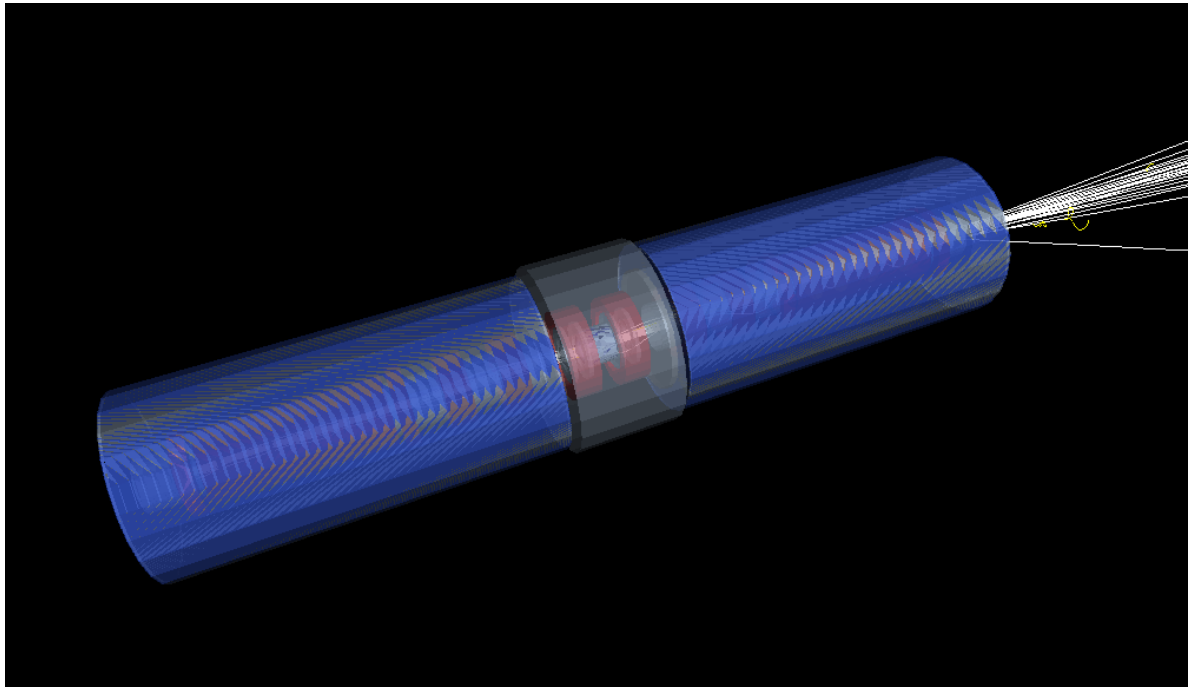
Cooling Perfomance of MICE Stage 4 With Reduced Current AFC

J. Pasternak, J. Lagrange, C. Hunt
Imperial College

May 29, 2014

MICE Step 4

One absorber, no RF, two trackers. Step 4 in simplicity.
Geometry tweaked to values provided by Pierrick



The AFC

Assuming a derrated focus coil in Step IV

First estimate: assume *approximate* derrating of 11%
(thanks to John Cobb)
Approx 167A

Beneficial to use asymmetric match currents in the Spectrometer Solenoids.
(First order Match Coil current reduction equal to fraction momentum loss through absorber)

A Recap

Last time...

- Using MAUS to simuate the beamline
- XBOA to perform the analysis
- Virtual plane emittance calculation
- Track reconstruction emittance calculation

The Problems...

