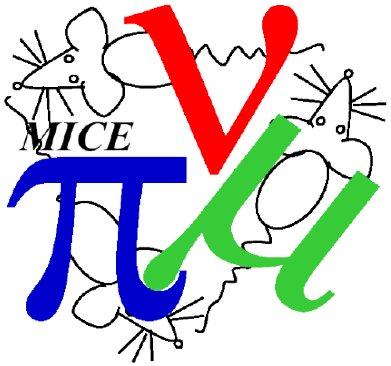
Physics Coordinator Report



C. Rogers,
ASTeC Intense Beams Group
Rutherford Appleton Laboratory

ASTeC

Physics Coordinator Report

- Step IV papers
  - Status of planning for Step IV
- Summary of presentations
  - Software parallel I (hope) will be summarised in Durga's talk
  - Magnetic fields and alignment
  - Quality of transported beam and cooling channel optics
  - Measurement of energy loss and beam polarisation
  - Batch production, xboa, data rate

Step IV Papers

- For quick release (these are papers):
  - **Description of MICE Step IV**
  - **First observation transverse emittance reduction**
- Slower boil, worthy of a publication, maybe not one per bullet
  - **Diagnostics**
    - Global track fitting
  - **Magnetics**
    - Measurement of optical emittance growth and non-linearities
    - Direct measurement of the transfer map including higher order terms
  - **Absorber**
    - Energy loss
    - Multiple scattering
    - Angular momentum
    - Beam (de)polarisation
    - Wedge
  - **“Cooling Channel”**
    - (Long, probably following end of Step IV with all results in) Observation of transverse emittance reduction
    - Emittance exchange with wedge

Physics support of operations

- We must turnaround physics soon after data taking begins
  - Requirement from funding agencies
- We can only get one chance at many measurements
  - Data taking period is short
- Need to be well prepared for data taking
  - We should be worrying about the problems, not the basic analysis
- Practice all of our data taking in advance using MC
  - Named measurement coordinator for each measurement
  - Live data checking
- Experience shows that without this we will take the wrong data or get hung up at analysis time
- Definition of measurement coordinator roll
  - http://micewww.pp.rl.ac.uk/documents/116
  - Next slide

Measurement coordinator

- Each “measurement” has a coordinator who must organise
  - Experimental configuration (currents, etc)
  - MC and analysis/planning
  - Any fast turnaround analysis tools
  - Coordination with MOM during data taking
  - Liaise with physics coordinator to arrange “physics shifters”
  - Evaluate need for more data following data taking
    - In liaison with operations/physics coordinators
- “Physics shifters”
  - Check that they can analyse the data
    - Using fast turnaround in recon, which must be working
  - Check that the analysis of the data looks sensible
  - Run any checks specified by the measurement coordinator
- Would like to get a physics shifter in place for >= March 21st
  - Even if they are looking at a less complete set of data/analyses
- Caveat: status of measurement planning (next slide)

Status of Planning for Step IV (1)

Before data taking

Measurement	Champion	Principle of Measurement	Laptop Studies	Batch MC & Analysis	Final Run Settings	Data Taking	First Analysis & Data Checks	Final Analysis	Publication
		Step IV							
Magnet Mapping	V. Blackmore	Complete	Complete	N/A	Complete	Complete	Complete	In progress	Not started
Detector alignment	M. Uchida	In progress	Not started	In progress	Not started	Not started	Not started	Not started	Not started
Detector resolution	M. Uchida	In progress	Not started	Not started	Not started	Not started	Not started	Not started	Not started
Detector efficiencies	M. Uchida	In progress	Not started	Not started	Not started	Not started	Not started	Not started	Not started
PID measurement	C. Pidcott	In progress	Not started	Not started	Not started	Not started	Not started	Not started	Not started
Magnet alignment	C. Rogers	In progress	In progress	Not started	Not started	Not started	Not started	Not started	Not started
Beam quality	C. Hunt	Complete	In progress	Not started	Not started	Not started	Not started	Not started	Not started
First emittance reduction	C. Rogers	Complete	In progress	Not started	Not started	Not started	Not started	Not started	Not started
Full emittance reduction	Unassigned	Complete	In progress	Not started	Not started	Not started	Not started	Not started	Not started
Non-linear optics	R. Ryne	Complete	In progress	Not started	Not started	Not started	Not started	Not started	Not started
MCS	Unassigned	In progress	Not started	Not started	Not started	Not started	Not started	Not started	Not started
Energy loss	Unassigned	In progress	Not started	Not started	Not started	Not started	Not started	Not started	Not started
Emittance exchange/wedge	Unassigned	In progress	In progress	Not started	Not started	Not started	Not started	Not started	Not started
Beam polarisation	Sophie Middleton	Complete	In progress	Not started	Not started	In progress	In progress	Not started	Not started

Status of Planning for Step IV (2)

