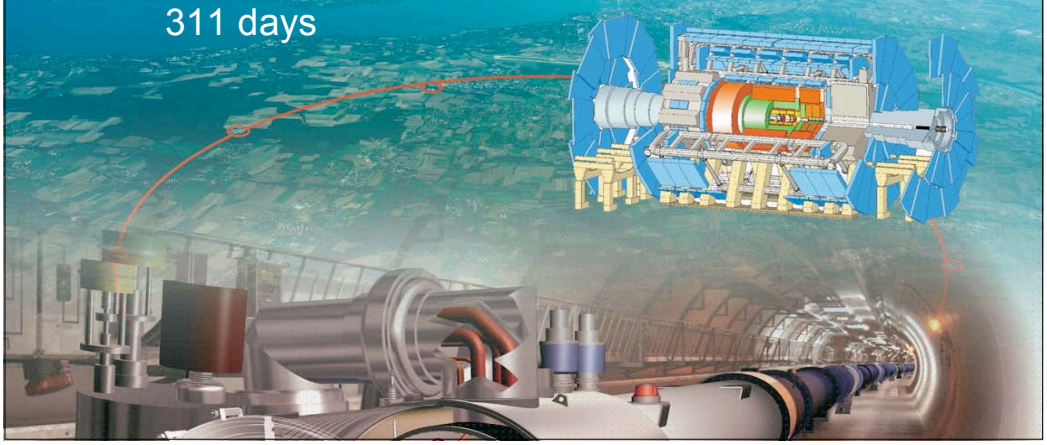
Common Projects and Installation

CERN-RRB-2006-110

Marzio Nessi
CERN, 23th October 2006

Time until Friday, August 31, 2007
(Geneva time)

311 days



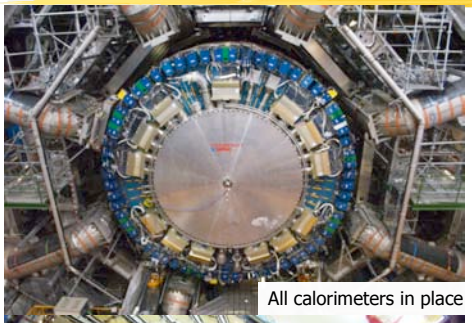
List of Common Projects (annex 10 MoU)

- ***Experimental Infrastructure / Detector Installation***
- ***Barrel Toroid Magnet → installed***
- ***End-cap Toroid Magnets (2) → in final assembly***
- ***Common Magnet Infrastructure → installed***
- ***Solenoid → installed***
- ***LAr Barrel Cryostat → installed***
- ***LAr End-cap Cryostats (2) → installed***
- ***LAr Cryogenic Plant → installed***
- ***Part of processors***
- ***Radiation Shielding → in final assembly***

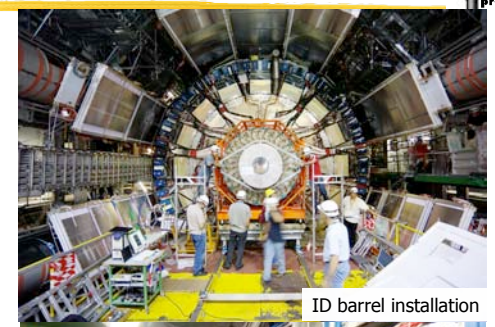
Today's main construction/commissioning activities

- ✓ Barrel Toroid tests at full current
- ✓ Magnets cryogenics/vacuum operation
- ✓ Detector access + cavern cleaning
- ✓ LAr Barrel Calo commissioning
- ✓ Calo End-caps services connections (chains)
- ✓ LAr cryogenics operation
- ✓ Solenoid commissioning and B-mapping
- ✓ Tiles Calorimeters commissioning
- ✓ Muon Barrel chambers installation
- ✓ Muon Barrel chambers cabling + gas
- ✓ Muon spectrometer commissioning
- ✓ Gas systems installation, operation
- ✓ Detectors cooling installation, operation
- ✓ Safety systems installation, operation
- ✓ Inner Detector Barrel installation
- ✓ Inner Detector Barrel commissioning
- ✓ Inner Detector piping and cabling
- ✓ Forward muon Big Wheels C install.
- ✓ Muon wheels services connections
- ✓ Preparation for BW A installation
- ✓ Preparation End-cap Toroids install.
- ✓ LVL1 trigger connection +commis.
- ✓ TDAQ hardware installation
- ✓ Detector slow control commissioning
- ✓ Counting rooms installatio, operation
- ✓ Electrical infrastructure installation
- ✓ Overall infrastructures operation
- ✓ Main Control Room construction

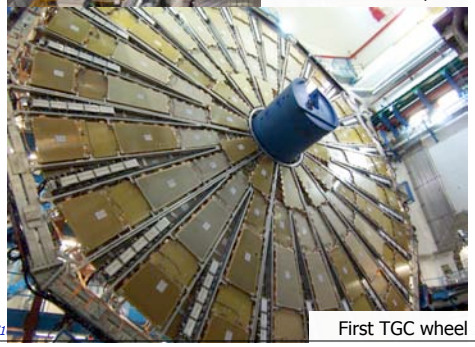
ATLAS Detector construction in UX15 (underground)



