Present R&D activities in INFN on superconducting magnets and possible interest in FuSuMaTech

P. Fabbricatore

- Three INFN laboratories are historically involved in the R&D on superconducting magnets: Genova, Milano-LASA and Salerno

- R&D activities are presently going on sc magnets for Hi-Lumi LHC , high field magnets for future hadronic accelerators, magnets for hadrontherapy and other specific developments. A new laboratory for testing of superconducting accelerator magnets has been recently set-up.

- The INFN community should like to stay into contact with FuSuMaTech and presently there the interest of one group to actively participate in some initiatives.

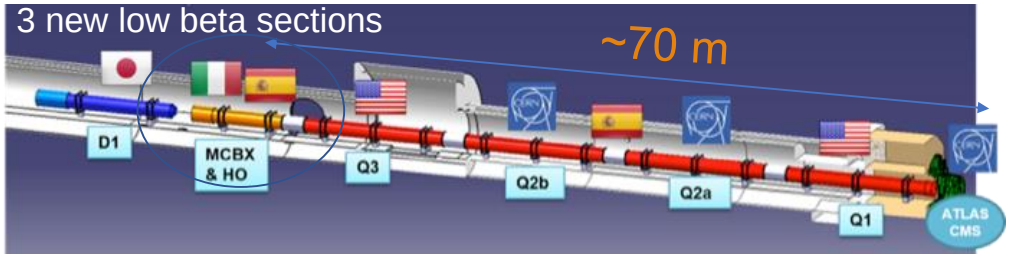
High Order Correctors for Hi Lumi LHC - INFN Milano-LASA- M.Statera and M. Sorbi
Co-funded by CERN and INFN

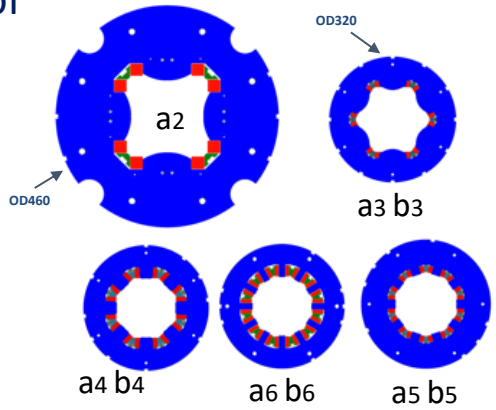
HL-LHC : High Order Correctors

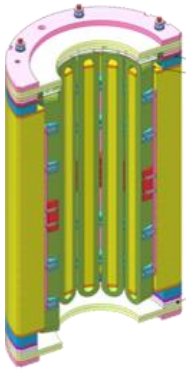
INFN LASA
In kind contribution

- Design, construction and test of the **5 different prototypes**
- **Series production** of **54** High Order correctors. 6 families of magnets

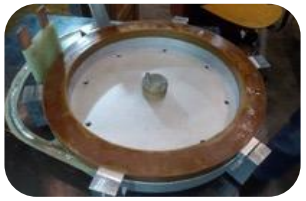
Half magnets produced







Accelerating NEWS March 2018



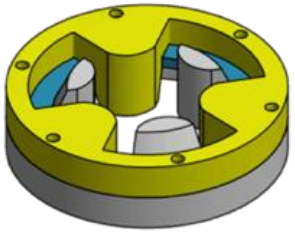
MgB_2 demonstrator accelerator magnet Sextupole round coil

Magnets specification and challenges

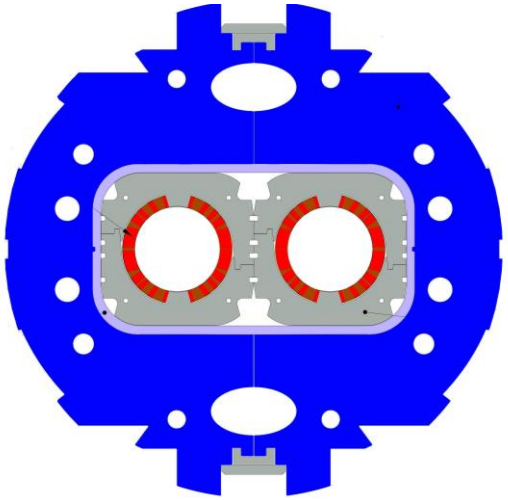
- **NbTi** superconducting coils
- **superferric design (first time in LHC)**
- **150 mm bore**
- **60% margin @ 1.9 K**
- 200 mm - 600 mm length
- Radiation hardndess: 15 MGy

«THE FIRST HL-LHC COMPONENT IS READY»

