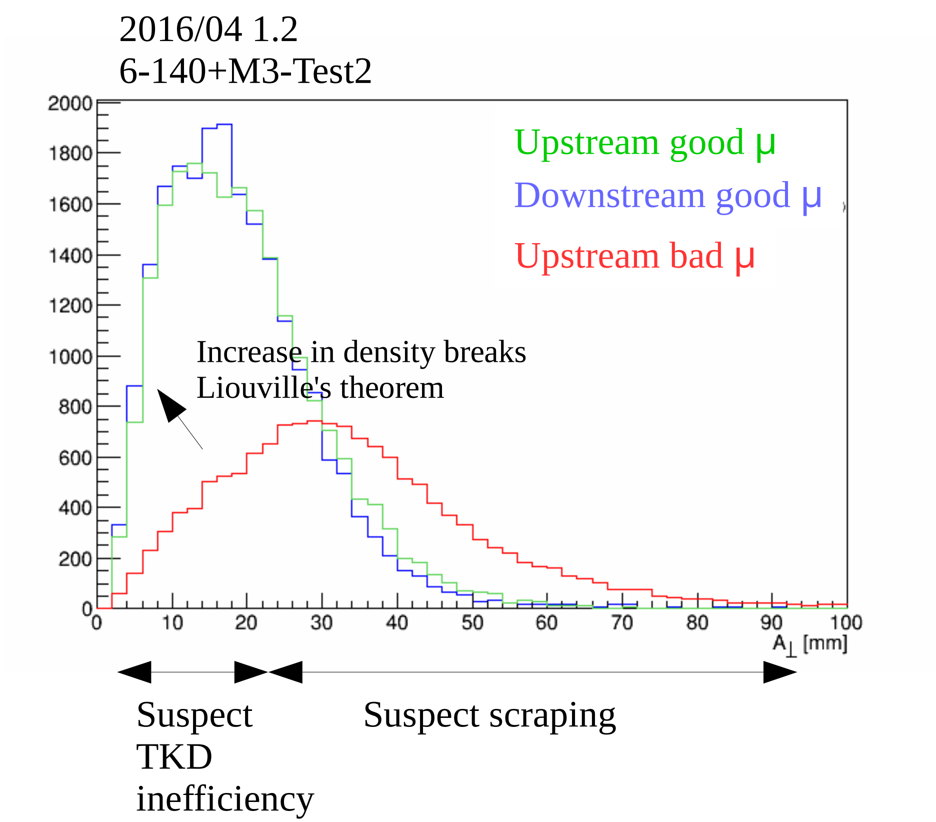
Run Plan and Last Data Report

C. Rogers,
ISIS Intense Beams Group
Rutherford Appleton Laboratory

Overview

- Analysis of 2016/05 data
  - Emittance reduction
- Upcoming data
  - Settings for ISIS run 2016/05
  - Wedge absorber - discussion

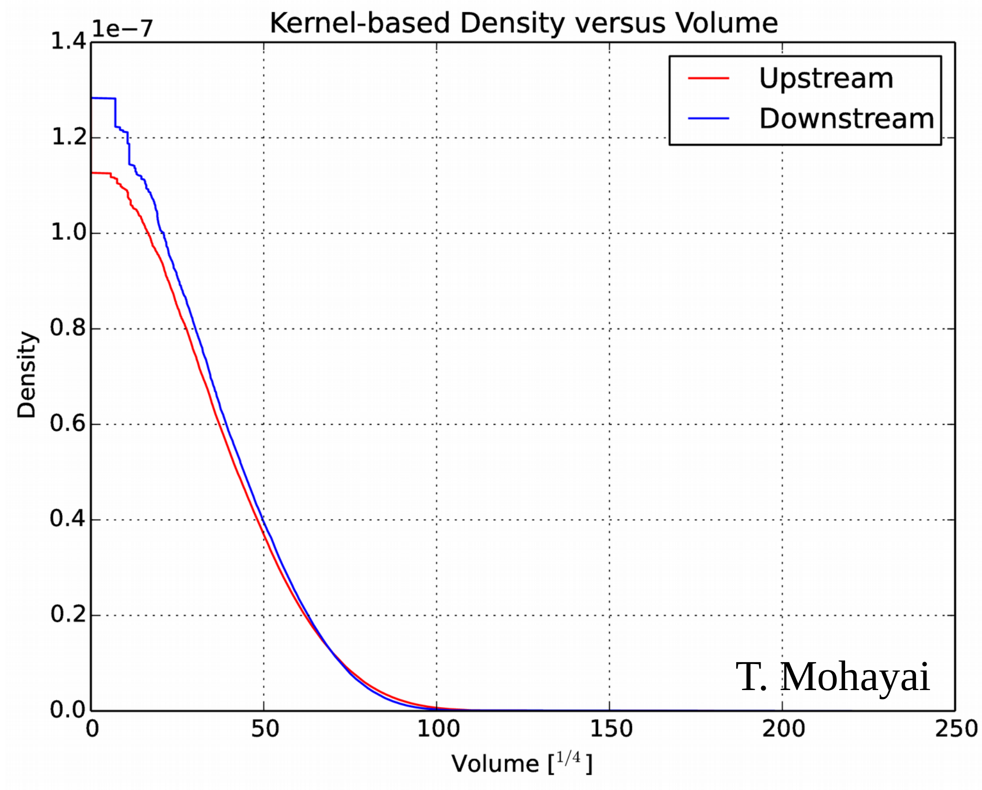
Emittance Reduction



- Plot from last time

Optical aberrations/KDE

- Smear the distribution using Gaussian "kernel"
- Calculate density of smeared distribution
- Density increases!
  - Modulo efficiency issues

