Status of CCT D2 correctors

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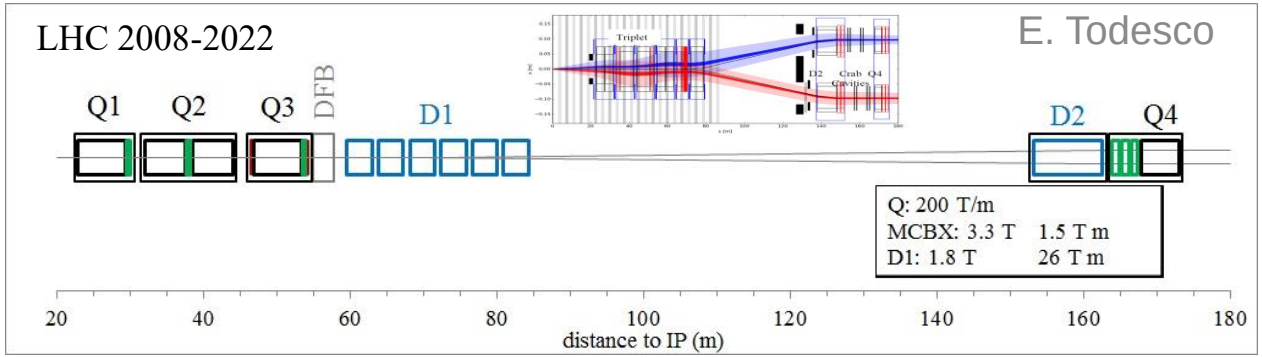
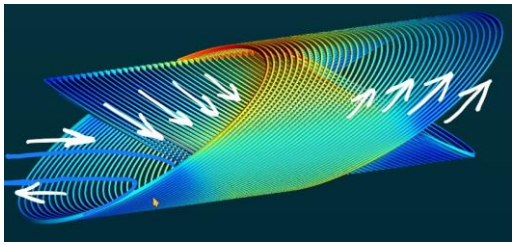
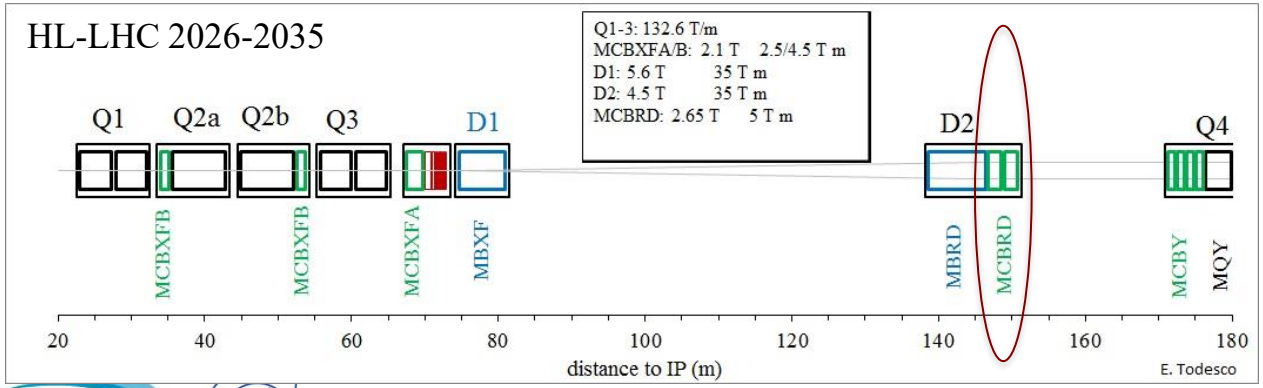
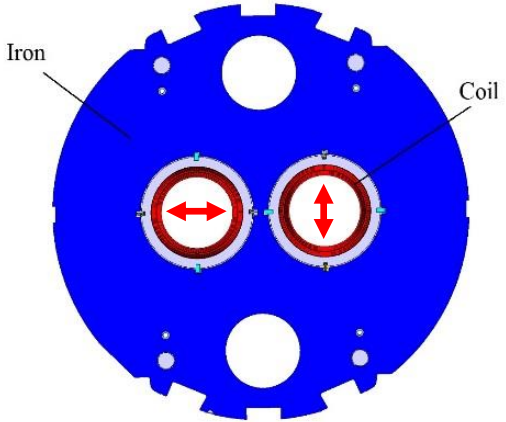
MCBRD: the HL-LHC D2 orbit correctors, 12+1 units, providing a 5 Tm integrated field in two apertures, vertical in one and horizontal in the other