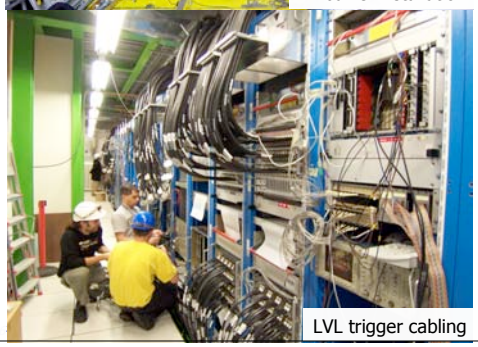
All calorimeters in place



ID barrel installation

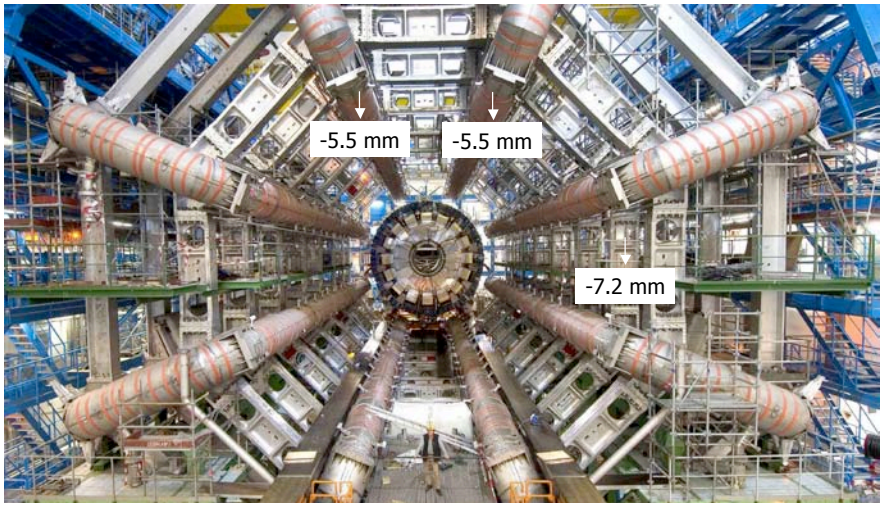


First TGC wheel



LVL trigger cabling

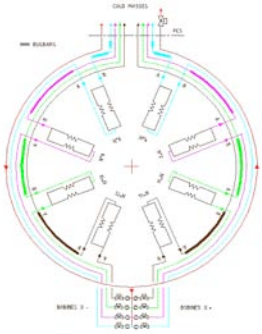
Barrel Magnet Toroid

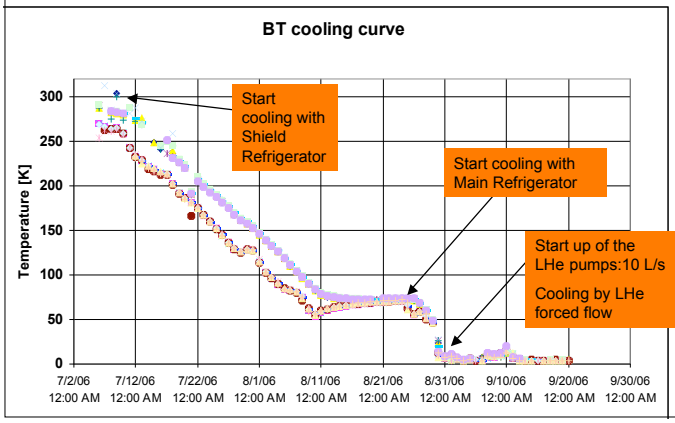


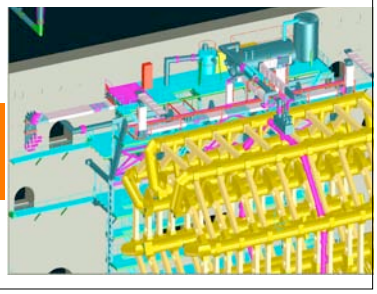
Average deformation since release = 24.3 mm (expected 27 mm, still ~20% of muon spectrometer weight to go)

Barrel Magnet Toroid cooling down completed

- ✓ All services connected and operational, vacuum on
- ✓ Started on 3 July, takes 5 weeks nominally, but many interruptions, power cuts, a broken turbine …
- ✓ Cooling down with 30-40K gradient
- ✓ Helium circulation pumps tested at 10L/s!
- ✓ No surprises in coil mechanics, all works fine ….







Barrel Magnet Toroid test campaign started

step-by-step in 3 phases to match timing of cavern cleaning from iron

Phase I (27 Sep - 14 Oct) : 0-300A (Cleaning: Large platforms removed)

- ✓Confirmation of main toroid characteristics, inductance, resistance RRR (300-10), ground insulation, fine tuning of coil cooling: **OK**
- ✓Check of cabling, identification of all sensors: **OK**

-> done

Phase II (16 Oct - 26 Oct) : 1-5kA (Cleaning: Detector area, completely)

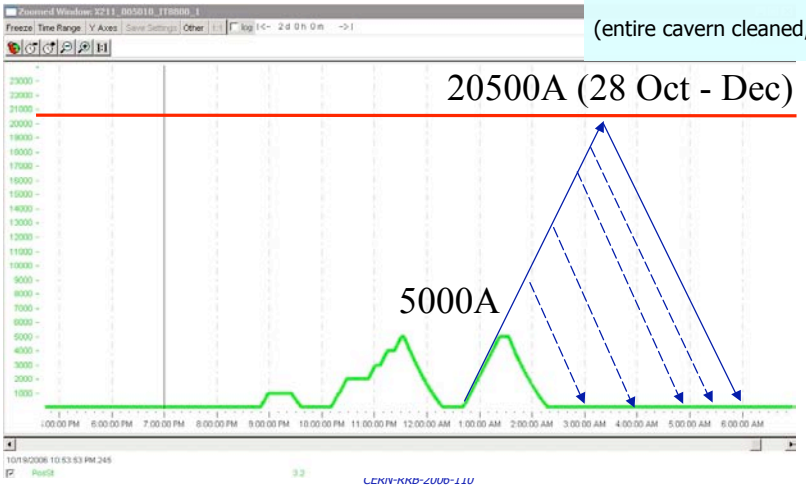
- ✓3h test duration at 20kA of the power circuit, toroid not connected: **OK**
- ✓Power converter 20.5 kA/16V current control optimization, Ipp ripple $<10^{-5}$ achieved: **OK**
- ✓Magnet Safety System checks and commissioning (must be OK before going further)
  - *Quench detection bridges adjustments, SQD settings etc, ongoing, 80% done: will be **OK by mid next week***
  - *Quench heaters identification, verification and power adjustments, will be tested early next week: **OK by next week***
  - ***Fast dump tests**: next week Wednesday 25 Oct*
- ✓First readings of mechanical sensors, tie rods, fixed point, done, **OK**