Measurement	Champion	Principle of Measurement	Laptop Studies	Batch MC & Analysis	Final Run Settings	Data Taking	First Analysis & Data Checks	Final Analysis	Publication
Step IV									
Magnet Mapping	V. Blackmore	Complete	Complete	N/A	Complete	Complete	Complete	In progress	Not started
Detector alignment	M. Uchida	In progress	Not started	In progress	Not started	Not started	Not started	Not started	Not started
Detector resolution	M. Uchida	In progress	Not started	Not started	Not started	Not started	Not started	Not started	Not started
Detector efficiencies	M. Uchida	In progress	Not started	Not started	Not started	Not started	Not started	Not started	Not started
PID measurement	C. Pidcott	In progress	Not started	Not started	Not started	Not started	Not started	Not started	Not started
Magnet alignment	C. Rogers	In progress	In progress	Not started	Not started	Not started	Not started	Not started	Not started
Beam quality	C. Hunt	Complete	In progress	Not started	Not started	Not started	Not started	Not started	Not started
First emittance reduction	C. Rogers	Complete	In progress	Not started	Not started	Not started	Not started	Not started	Not started
Full emittance reduction	Unassigned	Complete	In progress	Not started	Not started	Not started	Not started	Not started	Not started
Non-linear optics	R. Ryne	Complete	In progress	Not started	Not started	Not started	Not started	Not started	Not started
MCS	Unassigned	In progress	Not started	Not started	Not started	Not started	Not started	Not started	Not started
Energy loss	Unassigned	In progress	Not started	Not started	Not started	Not started	Not started	Not started	Not started
Emittance exchange/wedge	Unassigned	In progress	In progress	Not started	Not started	Not started	Not started	Not started	Not started
Beam polarisation	Sophie Middleton	Complete	In progress	Not started	Not started	In progress	In progress	Not started	Not started

March

June+

June+

September

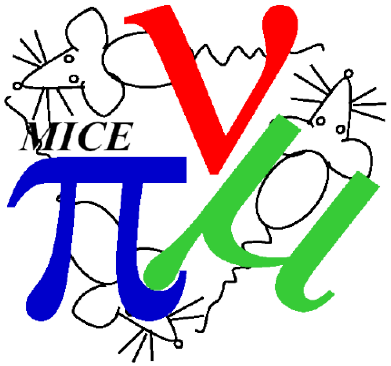
Status of Planning for Step IV (3)

- All of the physicists are panicking over getting kit/code ready
  - Understandable
- Time for analysis is short
  - 3 months of activity, limited progress
  - 3-6 months before data comes
- I cannot guarantee “that results from the Step IV data-taking are obtained as soon as possible in order to support the UK application to STFC for remaining funding for the completion of the project.” (MICE project board)

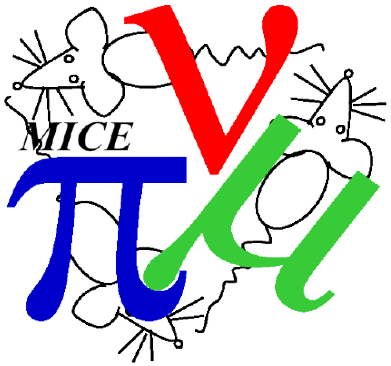
Run coordination meeting

- ISIS run 2015/01 starts 2nd June
  - Field off run, expect to have full complement of detectors
  - In context of magnet commissioning
  - Calibration and alignment...
- Propose run planning workshop around end of March
  - Decide on physics goals of June run
  - Outline run plan

