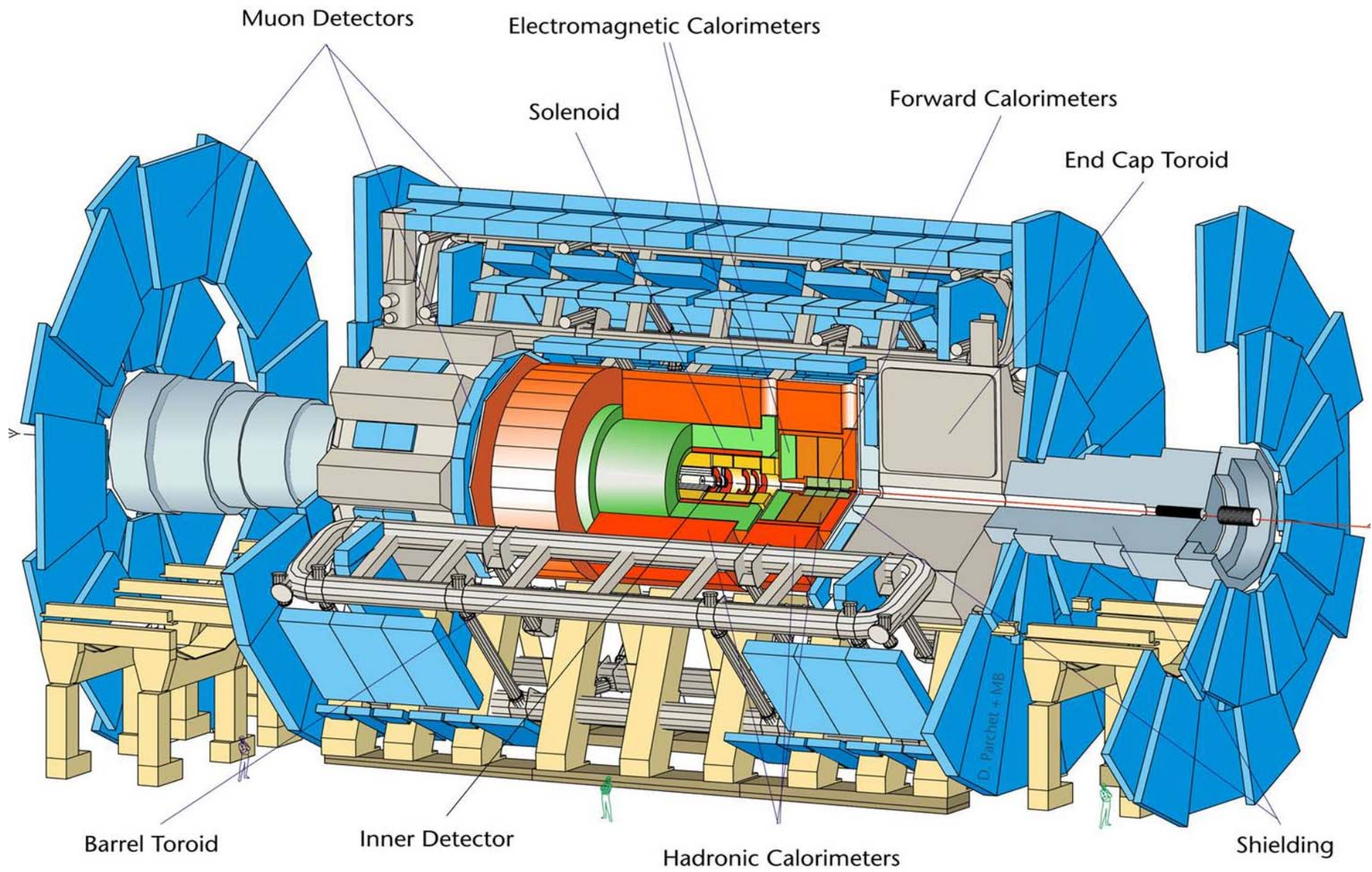


ATLAS progress report

Physics at LHC, 14 July 2004

M. Nessi, CERN

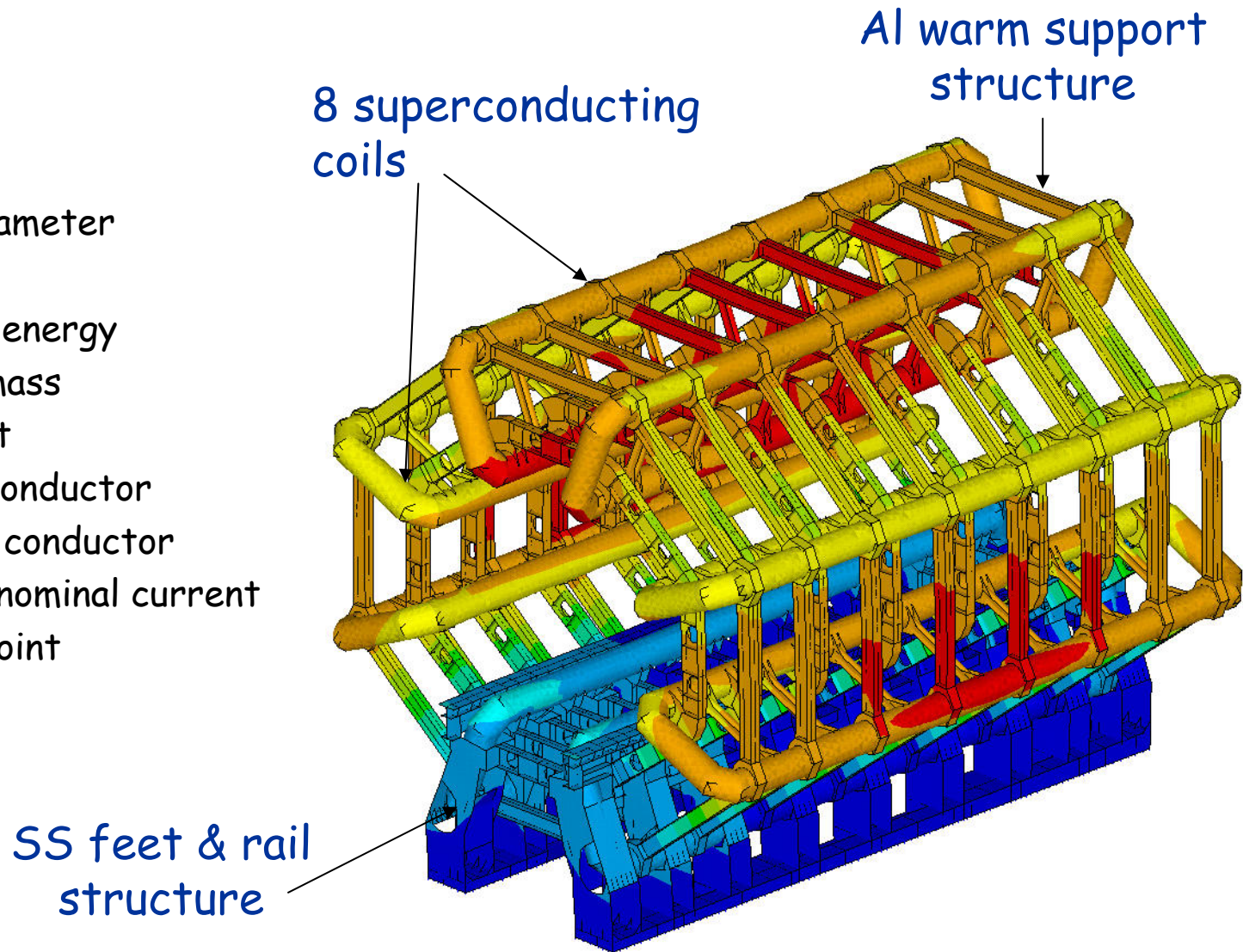




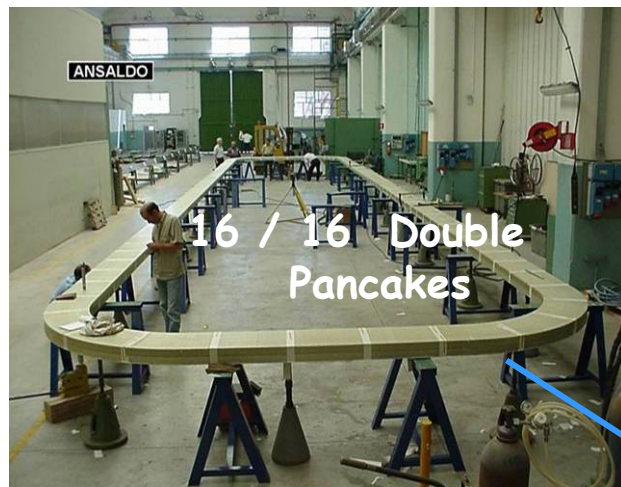
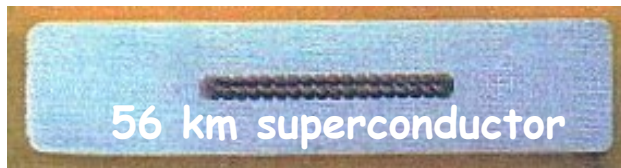
ATLAS Barrel Toroid (BT)

BT Parameters:

- 25.3 m length
- 20.1 m outer diameter
- 8 coils
- 1.08 GJ stored energy
- 370 tons cold mass
- 830 tons weight
- 118 tons superconductor
- 56 km Al/NbTi conductor
- 20.5 kA @ 4 T nominal current
- 4.5 K working point



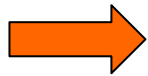
ATLAS BT: all components manufactured



ATLAS BT assembly status

✓ For *~9 months* the heat shield has been ATLAS' major problem, large delays in the delivery of components (N₂ cooling pipes welding problem)

✓ Effective solution found in early 2004



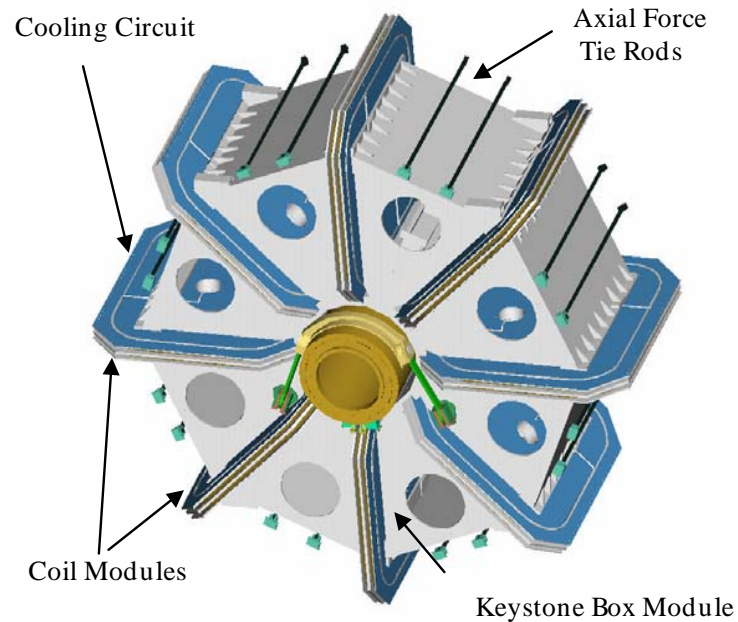
This has generated 6 months of delay in the toroid installation



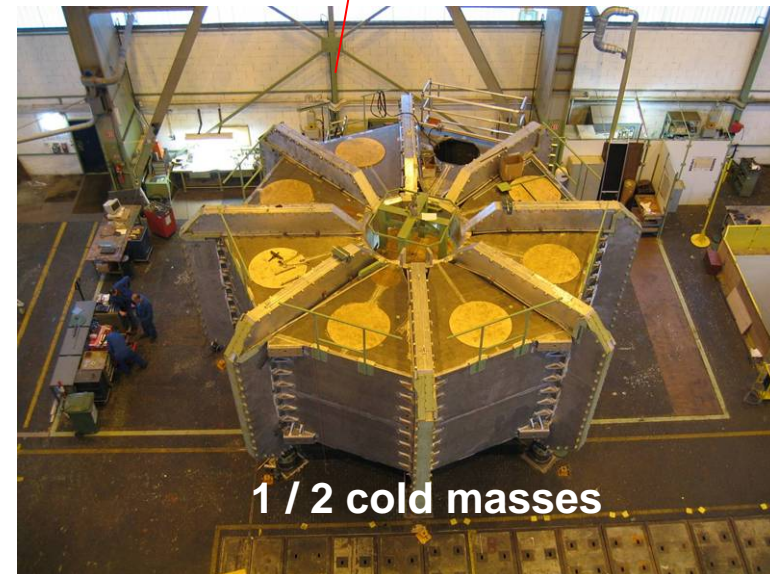
Today :

- 4 coils mechanically ready
- 2 coils in their cryostats
- 2 cryostats welded
- *First coil will be cooled down in the next days*

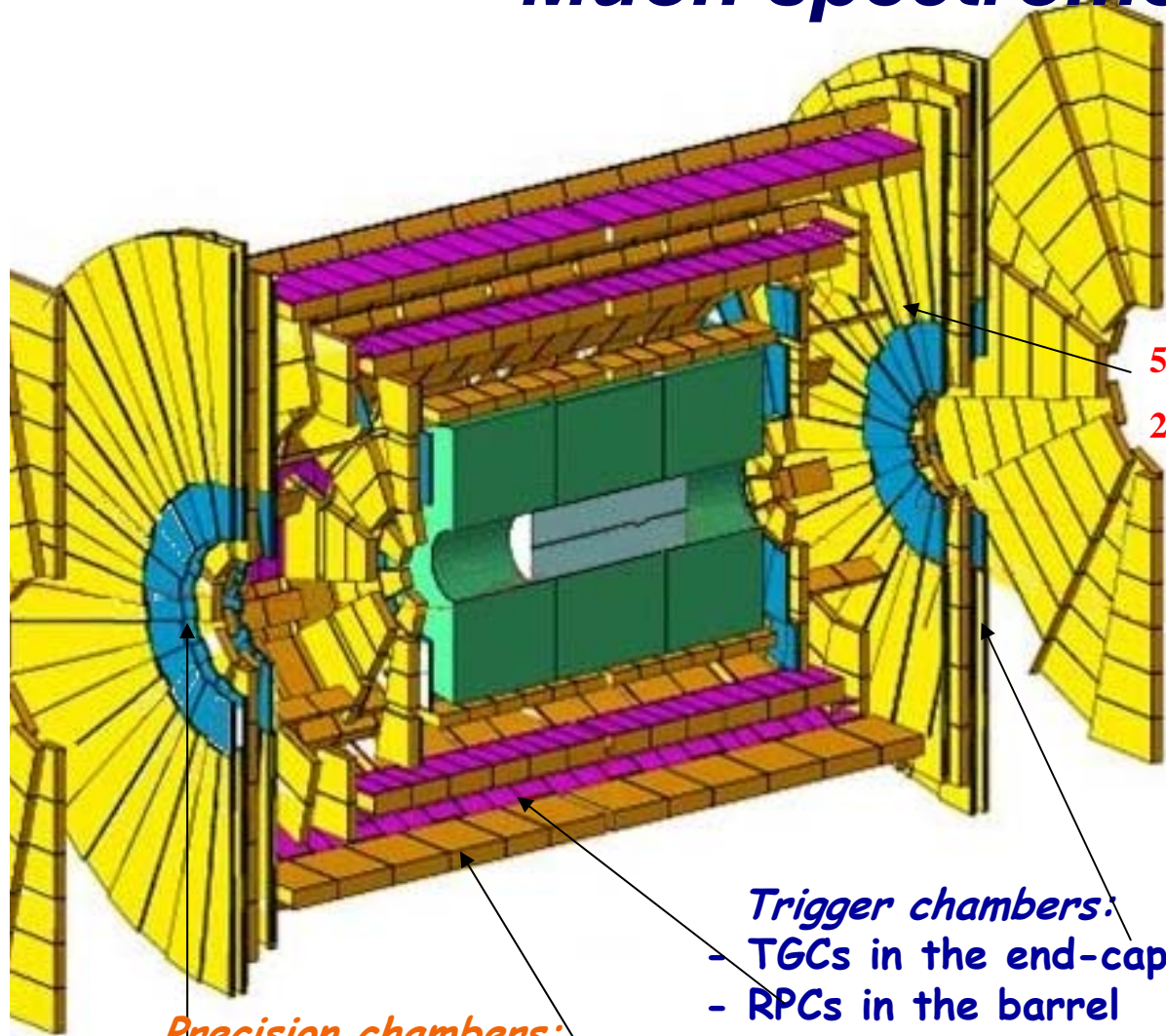
ATLAS End Cap Toroid



- ✓ *all coils wound, 10/16 impregnated, all mechanical pieces in hand, both cryostats ready*
- ✓ *financial problem with the cold mass producer, negotiations just concluded. First cold mass now traveling to CERN*
- ✓ *first coil should be ready and integrated at CERN by end 2004*



