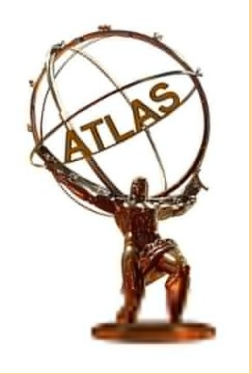
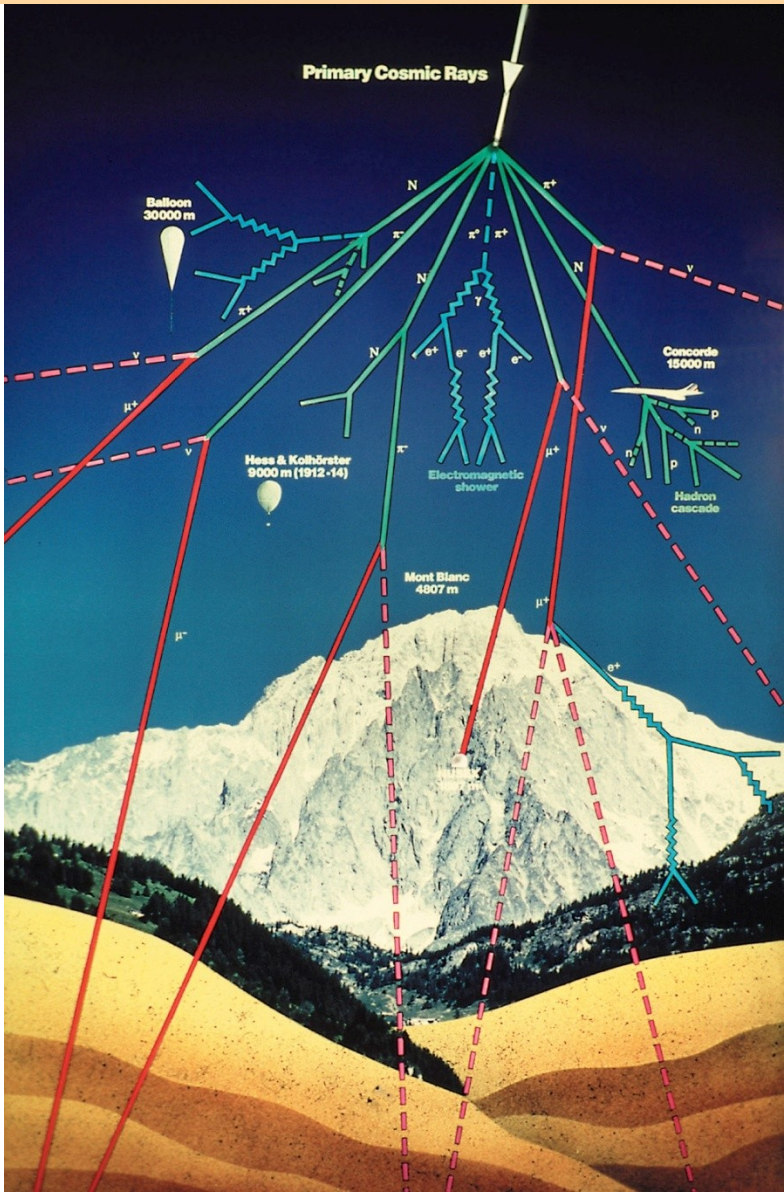


Cosmic commissioning Milestone runs

Jamie Boyd (CERN)

Outline

- Aims of commissioning runs
- M3 / M4 / M5
  - Setup
  - Results
  - Problems
- The Future – M6 & beyond…
- Conclusions



Aims of commissioning runs

- Main aim is to prepare the experiment for data-taking – by using the only source of real data we have before LHC turn on (cosmic rays)
- Integrate in new systems with the DAQ
- Take cosmic ray data for long periods of time – iron out problems found
- Run in factory mode – train shifters, develop ways of debugging the system effectively
- Not only commission the detectors but also the trigger, daq, online/offline software, monitoring, tier0, computing infrastructure, control room ....

- Format has been ~1 week long runs ~every 2 months

Differences between Cosmic Data and Collision Data

- Of course there are many differences between cosmic rays and collision data
  - Low multiplicity (mostly 1 track / event)
  - Low rate ~100Hz (<<40MHz)
  - Only muons (no El, Ph, Jet, Tau, Nu)
  - Tracks, Clusters not pointing at IP
  - Timing different (track hits top of detector, then bottom of detector)
  - Hits not in phase with the LHC clock (appear randomly within the 25ns)

Differences between Cosmic Data and Collision Data

- Muon systems, Trackers, Tile Calorimeter are designed to detect muons so detecting cosmic rays in these systems is in principle easy
- For LAr this is not the case
  - Muons leave very small energy deposit in LAr
  - Because not in phase with LHC Clock this means onboard DSP (optimal filtering) will not work to give an energy measurement
  - So in order to get a reasonable energy measurement LAr ship out 32 time samples and find the energy offline
  - This means that paradoxically the raw data event size for cosmics is much bigger than for physics ~10MB / event (totally dominated by LAr)
  - This means the LVL1 rate is limited to the SFO bandwidth (~200MB/s)
  - Also means the LAr conditions needed to analyze the data offline are much bigger than for physics data

Overview of the M-weeks

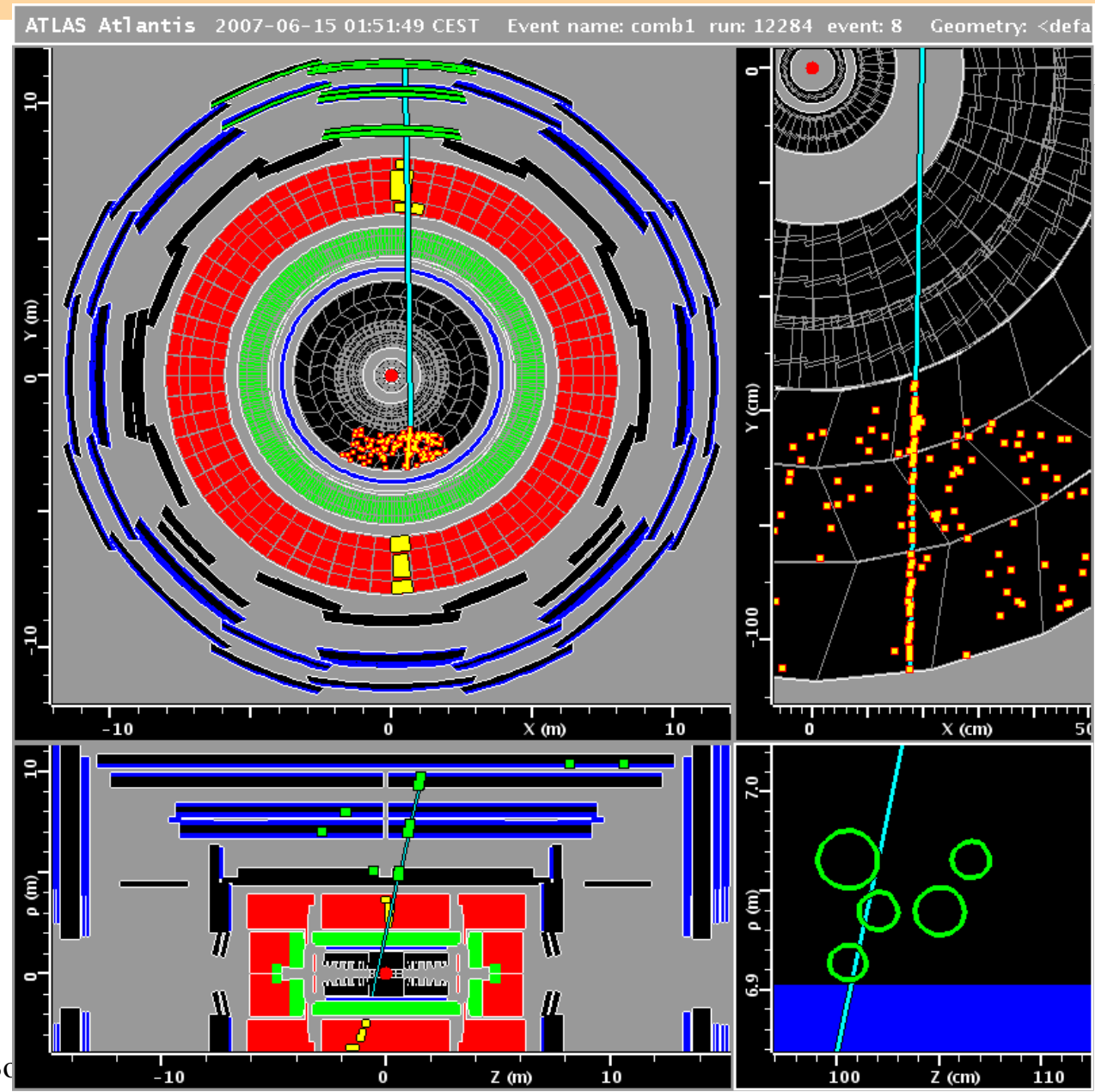
Week	Systems present	Triggers	Nevts / Raw Data size (TB)
M3 (4/6-18 /6)	RPC (1/32), TGC (1/36), MDT (1/16) Tile (3/4), LAr(3/4) TRT(6/32)	RPC (60Hz) Tile (<0.1 Hz)	2M / 9 TB
M4 (23/8-3/9)	RPC (4/32), TGC (2/36), MDT (2/16) Tile (3/4), LAr(3/4) TRT(12/32) (SCT DAQ Only)	RPC (60Hz) Tile (<0.1Hz)	3M / 18 TB
M5 (22/10-4/11)	RPC (1/8), TGC (5/36), MDT (1/4) Tile (~1/2), LAr(~3/4) No ID (SCT/Pixel DAQ Only)	RPC (20Hz (ps6)) TGC (20Hz(ps4)) Tile (<0.1Hz) L1Calo(<0.1Hz)	12M / 86 TB

