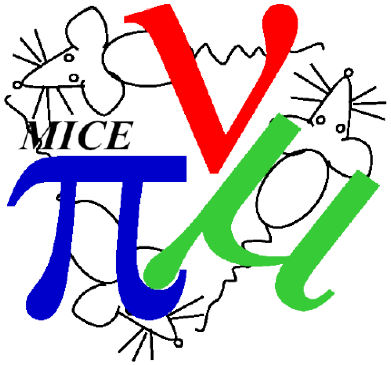
G4MICE - Status and Plans



Chris Rogers,
ASTeC,
Rutherford Appleton Laboratory

Progress in G4MICE

- New releases
  - mice-2-4-0
  - mice-2-4-1 imminent
    - All tests pass, documentation is ready
    - Want a quiet time to just check things over
  - “Roughly” 2 month release cycle
  - 27 open bugs
- Review of build procedure, dataflow, infrastructure
  - MAUS - C. Tunnell talk
- Code and Responsible persons
- Review of code QA and documentation
- New code

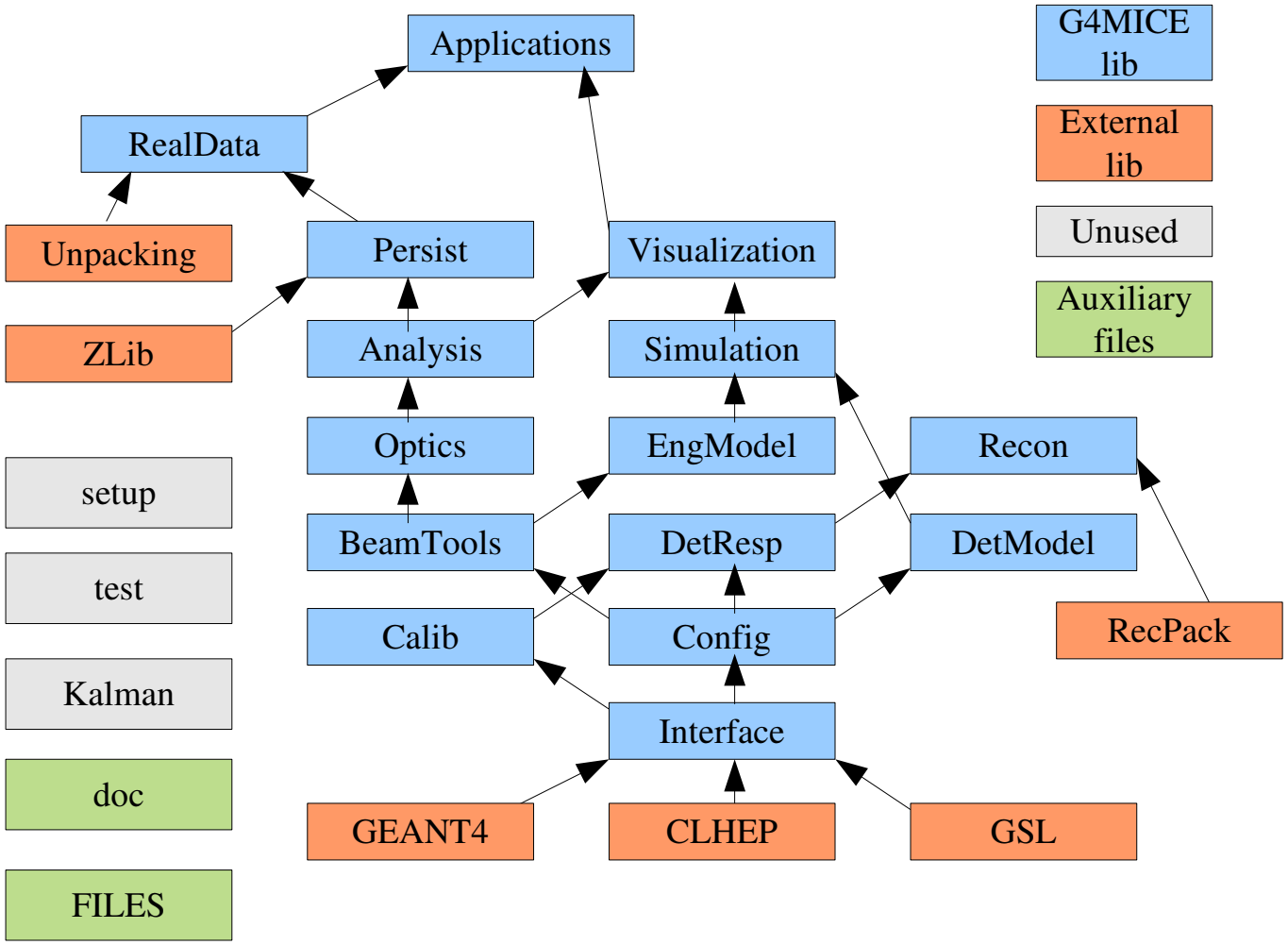
Aims

- User Documentation
- QA Process
- MC Simulation
  - Geometry model
- Digitisation
- Reconstruction
  - Segmentation fault
- Physics analysis tools
- Optics simulation of MICE (transport matrices)
- Event display
- Data quality check
- Calibration application(s)

