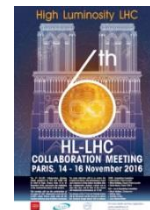




Pasquale Fabbricatore  
VI HL-LHC Collaboration meeting  
Paris 14/11/2016



# Superconducting Magnet Developments at INFN for HL-LHC and other CERN programs

P.Fabbricatore

INFN



*A dear  
friend left us*

Giovanni Volpini 1962-2016

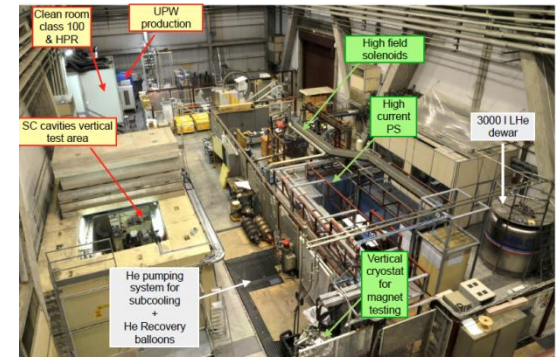


## Outline

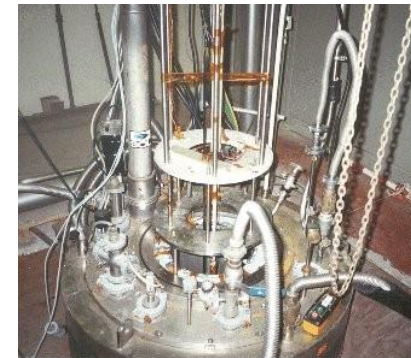
- 1) Applied superconductivity and cryogenics in INFN
- 2) MAGIX and INFN participation to HL-LHC
- 3) The development of the corrector magnets at Milano LASA
- 4) The design of D2 at INFN Genova
- 5) New agreements
- 6) Future

## Applied superconductivity and cryogenics in INFN

- INFN can count on a distributed large technical infrastructure for applied superconductivity dedicated to coordinated developments and tests of superconducting magnets for accelerators and accelerating cavities.
- The infrastructure is based on large cryogenic facilities located in four different sections and laboratories (Genova, Laboratori di Legnaro, Milano-LASA and Salerno-Napoli), some of them operating since 30 years.
- All local facilities are equipped with cryogenic plants for liquid helium (bi-phasic and supercritical) with cooling power at 4.2K ranging from 100 W to 1100 W.
- The facilities dedicated to sc magnets can count on large power converters up to 20 kA at 25 V and all ancillary equipment for testing long magnets (up to 8 m) in vertical and horizontal cryostats.



Milano- LASA



Genova



Napoli-Salerno

# MAGIX & INFN participation to HL-LHC

## MAGIX

<b>WP1</b>	CORRAL	Design, construction and test of the five prototypes of the corrector magnets for the HL interaction regions of HiLUMI
<b>WP2</b>	PADS	2D & 3D engineering design of the D2 magnets
<b>WP3</b>	SCOW-2G	Development of HTS coil for application to detectors and accelerators
<b>WP4</b>	SAFFO	Low-loss SC development for application to AC magnets

## CERN-INFN Collaboration Agreement

CERN endorses MAGIX WP1 & WP2 deliverables and milestones, contributing with 527 k€, through the collaboration agreement KE2291/TE/HL-LHC



1



2



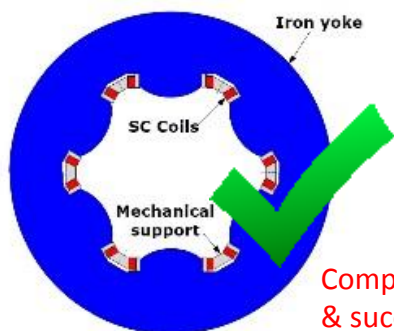
INFN already involved in FP7-HiLumi  
 WP2 beam dynamics, LNF  
 WP3 magnets, MI-LASA  
 WP6 cold powering, MI-LASA

**MAGIX** is a INFN-funded research project, (1.3 M€ in 2014-2017) with goal to develop superconducting technologies for application to future accelerator magnets . It includes four WP's, two of which are relevant to HL-LHC



