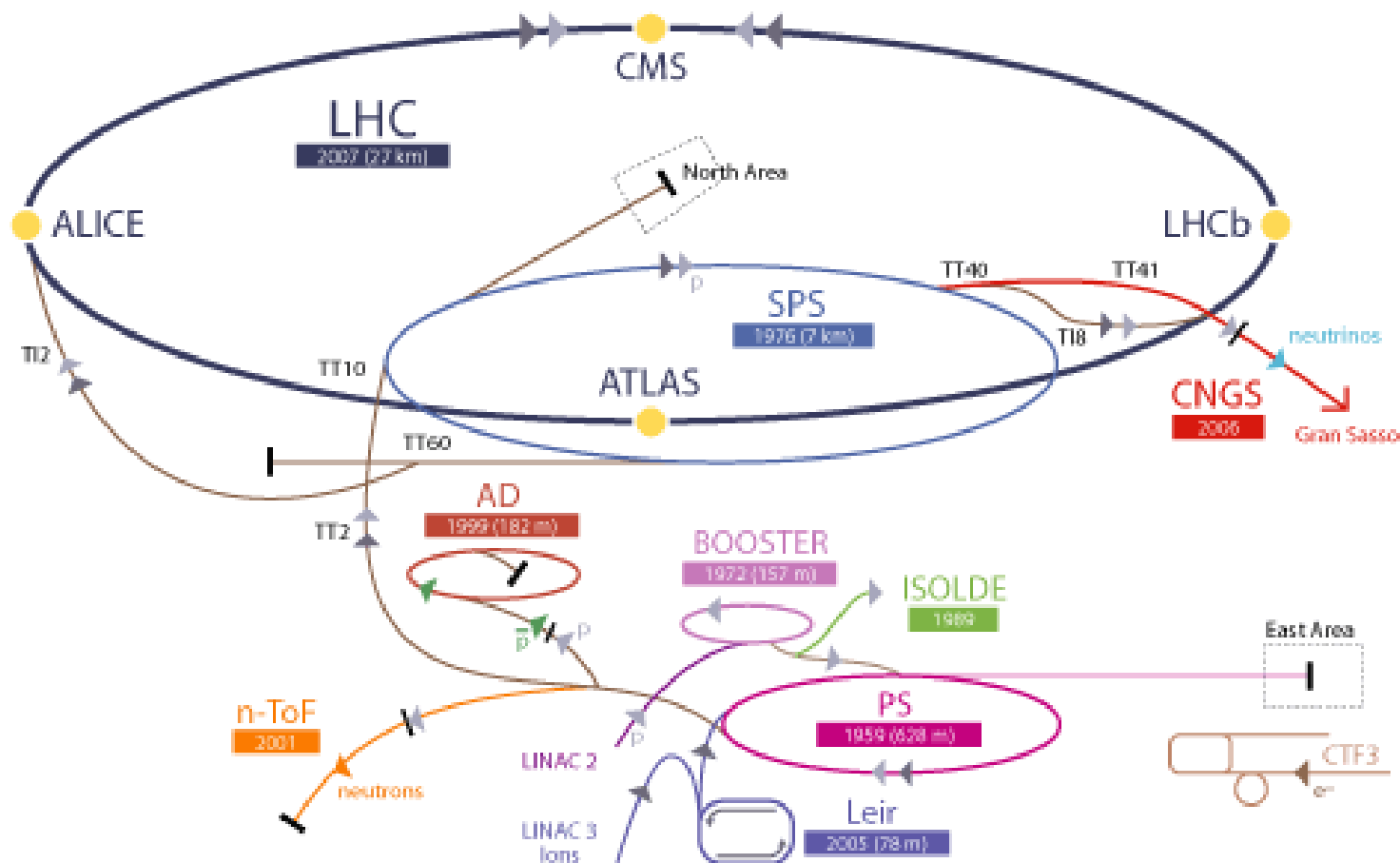


STATUS OF THE LHC

A.S.Vodopyanov

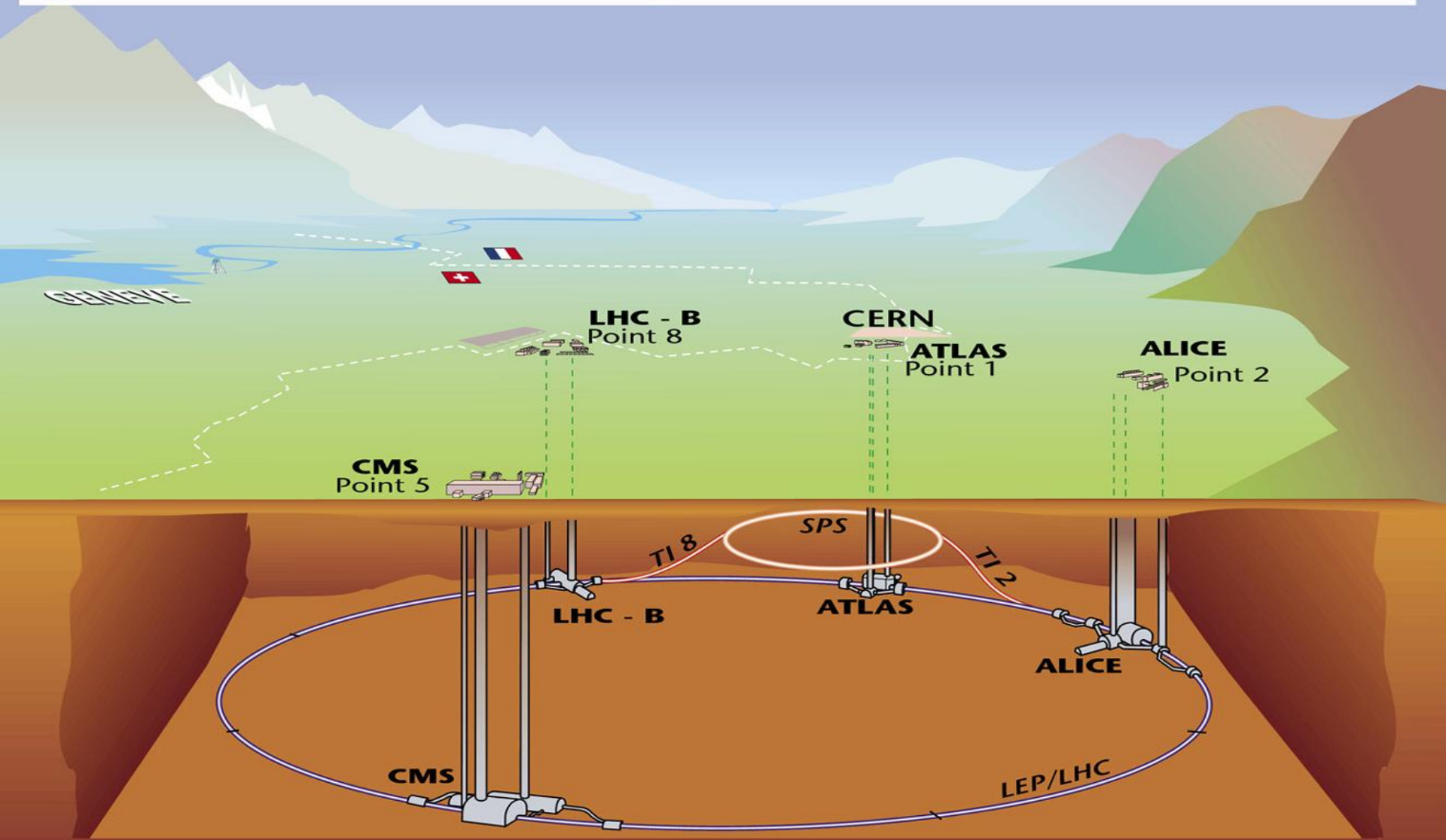
LHC construction & commissioning

The CERN accelerator complex



LINAC2- BOOSTER-PS-SPS-LHC

Overall view of the LHC experiments.



Underground



Main Dipoles

1. The main budget item and a serious technological challenge are the superconducting (1.9 K) dipoles, which bend the beams around the 27 km circumference of the LHC.
2. At 7 TeV these magnets have to produce a field of around 8.4 Tesla at a current of around 11,800 A.
3. The magnets have two apertures, one for each of the counter-rotating beams.

Each dipole is 14.3 meters long. A total of 1232 are needed.

