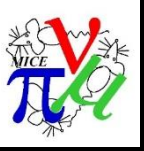


# Offline Software

A. Dobbs

CM43

30<sup>th</sup> October 2015



# Contents

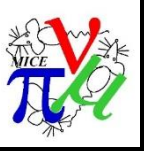
- MAUS Overview
- Infrastructure
- Geometry and CDB
- Detector Updates
  - CKOV
  - EMR
  - KL
  - TOF
  - Tracker
- Global Tracking
- Event Viewer
- Deployment
- Current Issues and Remaining Step IV Work





# MAUS Overview

- Mice Analysis User Software
- Provides simulation and reconstruction of the MICE beamline and detectors
- Map – Reduce based framework (Python wrapping C++)
- GEANT4 based simulation
- G4BeamLine upstream beam simulation
- Data persistency and analysis from ROOT
- Online data reconstruction
- Distributed via Bazaar and Launchpad, as well as tarballs of releases
- Website: <http://micewww.pp.rl.ac.uk/projects/maus/wiki>



# MAUS Development Subgroups

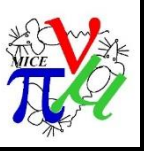
- Core MAUS and API (A. Dobbs)
- Detectors:
  - CKOV (A. Liu)
  - EMR (F. Drilesma)
  - KL (M. Bogomilov)
  - TOF (D. Rajaram)
  - Tracker (P. Kyberd)
- G4BeamLine (J. Nugent)
- Geometry and CDB (R. Bayes)
- Global Tracking (M. Uchida)
- Monte Carlo (C. Rogers)
- Online Reconstruction (C. Rogers)
- Unpacking (Y. Karadzhov)
- ... ..



# Infrastructure

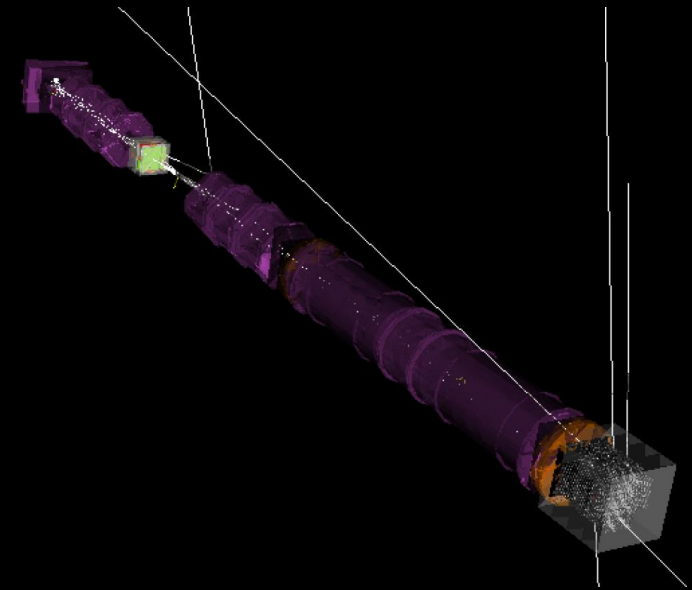
- API has now been completed (including for Reducers)
- Only MAUS::Data\* objects passed between modules (no string conversions)
- ➔ factor **60 to 75** speed up! Data processed faster than can be taken.
- Main memory leak now fixed! GRID running working again
- New online reconstruction framework currently being tested
- Support for C++11 now enabled (multithreading, smart pointers, auto, lambdas...)

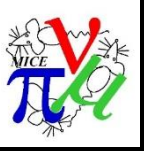




# Geometry and CDB

- CDB geometry has undergone a lot of improvements (TOF, KL, Tracker...), almost ready to replace the legacy as the MAUS default
- Still finding and resolving bugs
- Tracker configuration files now accessible from CDB
- MAUS CDB interface has been updated
- Almost ready to restart GRID MC running
- New geometry releases will be announced