- Position and momentum residuals between Virtual and Recon trackpoints were too large
- Emittance calculations were out by 0.6% and 2.6%
- Covariance corrections weren't yet working

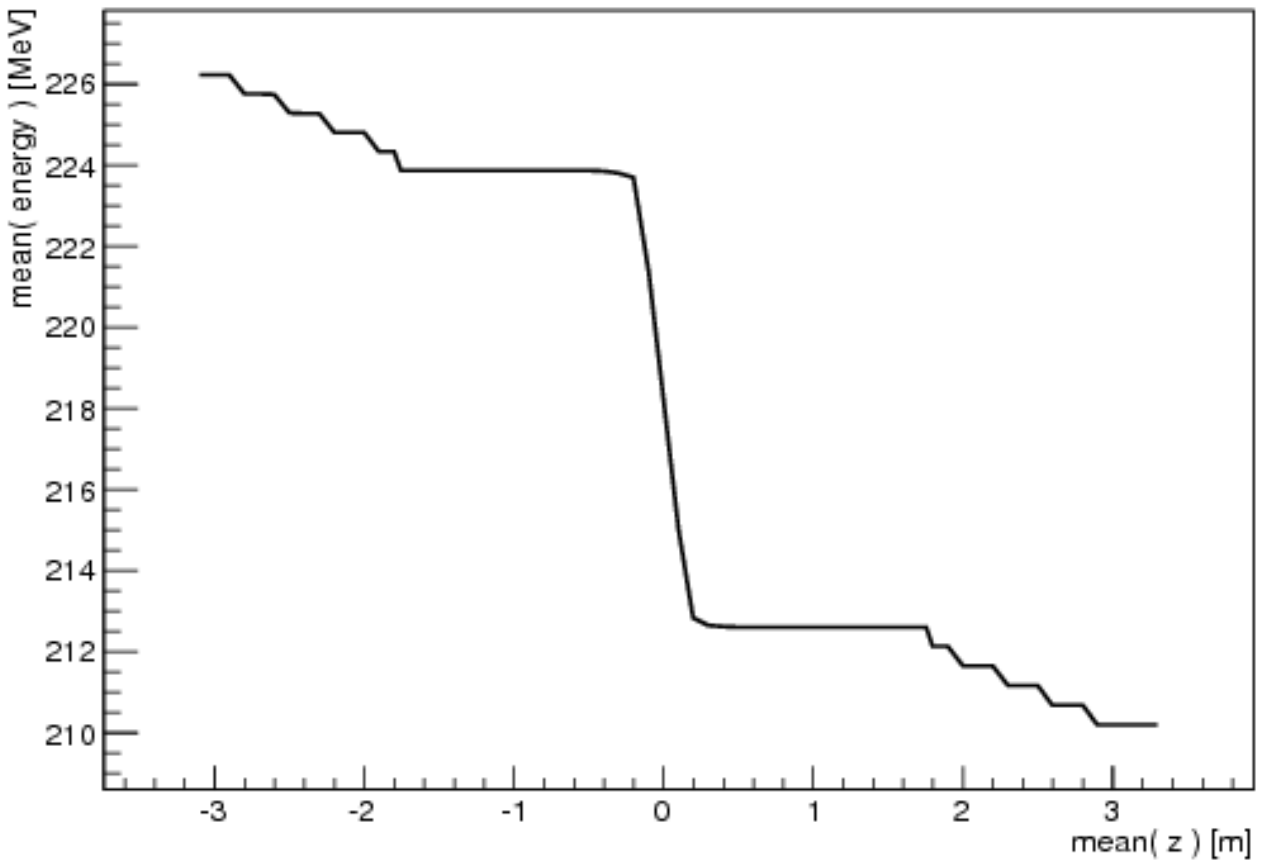
Method and Improvements

- **NEW** using *tracker_devel* branch of MAUS - Not the release! (Following 0.8.3)
- Assumed idealised input distributions (Gaussian, 6πmm 4D emittance, 5MeV RMS longitudinal momentum spread, starting just inside solenoid)
- Python matching script used to set up currents in the Match Coils (thanks to Chris Rogers)

- **NEW** updates to the Kalman fit have been implemented
- **NEW** additional covariance matrix calculation and correction class
- **NEW** single particle amplitudes also calculated
- Still using XBOA for emittance & beta function calculations
- Still applying cuts to Virtuals and recon

