ATLAS Canada - NSERC Review

R.S. Orr – 10 December 2004

Alberta
Carleton
McGill
Montréal
Simon Fraser
Toronto
TRIUMF
UBC
Victoria
York

33 University/Lab.physicists Over 88 people, including Engineers, Technicians, Students

Includes 4 IPP Research Scientists

Educational Role

20 UG Summer Students
21 Graduate Students
13 Post Docs

Focus on Liquid Argon Calorimetry

- 4 NSERC Funded Construction Projects

  Endcap Hadronic Calorimeter

  Forward Hadronic Calorimeter

  Front-End-Board Electronics

  Endcap Signal Cryogenics Feedthroughs

  Construction completed last year

  End of Installation this year

  Commissioning in 2006

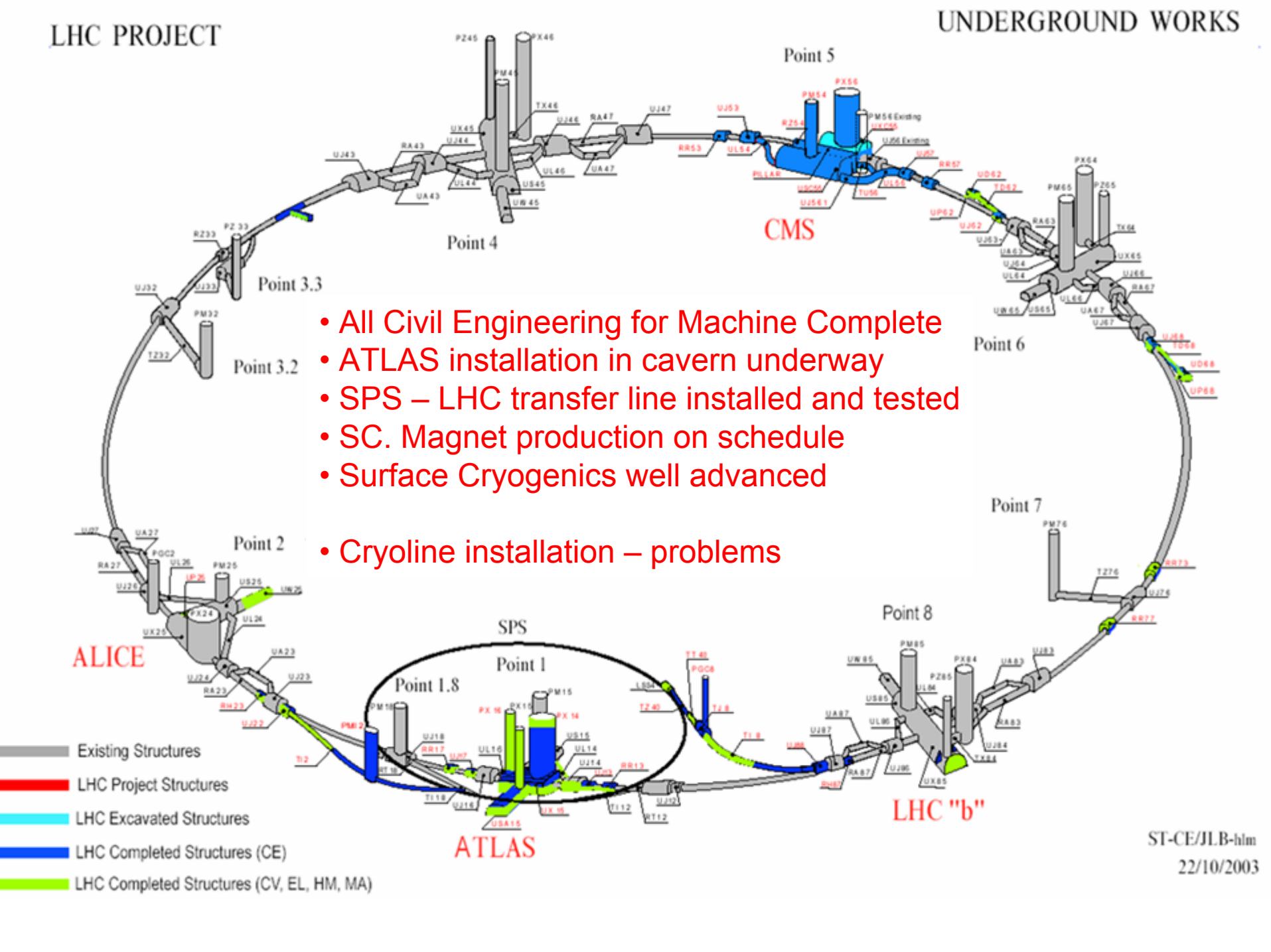
- Ongoing/Future Activities

  Analysis of Beam Tests
  Calorimeter Calibration
  Preparation for Physics
  Event Filter Processor Farm
  Computing - soft/hard

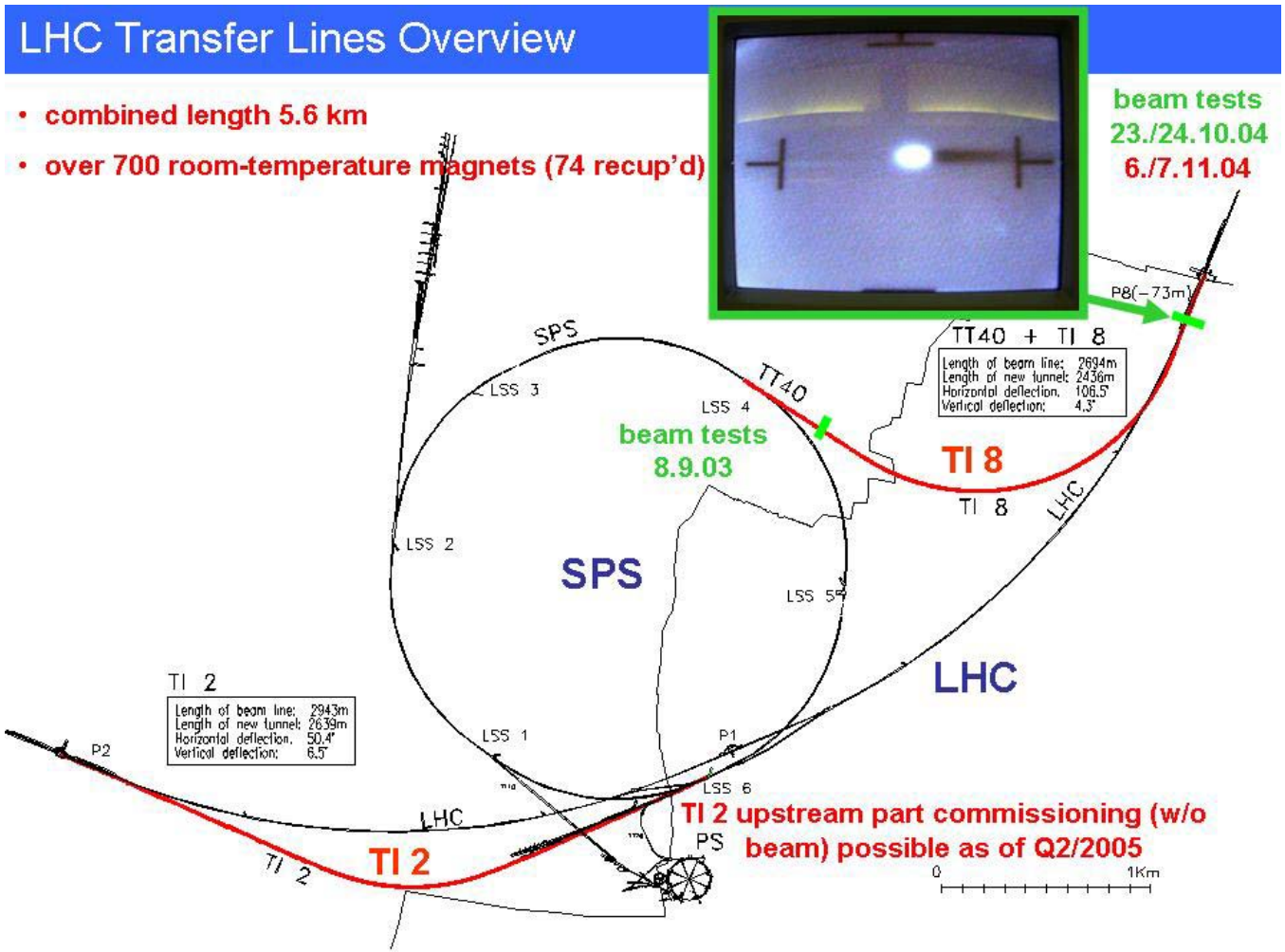
  Beam Condition Monitors

LHC machine Status

Dipole Cold Masses


LHC PROJECT
UNDERGROUND WORKS
Point 5
CMS
Point 4
Point 3.3
Point 3.2
Point 6
Point 7
Point 2
ALICE
SPS
Point 1
Point 1.8
Point 8
LHC "b"
ATLAS
• All Civil Engineering for Machine Complete
• ATLAS installation in cavern underway
• SPS – LHC transfer line installed and tested
• SC. Magnet production on schedule
• Surface Cryogenics well advanced
• Cryoline installation – problems
Existing Structures
LHC Project Structures
LHC Excavated Structures
LHC Completed Structures (CE)
LHC Completed Structures (CV, EL, HM, MA)
ST-CE/JLB-hlm
22/10/2003

Results of TI8 test



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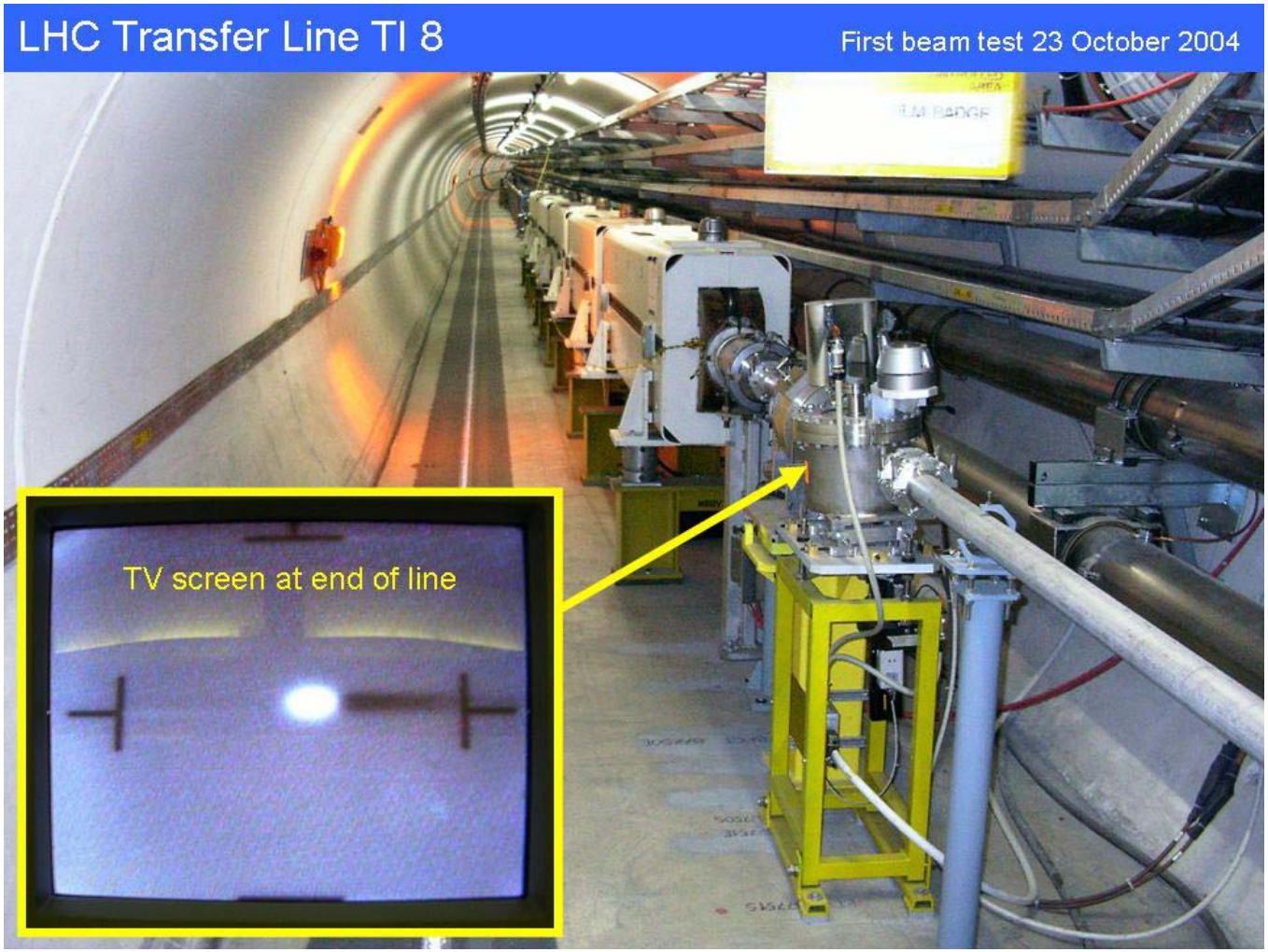
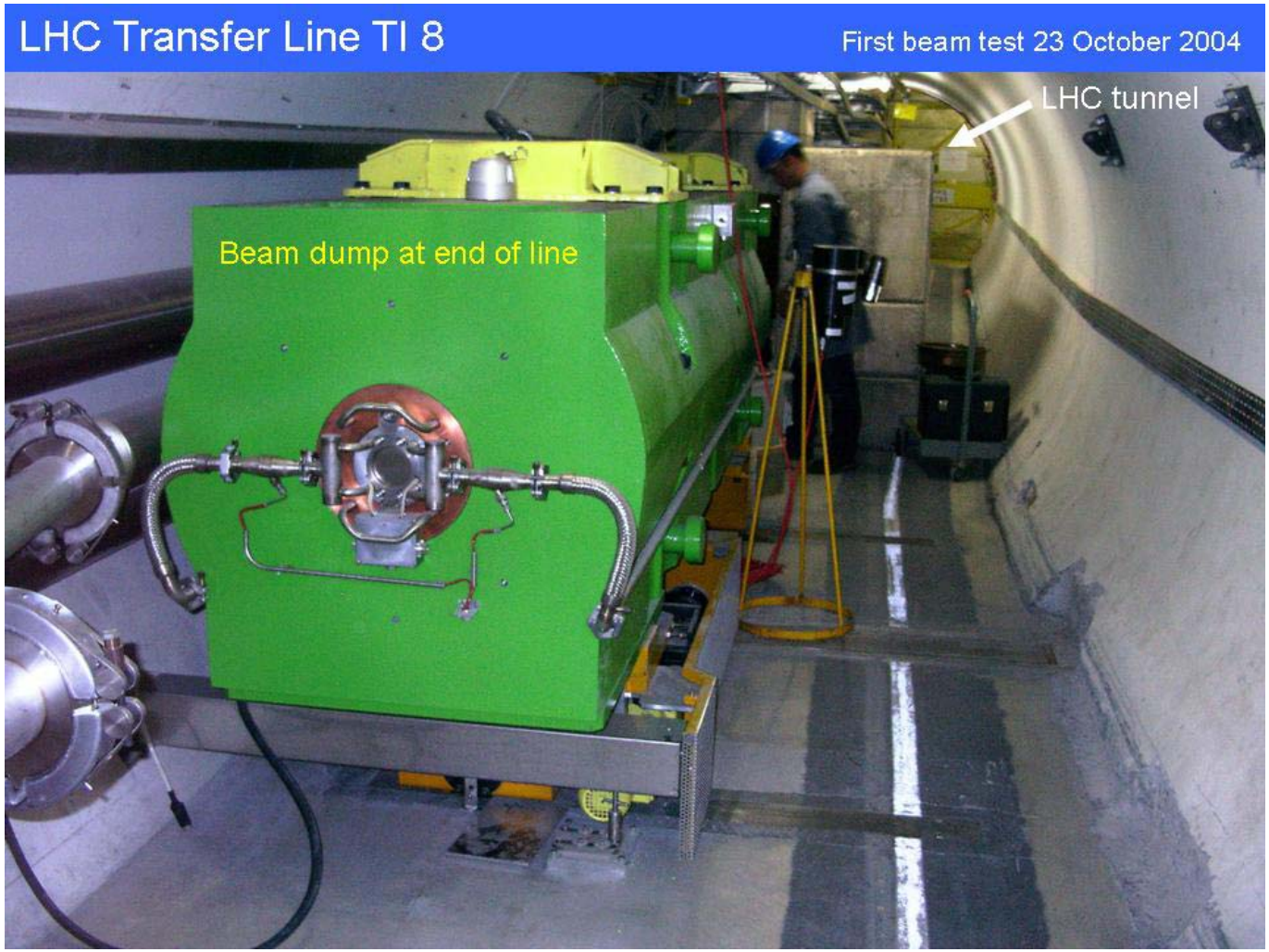
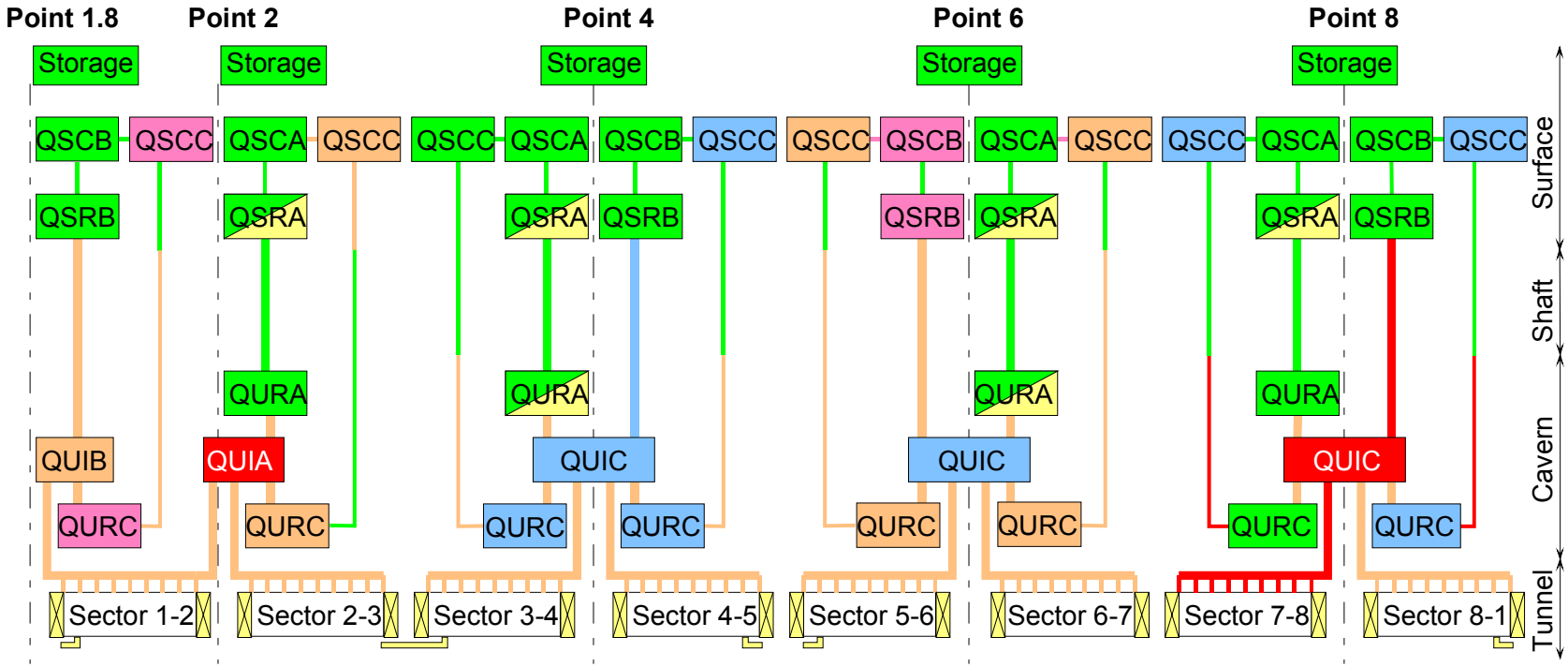


Results of TI8 test



Cryogenics Overview – Last Review



Legend

Cryogenic Distribution Line

QSC_(A,B,C): Warm Compressor Station
QSR_(A,B): Surface 4.5 K Refrigerator Cold Box
QURA: Underground 4.5 K Refrigerator Cold Box
QURC: 1.8 K Refrigeration Unit Cold Box
QUI_(A,B,C): Cryogenic Interconnection Box

Electrical Feed Box

Superconducting Link

Commisionned & accepted

Under installation

Ordered (Contract placed)