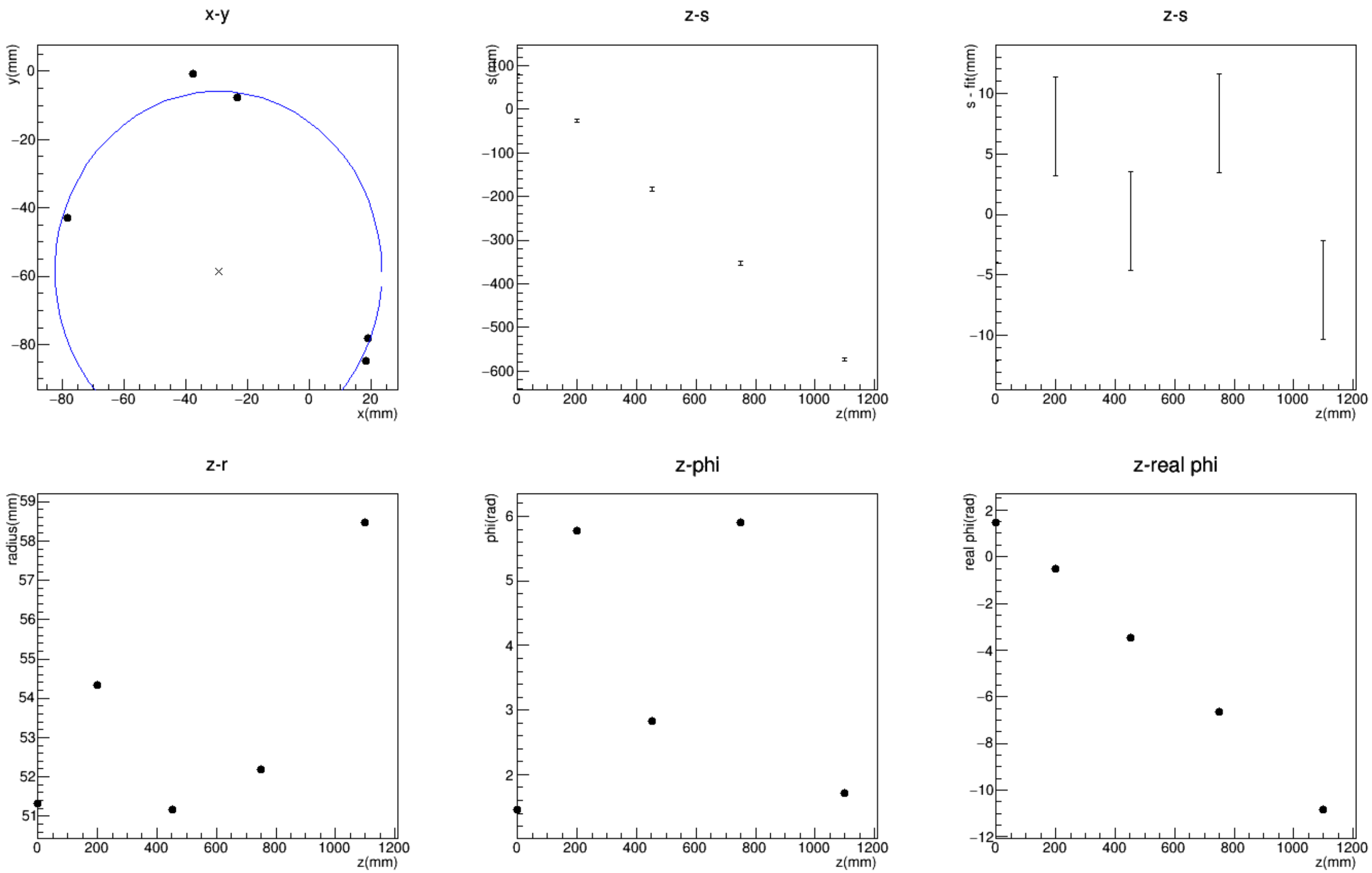


Biases and Uncertainties

- Seek to measure emittance change across the absorbers
- What are the biases and uncertainties?
- Bias on the measured x/px/y/py phase space and transmission
  - Intrinsic detector resolution (scattering and spatial resolution)
  - **Detector efficiency**
  - Magnetic field in reconstruction region
- Bias on the model of the channel
  - (Magnet) alignment
  - Absorber material
  - (Other) material budget
  - Measured upstream particle properties

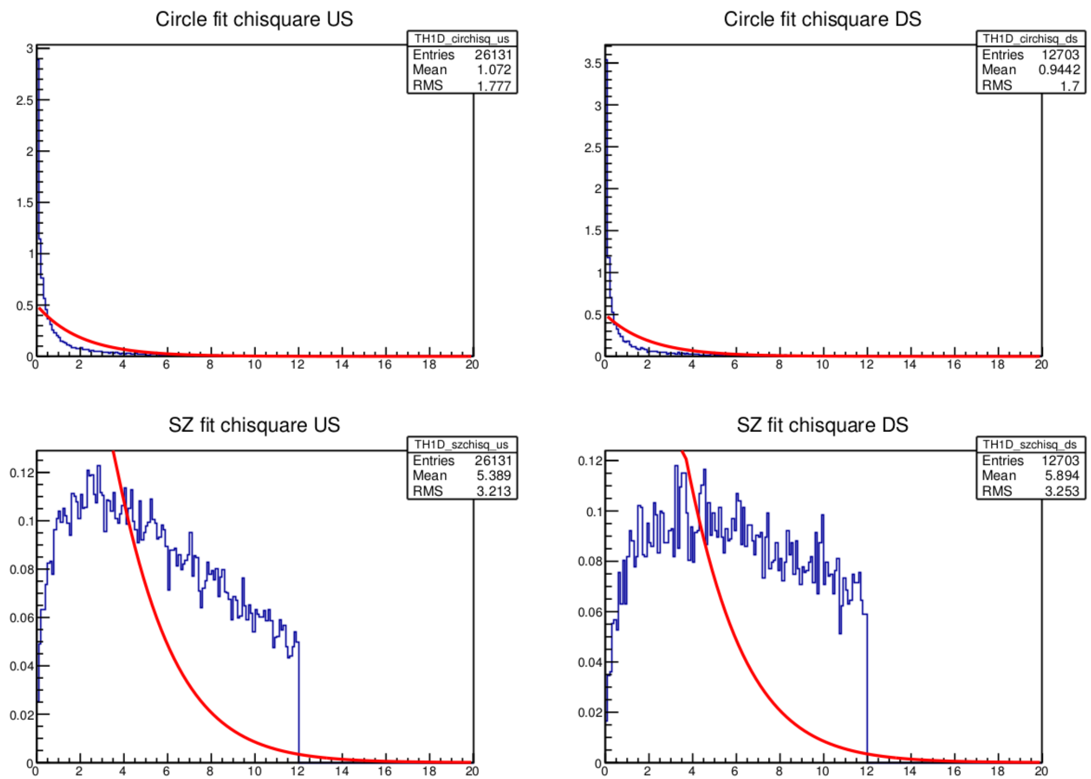
Tracker Inefficiency

Event display (E. Overton)



- Tracker reconstruction: digits, clusters, spacepoints, tracks
- Pattern recognition identifies particle tracks
  - Fits a circle to the measured particle positions in x-y
  - Fits a straight line to the azimuthal angle vs z (“SZ fit”)