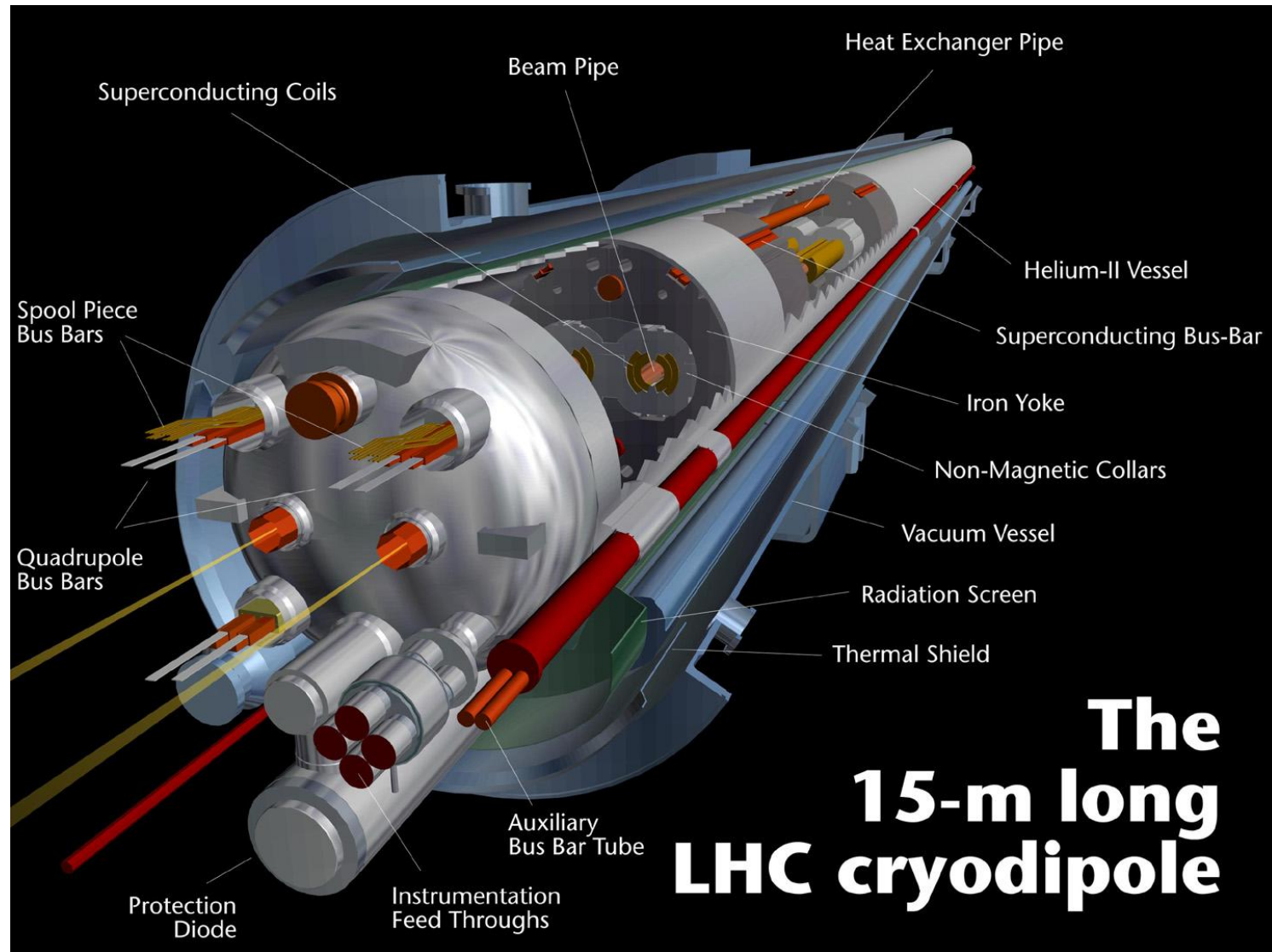
Cost: ~ 0.5 million CHF each.

4. Quads (~390) etc to keep beam focused and the motion stable
5. Stored magnetic energy up to 1.29 GJ per sector.

Total stored energy in magnets = 11GJ

6. One dipole weighs around 35 tones.

The 15-m long LHC cryodipole





CERN

LH... C'EST PAS SORCIER

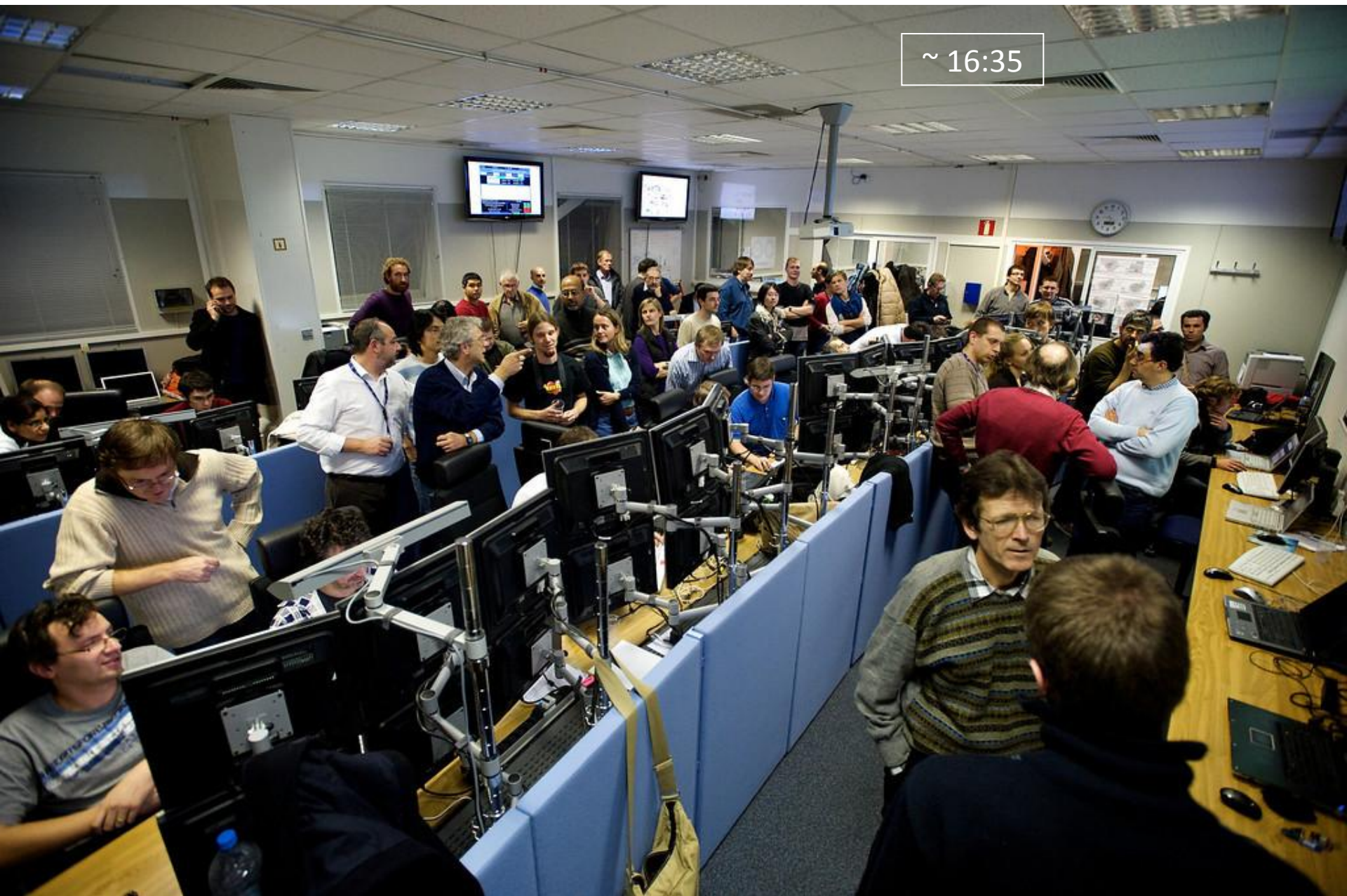
10 October 2008

- **First attempt to trace 450 proton GeV beams through the LHC took place on October 10, 2008.**
- **Two beams passed through the LHC in both directions.**
- **However, shortly after that success a short circuit had happened and some magnets in the ring were blown-up.**

23 November 2009 – Restart of LHC

- **During end of 2008 and most of 2009 lots of repairs were done.**
- **All damaged magnets (59) and service systems were changed or repaired.**
- **Many checks of various matter were performed.**
- **Some other weak points of the LHC construction, which would be able to cause further failures, were found.**
- **However, some repairs are scheduled for 2012 shutdown.**

ACR: November 23, 2009 -- some anxious minutes waiting for collisions..



