Status of MICE Software



Durga Rajaram, IIT

April 19, 2013

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Status of MICE Software

MAUS – Mice Analysis and User Software



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

Goals



- 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.

Software Design



- 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



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Who does what?



Project management Rogers

Build system	QA	Documentation
Rogers	Rogers	Rogers
Geometry + fields	GEANT4 Simulation	Data flow/API
Ricciardi/Bayes/ <mark>Snopok</mark>	Rogers/Bayes/Leonova	Rogers/Richards
TOF	Tracker	CKov
Rajaram	Dobbs/Santos/ <mark>Heidt</mark>	Cremaldi/Kafka
Data unpacking	EMR	KL
Karadzhov	Ruslan/Karadzhov	Bogomilov
Detector integration Taylor/Lane	Accelerator physics Rogers/Lane	

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Who does what - details





Data Flow





MAUS – Mice Analysis and User Software



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

MAUS modules



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

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Monte Carlo



- 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

Detector: TOF Rajaram



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



Detector: Ckov



Kafka, Cremaldi

- 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



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SciFi Tests



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



SciFi Pattern Recognition



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



SciFi Kalman



• Kalman fit has been tested with MC



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



Status of MICE Software

Detector: EMR

Asfandiyarov

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





Global Reconstruction

Taylor, Lane



- 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 \rightarrow "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.

Geometry & Database

Bayes, Ricciardi, Littlefield, Wilson



- Transitioning to a system where geometries are matched with surveys & get extracted from CAD drawings.
- CAD release \rightarrow Converted to GDML \rightarrow Uploaded to Configuration DB \rightarrow Checked by experts \rightarrow 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
2	Parent Directory		
Ì	04900 offline.tar	20-Feb-2013 13:24	68K
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Ì	04906 offline.tar	19-Feb-2013 17:44	24K
Ì	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

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Analysis: Emittance



- Emittance measurement from Step I based on TOF0 & TOF1
 - ID muons with TOF & measure x,y,t at TOF0/TOF1
 - Momentumdependent transfer matrices to map μ path
 - Iterate to calculate p_z → Determine trace space at TOF0/1
- Draft in circulation



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- This will form a basis for any "fancy" stuff we may need like beam sampling tools, etc.

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Cuts. etc

SS E2 MIM2 FC FC CC FC FC CC FC FC M2MI E2 SS

CC (A) 109.12



 Analysis suite and lightweight tool to calculate accelerator parameters Twiss parameters, 4D analogues

Analysis: Tools Rogers





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

• ...

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Getting ready for Step IV



- 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

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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	х	Jun 2013
Global with Kalman and PID	x (dependent on above)	Jan 2014
Geometry of final Step IV design	х	Jan 2014
Beam generation	х	?
Configuration Database	v	May 2013
Data challenge (start)	Dependent on all above	Jan 2014
Online analysis tools	v	Aug 2013
EMR MC + Reconstruction	x (not merged)	?
KL MC + Reconstruction	MC x	?
Ckov MC + Reconstruction	Reco 🖌, MC x	?
Batch production	v	Jun 2013
MC Trigger	х	May 2013

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- 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