Average Energy

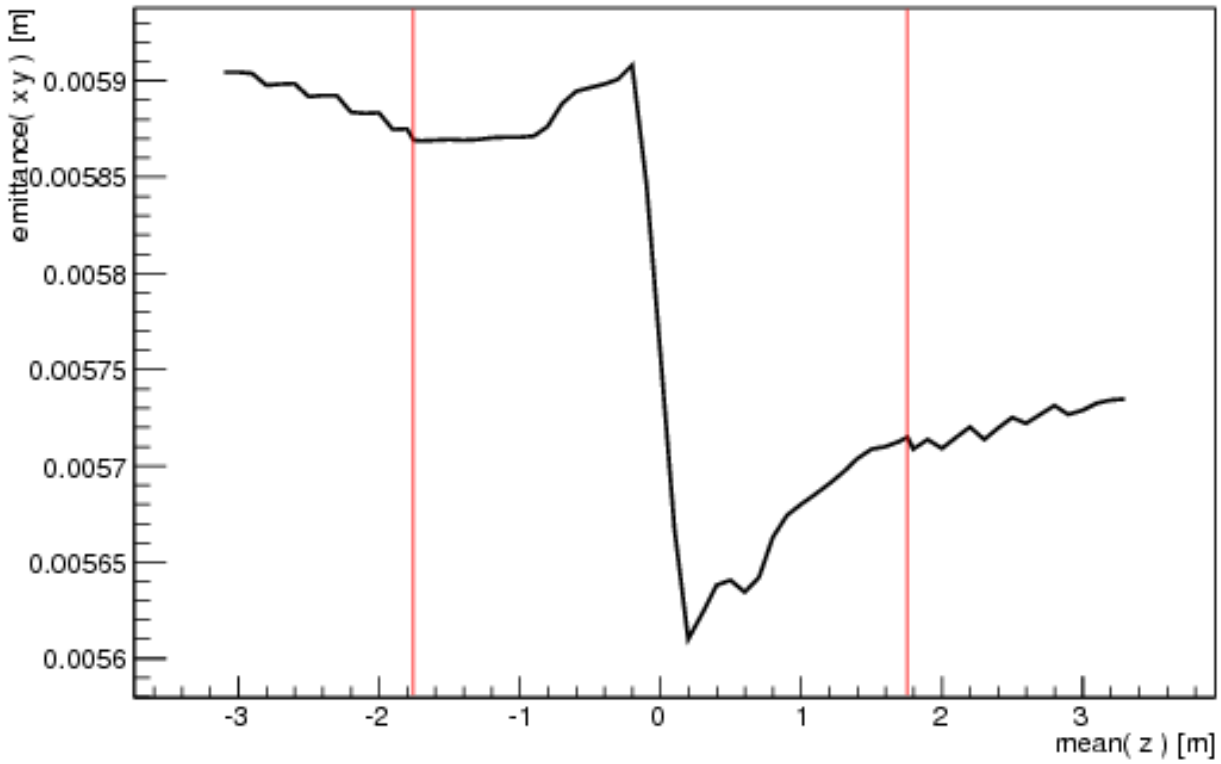
Can clearly see tracker planes, AFC windows and the absorber