Systems coverage and trigger rates approximate – as they varied over the period

M3 - Overview

- 4 – 18 June
- Used TDAQ 1.7
- First use of offline / tier0
  - Offline software running at point1 (EventDisplay/Online monitoring) 12 series whereas running at tier0 13 series – due to TDAQ compatibility
  - No official way to patch the offline software - groupArea
- No ECR / BCR so BCID not in sync
- Monitoring a weak point
- First time HLT running algorithms online

M3 - EventDisplay



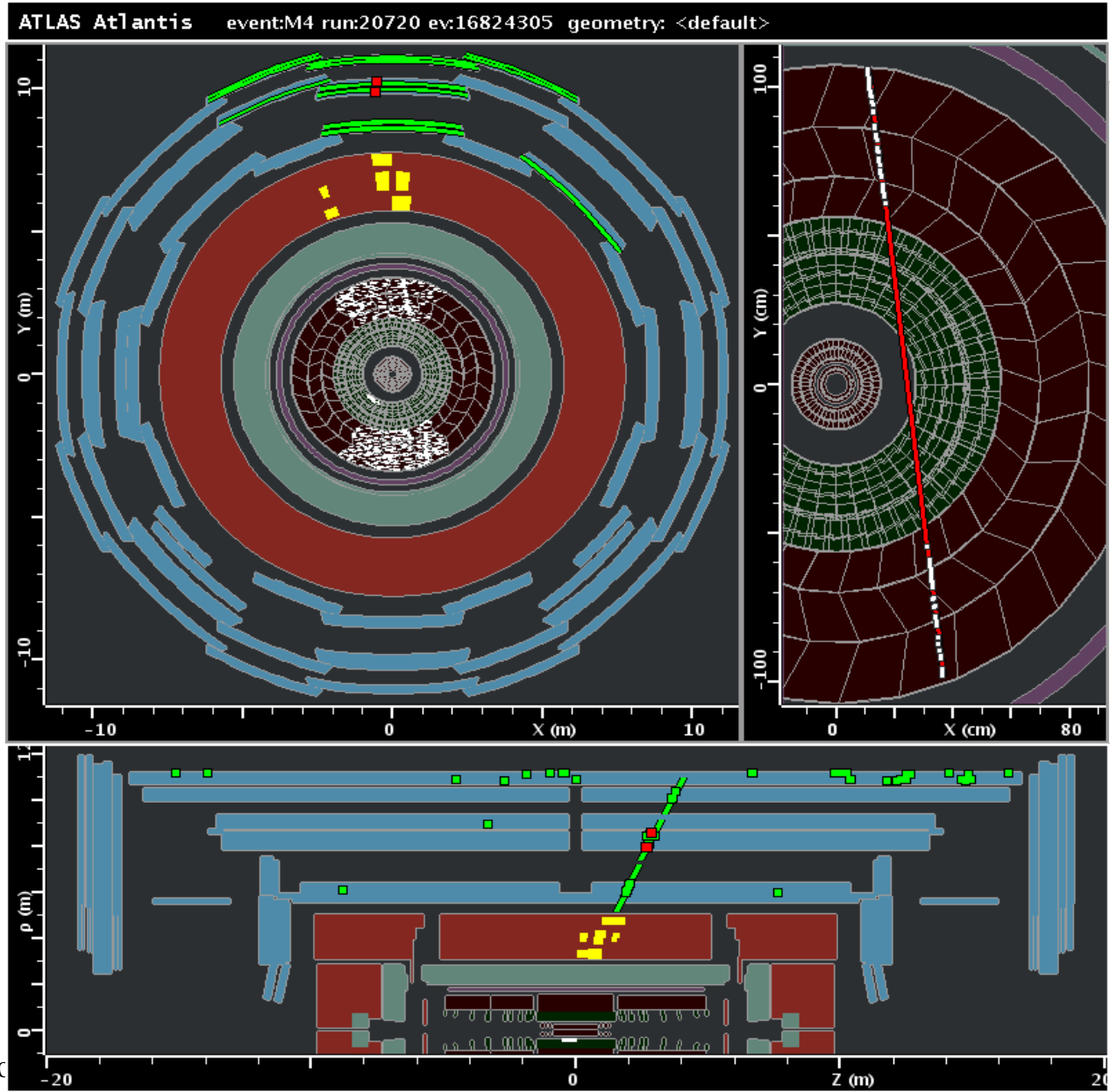
M4 - Overview

- 23 August - 3 Sept
- Used TDAQ 1.8
- Offline / tier0 used release 13.0.25.X
  - AtlasPoint1 patching for first time
    - Allows us to know what patches are used for every run
- ECR / BCR used
- Lumi blocks used for the first time
- Problems
  - CTP timing changed w/o LAr / Tile changing readout timing – Calo data bad for 5 days
    - Communication problem
    - Bad that monitoring did not spot this for 5 days!
  - MDT went out of sync wrt other systems
    - After M4 problem traced to BCR occurring too close to LVL1 Accept & fixed
- Not any good data (with MDT and Calo's)

M4 - EventDisplay

Can see more system coverage (MDT / TRT)

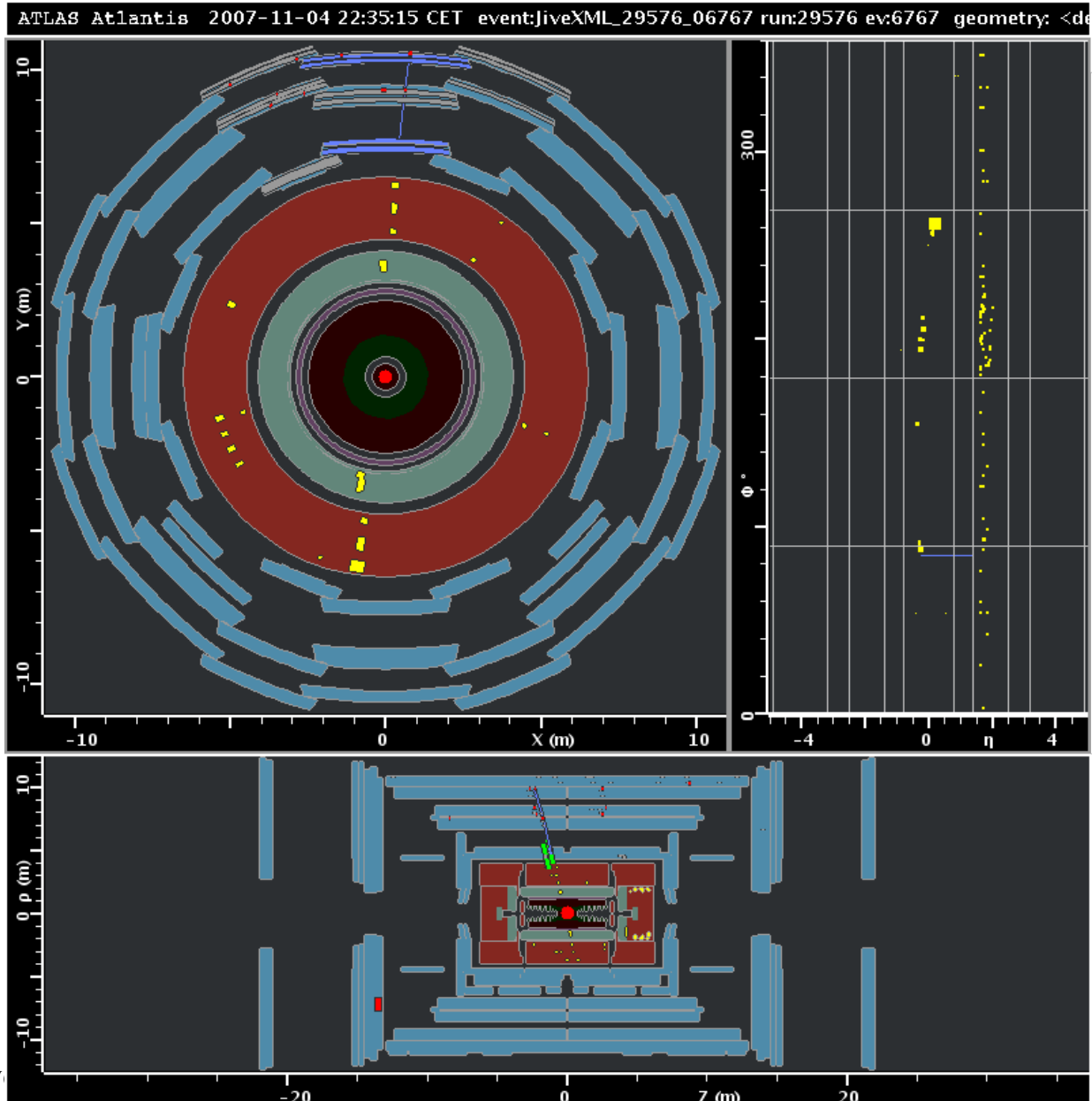
Also improved colour scheme of event display!



