

Status and Commissioning of the CMS Experiment

<http://cms.cern.ch>

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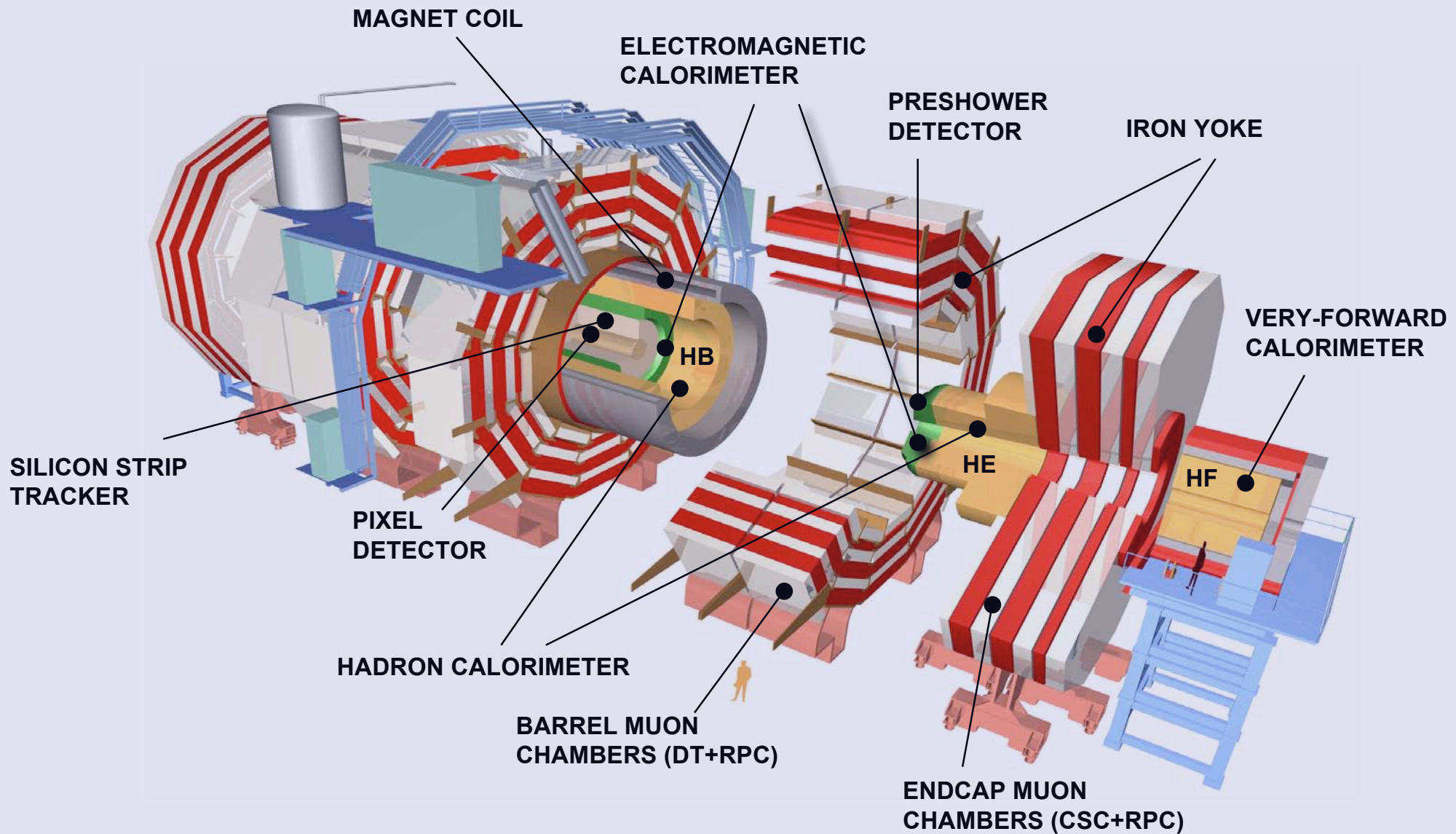
Institute for High Energy Physics of the Austrian Academy of Sciences

on behalf of the CMS Collaboration

HEP 2007, Manchester, 21 July 2007



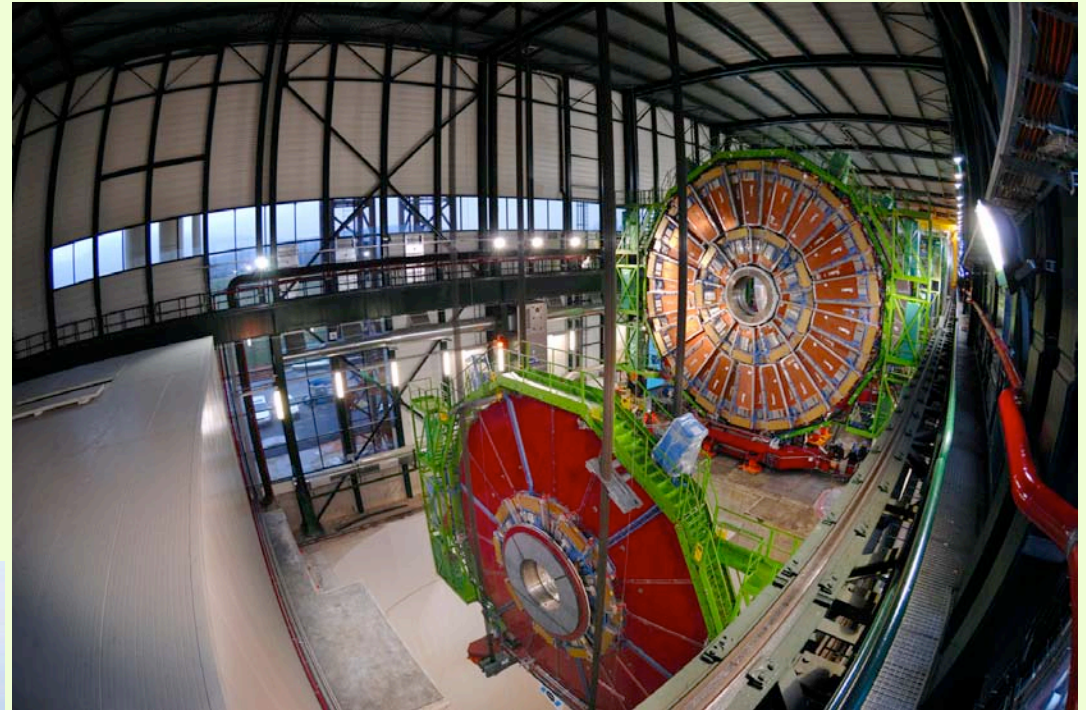
Layout of CMS





CMS Construction and Commissioning Strategy

- **First assembly and precommissioning of detector elements in surface hall**
- **Lowering of elements into experiment cavern**

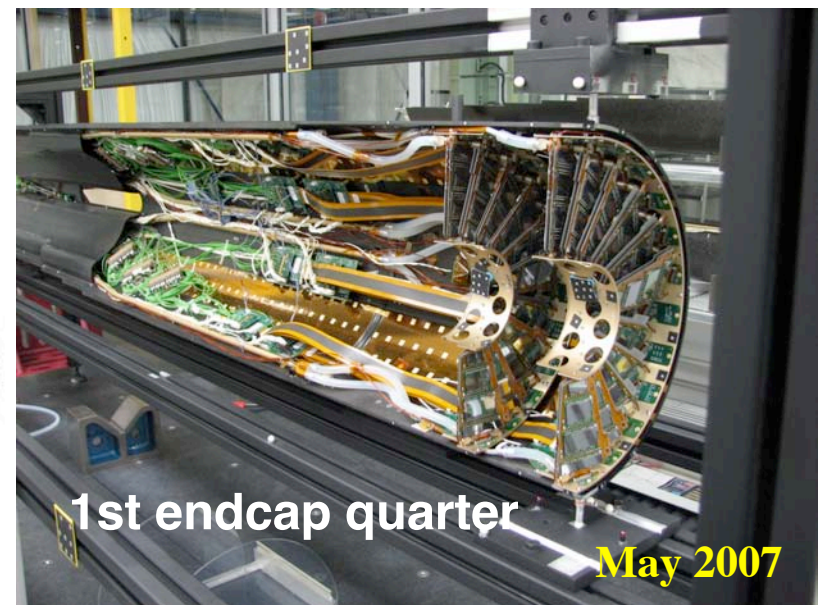
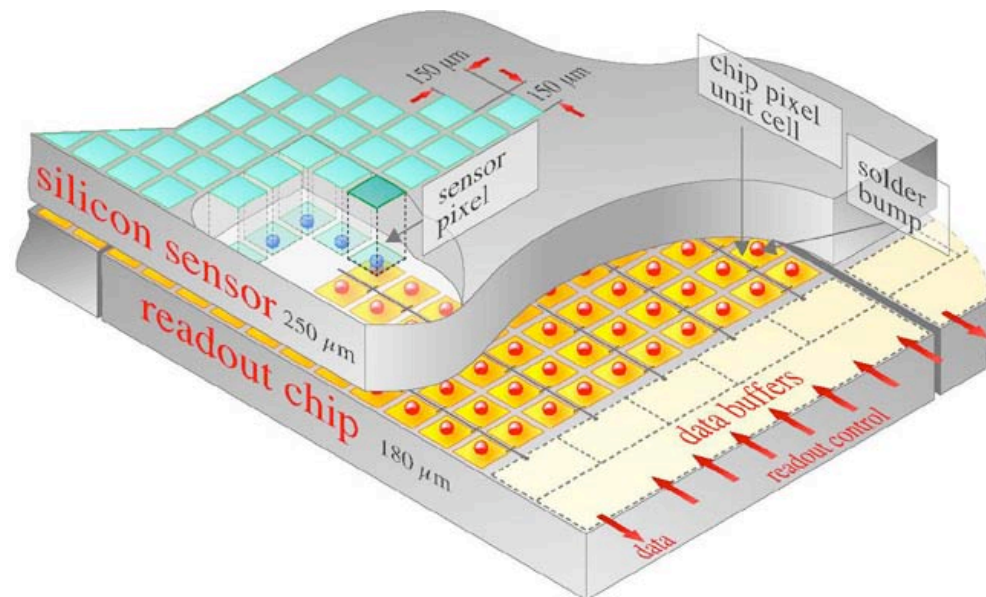