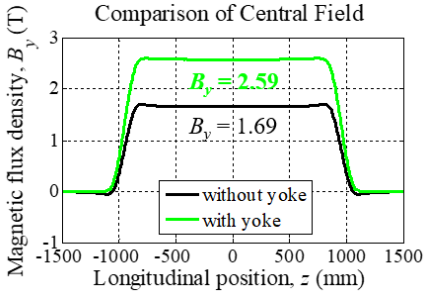


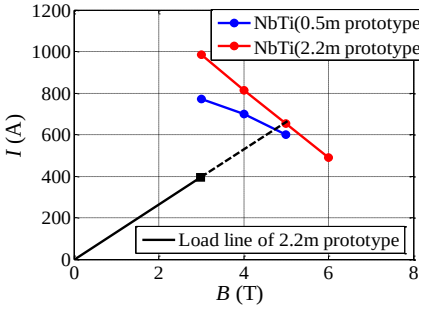


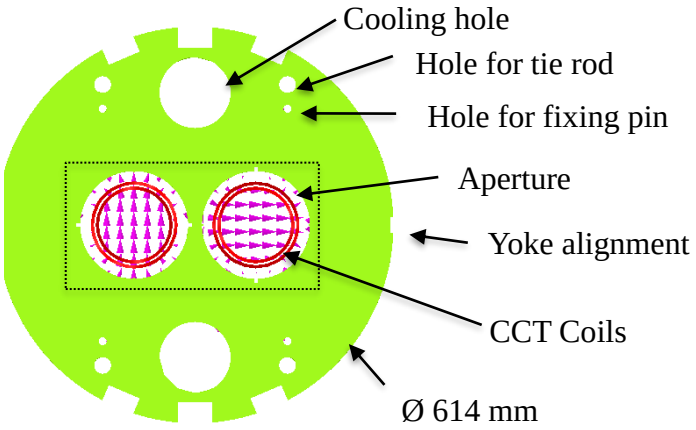


Main design parameters of the magnet

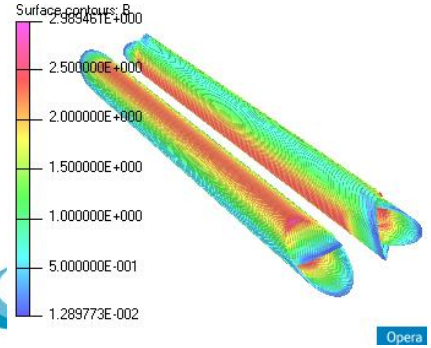
Items	Values
CCT skew angle	30°
No. of turns per layer	365
Slot size in former (mm)	2×5
Spacing per turn	5.222
Inside/Outside diameter of the former (mm)	Inner former:105.35/119.35 Inner former:120.80/134.85
Inside diameter of the groove/slot(mm)	1st layer: 109.15/119.15 2nd layer: 124.65/134.65
Reference radius (mm)	35
Diameter of aperture (mm)	105
Current (A)	395

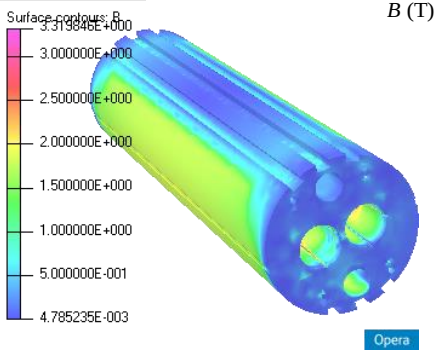






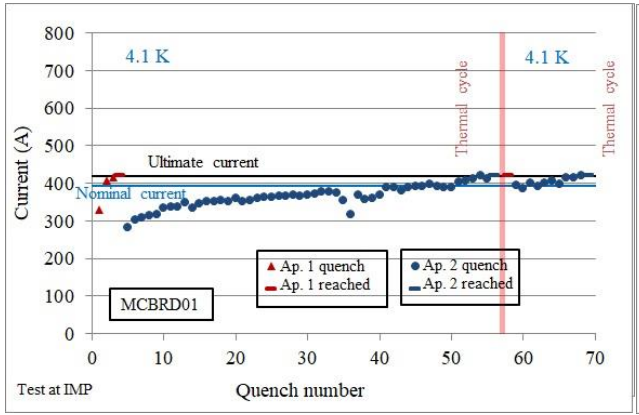
Items	Values
Diameter of yoke (mm)	614
Thickness of yoke lamination (mm)	5.8
Diameter of aperture (mm)	167
Position of aperture (mm)	94.19
Yoke key slot(mm)	8(3.01) ×6
Diameter of cooling hole (mm)	110
Position of cooling hole (mm)	205

