TWEPP 2007
Prague, Czech Republic

Infrastructures and Installation of the Compact Muon Solenoid Data AcQuisition at CERN

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on behalf of the CMS DAQ group

Outline

- Introduction
- Underground area
- Surface area
- What next ?

DAQ locations

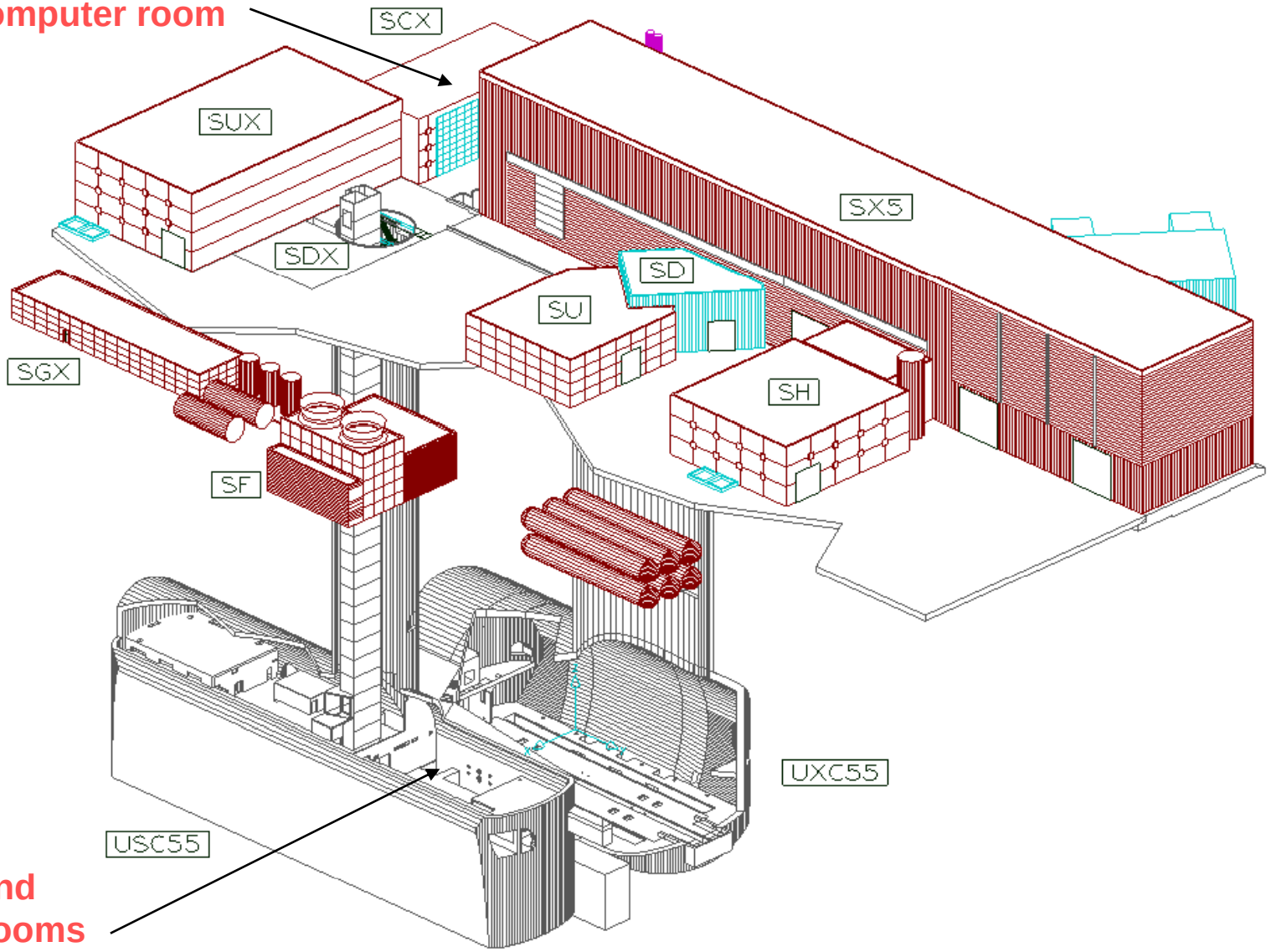
- DAQ elements are installed at the experimental site both in the underground counting rooms (USC55) and surface buildings (SCX5).

- Elements installed in underground areas are in charge of collecting pieces of events from about 650 detector data sources and transmitting these event fragments to the surface elements.
  They also elaborate a smart back pressure signal that prevents the first level trigger logic of overflowing the front-end electronic (Trigger Throttling System).

