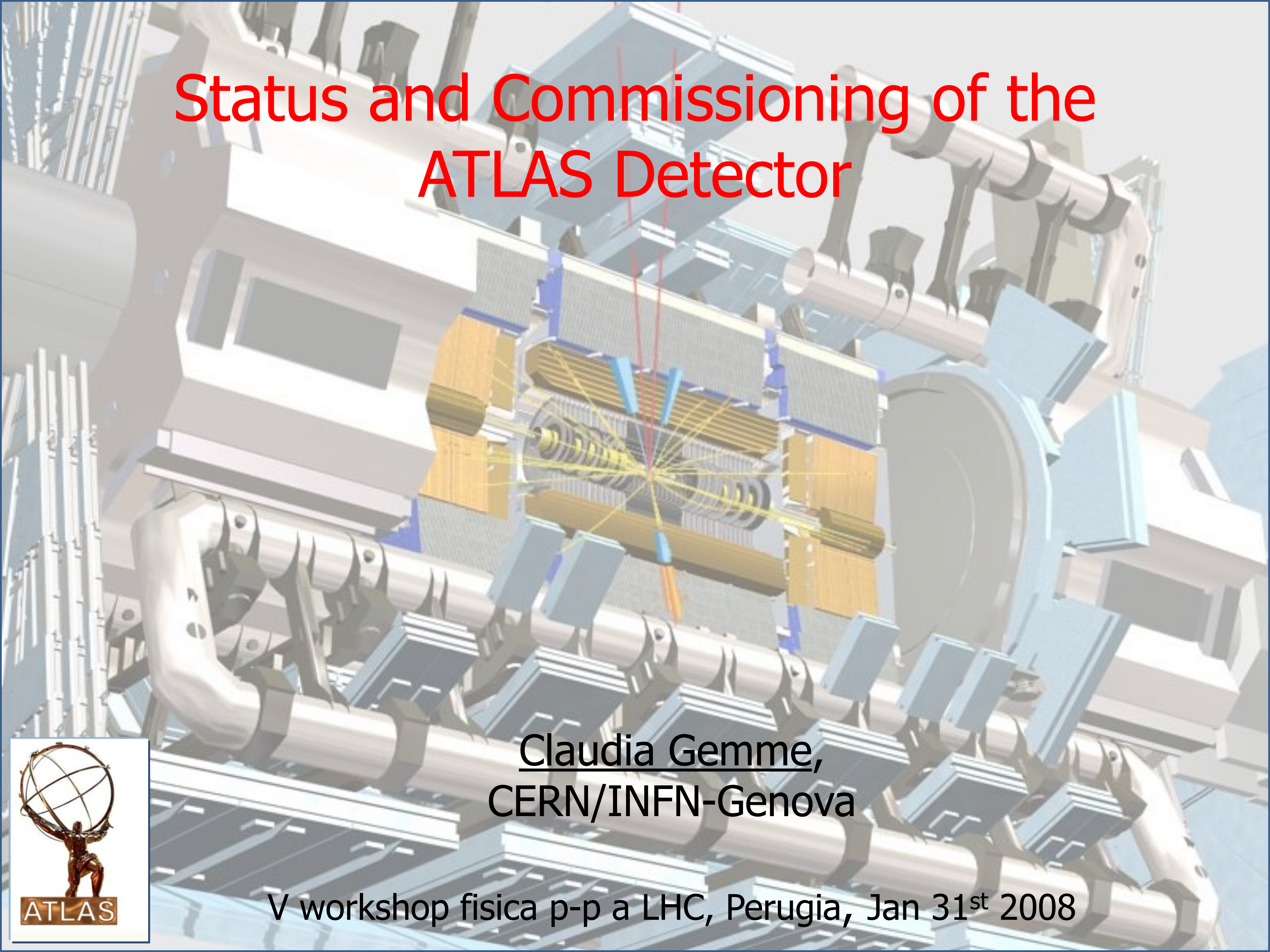
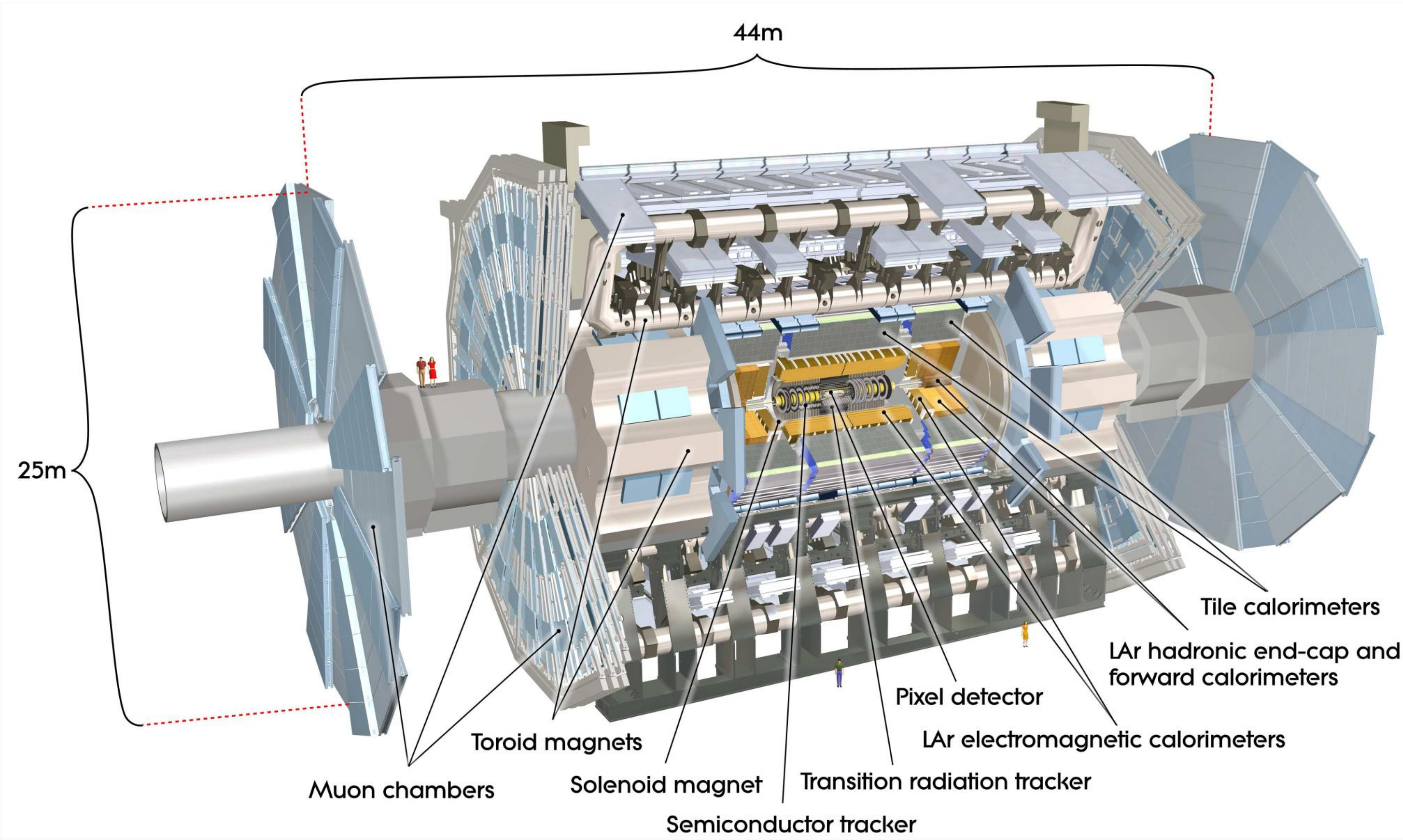
Status and Commissioning of the ATLAS Detector



Claudia Gemme,
CERN/INFN-Genova

V workshop fisica p-p a LHC, Perugia, Jan 31st 2008

ATLAS Detector: How far are we??



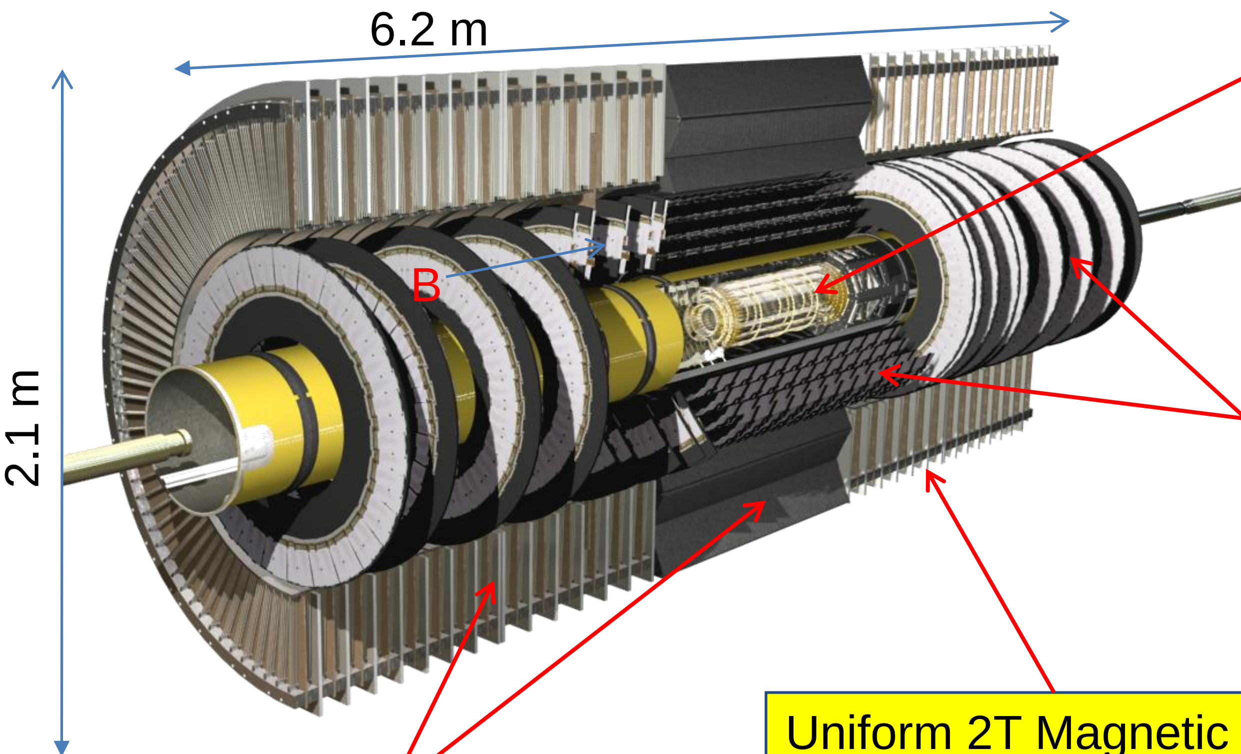
Outline

- ✓ The ambitious ATLAS physics program (Higgs, physics beyond standard model, SM precision measurements, ...) puts stringent requirements on the detector performance:

Detector component	Required resolution (E,pT in GeV)	η coverage
Tracking	$\sigma_{pT}/pT = 0.05\%\ pT \oplus 1\%$	± 2.5
EM Calorimetry	$\sigma_E/E = 10\%/\sqrt{E} \oplus 0.7\%$	± 3.2
Hadronic calorimetry (jets) Barrel and end-cap Forward	 $\sigma_E/E = 50\%/\sqrt{E} \oplus 3\%$ $\sigma_E/E = 100\%/\sqrt{E} \oplus 10\%$	 ± 3.2 $3.1 < \|\eta\| < 4.9$
Muon spectrometer	$\sigma_{pT}/pT = 10\%$ at $pT = 1$ TeV	± 2.7

- ✓ In this talk:
  - Status and commissioning of the subsystems
  - Only few selected topics per subsystem
  - Far from exhaustive!
- ✓ Detailed information in the ATLAS detector paper (com-phys-2007-102) and in many conference talks since years.

Tracker: Inner detector



Pixel
- 5 cm from beam
- 50 μm x 400 μm
- Resolution: 12 x 100 μm

SCT (microstrips)
- 80 μm pitch
- 40 mrad stereo angle
- Resolution:16 x 580 μm

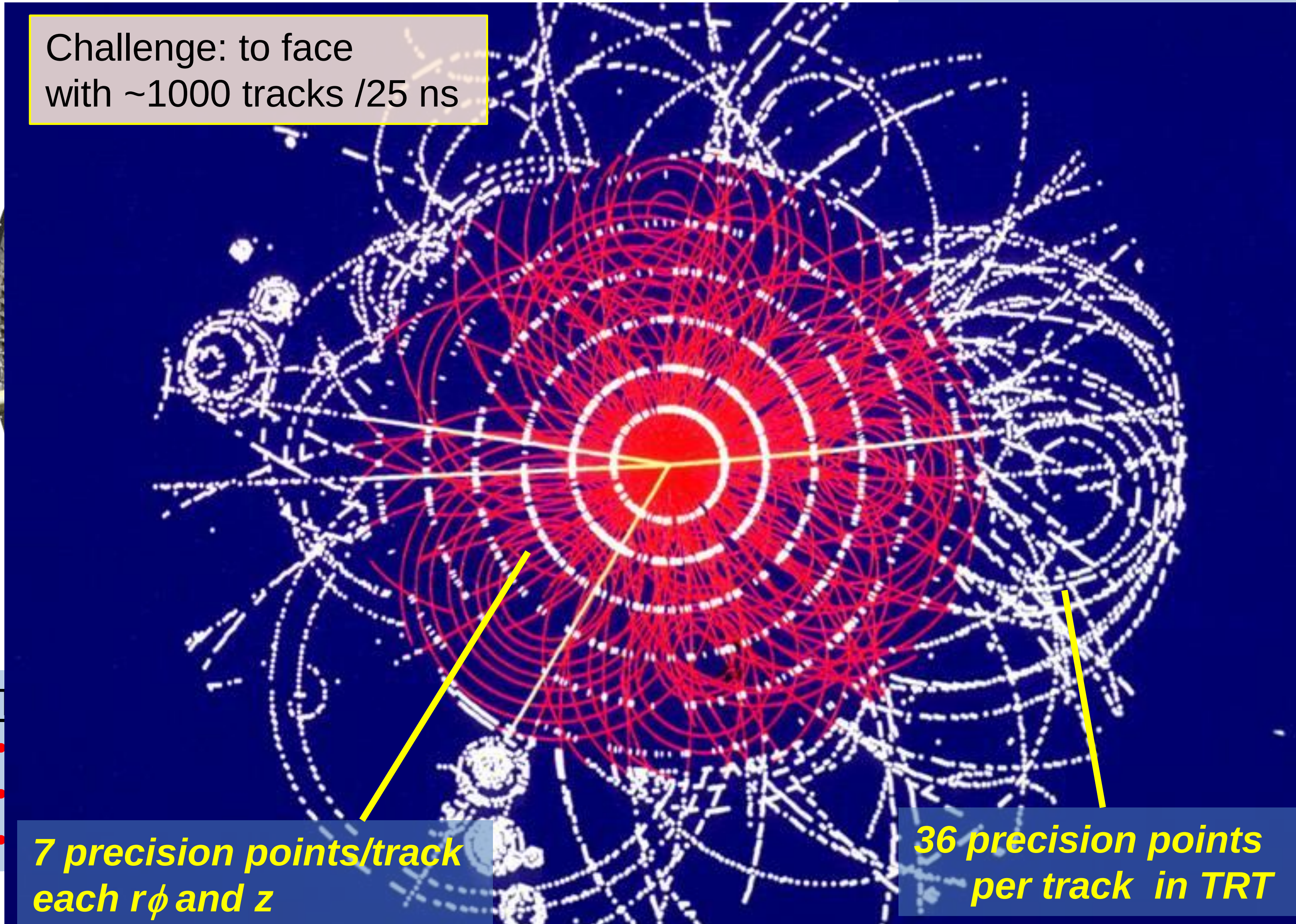
TRT (straw tracker)
- 96 barrel modules
- 28 endcap disks
- Resolution: 170 μm

Uniform 2T Magnetic field provided by a solenoid.

	Barrel		End-Cap	
Detector	Pixel	SCT	Pixel	SCT
#layers/disks	3	4	2 x 3	2 x 9
#modules	1456	2112	288	1976

Tracker: Inner detector

2.1 m



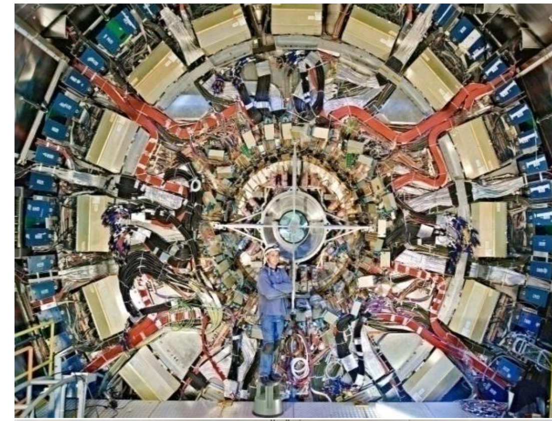
um

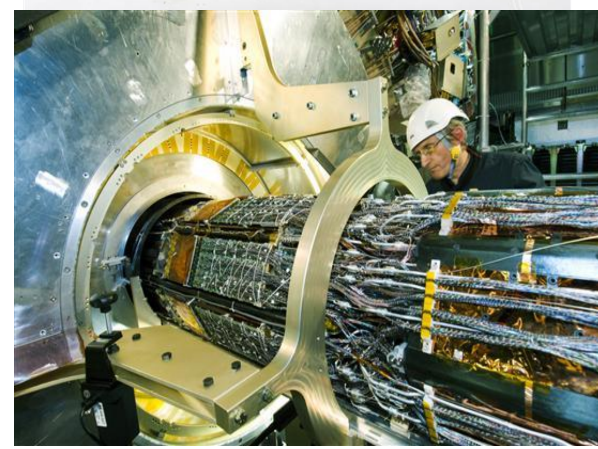
m

oid.

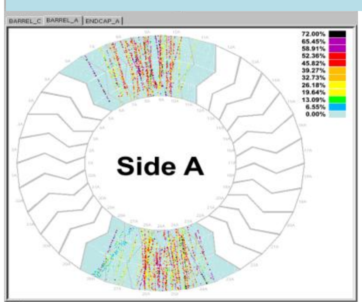
ID Installation

- Detector fully installed since June 2007 in ATLAS.
- TRT and SCT are completely connected; commissioning of detector and cooling (SCT) is on-going:
  - First Combined SCT-TRT cosmics in the pit in Feb.
- Pixel will start connection as soon as SCT has signed-off (Feb4!):
  - ~ 8 weeks for the connection
  - ~ 3 weeks for pixel sign-off
- ~ 2 weeks for ID sign-off before the ID EndPlate closure (that allows ATLAS to start the full closure).



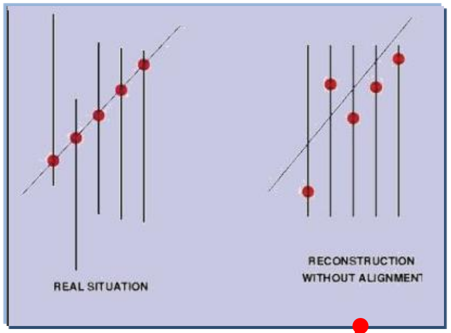


Pit Cosmics in TRT



ID performances commissioning

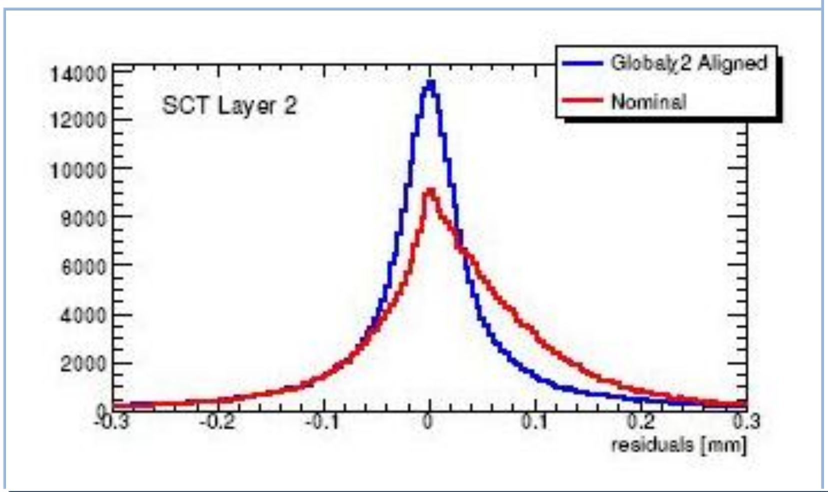
- Systematic error affecting the momentum measurement of charged tracks is dominated by the relative alignment of detector components and by B-field uncertainties, the former being the more demanding.
- One of the first task will be to align it precisely (O(10μm)) and then be able to monitor it (express stream, included cosmics).
- ID has many degrees of freedom.
  - Level 1 – subdetectors (few DOF's)
  - Level 2 – layers (~100 DOFs)
  - Level 3 – modules (35k DOFs)
  - Level 4 – module non planarities

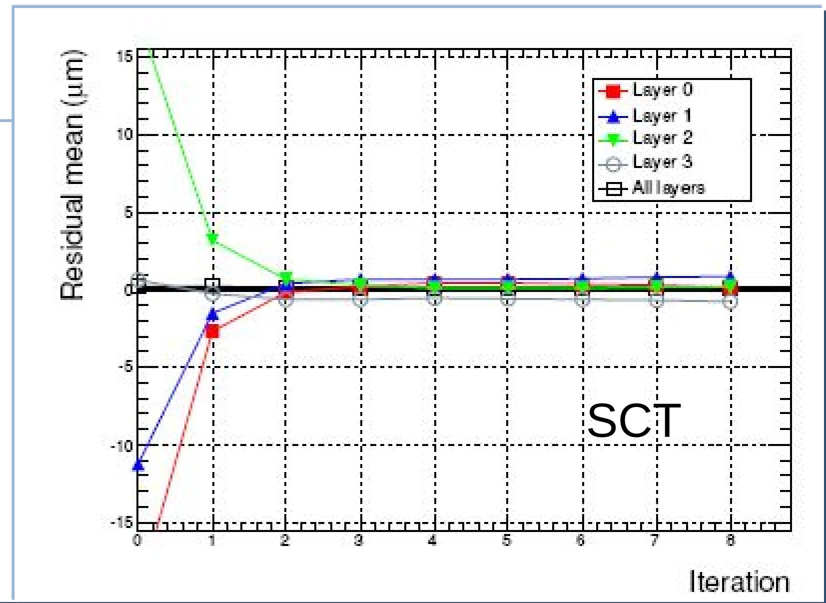


- Alignment strategy tested with MC artificially introducing misalignments.
  - Start from the survey data during integration and installation.
  - Use the hardware alignment when available (SCT)
  - Track based alignment (from collision and cosmics) to minimizing residuals (distance track-hits) or to detect "weak modes".
  - Validation with physical signals (generic track parameters, Z->μμ,..)
  - For the time being, strategy checked with on-surface data (slides)

TRT+SCT test on surface (alignment)

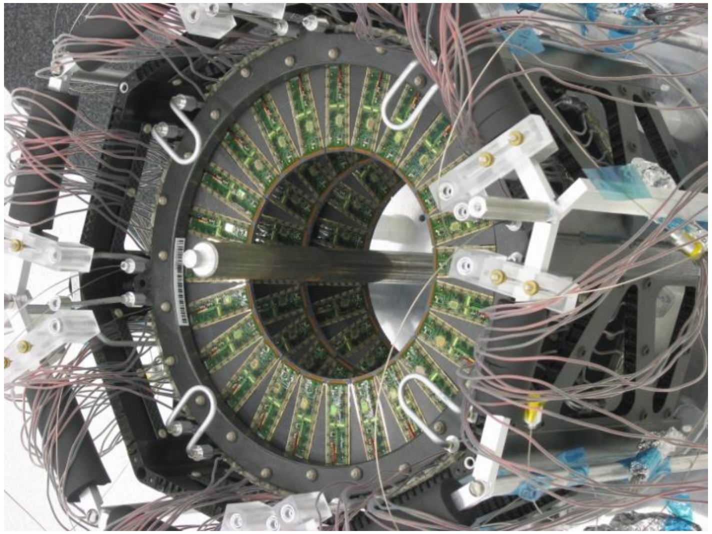
- ✓ 400k events in part of the barrel TRT+SCT on surface
- ✓ The width of the residual distribution is reduced compared to the width obtained with the misaligned setup. The algorithm quickly converges.