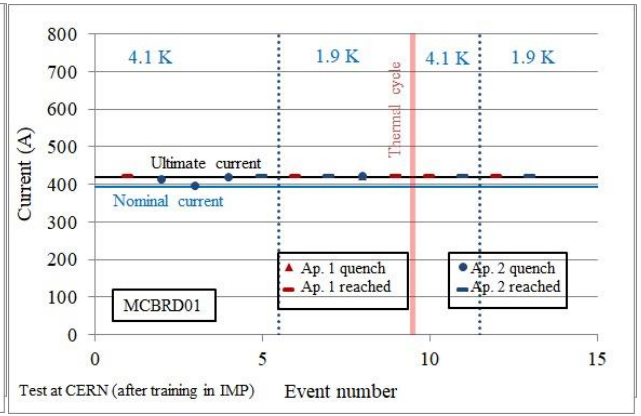




The beginning of the production

- Out of the 12 series magnets, 4 have been built in BAMA
- MBCRD01 and MCBRD02 coils were built with a variant of the CERN procedure (wet impregnation)
- Both magnets reached ultimate current, and had limited retraining after thermal cycle, at the edge of the requirements
  - They are now at CERN, where they have also been tested at 1.9 K





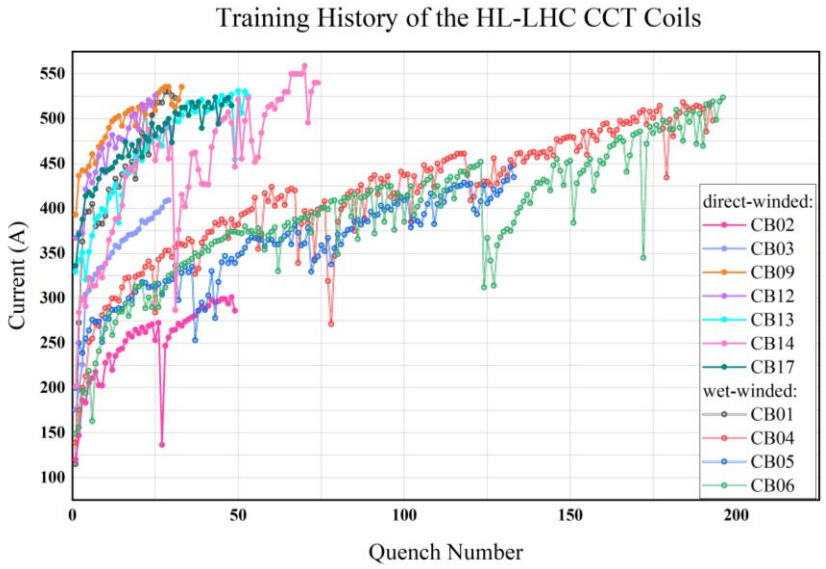
The test strategy

- IHEP added to the baseline the test of individual coils in IHEP test station at 4.1 K, to have a fast feedback on production and to cope with the long training

