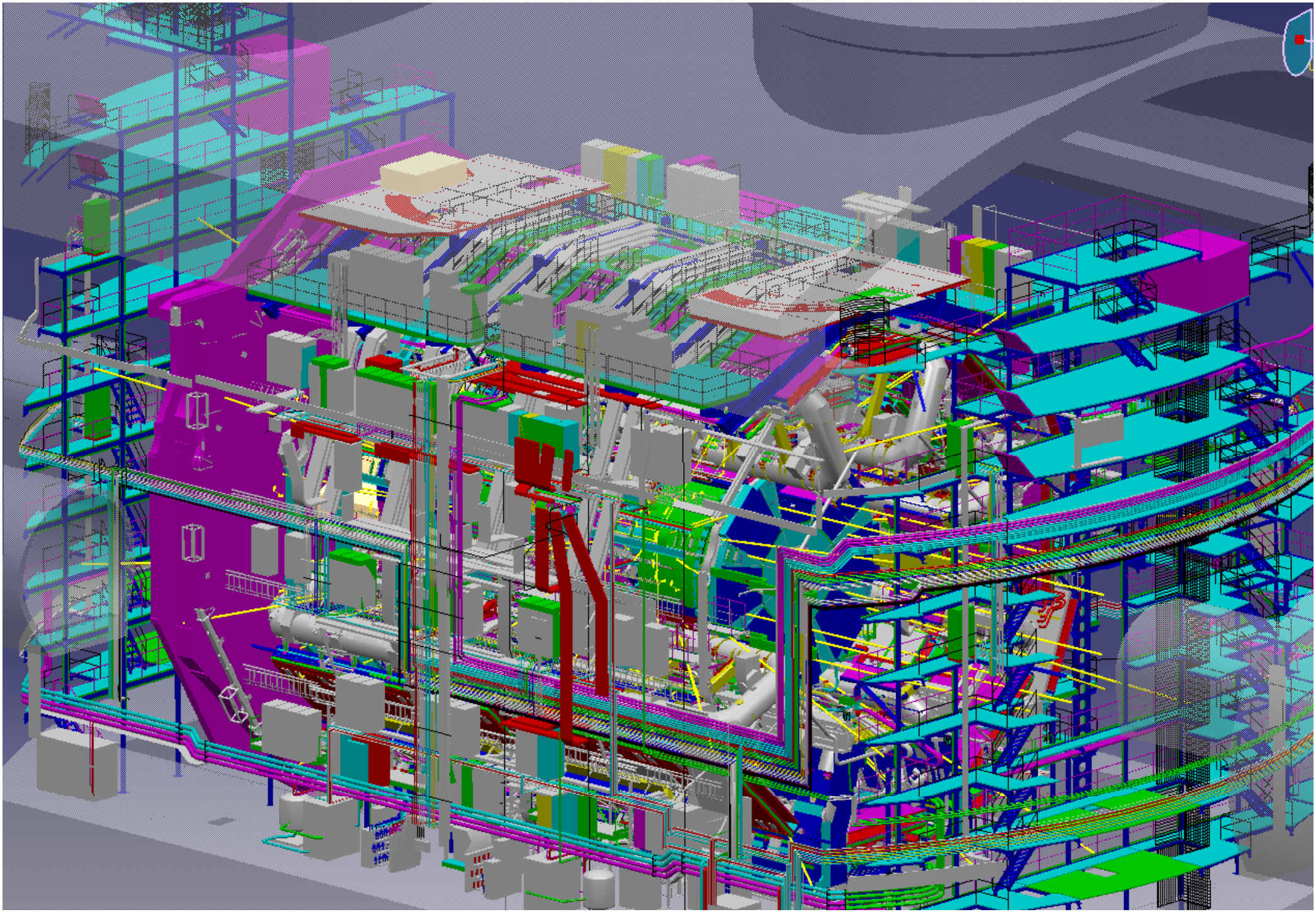
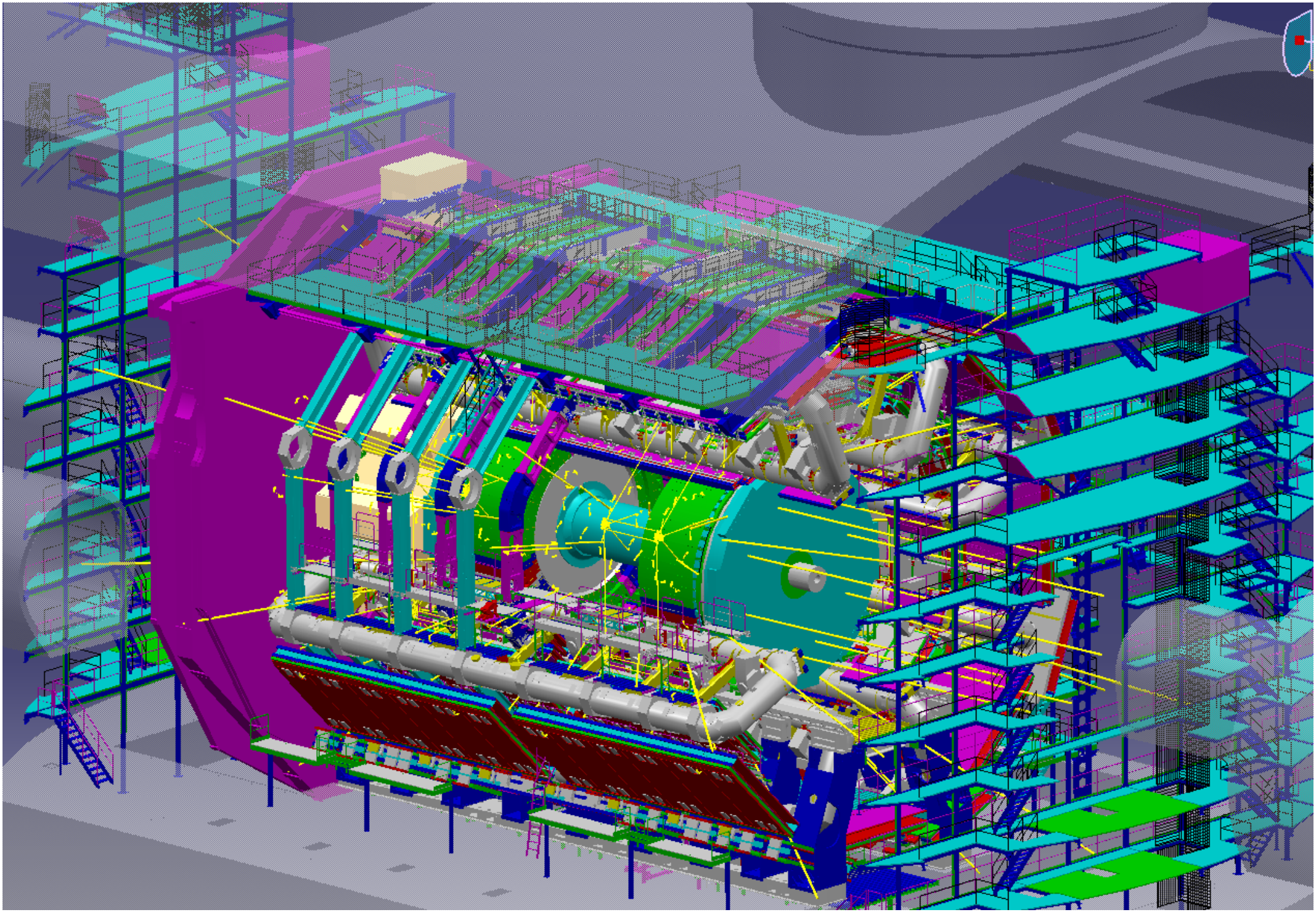
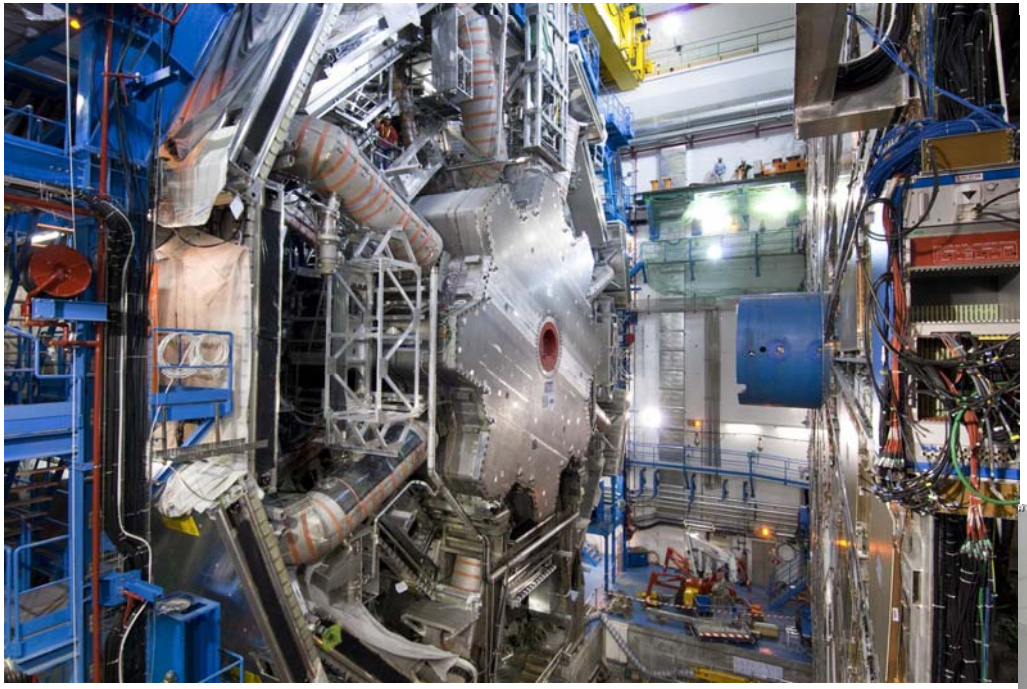
ATLAS Progress Report (part I)

CERN-RRB-2007-080
22nd October 2007





Todays activities



- ✓Completion of the detector installation and all related services (~6000/7000 tons installed) ... part of the forward muon spectrometer and forward shieldings still on surface
- ✓Hardware commissioning of all electronics components, controls and safety systems

- ✓Integration and tuning of all controls
- ✓Full test of the data taking chain with calibration and cosmics events. ATLAS runs and operation mode mimics
- ✓Test of all the online and offline software and computing infrastructure

What did we achieve in the last 6 months ?

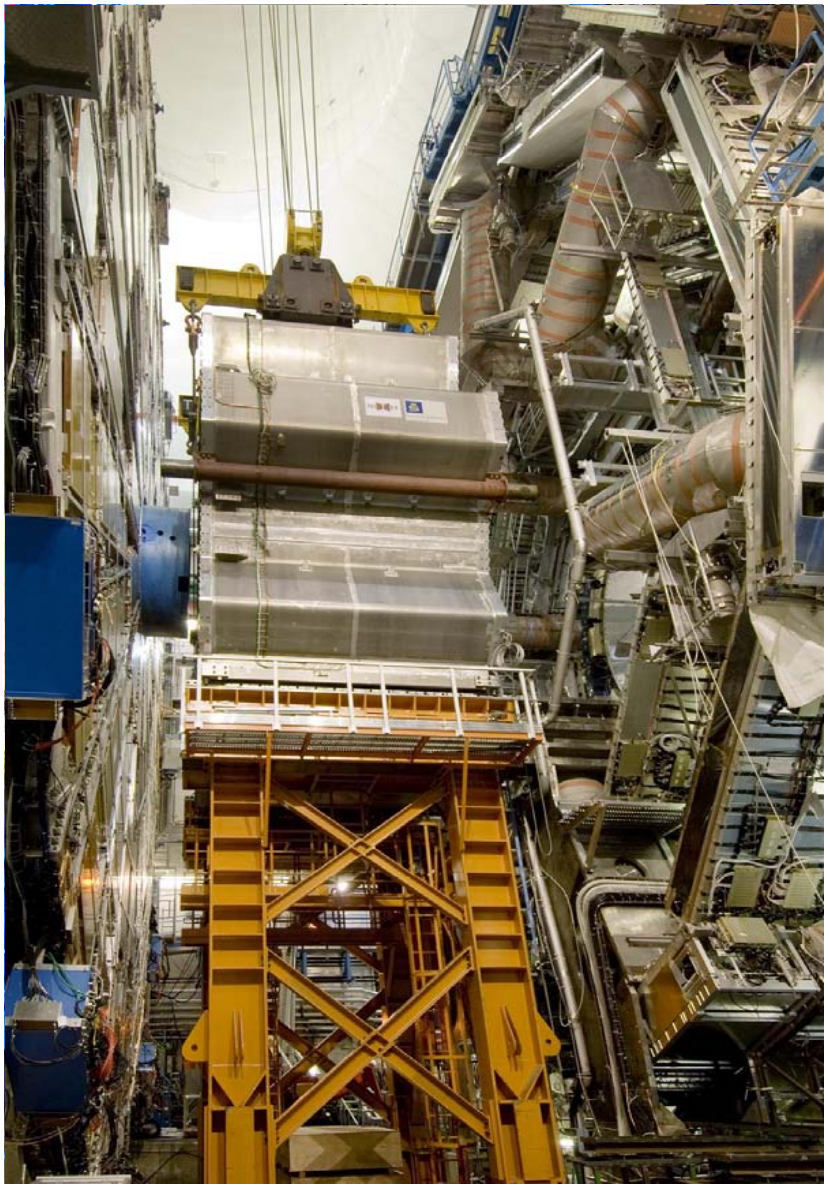
- ✓ Installation of the 2 Endcap Toroids and their services connections. Just preparing a full current test
- ✓ Installation of all services, cables, pipes, gas, cooling systems and access platforms for the barrel muon spectrometer. 99% of all chambers are in place. 90% of the alignment system is operational
- ✓ Installation and hardware connection of all forward muon big wheels
- ✓ All Calorimeters connected, cooled and brought to operation. Retrofitting and re-installation of all power supplies achieved. Still some retrofitting of electronics front end boards ongoing
- ✓ Installation and connection of all Inner Detector components (2 endcaps TRT + SCT, full pixel). Still missing the final in situ connection of the silicon detectors cooling system and of the entire pixel ... and the final closing of the ID volume
- ✓ Installation and vacuum test of the internal beam pipe system. All other beam pipes waiting on surface
- ✓ Preparation on surface of the first small wheel, the second is just following. All detector radiation shielding elements installed, the very forward is waiting on surface
- ✓ Installation of ~35% of the necessary online processing hardware, with all functional components present. LVL1 trigger mostly in place.
- ✓ Full scale activation of the main control room. Integration of all systems readout and controls
- ✓ Periodic global cosmic runs of the entire detector (ATLAS operation mode) to debug readout, controls and safety systems

Integration weeks schedule

Dates	Systems Integration	Detector configuration	Operations	Cosmic run	Training	ACR
M1: 11-19/12 2006	DAQ R/O Barrel Lar & Tile CTP	Barrel calorimeters	Achieve combined run	2 days Tile cosmic trigger	N/A	Initial setup: 5 desks Central DCS
M2 28/2 to 13/3 2007	DAQ/EB DAQ V. 1.7 Muon barrel (S. 13) Monitoring/DQ	Barrel calorimeters Barrel Muon	Combined runs Mixed runs	2 x weekd ends Tile cosmic trigger + RPC cosmic trigger Periodic cosmic runs after M2	After M2 week	Increase to 7 desks
M3 4/6 to 18/6 2007	Barrel SCT Barrel TRT Muon EC (MDT, TGC) Offline	Barrel and End Cap calorimeters Barrel muon (5&6) EC muon MDT Barrel SCT, TRT EC muon TGC	1st week focus on operations, checklist management, coordination between desks	1 week Tile + Muon cosmic trigger (side A)	4/6 to 11/6	Towards final layout: 13 desks
M4 23/8 to 3/9 2 day setup 2 week ends	Level-1 Calo HLT DAQ 1.8 Offline 13	Barrel & EC calos Barrel & EC muon Barrel TRT SCT R/O Level-1 Mu, Calo	ATLAS-like operations Use of DQ assessment	1 week Try also calorimeter trigger	Whole week	Final setup
M5 22/10 to 5/11	Pixel (R/O only) SCT quadrant or R/O only	M4 + Pixel (R/O only, no detector) No TRT	Week 1 system assessment Week 2 ATLAS-like operations	1 week	1 week	
Recovery exercise 22/01/08	N/A	All	Restart from "All off" condition Include demo run	N/A	Recovery procedures	
M6 February/March	CSC	+ SCT and Pixel detectors	ATLAS-like Operations	Whole week		

AVAILABLE FOR USE

The End-Cap Toroids

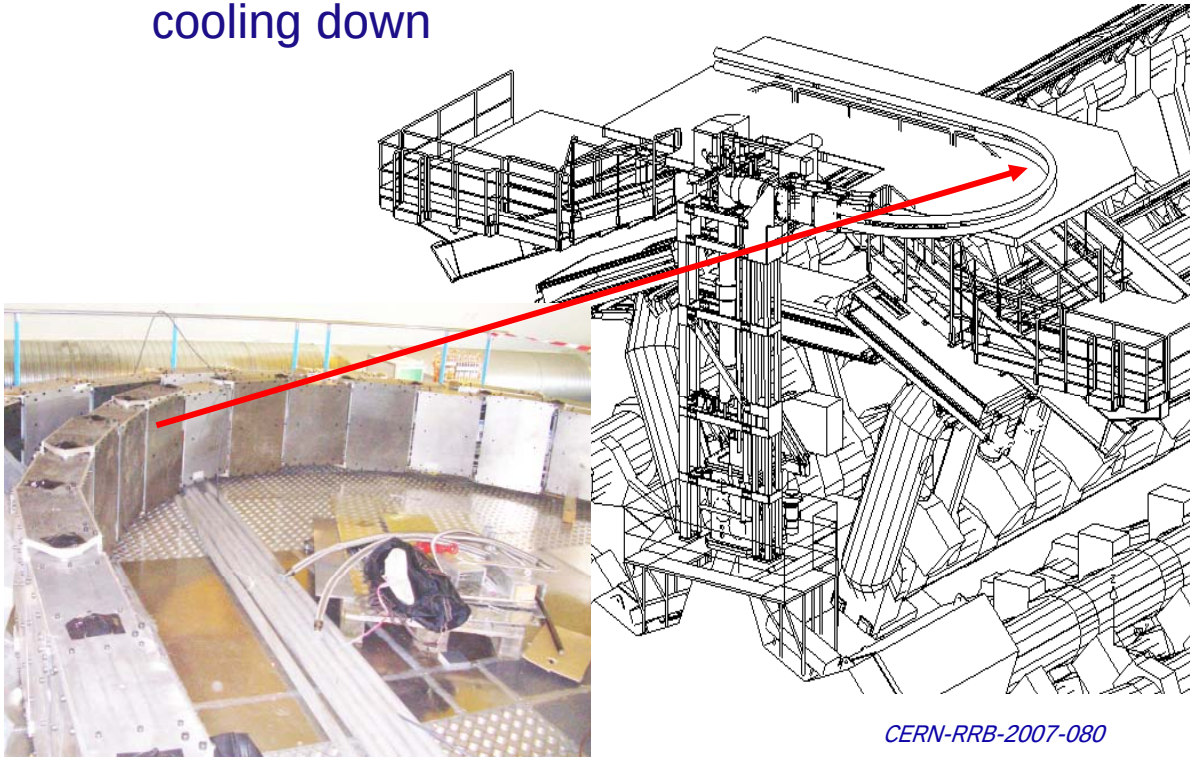


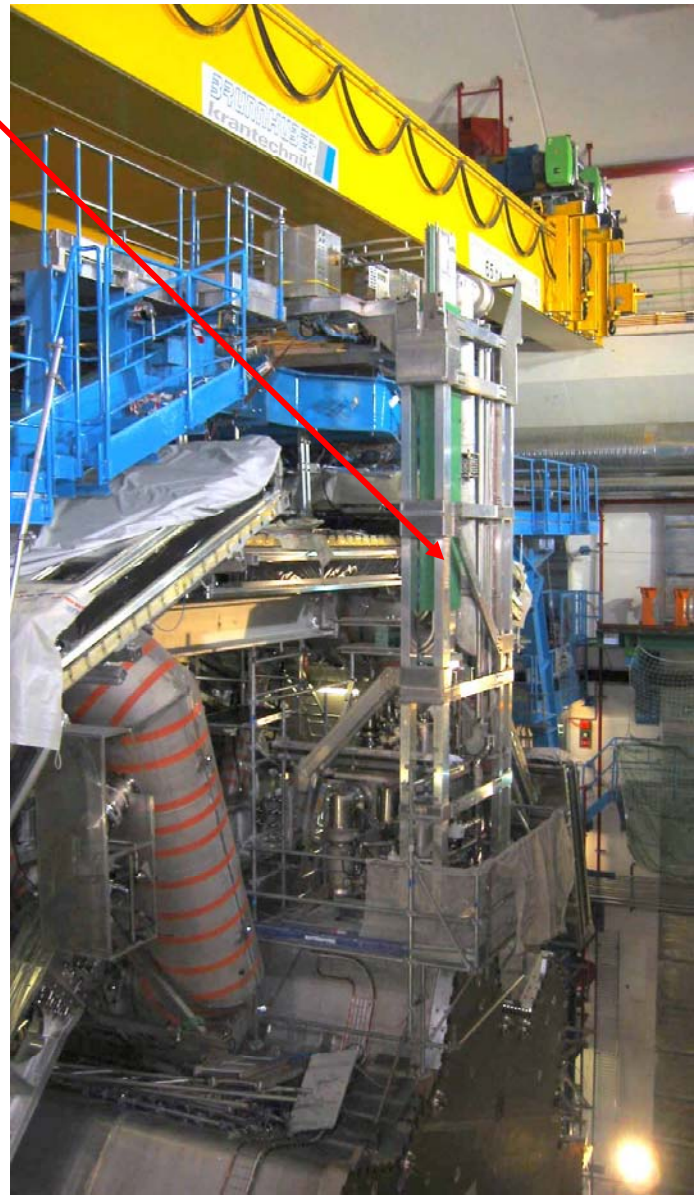
Last one smoothly inserted in the cavern on 12 July

