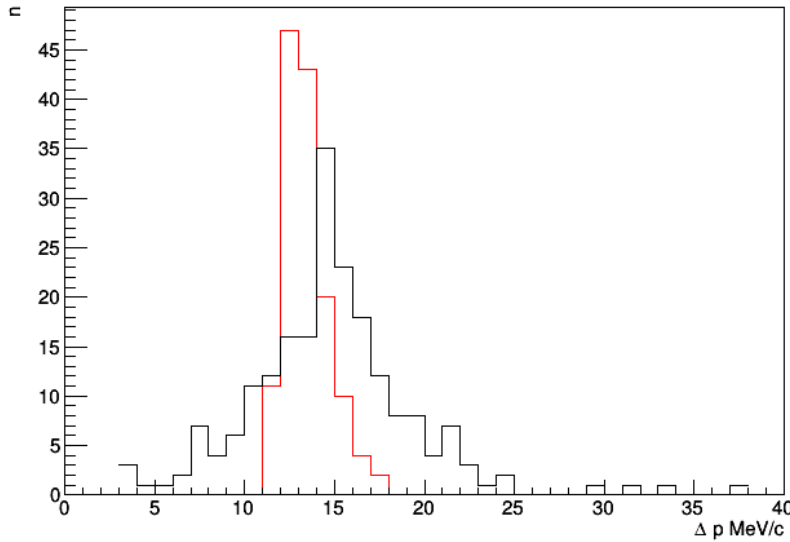


- Grid/Batch Production of MC
  - Simulation has been tested on the GRID from end to end
  - Archival support has not been tested
  - Have begun simulations of a beamline library
- Physics Block Challenge
  - New 6 mm/200 MeV/c setting generated
  - First analysis done;
    - Beam is dominated by mismatch
    - Could do with a momentum cut

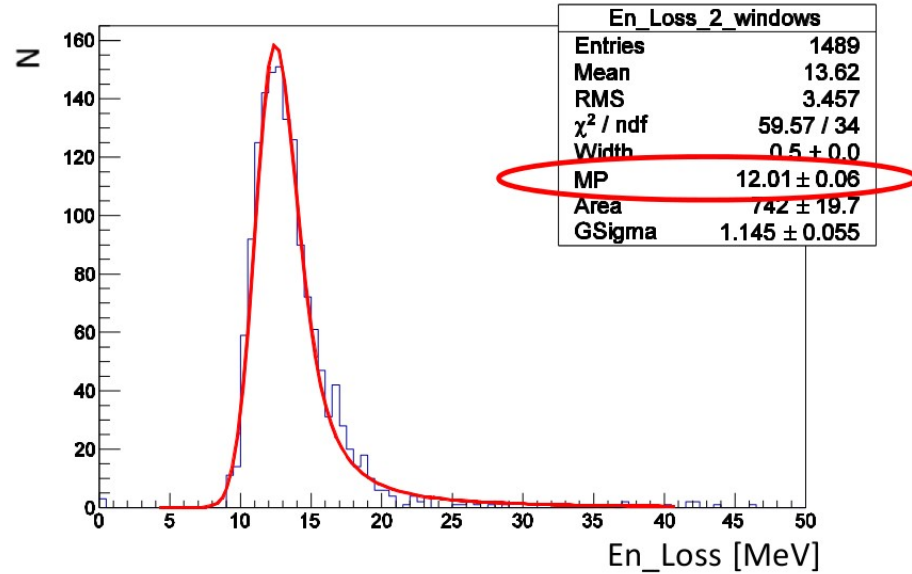
# Energy loss measurement (Dimitrije Maletic, Rhys Gardener)