# Development of corrector magnets at Milano LASA

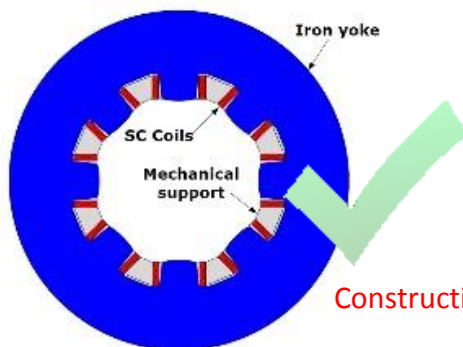
OD=320 mm



Completed & successfully tested

Sextupole

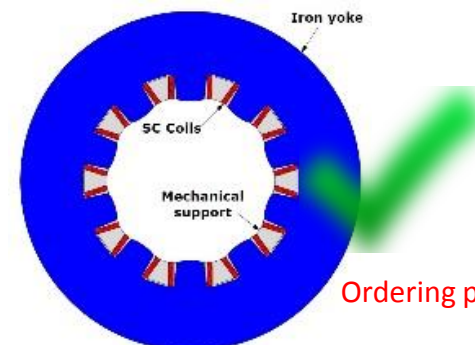
OD=320 mm



Construction phase

Octupole

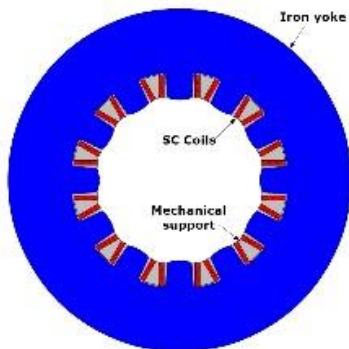
OD=320 mm



Ordering phase

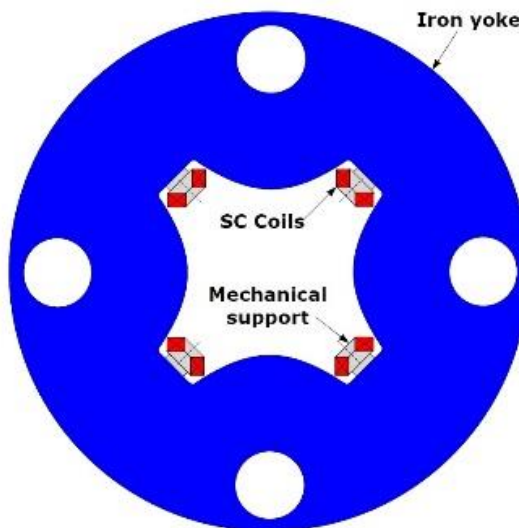
Decapole

OD=320 mm



Dodecapole

OD=460 mm



Skew quad

Physical length:

- 90-120 mm from 6-pole to 10-pole
- 430 mm 12-pole normal
- 840 mm 4-pole skew

Conductor type: NbTi

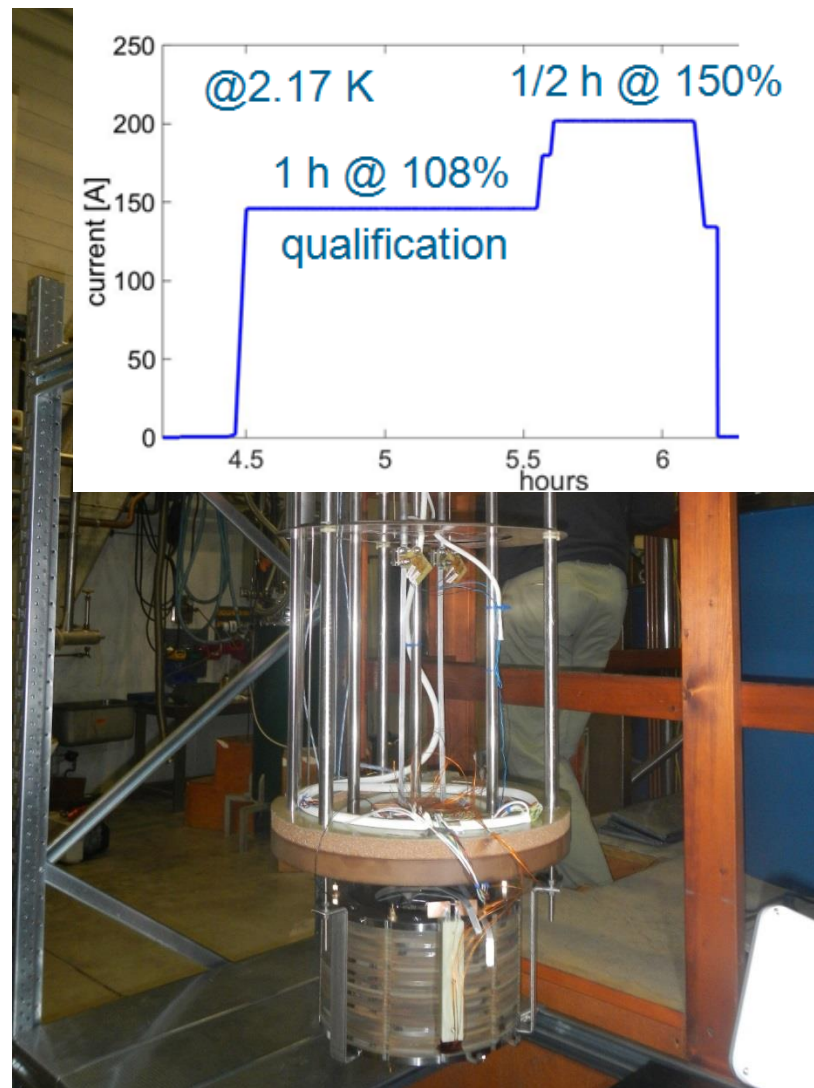
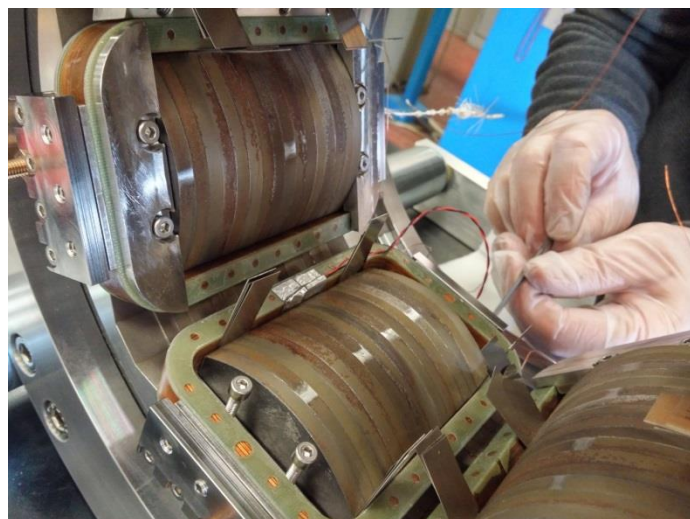
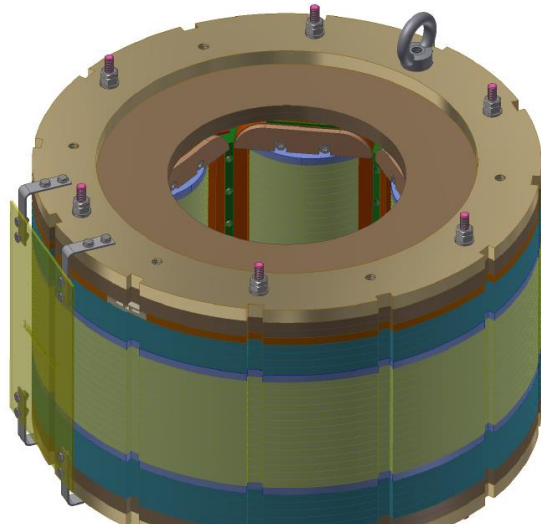
Peak field on cond.: 2-3 T

