



Scope of collaboration

CDTI – CERN – CIEMAT Meeting #1

Lucio Rossi
HL-LHC Project Leader

CERN, 13 February 2020

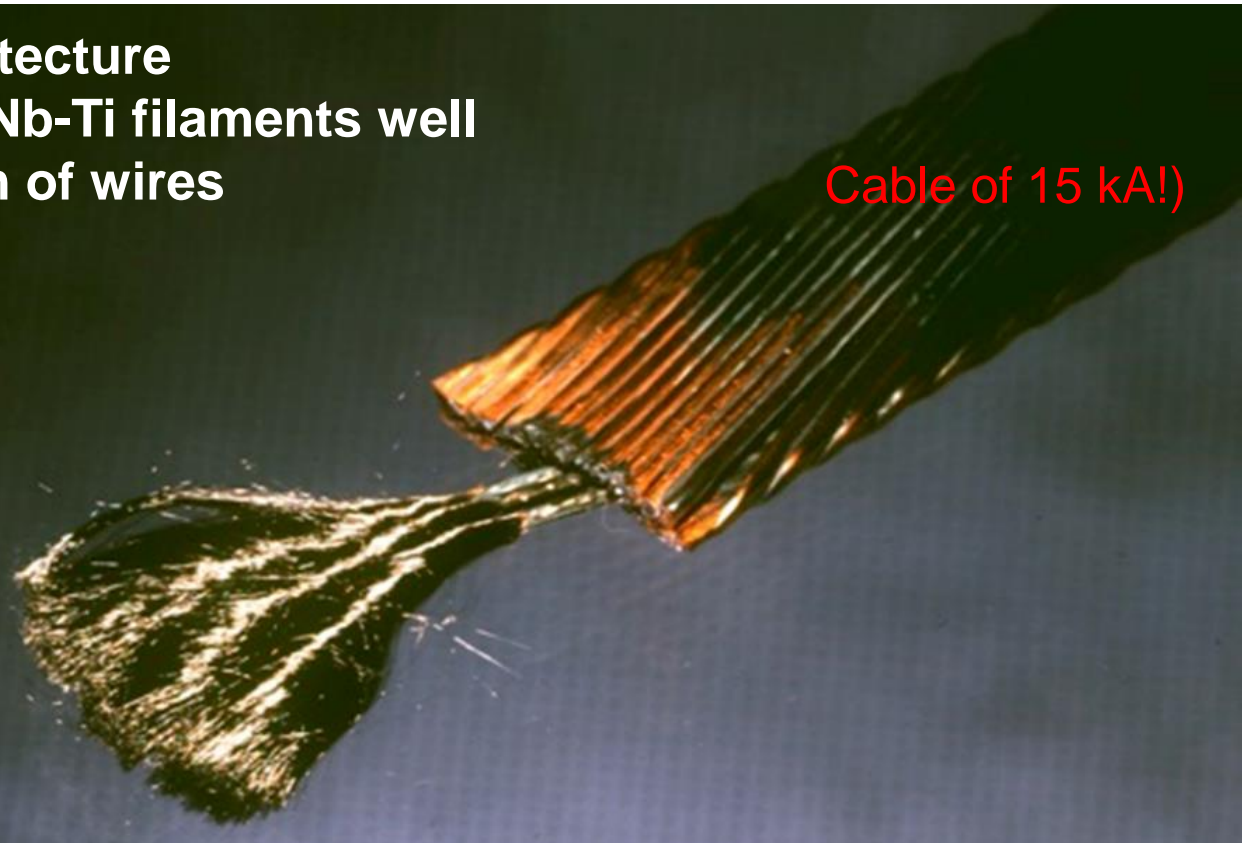
CERN & LHC