Summary of Presentations



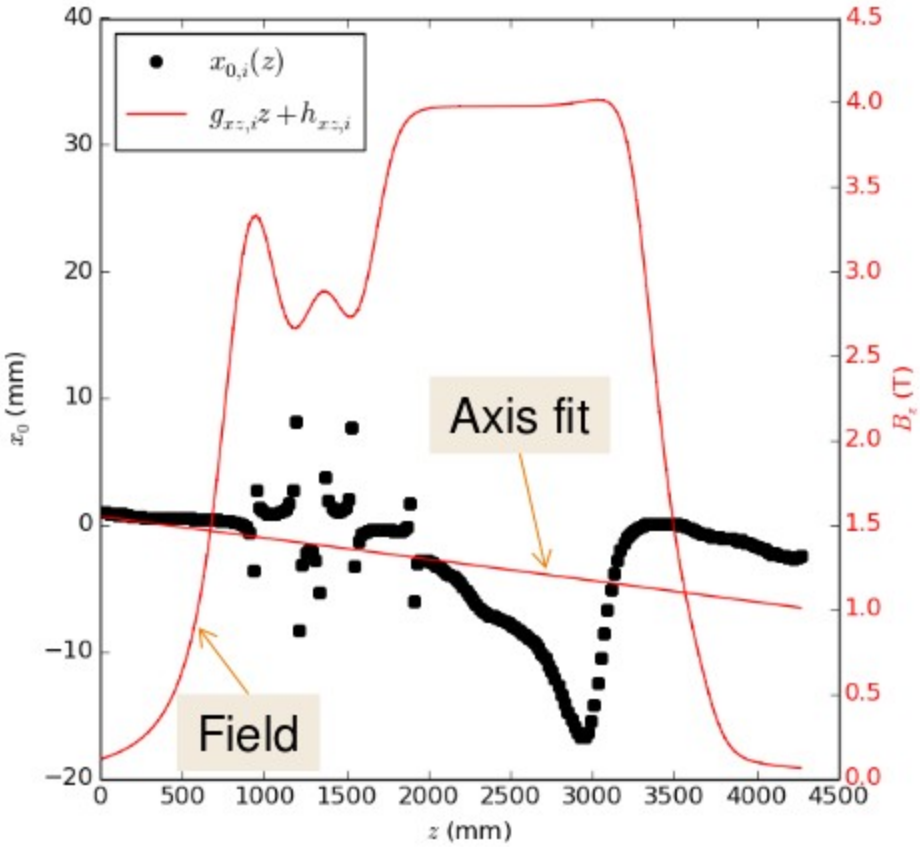
Field Mapping

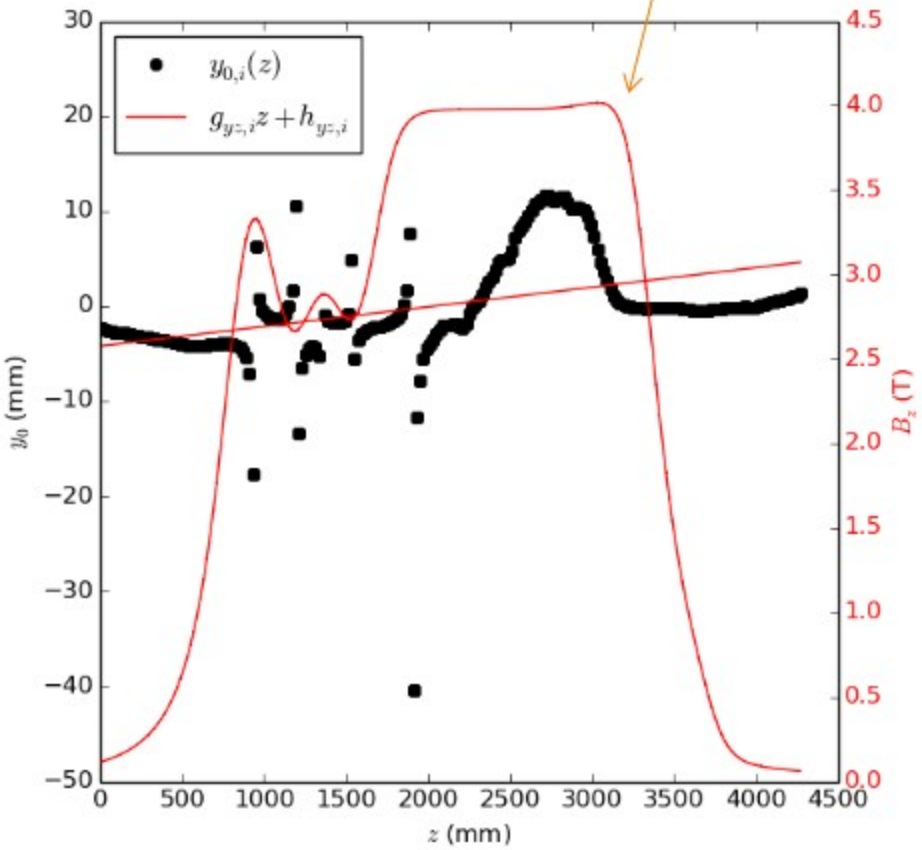


V. Blackmore
Imperial College

USS, fitting over full z-range

Non-uniform, E2 needs turning down (see DSS for 'tweaked' flat field) – Also see this in MAUS with 'default' currents.