- **Final assembly and commissioning in experiment cavern**
- **Commissioning and calibration: cosmic rays, lasers, LEDs, test pulses, test patterns, test beams.**



Pixel Detector

Barrel layers are at radii 4, 7, and 11 cm. Forward layers are at ± 34 and ± 46 cm from interaction point. Its silicon pads provide high-resolution (10 to 20 μm) patterns of space points. Pixel size 100 μm x 150 μm ; 16000 readout chips in 0.25 μm CMOS technology, bump-bonded to the silicon sensors; Challenging radiation environment (100 Mrad in 10 years).

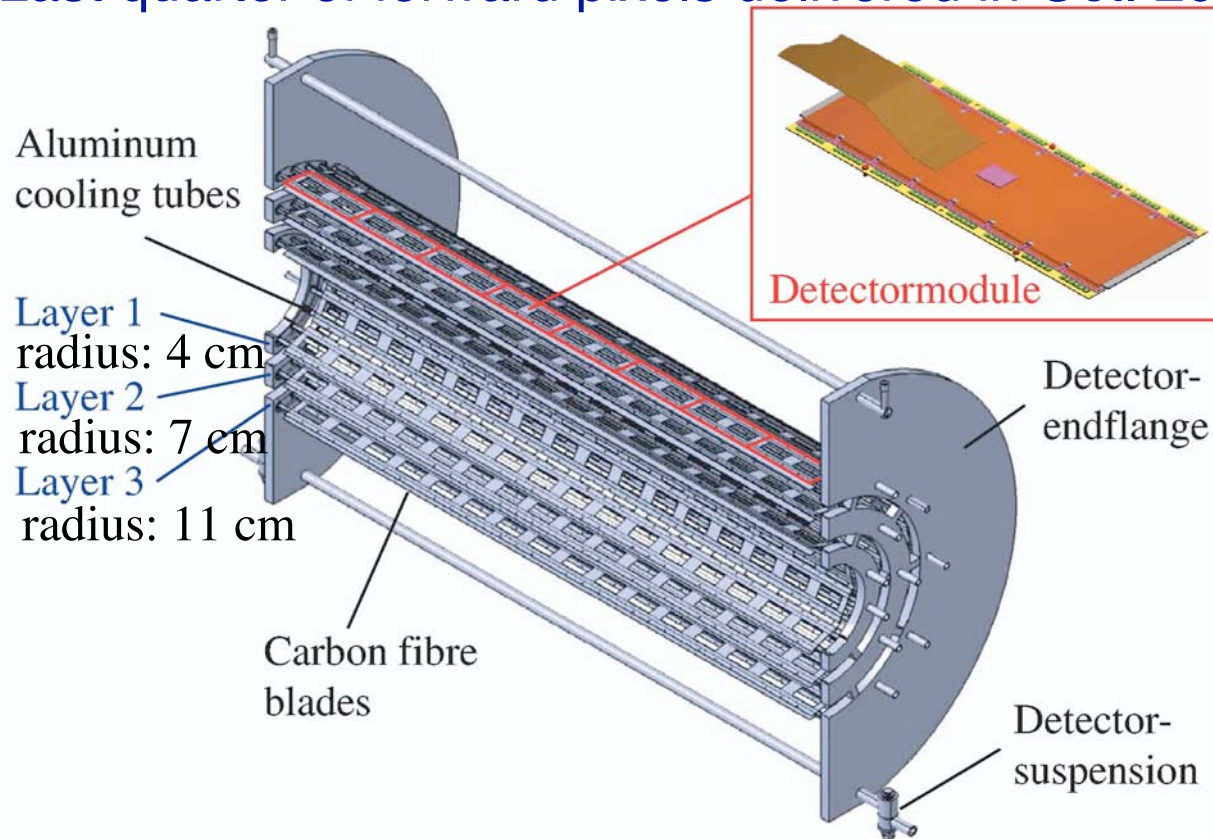
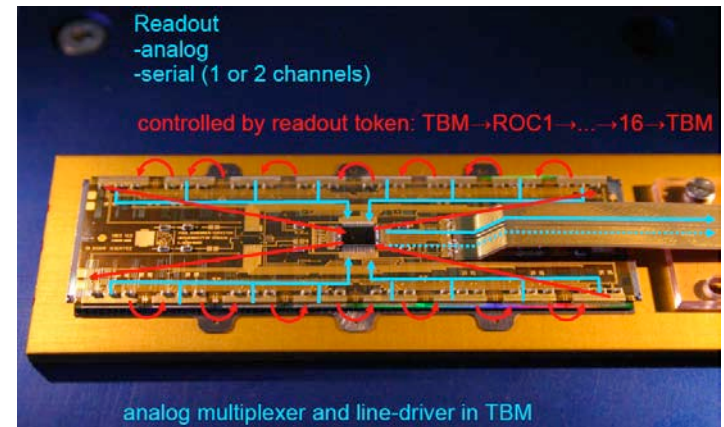


The pixel detector will be installed before summer 2008.



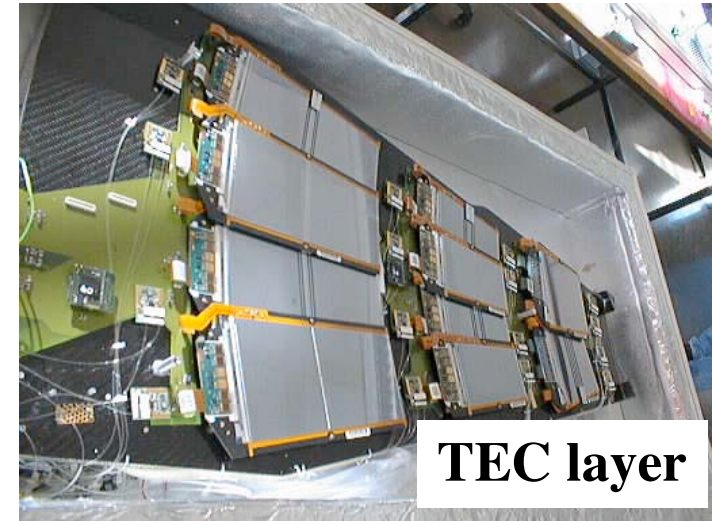
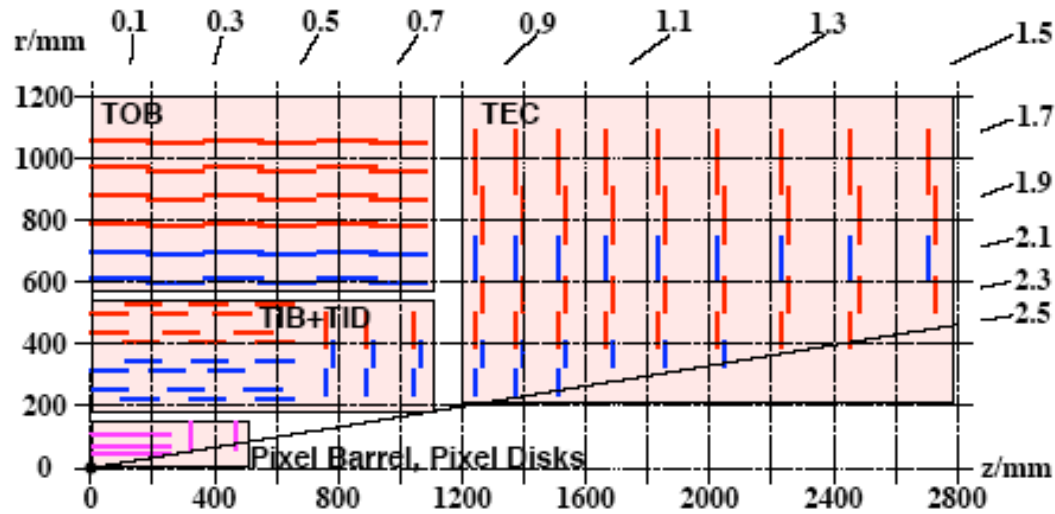
Pixel Detector Production