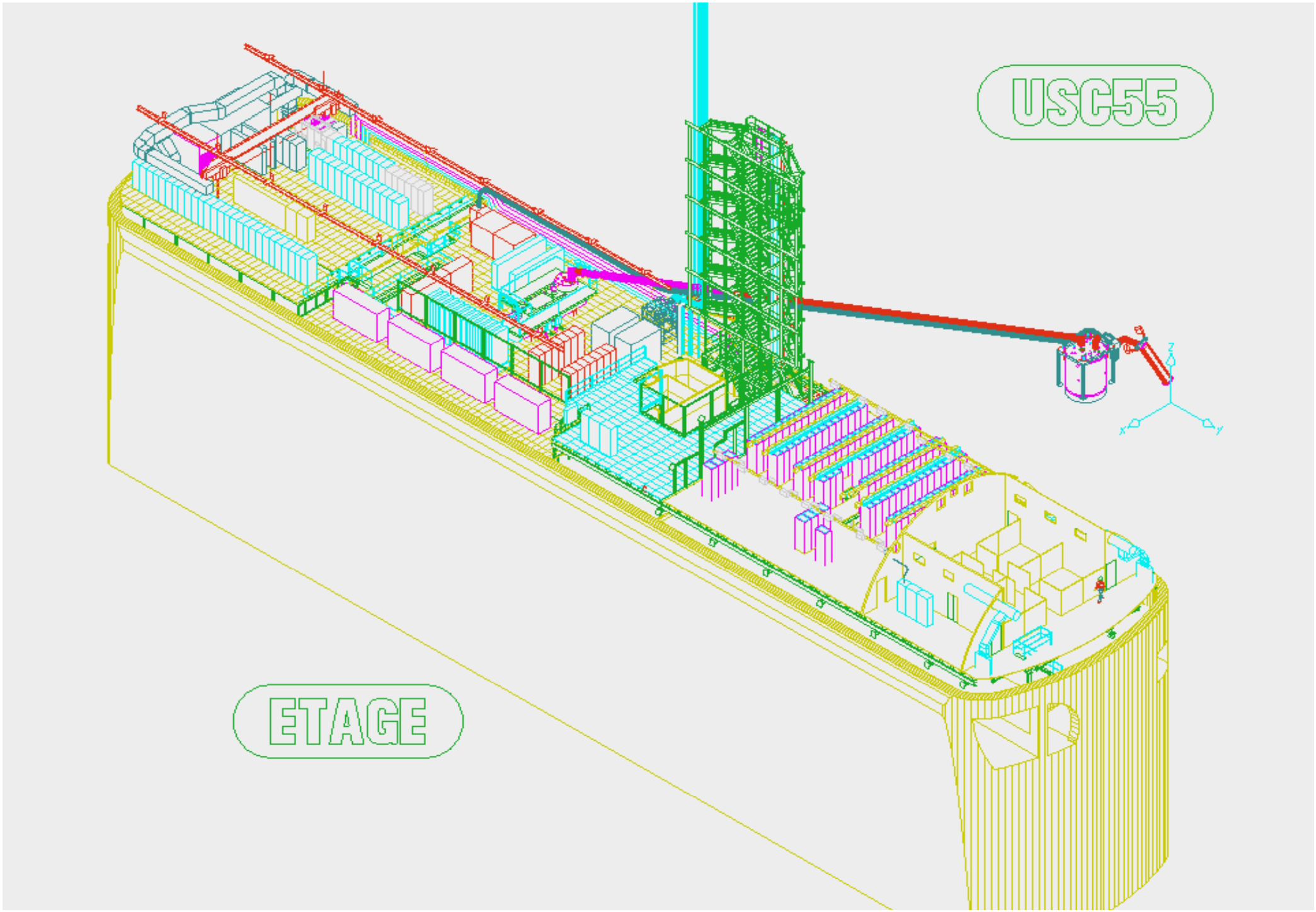
- Elements installed in surface areas are in charge of full event building (a partial event building already takes place underground) and running the High Level Trigger algorithms. Events that pass these filters are stored locally and transmitted later to main CERN computing center.

CMS experimental site

Surface computer room



Underground Counting rooms

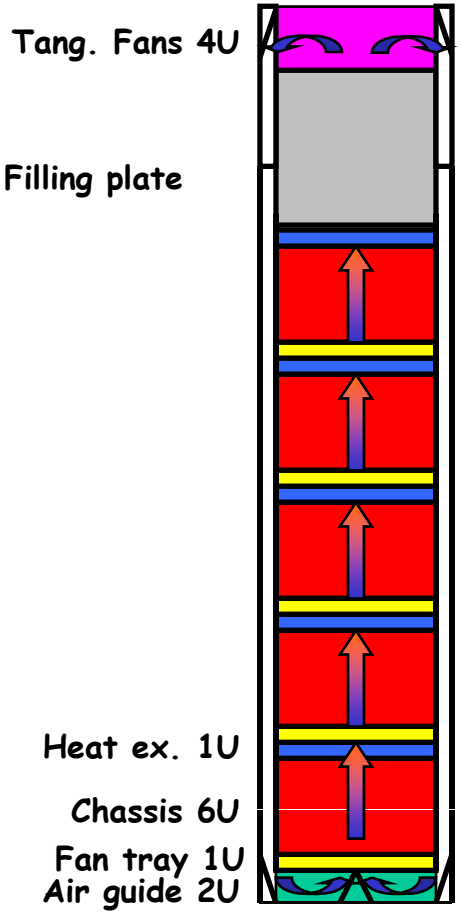

USC55
ETAGE

Underground DAQ elements

- 500 FRL cards receiving the data from one or two detector data sources
- 650 sender cards plugged on the detector readout card
- 650 S-link cables (total length 6 km) linking the senders with the FRLs
- 56 FMM cards, collects the status of every data sources and produce a back pressure
- 750 RJ-45 cables for TTS signals (total length 11 km)
- 500 Myrinet Network Interface Cards (NICs) plugged on the FRLs
- 6 Myrinet switches of 256 ports each
- 1000 optical patch cords connecting the FRL NICs with the switches (total length 38 km)
- 50 Compact PCI crates sub-divided into 60 logical crates to house the FRLs (some crates contain dual-backplanes)
- 60 crate controller PCs with their control cables (1.6 km)
- 30 opticables running between USC and SCX (216 fibers each, 200 m long)