Code as Engineering

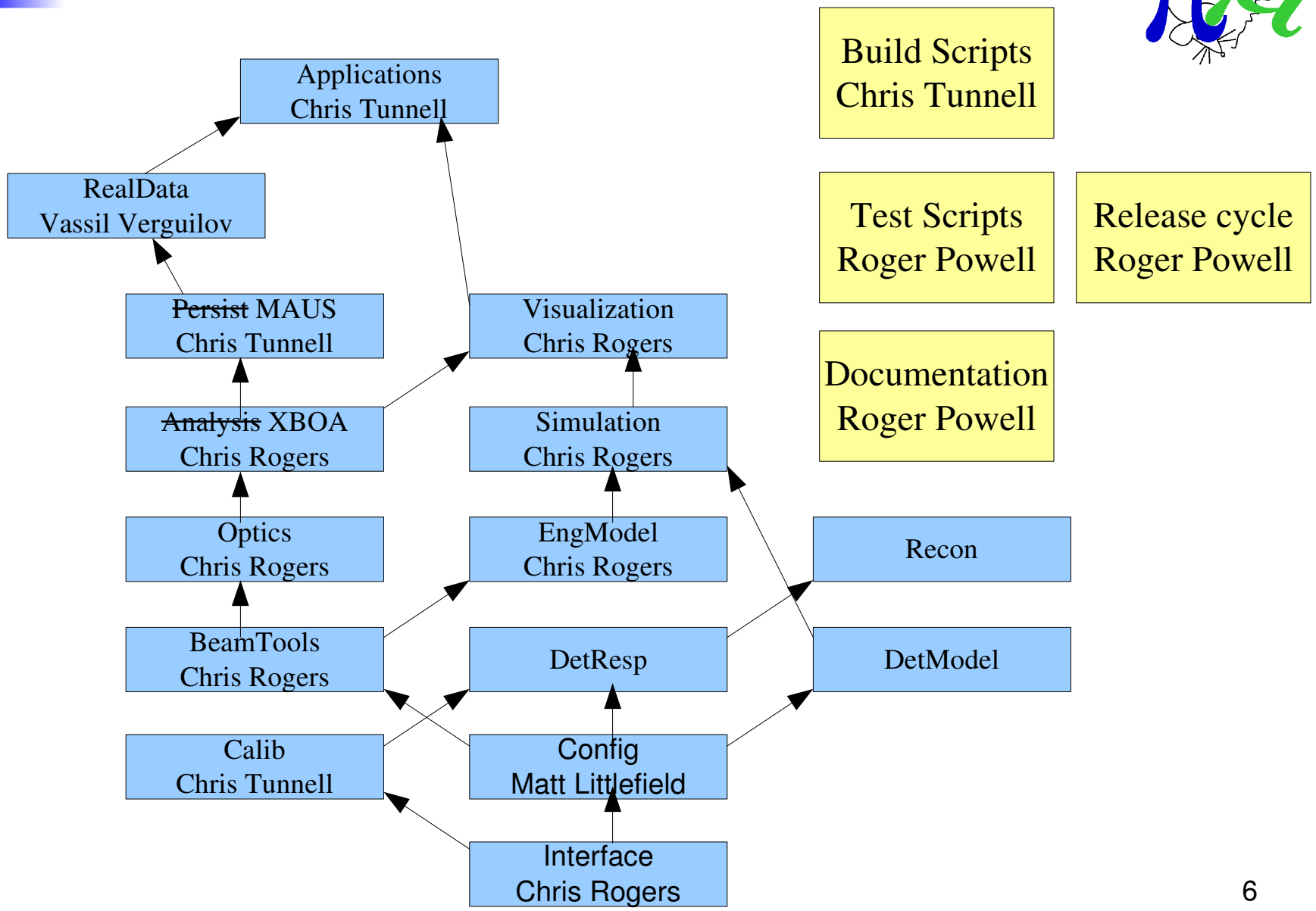
- Coding is a complex engineering problem
  - As G4MICE manager, it's my job to manage this complexity
  - We have brilliant coders making brilliant fancy algorithms
  - But somehow the bureaucracy of complex engineering gets us
    - Developers move on to bigger things
    - Code goes mouldy
    - People forget
- Keys to managing complexity
  - Clear interfaces
  - Rigorous and extensive testing
  - Rigorous and extensive documentation
- Not much fun!
  - We're physicists
  - We like doing fancy stuff
  - But the boring stuff will get us in the end
- My job is to manage the complexity
  - Use best practice/industry standard processes

G4MICE Domains Diagram



- Each domain contains ~ 10 objects each with ~ 20 functions
  - ~ few thousand custom components all of which need to work together

G4MICE Code Ownership



Recon Area

DetResp - Chris Tunnell
Global - Chris Tunnell
SciFi - David Adey
EMR - Vassil Verguilov
TOF - Yordan Karadzhov
KL - Mariyan Bogomilov
Ckov - Peter Sonnek
Virtual - Chris Rogers

Recon - Chris Tunnell
Global - Chris Tunnell
+ Simon Fayer
SciFi - David Adey
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Code QA and Documentation

- Code QA
  - G4MICE has issues with stability and usability
    - Reconstruction code returns segmentation fault and has done for years
      - Knowledgeable, competent developers take months to get it to reconstruct
    - Bugs all over the place
    - Crashes in control room
  - Need QA process to fix that
    - Unit tests allow to run every line of code at least once (and check it does what we think)
    - Application tests allow to run a few configurations and check certain conditions
- Documentation
  - We are turning over almost the entire G4MICE crew this year
  - MICE will need to operate for at least another 3 years
  - We need to ease the turnover process
  - Documentation!
    - Also leads to better quality code

Code QA and Documentation

- Unit testing framework implemented and operational
  - A few developers have contributed
  - Release 2-4-1 does not include changes that have not been tested
  - Rule will apply to future releases
  - Writing unit tests will take many months