Muon spectrometer



The chambers are mounted on the coil warm structure in the barrel, large wheels in the forward

**5 x 2 Wheels,
24 m diameter**

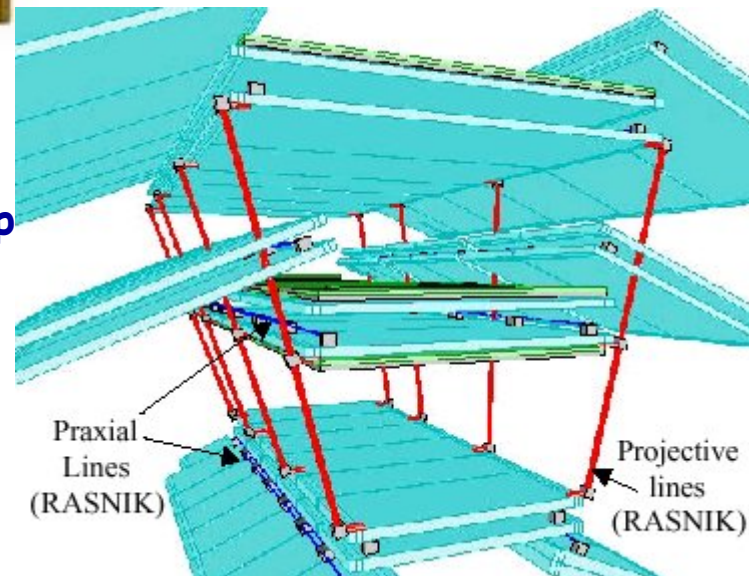
A crucial component to reach the required accuracy is the demanding alignment and monitoring system

Precision chambers:

- MDTs in the barrel and end-caps
- CSCs at large rapidity for the innermost end-cap stations

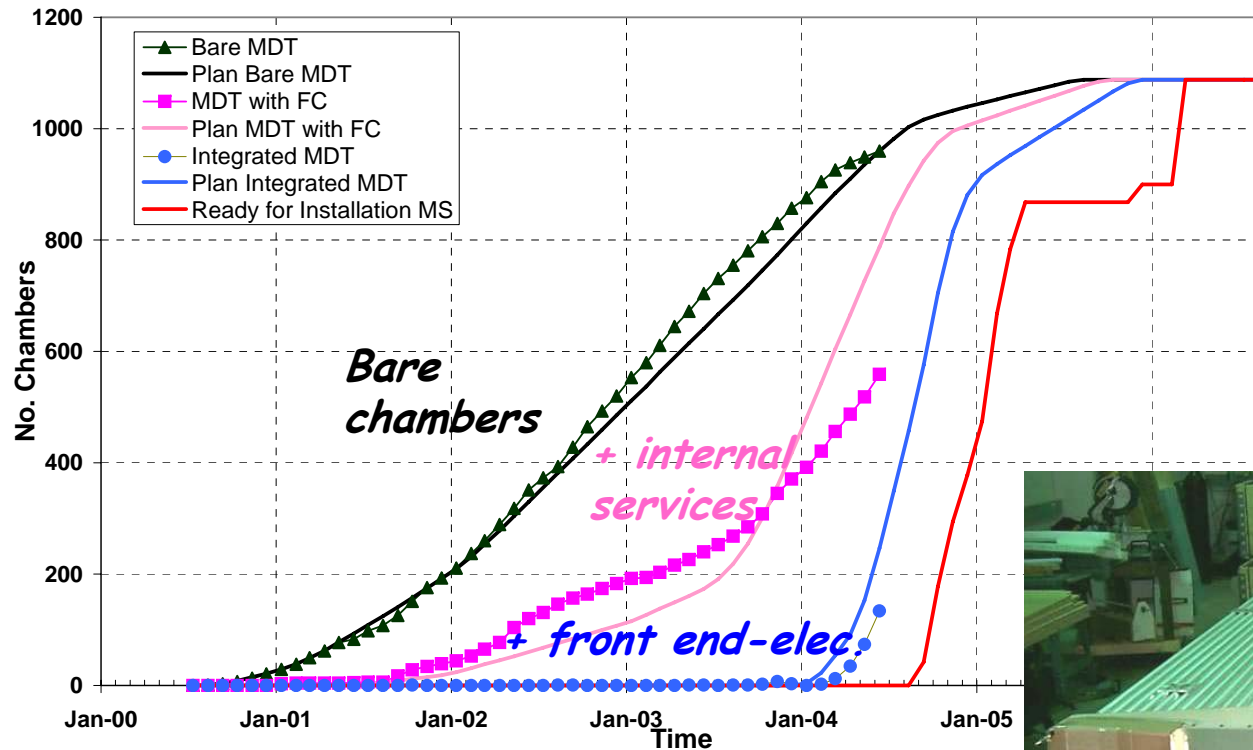
Trigger chambers:

- TGCs in the end-cap
- RPCs in the barrel



ATLAS MDT and CSC production

MDT Chamber Production (w/o EE)



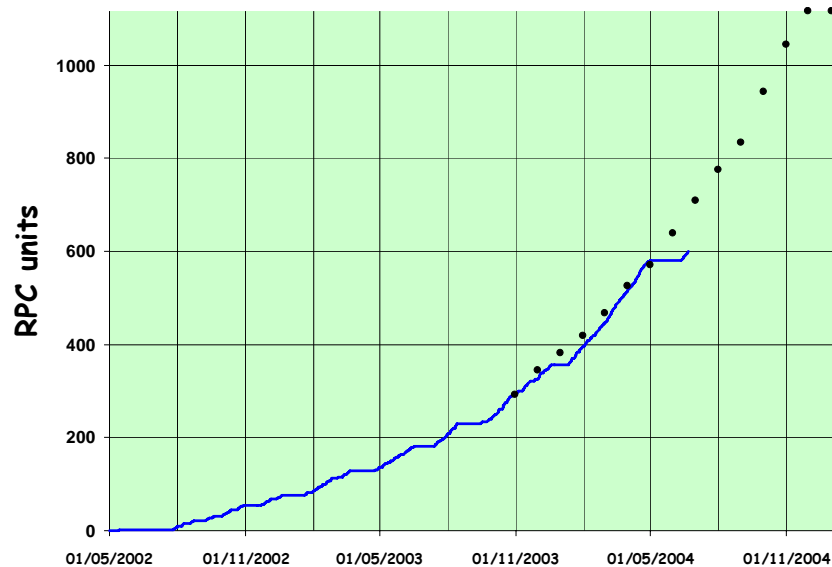
- 1088 MDT chambers needed
- 959 (88%) constructed

On the critical path: the availability of the front-end electronics



All 32 required CSC chambers have been produced !

ATLAS RPCs production



The RPC (barrel) production rate has significantly increased (and the re-work needs are much decreased)

62% of the 990 standard chambers constructed (end June '04)

A major activity is now the preparation of the final stations at CERN (1MDT + 2 RPCs)

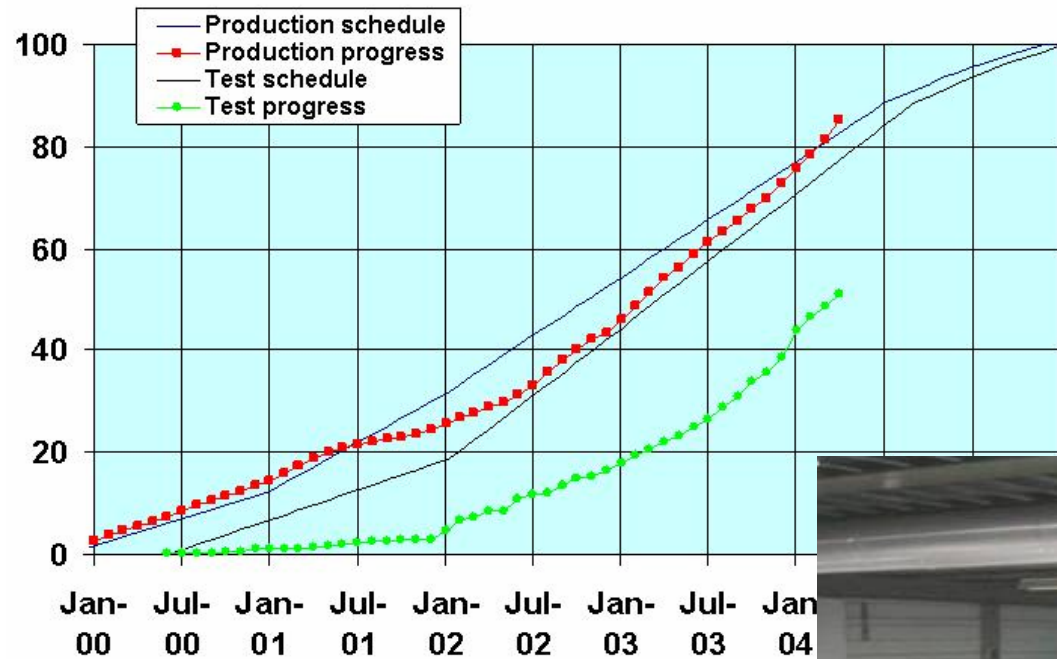
On the critical path: the availabilities of the MDT electronics and of the on-chamber trigger electronics for the RPCs

