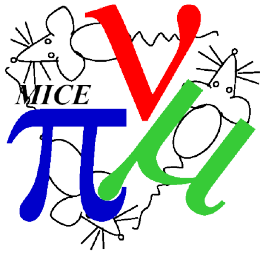

The University Of Sheffield.

Quadrupole/TOF Alignment Study of the MICE Beam line using Particle Data

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MICE CM36

Background & Motivation

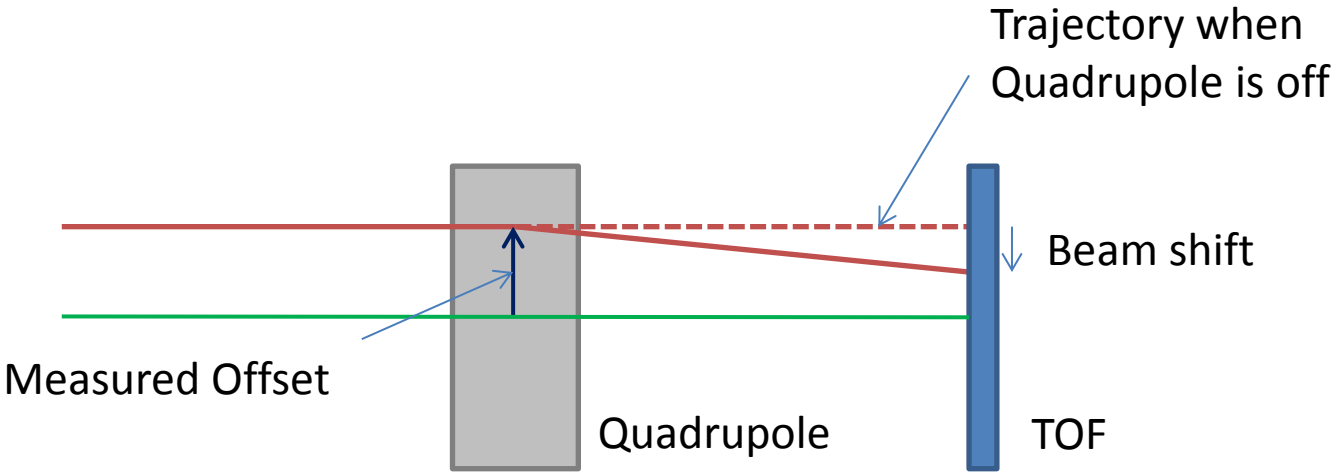
I have been looking for a study using pre-taken data to help improve my understanding of the Step I beam line which would also be of use to MICE.

Studying the alignment of the alignment of our quadrupoles has been on the wish list for some time, but needs a willing volunteer (me).

The quadrupoles were already aligned and surveyed (Note: 216) to better than 0.2mm but it would be nice to verify this using beam data…

Thanks to Chris R, who has pointed me towards this ‘half baked’ plan and some data taken during Step I running.

Study Idea



If the beam is not aligned to the quadrupole, then on average it will receive a transverse kick proportional to the quadrupole current.

By varying the quadrupole current and monitoring how the beam position changes in a TOF then the size of the kick can be calculated. This will enable the position of the quadrupole to be calculated relative to the beam position.

Study Limitations

Based on the beam size, distance to quadrupole and current scan size, it should be possible to measure an offset to a few mm. Note: Not as good as survey!

This procedure will need to be done for each quadrupole needing to be measured. In step I data there appears to be sufficient data for one quadrupole triplet (Q789).