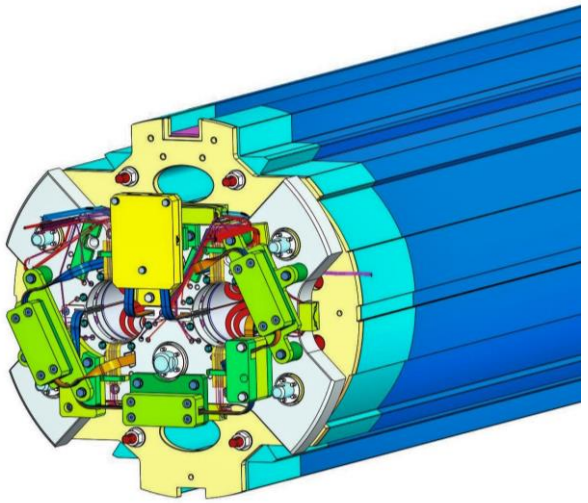
- **CERN Bulletin Issue n. 11-12, March 2016**
  INFN LASA prototype HO corrector TESTED
- **March 2021 first series production magnet deliverd to CERN**



D2 magnets for Hi Lumi LHC - INFN Genova- P.Fabbricatore and S.Farinon
Co-funded by CERN-INFN



Parameter	Value
Bore magnetic Field (T)	4.50
Magnetic length (m)	7.778
Peak Field (T)	5.26
Operating current (kA)	12.330
Stored Energy (MJ)	2.26
Overall Current Density (A/mm^2)	479
Coil Physical Length (m)	8.01
Aperture (mm)	105
Beam separation at cold (mm)	188
Operating temperature (K)	1.9
Load line fraction (%)	67.5%



- Development of a short model and a prototype and construction of six magnets.
- Presently the short model has been constructed and tested, the construction of the prototype is going on (delivery to CERN on July 2021) and the construction of the series in preparatory phase.

High Field Magnets - INFN Genova and Milano S.Farinon and M.Sorbi
Co-funded by CERN and INFN

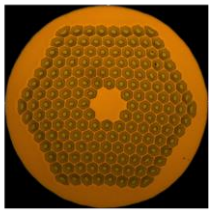
FalconD

Future Accelerator post-LHC Cos-theta Optimised Nb_3Sn Dipole

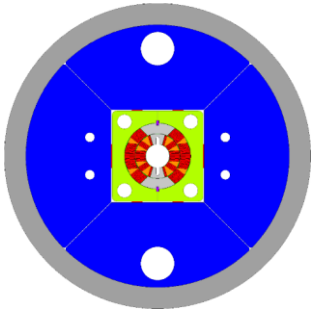
- FalconD is an INFN/CERN collaboration aimed at the design and construction in collaboration with industry of a Nb_3Sn 12 T dipole short model
- Characteristics:
  - 2 layers, 50 mm bore, ~1.5 m length
  - Rutherford 40 strands Φ=1 mm
  - Design magnetic field: 12 T
  - Ultimate magnetic field: 14 T
  - Short sample magnetic field ≲ 16 T
  - bladder&key mechanical structure
  - stress on conductors ≲ 150 MPa in any condition
  - Max. dimension: 650 mm (test at LASA)

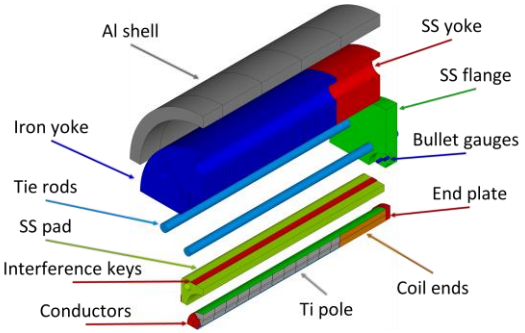
Reference:
FCC Magnets Collaboration Meeting 10 Dec 2019: Status of Conductor Procurement
S. Hopkins

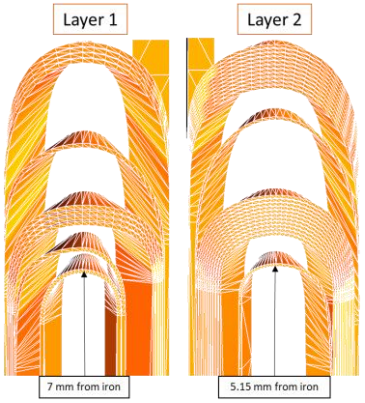
Diameter [mm]	1.0
Cu/non-Cu	0.9 ± 0.2
I_c at 4.22 K, 16 T [A]*	560 ± 14
d_{sub-el} (nom.) [µm]	58
Filament twist pitch [mm]	19 ± 3
RRR, rolled	159± 14
Heat treatment [°C]	665