~ 16:35

Energy Steps in p-p collisions

- **900 GeV collision energy;**
- **2.36 TeV collision energy;**
- **7 TeV collision energy**

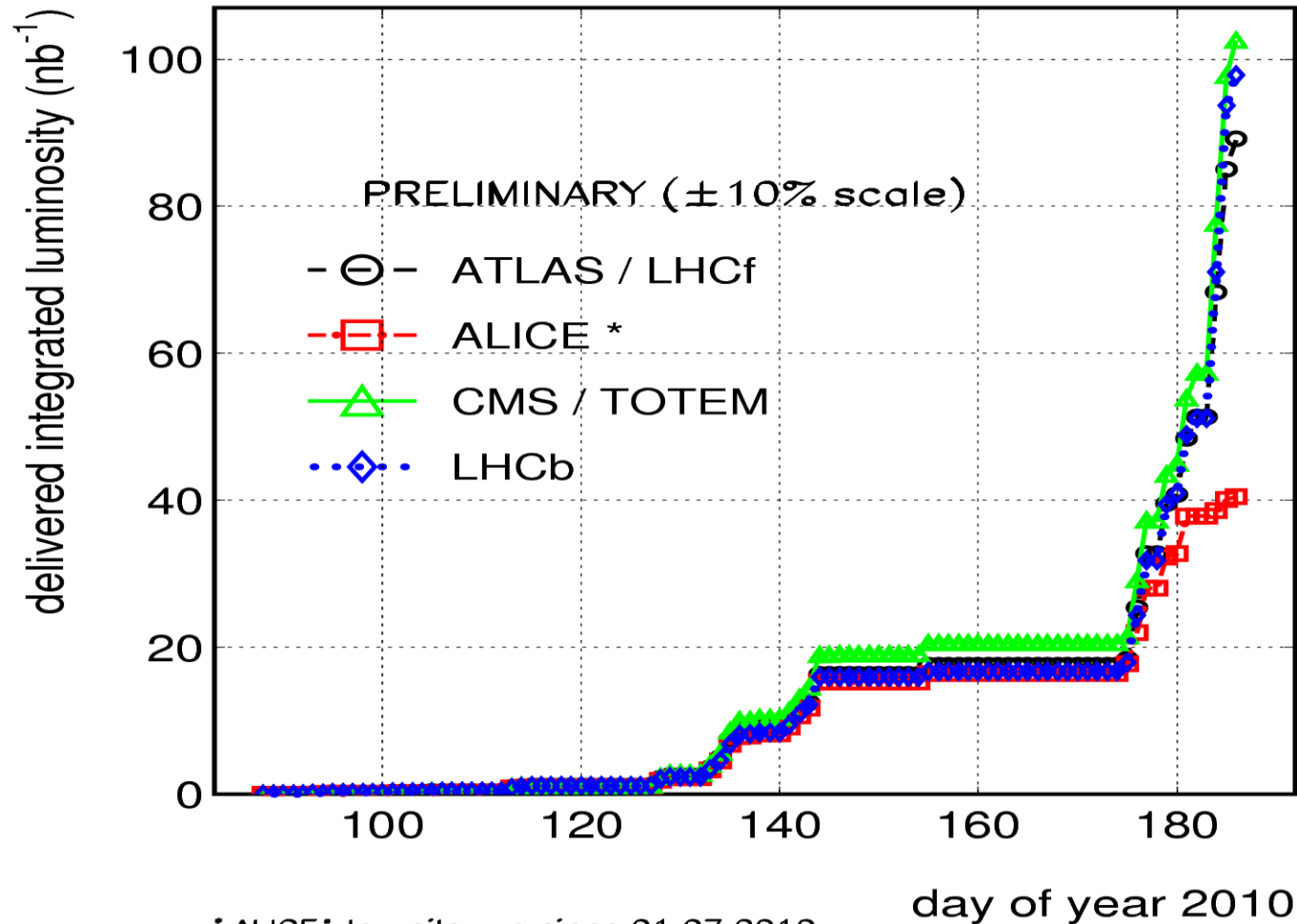
Luminosity improvements

- At the beginning the collisions were started with 1 bunch per beam.
- By August 20 the number of bunches was increased to 48.
- At September 24 the number of bunches was increased to 56 and the luminosity to $2 \times 10^{31} \text{ cm}^{-2} \text{ s}^{-1}$.
- 2010 goal is the running with 2808 bunches and the luminosity of $10^{32} \text{ cm}^{-2} \text{ s}^{-1}$.
- LHC design luminosity is $\sim 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$.

Integrated Luminosity on 7th July

2010/07/07 08.08

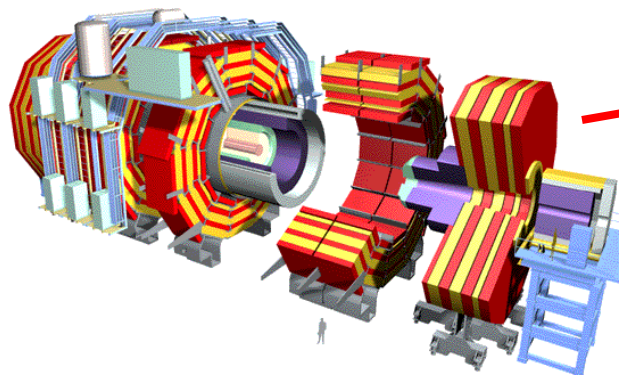
LHC 2010 RUN (3.5 TeV/beam)



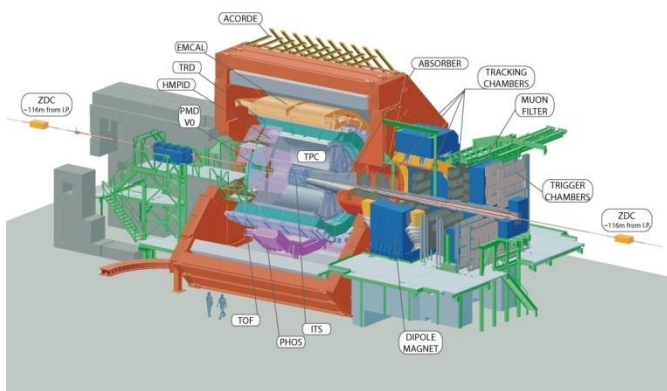
* ALICE: low pile-up since 01.07.2010

LHC detectors

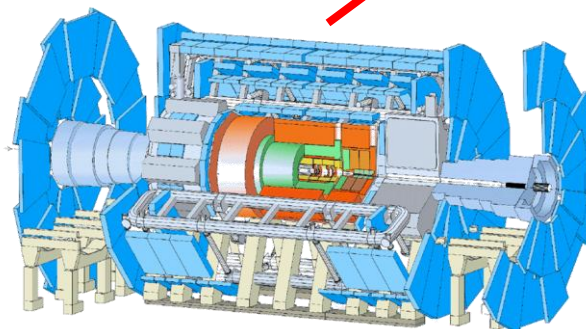
$p+p @ 14 \text{ TeV}$
 $Pb+Pb @ 5.5A \text{ TeV}$