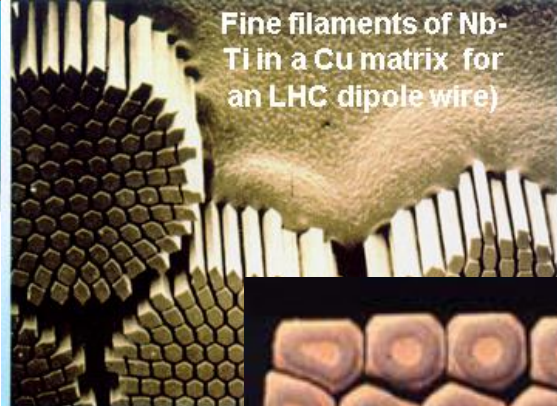
Very complex architecture

Thousands of fine Nb-Ti filaments well separated along km of wires

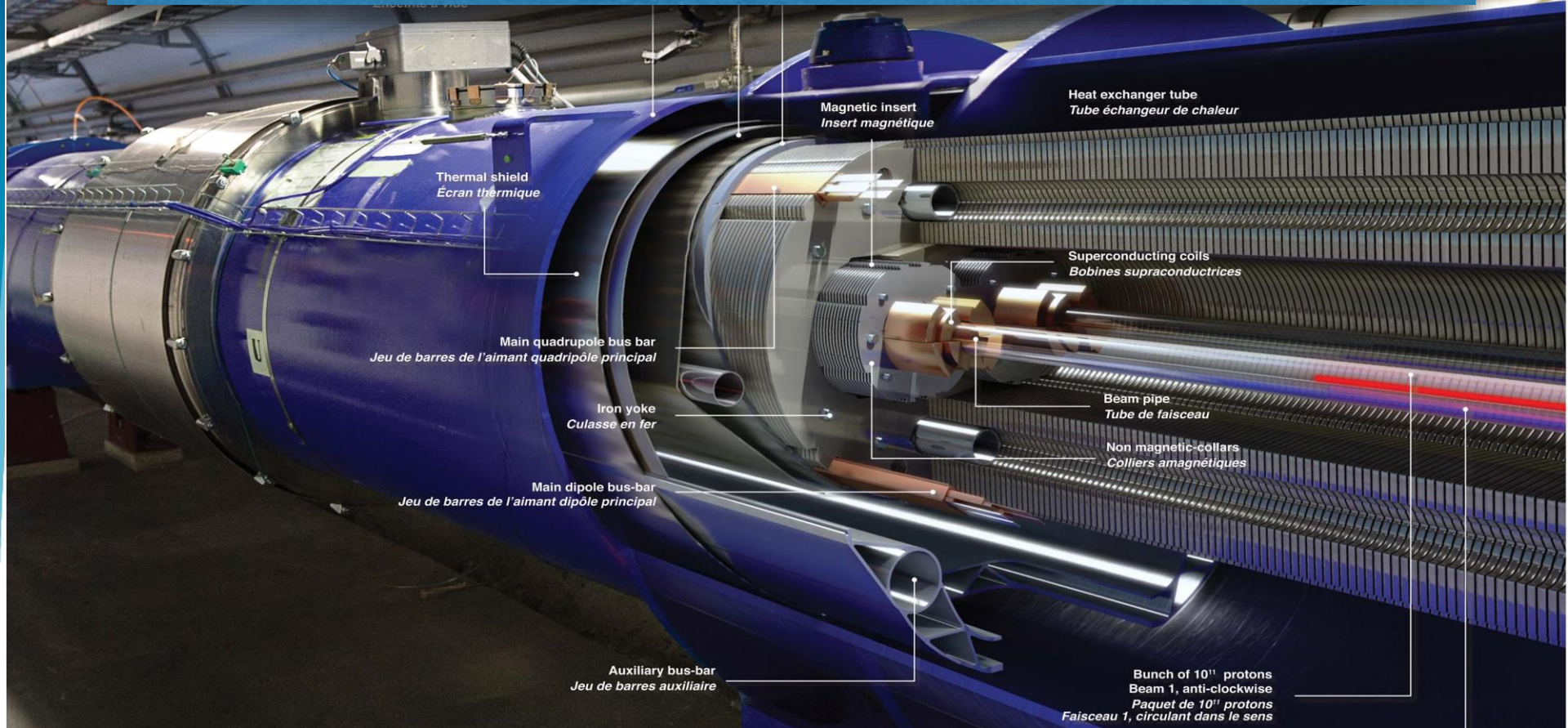
Cable of 15 kA!