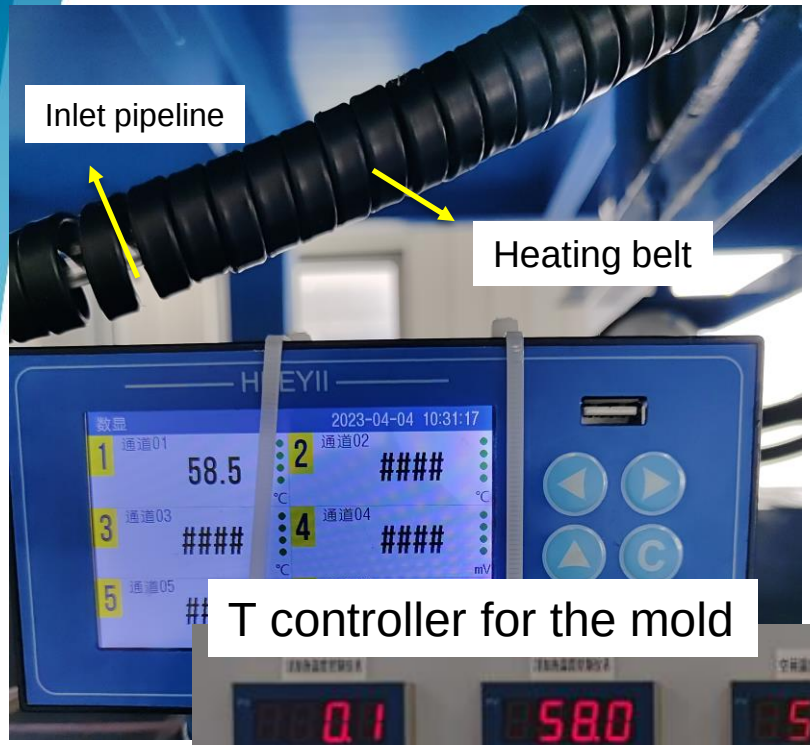
Test of individual coil in IHEP

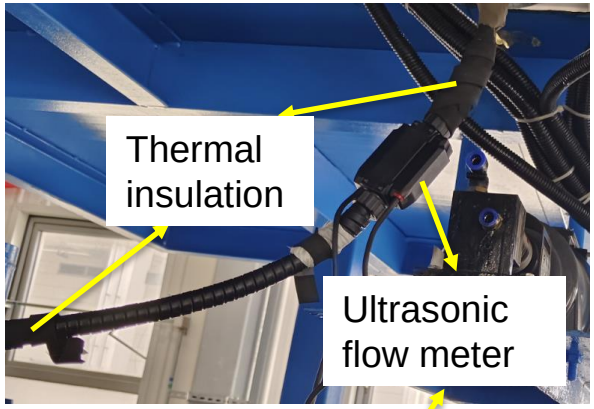
Performance of individual coils

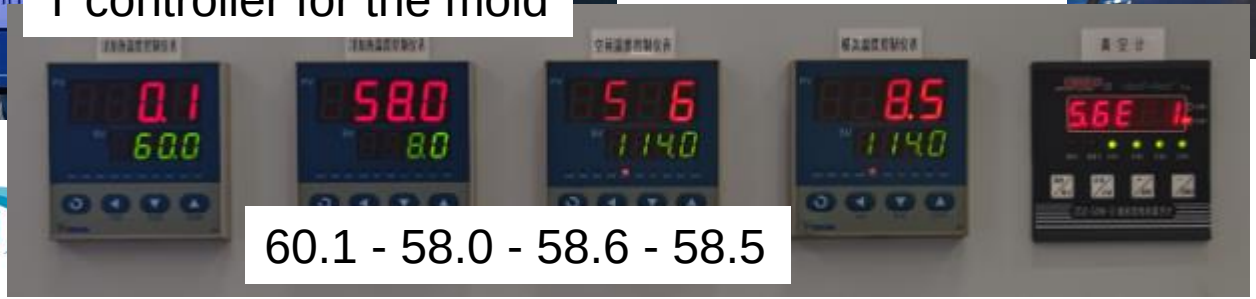
- The long training also induced an iteration on the impregnation procedures (VPI) and a fine tuning of the groove size (reduction of the height of the groove from 5.1 to 4.8 mm) to better fit the conductor in the former
- The iteration on coil procedures was positive, and more recent coils train faster



