HL-LHC

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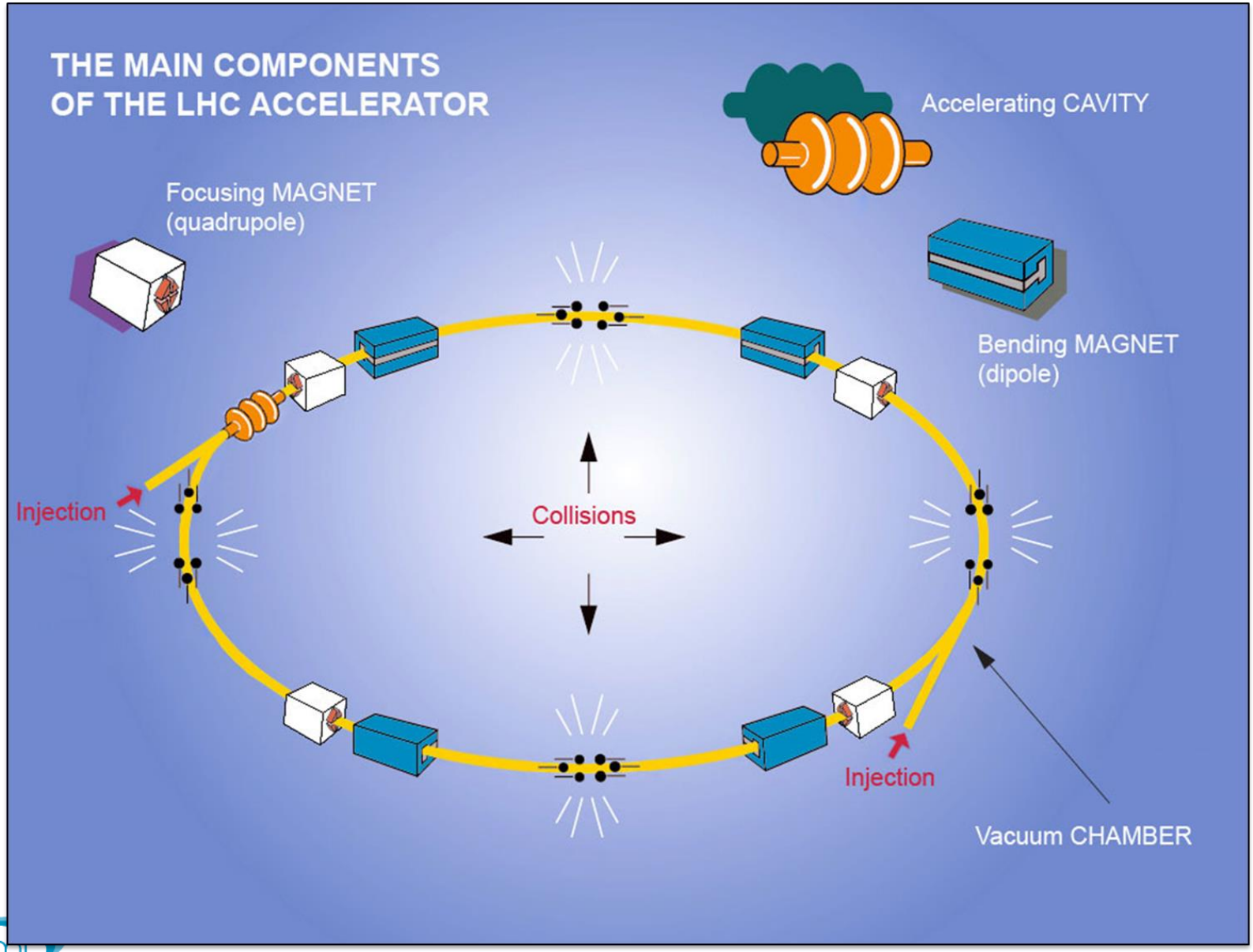
Project Leader

1st International Workshop of the Supeconducting Magnet Test Stands
CERN – Globe of innovation, 13 June 2016

LHC


THE MAIN COMPONENTS
OF THE LHC ACCELERATOR
Accelerating CAVITY
Focusing MAGNET
(quadrupole)
Bending MAGNET
(dipole)
Injection
Collisions
Injection
Vacuum CHAMBER

LHC
the largest scientific instrument

LHC dipoles: the collider backbone

- 27 km, p-p at 7+7 TeV
  3.5+3.5 start, 4+4 in 2012
  6.5+6.5 TeV in 2015
- 1232 x 15 m Twin Dipoles
- Operational field 8.3 T @11.85 kA (9 T design)
- HEII cooling, 1.9 K with 3 km circuits (130 tonnes He inventory).
- Field homogeneity **of 10** bending stren
  then 10
  (9 10).

