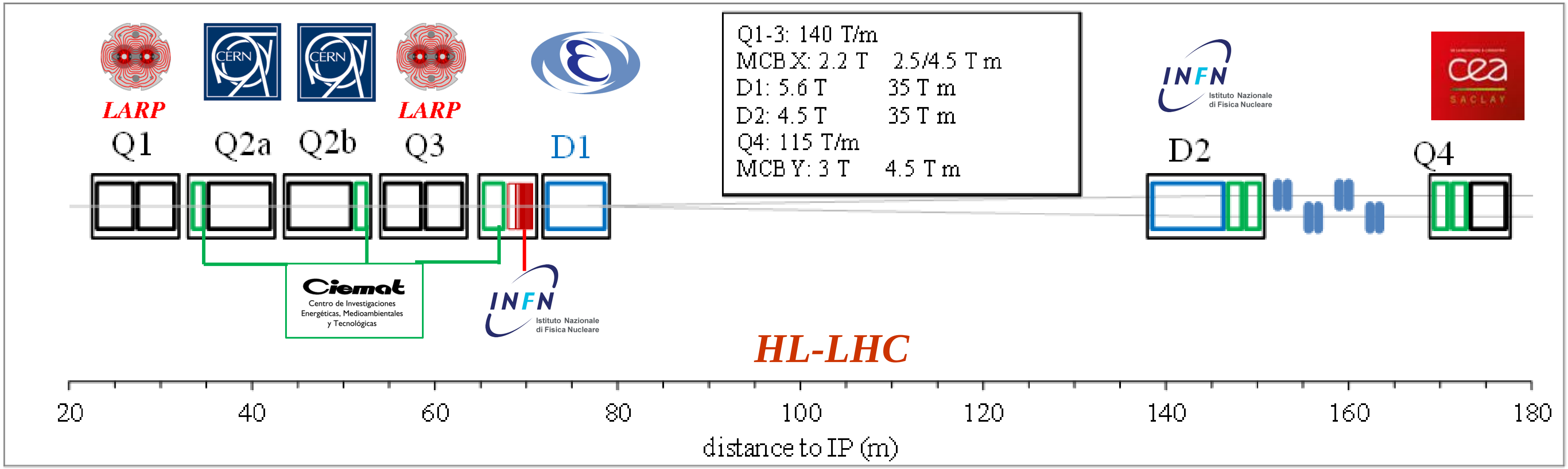
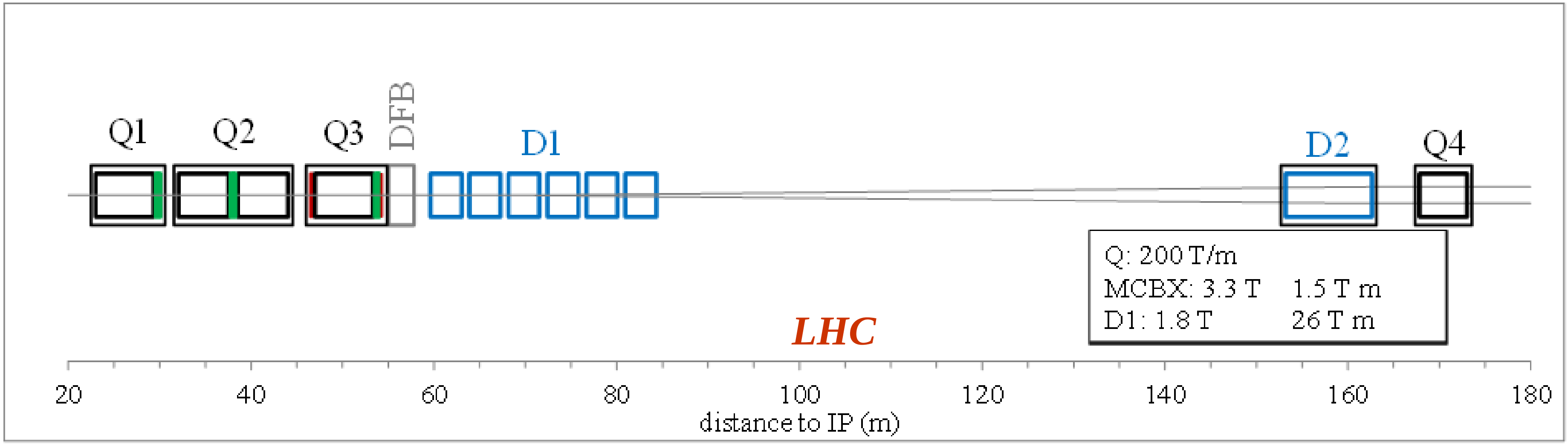
Work Package 3 Summary