Code QA and Documentation

cr67 on linux-rp26: /home/cr67/G4MICE/MICETESTS-dev/gUnit/mgr - Shell No. 2 - Konsole

Session Edit View Bookmarks Settings Help

```
[ RUN      ] BTMultipoleTest.BTMultipoleConstructorTest
[       OK ] BTMultipoleTest.BTMultipoleConstructorTest (0 ms)
[ RUN      ] BTMultipoleTest.BTMultipoleTransformToRotated
[       OK ] BTMultipoleTest.BTMultipoleTransformToRotated (37 ms)
[ RUN      ] BTMultipoleTest.GetFieldValueTest_HardEdged
[       OK ] BTMultipoleTest.GetFieldValueTest_HardEdged (0 ms)
[ RUN      ] BTMultipoleTest.BTMultipoleGetConstTest
[       OK ] BTMultipoleTest.BTMultipoleGetConstTest (0 ms)
[ RUN      ] BTMultipoleTest.GetFieldValueTest_TanhDipole
[       OK ] BTMultipoleTest.GetFieldValueTest_TanhDipole (4 ms)
[ RUN      ] BTMultipoleTest.GetFieldValueTest_TanhQuad
[       OK ] BTMultipoleTest.GetFieldValueTest_TanhQuad (4 ms)
[ RUN      ] BTMultipoleTest.GetFieldValueTest_Enge
[       OK ] BTMultipoleTest.GetFieldValueTest_Enge (1 ms)
[ RUN      ] BTMultipoleTest.PrintTest
[       OK ] BTMultipoleTest.PrintTest (0 ms)
[----------] 9 tests from BTMultipoleTest (46 ms total)

[----------] 3 tests from BTFieldConstructorTest
[ RUN      ] BTFieldConstructorTest.EndFieldTest
[       OK ] BTFieldConstructorTest.EndFieldTest (5 ms)
[ RUN      ] BTFieldConstructorTest.GetMultipoleTest
[       OK ] BTFieldConstructorTest.GetMultipoleTest (4 ms)
[ RUN      ] BTFieldConstructorTest.GetCombinedFunctionTest
[       OK ] BTFieldConstructorTest.GetCombinedFunctionTest (5 ms)
[----------] 3 tests from BTFieldConstructorTest (14 ms total)

[----------] 10 tests from MiceModToG4SolidTest
[ RUN      ] MiceModToG4SolidTest.checkDimTest
[       OK ] MiceModToG4SolidTest.checkDimTest (0 ms)
[ RUN      ] MiceModToG4SolidTest.buildWedgeTest
[       OK ] MiceModToG4SolidTest.buildWedgeTest (2 ms)
[ RUN      ] MiceModToG4SolidTest.buildBoxTest
[       OK ] MiceModToG4SolidTest.buildBoxTest (2 ms)
[ RUN      ] MiceModToG4SolidTest.buildCylinderTest
[       OK ] MiceModToG4SolidTest.buildCylinderTest (1 ms)
[ RUN      ] MiceModToG4SolidTest.buildTubeTest
[       OK ] MiceModToG4SolidTest.buildTubeTest (2 ms)
[ RUN      ] MiceModToG4SolidTest.buildSphereTest
[       OK ] MiceModToG4SolidTest.buildSphereTest (5 ms)
[ RUN      ] MiceModToG4SolidTest.buildPolyconeTest
[       OK ] MiceModToG4SolidTest.buildPolyconeTest (0 ms)
[ RUN      ] MiceModToG4SolidTest.buildMultipoleTest
[       OK ] MiceModToG4SolidTest.buildMultipoleTest (1 ms)
[ RUN      ] MiceModToG4SolidTest.buildTorusTest
[       OK ] MiceModToG4SolidTest.buildTorusTest (4 ms)
[ RUN      ] MiceModToG4SolidTest.buildEllipticalConeTest
[       OK ] MiceModToG4SolidTest.buildEllipticalConeTest (2 ms)
[----------] 10 tests from MiceModToG4SolidTest (19 ms total)

[----------] Global test environment tear-down
[==========] 61 tests from 13 test cases ran. (876 ms total)
[  PASSED  ] 60 tests.
[  FAILED  ] 1 test, listed below:
[  FAILED  ] MiceModuleTest.printTree

 1 FAILED TEST
gUnit/mgr>
```