JTT shielding (inside the cryostat bore) and related beam pipe installed as well

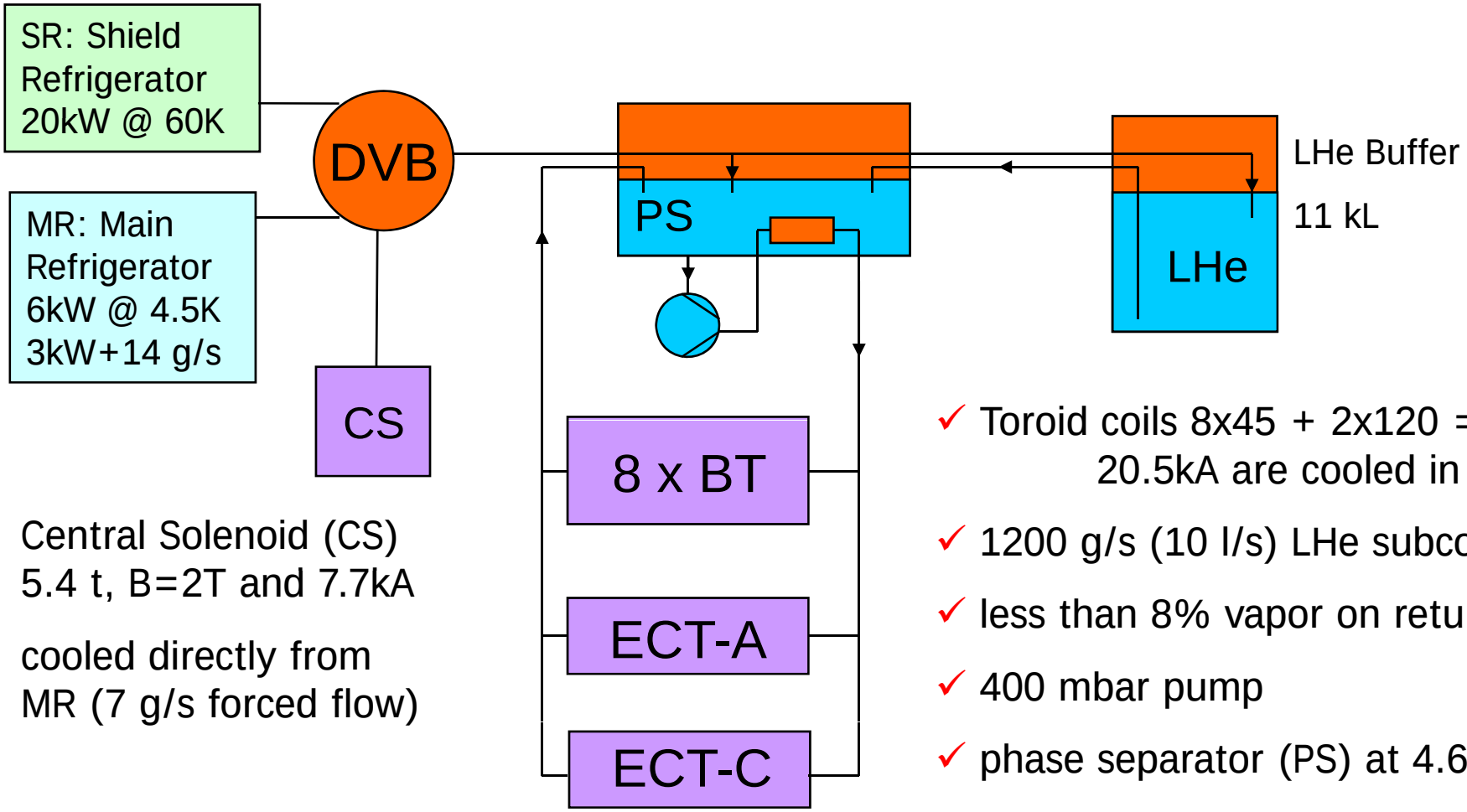
The End-Cap Toroids

- ✓ Routing of vacuum and helium lines, bus bars for current and control cables between turret on vessel and the chains on top of the detector
- ✓ Flex chains installation completed on both sides
- ✓ Leak testing of turret and tower connections completed, re-testing of the vessel O-rings, no leaks found, ALL is OK
- ✓ Pressure 2-5x10^{-4} mbar, perfect for starting cooling down





Magnets Cryo Plant



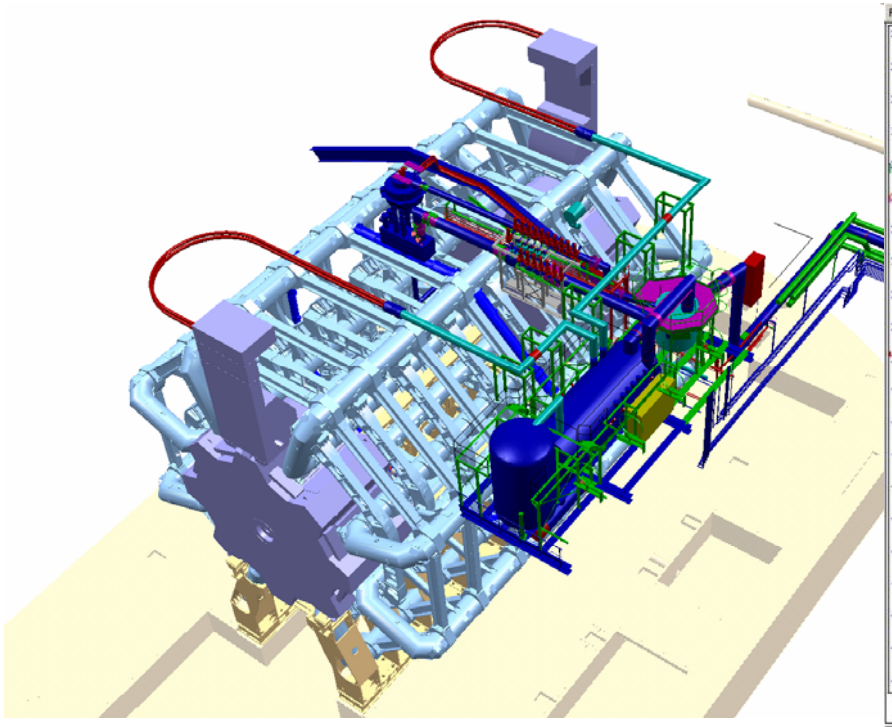
Central Solenoid (CS)
5.4 t, B=2T and 7.7kA

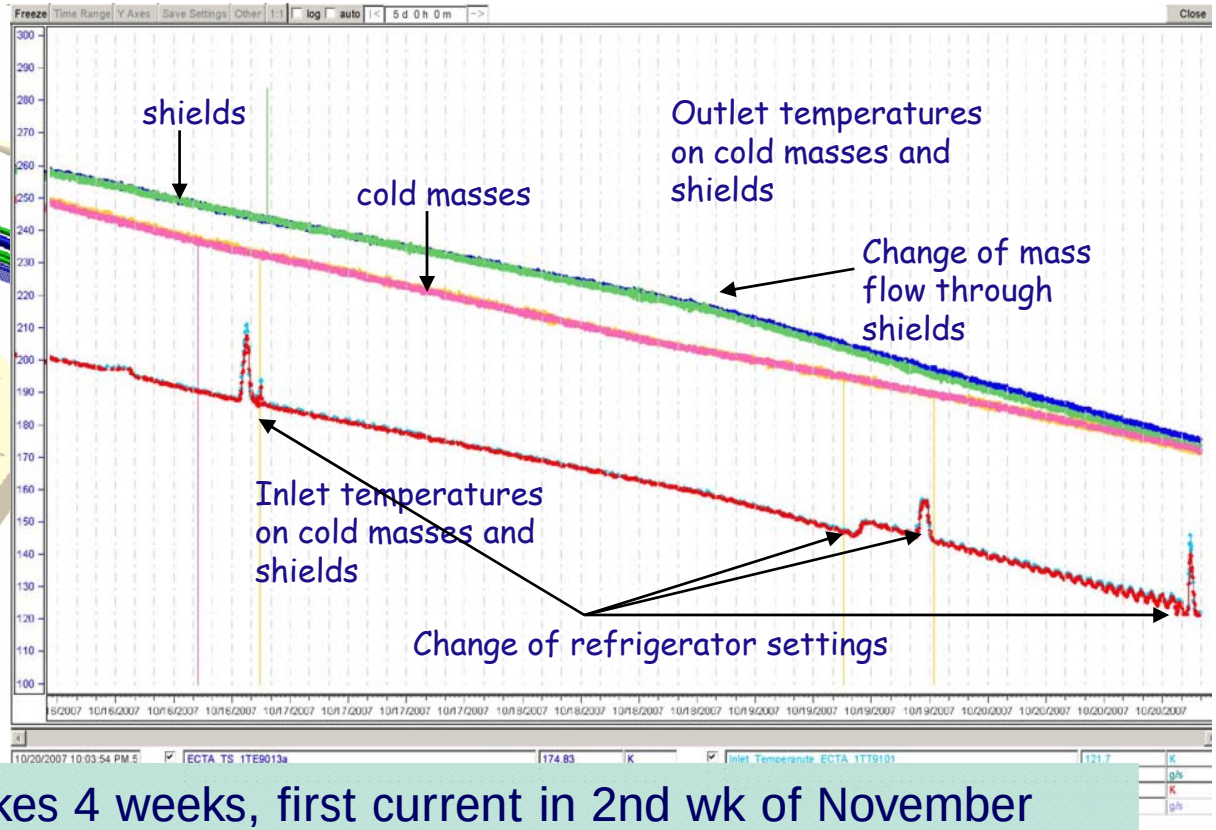
cooled directly from
MR (7 g/s forced flow)

Thermal load:
LHe Pumps: 660 W
PS+Lines+Cryoring: 250W
BT: 620 W
ECT=2x250=500 W

- ✓ Toroid coils 8x45 + 2x120 = 600t, 20.5kA are cooled in parallel:
- ✓ 1200 g/s (10 l/s) LHe subcooled
- ✓ less than 8% vapor on return
- ✓ 400 mbar pump
- ✓ phase separator (PS) at 4.6 K (4.6kL)
- ✓ 11 kL He to avoid fast dump and allow slow dump in 2 hrs
- ✓ 11 g/s of LHe for 8 current leads

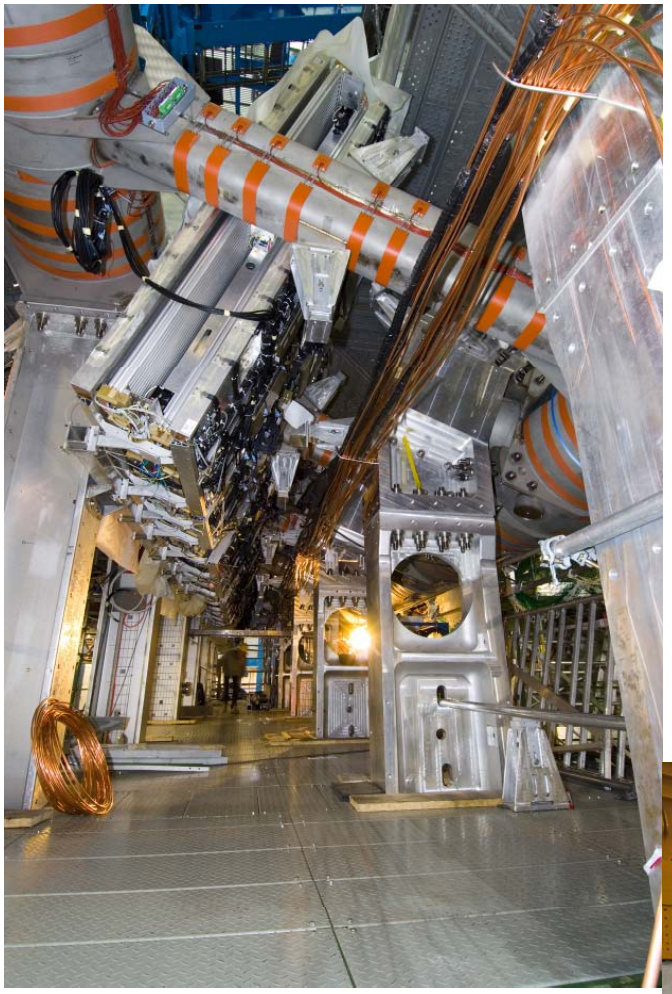
End-Cap Toroids test during November



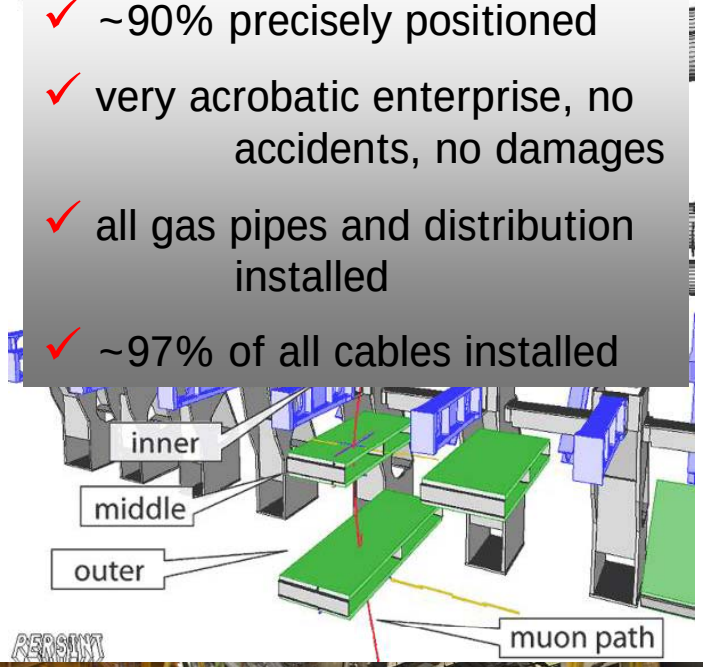


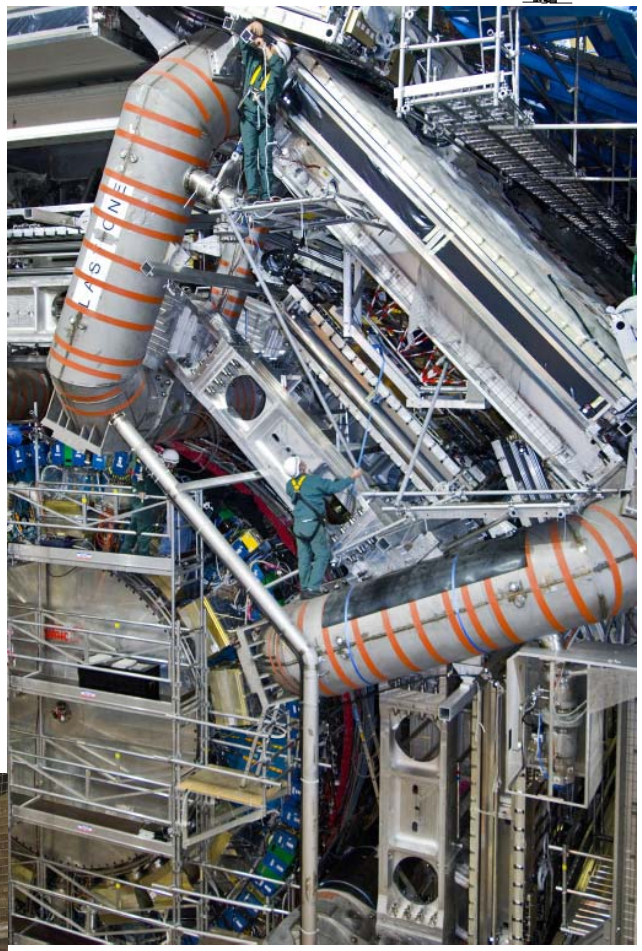
- Cooling down started wk 41, takes 4 weeks, first current in 2nd wk of November
- Test ECT-A and ECT-C separately (250 MJ), like with BT
  - safety system quench detection and quench heaters test first
  - then in steps up to 21 kA with intermediate slow dumps and fast dumps
  - recovery and duration test
- Test ECT-A+C in series (500 MJ), repeat of steps

99% of all barrel muon chambers installed



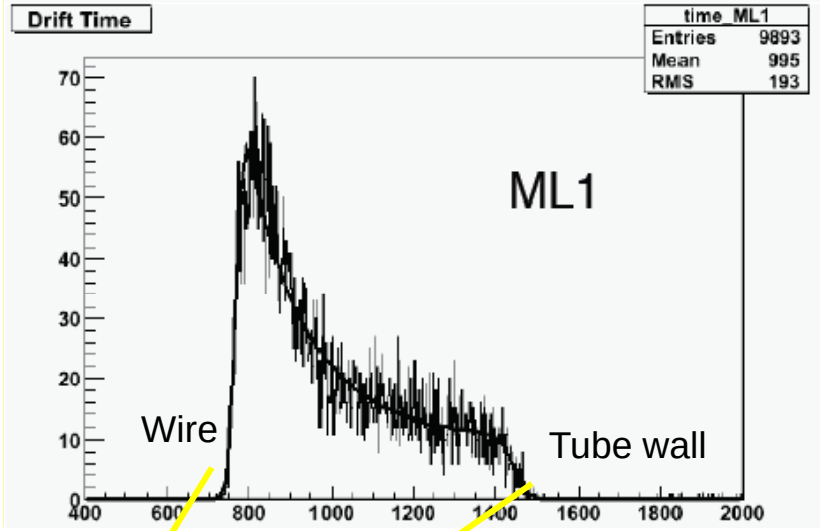
- ✓ 701/704 stations installed
- ✓ ~90% precisely positioned
- ✓ very acrobatic enterprise, no accidents, no damages
- ✓ all gas pipes and distribution installed
- ✓ ~97% of all cables installed



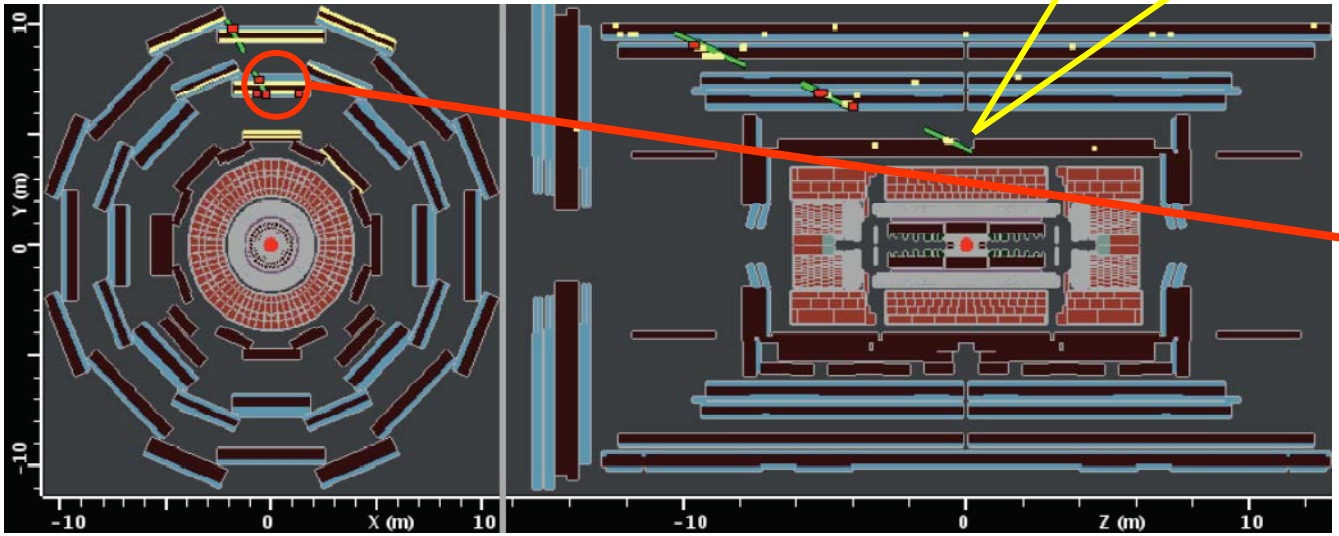


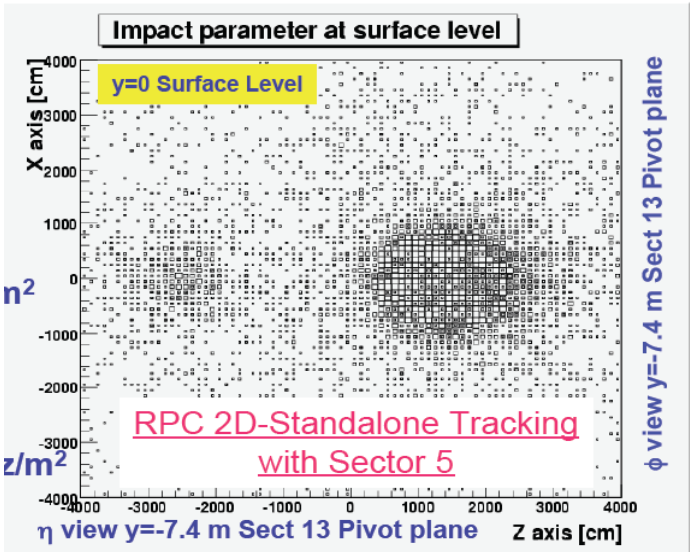
Barrel Muon Spectrometer

- ✓ Cosmic ray acquired for 25% of barrel precision chambers
  - ~144 MDT's →~50000 channels
  - Dead and Noisy channels <<1% level
- ✓ Trigger provided by RPC top sector
  - Trigger rate ~200Hz
  - Standalone RPC tracking reproduce shaft images



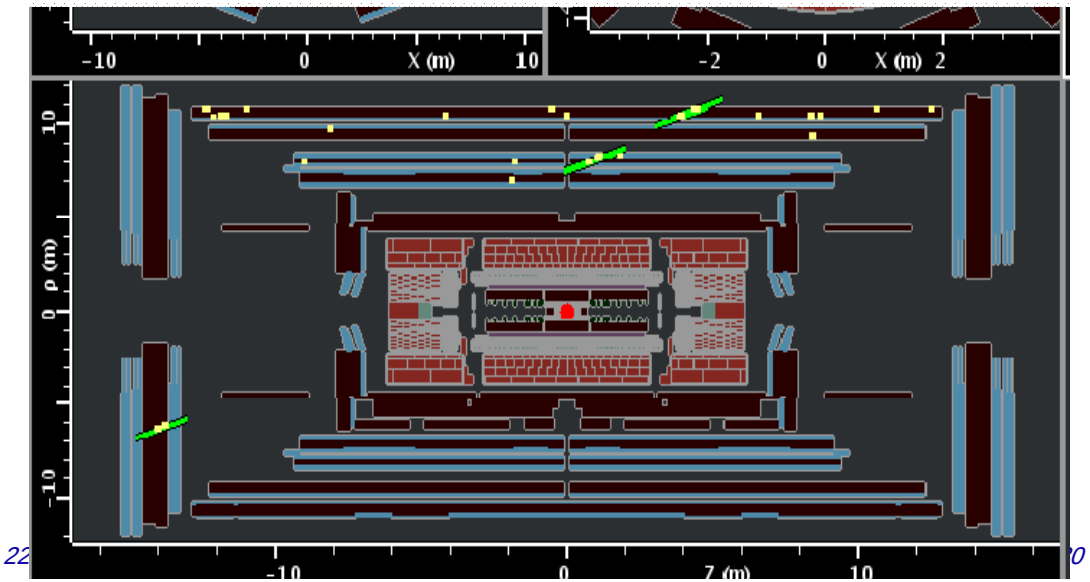
- Cosmic rays mainly from the shafts
- All open coincidence windows: 3/4 LowPt
- 3 clusters / track / view and chi2/dof<3