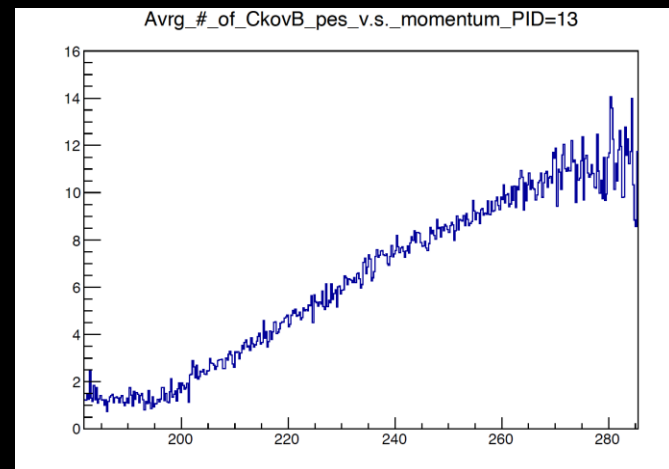
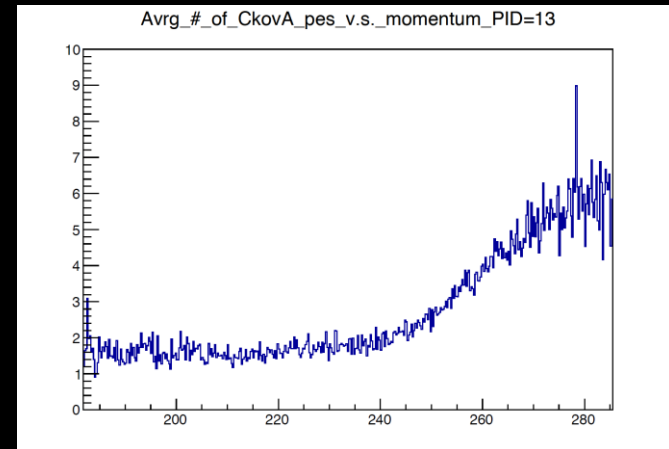


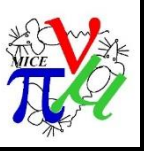


# Detectors: CKOV

- Rapid progress thanks to new team member Ao Liu
- Previously missing MC Digitiser now in place
- Geometry implementation updated
- Real data reconstruction producing results
- Currently not working with Stage4.dat legacy geometry (fix on the way)

## Offline analysis of recent runs





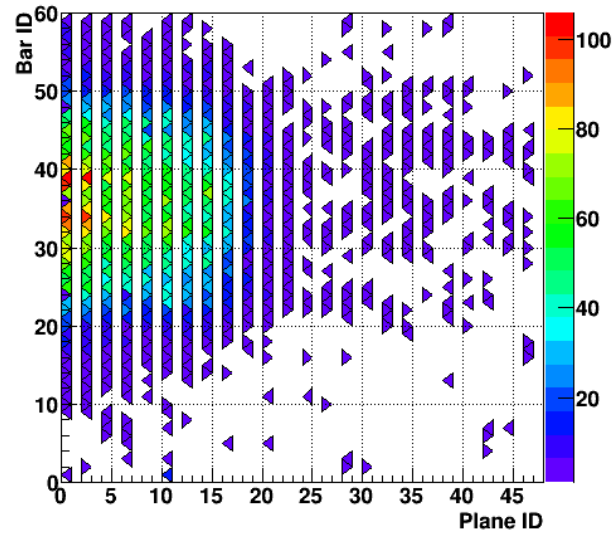
# Detectors: EMR

- Position and PID variable code completed – supplies coordinates for hits, muon tracks and decay products, charge deposition and various other PID variables
- Interface to CDB to access calibration and geometry completed
- Reducer for Online Reconstruction added
- Only a few jobs left:
  - New calibration file for single anode PMTs
  - Data quality flag
  - Documentation
- Currently a break in unit tests, fix on the way