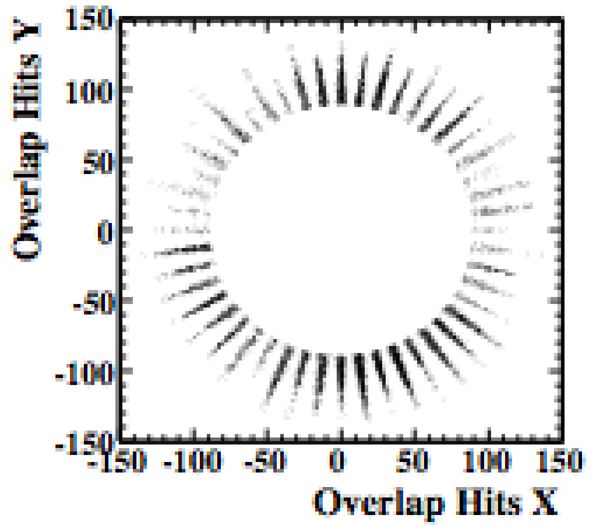




- ✓ The global SCT-TRT misalignment values are found to be consistent with the in situ survey of the relative position of the four SCT layers and the TRT.

Pixel test on surface (alignment)

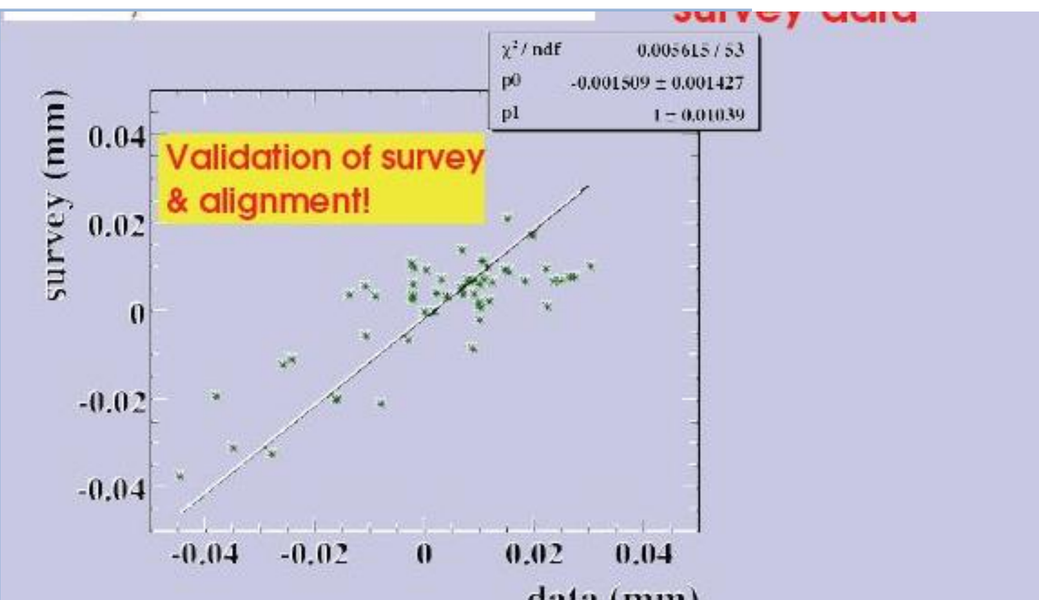


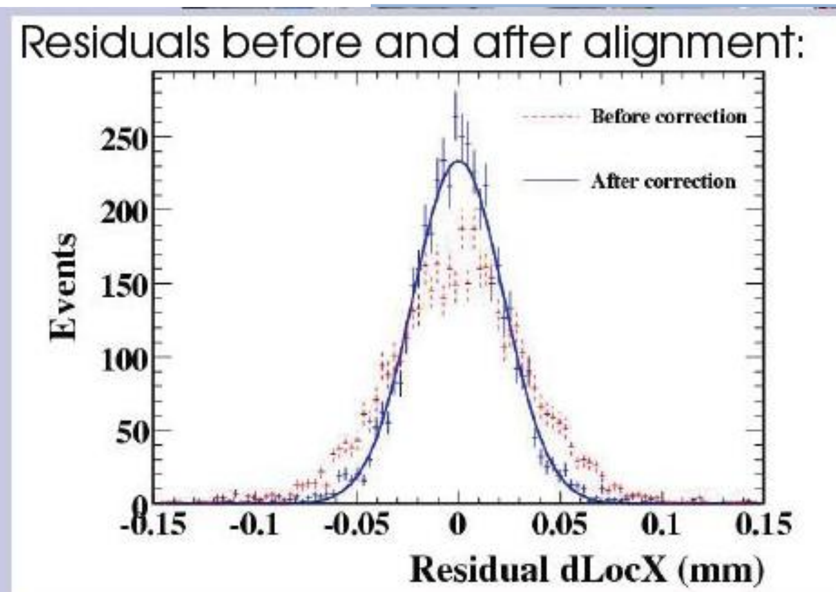


Test of one full Endcap

~150k cosmic tracks

Pixel noise occupancy below 10^{-9} per pixel/BCID





Solenoidal field

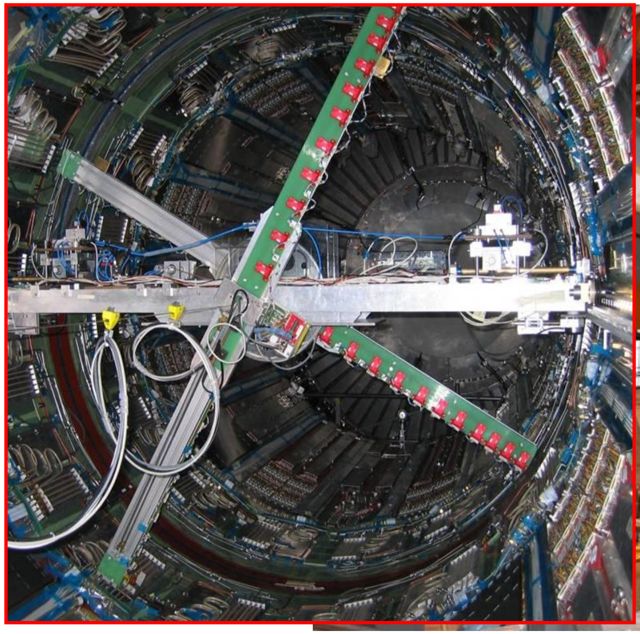
- Provides 2T field in the ID volume.
- Integrated design within the barrel LAr calorimeter cryostat.
- Minimize material before EM calorimeter -> *0.66 X_0*

✓ B field measured in situ by a scanning with a Hall probe array over a volume slightly larger than that now occupied by the inner detector

- *2.5 m diameter x 5.8 m length*
- *3.8 t superconductor*
- *5.4 t cold mass*
- *5.7 t total weight*
- *10 km superconductor*
- *7.73 kA at 2T*
- *38 MJ stored Energy*

✓ Typical map contains ~ 57600 data points measuring B(**r**).

✓ The overall fit produces RMS residuals of ~ 0.4 mT for all three field components.



Calorimeters

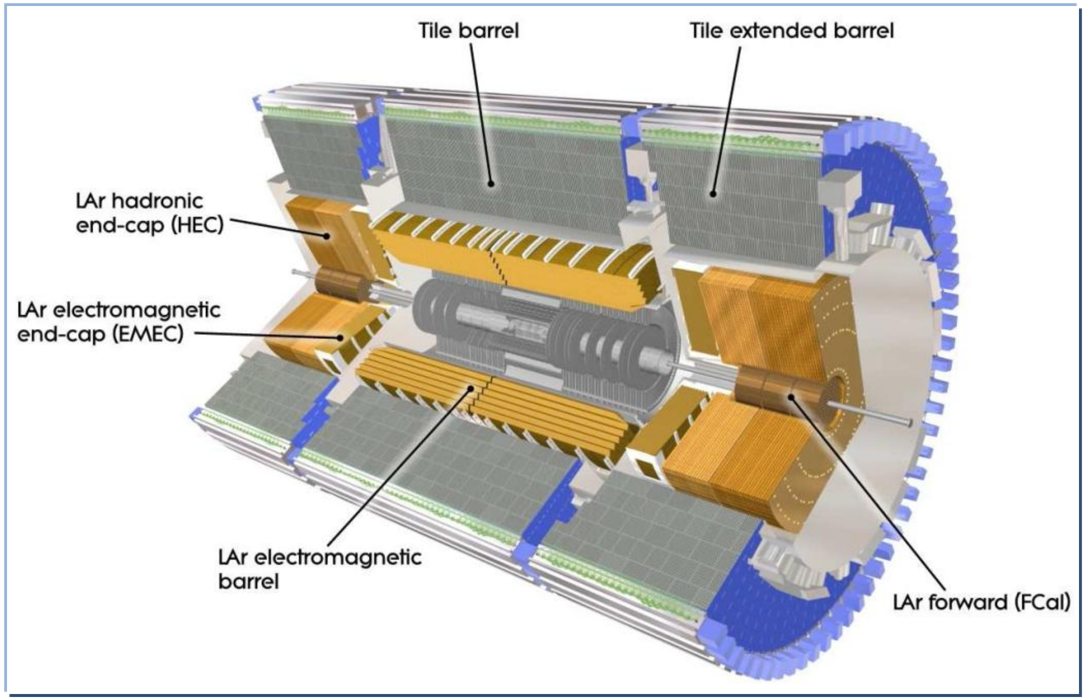
- Calorimeters cover the range $|\eta| < 4.9$, using different techniques suited to the widely varying requirements of the physics processes of interest and of the radiation environment over this large η-range.

Electromagnetic calo

- Accordion, Pb/Lar
- Barrel: $|\eta|<1.475$
- End-cap: $1.375<|\eta|<3.2$

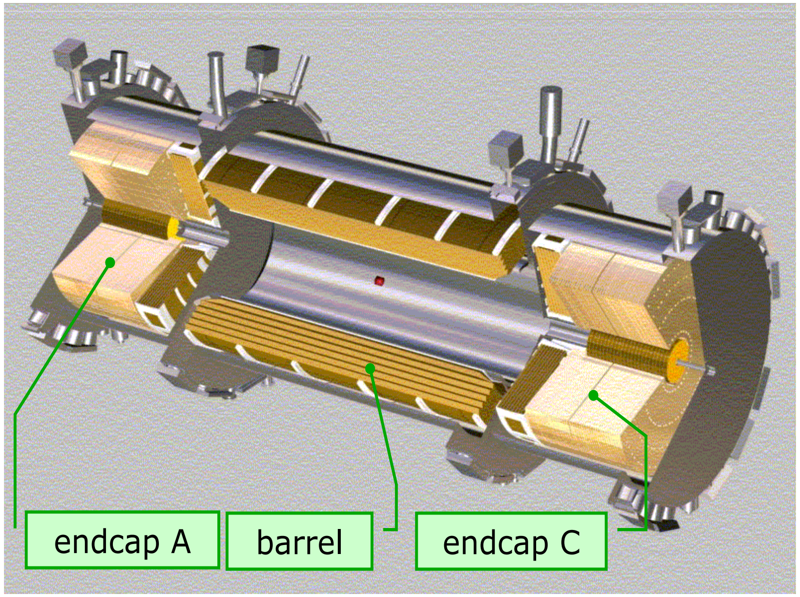
Hadronic calo

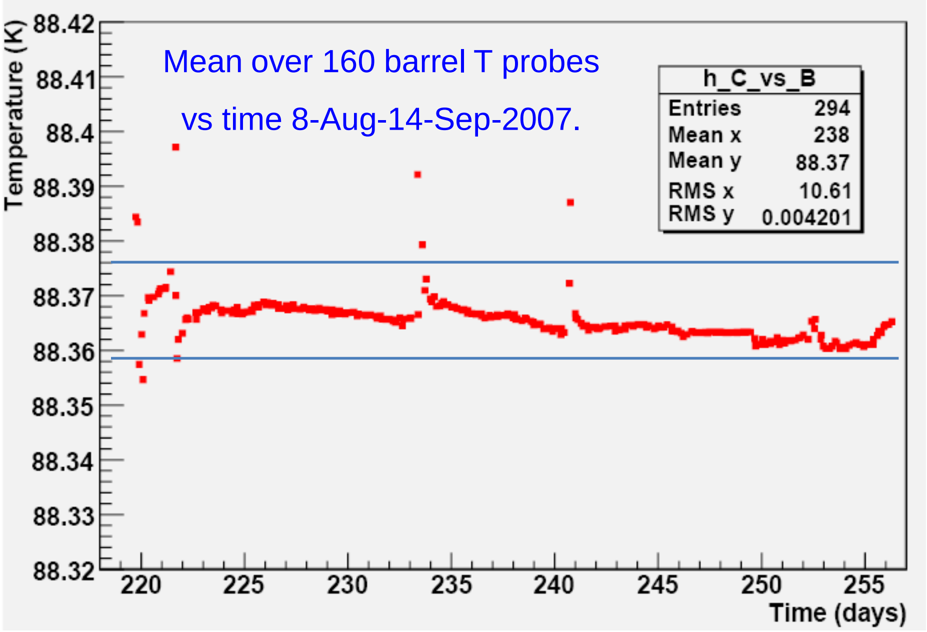
- **Tile**: Fe/scintillator, $|\eta|<1.0$ (barrel), $0.8<|\eta|<1.7$ (ext barrel)
- **Lar HEC**: Cu/LAr, two longitudinal wheels, $1.5<|\eta|<3.2$
- **Lar FCal**: Cu/W/LAr, $3.1<|\eta|<4.9$



LAr status

- Three cryostats were filled and operated continuously for several months. ECC will be filled again in March.
- Liquid purity stable and well below 0.5 ppm in all cryostats.
- Calorimeter Temperature very stable in time, average within +- 10 mK.
- All Endcap and Barrel back-end electronics available in the readout.



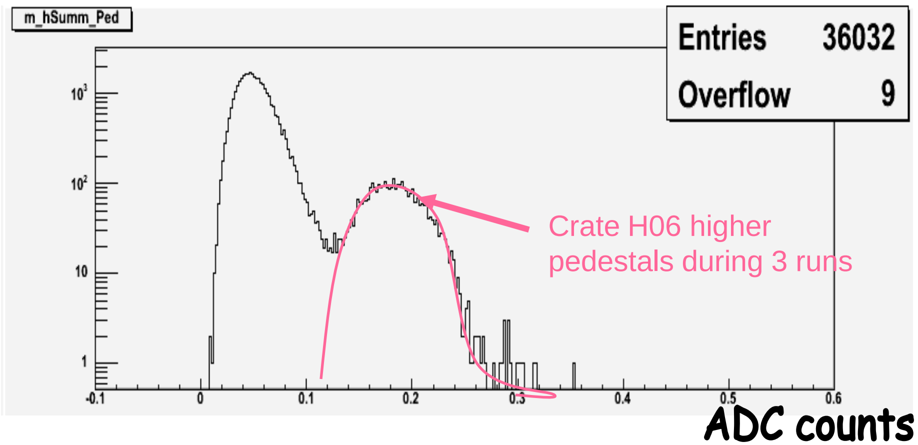


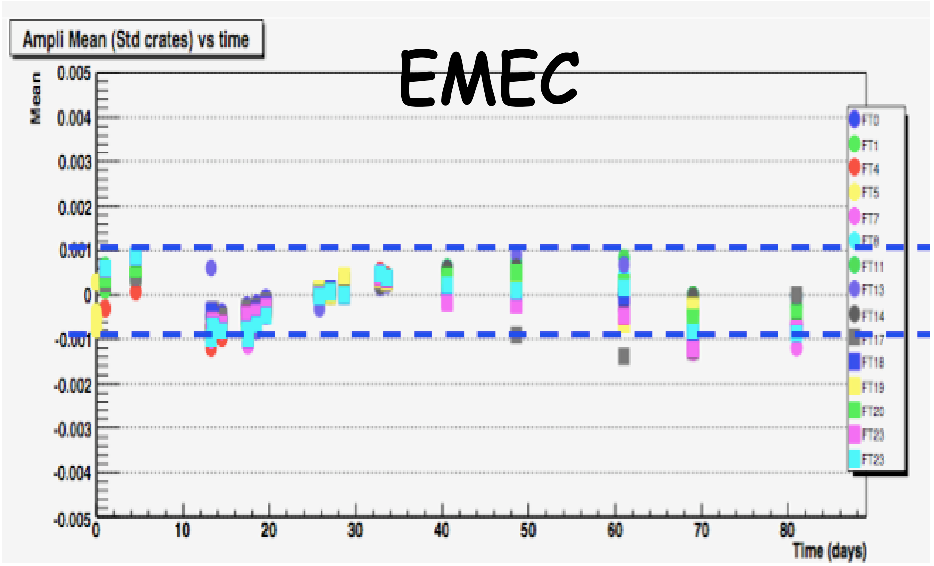
- Several components needed redesign /retrofitting /refurbishing:
  - High voltage power supplies HVPS (done)
  - Low voltage power supplies LVPS (done)
  - Front-end boards FEB due to possible long term stability problems. (on going).
- Operate LAr system regularly for calibration runs and cosmics data taking.

LAr commissioning: calibrations

- ✓ Stability of Calibrations counts: pedestals. Electronics is very stable and noise stability is ~0.05 ADC.
- ✓ Stability with time of maximum amplitude and shape of the calibration pulse: < 0.1% in barrel and EMEC

Pedestal variation over 4 months (11 runs)

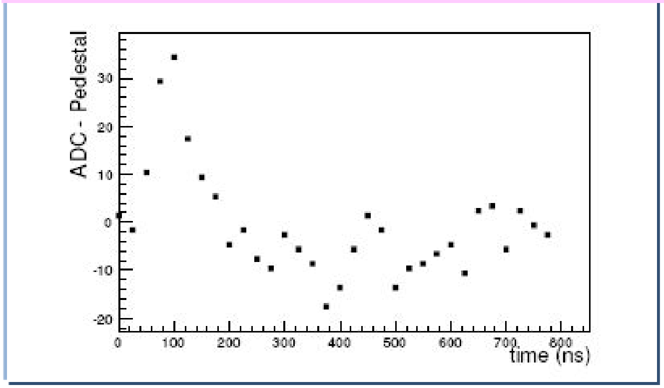




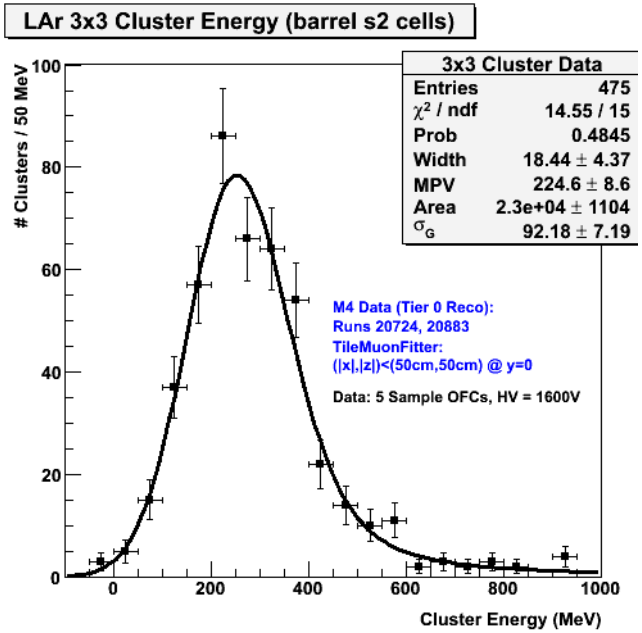
LAr Commissioning: cosmics

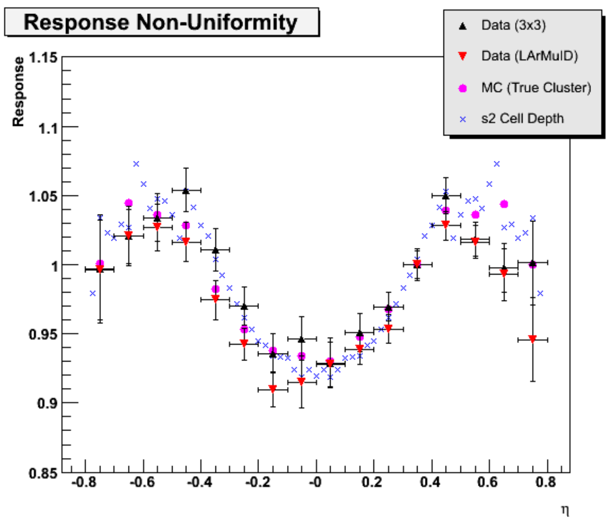
- ✓ Taking data every week-end and during milestones weeks.
- ✓ Cosmics rate: 15 events/min, Tile triggered.
- ✓ Total of ~500K cosmics events registered since Aug 06 (ATL-LARG-PUB-2007-013) to optimize timing, intercalibration. calorimeter uniformity in η.

Typical signal shape from an energy deposition by a muon (~300Mev)



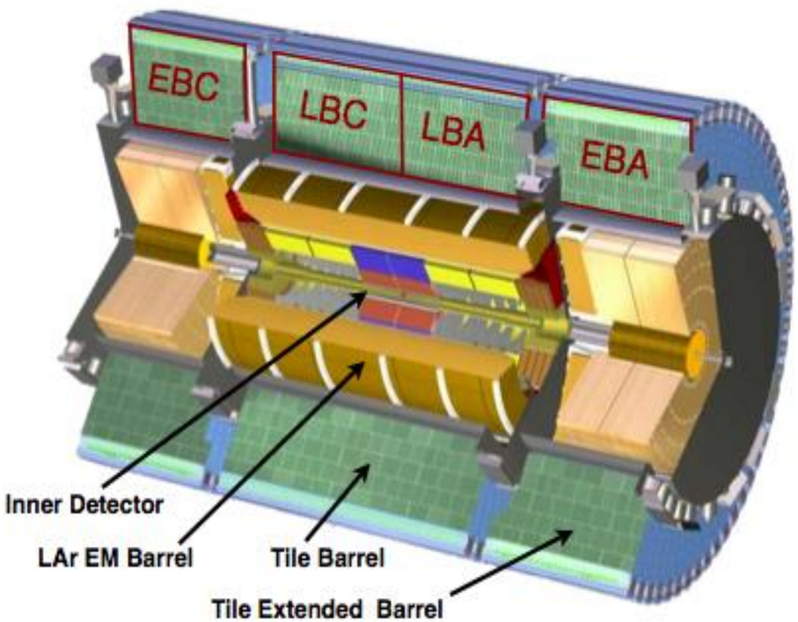
- ✓ Challenging S/N and asynchronous arrival time of the cosmic muon with respect to the trigger.