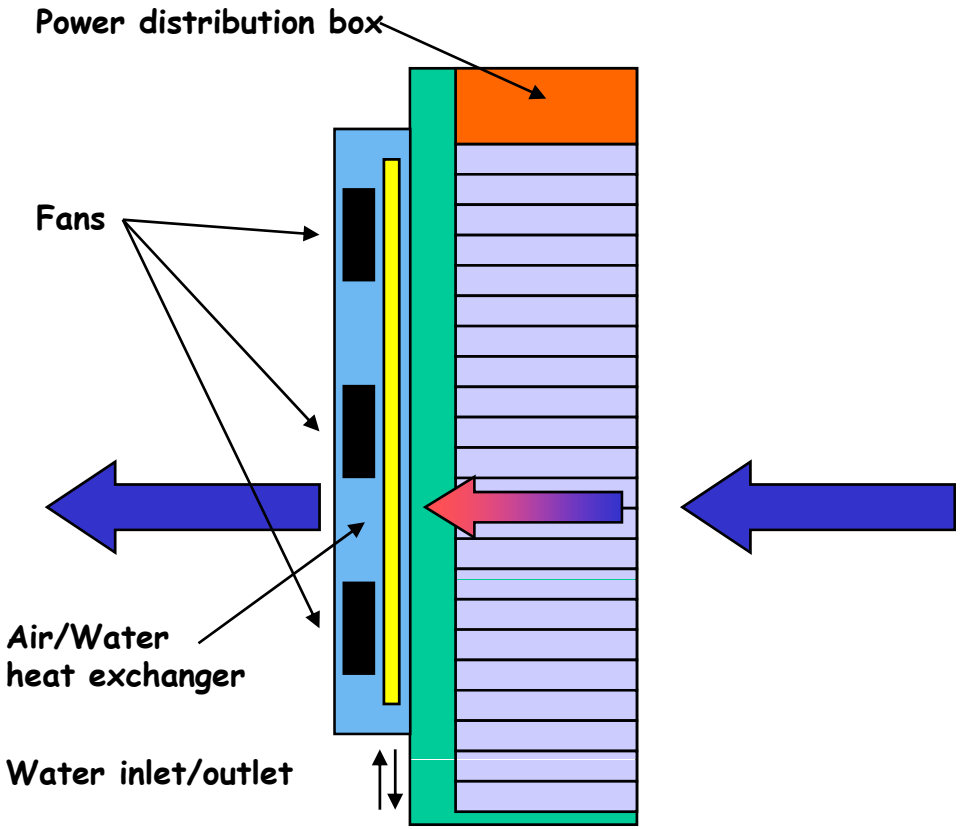
DAQ racks types

Racks for electronic crates (Front view)



Racks for computers (Side view)

Up to 44U usable space, 10 kW heat dissipation



Underground counting rooms

- The DAQ elements, the detector readout electronic and other services (i.e. High Voltage systems, Detector Safety systems) are located in a dual floor room, S1 and S2, having respectively the capacity of ~100 and ~160 racks of 60x90 cm2.

- The rack assignment between sub-systems has been done in order to satisfy numerous constraints. Some of them are :
  - Number of racks for each function
  - Keep minimal the latency for trigger detectors and trigger logic
  - maximum cable length for inter-rack cabling

- The final rack assignment was a very long iterative process (several years) and still some small changes/additions are requested !

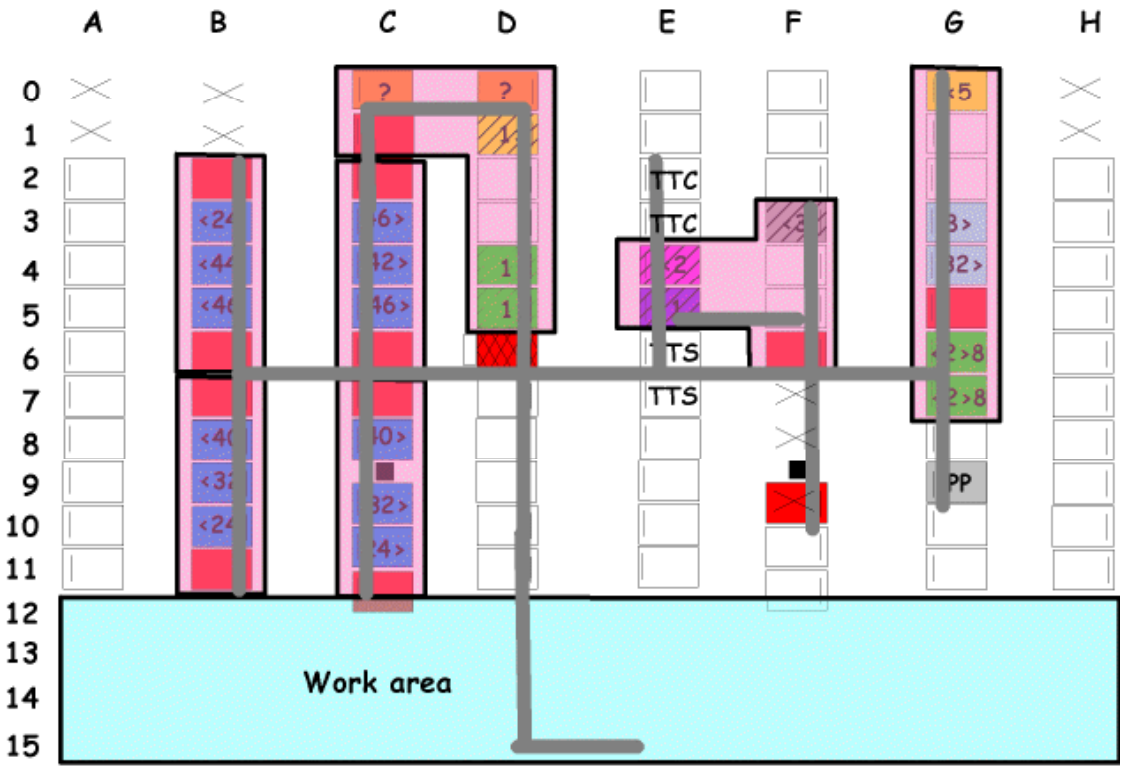
- Once rack assignment “stable”, design and installation of the DAQ cable trays for inter rack communication
  - Trays located very close to false floor tiles to keep the cable length minimal
  - List of every single cable/fibers, labeling…
  - Keep track of the tray occupancy and add always a huge contingency…