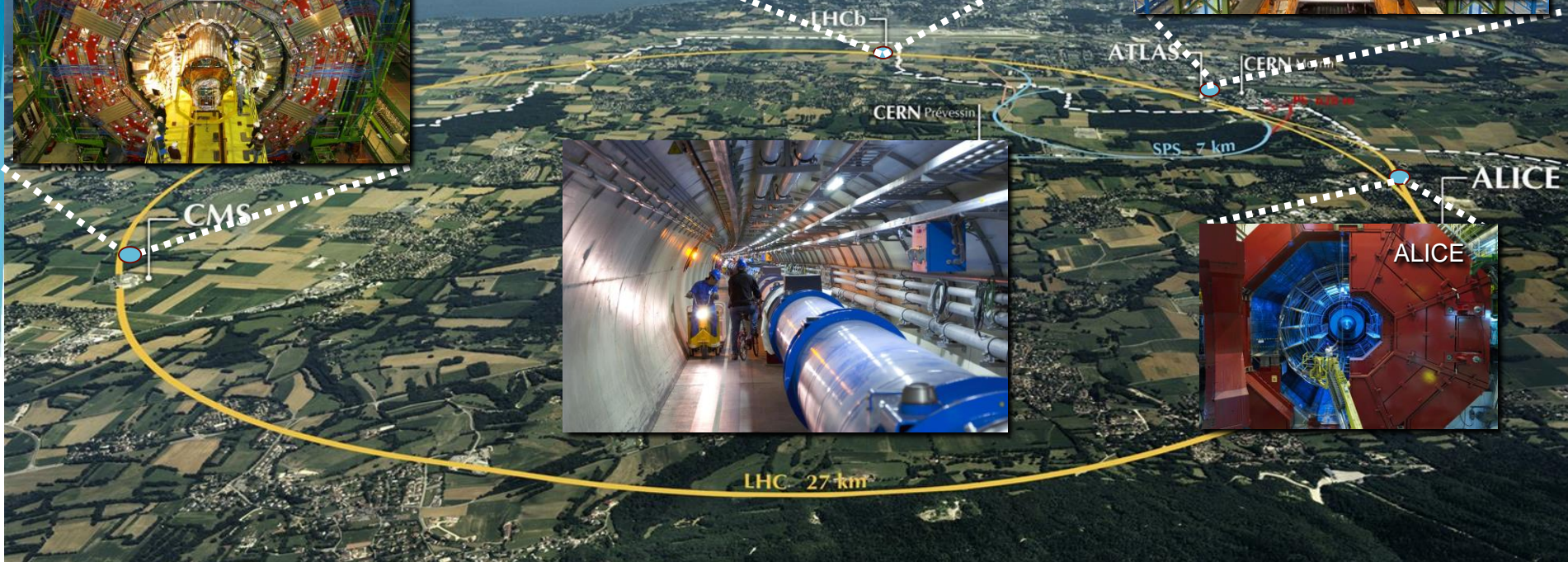
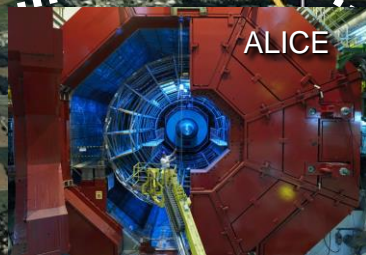
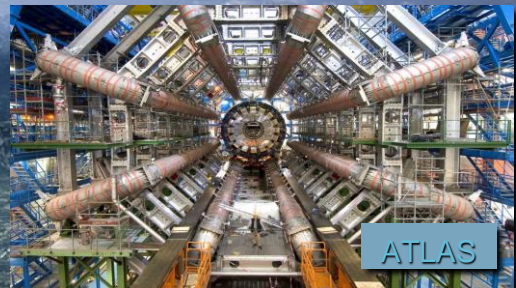
Fine filaments of Nb-Ti in a Cu matrix for an LHC dipole wire)