-> ongoing

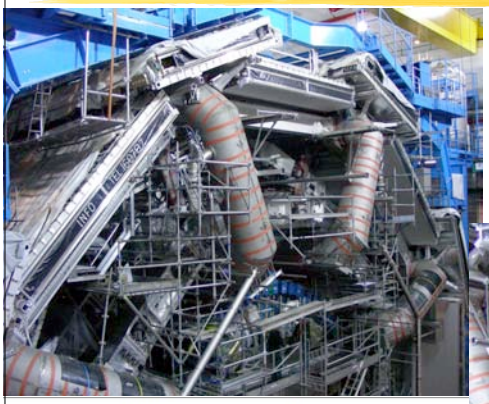
Barrel Magnet Toroid test 1-5kA on 18 Oct

- ✓Two 5kA cycles completed : 5kA ~ 25% of B, 7% of max force!
- ✓Toroid behaved well, inside cleaning ok, ready for the next step

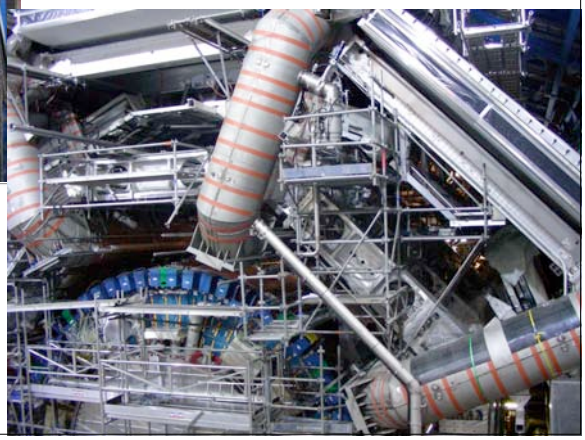
- Phase III 5-20.5kA (entire cavern cleaned, all fixed)



Barrel Muon Spectrometer



- ✓ **552** barrel MUON Stations have been installed (~78%), not all of them in final position
- ✓ **115** stations still to be installed in 2006, **37** in spring 2007 (they interfere with other activities)