Ploss

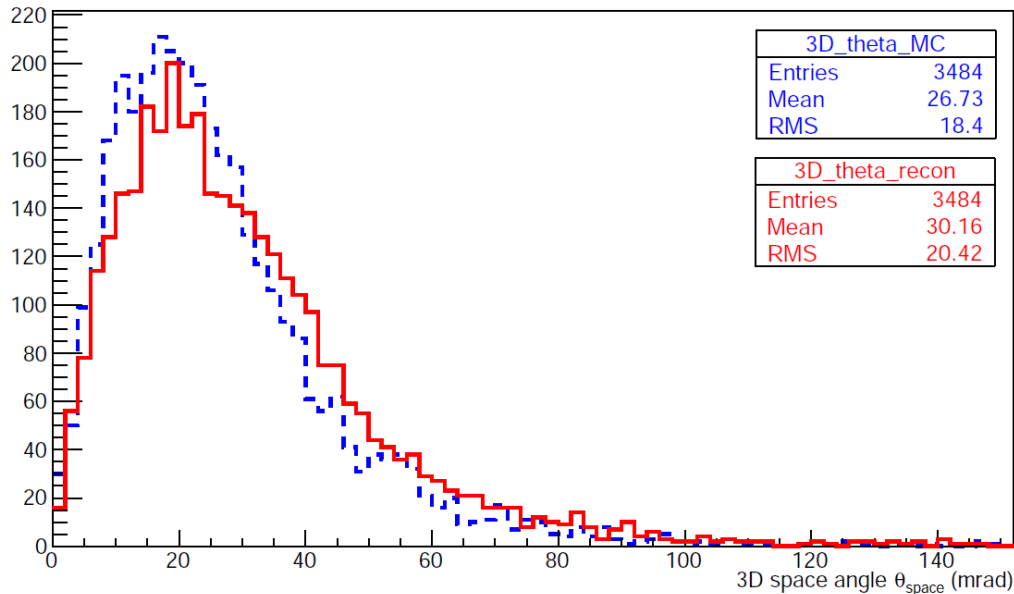
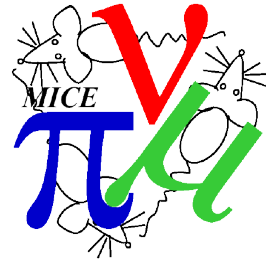


LiH target energy loss



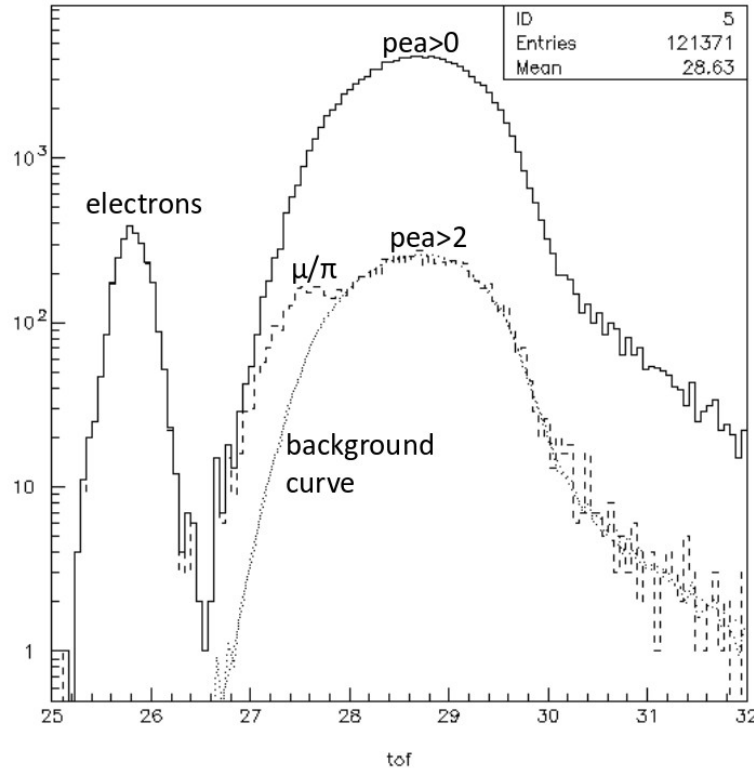
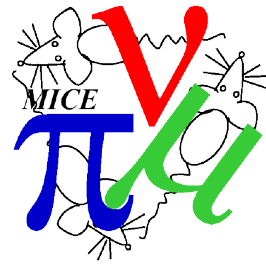
- Two complementary studies
  - Energy reconstruction compared to energy loss (R. Gardener)
  - Energy loss and geometry model in MAUS (D. Maletic)
- Energy loss measurement looks hard
  - Discussed ways to reduce the error
  - E.g. select off-axis beam