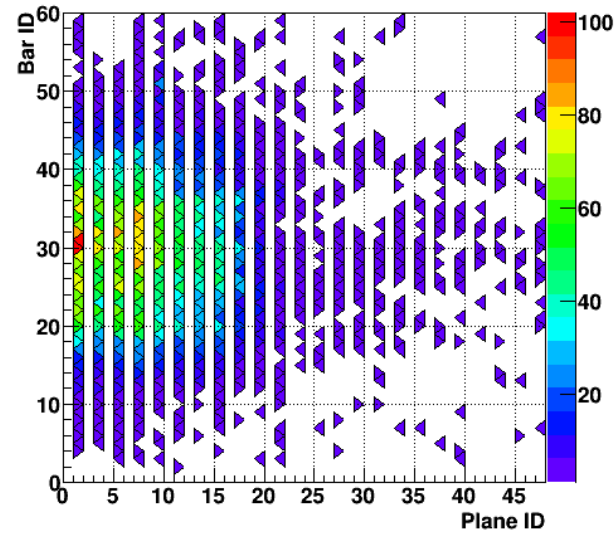




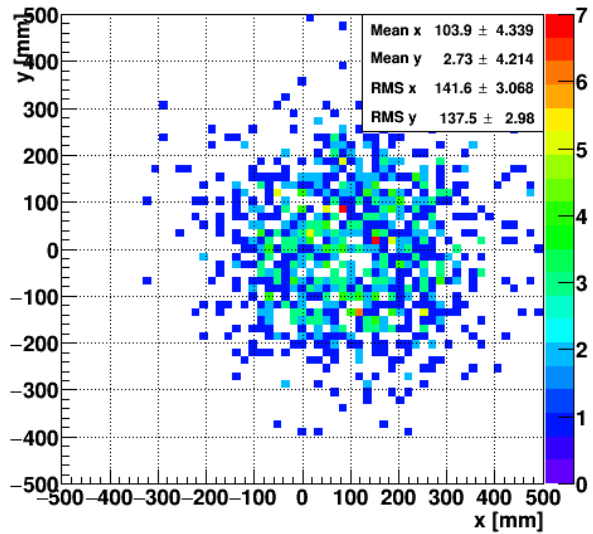
Occupancy in the XZ plane



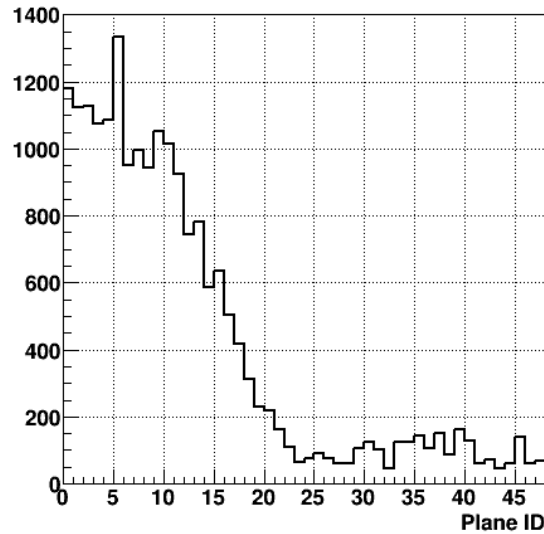
Occupancy in the YZ plane



Beam profile in the XY plane



Beam profile along the Z axis

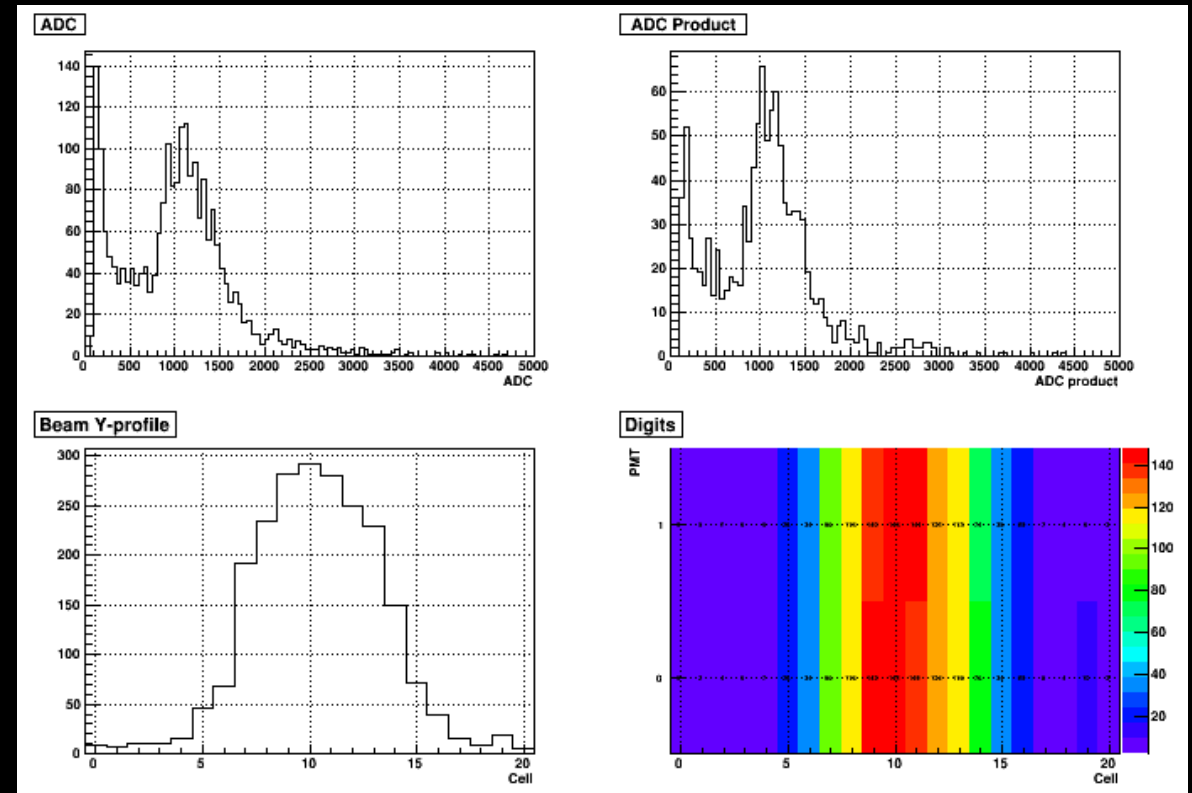




# Detectors: KL

- Functional, stable code base
- Reducer in place
- Global coordinate system output in place
- Data quality flag in place