- 600 out of 800 modules produced
- Support Tube produced
- 12 module system test under way
- Commissioning system ready by early autumn
- Final system one side by Nov. and the second in Jan. 2008.
- Last quarter of forward pixels delivered in Oct. 2007



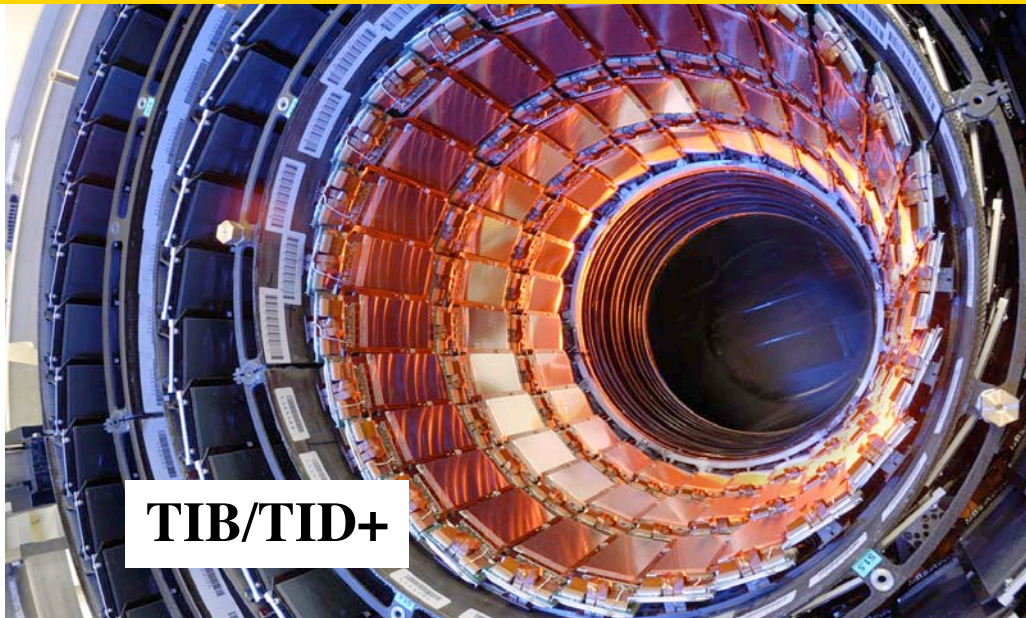


Silicon Strip Tracker

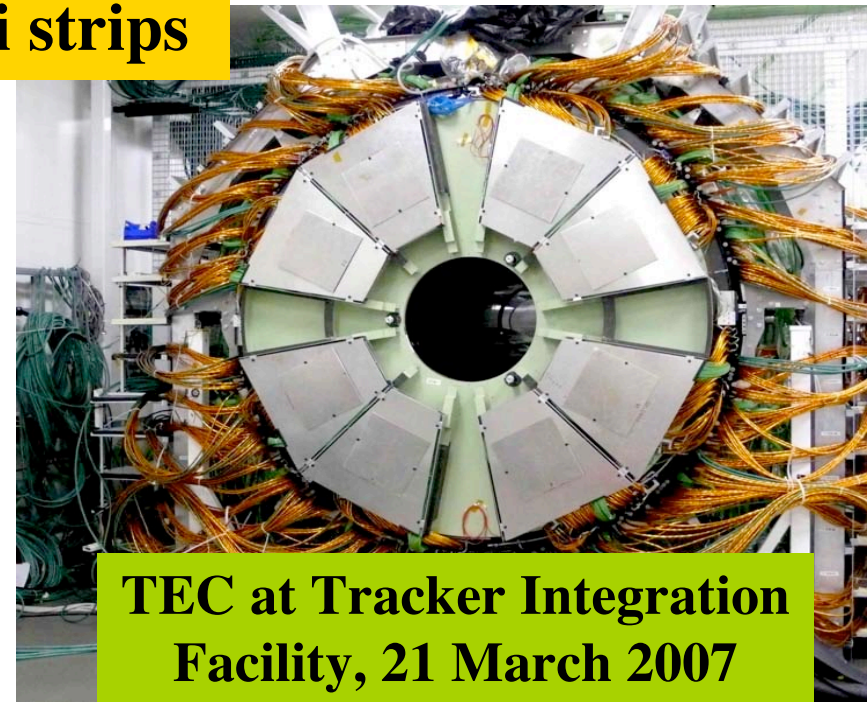


TEC layer

220 m² of Si sensors, 10.6 million Si strips



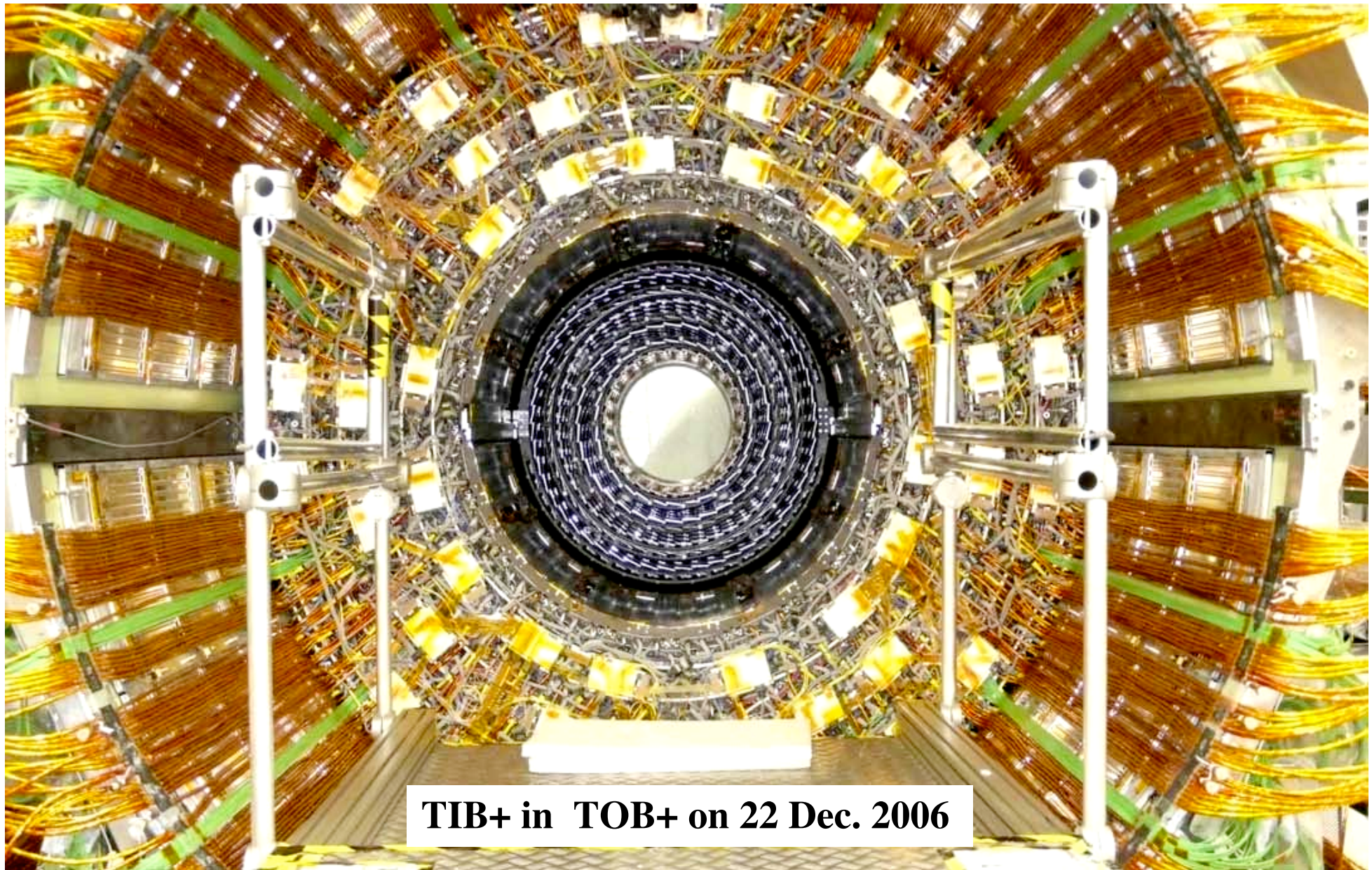
TIB/TID+



TEC at Tracker Integration Facility, 21 March 2007



Tracker Inner Barrel inserted in Outer Barrel



TIB+ in TOB+ on 22 Dec. 2006



Status of Silicon Strip Tracker

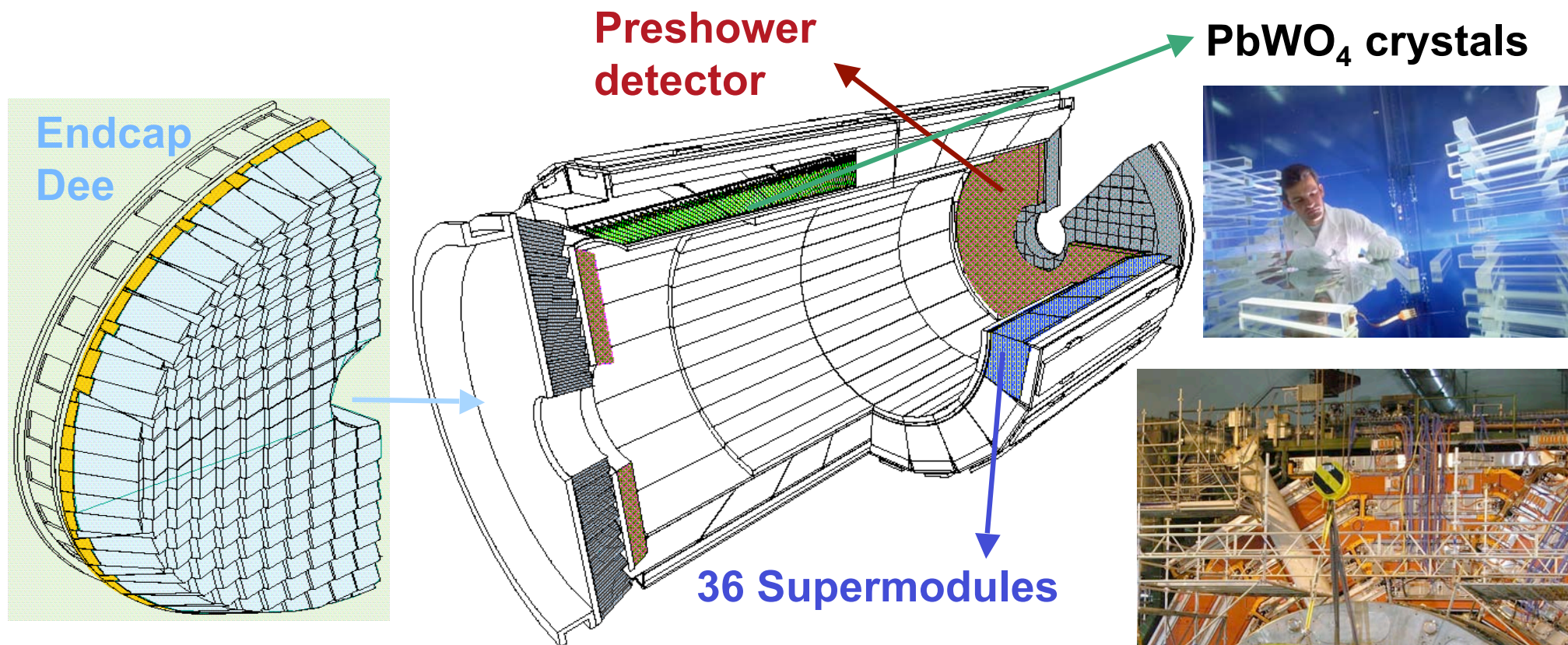
Cosmic μ

The laser alignment system has been successfully commissioned. Calibration and alignment goal for April 2008: $< 100 \mu\text{m}$ for tracker and pixels, $< 30 \mu\text{m}$ after about 2 months of collisions. Installation of the SST in CMS will begin shortly. Full operation in Nov. 2008.

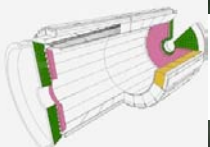