DAQ racks in USC55 Lower floor

Data sources

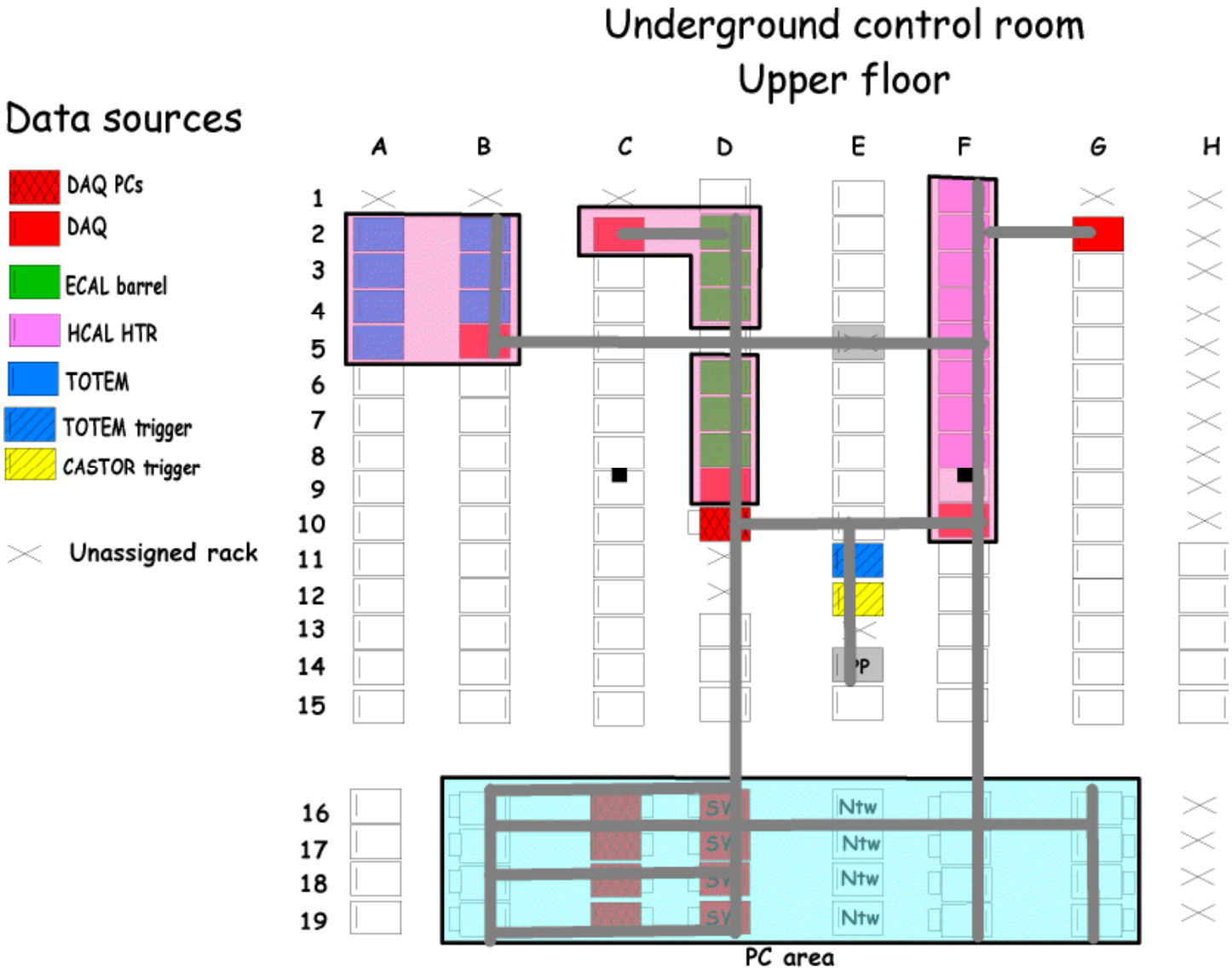
- DAQ PCs
- DAQ
- Tracker
- CSC muons
- CSC track finder
- Global trigger
- Cal. global trigger
- RPC trigger
- DT track finder
- DT
- Pixels
- Preshower
- Unassigned rack