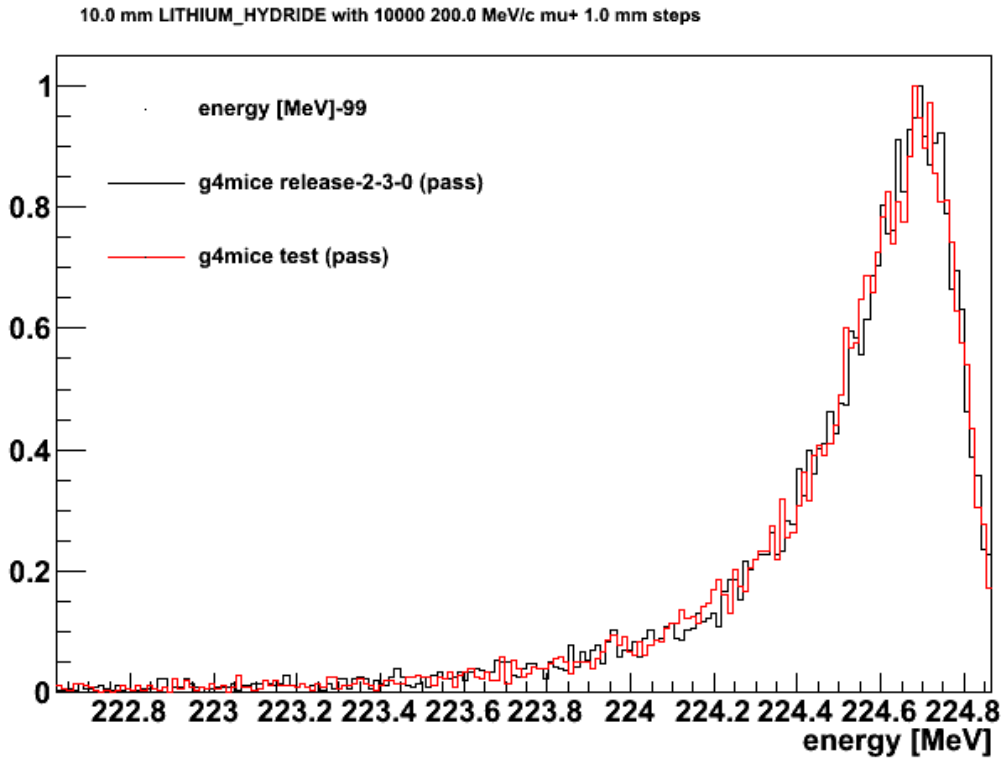
Shell | Shell No. 2 | Shell No. 3

cr67 on linux-rp2 | MICE Collaboration | MultipoleConfigurat | 08:24 London

Code QA and Documentation

- Unit testing framework implemented and operational
  - A few developers have contributed
  - Release 2-4-1 does not include changes that have not been tested
  - Rule will apply to future releases