The dipole line in the LHC ring

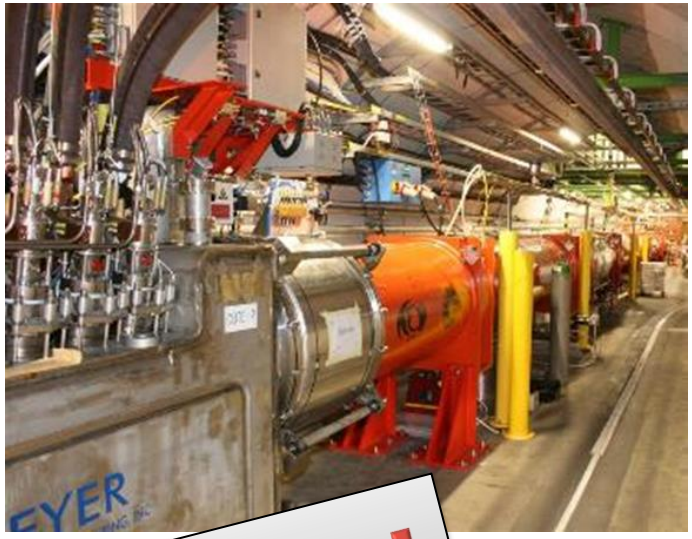
All fully cold tested

More than dipoles…

The pletora of SC magnets…

- 392 Main Quads Two-In-One rated for a peak field of 7 T.
- About 100 other Two-in-One MQs
- 32 MQX (low-β) single bore for luminosity (design $L=1 \cdot 10^{34}$ $cm^{-2}s^{-1}$), 70 mm apertures, about 8 T peak field, high quality
- A «zoo» of 7600 «small» Sc magnets (correctors and higher order magnets
- Total: 9 MJ stored energy (at nominal)
- Large detector m…

A…
C… GJ



All fully cold tested

SC radiofrequency, Cryogenics,

LHC: much more than magnets…

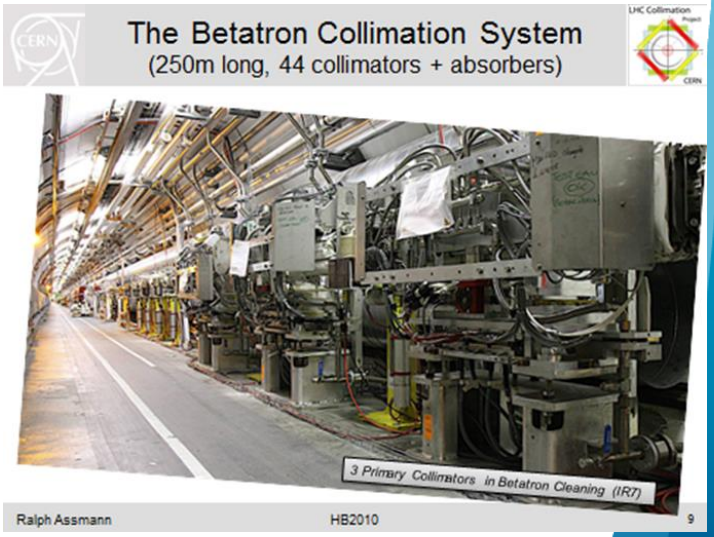
400 MHz Standing wave RF

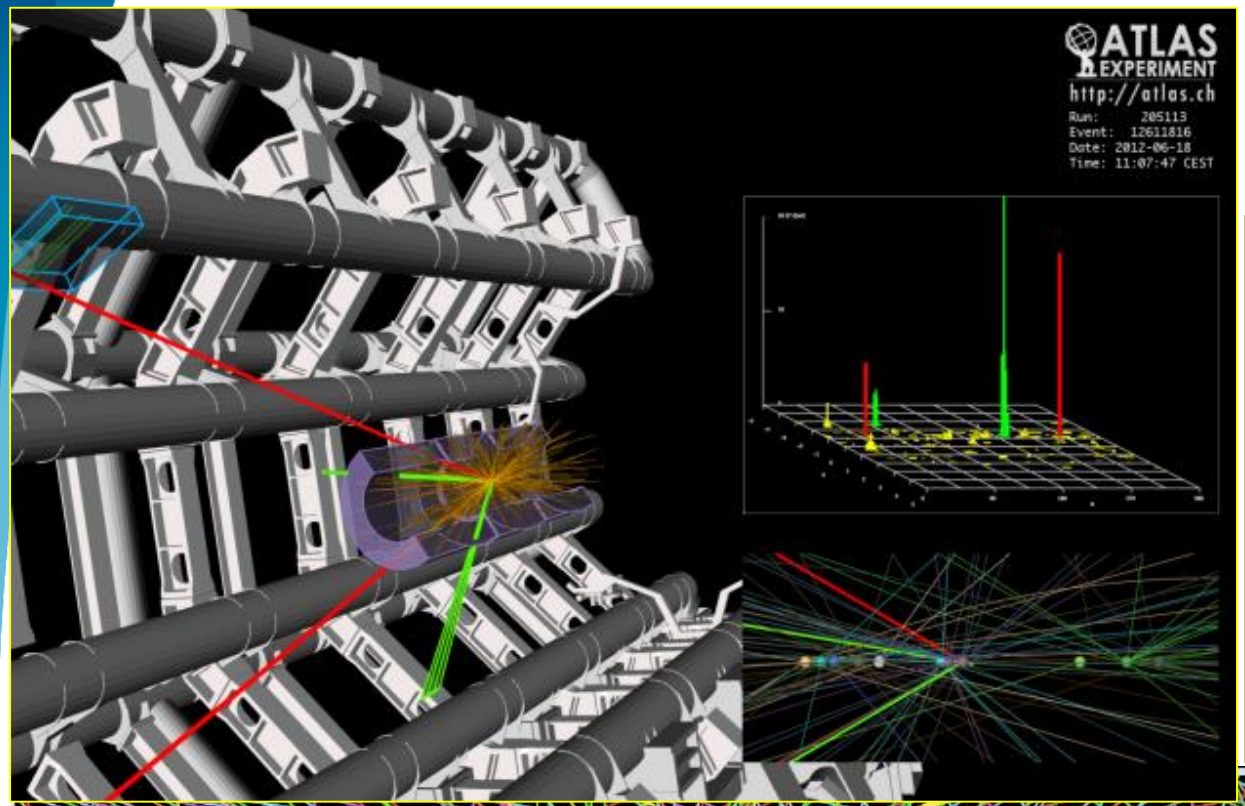
- 4 single cell cavities in cryomodule, 2 cr… beam …
- …ment 5.5 MV/m nominal (8 MV/m available)
- Nominal 2MV, up to 3 MV at 8 MV/m

