CMS at LHC

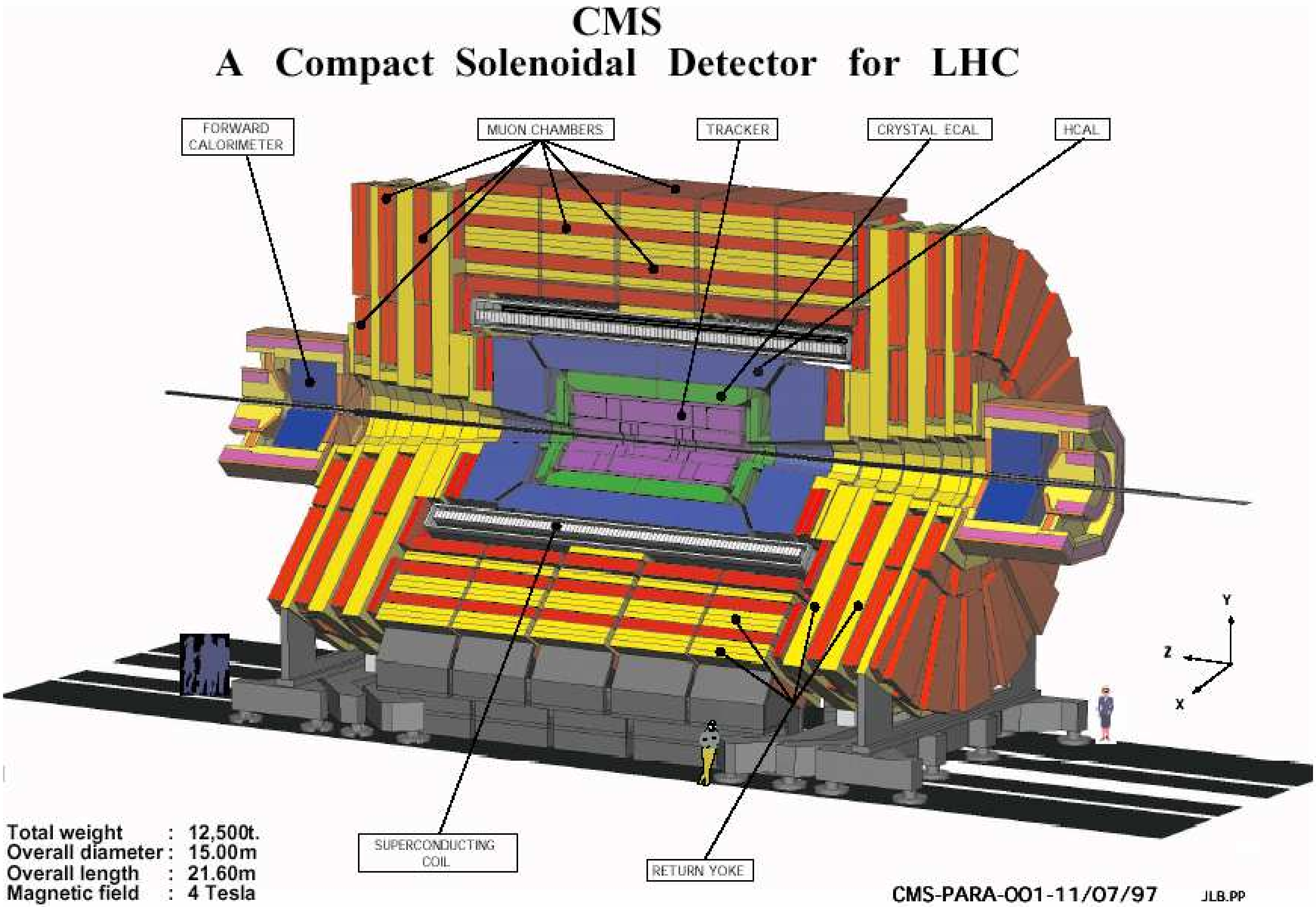
LHC

LHC

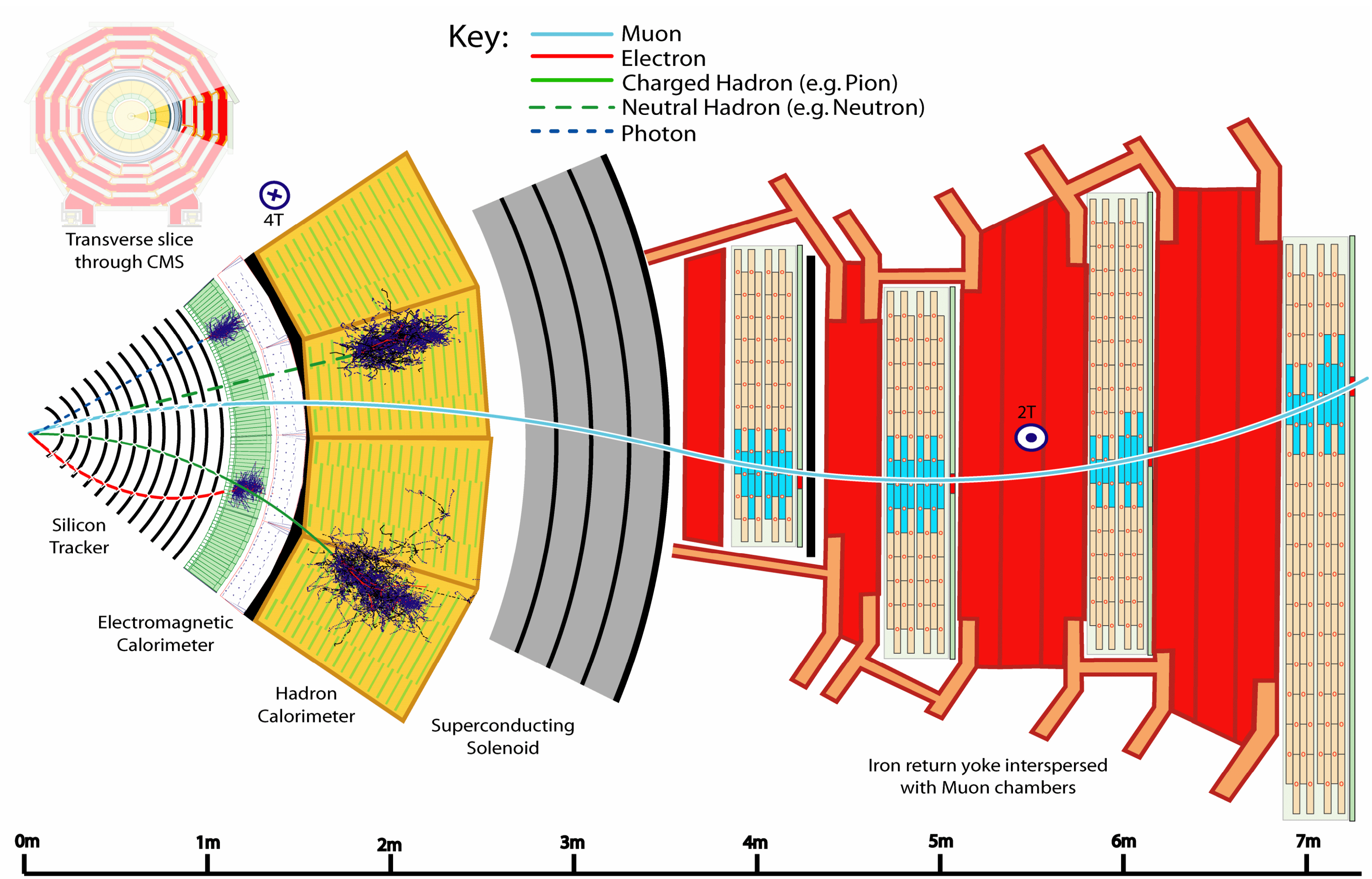
- 27 km in circumference, 100 m underground
- pp collisions
- 14 TeV center of mass energy
- 10^{34} $cm^{-2}s^{-1}$ luminosity
  - proton bunches collide every 25 ns
  - 20 pp collisions per bunch crossing
- beam energy 0.4 GJ
- energy stored in dipole magnets 10 GJ