# MCS measurement (Celeste Pidcott, John Nugent)



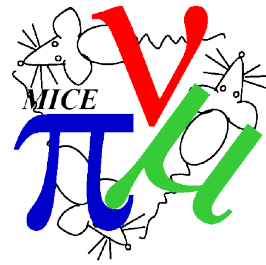
- Two complementary studies
  - Energy reconstruction compared to energy loss (R. Gardener)
  - Energy loss and geometry model in MAUS (D. Maletic)
- Energy loss measurement looks hard
  - Discussed ways to reduce the error
  - E.g. select off-axis beam

# Ckov analysis (Lucien Cremaldi)



- Ckov light threshold appears to have moved
  - Change in refractive index of both ckovs
  - $1.07 \rightarrow 1.09$ ;  $1.11 \rightarrow 1.14$
- Use shoulder in pe peak to id pion contamination

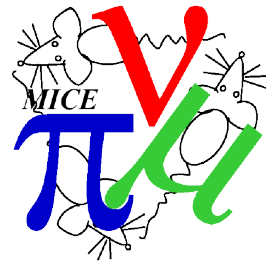
# Wedge absorber (Dave Neuffer)



$z(\text{cm})$	$P_z$ MeV/c	$\epsilon_x(\mu)$	$\epsilon_y$	$\epsilon_L$ (mm)	$\sigma_E$ MeV	6-D $\epsilon$ increase
0	<b>140</b>	272	268	1.22	0.68	1.0
1.4	135.7	102	273	4.0	2.15	1.2
2.8	131.3	<b>67.8</b>	275	7.5	3.92	1.44

- Wedge parameters are not accessible by MICE
  - Rogers to work with Dave to develop accessible parameters

# Bayesian Analysis (R. Ryne)



Inference of 10 solenoid parameters and 4 measurement uncertainties

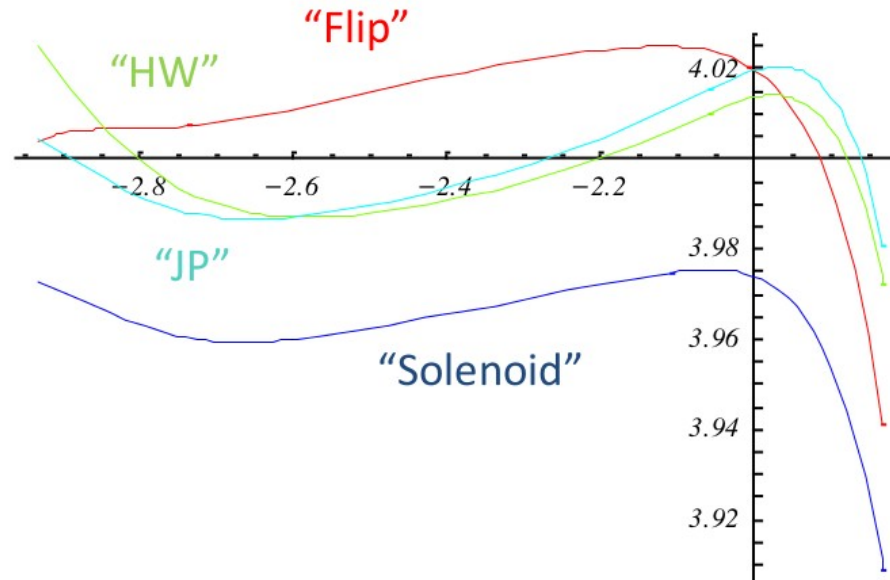
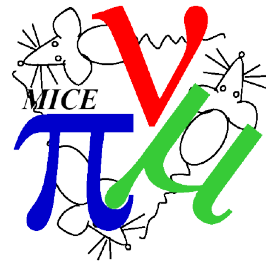
	parameter	exact	prior mean	posterior mean	prior std. dev.	posterior std. dev.
current density	$\theta_1$	151.634	147.	151.623	40.	.0185
	$\theta_2$	123.807	131.	123.752	40.	.0615
	$\theta_3$	142.602	135.	142.762	40.	.0722
	$\theta_4$	118.863	113.	118.930	40.	.0496
	$\theta_5$	103.874	104.	103.743	40.	.0652
	$\theta_6$	-101.920	-104.	-101.668	40.	.0918
	$\theta_7$	-108.330	-112.	-108.203	40.	.0753
	$\theta_8$	-132.950	-140.	-132.786	40.	.0976
	$\theta_9$	-127.378	-131.	-127.736	40.	.1266
	$\theta_{10}$	-133.948	-147.	-134.162	40.	.0669
1/variance	$\tau_1$	6.250e6	5.e6	6.256e6	1.0e6	.0903e6
	$\tau_2$	2500.	5000.	2434.	2236.	33.8
	$\tau_3$	6.250e6	5.e6	6.351e6	1.0e6	.0867
	$\tau_4$	2500.	5000.	2508.	2236.	36.7