GianLuca Sabbi, Ezio Todesco

4th HiLumi LHC – LARP Annual Meeting
KEK, November 17-21, 2014

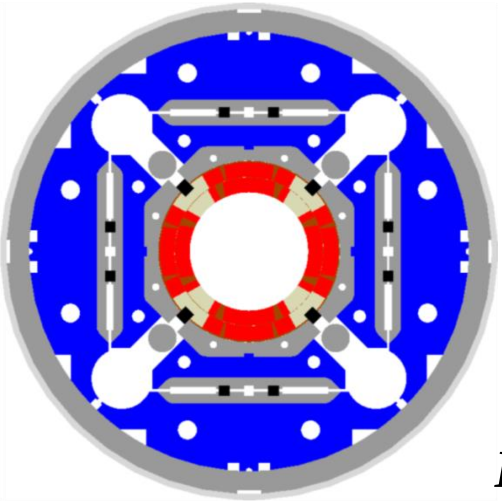
IR Magnets and Layout

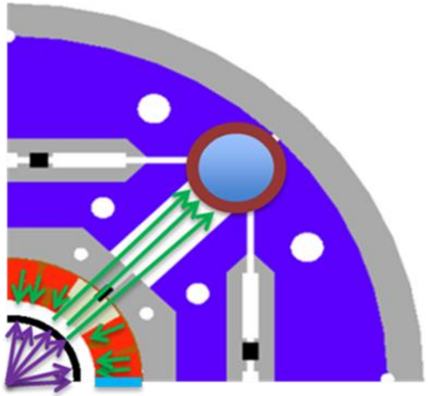


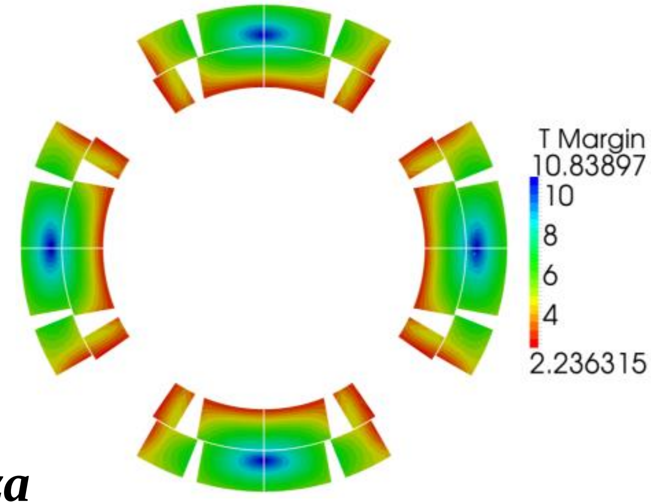


QXF Updates: Cooling

- Converged on key design choices and parameters: cooling scheme, system architecture/circuits, heat exchangers, heat removal path
- Detailed analysis shows acceptable temperature margins (>2.2K) assuming a conservative heat load map (thin W absorbers)
  - In particular, optimized IL heaters' effect on cooling is still acceptable for magnet performance
- Next steps: update calculation using new heat load map from WP10, refine results as magnet design details are finalized