Underground hall for CMS

CMS Overview



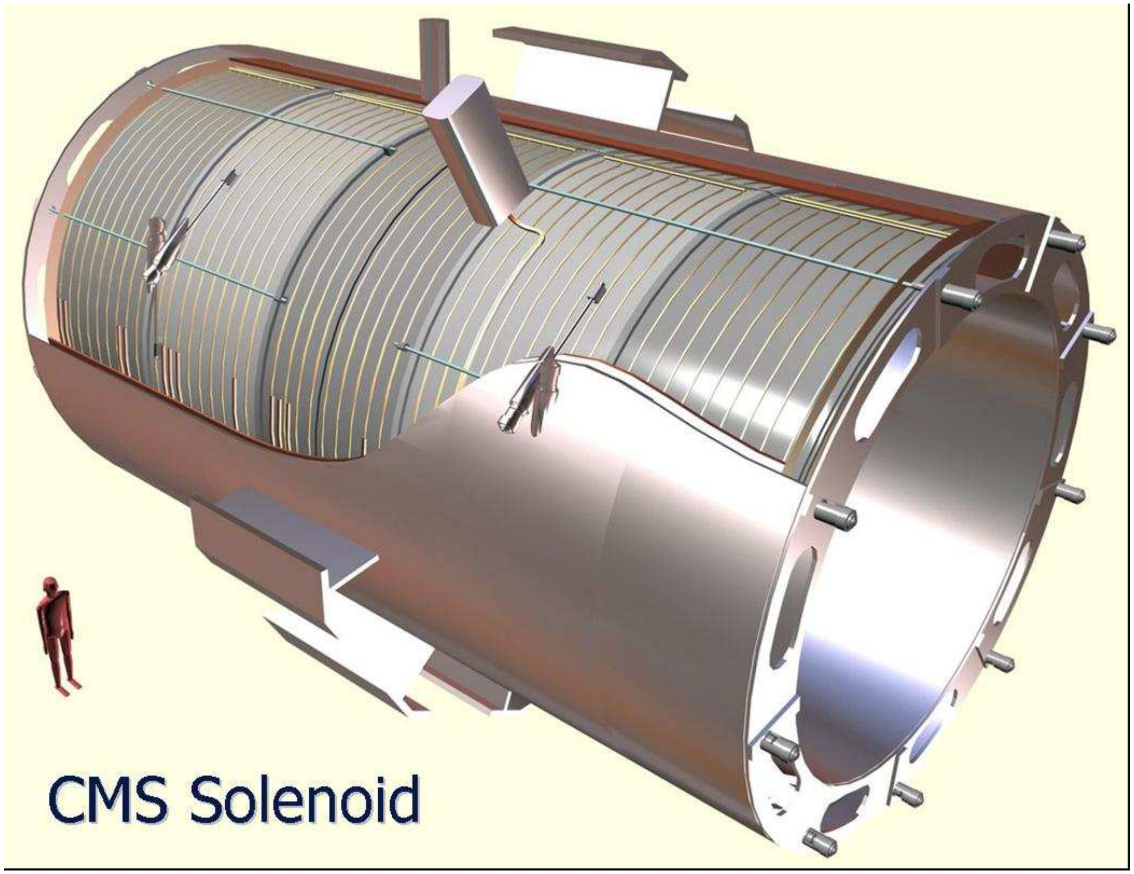
Conceptual Design



Solenoid

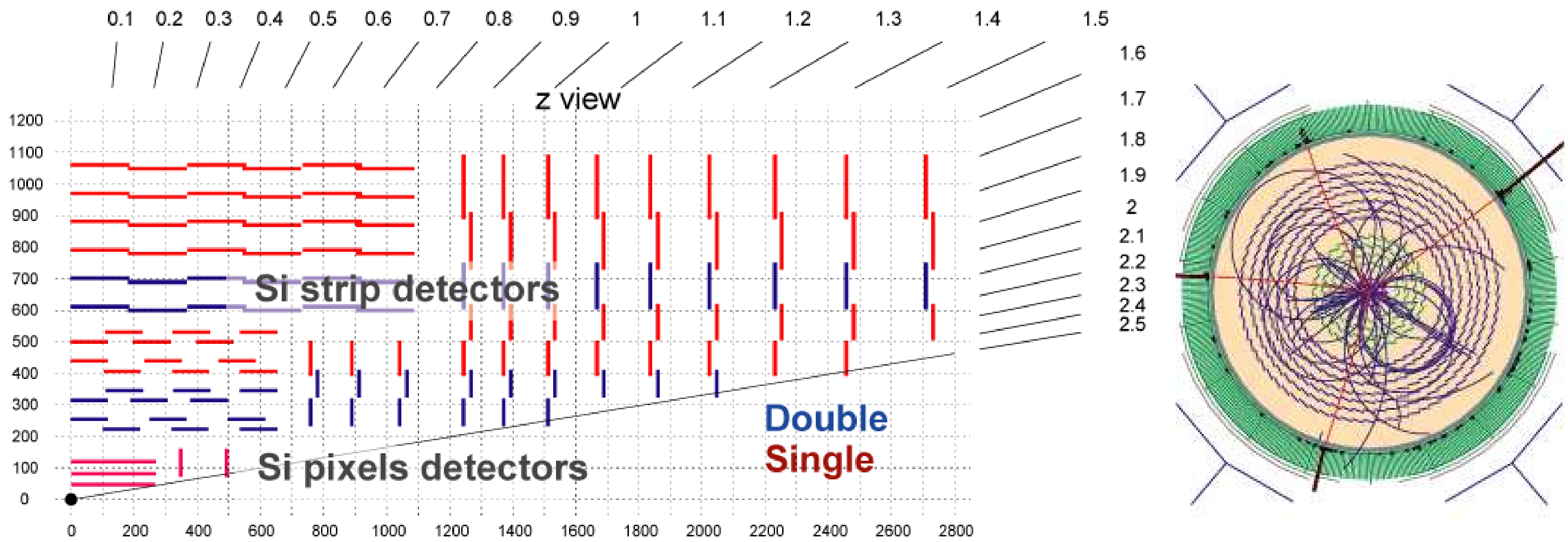
- 4 T field
- 8 m in diameter
- 12 m long
- 3 GJ stored energy

  (1500 cars on a highway)