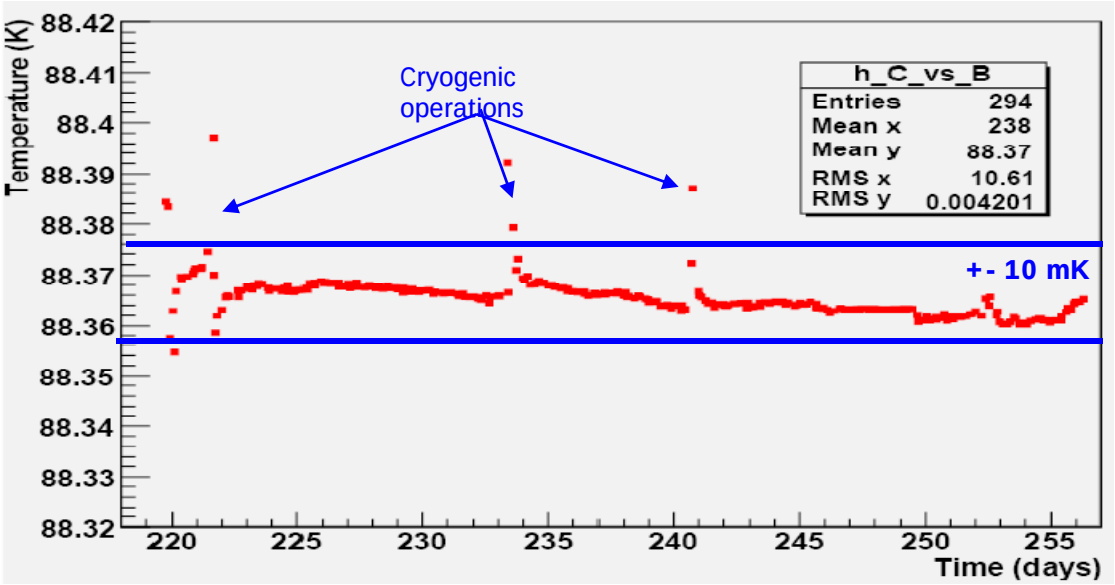
Forward Muon Spectrometer (Big Wheels)

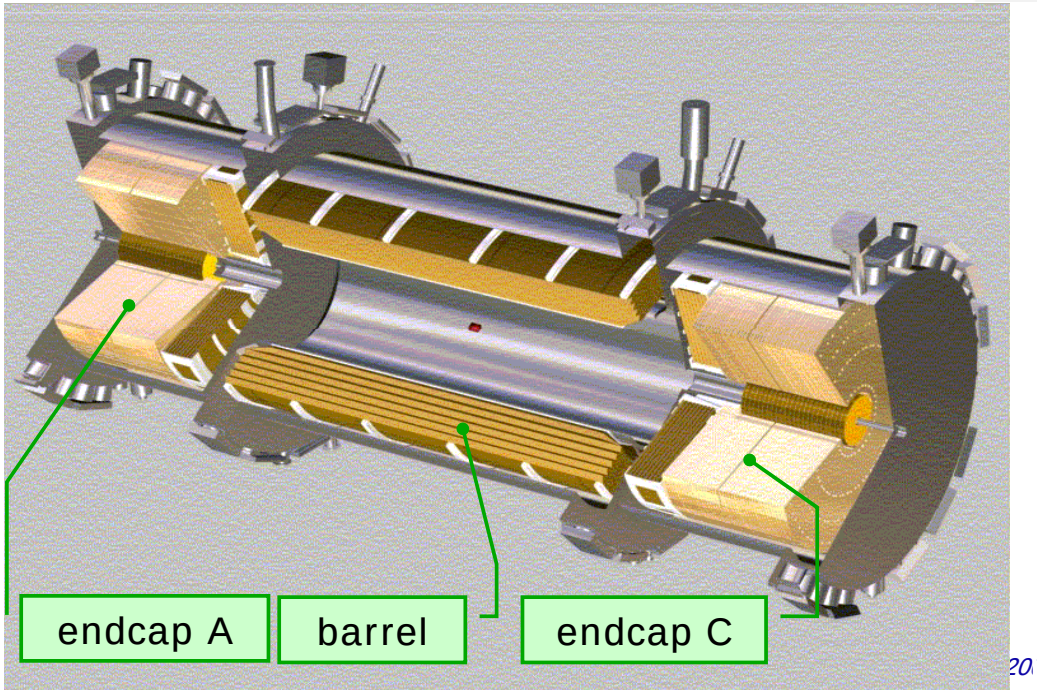
- ✓ ~ 3 years of integration and assembly work on surface
- ✓ 13 months of transport and installation in situ
- ✓ wheels translation system operational
- ✓ all BW chambers have been positioned
- ✓ all alignment azimuthal lines operational
- ✓ cables and services connected, still working on the final gas connection to the cavern wall
- ✓ Wheel side C already brought to operation



The LAr Calorimeters

- ✓ All 3 cryostats cold, full of LAr and operational since several months
- ✓ Temperature very stable in time, average within 20 mK
- ✓ Liquid purity stable and well below 0.5 ppm (barrel <210 ppb, EC <150 ppb)
- ✓ Controls, safety system,... unproblematic





- ✓ *Barrel calorimeter + presampler operational with HV on continuously since March 2007*
- ✓ *Endcap-A started electronics commissioning with all services on in April 07, Endcap-C in May 07*
- ✓ *All low voltage power suppliers on the detector retrofitted in summer 07*
- ✓ *Retrofitting of all the Front-end electronics boards ongoing*

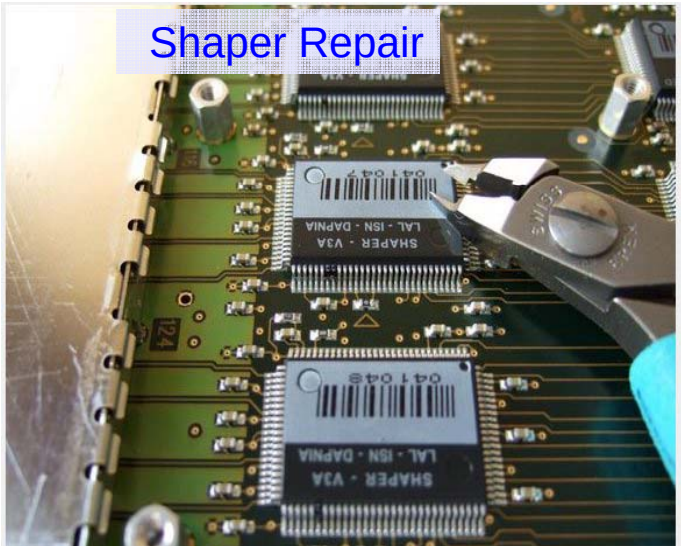
The LAr Calorimeters

- ✓ Mapping of all problematic channels (typically HV problems or connectivity errors) and fixing using various techniques

  Barrel / ECA: all channels active, few at reduced HV

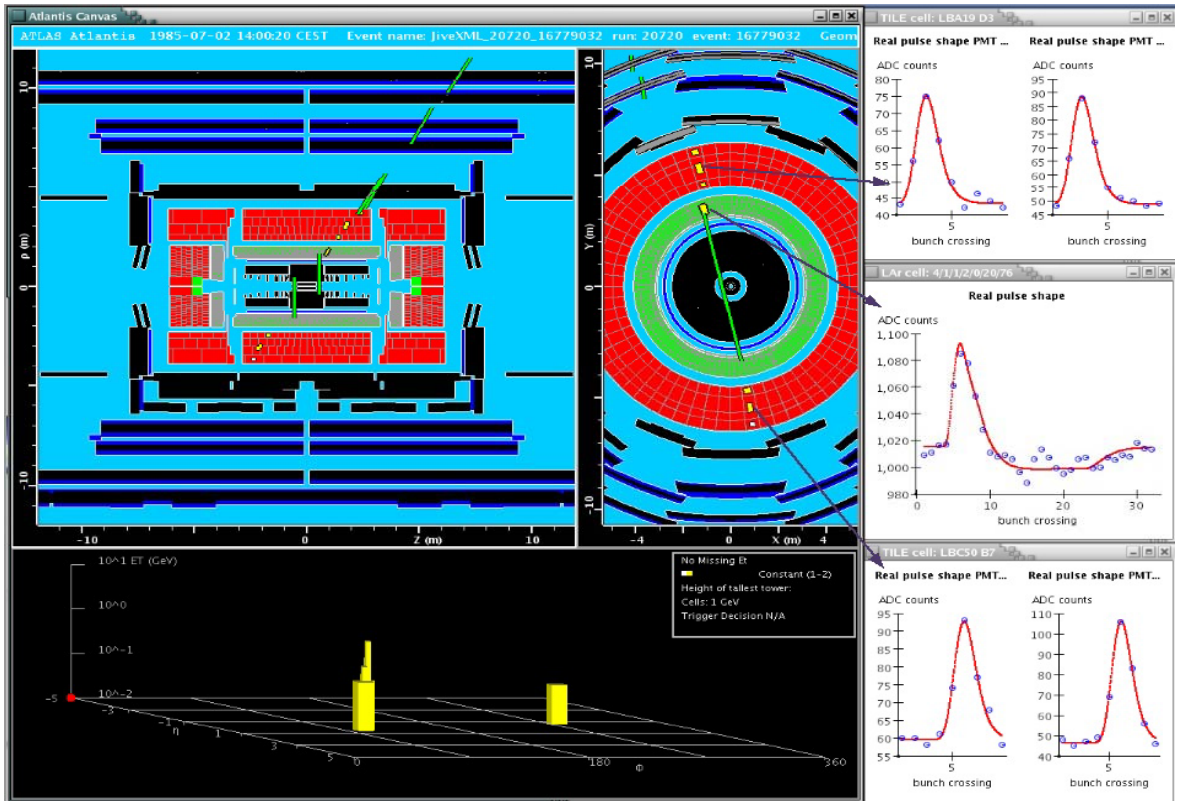
  ECC: all but 2 channels active, few have shorts (mostly in the hadronic section) and need to be operated with current

- ✓ Detailed analysis of all sources of electronic noise. Try to itemize noise contributions to LVL1 from detector, FEC, pickup on trigger cables and receiver modules

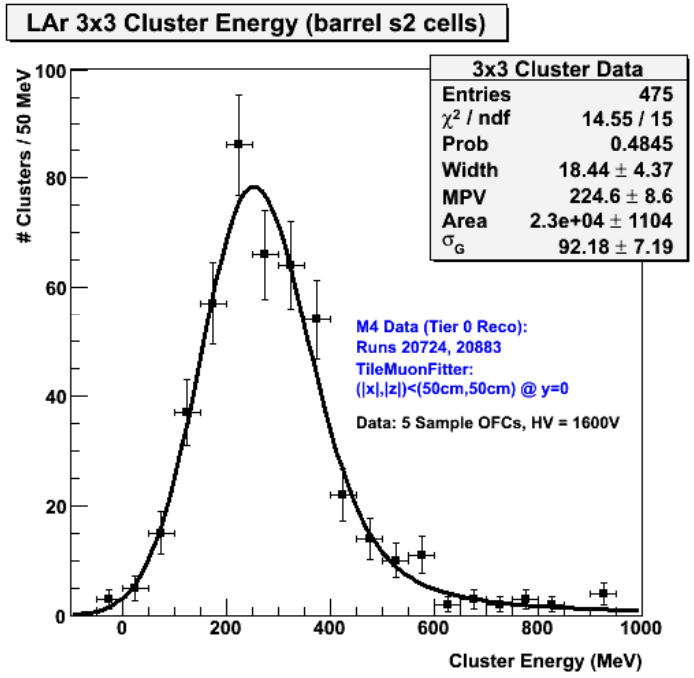


- ✓ In April 2007, two errors in the FEB schematics were discovered:
  - *missing voltage-level adaptation between some DMILL and DSM components*
  - *consequence is overstressing of components, reducing their lifetime*
  - *no failures observed yet, but decided (as a precaution) to repair all ~1600 FEBs*
- ✓ Take the opportunity to also:
  - *Fix the time constants 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*

The LAr Calorimeters



- ✓ Currently take data every week end and during commissioning milestone weeks
- ✓ Up to 50/58 of Endcap and Barrel crates are now included in the readout
- ✓ Cosmic rate: 15 events/minute, mainly in Barrel ... but also in Endcaps
- ✓ Extensive use of monitoring to check rates, DCS, bad channels, trigger timing
- ✓ A total of ~500k cosmic events registered since August 2006, 100K fully analyzed



Noise variation over 4 months (11 runs)

Noise stability: 0.05 permill

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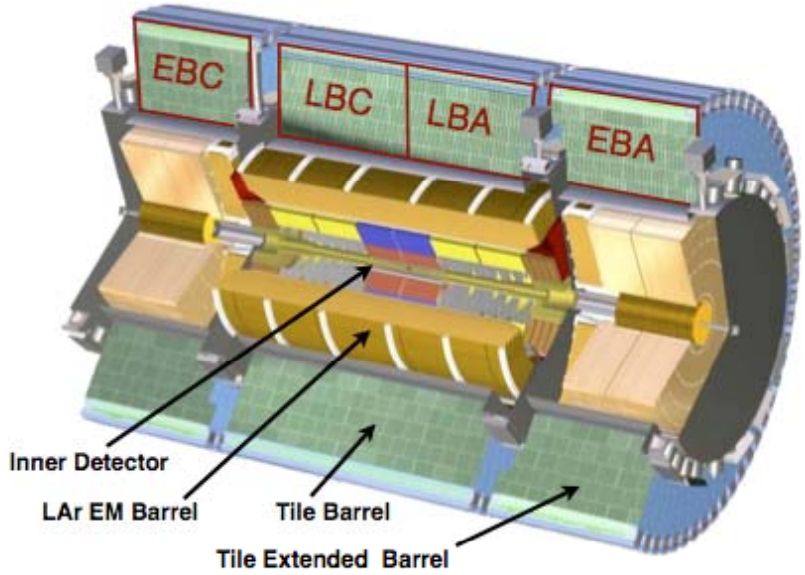
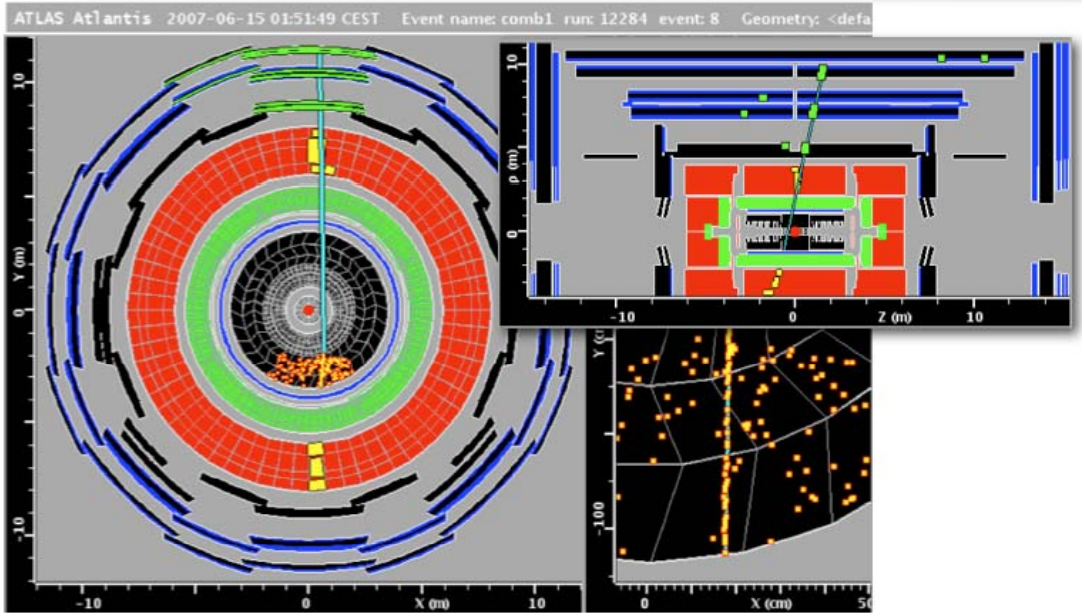
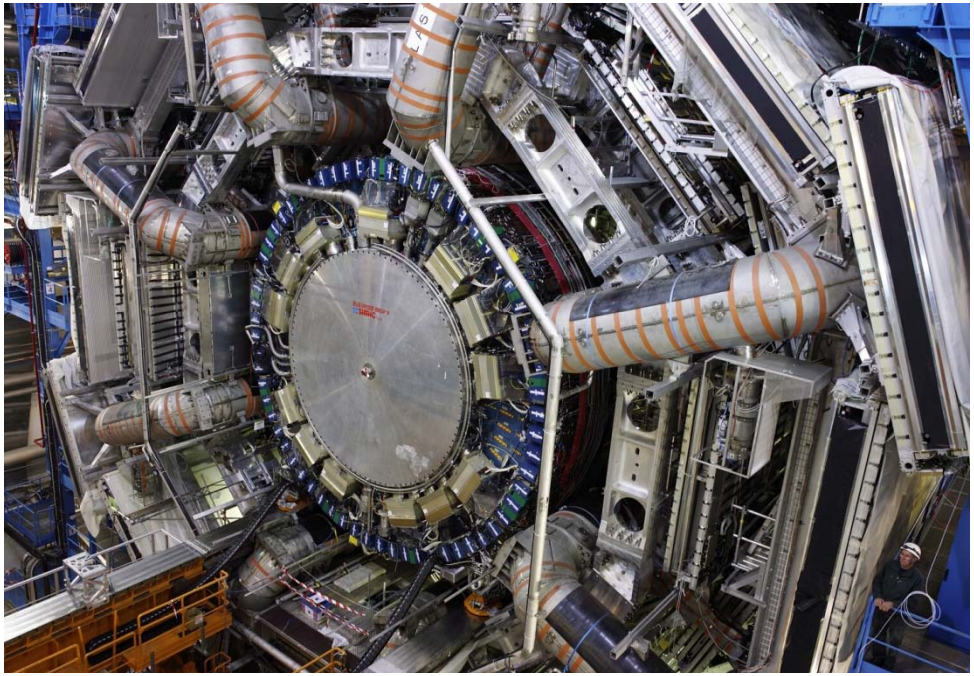
The Tile Hadron Calorimeter

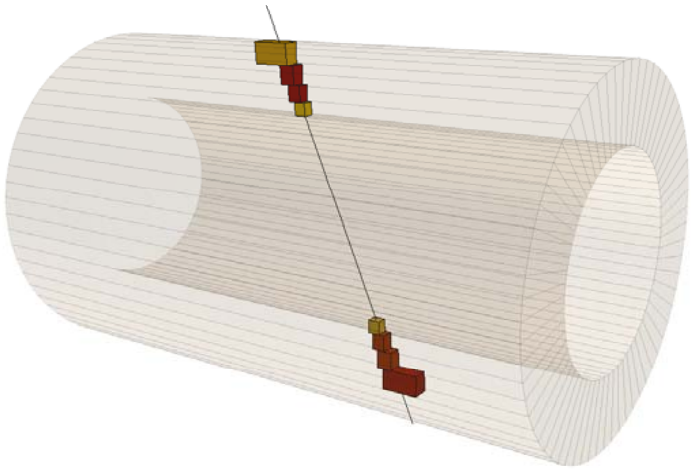






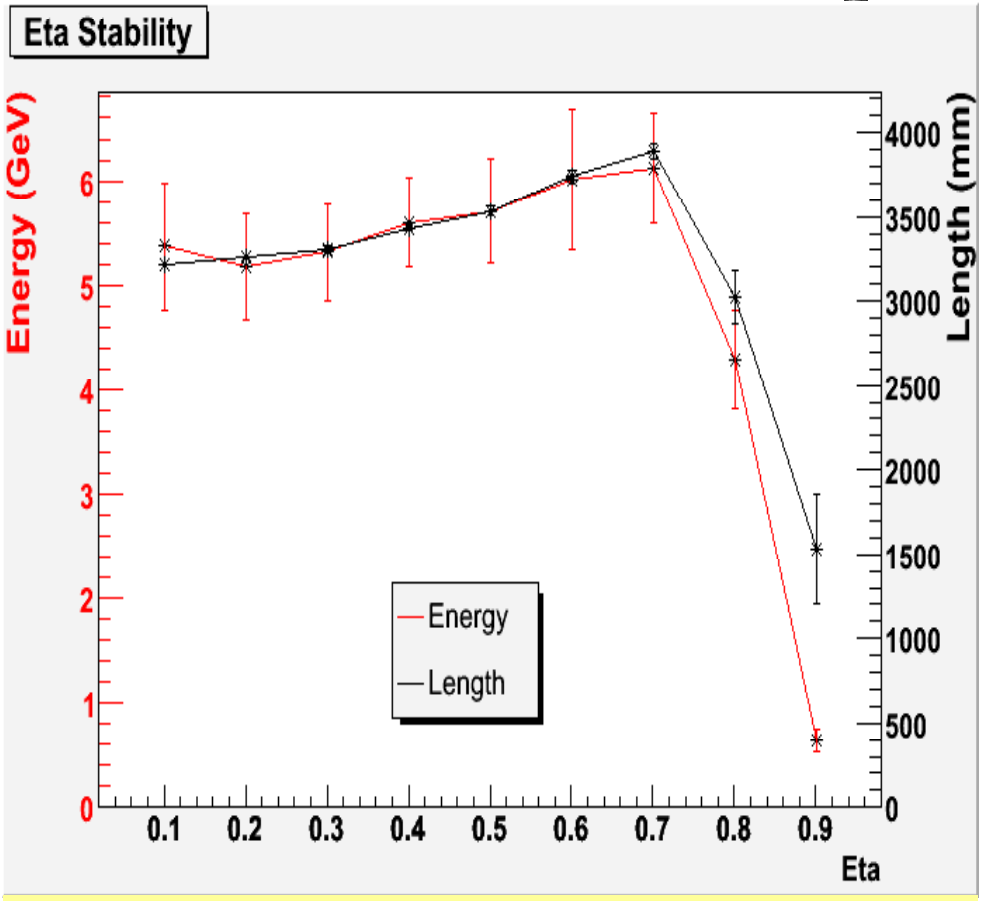
- ✓ Detector fully installed and operational since several months, including a set of dedicated minimum bias scintillators
- ✓ Low voltage power suppliers all refurbished and operational
- ✓ Instabilities in the front-end electronics readout observed and due to various connectivity problems (aging of connectors,..) -> decision to refurbish all drawers: 43% already done
- ✓ Entering operation-like phase, i.e routinely data-taking of calibration runs (pedestals, charge injection, integrator calibrations, laser) during the week. Cosmics data-taking during the week-ends, together with LAr