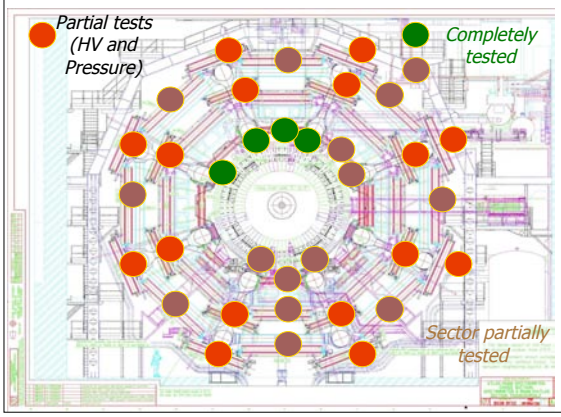
Barrel Muon Spectrometer

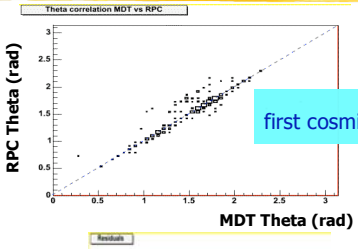
in 2007 | in 2006 | Inst UX15

	Side A	Rib	Side B	Rib	Side C	Rib	Inst	Total	%
Sector 1	EIL4 BIL6 BIL5 / BML7 BML6 BML5		BIL4 BIL3 / BML4 BML3		BIL2 BIL1 / BML2 BML1		BIL1 BIL2 / BML1 BML2		BIL3 BIL4 / BML3 BML4		BIL5 BIL6 EIL4 / BML5 BML6 BML7		13 / 7	14 / 14	93% / 50%
US	BOL6 BOL5		BOL4 BOL3		BOL2 BOL1		BOL1 BOL2		BOL3 BOL4		BOL5 BOL6		6	12	50%
Sector 2	BIS.8 BIS.7 BIS.6 BIS.5		BIS.4 BIS.3		BIS.2 BIS.1		BIS.1 BIS.2		BIS.3 BIS.4		BIS.5 BIS.6 BIS.7 BIS.8		16	16	100%
	BMS.6 BMS.5	S2 S3	BMS.4 BMS.3	S2 S2	BMS.2 BMS.1		BMS.1 BMS.2	S2 S2	BMS.3 BMS.4	S2 S3	BMS.5 BMS.6		20	20	100%
US	BOS.6 BOS.5		BOS.4 BOS.3		BOS.2 BOS.1		BOS.1 BOS.2		BOS.3 BOS.4		BOS.5 BOS.6		12	12	100%
Sector 3	EIL4 BIL6 BIL5 / BML7 BML6 BML5		BIL4 BIL3 / BML4 BML3		BIL2 BIL1 / BML2 BML1		BIL1 BIL2 / BML1 BML2		BIL3 BIL4 / BML3 BML4		BIL5 BIL6 EIL4 / BML5 BML6 BML7	0	13 / 7	14 / 14	93% / 50%
US	BOL6 BOL5		BOL4 BOL3		BOL2 BOL1		BOL1 BOL2		BOL3 BOL4		BOL5 BOL6		12	12	100%
Sector 4	BIS.8 BIS.7 BIS.6 BIS.5		BIS.4 BIS.3		BIS.2 BIS.1		BIS.1 BIS.2		BIS.3 BIS.4		BIS.5 BIS.6 BIS.7 BIS.8		16	16	100%
	BMS.6 BMS.5	S2 S3	BMS.4 BMS.3	S2 S2	BMS.2 BMS.1		BMS.1 BMS.2	S2 S2	BMS.3 BMS.4	S2 S3	BMS.5 BMS.6		20	20	100%
US	BOS.6 BOS.5		BOS.4 BOS.3		BOS.2 BOS.1		BOS.1 BOS.2		BOS.3 BOS.4		BOS.5 BOS.6		12	12	100%
Sector 5	EIL4 BIL6 BIL5 / BML7 BML6 BML5		BIL4 BIL3 / BML4 BML3		BIL2 BIL1 / BML2 BML1		BIL1 BIL2 / BML1 BML2		BIL3 BIL4 / BML3 BML4		BIL5 BIL6 EIL4 / BML5 BML6 BML7	0	14 / 14	14 / 14	100% / 100%
Top	BOL6 BOL5		BOL4 BOL3		BOL2 BOL1		BOL1 BOL2		BOL3 BOL4		BOL5 BOL6		12	12	100%
Sector 6	BIS.8 BIS.7 BIS.6 BIS.5		BIS.4 BIS.3		BIS.2 BIS.1		BIS.1 BIS.2		BIS.3 BIS.4		BIS.5 BIS.6 BIS.7 BIS.8		16	16	100%
	BMS.6 BMS.5	S2 S3	BMS.4 BMS.3	S2 S2	BMS.2 BMS.1		BMS.1 BMS.2	S2 S2	BMS.3 BMS.4	S2 S3	BMS.5 BMS.6		20	20	100%
USA	BOS.6 BOS.5		BOS.4 BOS.3		BOS.2 BOS.1		BOS.1 BOS.2		BOS.3 BOS.4		BOS.5 BOS.6		12	12	100%
Sector 7	EIL4 BIL6 BIL5 / BML7 BML6 BML5		BIL4 BIL3 / BML4 BML3		BIL2 BIL1 / BML2 BML1		BIL1 BIL2 / BML1 BML2		BIL3 BIL4 / BML3 BML4		BIL5 BIL6 EIL4 / BML5 BML6 BML7	0	13 / 7	14 / 14	93% / 50%
USA	BOL6 BOL5		BOL4 BOL3		BOL2 BOL1		BOL1 BOL2		BOL3 BOL4		BOL5 BOL6		12	12	100%
Sector 8	BIS.8 BIS.7 BIS.6 BIS.5		BIS.4 BIS.3		BIS.2 BIS.1		BIS.1 BIS.2		BIS.3 BIS.4		BIS.5 BIS.6 BIS.7 BIS.8		16	16	100%
	BMS.6 BMS.5	S2 S3	BMS.4 BMS.3	S2 S2	BMS.2 BMS.1		BMS.1 BMS.2	S2 S2	BMS.3 BMS.4	S2 S3	BMS.5 BMS.6		20	20	100%
USA	BOS.6 BOS.5		BOS.4 BOS.3		BOS.2 BOS.1		BOS.1 BOS.2		BOS.3 BOS.4		BOS.5 BOS.6		12	12	100%
Sector 9	EIL4 BIL6 BIL5 / BML7 BML6 BML5		BIL4 BIL3 / BML4 BML3		BIL2 BIL1 / BML2 BML1		BIL1 BIL2 / BML1 BML2		BIL3 BIL4 / BML3 BML4		BIL5 BIL6 EIL4 / BML5 BML6 BML7	0	12 / 3	14 / 14	86% / 21%
USA	BOL6 BOL5		BOL4 BOL3		BOL2 BOL1		BOL1 BOL2		BOL3 BOL4		BOL5 BOL6		6	12	50%
Sector 10	BIS.8 BIS.7 BIS.6 BIS.5		BIS.4 BIS.3		BIS.2 BIS.1		BIS.1 BIS.2		BIS.3 BIS.4		BIS.5 BIS.6 BIS.7 BIS.8		16	16	100%
	BMS.6 BMS.5	S2 S3	BMS.4 BMS.3	S2 S2	BMS.2 BMS.1		BMS.1 BMS.2	S2 S2	BMS.3 BMS.4	S2 S3	BMS.5 BMS.6	0	20	20	100%
USA	BOS.6 BOS.5		BOS.4 BOS.3		BOS.2 BOS.1		BOS.1 BOS.2		BOS.3 BOS.4		BOS.5 BOS.6		12	12	100%
Sector 11	BIM.5 / EIL4 BIR.6 BIR.5 / BML7 BML6 BML5		BIM.4 BIM.3 / BIR.4 BIR.3 / BML4 BML3		BIM.2 BIM.1 / BIR.2 BIR.1 / BML2 BML1		BIM.1 BIM.2 / BIR.1 BIR.2 / BML1 BML2		BIM.3 BIM.4 / BIR.3 BIR.4 / BML3 BML4		BIM.5 / BIR.5 BIR.6 EIL4 / BML5 BML6 BML7	0	5 / 0 / 0	10 / 14 / 14	50% / 0% / 0%
USA	BOL6 BOL5		BOL4 BOL3		BOL2 BOL1		BOL1 BOL2		BOL3 BOL4		BOL5 BOL6		6	12	50%
Sector 12	BIS.8 BIS.7 BIS.6 BIS.5 / BMF.3		BIS.4 BIS.3 / BMF.2		BIS.2 BIS.1 / BMF.1		BIS.1 BIS.2 / BMF.1		BIS.3 BIS.4 / BMF.2		BIS.5 BIS.6 BIS.7 BIS.8 / BMF.3		11 / 6	16 / 6	69% / 100%
USA	BOG.8 BOF.7 BOG.6 BOF.5		BOG.4 BOF.3		BOG.2 BOF.1	BOG.0	BOF.1 BOG.2		BOF.3 BOG.4		BOF.5 BOG.6 BOF.7 BOG.8		15	17	88%
Sector 13	EIL4 BIL6 BIL5 / BML7 BML6 BML5		BIL4 BIL3 / Elevator BML3		BIL2 BIL1 / BML2 BML1		BIL1 BIL2 / BML1 BML2		BIL3 BIL4 / BML3 Elevator		BIL5 BIL6 EIL4 / BML5 BML6 BML7		11 / 8	14 / 12	79% / 67%
Bottom	BOL6 BOL5		BOL4 BOL3		BOL2 BOL1		BOL1 BOL2		BOL3 BOL4		BOL5 BOL6		8	12	67%
Sector 14	BIS.8 BIS.7 BIS.6 BIS.5 / BMF.3		BIS.4 BIS.3 / BMF.2		BIS.2 BIS.1 / BMF.1		BIS.1 BIS.2 / BMF.1		BIS.3 BIS.4 / BMF.2		BIS.5 BIS.6 BIS.7 BIS.8 / BMF.3		11 / 6	16 / 6	69% / 100%
US	BOG.8 BOF.7 BOG.6 BOF.5		BOG.4 BOF.3		BOG.2 BOF.1	BOG.0	BOF.1 BOG.2		BOF.3 BOG.4		BOF.5 BOG.6 BOF.7 BOG.8		15	17	88%
Sector 15	BIM.5 / EIL4 BIR.6 BIR.5 / BML7 BML6 BML5		BIM.4 BIM.3 / BIR.4 BIR.3 / BML4 BML3		BIM.2 BIM.1 / BIR.2 BIR.1 / BML2 BML1		BIM.1 BIM.2 / BIR.1 BIR.2 / BML1 BML2		BIM.3 BIM.4 / BIR.3 BIR.4 / BML3 BML4		BIM.5 / BIR.5 BIR.6 EIL4 / BML5 BML6 BML7	0	5 / 0 / 0	10 / 14 / 14	50% / 0% / 0%
US	BOL6 BOL5		BOL4 BOL3		BOL2 BOL1		BOL1 BOL2		BOL3 BOL4		BOL5 BOL6		6	12	50%
Sector 16	BIS.8 BIS.7 BIS.6 BIS.5		BIS.4 BIS.3		BIS.2 BIS.1		BIS.1 BIS.2		BIS.3 BIS.4		BIS.5 BIS.6 BIS.7 BIS.8		16	16	100%
	BMS.6 BMS.5	S2 S3	BMS.4 BMS.3	S2 S2	BMS.2 BMS.1		BMS.1 BMS.2	S2 S2	BMS.3 BMS.4	S2 S3	BMS.5 BMS.6		20	20	100%
US	BOS.6 BOS.5		BOS.4 BOS.3		BOS.2 BOS.1		BOS.1 BOS.2		BOS.3 BOS.4		BOS.5 BOS.6		12	12	100%