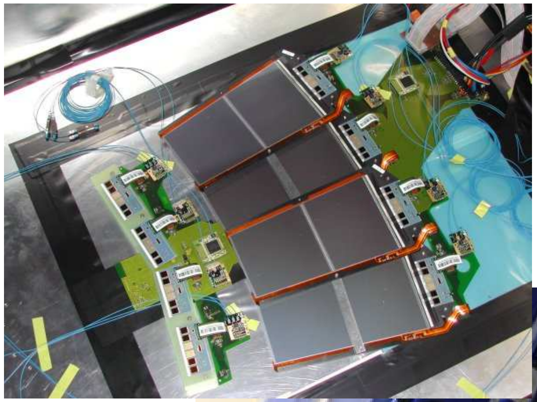
Solenoid

Si Tracker

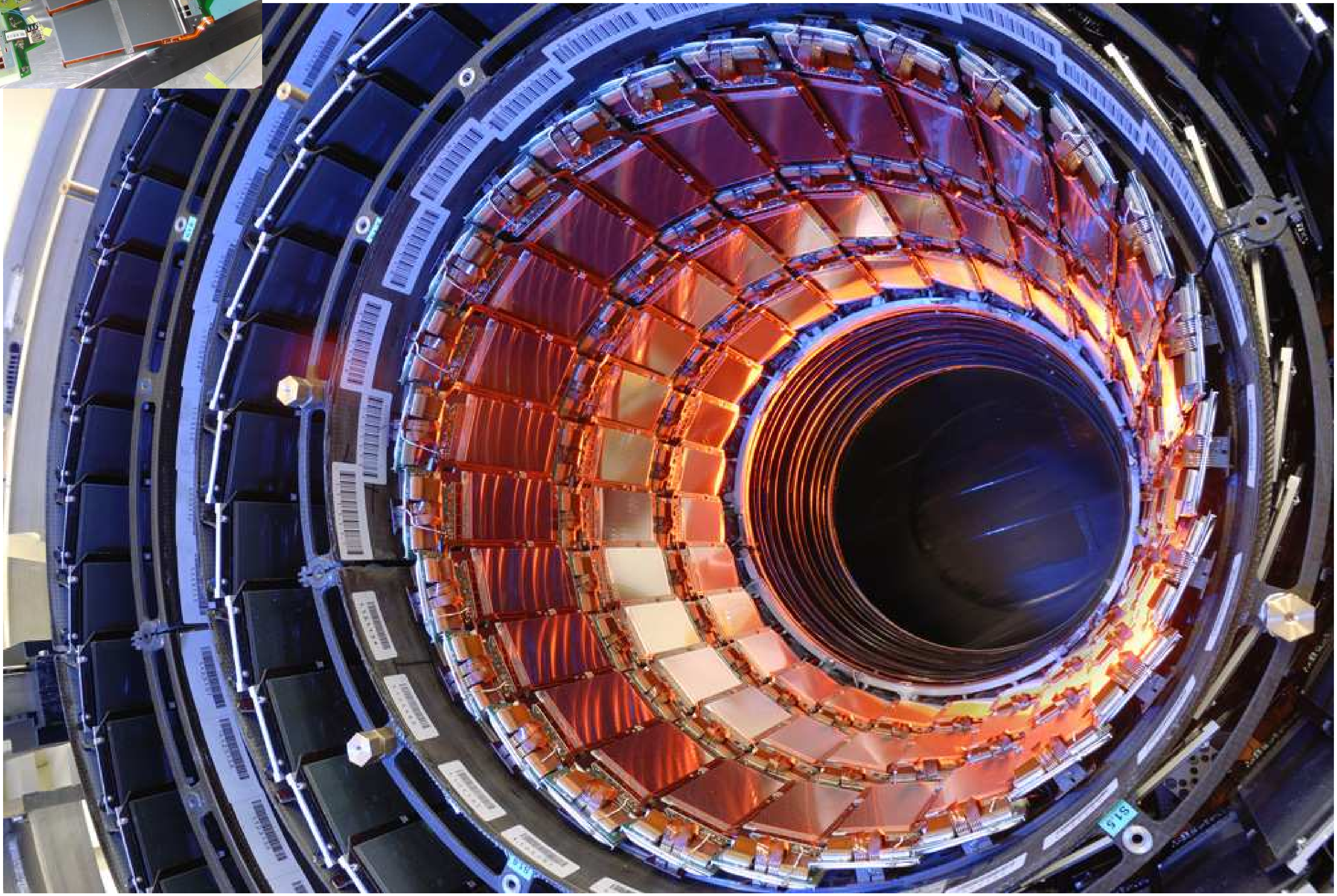


The layout of the CMS inner tracker

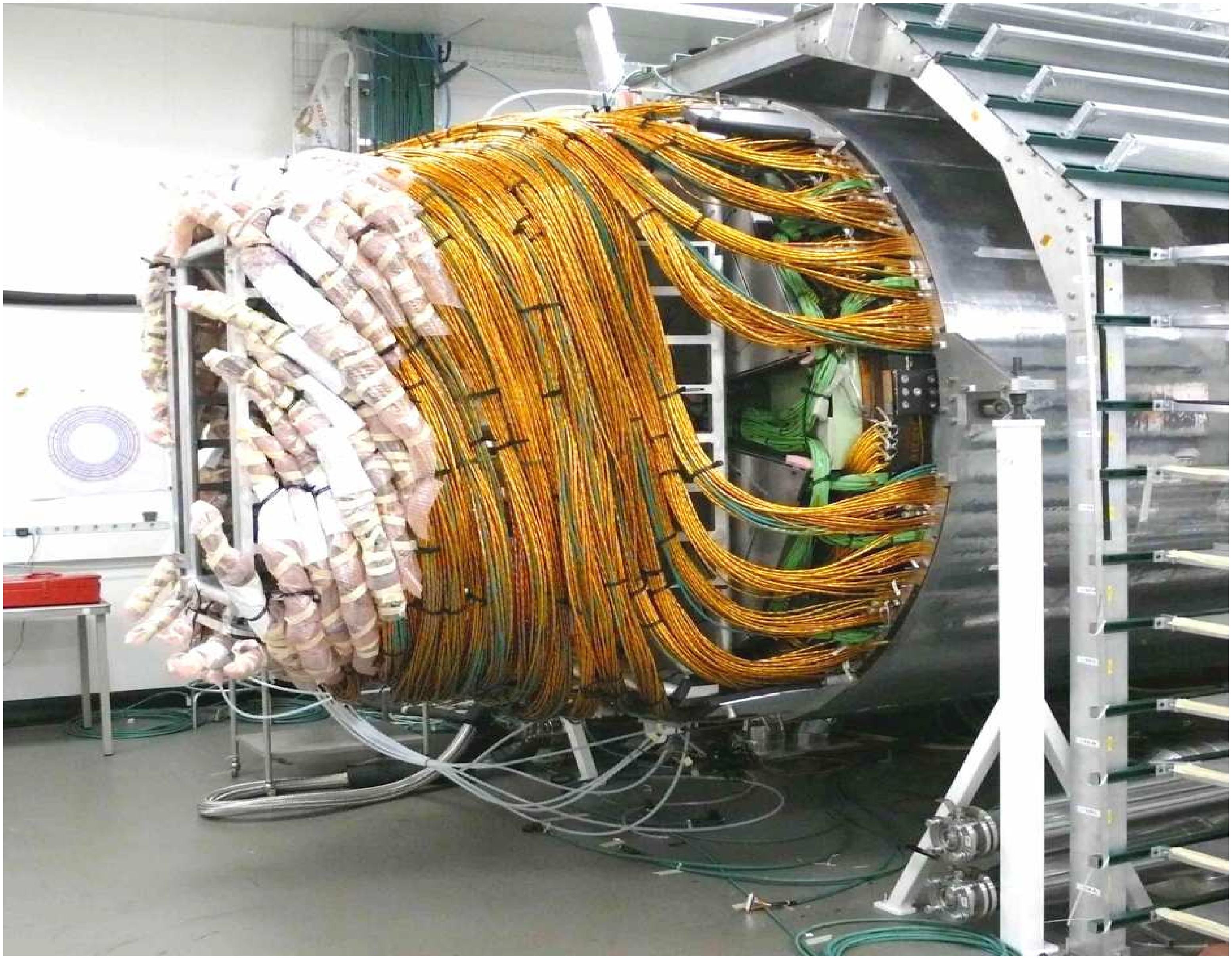
- Largest silicon-sensor system ever made
- 2.2 m diameter, 6 m long, operates at -15^{o} C
- more than 220 m^2 of sensors
- more than 60 million electronics channels (pixels and microstrips)