Under commissioning

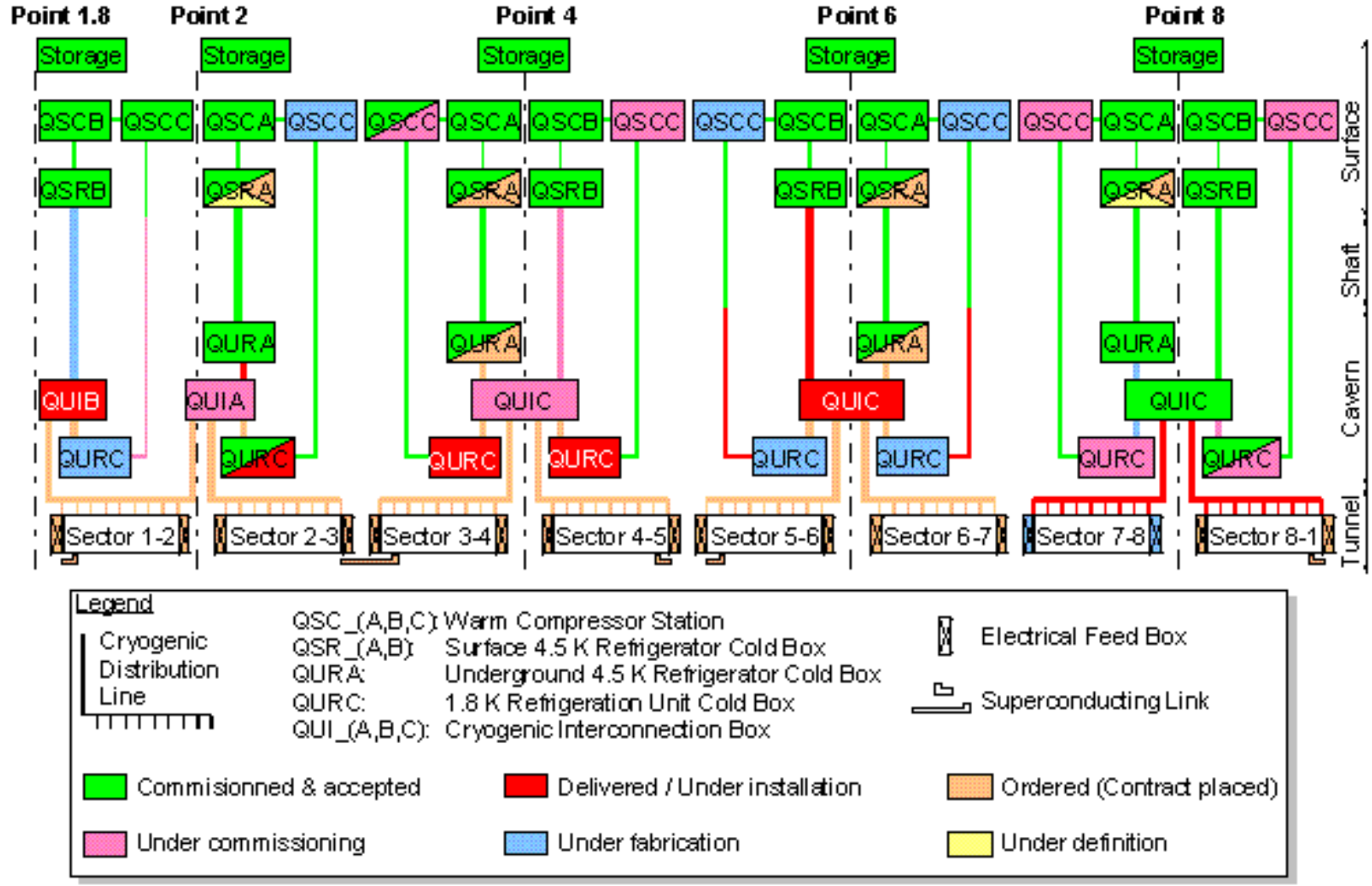
Under fabrication

Under definition

LHC Progress Dashboard

Accelerator Technology Department

Cryogenics overview



Updated 30 Nov 2004

Data provided by L. Tavian AT-ACR

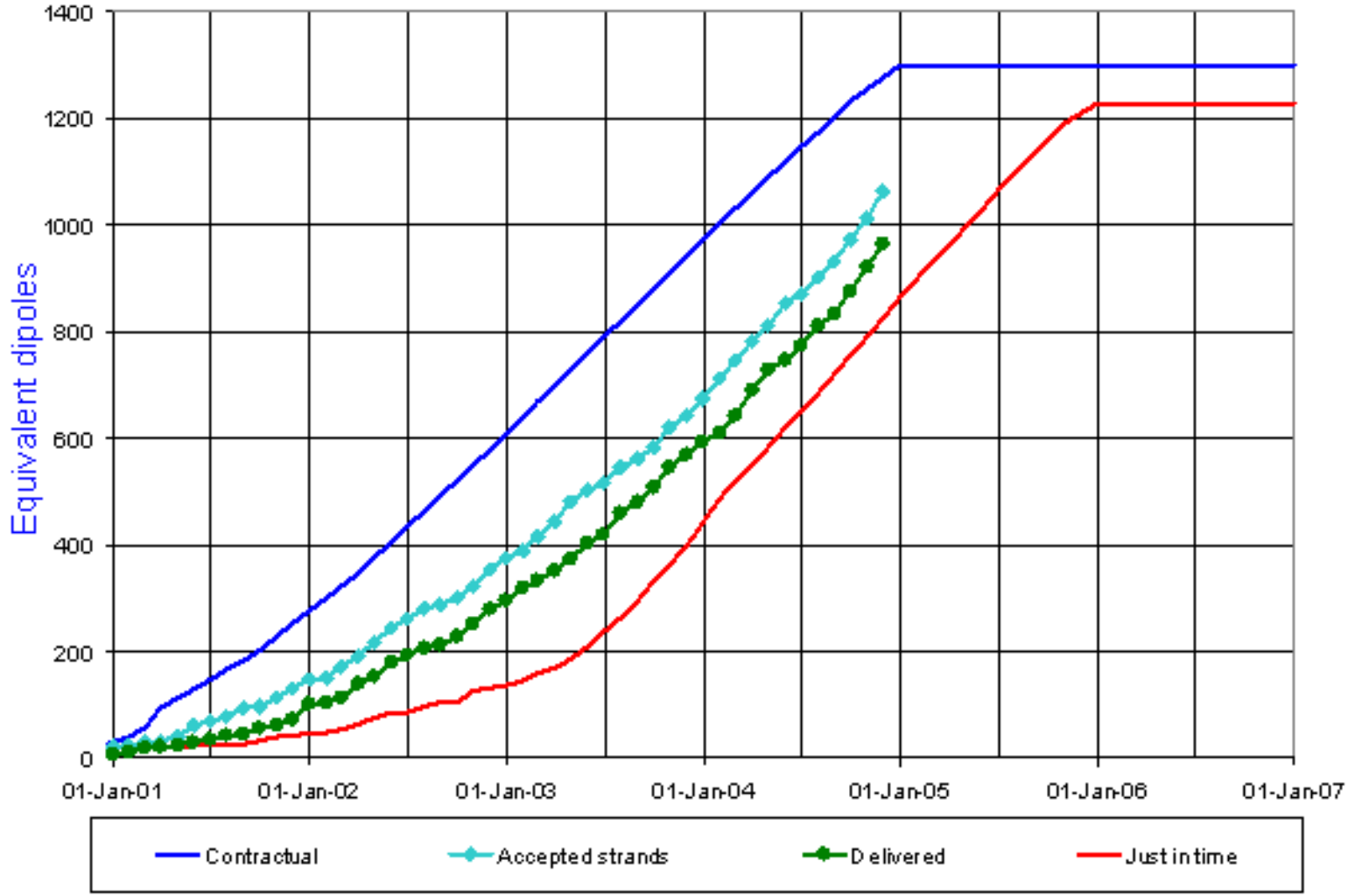
Superconducting Cables

- At Review Last Year
  - Nominal production rates attained by all suppliers
  - Steady performance achieved and maintained
    - critical current >6% above specification
    - transverse dimensions within tolerance of +/- 6 μm
    - strand magnetization and contact resistance under control
- This year we can see the effect of that
- SC Cables no longer a critical item

LHC Progress Dashboard

Accelerator Technology Department

Superconducting cable 1



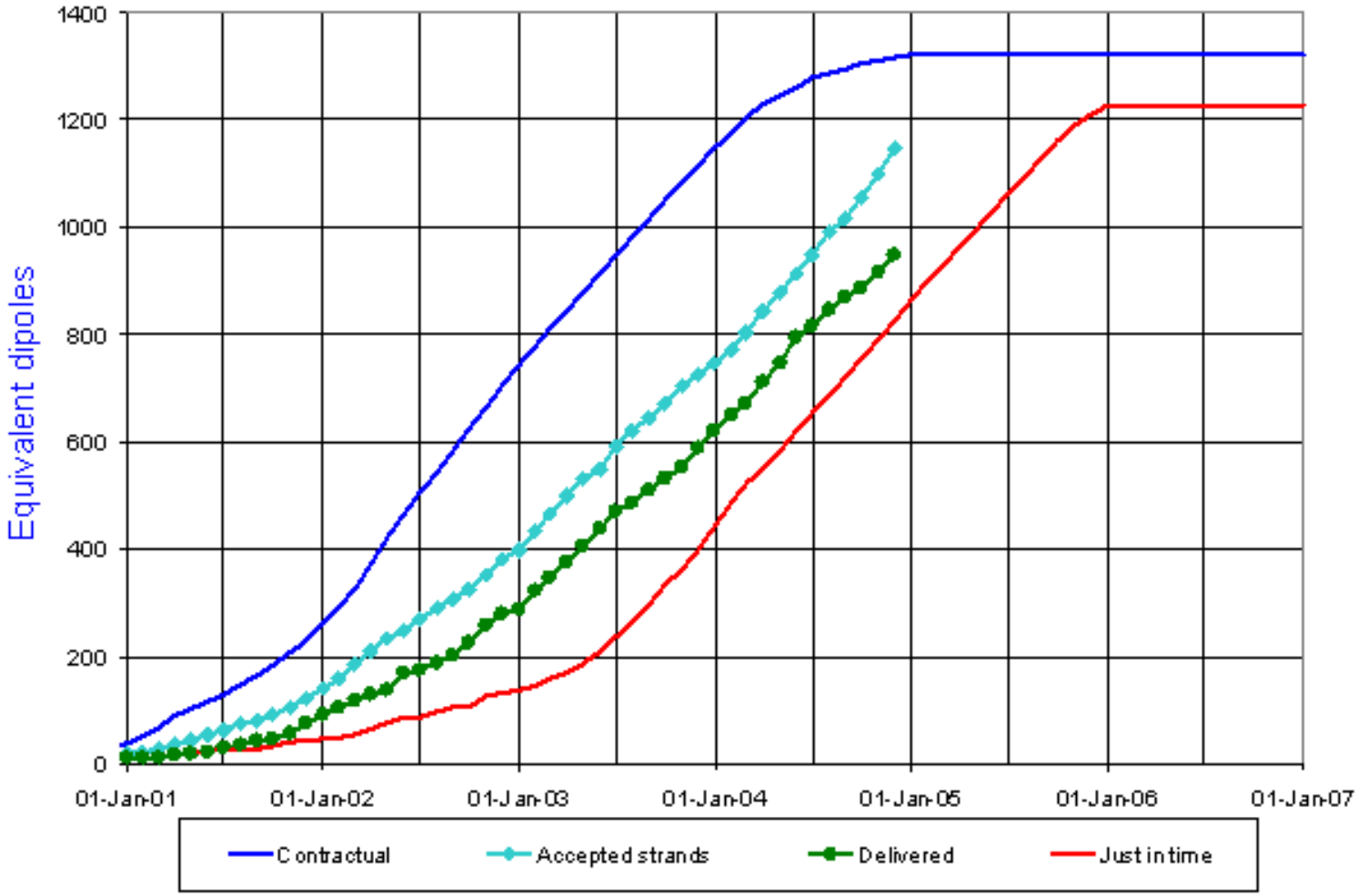
Updated 30 Nov 2004

Data provided by A. Verweij AT-MAS

LHC Progress Dashboard

Accelerator Technology Department

Superconducting cable 2



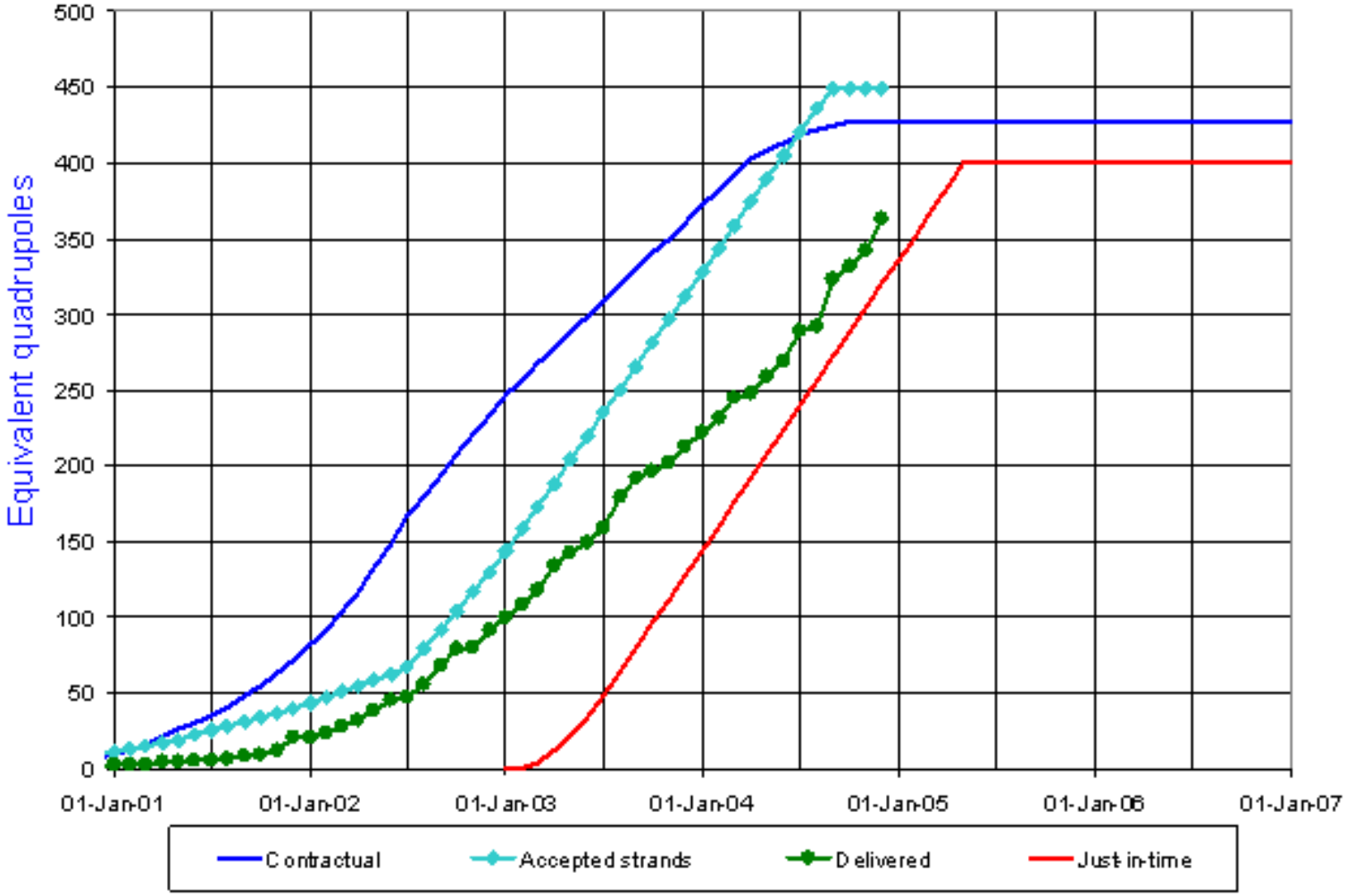
Updated 30 Nov 2004

Data provided by A. Verweij AT-MAS

LHC Progress Dashboard

Accelerator Technology Department

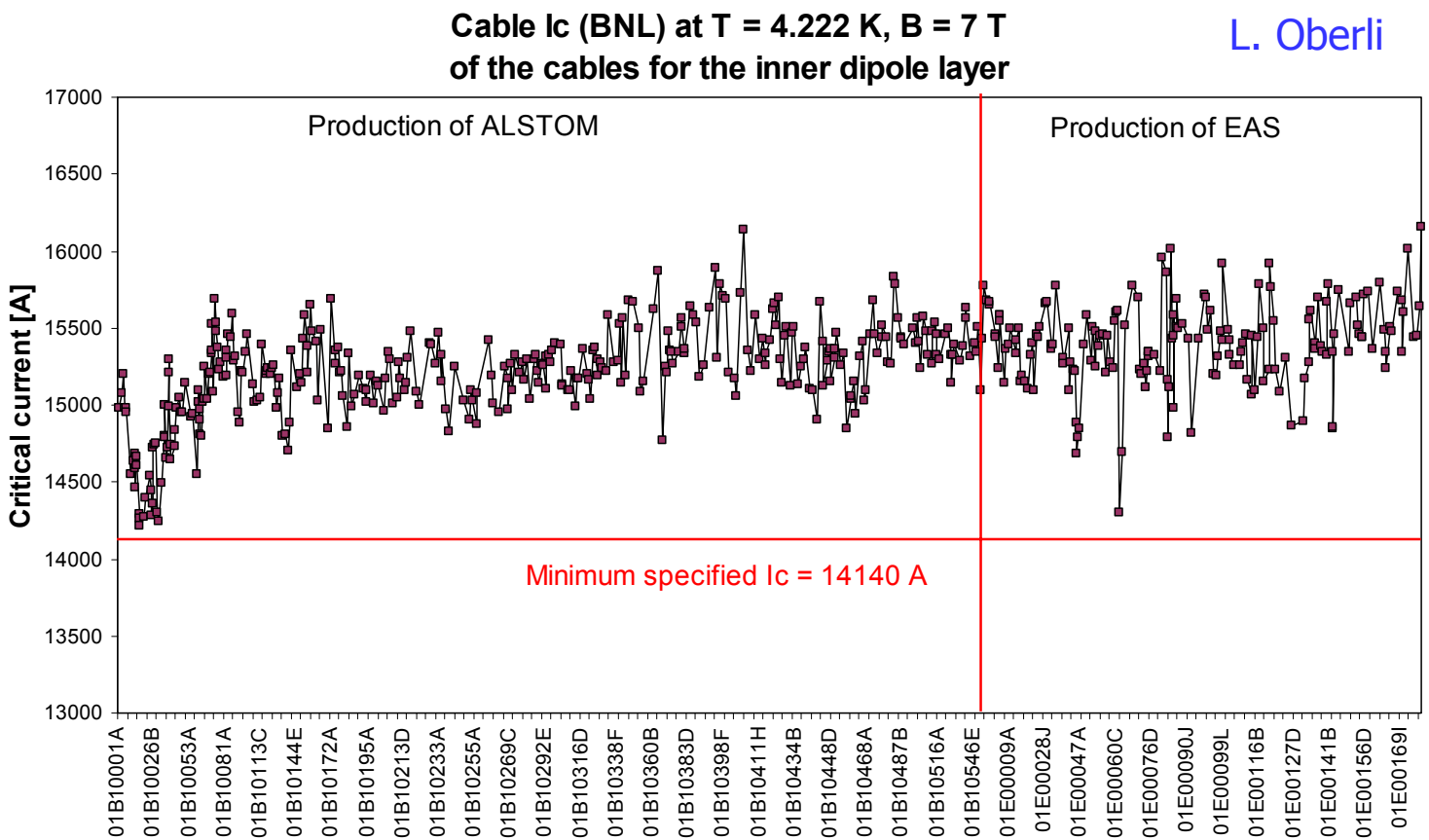
Superconducting cable 3



Updated 30 Nov 2004

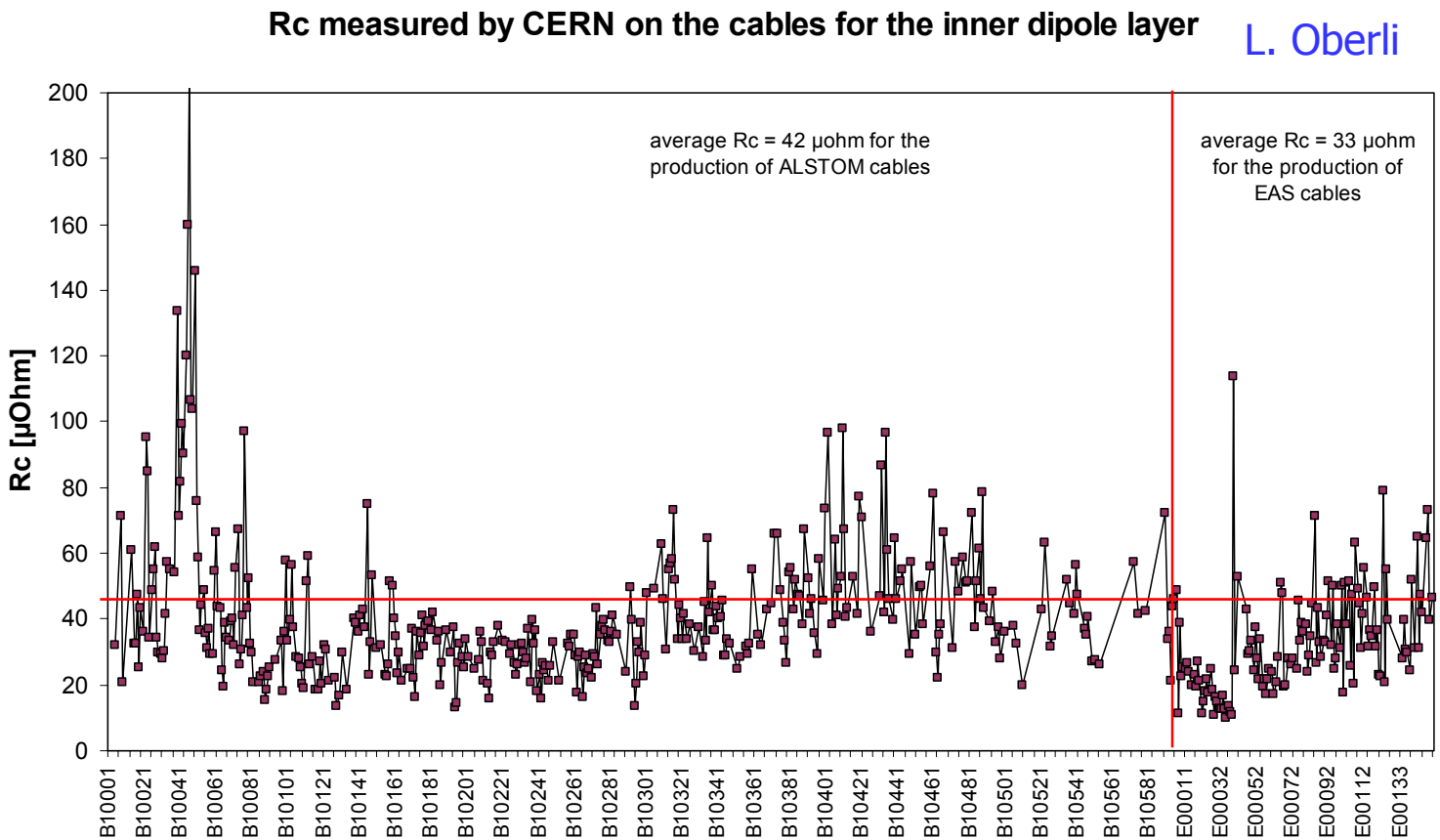
Data provided by A. Verweij AT-MAS

Critical Current
=> ultimate field, low-field remanance



Inter-strand Resistance

=> ramping losses, dynamic field quality



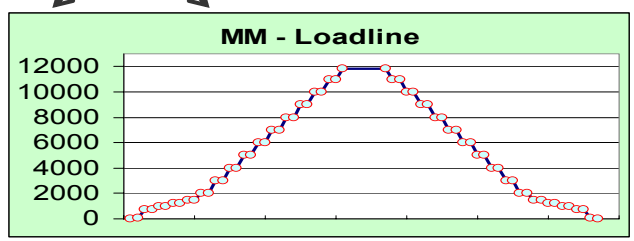
Cryogenic Magnet Test Station

Typical Cryogenic Test Sequence

L. Walckiers

12h	12h	12h	14h	26-30 h	12h	12h
Installation	Pumpdown	Cooldown 300K-90K	Cooldown 90K-1.9K	Tests at 1.9 K	Warmup	Disconnect

1h	1.5h	1.5h	5h	5h	3h	3h	1h	1.5h	5h
Electronics & instrumentation checks	HV tests at 1.9 K	Protection tests at 1.9 K	Training quench at 1.9 K	Training quench at 1.9 K	Dynamic magnetic measurements	Static magnetic measurements	Diode test	HV test at 1.9 K	Warmup quench



Duration of total sequence ~100 h

ROCLA vehicle

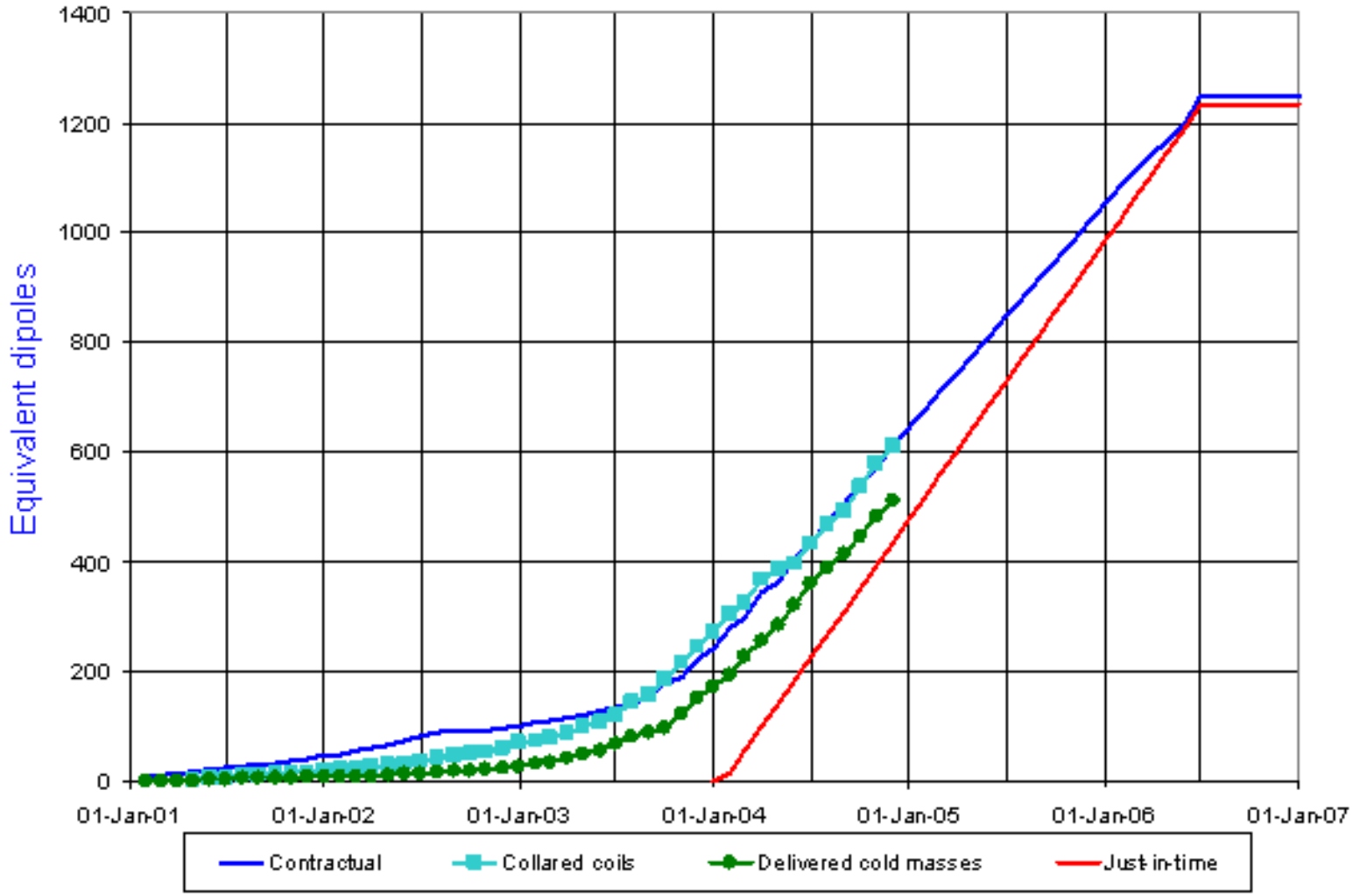
Rejected Dipoles

- 14 dipoles have been returned to the firms (of 200 tested).
- Six have been repaired and returned to CERN.
- Mostly insulation faults.
- Five dipoles returned to the same firm for unacceptable training, but now the problem has been fixed (insufficient pre-stress) and the firm is producing dipoles of the same quality as the other two.