Most probable energy value vs η (normalized)

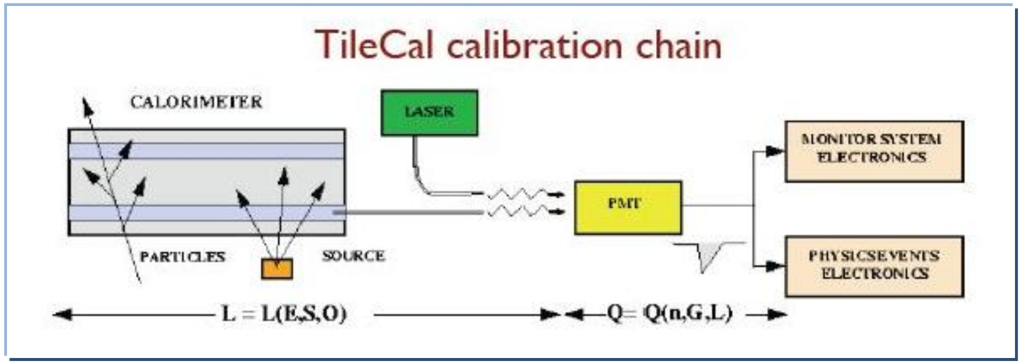
Tile Hadron calorimeter status

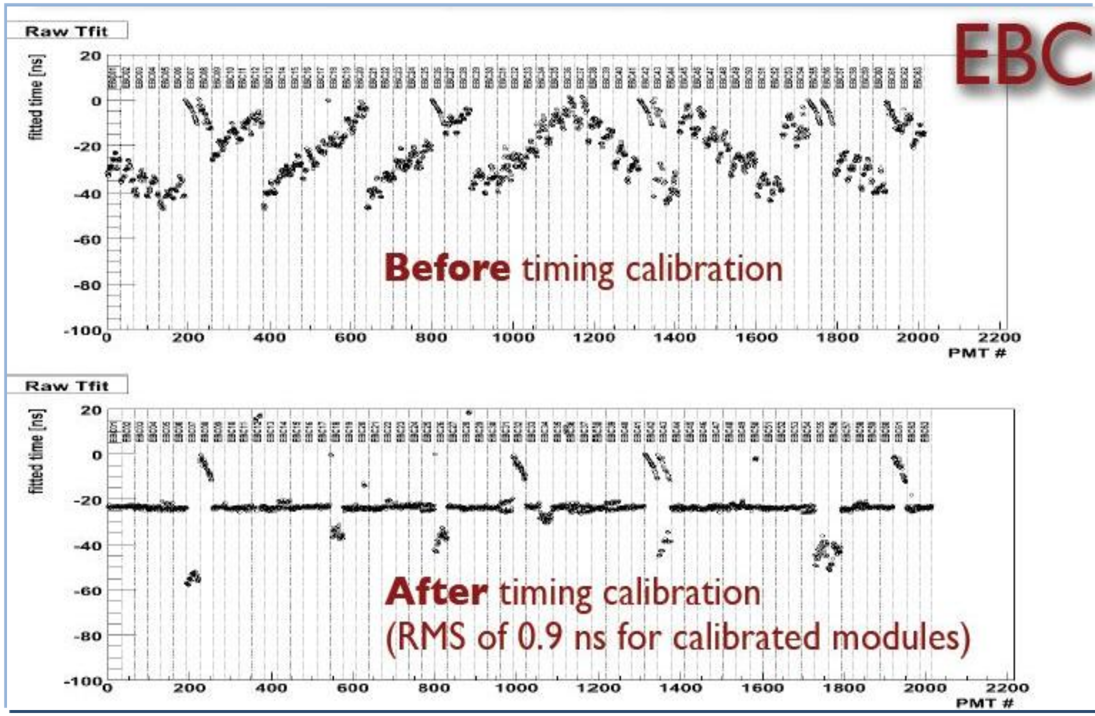


- ✓ Detector fully installed and operational since several months.
- ✓ Problems in the front-end electronics readout observed -> decision to refurbish it ~ 60% already done.
- ✓ Low voltage power suppliers all refurbished and operational.
- ✓ Entering operation-like phase:
  - routine calibration runs (pedestals, charge injection, integrator calibrations, laser, source) during the week
  - cosmics data-taking during the week-ends.

Tile commissioning: Calibration -> laser

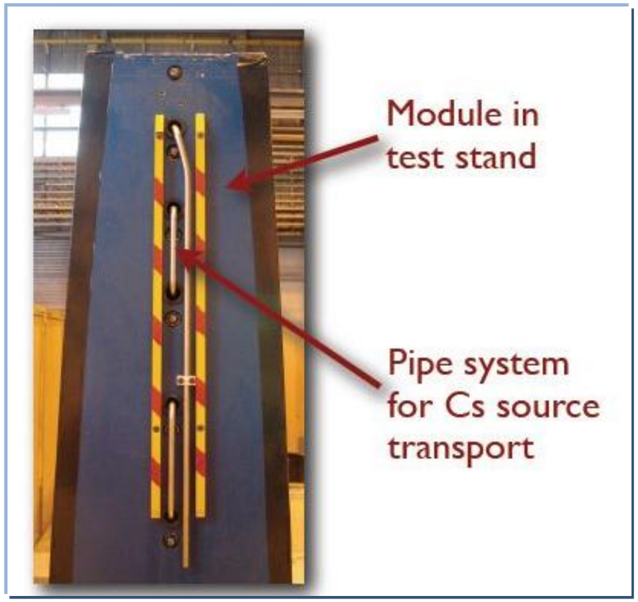
- ✓ Laser system is by now routinely used in commissioning runs to pulse all PMTs simultaneously with light:
  - Testing of optics and electronics chain
  - Essential for timing intercalibration ofTileCal readout.
  - Reconstructed pulse times are used to equalize the arrival time at each PMT by changing hardware timing parameters.
- ✓ Charge injection system not mentioned (working since long time).

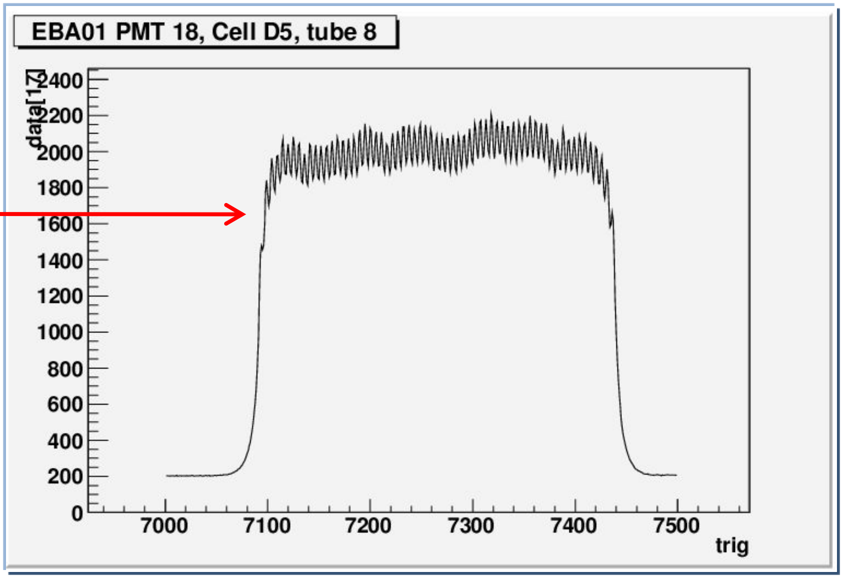




Tile commissioning: calibration -> source

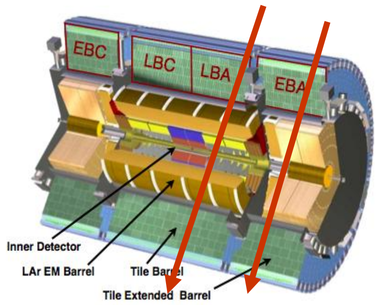
- ✓ To calibrate and monitor the tile-calorimeter scintillator and optical system, a Cs of ~ 10 mCi is moved hydraulically inside the calorimeter body.
- ✓ These calibrations are performed during dedicated runs, with the source traversing each of the 463,000 tiles in the detector.
- ✓ It enables the setting of the high voltage of each channel and response inter-calibration of all the 10000 tile channels.
- ✓ Moreover, the individual tile response might be measured in each channel.

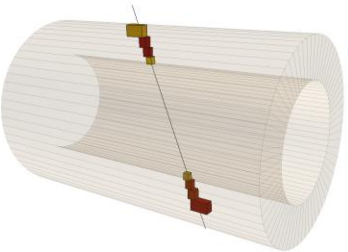


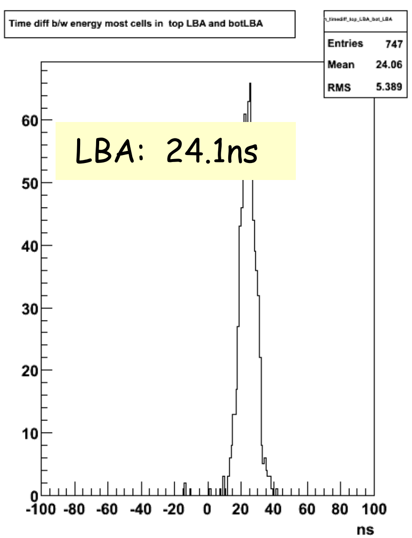


Tile commissioning: cosmics

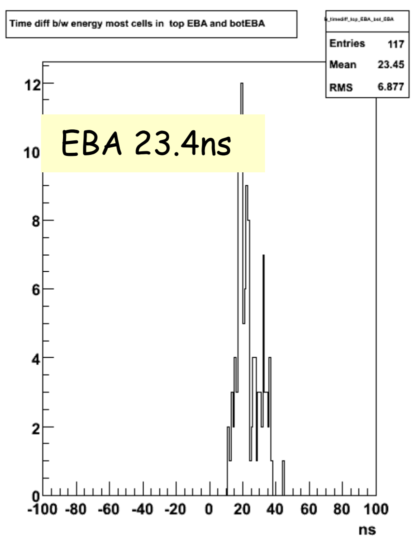
Time of flight measurement







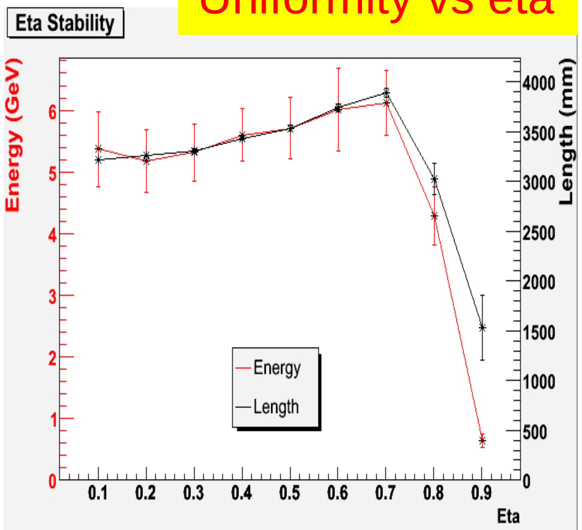
LBA: 24.1ns



EBA 23.4ns

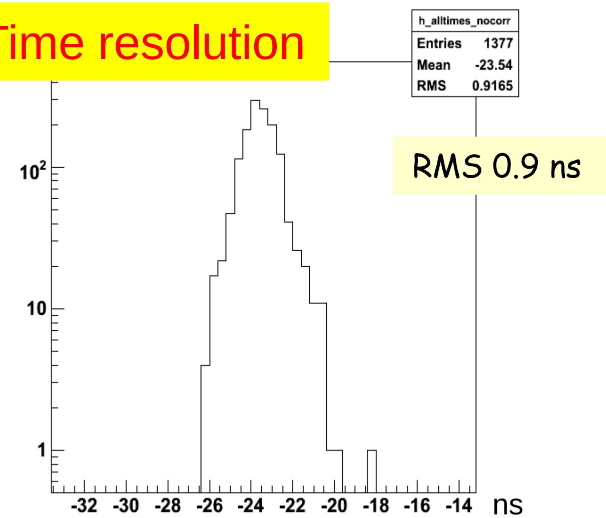
M4 data not yet offline corrected
Central values in agreement with track paths

Uniformity vs eta



Agreement with expected track length

Time resolution

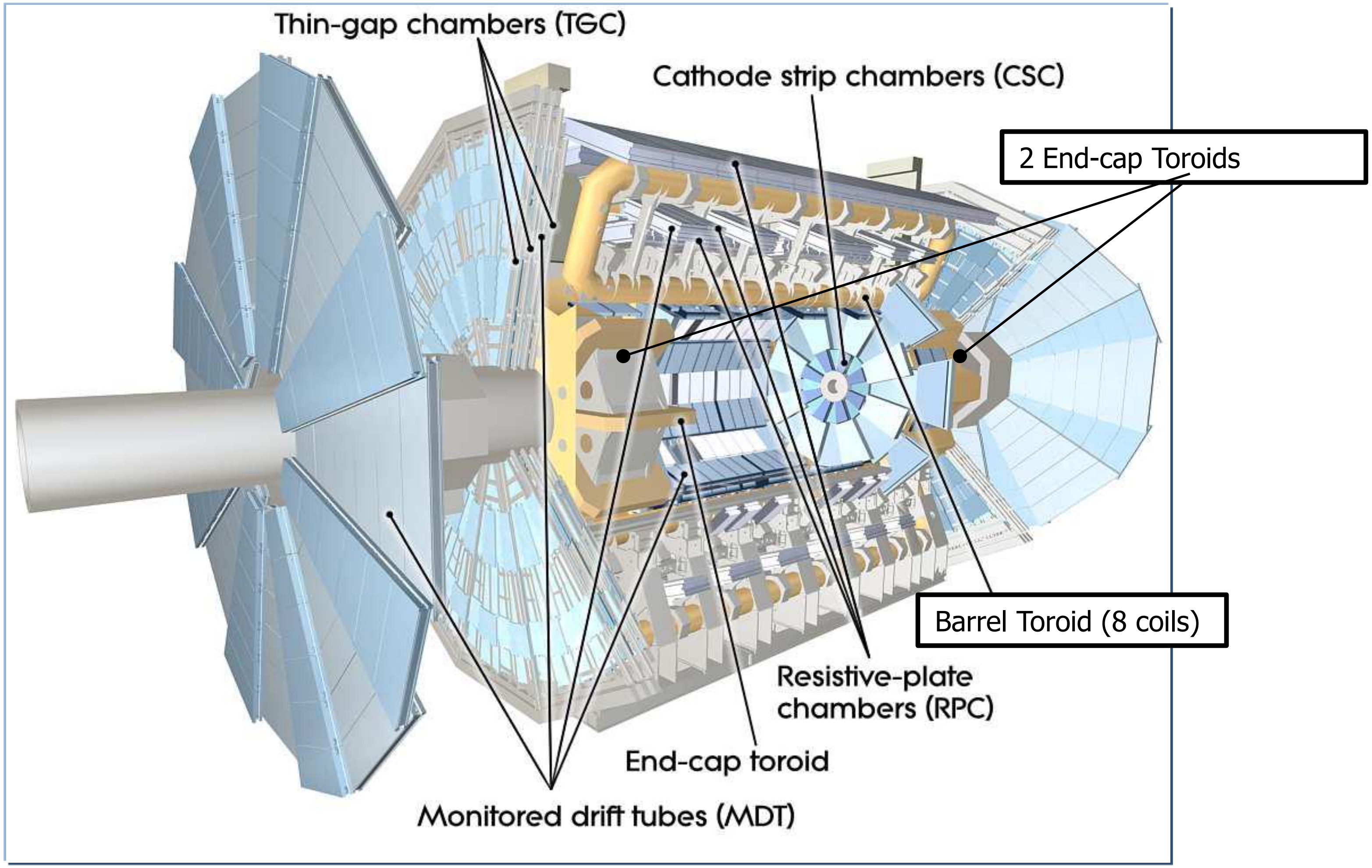


RMS 0.9 ns

44 well calibrated drawers (69% of EBC)

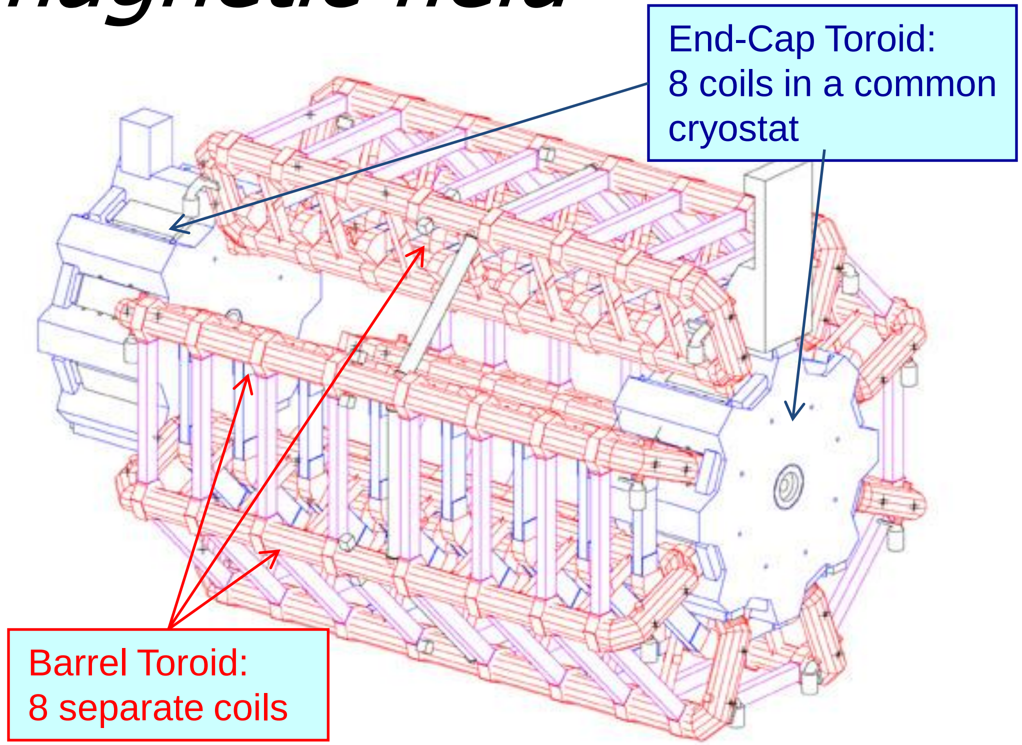
Muon Spectrometer

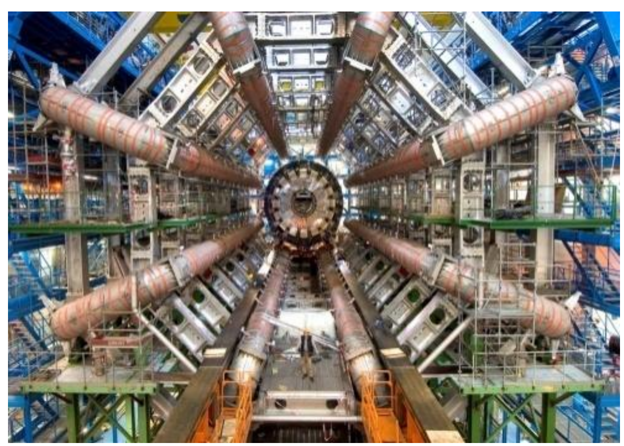
- Installation and commissioning of the magnet
- Installation and commissioning of the muon chambers



Toroidal magnetic field

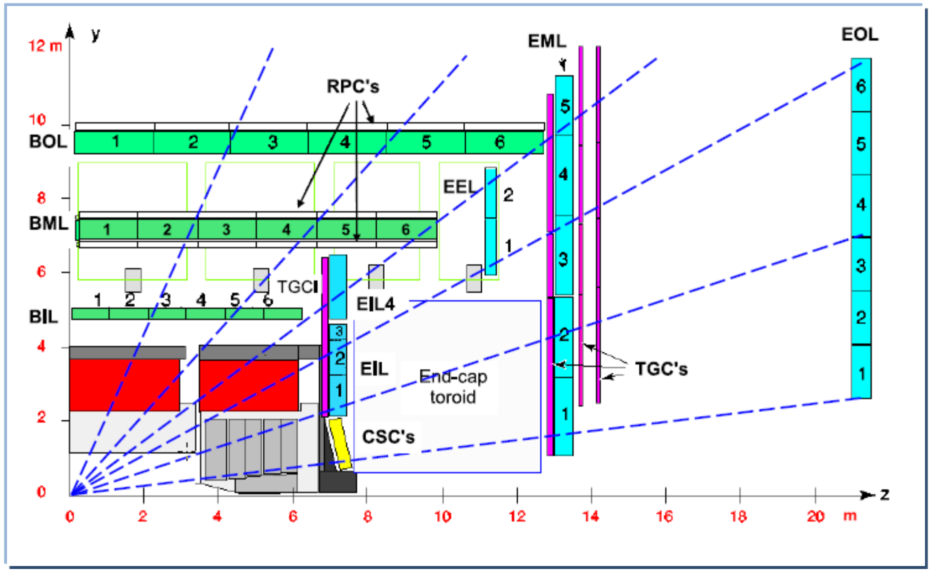
- ✓ The air core system generates a strong bending power in a large volume (minimization of multiple-scattering effects).
- ✓ All magnets hardware installed (ECT during 2007). Barrel toroid tested at 20.5 kA.
- ✓ End-caps cool down in Nov (5 weeks) then tested separately at 10kA (not in the final position).
- ✓ A final combined magnet test foreseen as soon as ATLAS will be fully closed.





Muon chamber system

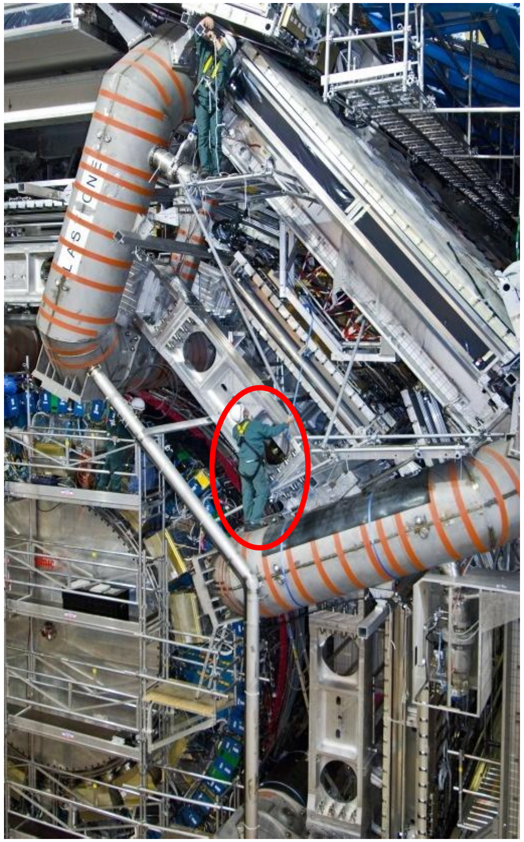
- The high momentum resolution is achieved with 3 layers of <u>high precision</u> tracking chambers arranged in 3 cylindrical layers (barrel) or perpendicular to the beam (end cap wheels).
- <u>Trigger chambers</u> make part of the LVL1 trigger in ATLAS providing BC identification, muon pT triggers selection and second coordinate information.



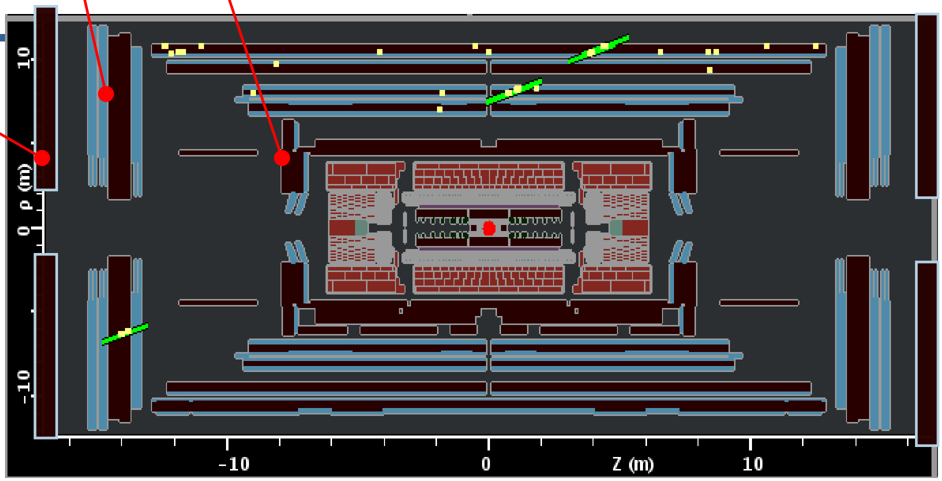
	Function	Resolution (RMS) in			Chambers	Channels	Coverage
		z/R	ϕ	time			
MDT	Tracking	35 μm (z)	-		1108	339k	$\|\eta\| < 2.7$
CSC	Tracking	40 μm (R)	5 mm	7 ns	32	31K	$2.0 < \|\eta\| < 2.7$
RPC	Trigger	10 mm (z)	10 mm	1.5 ns	544	359k	$\|\eta\| < 1.05$
TGC	Trigger	2-6 mm (R)	3-7 mm	4 ns	3588	318k	$1.05 < \|\eta\| < 2.7$ (2.4 for trigger)

Installation

- ✓ Barrel: 701/704 stations installed; ~96% precisely positioned; Services almost ready. Sectors Commissioning is on-going -> Spring 2008.