Tracker Inefficiency



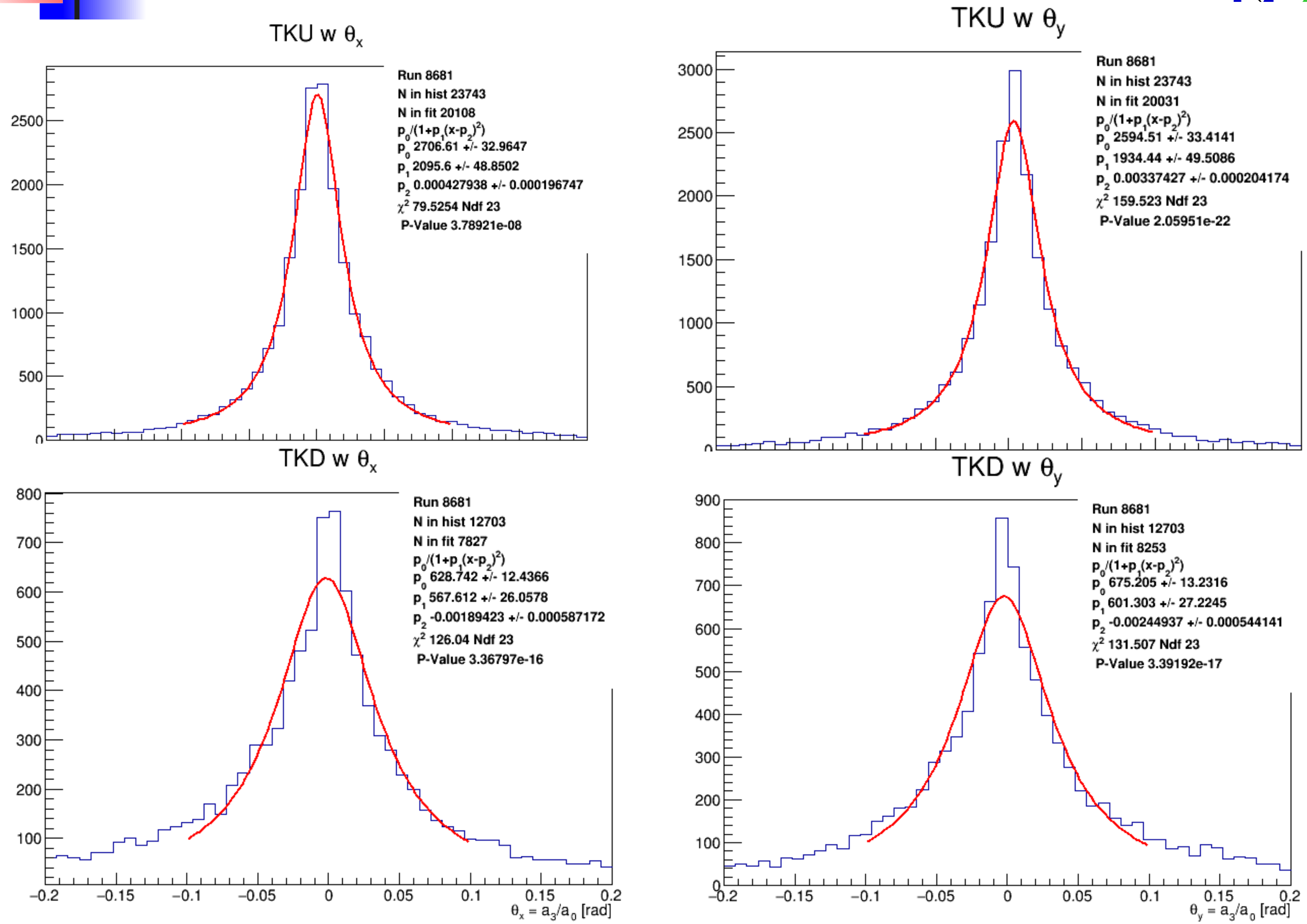
Chi2 of **reconstructed** muons (E. Overton)

- Incorrect normalisation – errors are not understood
  - Worse in TKD than TKU;
  - worse in data than MC;
  - worse at 140 MeV/c than higher momentum

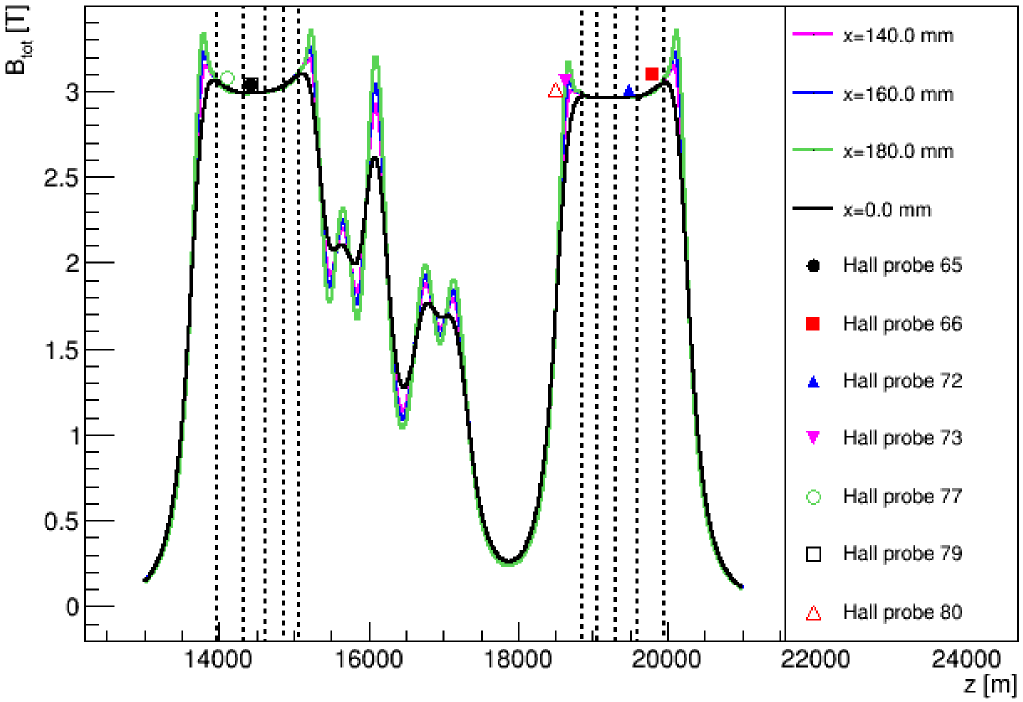
Sources of noise

- Sources of noise in pattern recognition fits
  - Intrinsic spatial resolution
  - **Tracker-solenoid misalignment**
  - **Field non-uniformity**
  - Internal detector alignment (and management in software)
  - Energy Loss
  - Scattering
  - Detector noise
- Working through the data to isolate discrepancies between:
  - MC and data;
  - TKU and TKD;
  - Low p and high p;
- and implement correct normalisation of chi2

Tracker-solenoid misalignment



Field non-uniformity/etc



- Hall probes do not agree with MAUS model (no PRY)
  - Holger has provided us with field map from COMSOL model
- Back of the envelope calculation gives ~ 10 mrad error in dphi for MAUS model