Corrective actions of the VPI station

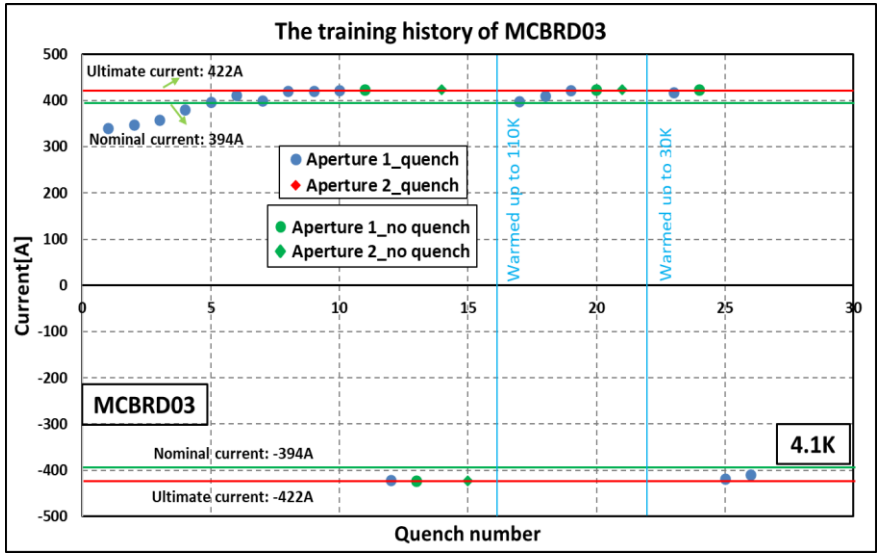


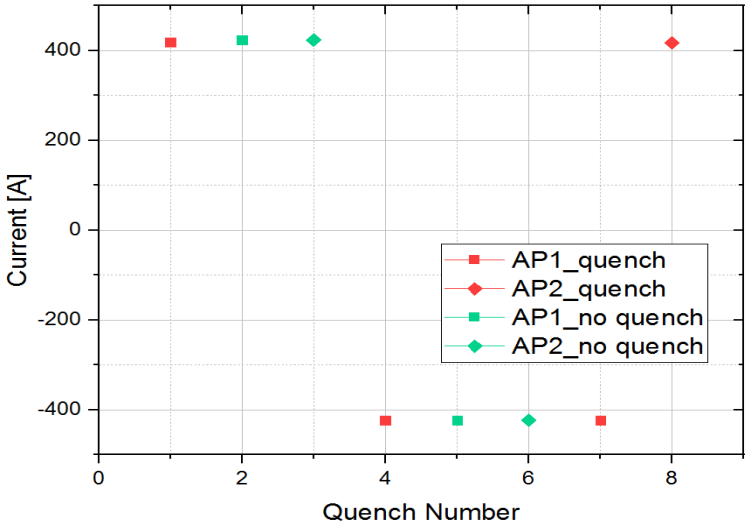




MCBRD03 (third series magnet) performance

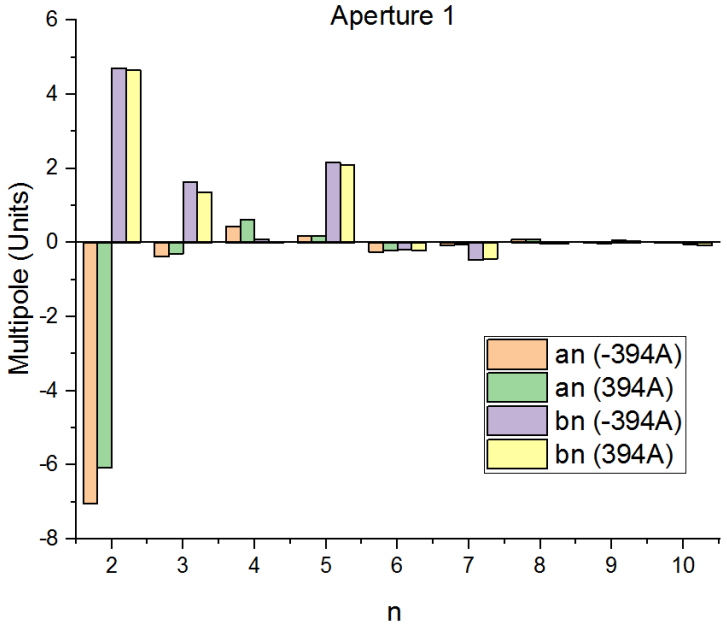
- MCBRD03 was tested in IMP, reached performance and is now at CERN
  - No retraining below nominal current