The Tile Hadron Calorimeter

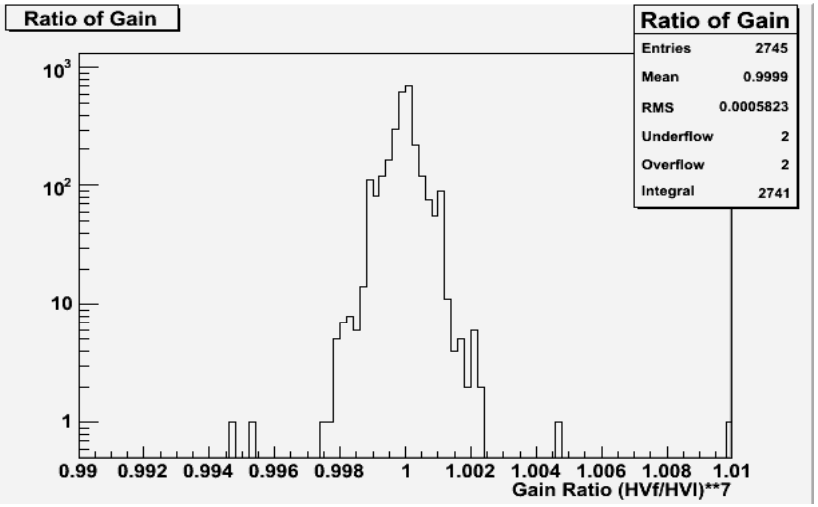


Sum all cells with energy >120MeV (cosmics events)

1021 projective events (1.2 %) in the recorded sample



Nice agreement with expected track length vs eta

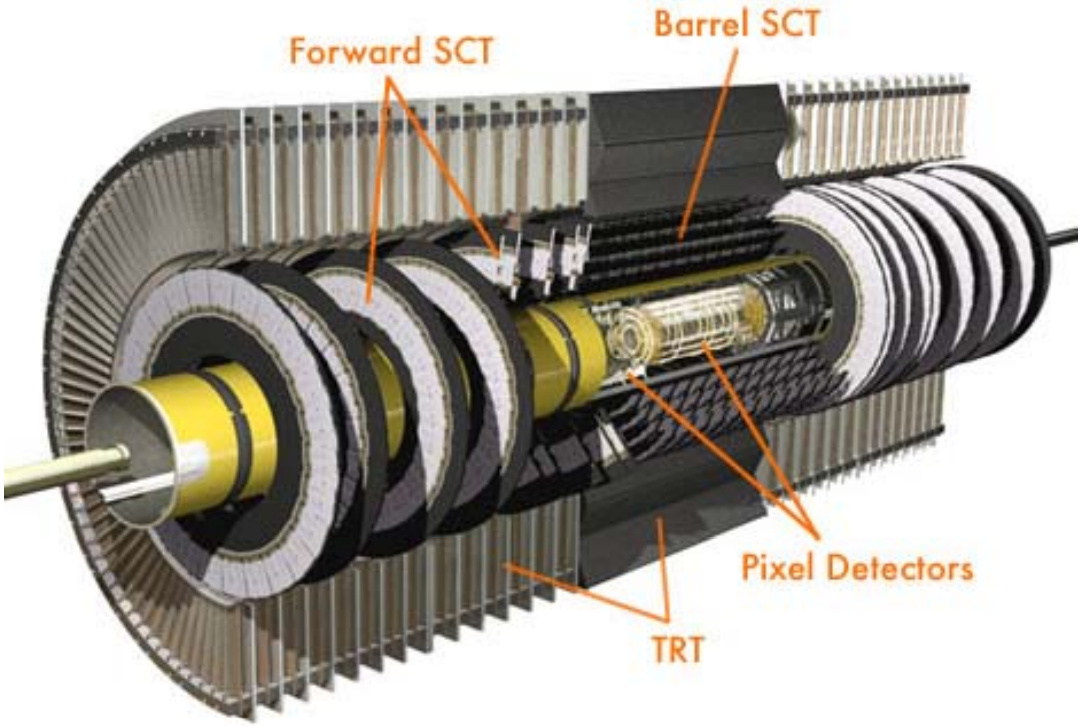


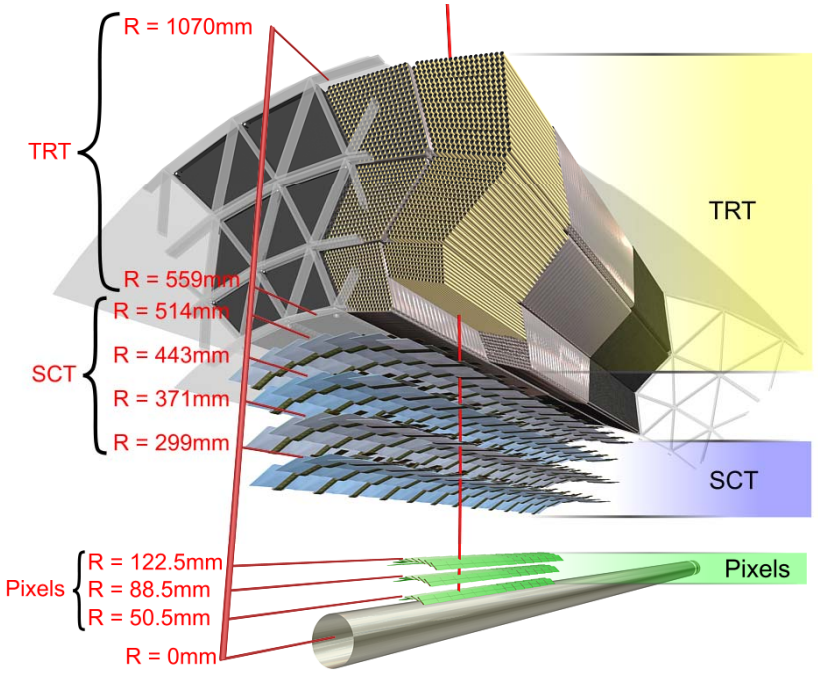
Using the laser to study HV stability :

Results in LBA, EBA :

- ✓ Gain ratio over 3 days, is stable at the level of 0.05%
- ✓ No hint for voltage fluctuations

The Inner Detector



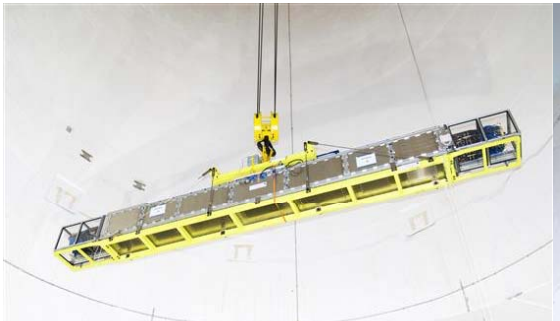


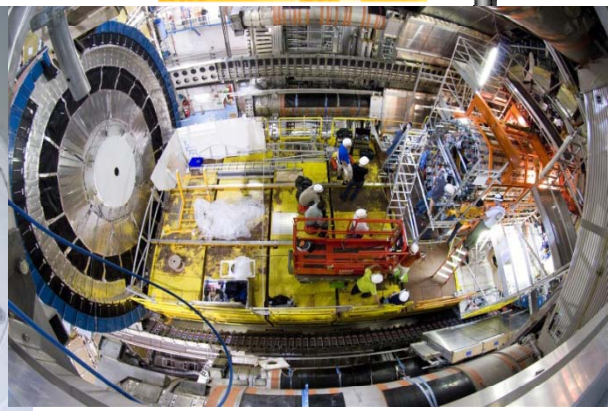
All detector components installed in 4 steps

- ✓ Barrel SCT + TRT
- ✓ 2 End-Caps SCT + TRT
- ✓ Full pixel detector + Be beam pipe

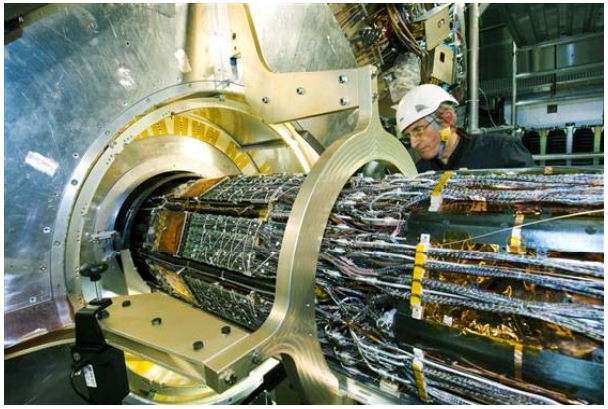
- ✓ All cables and pipes installed, SCT and TRT fully connected
- ✓ Pixel detector cables and pipes installed, pixel connection waiting for SCT sign off
- ✓ Problem found in a power connector of the heaters of the evaporative cooling system

Inner Detector installation

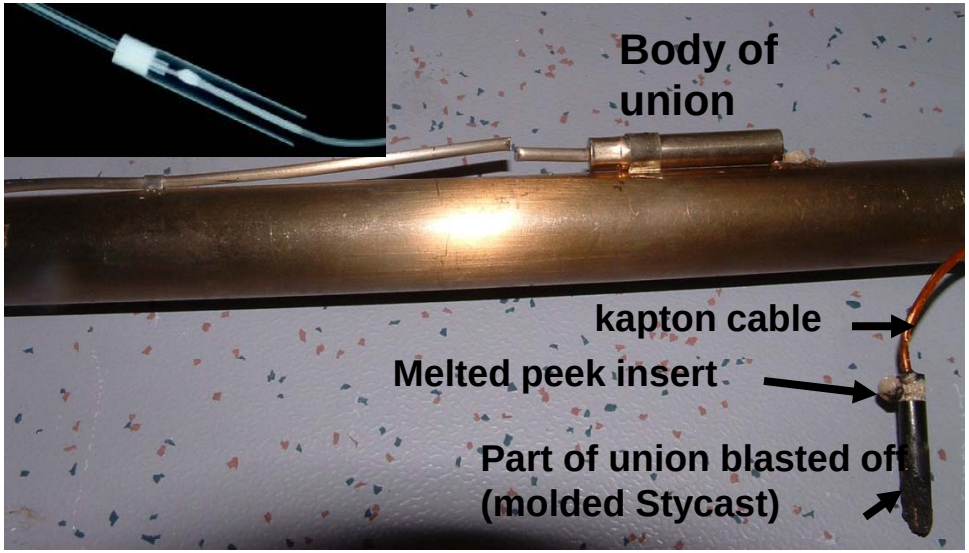




Task Name	Date
Lower ID EC-A	May 24
ID EC-A installed	May 29
Lower ID EC-C	June 18
ID EC-C installed	June 19
Lower Pixel	June 25
insertion LAr vacuum pipe	June 25
Pixel insertion	June 26
Pixel insertion completed	July 2
Be beam pipe aligned	Aug 9
Connection of all 3 central beam pipes	Aug 28



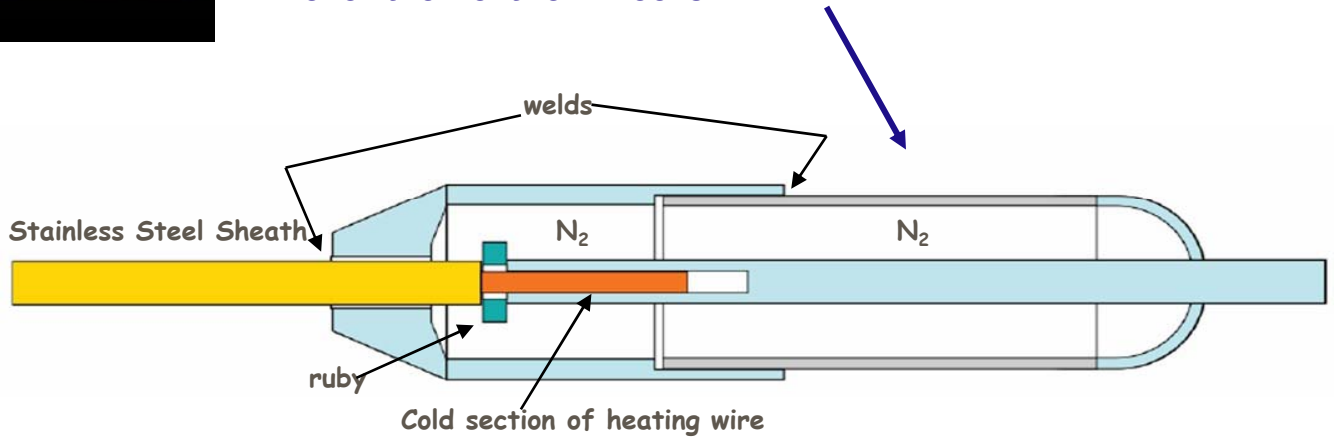
ID heater problem



On Friday Feb 16, heater # 130 had a catastrophic failure while in steady operation. This heater was used ~2hrs on Feb 15 and then in operation on Feb 16 since ~1hr when a short to ground blew up the union joining the heater cable to the Power Supply cable. A spark was seen. The connector overheated

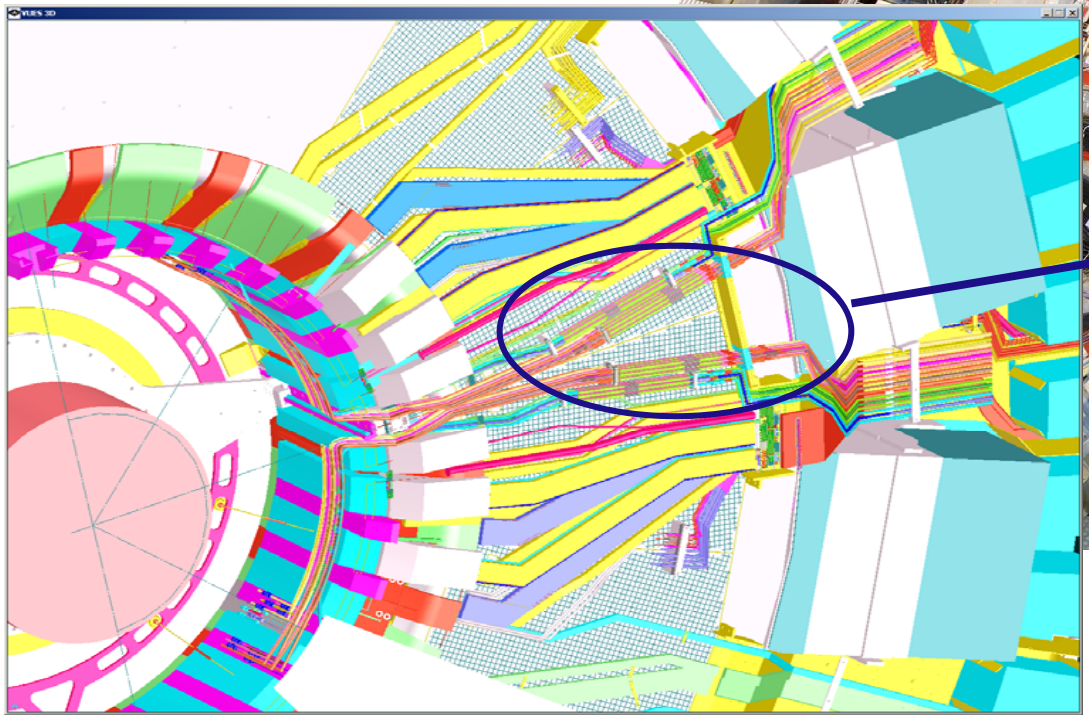
Heaters were placed just at the end of the cooling loop and their function is to vaporize the cooling liquid exiting the detector, in order to push it through the circuit loop

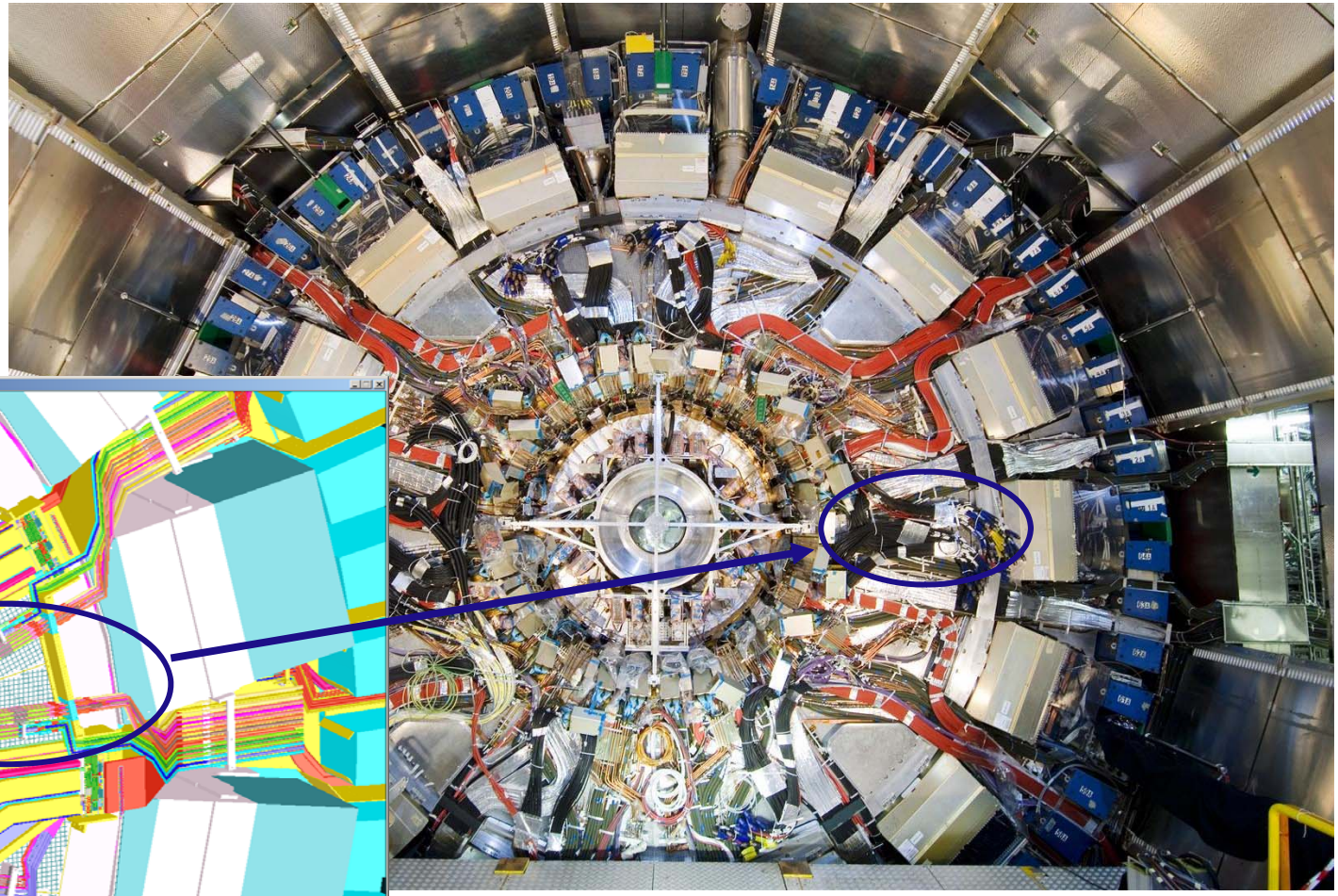
After a new failure in May the decision was taken to bring the heaters outside the ID volume (far heaters solution). A new connector was developed with the producers with good results (air ceramic connector). Full delivery expected over the next few weeks



Far heaters solution

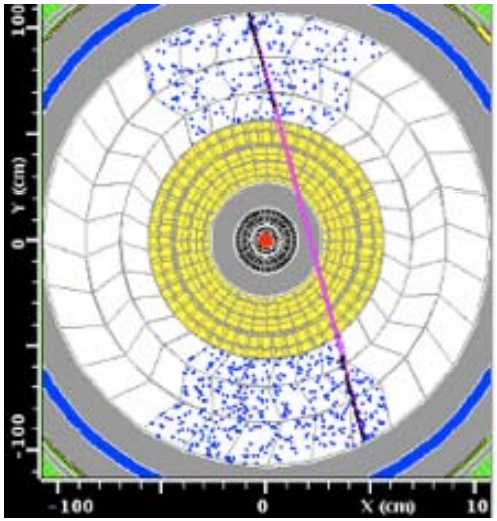
Decision taken a few months ago to place all SCT heaters outside the detector volume, on the calorimeter barrel flange





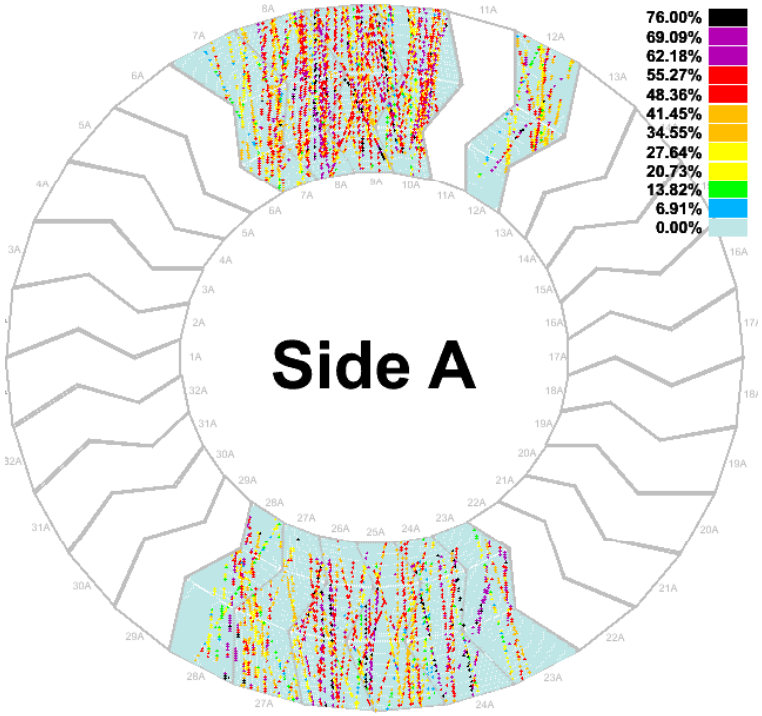
Most pipes rerouted inside and outside the detector, waiting to install in the next few weeks all retrofitted heater units, then extensive tests and SCT sign off