Underground control room
Lower floor



Last update: June 6, 2006
according to version 67 of official layout file

DAQ racks in USC55 Upper floor



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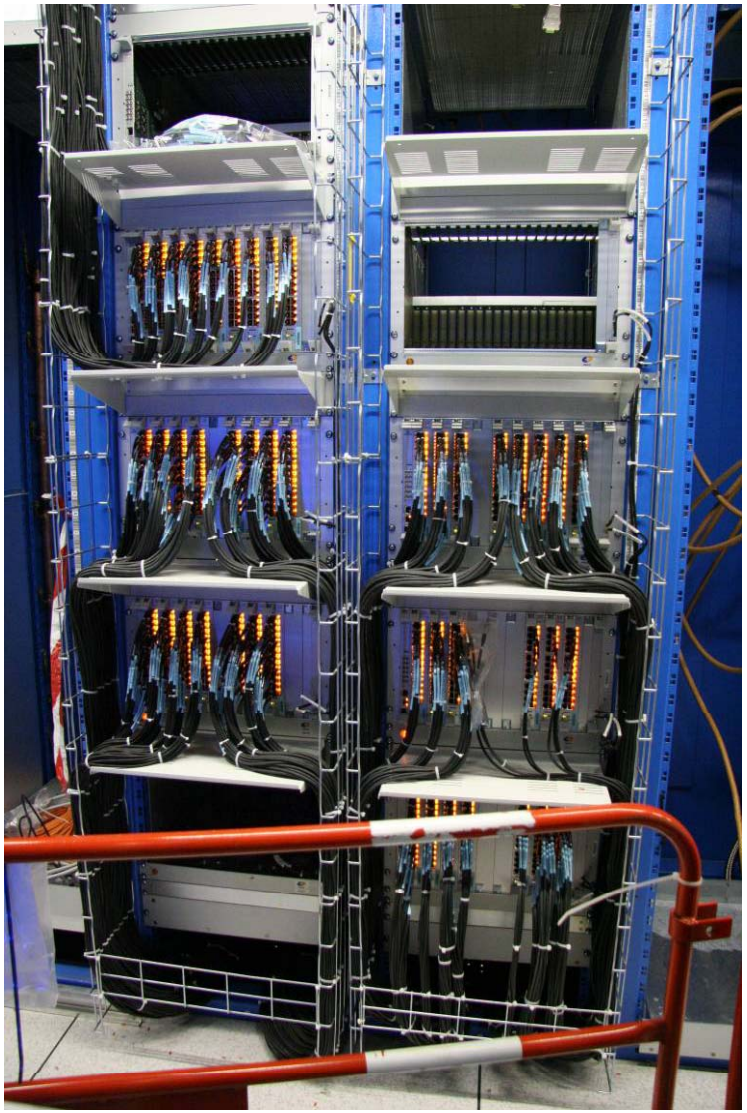
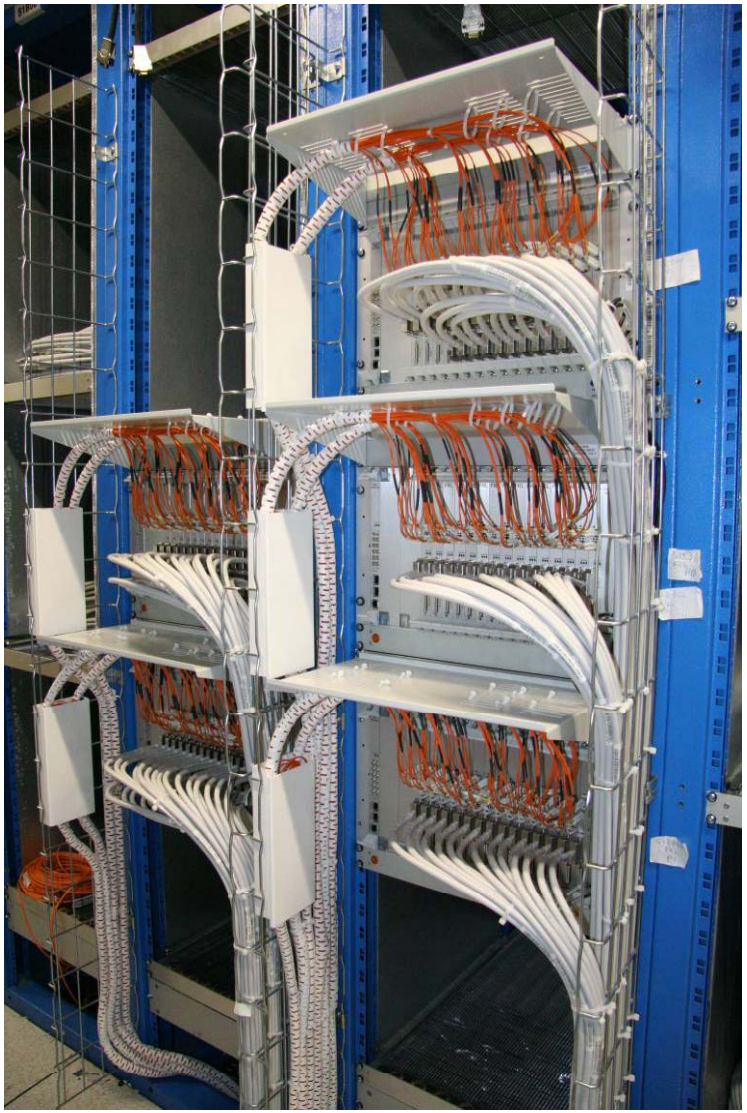
USC DAQ installation schedule/status

- Rack welding in the counting rooms : Q3-Q4 2005
- CPCI crate controller PC install : December'05
- Cable tray installation and rack equipment : January'06
- Rack manifolds repair : up to July'06
- Copper cabling and electronic installation : Q3-Q4 2006
- Optical patch cords : 7 "big" days between November'06 and January'07
  - With the help of many DAQ group member from the software side !
- Optical cables installation : March-April'07 (External company)
- Test of every single elements/cables/fibers : Q1 2007
  - Broken: 2 FMM cables, one optical patch cord, 3 FRLs and 2 CPCI backplanes
  - All these items have been changed or fixed.