MDT (BML-D type) sandwiched between the two RPC trigger stations



ATLAS TGCs production

TGC production & test: schedule and progress



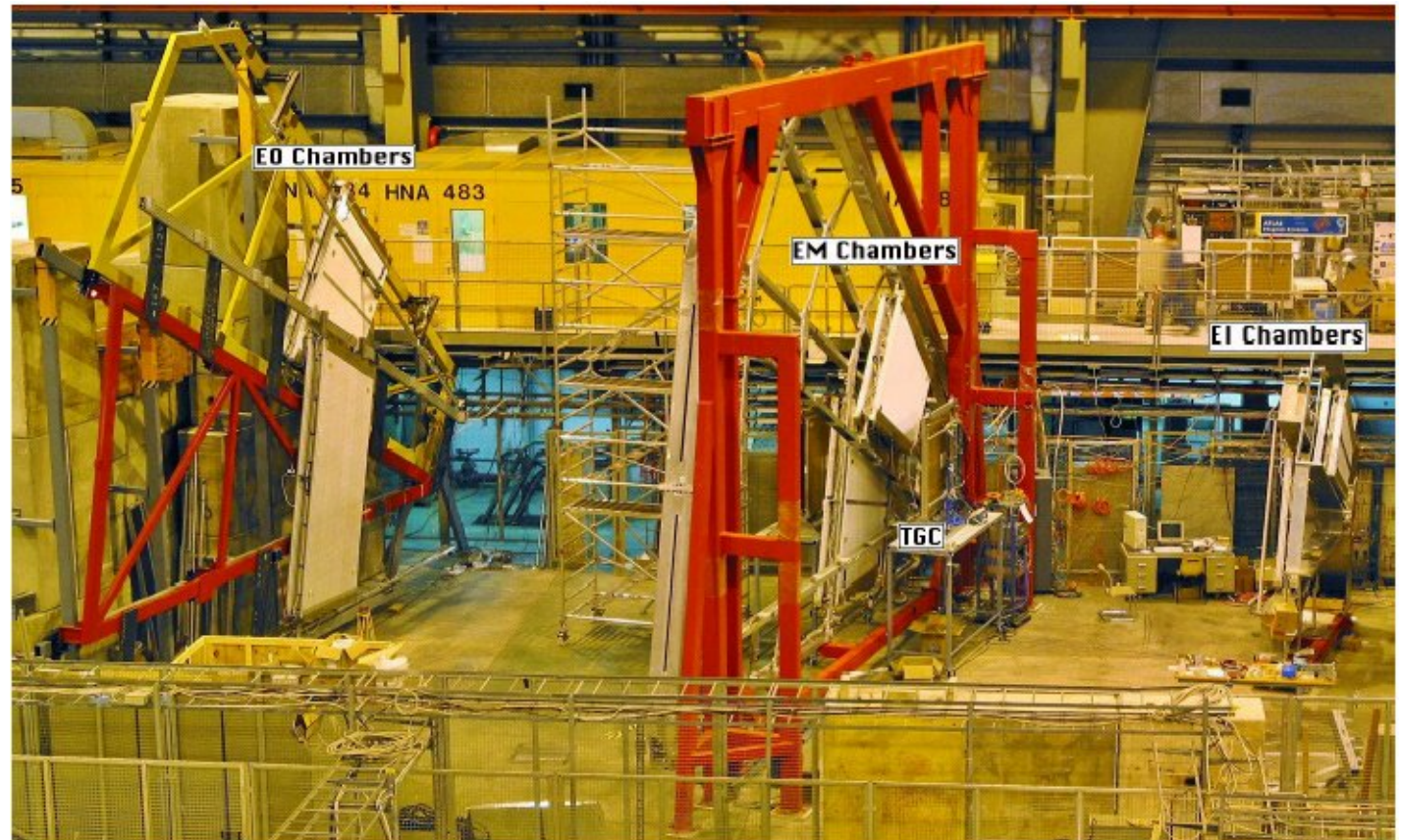
87% of the 3574 chambers constructed

100% cosmic rays qualification foreseen



ATLAS muon chambers system test

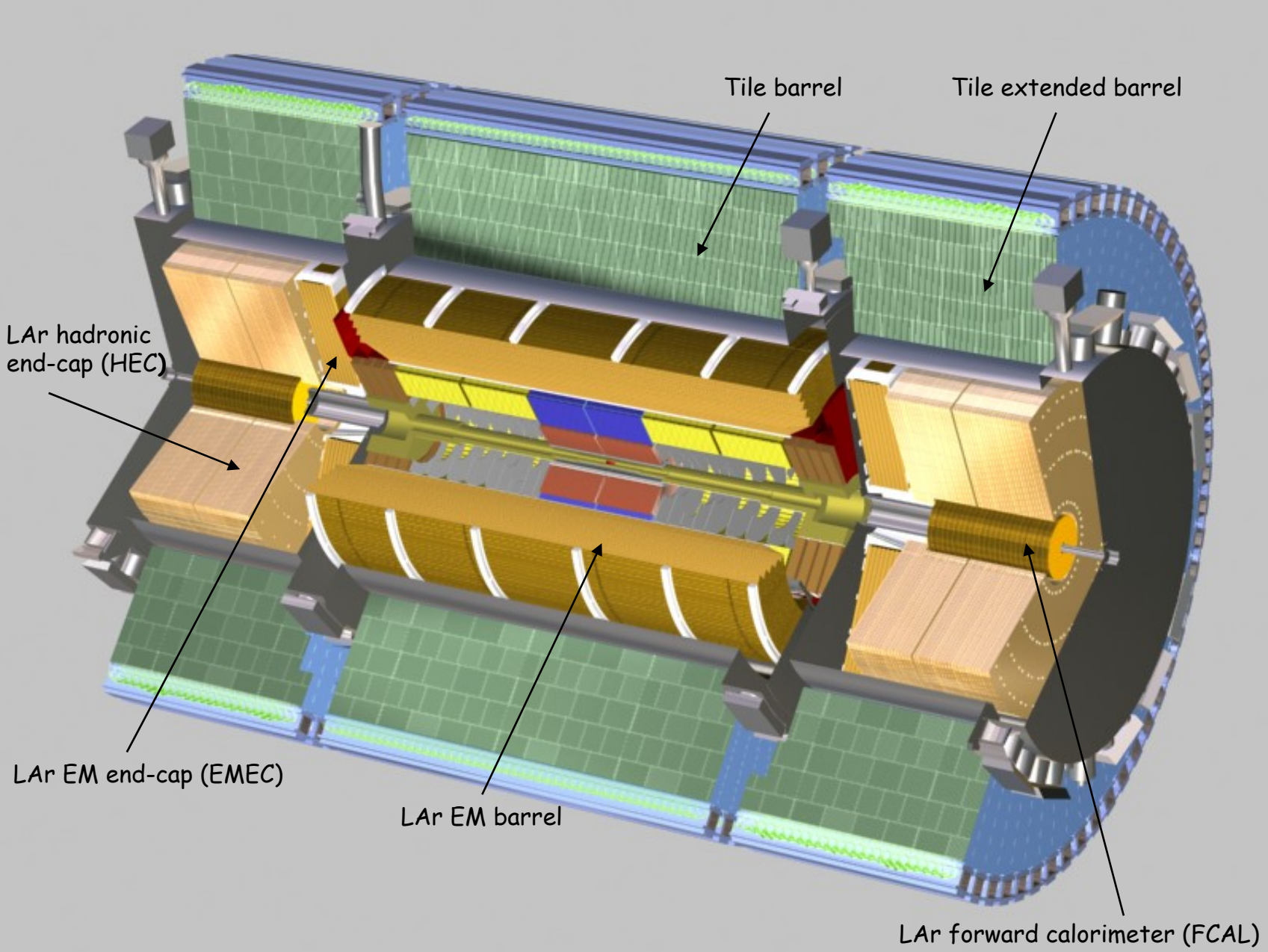
The large-scale system test facility for alignment, mechanical, and many other system aspects, is kept operational with sample series chamber stations at the CERN SPS H8 beam



Muon spectrometer summary

- ✓ All chamber production centers are near to completion of their production, 6-8 months to go !
- ✓ The less advanced chambers in production are the RPCs. Intensive aging tests under irradiation (Gif facility at CERN) have been performed with good results
- ✓ The readout electronics is now the critical item
- ✓ The assembly and testing of barrel stations (2 RPCs + 1 MDT) has started. On the critical path is the construction of the large mechanical wheels support structures (24 m diameter)
- ✓ Underground installation will have to wait until spring '05, when most of the barrel toroid is installed

ATLAS Calorimetry

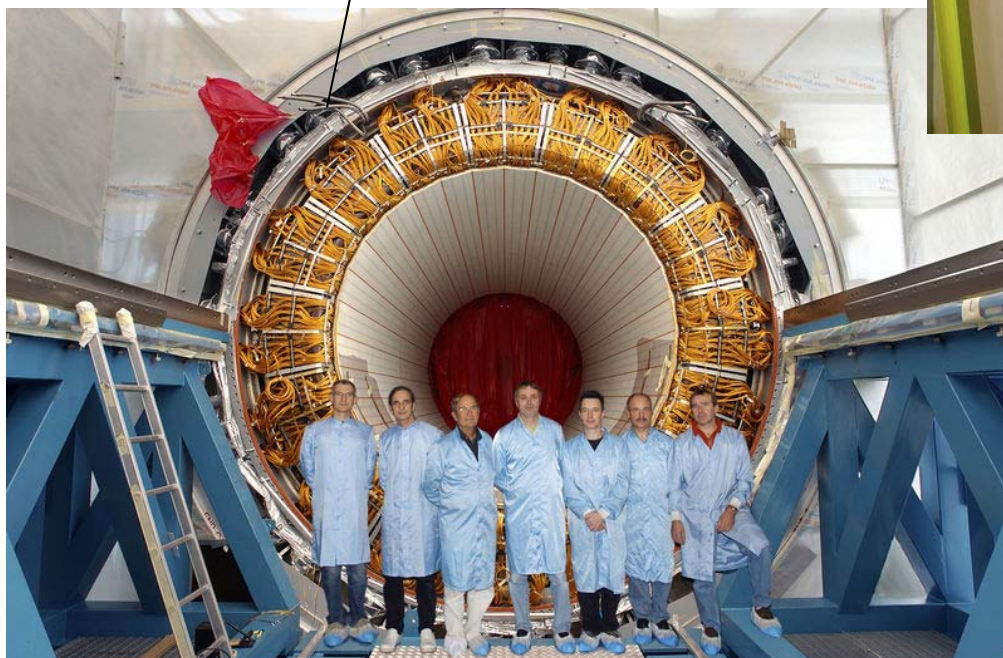
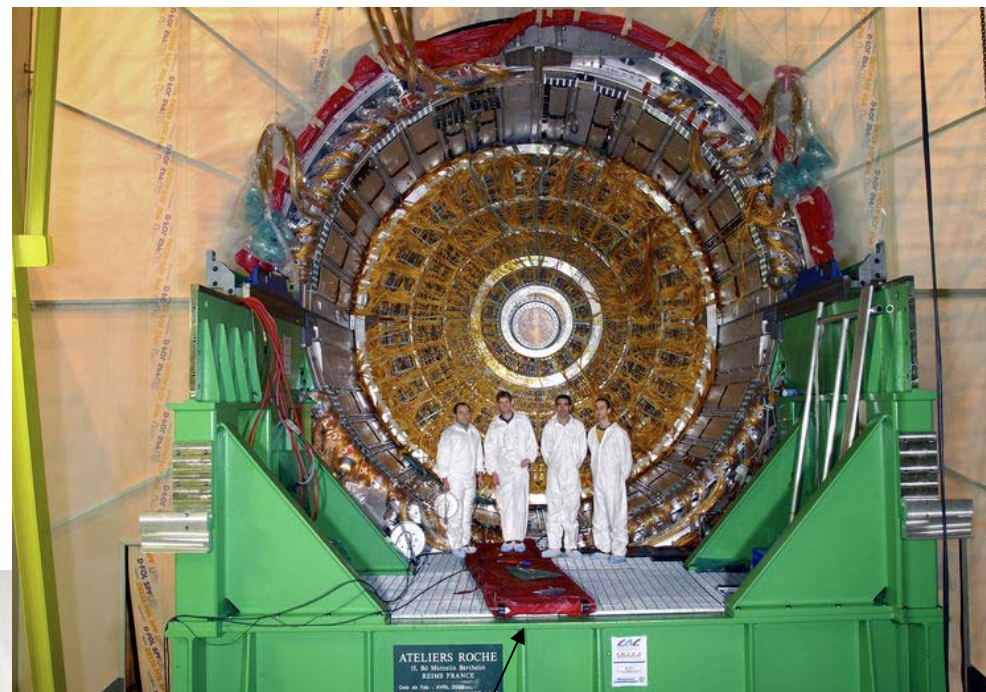


ATLAS LAr EM Calorimetry

The barrel EM calorimeter is installed in the cryostat, and after insertion of the solenoid, the cold vessel has been closed and welded

The warm vessel has been closed as well, the detector has been cooled down

The final tests of the barrel EM are scheduled until September



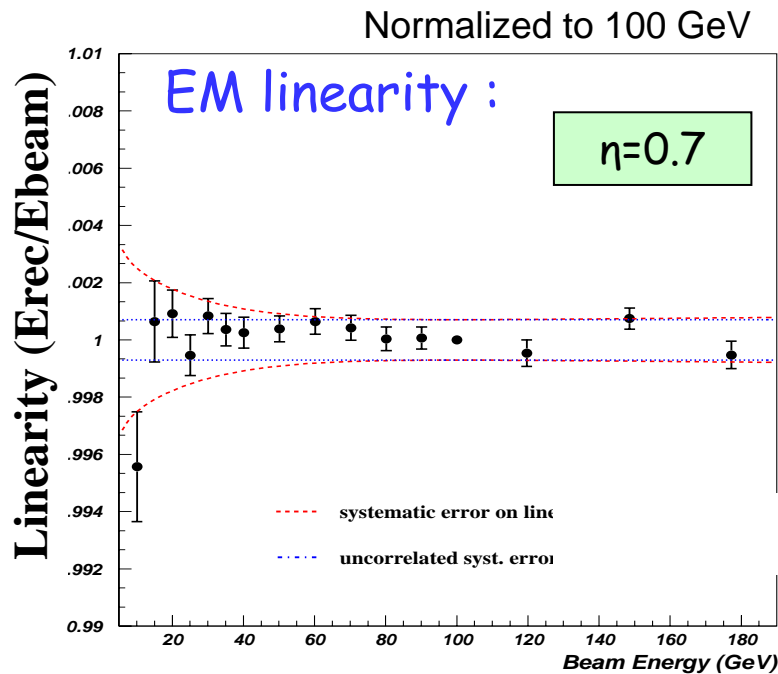
The first of the two LAr end-cap EM calorimeter wheels is inserted in the cryostat (for side C)

The second wheel has very recently been completed as well and inserted into the side-A cryostat.

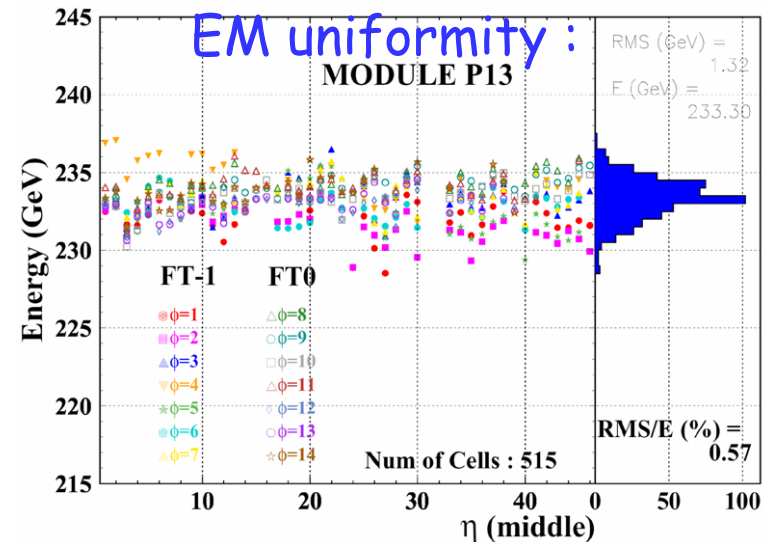
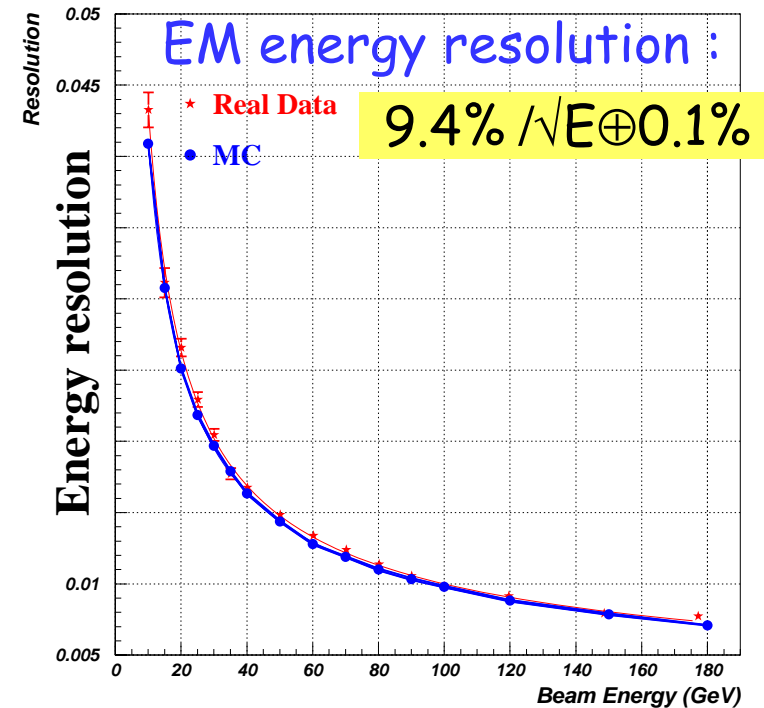
LAr Calorimetry test beam performance

Test beam runs of series modules:

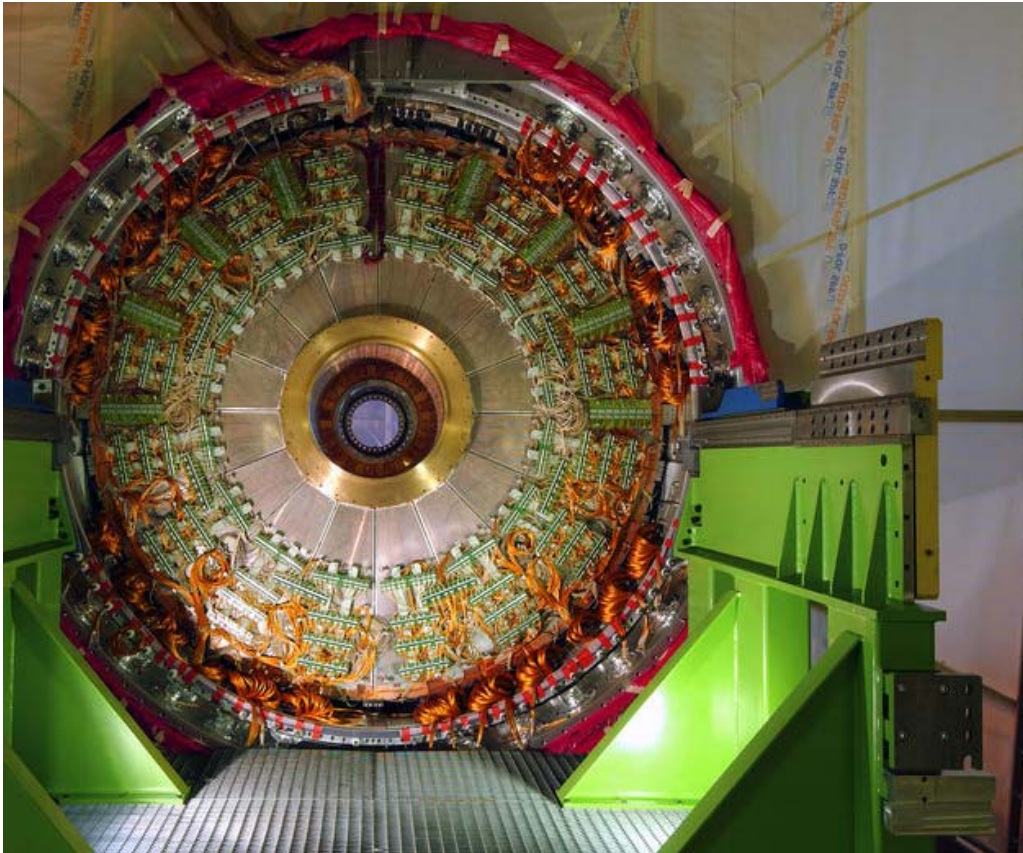
- EMB finished in 2002. 4 / 32 modules tested.
- EMEC finished in 2002. 3 / 16 modules tested.
- HEC finished in 2001. 24 / 128 modules tested.
- FCAL beam calibration in 2003. 3 / 6 modules.