SCT/TRT commissioning



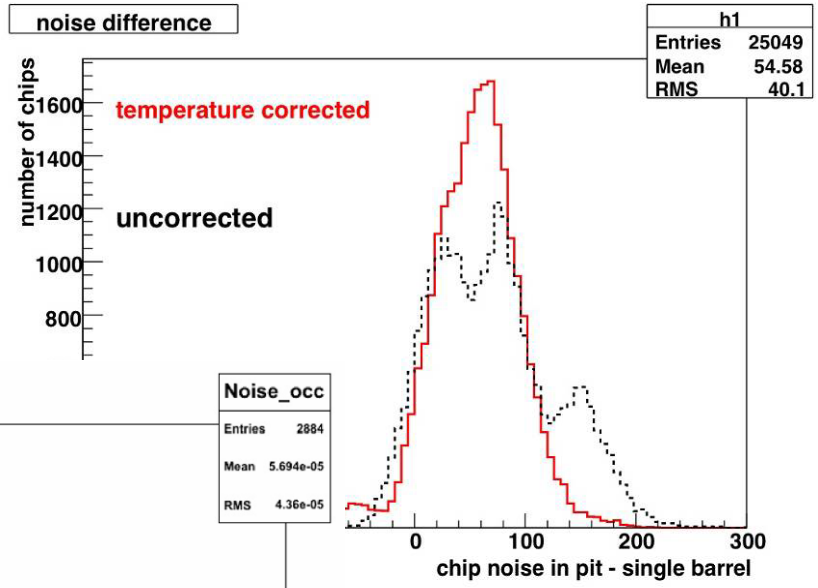
TRT part	Dead channels Mech.,Electr., HV	Gas Ar/CO2 since	HV
Barrel	1.8% (A) 2% (C)	March 2007	~5 months
EC-A	1.7%	August 2007	~ few weeks
EC-C	1.2%	Sept. 2007	~ few weeks

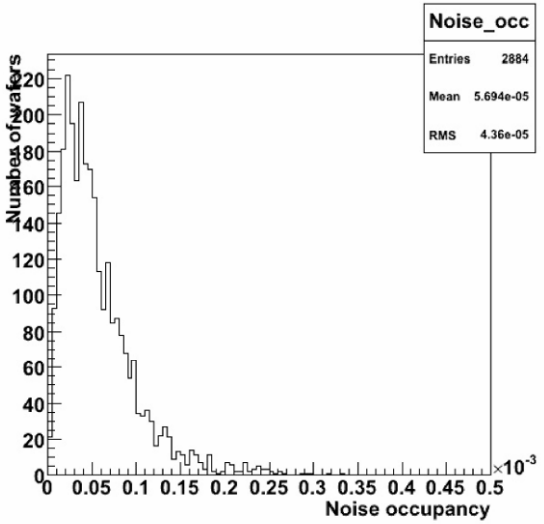
4 10^5 active channels



SCT: Noise + 60e as lab tests, only 1 additional module lost during installation (HV connection),

overall ~0.3% dead channels out of 6 10^6 channels





Noise Occupancy
<NO> = 5.7 10^{-5}
when operated
Together (SCT + TRT)

Pixels performance

Electrical quality tested just before installation in situ (0.8 10^8 active channels):

Barrel quality excellent

		L2	L1	B
STAVE	Mean bad/module	120	81	31
	Fraction of Bad pixels (%)	0.26	0.18	0.07
LOAD	Mean bad/module	91	66	18
	Fraction of Bad pixels (%)	0.20	0.14	0.04
BIST	Mean bad/module	100	75	18
	Fraction of Bad pixels (%)	0.22	0.16	0.04
'Conservative' fraction of Bad pixels (%)		0.29	0.20	0.07

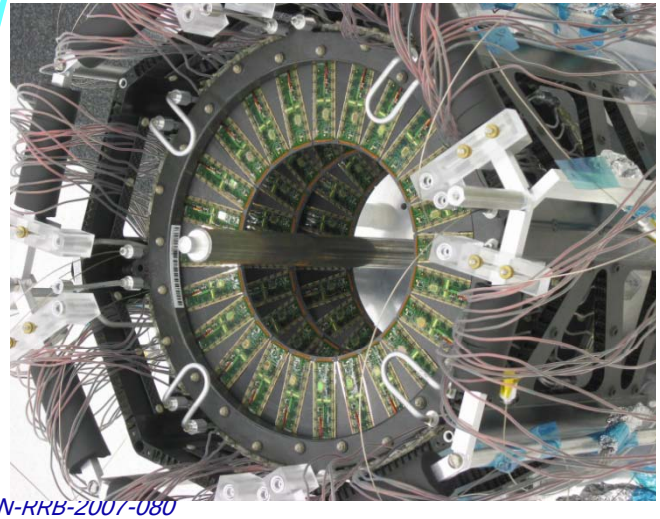
Endcaps quality excellent, except 2 faults

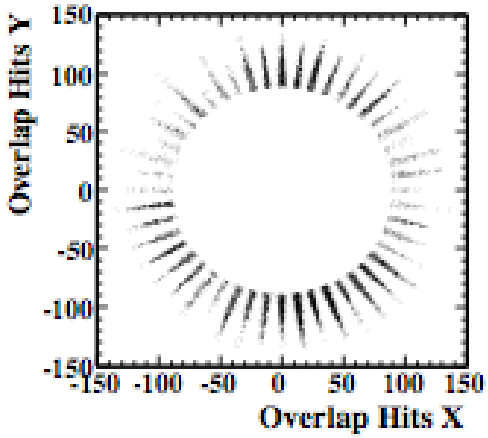
EC-C has an average of 0.15% bad pixels

EC-A has an average of 0.20% bad pixels

System test of Endcap A done on surface prior to installation:

- 15K tracs of cosmics reconstructed
- Achieved pixel noise occupancy below 10^{-9} per pixel. Very good!

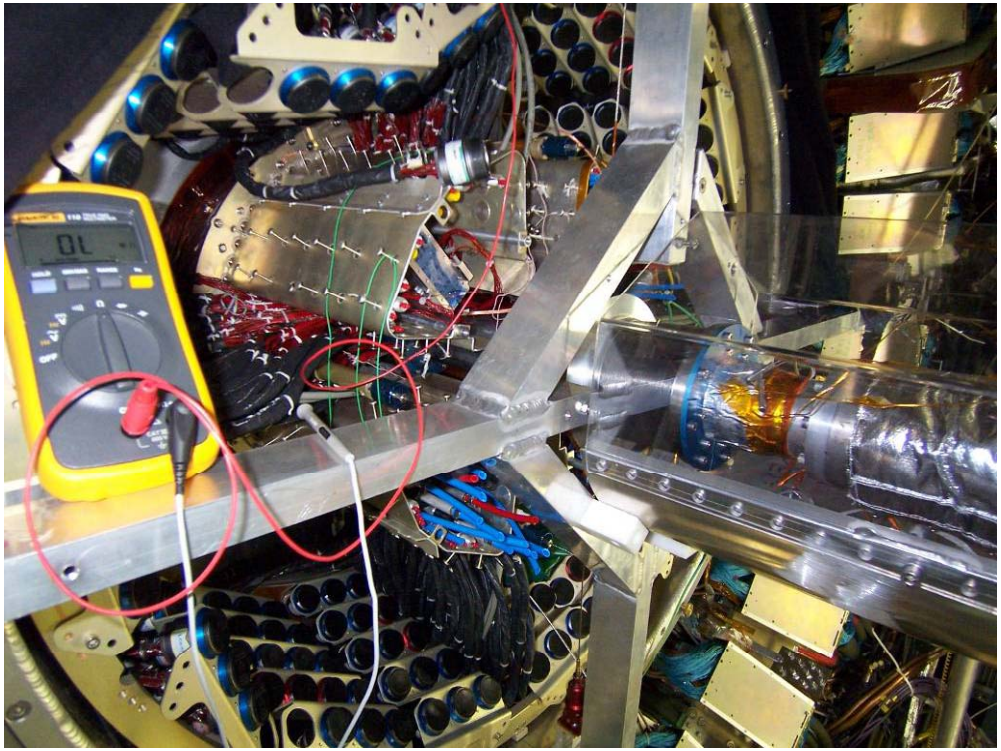




The beam vacuum pipe

The first three sections of the beam pipe have been installed and connected, and they passed the initial leak test

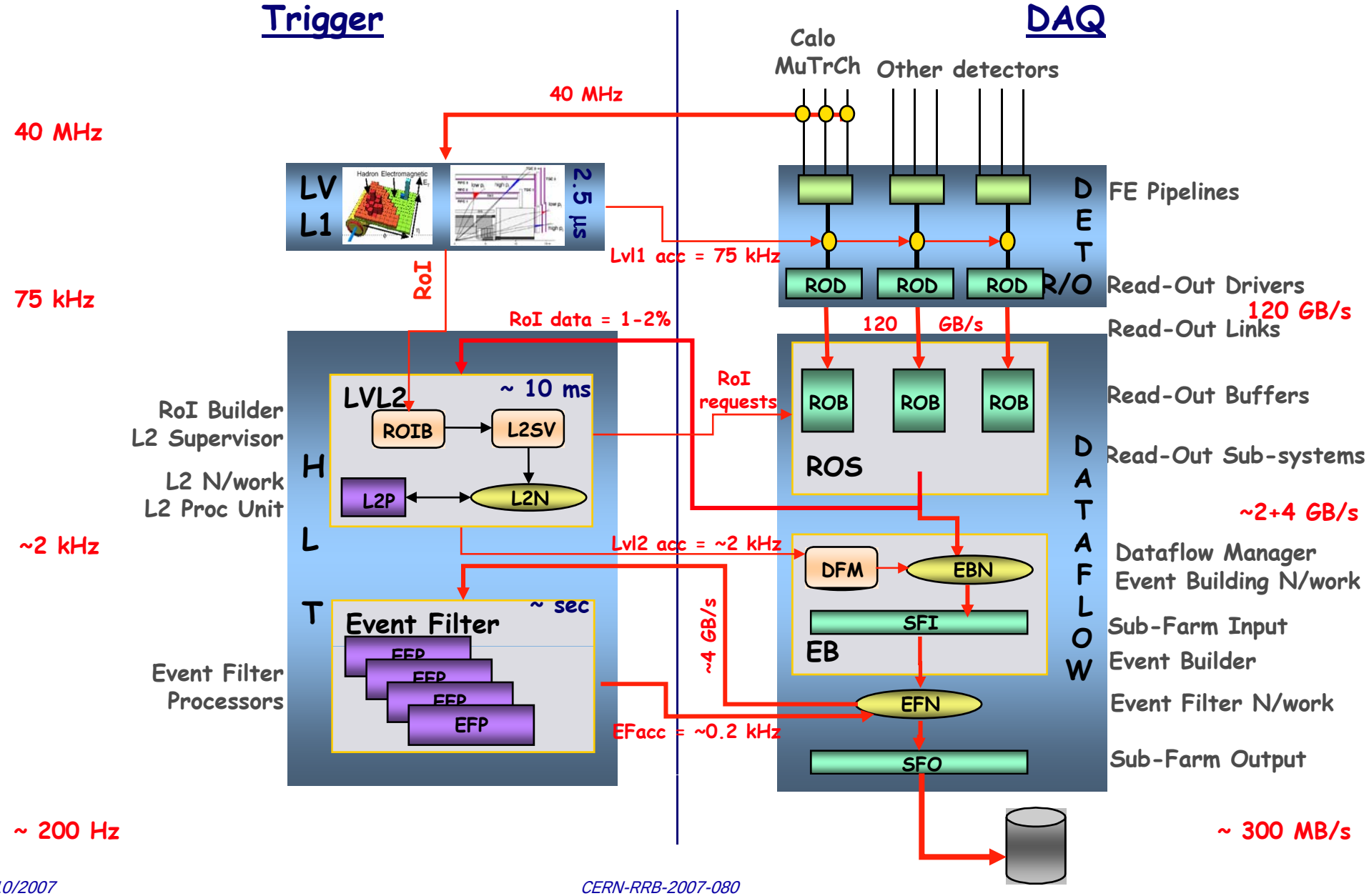
The two sections in the ECT bores are also installed, and the preparation of the other outer section is also well advanced



Installation of the ID beam pipe (with the Beryllium section) together with the Pixel package

Connection of the ID section to the LAr EC beam pipe section

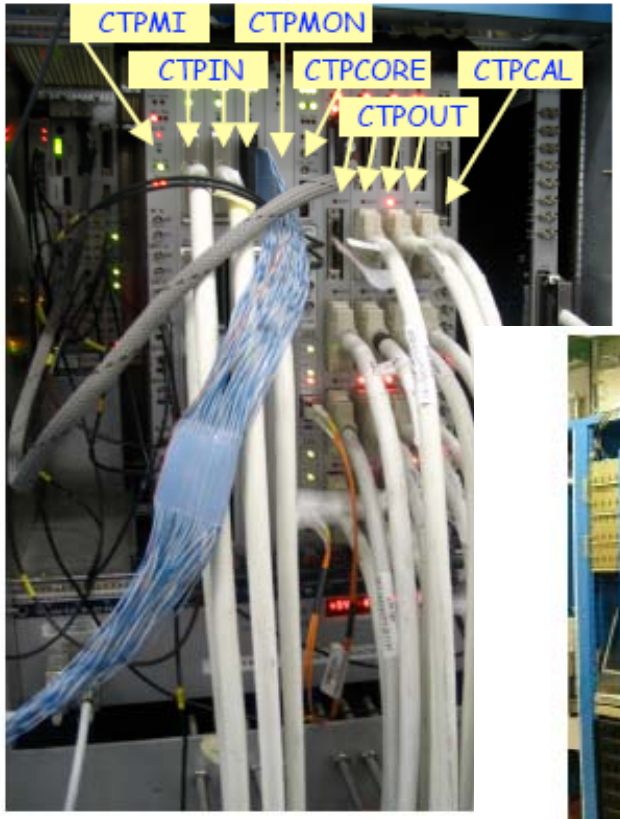
Trigger and Data Acquisition



LVL1 trigger

Almost fully installed & commissioning in full swing

- ✓ *Central trigger – Final system installed and in regular use in M# runs*
- ✓ *Calorimeter trigger – Almost fully installed (will be complete by end 2007)*
- ✓ *Muon trigger – Almost fully installed (CAEN power supplies and readout modules are the most critical items)*



Dataflow, High level trigger

- *DATAFLOW*
  - Read-Out System : 100% installed + operational
  - Networks : 30% installed + operational -> 100% by end 2007
  - EB nodes : 30% installed + operational -> 50% for 1st LHC run -> 100% later
  - Farm Output nodes: 100% installed + operational (500 MB/s to Castor - 60 TB local disks)

- *HIGH-LEVEL TRIGGERS*
  - Infrastructure : 100% installed
  - Supervisors : 50% installed + operational -> OK for 1st LHC run -> 100% later
  - Processing nodes : 161 installed + operational (1164 cores) = 7% of final
    -> 1100 (9000 cores) for 1st LHC run = 47% of final
    -> 2370 (~20000 cores or more) = 100% later

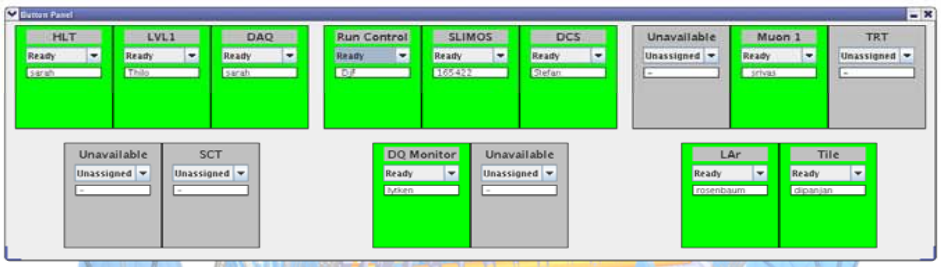
(35% of HLT nodes are configurable as Level-2 or Event Filter)

- *ONLINE INFRASTRUCTURE*
  - Online services : 100% installed + operational
  - Monitoring : 100% installed + operational (TDAQ)
  - Central File Servers : temporary system today -> 50% for 1st LHC run
    -> 100% later
  - Local File Servers : 18 installed + operational -> add as needed

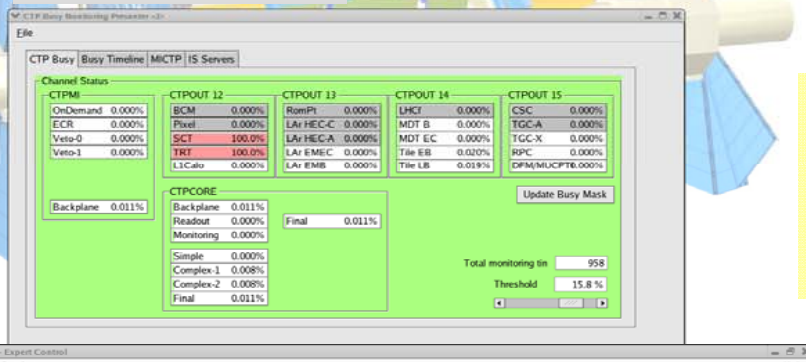
Run Control

ATLAS Control Room

Shifters and systems readiness



Trigger status



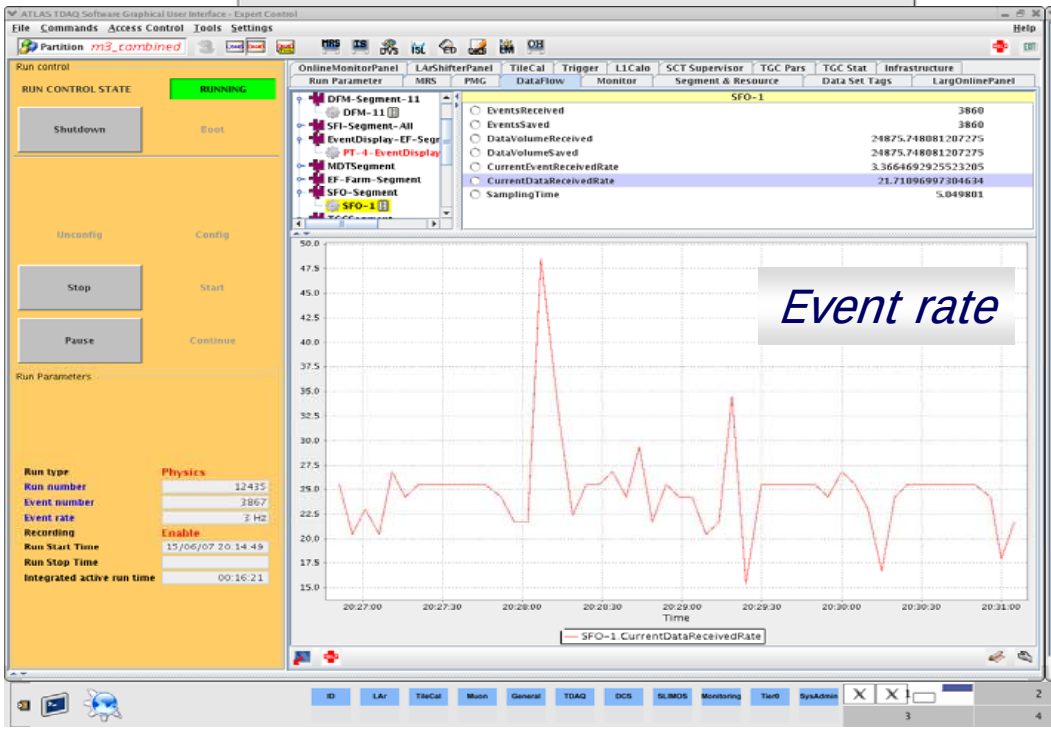
The M4 Commissioning Run (Aug 23 - Sep 03, 2007)

Essentially all detectors integrated

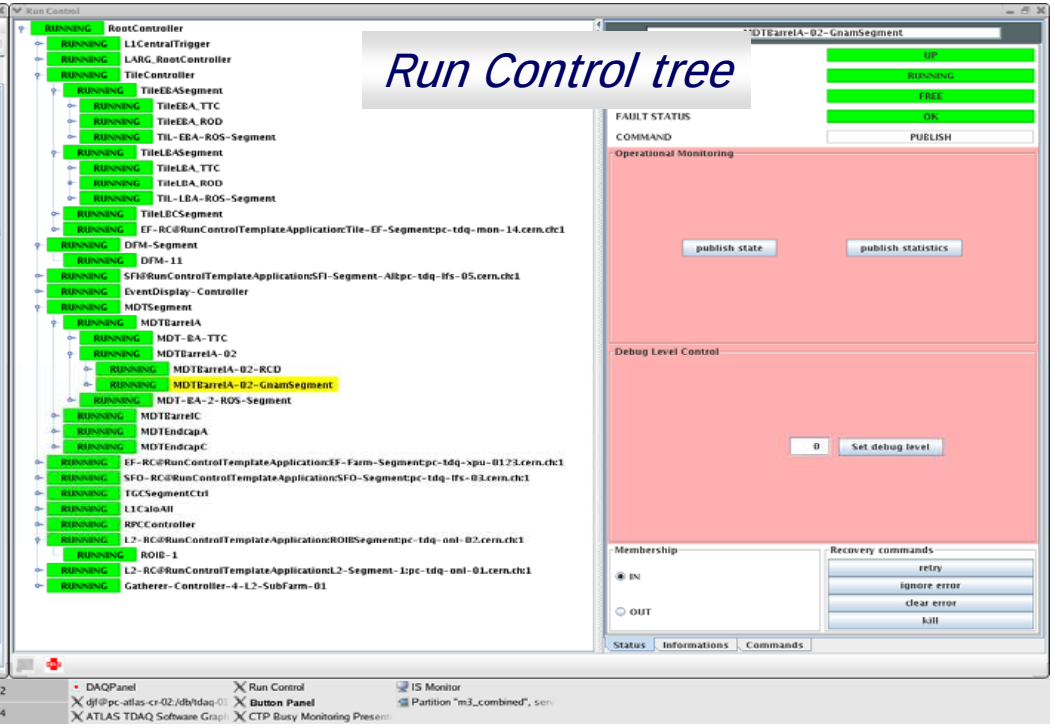
Full DAQ chain (up to Tier0)