# of observations=10000    length of MCMC chain = 5000 after 5000 burn-in

13

- Analysis technique to calculate transfer matrix and magnet parameters

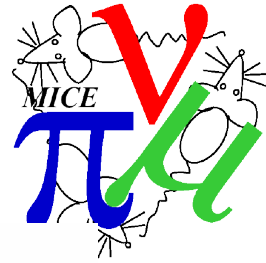
# Cooling Channel (J. Pasternak)



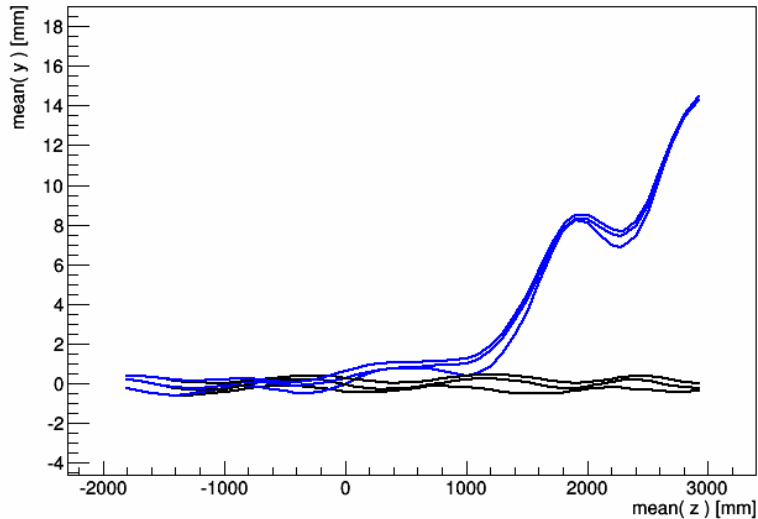
- Continuing to improve estimate of real field effects
- SS field uniformity