All fully cold tested

Cryo : 8 x 18 kW@4.5K

Collimators: 146





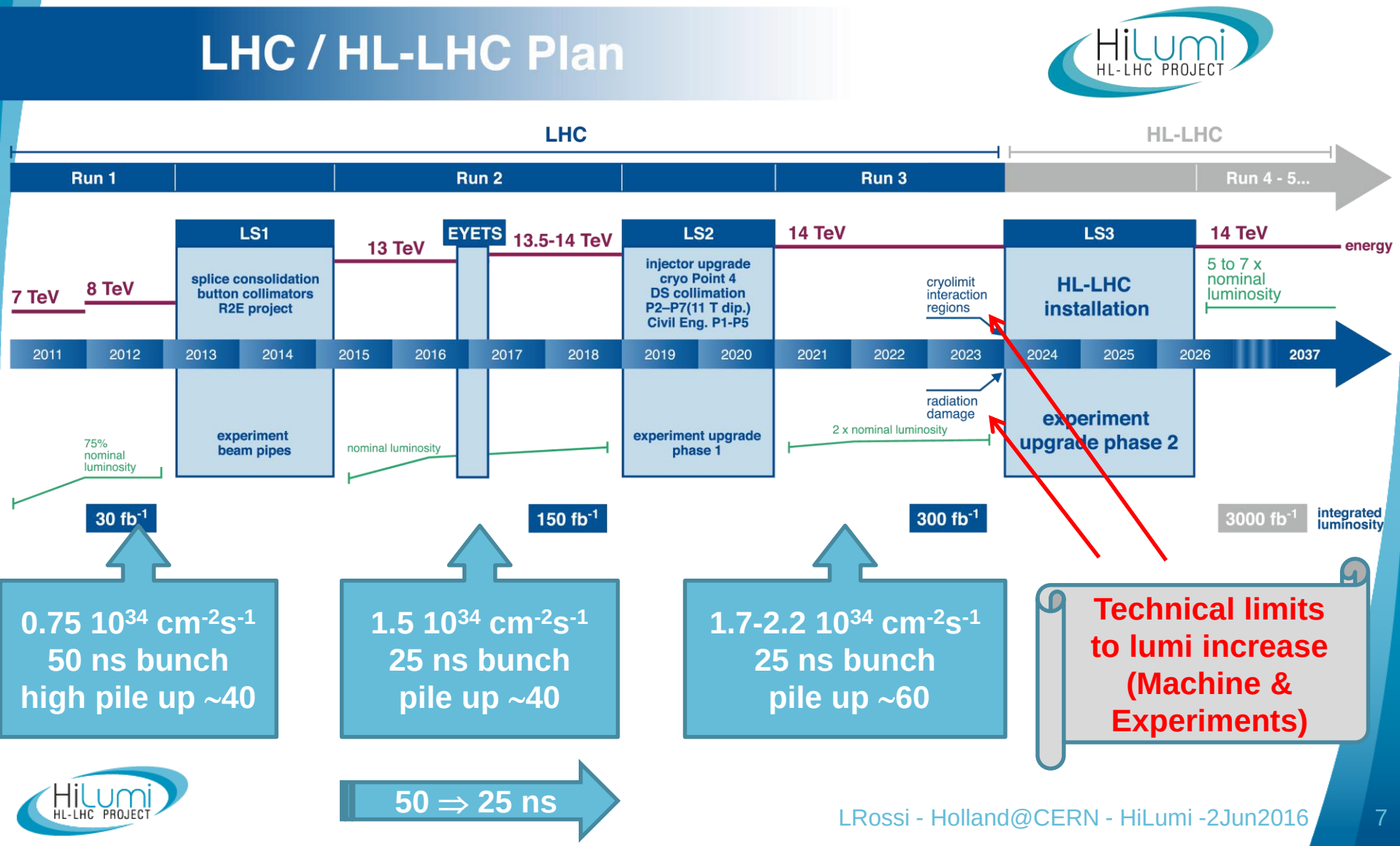
The Higgs: the needle in a haystack

luminosity: collision rate)

Z→ μμ

Z→ μμ event from 2012 data with 25 reconstructed vertice

Why upgrading the LHC?