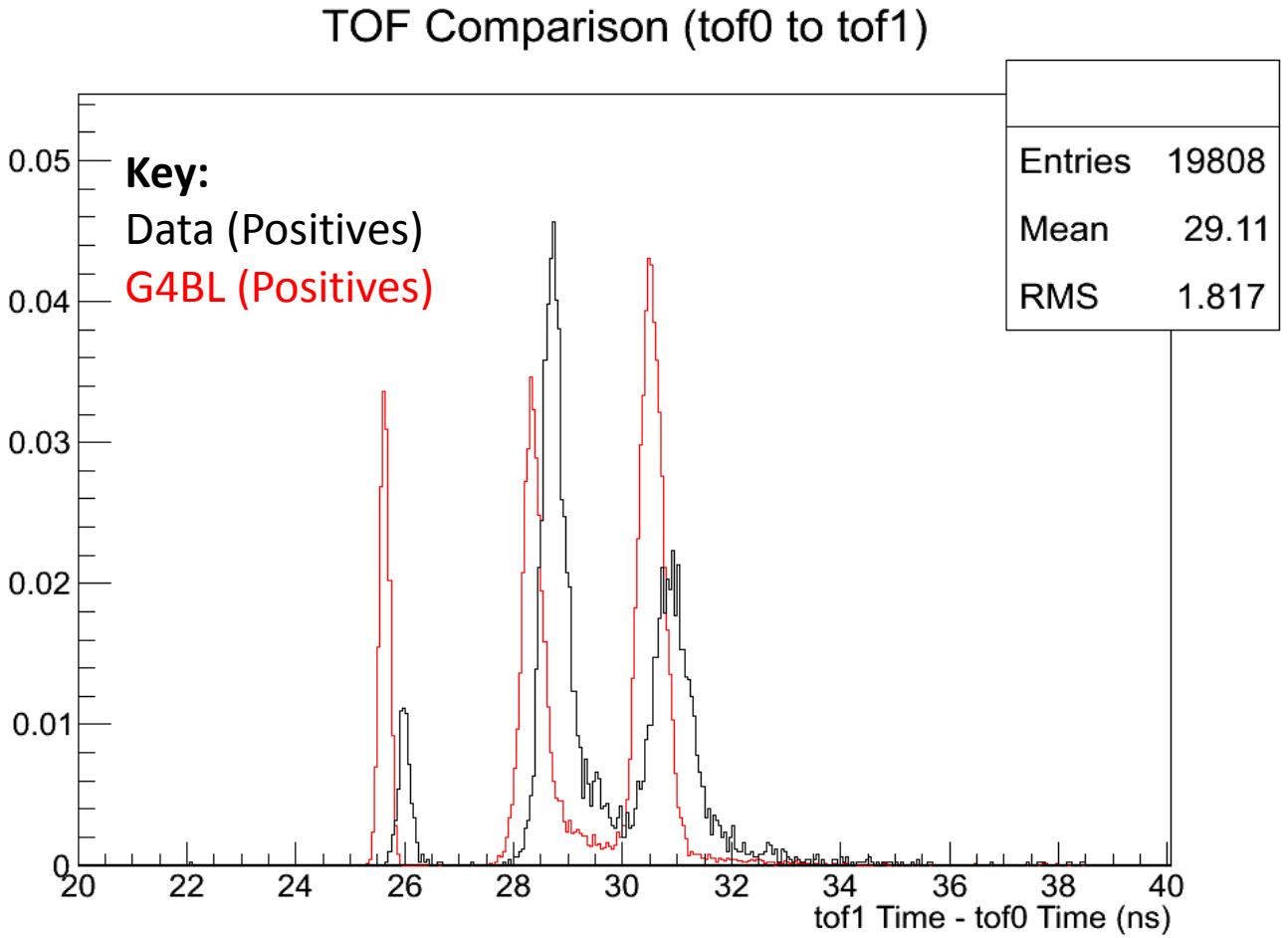
Because the quadrupole can also have an angular misalignment, this study is under constrained without TOF2 (although it may be possible to say something about the combined angular/position offset).

Study requires the Z location of all three TOF detectors (currently ~TOF0, ~TOF1).

G4Beamline Model

To verify my understanding of the problem I have been using G4Beamline, with a copy of Ole H's deck and adjusting the magnet field values to those found in MICE runs.

Begun comparing the output of G4Beamline to MAUS:

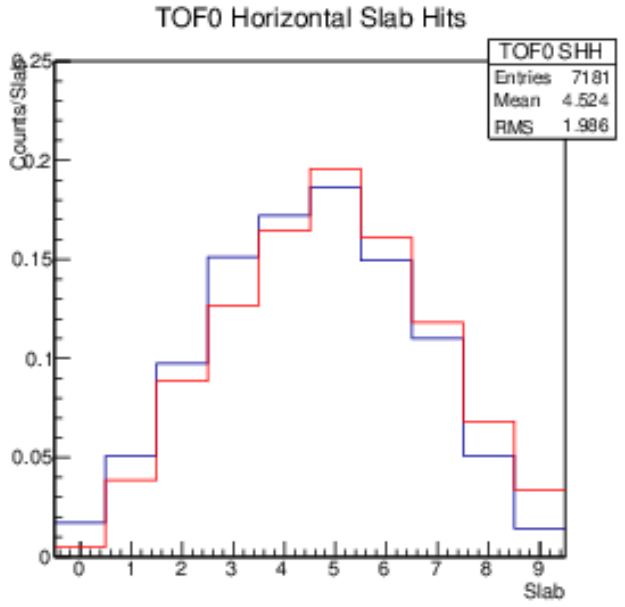


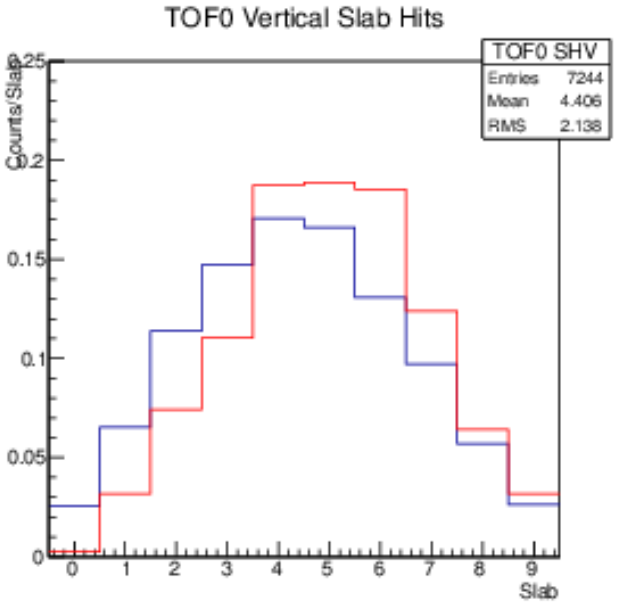
Problem 1:
Clear offset between data & G4BL Electron peaks at:
Data 26ns = 7.8m (@c)
G4BL 25.6ns = 7.68m (@c)

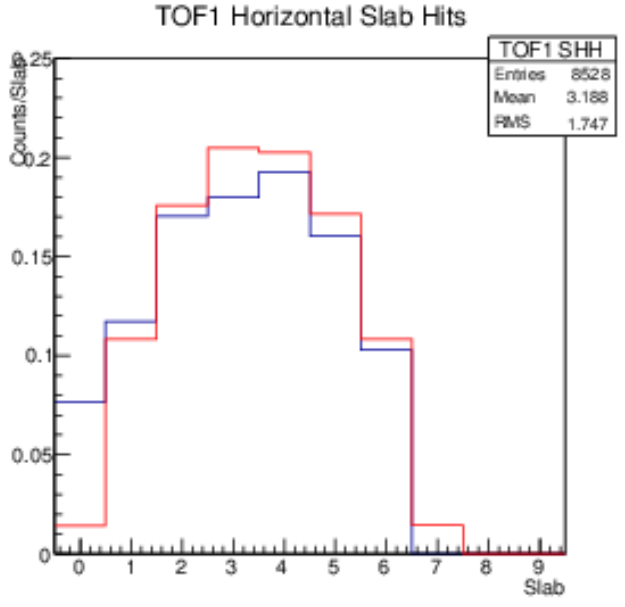
Survey data says ~7.7m.
Working with Durga & Yordan to try and figure it out..

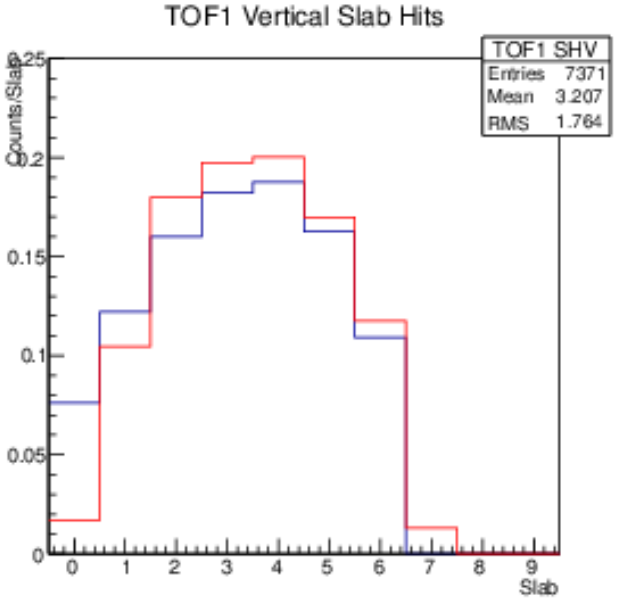
Problem 2:
Difference ratio of e+, mu+, pi+