Emittance

Reasonable behaviour

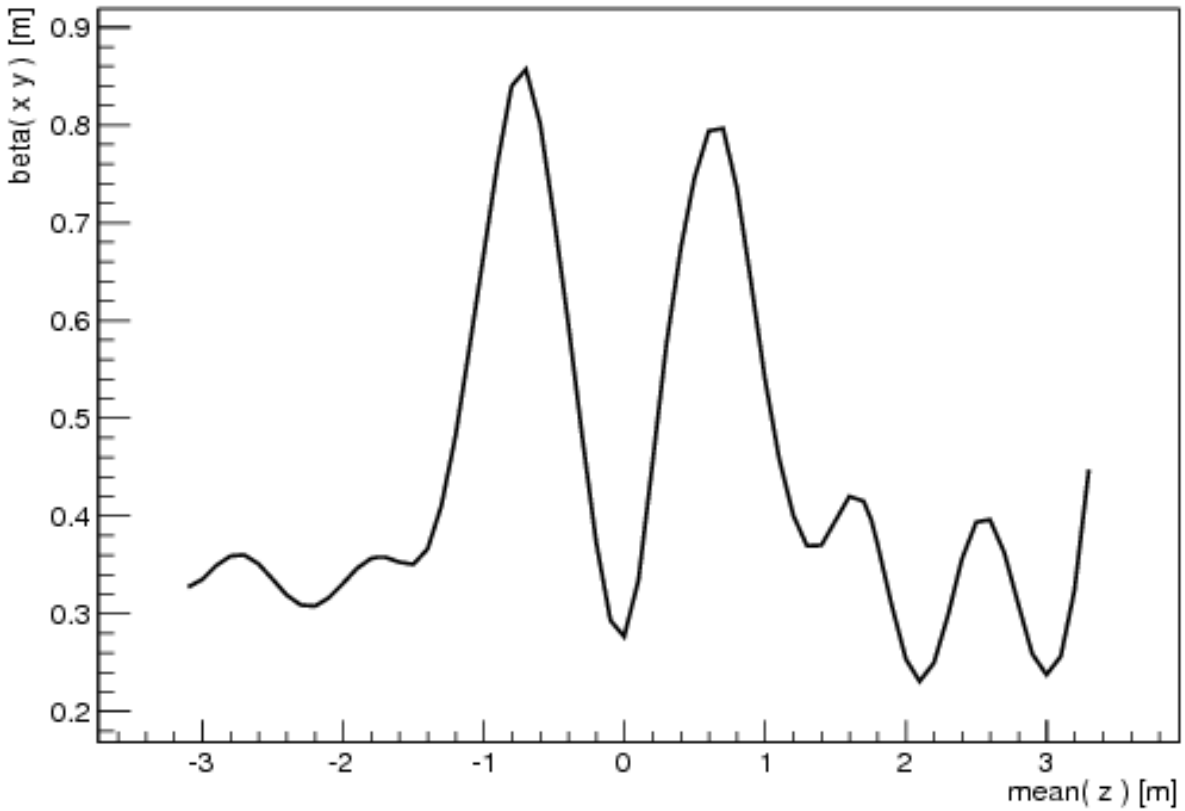
Some issues downstream - possibly the Beta Function...



Red lines mark the Tracker Reference Plane Location.

Beta Function

Looks like the Beta Function could be improved downstream.
Currently on the todo list!



Raw Emittance Calculations

Parameter	Virtual	Reconstructed	Deviation
Emittance Upstream	5.808 mm	5.805 mm	-0.05%
Emittance Downstream	5.641 mm	5.621 mm	-0.35%
Beta Upstream	356.1 mm	353.8 mm	-0.64%
Beta DownStream	393.9 mm	385.2 mm	-2.2%
Number Upstream	15590	15590	0.0%
Number Downstream	15590	15590	0.0%

Covariance Matrix Correction Formula:

$$\mathbf{V}^{\mathrm{true}} = \mathbf{V}^{\mathrm{meas}} - \mathbf{R}^{\mathrm{T}} - \mathbf{R} - \mathbf{C}$$