More than 20 years to develop and build the LHC dipole magnets



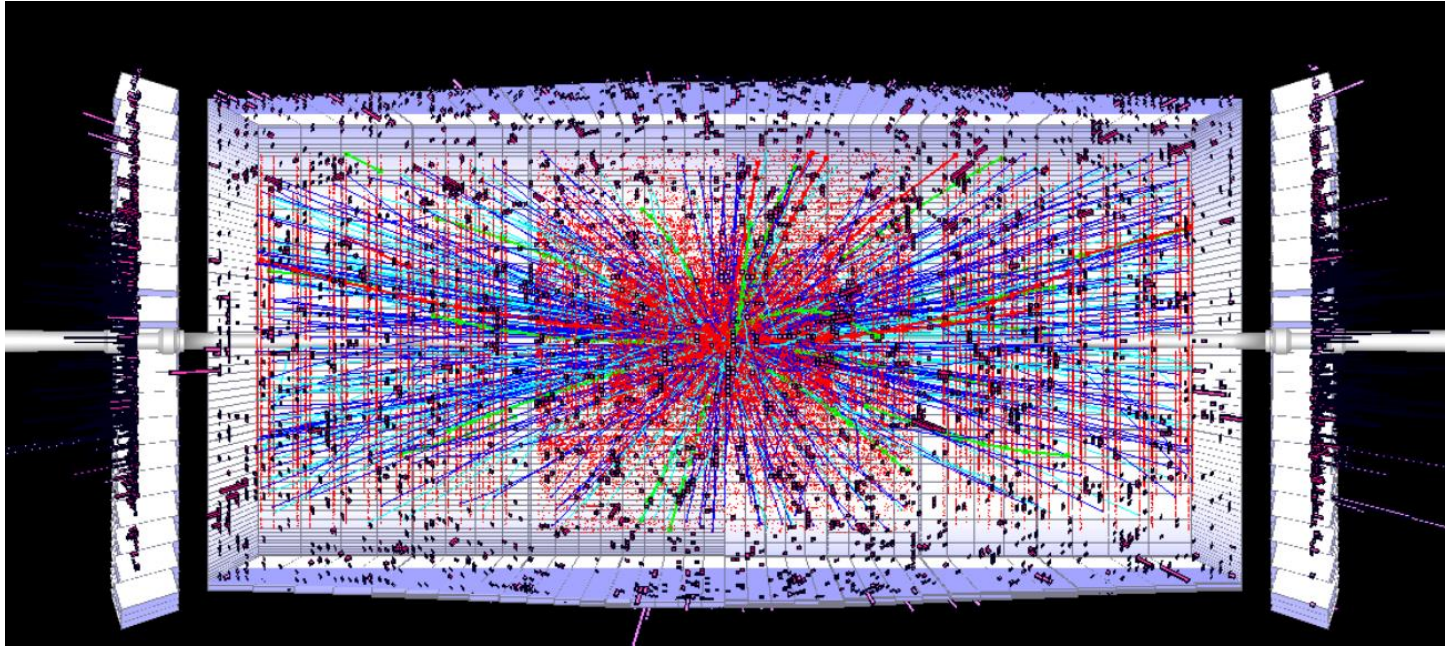
LHC the supermicroscope with its big four eyes



High Luminosity: a bright future for the LHC

Generate more light → machine upgrade

Better eyes to profit of higher luminosity → detector upgrade



Goal of HL-LHC

From EC-FP7 HiLumi LHC Design Study application of 2010

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 $L_{\text{peak}} = 5 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$ **with levelling**, allowing:

An integrated luminosity of **250 fb⁻¹ per year**, enabling the goal of

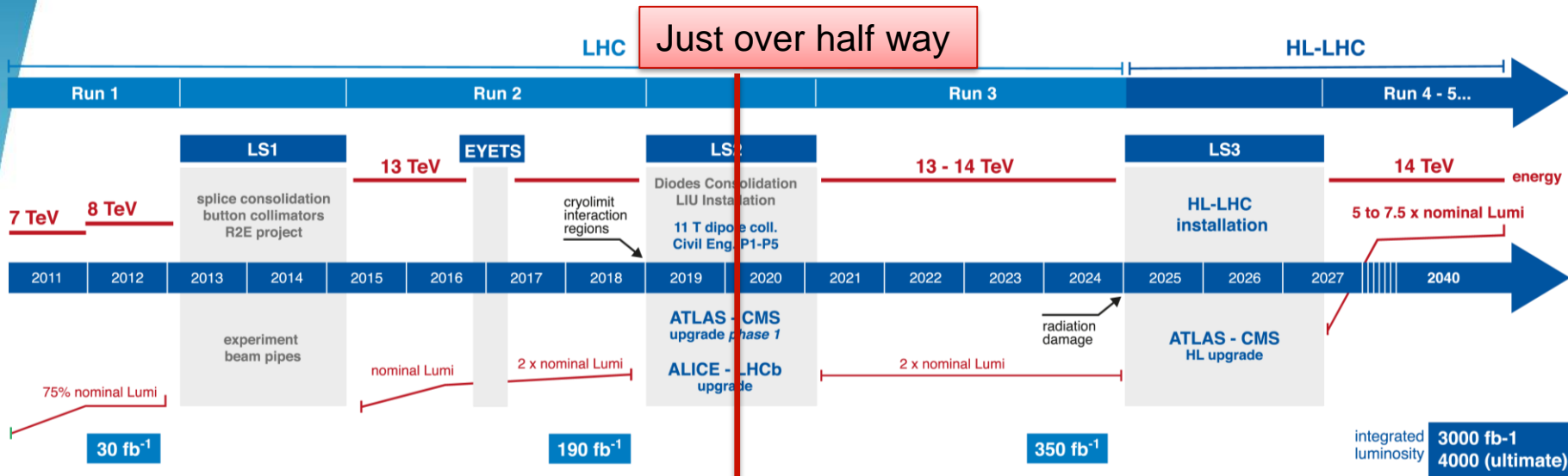
$L_{\text{int}} = 3000 \text{ fb}^{-1}$ twelve years after the upgrade.

