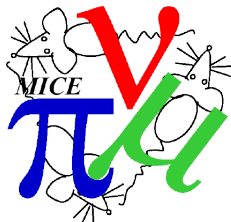


Status of MICE Software



Durga Rajaram, IIT

April 19, 2013



- MAUS goals
- MAUS structure & management
- Components
- Analysis
- Future



- Data I/O
- Simulation & Digitization
- Reconstruction & Particle ID
- Provide a framework for high level accelerator physics analysis
- Provide online diagnostics during running of MICE
- In addition to MAUS's role within MICE, the code is also used for generic accelerator development, in particular for the Neutrino Factory.

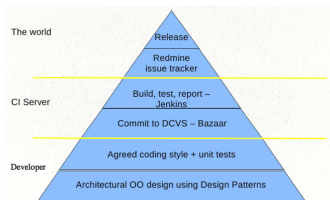


- Plug-in design
 - ▶ Map-Reduce framework (Hadoop, Google, etc)
 - ★ Map – user operation on single “event”
 - ★ Reduce – user operation on all “events”
 - ▶ Input-Transform-Merge-Output
- Input: Read data
 - ▶ Access socket
 - ▶ Read binary DAQ data or MC beam-input
- Transform: Process spill & return modified spill data
 - ▶ MC digitization
 - ▶ Detector reconstruction
- Merge: Summarize data from several spills
 - ▶ Detector summary plots, run summary, etc
- Output: Write out data
 - ▶ ROOT (or JSON format)

Code Management

Rogers

- Code hosted on launchpad, Bazaar DVCS repository
- Development “trunk” & stable releases every two weeks (current release 0.5.1)
- Commits trigger builds & tests on test-server (Jenkins)
- Redmine Wiki for issues & bug reports



MAUS User Analysis Software

Overview **Code** Bugs Blueprints Translations Answers

Bazaar branches of MAUS

You can browse the source code for the development/focus branch or get a copy of the branch using the command:
btr: btr:trunk 1p:trunk

MAUS has 27 active branches owned by 23 people and 7 teams. There were 55 commits by 9 people in the last month.

Branches with status: Any active status | by most interesting

Name	Status	Last Modified	Last Commit
btr:trunk, release	Development	2013-03-19	681. MAUS-v0.5.1
btr:maus/merge	Development	2013-04-11	925. tnf histogram test
btr:maus/release-candidate Series: release-candidate	Development	2013-03-18	722. And docs for 0.5.1
btr-mauscf/trunk/tracker_devel	Development	2013-04-15	942. debug
btr-e-santolo/maus/develop	Development	2013-04-11	940. a style fix.
btr-chris-rogers/maus/develop_2	Development	2013-04-11	925. Specify tmpdir or mkdir tmp if not set
btr-planet1/maus/develop	Development	2013-03-29	726. Checkpoint of mapper conversion to ne...
btr-che4d001/maus/develop_2	Development	2013-03-22	935. Added in MAUS_VERSIONED_CLASS_DEFID a...
btr-taylor/maus/map-base	Development	2013-03-21	935. Merge with MAUS-0.5.1.
btr-ryan-bayes/maus/develop	Development	2013-03-21	682. Completing the update to the data str...
btr-gfalna/maus/CloneM2C	Development	2013-03-28	919. Clone_M2C
btr-che4d001/maus/for-mc-truth	Development	2013-03-25	927. working M2C hit to digit bridge
btr-che4d001/maus/develop	Development	2013-03-25	881. Corrected tests for new-data structure...
btr-chris-rogers/maus/1219	Development	2013-03-22	920. python_extra did not fall even thoug...

Dashboard [jenkins]

Jenkins

All	Release	Third Party	Trunk	Last Success	Last Failure	Last Duration								
MAUS_trunk_devel	MAUS_release_candidate	MAUS_per_commit_third_party_headers071	MAUS_per_commit_third_party_headers071	MAUS_integration_tests	MAUS_full_test	MAUS_accept_9.5-0.01	MAUS_build_and_unit_test	MAUS_release	MAUS_release_candidate	MAUS_rogers	MAUS_karabozuk	MAUS_per_commit_headers071	MAUS_inoan	MAUS_control_plane

Who does what?