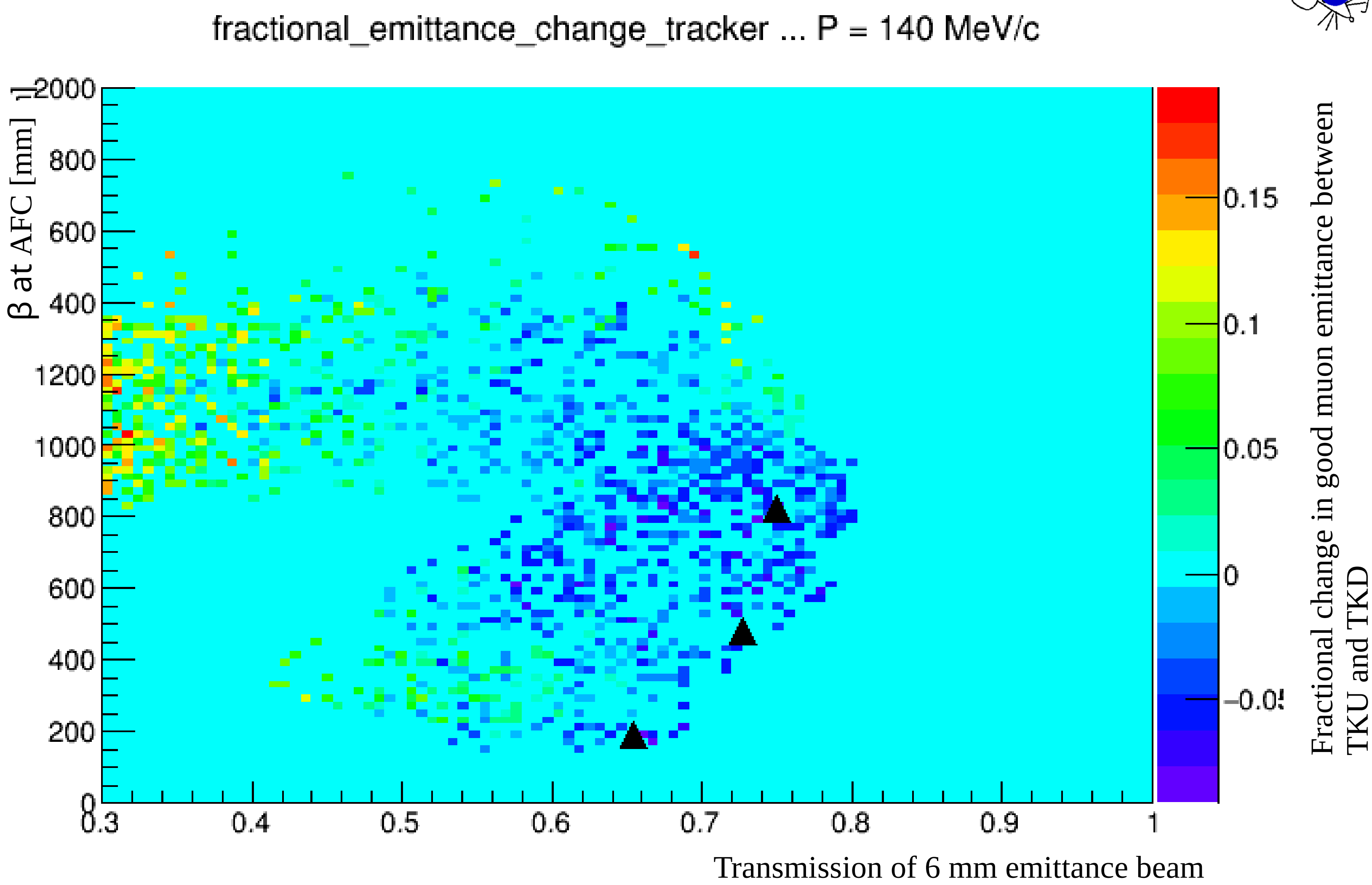
2016/05

C. Rogers,
ISIS Intense Beams Group
Rutherford Appleton Laboratory

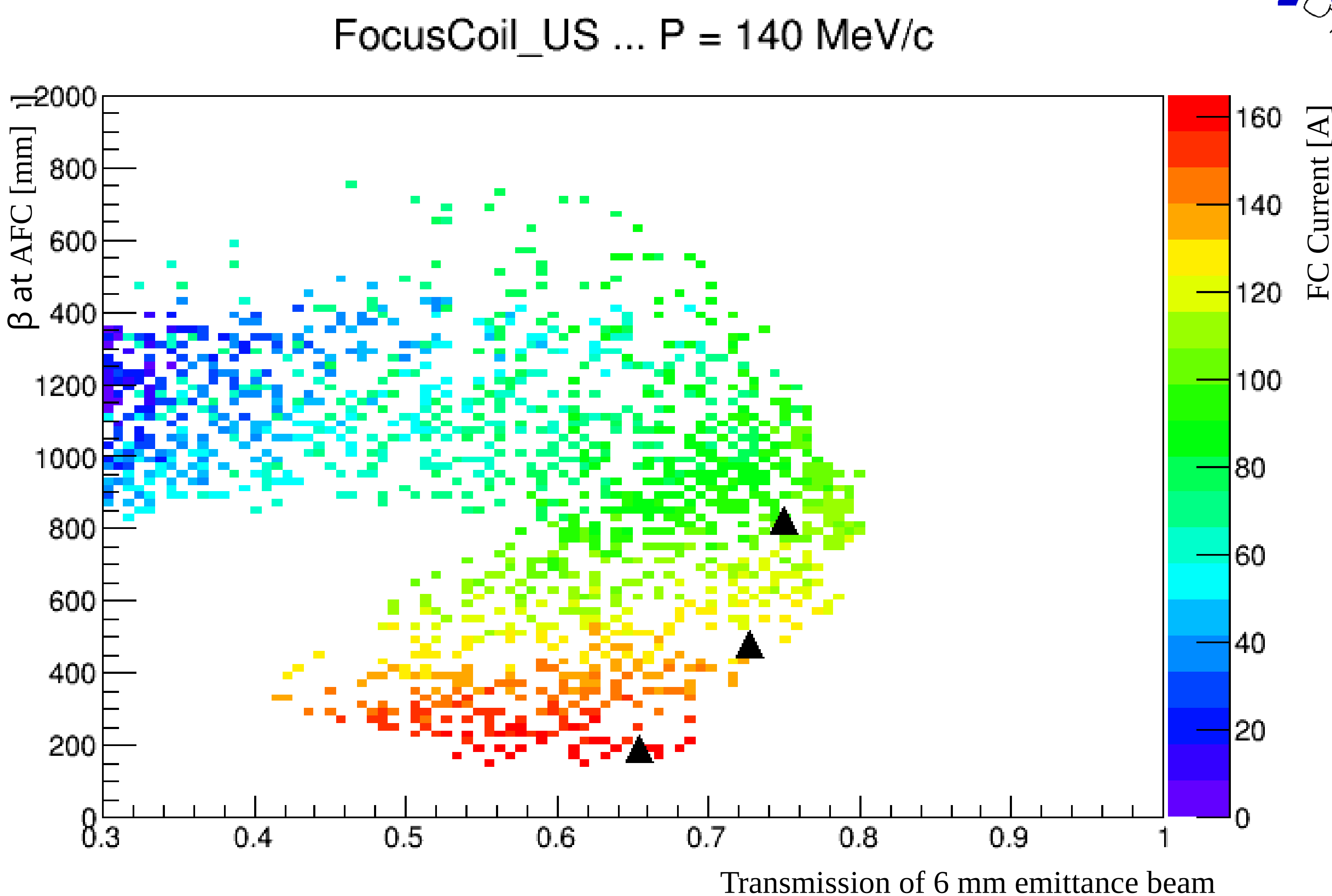
2016/05

- ISIS User run 2016/05
  - 14^{th} February to 31^{st} March
  - Lithium Hydride absorber
  - Flip mode
  - M2D will not be powered initially
- Plan to run
  - Beta function scan at 140 MeV/c (3 settings)
    - Optics performance best at 140 MeV/c
    - But TKD performance is a concern
  - Momentum scan
  - Nb: some optics settings provided by Ao, with thanks