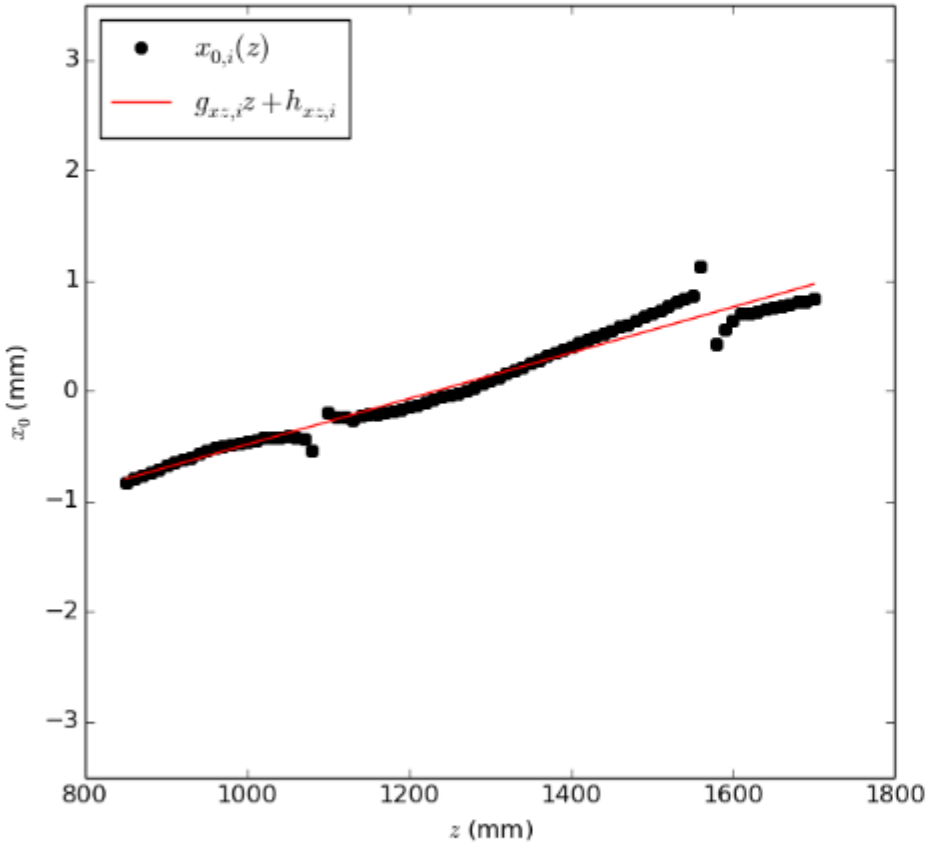


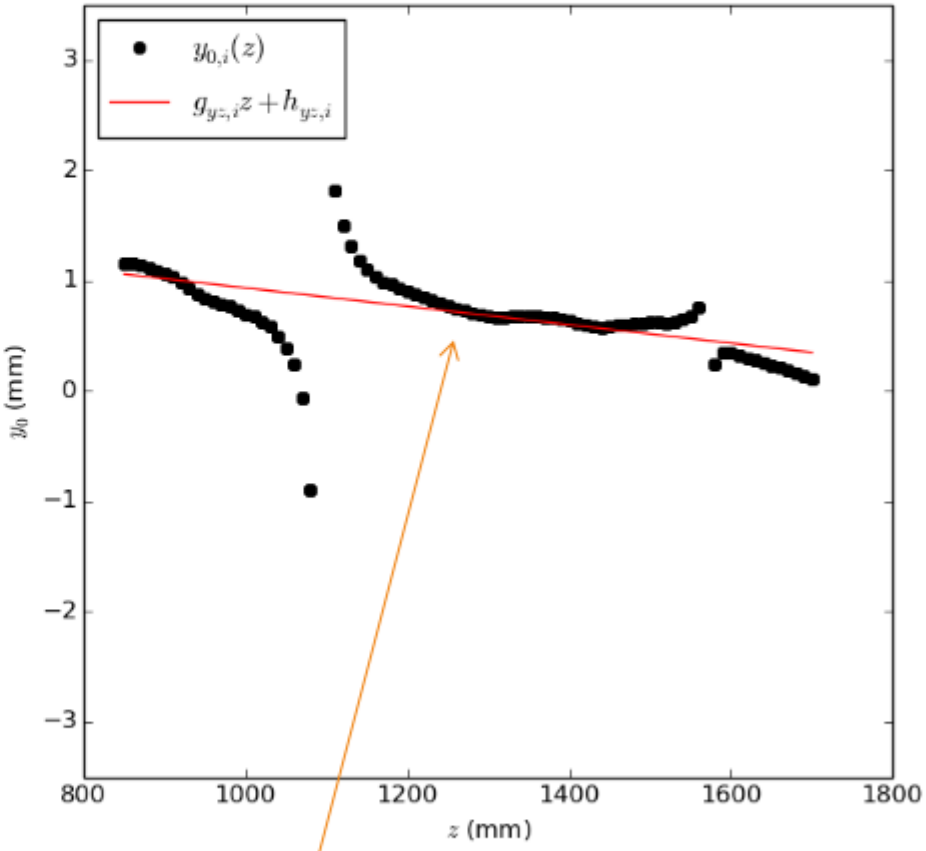


Reminder: All lines are in the mapper co-ordinate system.

FC2

(Run 3, 100A, flip mode)