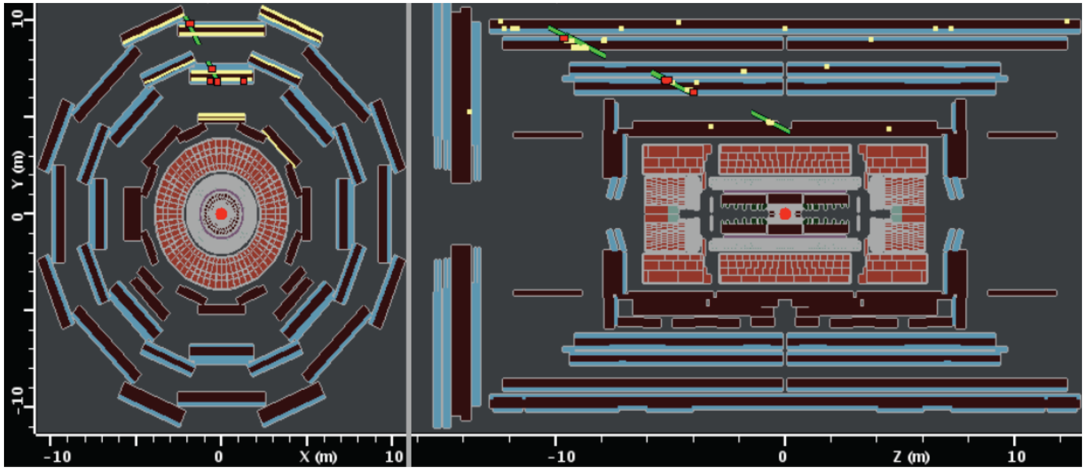


- ✓ End-caps: Big wheels are installed and in commissioning. Small wheels still in surface but ready, will be installed in the pit in Feb. EO(Outer): installation in situ on-going.

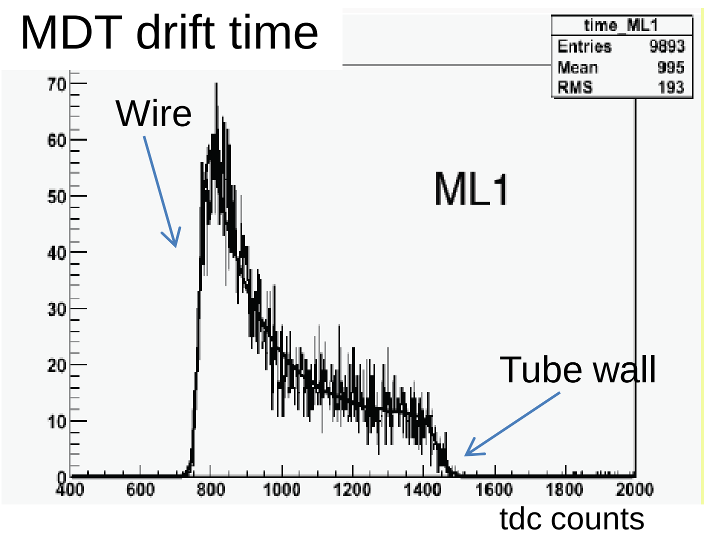


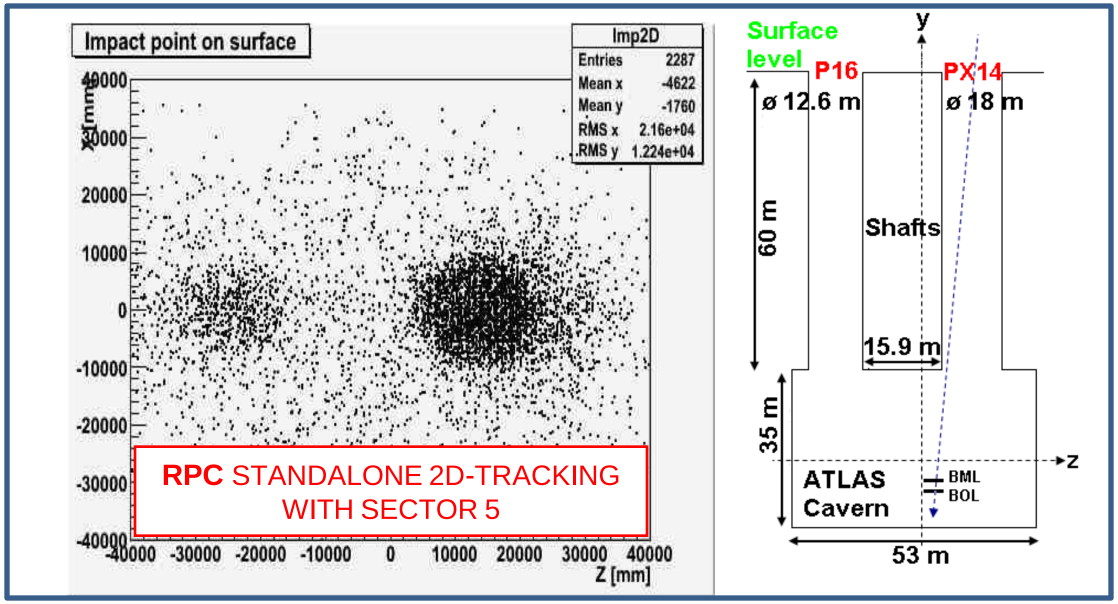
Commissioning with cosmics

- ✓ Cosmic rays acquired on:
  - ✓ MDT 10/16 sectors
  - ✓ RPC 4-6/16 sectors
  - Dead and Noisy channels <0.5% level
- ✓ Trigger provided by RPC top sector
  - Trigger rate ~200Hz
  - Standalone RPC tracking reproduce shaft images



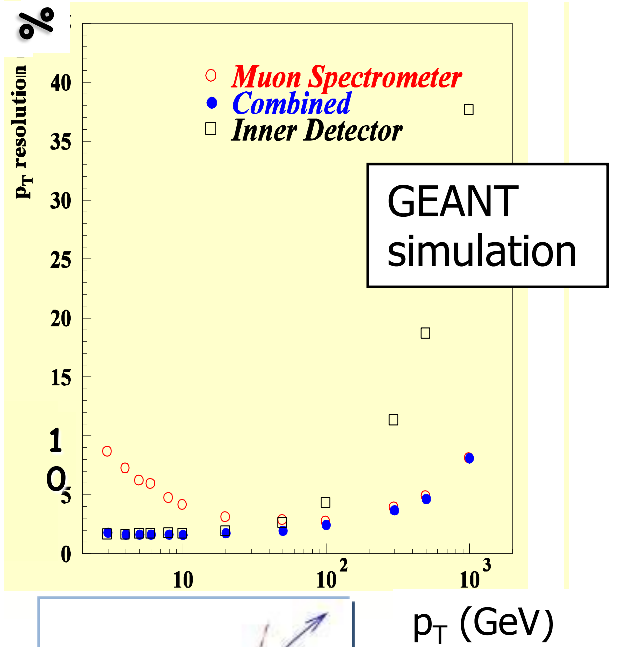
MDT drift time



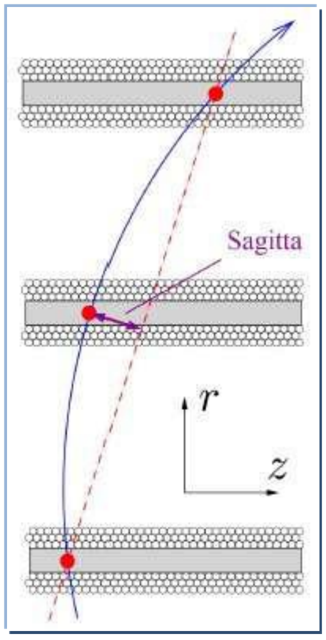


Muon spectrometer performance

- The driving performance goal is the stand-alone transverse momentum resolution
  - σ/p < 3% for Eμ ~ 10-100 GeV
  - σ/p < 10% for pTμ ~ TeV which translates into a sagitta along the *z (beam) axis of about* 500 μm for 1 TeV , to be measured with a resolution of ≤ 50um



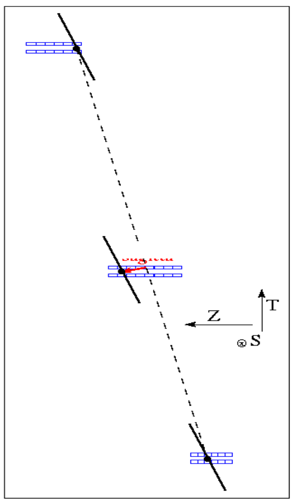
- Three sources of uncertainties on the muon measured curvature. To achieve the requested resolution:
  1. Intrinsic resolution of precision chamber -> 50um
  2. Relative position of chambers and coil (12k sensors) -> 30um
  3. Field measurement (1840 B-field sensors) -> 1-2mT

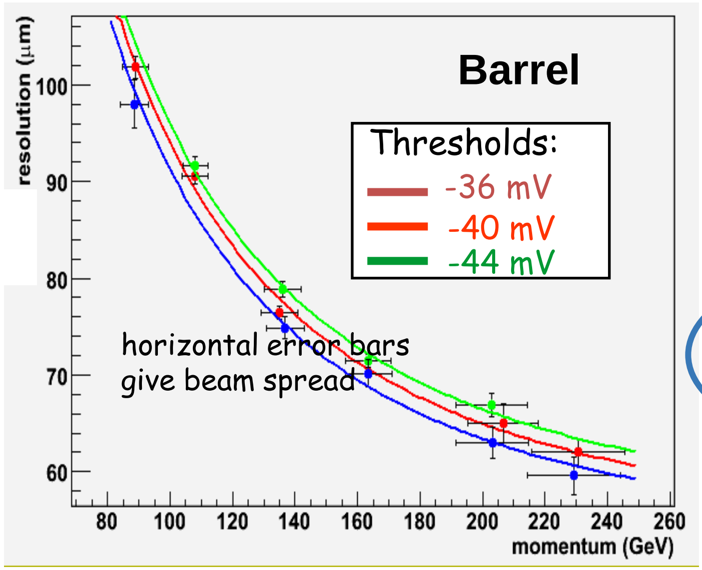


MDT intrinsic resolution

- ✓ Accuracy goal: 50um

- ✓ It has been verified in the CTB 2004.





Data fitted with: $\sigma = \sqrt{K_1^2 + (K_2/p)^2}$

- p = muon momentum from beam magnet
- K_1 = intrinsic resolution
- K_2 = multiple scattering

Data	Simulation
K_1 = 50.7±1.5 μm	K_1 = 40±3 μm
0.29±0.01 X_0	0.32 ±0.02 X_0

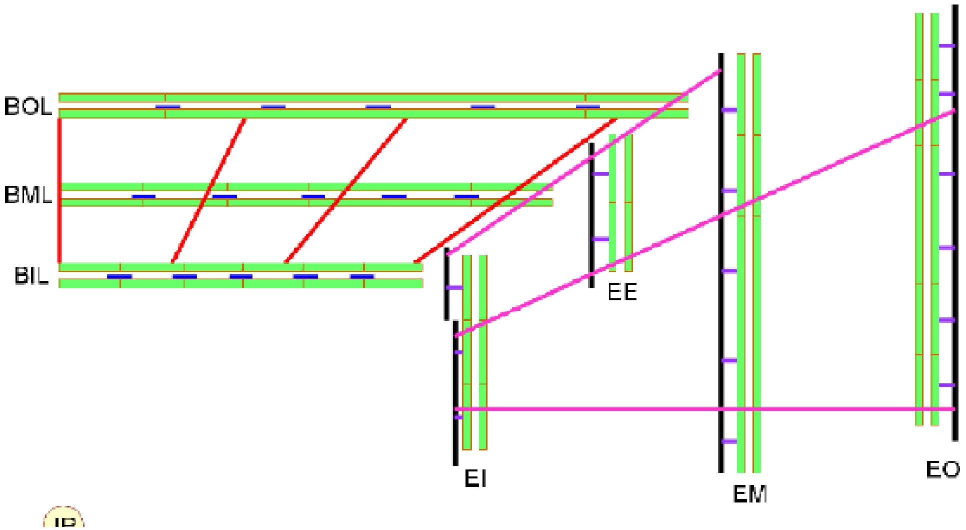
- ✓ As MDTs are operated with a strongly non linear gas mixture and the resulting space-time relation is very sensitive to the operating conditions (mainly gas, T, B)
- ✓ MDTs will then be autocalibrated daily using μ tracks (*muon calibration stream* (O(1kHz))

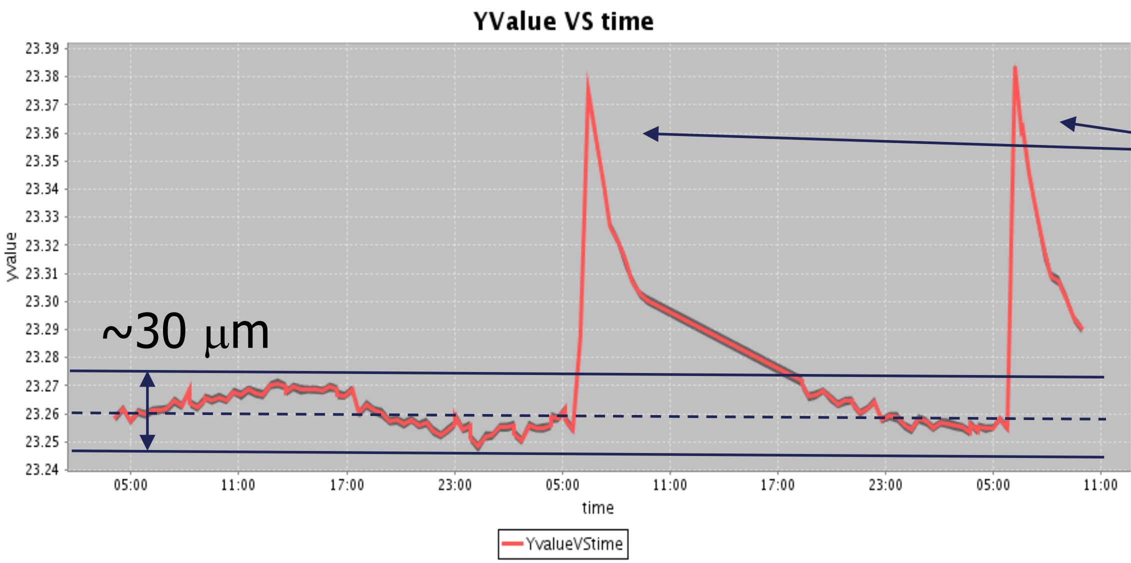
Chambers alignment

Accuracy goal: 30um

Chambers are aligned using an optical system consisting of 5800 (barrel) and 6400 (end-cap)

- ✓ internally to monitor deformations
- ✓ to monitor the relative position amongst neighbours in each chamber layer
- ✓ along projective lines, corresponding to infinite momentum tracks, to monitor displacements in a tower of sequentially traversed chambers.

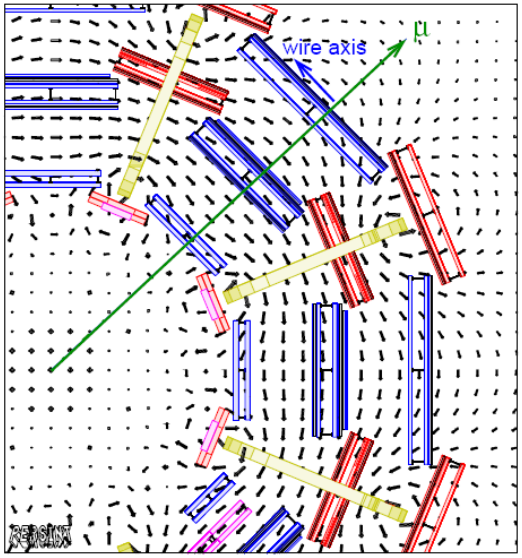


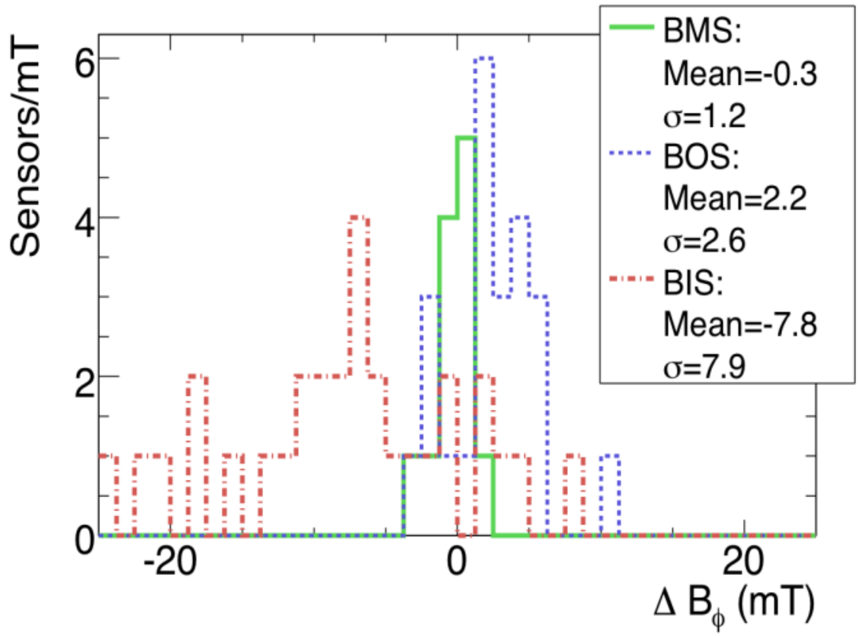


Safety Barrel Toroid Magnet heaters periodically turned on (temperature deformation)

B field measurement

- ✓ Accuracy goal: 1-2 mT
- ✓ To achieve such precision:
  - Measure B-field vector to < 0.5 mT with ~ 1800 sensors (3-D Hall cards) positioned (2mm, 3 mrad) at places where the field gradient is large;
  - Use the B-sensor readings after correcting for the magnetic pollution predicted for known regions, to fit the position (and shape) of each toroid coil;
  - Once the geometry is known, compute B numerically everywhere.





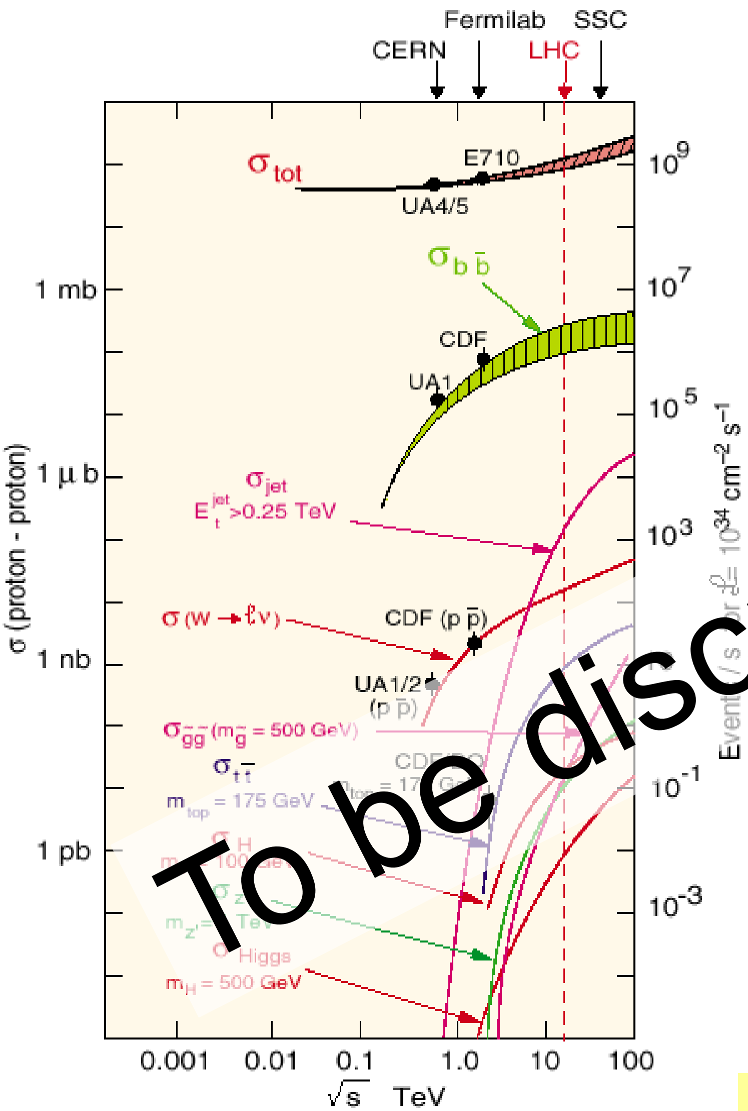
First results (no ECT, 400 Hall cards only, nominal position for chambers and B-sensors)

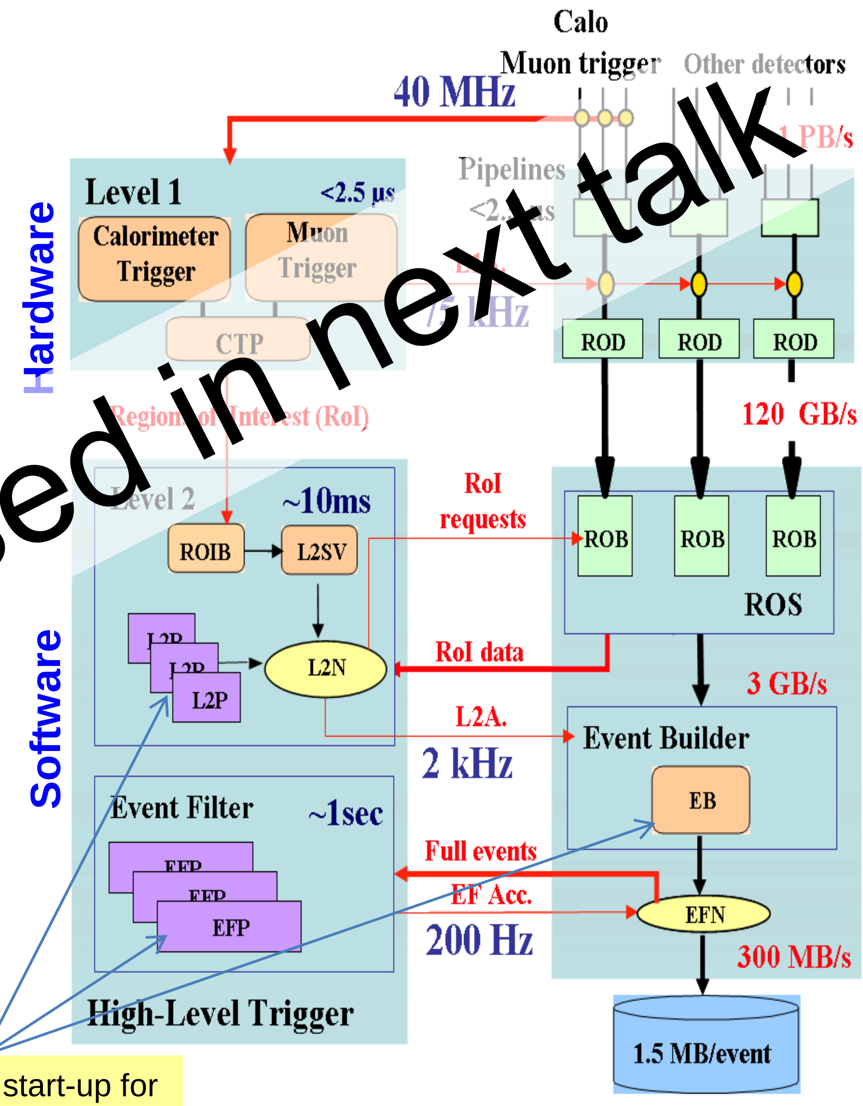
Field reconstruction residual ΔB_ϕ, in mT, for a middle (green, solid), outer (blue, dashed) and inner (red, dot-dashed) MDT layer.