Project management
Rogers

Build system
Rogers

Geometry + fields
Ricciardi/Bayes/**Snopok**

TOF
Rajaram

Data unpacking
Karadzhov

Detector integration
Taylor/**Lane**

QA
Rogers

GEANT4 Simulation
Rogers/Bayes/**Leonova**

Tracker
Dobbs/Santos/**Heidt**

EMR
Ruslan/Karadzhov

Accelerator physics
Rogers/**Lane**

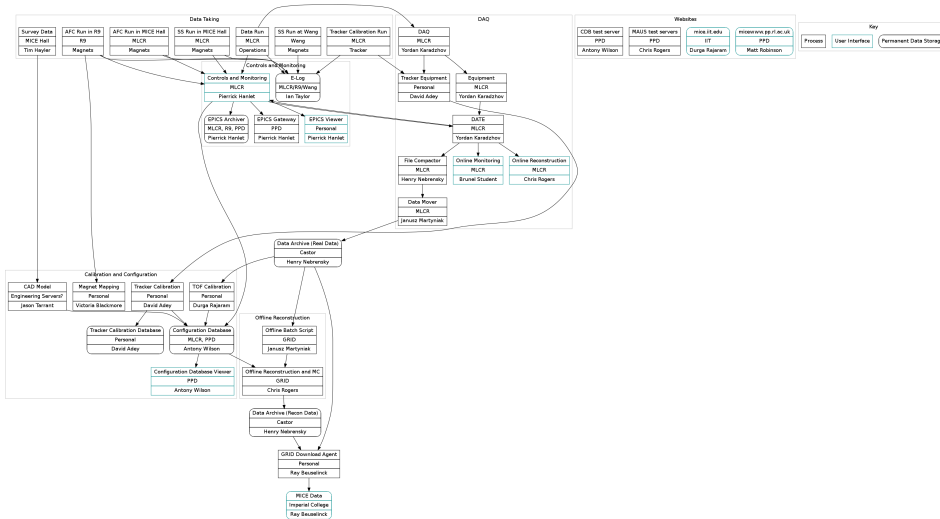
Documentation
Rogers

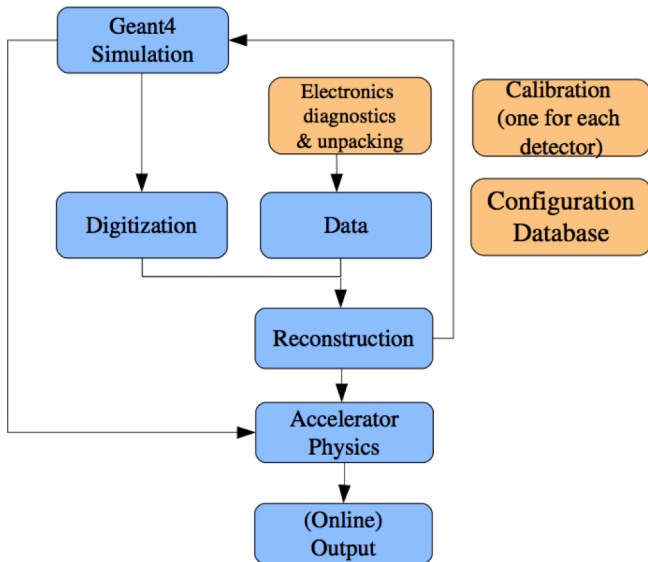
Data flow/API
Rogers/Richards

CKov
Cremaldi/Kafka

KL
Bogomilov

Who does what – details







- MAUS goals
- MAUS structure & management
- Components
 - Analysis
 - Future

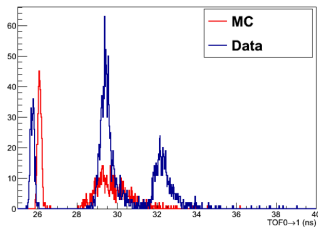
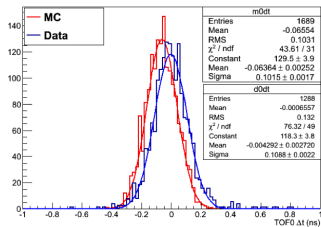