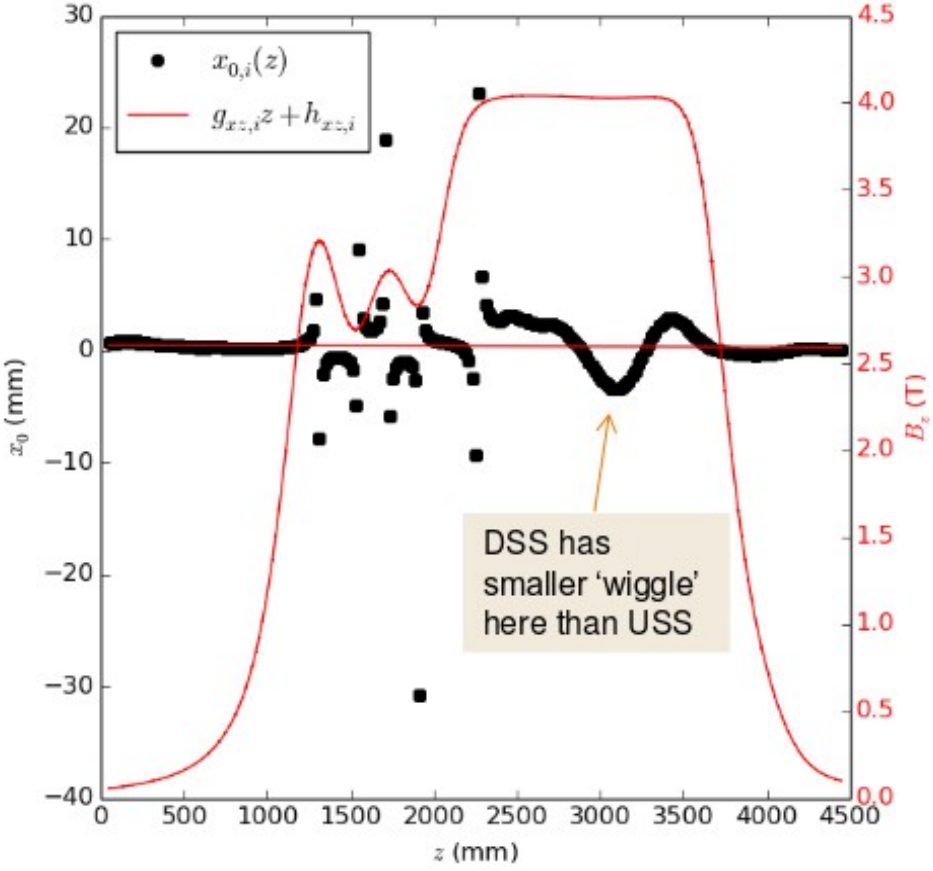


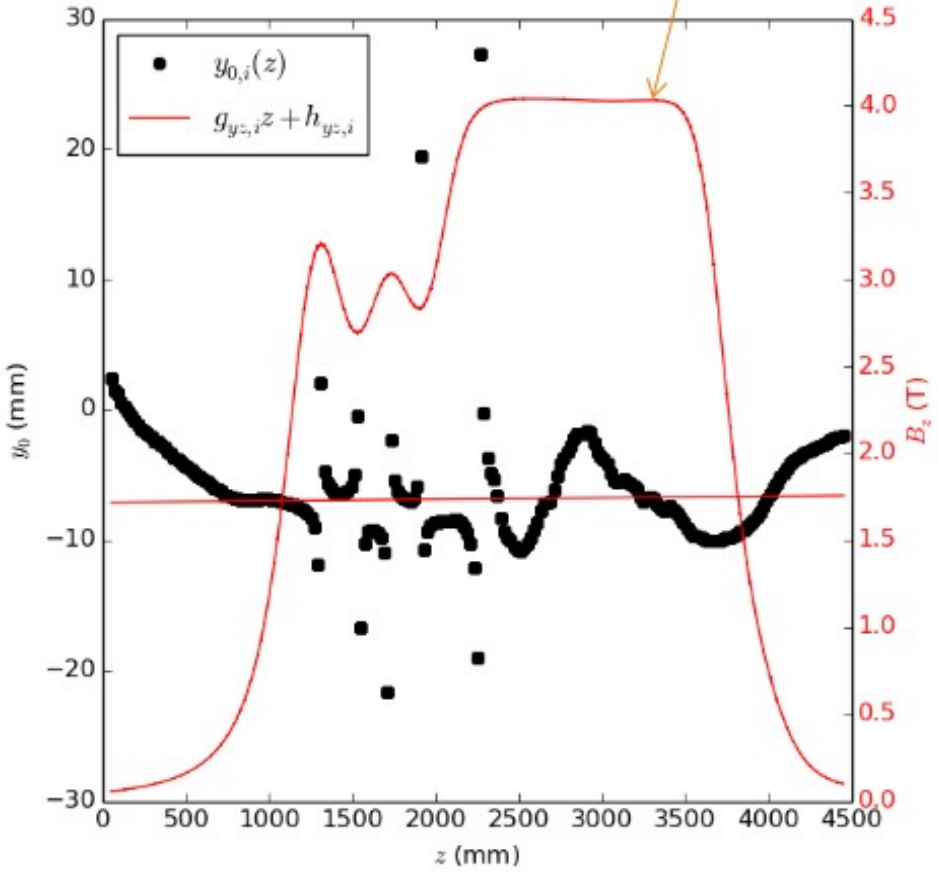


Has more ‘character’ than FC1

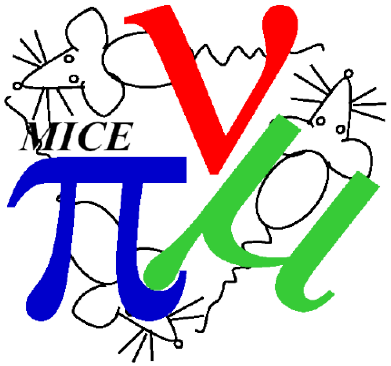
DSS, fitting over full z-range

Much flatter with tweaked currents.





Beam based alignment (measurement)



V. Blackmore
Imperial College

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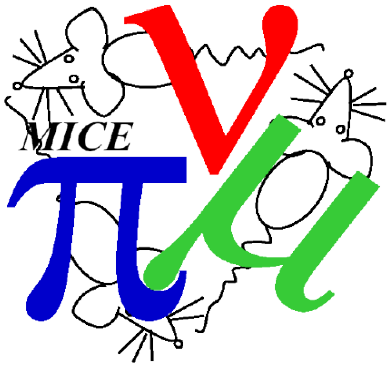
Alignment between Modules

- What is the algorithm we use?
- Multiparameter minimisation
  - Fix currents, apply minimisation
    - Minimise chi2 of upstream tracker propagated to downstream tracker
  - 3 modules * 5 parameters = 15 parameter fit
  - Many data points, it may work
- Single magnet powered
  - Power one magnet, apply minimisation
  - 5 parameter fit, many data points, it should work
  - But effects due to non-linearities may dominate
    - e.g. effect of iron is likely to be different if the field is in the linear regime
- Scale magnet power
  - Move current on one magnet up and down, look at movement of beam centre
    - Should be possible to use individual tracks, but I haven't thought how
  - 5 parameter fit, not many data points, it may work
  - Effects due to non-linearities may be less significant

Effect of Iron/Non-linearities

- Open question about how we model iron
  - At the moment we need to hand current settings to Holge
  - Holge builds a field map in OPERA/whatever
- This is not really manageable
  - Need a reasonable model for mapping currents to field maps
    - E.g. Enge model, what are the parameters?
  - Need to validate that model somehow