SST construction including insertion in support tube was terminated in March 2007. Tests with cosmic muons at the Tracker Integration Facility have just ended, with several million events recorded. The operating temperature ranged between room temperature and -15°C . Only a few per mille of dead or noisy strips, signal-to-noise ratio $> 25:1$.



Electromagnetic Calorimeter



All barrel crystals, manufactured largely in Russia with some in China, are delivered. Endcap crystal delivery from Russia and China is ongoing and foreseen to end in March 2008. First endcap Dee will be ready for insertion end of Feb. 2008. Construction of second endcap will be finished by early summer 2008.



Barrel ECAL Construction

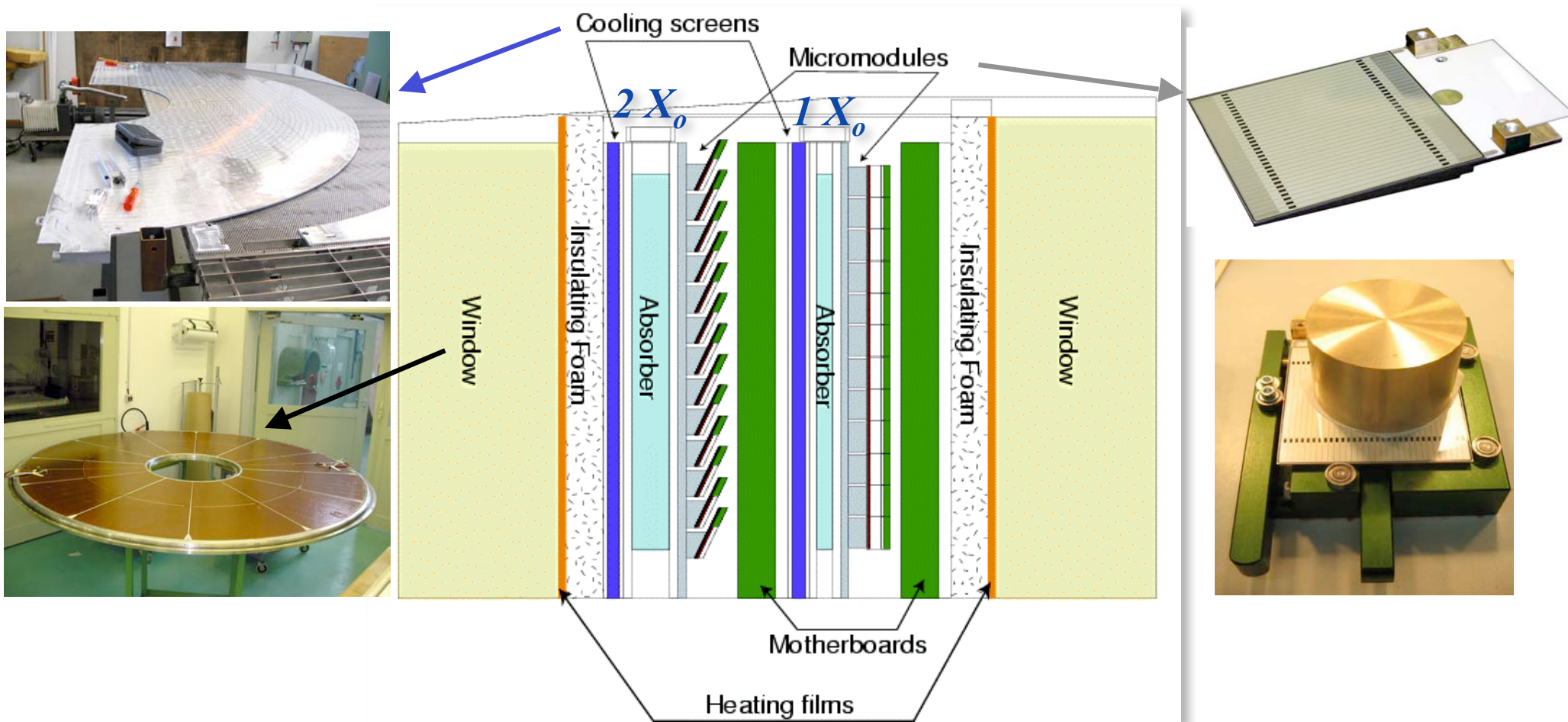
EB-

- Bare Supermodule production finished on 20 April 2007
- Insertion of first half-barrel (EB-) finished on 22 May 2007
- Last Supermodule with integrated electronics ready in July 2007
- Installation and cabling of EB+ will be finished by September 2007