By comparison, the accuracy goal is $<\Delta B> = 0$, $\sigma(\Delta B) \sim$ 1-2 mT

Now waiting for final B test in Spring.

Trigger and Data Flow: battle of the Titans





To be discussed in next talk

50% viable at start-up for resource reason

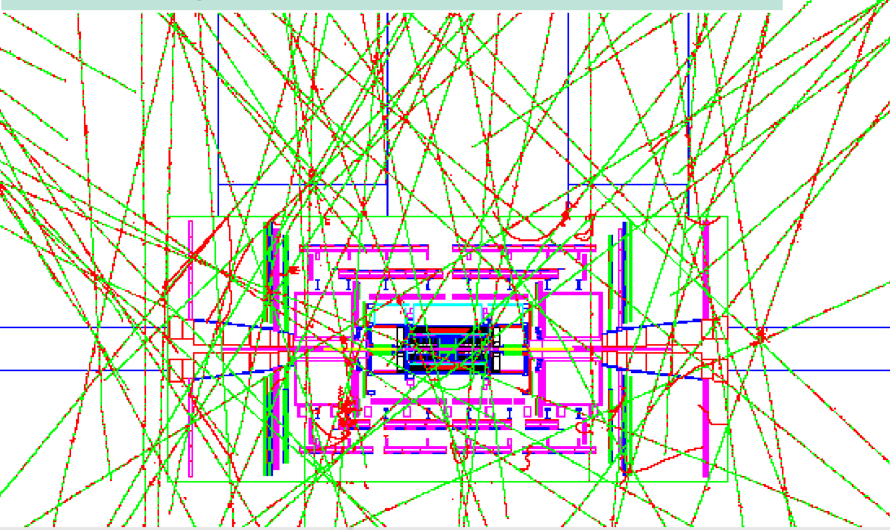
ATLAS commissioning

- In parallel to subsystem commissioning…
- ATLAS has started to run in combined mode:
  - Mx weeks every 6-8 weeks
  - M5 in Nov07, M6 scheduled for March3

✓ Main activities:

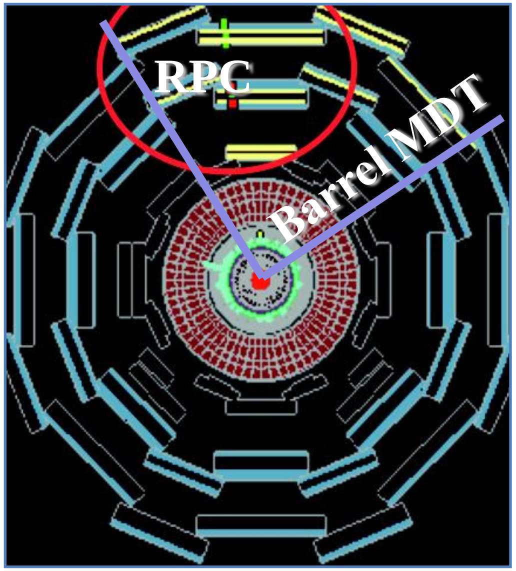
  - ✓ Integration of online and offline software,
  - ✓ Cosmics data-taking,
  - ✓ Correlation of measurements between systems and timing,
  - ✓ High trigger rate,
  - ✓ Data quality monitoring,
  - ✓ Data flow and Trigger algo

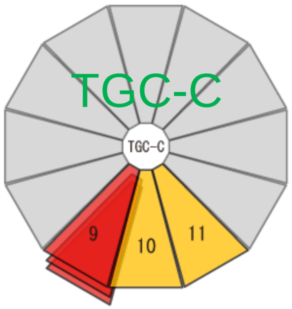
10 ms of cosmics, trigger rate 1-200Hz depending on experimental cuts

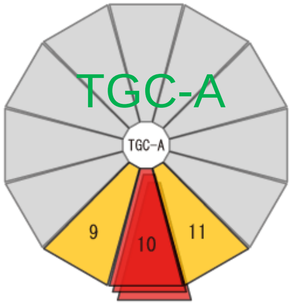


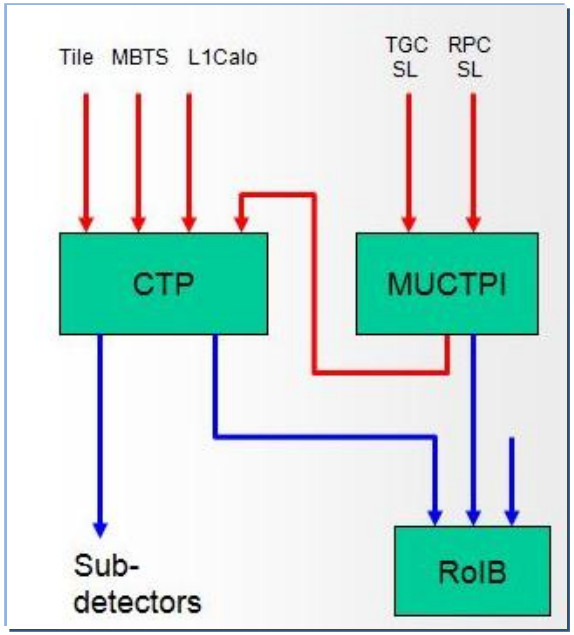
M5 combined run

- RPC (12.5%): Sectors 5,6
- MDT (~25%): barrel sectors 3-6, 16EIL4 chambers
- TGC: 5/36 stations with final setup in read out and trigger on each side (~14%). First operation on A-side
- Tile: ~55%; LAr: 68%-87%
- Pixel: Readout only, no TRT (but M4 and M5.x in Dec)



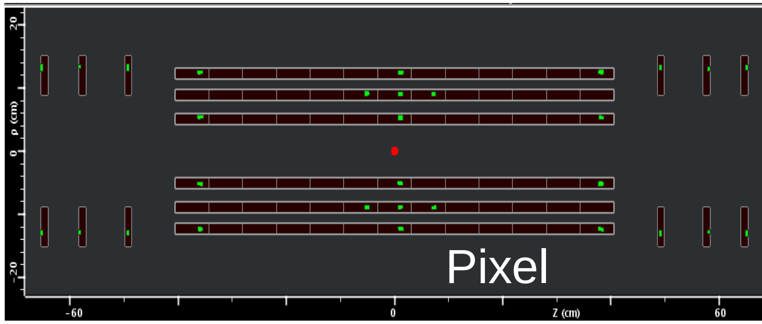




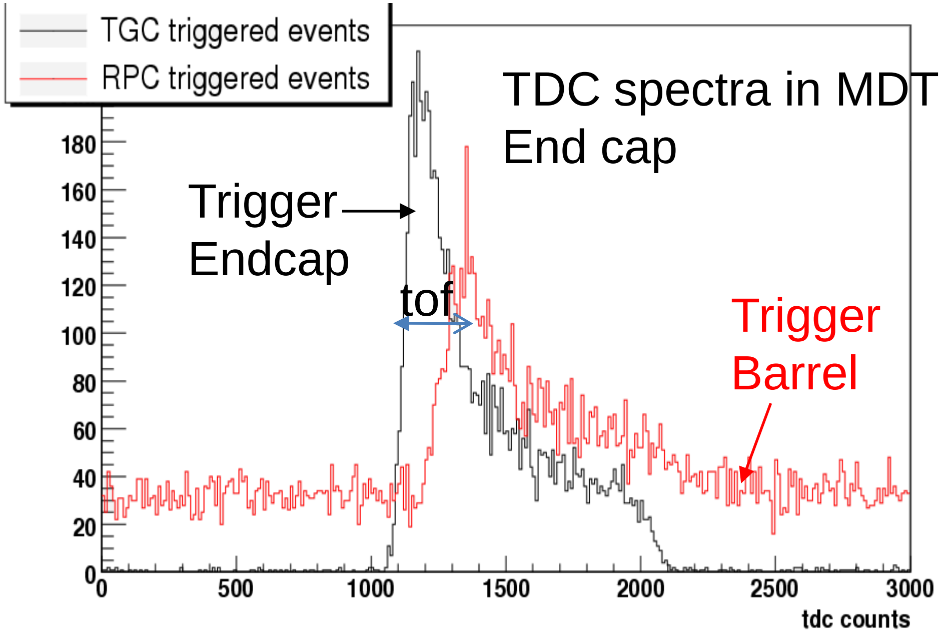


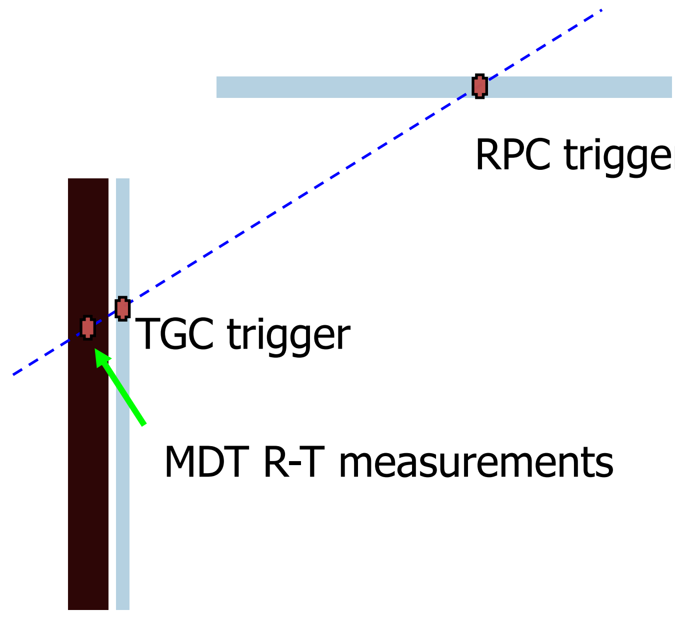
✓ Cosmic trigger:
- Tile: sub-Hz
- RPC: few tens Hz
- TGC: few Hz
- L1Calo: sub-Hz
- MBTS: sub-Hz

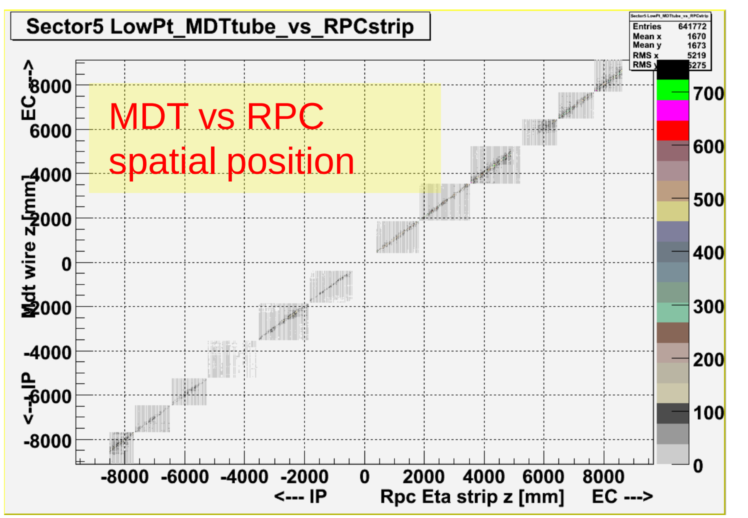
✓ Technical triggers:
- random, fixed frequency from CTP



… subsystems working together

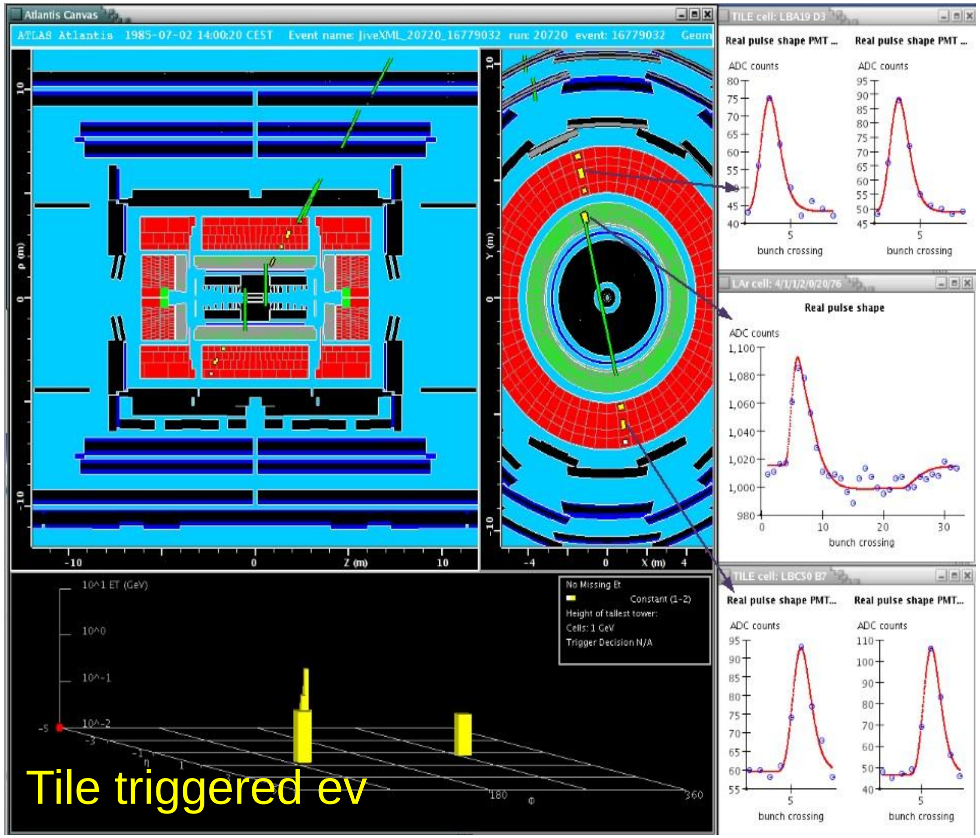




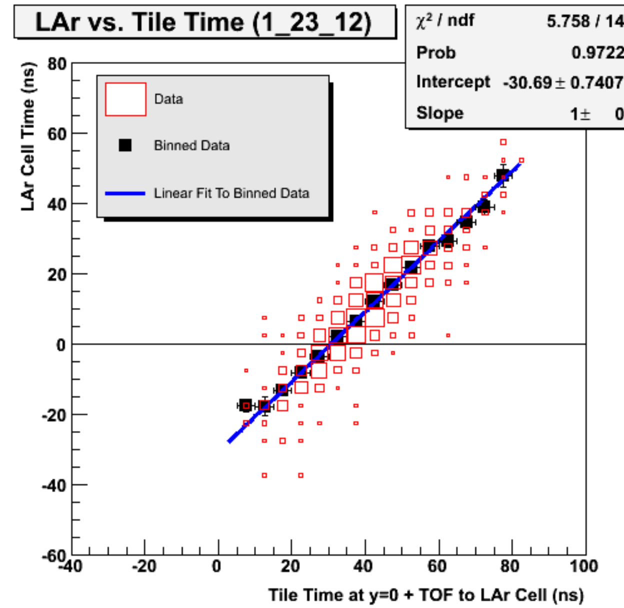


- ✓ Both, endcap- and barrel-triggered events have hits in the precision muon chambers with a characteristic muon TDC spectrum.
- ✓ Trigger from barrel reaches the precision muon chamber front-end electronics 130 ns sooner than from endcap.

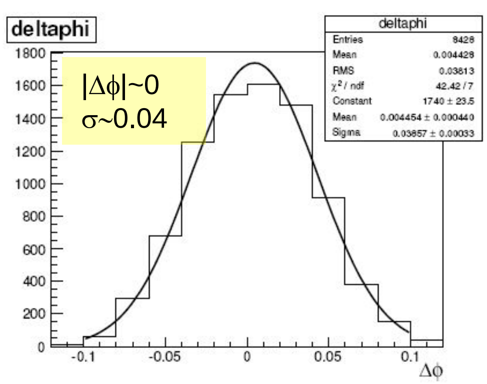
LAr and Tile cosmics



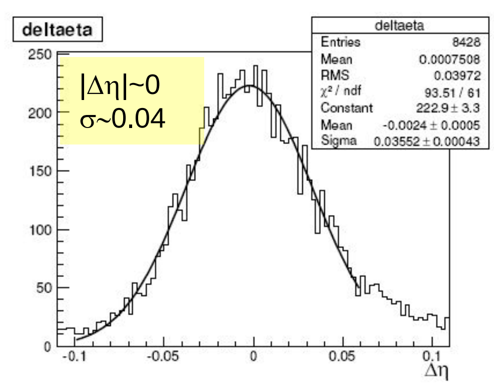
Correlation TileTime vs LArgTime



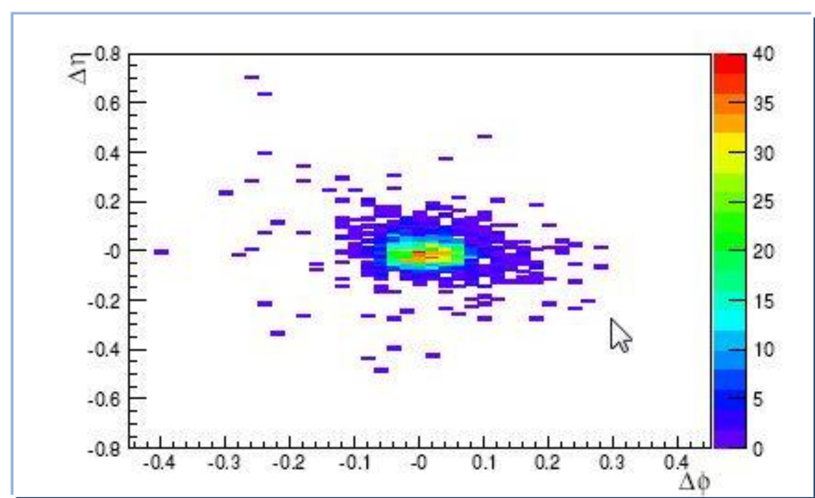
Correlation Tile(ϕ,η) and LArg(ϕ,η)



(a) $\Delta\phi = \phi_{Tile} - \phi_{0LAr}$



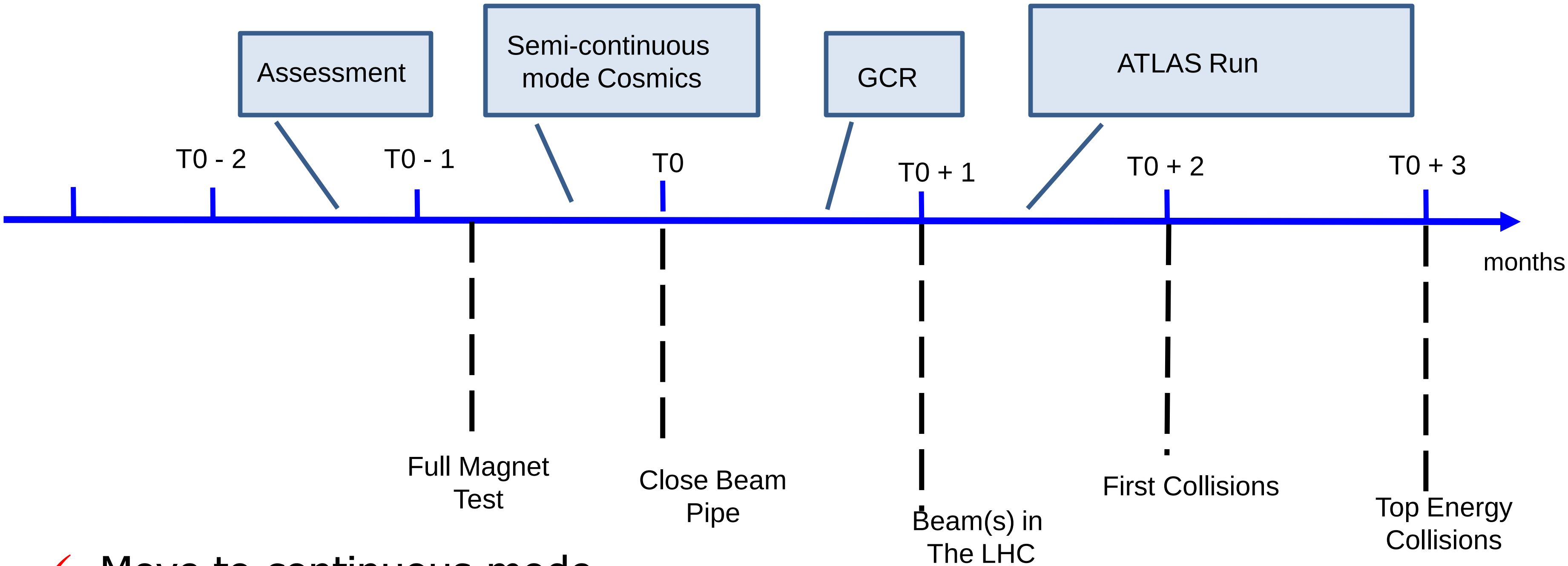
(b) $\Delta\eta = \eta_{Tile} - \eta_{0LAr}$



Towards final operation (I)

- ✓ Schedule is linked to T0 = beam pipe closure
- ✓ Detector: ~ 5-6 weeks before T0 need to start the closure to the final position: close the ID, move back the calorimeters (-3m), install Small Wheels, position of the ECT, test of the magnet system, Shielding
- ✓ Operation:
  - Keep current mode global commissioning along two lines up to T0 - 2 months
    - Periodic (~ 2 months) global commissioning (Mx) weeks for Integration, Operation, Training, cosmic runs
    - System dedicated periods (few days/system) for System studies, and Problem solving, including DQ/monitoring, Data flow (FDR), trigger
  - Start Moving to continuous mode starting to T0-2 months

Towards final operation (II)



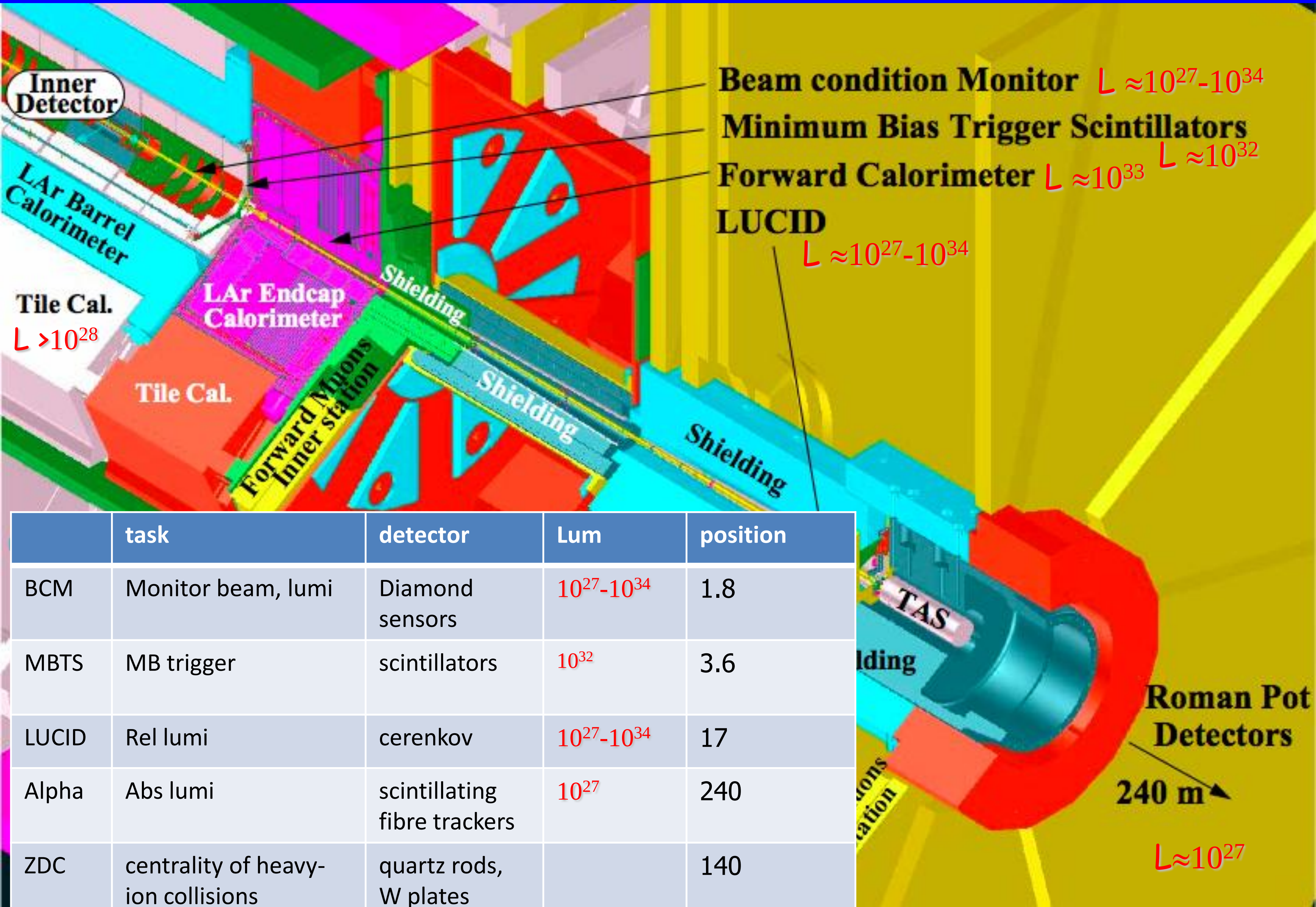
✓ Move to continuous mode

- [T0 - 2 to T0 -1] Assessment month: Check system stability, controls, Data Quality/monitoring.
- [T0 -1 to T0] Semi-continuous Global Cosmic Run (GCR) and problematic detector out for debug.
- [T0 to T0 + 1] Global Cosmic Run; start 24/7
- [T0 + 1 to T0 + 3] ATLAS Run: commissioning with beams, global run with beam/cosmics, timing, 24/7 operation.