LHC Progress Dashboard

Accelerator Technology Department

Dipole cold masses



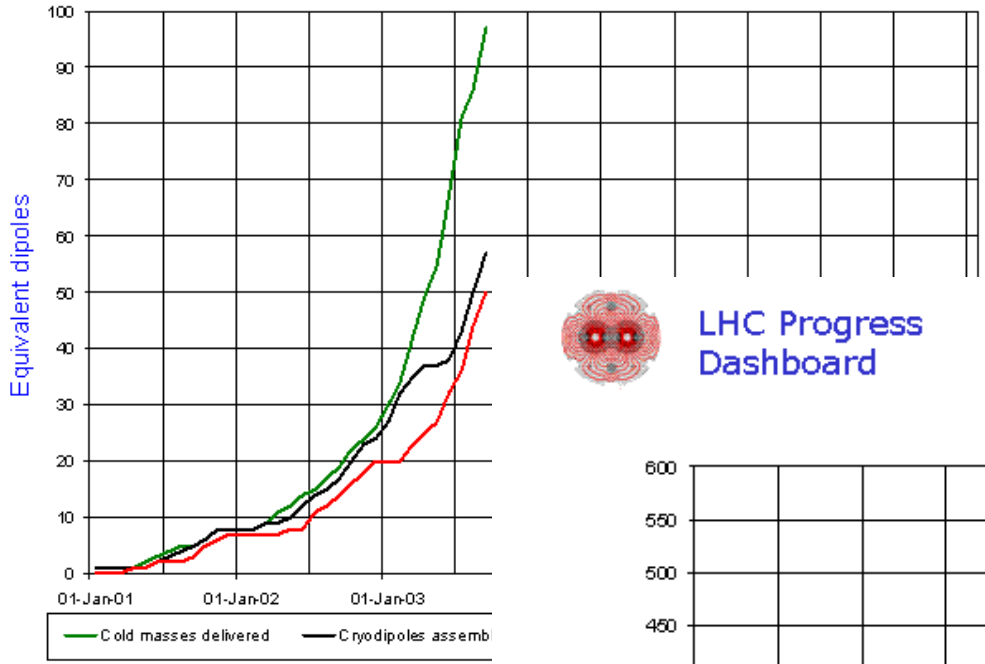
Updated 30 Nov 2004

Data provided by P. Lienard AT-MAS

LHC Progress Dashboard

Accelerator Technology Division

Cryodipole overview

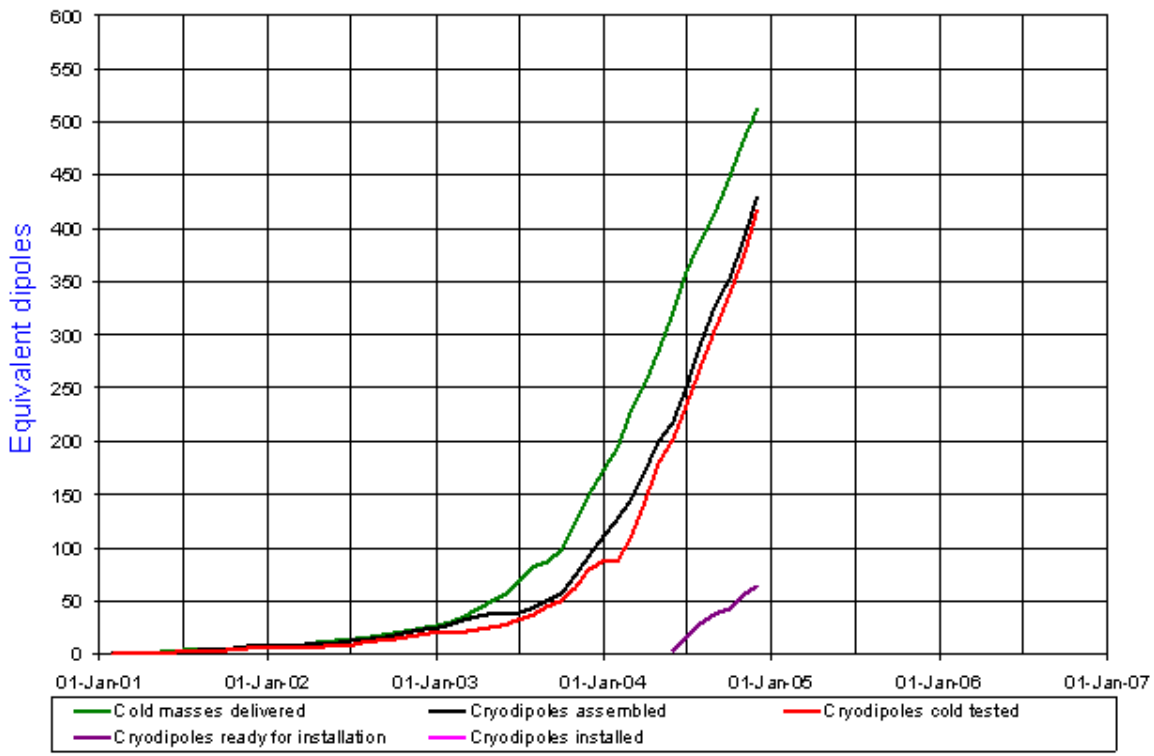


Updated 30 Sep 2003

LHC Progress Dashboard

Accelerator Technology Department

Cryodipole overview



Updated 30 Nov 2004

Data provided by D. Tommasini AT-MAS

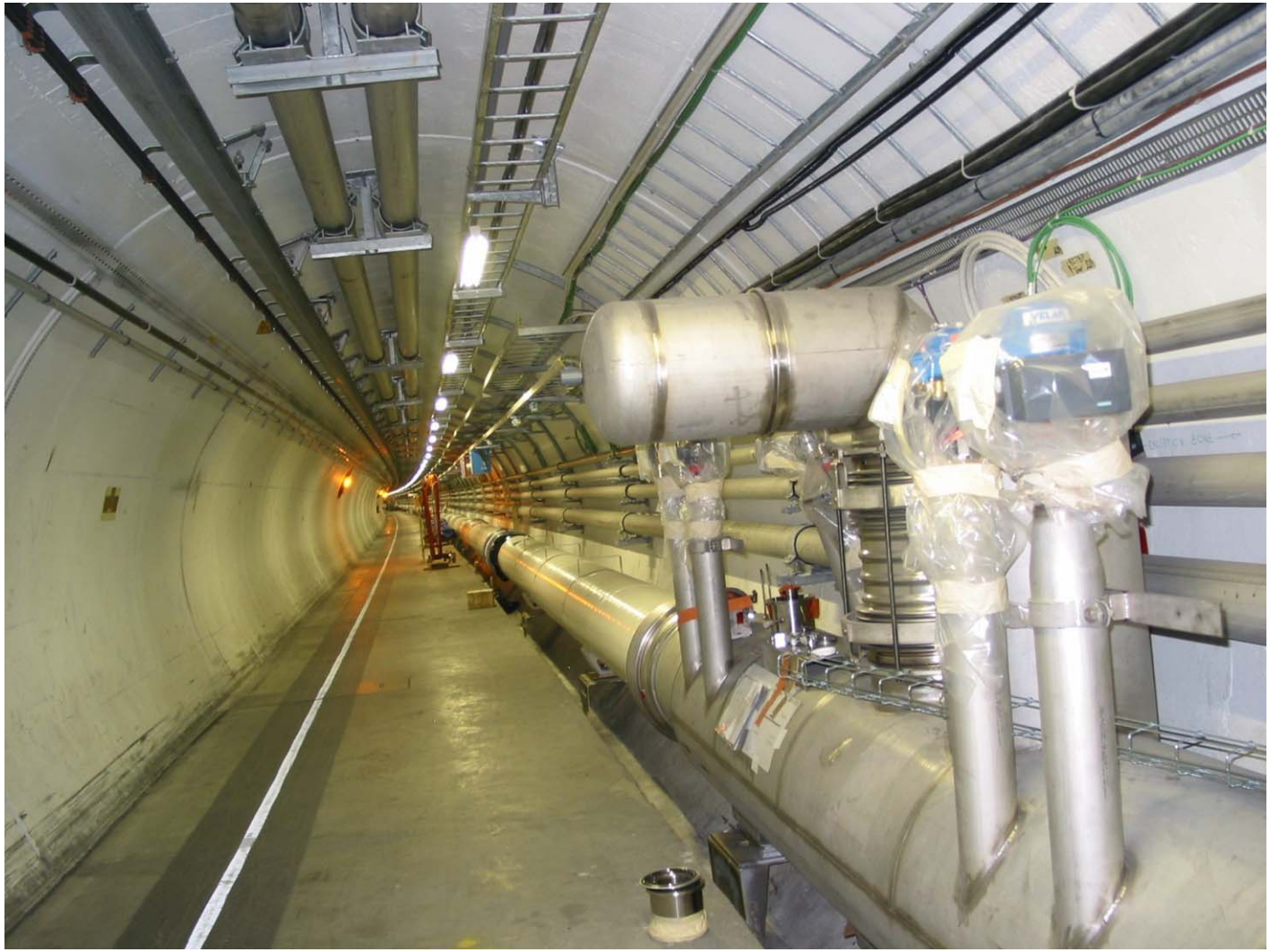
Tested Cryodipoles Stored at Prévessin

Cryoline (QRL) History

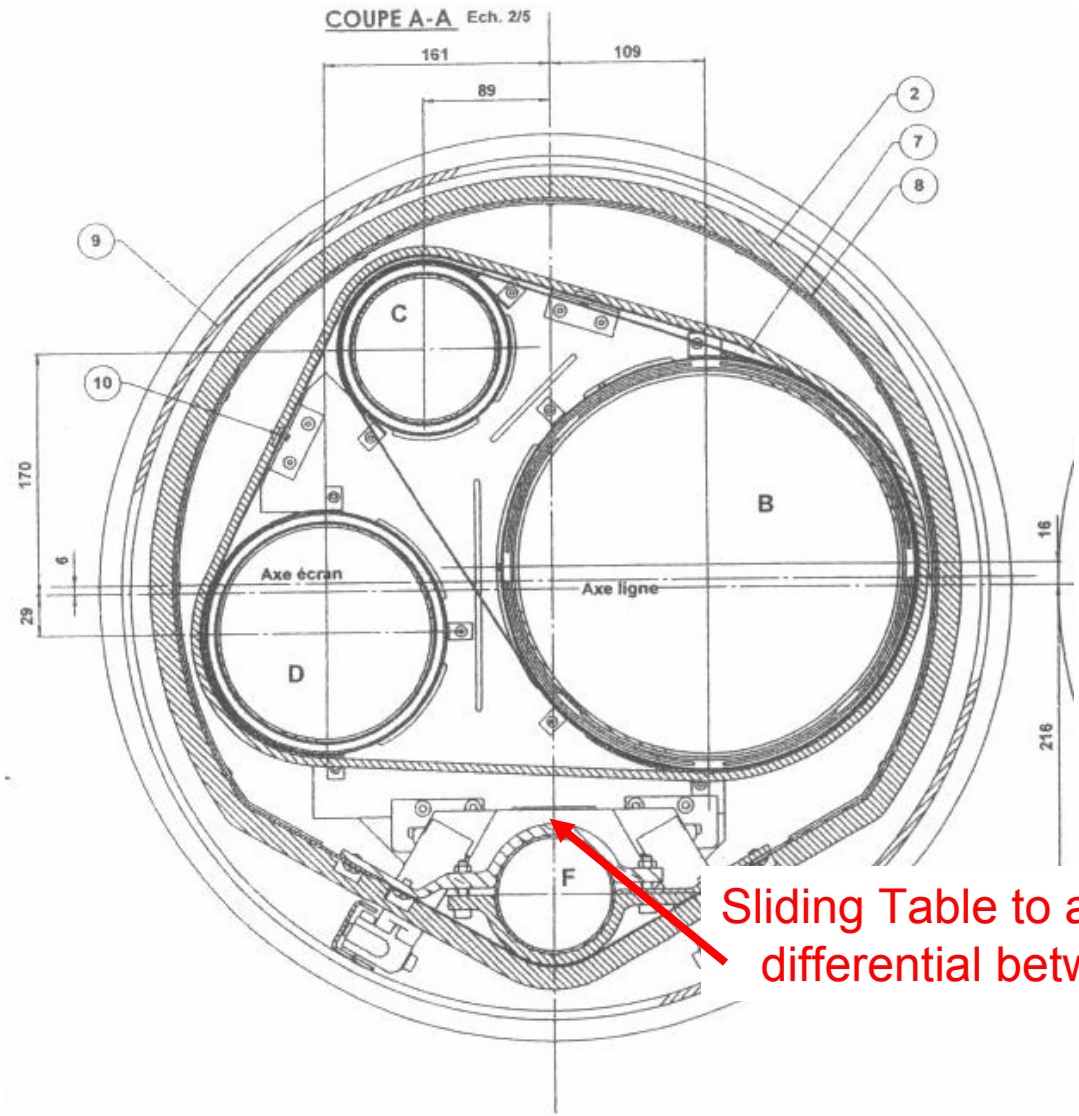
- Early June 2004 – leak detected on a pipe element. Extraction of pipe bundle mid-June revealed damaged tables.
- End of June 2004 – endoscopic examination revealed damaged tables in many pipe elements and service modules.
- CERN investigation reveals that tables are not moulded in conforming material. Resistance to shock an order of magnitude too low.
- July 2004 – CERN task force to verify QRL design. Production Restart Review 15 September 2004.
- Installation was scheduled to be restarted beginning of November.

Installation of Cryoline in Sector 7-8

QRL Service Module

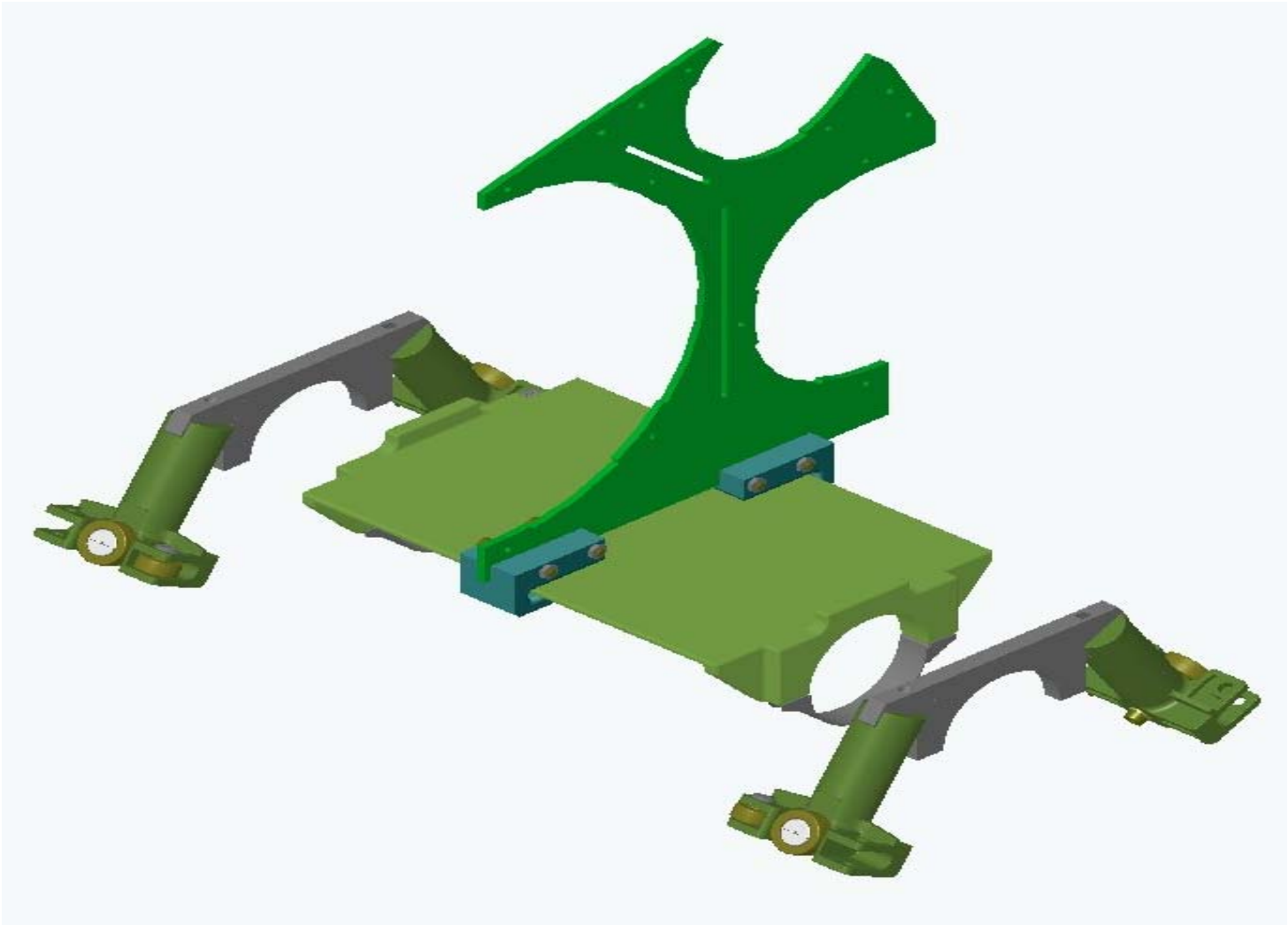


QRL Cross Section

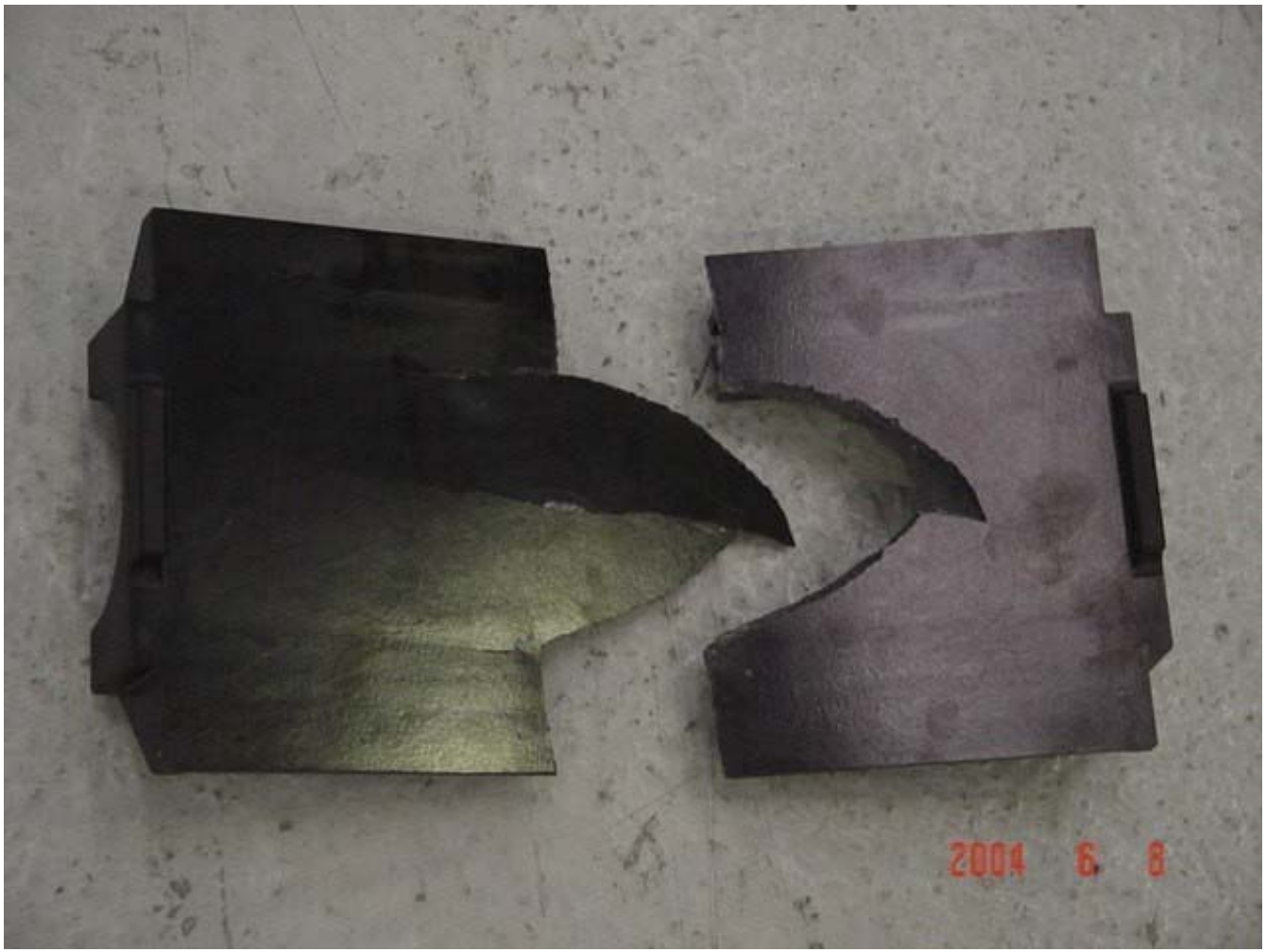


Sliding Table to allow for temperature differential between different lines

Sliding Table



Sliding Table



Cryoline (QRL) History

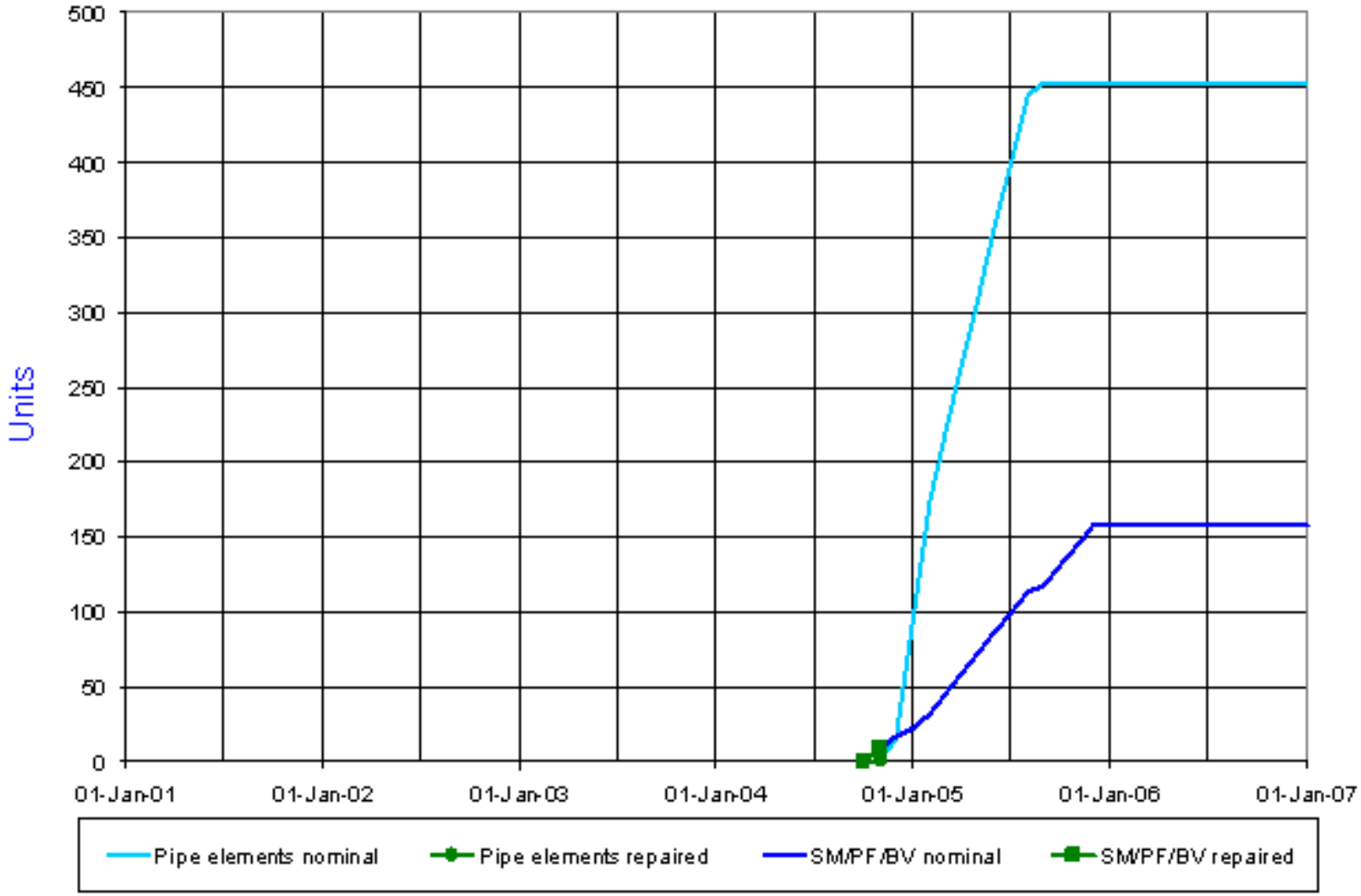
- About 600 pipe modules and 70 service modules need to be repaired. If it is done by AL, their production facility will be completely saturated.
- The repair will be made at CERN, in the main workshop for service modules and using dipole cryostating contract for pipe modules.
- Preparing for a concentrated repair effort, including working during the Christmas closure.
- The effect on the schedule can only be clearly assessed when installation restarts and is running smoothly.