The project started in 2010 as EC-FP7 Design Study

From FP7 **HiLumi LHC** Design Study application

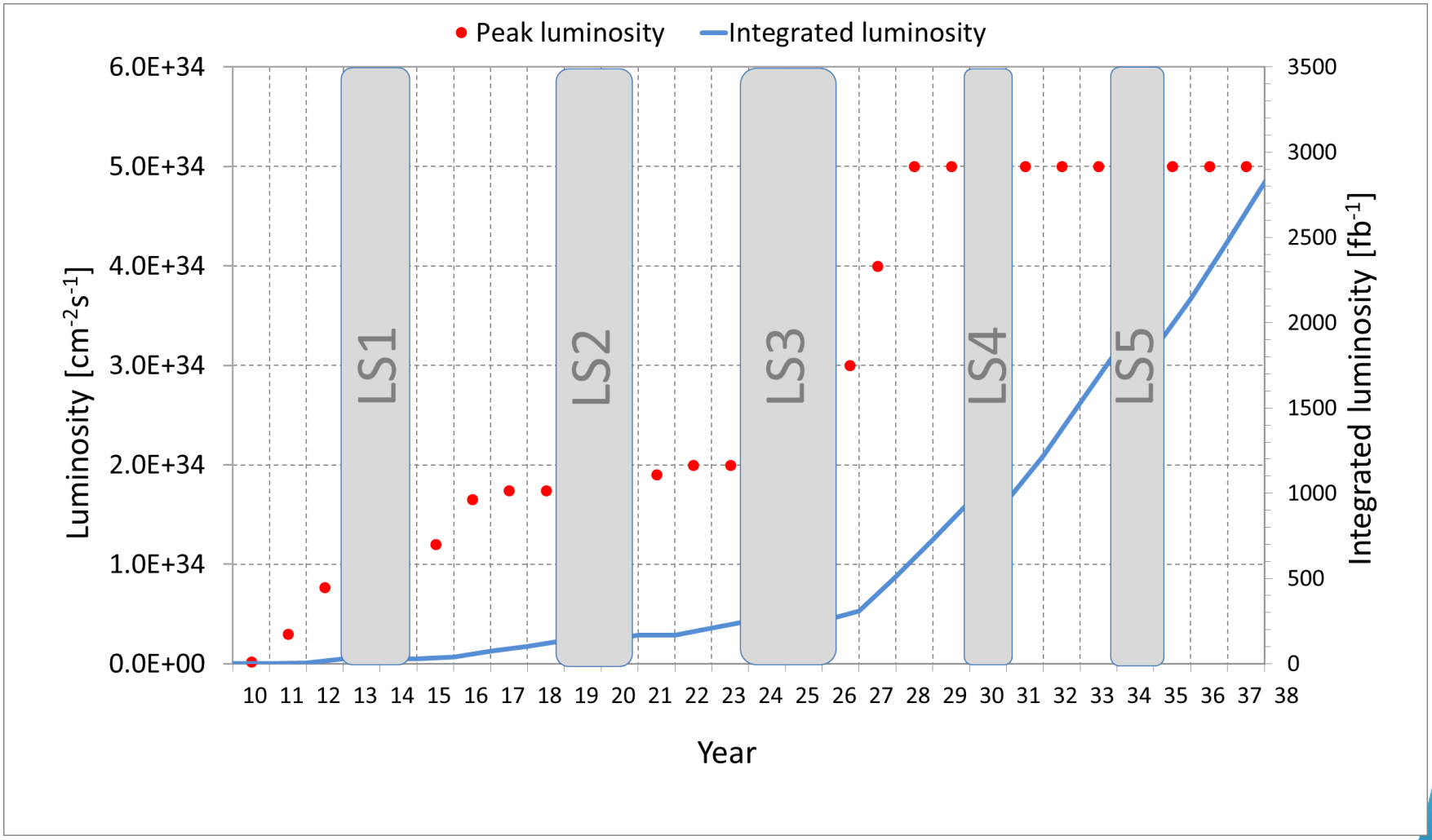
The HiLumi LHC Design Study (a sub-system of HL-LHC) is cofunded by the European Commission within the Framework Programme 7 Capacities Specific Programme, Grant Agreement 284404

The main objective of HiLumi LHC Design Study is to determine a hardware configuration and a set of beam parameters that will allow the LHC to reach the following targets:

A peak luminosity of L_{peak} = **5×10^{34} $cm^{-2}s^{-1}$ with levelling**, allowing:

An integrated luminosity of **250 fb^{-1} per year**, enabling the goal of **L_{int} = 3000 fb^{-1}** twelve years after the upgrade.
This luminosity is more than ten times the luminosity reach of the first 10 years of the LHC lifetime.