- MC/DAQ
- Digitization/Reconstruction
 - ▶ TOF
 - ▶ Ckov
 - ▶ SciFi tracker
 - ▶ KL sampling calorimeter
 - ▶ EMR electron-muon-ranger
- Geometry & Database
- Online reconstruction
- Batch processing

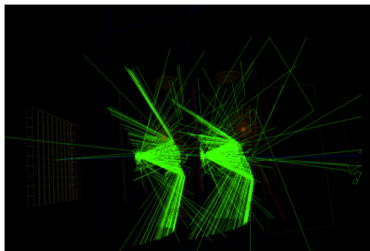
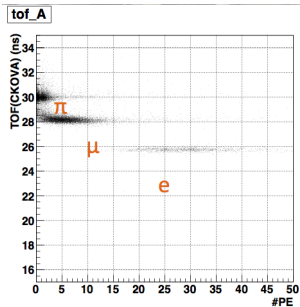


- GEANT4
- Beam generation:
 - ▶ either take particles from file *or* sample particles from a generated distribution
 - ▶ type of beam to generate/sample specified through cards
 - ▶ G4BL input generation in progress
- Geometries: in place (more later)
- Digitization: complete for most detectors
- Visualization: VRML is default, optionally enable OpenGL, etc
- Simulation of MICE-trigger is ongoing
- After digitization, the reconstruction handles both MC-digits and DAQ-data the same way

- Reconstruction code stable
- Monte Carlo digitization completed
- Producing histograms for online reconstruction
- Calibrations in DB
- "Code review" scheduled before next CM



- Reconstruction and online histogramming in place
 - ▶ Potential improvements in the peak-finding algorithm
- MC generation fixed; To do: Digitization & validation of MC-reco
- PID analysis in progress
- New reflector panels should increase photoelectron yield

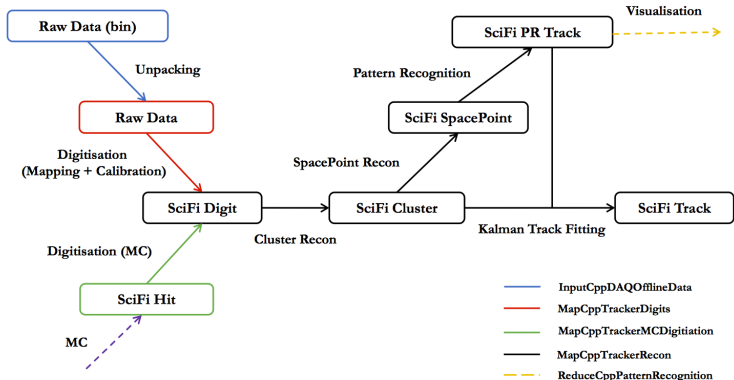


Detector: SciFi trackers

Dobbs,Santos,Heidt

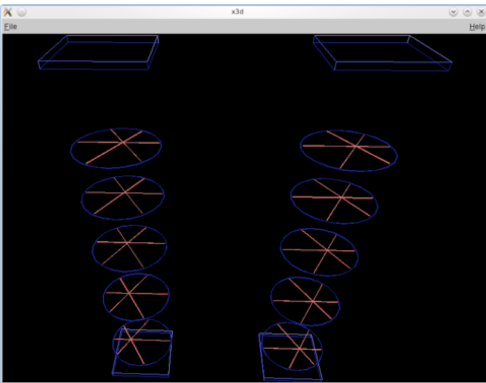


- Raw Data \rightarrow Digits(Hits) \rightarrow Clusters \rightarrow Space Points \rightarrow Pattern Recognition \rightarrow Tracks

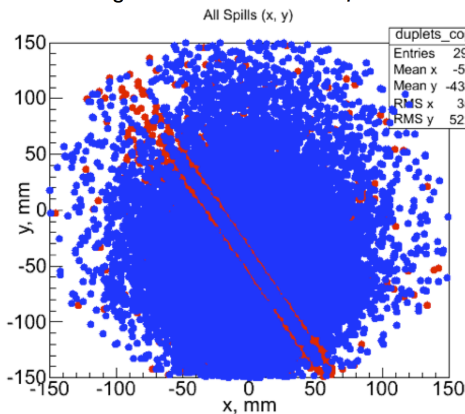


- Successful cosmic run at end of 2011 & a single-station run in May'12 validated hardware, DAQ, and space-point reconstruction