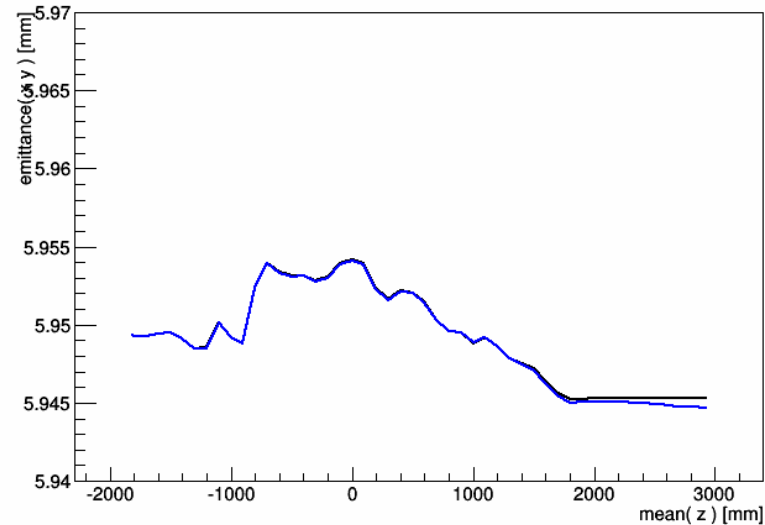
# Misalignments - effect



10k muons

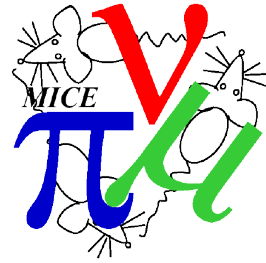


10k muons

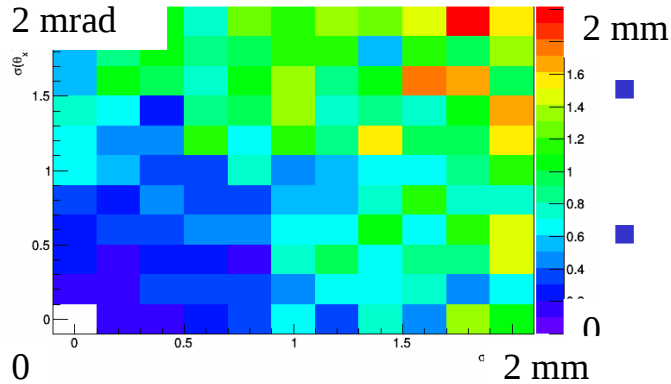


- Geometry is J. Cobb 2015-05-11 in solenoid mode
  - No material, only magnetic fields
- How does the emittance respond?
  - BLACK: magnets with perfect alignment
  - BLUE: magnets with measured alignment
    - Few different emittances in left hand plot
  - Small increase in emittance

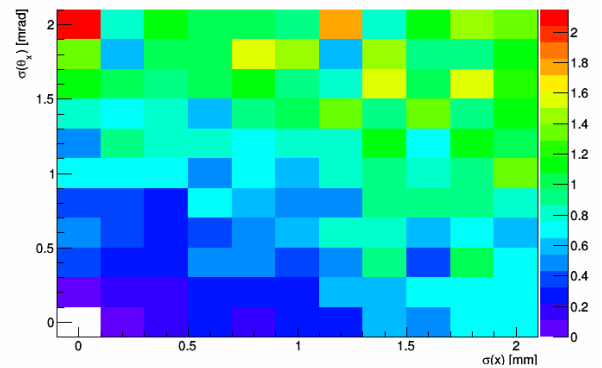
# Measurements (sensitivity)



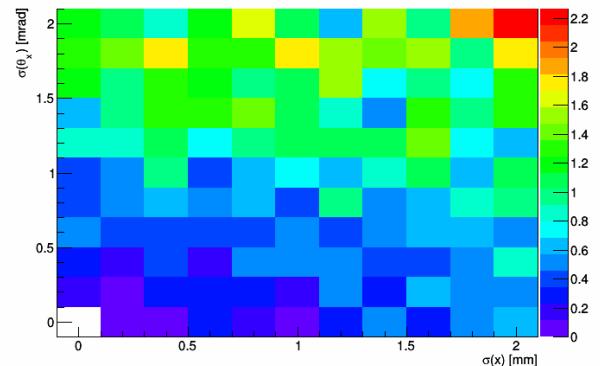
RMS movement of beam centre [mm] as a function of SS\_US RMS offset and tilt



RMS movement of beam centre [mm] as a function of AFC RMS offset and tilt

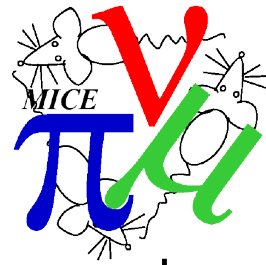


RMS movement of beam centre [mm] as a function of SS\_DS RMS offset and tilt



- Move a module
  - Align everything else perfectly
- What is the dependence of downstream position of an axial particle on tilt, offset?
  - Sample size is only 10 axial mu per grid point
- Expect to be able to perform beam-based measurement of field at 1 mm-mrad scale
  - May be able to do better with appropriate statistical analysis

# Coming up...



- Magnetic field mapping and implications for magnet alignment
- Measurement of beam polarisation from Step I data
- MICE demonstration of ionisation cooling
- Pion contamination paper update
- EMR paper update
- ... a full session, please keep questions to the end of each talk