  - Writing unit tests will take many months
- Application level framework implemented
  - Focus on simulation but should be extensible
  - So far implementation has regression tests for physics list, quadrupole model

Code QA and Documentation



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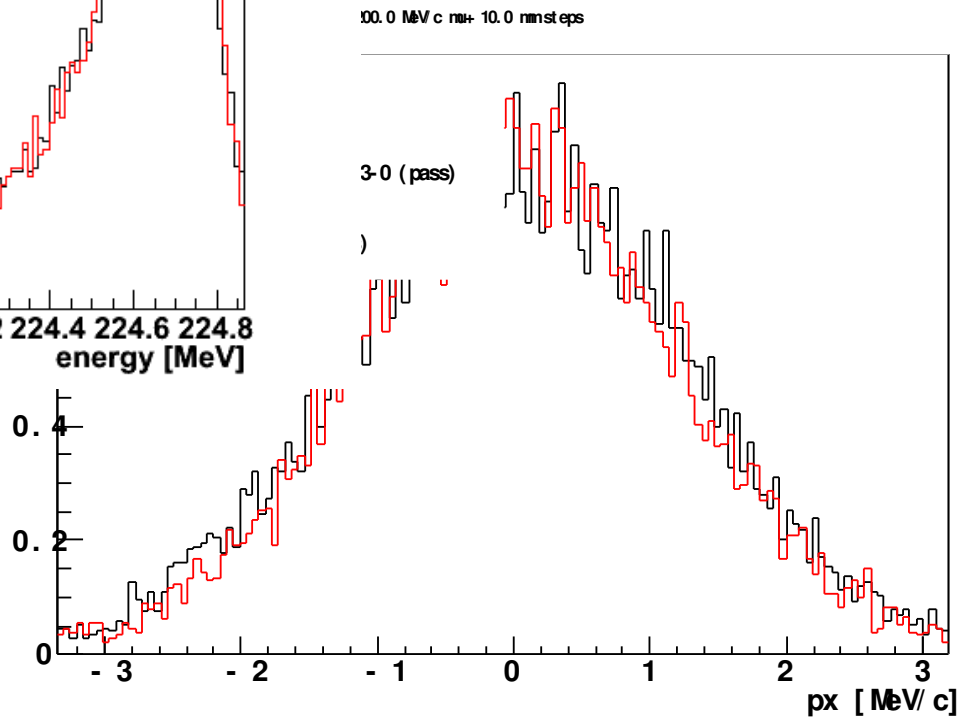
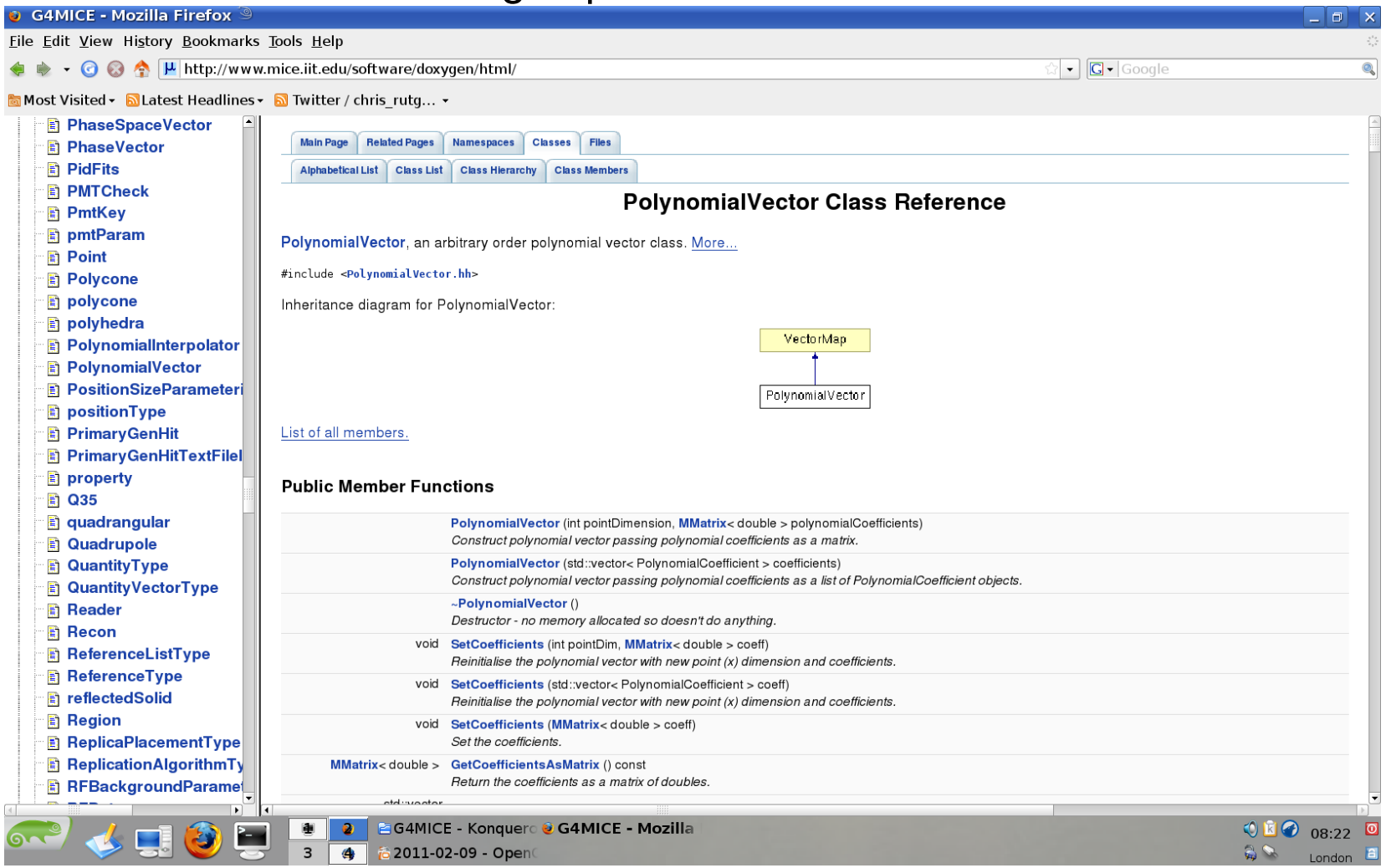