- Possible bug, very low number of events providing good global coordinate output

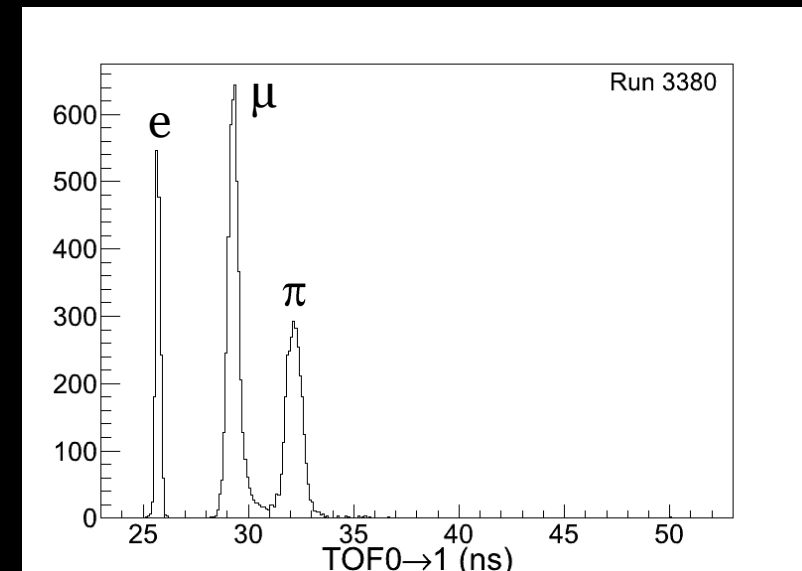
## Online Reconstruction plot from recent running





# Detectors: TOF

- TOF code stable – longest standing functional detector code
- Geometry bug recently found and fixed (showed up on comparison with tracker)
- Global coordinate system output added
- MC trigger issue remains (needs a person...)