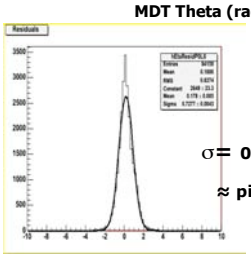
Barrel Muon Spectrometer

- ✓Services installation going on in parallel for MDT cables and pipes
- ✓Full gas system distribution being commissioned, RPC gas system ok
- ✓ Alignment system being debugged





first cosmics runs

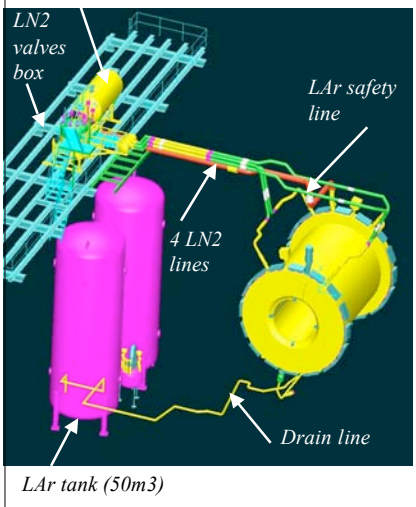


σ = 0.74 cm

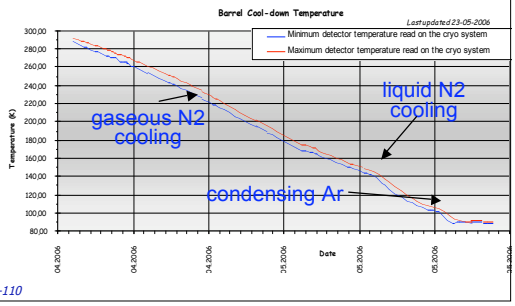
≈ pitch/√12

- ✓Services installation slower for RPC cables, delivery problems
- ✓Procurement of the power supply on the critical path (contractual problem)

Calorimeters (Barrel LAr + Tiles)



cooling down



All components installed (detectors, cryogenics, services,..)

Calorimeters (Barrel LAr + Tiles)

✓**Oct `05**: Tilecal completed, move barrel calorimeter to IP position + service connection

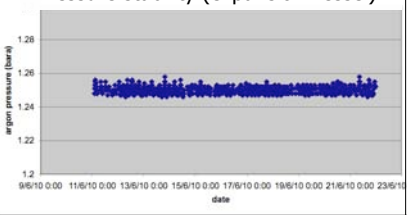
✓**Jan `06**: Start of commissioning phase 3

✓**Apr-/May `06**: Final cool-down (7 weeks)

✓**June `06**: Barrel filled with LAr
-> Few shorts, try to burn it in few modules

✓**July `06**: Decide to empty / refill by condensation
-> Refilling took 20 days

Pressure stability (expansion vessel)



Impurity level

Measured with four purity cells:

(0.20 +- 0.05) ppm O_2

LAr Calorimeter QC (HV on):

✓ total 448 independent sectors

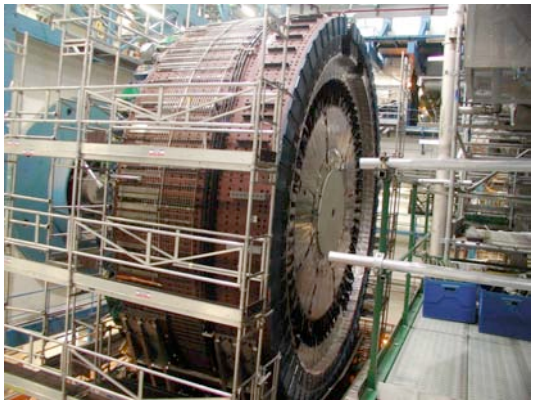
✓ all channels functioning

-> ~95% at nominal sensitivity

-> ~5% at 50-80% sensitivity

(improvements being investigated)

End-cap Calorimeters (LAr + Tiles)



✓ both end-caps mechanically assembled (May `06)

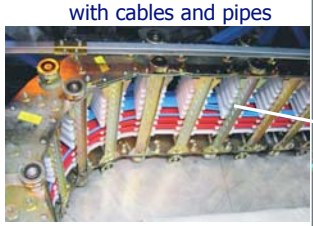
✓ LAr infrastructure (pedestals, crates,…) installed

✓ gap, cryostat and minimum bias scintillators completely installed on both ext. barrels