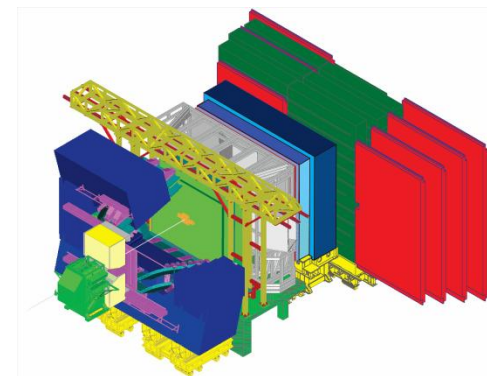
CMS



ALICE



ATLAS

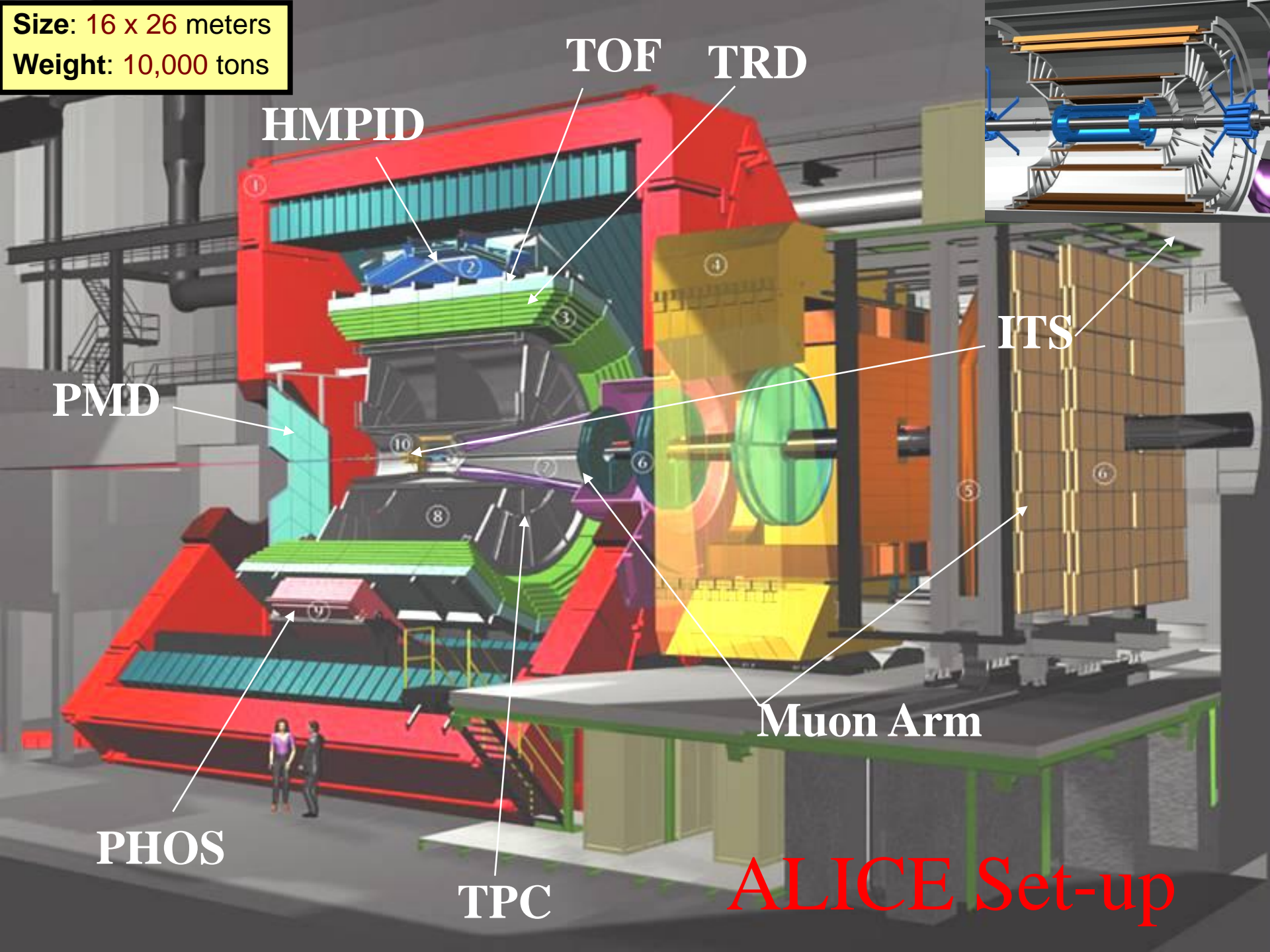


LHCb

What Physics Questions might be answered at LHC

- *ALICE:*
 - *Chiral Symmetry breaking;*
 - *Origin of mass of hadrons;*
 - *Deconfinement;*
 - *Hadronization;*
- *ATLAS, CMS, LHCb:*
 - *Higgs mechanism;*
 - *Supersymmetry;*
 - *CP violation;*