LHC Progress Dashboard

TS-MME

Accelerator Technology Department

Cryogenic distribution line repair



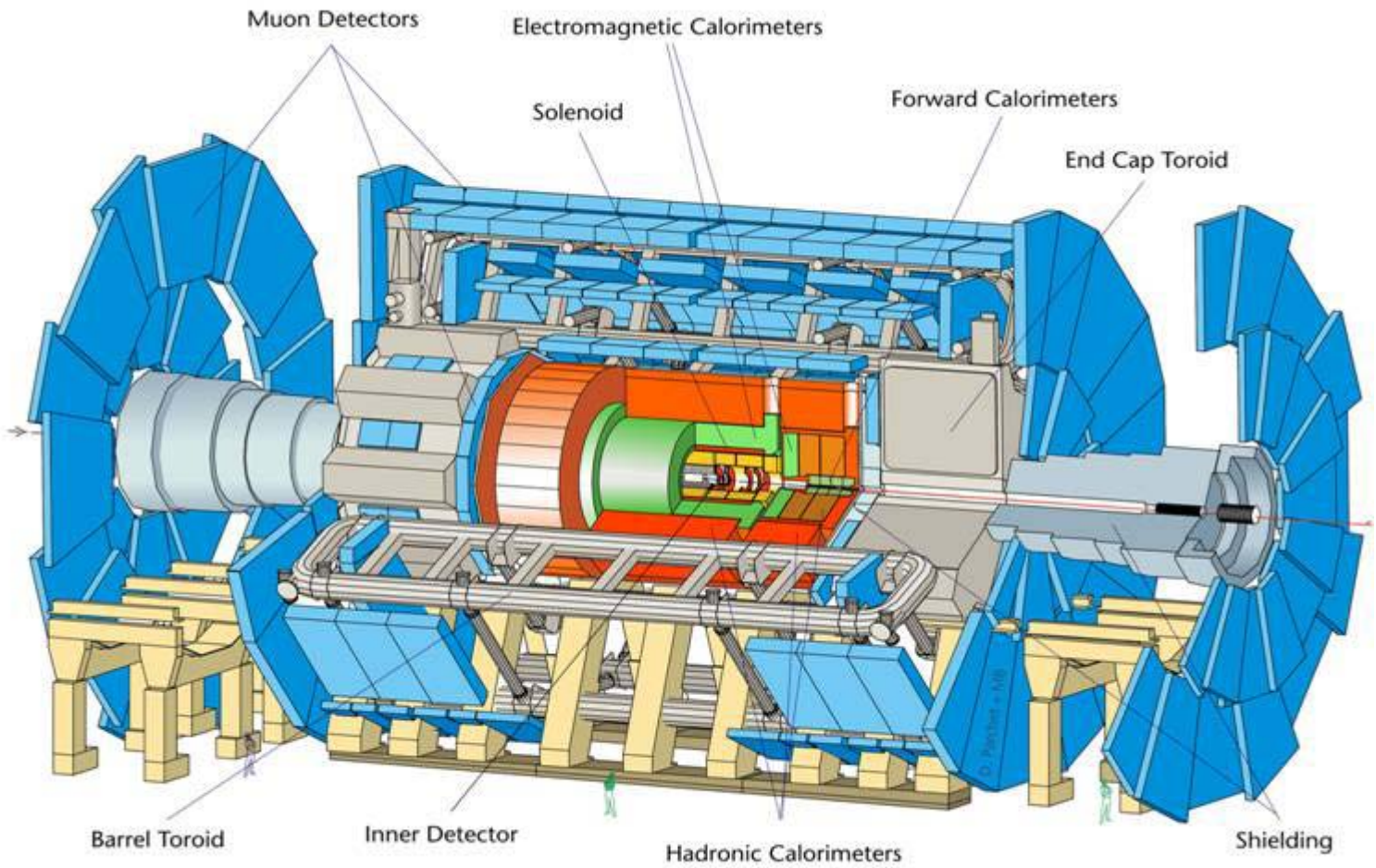
Updated 31 Oct 2004

Data provided by G. Riddone AT-ACR

Conclusions

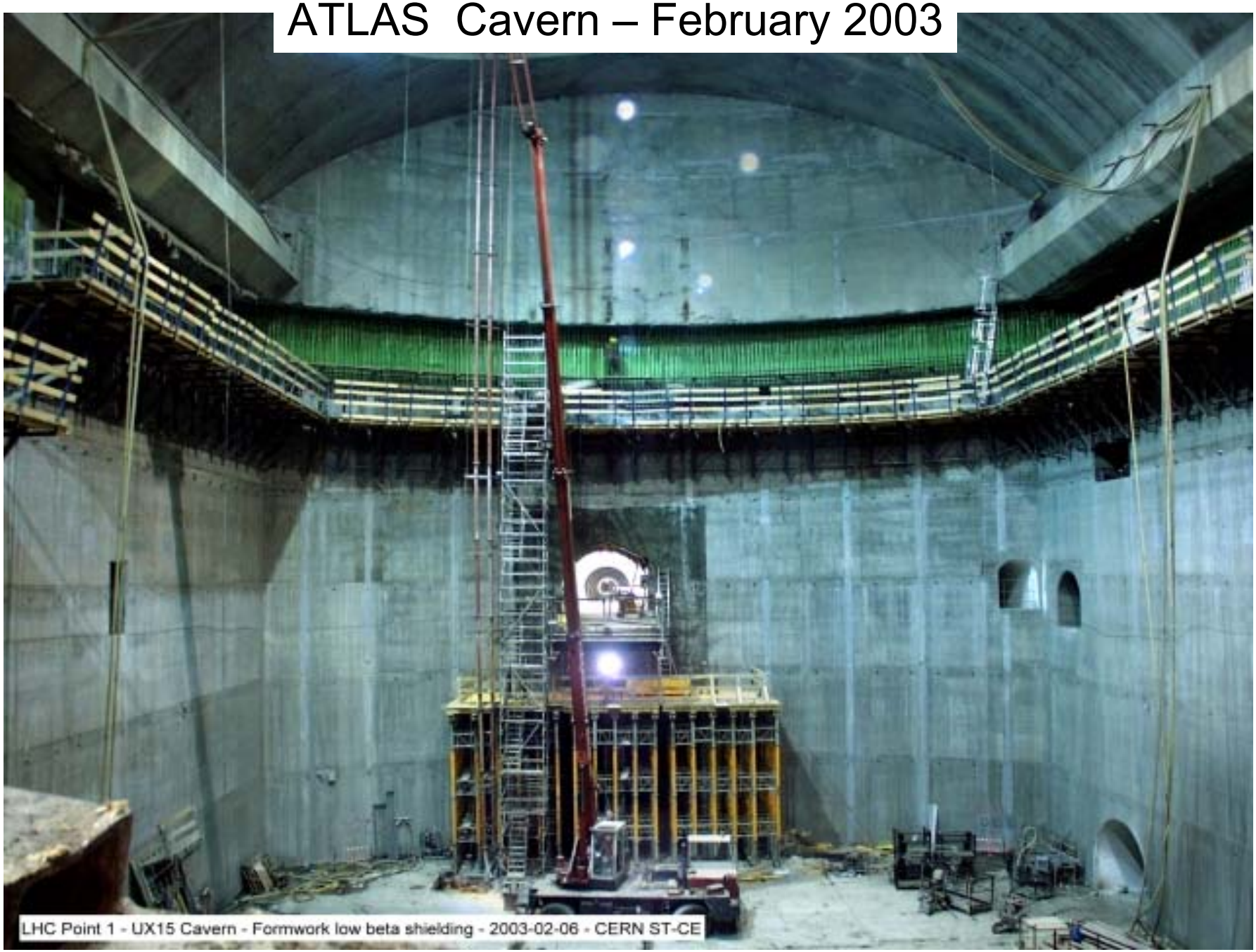
- Component delivery is proceeding at a rate compatible with a startup of the machine in summer 2007.
- The new QRL problems will cause delays in installation. The impact of these delays can only be reliably evaluated once QRL installation is proceeding smoothly.
- LHC has re-ordered tasks to minimize effect on schedule. Local cabling is now being done before QRL installation.
- At RRB plenary in October Aymar said that CERN was committed to an LHC startup in 2007 – and that this was feasible.

Construction Status of the Main ATLAS Detector Systems



Diameter	***25 m***
Barrel toroid length	***26 m***
Endcap end-wall chamber span	***46 m***
Overall weight	***7000 Tons***

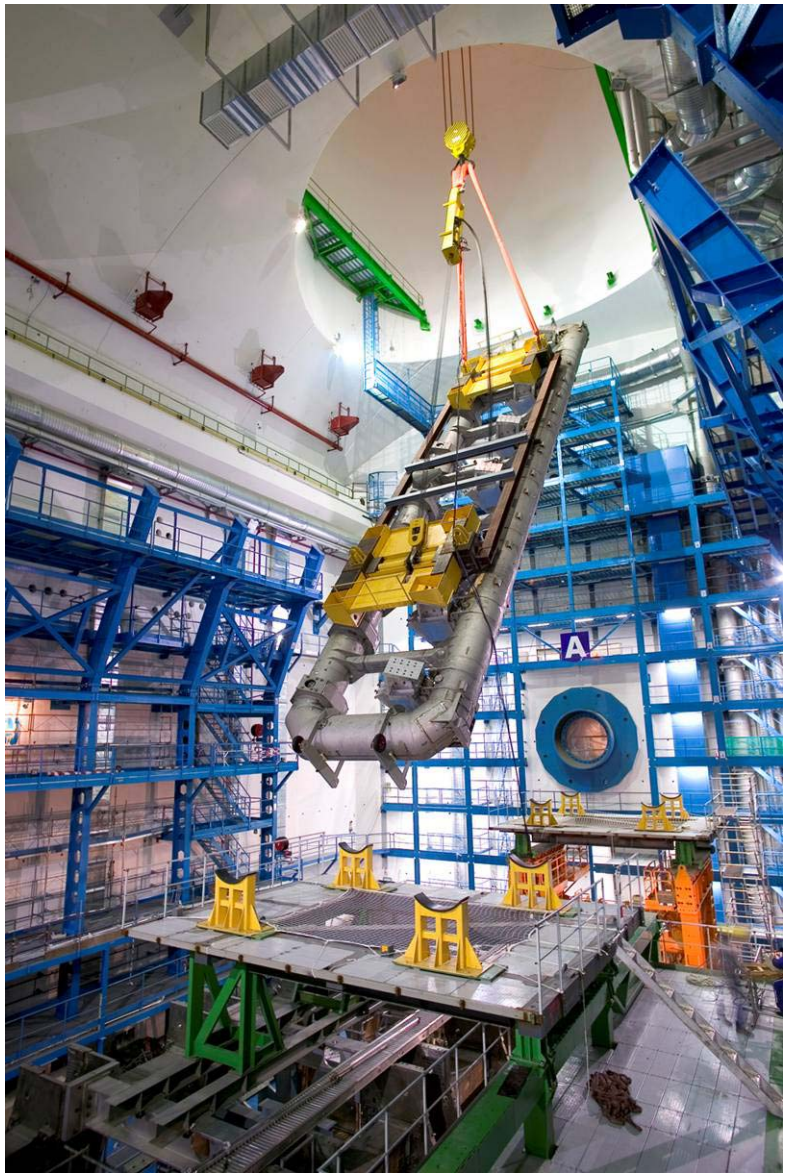
ATLAS Cavern – February 2003

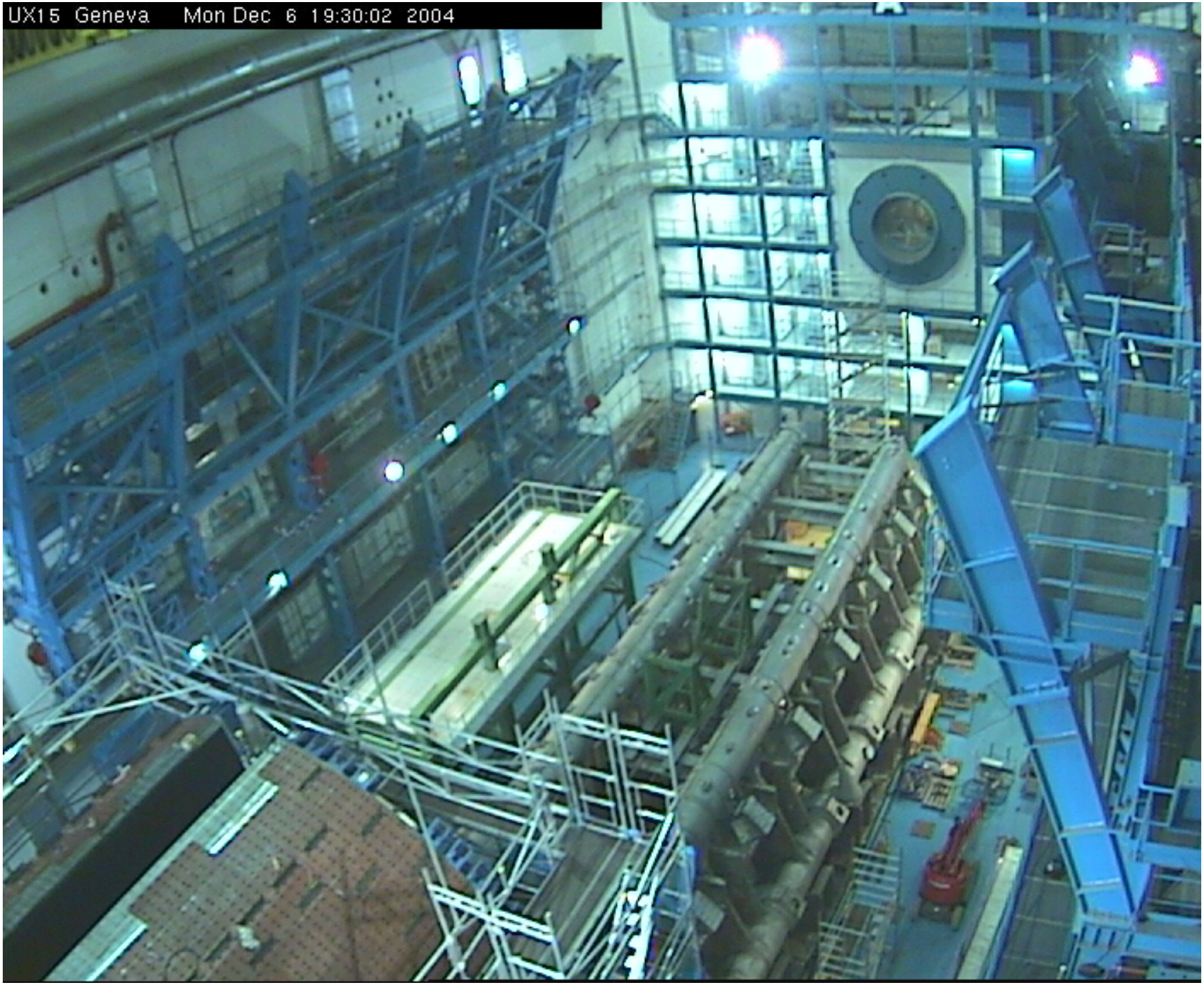


ATLAS Cavern – October 2003

ATLAS Cavern – November 2004

BT-1 installation in the cavern




UX15 Geneva Mon Dec 6 19:30:02 2004

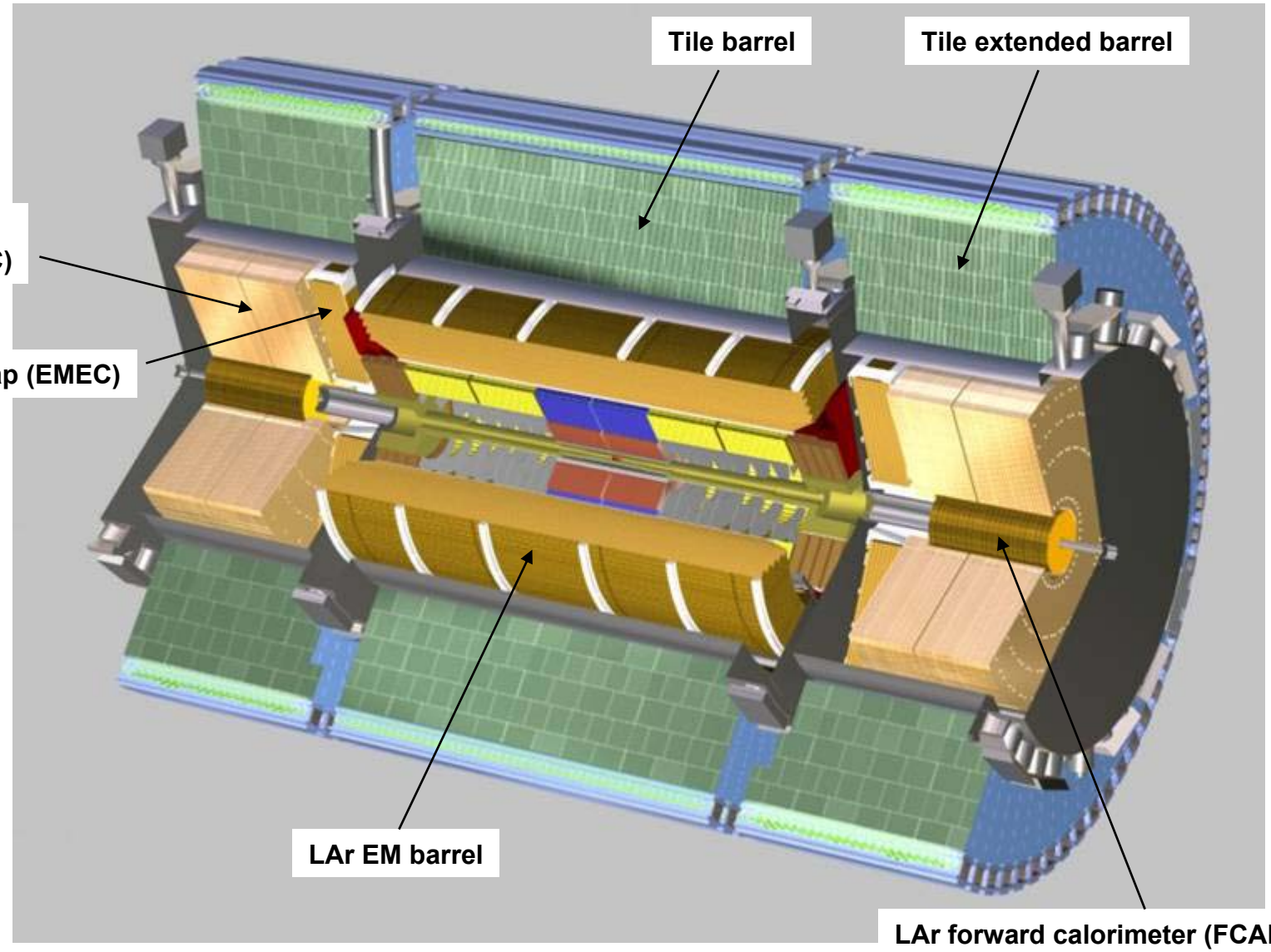
ATLAS End-cap Toroids

- All 16 coils for both ECTs are wound
  - 14 of them have been impregnated
  - all 16 are expected to be completed in January 2005
- Both ECT vacuum vessels are at CERN + all components for the assembly of the first ECT
- Preparations for ECT-1 integration have started in Hall 191 , on schedule for
  - cold mass completion in spring 2005
  - insertion into vacuum vessel in summer 2005

ECT vacuum vessel

Preassembled ECT-1 cold mass components at HMA before shipment to CERN

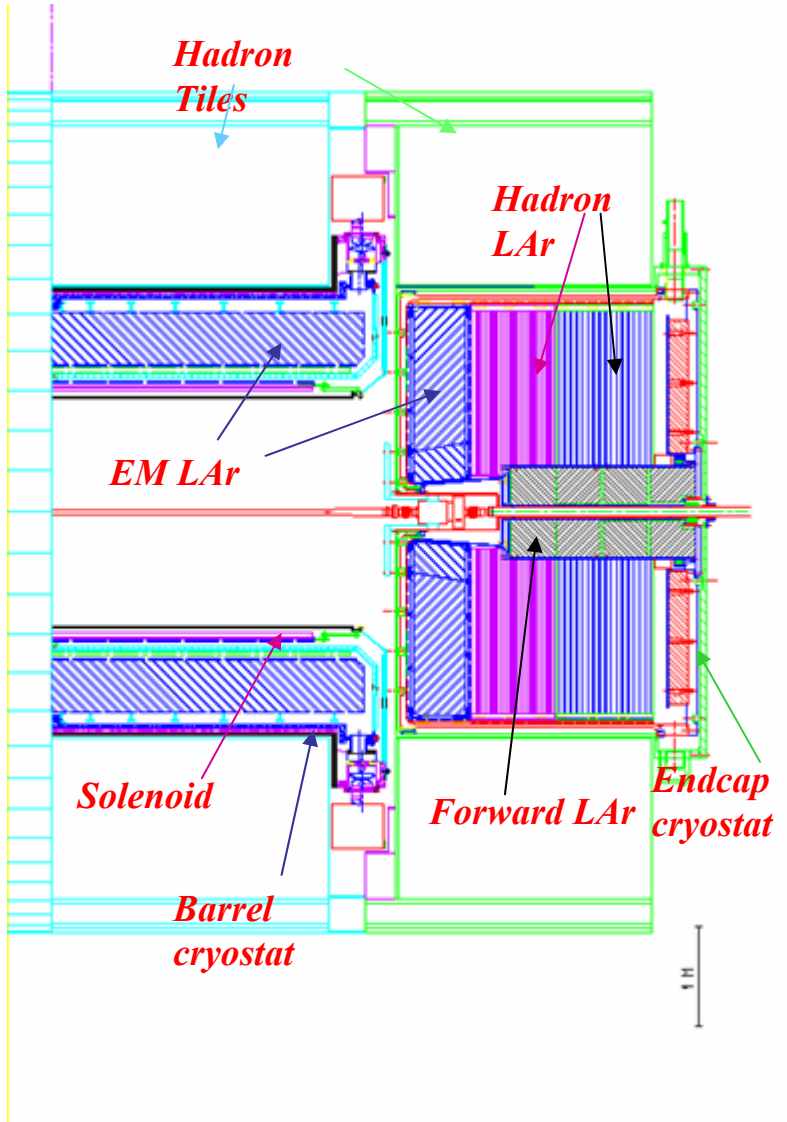
LAr and Tile Calorimeters



Liquid Argon Calorimetry

The LAr calorimetry (pre-samplers, EM, hadronic end-caps, and forward calorimeters)

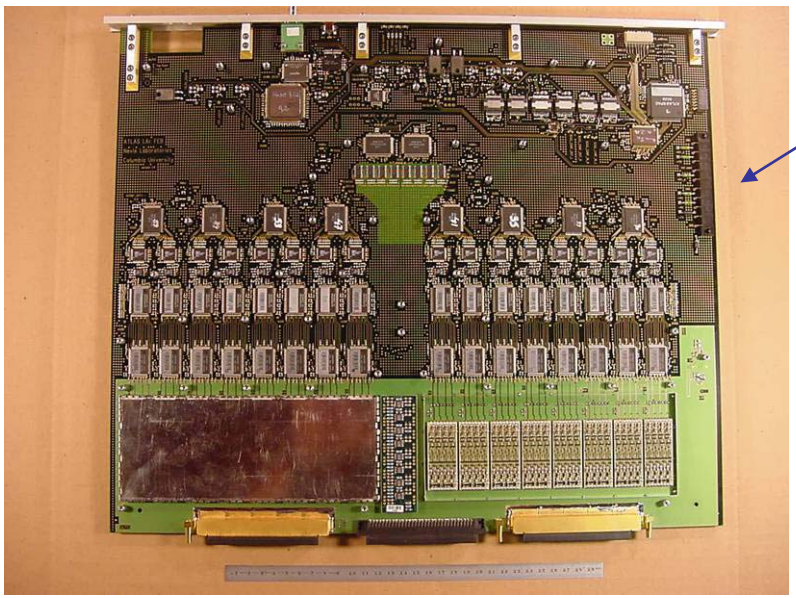
C-End: Integration complete, cold test underway ready for pit May 2005 (Move Sept 2005)
A-End: Integration well-advanced, cold test in summer 2005,ready for pit November 2005