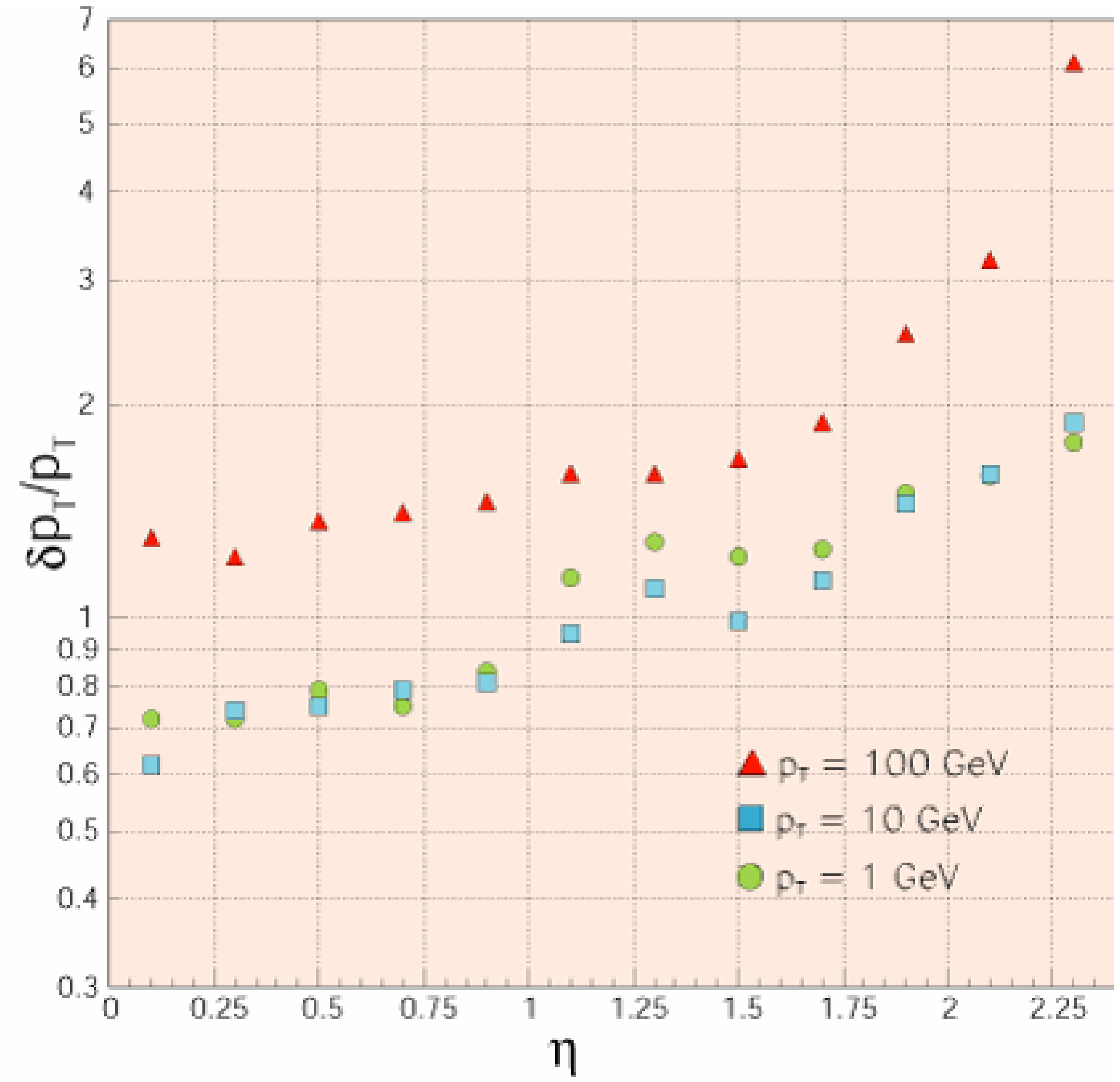
Si Tracker



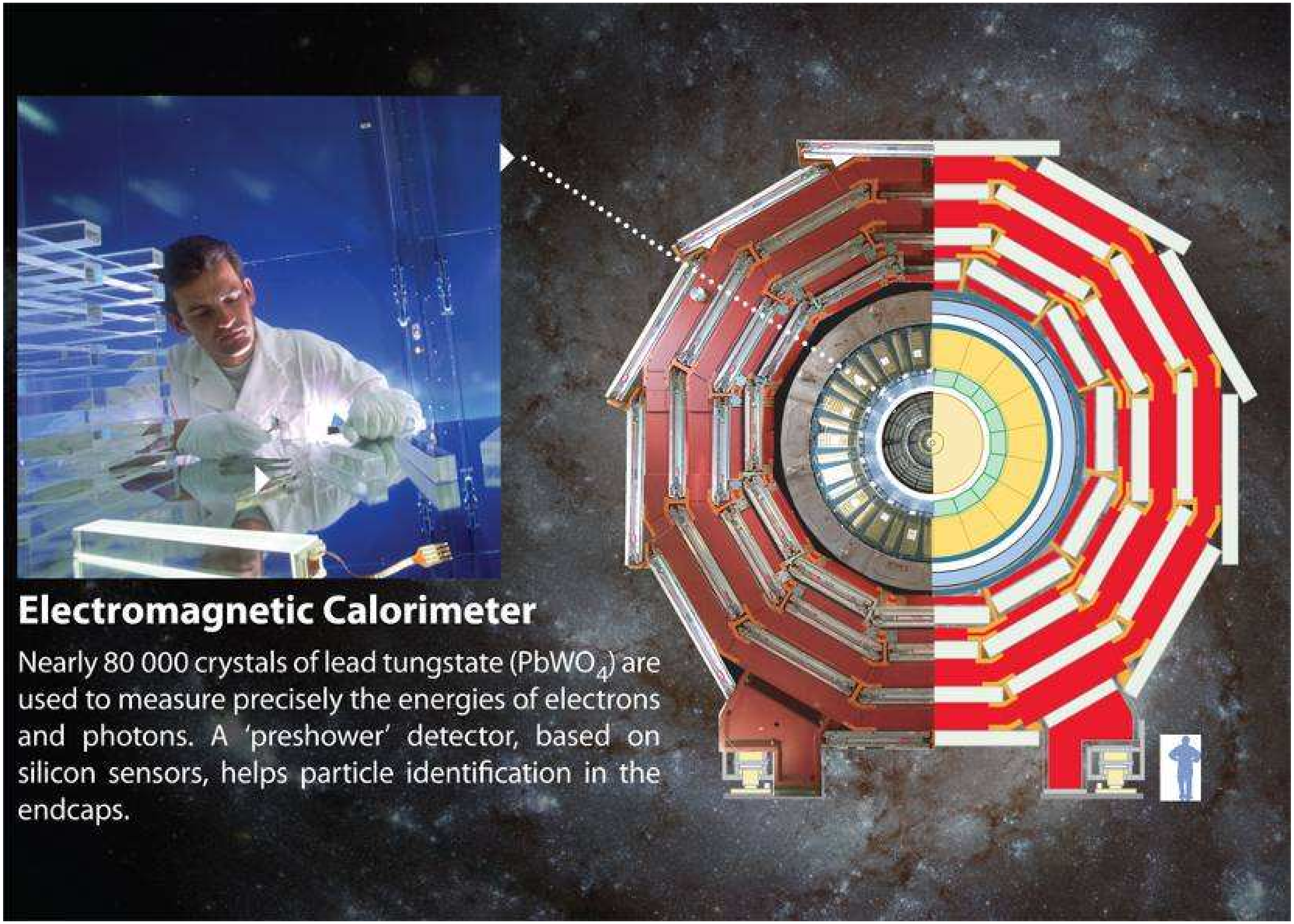
Si Tracker



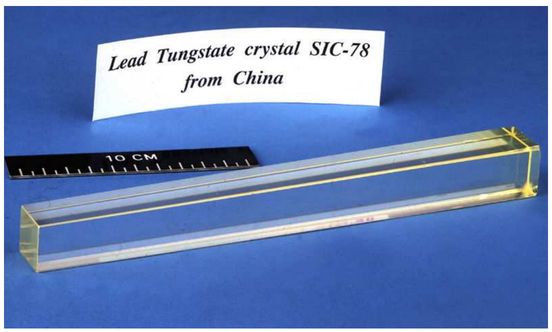
Tracker Performance

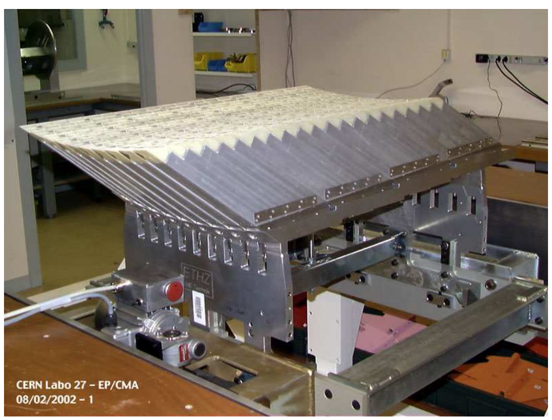


EM Calorimeter

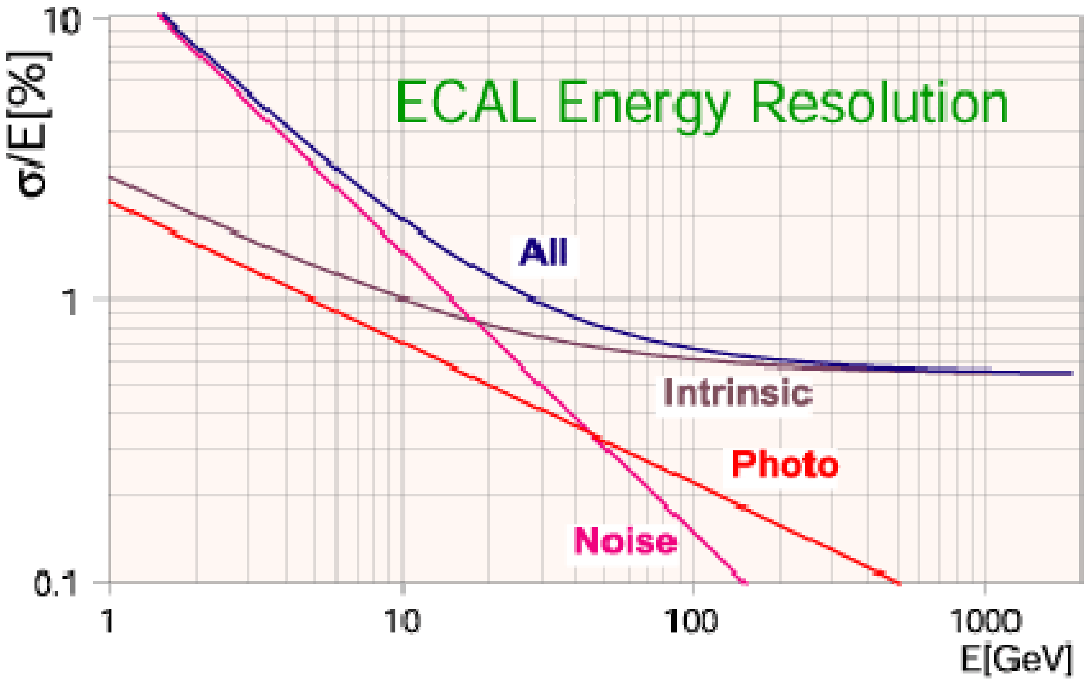


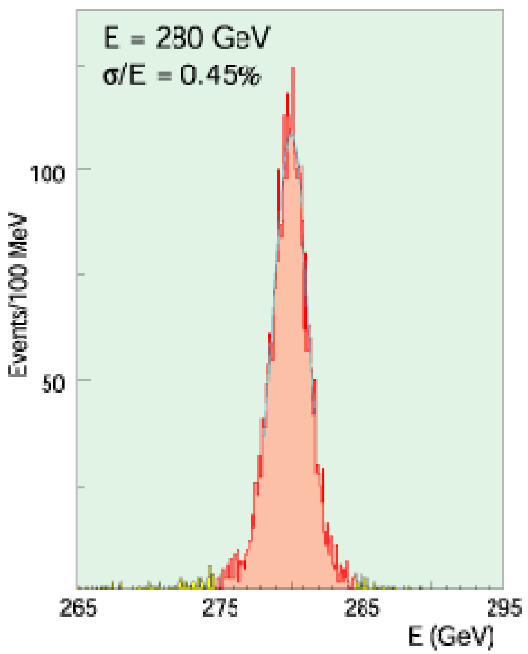
EM Calorimeter



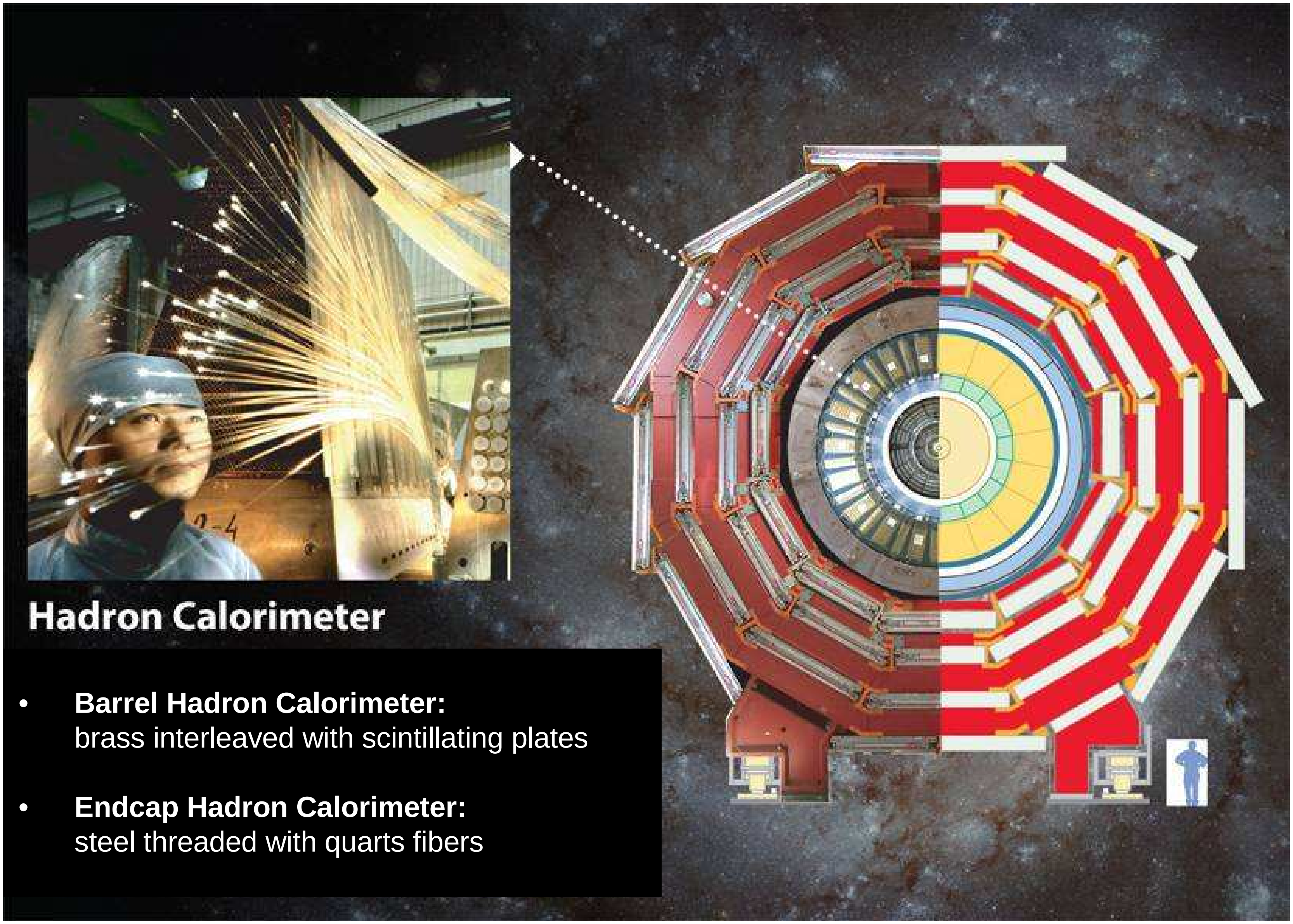


EM Calorimeter Performance

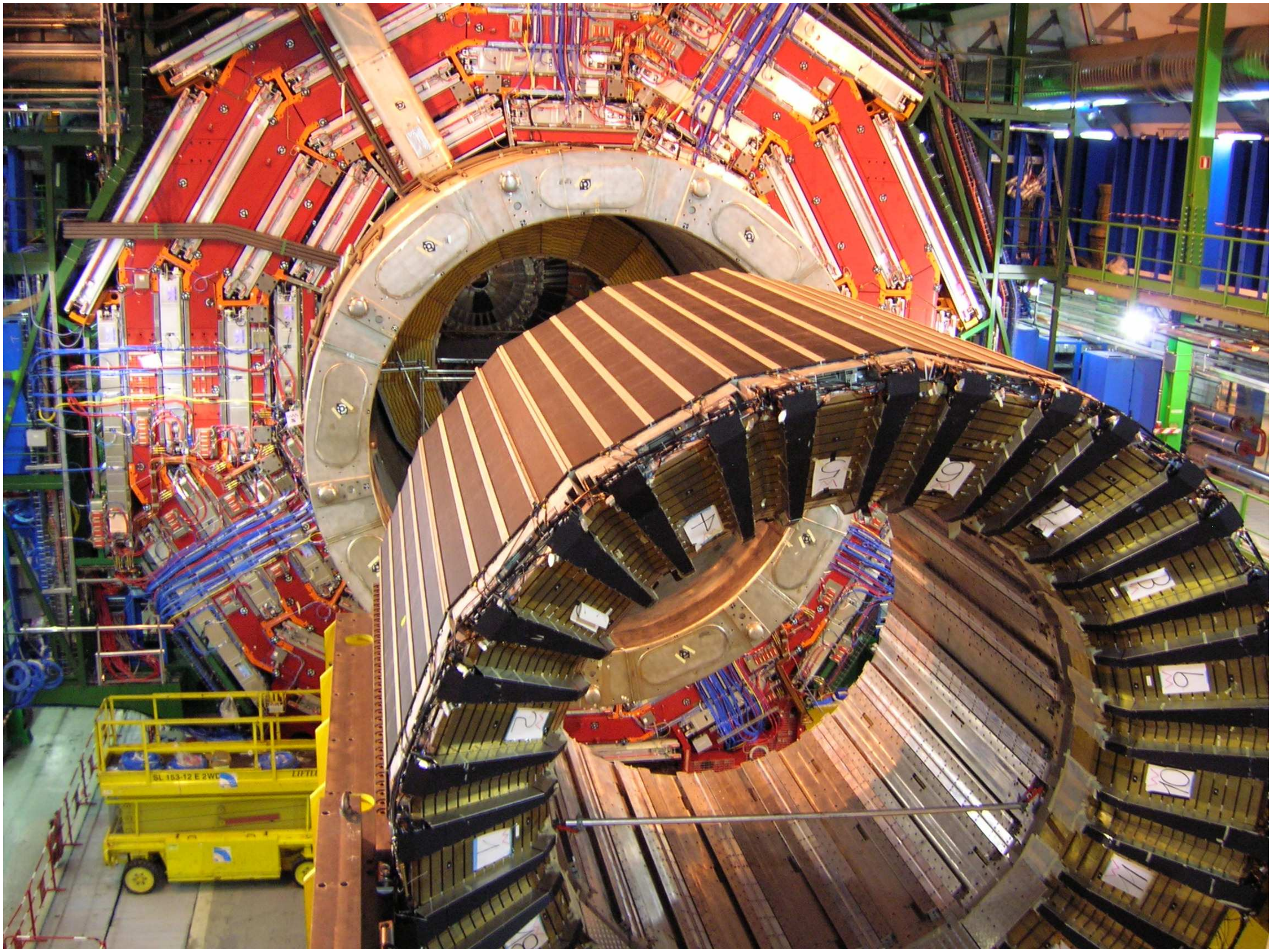