This luminosity is more than ten times the luminosity reach of the first 10 years of the LHC lifetime.

**Approved by ESU for PP 2013 as next major European project;
Then fully approved and funded by CERN Council in June 2016**



LHC / HL-LHC Plan



HL-LHC TECHNICAL EQUIPMENT:



HL-LHC CIVIL ENGINEERING:



HiLumi covers almost 20 years from summer 2010 (CERN DS establishment) to operation in summer 2027



IN-KIND CONTRIBUTIONS

EU in-kind collaboration



Collaboration with personnel



CERN -
KEK R&D



BINP+...
Absorbers
CC ampli.
C. Leads
e-lens
LBDS

BLM
Crystal
Coll.

TRIUMF
CC
cryostat

IHEP
CCT
correctors

KEK D1
design &
construction



FP6
CARE
Nb3Sn



FP7
sLHC PP
(INJ)

sLHC INJ
implem.

LHC Injectors Upgrade
implementation

FP7
EuCARD
HiField
Dip

HL-LHC
Prototyping &
Construction

HL-LHC
Install. & Comm.

Hi-Lumi LHC
HL-LHC Construction

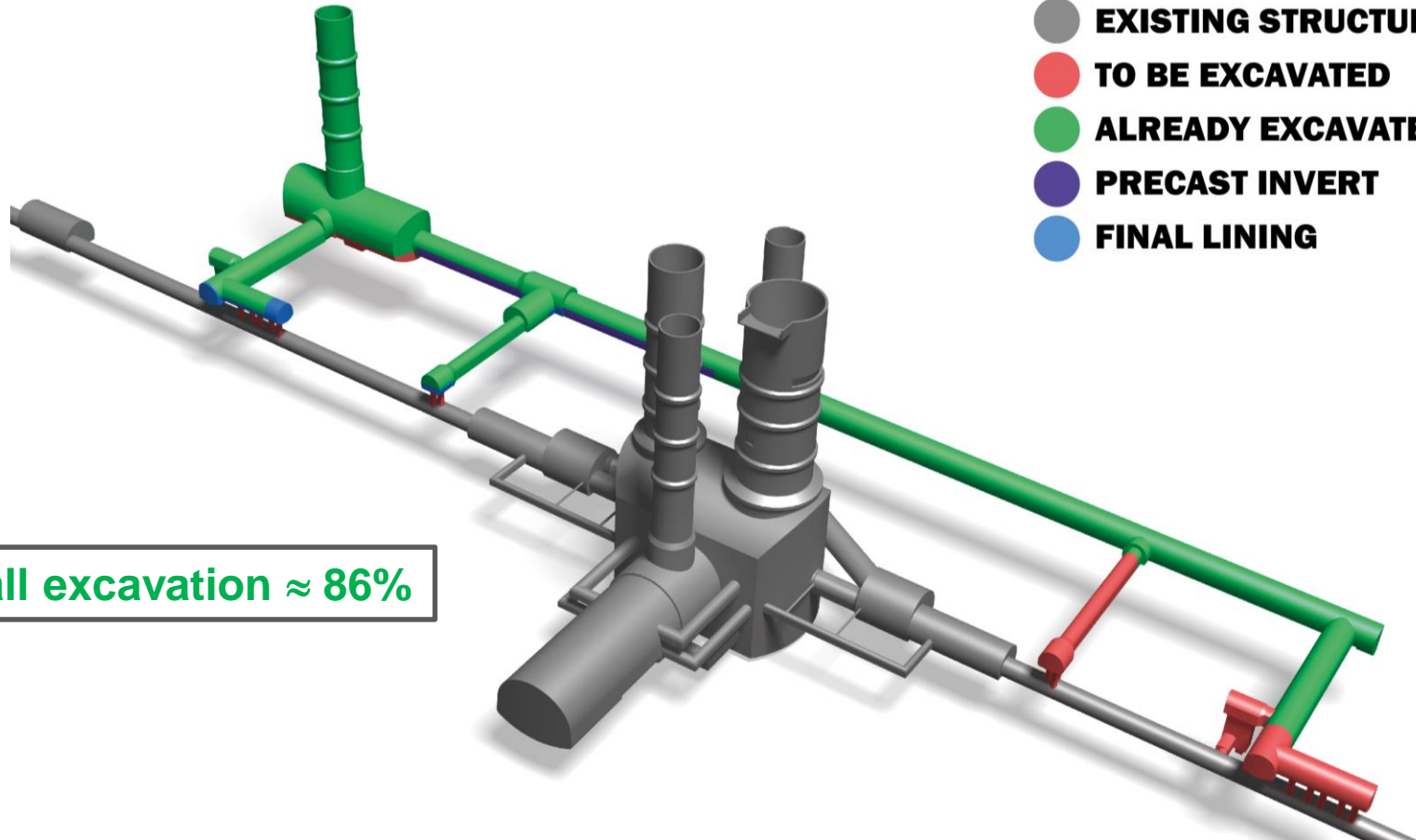
HiLumi:
a global
project
since the
start