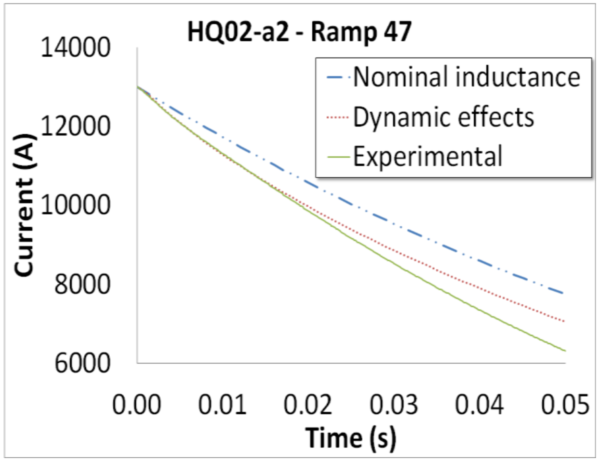


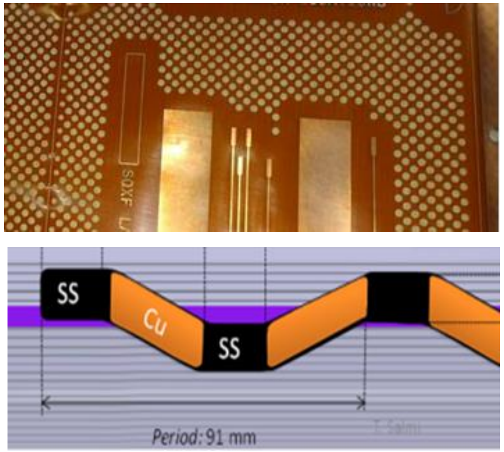


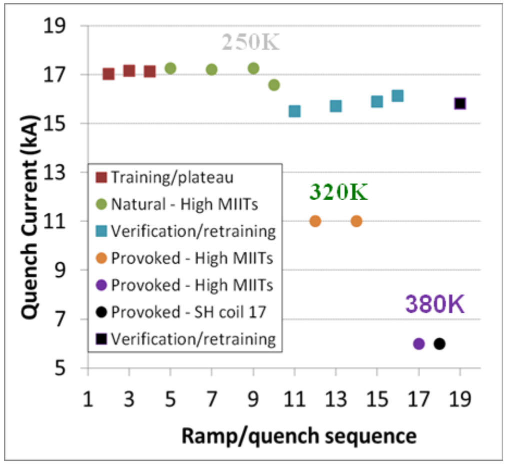
R. van Weelderen, G. Bozza

Quench Protection

- Significantly improved from last year: meeting all key requirements
- Refined analysis using more realistic models of current decay
  - Based on and calibrated with HQ test results
- Optimized design of heaters while meeting cooling requirements
- Expecting max temperature ~290K vs. 350K design limit
- Additional margins: HQ/LHQ results indicate that T limit is >350K; natural/induced quench back still not included in the analysis



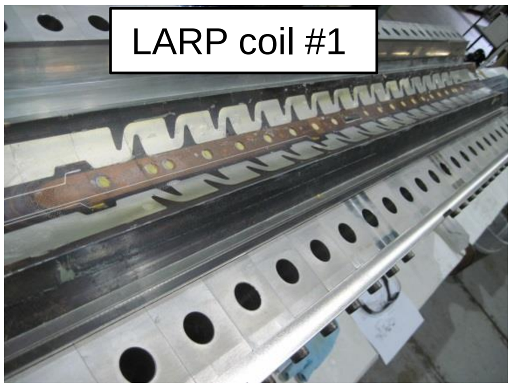


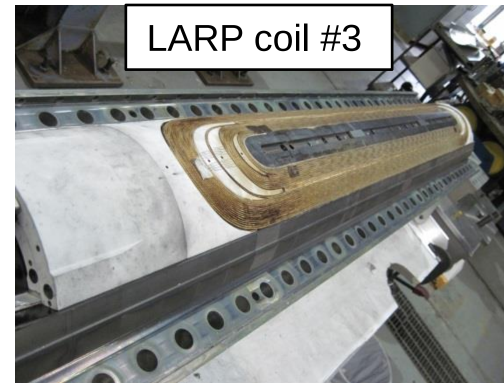


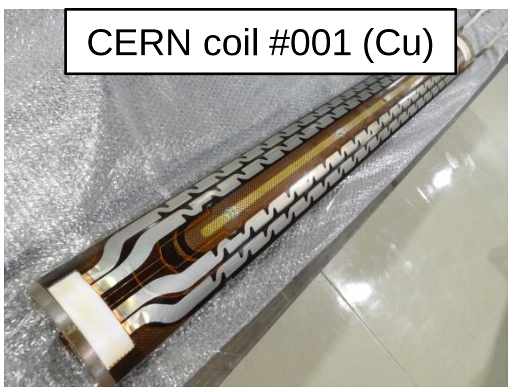
G. Ambrosio, H. Bajas, D. Cheng, M. Martchevsky, V. Marinozzi, J.C. Perez, E. Ravaioli, T. Salmi

Short Model Coil Fabrication

- Three coils completed (2 practice) and 3 coils under fabrication
- LARP #2 will be assembled in a mirror structure for test in February
- Four coils available for first short model assembly at the same time







G. Ambrosio, P. Ferracin, F. Nobrega, J. C. Perez, J. Schmalzle, M. Yu

Coil Electrical QA

- All HQ03 coils and first of QXF coils passed all electrical checks with substantially increased targets (based on LHC requirements)
- Some details of the coil electrical QA plan still need to be confirmed

Hipot Checks

Actual / Target

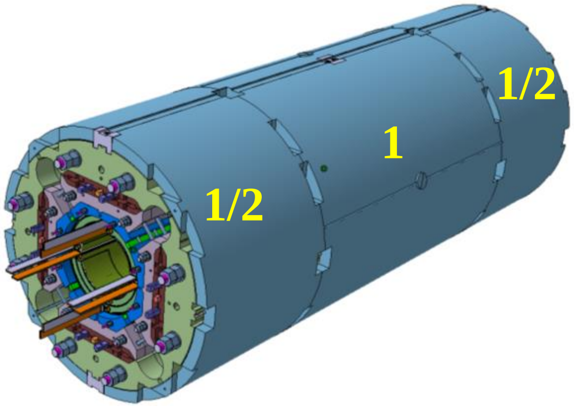
(< 1 uA leakage)