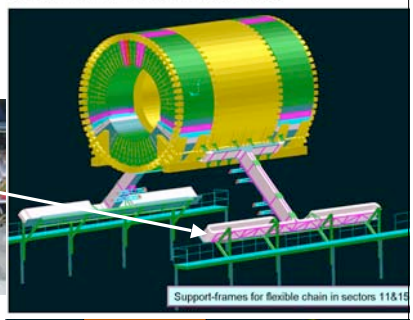
Services connection is ongoing

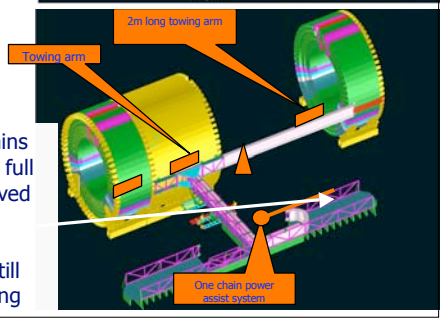
LAr flexible lines during installation, now completed

45o flexible chains completed on side A and being filled with cables and pipes



90o flexible chains installed, Side A full and already moved twice. Operation performance still under debugging





Calorimeter end-caps commissioning plans

✓ *The cool down of the ECA can only start when all services are connected and tested. At this moment the start of the ECA cool-down can be foreseen for the second half of November*

✓ *Not enough cryogenic power to cool both end-caps in parallel*

✓ *The cryo-operations will be sequential. For each cryostat we expect 8-9 weeks for the cool-down process and 2 weeks for the LAr filling by condensation*

✓ *The testing and commissioning of the electronics chain proceeds steadily. On the critical path is the final acceptance of the LV power supplies for both calorimeters*

Main LAr activities and plans for the end-caps

EC-A:

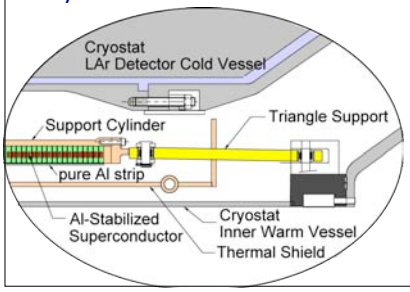
- Since August installation of LAr FE electronics (no all LVPS yet)
- Tiles electronics debugging (LVPS partially missing)
- Services connection now half-way
- November 2006 start cool-down
- February 2007 start cold operation

EC-C:

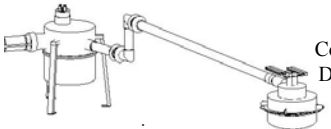
- Since April installation of FE electronics, then switched to EC-A
- February 2007 start cool-down
- April 2007 start cold operation

Final Solenoid commissioning and field map

Inserted in the LAr cryostat and fully tested on surface in 2004



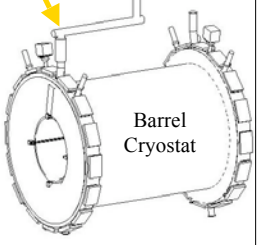
Services integration and connection in the ATLAS cavern done



cryogenics distribution box

chimney (double bus-line)

field joints

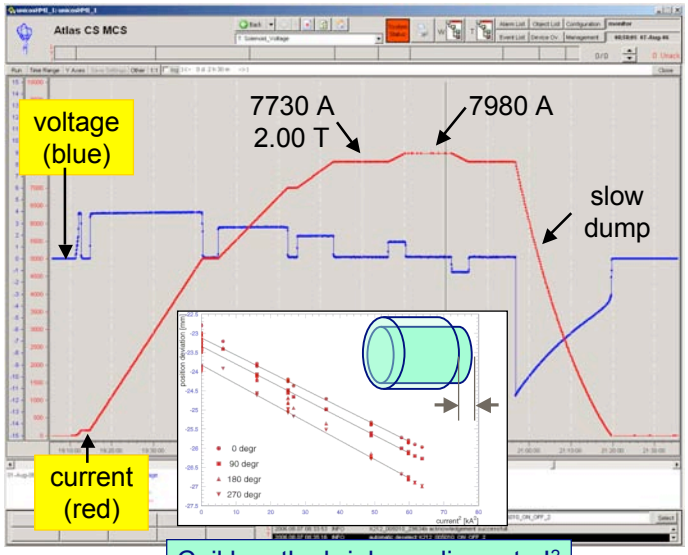


Final Solenoid commissioning and field map

- ✓ Cool down with shield refrigerator to 75 K, then swap to main refrigerator, heading for 4 K
- ✓ August magnet excitation and final operation commissioning

August 1st -> 8KA

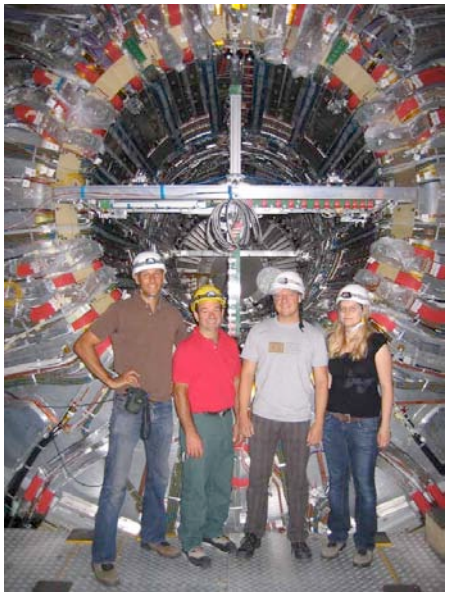
- ✓ Ramp in steps: 7730 A = 2 T
- ✓ repositioning accuracy ±0.1 mm
- ✓ final position 0.0 ± 1.4 mm (relative IP)



Coil length shrinkage, linear to I^2

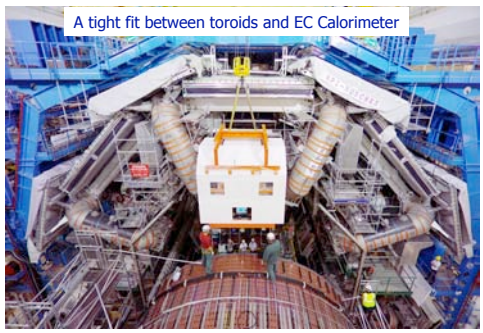
Final Solenoid commissioning and field map

