

# Offline Software

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# Overview

























- Current Release
- Tests
- Detectors
  - CKOV
  - KL
  - EMR
  - TOF
  - Tracker
- Global
- Performance
- Step IV To Do




















































































# Current Release

- MAUS is currently on version 0.9.3
  - bzip branch lp:maus
  - See <http://micewww.pp.rl.ac.uk/projects/maus/wiki>
- Now supports building with multiple cores (use `-j N`)
- G4BeamLine now fully incorporated for upstream beamline simulation
- GRID running now working with a full release
- Physics Block Challenge data produced using release 0.9.2
  - [http://www.ppe.gla.ac.uk/~rbayes/MICE\\_6pi200\\_1/pass2\\_simulation\\_mausv0p9p2.tar.gz](http://www.ppe.gla.ac.uk/~rbayes/MICE_6pi200_1/pass2_simulation_mausv0p9p2.tar.gz)

# Test Coverage I

Directory	Line Coverage ↕	Functions ↕	Branches ↕
src/common_cpp/API	 <b>74.2 %</b>	230 / 310 <b>76.4 %</b>	178 / 233 <b>44.2 %</b>
src/common_cpp/Converter	 <b>92.5 %</b>	49 / 53 <b>66.5 %</b>	149 / 224 <b>40.2 %</b>
src/common_cpp/Converter/DataConverters	 <b>88.7 %</b>	204 / 230 <b>59.7 %</b>	105 / 176 <b>47.6 %</b>
src/common_cpp/DataStructure	 <b>27.8 %</b>	12585 / 45322 <b>25.5 %</b>	2270 / 8889 <b>11.2 %</b>
src/common_cpp/DataStructure/Global	 <b>95.3 %</b>	548 / 575 <b>83.9 %</b>	151 / 180 <b>77.0 %</b>
src/common_cpp/DetModel	 <b>100.0 %</b>	23 / 23 <b>90.0 %</b>	9 / 10 <b>70.0 %</b>
src/common_cpp/DetModel/EMB	 <b>1.7 %</b>	3 / 180 <b>15.4 %</b>	6 / 39 <b>14.3 %</b>
src/common_cpp/DetModel/SciFi	 <b>62.1 %</b>	64 / 103 <b>55.0 %</b>	11 / 20 <b>38.9 %</b>
src/common_cpp/FieldTools	 <b>93.8 %</b>	316 / 337 <b>90.7 %</b>	49 / 54 <b>75.8 %</b>
src/common_cpp/Globals	 <b>97.9 %</b>	95 / 97 <b>100.0 %</b>	12 / 12 <b>73.6 %</b>
src/common_cpp/JsonCppProcessors	 <b>95.0 %</b>	1168 / 1230 <b>74.3 %</b>	1848 / 2486 <b>39.8 %</b>
src/common_cpp/JsonCppProcessors/Common	 <b>81.3 %</b>	157 / 193 <b>68.3 %</b>	569 / 833 <b>37.6 %</b>
src/common_cpp/JsonCppProcessors/Common/ObjectContexts	 <b>83.0 %</b>	190 / 229 <b>91.0 %</b>	1842 / 2025 <b>54.4 %</b>
src/common_cpp/JsonCppProcessors/Global	 <b>92.9 %</b>	78 / 84 <b>65.0 %</b>	39 / 60 <b>46.2 %</b>
src/common_cpp/JsonCppStreamer	 <b>60.3 %</b>	149 / 247 <b>62.7 %</b>	52 / 83 <b>31.2 %</b>
src/common_cpp/Maths	 <b>88.5 %</b>	1735 / 1961 <b>85.7 %</b>	355 / 414 <b>79.1 %</b>
src/common_cpp/Optics	 <b>92.7 %</b>	558 / 602 <b>79.1 %</b>	87 / 110 <b>75.7 %</b>
src/common_cpp/Plotting/SciFi	 <b>44.1 %</b>	520 / 1179 <b>62.2 %</b>	56 / 90 <b>28.6 %</b>
src/common_cpp/Recon/Bayes	 <b>54.5 %</b>	54 / 99 <b>64.7 %</b>	11 / 17 <b>57.1 %</b>
src/common_cpp/Recon/Global	 <b>86.5 %</b>	787 / 910 <b>82.9 %</b>	126 / 152 <b>63.0 %</b>
src/common_cpp/Recon/Kalman	 <b>92.7 %</b>	999 / 1078 <b>94.0 %</b>	125 / 133 <b>76.4 %</b>
src/common_cpp/Recon/SciFi	 <b>85.7 %</b>	1317 / 1536 <b>93.2 %</b>	138 / 148 <b>61.1 %</b>
src/common_cpp/Simulation	 <b>88.8 %</b>	1359 / 1530 <b>93.8 %</b>	182 / 194 <b>62.8 %</b>
src/common_cpp/Utils	 <b>70.2 %</b>	1239 / 1764 <b>79.5 %</b>	245 / 308 <b>54.4 %</b>