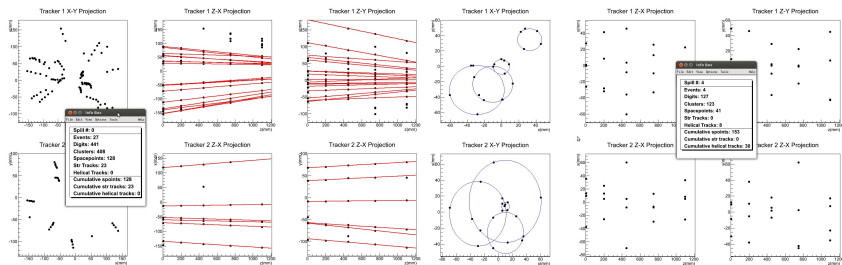
Cosmic ray events in both trackers.



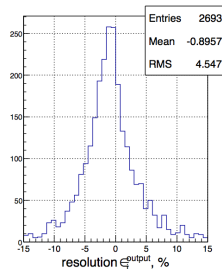
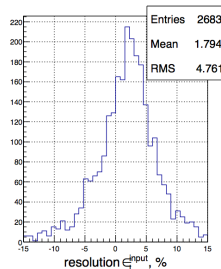
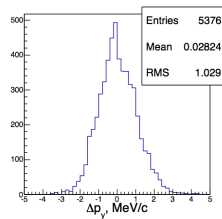
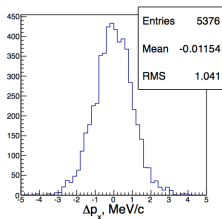
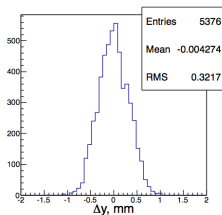
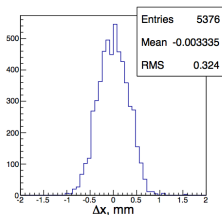
Single Station Run Beam-Profile



- Pattern recognition producing straight & helical tracks
- Works well in clean environment, but needs to be tested (especially efficiency) in noisy environment

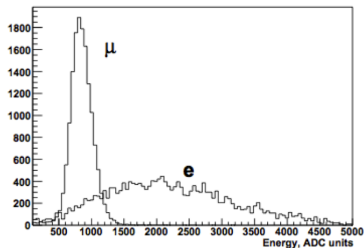
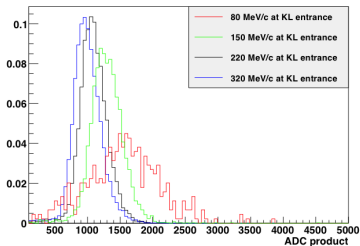


- Kalman fit has been tested with MC



- Reconstruction in place
- Analysis of Step I data using KL led to PID paper
- MC simulation & digitization in progress

Muons

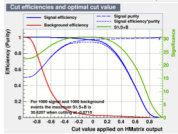
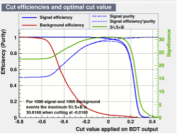
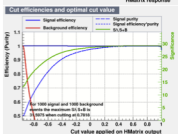
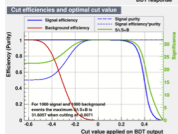
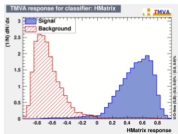
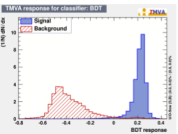
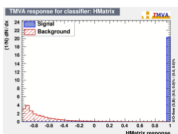
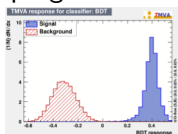
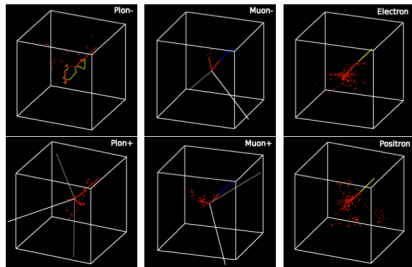