Schedule is complex since in-kinds are interleaved with our works: we do not receive finished equipment)

HL-LHC excavation in P1

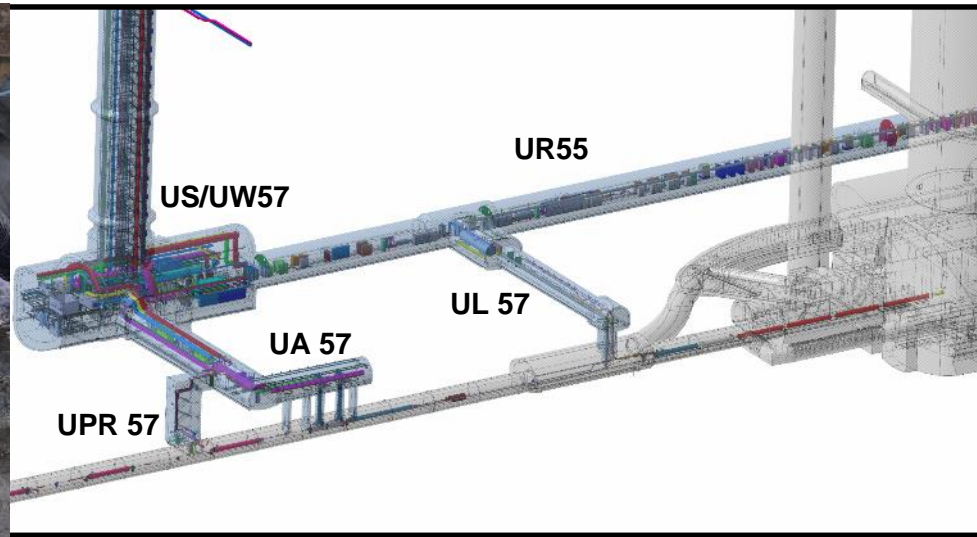
STATUS: 2020.01.17

- **EXISTING STRUCTURES**
- **TO BE EXCAVATED**
- **ALREADY EXCAVATED**
- **PRECAST INVERT**
- **FINAL LINING**



Overall excavation \approx 86%

US/UW57 cavern with entrance to UR55 and UA57 galleries



Location of future UPR57 access door into LHC

Technology Intensive Project

Technology landmarks

No accelerator project has so many absolute novelties and in such a broad technology spectrum



CLIQ
A novel concept of magnet protection, based on fast injection of oscillating currents, will improve the safety of the very large stored energy quadrupoles.



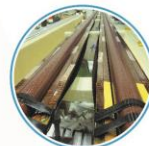
"CRAB" CAVITIES
8 SRF "crab" cavities on each side of ATLAS and CMS experiments to tilt beams at collision.



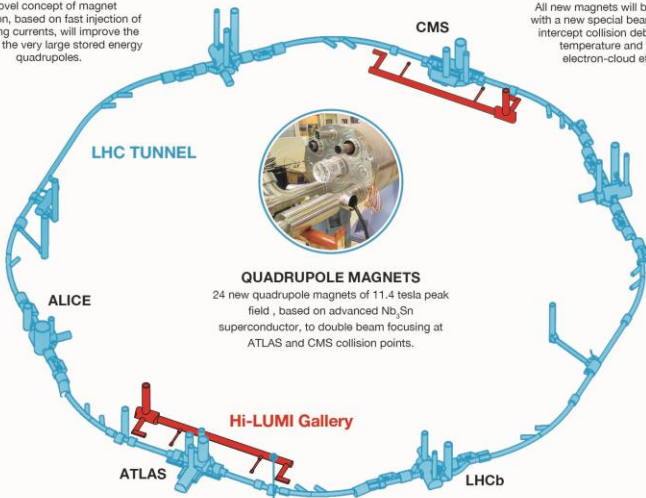
BEAM SCREEN
All new magnets will be equipped with a new special beam screen to intercept collision debris at 60 K temperature and cancel electron-cloud effects.