Tile+RPC+TGC triggering on cosmics

Event rate

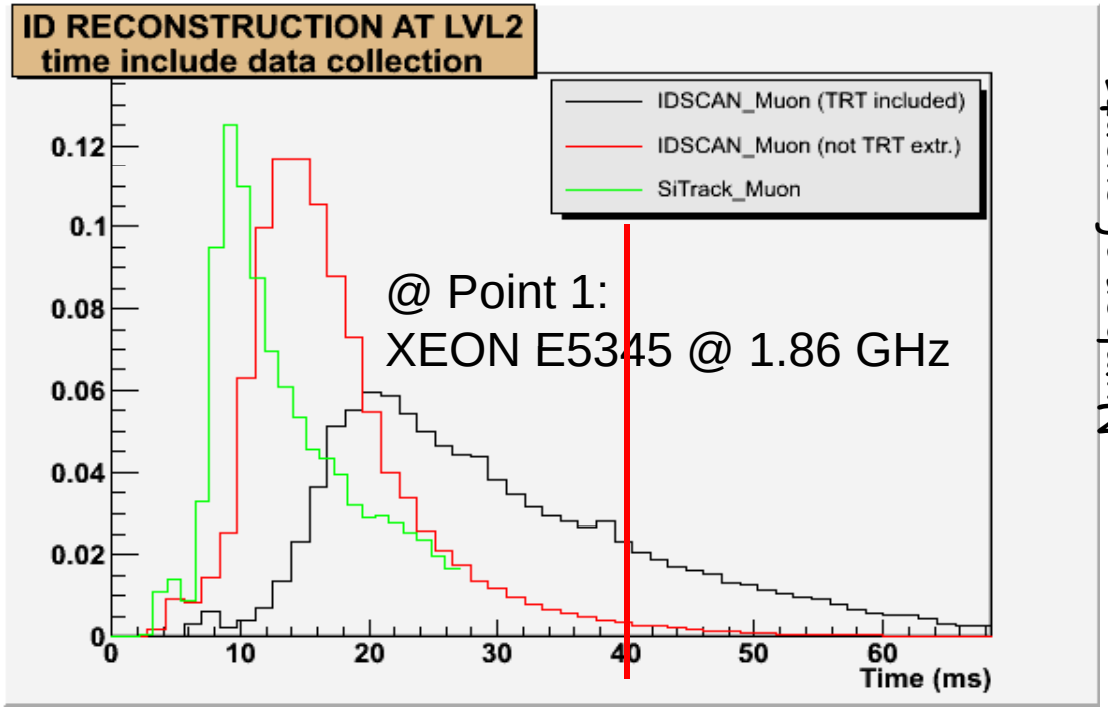


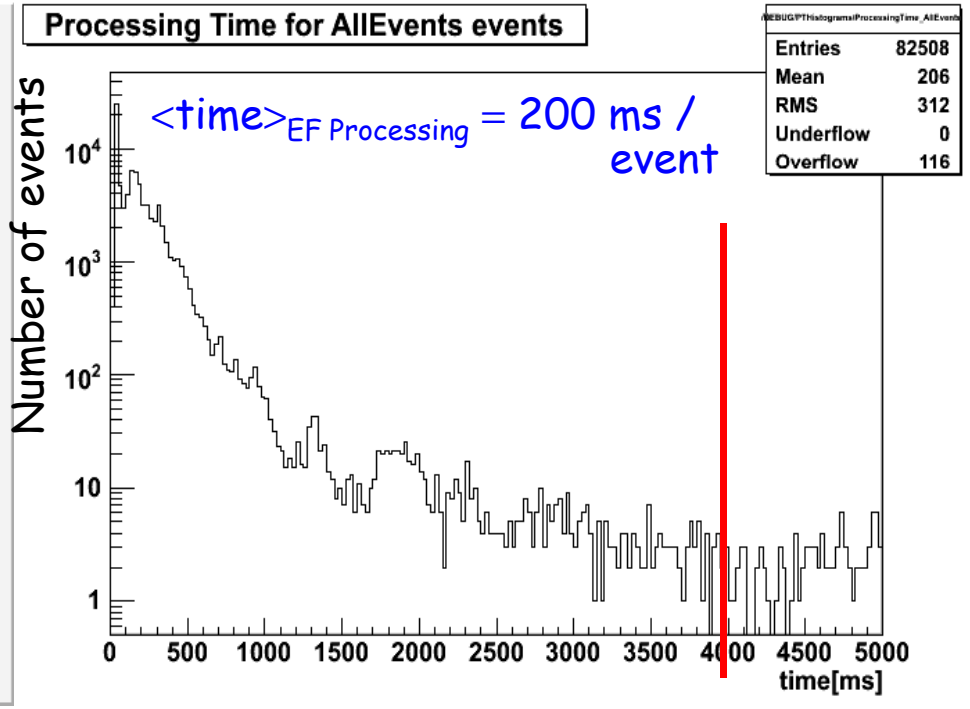
Run Control tree



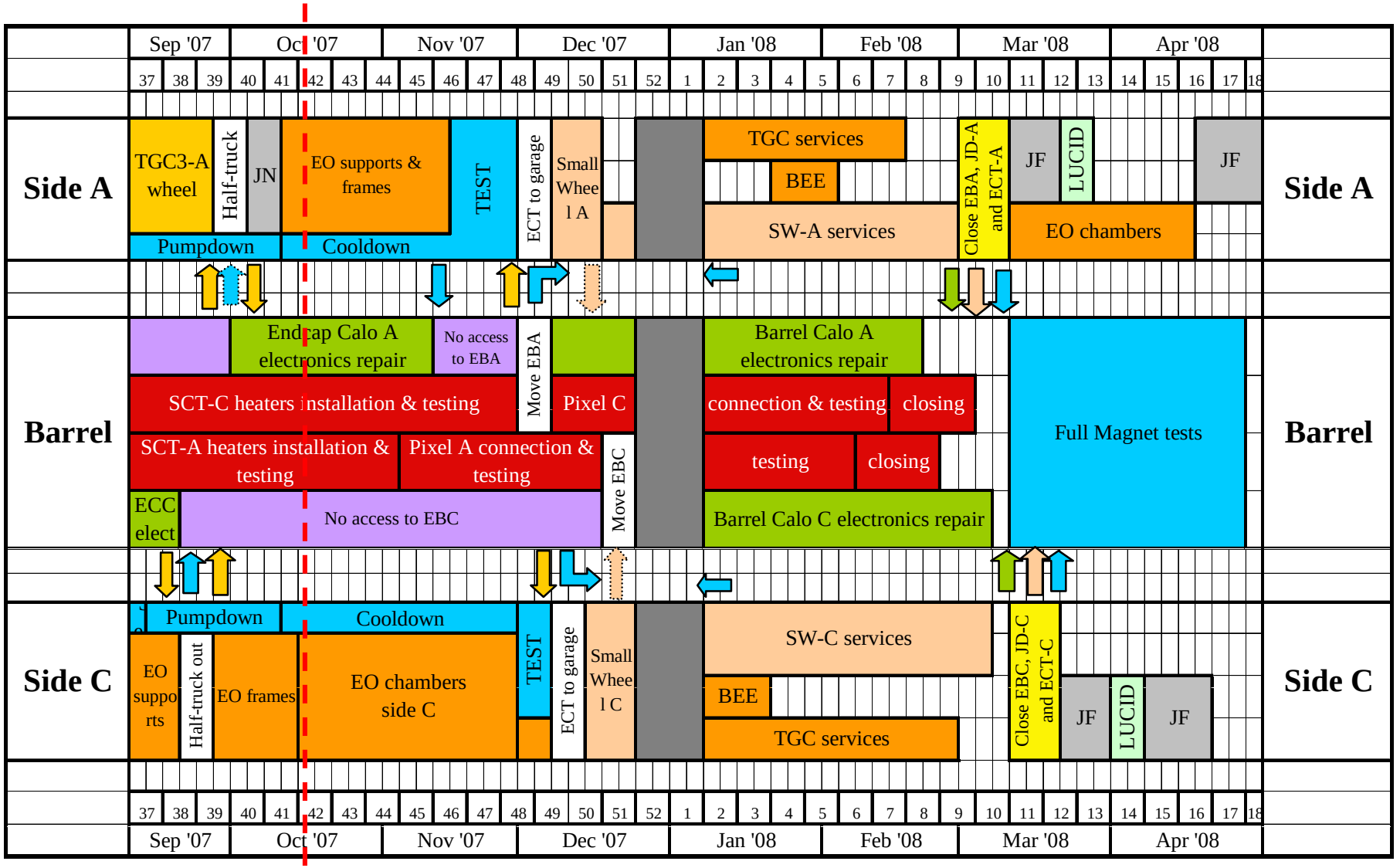
LVL2 & EB performance studies

- ✓ Trigger performance studies advancing well – main focus: signal efficiency, background rejection and algorithm execution time
- ✓ Algorithms from all slices are tested continuously online with cosmic ray events and by playing back pre-loaded simulated physics events
- ✓ Timing measurements are consistent with projections in the TDR (40ms/event LVL2, 4s/event EF on 2 GHz machines)
  -> Examples of algorithm timing for simulated tau and jet event samples

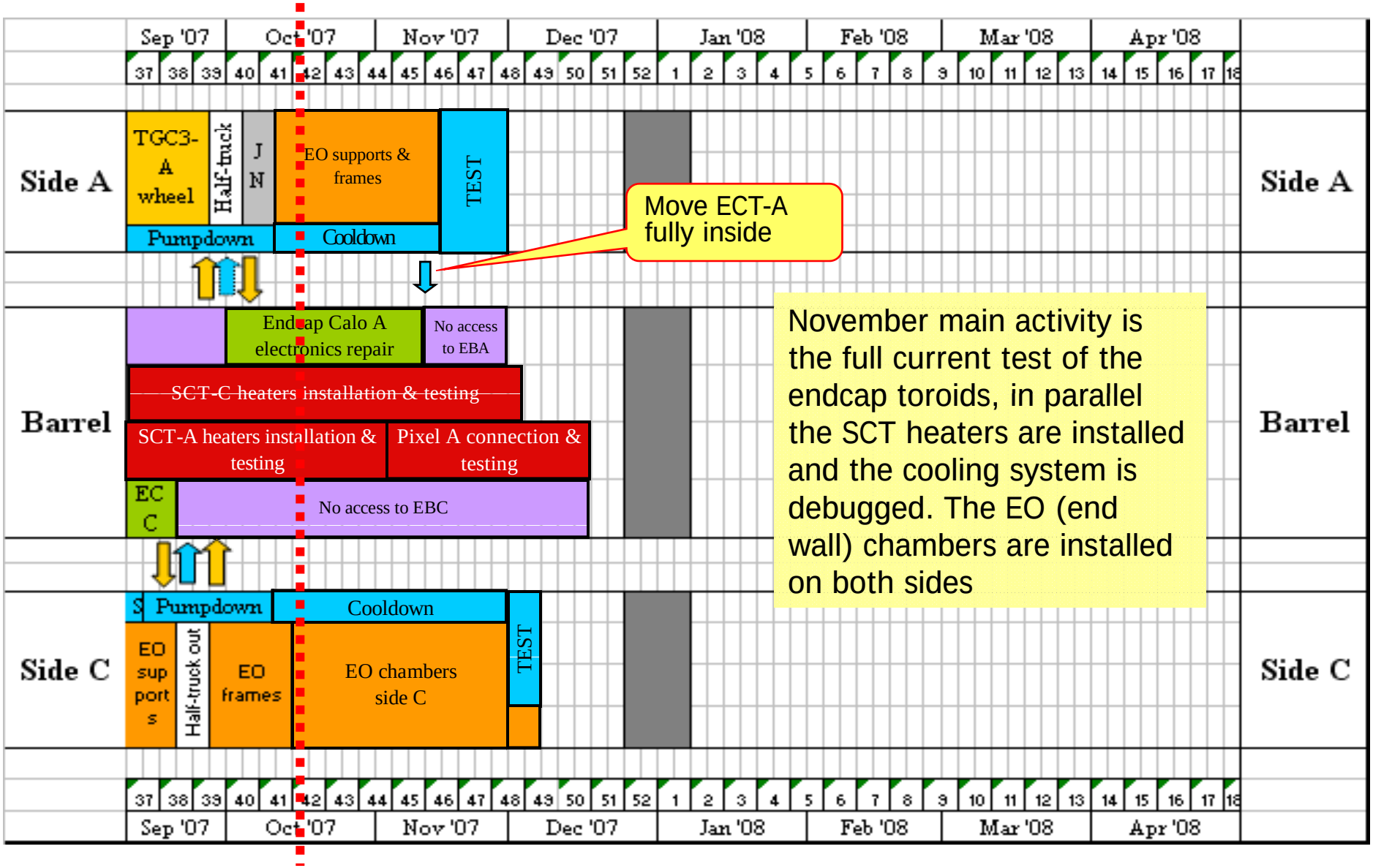




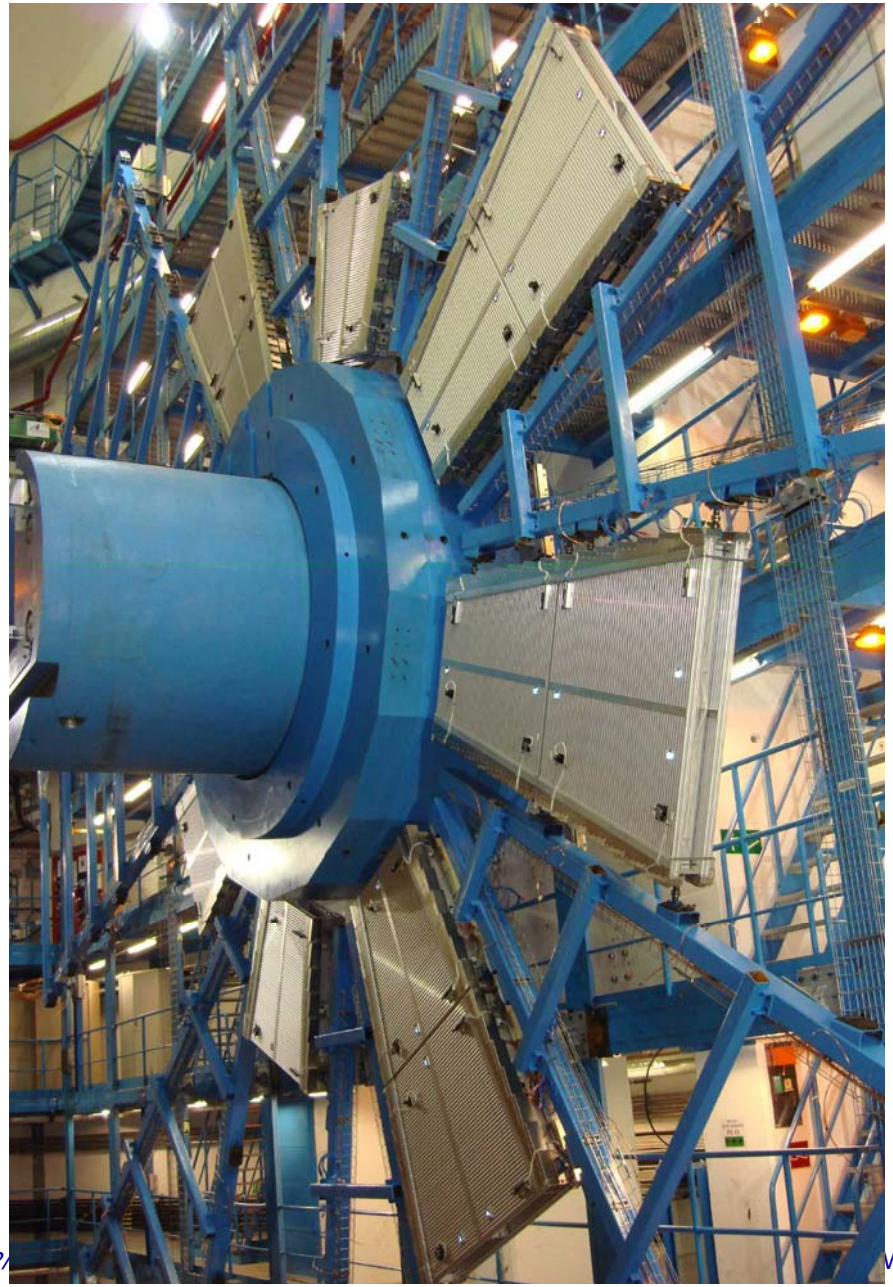
Completion schedule (version 9.2)



From now till end November

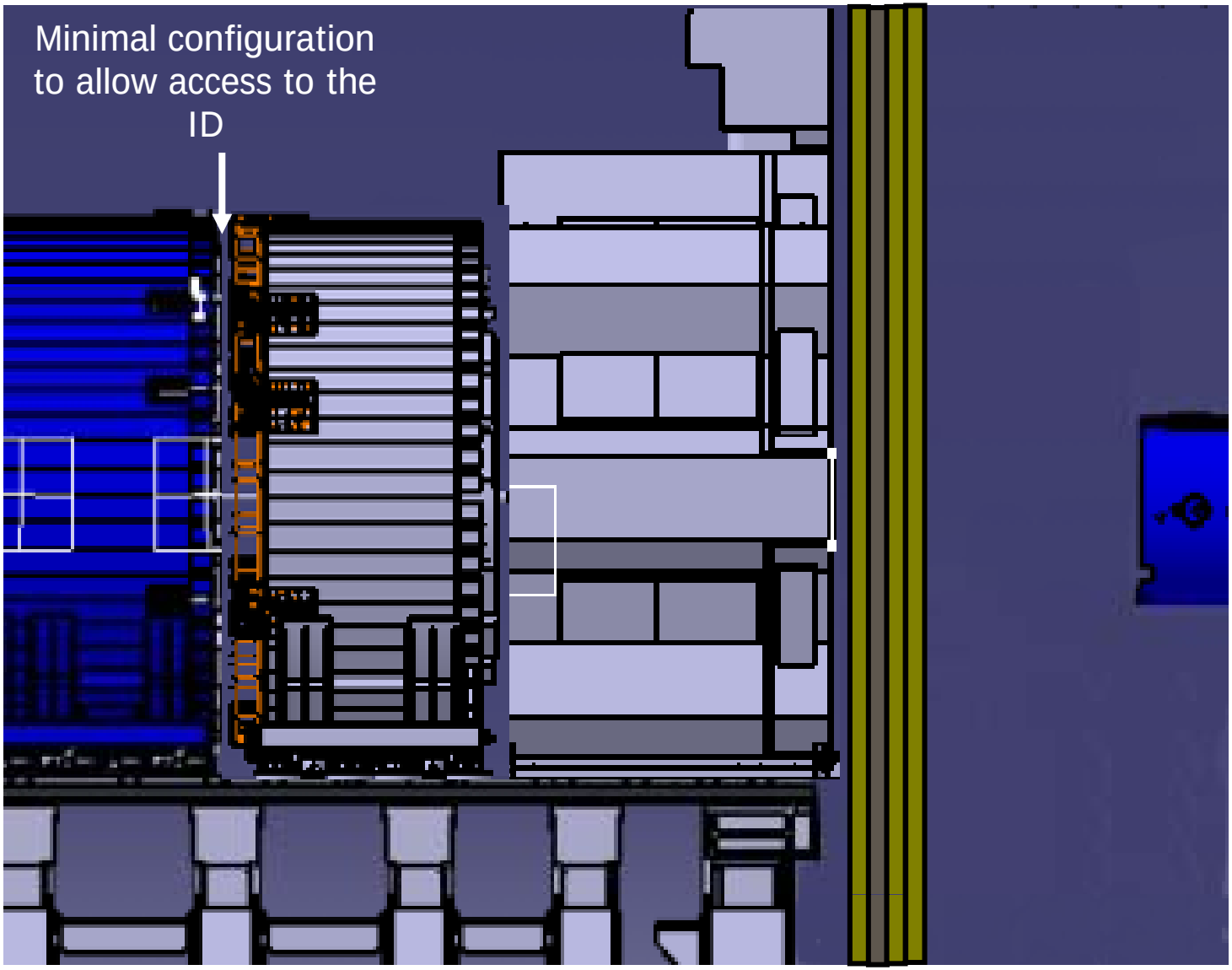


EO muon chambers on side A & C

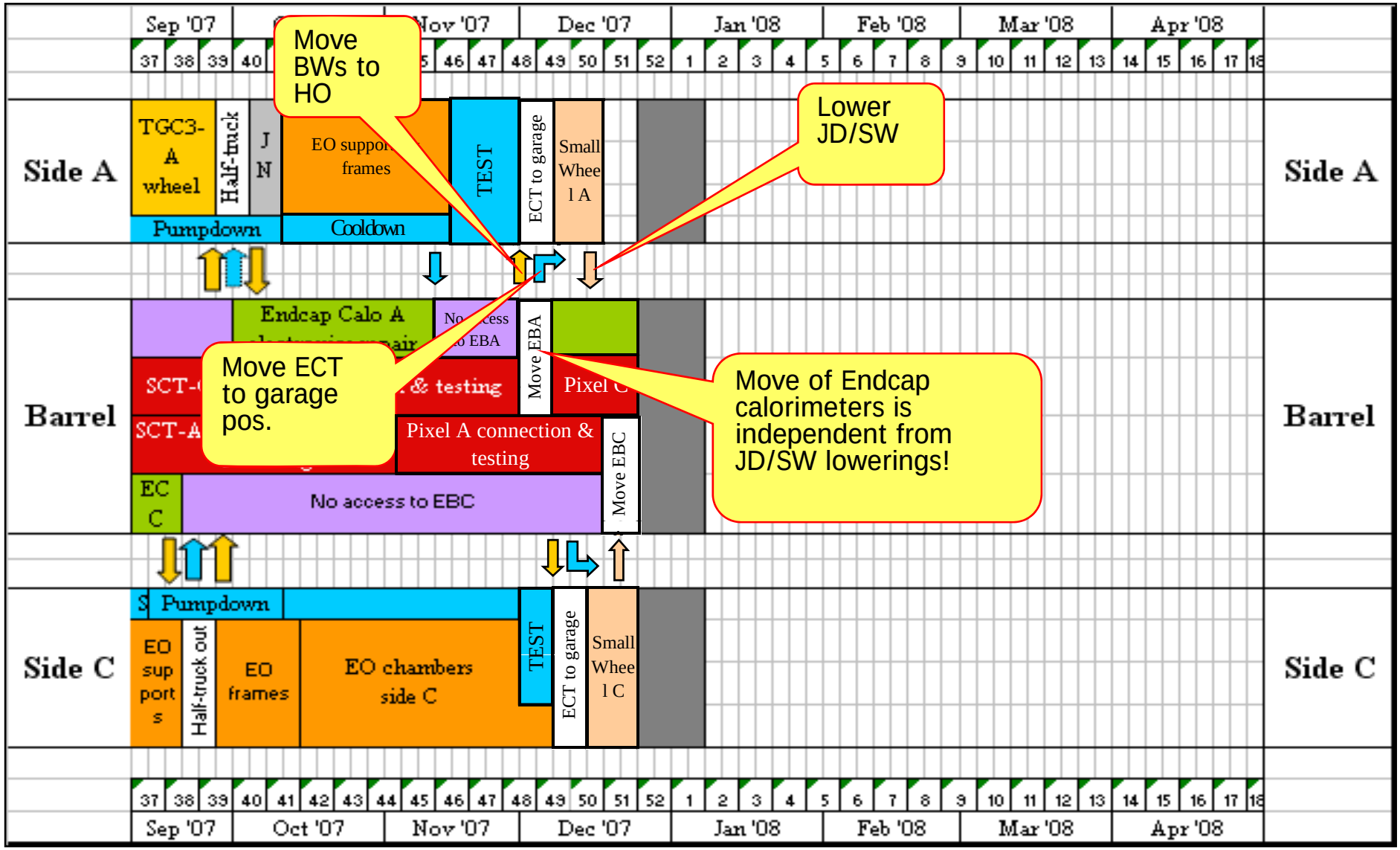


- ✓ Almost all supports and frames already in place. Chambers installation started few days ago
- ✓ Critical is the arrival of the last alignment bar, due in December
- ✓ 96 chambers to be installed on each side, we plan 6-8 chambers per day
- ✓ If we loose time, it is possible to finish later, with the beam line in place, after closing.