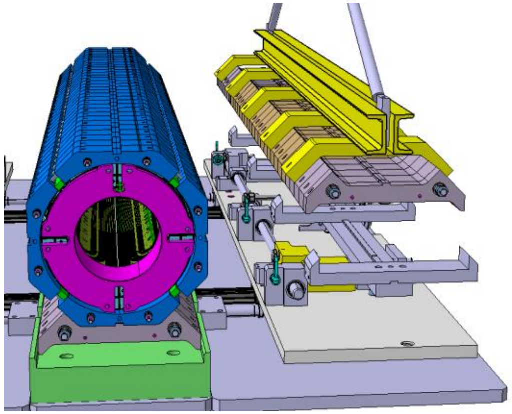
SQXF01	Coil	PHA01	PHA02	PHB01	PHB02	PHB03	PHB04	LE IL Endshoe	RE IL Endshoe
PHA01	2000 / 2000								
PHA02	2000 / 2000								
PHB01	2000 / 2000								
PHB02	2000 / 2000								
PHB03	2000 / 2000								
PHB04	2000 / 2000								
LE IL Endshoe	1200 / 1200	1000 / 1000	1000 / 1000						
LE OL Endshoe	1200 / 1200			1000 / 1000	1000 / 1000	1000 / 1000	1000 / 1000	600 / 600	
RE IL Endshoe	1200 / 1200	1000 / 1000	1000 / 1000						
RE OL Endshoe	1200 / 1200			1000 / 1000	1000 / 1000	1000 / 1000	1000 / 1000		600 / 600
Pole	500 / 500								

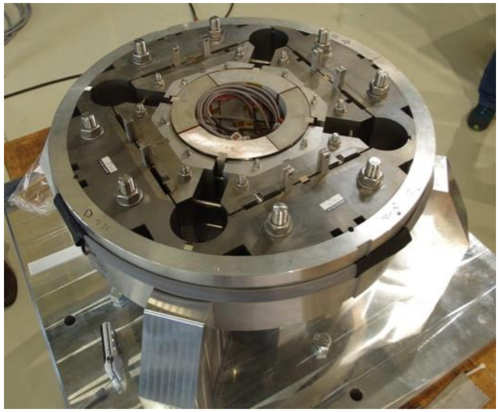
P. Ferracin, P. Fessia, M. Martchevsky, J. C. Perez, J. Schmalzle

Support structure and assembly

- Optimized longitudinal split of Al shell based on latest analysis
- All steps of the assembly and supporting tooling were finalized
  - Procedures and tooling for short models are extendable to long models
- Structure components and tooling are in procurement
  - Schedule is consistent with coil fabrication, but small/no margin
- Several assembly/cool-down cycles using 15 cm mechanical model
- Under study: options for single coil testing in quadrupole structure







D. Cheng, H. Felice, P. Ferracin, M. Juchno, J. C. Perez

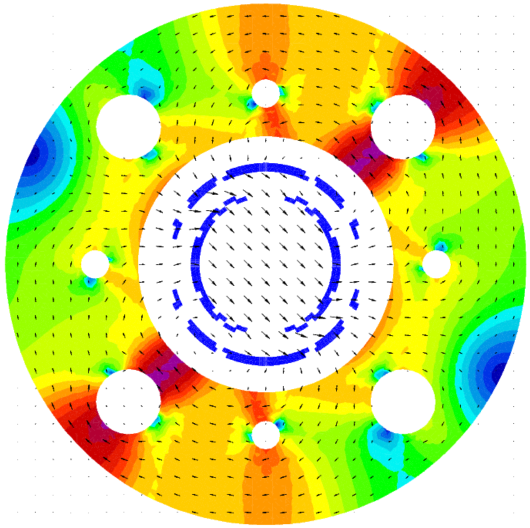
QXF Conductor Review

Main findings and recommendations:

1. Critical current specification still not fully demonstrated and margin requirement difficult to predict: recommending to “maximize the operating margin of the superconductor”
   - Consider all options including a reduction of the operating gradient
   - Possible lower bound: 130 T/m, with a ~7% length increase
   - This topic will be covered at the upcoming design review
2. A change of cable keystone angle (from 0.55 to 0.4 deg.) will be required for one of the conductor options (PIT)
   - May also benefit the RRP option, and so far we have been able to avoid significant design variants
   - This change can be implemented with a fundamentally similar cross-section, but likely require an iteration in the parts design

G. Ambrosio, A. Ballarino, B. Bordini, D. Dieterich, P. Ferracin, A. Ghosh, L. Oberli
Reviewers: A. Devred, D. Larbalestier, H. ten Kate, B. Strauss, A. Yamamoto

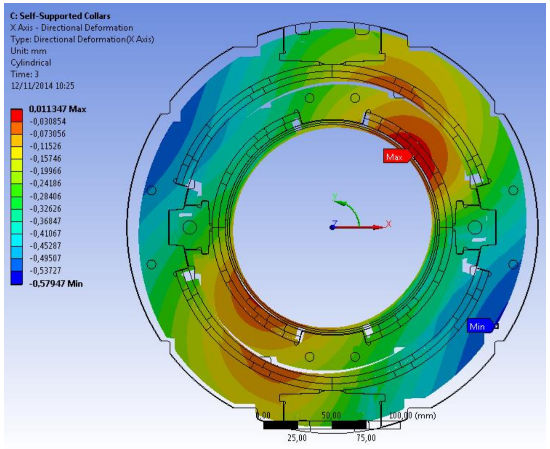
Orbit Corrector (CIEMAT)