- ✓ 3D scanning machine, 3D calibrated Hall probes
  Accuracy: ±1x10^{-4} T (at ≤1.2T)
- ✓ Excitation reproducibility
  ->Field: < 0.1x10^{-4} T
  ->Current: < 5 ppm
  No hysteresis effect from iron
  iron contribution to field: ~ 3.5 %
- ✓ Data confirms required mapping precision and coil position from survey and monitor system:
  ->horizontal offset: 0.1 mm
  ->vertical offset: -2.3 mm



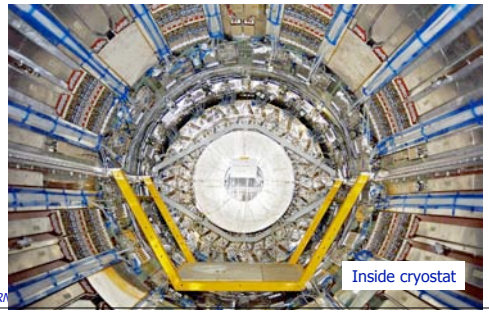
Inner Detector Barrel installed in situ

24 & 25 Aug `06



A tight fit between toroids and EC Calorimeter

From the trolley to the support rails



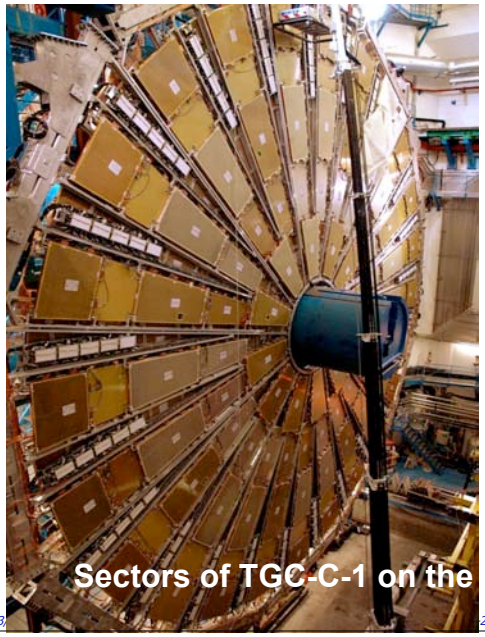
Inside cryostat

ID cabling, services installation and commissioning

Incredible effort over > 1 year to install all cables and pipes from the counting rooms to the detector front end

- ✓ all TRT cooling and gas systems operational and commissioned, entire barrel connected
- ✓ *By the 1st week of November all TRT barrel cables will be connected and tested (entire chain)*
- ✓ Then a 11 weeks connection and commissioning period of the barrel SCT will start
- ✓ *We plan then to install the end-caps ID in February 2007 + 11 weeks of commissioning*

Forward Muon Spectrometer



Sectors of TGC-C-1 on the

end-wall of the ATLAS hall

Big wheels

- ✓ First wheel mechanical installation has been a success, all went perfectly & safe
- ✓ Right now the services installation and final readout tests are ending
- ✓ Once a last stability problem of the structure is solved, it will be moved on chariots to the front of the barrel toroid and the construction of the second MDT wheel will start (end October)

- ✓ *In the last few months we lost several weeks in this installation process, because of various small technical problems, transport difficulties and cohabitation problems with the rest of the installation work underground*
- ✓ *We have now to reorganize all this work, bringing in all resources which are becoming free from the ending of the major installation work on calorimeter and barrel muon*
- ✓ *We have also decided to double the tooling and to proceed in parallel after December '06 with the parallel installation on side A*
- ✓ *The preparation of the sectors on the surface and their final QC is proceeding as expected and should not create additional delays to the installation. Still this remains on the ATLAS critical path*

End-cap Toroids

✓Last 6 months of integration of all component of the end-caps toroid have become very problematic and we lost 3-4 months!

✓Once all components have become available and passed final qualification, it became evident that the integration work was too constraint and a few components could not perfectly fit during the closing of the cryostat.

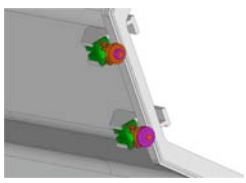
Practical example:

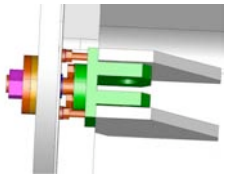
- ECT cold mass is pulled into the BT with ~260 tons taken by 16 tie rods that transfer load to the vessel and then to the 8 BT vessels trough the 8 connection points

- Design assumed infinite stiffness of vessel during integration and 0.5mm tolerances, impossible to do, they may break!

- Redesign to make them adjustable after closing, transport, cooling down in the cavern

- Bring the connections through the end plate to the outside, 16 new feed-throughs + vacuum seal



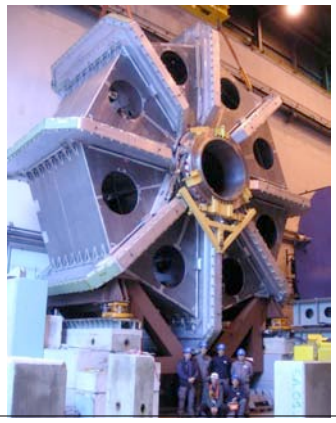


End-cap Toroids (today's status of ECT-C)

- ✓ New AFT design implemented
- ✓ Thermal shield installation completed at both sides
- ✓ A problem of grounding connection was also solved in between
- ✓ Next steps:
  - install stay tubes
  - Complete superinsulation behind end-plates
  - Start closing the vessel + vacuum tests
- ✓ Schedule is still OK for 80K test in Feb/March '07

End-cap Toroids (today's status of ECT-A)

- ✓ We started immediately the assembly in parallel of the second toroid, doubling the teams (thank you to several FAs who helped on this !!)
- ✓ Today the second cold mass is mechanically assembled in b.191
- ✓ Next:
  - ->Connecting cooling lines manifolds
  - ->Welding of superconductor joints
  - ->6K shield installation
  - ->Instrumentation
- ✓ Work progresses well and will be completed before end of Dec