LAr Front End Electronics

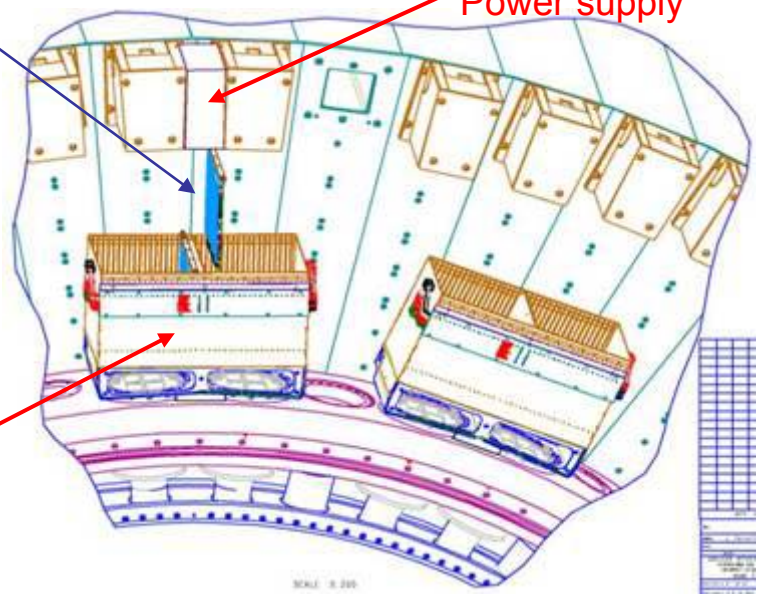
- Development and fabrication on track for most components, boards
- Issues:
  - Still have a delay in the rad-hard ST negative voltage regulators.
  - Rad-tolerant low voltage power supplies finally in fabrication
  - Problem encountered with a special timing circuit (QPLL)

    FE board production is currently stopped



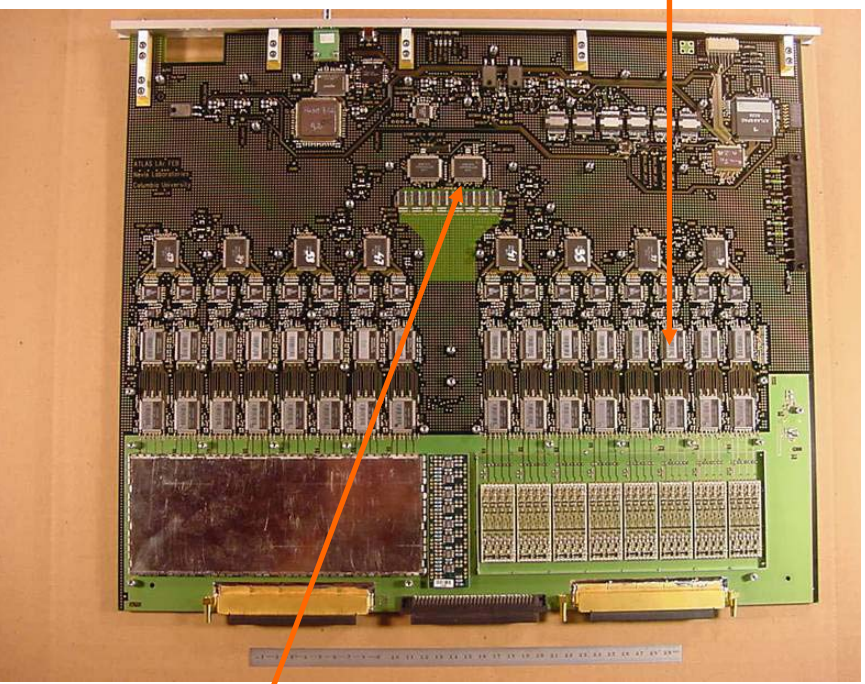
Rad-tolerant FE board
(1524 boards, each 128 channels)

Power supply



Front-end crate electronics

Front-End Board Schedule



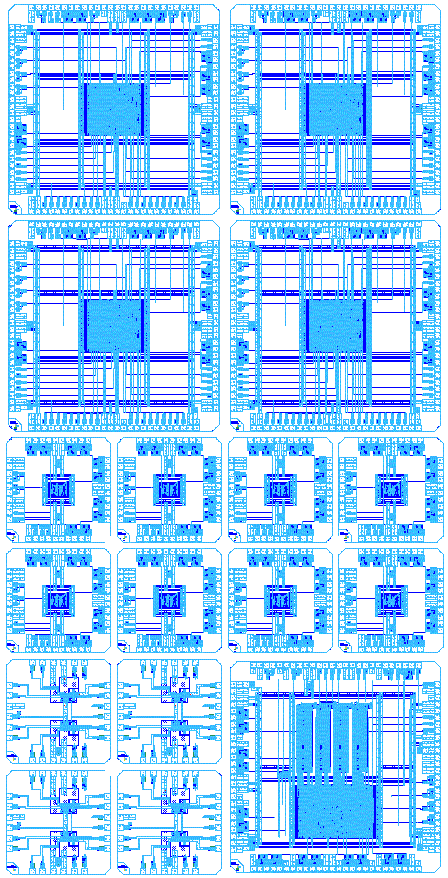
- Light Blue is schedule before Delay at Bottom

- 2003 October: full 14 board test.
- 2004 March: start of front-end board production
- 2004 November: begin front-end board installation (1.25 days/crate)
- Stopped late summer due to QPLL problems
- Solution found – mezzanine board
- Resume Production Feb 2005
- Six Month Delay

No Final Schedule at present for Installation
Not affected by production delay

- Jan 05 – Aug 05: Phase 1 – EM barrel at truck
- Aug 05 – Sep 05 : Phase 2 – EM Barrel at IP
- Dec 05 – Jul 06: Endcap C
- Feb 06 – Aug 06: Endcap A

Deep Submicron Chip Status



- Each front-end board requires: 2 SCA controllers, 8 gain selectors, 7 clock fanouts.
- Use deep submicron (DSM) instead of DMILL ($538k cost savings).
- Given small quantity requirements for DSM production, all three designs were implemented on same wafers ($500k cost savings).
- Still room for other chips so collaborated with NIKHEF ($42k cost savings).
- 2002 December: finalized reticle.
- 2-wafer engineering run (362 reticles).
- 2004 Summer: finished bench testing all SCA controller parts and delivered to NEVIS.

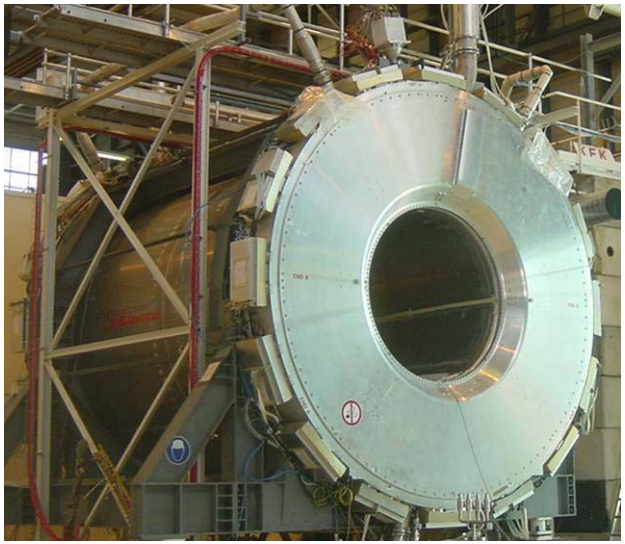
Other Electronics Contributions

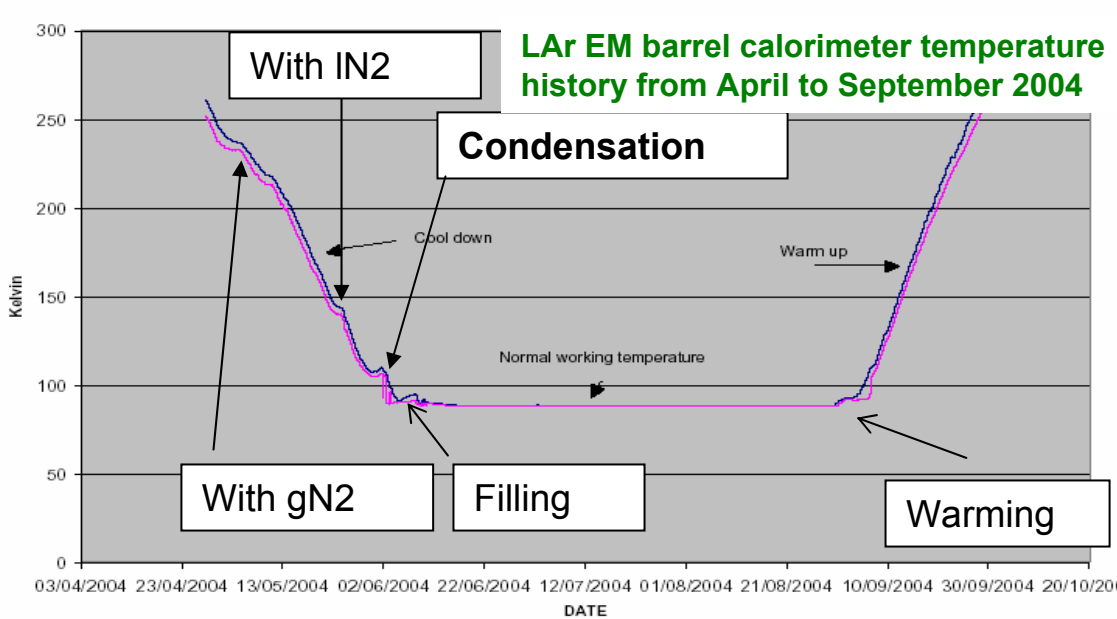
- With aid of RTI grant, meet commitments to front-end crate system.
- Acquired radiation tolerant QPLL and Xtals (phase-locked loop and crystal oscillator).

LAr EM Barrel Calorimeter and Solenoid Commissioning on Surface

Cold system test of barrel LAr EM calorimeter and the solenoid in Hall 180 completed (including excitation to full current (8 kA) for the solenoid)

Warmed up again & transported to the cavern on 26th October as scheduled





Installation of the Barrel Cryostat on 28th October 2004 in the pit onto the lower part of the Barrel Tile Calorimeter

EndCap Integration Summary

EndCap C

- Cryostats preparations
  - Feed throughs, pedestals, warm cables installation
  - Finished in spring 2003
- Electromagnetic EndCap insertion
  - PS installation in June 2003
  - EM wheel insertion in Aug. 2003
- Hadronic EndCap insertion
  - HEC1 insertion in Sept. 2003
  - HEC2 insertion in Oct. 2003
- Forward calorimeter insertion
  - FCal insertion in Aug. 2004
- Final closing of the cryostat
  - Final closing and welding of cold vessel July – Oct. 2004
  - Closing warm vessel Oct. 2004
- Cool down for the cold commissioning
  - Started Nov 2004
  - Cool down scheduled to take 8 weeks
- Delivery to the pit
  - Planned for Sept. 2005

EndCap A

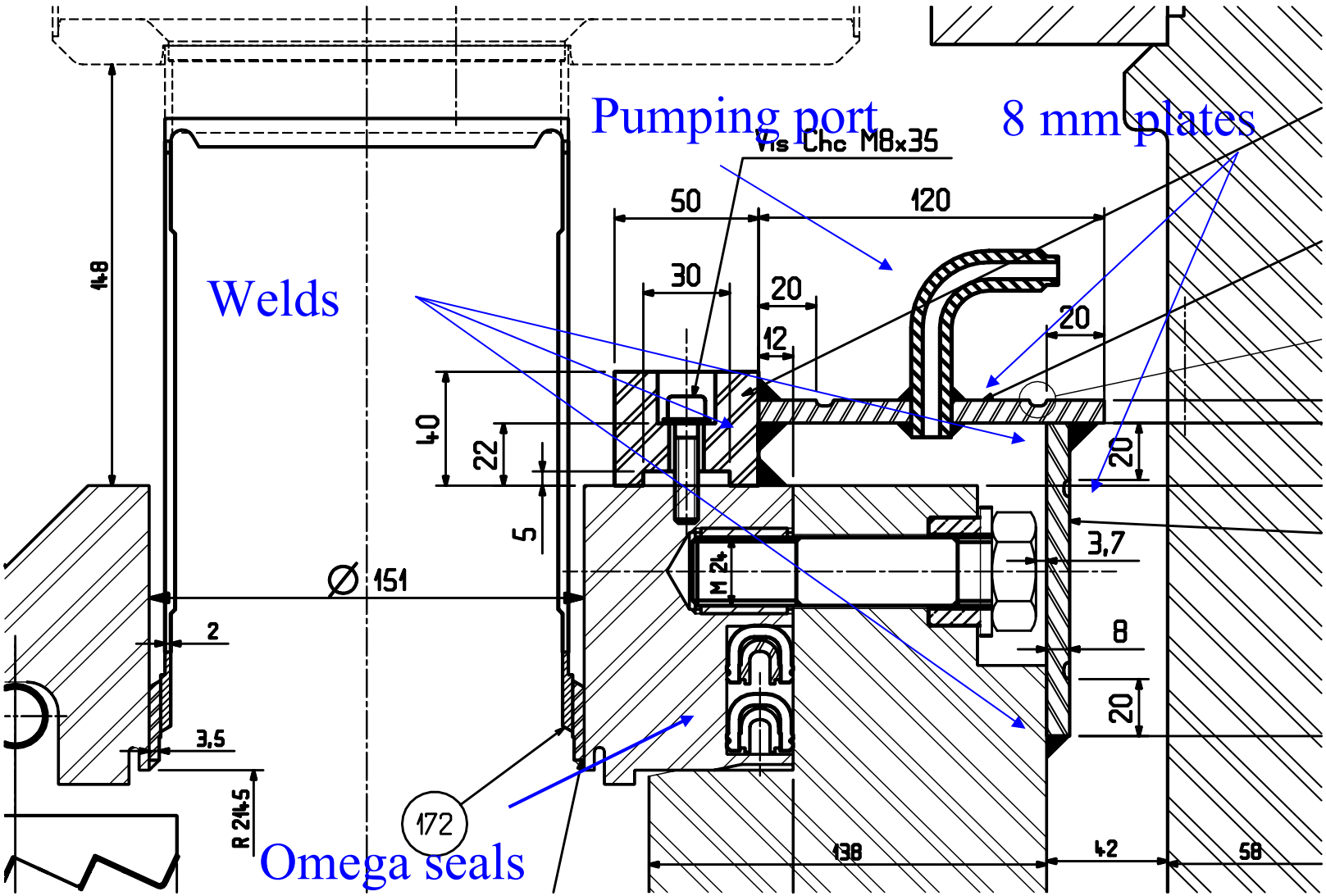
- Cryostats preparations
  - Feed throughs, pedestals, warm cables installation
  - Finished in fall 2003
- Electromagnetic EndCap insertion
  - PS installation in May 2004
  - EM wheel insertion in July 2004
- Hadronic EndCap insertion
  - HEC1 insertion in Aug. 2004
  - HEC2 insertion in Sept. 2004
- Forward calorimeter insertion
  - FCal insertion planned for Jan. 2005
- Final closing of the cryostat
  - Final closing and welding of cold vessel planned for Dec. 2004 – Feb. 2005
  - Closing warm vessel planned for Feb. 2005
- Cool down for the cold commissioning
  - Planned to start in May 2005
  - Cool down scheduled to take 8 weeks
- Delivery to the pit
  - Planned for Nov. 2005

EC Cryostat Preparation

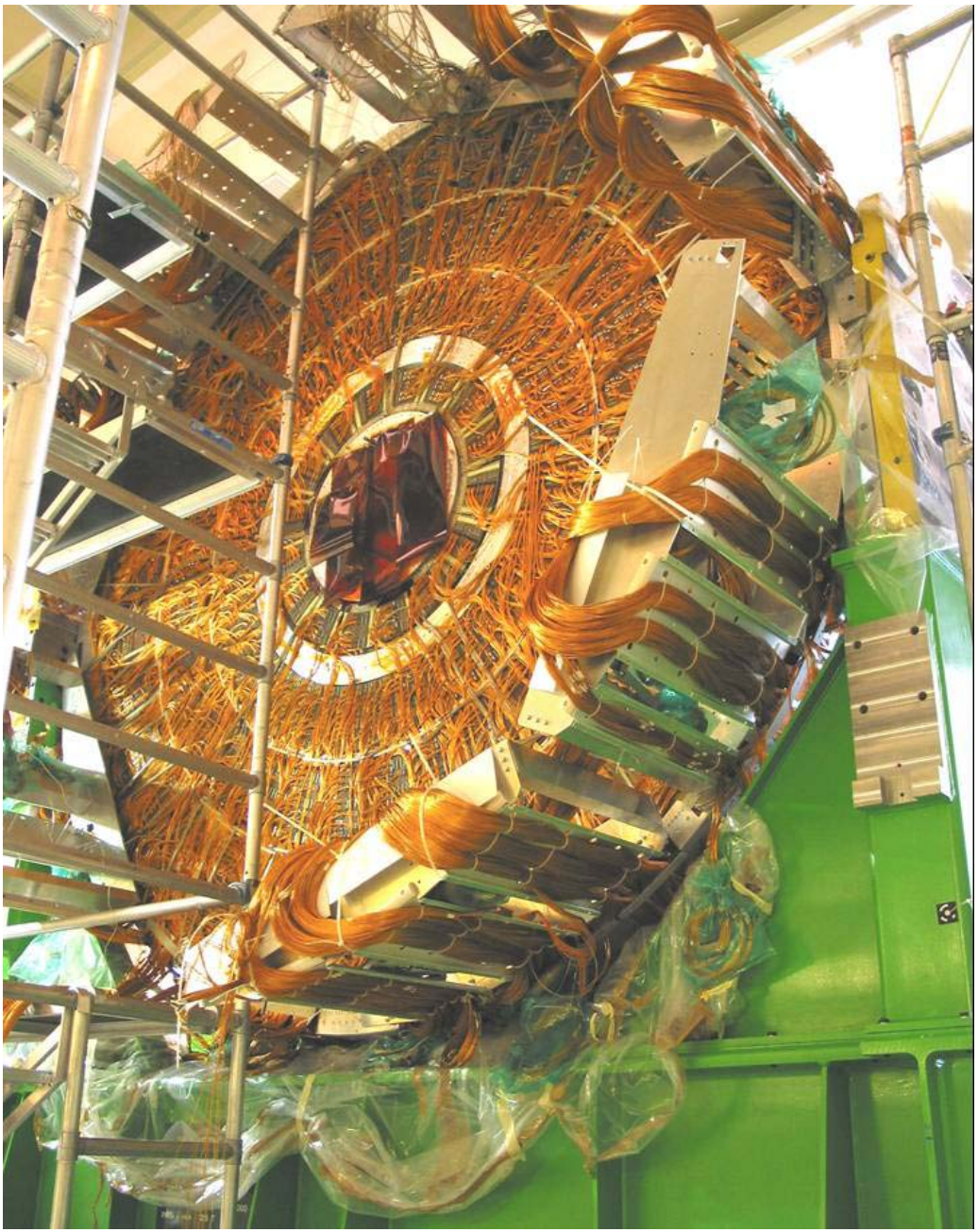
- Cryostat preparation:
  - Feedthrough Installation
  - Pedestal installation, warm cabling, testing
- Rotation
- Pressure test of the empty cryostat
  - ECA pressure test winter 2004
  - Leak of interior large Ω-seal at 2.6bar
    - below working pressure (2.7bar)
  - Exterior large Ω-seal started to leak at 2.8bar
  - Leak re-disappeared at lower pressures

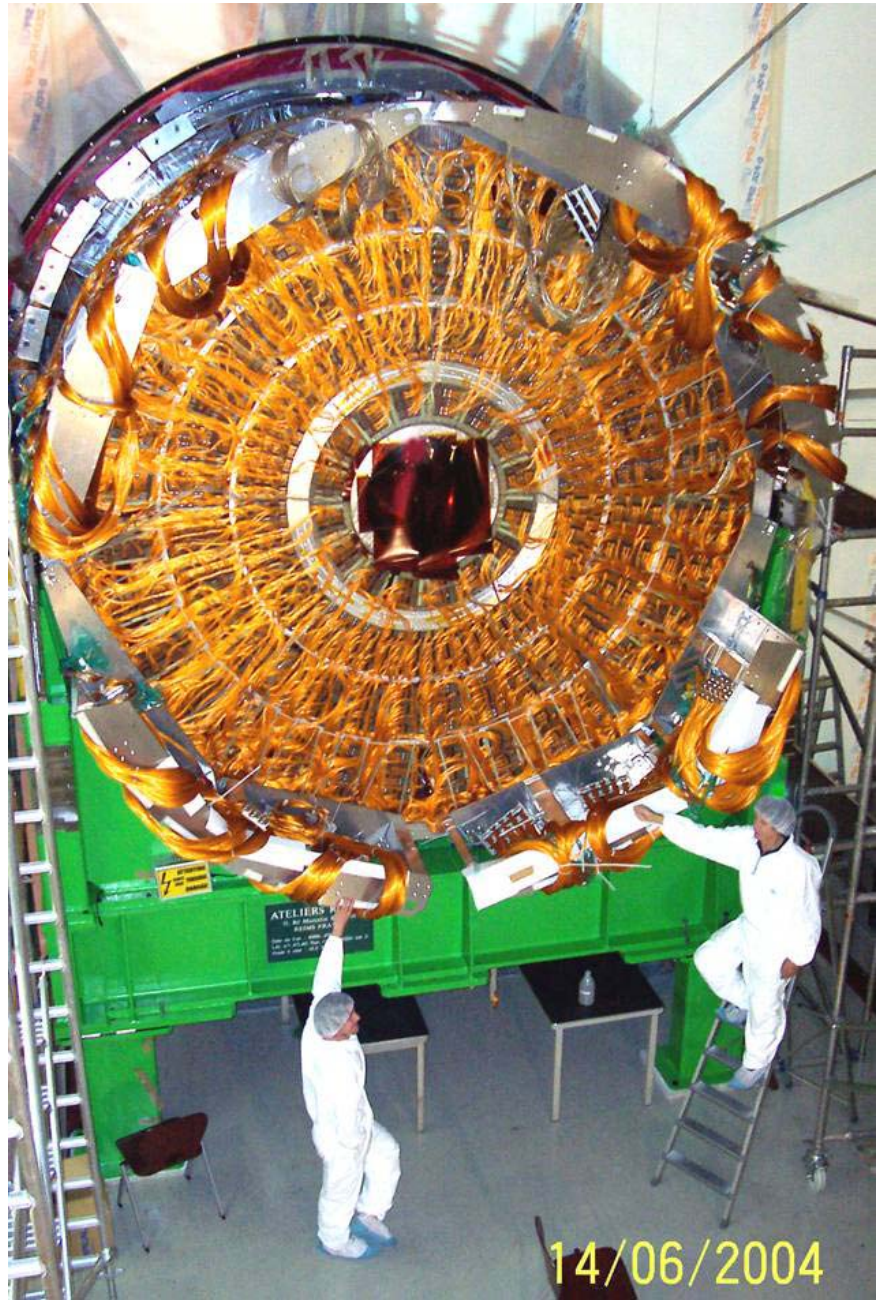
ECC rotated with all feedthroughs installed, Mar 2003