CRYOGENICS
2 new large 1.9 K helium refrigerators for HL-LHC near ATLAS and CMS will allow cryo-separation between arcs and triplet regions.



11 T DIPOLE MAGNET
2 pairs of bending magnets, based on advanced Nb₃Sn superconductor and much stronger than LHC dipoles, to free up space for special collimators in the cold regions



QUADRUPOLE MAGNETS
24 new quadrupole magnets of 11.4 tesla peak field, based on advanced Nb₃Sn superconductor, to double beam focusing at ATLAS and CMS collision points.



BEAM GAS VERTEX
Two new novel beam instruments based on beam gas vertex detectors will allow non-invasive accurate measurements of the beam size.



COLLIMATORS
20 novel low impedance collimators for beam stability and further 24 new collimators for improved machine protections




CIVIL ENGINEERING
2 new caverns, 1km underground galleries, two new large shafts; 10 new technical buildings on surface in P1 and P5 (near ATLAS and CMS)




SUPERCONDUCTING LINKS
8 novel electric current superconducting lines, 140 m long and rated for 30-100 kA, based on M₃B₂ superconductor operating at a temperature up to 20 K.

And more technology novelties...



Canted Cosine Theta – CCT
For D2 (Dual) orbit correctors
CERN-IHEP Beijing



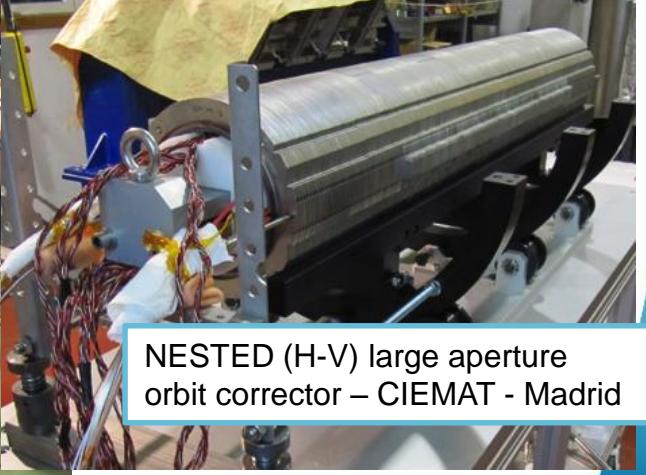
Super Ferric magnets for single
large aperture HO Correctors
INFN-LASA-Milan