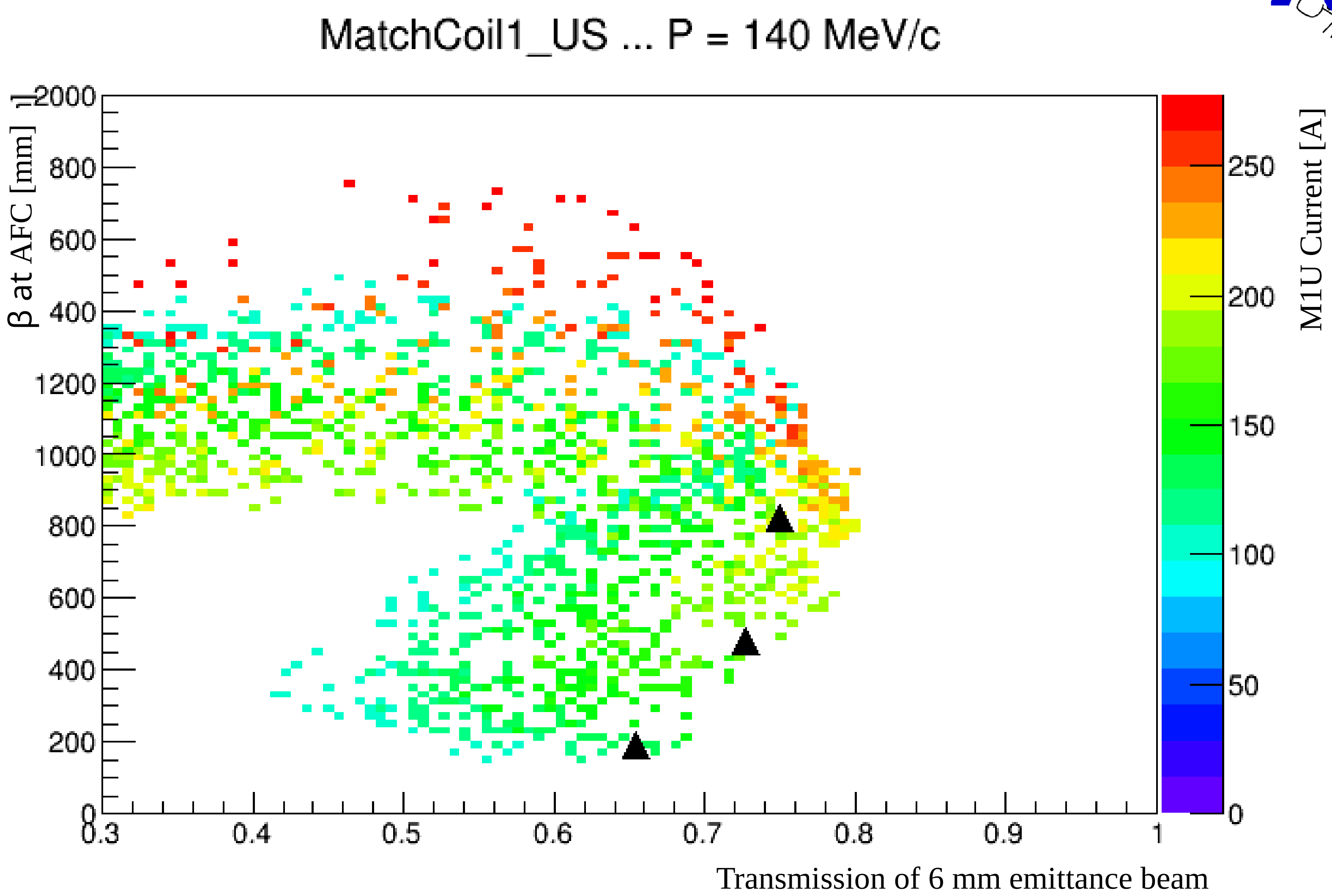
140 MeV/c Parameter Space



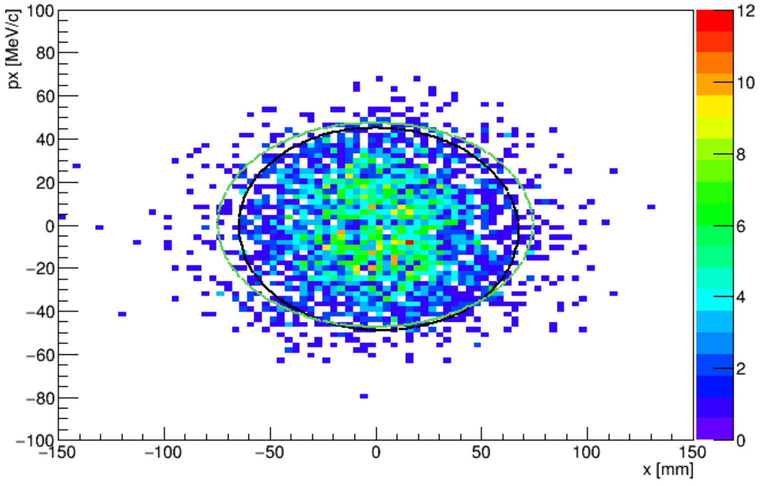
140 MeV/c Parameter Space - FC

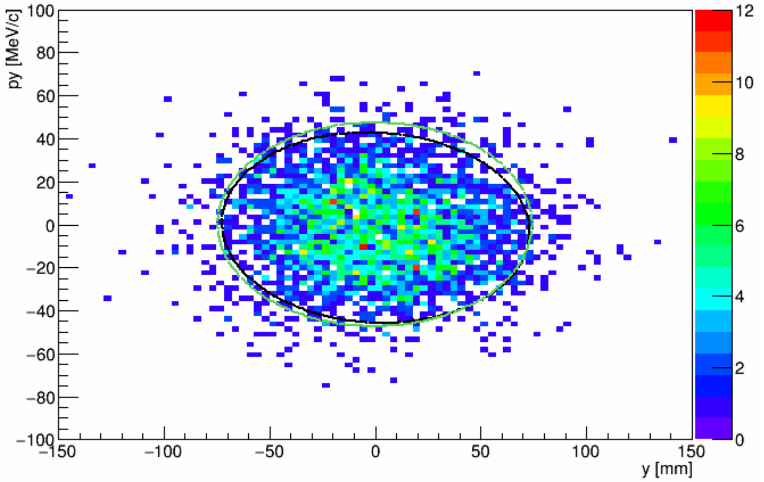


140 MeV/c Parameter Space -M1U



Matching from beamline





P. Franchini

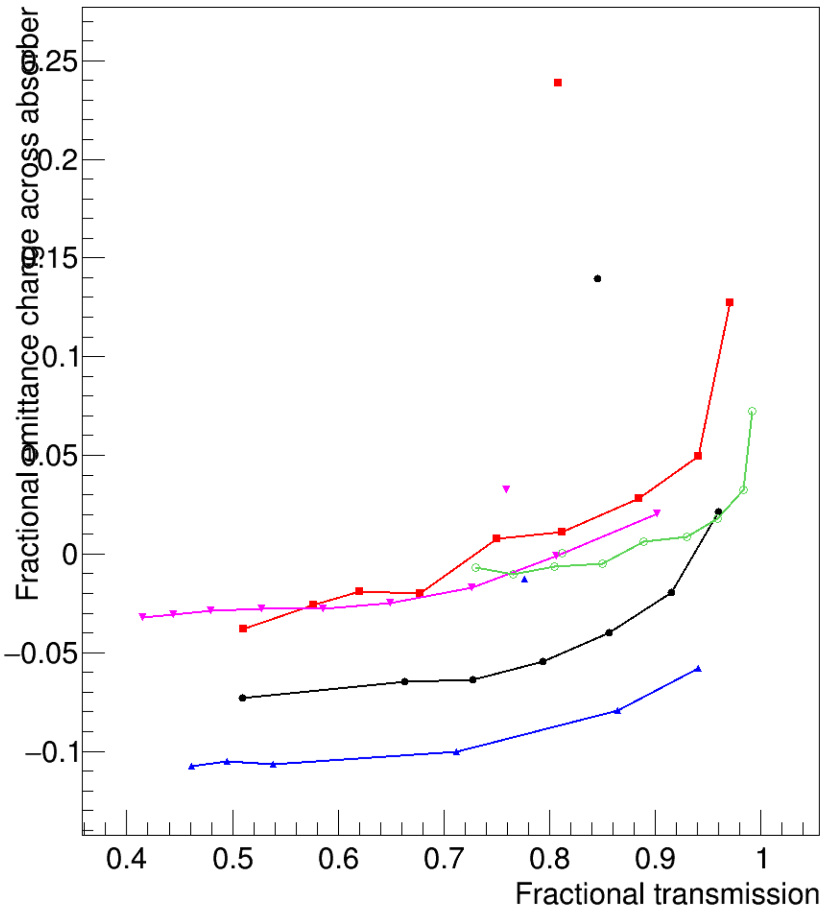
Black ellipse = measured
Green ellipse = target