The bolt advance in luminosity

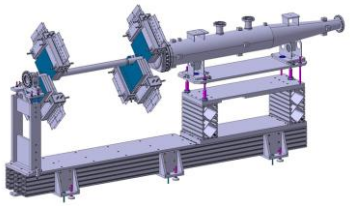


FP7-HiLumi classified as «success story» by EC

High Luminosity LHC

The HiLumi LHC Design Study (a sub-system of HL-LHC) is cofunded by the European Commission within the Framework Programme 7 Capacities Specific Programme, Grant Agreement 284404

Cryo@P4

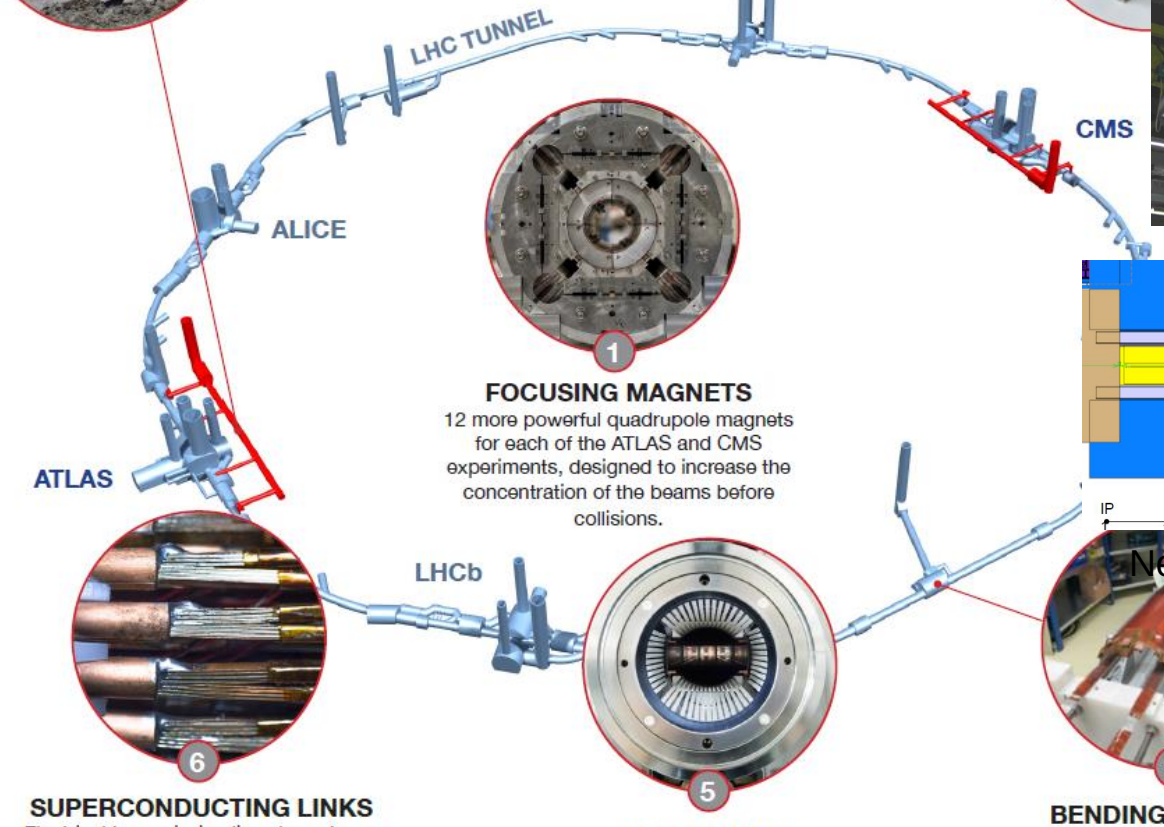


Beam diagnostics
BGV

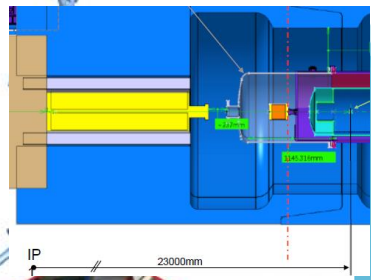
2 CIVIL ENGINEERING
2 new 300-metre service tunnels and 2 shafts near to ATLAS and CMS.

"CRAB" CAVITIES
16 superconducting „crab" cavities for each of the ATLAS and CMS experiments to tilt the beams before collisions.

Cryo@P1-P5



1 FOCUSING MAGNETS
12 more powerful quadrupole magnets for each of the ATLAS and CMS experiments, designed to increase the concentration of the beams before collisions.



New TAS and VCX

6 SUPERCONDUCTING LINKS
Electrical transmission lines based on a high-temperature superconductor to carry current to the magnets from the new service tunnels near ATLAS and CMS.