# Test Coverage II

Directory	Line Coverage ↕	Functions ↕	Branches ↕
src/map/MapCppEMRPlaneHits	 94.5 % 172 / 182	 73.3 % 11 / 15	 71.3 % 67 / 94
src/map/MapCppEMRRecon	 93.2 % 382 / 410	 82.6 % 19 / 23	 77.2 % 224 / 290
src/map/MapCppExampleMAUSDataInput	 100.0 % 17 / 17	 90.0 % 9 / 10	 43.8 % 7 / 16
src/map/MapCppGlobalPID	 94.5 % 69 / 73	 70.0 % 7 / 10	 67.2 % 39 / 58
src/map/MapCppGlobalReconImport	 93.6 % 44 / 47	 70.0 % 7 / 10	 56.2 % 18 / 32
src/map/MapCppGlobalTrackMatching	 90.9 % 30 / 33	 70.0 % 7 / 10	 41.7 % 10 / 24
src/map/MapCppKCellHits	 93.9 % 77 / 82	 75.0 % 9 / 12	 48.1 % 26 / 54
src/map/MapCppKLDigits	 92.6 % 88 / 95	 69.2 % 9 / 13	 51.9 % 28 / 54
src/map/MapCppKMKDigitizer	 82.6 % 176 / 213	 80.0 % 12 / 15	 54.4 % 86 / 158
src/map/MapCppSimulation	 96.4 % 27 / 28	 77.8 % 7 / 9	 33.3 % 6 / 18
src/map/MapCppTOFDigits	 90.8 % 148 / 163	 87.5 % 14 / 16	 66.0 % 70 / 106
src/map/MapCppTOFMCDigitizer	 87.6 % 227 / 259	 81.2 % 13 / 16	 56.2 % 126 / 224
src/map/MapCppTOFSlabHits	 97.2 % 106 / 109	 91.7 % 11 / 12	 56.9 % 33 / 58
src/map/MapCppTOFSpacePoints	 91.7 % 143 / 156	 94.1 % 16 / 17	 50.4 % 67 / 133
src/map/MapCppTrackerDigits	 47.6 % 10 / 21	 54.5 % 6 / 11	 6.2 % 2 / 32
src/map/MapCppTrackerMCDigitization	 68.7 % 92 / 134	 58.8 % 10 / 17	 39.2 % 29 / 74
src/map/MapCppTrackerMCNoise	 90.5 % 38 / 42	 66.7 % 8 / 12	 33.3 % 14 / 42
src/map/MapCppTrackerRecon	 98.7 % 74 / 75	 86.7 % 13 / 15	 43.1 % 25 / 58
src/output/OutputCppRoot	 83.7 % 128 / 153	 96.6 % 28 / 29	 49.8 % 128 / 257
src/output/OutputCppRoot/build	 25.2 % 362 / 1436	 28.3 % 41 / 145	 14.5 % 154 / 1059
src/py_cpp	 76.7 % 415 / 541	 89.8 % 53 / 59	 55.4 % 133 / 240
src/reduce/ReduceCppGlobalPID	 79.1 % 87 / 110	 85.7 % 6 / 7	 61.4 % 43 / 70
src/reduce/ReduceCppGlobalPID/build	 25.9 % 290 / 1121	 29.7 % 33 / 111	 14.4 % 121 / 843
src/reduce/ReduceCppPatternRecognition	 69.2 % 36 / 52	 21.9 % 7 / 32	 37.5 % 3 / 8
src/reduce/ReduceCppPatternRecognition/build	 25.0 % 290 / 1160	 29.2 % 33 / 113	 14.2 % 124 / 871
src/reduce/ReduceCppToCalib	 44.6 % 79 / 177	 29.4 % 10 / 34	 10.5 % 4 / 38
src/reduce/ReduceCppToCalib/build	 26.8 % 305 / 1137	 32.1 % 36 / 112	 14.8 % 126 / 849

# CKOV

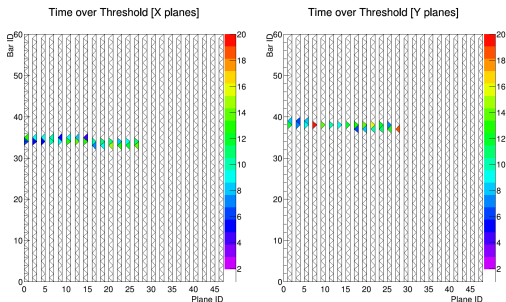
## L. Cremaldi, D. Rajaram

- MC: 30% complete.
- MC data digitisation: 0% complete
  - Private versions of MC hit generators exist and need to be implemented in to MAUS
- Real data digitisation: 50% complete
  - fadc integrators and pedestal finders rewritten by M. Winter and M. Drews, close to being ready for submission to MAUS
  - 2014 HV scans have been analyzed using these updates
- Reconstruction: 25% complete
  - PE counts from the PMTs used for a while to make  $e/\mu/\pi$  predictions using Poisson algorithms for producing likelihoods - need to be finalized and uploaded to MAUS
- CKOV thresholds and responses seem stable. Efficiency is high for particles above threshold.