Detector linear within $\pm 0.25\%$
 ($\pm 0.1\%$) for $E > 10$ (40) GeV



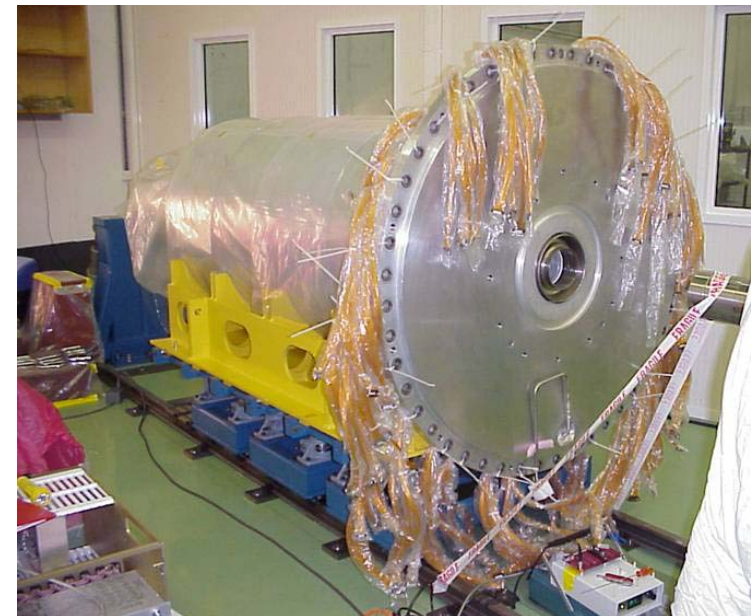
ATLAS LAr Hadronic & Forward Calorimetry



Back view of the HEC wheels in cryostat side-C

The LAr hadronic end-cap (HEC) wheels are all assembled, and those of side-C were inserted in the cryostat and tested with very good results

The LAr forward calorimeters (FCAL) are integrated and cold-tested as well, ready for final insertion



Integrated FCAL ready for insertion

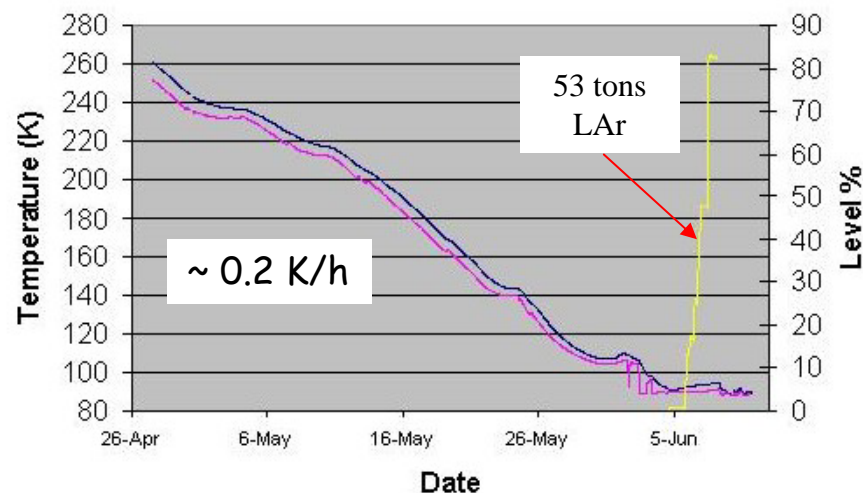
ATLAS EM Barrel + Solenoid assembled

Today the barrel EM calorimeter and the solenoid are cooled and ready for their final electrical tests



Solenoid insertion into the barrel LAr vessel

Cool down and filling Barrel liquid argon cryo



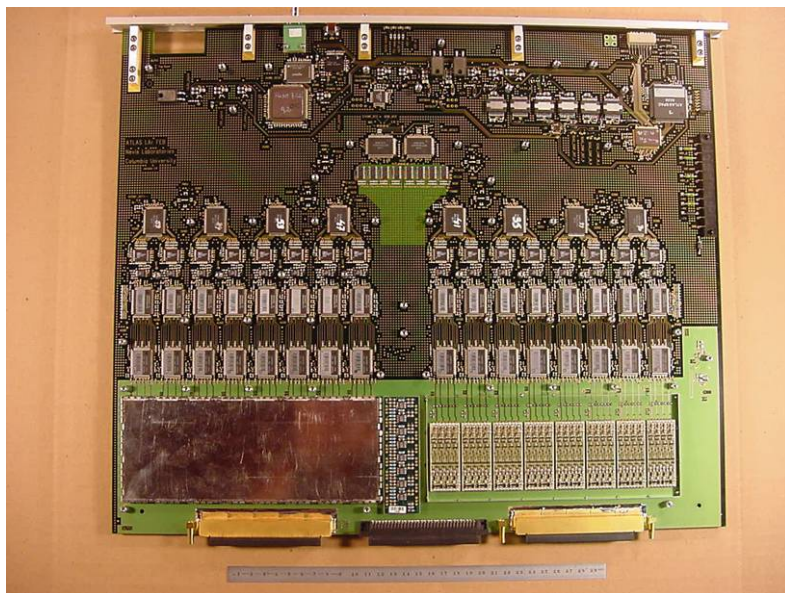
The solenoid has been very recently successfully tested and operated at 8.2 KA, which is 7.5% above its nominal operation current

ATLAS EM Front-End Electronics

Final prototypes of the LAr front-end (FE) electronics were tested successfully, and first results from the back-end (BE) tests are promising

All radiation-hard electronics chips in hand, series production of final boards has started after a series of Production Readiness Reviews (PRRs) took place over recent months, in particular for the FE boards and the power supplies which are on the critical path

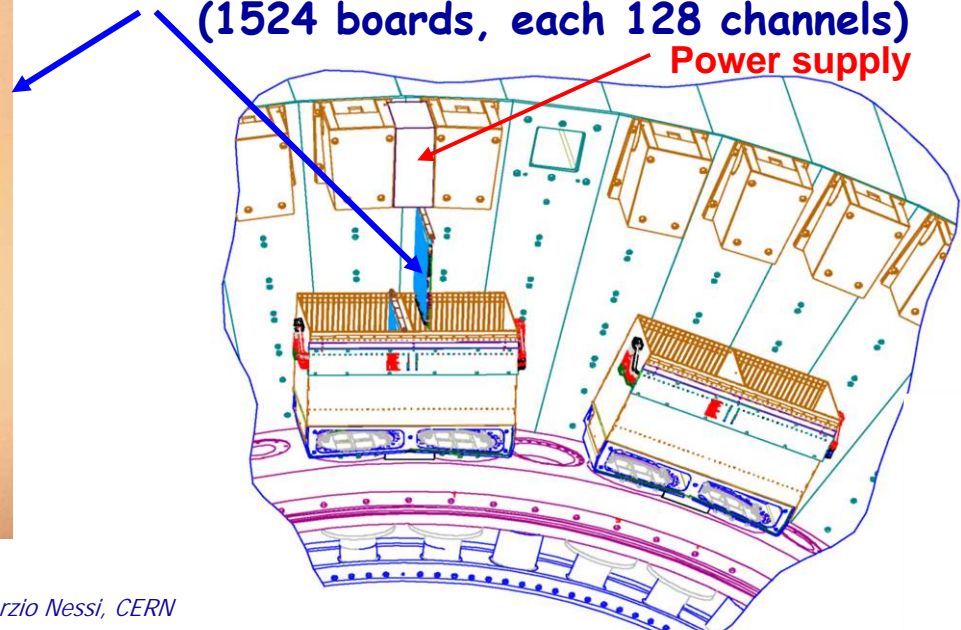
Detailed underground installation and commissioning plans for the LAr electronics have been prepared. Work will start early 2005.



Front-end crate electronics

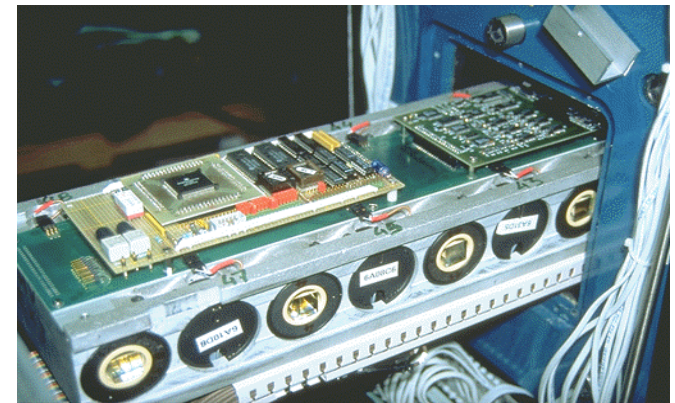
Rad-tolerant FE board
(1524 boards, each 128 channels)

Power supply



ATLAS Tile Calorimeter

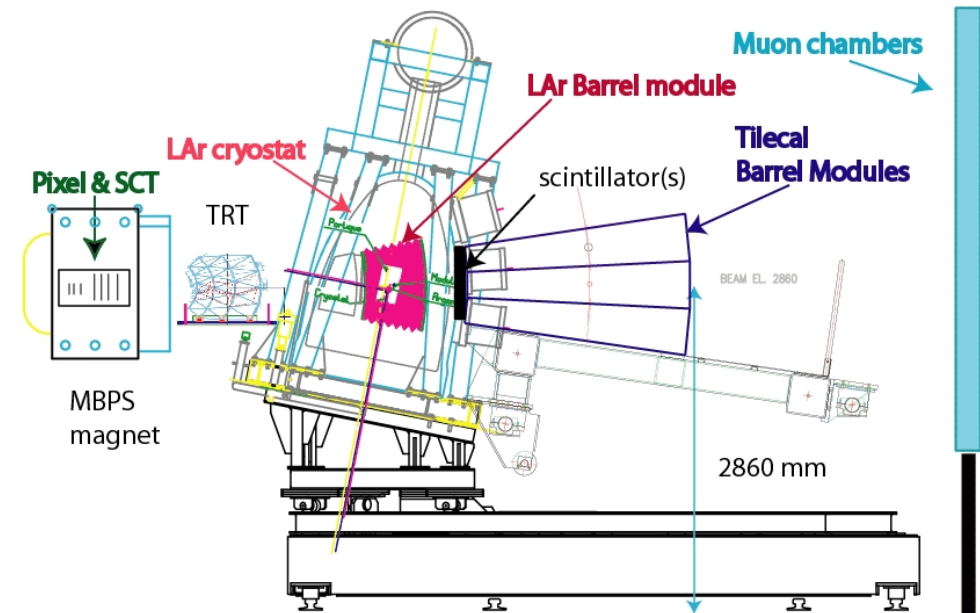
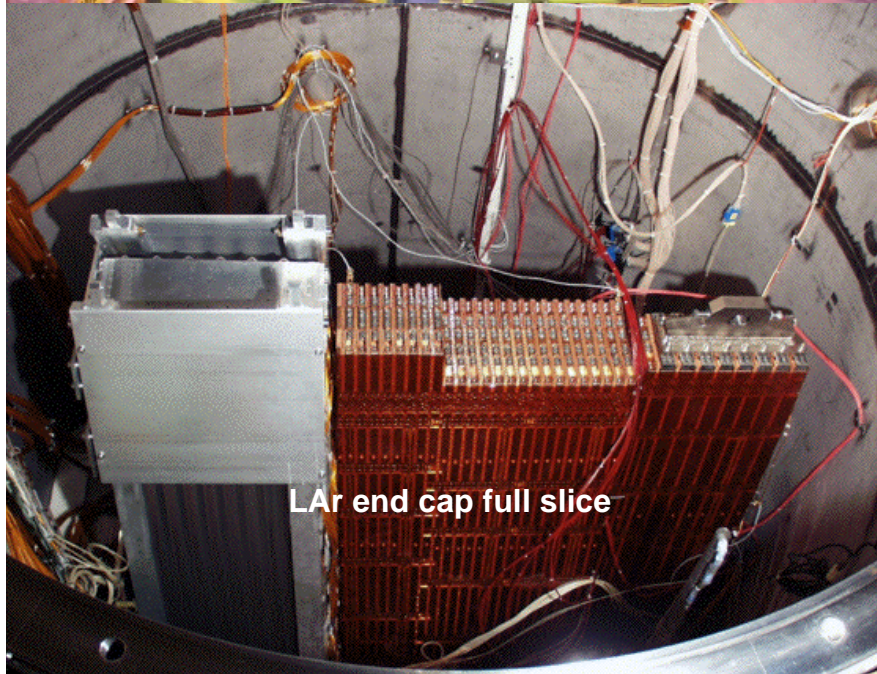
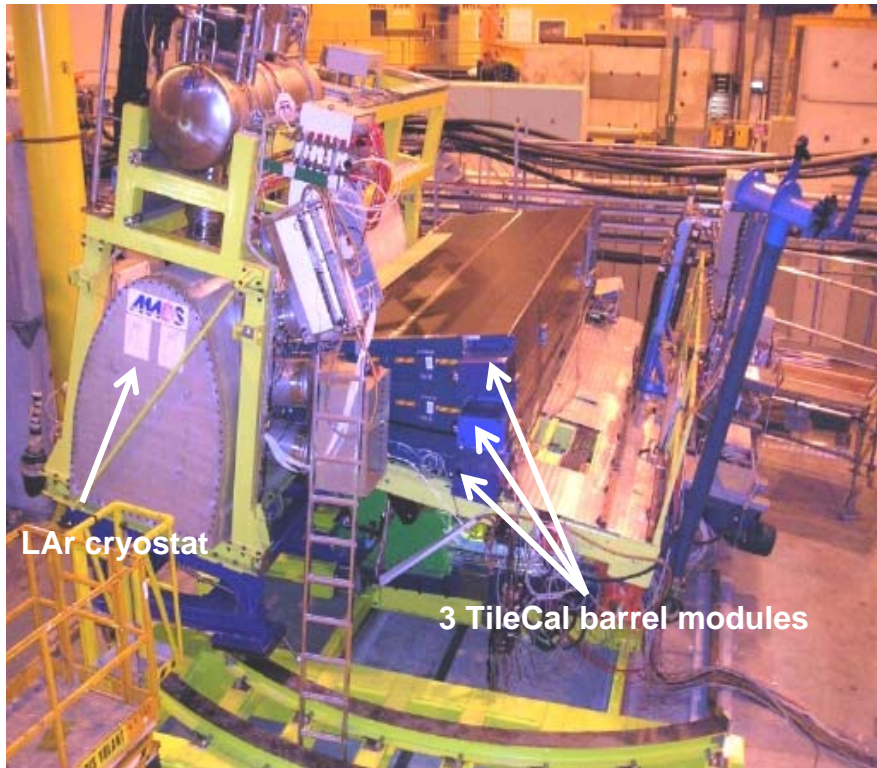
Modules construction and optical instrumentation has been completed since one year, and in the meantime the pre-assembly and disassembly on the surface of the first extended barrel (EB) cylinder as well as of the barrel have been completed, the second EB is now going through the same procedure



The electronics components are in fabrication, the 'drawer' system with all on-detector circuits is now installed in all modules going underground.