Code QA and Documentation

- Code documentation being implemented
  - Doxygen style comments inline

Code QA and Documentation

- Code documentation being implemented

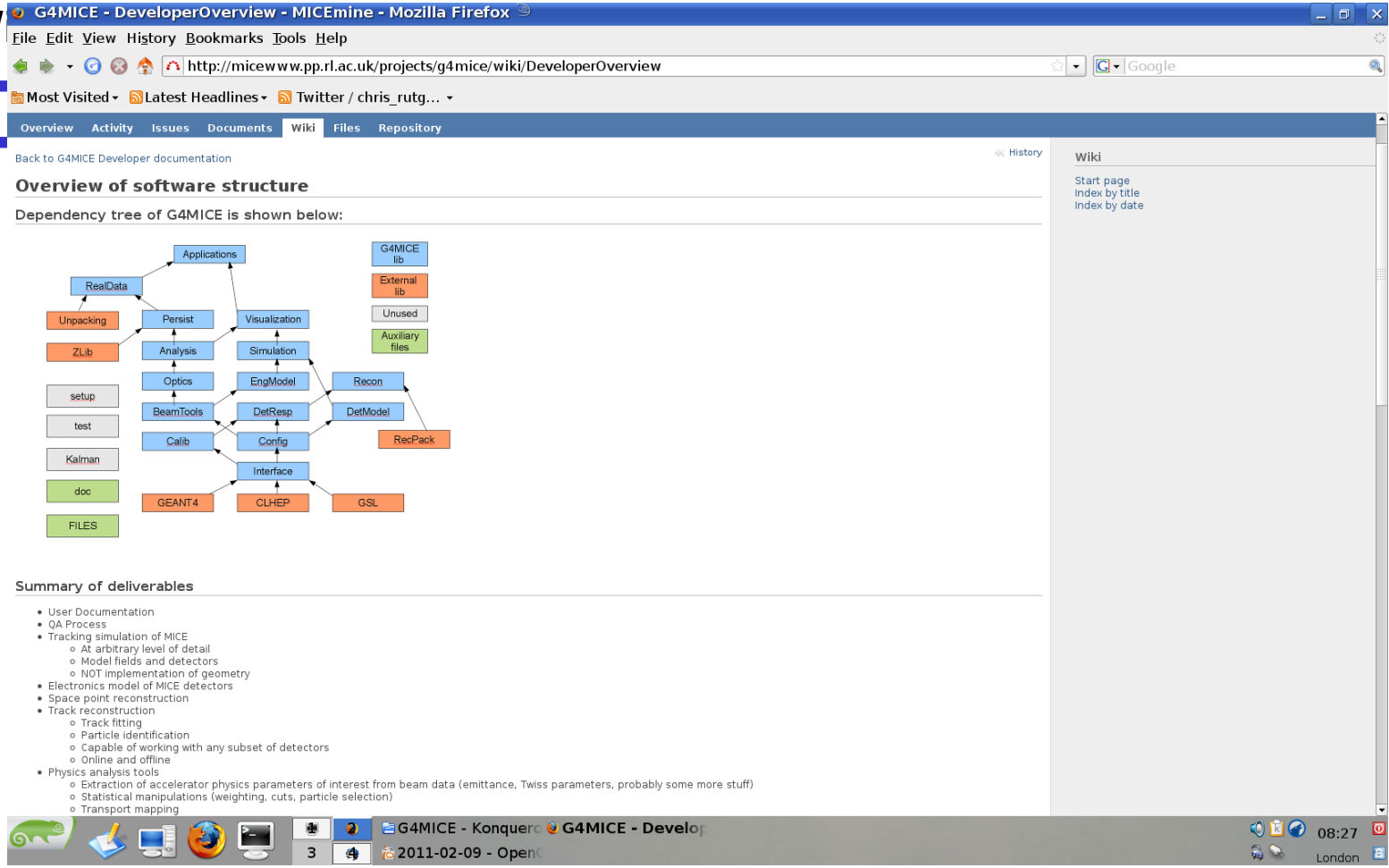


Code QA and Documentation

- Code documentation being implemented
  - Doxygen style comments inline
  - Wiki + pdf for overview documents
    - Developer documentation
    - User documentation
  - Support email list
    - Use it!

Code QA and Documentation

- Code documentation being implemented
  - Doxygen style comments inline
  - W



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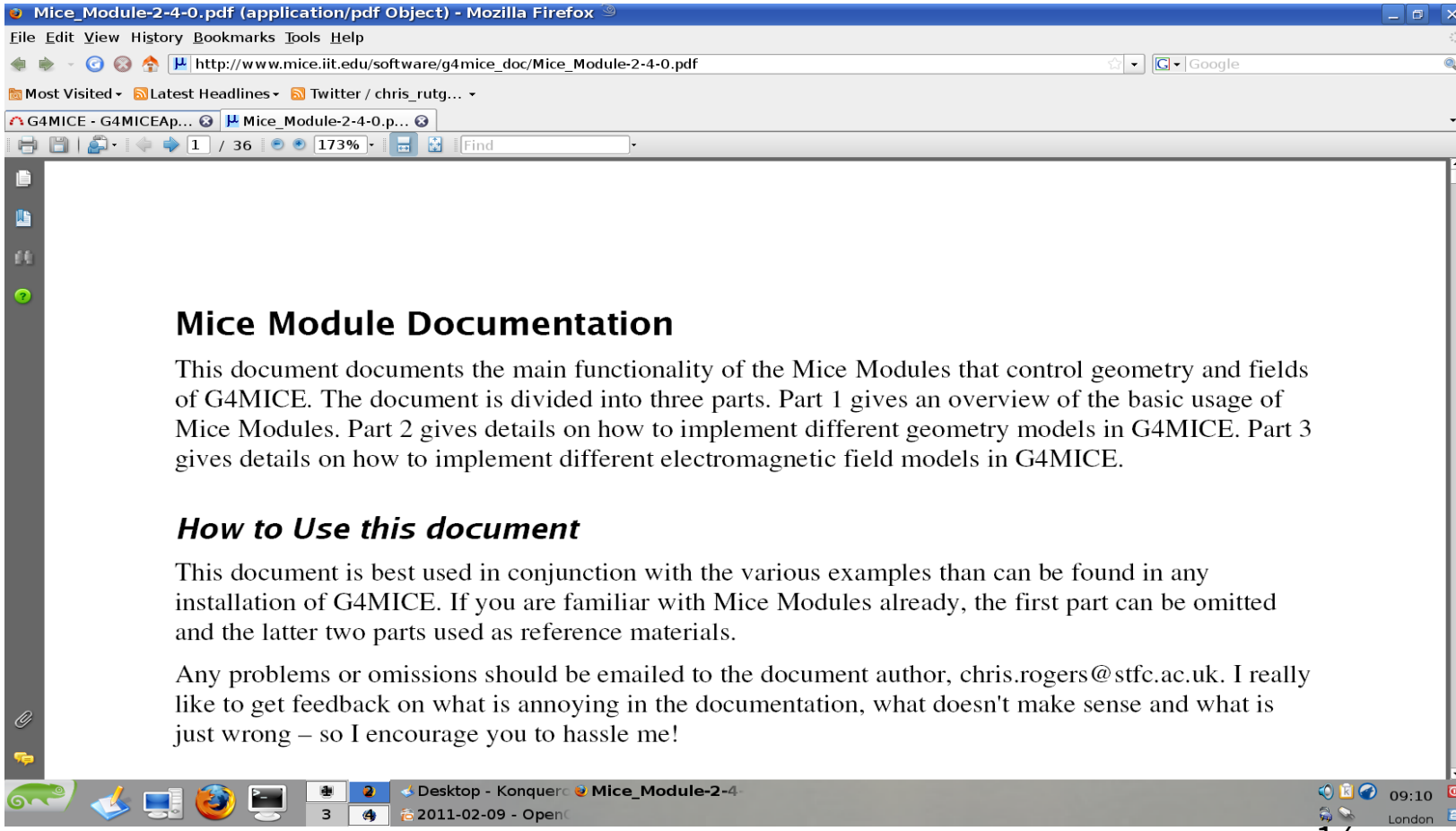
  - 