Size: 16 x 26 meters
Weight: 10,000 tons



HMPID

TOF

TRD

PMD

ITS

Muon Arm

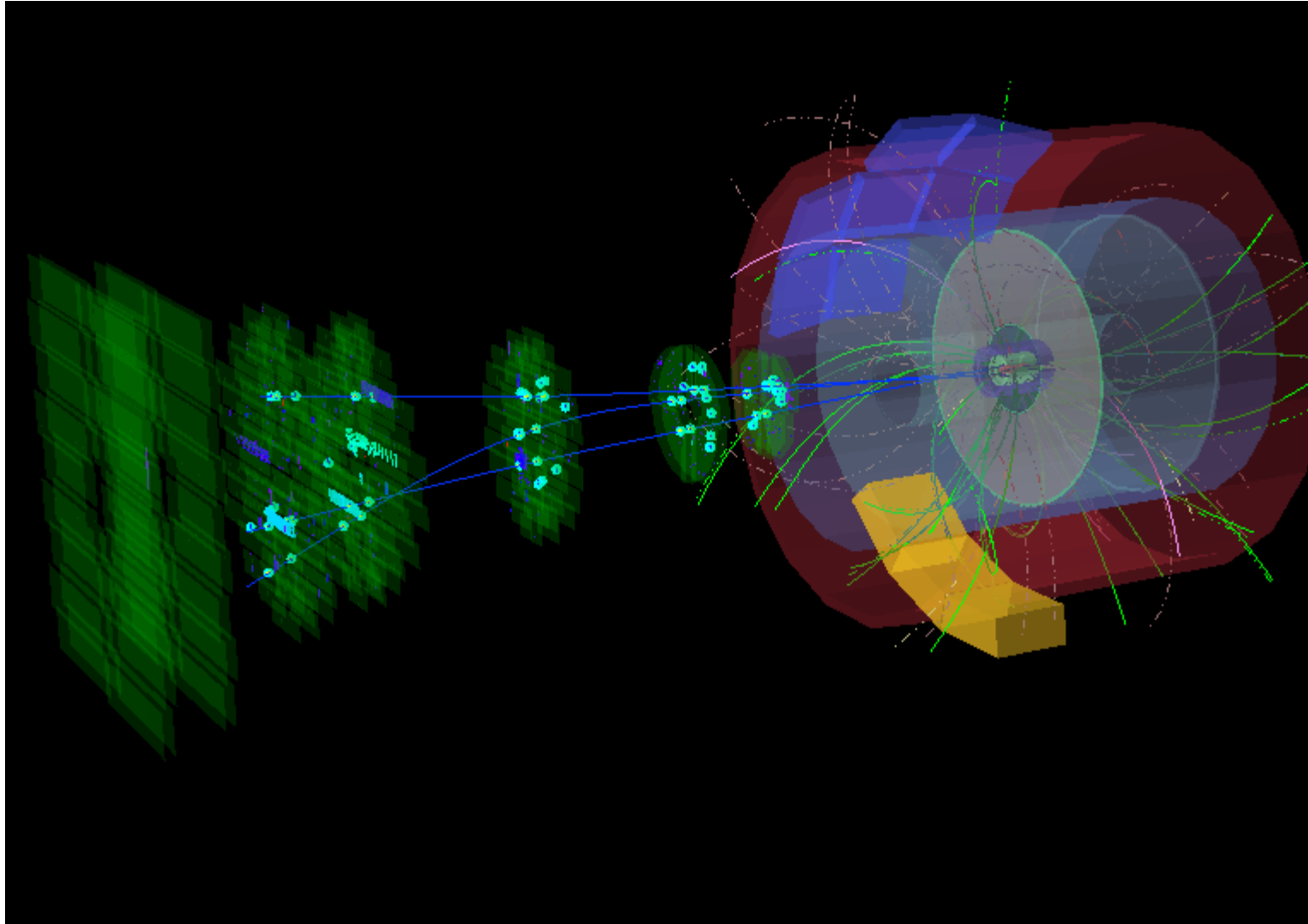
PHOS

TPC

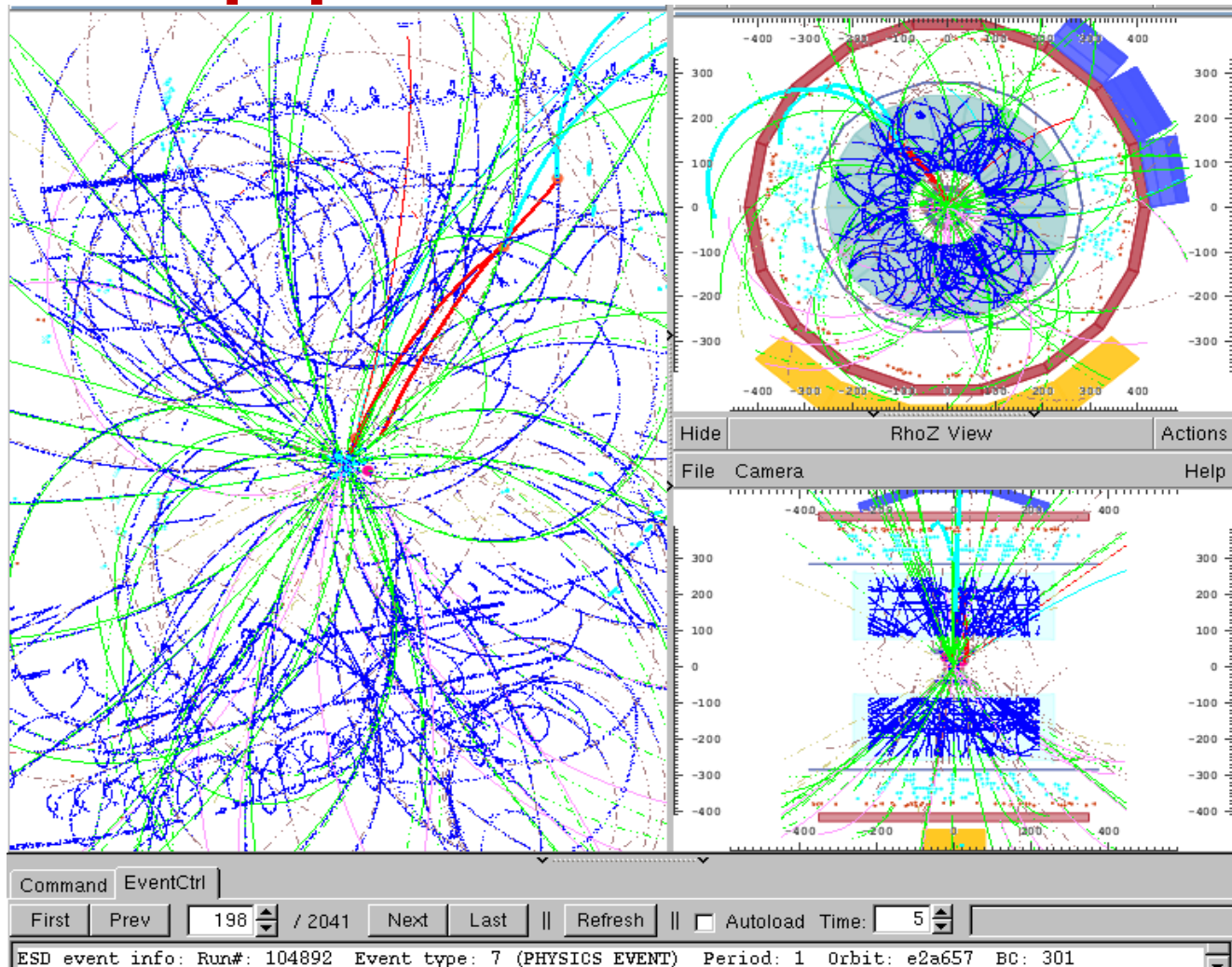
ALICE Set-up

Dimuon Spectrometer

First J/Ψ candidate ($M \approx 2.88 \pm 0.15 \text{ GeV}/c^2$)

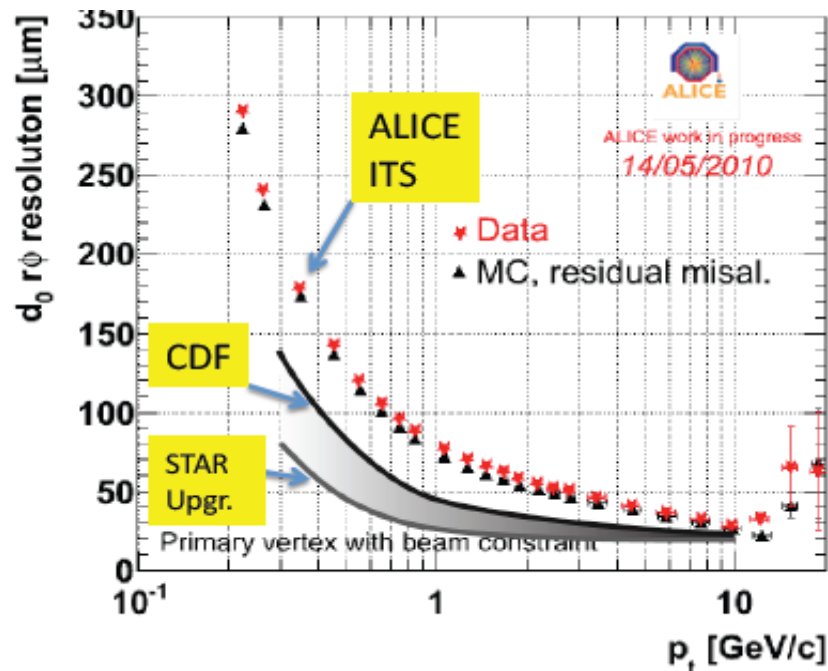


Display of high multiplicity event in p-p interaction at 7 TeV



ITS Performance: Impact parameter

Resolution well comparable to simulation and close to design value (CDF/running and STAR/upgrade for comparison)



Physics exploitation of ALICE has started for good !

The European Physical Journal

volume 65 - numbers 1-2 - January - 2010

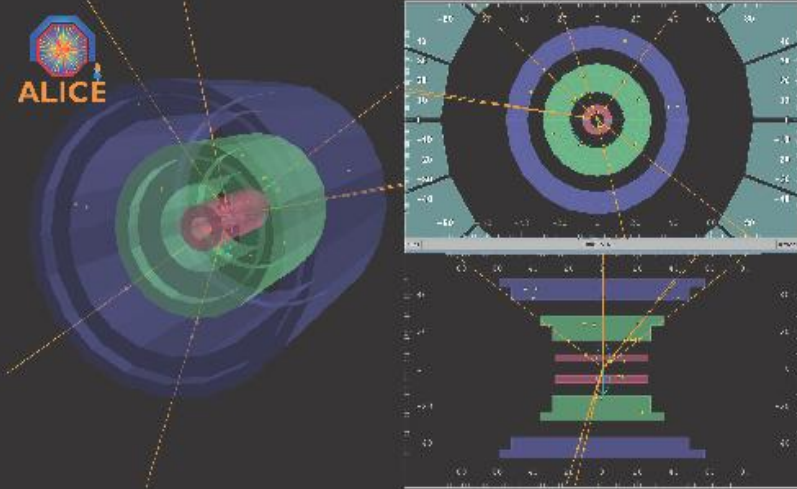
EPJ C



Recognized by European Physical Society

submitted to EPJC 28 Nov 2009

Particles and Fields



The first pp collision candidate shown by the event display in the ALICE counting room (3D view, $r-\phi$ and $r-z$ projections), the dimensions are shown in cm. The dots correspond to hits in the silicon vertex detectors (SPD, SDD and SSD), the lines correspond to tracks reconstructed using loose quality cuts. From the ALICE Collaboration: First proton-proton collisions at the LHC as observed with the ALICE detector: measurement of the charged particle pseudorapidity density at $\sqrt{s} = 900$ GeV

Phase 1: rediscovering the standard model

(QCD in the case of ALICE)

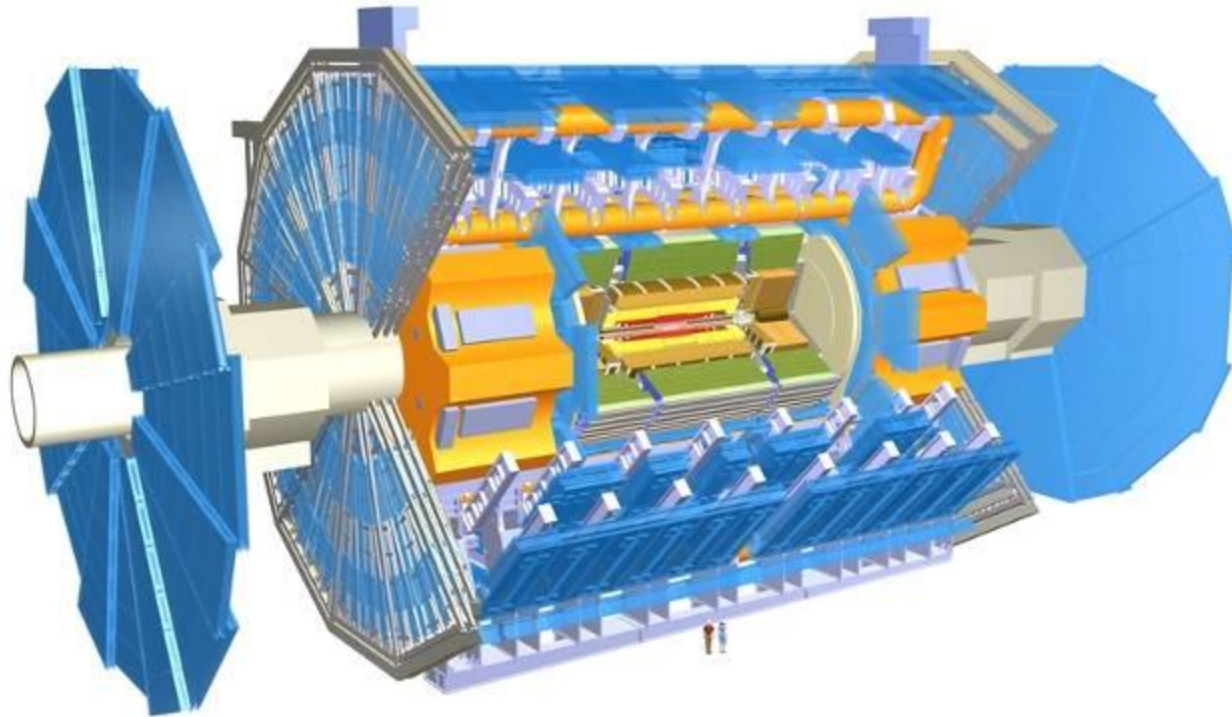
The average number of charged particles created perpendicular to the beam in pp collisions at 900 GeV is:

$$dN/d\eta = 3.10 \pm 0.13 \text{ (stat)} \pm 0.22 \text{ (syst)}$$

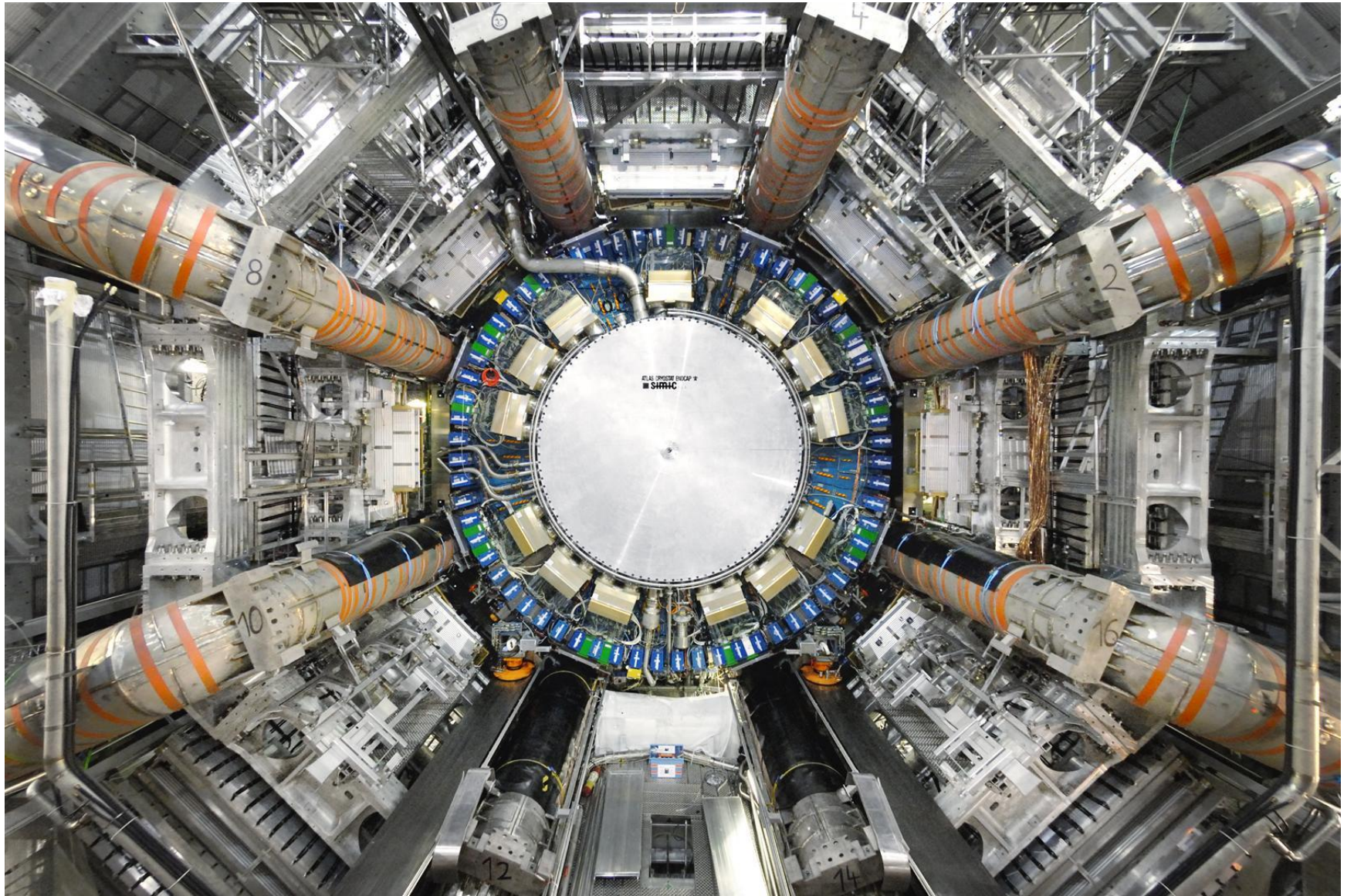
National Geographic News (4 Dec.)

‘....a machine called ALICE.... found that a (!) proton-proton collision recorded on November 23 created the precise ratio of matter and antimatter particles predicted from theory.’

ATLAS detector

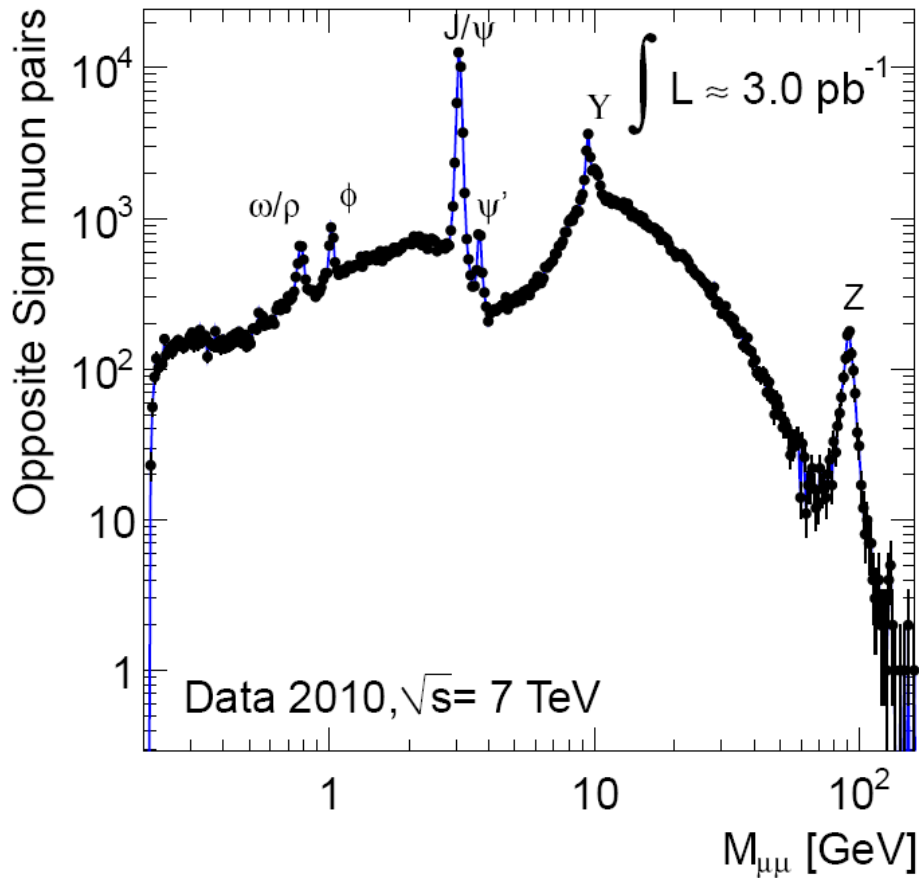


<i>Diameter</i>	<i>25 m</i>
<i>Barrel toroid length</i>	<i>26 m</i>
<i>End-cap end-wall chamber span</i>	<i>46 m</i>
<i>Overall weight</i>	<i>7000 Tons</i>



Dimuon Resonances (+ the Z)

ATLAS Preliminary



Simple analysis:

- LVL1 muon trigger with $p_T \sim 6 \text{ GeV}$ threshold
- 2 opposite-sign primary muons reconstructed by combining tracker and muon spectrometer

CMS Detector

SILICON TRACKER

Pixels ($100 \times 150 \mu\text{m}^2$)
~1m² ~66M channels

Microstrips (80-180 μm)
~200m² ~9.6M channels

CRYSTAL ELECTROMAGNETIC CALORIMETER (ECAL)

~76k scintillating PbWO₄ crystals

PRESHOWER

Silicon strips
~16m² ~137k channels

STEEL RETURN YOKE

~13000 tonnes

SUPERCONDUCTING SOLENOID

Niobium-titanium coil
carrying ~18000 A

HADRON CALORIMETER (HCAL)