Preshower Detector

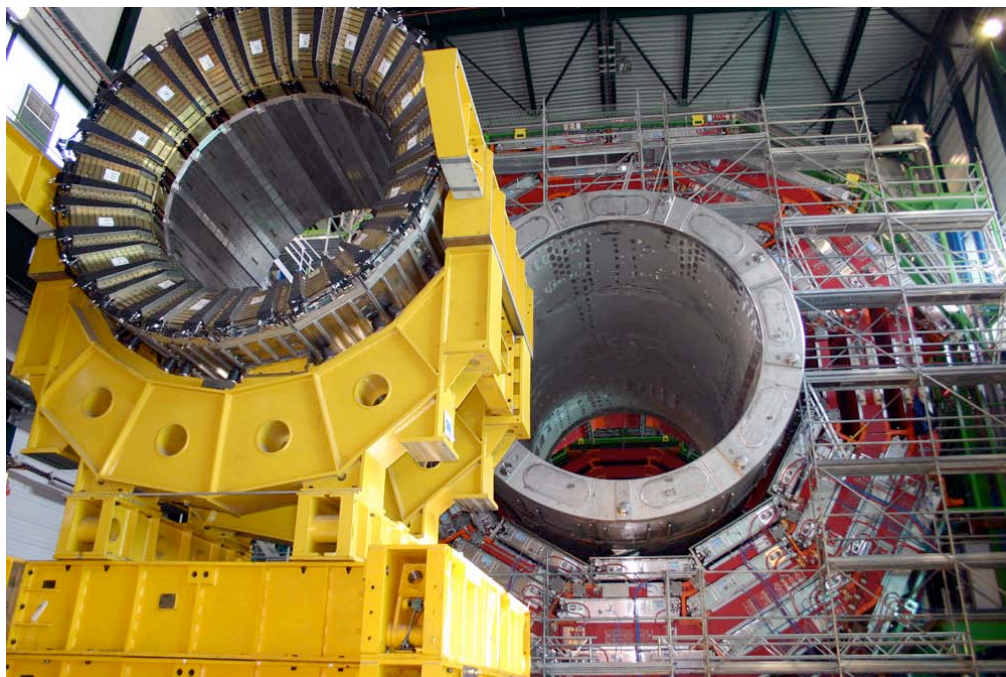
Task: separate photons from π^0 's and identify diphoton vertex. Two-layer sampling calorimeter consisting each of a lead absorber and silicon microstrip detectors (320 μm thick sensors, 32 strips with pitch of 1.9 mm) behind. Final installation is foreseen to be completed by March 2008.



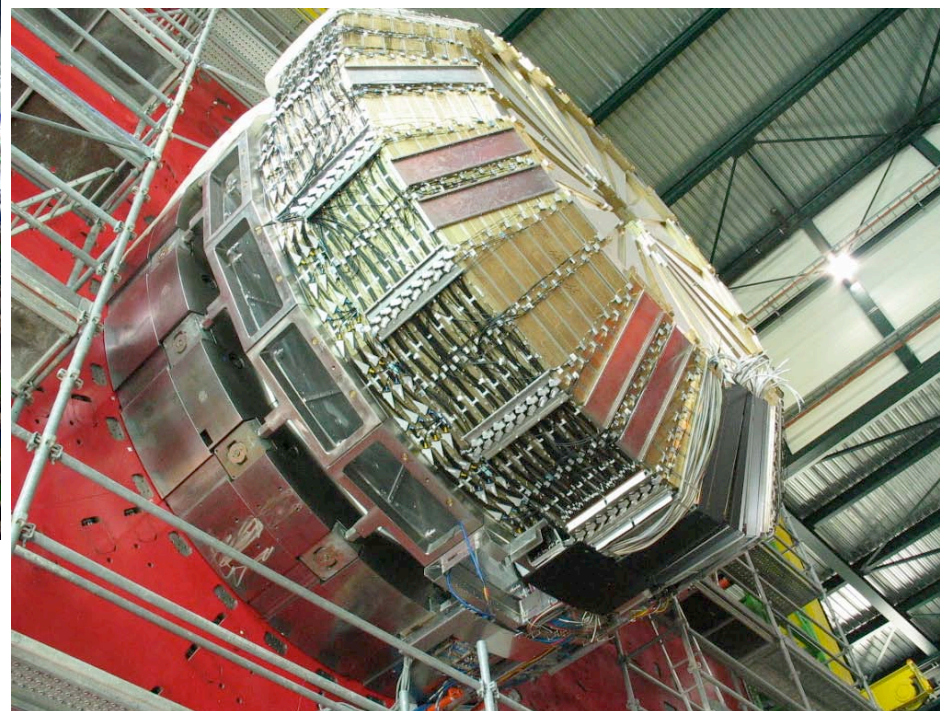


Hadronic Calorimeter

The central part (barrel + endcaps) consists of alternating plates of brass and plastic scintillator read out by photodiodes through wavelength shifting optical fibres. Most HCAL modules are installed underground. HB commissioning will start in Aug. Schedule of about 6 weeks is tight. There is also a test beam from July 2007 for EE/HE measurements.



Barrel HCAL (HB)

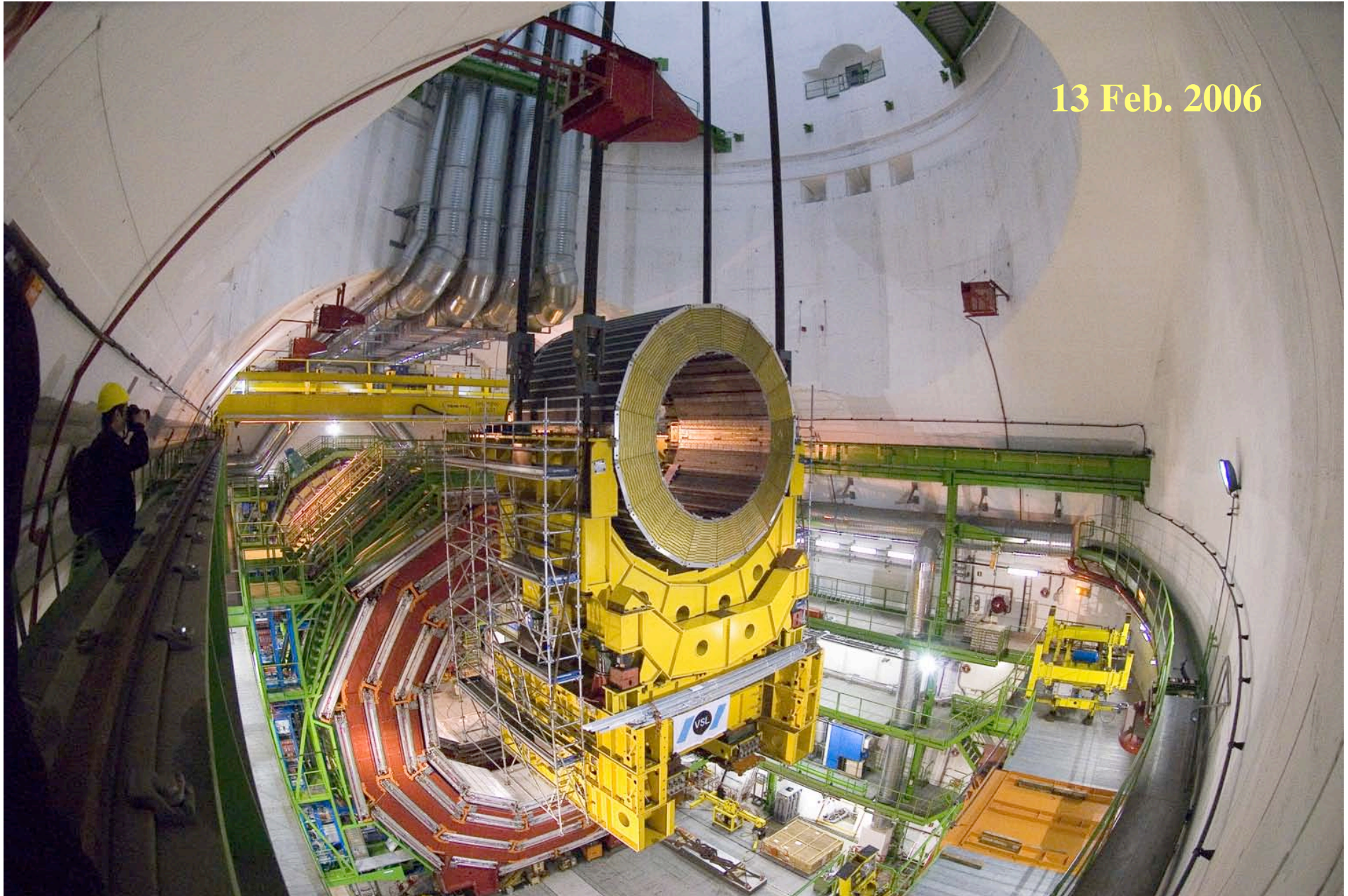


Endcap HCAL (HE)