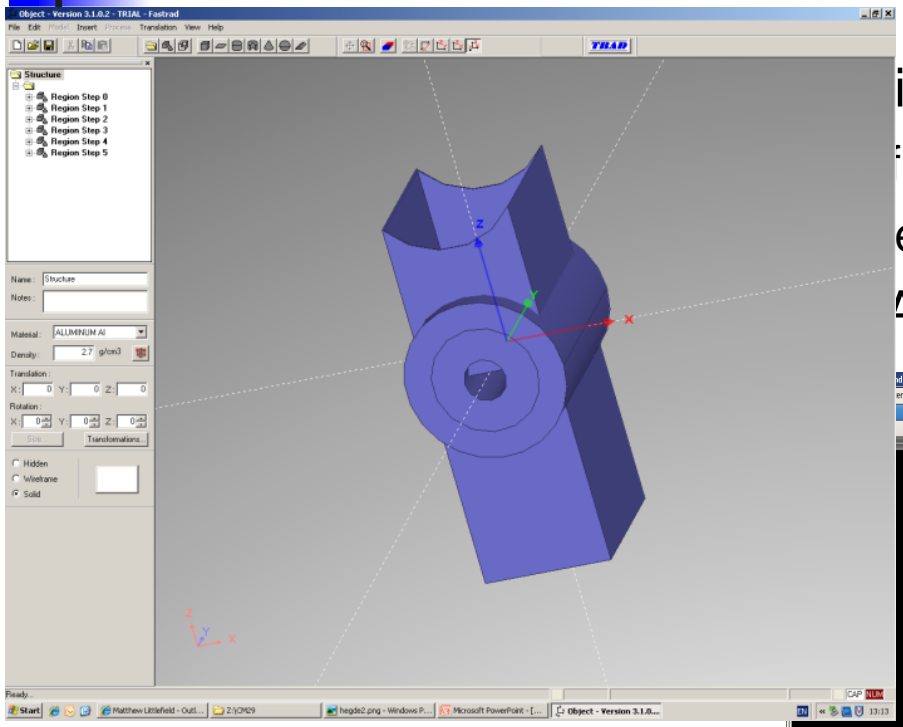
Continuous Integration

- Continuous Integration
  - When we check in the code we do some rudimentary tests on coding standards, testing
  - We have regular automated scripts to run nightly build and test jobs
  - Aspire to daily (or so) email to developers if the test job is broken
- If the code breaks, we know what broke and where

Geometry + ConfigDB Interface

- It is not G4MICE crew's job to figure out what MICE is made of
  - We can't end up with the job of writing TRD - too much
  - DECISION: we will implement engineering CAD model
- We will implement the MICE CAD model
- Some subtleties
  - Manage issues like diffuser, proton absorber
  - Add tags for detector guys (e.g. channel + station number)
  - Add field map tags (e.g. field type)
- Workflow: CAD -> GDML <-> MiceModule -> GEANT4
  - Allows to add coil configurations
- Workflow: CAD -> GDML <-> ConfigDB
- Status - preliminary implementation complete
  - Further work requires license for CAD -> GDML converter code

Geometry + ConfigDB Interface



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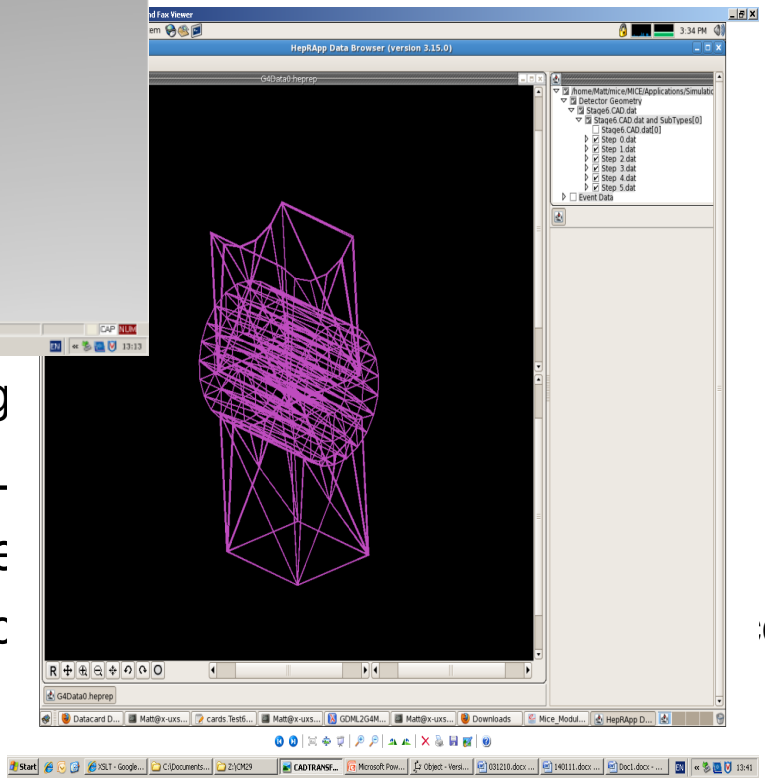
writing TRD - too much

engineering CAD model

AD model



- Allows to add coil config
- Workflow: CAD -> GDML
- Status - preliminary imple
  - Further work requires lic ode

Simulation

- Bug fix to multipole model for quadrupoles
  - Required some significant reworking of the code
  - Proper treatment for end fields
  - All new code is unit tested, doxygenated, application tested
- Added regression tests for physics model
  - Check that physics process model does not change from one version to the next
  - Test for most relevant materials, particle species, particle momenta