Brass + plastic scintillator
~7k channels

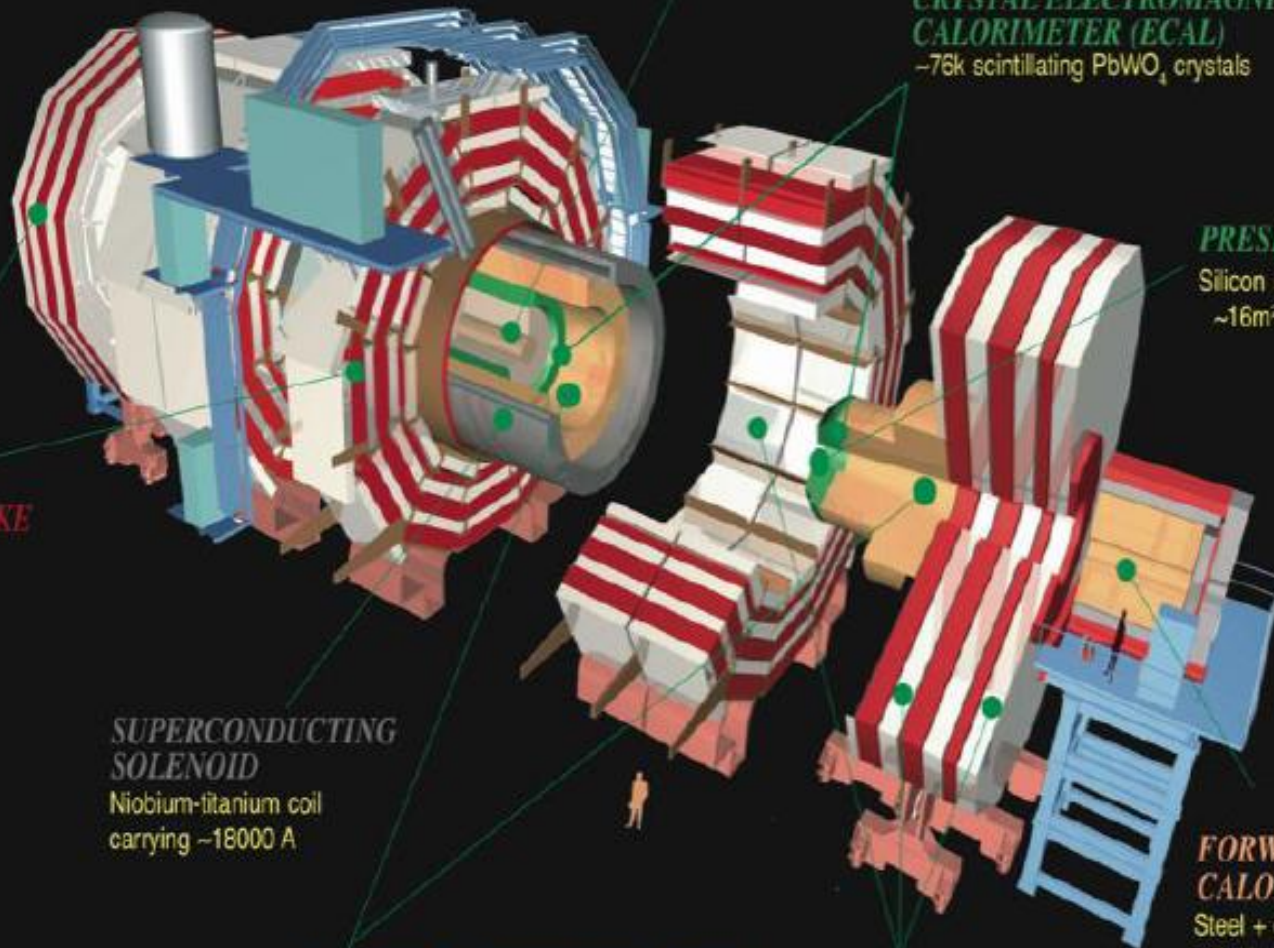
FORWARD CALORIMETER

Steel + quartz fibres
~2k channels

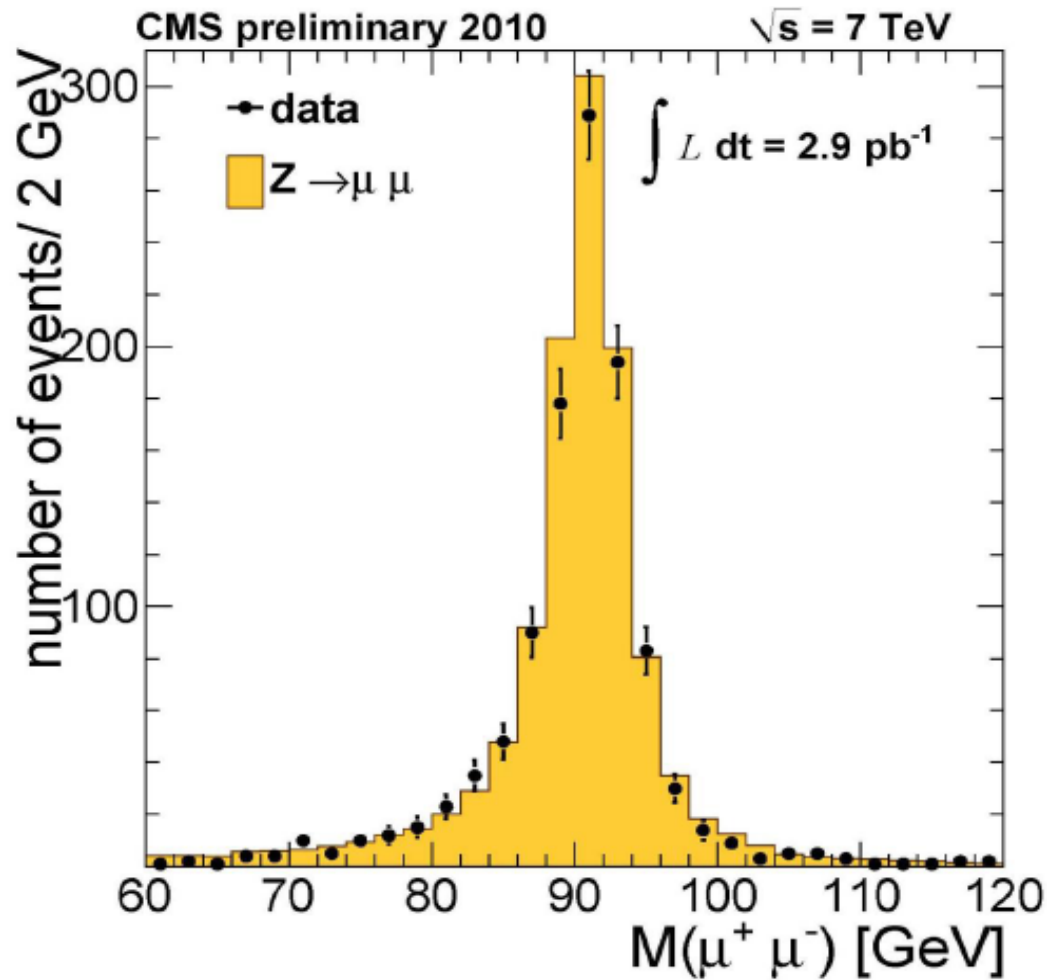
MUON CHAMBERS

Barrel: 250 Drift Tube & 480 Resistive Plate Chambers
Endcaps: 473 Cathode Strip & 432 Resistive Plate Chambers

Total weight : 14000 tonnes
Overall diameter : 15.0 m
Overall length : 28.7 m
Magnetic field : 3.8 T