Operating current: 120-180 A

Margin on load line: 40%

Courtesy of M.Sorbi

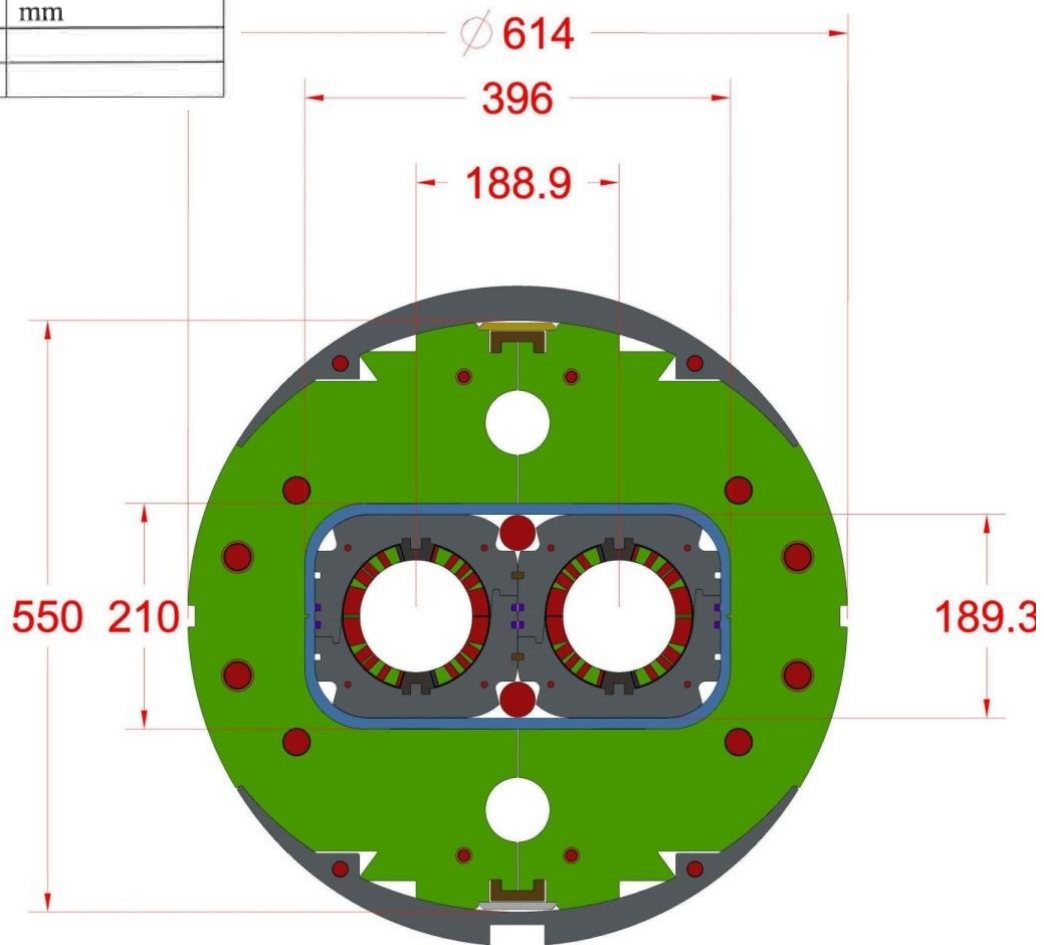
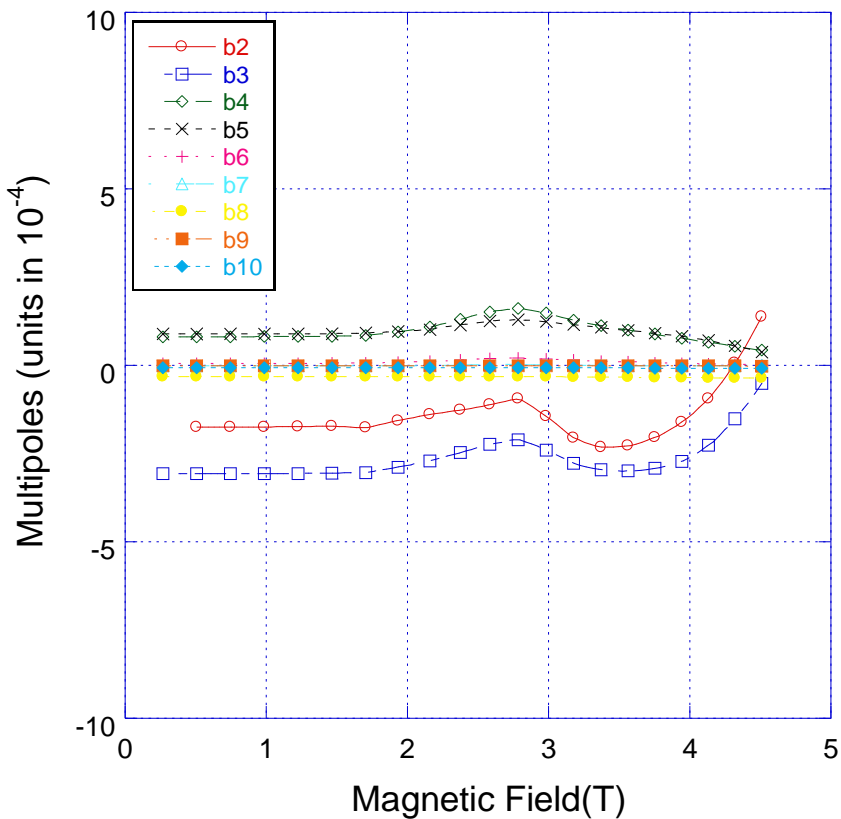
# Design, construction and test of the prototype sextupole at Milano LASA