MICE Muon Beamline



J. Pasternak
Imperial College

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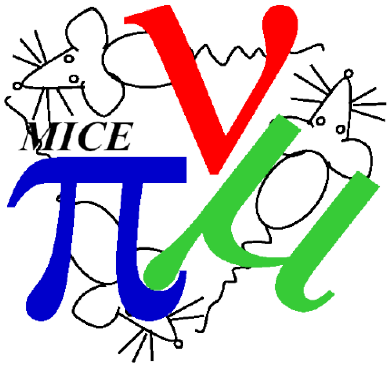
Sensitivity to magnet alignments



C. Hunt
Imperial College

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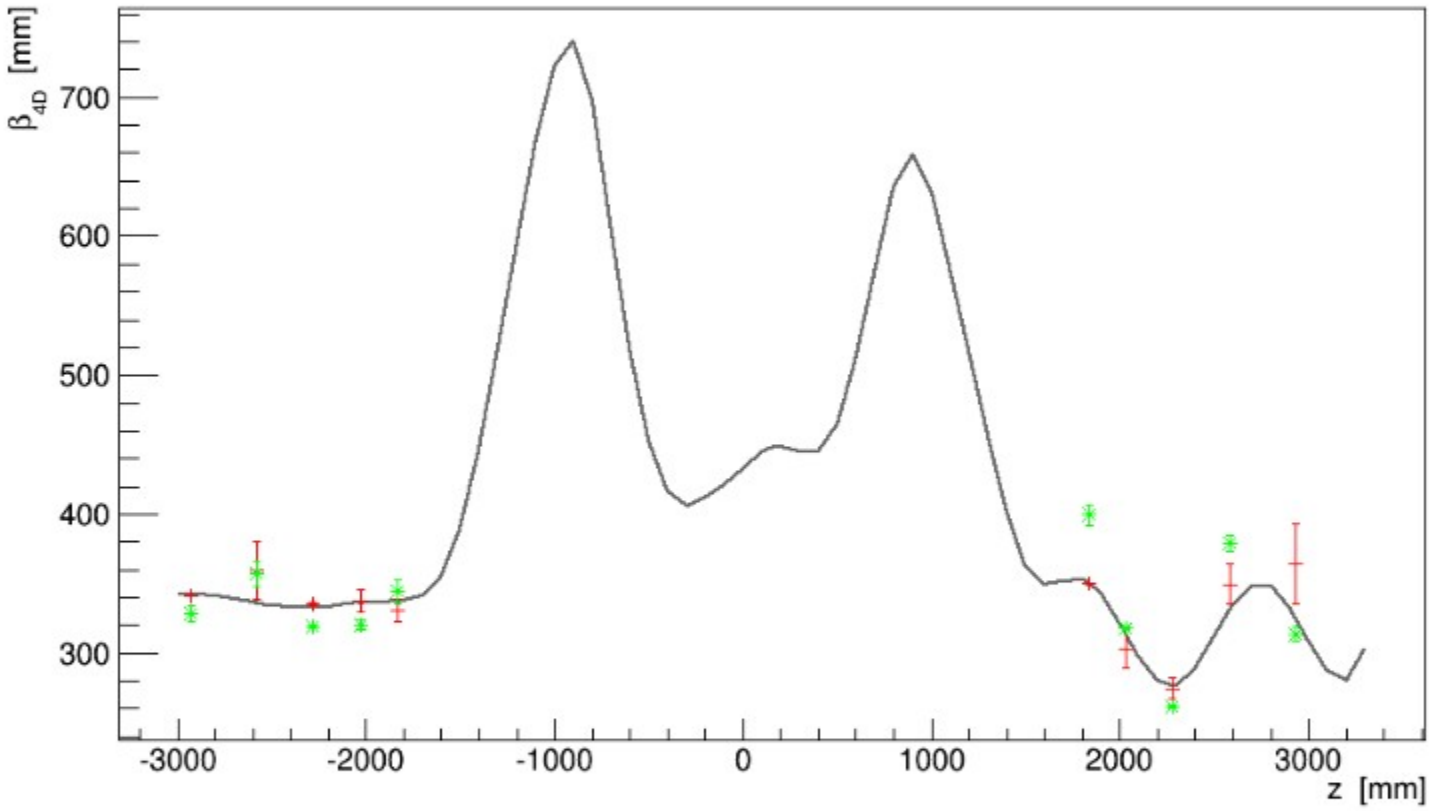
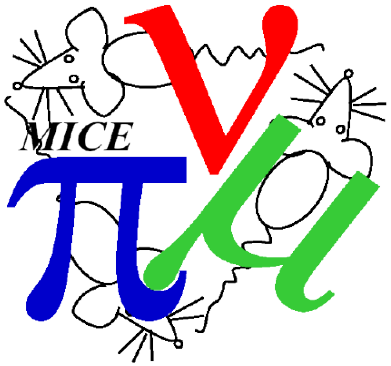
Beta Function