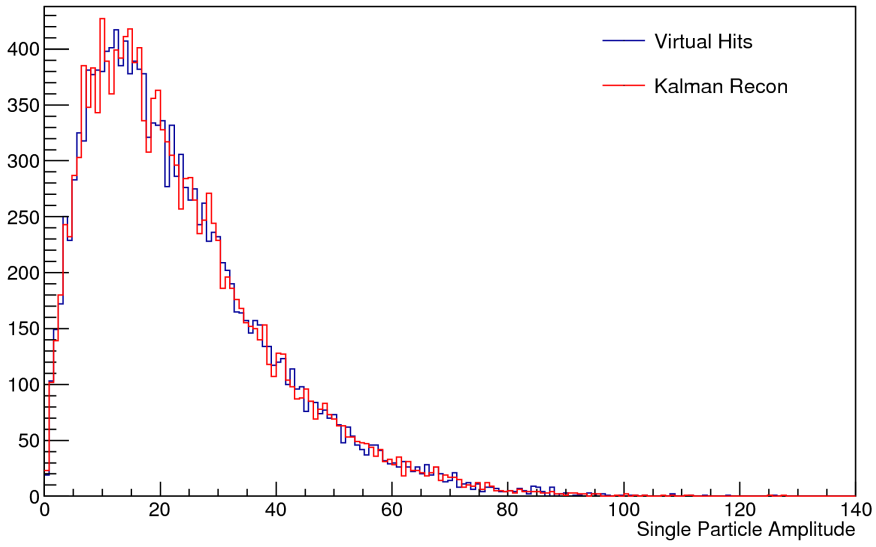
Holds perfectly for Upstream tracker.

Holds $\approx 1.3\%$ for Downstream tracker

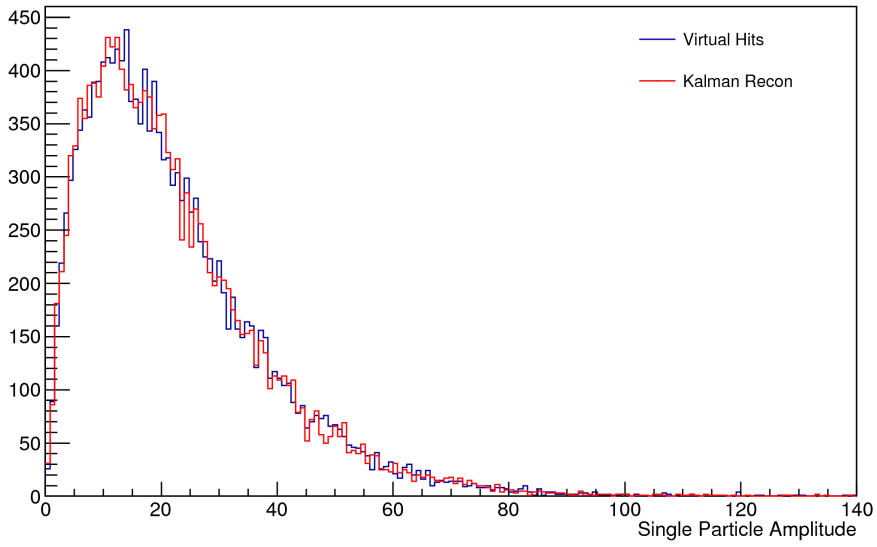
There is a reason for this!

With a slight adjustment we get 0.02%

Single Particle Amplitudes



Upstream



Downstream

For idealised situation Mean Amplitude $= 4 \times$ Emittance.
This holds!

Conclusions

We fixed the problems with emittance calculations.

Exact cause not precisely known - several bugs were fixed with the new code. Main cause expected to be incorrect assignment of track points to the tracker planes

Still to Come:

- Write up a full C++ framework in MAUS to handle emittance calculations and correction matrices
- Write a MICE note
- Consider an improved current matching algorithm
- Correct tracker reference plane positioning

Extra Slides

Analysis Details

The Reconstruction Cuts:

- Transverse Momentum: Pt $<$ 150 MeV/c
- Longitudinal Momentum: Pz $<$ 300 MeV/c

The Virtual Plane Cuts:

- Aperture cut: r $<$ 189mm
- PID selection: Only Positive Muons (PID = -13)

Other Cuts:

- Require a reconstructed track in UP- and DOWN-stream trackers
- Ignore complicated events. i.e. multiple hits in the reconstruction plane (possible decays)
- Straight tracks completely ignored
- Optional low-pt cut to remove hard to reconstruct tracks