Quench propagation measurements on 2 km MgB$_2$ coil up to 4 T

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**Experiment presentation**

19 MgB$_2$ filaments in a Nickel matrix produced in 2014 by

**Main Conductor characteristics**

- Parameters: Values [Units]
  - Bar conductor dimensions: 3.1 x 0.7 mm$^2$
  - Insulation thickness: 0.07 mm
  - MgB$_2$ cross section: 0.31 mm$^2$
  - Ni cross section: 1.24 mm$^2$
  - Cu cross section: 0.62 mm$^2$
  - Cu ERR: 249

**3 T homogeneous solenoid**

- M heater (middle)
- Z heater (axis)
- P heater (punctual)

**Experiment results**

- The IT solenoid is a dry magnet with only voltage taps and 3 Cernox as instrumentation.

**Resistance versus quench length**

We calculated the value of the conductor linear resistance and corrected it roughly by the ratio of 17/11.5. This ratio gives the link coefficient between the resistance of the conductor and the quenched length: 0.20 mΩm at 3 T and 0.23 mΩm at 3.5 T.

**Expected quench velocities calculated in 2013 [1]**

A FEM study has been performed to design the magnet and its protection. The entire coil is meshed. The computed MQE value equals 1.1. The MPD value expressed in conductor length is 6.8 m and involves 40 adjacent turns. The quench velocities were also calculated:

**Longitudinal quench velocity**

- Theoretical quench velocity

**Radial and axial quench velocity**

- The nominal condition was set to: 100 A, 10 K, and 4.2 T. Calculations were done without the mandrel and the fiberglass bulking.

- The IT solenoid is a dry magnet with only voltage taps and 3 Cernox as instrumentation.

**Experimental results**

- On the external layer, for a quench starting from the extremity corner, we can see up to 3 slops on the resistance curve. These slopes correspond to the number of adjacent quenched turns. The average quench length is directly obtained with the corresponding link coefficient.

**Conclusion**

The longitudinal quench velocity is 2 time faster than expected probably due to the axial transvers velocity that is found to be 5 time less. The bulking and the presence of the conductor corners inducing a lower fiber contact could explain such difference.

The radial quench velocity was not measured because we were too far from the asymptotic conditions.