M5 - Overview

- 22 Oct - 4 Nov
- TDAQ 1.8
- Offline / tier0 used release 13.0.30.X (AtlasPoint1 patching)
- First time triggers from L1Calo & TGC
- Improved monitoring (especially for calorimeters)
- New format
  - First week detector assessment, 1 day per system
  - Second week stable combined running
- More detailed shifters and checklists
  - Shiftleader & Run control shifter – as well as expert shifters from each system

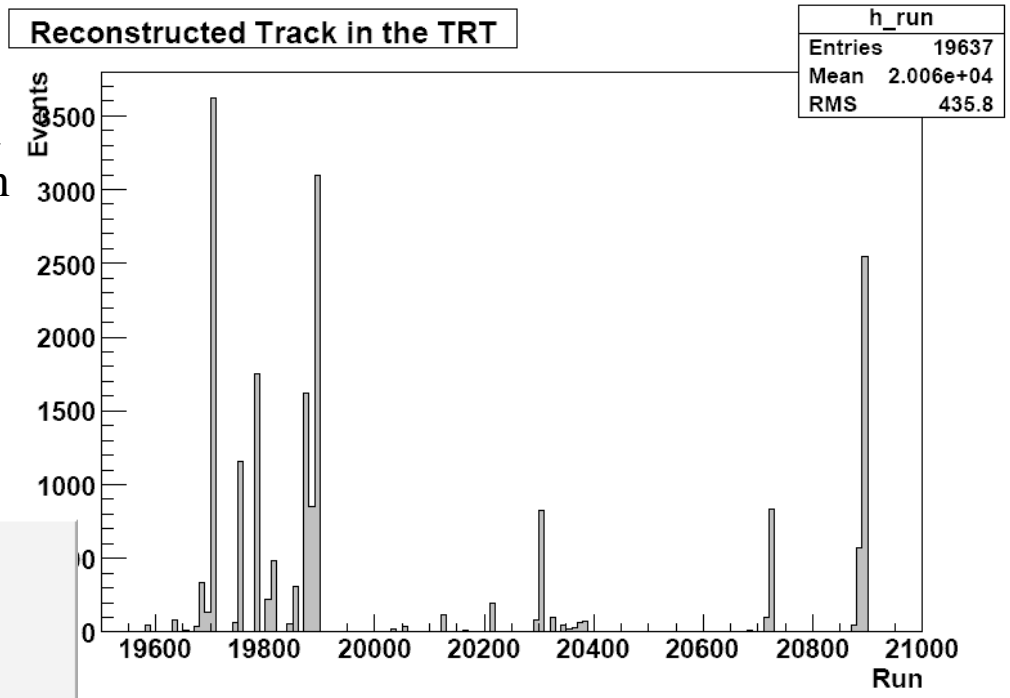
M5 – Event Displays

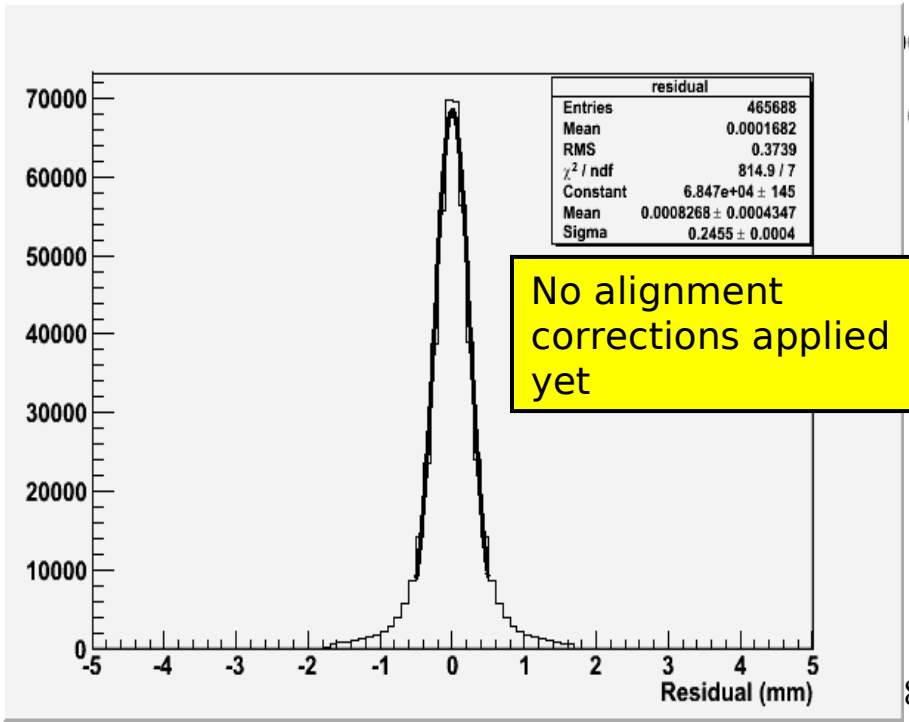


System highlights

ID (TRT in M4)

Number of offline TRT tracks per run in M4
In total 20k tracks, ~10^6 hits on track





No alignment corrections applied yet

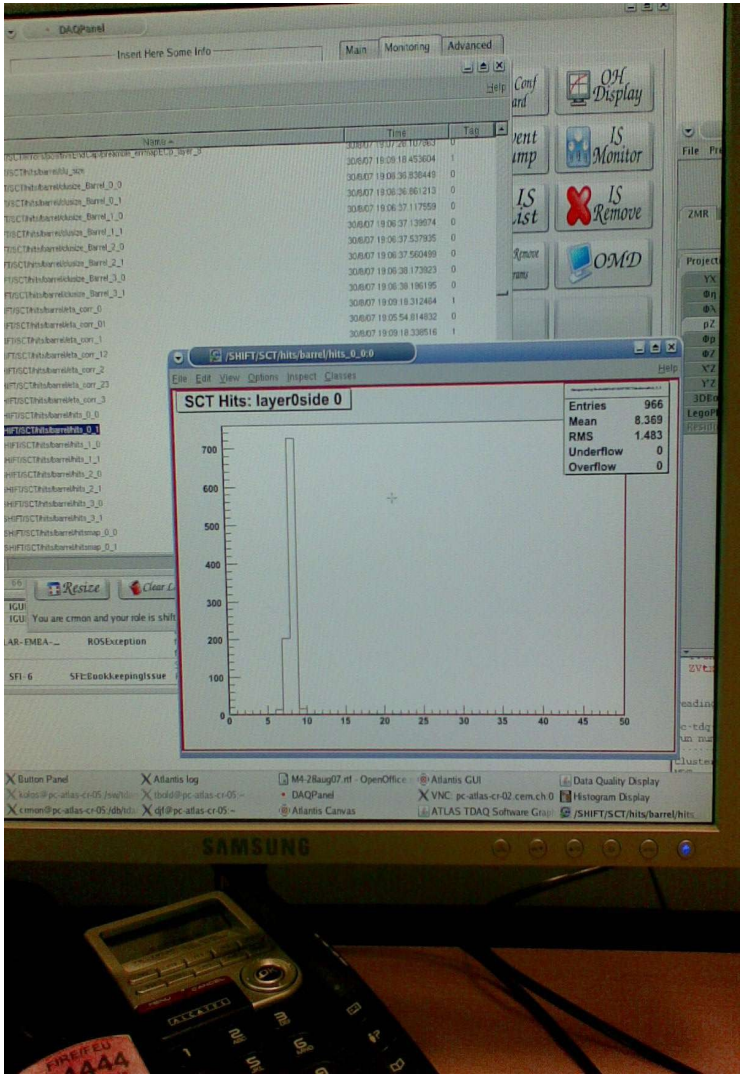
First R(t) calibration for TRT
For each *r* bin, extract t(r), fit with a gaussian to get the average t(r). Use this to update the t_0 of the straw. Repeat until the procedure converges

σ [±300 um] ➔ 226 um

ID

SCT and (for M5) pixel ran with DAQ only setups. This meant they could test their DAQ and become integrated in the monitoring infrastructure.
(will save debugging time when the detectors become available)

SCT online monitoring plot



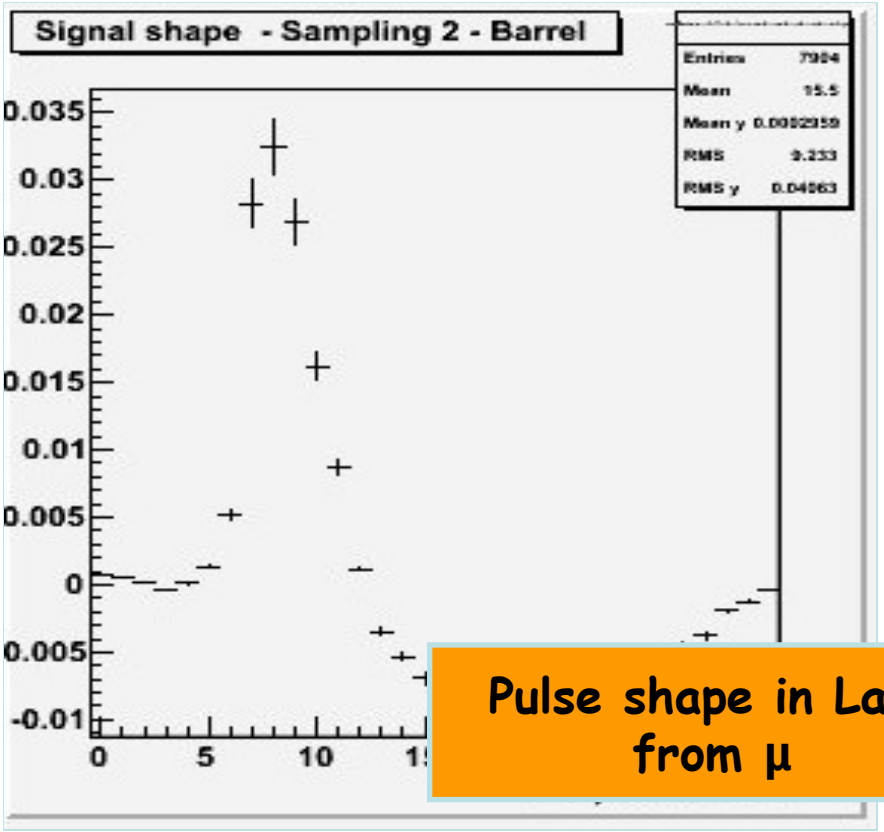
LAr

To see a nice cosmic signal in the LAr requires a lot of work. Need calibration constants for all cells and need to remove all noisy cells.