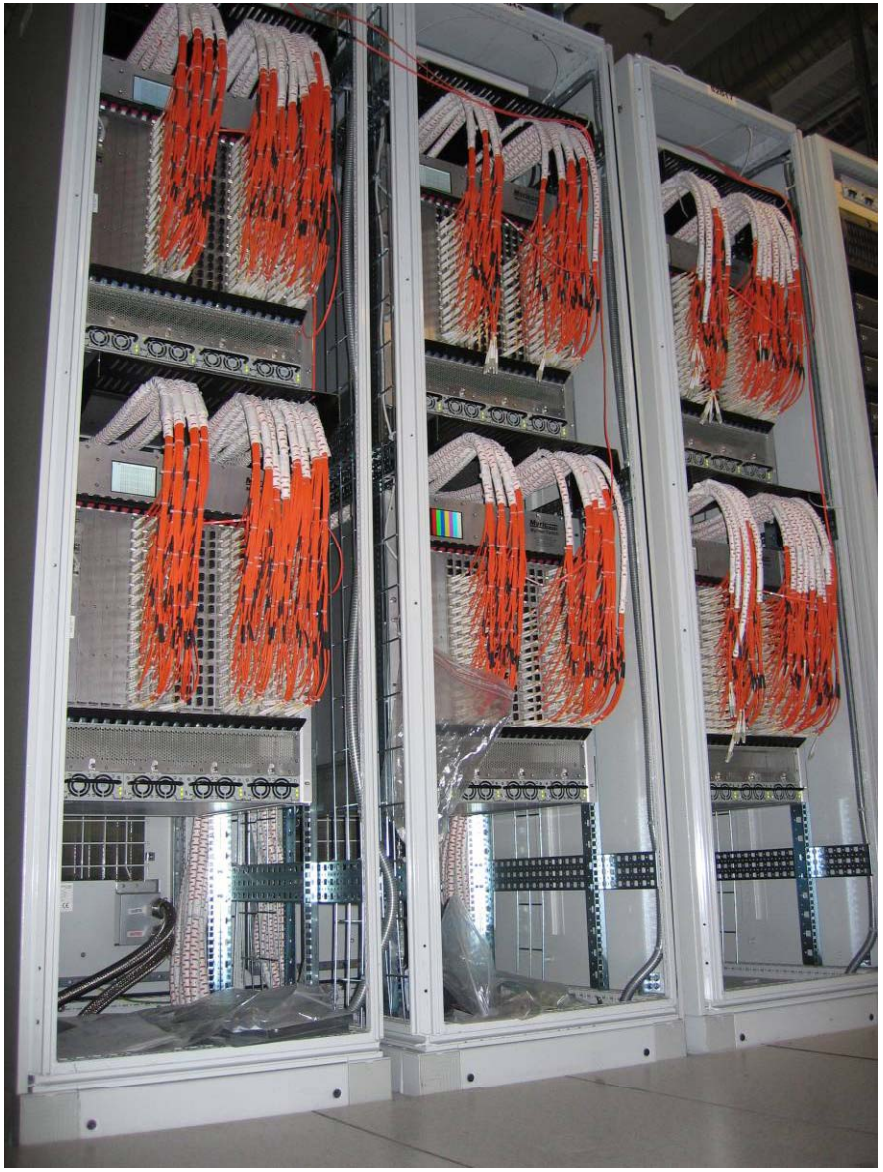
- Since April'07, all underground DAQ hardware is used for sub-detector commissioning

USC area S1





USC PC S2 area



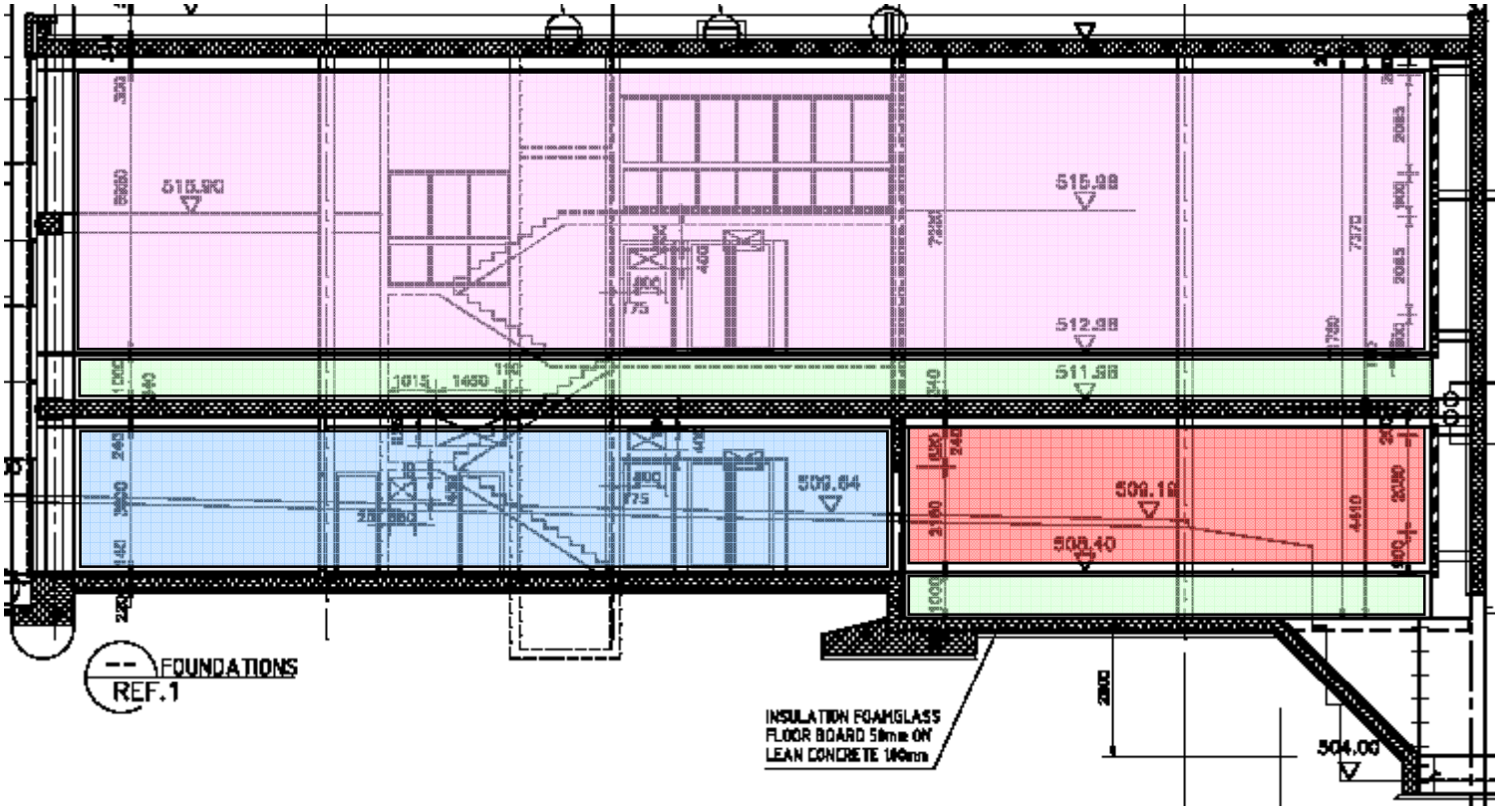
CMS DAQ installation crew

Surface DAQ elements

- All DAQ surface elements are installed in SCX5 DAQ building
  - 640 Readout Unit/Builder Unit PCs , 2U server
  - 160 2U servers for services :data storage, DQM, databases, Run control…
  - 6 Myrinet switches of 256 ports each (the same than underground)
  - Storage systems
  - 6 Gigabit ethernet switches (256 ports each)
  - ~1200 Filter Unit PCs for 50 kHz trigger rate (June 2008)
  - Again ~1200 PCs for 100 kHz trigger rate (Sometime in 2009)