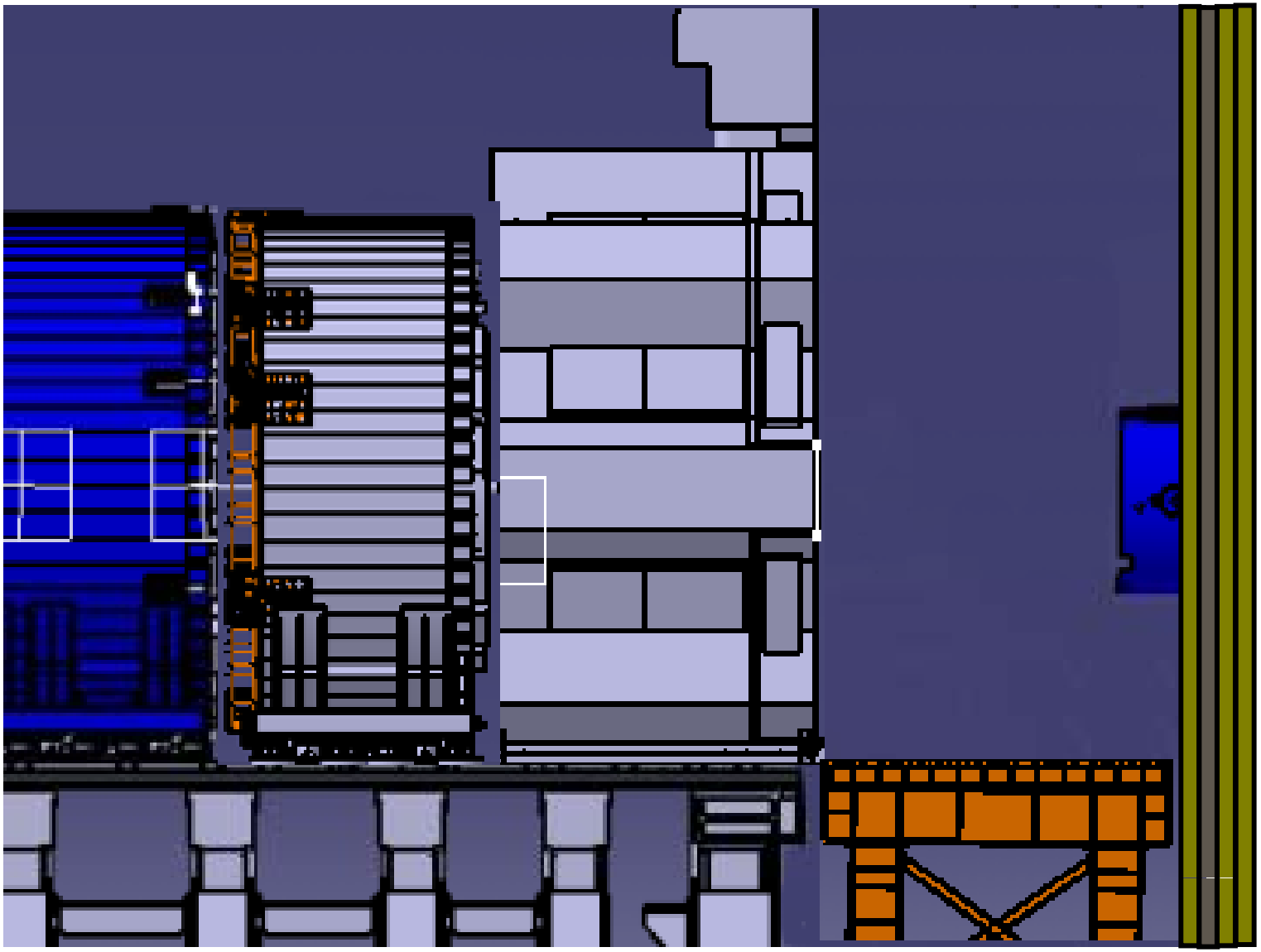
Detector configuration during ECT tests



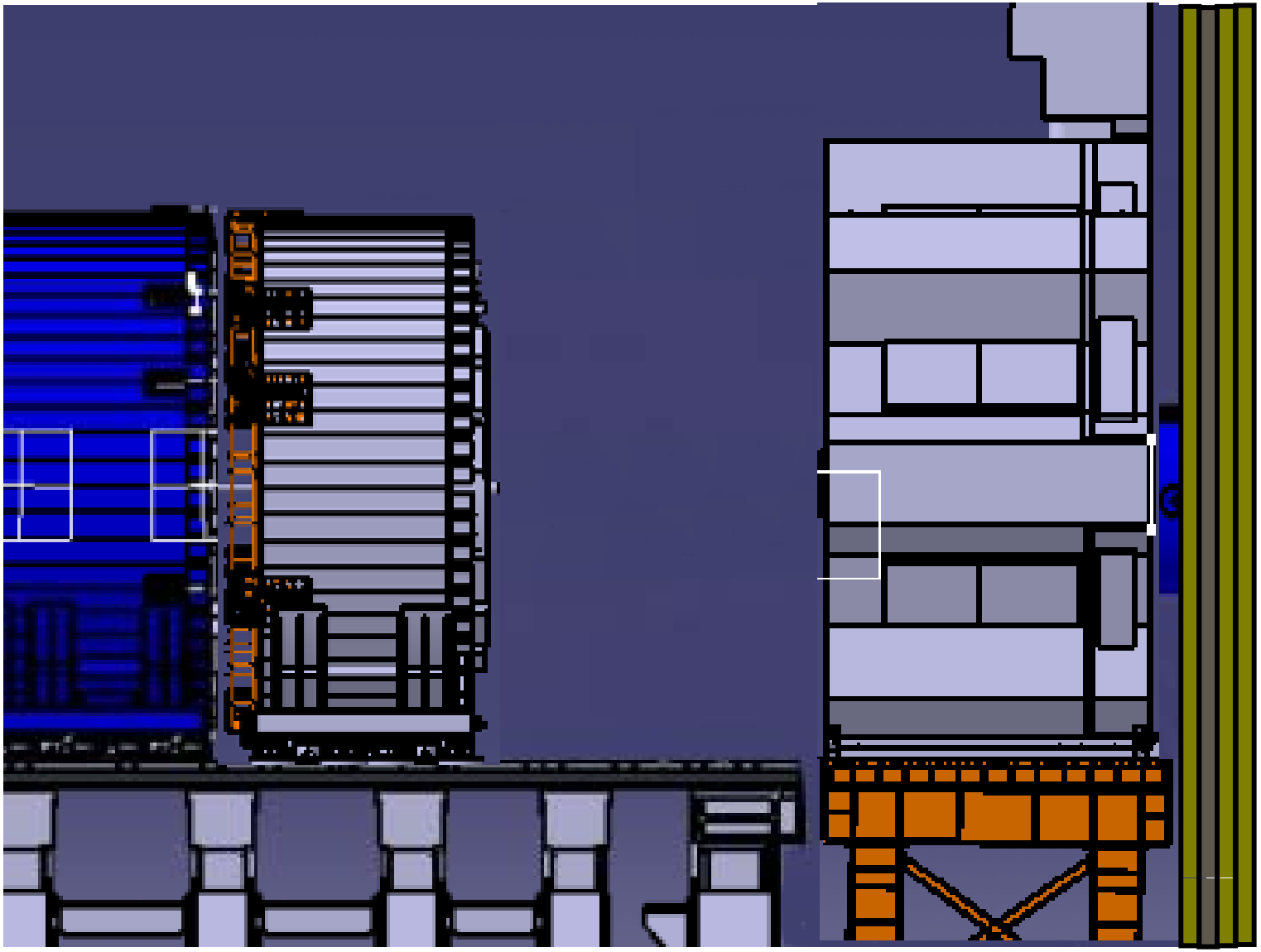
From ECT tests till end of the year



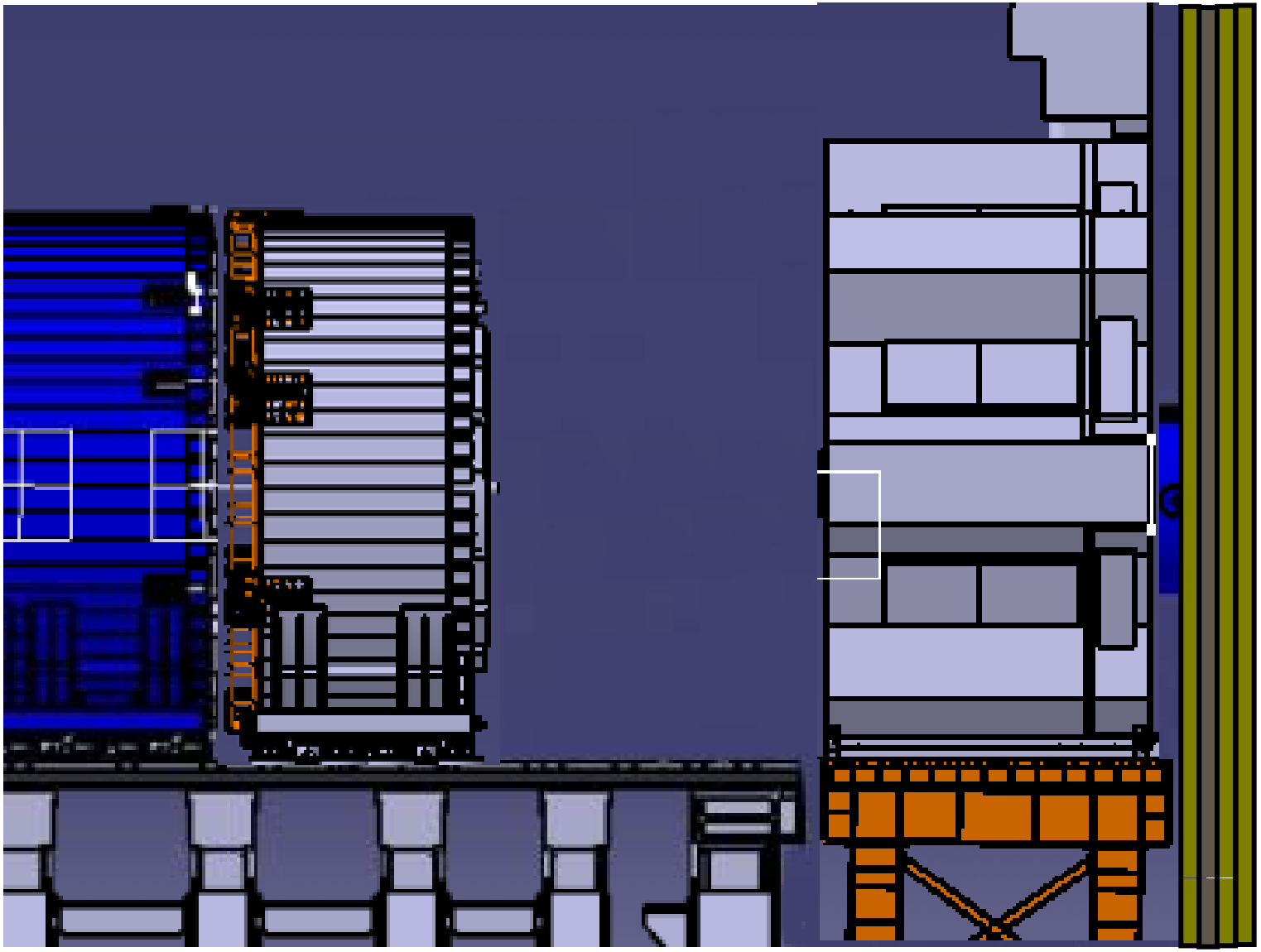
Open BWs and bring down light truck



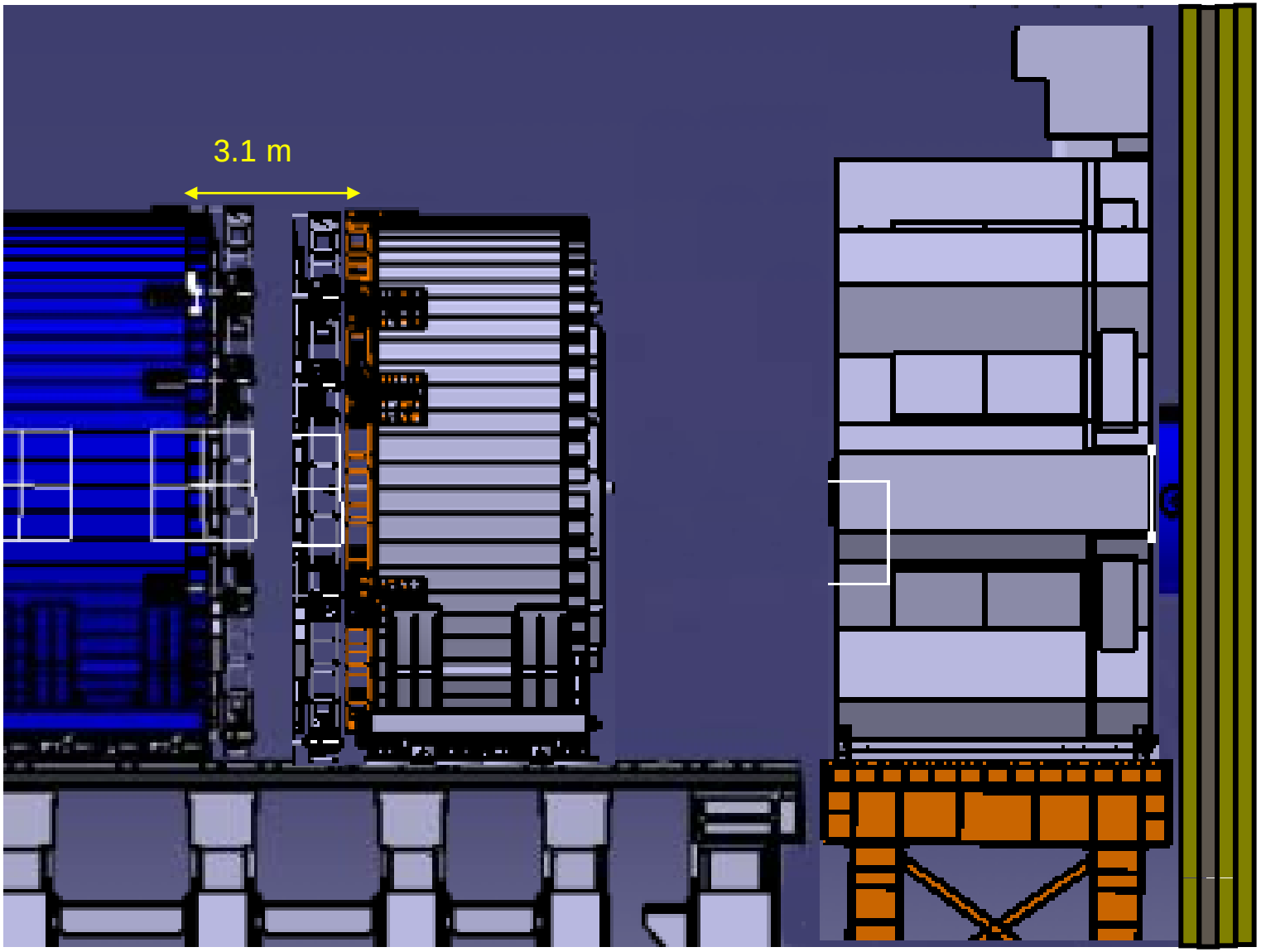
Open ECT



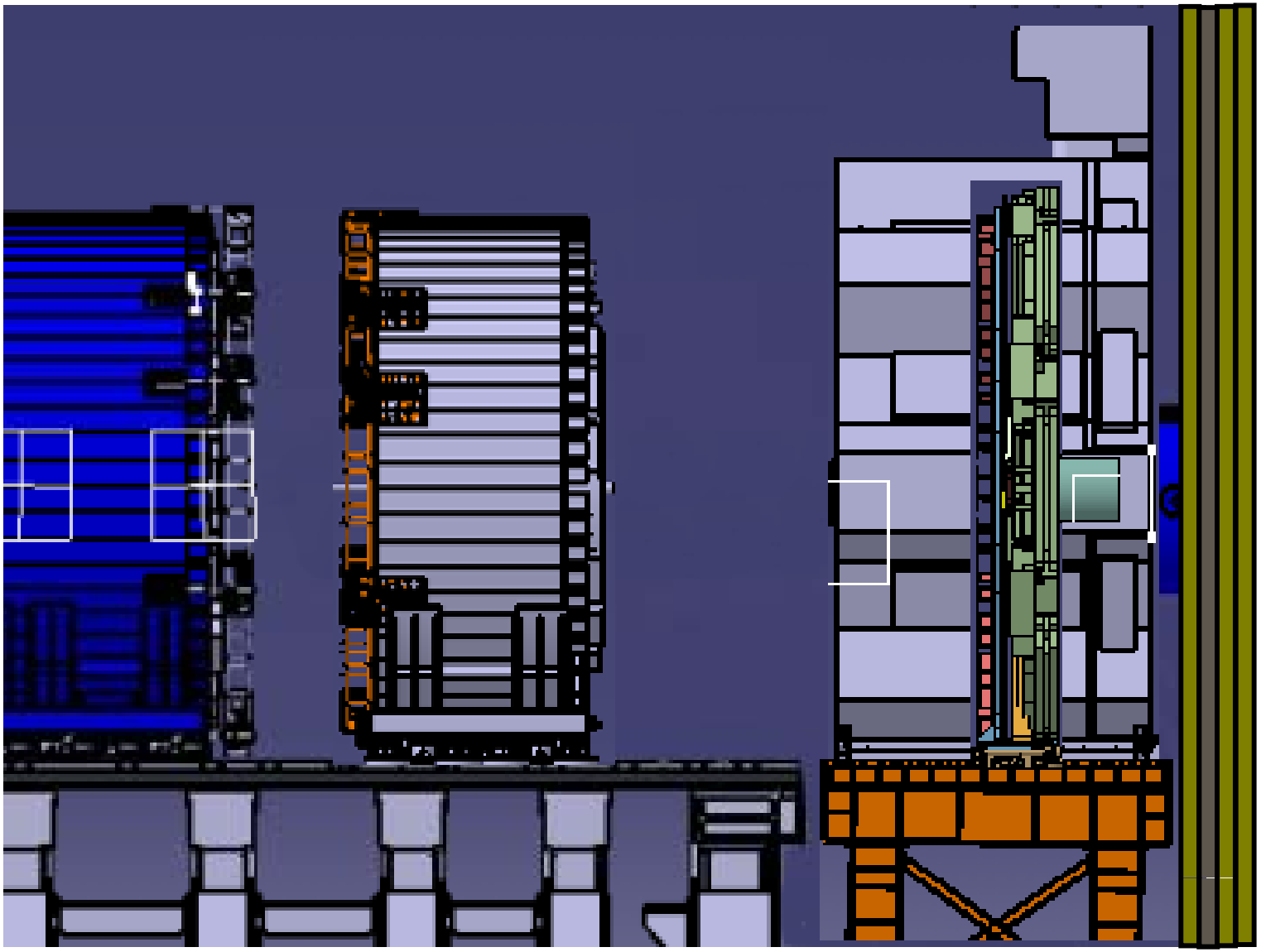
Move ECT to side and lower 2nd truck



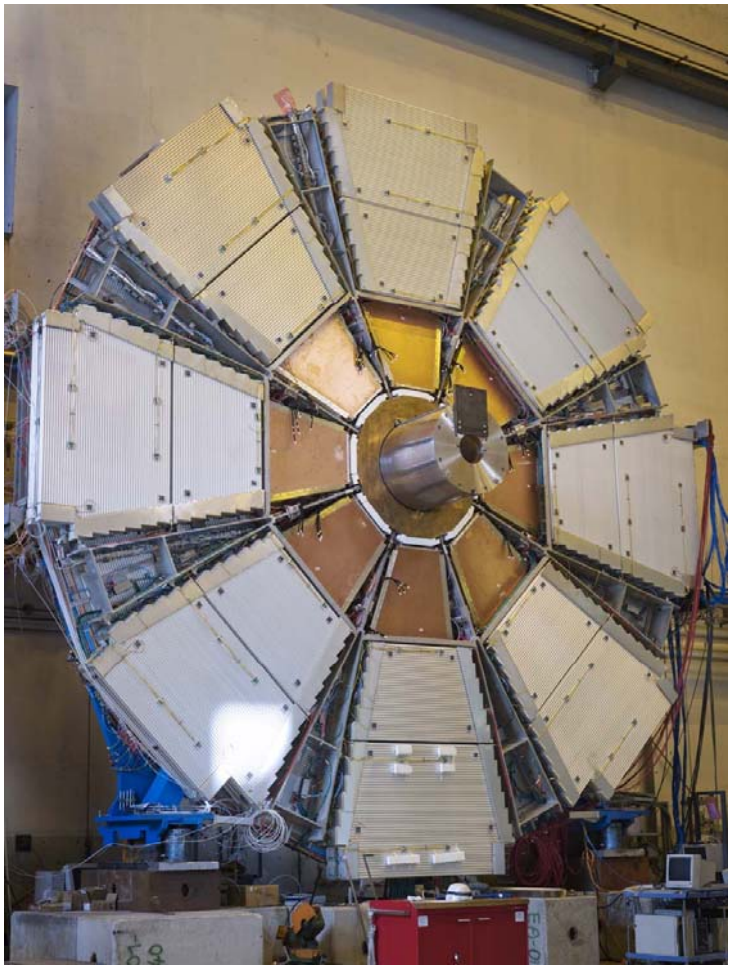
Open Endcap Calorimeter



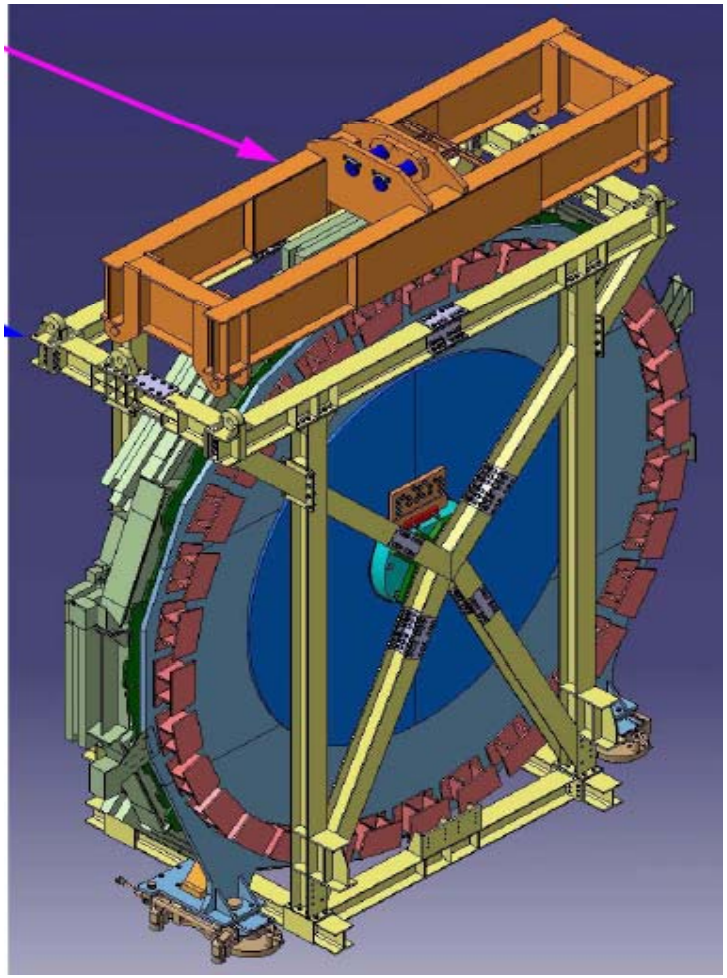
Lower JD/SW and move it inside



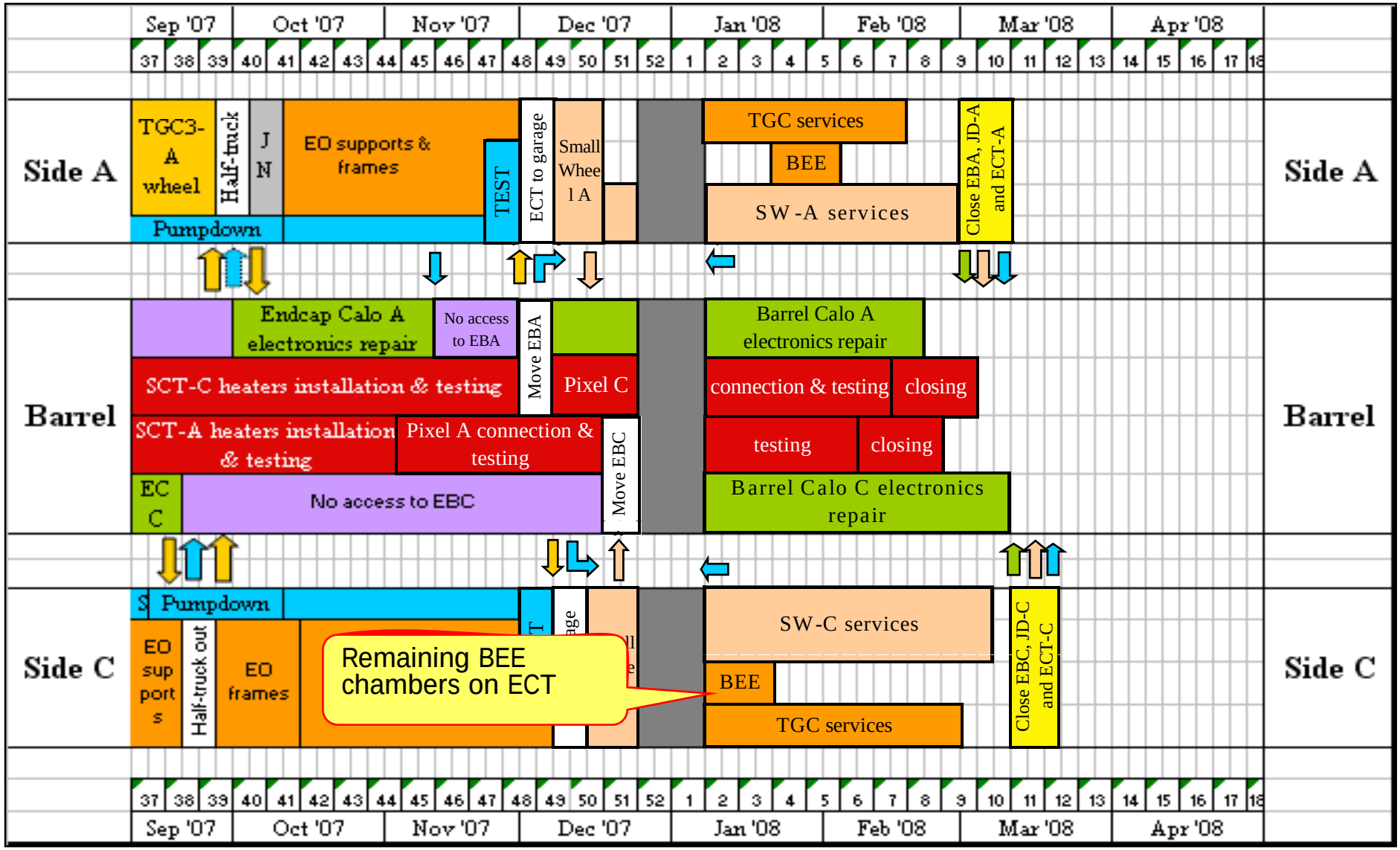
Small wheels construction



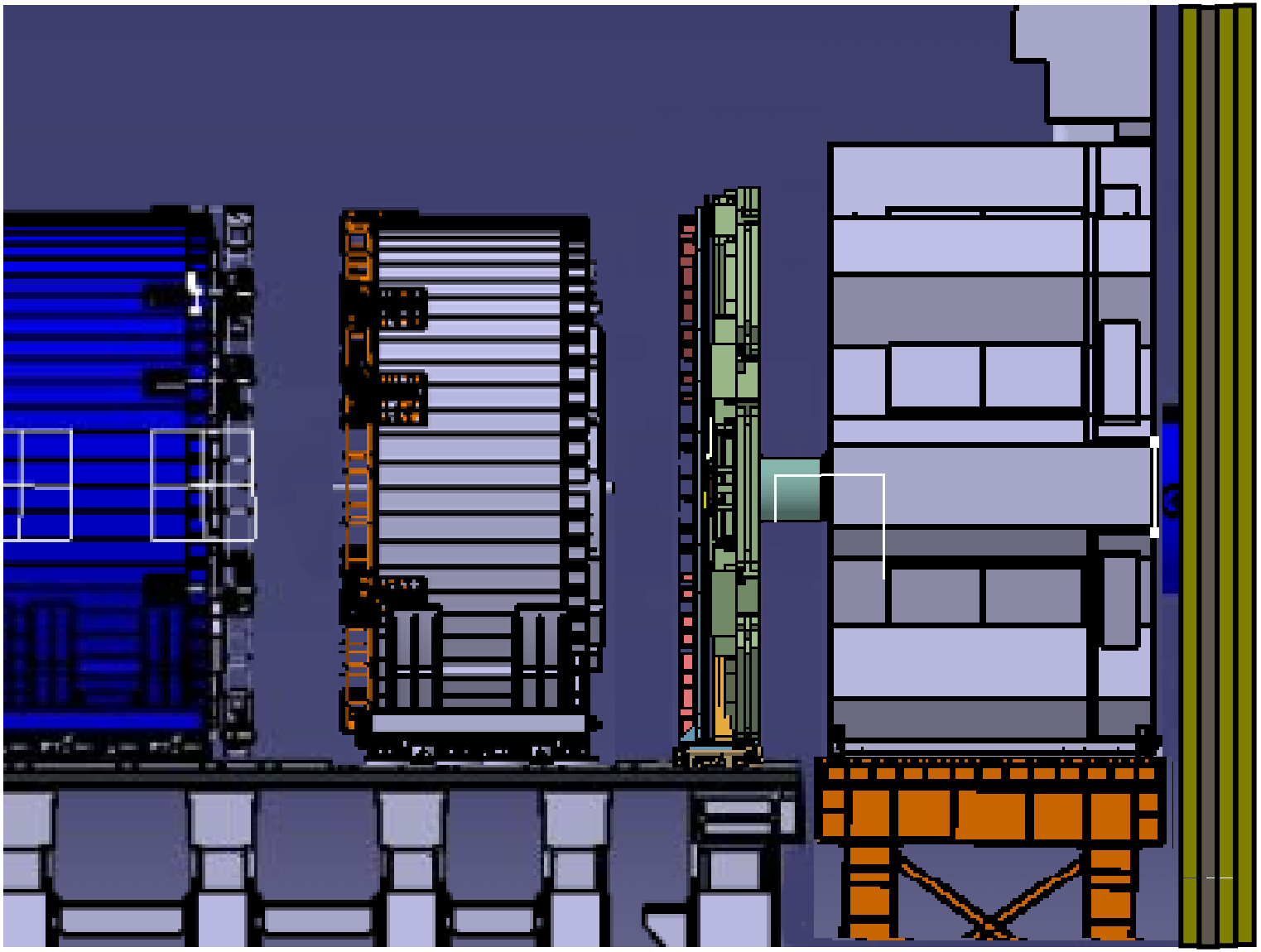
- ✓ First small wheel assembled and waiting to be transported to point 1
- ✓ Second wheels is being assembled
- ✓ Critical is the test of the transport frame, to be done beginning of November
- ✓ Transport to point 1 by end November



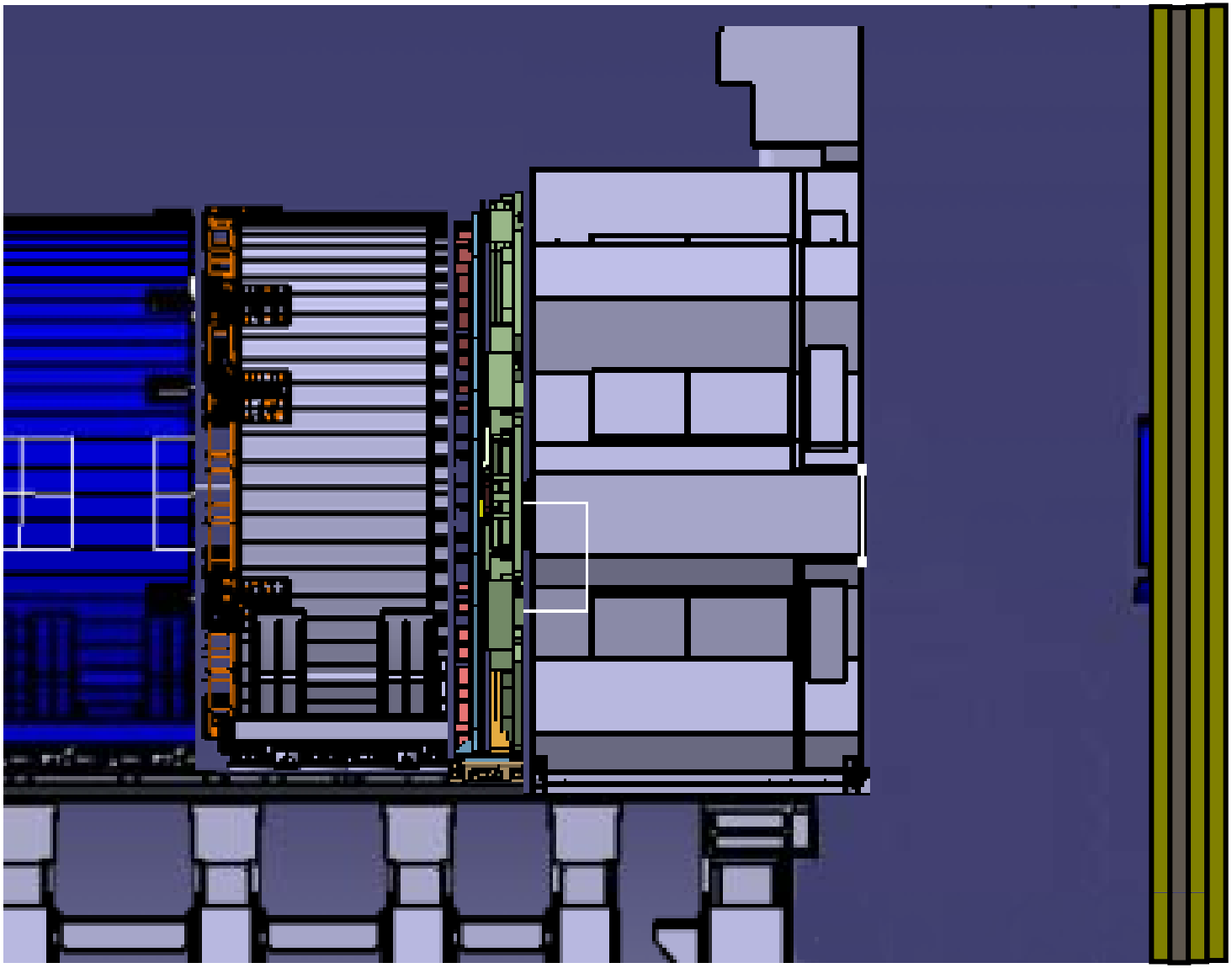
Jan-Feb 2008


Sep '07
Oct '07
Nov '07
Dec '07
Jan '08
Feb '08
Mar '08
Apr '08
37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Side A
TGC3-A wheel
Half-truck
J N
EO supports & frames
TEST
ECT to garage
Small Wheel A
TGC services
BEE
SW-A services
Close EBA, JD-A and ECT-A
Pumpdown
Barrel
Endcap Calo A electronics repair
No access to EBA
Move EBA
Barrel Calo A electronics repair
SCT-C heaters installation & testing
Pixel C
connection & testing
closing
SCT-A heaters installation & testing
Pixel A connection & testing
testing
closing
EC C
No access to EBC
Move EBC
Barrel Calo C electronics repair
Side C
Pumpdown
EO support s
Half-truck out
EO frames
SW-C services
BEE
TGC services
Close EBC, JD-C and ECT-C
Remaining BEE chambers on ECT

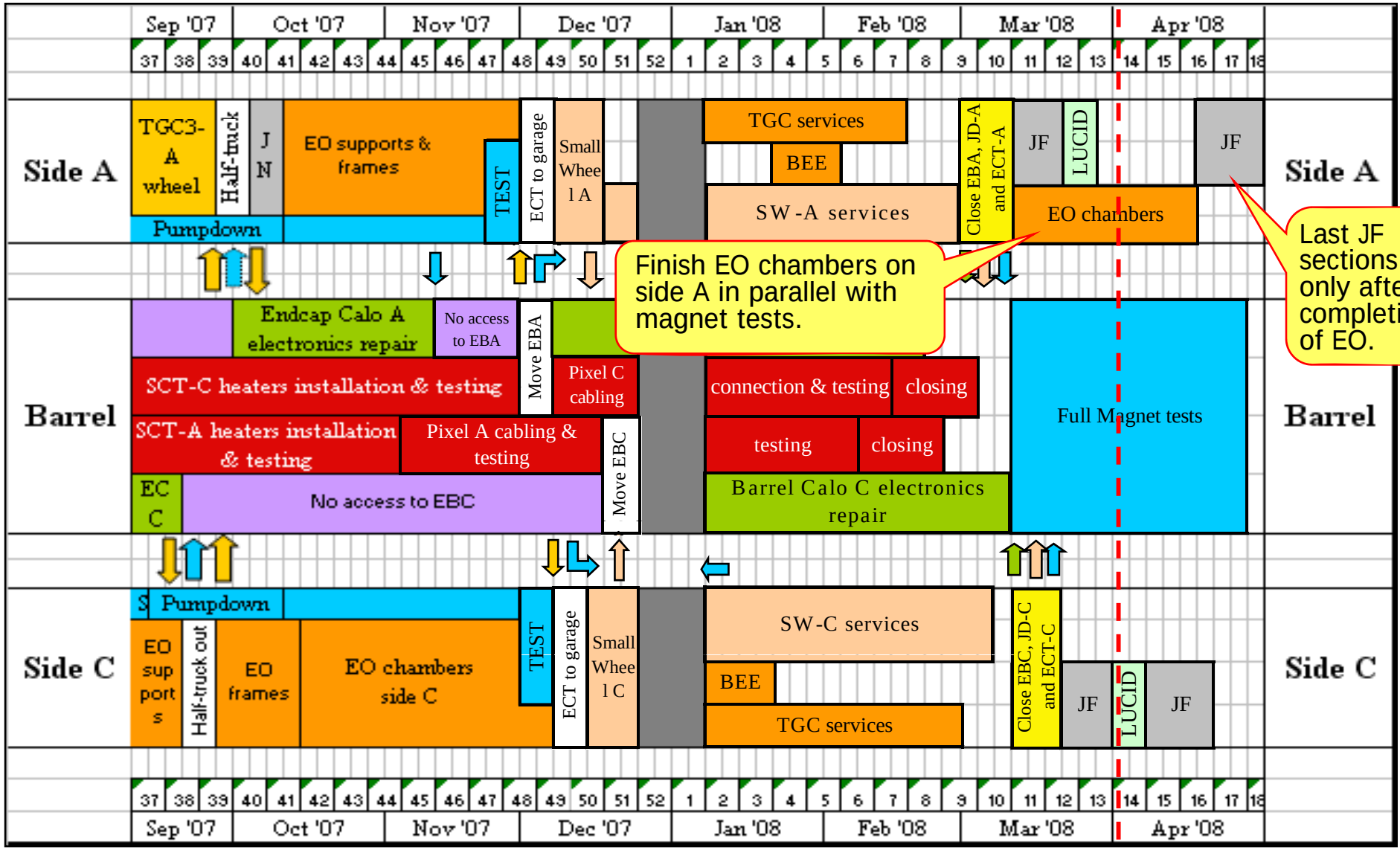
Remove 2nd truck and move ECT back to beam line



And then in March we close the detector



March-April: Full magnet tests, Beam pipe, LUCID, JF



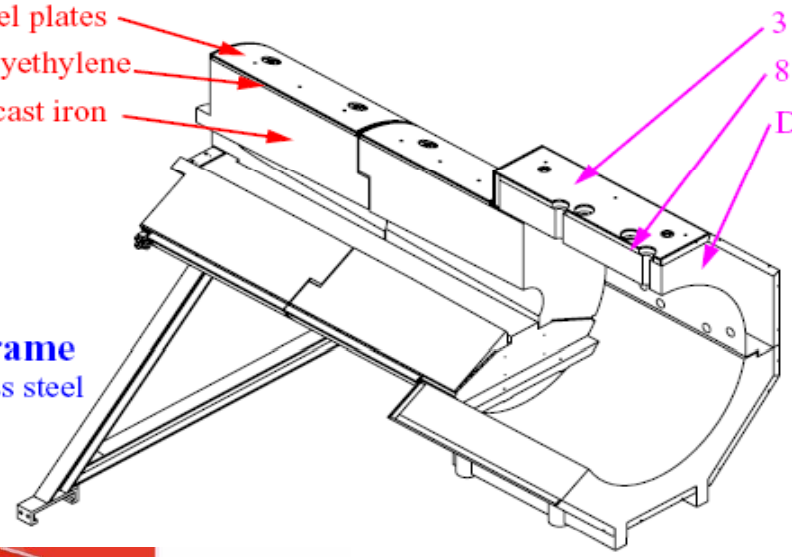
JF Shielding

Cylindrical core sections

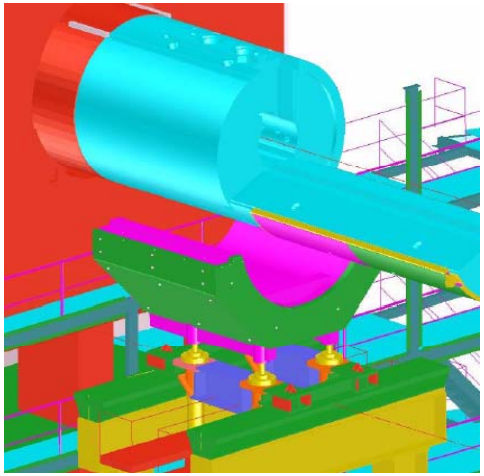
3 cm steel plates
5 cm polyethylene
Ductile cast iron

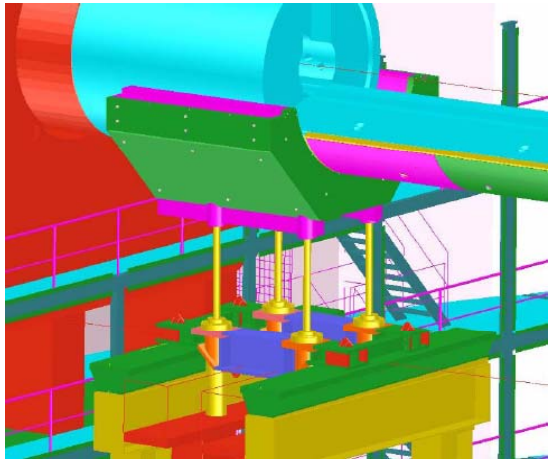
Octagonal sections

3 cm steel plates
8 cm polyethylene
Ductile cast iron



A - frame
Stainless steel





Summary