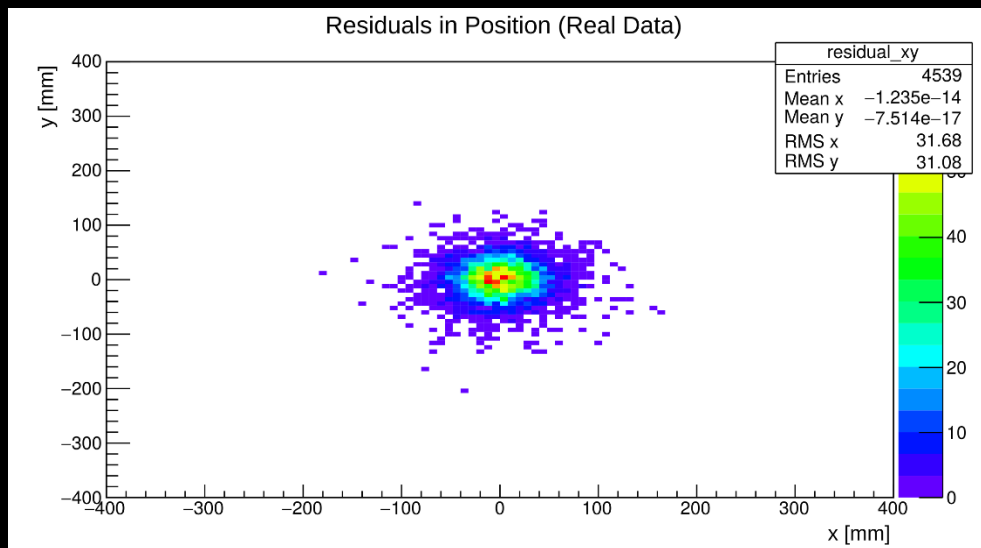
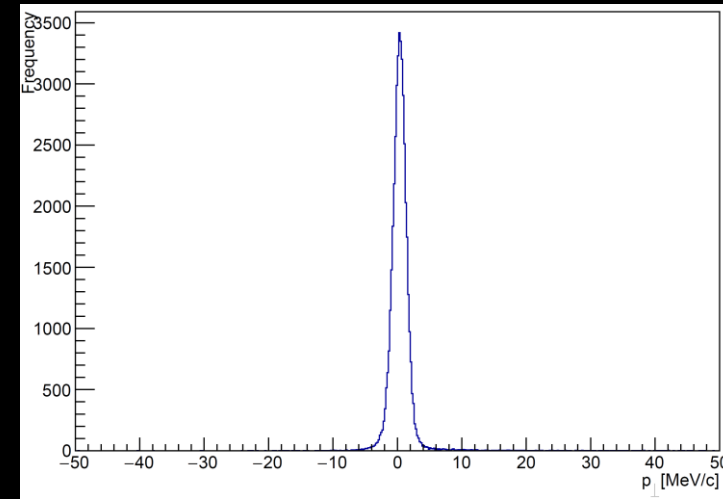
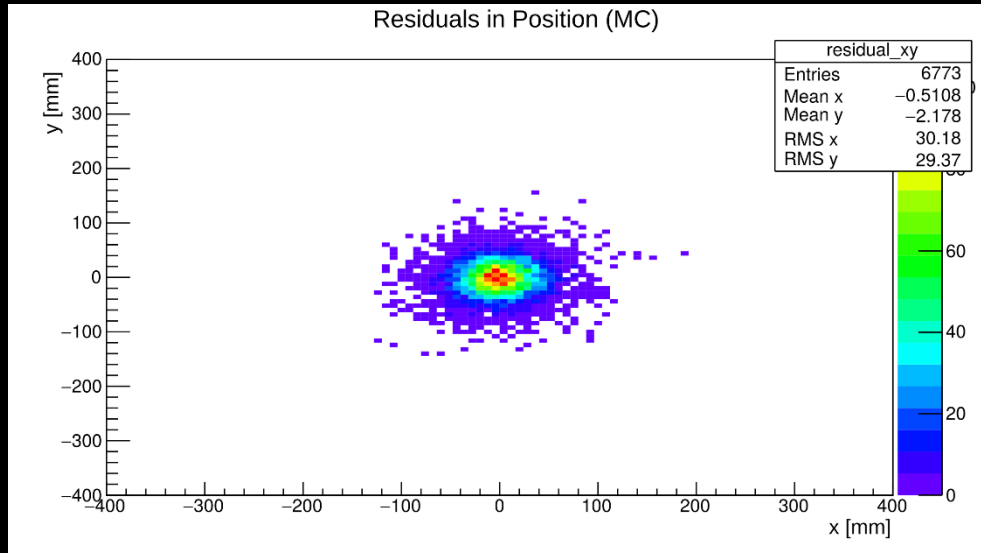
# Detectors: Tracker