Hadronic Calorimeter

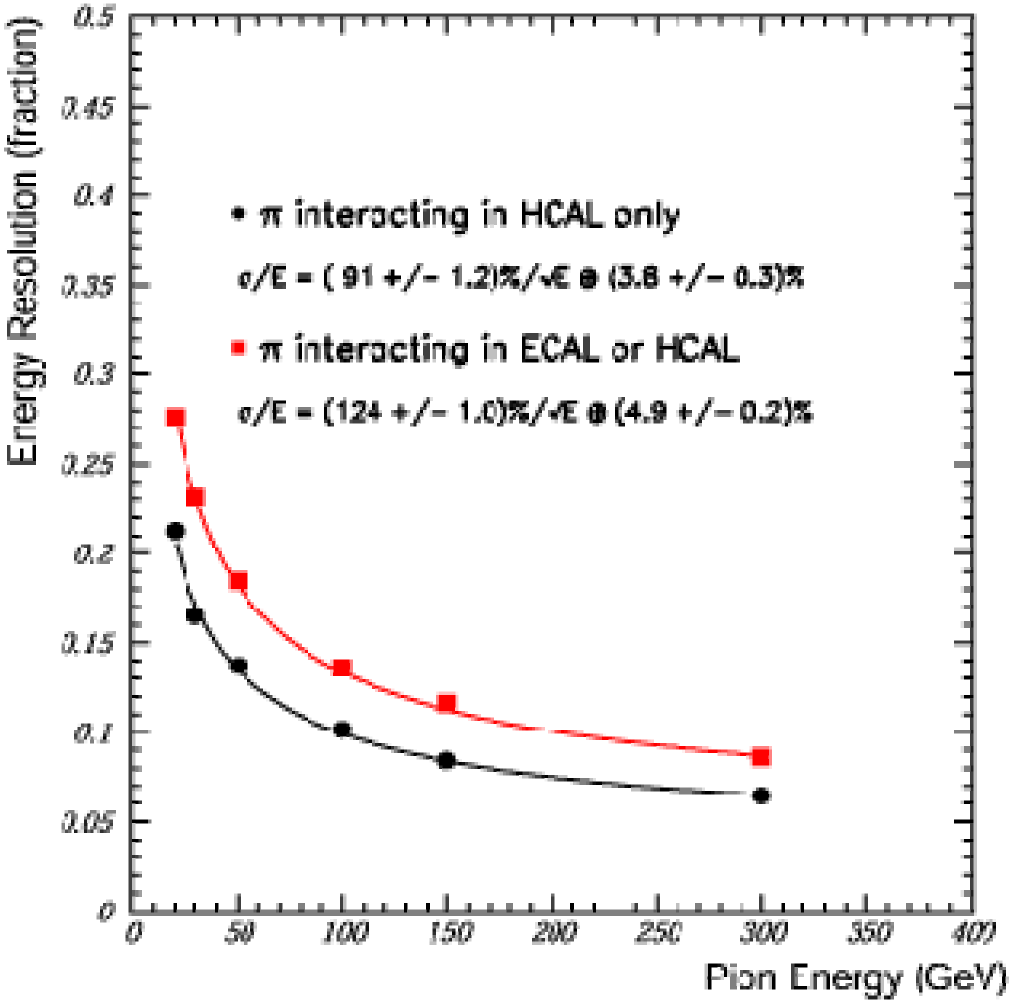


Barrel Hadron Calorimeter

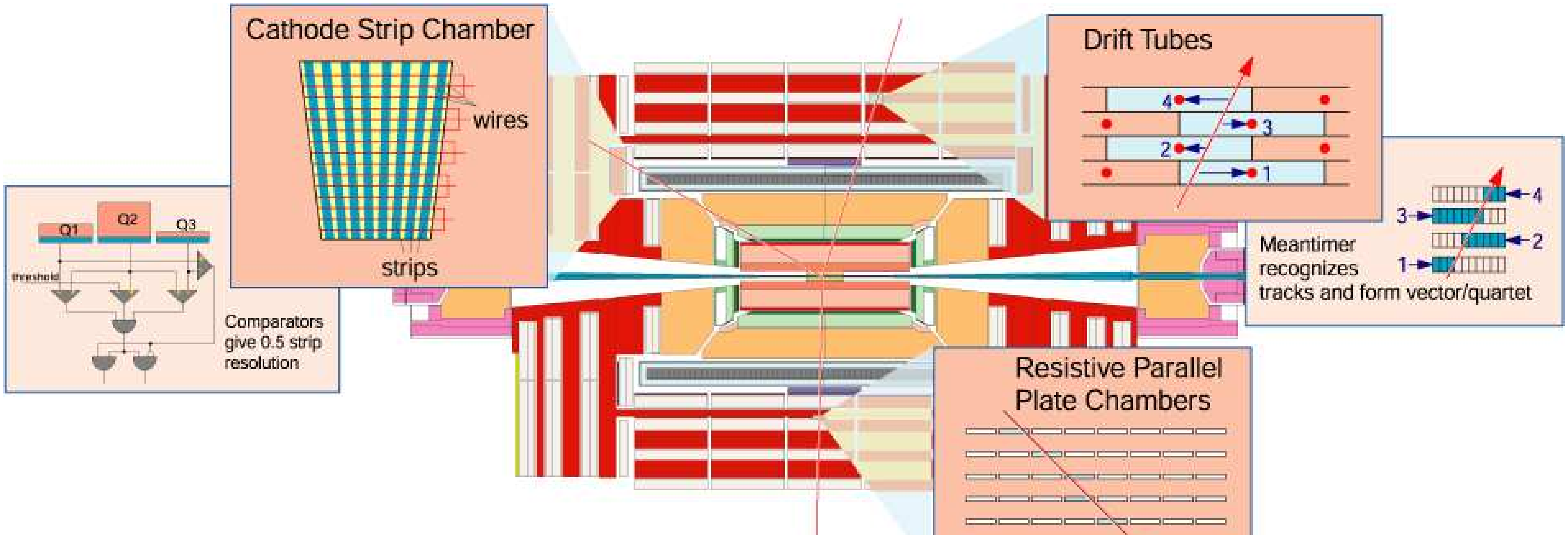


Endcap Hadron Calorimeter

Hadron Calorimeter Performance



Muon System

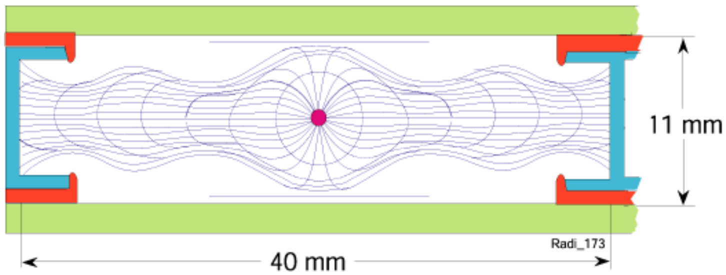


Barrel: Drift Tubes and Resistive Plate Chambers

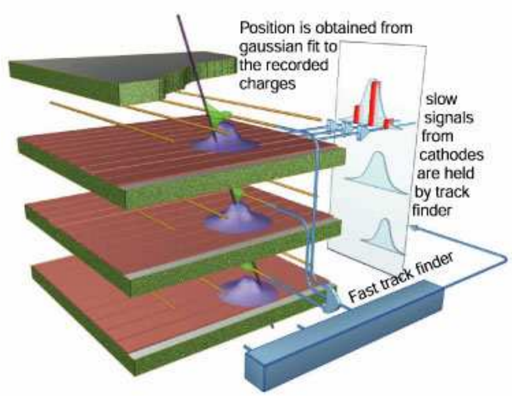
Endcaps:

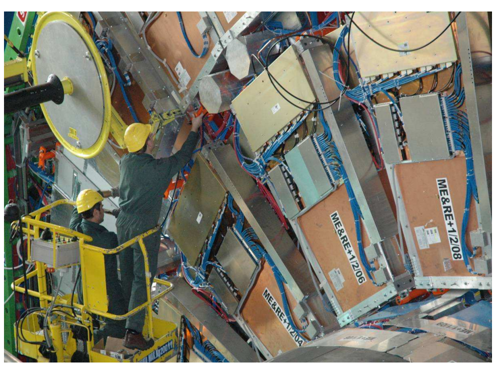
Cathode Strip Chambers and Resistive Plate Chambers