Installation of HB+

13 Feb. 2006





Forward Hadronic Calorimeter



Lowering of HF+ on 11 Nov. 2006



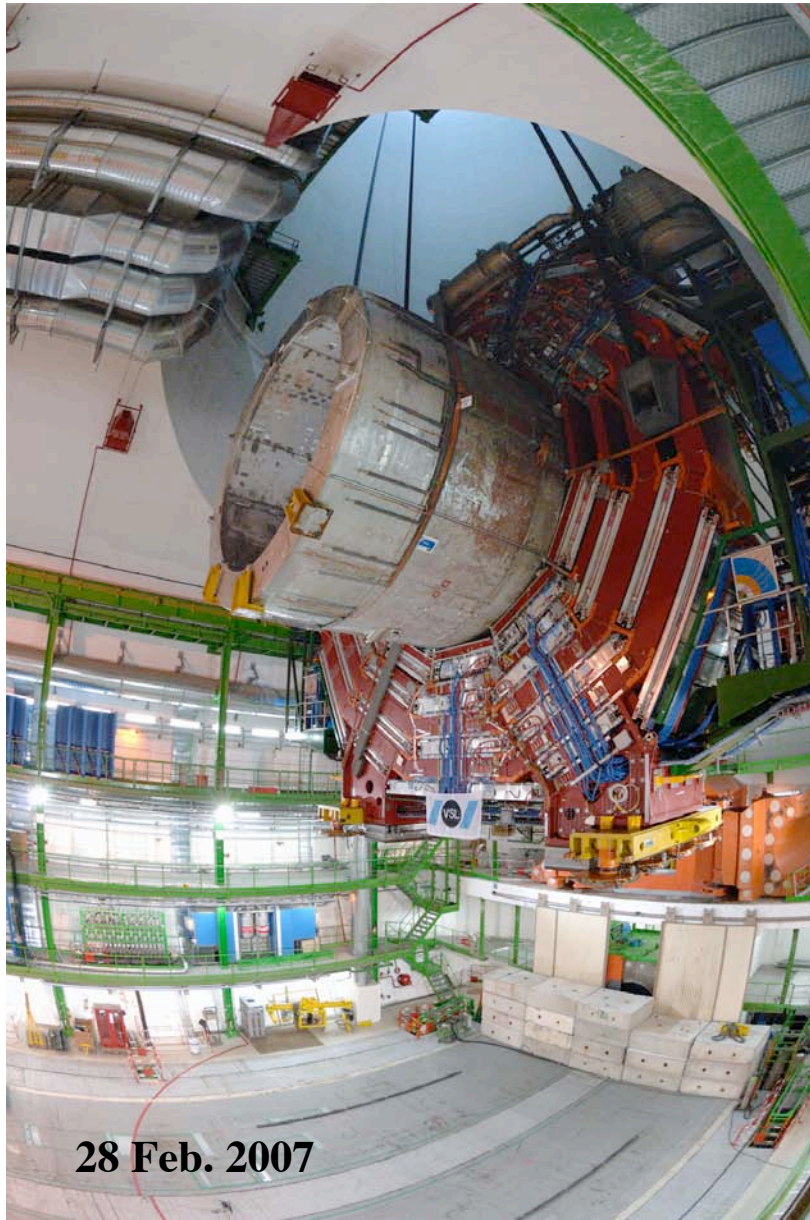
Steel absorber plates sampled by quartz fibres due to their good radiation tolerance, read out by conventional photomultipliers as magnetic flux density is much lower than in the central region.

Slice test on 28 March 2007 -> **first data in CMS underground hall!**

HF+ is now fully commissioned.



Magnet Coil Status and Plans



Coil and all magnet systems (cryogenics, control, vacuum, powering, safety) **transferred** to cavern and reconnected.

Commissioning has started. **Cool-down** will be possible from Sep. 2007. Discharge and powering lines as well as dump resistor will be commissioned in Sep./Oct. 2007.

Nov. 2007:

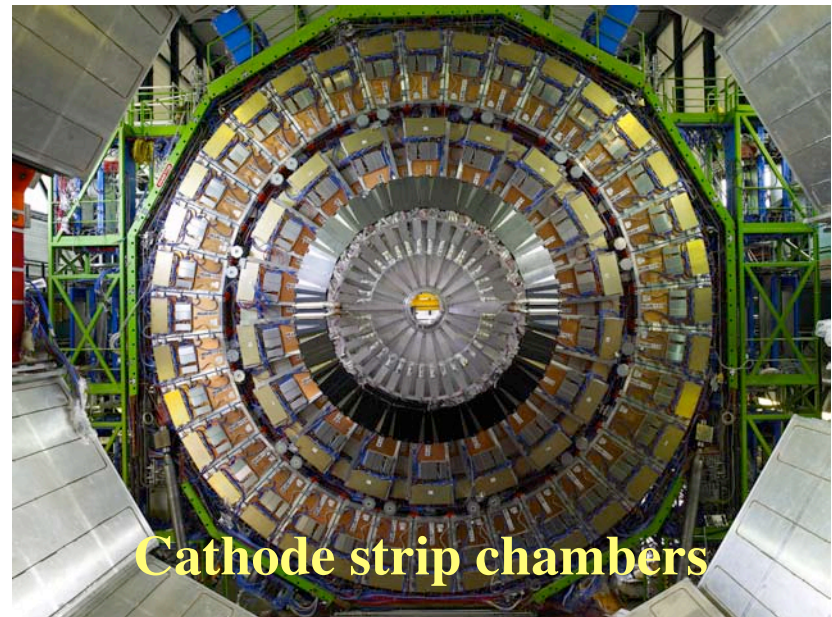
400 A current testing at 4.5K.

March 2008: One week of final commissioning in steps between 3 kA and 19 kA (4 T flux density) plus one slow dump at 14 kA.



Muon System

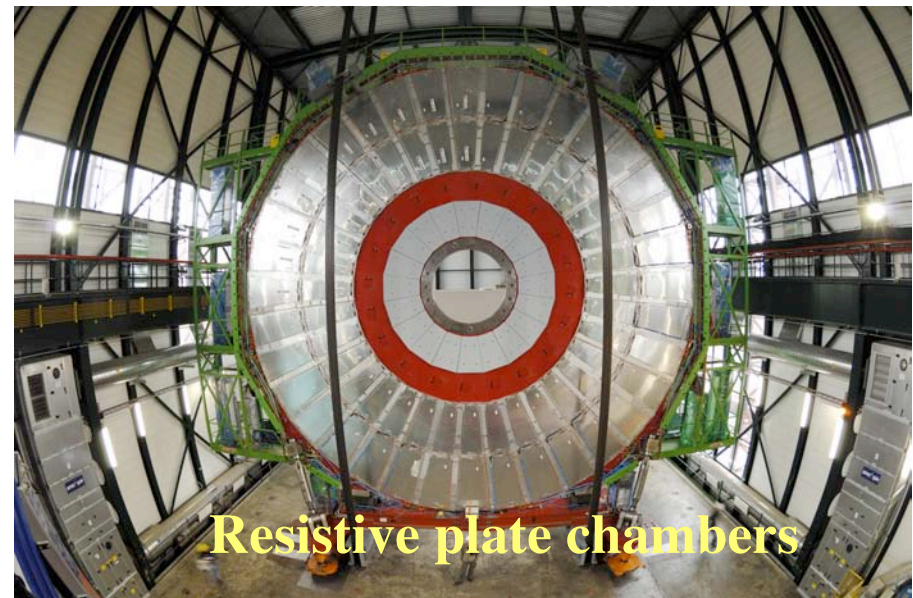
For redundancy and robustness, 3 types of muon detectors, are used both for precision tracking and triggering: drift tubes (barrel), cathode strip chambers (endcaps), resistive plate chambers (barrel, endcaps).