Simulation

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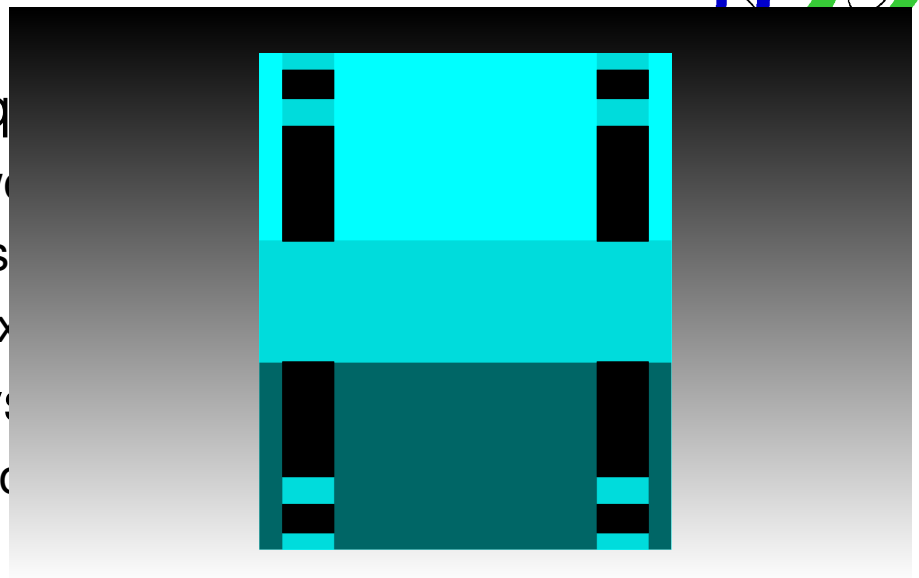

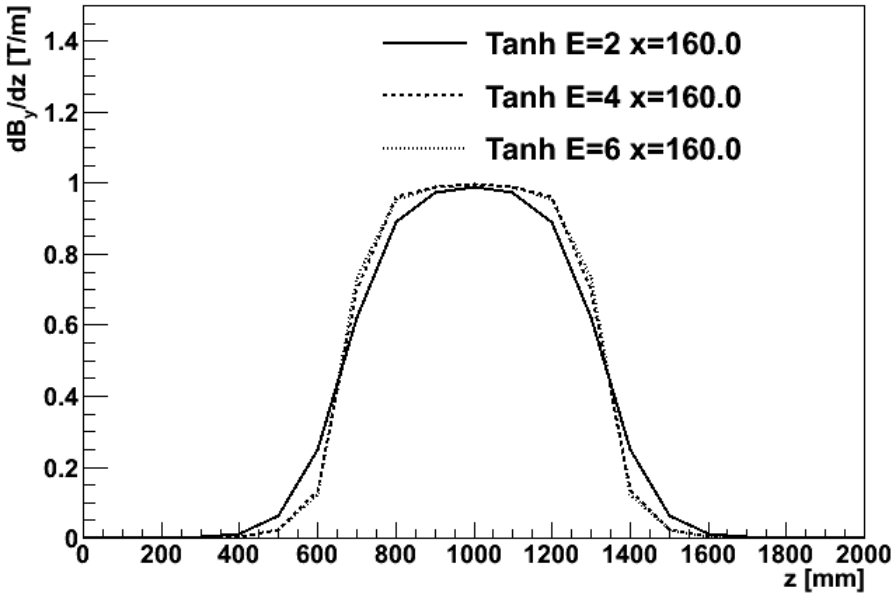

Detectors

- EMR work is progressing
  - Simulation is advanced
  - Some work on cluster finding
  - Not committed to CVS
  - No manpower for testing
- TOF progress in documentation
  - Code is being commented up
  - Testing is planned
- Tracker is work in progress
  - Focus is on unpacking (out of scope)
  - But getting reconstruction code to work seems non-trivial
- Need to integrate with MAUS data structures
- Need to start work on global interfaces

Physics analysis tools

- MICE analysis software requirements
  - Physics analysis routines for MICE control room
    - Beta, alpha, emittance, plotting
    - Need fast turnaround of plots
- Current physics analysis routines are not fit for purpose
  - Written by some rubbish graduate student as a first coding project
- Instead use XBOA physics analysis library
  - ~ few thousand lines of code
  - Good test coverage
  - Well documented (function-by-function + worked examples)
  - Local expertise
  - Written by some rubbish RAL staff guy
- Allows for quick and dirty physics analysis online
  - People need to get acquainted off line to use it (quickly) online
  - Avoid long turnaround to get slight changes to plots, etc

Operations

- We will make an on-call rota during operational periods
- Some discussion about how we manage robust approach to bug fixing in control room
  - We find a bug and fix it...
  - Did we really fix it?
  - Did we make a new bug?
  - Are we keeping the control room code and offline code in sync?
- On the other hand, we don't want to compromise running with procedural crud

Manpower

- Almost total turnover of manpower in this year
- Welcome to new folks joining the team!
- We have our work cut out for us
  - Documentation is poor
  - Testing is poor
  - How can I change the code if I don't know what it's supposed to do?
    - Was that a bug?
    - Was that supposed to happen?
- We should anticipate **now** another turnover cycle in 3 years time
  - Documentation
  - Testing

Timescale

- Hope for
  - Config DB Interface - March 1
  - Simulated beam timing within spill structure - March 18
  - CAD model first implementation - April 8
  - Existing functionality replicated in MAUS framework - April 15
  - 3D meshing routines (but no interpolation) - May 1
  - Optics refactor - August 1
  - EMR
  - Ckov
  - Tracker refactor