Conclusions

- ✓ The ATLAS detector is there! (Including luminosity/beam aux detectors that I have not discussed). Only few parts still need to be installed (part of muon EndCap) or connected (Pixel). Nothing appears to be on the critical path to prevent ATLAS being ready for interactions.
- ✓ All subdetectors are well advanced in the commissioning phase!
- ✓ Commissioning weeks (Mx) have been (will) be very useful to help in the transition from individual subdetectors to ATLAS mode.
- ✓ The cosmic rays are a powerful debugging/calibration tool. They will be important also in the next months.
- ✓ Waiting for the beams and first collisions: 2008 will be an extremely exciting period!

Auxiliary detectors



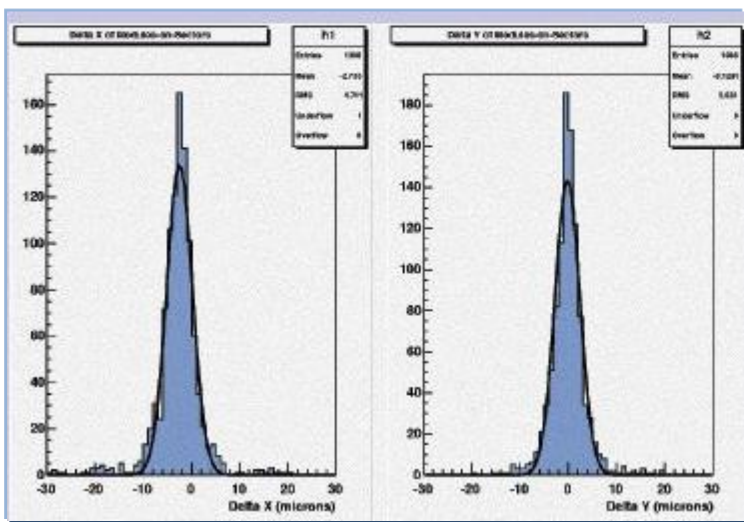
	task	detector	Lum	position
BCM	Monitor beam, lumi	Diamond sensors	10^{27}-10^{34}	1.8
MBTS	MB trigger	scintillators	10^{32}	3.6
LUCID	Rel lumi	cerenkov	10^{27}-10^{34}	17
Alpha	Abs lumi	scintillating fibre trackers	10^{27}	240
ZDC	centrality of heavy-ion collisions	quartz rods, W plates		140

ID commissioning: alignment

✓ Strategy:

- Verify using MC that misalignments can be recovered
- Start from the survey data during integration and installation.
- Use the hardware alignment when available (SCT)
- Track based alignment (from collision and cosmics)

Measurement precision (optical) ~ 1μm
Positioning precision < 3 μm
⇒ Constrain nearby modules on rigid body in alignment

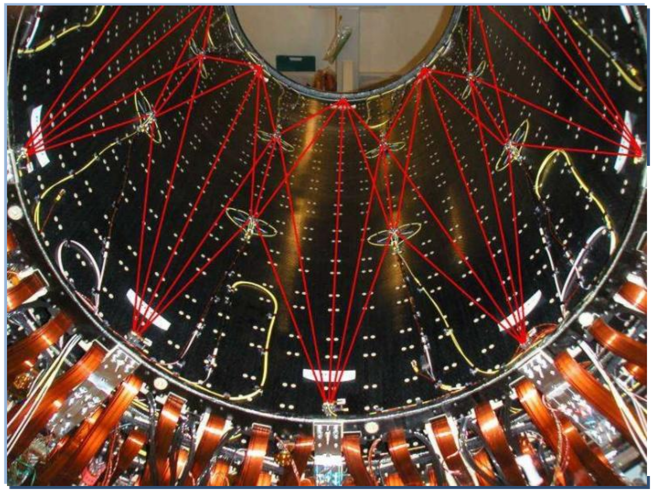


ysical signals

ID commissioning: alignment

✓ Strategy:

- Verify using MC that misalignments can be recovered
- Start from the survey data during integration and installation.
- Use the hardware alignment when available (SCT)
- Track based alignment (from collision and cosmics)



SCT: Frequency Scanning Interferometry:

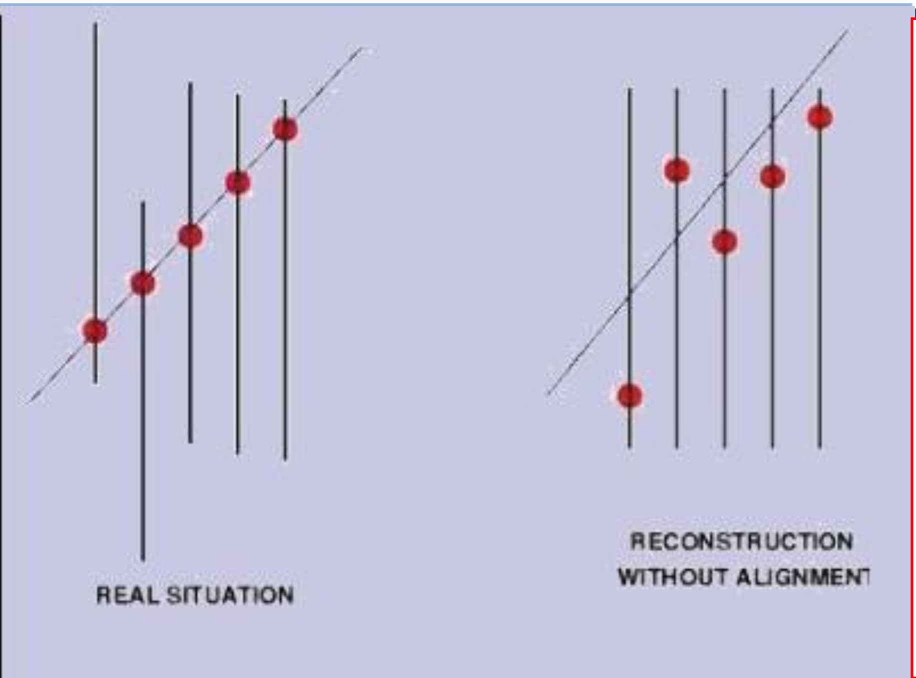
✓Precision of ~1 μm

✓Monitoring vs time of deformations

❖No absolute position measurement

ID commissioning: alignment

- ✓ Strategy:
  - Verify using MC that misalignments can be recovered
  - Start from the survey data during integration and installation.
  - Use the hardware alignment when available (SCT)
  - Track based alignment (from collision and cosmics)

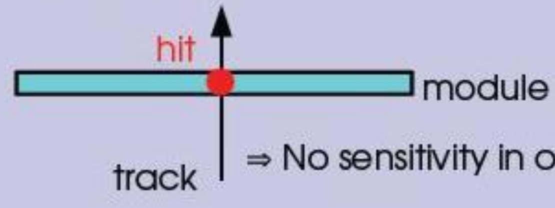


✓ The alignment procedure focuses on minimizing residuals (distance from track to hit).
✓ There are “weak modes” where the residuals are fine but the track parameters are biased. For example they will lead to a wrongly measured track pT
✓ Residuals are fine but not enough: also needed physical quantities, different topologies, redundancy,..

"Weak Modes"

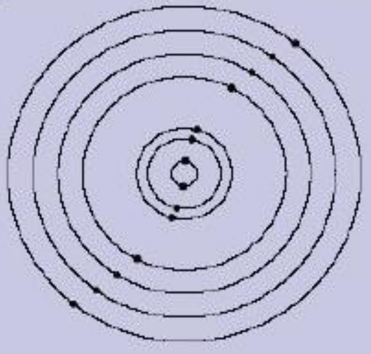
Minimizing residuals is necessary but not sufficient
Weak modes: systematic deformatins, track χ^2 ~ unchanged, track parameters biased
⇔ tracks are fitted to WRONG helices

Example 1:



⇒ No sensitivity in out-of-plane direction

Example 2:
Barrels rotated about symmetry axis ~ radius
⇒ p_T bias (charge dependent)

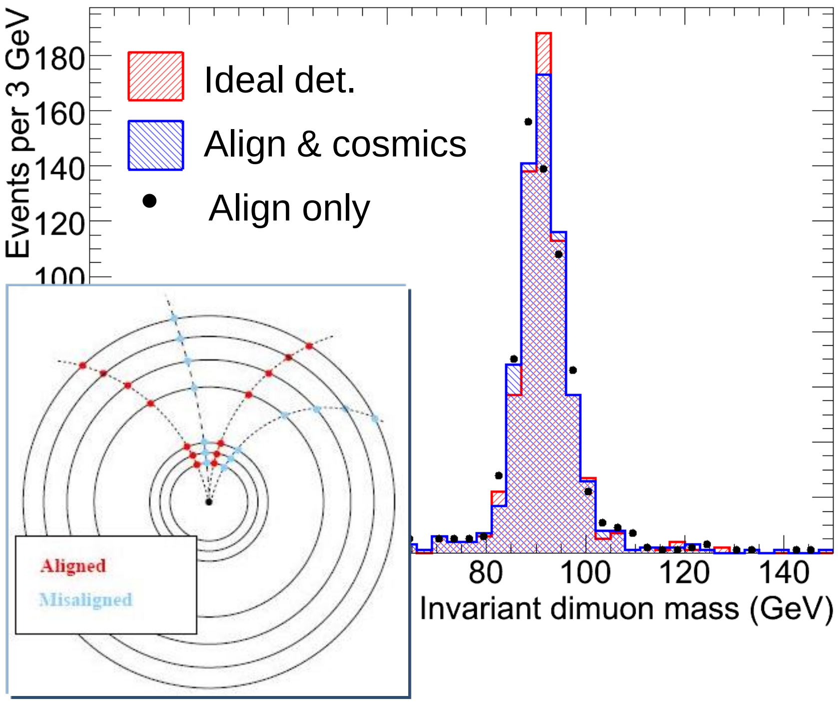


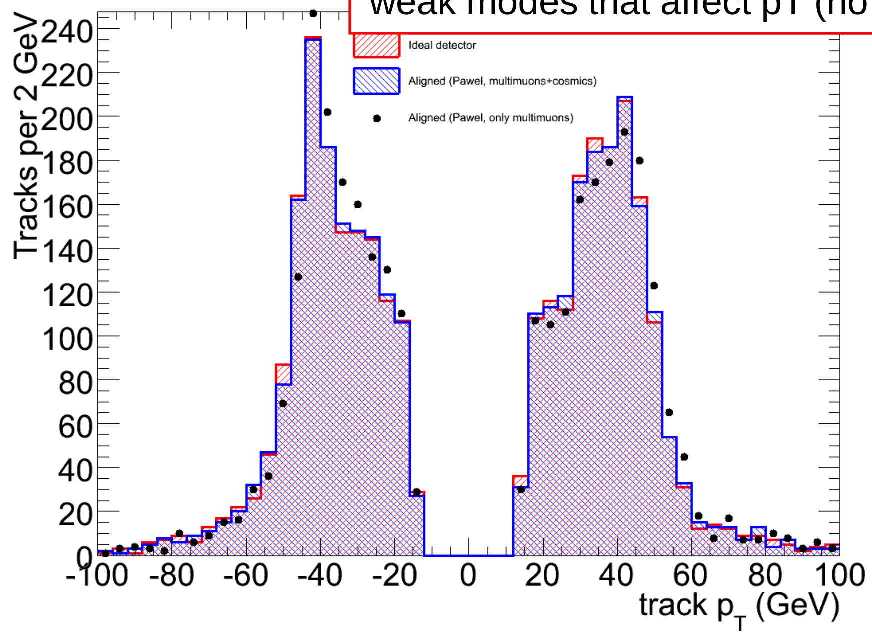
Example 3: "Telescope mode"
Barrels translated along beam ~ radius
⇒ η, z_0 bias

⇒ Residuals alone not good enough!
- Physics quantities, e.g. mass, vertex constraint
- Different event topologies: Off-axis cosmics, beam halo
- Redundancy (TRT, muon spectrometer, EM calorimeter)
- Survey

ID commissioning: alignment

Cosmics useful to solve
weak modes that affect pT (no Mμμ)





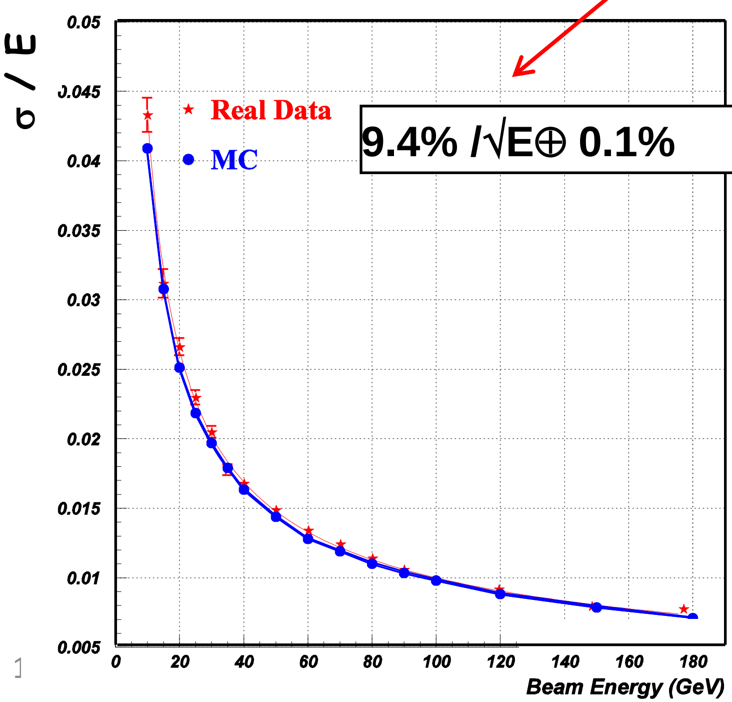
- Validation with physical signals (Z->μμ,..)
- For the time being check with on-surface data
  - SCT and TRT Barrel
  - Pixel Endcap

LAr FEB Refurbishing

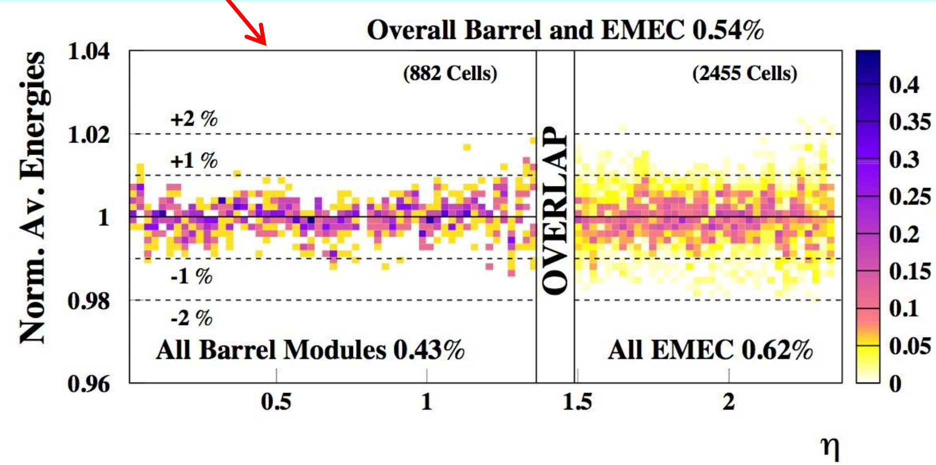
- ✓ Two errors in the FEB schematics were discovered:
  - missing voltage-level adaptation between some DMILL and DSM components
  - consequence is overstressing of components, reducing their lifetime
  - no failures observed yet, but LAr decided to repair all ~1600 FEBs (as a precaution)
- ✓ Take the opportunity to also:
  - Fix the time constants of all shapers
    - cutting fuse pins according to time constants obtained during burn-in
    - solves a stability problem observed on a few per mille of all shapers
  - Inspect and clean boards with severe corrosion damage caused by improper repairs performed by a subcontractor during the analog-testing phase in 2006

LAr Test beam Performances (spare)

- 4 (out of 32) barrel modules and 3 (out of 16) end-cap (EMEC) modules tested with beams.
- Goal *local resolution of 9.4% / √E⊕ 0.1% and overall response uniformity 0.7%*



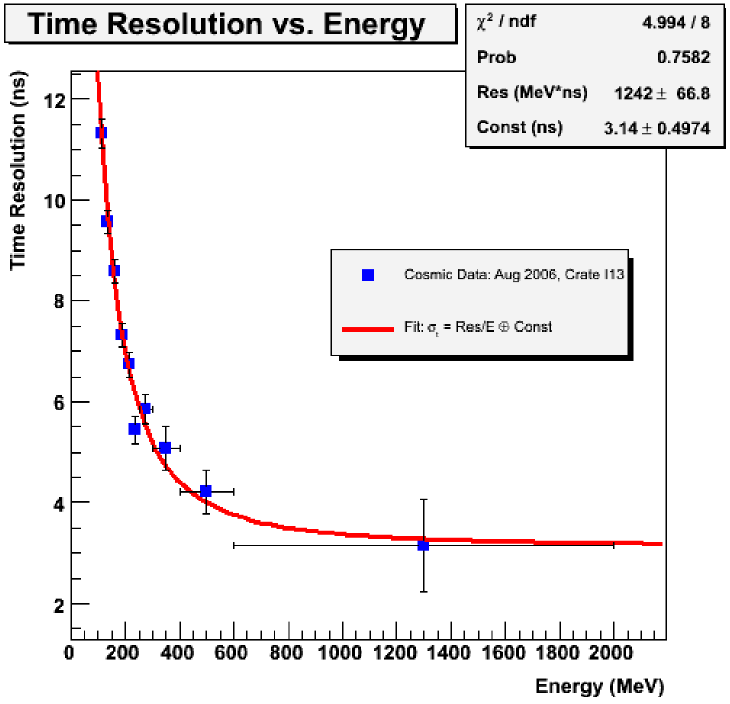
Scans with 120-245 GeV electrons (7 tested modules)

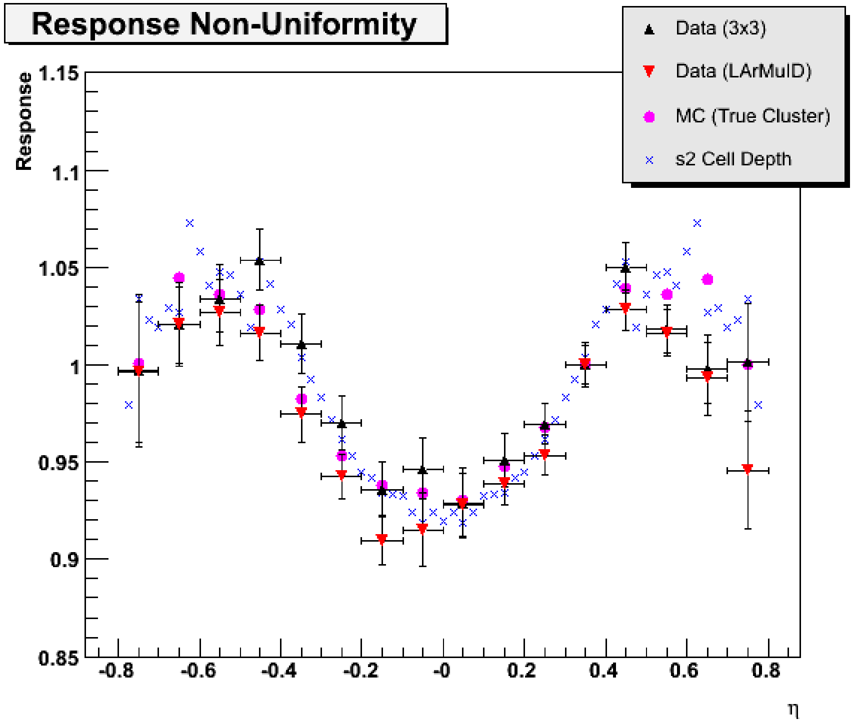


Electron Energy resolution measured in beam tests of the ATLAS EM accordion calorimeter (Pb/LAr)

LAr Commissioning: cosmics (spare)

Most probable energy value vs η (normalized)





Time resolution is consistent with test beam data once the Tile uniformity and resolution are taken into account

Tile status (I)

Reminder of 3 Main Drawer Problems

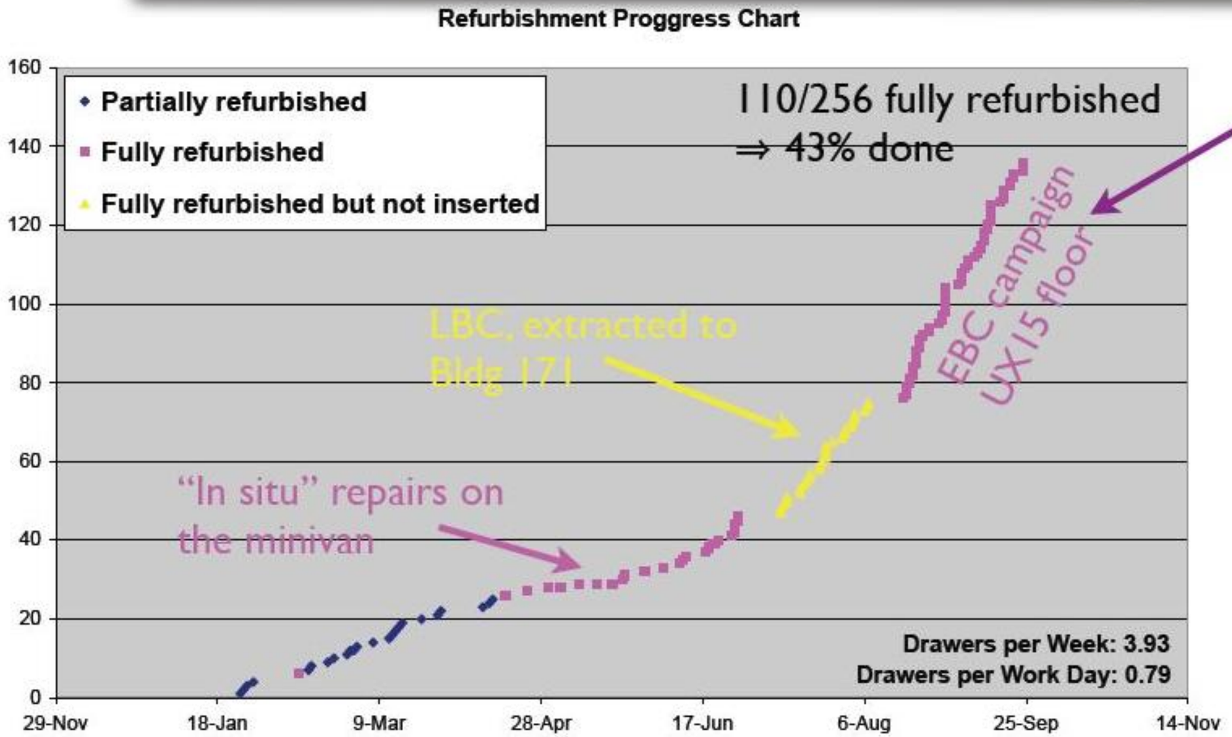
- Significant voltage drops between LVPS and electronics PCBs
  - MB power connectors. Implementing screw terminals.
  - Digitizer power connectors. Implementing screw terminals.
  - Harting connectors bad solder. Mechanical check and fix.
- Digitizer-to-digitizer flex foil connections
  - Connections are fragile
  - Very hard to troubleshoot

    New foils with correct impedance are now being installed
  - Sensitive to mechanical pressure. "Collars" installed.
- HV discharges and trips
  - Reduced by flowing dry air through drawers, but not eliminated.
  - Capton flexfoils between inner & outer drawers show C tracks.