For every cell need to find the phase wrt the LHC clock, and use conditions for that phase.

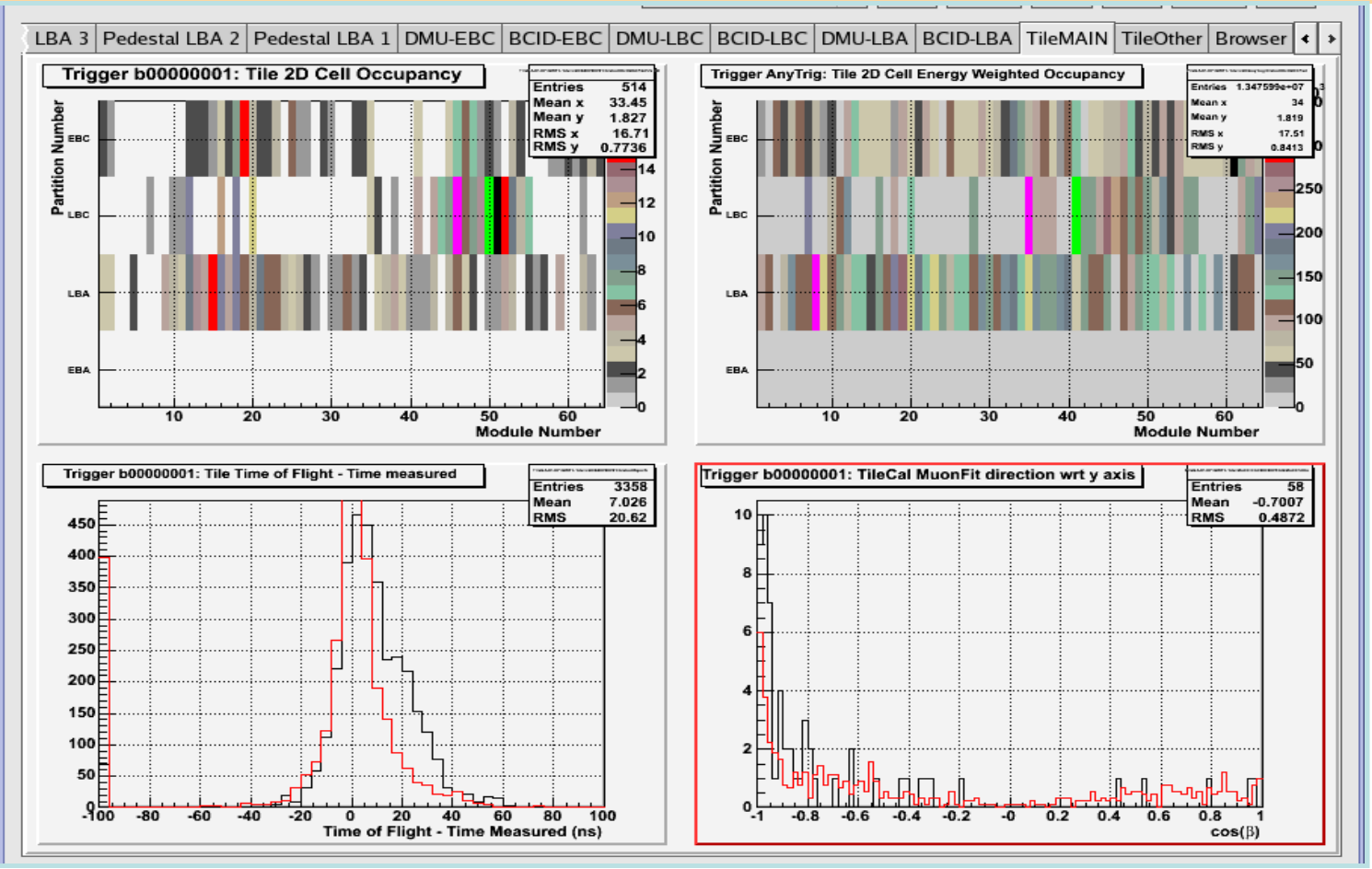
This makes the LAr reco very slow and very memory intensive, cant use it to predict speed, memory use for physics reco.

With sophisticated online monitoring in M5 LAr can see cosmic rays online in 30mins of datataking!