ATLAS combined test beam

The combined test beam
(CTB) runs 2004 in the CERN
SPS H8 and H6 beam lines
are in full swing
(1 to 300 GeV/c).



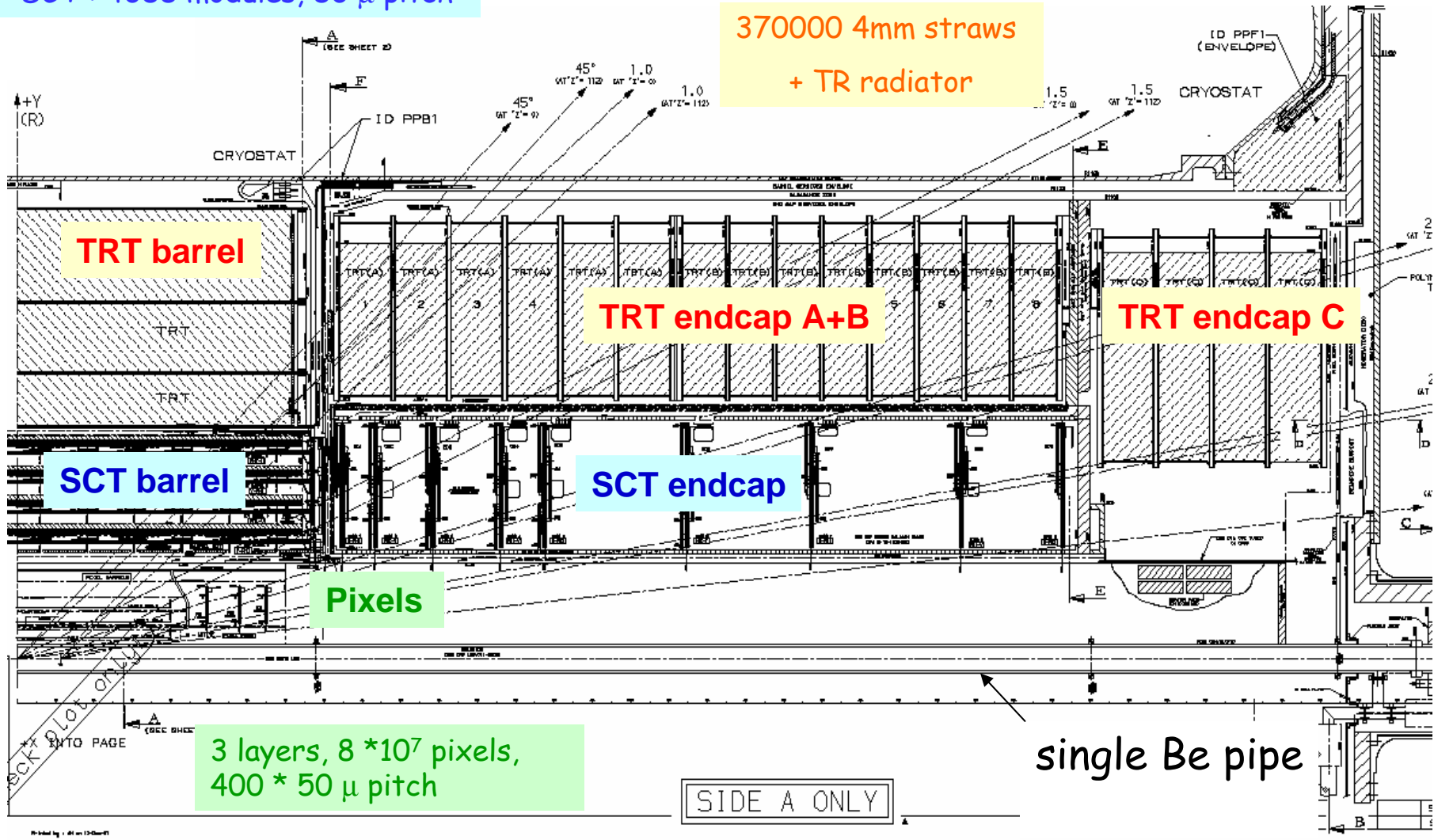
Calorimetry summary

- ✓ All ATLAS calorimeters are in the final assembly phase. The barrels are ready for installation and will be lowered in the experimental cavern by end '04
- ✓ The 2 T Solenoid is integrated inside the LAr cryostat, it has been surveyed and tested, performances are excellent
- ✓ The front-end electronics mass production has started, all rad hard chips are in hand
- ✓ Substantial test beam efforts ongoing, design performance demonstrated
- ✓ The next major step is the underground installation
- ✓ We expect to turn on the barrel Tiles to cosmics by mid '05 and the barrel LAr to cosmics by the end of '05
- ✓ For the end-cap cryostats, due to a tightness problem (inner cold flange), decision taken to weld the flange in place

ATLAS Inner Detector

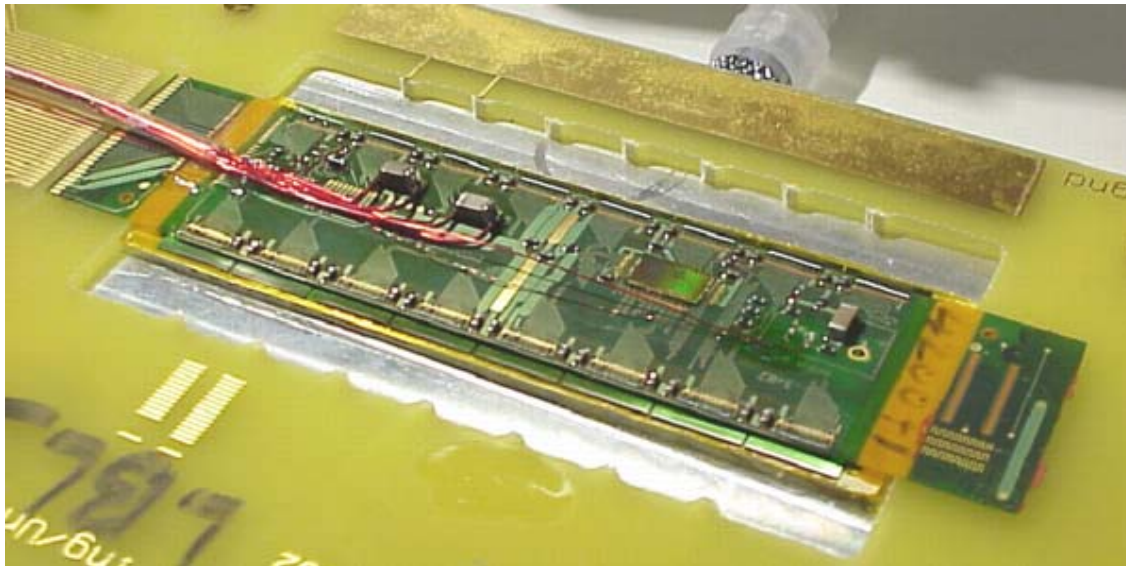
SCT : 4088 modules, 80 μ pitch

370000 4mm straws
+ TR radiator



ATLAS pixels

The sensor production is complete at 60%, with good quality !



The module fabrication is just starting up. Already proven the capability to mount without damage (3 sectors and 3 staves mounted and tested and burned-in and tested again) and that the thermal interface and the precise positioning is under control

The support structures have been delivered

Marzio Nesi, CERN

The module production has started, and has just met the 10% module production milestone

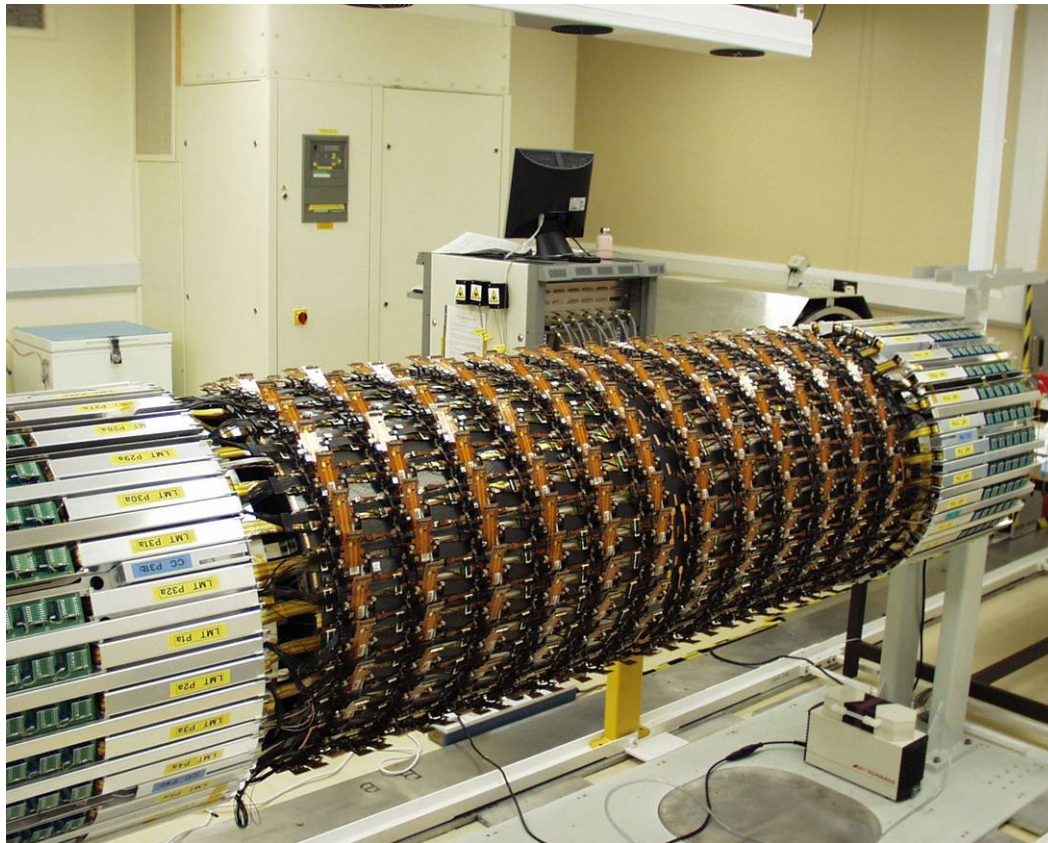
Still to be proven is the full rate (throughput) for the two bump-bonding companies and module production

The FE electronics in DSM technology is in production, 40% of the FE wafers in hand



ATLAS barrel SCT

All sensors procured, ~80% of the modules have been produced, the completion is scheduled for end of August 2004 !



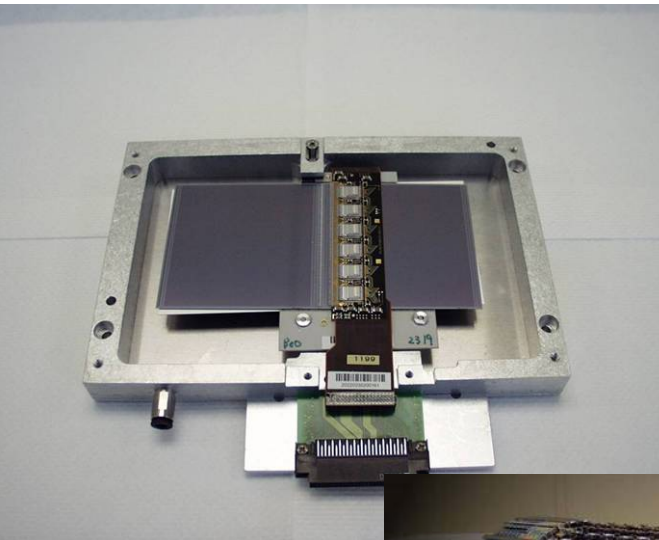
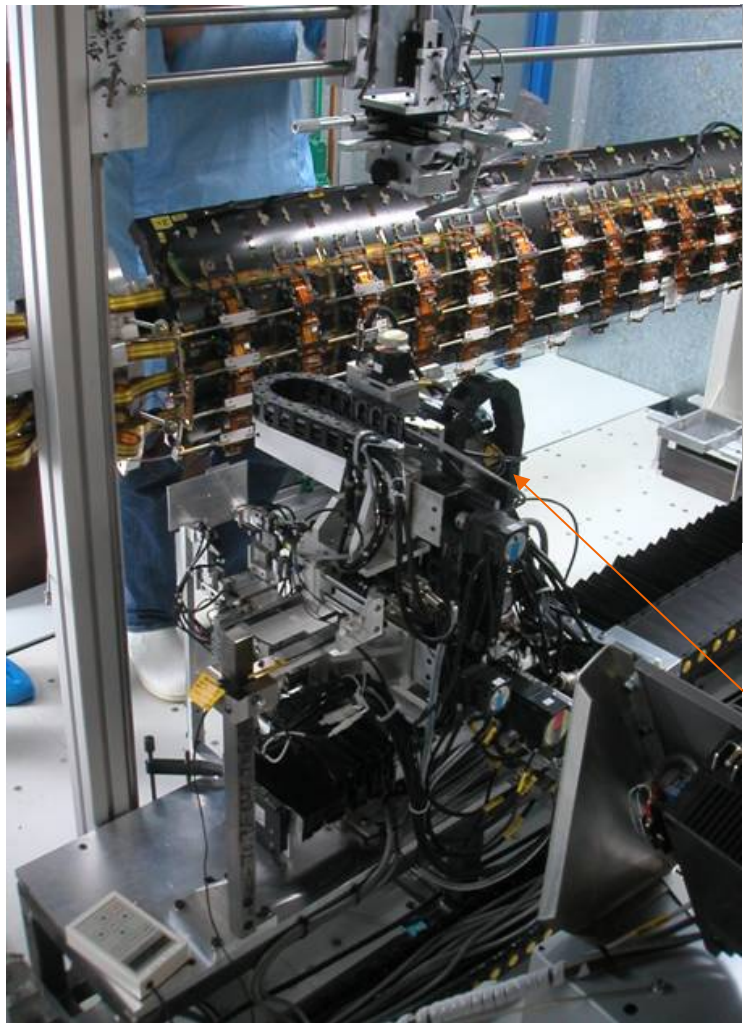
The barrel assembly started with services, all material available. The first of the four cylinders is just going through modules mounting.

Several integration problems of services, supports have slowed down the process, solutions have been found ad hoc. As an example recently a new problem was encountered: the module support brackets need a reinforcement, now solved



ATLAS barrel SCT

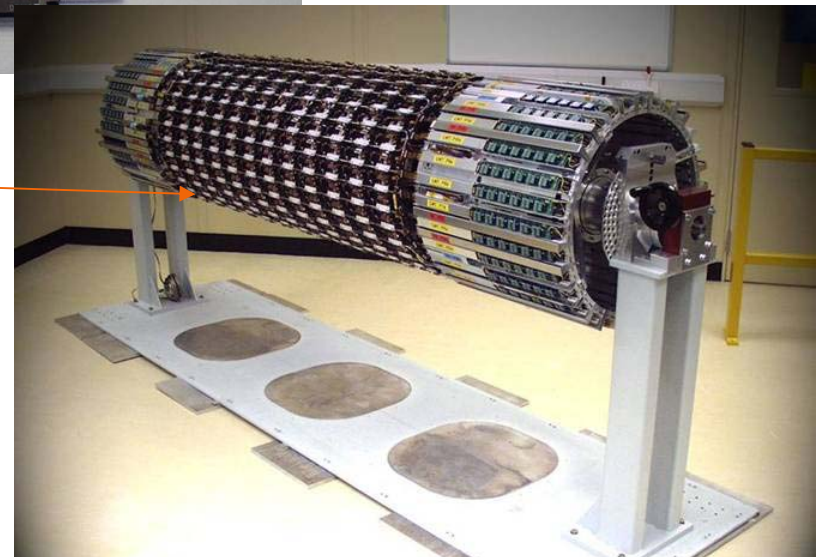
Macro assembly of the modules on the support cylinder just starting. Full electrical qualification foreseen at nominal running cold temperature.