EC Cryostats Welding Solution

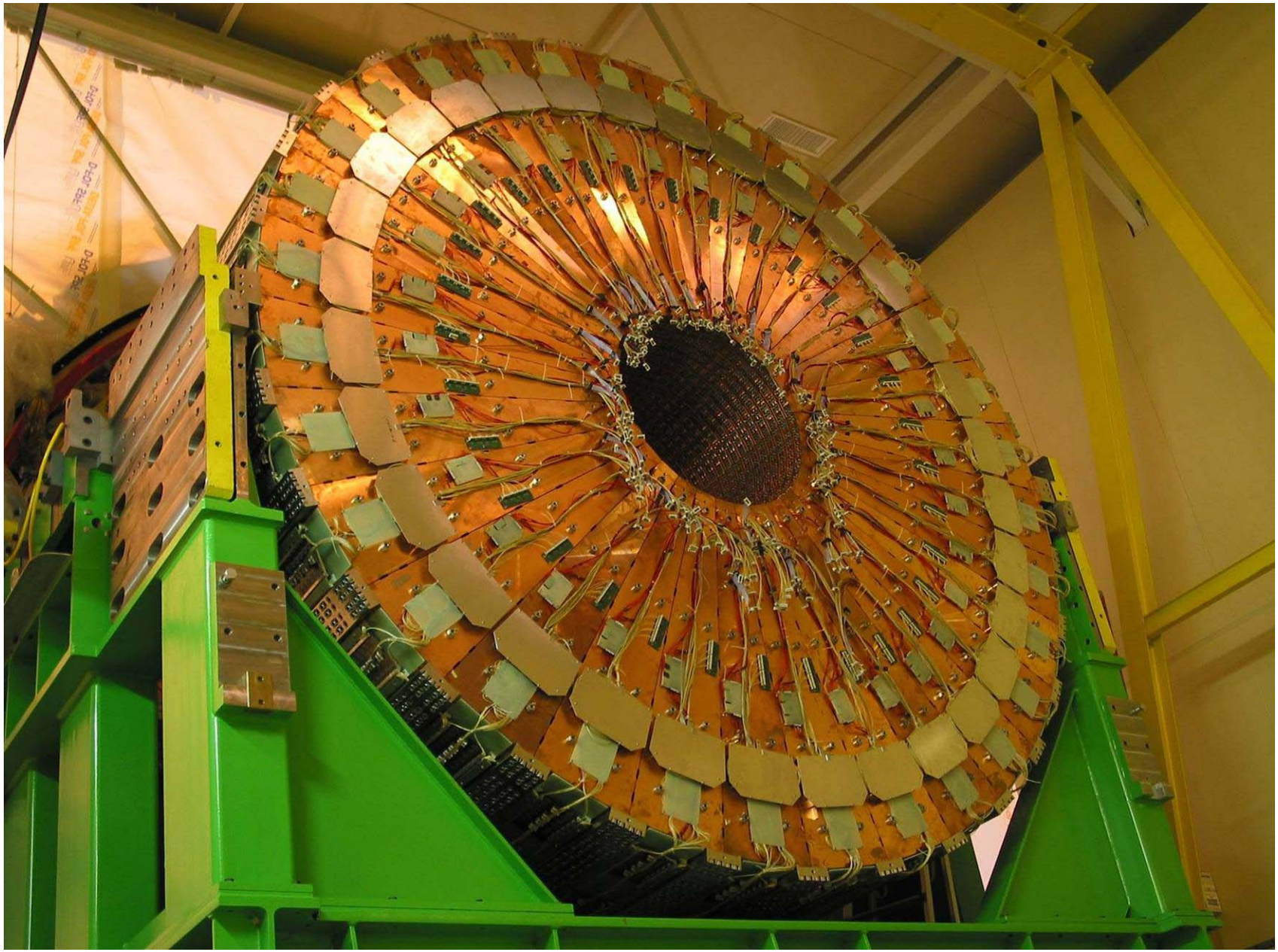


EM EndCap A wheel on the insertion stand, May - June 2004





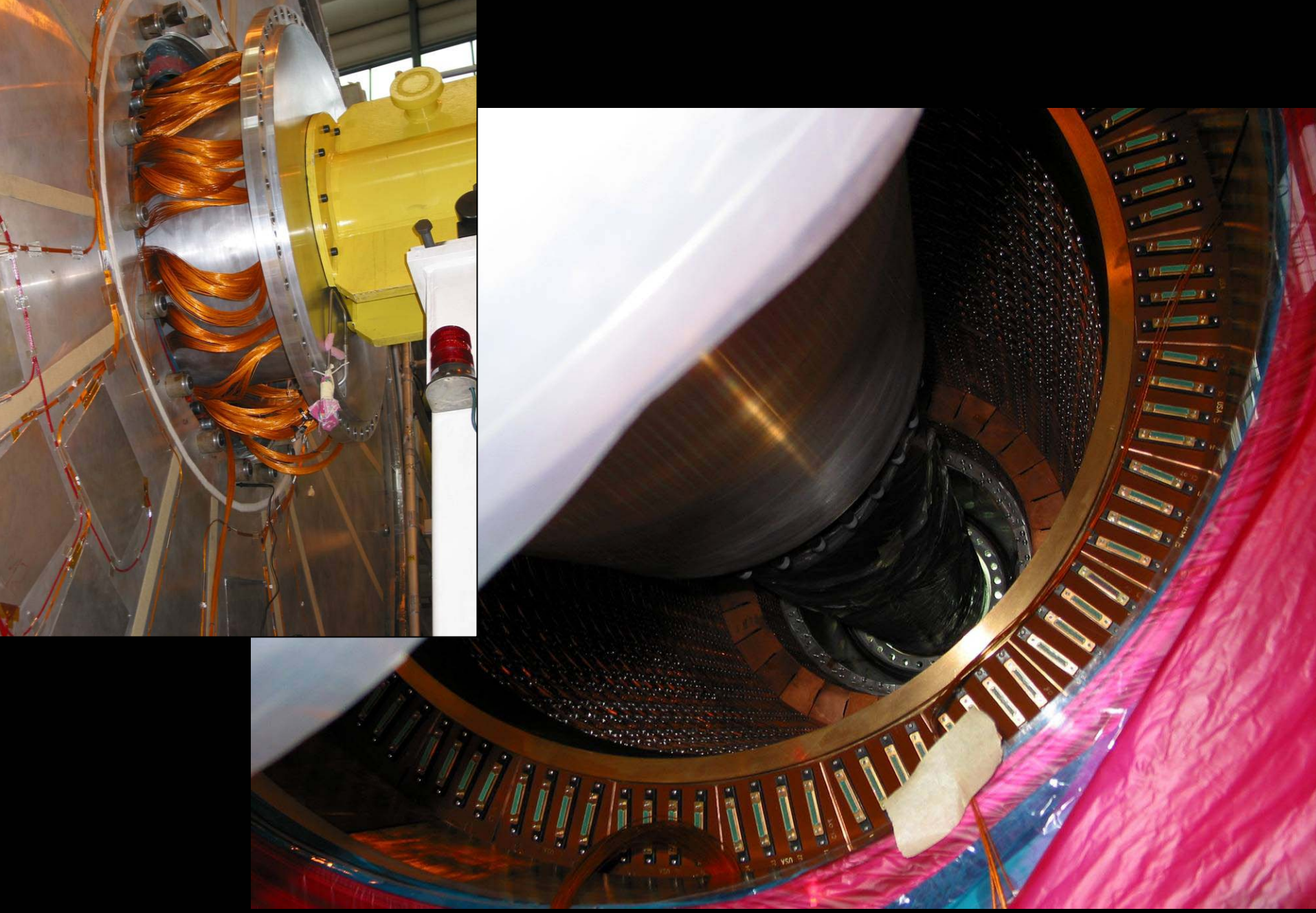
HEC 2 A-wheel on the insertion stand, Aug. 2004



LAr Forward Calorimeters

- C end in Cryostat
- A end assembled into support tube

- FCAL C assembly into tube – Fall 2003



FCal C insertion, August 2004

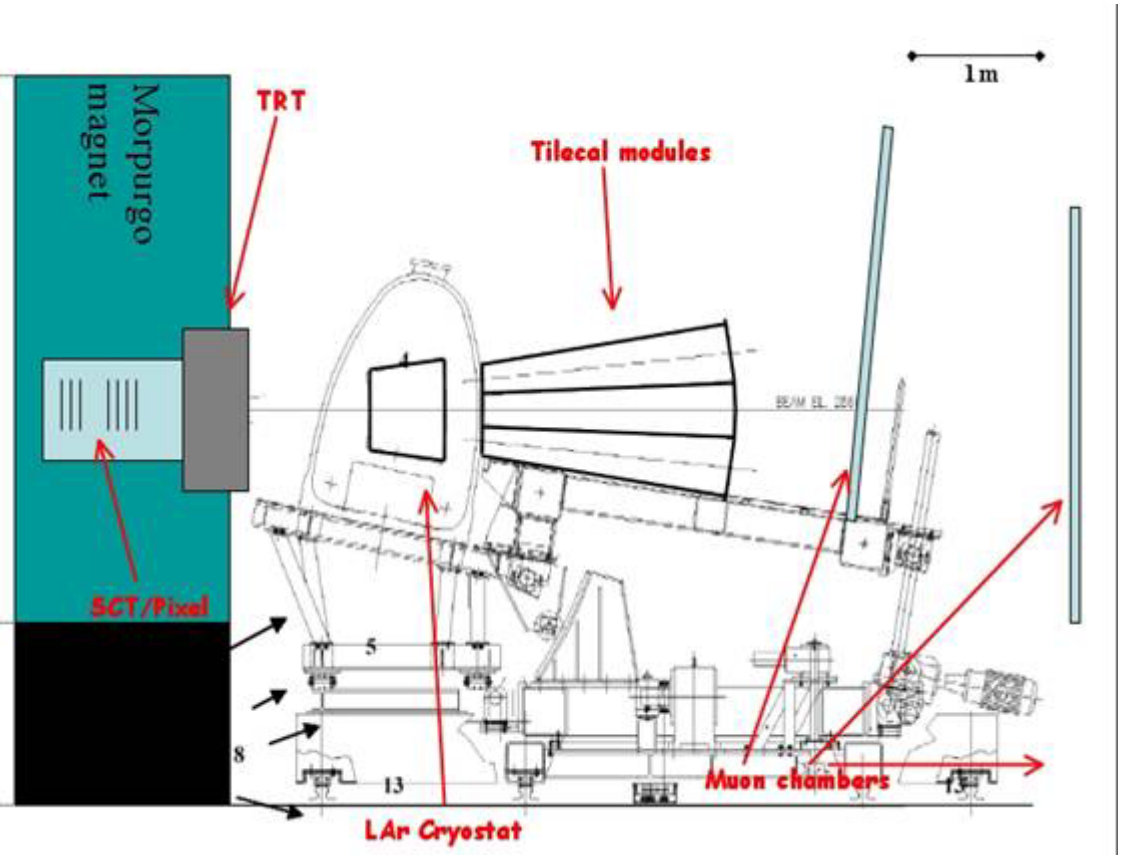
End Cap Cold Commissioning

- End cap C cold commissioning is planned to start in Jan. 2005
- End cap A cold commissioning is planned to start in July 2005

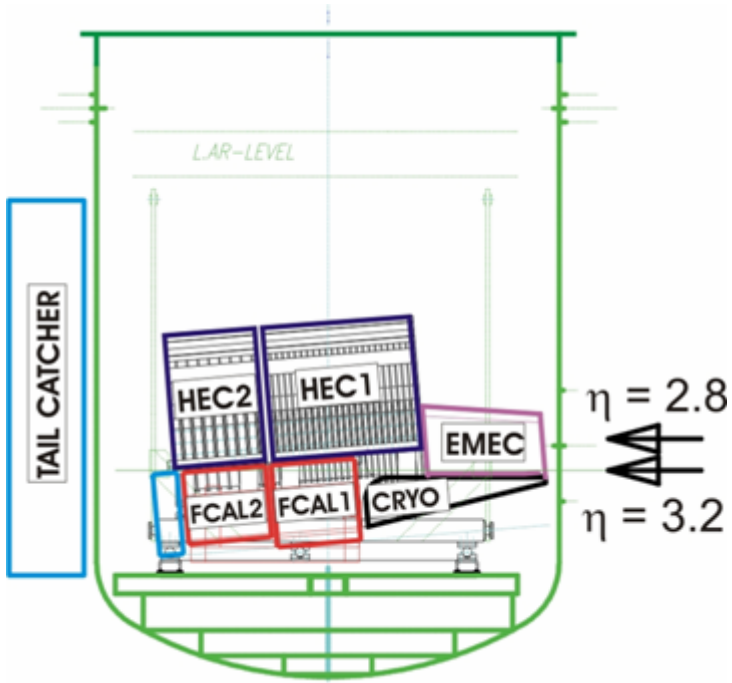
	EMEC	FCAL	HEC
Week 1	HV test		
Week 2	HV test		
Week 3	HV test	HV test	
Week 4	HV test		HV test
Week 5	TPA, LC, Rcal		Ramp, delay, x-talk
Week 6	TPA, LC, Rcal	Reflection test	Ramp, delay, x-talk
Week 7	TPA, LC, Rcal	Tests with calib.p.	TDR test
Week 8		FEC test	
Week 9	FEC test		
Week 10			FEC test

Combined Beam Tests

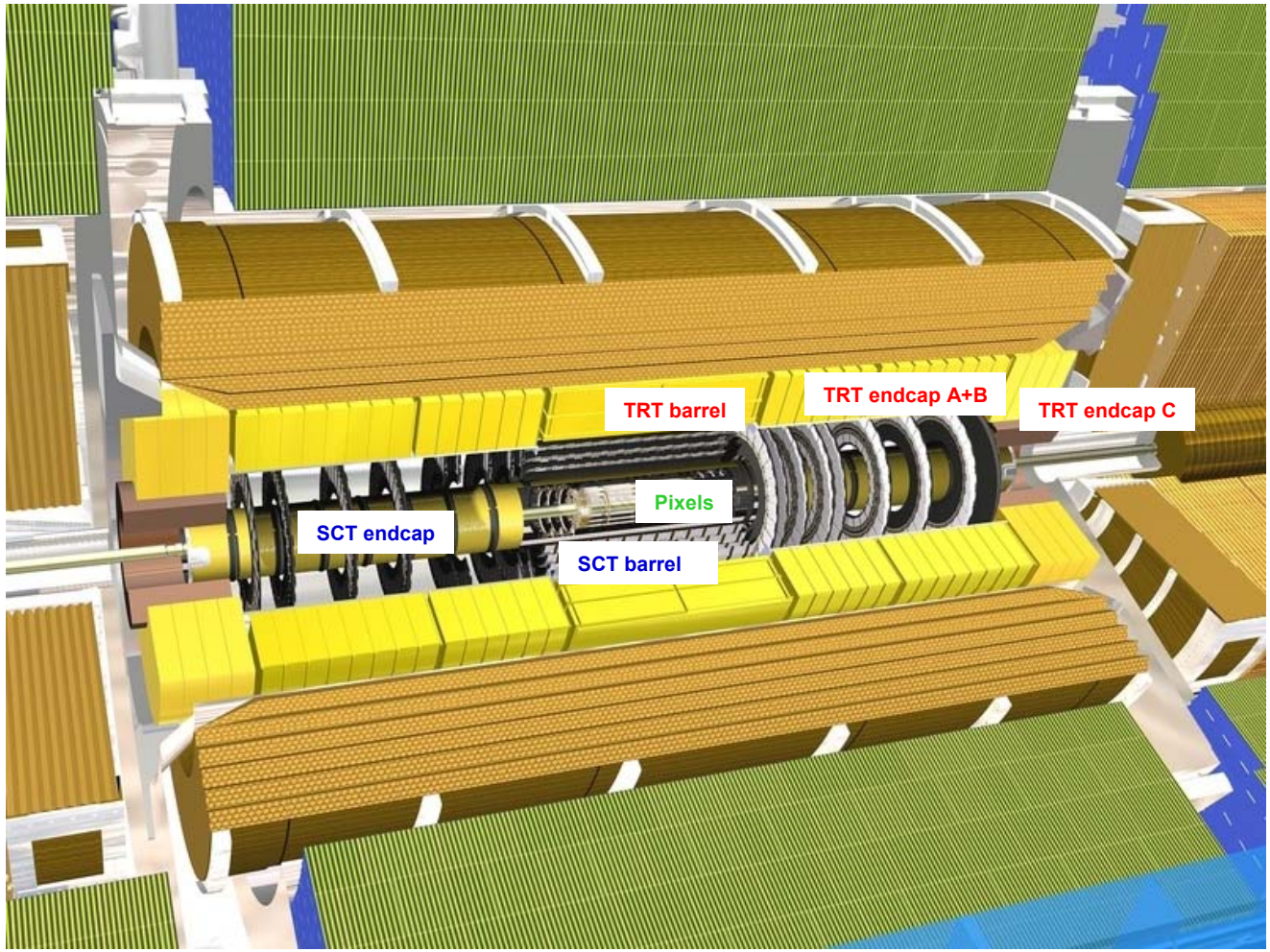
H8 beam
General ATLAS multi-system test beam



H6 beam
EMEC-HEC-FCAL test



Inner Detector



- TRT Straw Tube Tracker
- Silicon strips (SCT)
- PIXELs.

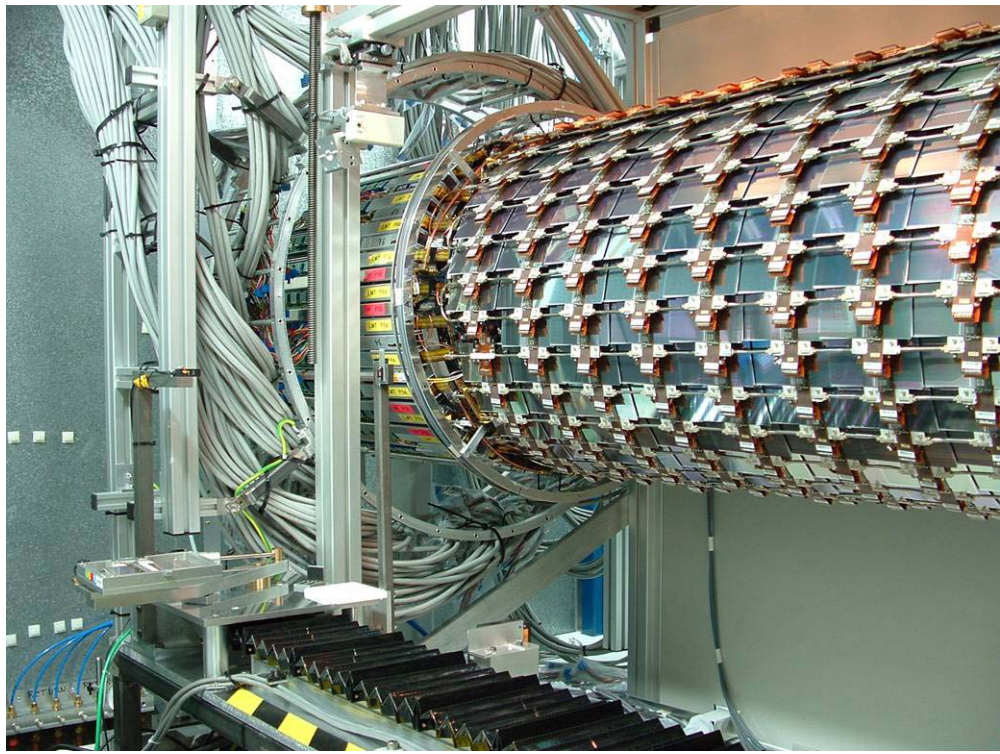
TRT

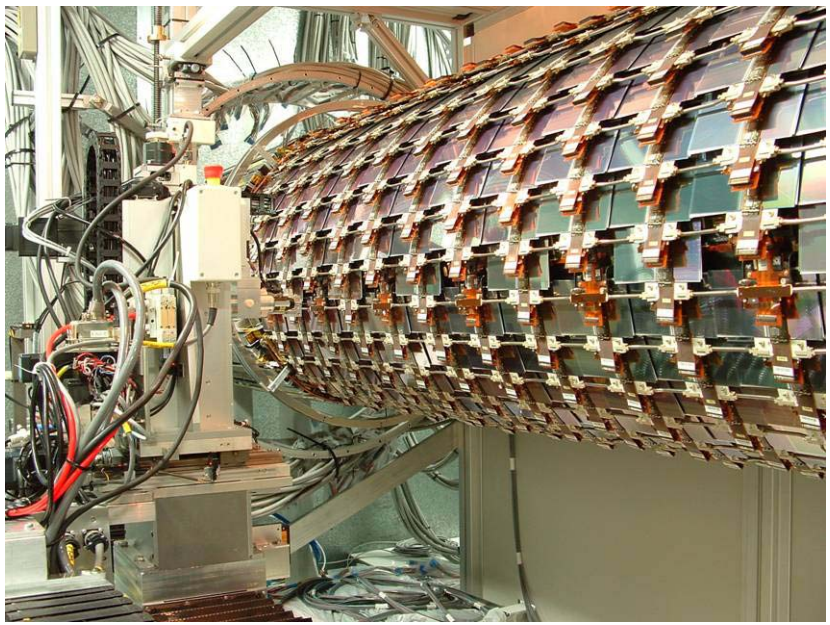
- TRT barrel second layer modules now into support structure, plus 10 modules of last layer.
- FE boards for layer one ready, and first 25 modules are tested successfully with final electronics.
- Schedule ok.

- TRT wheel stacking started, all wheels for first EC (C) at CERN.
- First boards plugged in and tested.
- Second endcap (A) remains critical but ok if current wheel delivery schedule is kept.

SCT Barrel

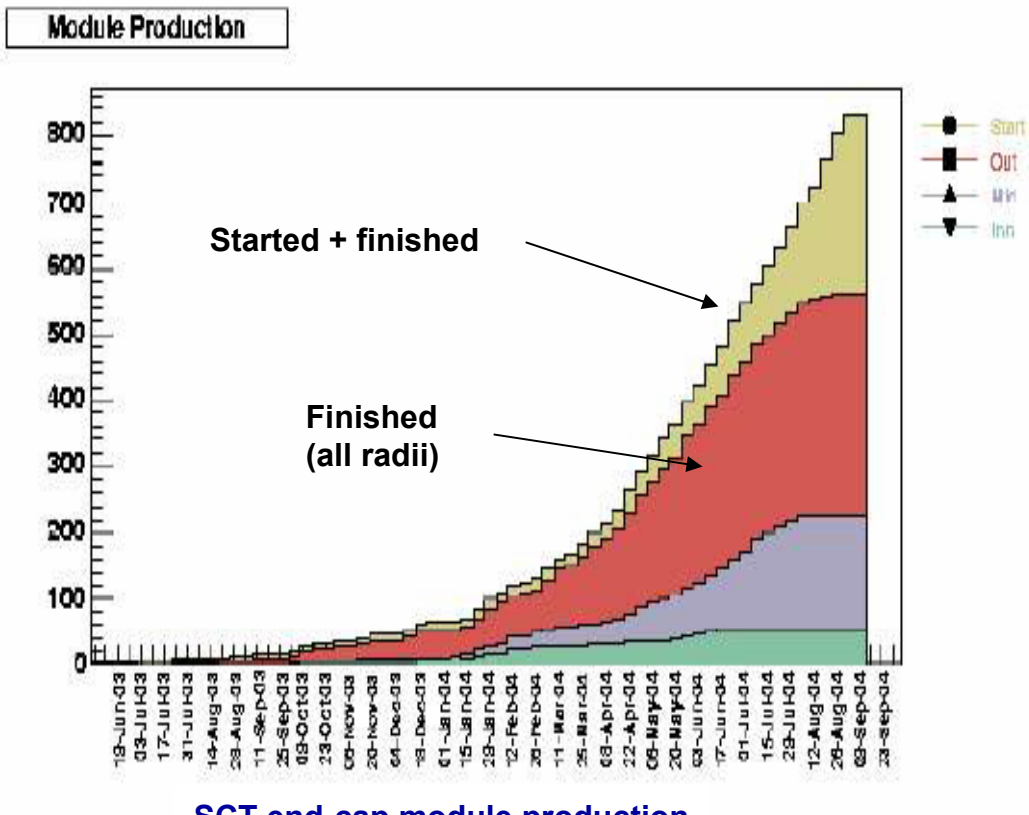
- B3 completed at Oxford
  (384 modules mounted and tested)
- B6 next
- Module building 98% completed



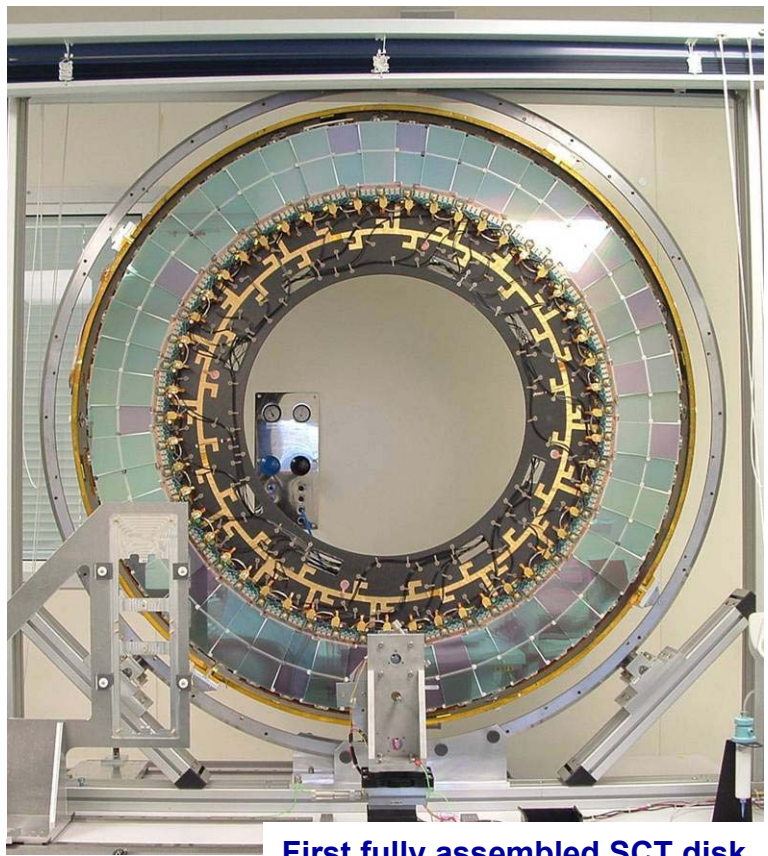


SCT End Wheel

- The end-cap module production has passed 30% point - yield above 90
- This is 80% of required speed
- Schedule tight for first EC (C)
- Second EC (A) currently late by 3-5 months