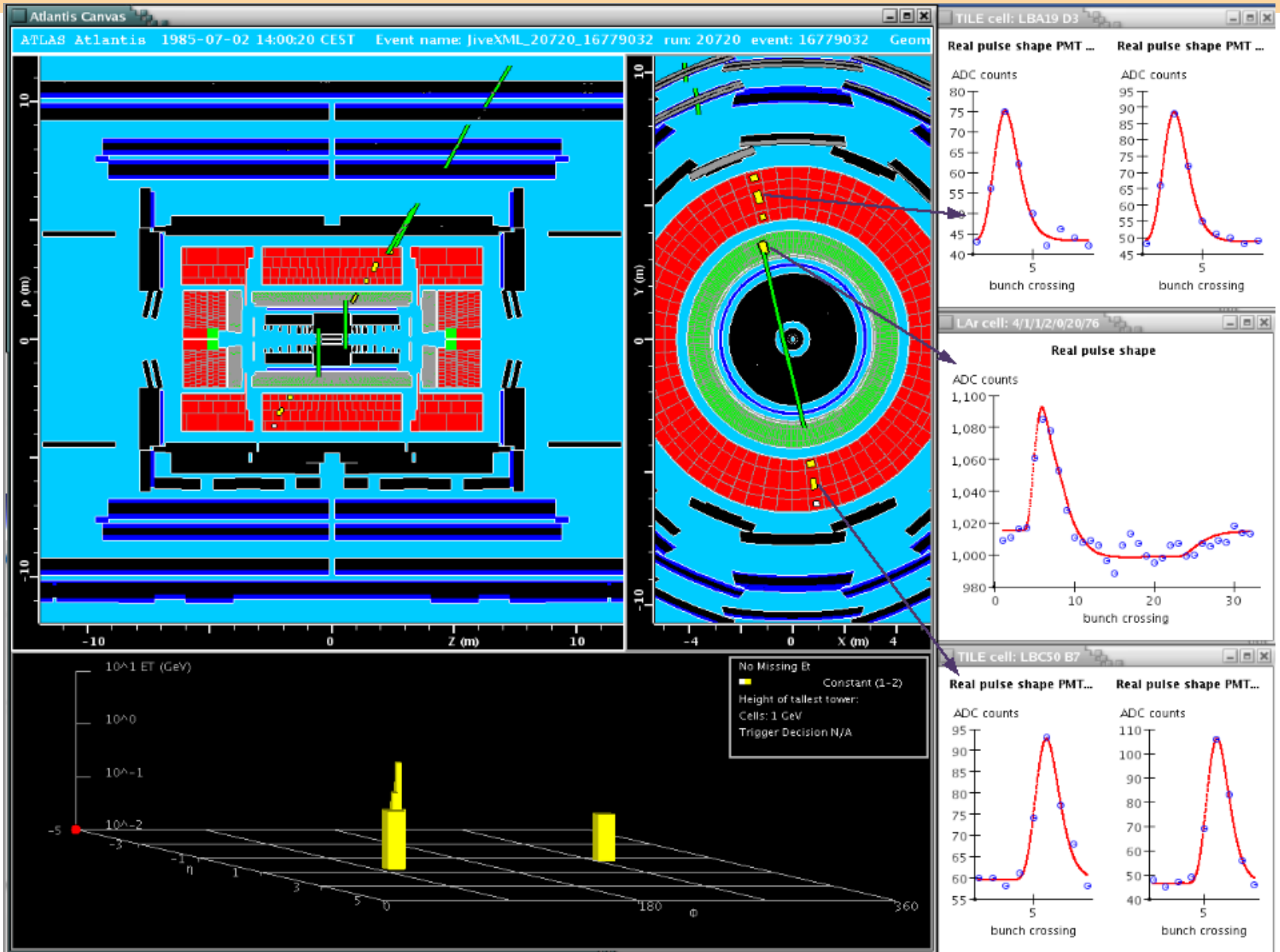
Pulse shape in Larg from μ

Tile



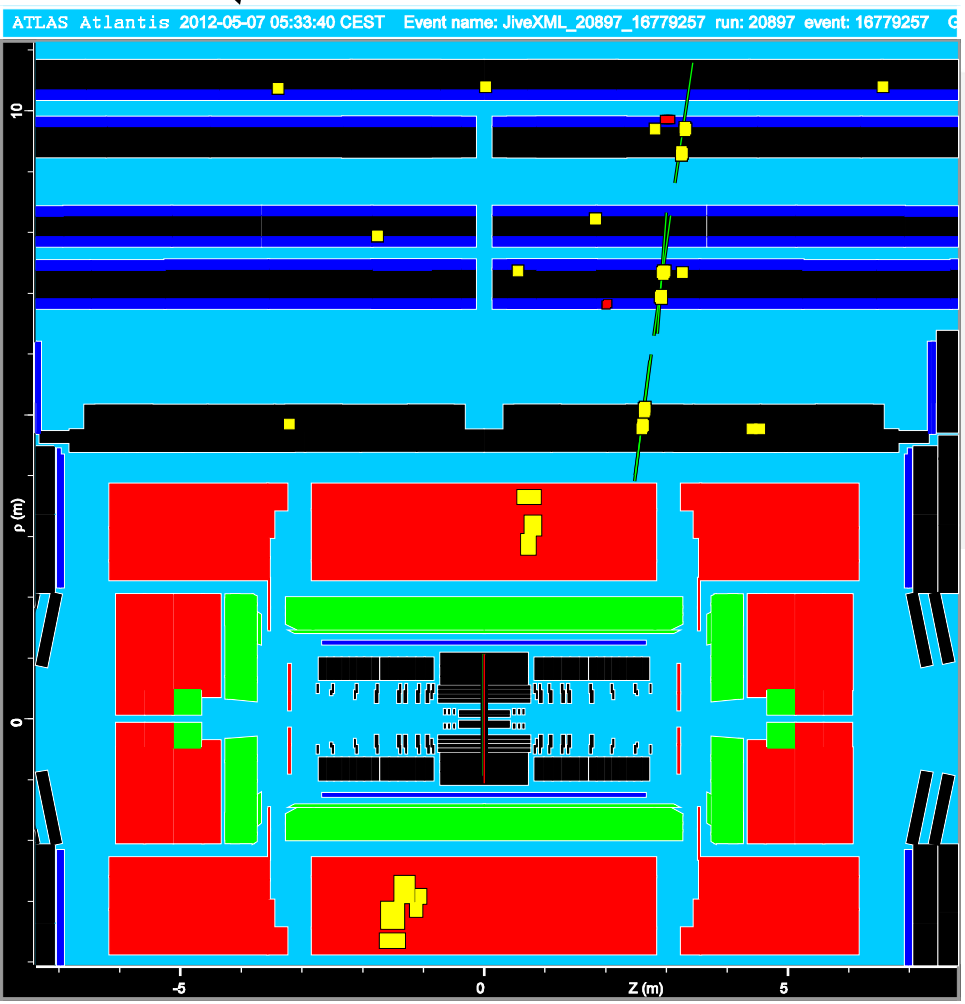
Online monitoring plots from Tile calorimeter (M5):
Bottom Left shows the timing difference
Bottom Right shows angle of cosmic ray (red are reference plots)
Tile can now (M5) 'see' cosmic rays online in a few minutes of datataking starting

Calo

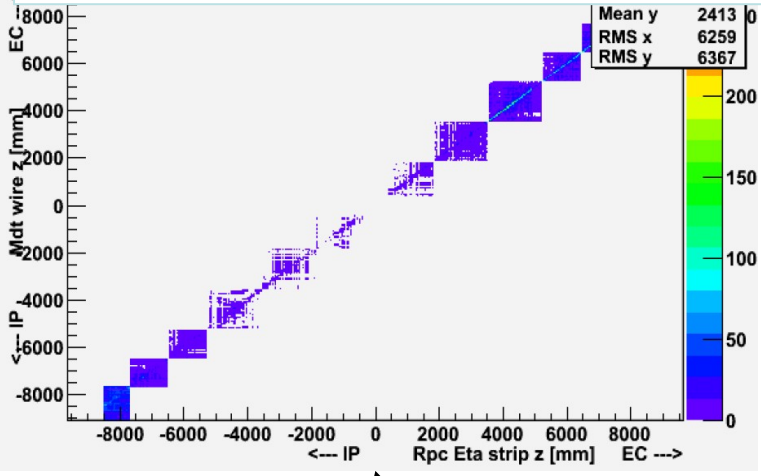

Atlantis Canvas
ATLAS Atlantis 1985-07-02 14:00:20 CEST Event name: JiveXML_20720_16779032 run: 20720 event: 16779032 Geom
ρ (m)
Z (m)
Y (m)
X (m)
10^1 ET (GeV)
10^0
10^-1
10^-2
η
Φ
No Missing Et
Constant (1-2)
Height of tallest tower:
Cells: 1 GeV
Trigger Decision N/A
TILE cell: LBA19 D3
Real pulse shape PMT ...
ADC counts
bunch crossing
LAr cell: 4/1/1/2/0/20/76
Real pulse shape
TILE cell: LBC50 B7
Real pulse shape PMT...

Muons

Event display from M4
MDT track segments do not point at Tile / RPC hits, because MDT out of sync



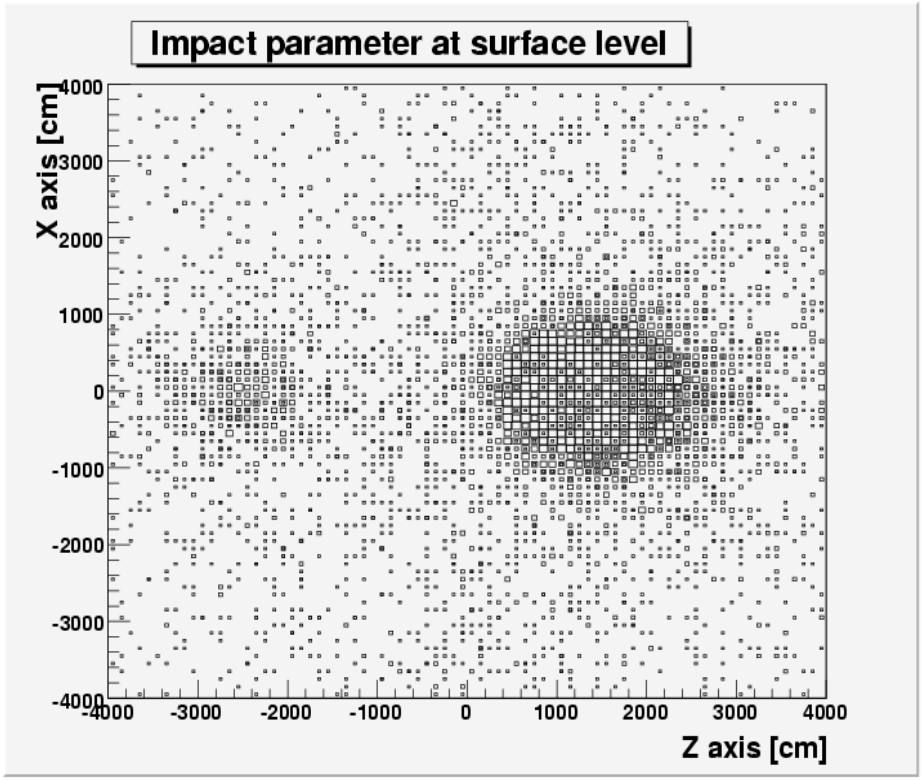
Correlation b/w hit positions in RPC and MDT

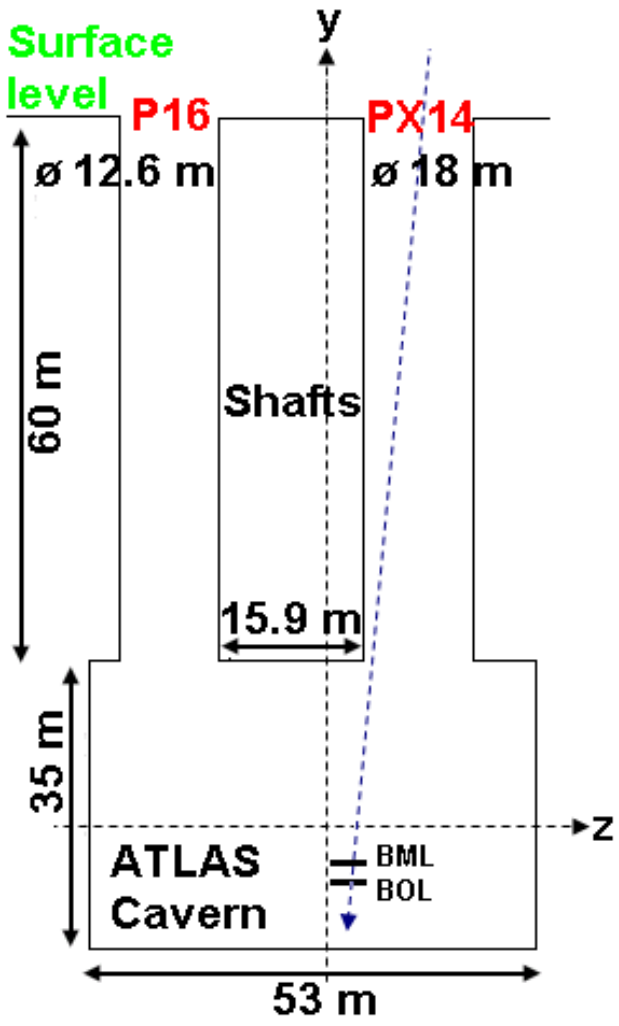


Plot showing the correlation in z of hits from MDT and RPC showing that these are seeing the same tracks (MDT in sync) in M5.

Muons

The position of the muon candidates extrapolated to the surface – can clearly see the position of the large and small shafts!