1643 modules ready

B3 cylinder ready

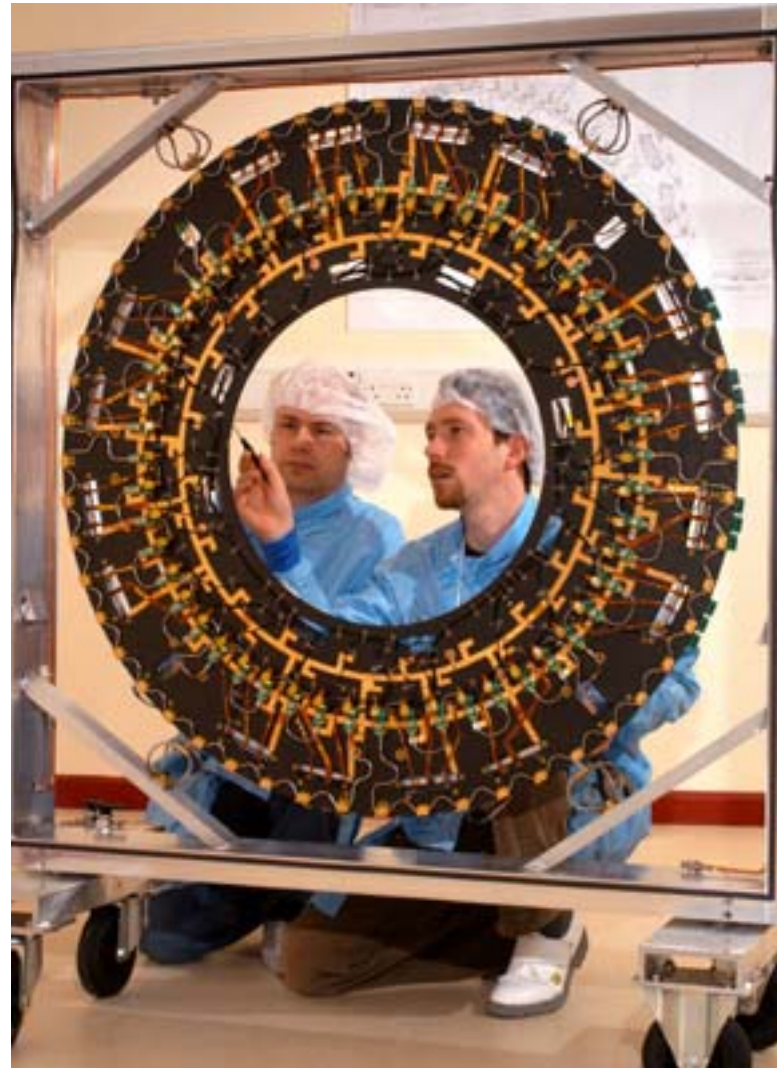
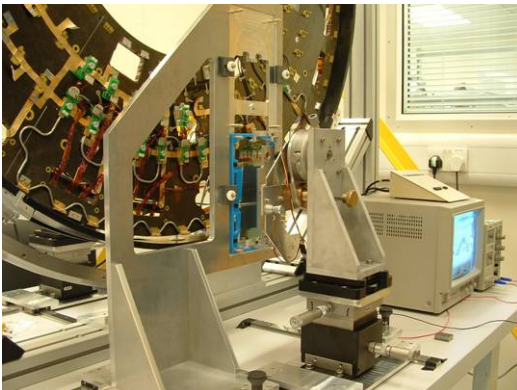
Mounting robot ready to go



ATLAS SCT disks assembly

All sensors procured (two producers). Some characteristics of the modules built from the second producer are not stable and appear to depend on the environment and operating history

Decision was taken to replace a few of them, buying more from the first producer



The module production has now started, after a slow start-up due to various technical issues (> 15 %)

The support disks preparation is in full swing, and first module mounting has started

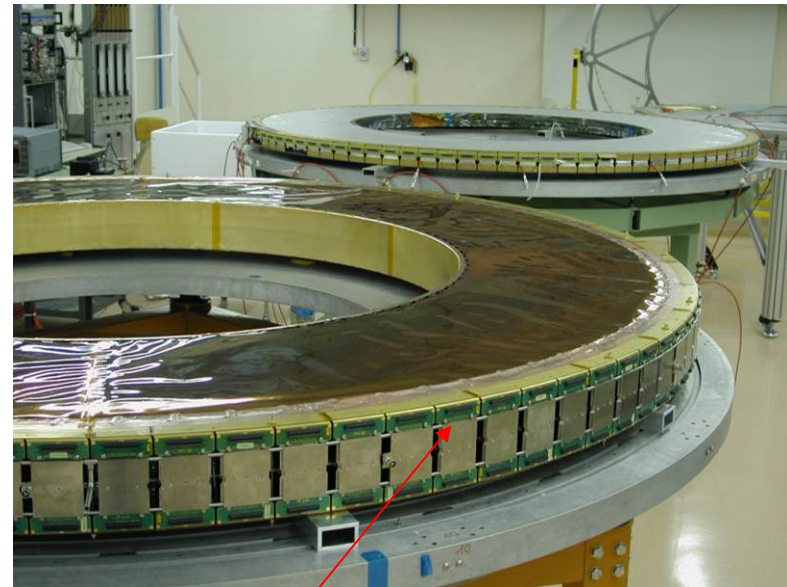
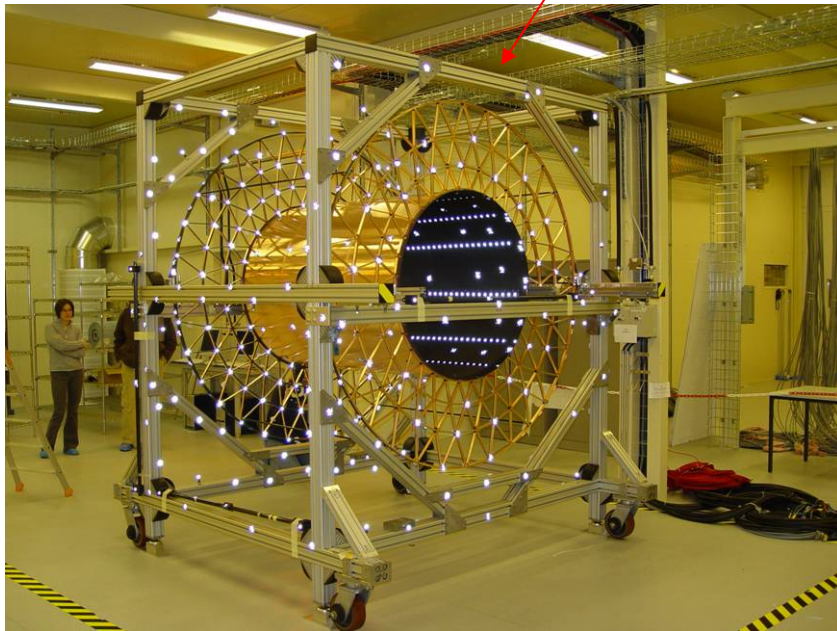
The hybrid production problem for the modules is now solved

The current end-cap side-A disk assembly schedule is on the critical path, point of view integration and installation. Action when production becomes stable

ATLAS TRT Tracker

All barrel modules are made, and all of them are at CERN, being prepared for final integration into the barrel Inner Detector support structure

The front-end (FE) electronics chips production in DMILL is completed

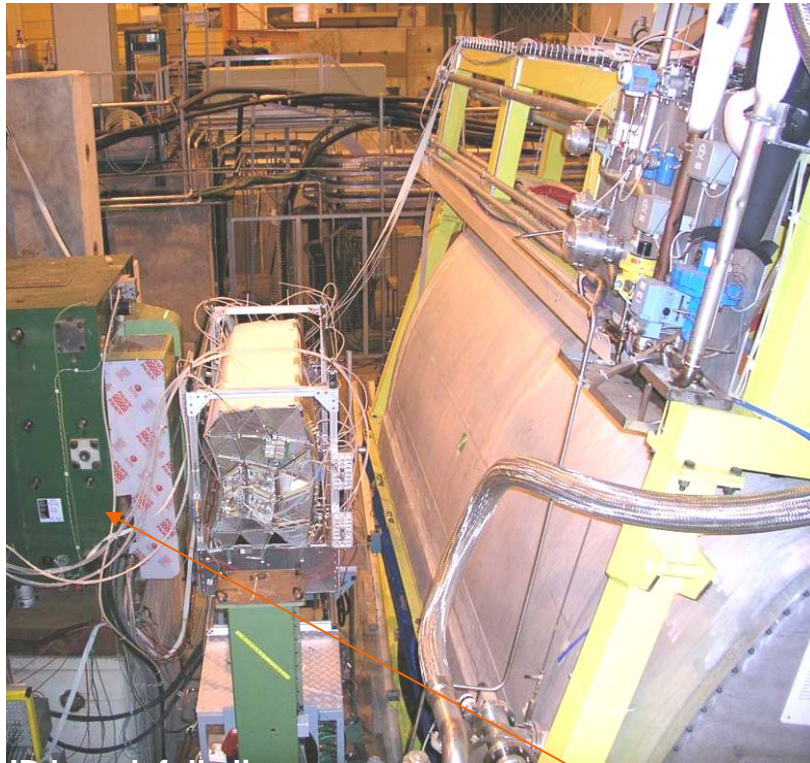


On the critical path (no float left): the construction of the forward wheels

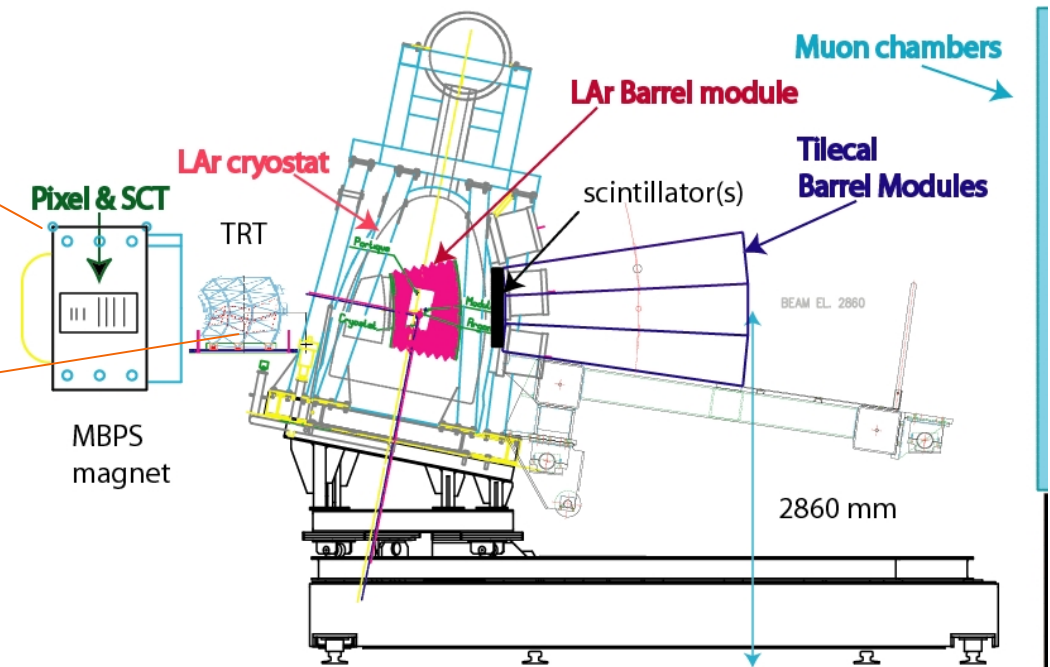
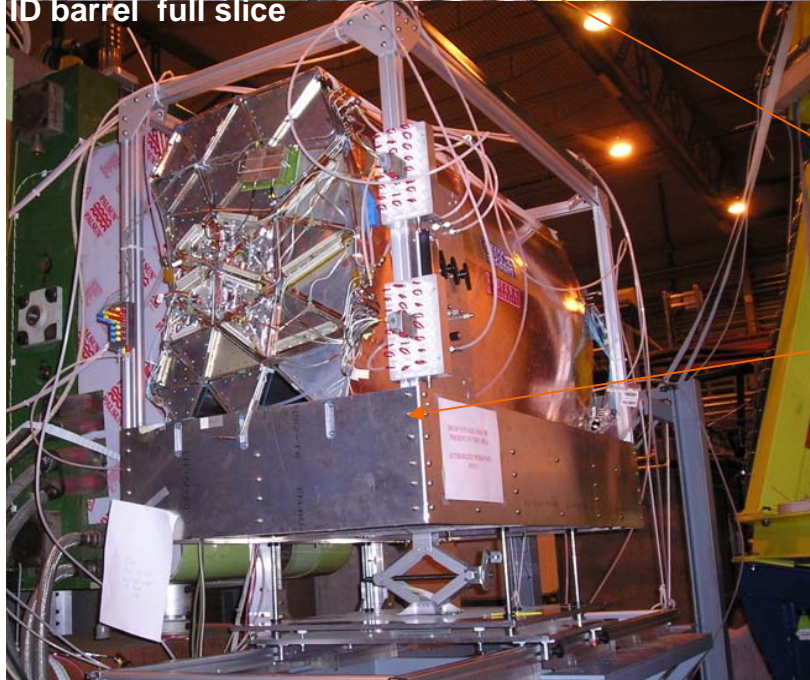
A delamination problem of the active web circuits has slowed down production over the last 8 months → now solved, but still critical

ATLAS combined test beam

Full barrel slice simulated in
the H8 SPS beam line
(3 pixel layers, 4 SCT layers,
TRT barrel wedge) + B field