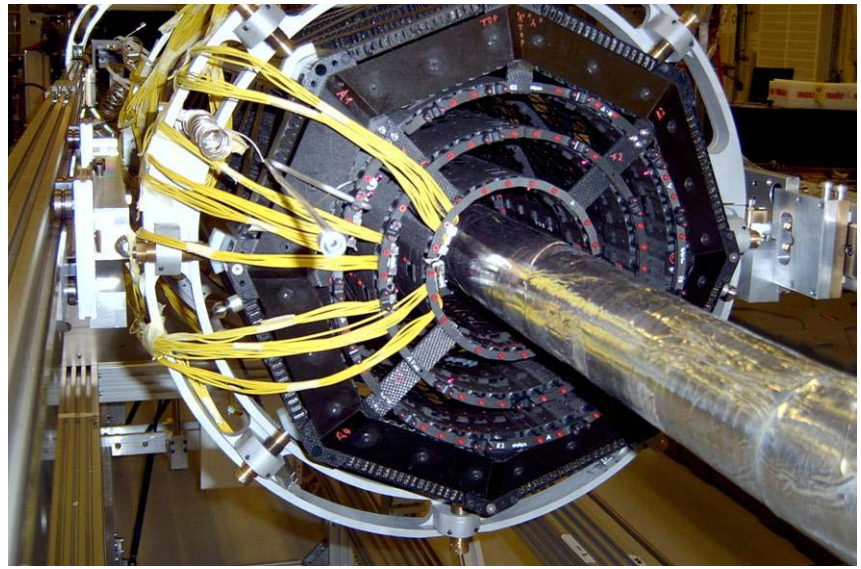
SCT end-cap module production

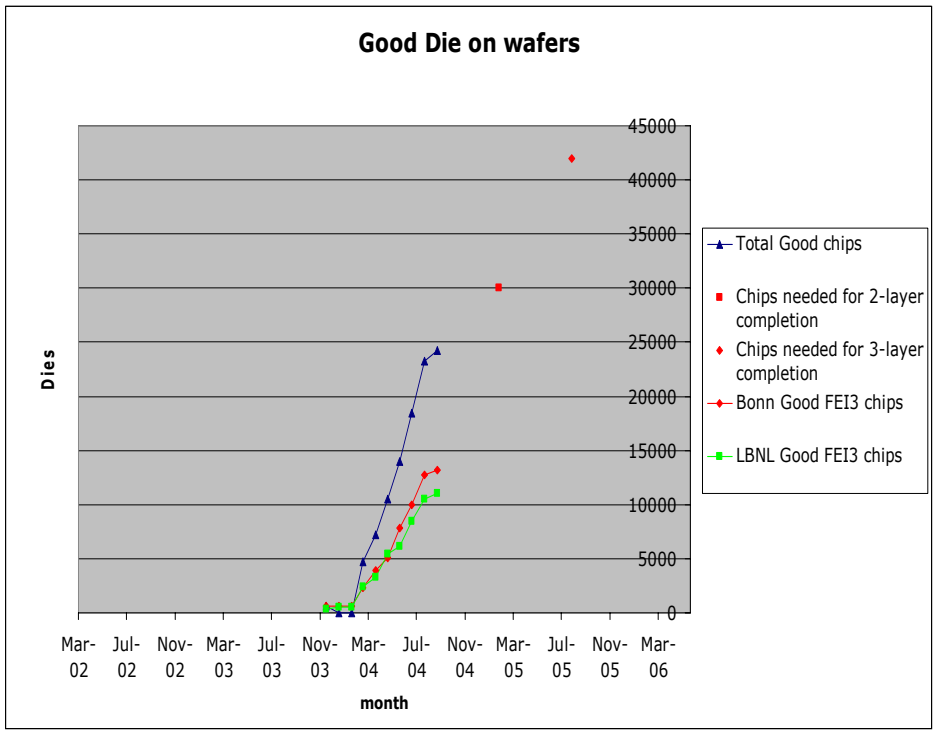


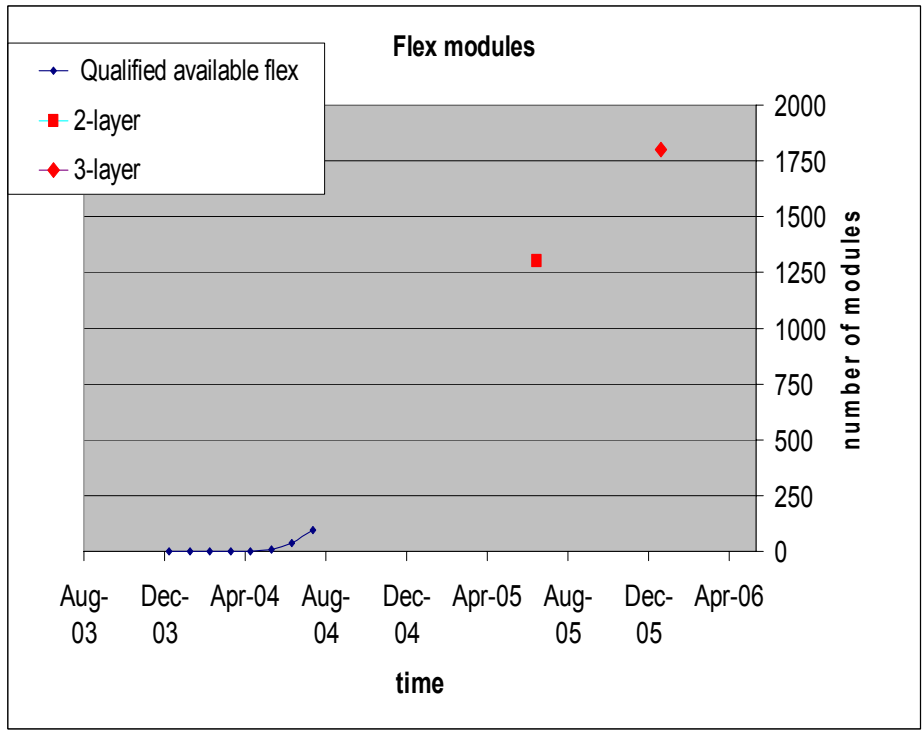
First fully assembled SCT disk

PIXELS

- The 2nd and 3rd lots of PIXEL chips have excellent yield greater than 80%
- Barrel support structure has been Integrated with beam pipe

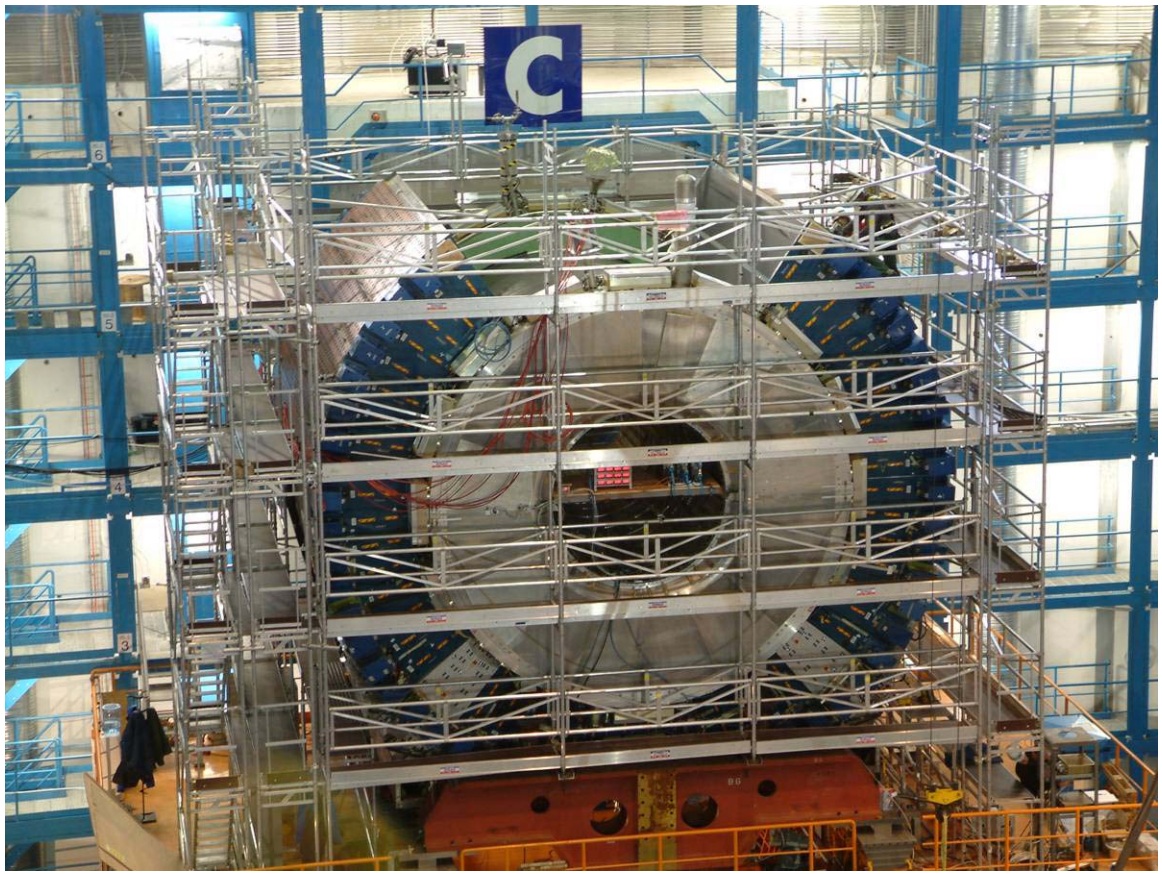






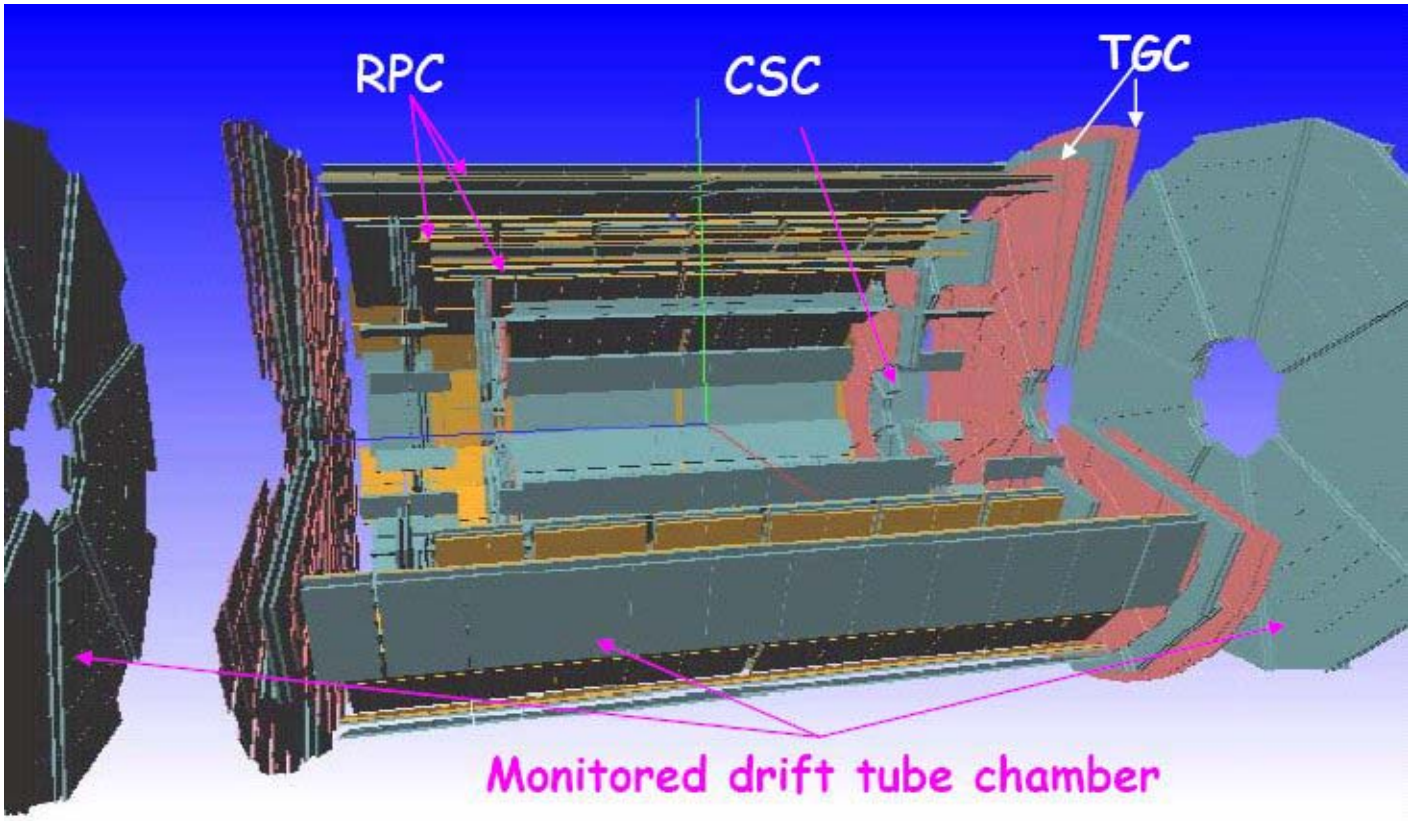
Tile Calorimeter

- Before lowering Barrel Cryostat bottom part of tile cal assembled
- Barrel lowered and installed
- Resumed assembly - completion expected 15-12-2004)



Completion of the barrel assembly in the pit in progress

Muon Spectrometer Instrumentation

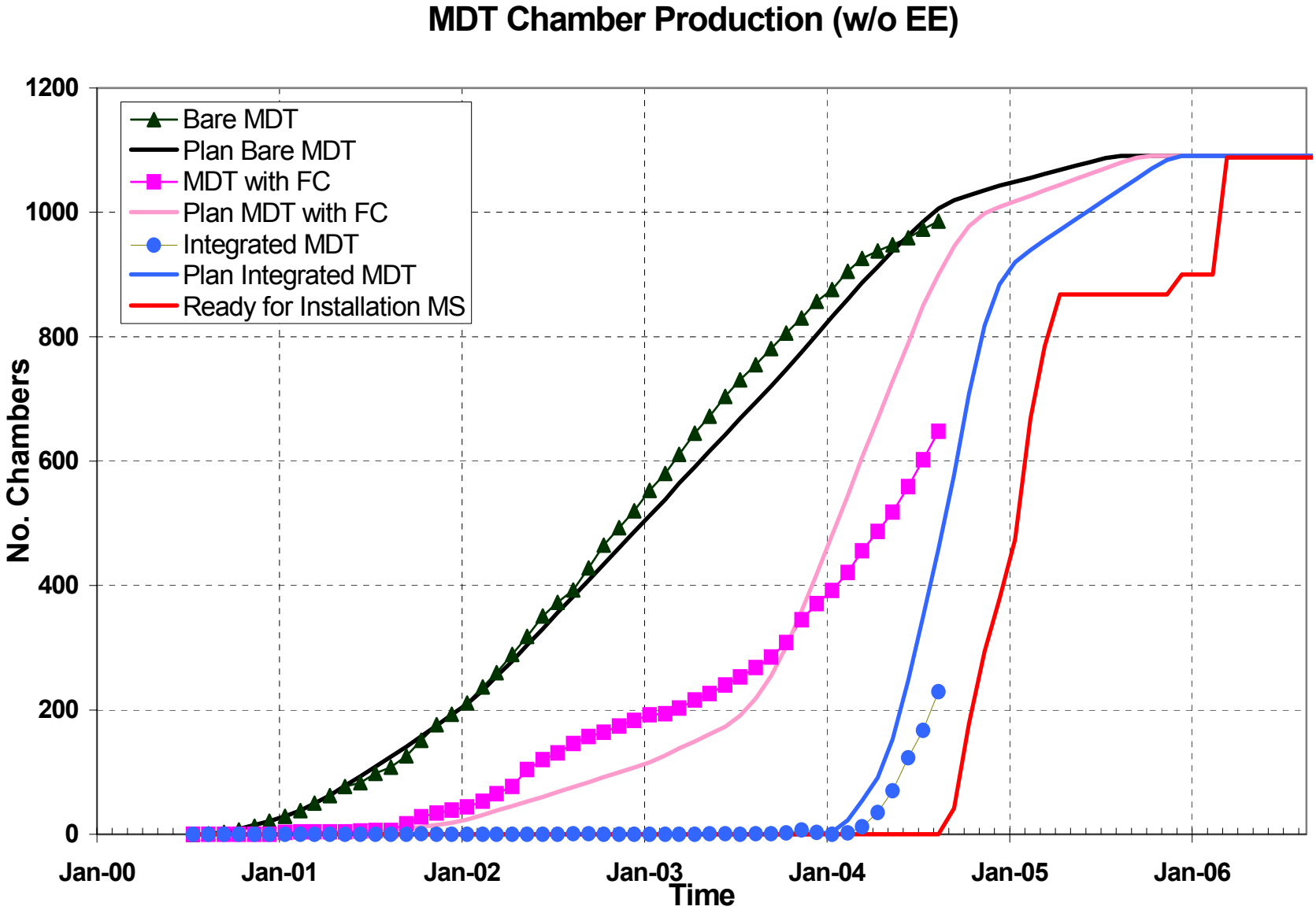


The Muon Spectrometer is instrumented with precision chambers and fast trigger chambers

A crucial component in order to reach required accuracy is the sophisticated alignment measurement and monitoring system

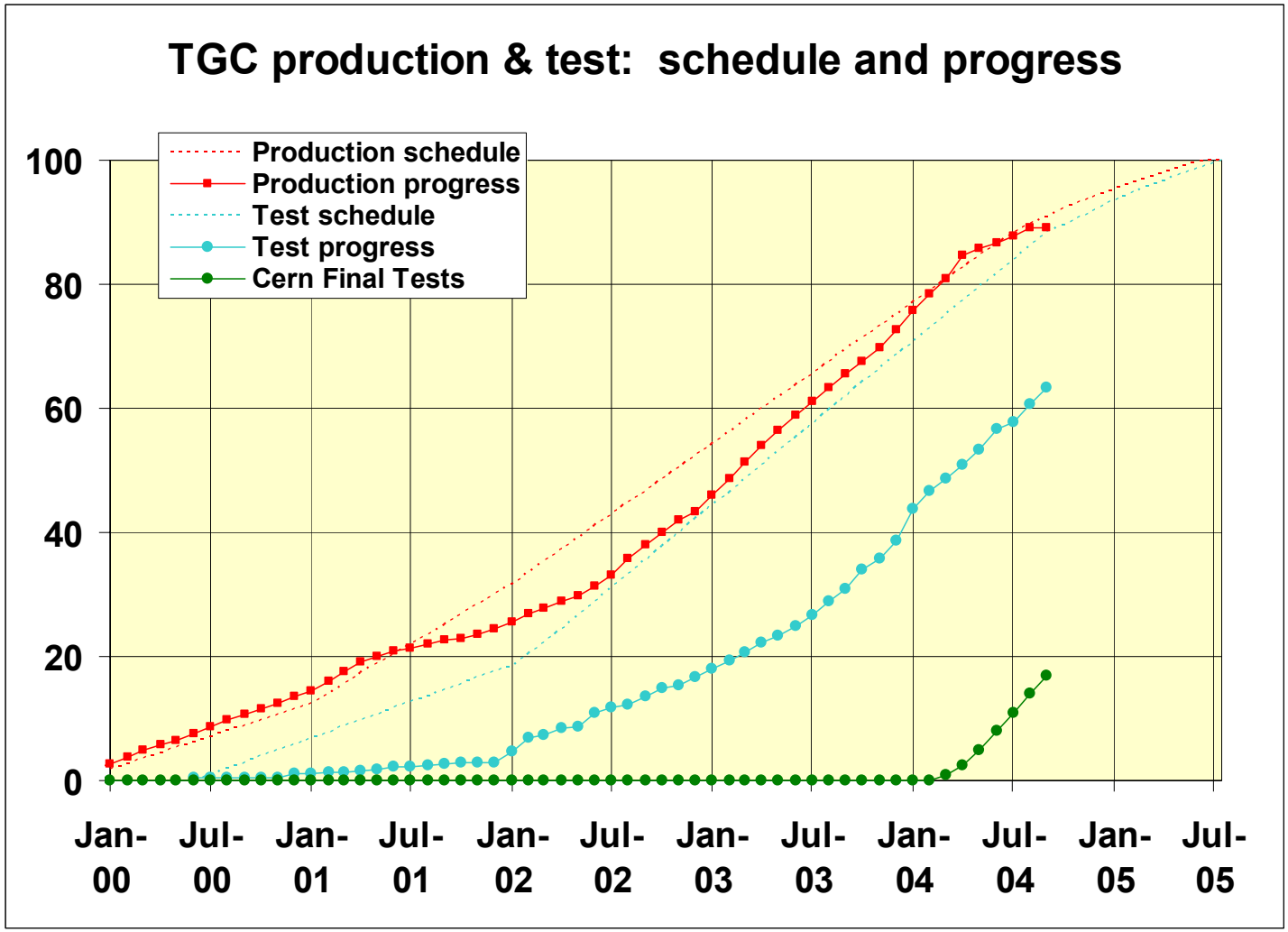
Precision chambers:
- MDTs in the barrel and end-caps
- CSCs at large rapidity for the innermost end-cap stations

Trigger chambers:
- RPCs in the barrel
- TGCs in the end-caps


MDT Chamber Production (w/o EE)
Bare MDT
Plan Bare MDT
MDT with FC
Plan MDT with FC
Integrated MDT
Plan Integrated MDT
Ready for Installation MS
No. Chambers
1200
1000
800
600
400
200
0
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Time