Detector: EMR



Asfandiyarov

- Construction should be finished by May
- Cosmic test with assembled plane
- Simulation & digitization finishing
- TMVA, HMatrix analyses in progress





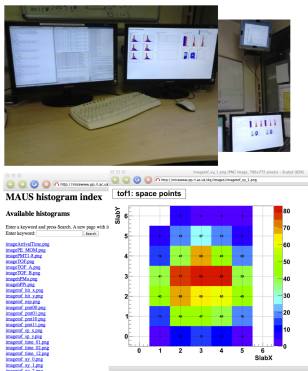
- Goal: to form “global” tracks using space-points and track segments from individual detectors & to do a PID
- Data structure in place. Close to having Minuit track fitting code working with that structure → “Single Track” fitting
- Future milestones
 - ▶ Kalman-based fits, multi-track and background events
 - ▶ PID – “Tracker + TOF” and EMR data.
 - ▶ “Hypothesis Construction”, i.e. the preparation of all tracks inside a particle trigger, determining how many primaries we have, the paths taken, the emittance upstream and downstream of the cooling channel, and whether the track is clean (rejecting decays in flight, hard multiple scatters, etc).
 - ▶ Goal is to have this ready for the winter data challenge.



- Transitioning to a system where geometries are matched with surveys & get extracted from CAD drawings.
- CAD release → Converted to GDML → Uploaded to Configuration DB → Checked by experts → Tagged as a release of new geometry
- Needs to be validated
- Geometries saved in Configuration Database
- Config DB (Postgres) also holds: calibrations for each detector/date, run information
- Server hosted at RAL. Last week we got a computer at FNAL to mirror the DB

Online reconstruction

- Online reconstruction has basic functionality - TOF, Ckov, SciFi plots.
 - ▶ Improvements needed – more summary plots, documentation



Offline processing



- Automatic batch processing of MC & reco
 - ▶ watches for data on the Grid
→ runs MC/reco jobs → push output to data-server

Index of /micedata/RECO/0.4.1/Step1/04900

Name	Last modified	Size	Description
Parent Directory	-	-	-
04900_offline.tar	20-Feb-2013 13:24	68K	
04901_offline.tar	19-Feb-2013 17:45	11K	
04902_offline.tar	19-Feb-2013 17:44	26K	
04903_offline.tar	19-Feb-2013 17:45	68K	
04904_offline.tar	19-Feb-2013 17:45	68K	
04905_offline.tar	19-Feb-2013 17:45	69K	
04906_offline.tar	19-Feb-2013 17:44	24K	
04907_offline.tar	20-Feb-2013 13:24	44K	