Nested X-Y dipole with large asymmetric forces

Recent analysis results and design decisions:

- Decided on a two layer design coil design
- Dump resistor is sufficient for protection
- Self-supporting collar is mechanical baseline



Next steps:

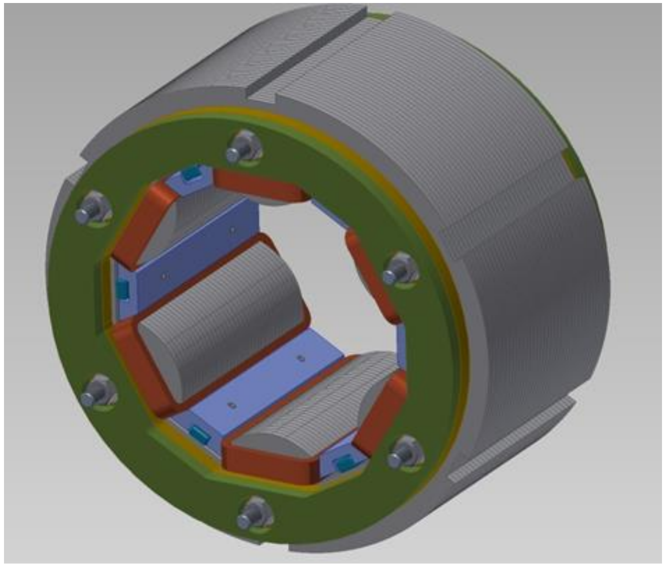
- Optimize field quality, in particular the saturation sextupole
- Detailed study of assembly procedure

Short model fabrication planned for 2015

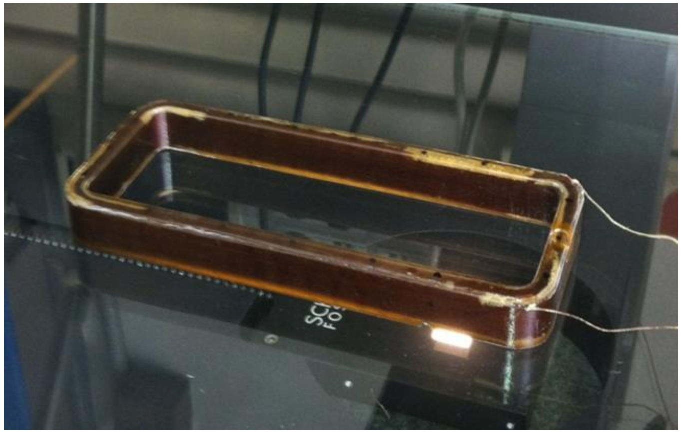
J. Garcia, F. Toral, P. Fessia

Non linear correctors (INFN)

Recent progress and next steps:

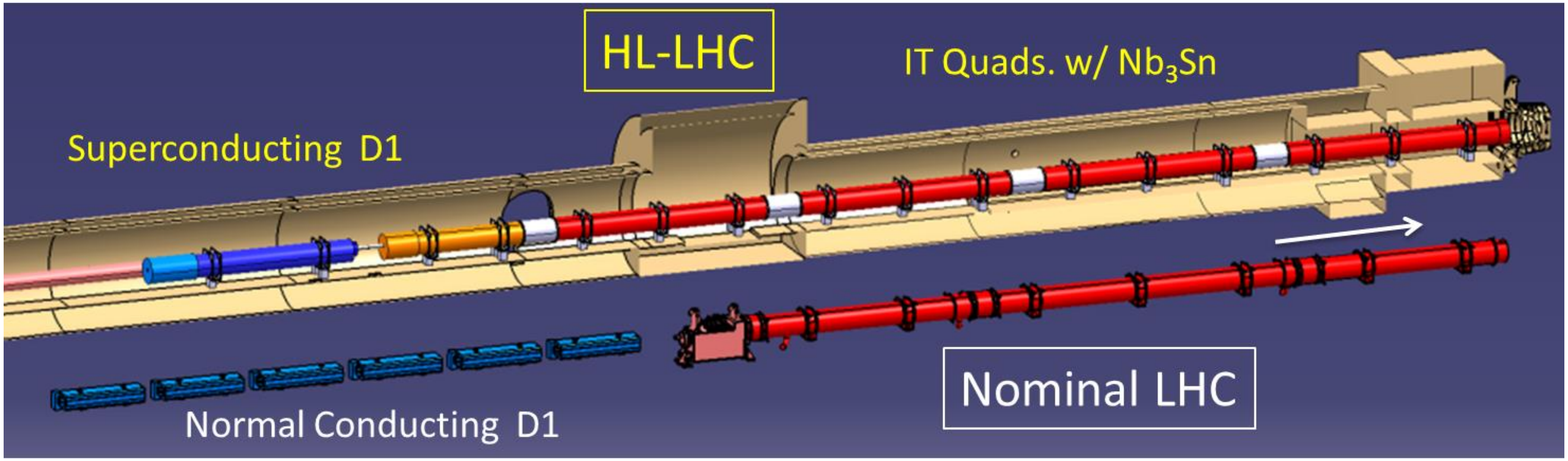


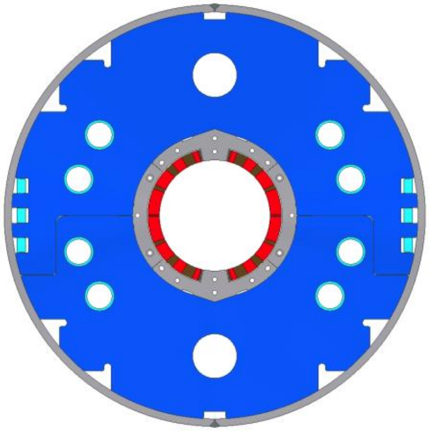
- Compact super-ferric design chosen
- Conceptual design from quadrupole to dodecapole concluded
- Detailed study of electromagnetic cross-talk and forces acting between adjacent corrector magnets
- Superconducting wire delivery to be completed soon
- Winding & impregnation tests in progress
- Test preparation in progress, in view of the first sextupole test in 2015

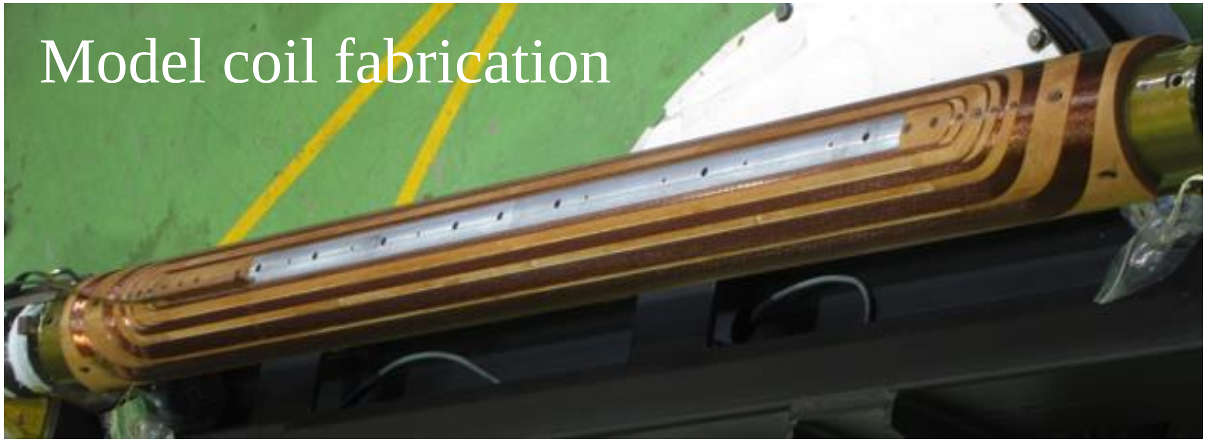


G. Volpini, P. Fessia

Separation Dipole (KEK)





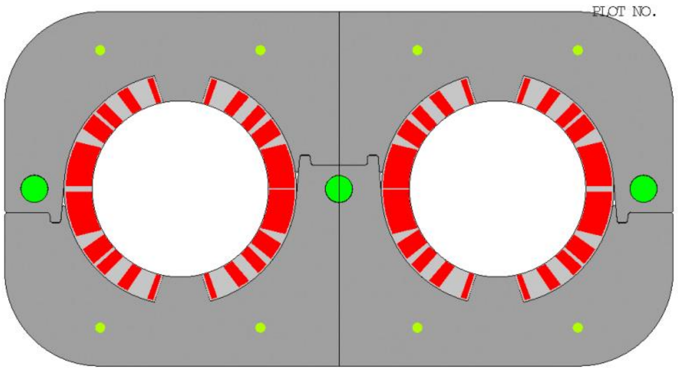


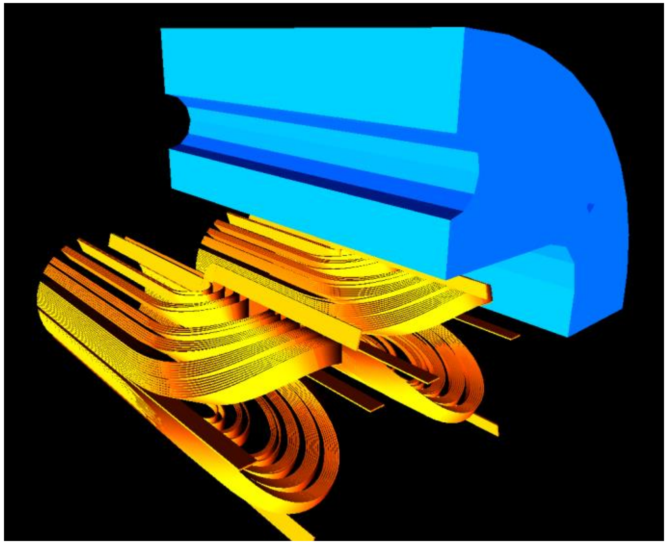
T. Nakamoto, M. Sugano, H. Kawamata, S. Enomoto