## Design of the separation/recombination dipole D2

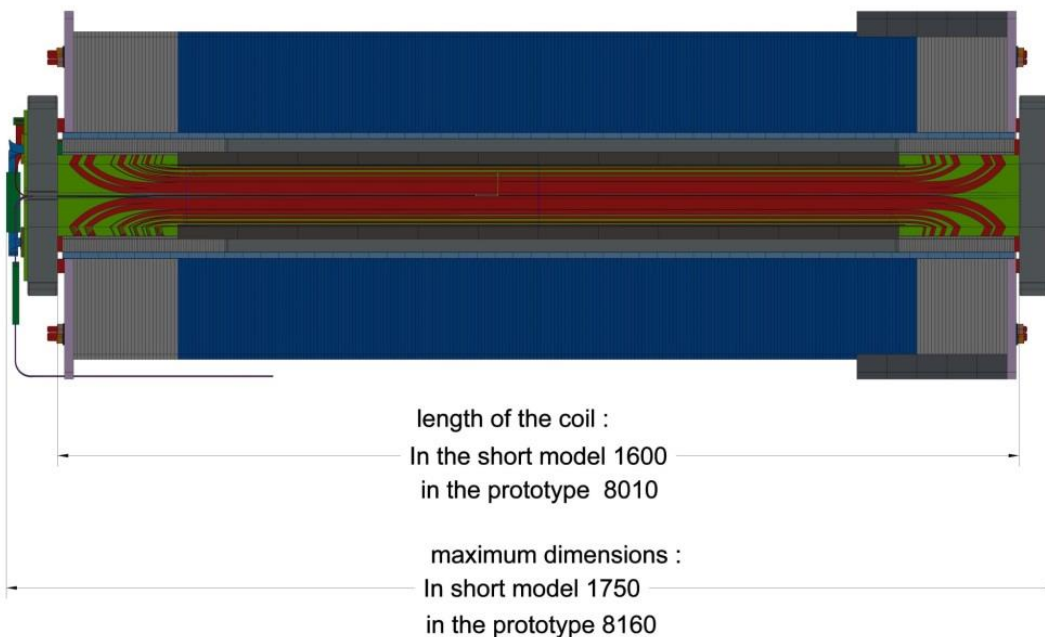
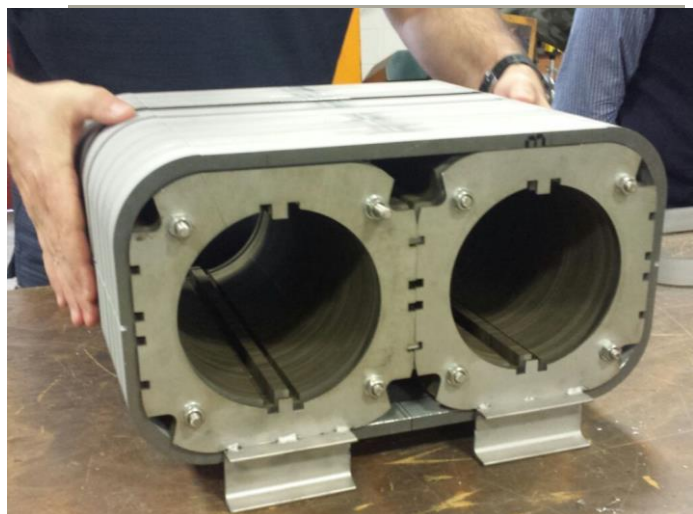
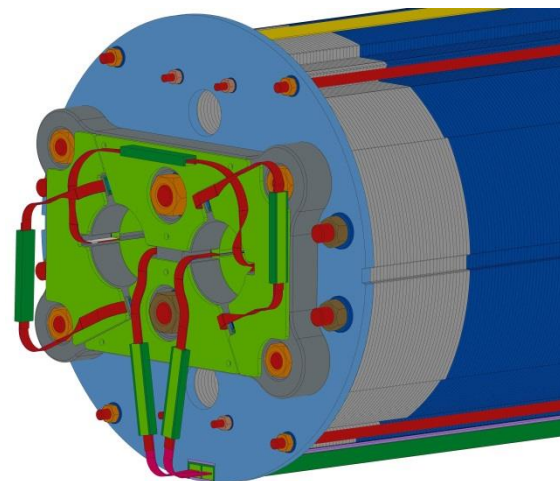
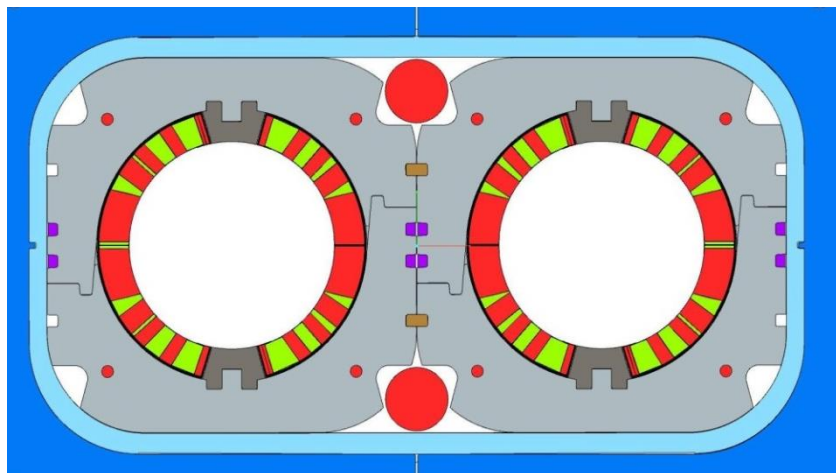
Table 2.3. D2 Magnet preliminary features.