- ✓ All major detector components are installed, are being commissioned and debugged. For the moment we have a initial detector which correspond to the design in term of layout and expected performances
- ✓ A systematic commissioning program is following the installation of the last single devices
- ✓ Around March we will start a continuous operation mode of the detector, manning slowly the main control room with people and shifts. Turn on the run coordination organization and all piquet services
- ✓ Up to that moment we bring up, piece by piece, each component through the full read out chain, debug the control system and the trigger system. Time in all read-out components as much as possible without beam. Run global cosmics runs to tune the system and to build up experience
- ✓ We will start closing the detector, when the machine will tell us, we need ~2 months of notice. As of today we plan to close the beam pipe end of March/early April 2008

Adjustments in-kinds (CF/CC-A)

✓ Busbars (CORE: 700 kCHF; IHEP, Russia)

The in-kind manufacturing of the busbars in Russia (IHEP) for the magnet system was approved by the RRB in October 2002 for a CORE value of 420 kCHF. Following reorganization of work within the relevant work packages, the original CORE value was adjusted in April 2003 and October 2004, resulting in a net decrease of 20 kCHF. Since then, a series of additional technical and organizational changes have taken place resulting in shift of work from central ATLAS to Russia. The total net value of this additional in-kind work is recognized at 300 kCHF (within the original CORE cost envelope) thus increasing the total Russian in-kind value of the busbars to 700 kCHF.

✓ MDT Wheels support (CORE: 680 kCHF; IHEP, Russia)

Large components of the two MDT Wheels (BW) structures were produced in Russia (IHEP) as in-kind contributions, following the original RRB approval in October 2003 for a CORE value of 825 kCHF. During the execution of work, a reorganization of work took place between the manufacturing of the rims and spokes. As a result, the final value of the rims amounted to 540 kCHF and 140 kCHF for the spokes, correspondingly. The final value of the BW components therefore amount to 680 kCHF, representing an adjustement of – 145 kCHF w.r.t the original CORE value.