    Each is scrubbed and coated.

Tile status (II)

Refurbishment Progress



Intense campaign with dedicated effort from Tile, supported by TC.

Big "Thank You" to everyone involved!

- LBC: 43/64 drawers fully refurbished.
  27 repaired in Bldg 171, waiting for access ≥ December to re-insert.
- LBA: 6/64 drawers fully refurbished
  To continue ≥ December after BT tests.
- EBC: 61/64 drawers fully refurbished. DONE
  Extracted to level 0 in UX15 where repairs were done. All finished within 6.5 weeks.
- EBA: Similar campaign to EBC.
  Started last Wednesday. If can't finish by ECT test, transport to Bldg. 171 during November.

Tile Status (III)

Low Voltage Power Supplies

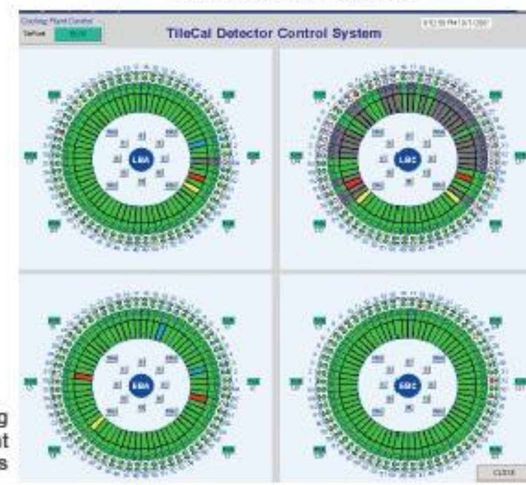
Status

- **88% of TileCal modules now have running fLVPS with final modifications**
- **Remaining 12% ready to be inserted when superdrawers go back after refurbishment**
- **Repair of PCBs continues for assembly of spare LVPS boxes**
- **Expect to produce up to 285 fLVPS by December; *i.e.*, about 10% spares. Additional spare bricks are in pipeline**

Experience with fLVPS in PIT

- **Requirements for modified power supplies have been met well by the modifications**
- **Stable operation for most power supplies**
- **10% of installed LVPS boxes have needed repair**
  - ***PCBs have been challenged by modification work***
  - ***Most problems within first month (infant mortality), but not all.***

fLVPS online status



Green = running
Grey = SD extracted for refurbishment
Innermost circle present HV power supplies

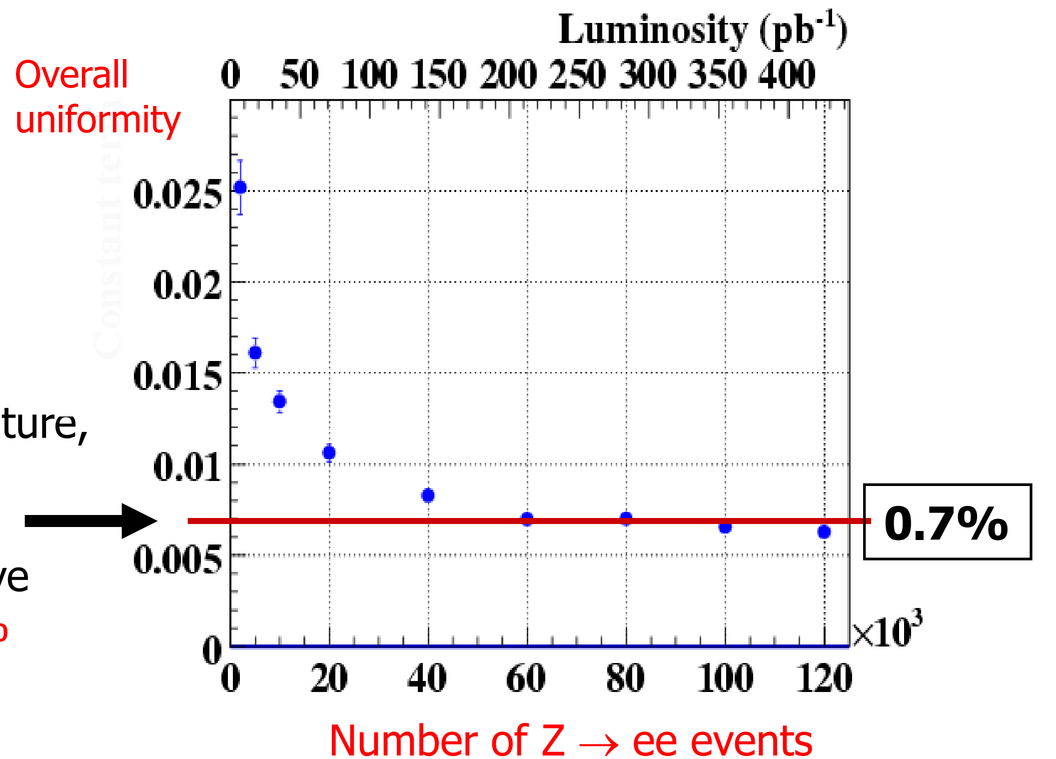
Expected calo perf at day 0 (spare)

(examples)	Expected performance day-0	Physics samples for improvement
ECAL uniformity	1-2% (~0.5% locally)	Isolated electrons, $Z \rightarrow ee$
e/γ E-scale	~ 2 %	$Z \rightarrow ee$
HCAL uniformity	~ 3 %	Single pions, QCD jets
Jet E-scale	< 10%	γ/Z + 1j, W $\rightarrow$ jj in tt events

ECAL calibration:

use Z-mass constraint to correct residual long-range non-uniformities (module-to-module variations, temperature, effect of upstream material, etc.)

~ 10^5 $Z \rightarrow ee$ events enough to achieve the goal response uniformity of ~ 0.7%



Toroidal magnetic field: parameters

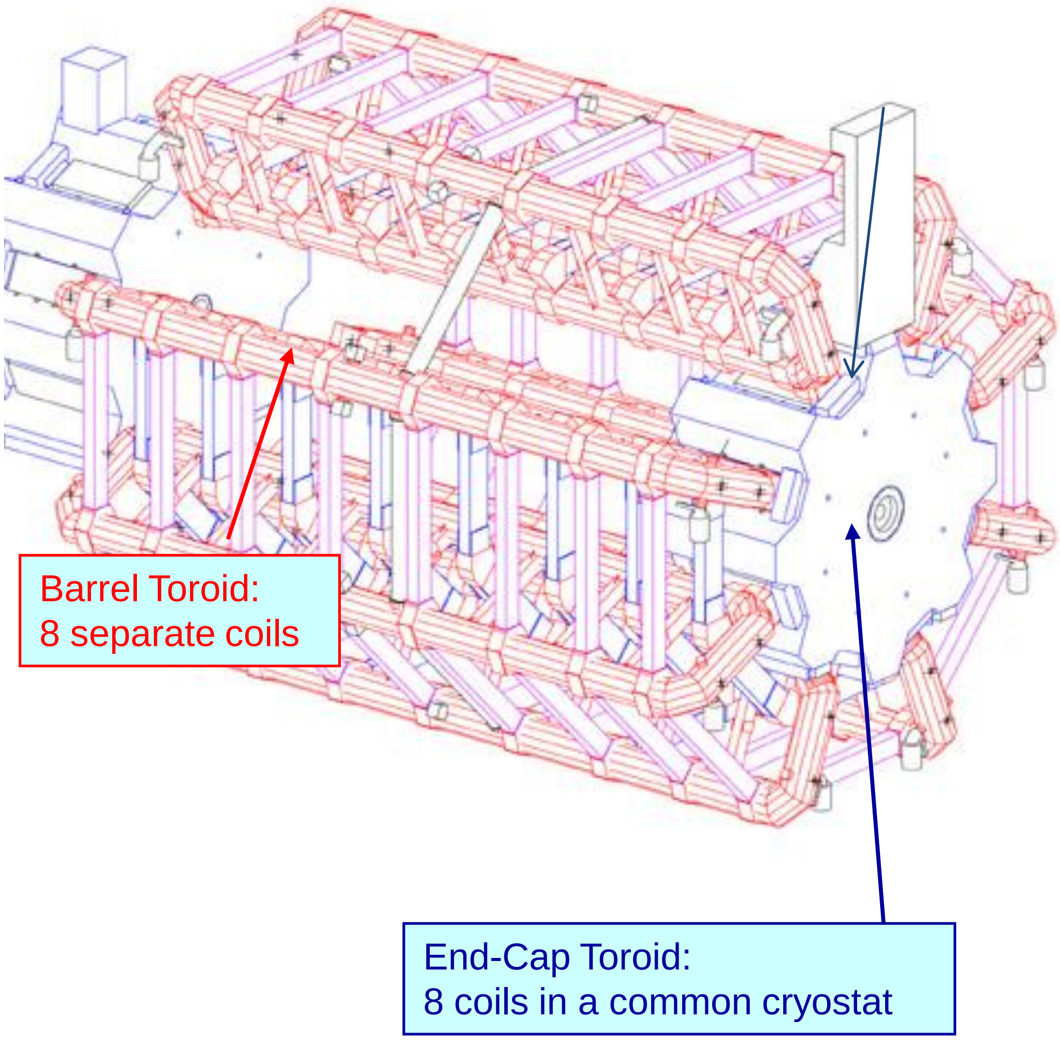
Field coverage:
$|\eta| < 1.4$ Barrel toroid
$1.4 < |\eta| < 1.6$ Barrel + EC toroids
$1.6 < |\eta| < 2.7$ EC toroids

Barrel Toroid parameters

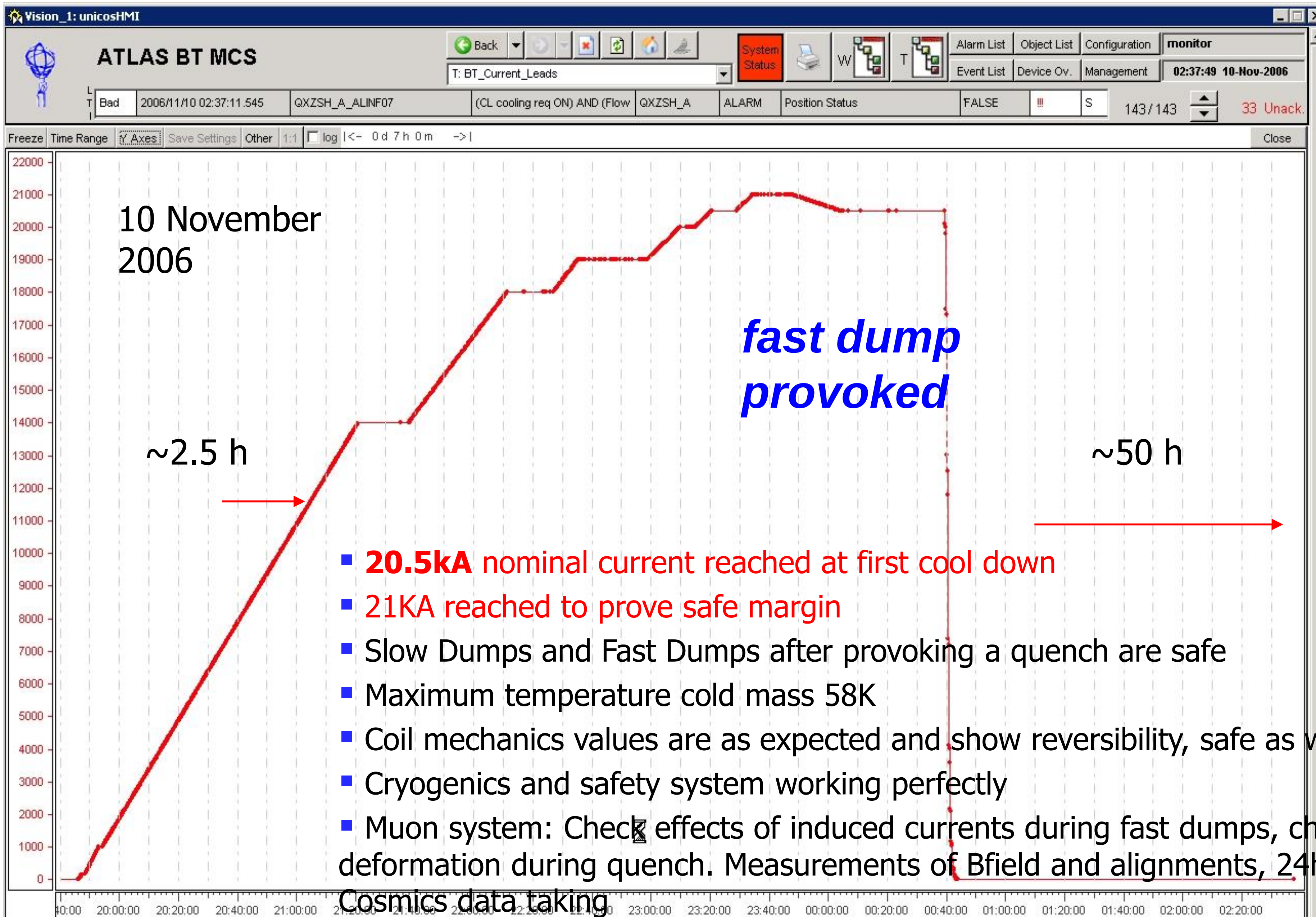
- 20.1 m diameter x 25.3 m length
- 1.08 GJ stored energy
- 118 t superconductor
- 370 t cold mass
- 830 t total weight
- 56 km conductor
- 20.5 kA at 4.6 K

End-Cap Toroid parameters

- 10.7 m diameter x 5.0 m axial length
- 2 x 0.25 GJ stored energy
- 2 x 20.5 t superconductor
- 2 x 140 t cold mass
- 2 x 239 t total weight
- 2 x 13 km conductor
- 20.5 kA nominal current at 4.6 K



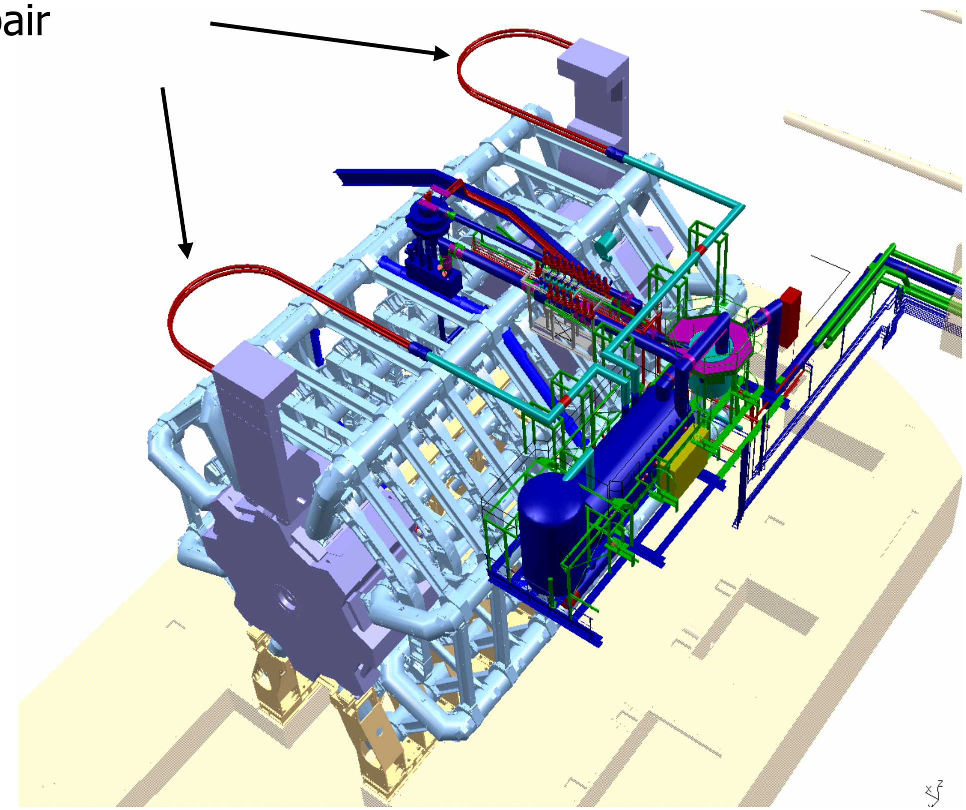
Barrel Toroid Test



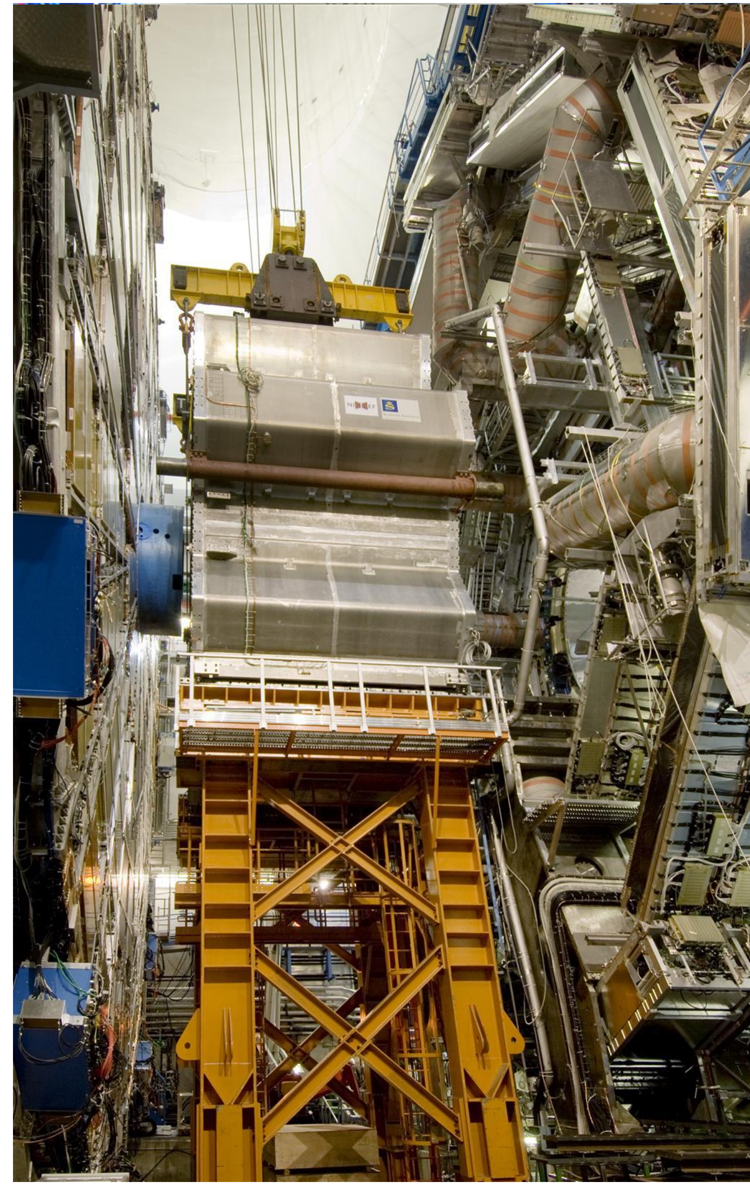
- **20.5kA** nominal current reached at first cool down
- 21KA reached to prove safe margin
- Slow Dumps and Fast Dumps after provoking a quench are safe
- Maximum temperature cold mass 58K
- Coil mechanics values are as expected and show reversibility, safe as well
- Cryogenics and safety system working perfectly
- Muon system: Check effects of induced currents during fast dumps, check deformation during quench. Measurements of Bfield and alignments, 24h Cosmics data taking

The End-Cap Toroids

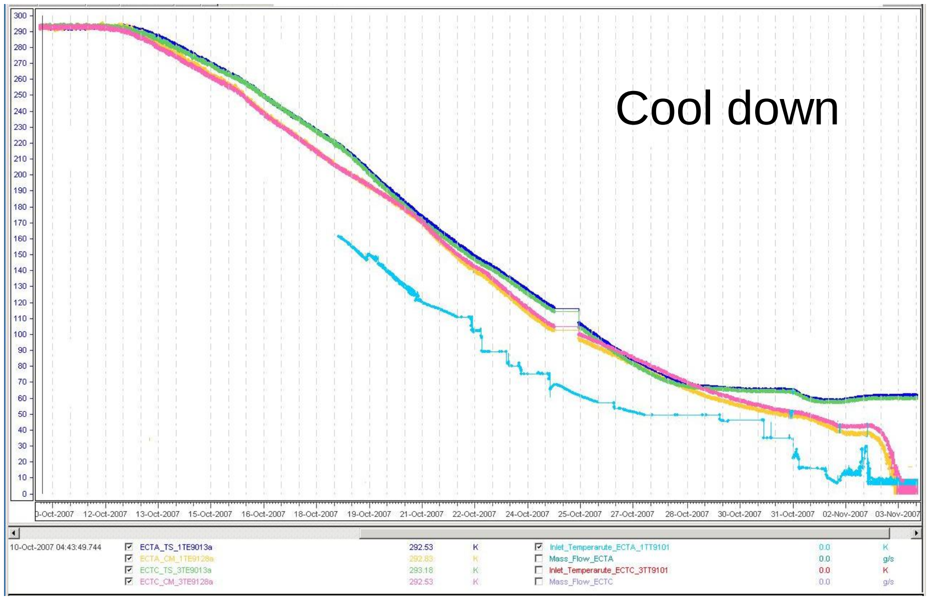
Flexible service lines as ECTs have to be moved to access calo and ID for maintenance and repair