Recombination Dipole D2 (INFN)

Recent progress and next steps:

- Selected coil lay-out with coils composed of 62 turns
- The operating current is 12037 A generating a magnetic field of 4.5 T and a margin on the load line of 65%
- 2D mechanical analysis performed. Baseline is a single collar for both coils, second option with one collar per coil.
- A first design of coil ends was completed
- Possible options and plans for model fabrication are under discussion



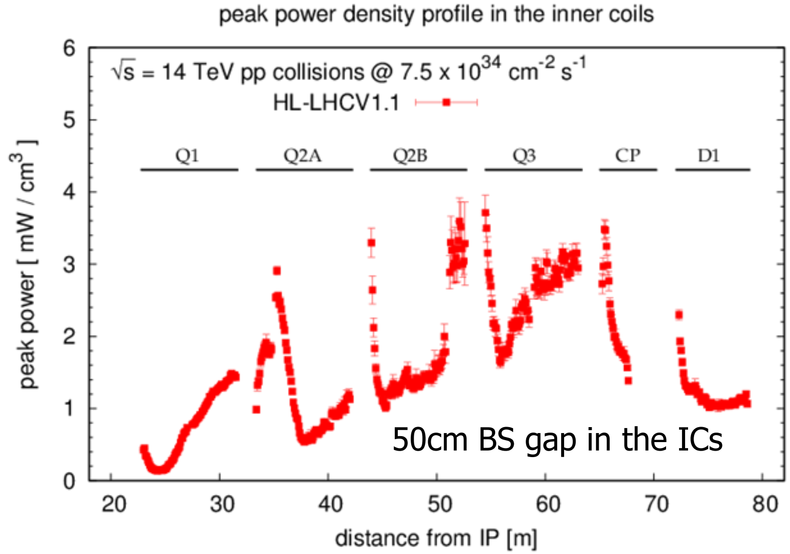


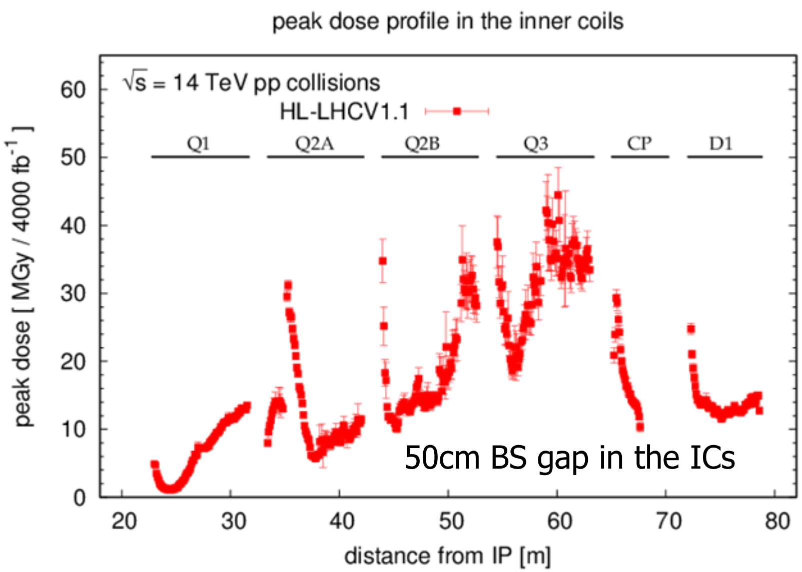
P. Fabbricatore, S. Farinon

Energy Deposition Updates

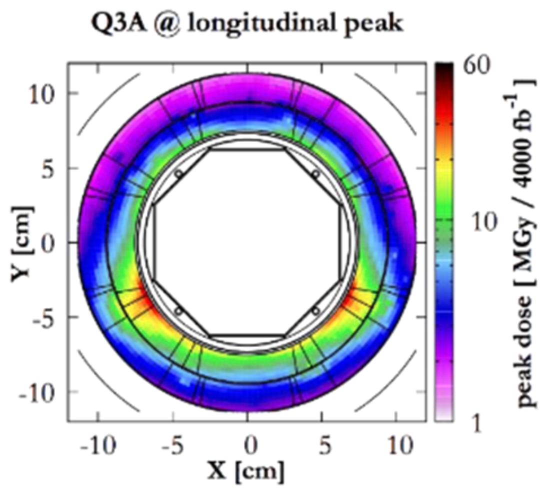
- Incorporated new luminosity targets, updated orbit corrector, quadrupole coil, beam screen (waiting for shielded BPMs), TAXS aperture reduction.
- Main results: IT < 4 mW/cm^3 and < 40-50 MGy, with Q3 especially hit; 20 MGy in the high order correctors; total heat load: 1 kW in the cold masses and 800 W in the beam screen
- Details of the beam screen design are critical for the coil protection.
- BPMs embedding absorbers are clearly beneficial in the Q2a-Q2b and Q2b-Q3 (and Q3-CP) interconnects.
- Beam screen dose up to GGy, dominated by electromagnetic component.