- MC (G4BL) does not correctly model beamline
  - E.g. Momentum in data is lower than the simulated one
  - Few percent tuning of D1 to match the requested Pz
- Further tuning of quads to get matched beam
- We have pretty well matched beams for 140, 200, 240 MeV/c momenta with emittances ~ 6 mm and 10 mm
- We were not able to get a matched beam without the diffuser

Matched or unmatched?

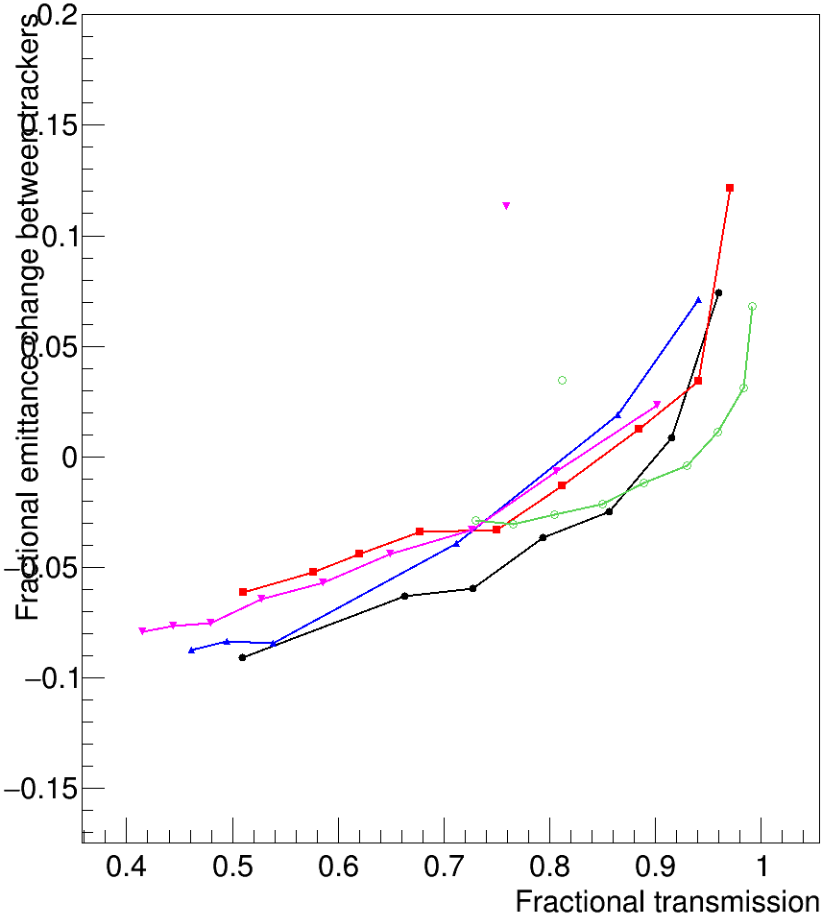
- We are able to get matched beam with diffuser, no problem
  - For loose focussing, this is okay
- For tight focussing, equilibrium emittance << natural (no diffuser) beamline
  - We can't match for this diffuser
- Should we optimise for unmatched beam?
  - Lots of optical emittance growth for “unmatched” beam, no matter what
  - Can't observe emittance reduction between trackers
    - Need to do an extrapolation to the absorber
- So far:
  - Choose optics for the matched beam
  - Hope that we can sample a matched beam from the unmatched one

Performance Plots (1)



- P = 140 MeV/c, β_{AFC} ~ 450 mm
- P = 140 MeV/c, β_{AFC} ~ 800 mm
- P = 140 MeV/c, β_{AFC} ~ 200 mm
- P = 200 MeV/c, β_{AFC} ~ 650 mm
- P = 240 MeV/c, β_{AFC} ~ 1100 mm

Performance Plots (2)



- P = 140 MeV/c, β_{AFC} ~ 450 mm
- P = 140 MeV/c, β_{AFC} ~ 800 mm
- P = 140 MeV/c, β_{AFC} ~ 200 mm
- P = 200 MeV/c, β_{AFC} ~ 650 mm
- P = 240 MeV/c, β_{AFC} ~ 1100 mm