ECTs working schedule

ECT-A

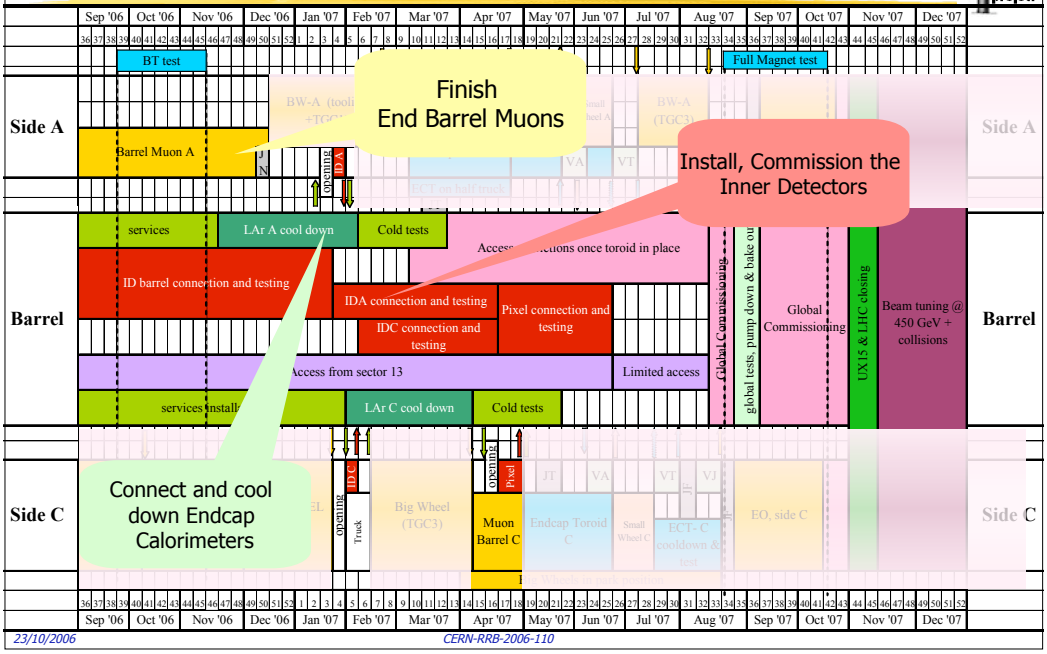
- *Closing vessel Oct-Dec '06*
- *Vacuum test during Xmas*
- *Preparations for transport Jan '07*
- *Transport to 80K test station ~1st Feb*
- *Transport to point 1 in March*
- *Connections and test in cavern Mar-Jun '07*

ECT-C

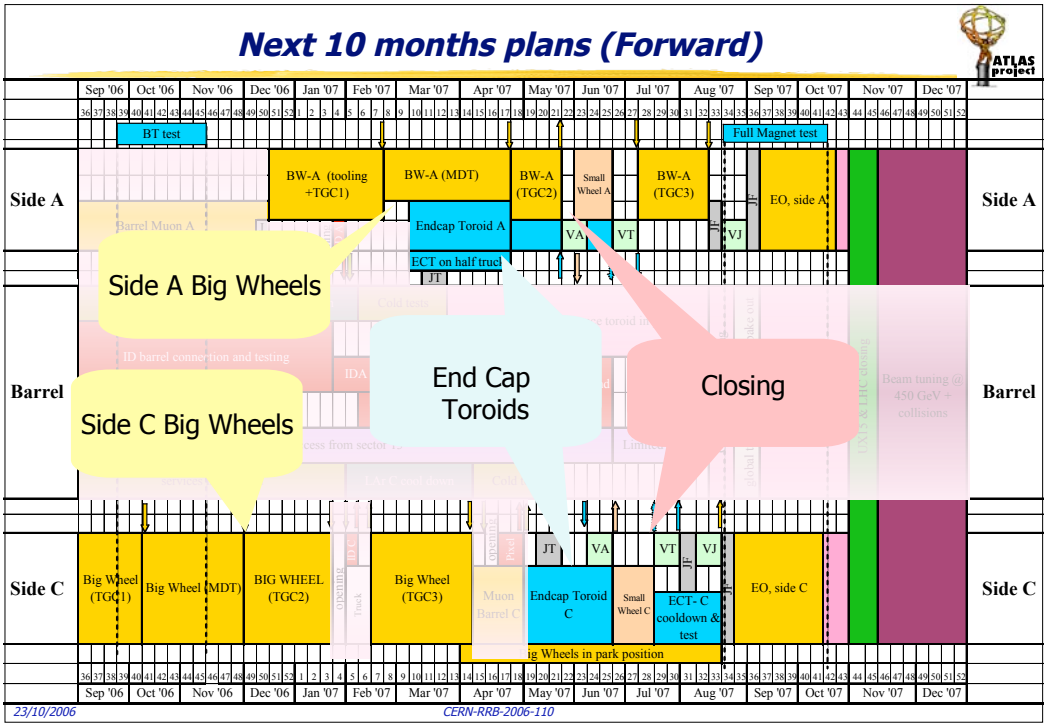
- *Cold mass ready by Dec 06 in B191; cryostating can **not** start before ECT-A is out of B191*
- *Cryostat integration Feb-Apr '07*
- *Vacuum test and preparations for transport May '07*
- *80K test in May-June (if proven necessary)*
- *Transport to point 1 by end of June*
- *Connections and test in the cavern by Jul-Sep '07*

This represents today the main ATLAS critical path and a big complication to the integration of the forward muon spectrometer !!

Next 10 months plans (Barrel)



Next 10 months plans (Forward)



Summary

- ✓ ATLAS installation is proceeding (master schedule 8.01), targeting end August 2007 for the beam pipe closing.
- ✓ Many technical problems of the last 6-8 months solved, we are working now in parallel on many fronts (much more that we expected few years ago !!). The largest part of the services (cables and pipes) have been put in place with a major effort.
- ✓ The Barrel construction and commissioning is proceeding well. It will be mostly installed by beginning of 2007. The commissioning of all installed component is proceeding in phase with installation.
- ✓ Today most critical activities relates to the forward muon spectrometer: End-Cap Toroids and Forward Muon wheels
- ✓ The next 10 months will be impressively intense!