Integrated field	35	T·m
Central field	3.5 - 5	T
Beam separation	188	mm
Target variations of b2 b3 b4 due to saturation	< 10 units	
Change of b2 b3 b4 between 6.5 and 7 TeV	< 1 unit	





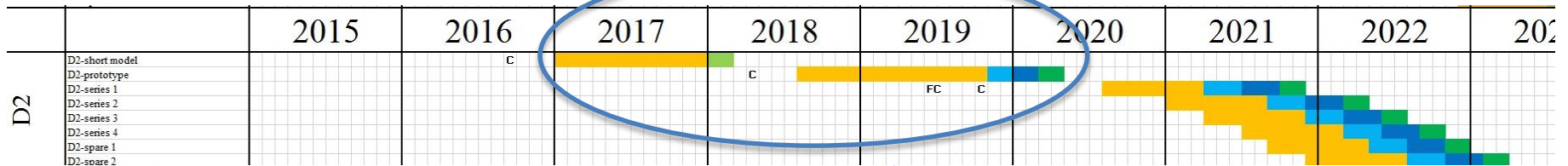
## D2 engineering design completed



## New agreements CERN-INFN for magnet constructions

- A agreement is being finalised between CERN and INFN for the construction (in industry) of a short model (1.6 m) and a prototype (8 m) of the **D2** magnet.
  - The short model shall be delivered to CERN at the end of 2017 and tested at CERN in a vertical cryostat.
  - The prototype shall be delivered at end of 2019, assembled in a cold mass with the correctors, and tested in a horizontal cryostat.
  - The involved INFN section is the Genova section.
  - On the basis of this agreement and subsequently to an international tender, INFN has awarded to ASG Superconductors the construction of the short model
- 
- In parallel an agreement is being finalised for the design, procurement and testing of the **high-order orbit corrector superconducting magnets** (54 magnets to be built).