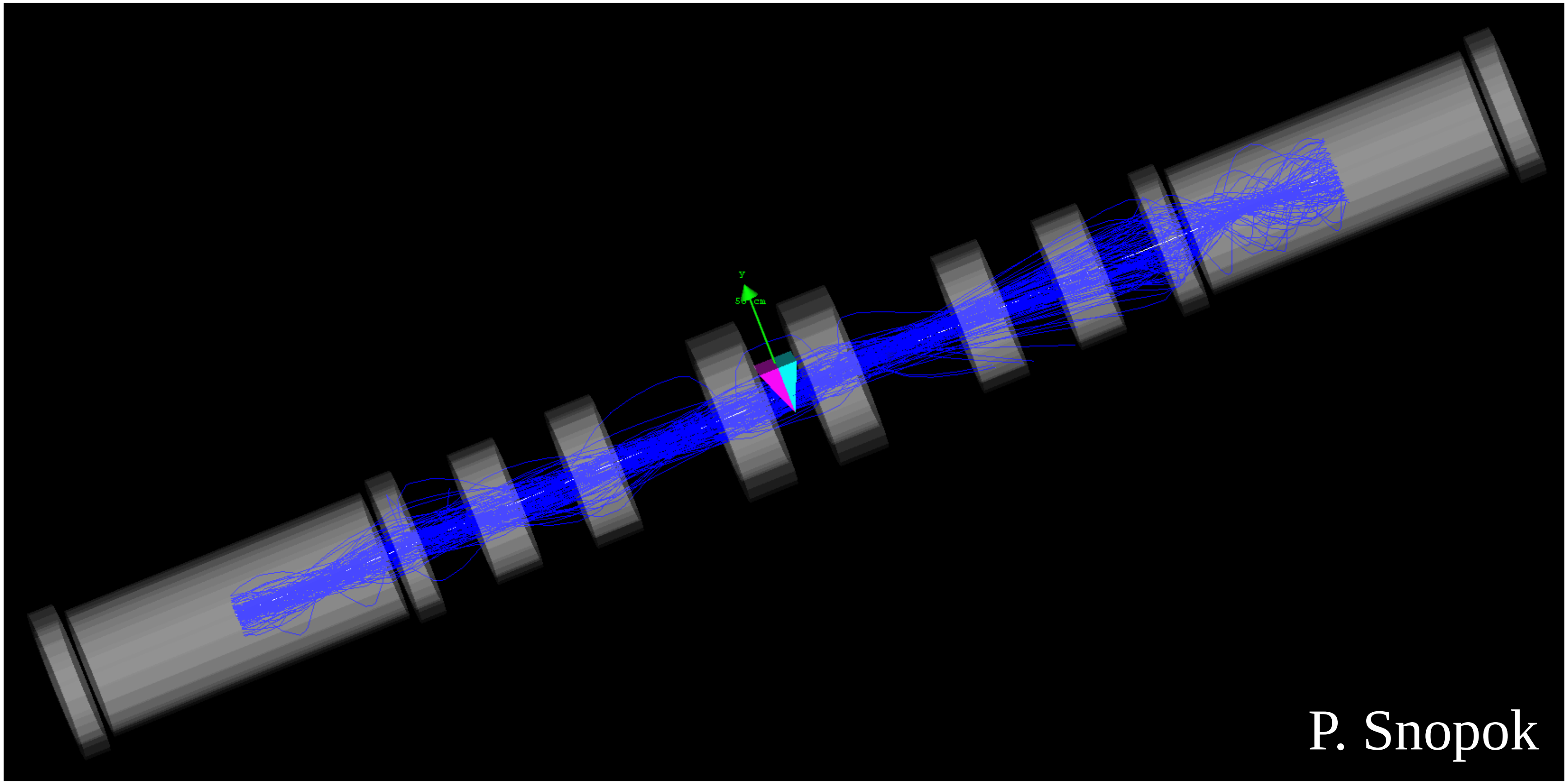
Wedge Absorber

C. Rogers,
ISIS Intense Beams Group
Rutherford Appleton Laboratory

Looking forwards

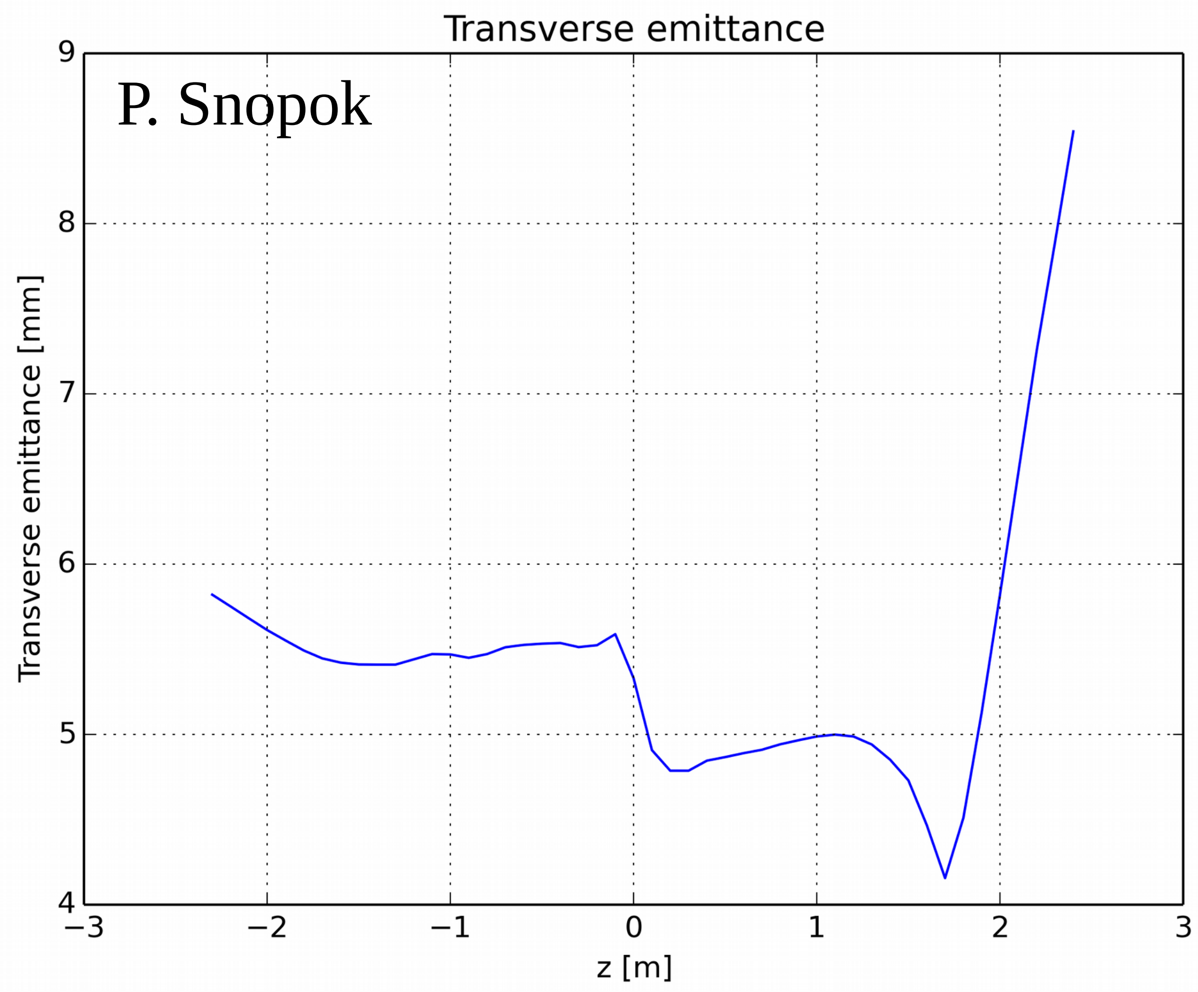
- ISIS user run 2017/01 runs from 2 May to 2 June 2017
  - lH_2 may be available
  - Alternately, might be able to persuade the paymasters to provide £ for RF – and start RF install
  - Wedge shaped absorber is also an option (discussed here)