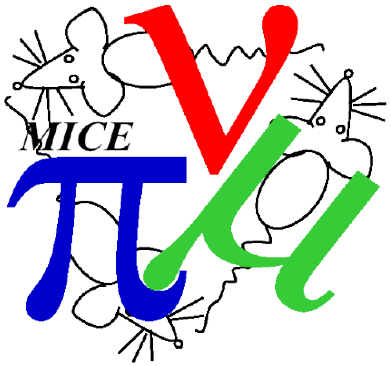
Preliminary

Cooling Channel Optics at Step IV



J. Pasternak
Imperial College

Nonlinear beam dynamics



R. Ryne
Lawrence Berkeley National Laboratory

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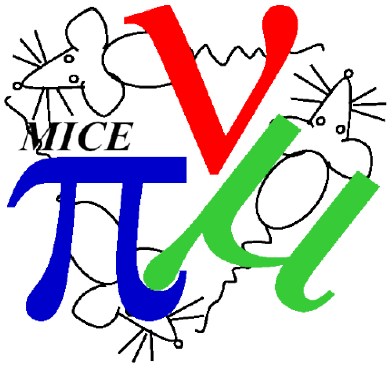
Conclusions (with absorber)

- Mismatch can cause significant emittance growth, obscure the cooling
  - In the mismatched example studied here, a 4% cooling effect due to LiH absorber was reduced to a 1% effect
  - But this needs to be studied further using a degree of mismatch that is physically motivated
- Measurement error (based on the simple model used here) does not appear to be a significant problem

Measurement of energy loss and MCS



J. Cobb
Oxford University

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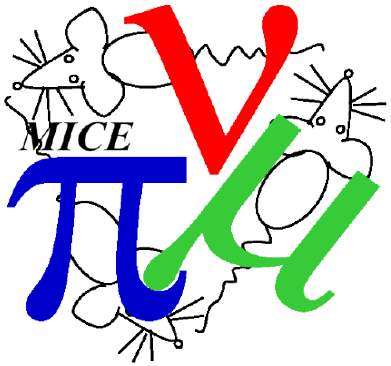
SUMMARY

1. Must have model if measurements are to be useful

2. Forget about measuring dE/dX distributions
   - Energy resolution just not good enough

3. May be possible to measure scattering
   - Doesn't beat MUSCAT
   - Straight track angular resolution better than with fields
   - Substantial unfolding required in either case
   - Conclusions should be checked with full tracker recons.

Measurement of beam polarisation



S. Middleton
Imperial College

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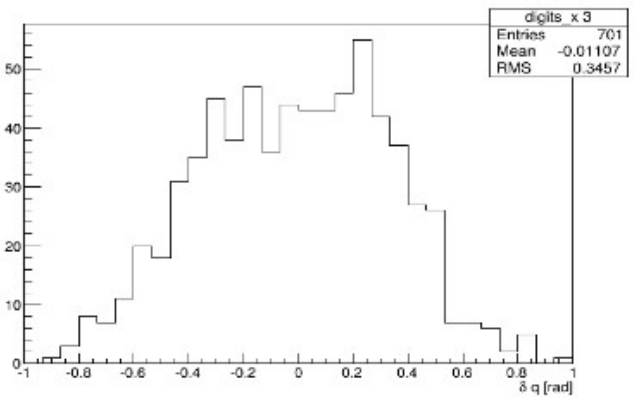
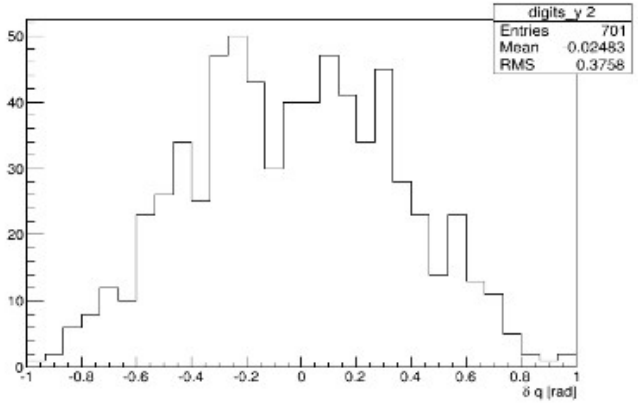
Residuals

Difference between reconstructed decay angle and true decay angle (as taken from MC)

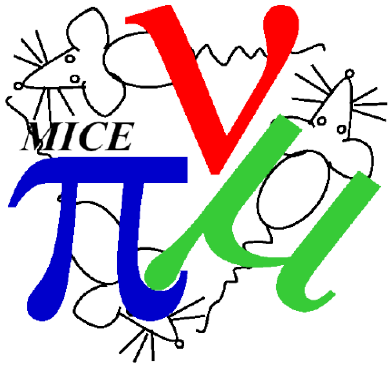




- RMS varies from **0.3-0.4 rad** for horizontal and vertical. - **sufficient for the study**
- **From detector limits: with a track length of ~10 bar widths then tan(theta) = 1/10 → theta ~0.1 rad → I think 0.3 rad is ok**

Imperial College London

Ckov



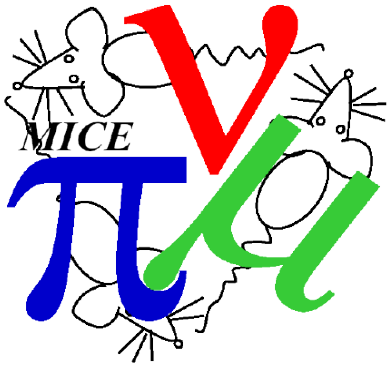
(Kaplan)/Cremaldi/Winter
IIT/Mississipi

ASTeC

Summary

- New pedestal and fadc Integrators code very close to being submitted.
- 2014 HV scans have been analysed with new pedestal and fadc charge integrators.
- MC hit generators and reco code forthcoming.
- Ckov thresholds and responses seem stable. Efficiency is high for particles above threshold. The inefficiency is more important for pion ID.
- Light splashes below Ckov threshold being investigated.