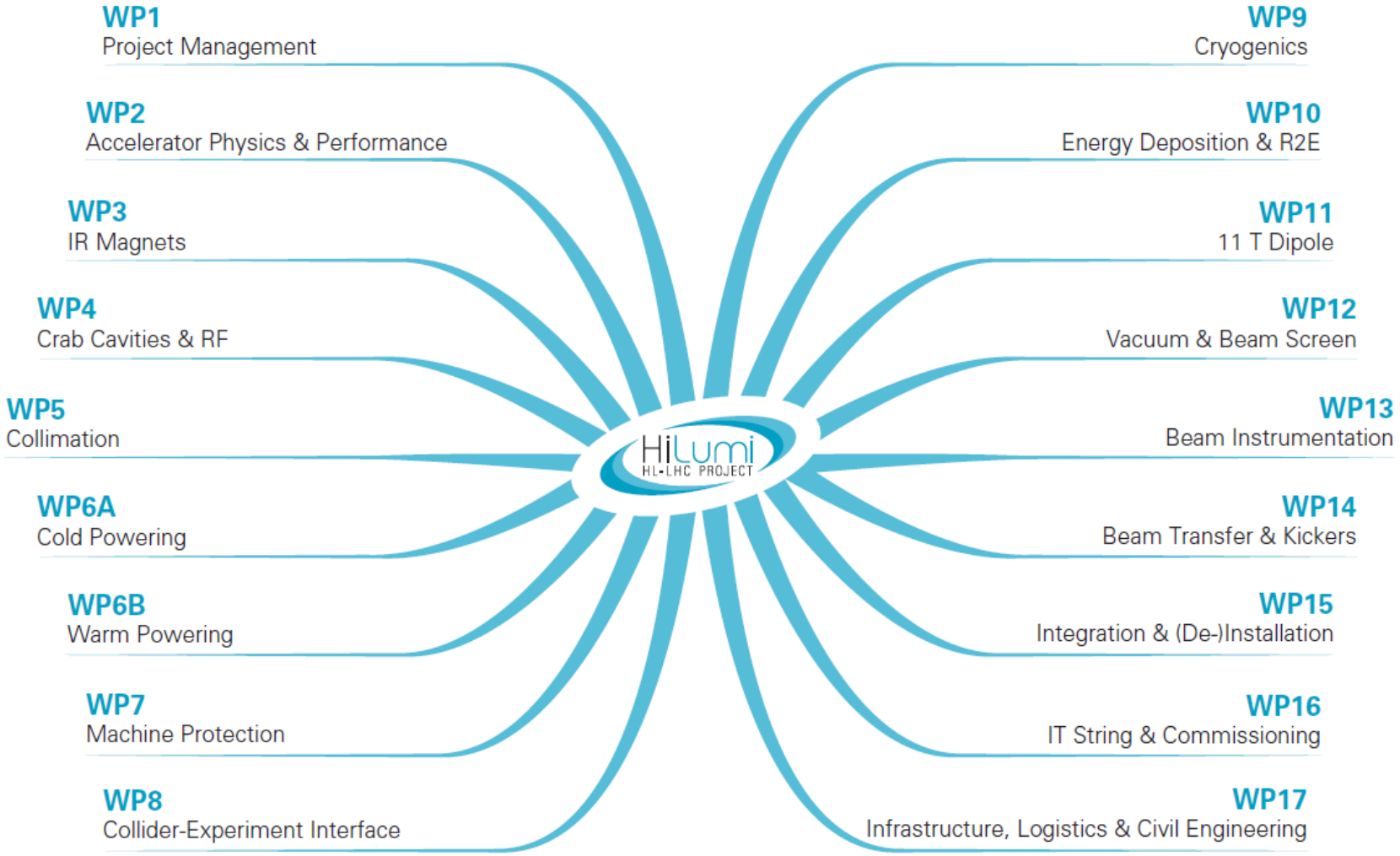
5 COLLIMATORS
15 to 20 new collimators and 60 replacement collimators to reinforce machine protection.