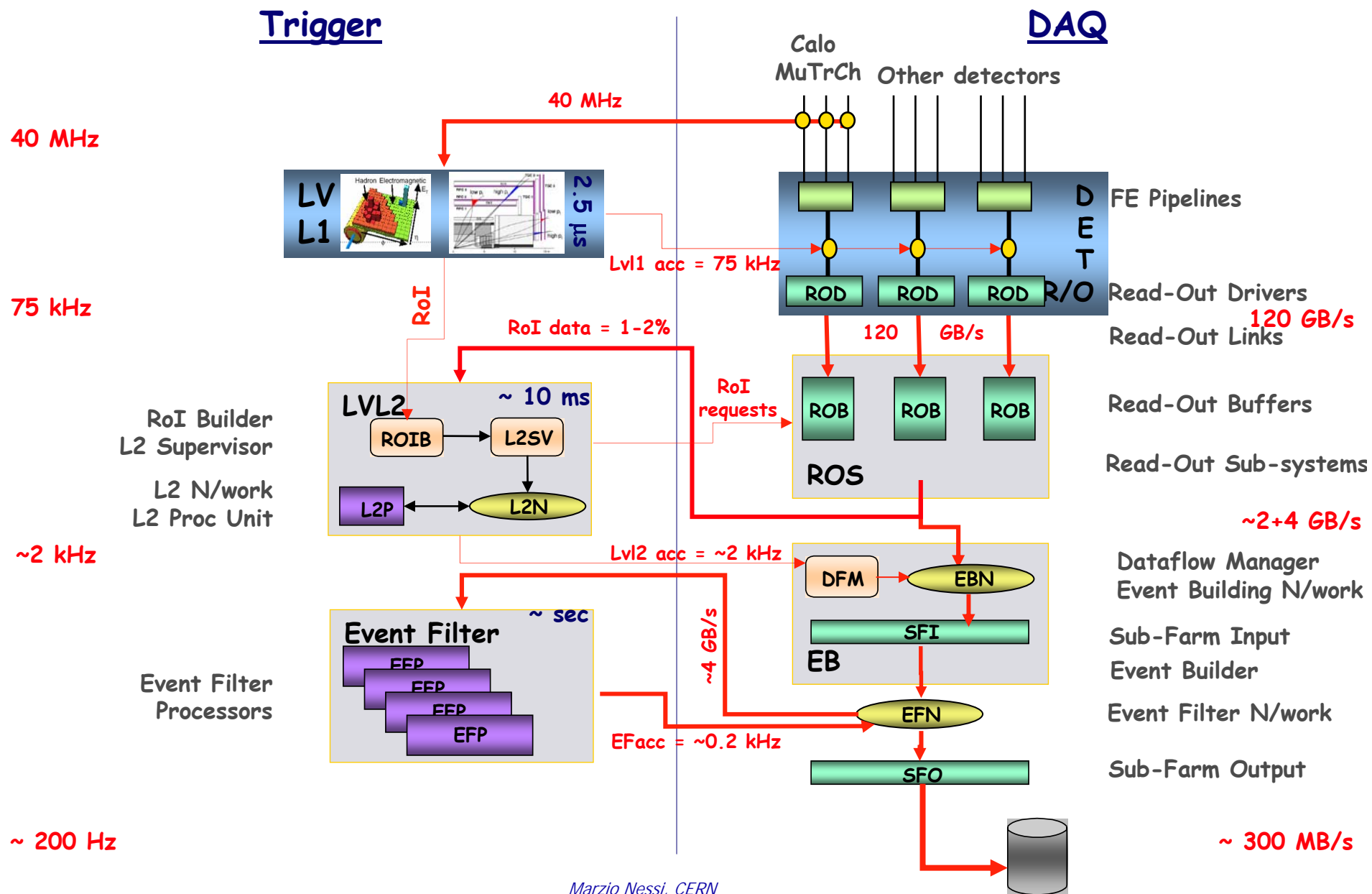
ID barrel full slice



Inner Detector summary

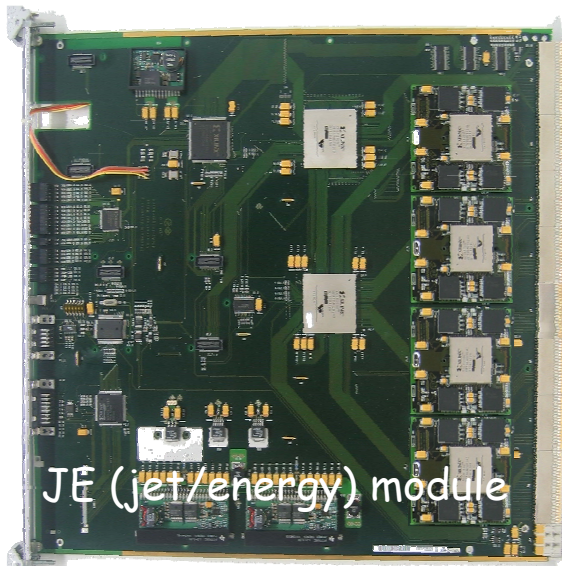
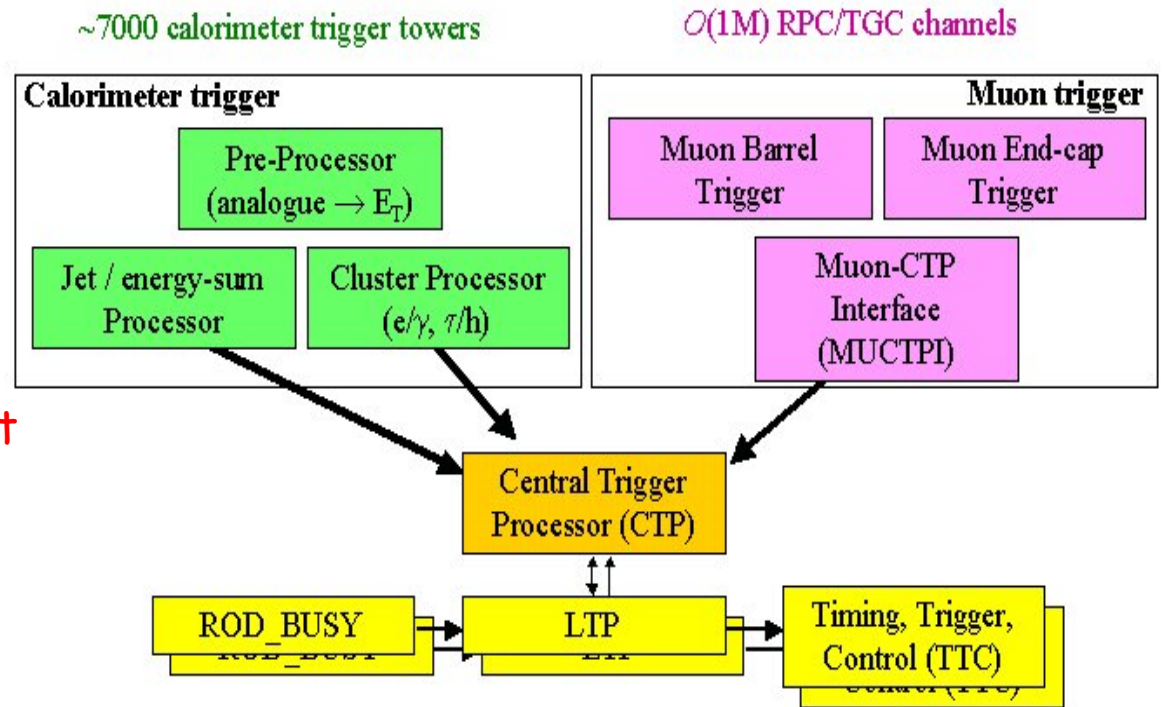
- ✓ Components production is in full swing (Si modules production, rad-hard front-end electronics,...). SCT sensors production done.
- ✓ The SCT detector has started the final instrumentation of the cylinders and the forward disks.
- ✓ The TRT is just recovering from a difficult delamination problem in the flexible webs, now the instrumentation of the wheels has restarted
- ✓ The integration work is ongoing with a ready-for-installation milestone for early '06. The barrel TRT is the first system to be integrated
- ✓ The pixel project is running well, modules production has started
- ✓ Underground the main issue is the installation of all ID services and cables

ATLAS Trigger/DAQ architecture (TDR '04)



ATLAS LVL1 trigger

- ✓ The muon trigger electronics has been validated with 25 ns bunched test beams in 2003
- ✓ Several modules re-optimized and improved to take into account new integration requirements
- ✓ On the critical path is the on-detector muon electronics

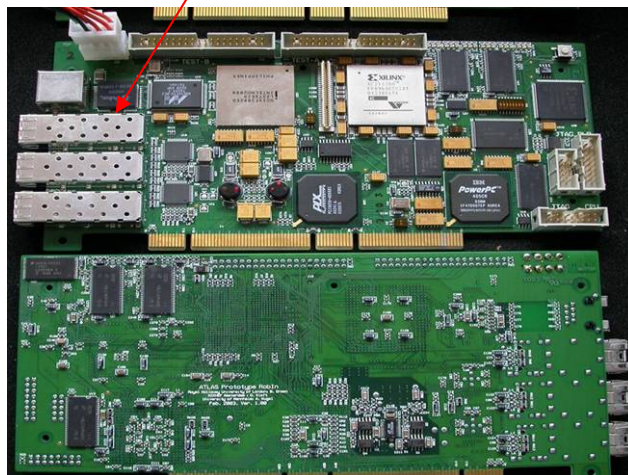
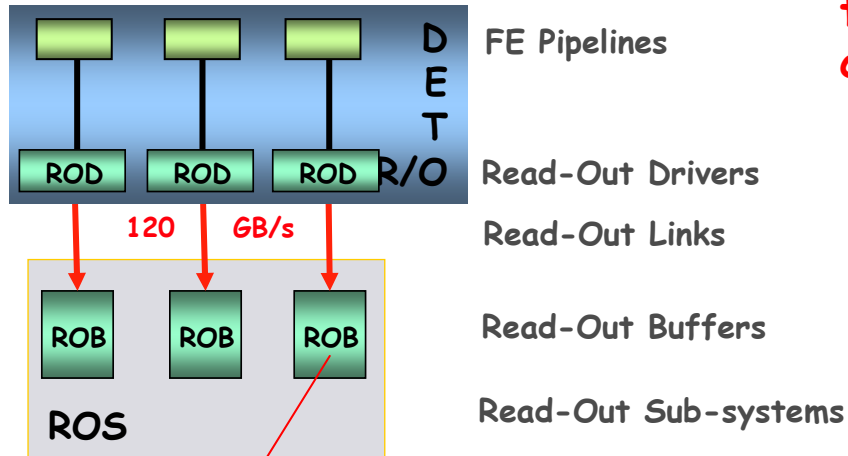


The level-1 system activities (calorimeter, muon and central trigger logics) are progressing with the final ASICs developments and with testing full-functionality prototype modules. The fabrication start-up is planned for most components in 2004

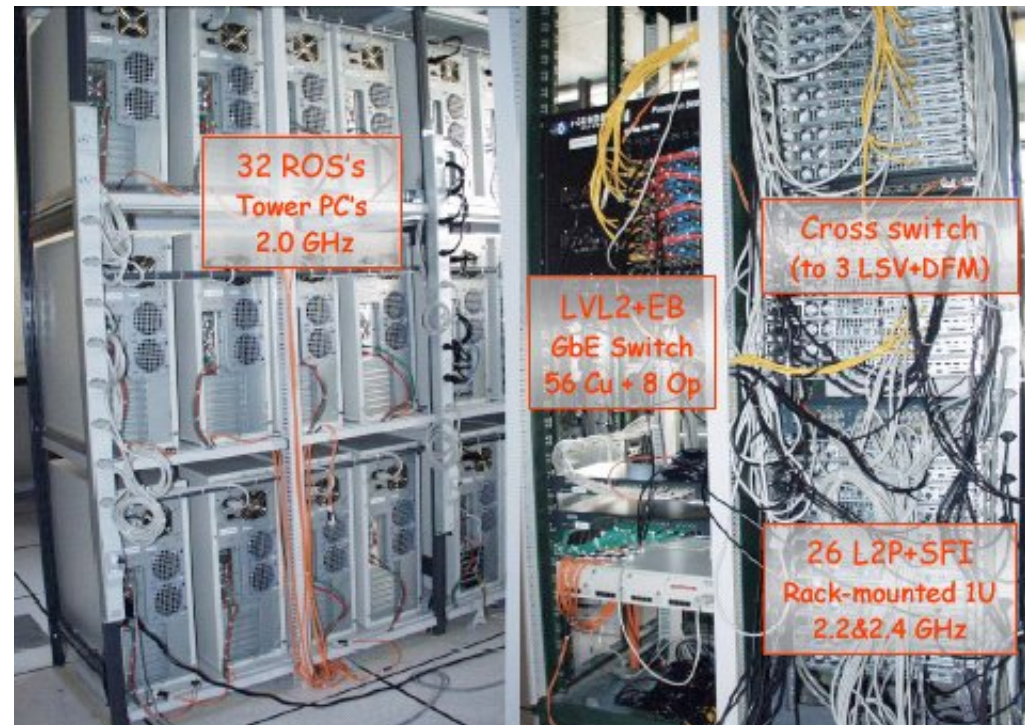


ATLAS DAQ/HLT

ATLAS is testing all TDAQ components in the test beam as part of the ATLAS wedge combined run effort



ROBIN prototype , ready for mass production



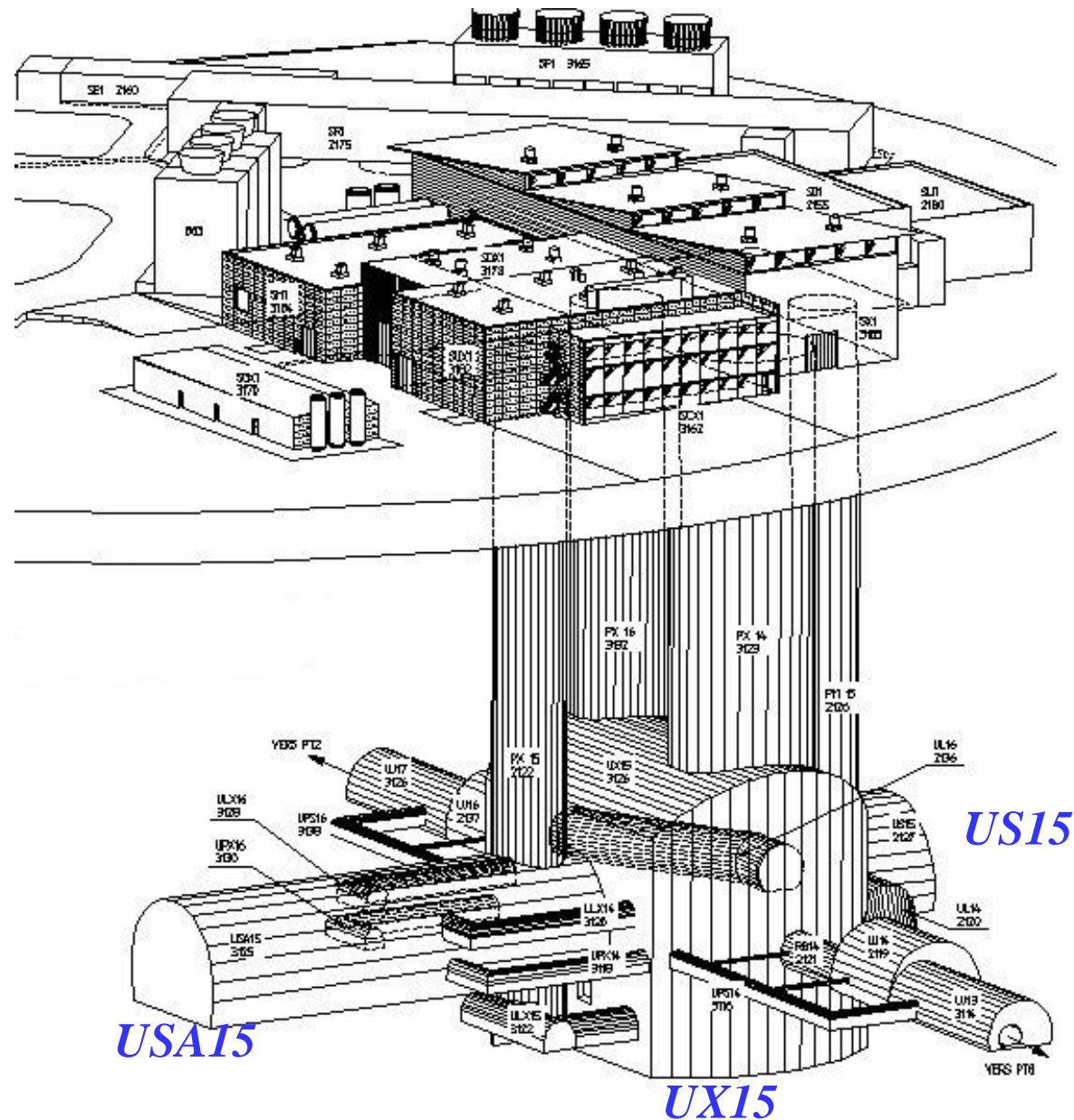
Full slice prototype which supports different configurations to validate various HLT/DAQ aspects. An important issue in the choice of the HLT/DAQ architecture was the ability to scale the system for staging needs during the initial running of ATLAS