## Schedule in HL LHC scheme



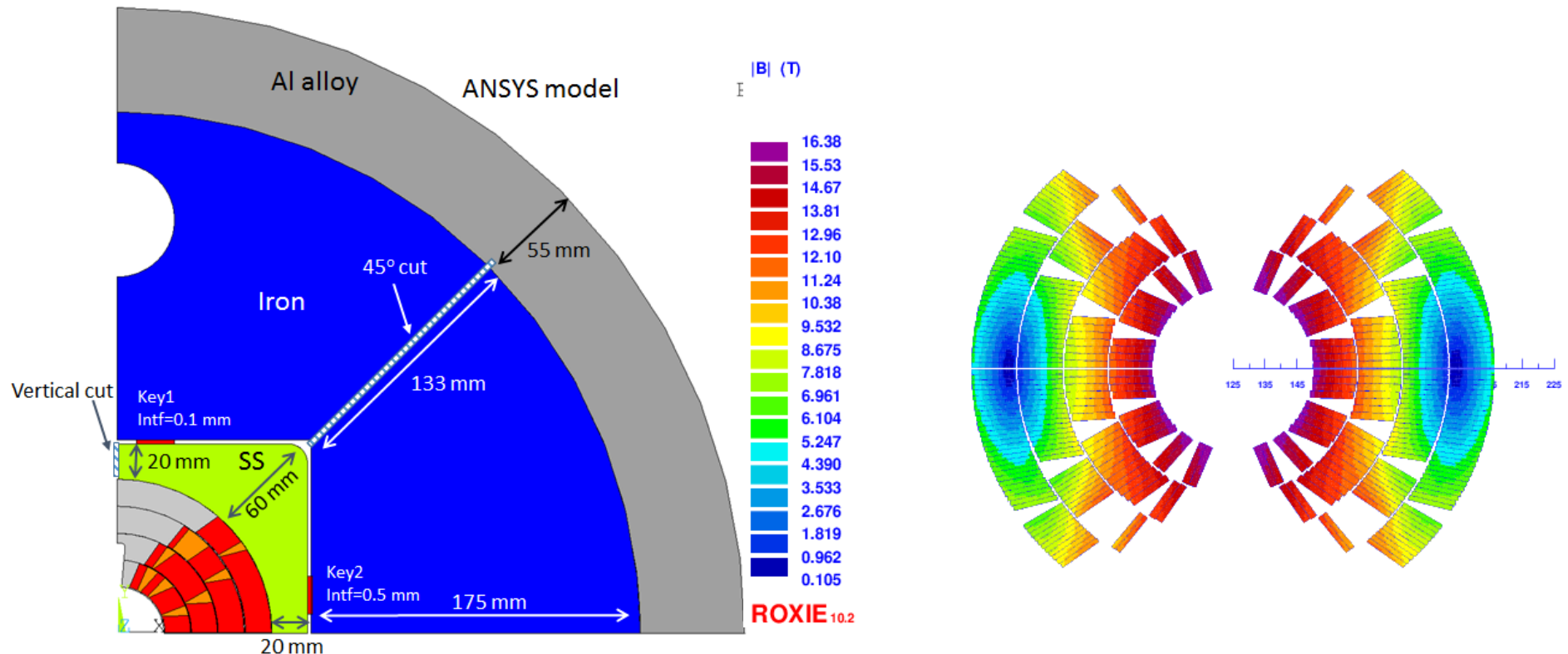
Existing Agreements

New Agreements



## Future

The INFN teams of Genova and Milano-LASA are currently involved in the design of a 16T dipole for FCC in the framework of EuroCirCol project WP5 (H2020).

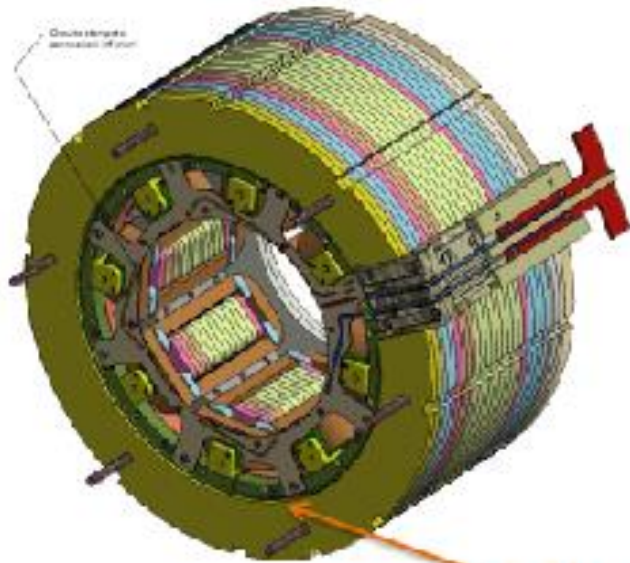




## Summary

- INFN is involved in the superconducting magnets of HL-LHC through design and prototyping activities involving the team of Genova and Milano-LASA
- New agreements are being finalised for D2 prototyping and construction of high-order orbit correctors.
- The INFN teams are involved in the project EuroCirCol with the design of a 16T magnet. A cos-theta design is under development.

**Thank you for your attention**



lower layer