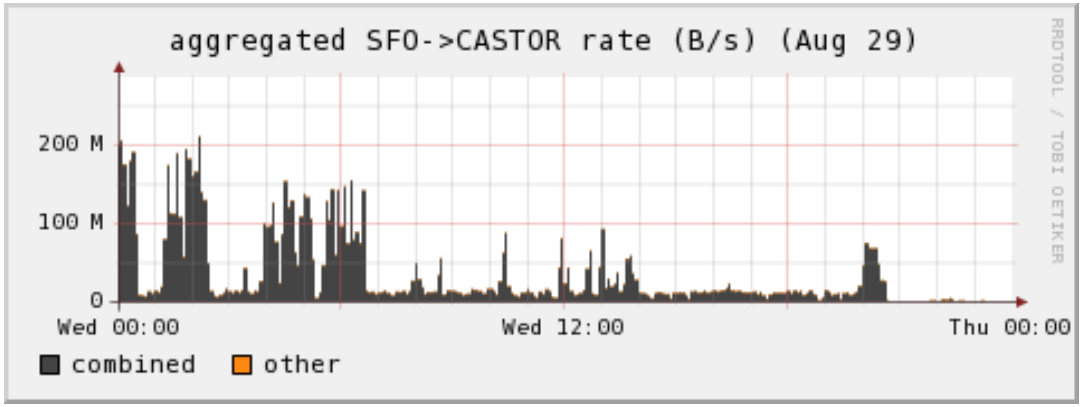
DAQ

DAQ operations clearly getting better from M3 -> M5 for example – the time to start / stop a run now takes a few minutes whereas could take more than an hour in M3. Also when things do go wrong the reason is more easily understood, and easier to debug. This is a big step forward!

Still need to improve the usefulness of the e-log (in my opinion)

DAQ infrastructure (RODs, ROSs, SFI, SFO...) working well.
Some problem when running HLT algorithms accessing RPC data as RPC using non final RODs – should be fixed for future runs

Rate of SFO -> castor transfer during M4 (200MB/s is goal in this setup)



High rate tests

- To excerises the detector front end read out, we carried out high rate tests during MX weeks – final LVL1 rate should be ~100kHz
- Use Random trigger with high rate – push it as high as it can go
- Use prescales at HLT to keep some fraction of events for event building (but remove deadtime from HLT)
- Results from M5 are (these always include CTP+DAQ+) :

MDT R/O rate ~100KHz, limited by Lvl2 back-pressure

L1Cal ~50kHz

Tile stopped at 25kHz during acceptance test, large fraction of events discarded. Successful running up to 100kHz if L1A uniformly distributed L1A. Complicated interaction b/w delays in busy propagation and buffer sizes.

LAr ~60kHZ rate with physics format (smaller event size than cosmic mode).

RPC not final RODs, PIX, SCT no detector readout.

Overall: achieved combined run at 53kHz L1A with LArg, MDT, TGC, L1Cal, CTP (+Tile up to 20kHz)

LVL1

LVL1 setup from M5

First use of trigger presenter to display rates and prescales in real time

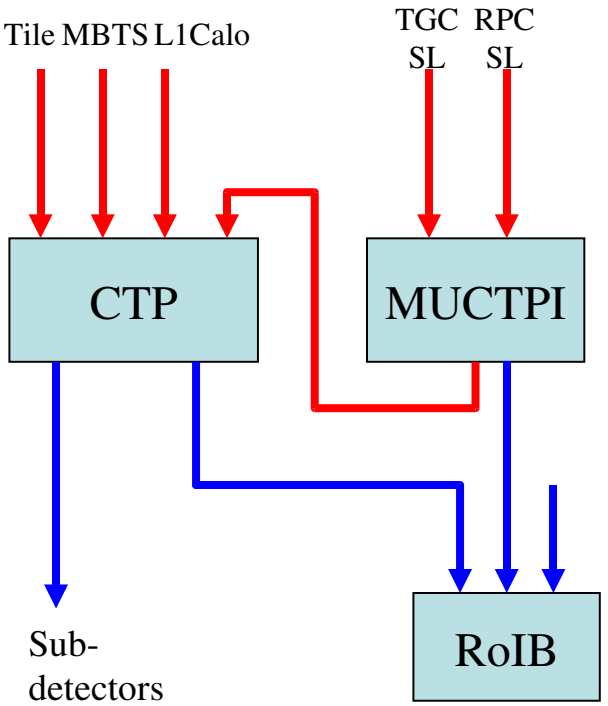
LVL1 configuration written to COOL at end of each run (for first time)

Data streaming done on LVL1 result – ie. Tile triggered events written to different BS file than RPC triggered events

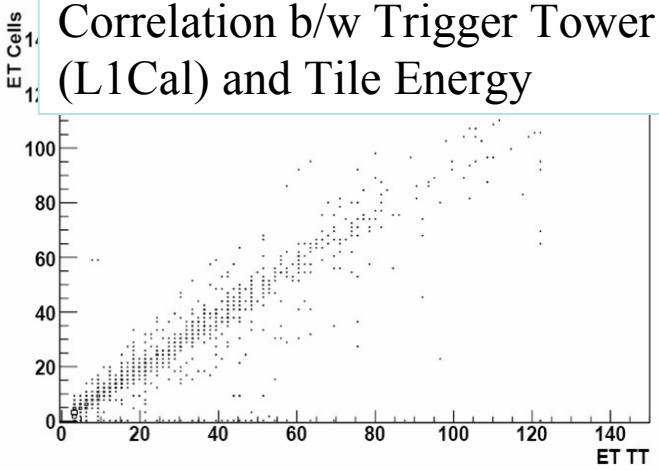
RPC configuration not pointing in phi – want to add this for future cosmic runs (TRT need better LVL1 timing than available from Tile trigger)

L1Calo triggering experiment for first time in M5 (~90% preprocessers, ~100% processers, ~50% readout)

Jet ROIs received and decoded by HLT

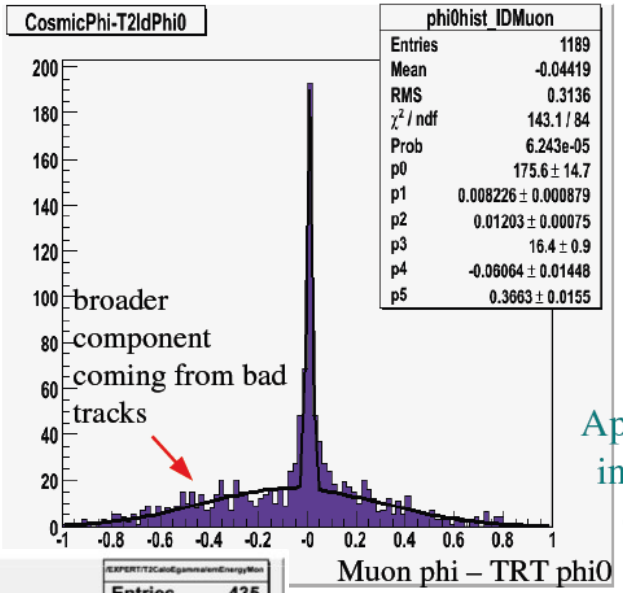


Correlation b/w Trigger Tower (L1Cal) and Tile Energy

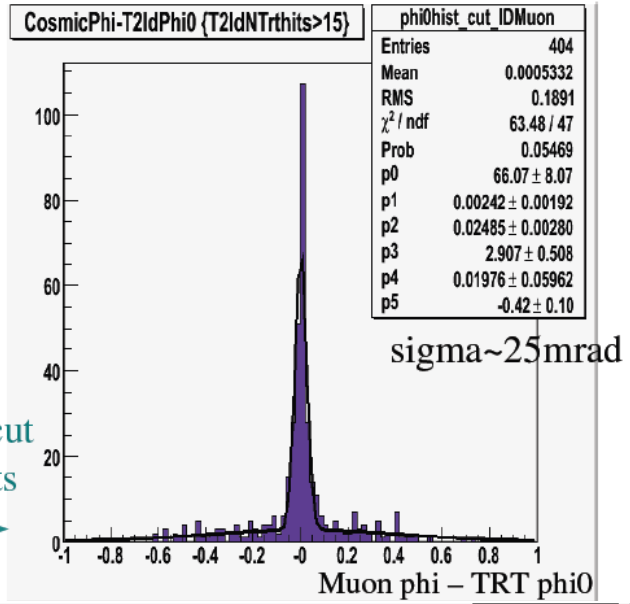


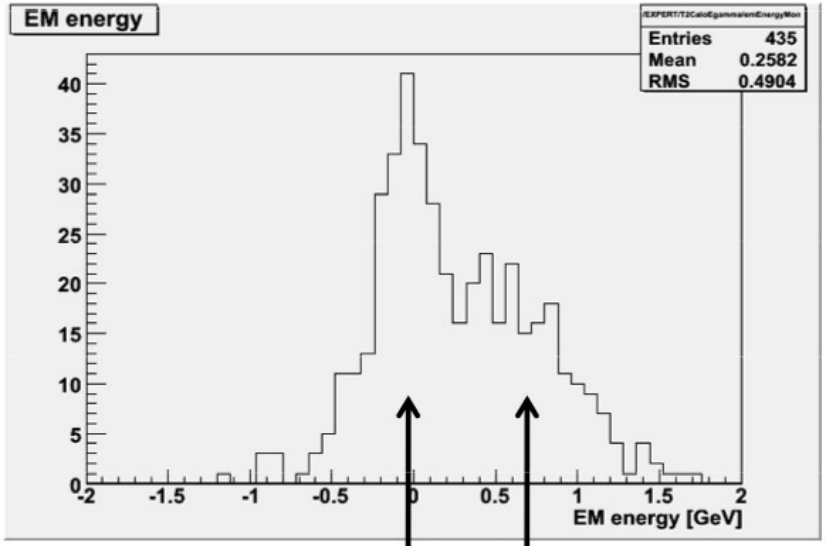
HLT

Have been running HLT algorithms using info from
RPC/MDT
Tile/LAr
TRT
All configured to pass all events
In M5 HLT configured using trigger tool (db)