- Important dependence on crossing angle, whereas the TAS aperture is not critical with respect to triplet (Q1) protection.
- Thermal load specs made available for TAXS design development.
- High energy hadron fluence in the UJ exceeding 10^9 cm^{-2} per year (300 fb^{-1}).
- Triplet (Q1) exposure in IR8 (without TAS) after the LHCb luminosity upgrade does not exceed the IR1 levels at nominal lumi.

Debris impact in the TAS-IT-D1 area





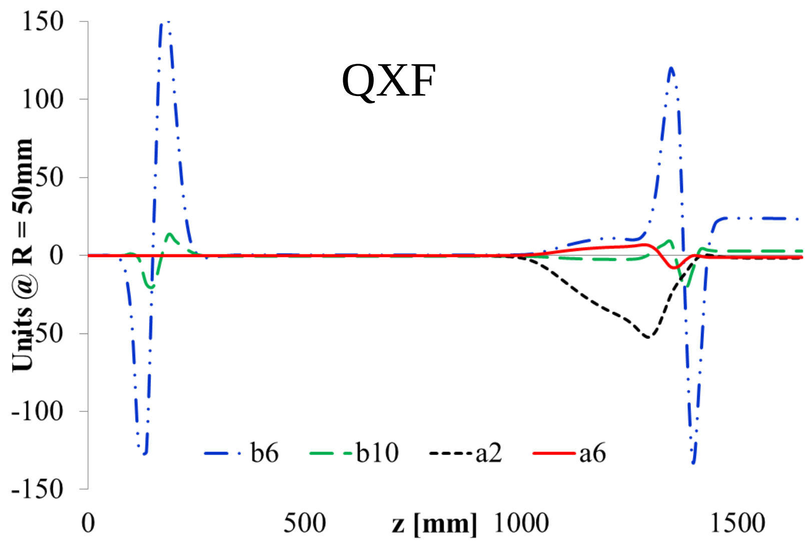
@ 7.5 L_0	HL-LHCV1.1	
Power [W]	Magnet cold mass	Beam screen
Q1A + Q1B	140	210
Q2A + corr	150	90
Q2B + corr	165	100
Q3A + Q3B	220	105
CP	105	90
D1	135	80
Interconnects	30	110
Total	**945**	**780**

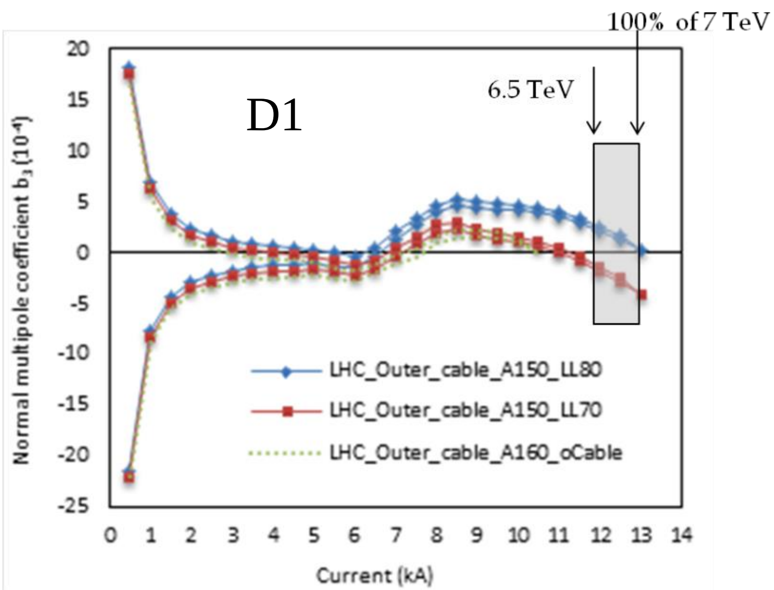


F. Cerutti. L. Esposito

Field quality

- Improvements in coil dimensional uniformity will be required (and are expected) to meet targets for un-allowed harmonics
  - Correction with magnetic shims is being developed as a backup
- Expected gradient uniformity 0.1% may allow removing the Q2 trim
- Proposing to optimize field quality taking into account current uncertainties in the operating point





S. Bermudez, J. DiMarco, P. Fabbricatore, T. Nakamoto, X. Wang