G4beamline deck geometry



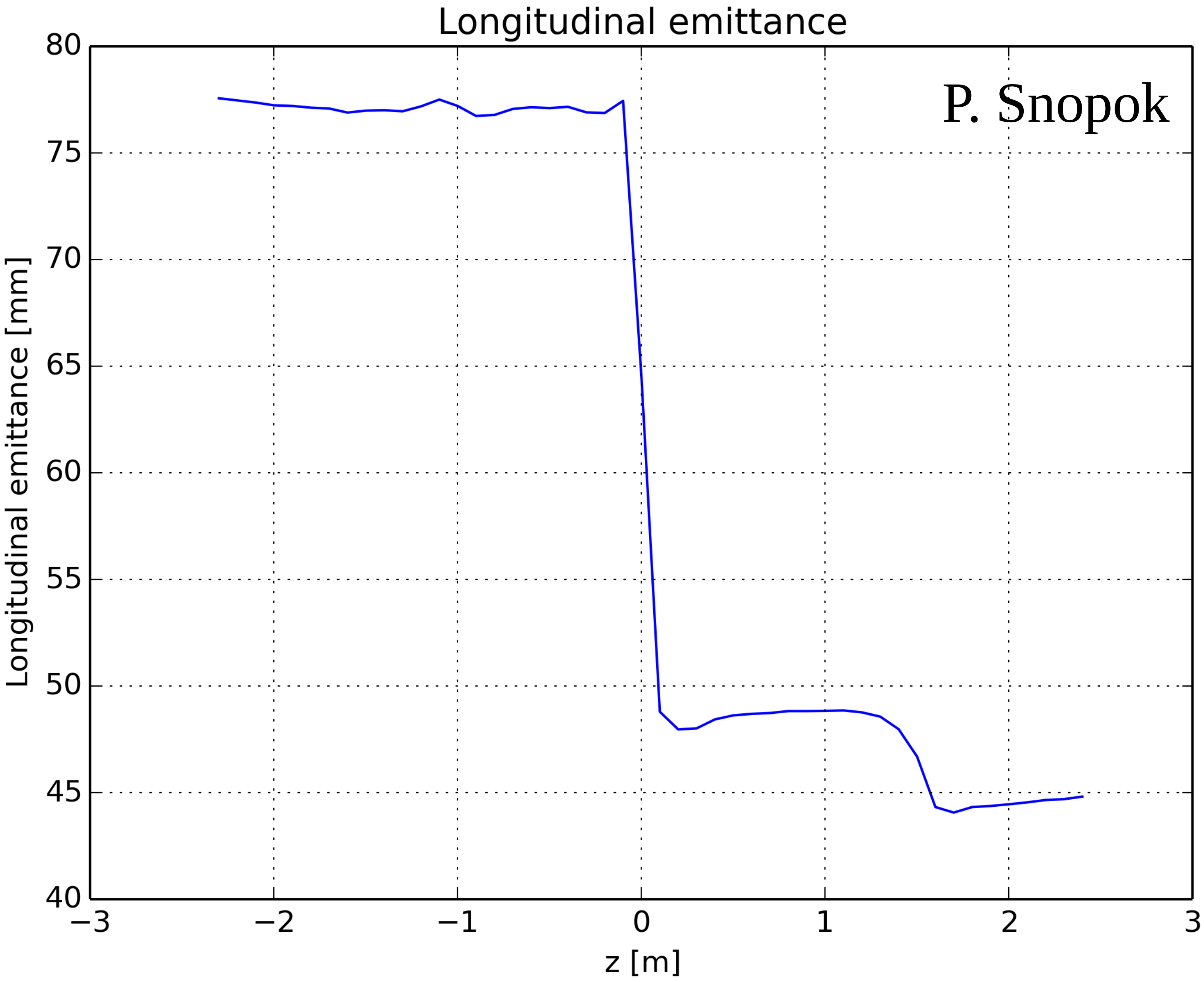
- Revived the Feb 2015 simulation:
  - This time the channel is asymmetric, M1D/M2D are off
  - Currents as per “P = 140 MeV/c, β_{AFC} ~ 200 mm”
  - Complicated and difficult beam selection procedure to get non-linear “matching”

Results (transverse emittance)

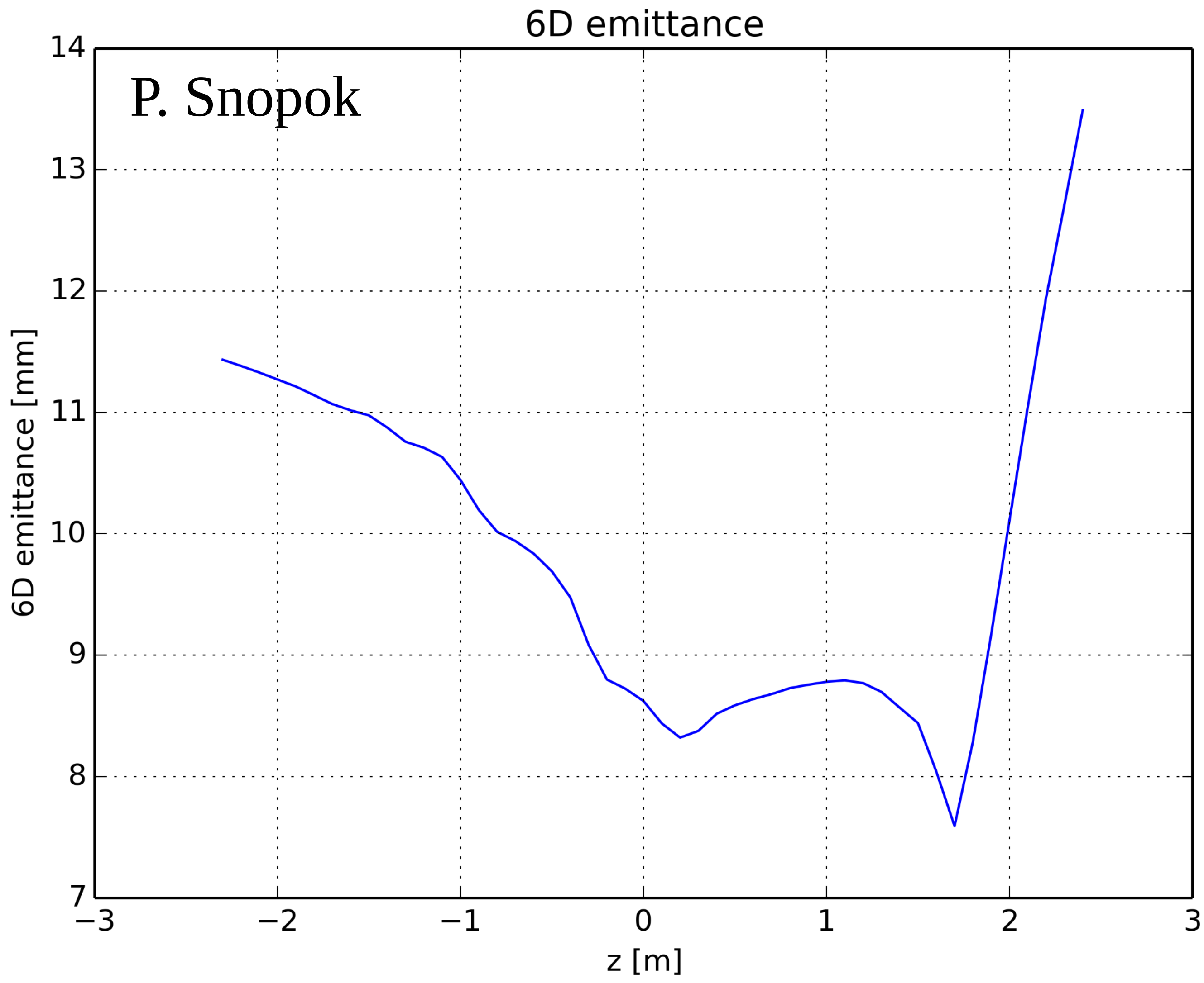


ε_T(upstream reference plane)=5.55 mm
ε_T(downstream reference plane)=5.13 mm

Results (longitudinal emittance)



Results (6D emittance)



Wedge - Summary

- Observing simultaneous 6D/longitudinal/transverse emittance reduction is possible in MICE Step IV using a polyethylene wedge,
  - even without M1D/M2D;
  - with M2D on the situation could only get better.
- Dispersion in the beam needs to be generated by particle selection.
- 45-degree wedge works best:
  - more transverse cooling;
  - longitudinal cooling is not jeopardized;
  - Lighter/small wedge;
  - covers more aperture (apex offset wrt beam centerline is 63 mm; for a 60-degree wedge it would be 45 mm).