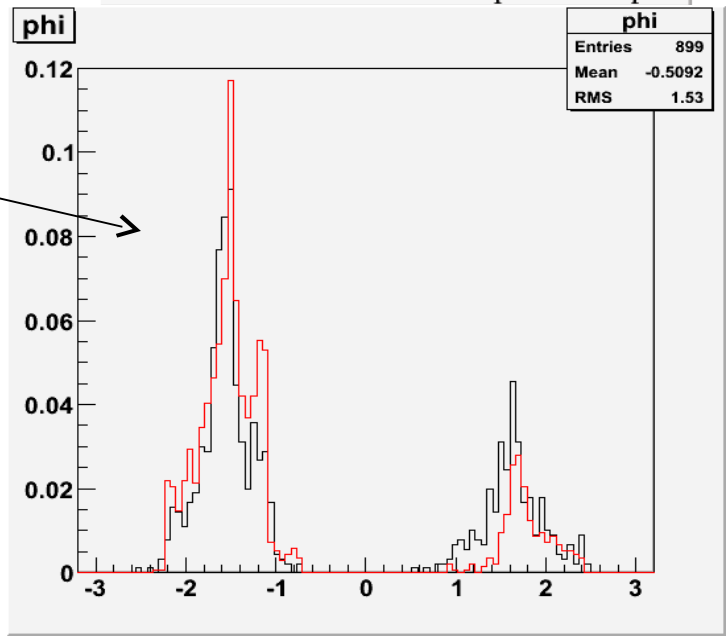


Applying cut in NTrthits





Phi distbn for tracks found in TRT at HLT (red = data, black=sim)



Monitoring

Online monitoring

- Runs in EF like athenaPT processes or GNAM
- Automatic comparison with references (DQMF) checking >1000 histograms by end of M5
- Running well by end of M5

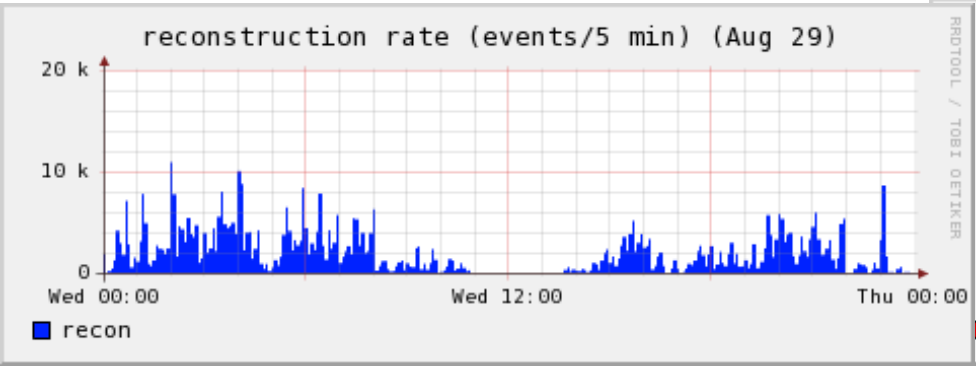
Offline monitoring

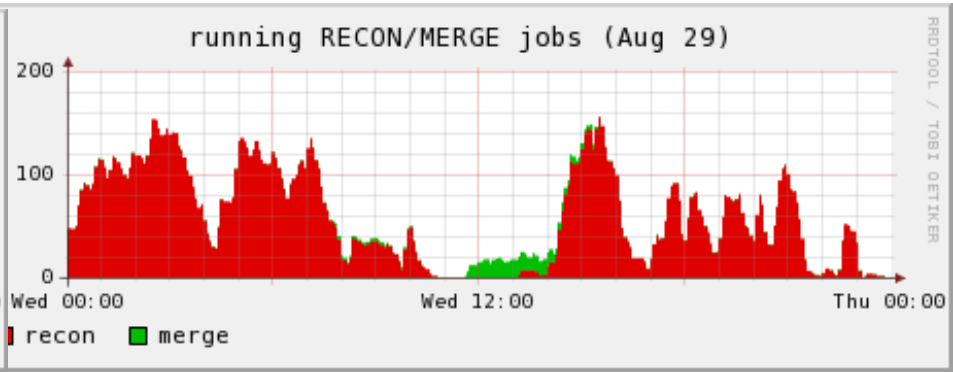
- Histograms produced at by tier0 reconstruction
- Scripts to merge across runs and put on webpage http://webafs07.cern.ch/atlasdqm/
- DQMF not working for offline yet
- Some memory problems with offline histograms (some 2D histograms >10MB each!)

Tier0

Tier0 running reconstruction (RecExCommission package) over MX week data

- Writing out: CBNT ntuple, ESD, muon calibration ntuple and monitoring histograms
- Latency between data being taken and tier0 processing data 1-2 hours
- Various problem found at tier0 (first time that reconstruction code see's corrupt events)
- Crash rate reduced as code quality improves
- Reprocess the data a few weeks after the MX week – with improved code and calibrations (trying at tier1s too)
- Good test of the tier0 system
- Reconstruction time ~10s/evt – some (noisy) events much longer!

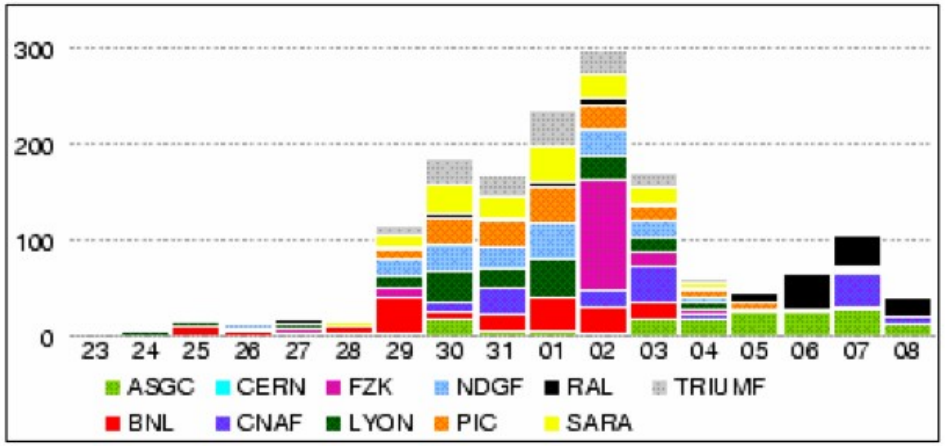


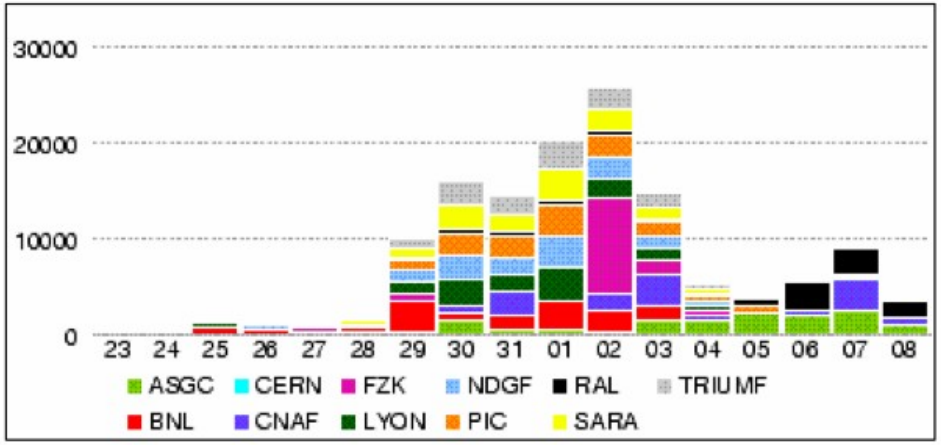


Data Distribution

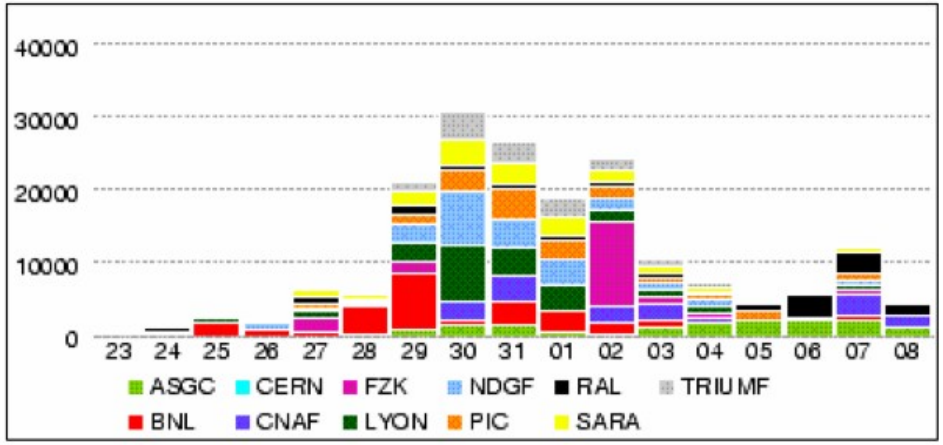
During M4 & M5 the raw data was distributed to the Tier-1's. These plots show the transfer during M4. This is an important test of the Computing infrastructure