4 BENDING MAGNETS
4 pairs of shorter and more powerful dipole bending magnets to free up space for the new collimators.

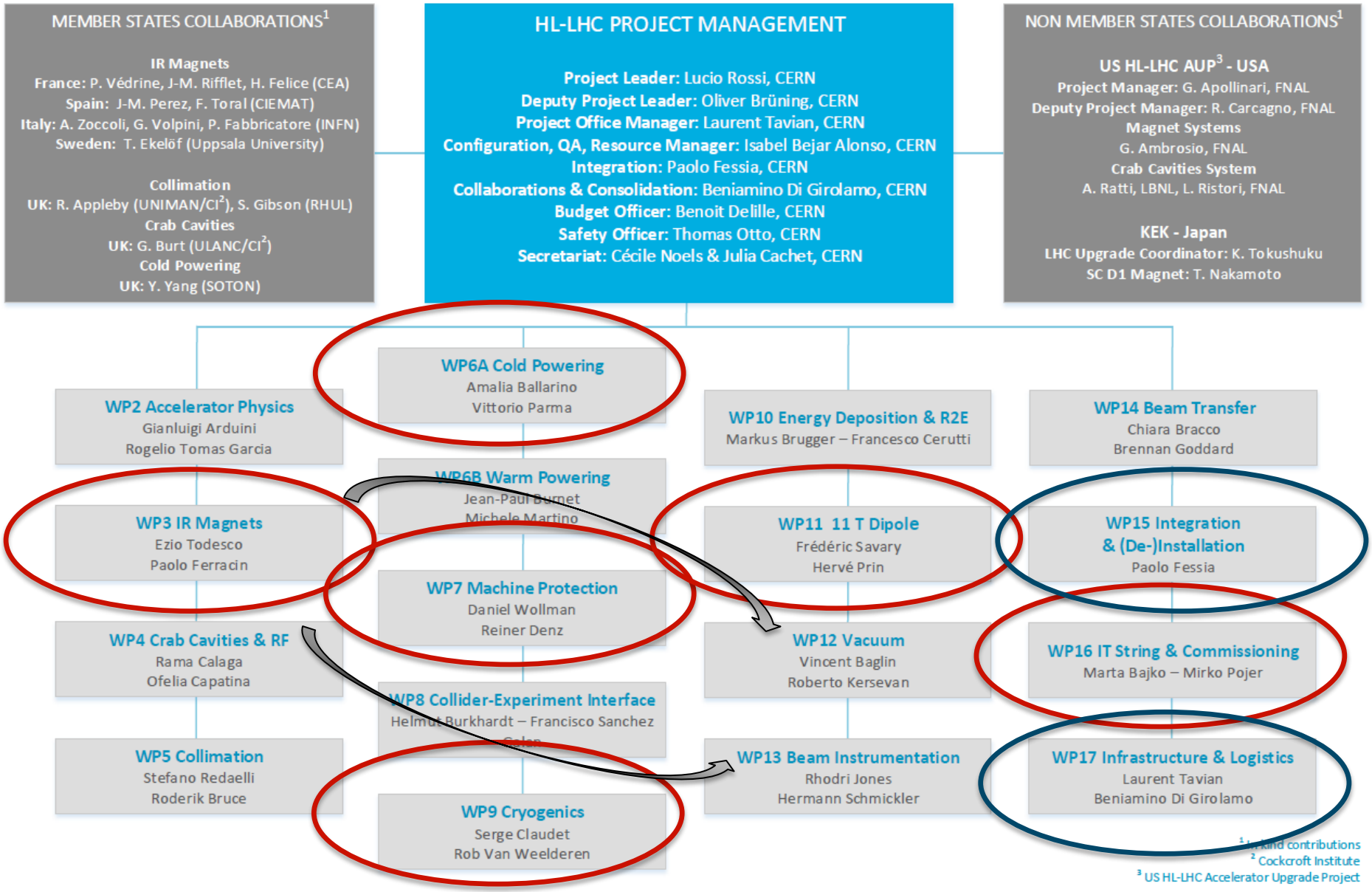
CERN November 2015

HiLumi HL-LHC PROJECT

HL-LHC project breakdown structure

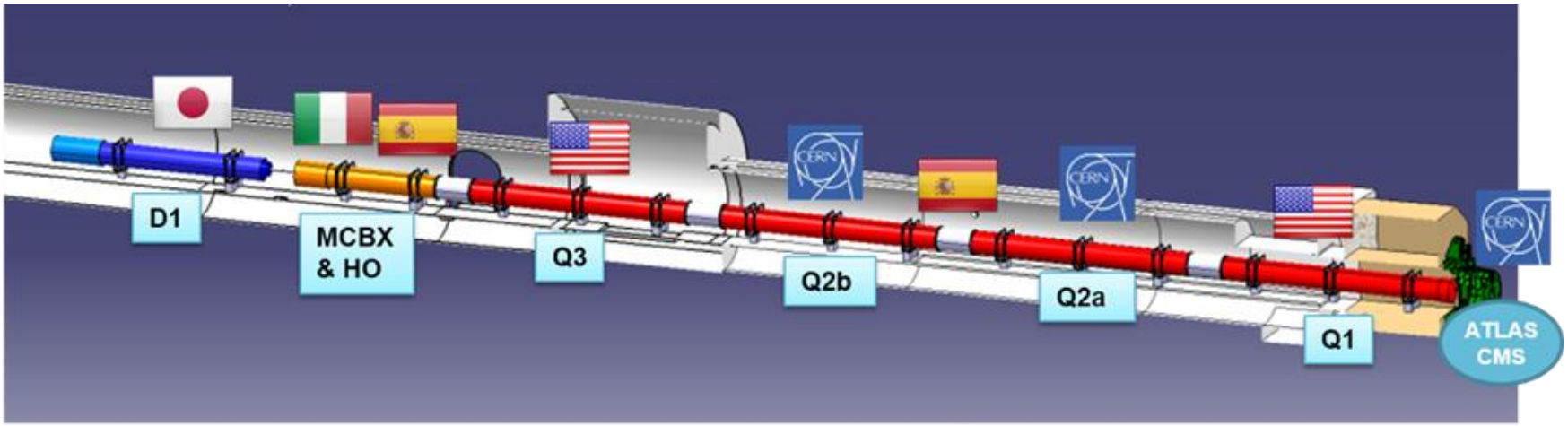


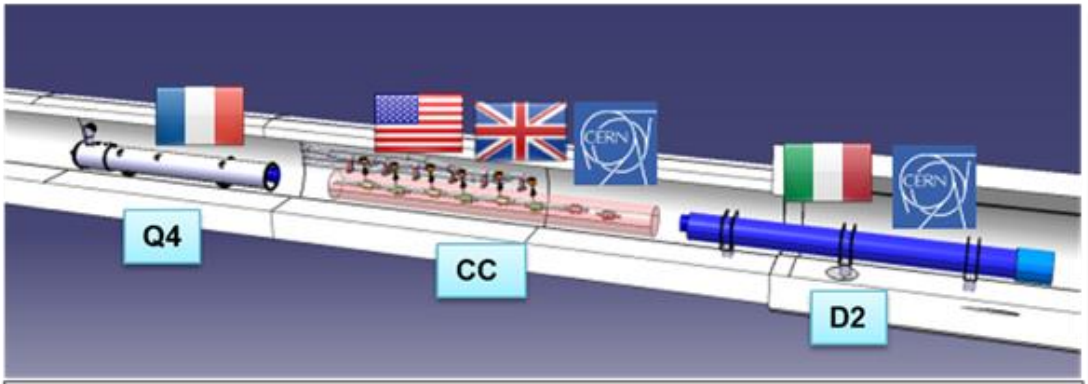
High Luminosity LHC Project



[1] + in-kind contributions
[2] Cockcroft Institute
[3] US HL-LHC Accelerator Upgrade Project

Deep changes in the Inner Triplet region (around ATLAS & CMS experiments)



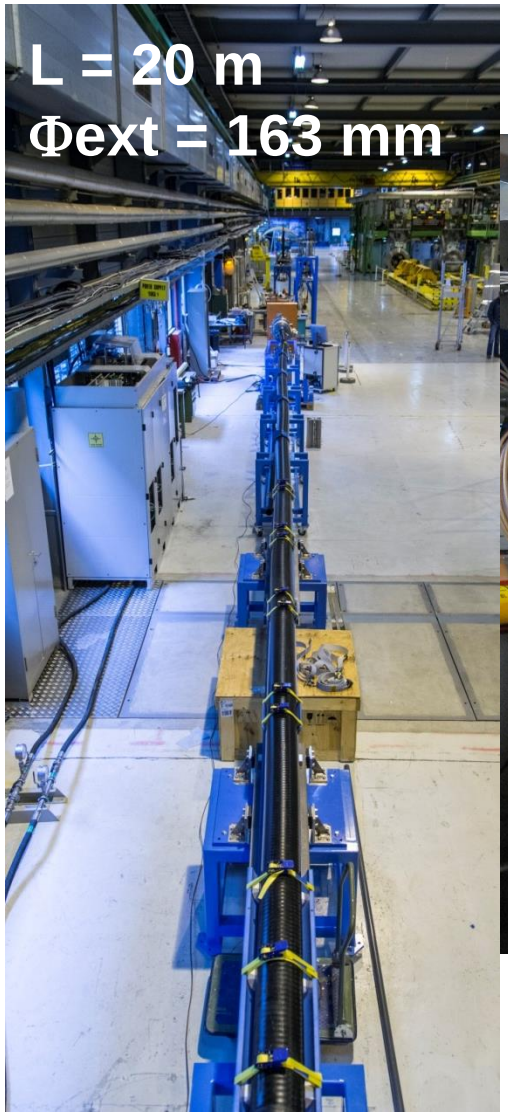


CC : R&D, Design and in-kind **USA & UK**

Q1-Q3 : R&D, Design, Prototypes and in-kind **USA**
D1 : R&D, Design, Prototypes and in-kind **JP**
MCBX : Design and Prototype **ES**
HO Correctors: Design and Prototypes **IT**
D2 Design **IT**
Q4 : Design and Prototype **FR**

International collaborations: an opportunity and a challenge, also for testing!

Magnets, Nb_3Sn, NbTi, Correctors, SC links, DFs,…



International collaboration regards also tests

- SM18 @ CERN
  - HiLumi has triggered the SM18 upgrade and pays about half of it.
  - HiLumi IT string is in the plan since 2015 (see talk)
- US/LARP-AUP : FNAL and BNL
- KEK
- INFN-LASA (Milano)
- UPPSALA univ. (FREIA)
- CEA (possibly)
- More?

HiLumi counts on cryogenic full power tests: no harware will be installed without test

- First test in the chain is the strand/conductor! Try also to be synergic to these test!
- A Magnet not testet is not worth anything, yet!
- Testing, for HiLumi like for LHC, is integral part of the design-construction-qualification cycle:
  - Validation of design & basic choice
  - Verification of performance and of conformity to specs
  - Most crititical acceptance,releasing payment and **tranfer of properties** (from Industry or Collaboration)
    - → time and schedule are IMPORTANT!!!
  - Anticipate HWC and operation issues (stand-alon test and especially IT string)

Thanks to Marta for orgnaizing this meeting and all of you for the great support to HiLumi