- The room has a total capacity of 170 racks (see layout) and 800 kW of cooling
  - The remaining racks will be used for the filter units when the LHC will ramp up in luminosity hence creating more data to analyse

DAQ building (SCX)



352 m2,
~6m height

165 m2,
~3m height

Data fibers and commodity networks from the pit

Computer rooms
Conference rooms / labs
False floor
Main Control room

Overall dimension:
~ 14 x 30 m2

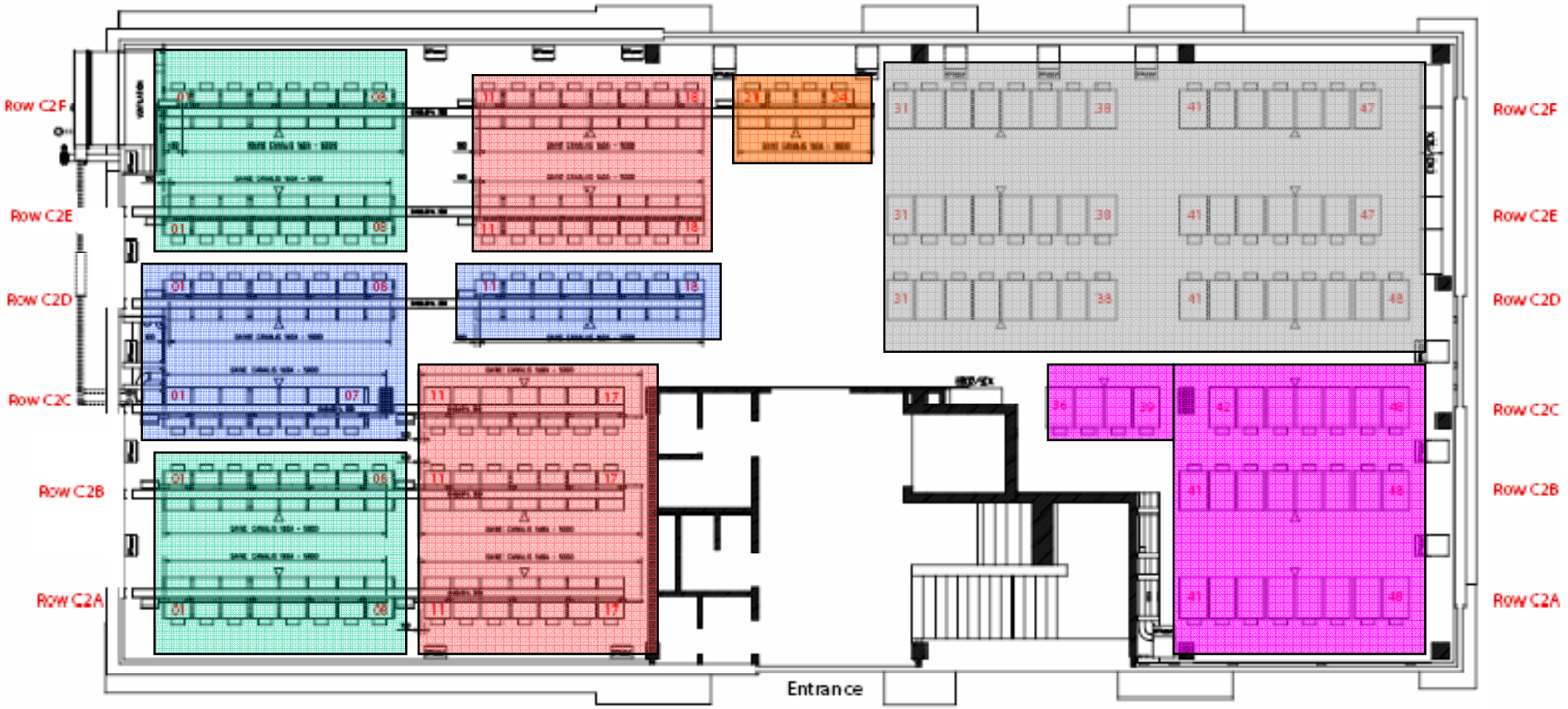
Rack layout in SCX5

RUBU racks

Servers/Storage/Switches

IT racks

Filter Units 100 kHz
2009…

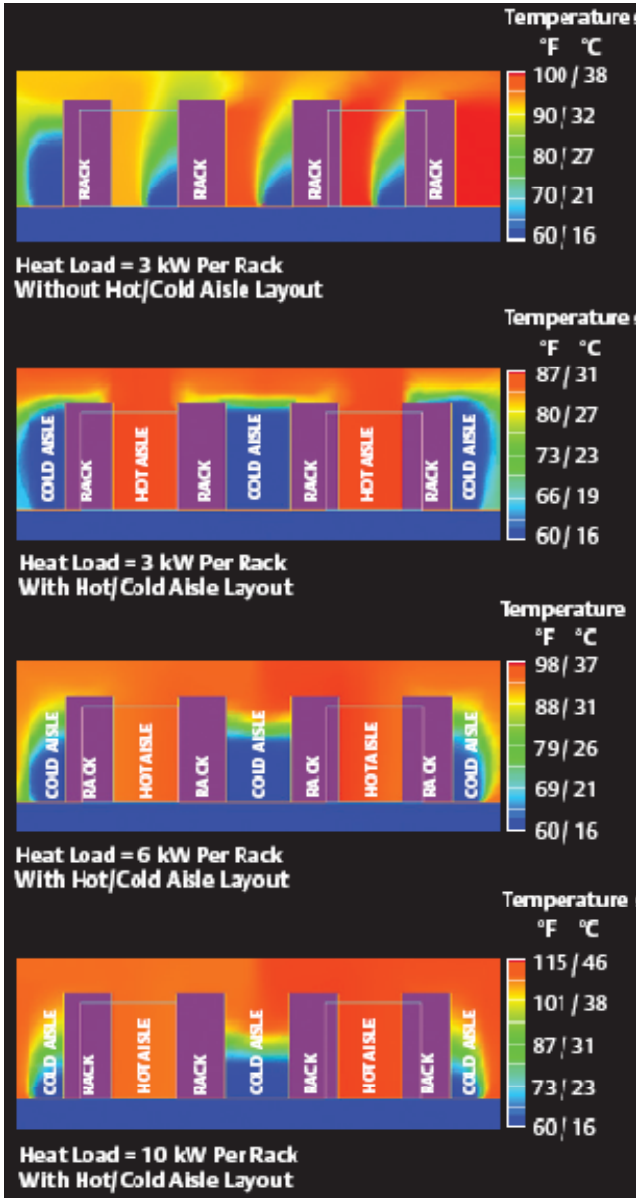


Filter Units 50 kHz
June 2008

Contingency…

Why water cooled racks ?

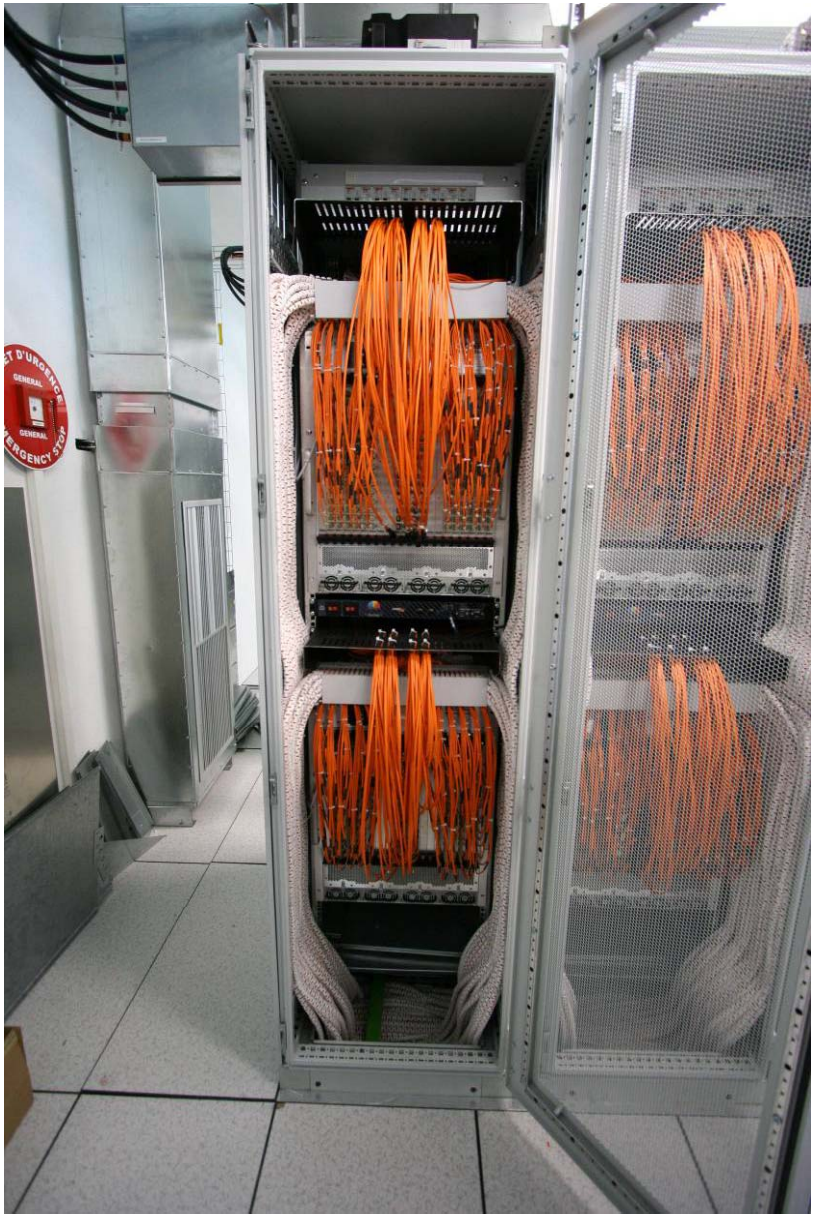
- Usually, plenum floors with forced cold air is used to cool down data centers
  - People do not like water close to PCs…
- With 10 kW/rack and 2kW/m2, air is no more efficient and requires a real storm
  - Hot spots are created what ever you do !
- Water cooled racks catch the heat at the very source, hence avoiding hot spots and giving a better usage of the floor space



Heavy computer science…

Force10 switches and RUBU rack

Myrinet switch and storage



What next ?

- Commissioning in USC will continue with real detectors (November 2007)
  - Readout done from surface building very soon
- Central Control room installation (December 2007)
- 1200 Filter Unit PCs to purchase and install for June 2008
  - 50 kHz trigger rate capacity
  - Ready for first LHC collisions
- ~1200 Filter Unit PCs to purchase and install for 2009…
  - Depends on LHC program