Powering test of the prototype CCT orbit corrector


MT26 Conference – Vancouver, Canada – 2019 Sep 26
HL-LHC D2 orbit corrector “MCBRD”

Main magnet specs:
- NbTi conductor
- Nominal integrated field: 5 Tm (@ 393 A)
- Nominal / peak field: 2.6 / 3.1 T
- Length: 2.19 m
- Multipoles < 10 units
- Two independently powered apertures, with perpendicular magnetic field
MCBRD magnet design: “CCT”

**Canted Cosine Theta:**
Two canted solenoids generate a net dipole field

Each canted solenoid is supported on a cylindrical former with grooves for the superconducting wires.
MCBRD prototype magnet

Canted solenoid winding

Superconductors in the cylinder’s grooves
Outline

- Training
- Magnetic field quality
- Conclusions

For information about quench protection, please see Matthias Mentink’s presentation
Magnet training overview

- AP2 has very slow training

```
Current [A]

0  20  40  60
```

- "-" represents no-quench

```
1.9 K
4.5 K
Thermal cycle, 1.9 K
```

- Nominal
- Ultimate

```
AP1
AP2
Both
```

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Magnet training overview

- AP2 has very slow training
- However: no detraining

![Graph showing current vs event number with symbols for AP1, AP2, and both. Symbols represent no-quench.](image)
Training aperture 1 (vertical field)

![Training aperture 1 diagram]

- **Shallow**
- **Deep**

**Graph:**
- **Current [A]:** 250, 300, 350, 400, 450, 500
- **Event #:** 0, 2, 4, 6, 8, 10
- **Markers:**
  - EE13-EE14
  - EE14-VCL
  - VCL-EE17
  - EE17-EE18
  - No Quench
  - Nominal
  - Ultimate

**Temperature Points:**
- 1.9 K
- 4.5 K
- Thermal cycle, 1.9 K
Training aperture 2 (horizontal field)

Shallow

Deep

Precursor?

- EE23-EE24: 1 / 2
- EE24-VCL: ----
- VCL-EE27: 0 / 1
- EE27-EE28: 24 / 33

Symbols:
- ▲: Symmetric
- +: Unknown
- ■: No Quench
- Nominal
- Ultimate
Outline

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Nominal integrated magnetic field

The magnet will be cycled up to nominal so we consider the branches going up.

The magnet reaches 5 Tm ±1‰ at 393 A
- both polarities
- both apertures

This is 9% less than the simulated nominal current (430 A)
Transfer function - Crosstalk

Crosstalk effect: 2% at nominal current

- AP1 while 0 A in AP2
- AP2 while 0 A in AP1
- AP1 while 393 A in AP2
- AP2 while 393 A in AP1
Magnetic field quality

AP1 (vertical field): all within specs (10 units) ✓
AP2 (horizontal field): all within specs except a3:

These 10 units of a3 are still present at room temperature, but they disappear when the iron is removed.
Outline

- Training
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Conclusions & future plans

- **Training** to ultimate current:
  - Good in aperture 1 (3 quenches to ultimate current)
  - Very slow in aperture 2 (26 quenches to ultimate current). Mostly in the shallower three wires of the winding.
  - No further training at 4.5 K, and perfect memory after thermal cycle

- **Magnetic field quality**:
  - Nominal field is reached at 393 A instead of 430 A, acceptable main field crosstalk (2‰)
  - Large a3 (-15 units) on aperture 2 when affected by crosstalk. All other multipoles within 10 units

- **Future work**:
  - A new aperture is being manufactured to replace AP2
  - New magnet assembly to be tested in November 2019
Test setup

- Two independent quench detection systems:
  - Baseline asymmetric QDS: ▲ vs ◆ ▼
  - Additional symmetric QDS: ▲◆ vs ▼

Wiring schema of the magnet

Superconductor in the groove