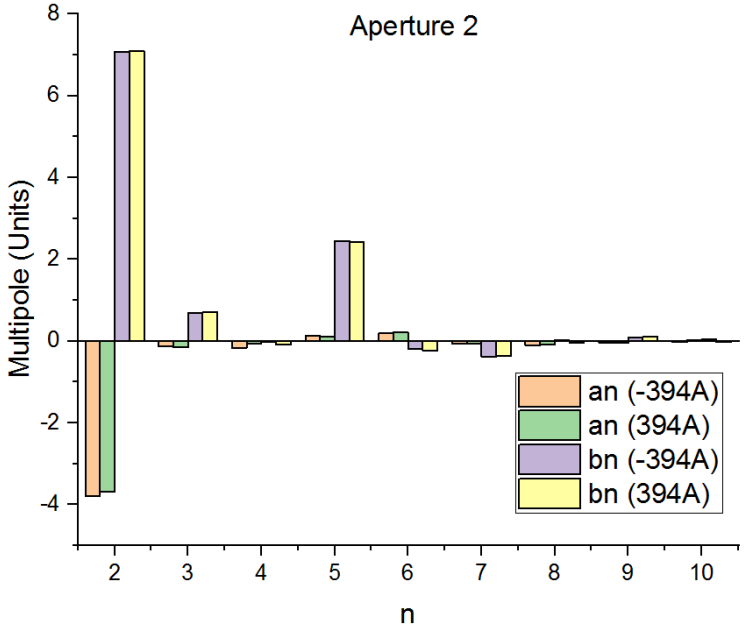




Field Quality of MCBRD03

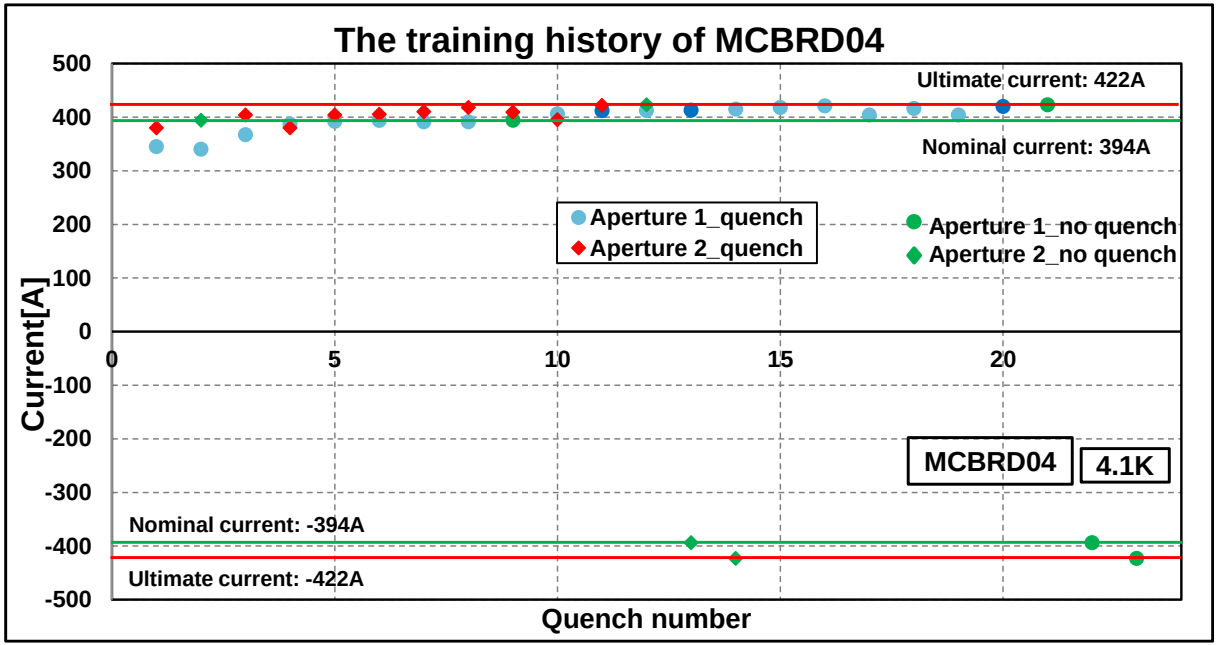
- Field quality is systematically measured in China and is within specifications





MCBRD04 (fourth series magnet) performance

- MCBRD04 was tested in IMP, reached performance and thermal cycle will take place in October
  - It also reached ultimate current, with short training to nominal current



Schedule and CERN contribution

- Iteration on procedures induced some delays with respect to initial schedule – but quality comes before schedule
- To mitigate the risk of having limited corrector availability for D2 cold mass, CERN proposed to manufacture two magnets with Chinese components
  - Efforts are ongoing in 927 laboratories, dedicated talk of A. Foussat in the parallel session

Summary

- 4 MCBRD magnets (out of 12 needed) have been fabricated in BAMA
  - All of them reached the ultimate current at 4.1 K
- Long virgin training issues (not in requirements, but consuming IHEP resources) and retraining (at the margin of HL-LHC requirements) induced an iteration on manufacturing procedure and a fine tuning of design - this iteration took place after MCBRD02
  - MCBRD03 confirmed the positive effect of the iteration on performance
  - MCBRD04 confirmed reproducibility, thermal cycle is pending
  - MCBRD05 shall be assembled at the end of the year
- This small series of CCT is giving relevant information on this type of design and technology that is considered for many applications well beyond HL-LHC correctors