- Tracker tested with full MICE beam for the first time – data looking pretty good
- Bugs found and fixed e.g. plane ordering in mapping file
- Tracker configuration files now in CDB, script in MAUS to access them
- Zero suppression code updated
- MC noise algorithm updated
- Efficiency studies underway – initial results look good
- Kalman fit – in use, but still a number of high priority issues to fix:
  - pz recon not good, 40MeV offset vs TOF calculation
  - sign flips and / or rotations seen in Global Tracking and Event Viewer
- Online Reconstruction plots in place, more requested

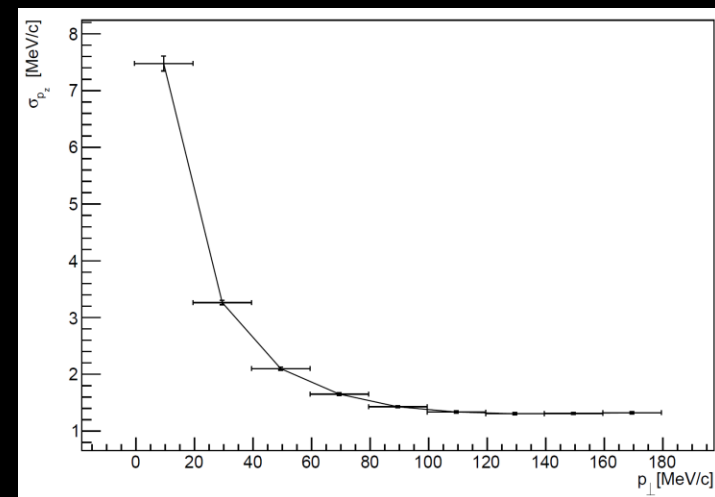


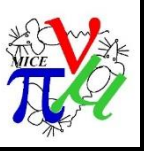
# Kalman Fit Residuals: MC and Real Data

Pt



## Pz Resolution vs Pt



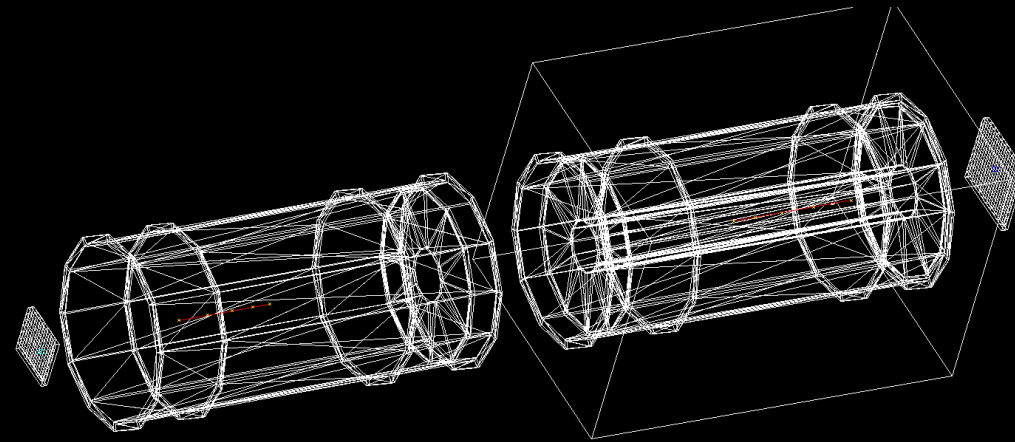
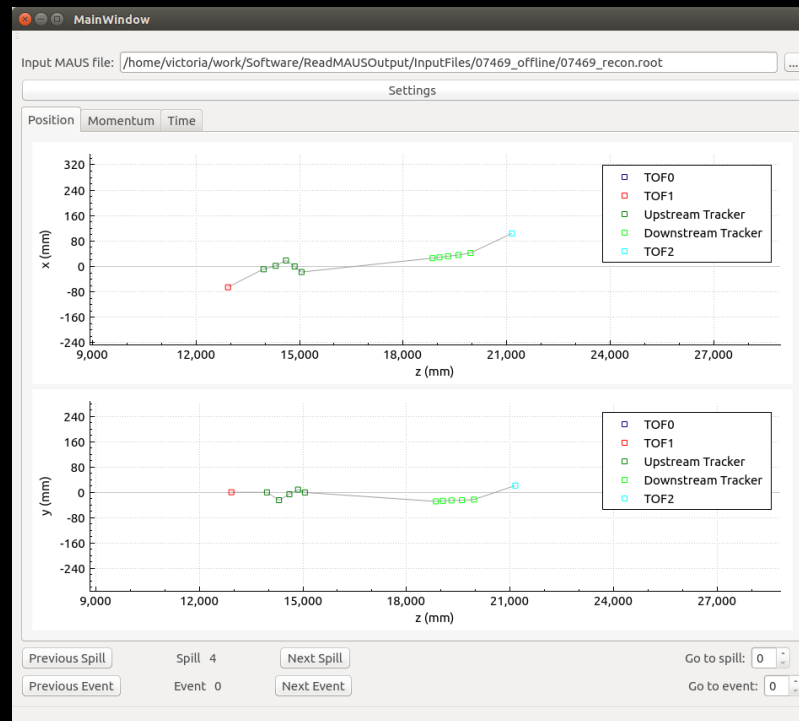