Cathode strip chambers



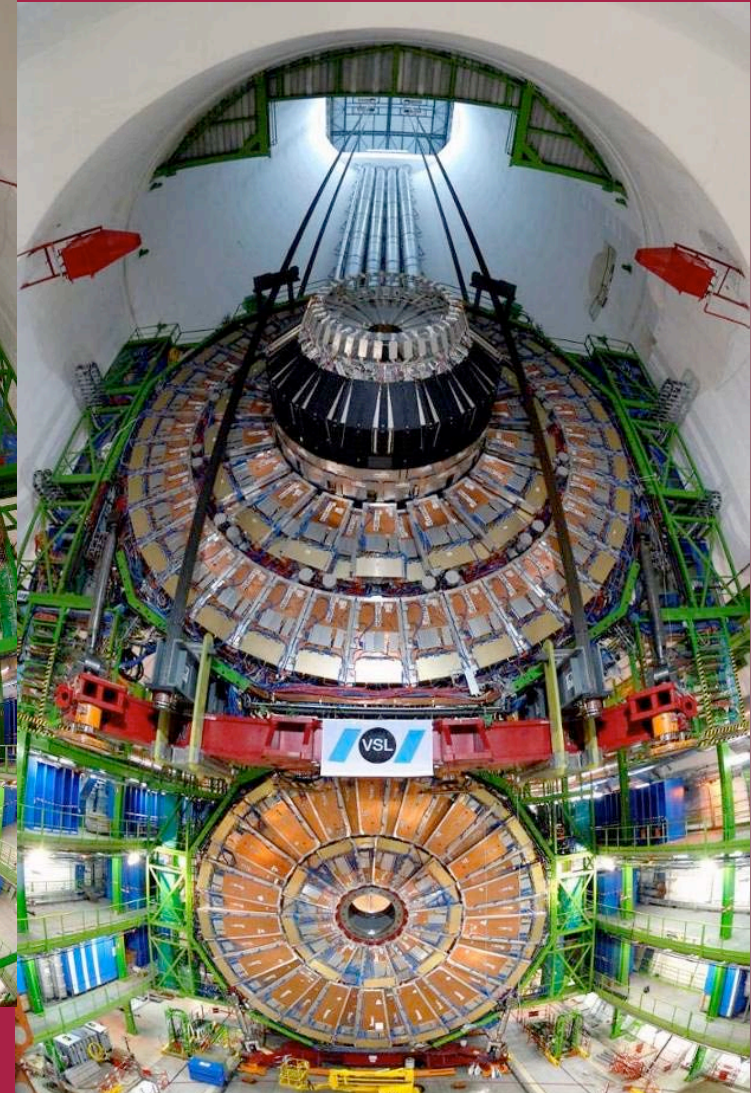
Drift tube chambers



Resistive plate chambers



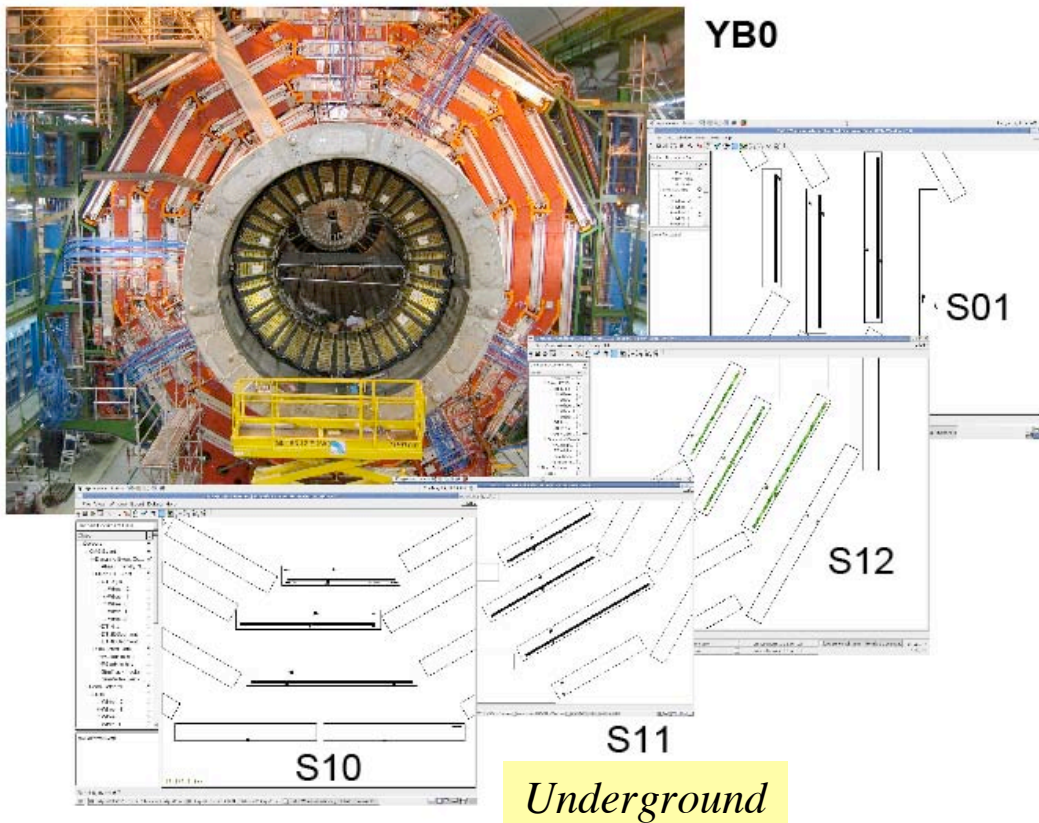
Installation of the CMS Endcaps





Status of Muon System

- All 468 CSC chambers installed since 8 March 2007
- All but a few DT and RPC chambers installed
- Commissioning with cosmics underground for central and negative side wheels, on surface for remaining wheels until lowering Oct.-Dec. 2007