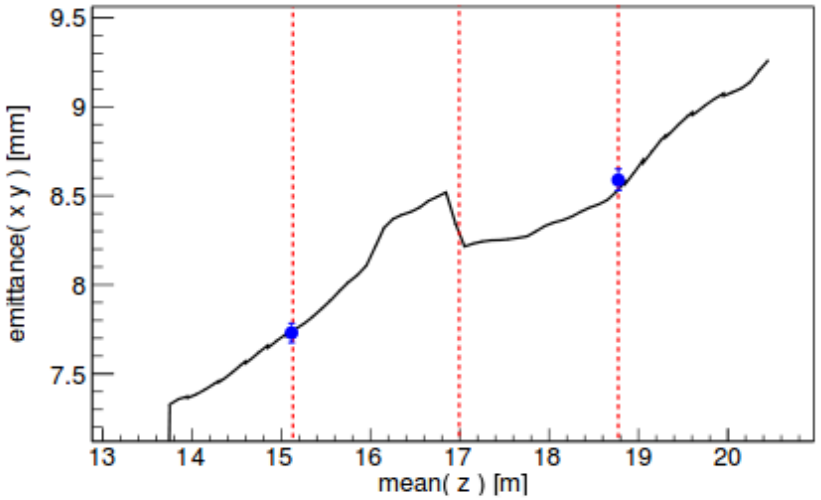
Status of Batch MC

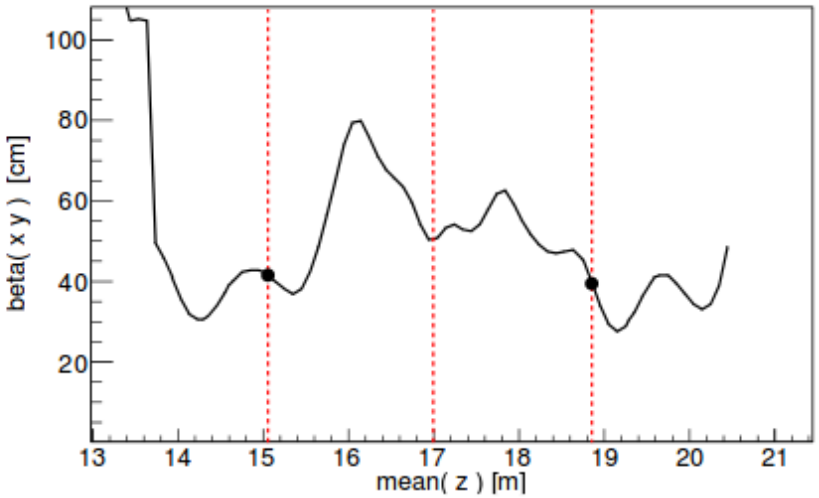


R. Bayes
Glasgow University

Emittance Analysis of Existing Simulation

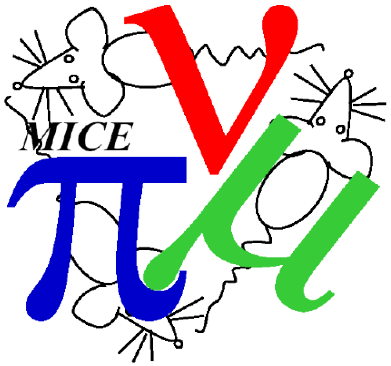
- Thanks to Chris Hunt for his analysis.
- Total of 20000 events pass cuts.
- Increase of emittance across absorber.
- Corrected reconstruction shown with blue dots





- Beta function shows poor matching.
  - Not symmetric across the absorber.
  - Large local minimum at absorber.

xboa and online analysis



C. Rogers
RAL

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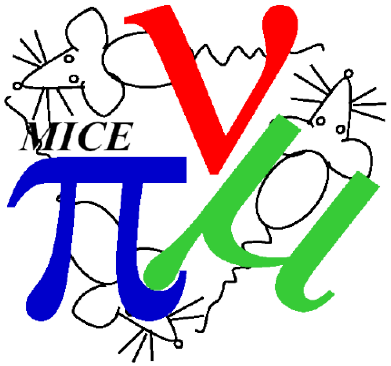
XBOA

- G4MICE Analysis package
  - Developed by Rogers as part of graduate studies
  - Needed a refactor
- XBOA
  - Developed to support Neutrino Factory design study
  - Developed outside of G4MICE framework
    - G4MICE was dying
  - Aim to make “plot emittance vs z” type needs easy:
  - Three lines of code:
    - Import library
    - Load file
    - Make the plot
  - Aim to make more complicated things easier
    - Cuts/statistical weighting
    - Amplitude calculations and plots
    - 2D/4D/6D
- Available for people to use now
  - Comes packaged with MAUS

Data rate and Trigger



C. Rogers
RAL

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Job list

- Set the desired number of good muons/what are the aims/scope?
- Generate (re)optimised beamlines
- Redo analysis with optimised beamline
  - Consider collimation scheme somewhere before TOF1
- Redo analysis with softer transverse cut
- Redo analysis with softer momentum cut
- Look at TOF2 trigger effect on analysis i.e. downstream cut