Comparison between G4BL and MAUS TOF Slab Hits:





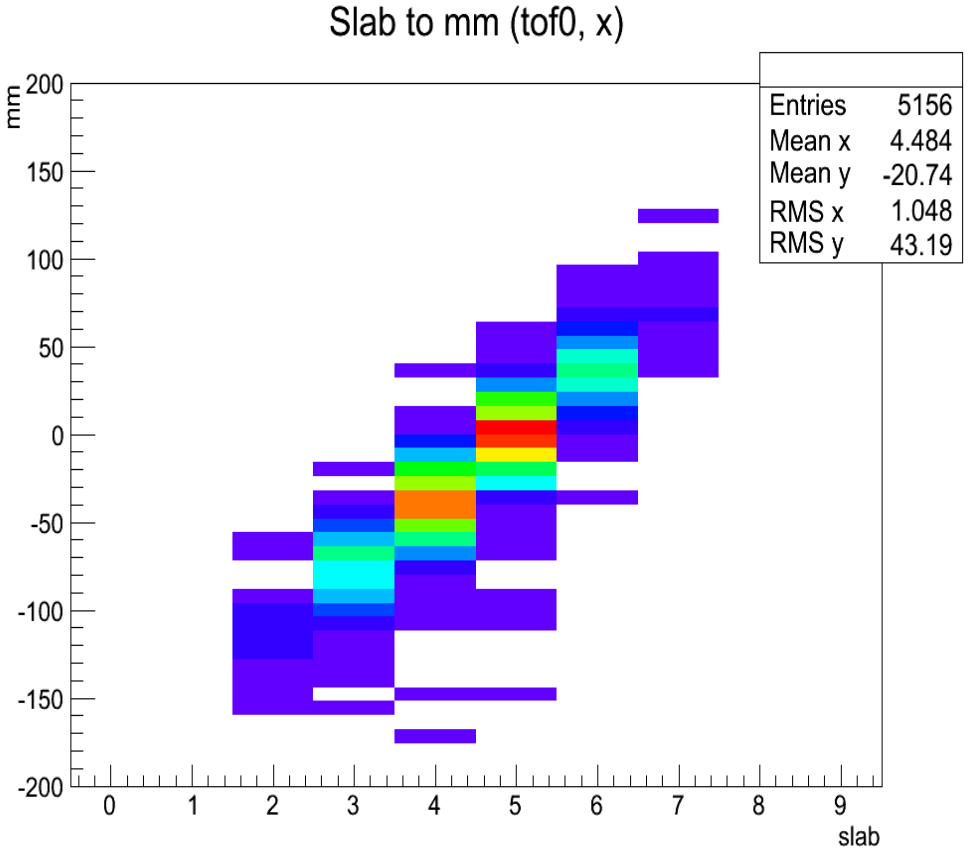




Key:
Data
G4BL

Plots not perfect:
G4BL D2 field was ~5% incorrect

Enhancing TOF position resolution



Because the study relies on measuring the position of the beam, improving the position resolution of the TOFs is desirable.

It is possible to apply the same technique Mark R used in G4MICE, to the data output from MAUS. Once a Space point is found, the individual calibrated PMT times (after Time walk, cable length) are applied to the PMTs in the Slab Hits section.

The (not so far) Future

- Will continue working to line up Data and G4Beamline.
- Plan on beginning to combine different runs to start measuring offsets.
- Study of errors which will contribute to measurement:
  - Dispersion of the Beam
  - Skew-ness of the TOF Detectors
  - **Z Distance offset**?
  - XY Measurement resolution.
- Putting together a run plan for re-taking data (rough plan so far):
  - Based on 20 particles /spill /Vms without Decay Solenoid.
  - For 20K particles need ~500 spills @ 2V Beamloss = 20mins per magnet setting
  - Need 6 settings per magnet = 2hr per magnet
  - 6 Magnets = 12Hrs.