Assembly / Commissioning

- ✓ ATLAS is large and open. Its geometry is defined by the air core toroid system. An open geometry where services, structures and detectors share the same space Very complex integration
- ✓ Installation underground is performed piece by piece, starting from components which are pre-assembled and tested on the surface. Two shafts to lower material and to allow parallel operations on both ends. The surface buildings are spread all over CERN, large logistic effort, many special transports, 3.5 years operations
- ✓ Components are commissioned as soon as they are installed, cabling and services installation parallel to the mechanical positioning and integration

ATLAS Point 1

- All surface buildings delivered
- Experimental cavern (UX15) received
- Service cavern (USA15) received
+ part of US15



ATLAS : 1 year underground activities

June '03

Oct '03

July '04

Phase 1 : Infrastructure (UX15, USA15)

- ✓ Finish civil eng
- ✓ TAS shieldings
- ✓ Metallic structures
- ✓ 13 Cranes
- ✓ Ventilation, Air conditioning
- ✓ External Cryogenics, transfer lines, dewards
- ✓ Elevators
- ✓ Electrical services
- ✓ Survey network
- ✓ Cooling plants
- ✓ Gas piping
- ✓ Racks & cable trays
- ✓

Phase 2 : Barrel Toroid + Barrel Calorimeters

- ✓ Bed plates
- ✓ Feet & Rails
- ✓ Trucks (extended rails)
- ✓ HM supports (muon wheels supp.)
- ✓ Tile Calorimeter Barrel
- ✓ Barrel Toroid installation tools
- ❖ LAr Barrel
- ❖ BT coils
- ❖ Proximity cryogenics
- ❖ Calo and BT services

Cavern center

Early June 2003



Marzio Nessi, CERN

July 2003



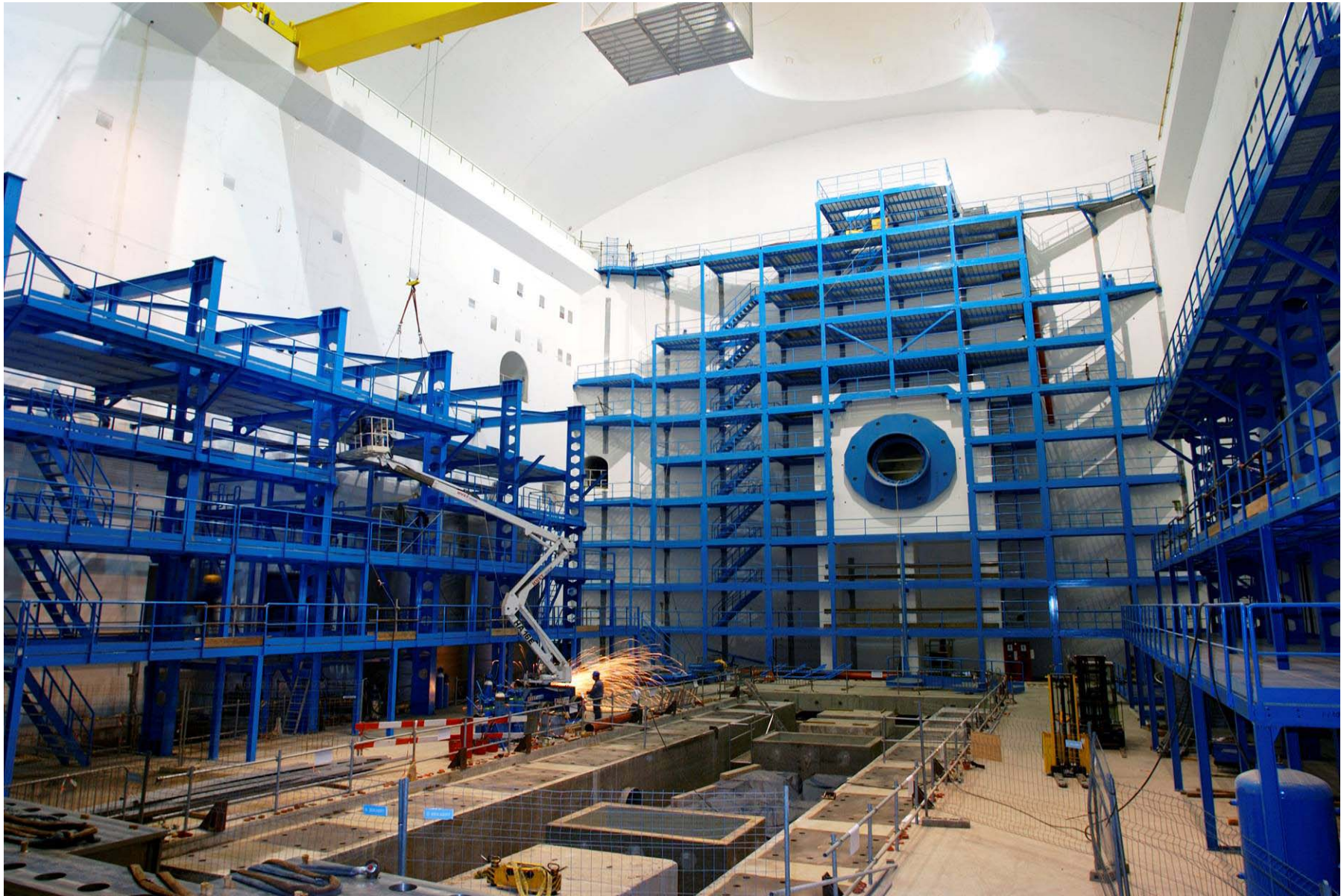
Marzio Nessi, CERN

Early August 2003



Marzio Nessi, CERN

End September 2003



Marzio Nessi, CERN

Early November 2003



Marzio Nessi, CERN

Mid December 2003



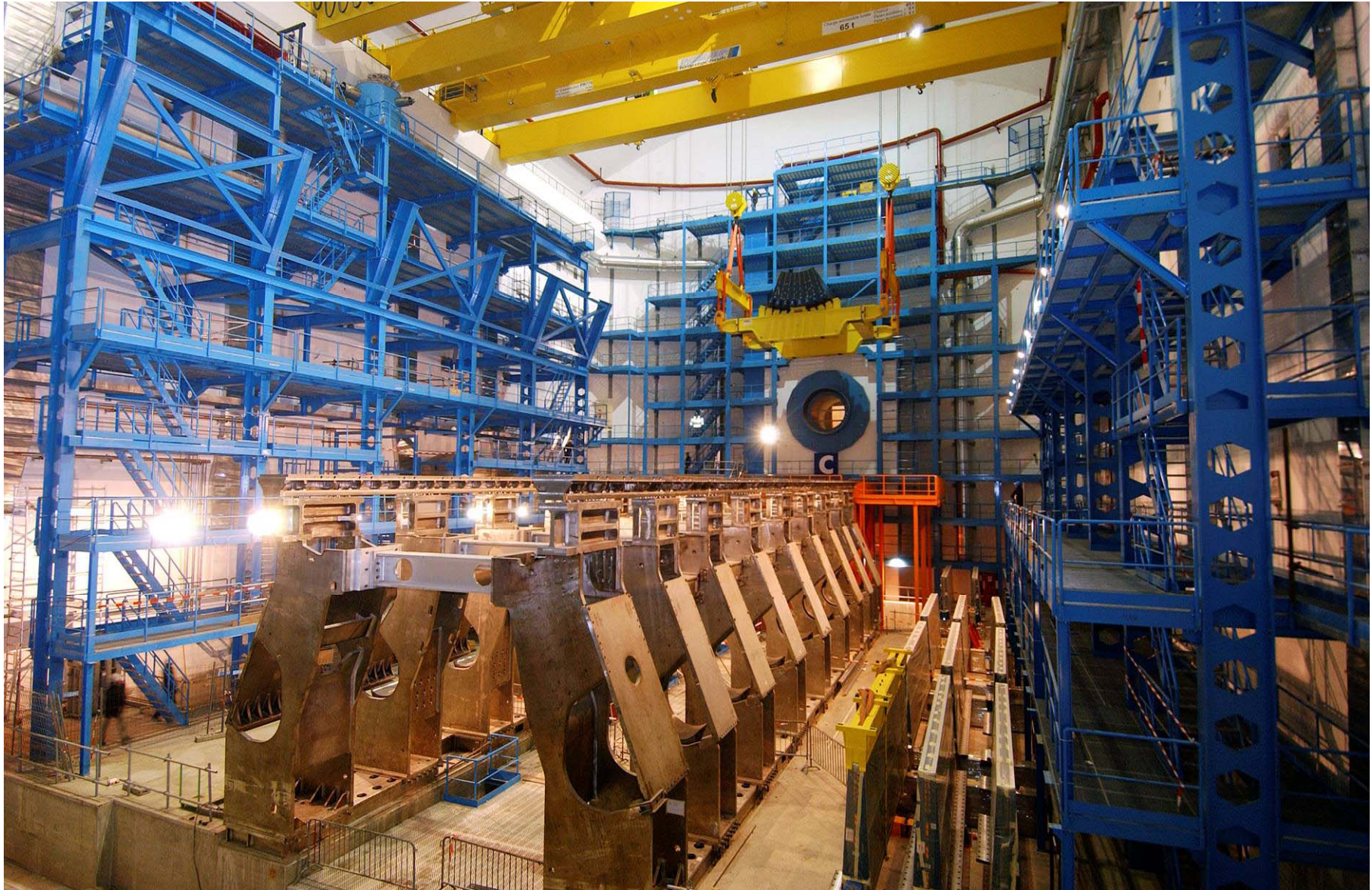
Marzio Nessi, CERN

Mid February 2004



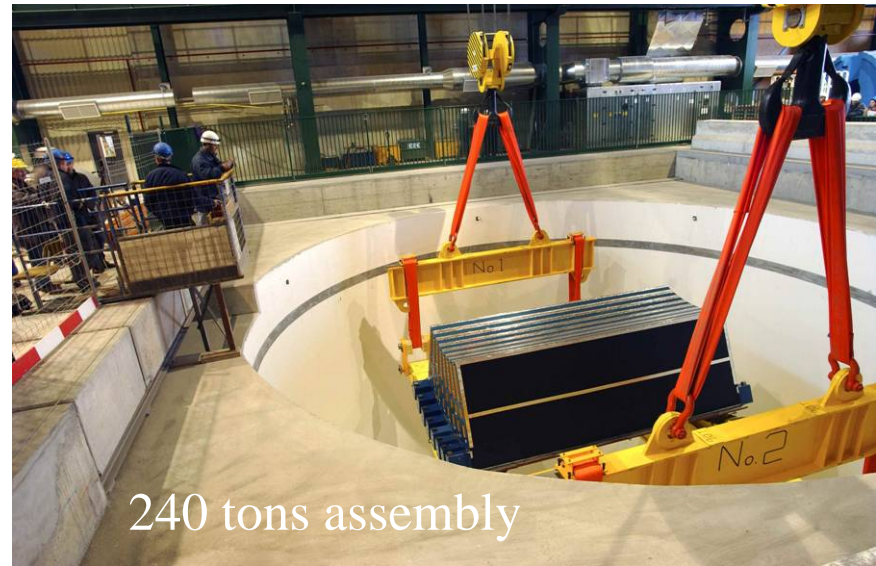
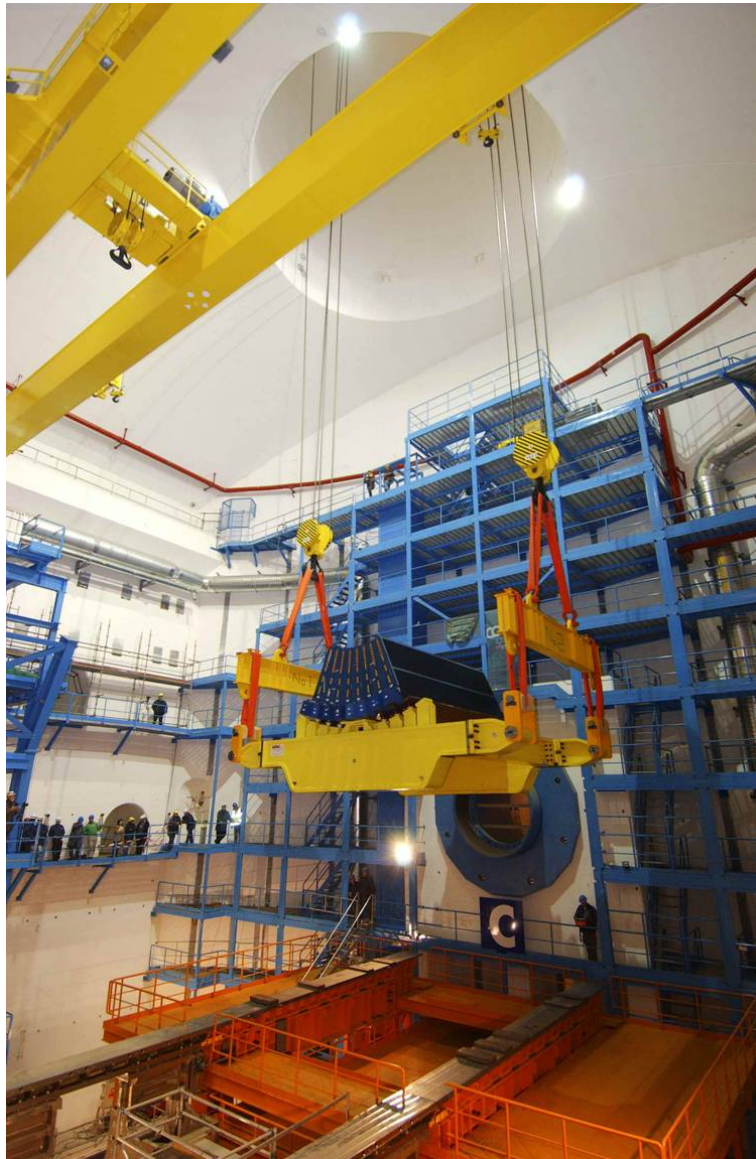
Marzio Nessi, CERN

Early March 2004



Marzio Nessi, CERN

Barrel Tile Calorimeter lowering



Mid May 2004



Marzio Nessi, CERN

ATLAS UX15



Conclusions (1)

- ✓ Clear and visible progress in the detector construction. For many components we are moving on from construction to installation and commissioning (infrastructure, cryogenics, muon system, calorimetry, ...)
- ✓ Most of the efforts go presently into the construction of the inner tracking systems, which need to be ready in the first half of 2006
- ✓ For ATLAS the main problem today is the timely construction, test and assembly underground of the barrel toroid, which is late by several months due to components manufacturing delays occurred in 2003
- ✓ Major assembly, testing and commissioning activities going on at CERN in surface buildings, which are crucial to the successful and efficient installation work underground
- ✓ Installation underground has started. ATLAS has received since one year all underground caverns and has just concluded the installation of the necessary infrastructure

Conclusions (2)

- ✓ The installation of the detector and its services underground has started. The activities underground are today very spectacular
- ✓ Major milestones: end of September installation of the first toroidal coil, mid October lowering down of the barrel LAr cryostat
- ✓ ATLAS has started a very ambitious combined test beam program. A slice of the entire detector has been assembled and put into operation. This work includes all TDAQ and software aspects. An important pre-commissioning milestone
- ✓ Commissioning activities at the system level, but also at the full detector level are starting. The necessary organization has been set up

***ATLAS is highly motivated to remain on track
for LHC physics in 2007***

We are slowly getting there !



Marzio Nessi, CERN