D1 large aperture– KEK

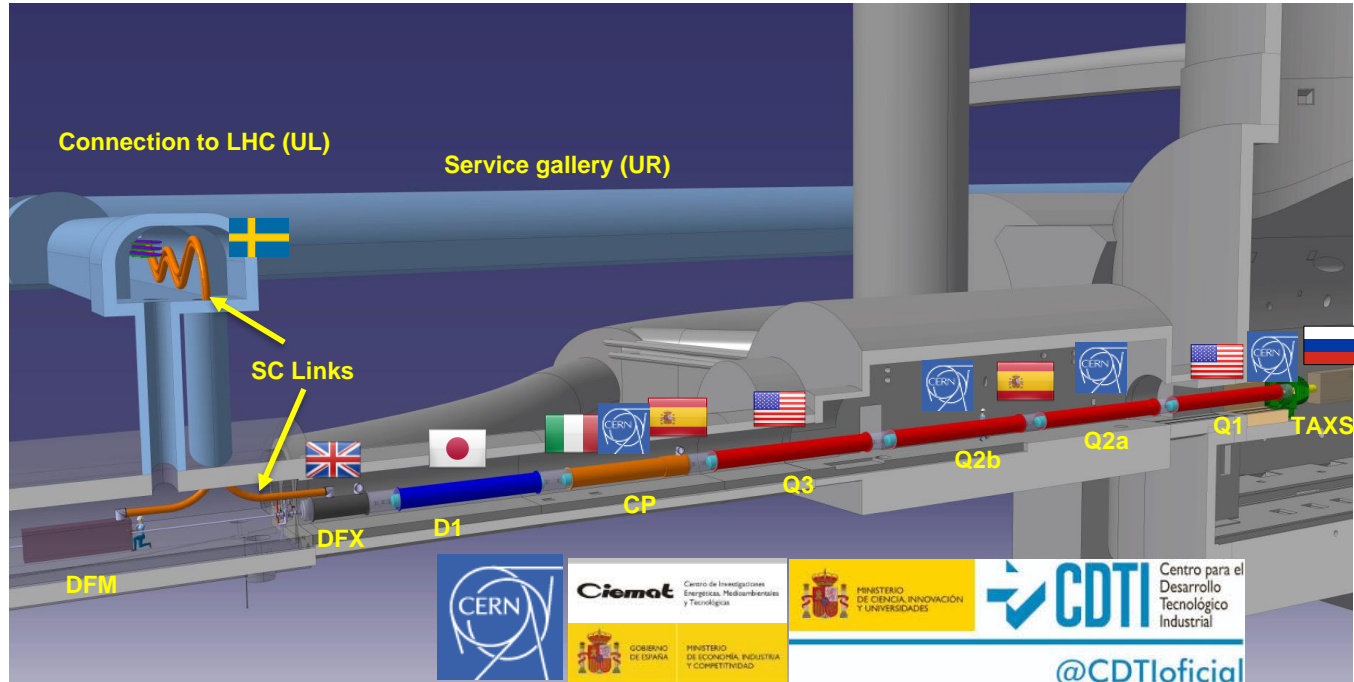


D2 INFN-Genova
Asymmetric coils



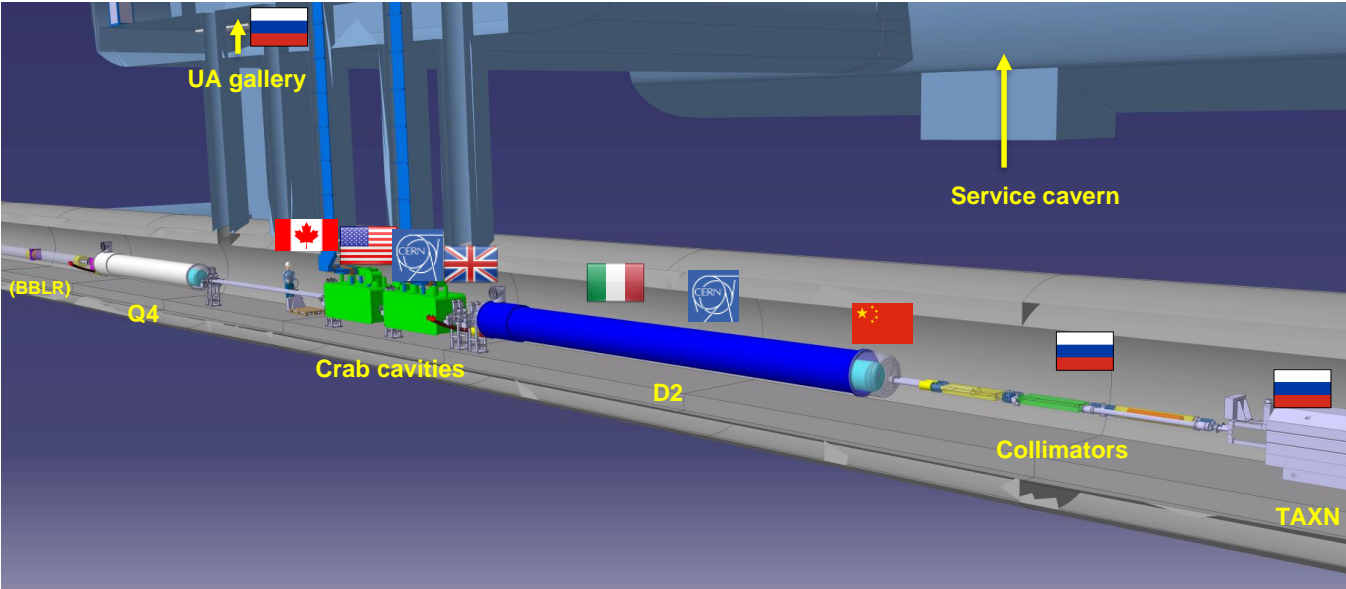
NESTED (H-V) large aperture
orbit corrector – CIEMAT - Madrid

High Luminosity LHC - IT region



We need the Spanish collaboration and Industry!

High Luminosity LHC – Matching Section



HiLumi LHC is a wonderful project in a unique environment: thanks for joining us in this adventure!