Total throughput (MB/s)
Aug 23 – Sep 8





Data transferred (GB)
Aug 23 – Sep 8

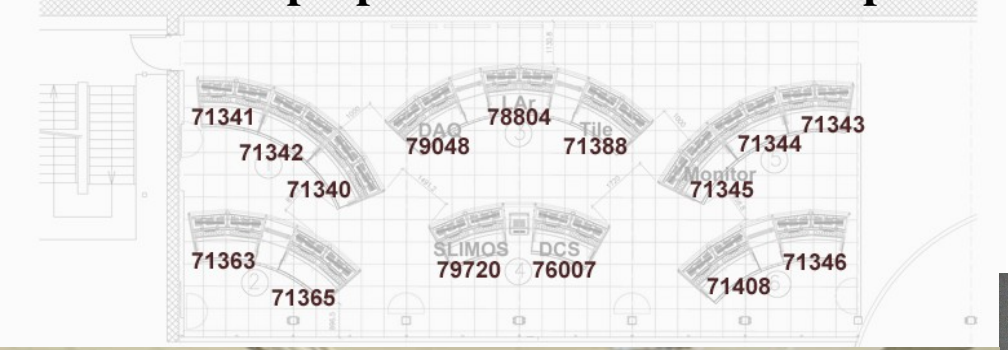


Completed file transfers
Aug 23 – Sep 8

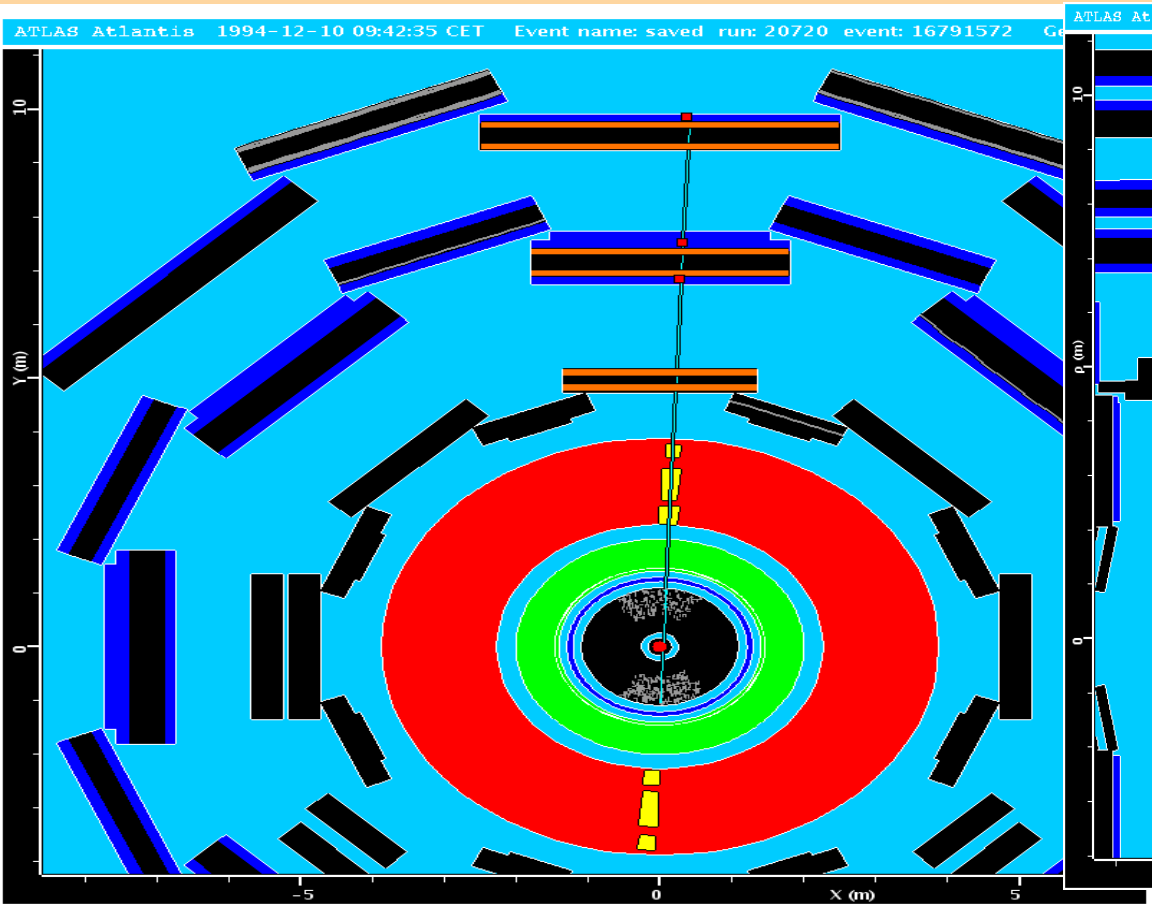
Atlas Control Room

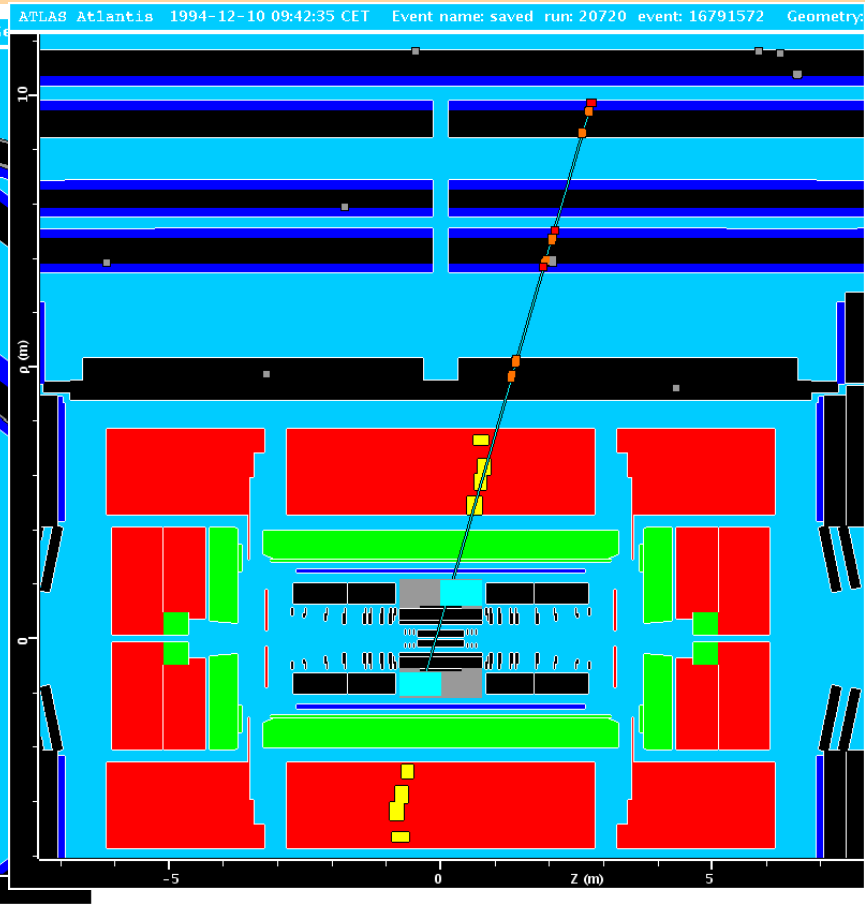
The ACR has been stressed by the MX weeks. Many people (~10) per desk. Has become obvious that systems need to use their satellite control rooms.

Web cam: **http://pcatdwww.cern.ch/atlas-point1/ATLASview/ACR.htm**



Combined track fit





- Combined straight-line fit with TRT, RPC & MDT hits (80 hits in total)
- Fit Quality Chi^2/Ndof = 380 / 76
- Difficult to include energy loss and multiple scattering effects without magnetic field

Future plans...

- M6
  - Planned for 3-10 March 2008
  - Will (hopefully) include some SCT – but no pixel detectors
  - Still no magnetic field either...
- After M6 plan depends on LHC schedule – idea would be to go into cosmic data-taking with full detector & field 24/7 ~1 month before beam pipe closes
  - Need to migrate to TDAQ 1-9 and offline 14 during this period!

- Before M6 we will have system weeks in Feb to integrate more parts of each system (TDAQ / Muons / L1Calo / ID) (calorimeter electronics undergoing refurbishment)
- Nothing happening in Jan - due to cooling maintenance at point1
- System will effectively be in continuous use from begining of February until after LHC running!

Conclusions

- M-X weeks have been very successful
- Integrated nearly all systems (except Pixel, SCT & CSCs)
- Many problems found and fixed
- Commissioning / testing much more than just the detector systems
  - Control room
  - Operations (shifts, e-log, ...)
  - DCS
  - DAQ / Trigger (LVL1 & HLT)
  - Online / Offline software
  - Monitoring
  - Tier0
  - Data distribution
- Still much to do
  - Run with more systems, more coverage, magnetic field
  - Exercise alignment, calibrations...
- But these exercises have put us in an excellent position to get the most out of the system when we have first beam!

Useful information

- Useful information about:
  - Running RecExCommission
  - Access to raw MX week data
  - Access to (original & reprocessed) Tier-0 output
  - ‘good run’ lists
  - Useful links to Tier-0 monitoring, COOL runlist, e-log
- Available through the Offline Commissioning wiki
  - **https://twiki.cern.ch/twiki/bin/view/Atlas/CosmicCommissioningReconstructionStatus**