Apache/2.2.3 (Red Hat) Server at www.hep.ph.ic.ac.uk Port 80

- Needs fuller configuration DB & proper MC beam-input

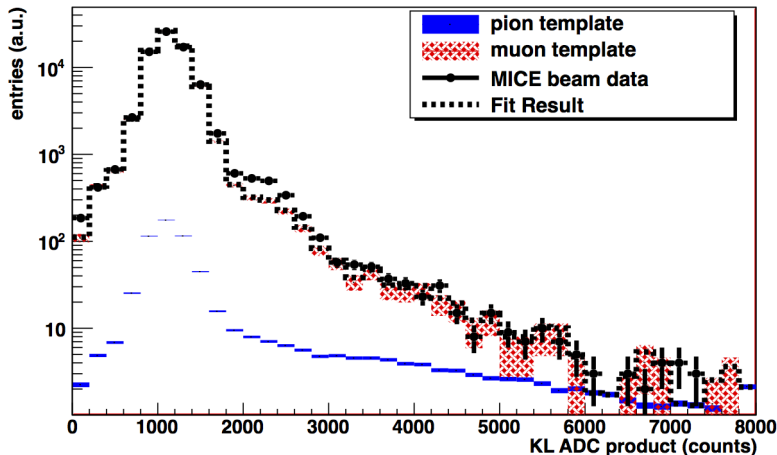


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Analysis: PID



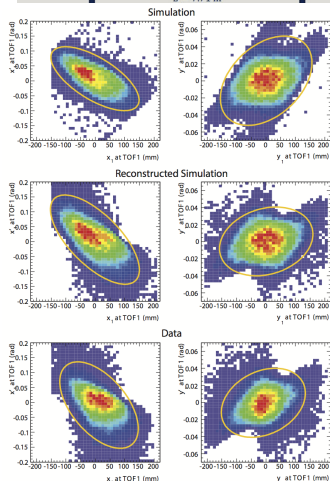
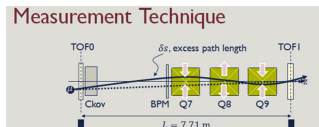
- Measured π contamination in μ beam
- Based on analysis of Step I data
- Draft near final



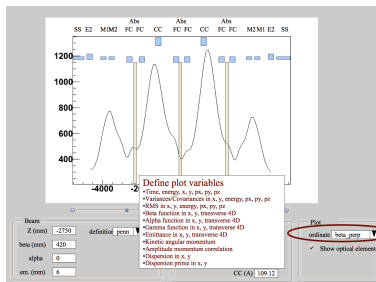
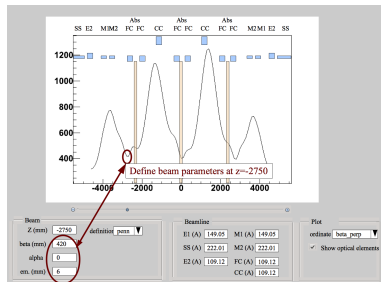
- Emittance measurement from Step I based on TOF0 & TOF1

- ▶ ID muons with TOF & measure x, y, t at TOF0/TOF1
- ▶ Momentum-dependent transfer matrices to map μ path
- ▶ Iterate to calculate p_z → Determine trace space at TOF0/1

- Draft in circulation



- Analysis suite and lightweight tool to calculate accelerator parameters
 - ▶ Twiss parameters, 4D analogues
 - ▶ Cuts, etc
- This will form a basis for any “fancy” stuff we may need like beam sampling tools, etc.





- Analysis group holds bi-weekly meetings
- G4beamline Step 1 comparisons
- TOF rate-effect, detector analyses
- Magnetic field analyses
- Multiple scattering & energy loss models
- ...



- MAUS goals
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- Data challenge in winter 2013/2014 in preparation for running Step IV
- Goal: Run the system from datamover through to batch reconstruction using Monte Carlo data & perform a mock analysis.
- Monte Carlo: G4Beamline generator (**Leonova**)
- Geometry: Implement & validate Step IV geometry (Bayes, Ricciardi)
- Detectors
 - ▶ TOF: Improved Monte Carlo (**Rajaram**)
 - ▶ Tracker: Finalize reco, Calibrations/DB, Geometry, MC noise (Dobbs, Santos, **Heidt**)
 - ▶ Cerenkov: Improved reco, Fix MC geometry/physics (**Kafka**)
 - ▶ Global: Trigger (Bayes), Tracks & PID (Taylor, **Lane**)
- Tests
- Data challenge infrastructure

Step IV readiness



Module	Code released?	Target-date
TOF MC + reconstruction	✓	May 2013
Tracker MC + reconstruction	PR ✓, Kalman x	Jun 2013
Global track fitting single tracks	x	Jun 2013
Global with Kalman and PID	x (dependent on above)	Jan 2014
Geometry of final Step IV design	x	Jan 2014
Beam generation	x	?
Configuration Database	✓	May 2013
Data challenge (start)	Dependent on all above	Jan 2014
Online analysis tools	✓	Aug 2013
EMR MC + Reconstruction	x (not merged)	?
KL MC + Reconstruction	MC x	?
Ckov MC + Reconstruction	Reco ✓, MC x	?
Batch production	✓	Jun 2013
MC Trigger	x	May 2013



- MICE software is advancing well
- Most detectors' simulation and reconstruction in place and working
- Online reconstruction and automated offline processing
- Lots of ongoing work to improve and fill in blanks
- Focus now is to get ready for Step IV running