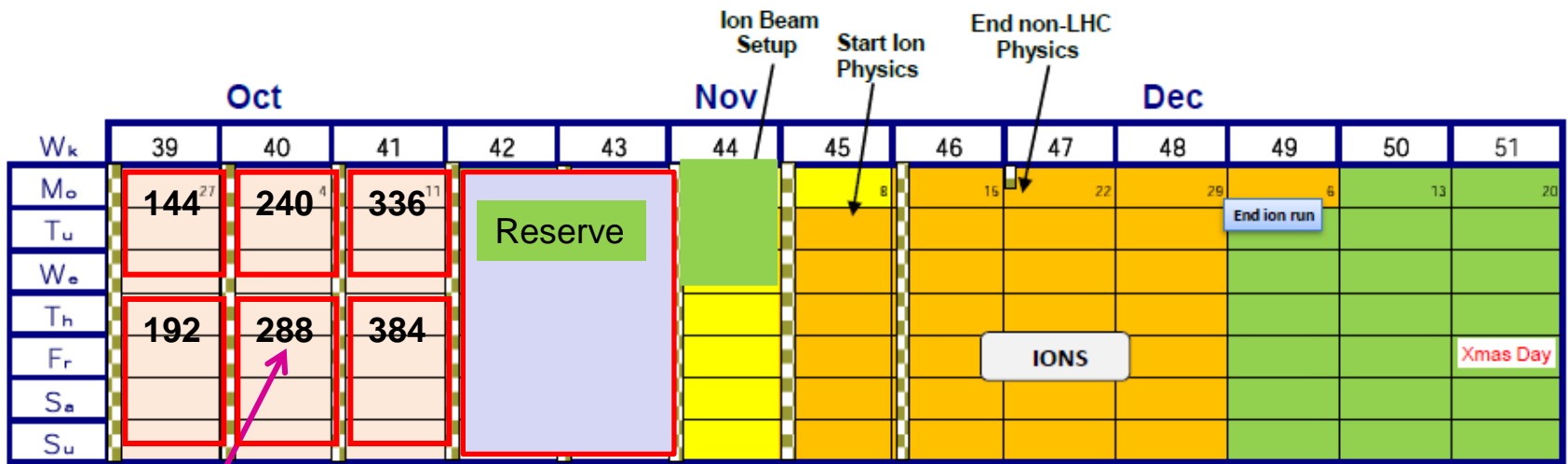
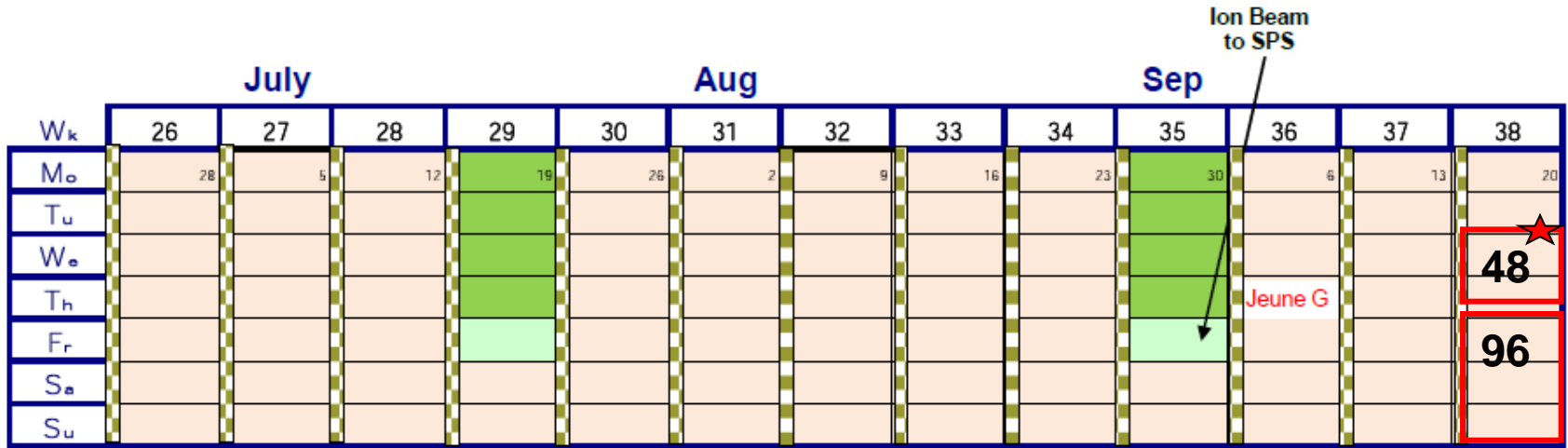
CMS preliminary result on Z boson



No bias with a
precision of 0.15%

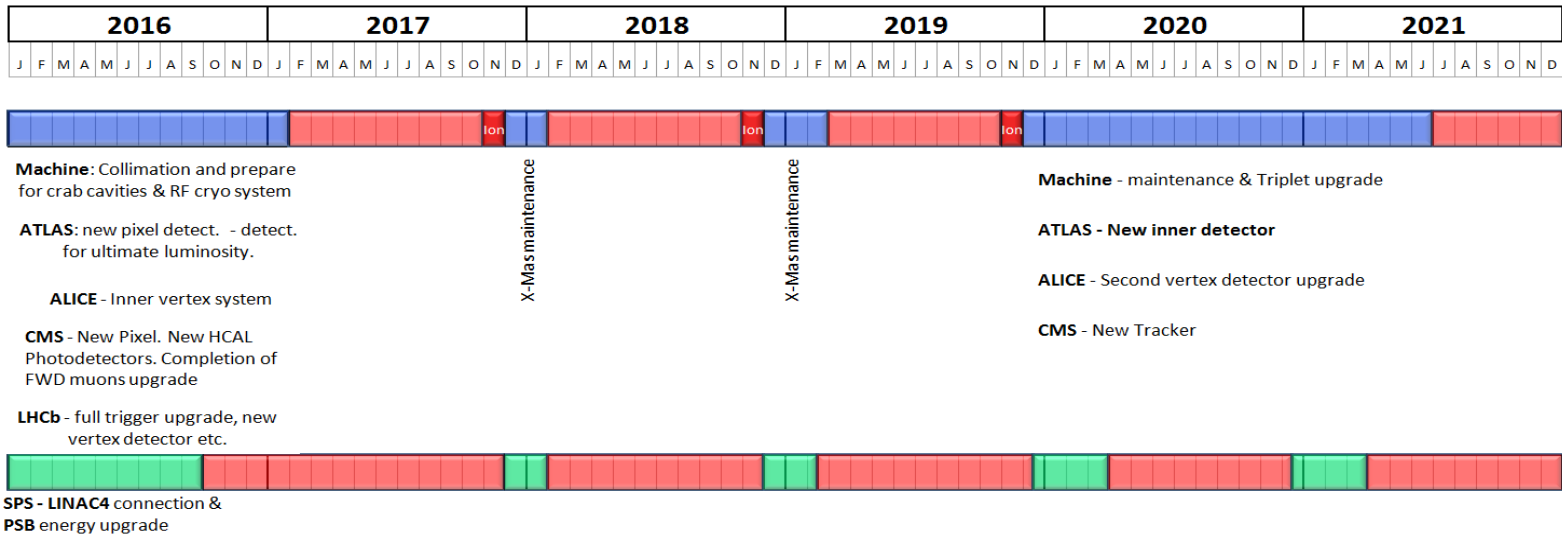
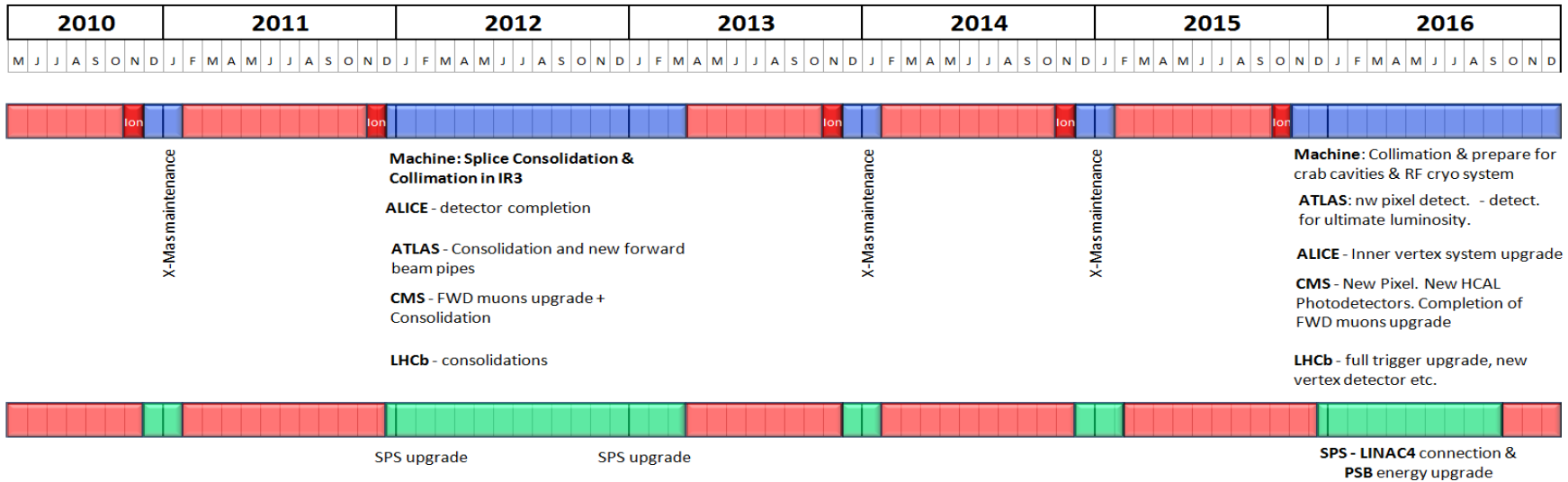
LHC Running Plans for 2010 & further

Aggressive Schedule (short term)



Injection of 24 bunches

The 10 year technical Plan



LHC Upgrade: Super LHC

**1st priority: Luminosity increase to
 $\sim 10^{35} \text{ cm}^{-2} \text{ s}^{-1}$.**

The other options:

- beam energy increase to $\sim 7.5 \text{ TeV}$ if running bending magnets at 9 T field;
- beam energy increase to 12.5 TeV if install new 15 T bending magnets.

**THANK YOU
FOR
YOUR ATTENTION**