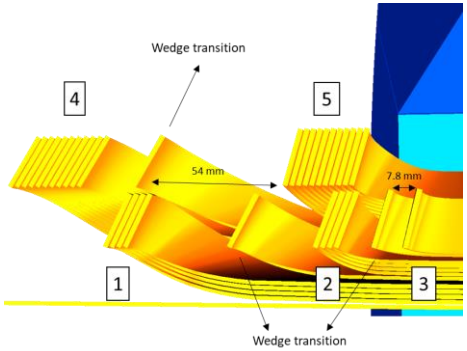


- It is a 5 year program (deadline Sep. 2023)
- The construction of the 6+2 coils and a *pre-assembly* will be carried out in ASG Superconductors while the integration into the iron with the bladder & keys technique will be carried out at LASA, where a first cold test will also be carried out



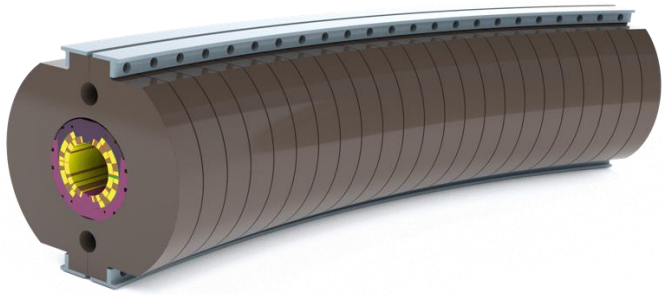


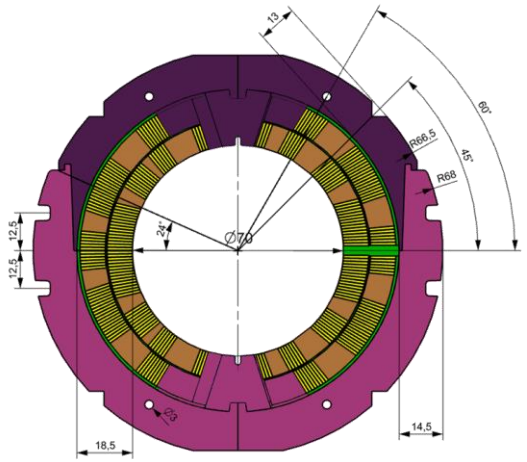




Initiatives on SC magnets for hadrontherapy -- L.Rossi INFN Milano

Four parties collaboration for ion gantry (4PCIG): CERN-CNAO-INFN-MedAustron
INFN (LASA and GE) is discussing to take up:
SC 4T dipole magnet demonstrator curved (R=2m), dB/dt=0.3-1 T/s , cryogen-free





Participation to EU programs HITRI and I.FAST. These programs (and the 4PCIG) aim at bridging the gap with Japan and advancing technologies with EU Industry

R&D on SC CTT-- R.Musenich INFN Genova

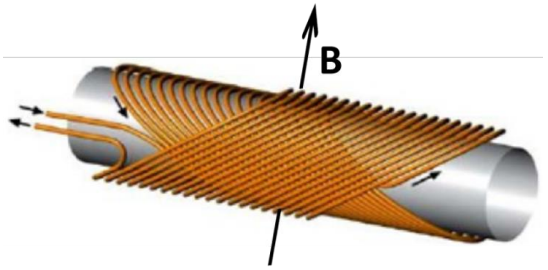
BISCOTTO

BiSCCO Cosine Theta Tilted Solenoids

3 years (2019-2021) project funded by INFN

INFN Genoa, INFN Milan, University of Bologna, CNR-SPIN Genoa

Development of key technologies to be involved in the design and construction of canted solenoids wound with BiSCCO-2212 (high field applications) and MgB_2 (low field applications.)



Canted Solenoid Dipole

Activities: development of BiSCCO conductor
winding tests (BiSCCO e MgB_2)
optimization of heat treatments
quench calculations
design, construction and tests of small demonstrators.

Test facility for accelerator (and not only) magnets - U.Gambardella INFN- Salerno

External view of the *THor Test Facility*

The shed is 30 m long and 15 m large plus a control room and a workshop. The roof clearance is 9 m. On the right side of the picture there are technical services (cooling tower, the LN2 and gas inventory tanks are visible.

The workshop is provided with a CNC milling machine, a TIG/MIG and an orbital welding machines.

Internal view of the *THor Test Facility*

The test facility has a Linde He refrigerator/liquifier, a multi-purpose testing cryostat, a 0.35 kA, 5 kA and 20 kA power supplies and the test line (under construction) for SIS100 superconducting quadrupole modules (one visible on the right side). A second test line will be set by this year.

The laboratory equipments includes the up to date instrumentats for room temperature test (insulation, flow impedance, instrumentation checks, etc.) as well as for cryogenic tests (flow measurements, power supply, temperature mapping, etc.).

This group is presently available in contributing to FuSuMaTech into the following areas

- **Development of specific infrastructures for magnet testing, cryogenic standard.**
- **New cryogenic solutions for next generation s.c. applications**.

Thank you for your attention