# Global Tracking

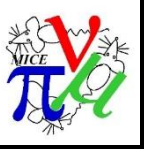
- Global Tracking: integrate data from all detectors to give best possible track fit and PID through the beamline
- PID analysis now using data from all detectors except CKOV (on its way)
  - ➔ PID framework complete excepting CKOV
- PID efficiency and purity MC analyses underway
- Tracking done in two parts: track matching and track fitting
- Runge-Kutta integration (RK4), which propagates tracks for track matching, now complete, under testing
- Track matching functional, undergoing optimisation
- Track fitting method not yet chosen (Kalman and Runge-Kutta contenders)

# Event Viewer

- Original work by V. Blackmore, lots of additional progress under M. Savic
- Considering various extension options, HepRApp currently favoured



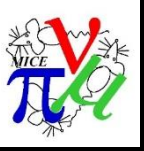
Code: <https://code.launchpad.net/mice-event-viewer>



# Deployment

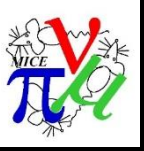
- MLCR for live online reconstruction (miceonrec02 and miceonrec03)
- Fast offline reconstruction (miceoffrec01)
- GRID offline reconstruction and MC simulation
- Many local university / lab installations, batch clusters, personal laptops...
- Various Linux flavours: SL6, CentOS, Ubuntu





# Current Issues

- Tracker final fit pz recon #1782
- Tracker final fit coordinate system issues, etc
- Fix CKOV operation with legacy geometry #1781
- Fix EMR unit tests
- Investigate KL very low # of events with good global coordinate output #1779
- Finalise CDB geometry, validate by running recon, and make default
- Investigate slow MC running #1785



# Remaining Step IV Work

- Finish final tracker track fit
- Sort out any remaining issues with geometry and coordinate system translations
- Finish Global tracking code and perform efficiency and purity studies
- Complete efficiency and performance study of tracker software and publish
- Finish CKOV work
- Add data quality check flags for all detectors
- Complete Event Viewer and possibly add to MAUS as a third party
- Expand tests (focus on integration tests)
- Finish new Online Reconstruction framework
- Fix remaining bugs (e.g. previous slide)
- Post Step IV will need to consider DEMO (correlated noise, new geometry, ...)



# Questions



# Backup: Possible Future Upgrades

- Upgrade version control and distribution: move from Launchpad and Bazaar to Git and GitHub (Bazaar going the way of BetaMax and HD DVD)
- Upgrade build system (SCons slow and less favoured, CMake used by ROOT, GEANT4...)