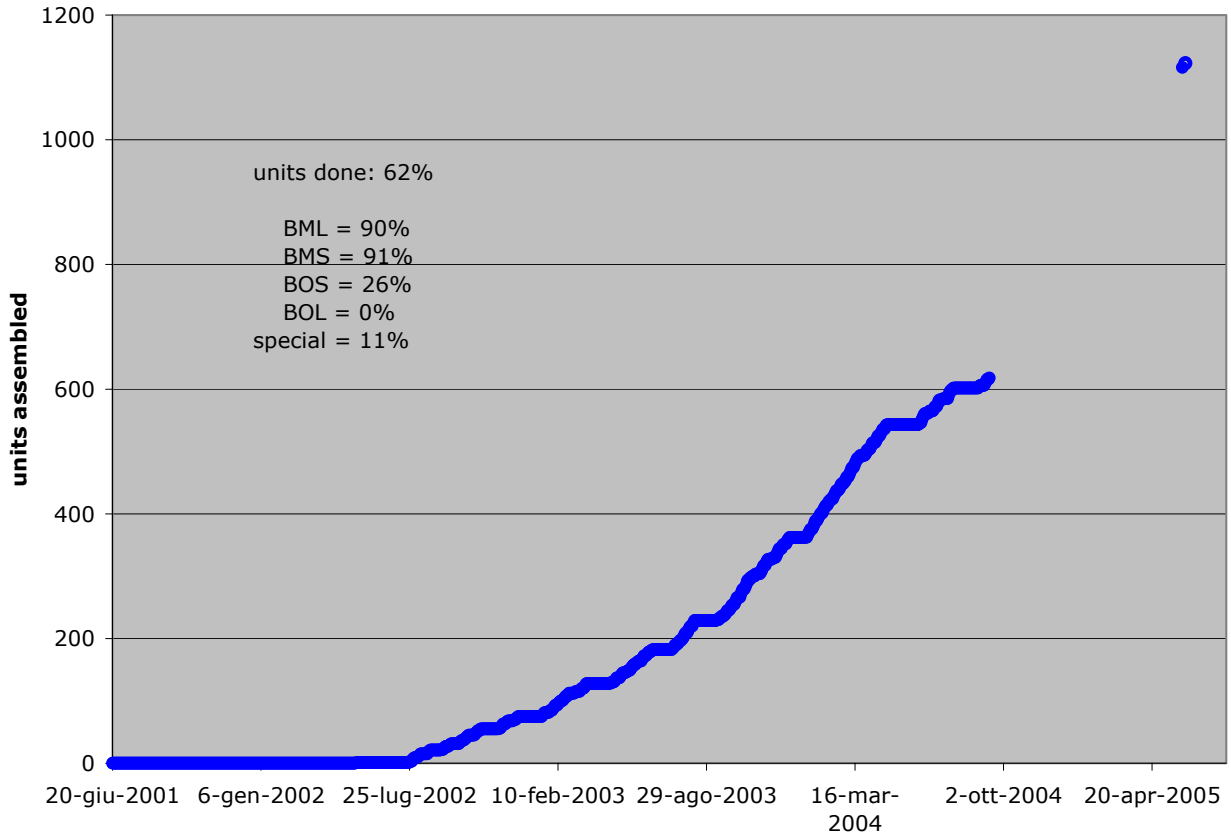
Muon trigger chamber production

The production rate for the TGCs (end-caps) is as scheduled

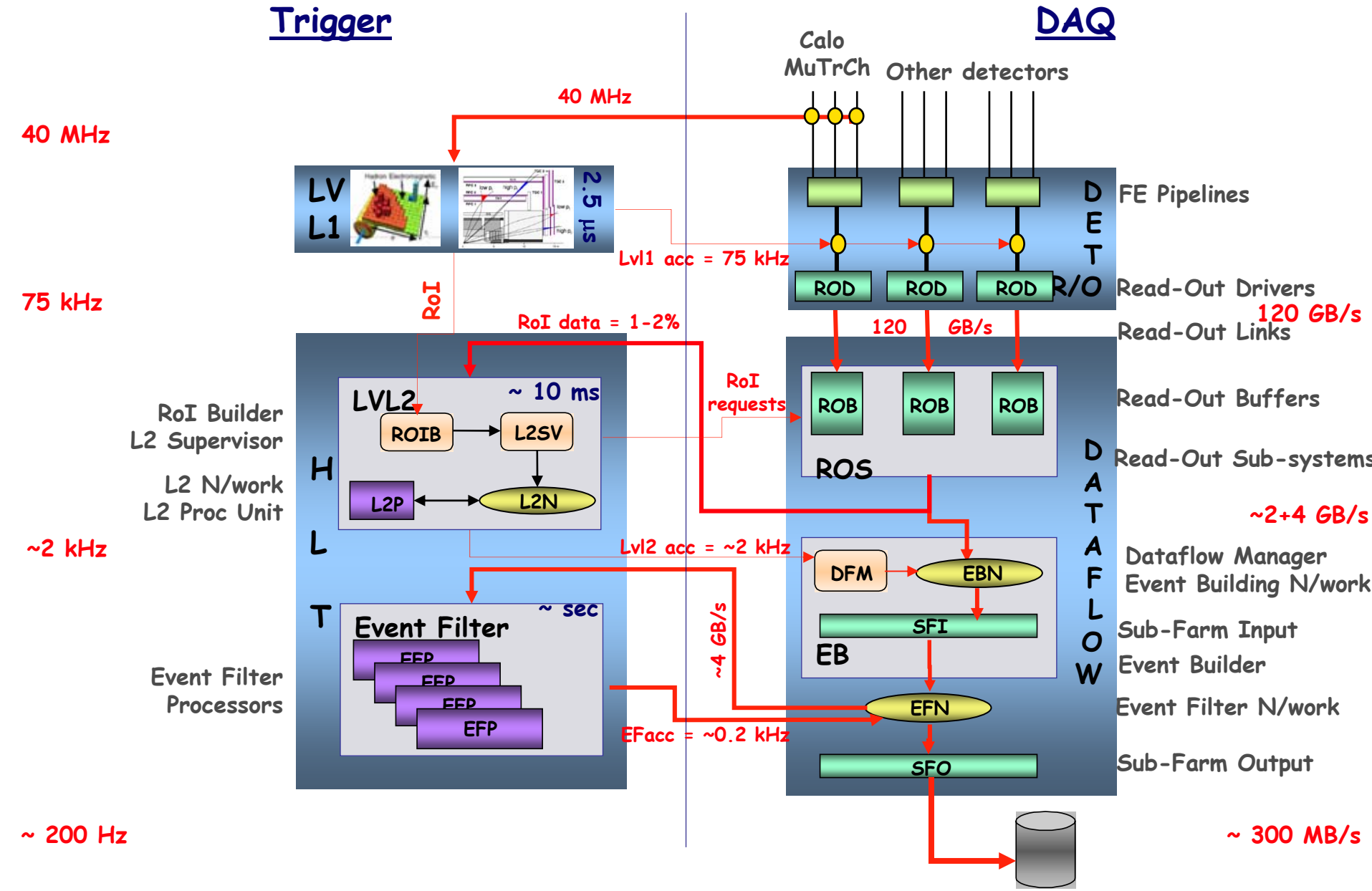


RPCs

The RPC (barrel) production rate is expected to reach completion by spring 2005



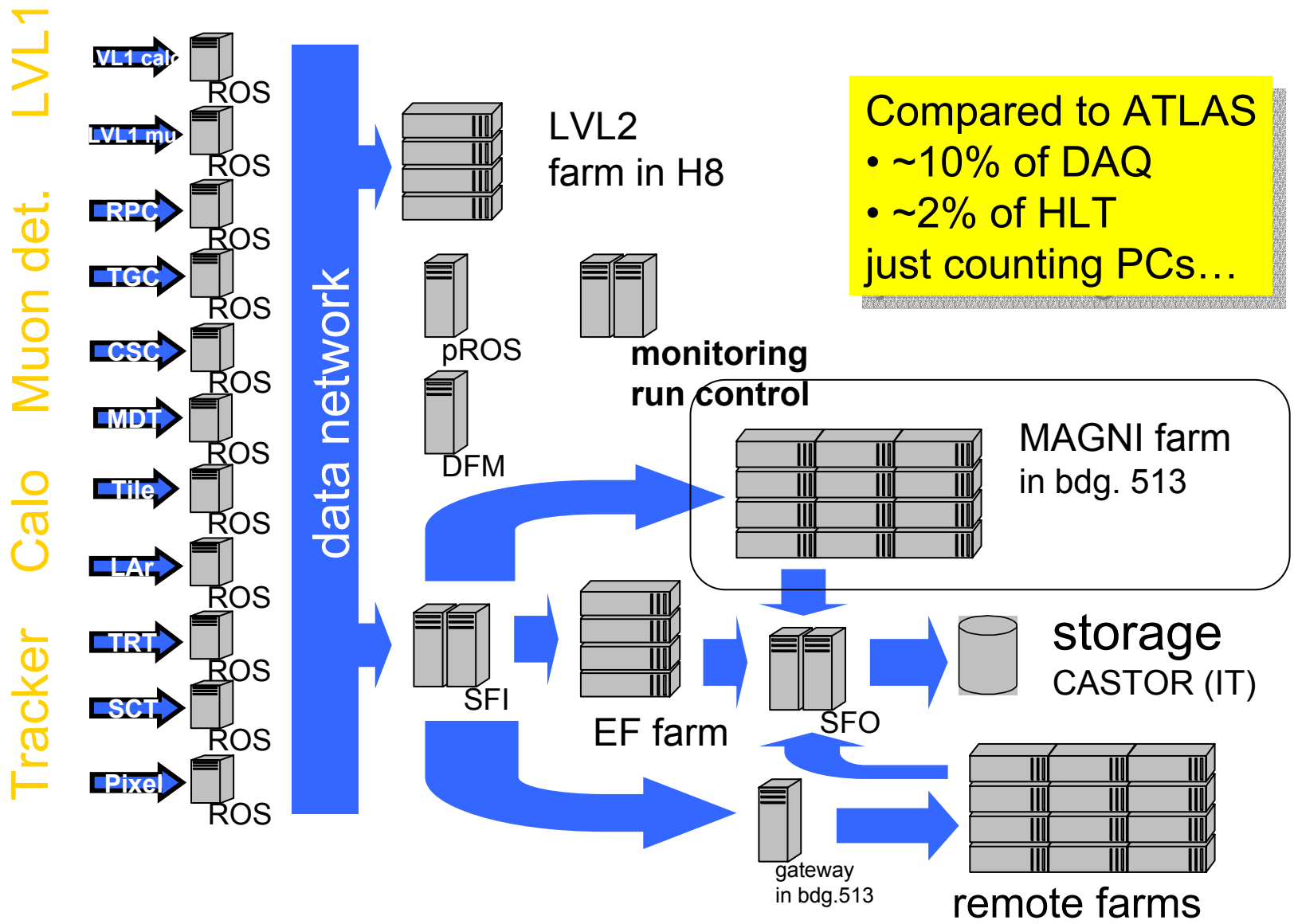
Trigger, DAQ and Detector Control



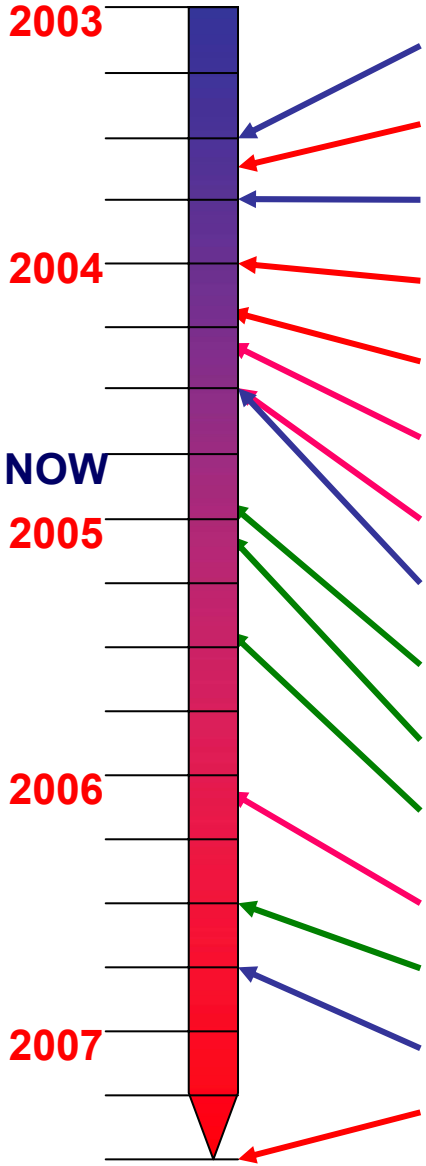
High Level Trigger

- Principal focus Combined Testbeam
  - LVL2 muon slice fully integrated in H8 combined testbeam
    - μFast LVL2 μ reconstruction, and detector description infrastructure integrated
    - TrigMoore EF μ reconstruction integrated
    - Steering of TrigMoore from LVL2 result implemented
    - These integration tests are the first demonstration of a complete HLT chain with algorithms in an online setup, reading out directly detectors
  - ID LVL2 tracking algorithms integrated and run in the testbeam
  - CaloRec in EF
- Timing algorithm & data preparation timing studies
- Extensive testing of the event selection steering component
- Online histogramming

TDAQ Setup in Combined Test Beam

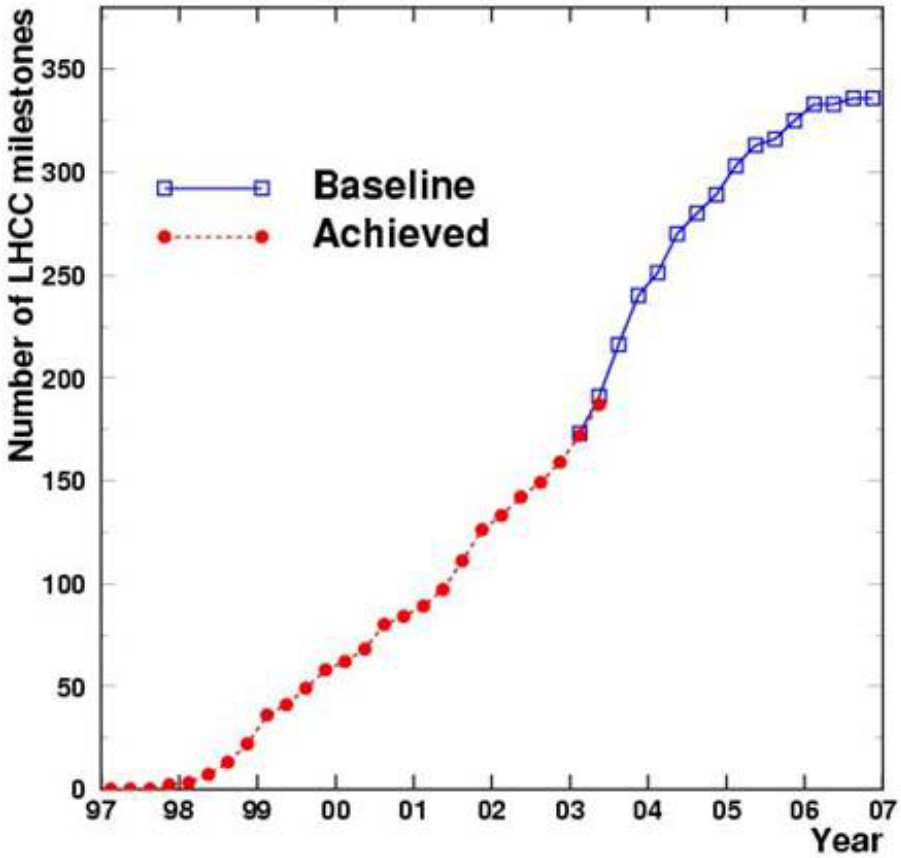


ATLAS Computing Timeline

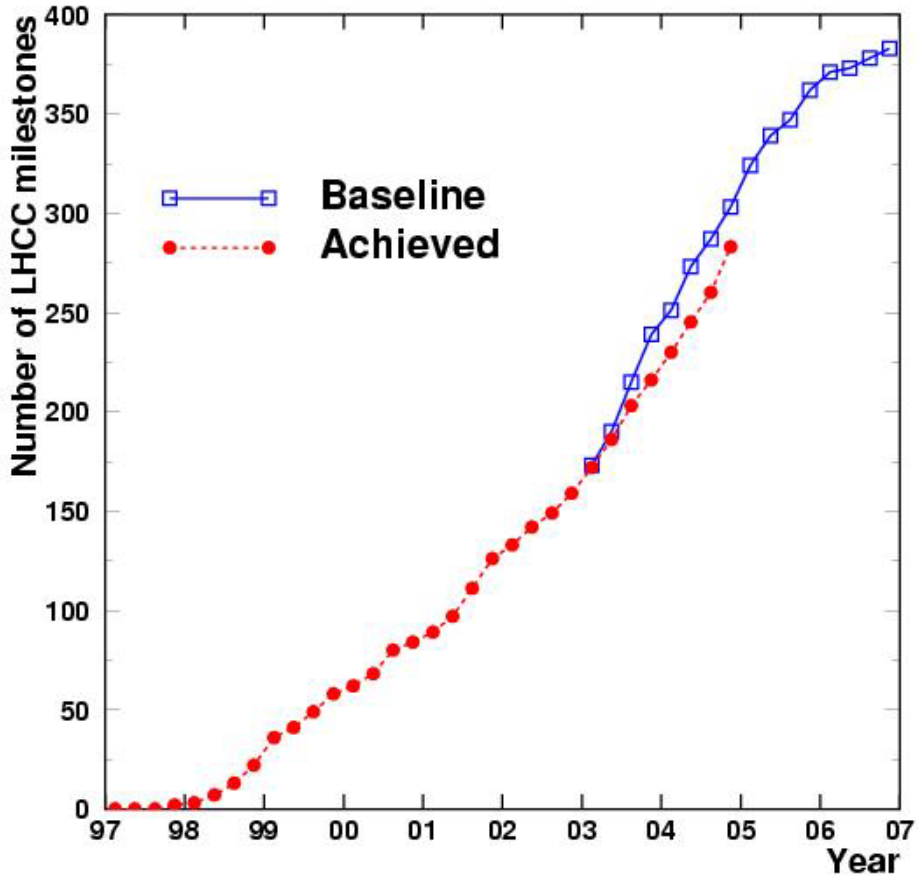


- POOL/SEAL release (done)
- ATLAS release 7 (with POOL persistency) (done)
- LCG-1 deployment (done)
- ATLAS complete Geant4 validation (done)
- ATLAS release 8 (done)
- DC2 Phase 1: simulation production (in progress)
- DC2 Phase 2: intensive reconstruction (the real challenge!) ***late***
- Combined test beams (barrel wedge) (in progress)
- Computing Model paper
- Computing Memorandum of Understanding
- ATLAS Computing TDR and LCG TDR
- DC3: produce data for PRR and test LCG-n
- Physics Readiness Report
- Start commissioning run
- **GO!**

LHCC Milestones



Last Review for Comparison



Integrated LHCC milestones
LHCC November 2004

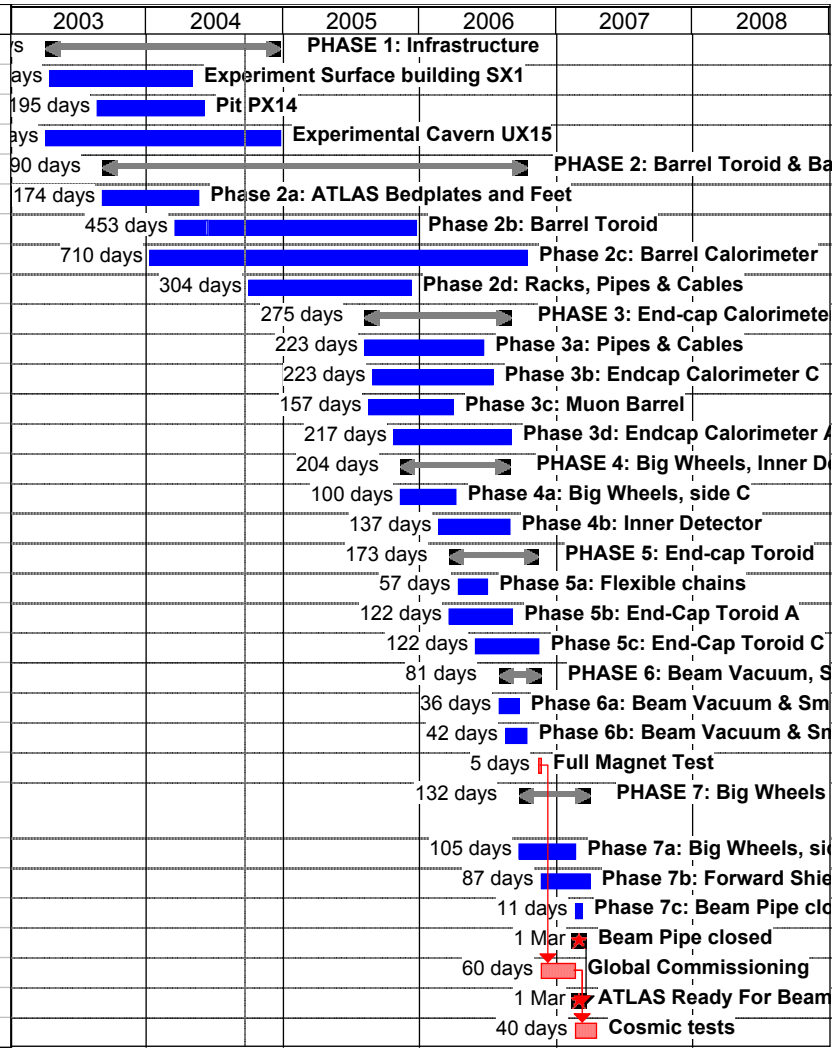
Summary of Major Concerns

- Delay of the Barrel Toroid coil integration (heat shield schedule, vacuum vessel integration) → now progressing as scheduled, two first coils tested
- End-cap Toroid cold mass assembly (contractual situation unblocked)
- Macro-assembly of the barrel SCT (delay because of brackets repair and the harnesses problem, but progressing well now)
- End-cap SCT schedule for assembly of modules onto disks (good recent progress)
- TRT on-detector electronics boards and end-cap schedule (delay from the webs, again progress very satisfactory now)
- LAr FE board production delayed because of recent TTC QPLL problem

ATLAS Installation Schedule (working version 6.24, not baselined)

Technical Coordination is working on optimizing and updating the schedule taking into account the by now better known and consolidated BT construction schedule

Name	Start	Finish
PHASE 1: Infrastructure	4 Apr '03	21 Dec '04
Experiment Surface building SX1	15 Apr '03	27 Apr '04
Pit PX14	19 Aug '03	31 May '04
Experimental Cavern UX15	4 Apr '03	21 Dec '04
PHASE 2: Barrel Toroid & Barrel Calorimeter	3 Sep '03	13 Oct '06
Phase 2a: ATLAS Bedplates and Feet	3 Sep '03	17 May '04
Phase 2b: Barrel Toroid	15 Mar '04	18 Dec '05
Phase 2c: Barrel Calorimeter	7 Jan '04	13 Oct '06
Phase 2d: Racks, Pipes & Cables	29 Sep '04	7 Dec '05
PHASE 3: End-cap Calorimeters & Muon Barrel	3 Aug '05	30 Aug '06
Phase 3a: Pipes & Cables	3 Aug '05	19 Jun '06
Phase 3b: Endcap Calorimeter C	24 Aug '05	11 Jul '06
Phase 3c: Muon Barrel	16 Aug '05	30 Mar '06
Phase 3d: Endcap Calorimeter A	21 Oct '05	30 Aug '06
PHASE 4: Big Wheels, Inner Detector	8 Nov '05	28 Aug '06
Phase 4a: Big Wheels, side C	8 Nov '05	4 Apr '06
Phase 4b: Inner Detector	16 Feb '06	28 Aug '06
PHASE 5: End-cap Toroid	17 Mar '06	14 Nov '06
Phase 5a: Flexible chains	12 Apr '06	29 Jun '06
Phase 5b: End-Cap Toroid A	17 Mar '06	4 Sep '06
Phase 5c: End-Cap Toroid C	29 May '06	14 Nov '06
PHASE 6: Beam Vacuum, Small Wheels, Start closing	31 Jul '06	21 Nov '06
Phase 6a: Beam Vacuum & Small Wheels, side A	31 Jul '06	19 Sep '06
Phase 6b: Beam Vacuum & Small Wheels, side C	17 Aug '06	13 Oct '06
Full Magnet Test	15 Nov '06	21 Nov '06
PHASE 7: Big Wheels A, Forward Shielding & End wall chambers	19 Sep '06	30 Mar '07
Phase 7a: Big Wheels, side A	19 Sep '06	21 Feb '07
Phase 7b: Forward Shielding & End wall Chambers	22 Nov '06	30 Mar '07
Phase 7c: Beam Pipe closing and bake-out	22 Feb '07	8 Mar '07
Beam Pipe closed	1 Mar '07	1 Mar '07
Global Commissioning	22 Nov '06	21 Feb '07
ATLAS Ready For Beam	1 Mar '07	1 Mar '07
Cosmic tests	22 Feb '07	18 Apr '07



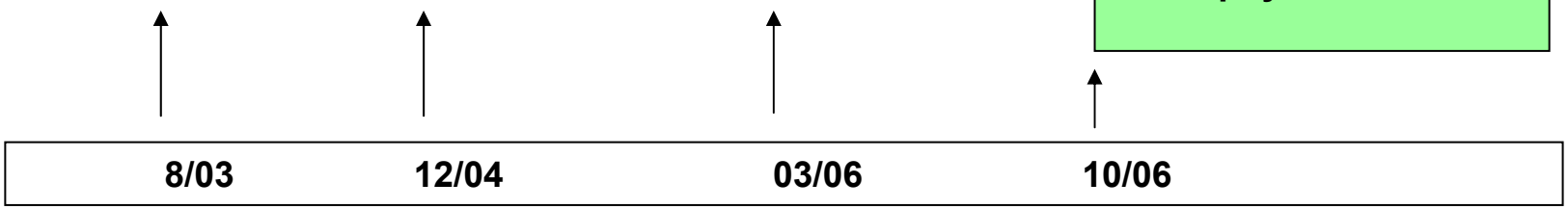
Commissioning

Phase A
System at ROD level.
Systems for LVL1, DCS and DAQ.
Check cable connections.
Infrastructure.
Some system tests.

Phase B
Calibration runs on local systems.

Phase C
Systems/Trigger/DAQ combined.

Phase D
Global commissioning.
Cosmic ray runs.
Initial off-line software.
Initial physics runs.



Conclusion

- CERN Committed to LHC Startup in 2007
- ATLAS Detector on Schedule for 2007 Startup
- Canadian Projects have proceeded in timely fashion