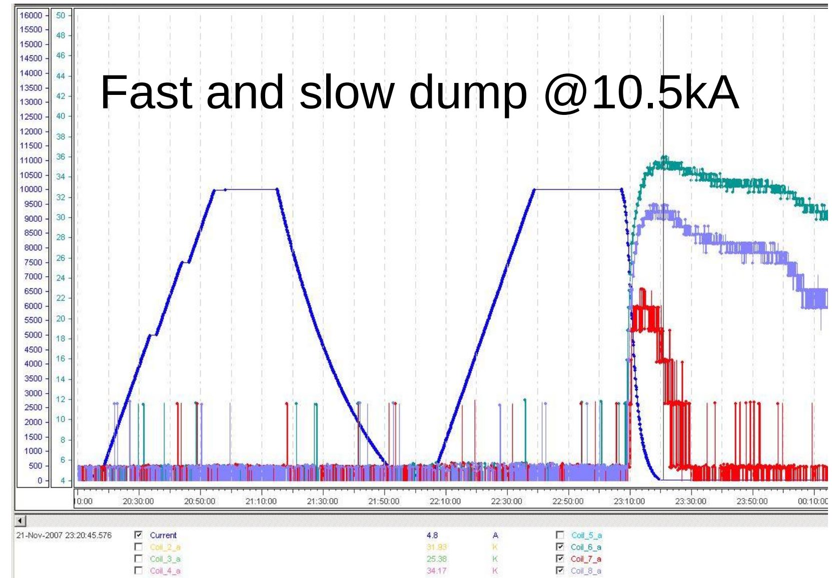


Last one smoothly inserted in the cavern on 12 July 2007



End-Cap Toroids test

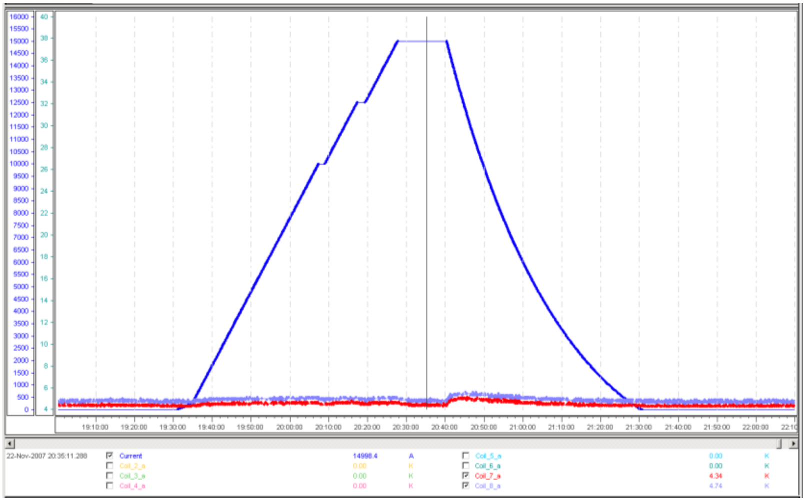




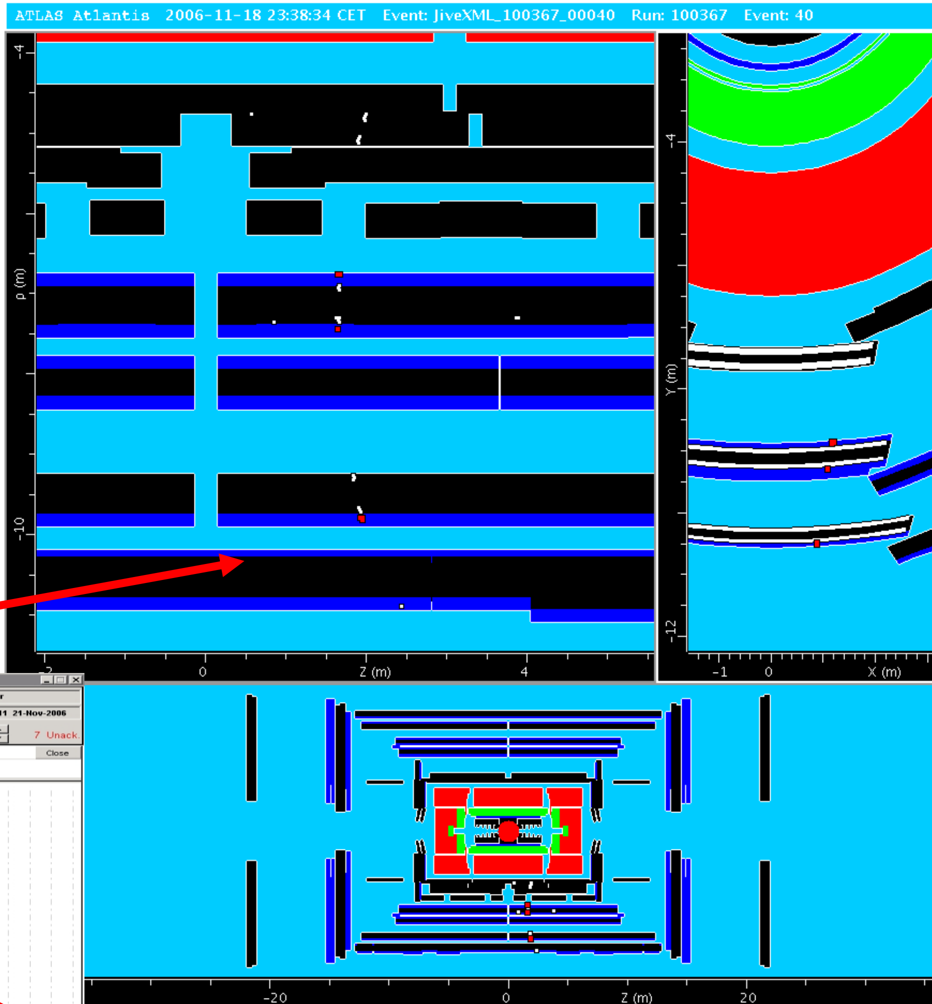
- Cool down of ECT A&C in parallel completed within 5 weeks (cold mass at 4.6 K)
- Test with ECT in temporary position with extra gap of 176mm separated from the BT (to allow access during the test period)
- ECT tests done in non-standard configuration which showed a failure in the toroid blocking jacks fixation (20t measured < 70t sustainable, but ECT C moved anyway), needs to be reinforced
- Tested ECT-A and ECT-C separately: 10 kA SlowDump+FastDumps.
- Postpone 15-21kA test to Spring, Then ABC test.

ECT displacement, what happened (superspare)

- ✓ At 14.8 kA ECT moved towards TC/ECC
- ✓ Damage to ECC:
  - LiAr transfer line outer shell squeezed
  - insulation vacuum partly broken
  - Li Arg in line removed, ECC emptied
  - brought into safe condition
- ✓ Damage to ECTC:
  - blocking jacks connection damaged
  - needs to be removed and reinforced
- ✓ Next is to move the ECTC back and do the repairs
- ✓ We measured ~20 t on AFT rods
- ✓ Blocking jacks connection/friction was considered to sustain 70-90 t
  (0.20-0.25 x 340 t = 70-80 t)
- ✓ There was no spacer in between ECTC and TC so it could move



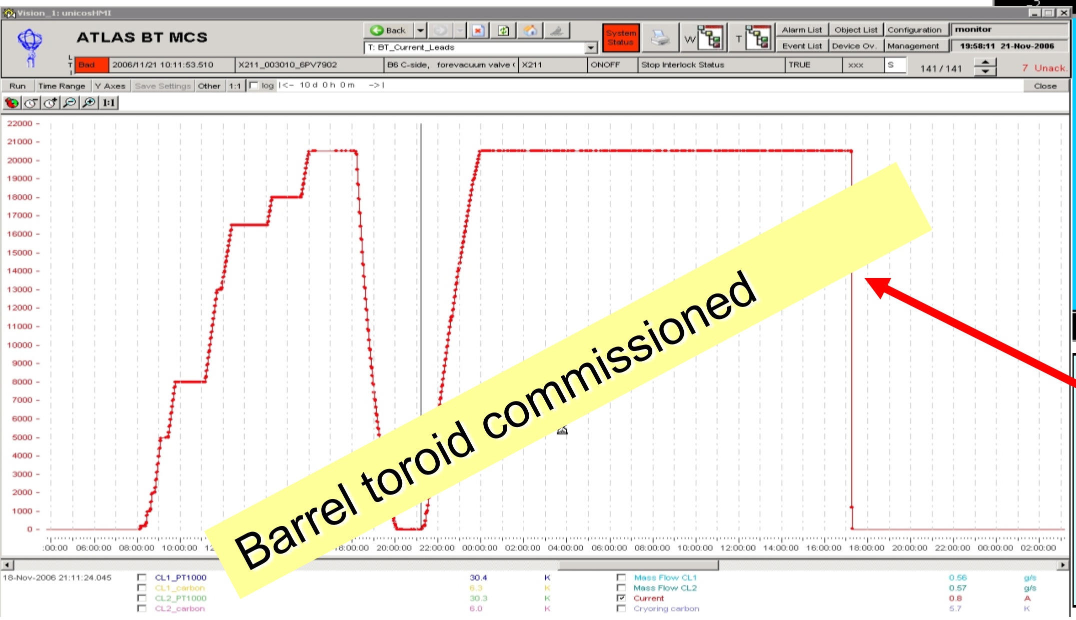
Cosmics with Barrel Toroid Field



18-19 November: 24 h test of Toroid Barrel

>20 h of cosmic ray data taking with the muon chambers of sect 13

- (3BIL+ 3BML+ 3BOL) MDT+RPC+LVL1
  - Data taken with field on, off and at different values
  - 1ME events collected
- The first muon track with magnet on triggered by the RPCs!!



A new provoked quench with FD

→All OK!!

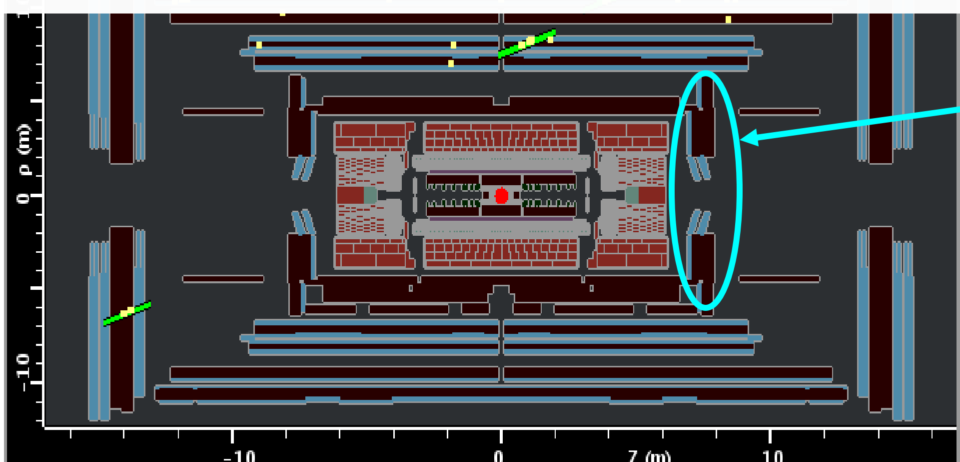
→ A major achievement for all the muon community!!

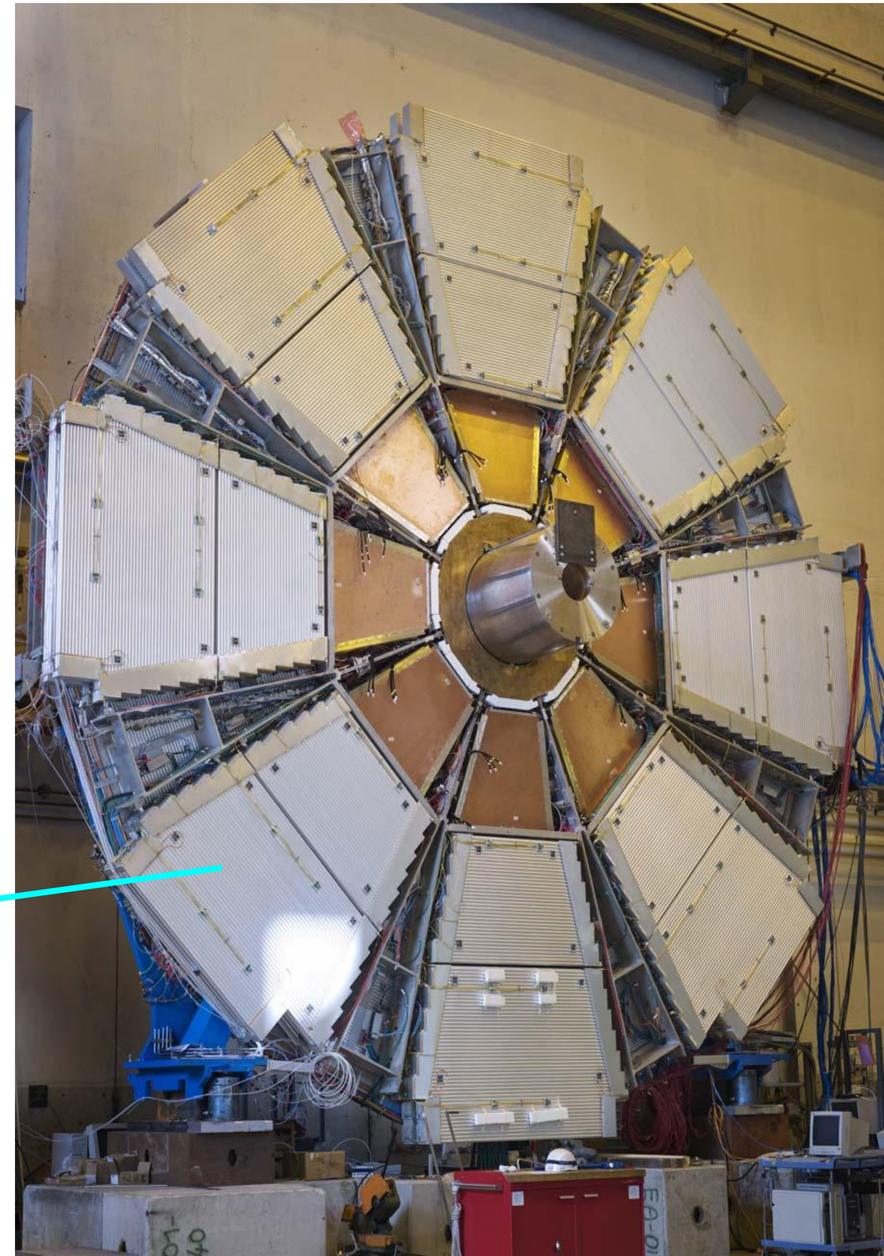
Forward Muon (Small Wheels)

- ✓ Still on surface and being prepared for installation during December/January

- ✓ Once in position they will stop most of the access activities to the inside of the detector. Therefore they have been left as last element to be installed, just before closing

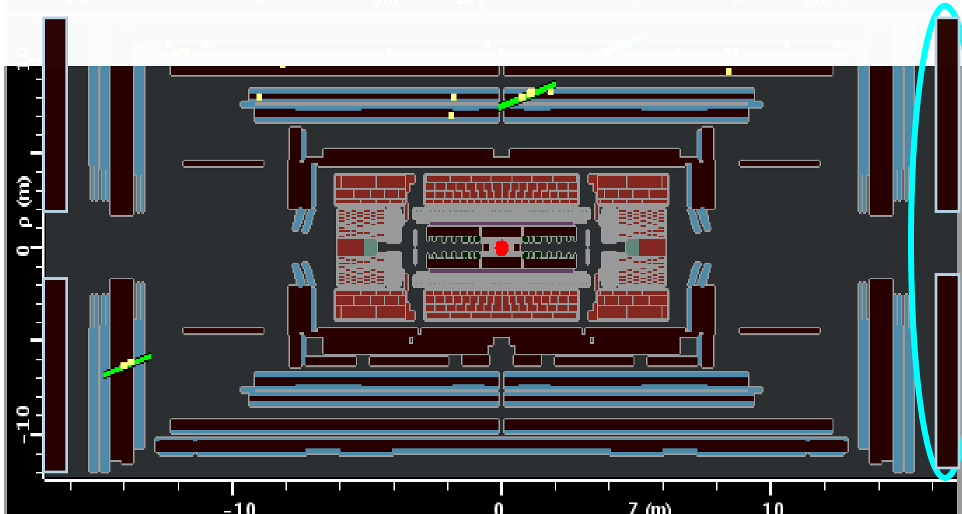
- ✓ Some of these chambers are designed for high rate and are the closest to the beam line (CSC)

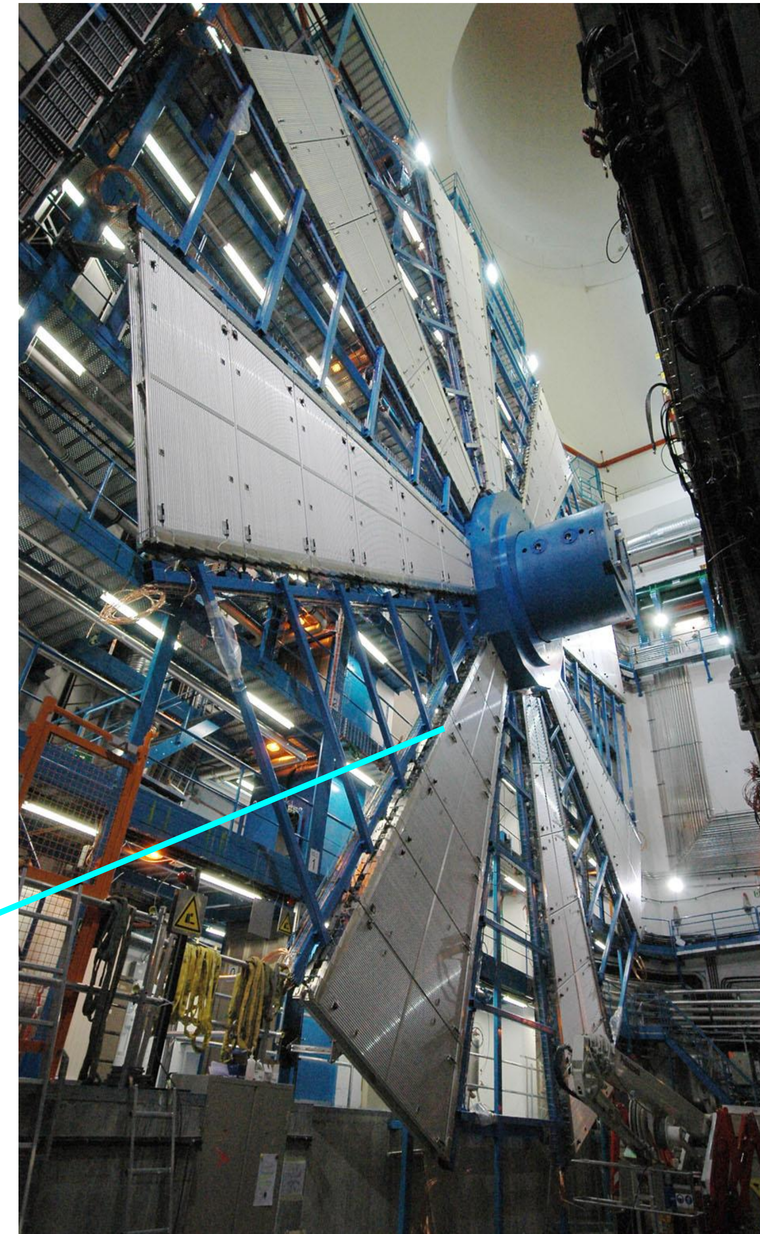




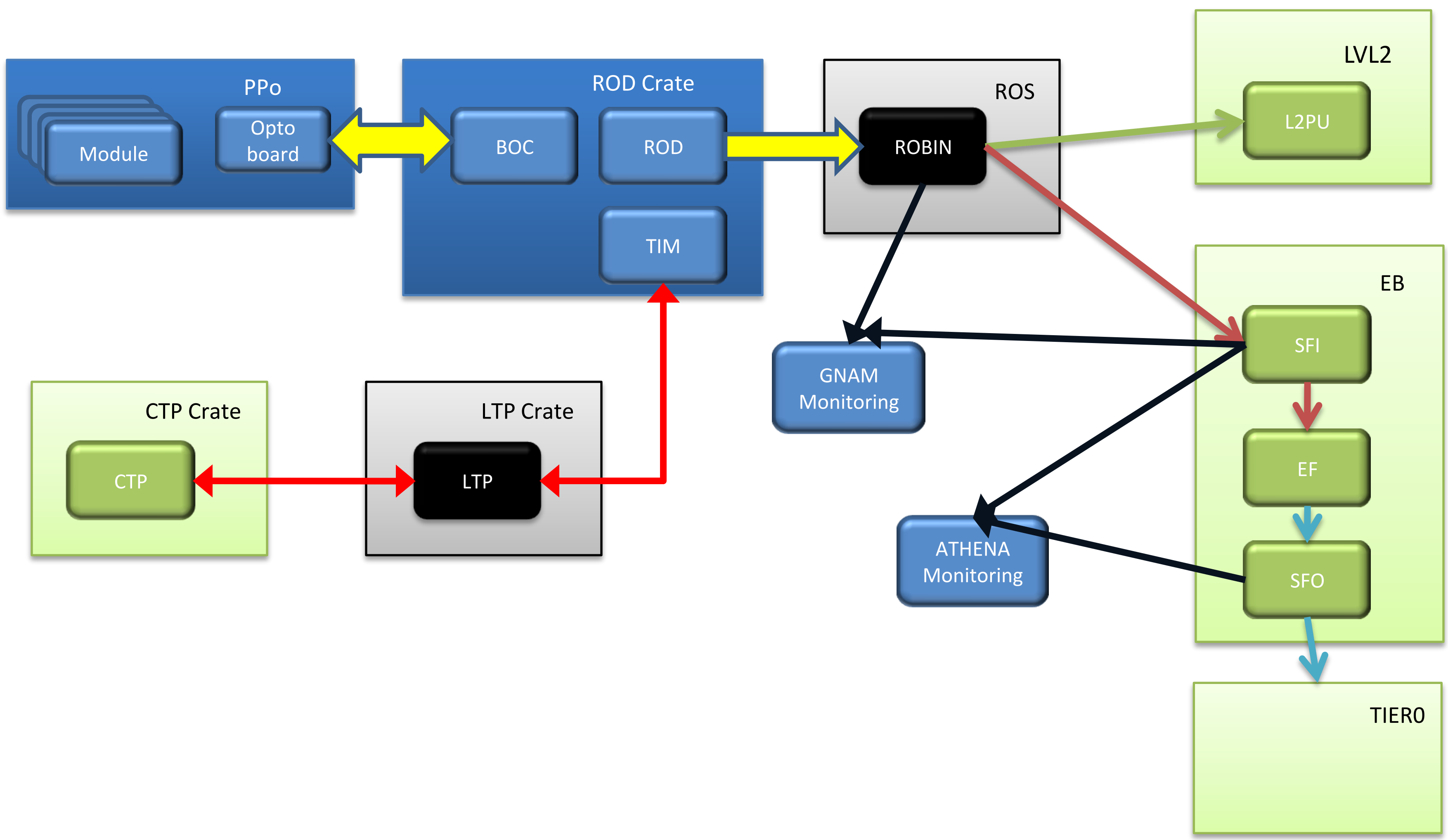
Forward Muon Spectrometer (EO Wheels)

- ✓ Last large mechanical assembly we are installing
- ✓ It covers the end wall of the cavern with precision chambers (MDT), too big to be sectorized on surface. We are installing it in situ piece by piece
- ✓ It will close the alignment system with large bars that will link all projective rays.





Global Data Taking (ATLAS)spare



Efficiencies Spare just for me

pixel (*)	Fe or Module	total	comment
0.29	0	0.29	
0.20	0.20	0.40	1 module dead (no HV)
0.07	0	0.07	
0.12	0	0.12	
0.11	2.08	2.19	1 Module dead (ck-VDD short)
0.18	0.13	0.31	FE AVDD short
0.14	0	0.14	
0.10	0.13	0.23	FE AVDD short
0.26	0.13	0.39	FE C dead

TRT part	Dead channels Mech.,Electr., HV	Gas Ar/CO2 since	HV
Barrel	1.8% (A) 2% (C)	March 2007	~5 months
EC-A	1.7%	August 2007	~ few weeks
EC-C	1.2%	Sept. 2007	~ few weeks

SCT: overall ~0.25% problematic channels out of 6 10^6 channels

Lar A complete map of dead cells has been extracted from electrical measurements [3] and concerns
less than 0.02% of the cells