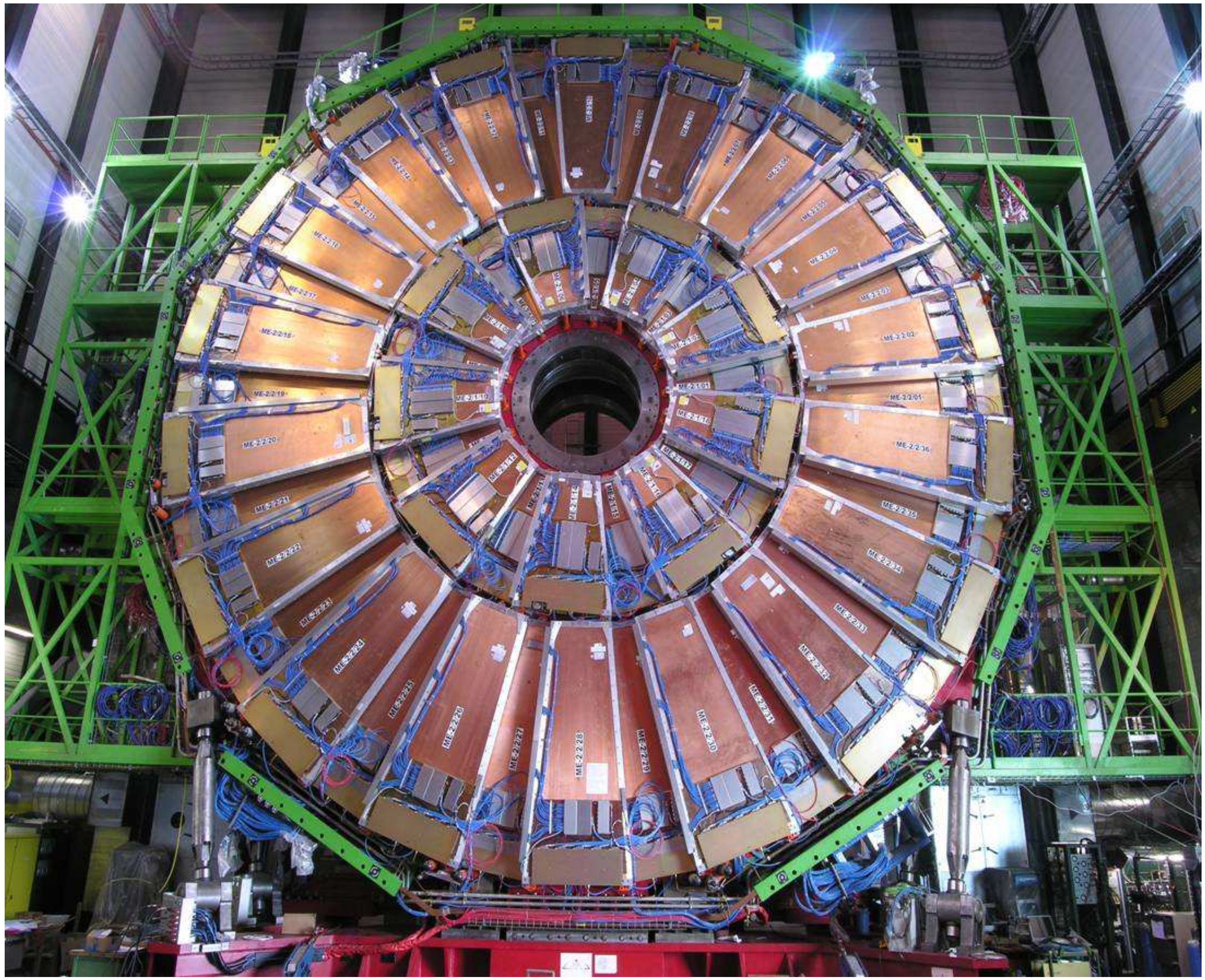
Barrel Muon System DTs



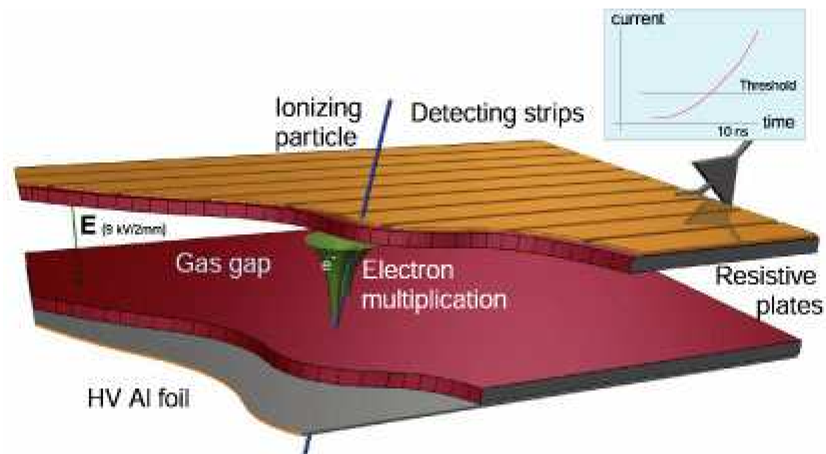
Endcap Muon System CSCs



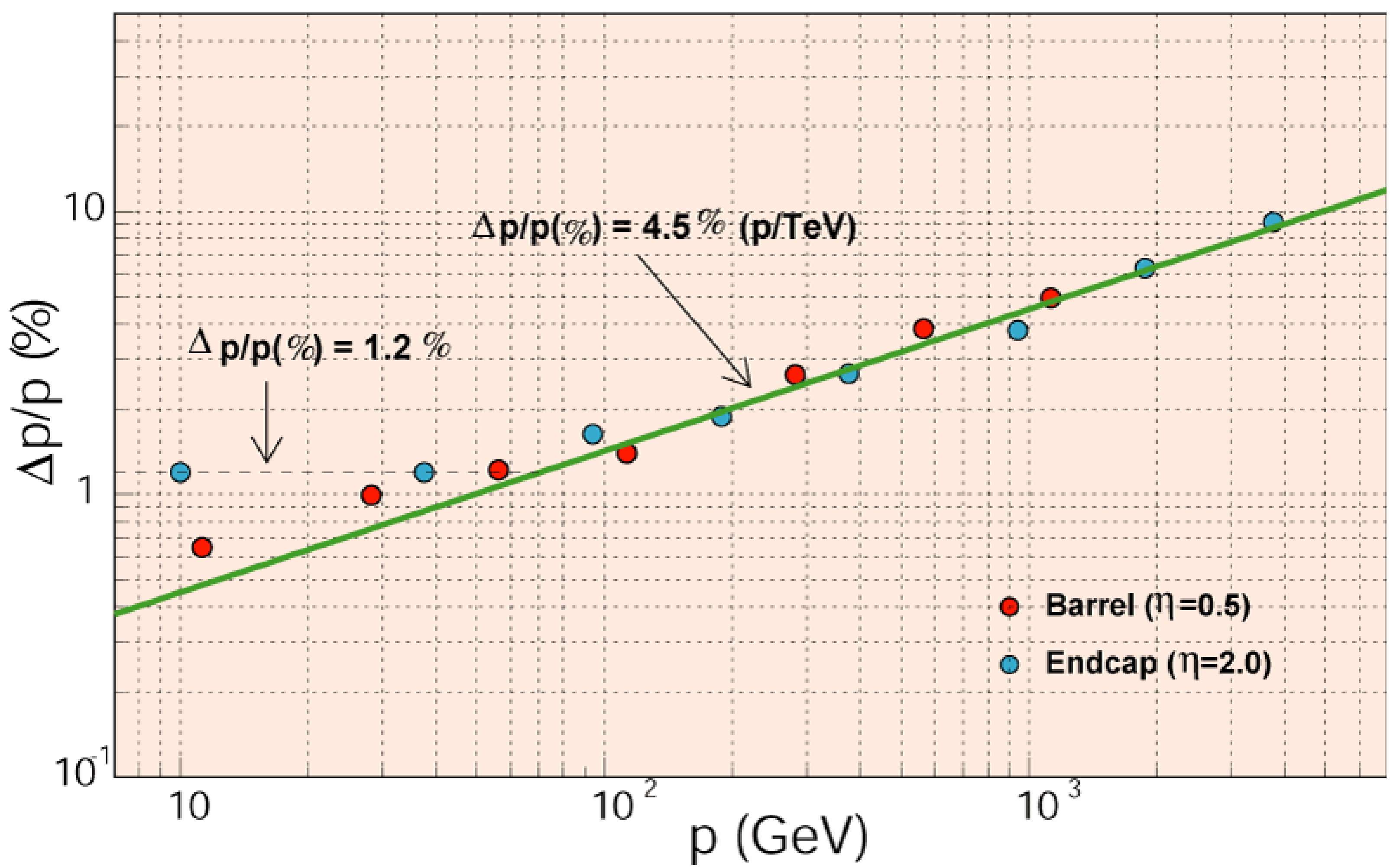




Muon System RPCs

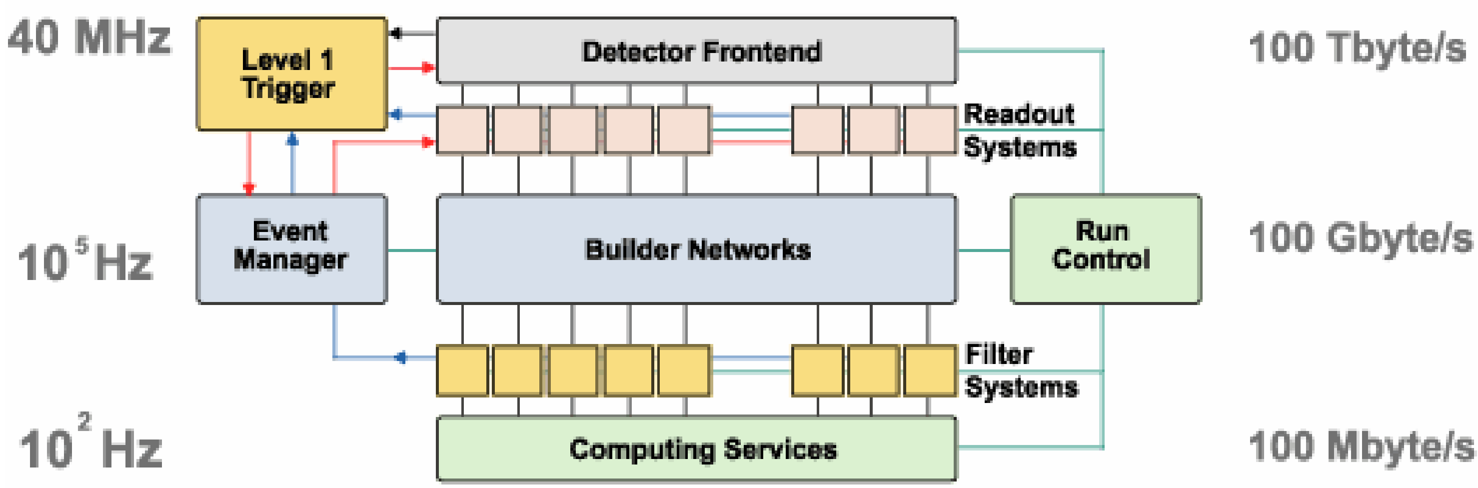


Muon System Performance



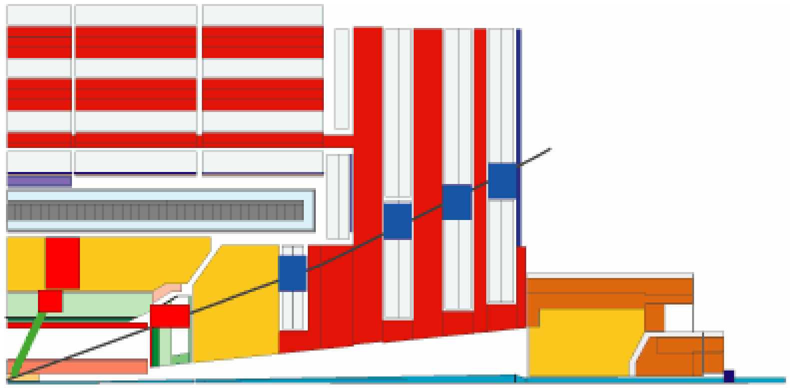
Trigger and Data Acquisition

Data Acquisition Main Parameters	
Collision rate	40 MHz
Level-1 Maximum trigger rate	100 kHz
Average event size	1 Mbyte
No. of electronics boards	10000
No. of readout crates	250
No. of In-Out units (200-5000 byte/event)	1000
Event builder (1000 port switch) bandwidth	1 Terabit/s
Event filter computing power	5 10^6 MIPS
Data production	Tbyte/day



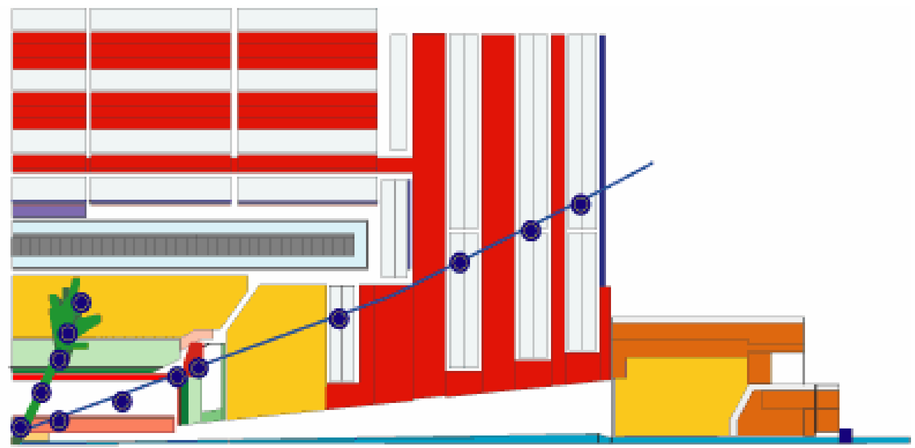