## EMR

*F. Drielsma*

- MC: Complete
- MC digitisation: Complete
- Real data unpacking: Complete
- Reconstruction: 80% complete
- Calibration needs to go to CDB
- See EMR talks

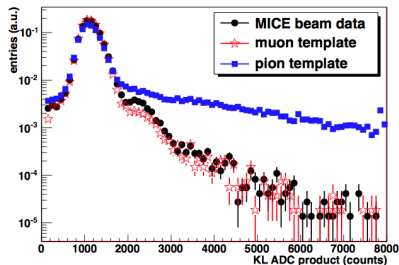


250 MeV/c Muon Event

## KL

*M. Bogomilov, J. Nugent*

- MC: Complete
- MC data digitisation: Virtually complete
- Real data digitisation: Complete
- Reconstruction: Complete
- MC validation: Complete

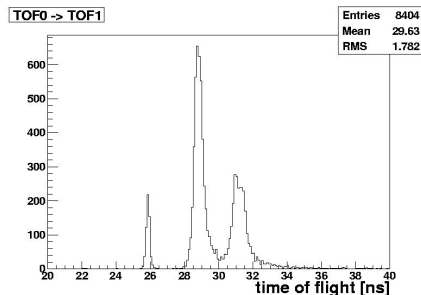




# TOF

## D. Rajaram

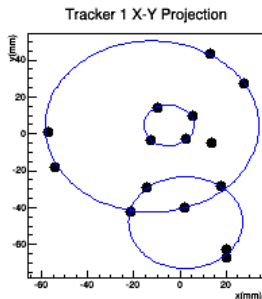
- MC: Complete
- MC digitisation: Mostly complete
  - MC trigger work ongoing
- Unpacking: Complete
- Real data digitisation: Complete
- Reconstruction: Complete
- Online displays: Complete



# Tracker

*D. Adey, A. Dobbs, C. Heidt, C. Hunt, M. A. Uchida*

- MC: Complete (perhaps a bit of tinkering with the noise algorithm)
- MC data digitisation: Complete
- Unpacking: Broken post release 0.7.3 (fix done?)
- Real data digitisation: Status unsure due to unpacking problem
- Reconstruction
  - Almost complete
  - Final track fit algorithms being refined and tuned
  - Efficiency may be a problem at low  $p_t$
- MC validation: Mostly complete.
- Online displays: 60% complete



# Global

*M. A. Uchida, C. Pidcott, J. Greis*

- 3 PID variables now in release
- EMR importer and an EMR based PID variable are in development
- Tracking being overhauled, switched from transfer matrix method to Runge-Kutta (RK4)
- Downstream: **Tracks and PID**, 1 PID variable
- Upstream: **Tracks**, 2 PID variables
- Through-going tracks with PID, for commissioning are in development
- Efficiency and Pt calculations are coming along
- Require detector output in global coordinate system - C. Hunt and C. Heidt working on this
- Good progress being made, estimate 50% complete, expected completion date of 30th June 2015

# Geometry

*R. Bayes*

## Purpose

- An accurate and reproducible record of the beam line geometry
- Reproduce the geometry in software

## Status

- Working geometry versioning system is in place based on CAD models + detectors + fields
- Validations are in place for the generation of new geometries
- Geometry release procedure: [micewww.pp.rl.ac.uk/projects/maus/wiki/Geometry\\_release\\_procedure](http://micewww.pp.rl.ac.uk/projects/maus/wiki/Geometry_release_procedure)
- GDML parser implemented, excellent loading time: Legacy - 2m40, CDB (MM) - 26m51, CDB (GDML parser) - 1m27

# Performance

Recently needed to produce estimate of GRID resources required by MICE:

- Result came out at least an order of magnitude too large
- Cause: Analysis group requested 2000 beams to be simulated by G4BL, each producing  $10^6$  muons at TOF1
- J. Nugent:  $48 \times 50$  CPU hours for  $10^5$  muons at TOF1 for one beam
- Hence need  $\sim 4.8 \times 10^8$  cpu hours - not feasible
- Solution: Analysis group - Do we really need 2000 beams? Software group - how much can we optimise?

# To Do for Step IV

## Towards **MAUS 1.0**:

- Fix tracker real data unpacking and digitisation
- Achieve desired tracker final track performance - 01/04/15 (Milestone)
- Remove memory leaks still present
- Produce detector output in global coordinate frame
- Finish Global PID and track reconstruction - 30/06/15 (Milestone)
- Finish online displays
- Bring G4BL resource usage to acceptable levels
- Profile and optimise general MAUS processing speed