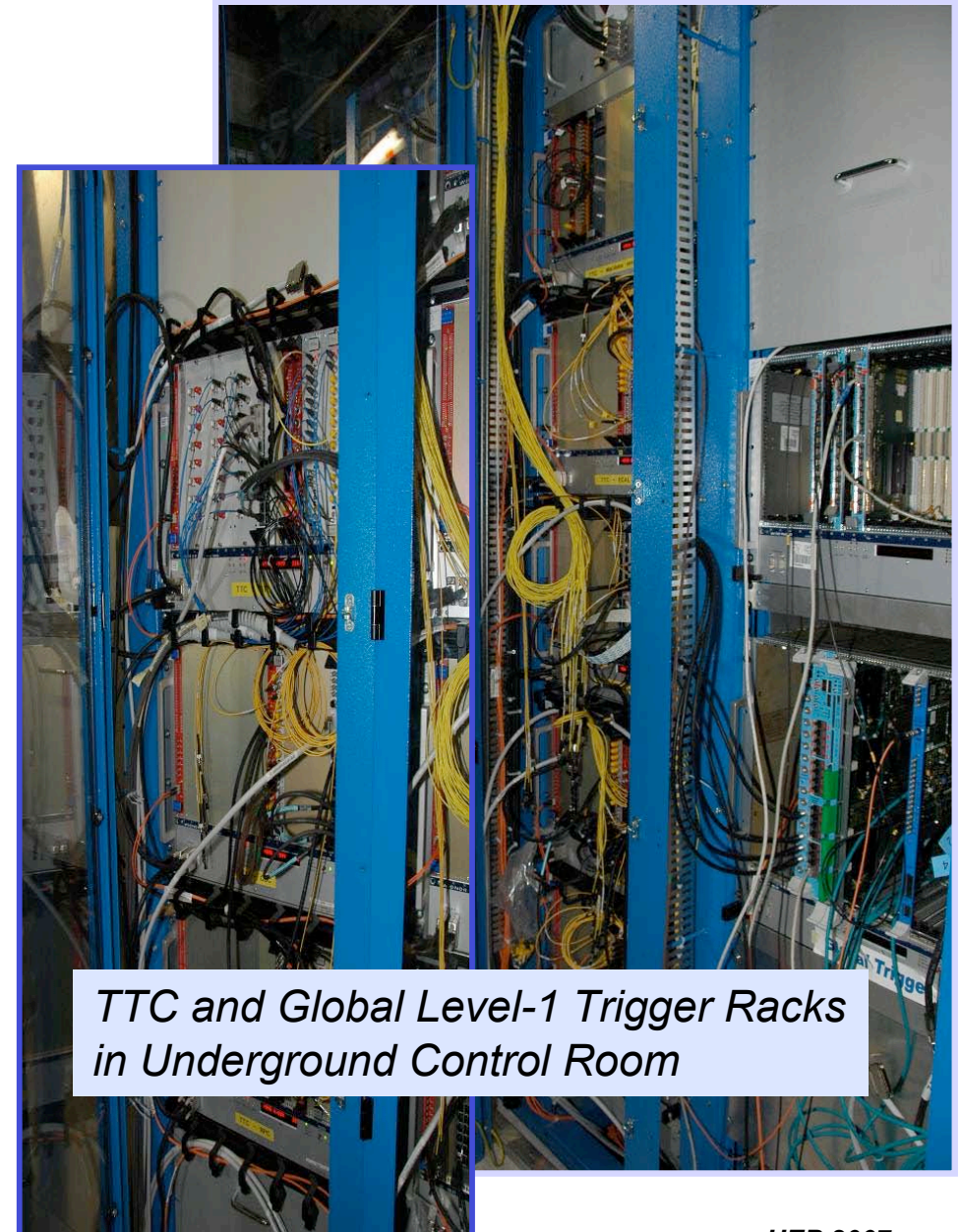


Surface



Trigger

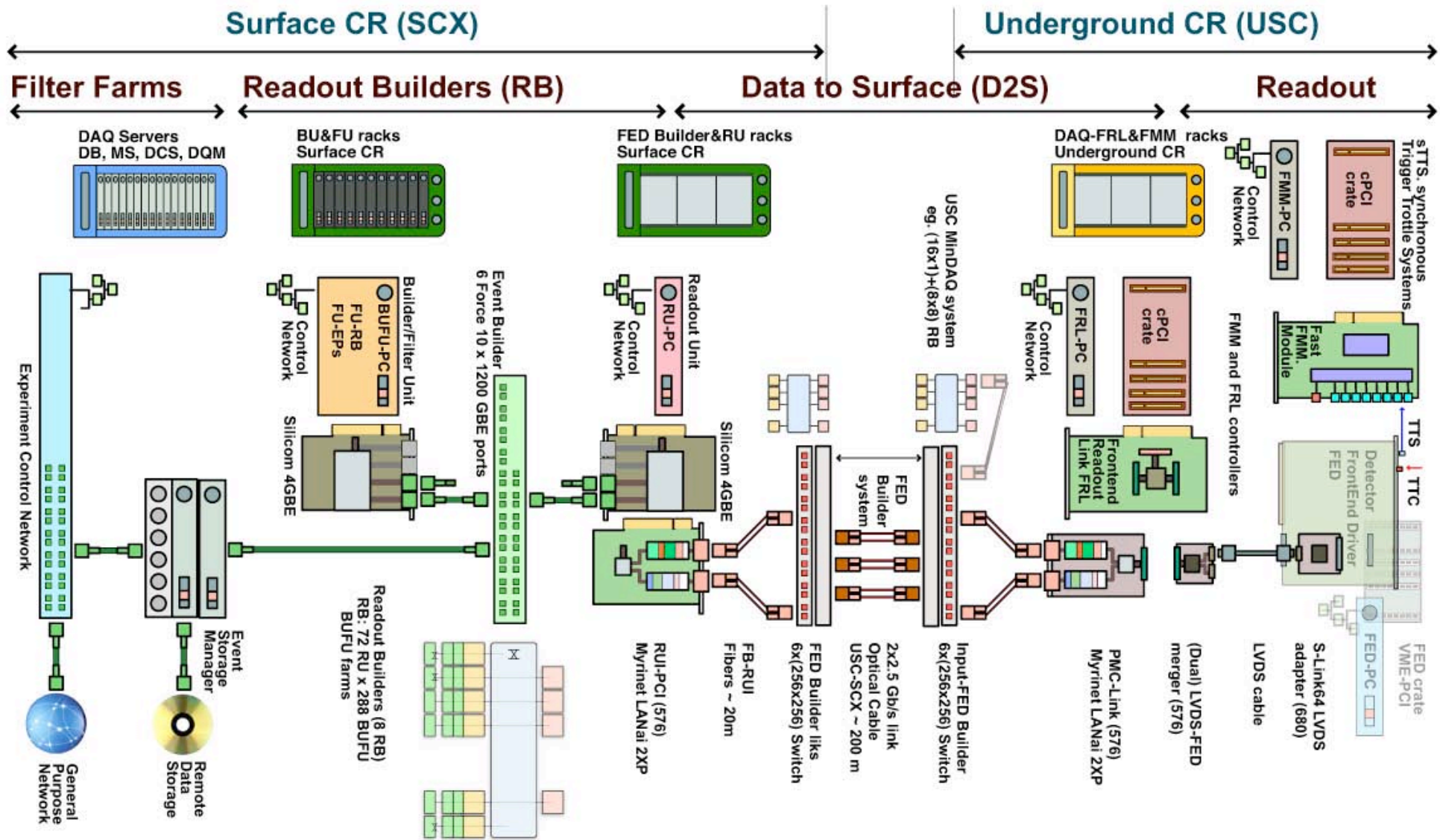
- Installation of Trigger Hardware in USC55 is mostly done.
- **Trigger and timing control distribution** are mostly done.
- **Trigger System Commissioning** with test patterns ongoing (Mar. - Sep. 2007).
- Integration with detectors connected to Underground Control Room ongoing.
Trigger Slice Tests with cosmics using DT, CSC, RPC, ECAL&HCAL mip triggers (Jun. - Nov. 2007).



TTC and Global Level-1 Trigger Racks in Underground Control Room



Data Acquisition





Data Acquisition

D2S (USC)

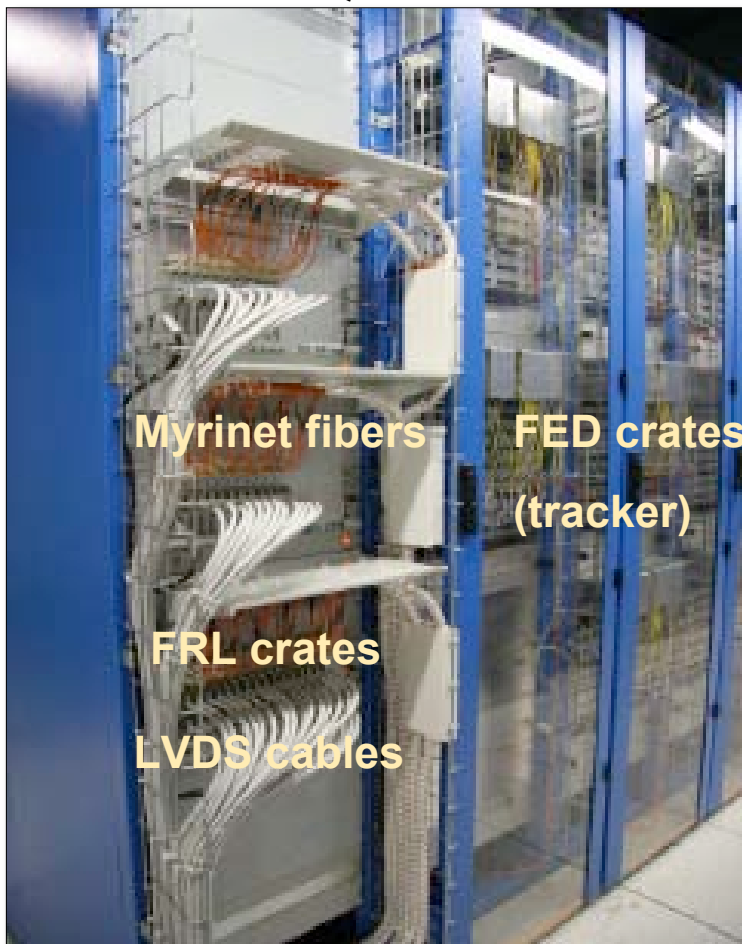
- Installed & tested
- 650 Slink/FMM cables
- 650 FRL/FMM modules
- 60 FRL/FMM crates
- 200 DAQ/DCS PCs

D2S (USC-SCX)

- Installed & Tested
- Myrinet switches
- Myrinet Fibers (1024)
- D2S optical cables (2 TB/s)
- MiniDAQ

SCX (DAQ Farms)

- 800 PC 2x2 2GHz Xeon, 4 GB **delivered**
- 650 RU/BU PCs (650) **under installation**
- Event Builder GBE switches (Force10) **installed**
- Mass storage (22 TB, 1GB/s) **ordered**





Startup Plan for CMS / LHC

Global runs (cosmics, test data) with selected detectors:

A few days at end of each month, first in May 2007

Computing, Software and Analysis Challenge:

September 2007

Cosmic runs with all detectors except ECAL endcaps and pixels:

October - December 2007

Beam pipe closed and baked out, followed by installation of final pixel system and one ECAL endcap:

February 2008

Cosmic run with one ECAL endcap and pixels included:

March 2008

Close of experiment for 14 TeV collisions:

April 2008

Start of 14 TeV physics run:

June 2008



Conclusions

CMS construction is coming to an end.

Extensive tests of complete detector system will be performed throughout 2007.

We look forward to the exciting physics to come!

Thanks to my CMS colleagues and to you for your attention!