Trigger and Data Acquisition baseline structure

What is in Trigger?



Level-1 trigger. 40 MHz input :

- Specialized processors (25 ns pipelined, latency < 1 s
- Local pattern recognition and energy evaluation on prompt macro-granular information from calorimeter and muon detectors
- Particle identification: high p_t electron, photon, muon, jets, missing E_T



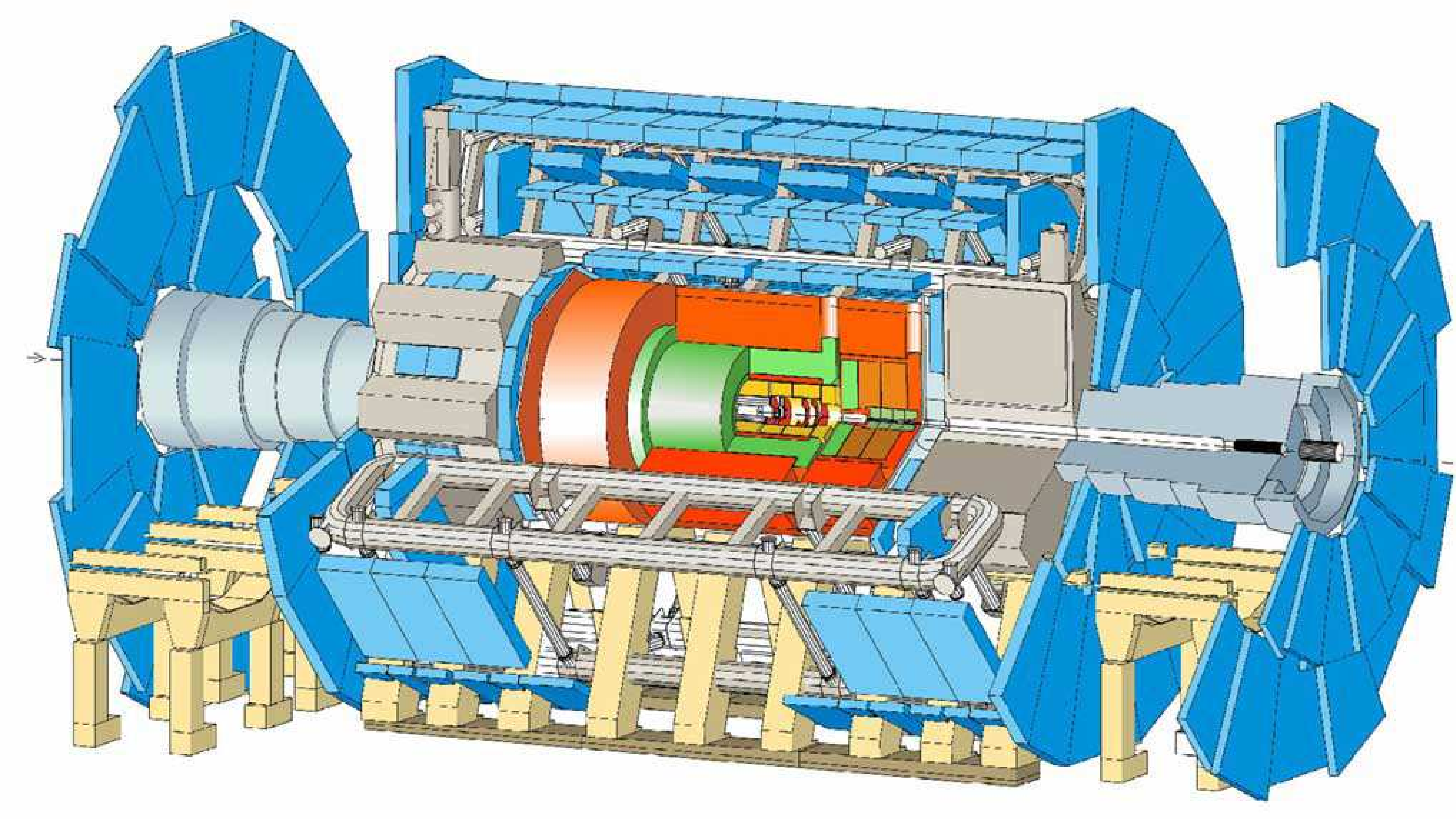
High trigger levels (>1). 100 kHz input :

- Large network of processor farms
- Clean particle signature. All detector data
- Finer granularity precise measurement
- Effective mass cuts and event topology
- Track reconstruction and detector matching
- Event reconstruction and analysis

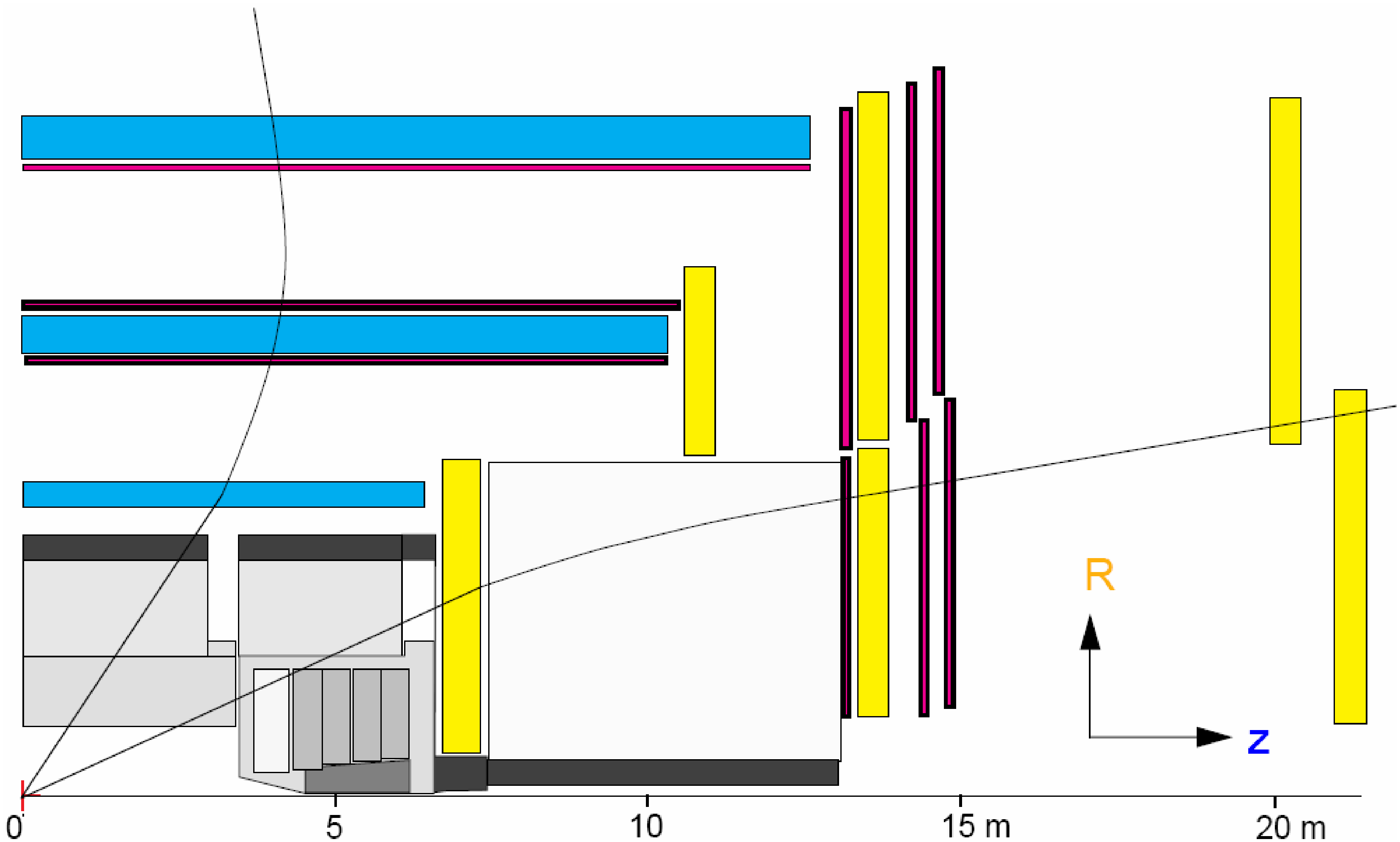
CMS on surface

CMS now (underground)

ATLAS (for comparison)

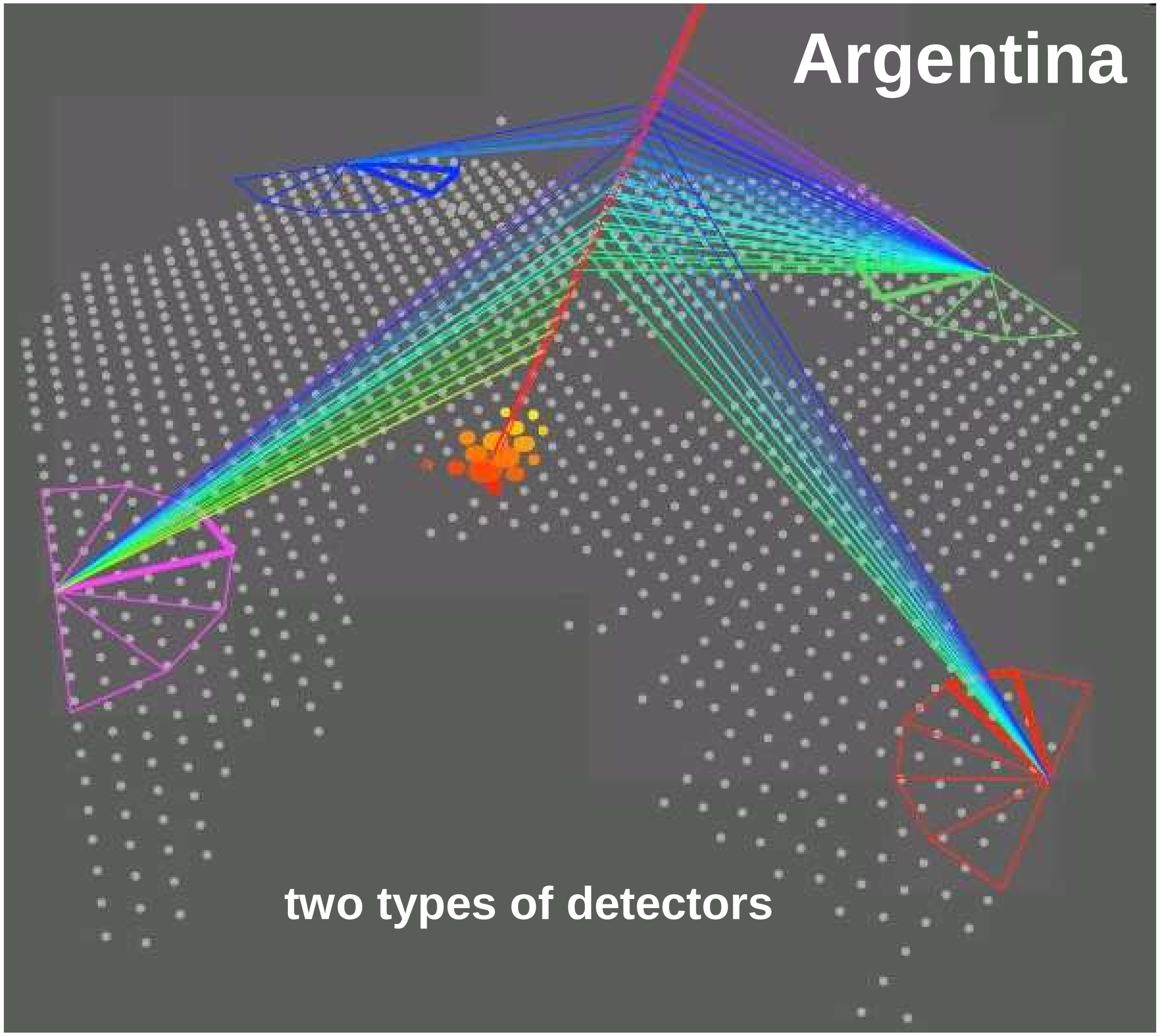


ATLAS concept (cf CMS)

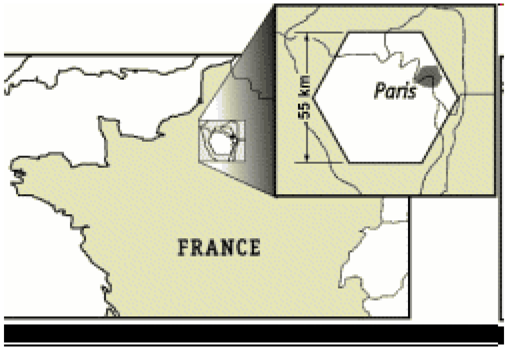


Pierre Auger Observatory
(largest cosmic ray shower detector)

Pierre Auger Observatory



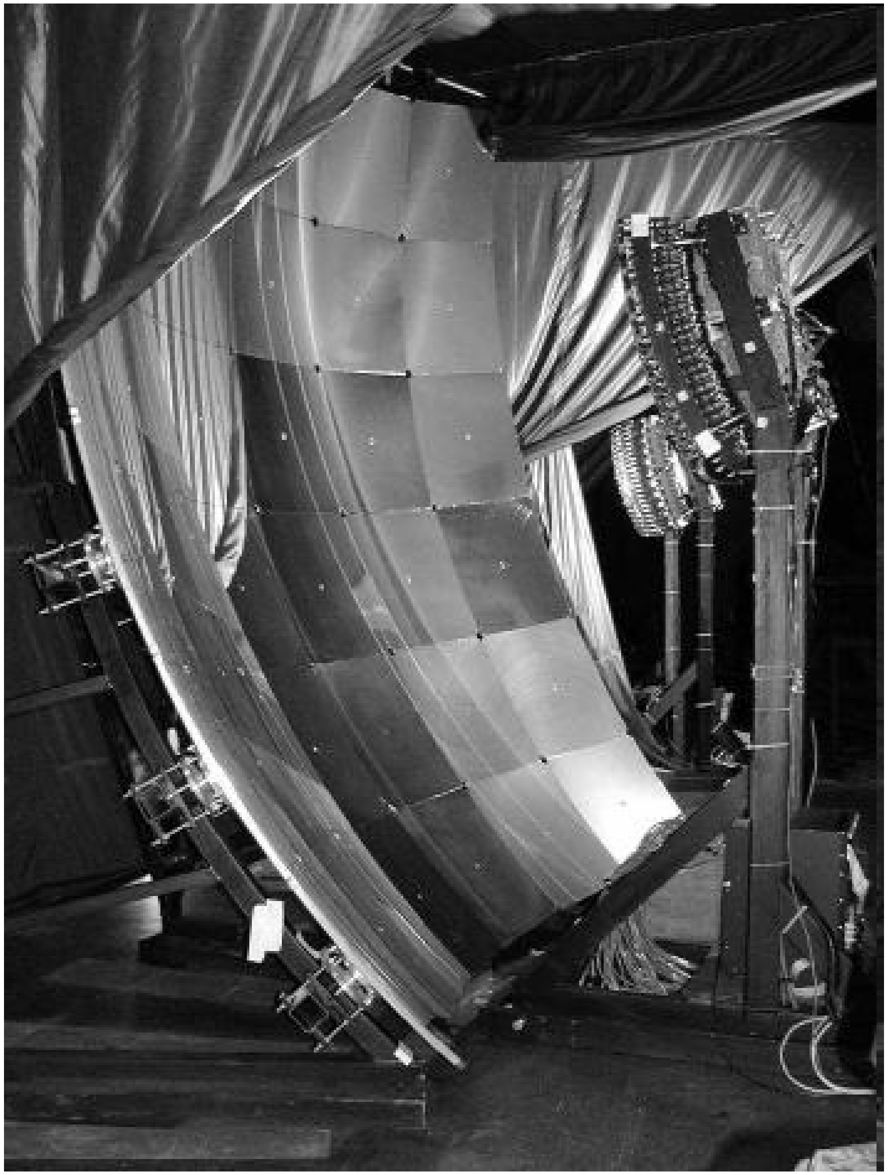
size of the detector site
compared to Paris



Water Tanks

Cherenkov light
from muons reaching
the earth surface

Fluorescence Light Detector



Telescopes recording the development of cosmic ray showers (em and hadronic) in the upper layers of atmosphere via fluorescence light detection