Test Coils for the 32 T All-Superconducting Magnet

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Introduction

The 32 T project is a ground-breaking effort to build a 32 T all-superconducting user magnet with REBCO coated-conductor high-field coils [1]. No existing superconducting user magnet exceeds 23.5 T, so a successful project would represent an unprecedented leap in available magnetic field strength for scientific users. The REBCO High Temperature Superconductor part of this magnet requires the development and rigorous testing of new technology, particularly on assembly techniques and quench protection.

Experimental

A six module superconducting test coil was built and tested twice at 4.2 K in a cryostat fitted to the Cell 4 20 T resistive magnet. The test coil design shares many features and design approaches with the 32 T design, whereas the number of modules and radial dimensions are reduced. Quench protection relies on active heaters to create multiple normal zones in case of a quench, so the stored energy can be dissipated over a sufficiently large volume. The test coil is shown in **Figure 1**.

Results and Discussion

The test plan was successfully executed within two test runs. The effects of an instrumentation problem, now resolved, had limited the maximum current and compromised one of the protection heaters during the first run. As the test plan had meanwhile expanded, a repair attempt and a second run were justified. The coil was dis-assembled; and a module and protection heater were replaced. Subsequent quench tests and load cycling exercises in high magnetic field showed that the rebuilt coil performed well, exceeding design current and design stress levels. The replacement exercise also provides confidence that repairs of the 32 T YBCO coils are entirely feasible, should that ever be necessary, and accentuates the value of the chosen modular approach in coil winding and assembly. Data was also obtained for normal zone initiation resulting from continuous local low-power heating and high-power pulses of 0.5-1 second using heaters of different sizes at nominal and reduced coil current. A sample of the high-power pulse data set is shown in **Figure 2**.

Figure 1. Image of the test coil.

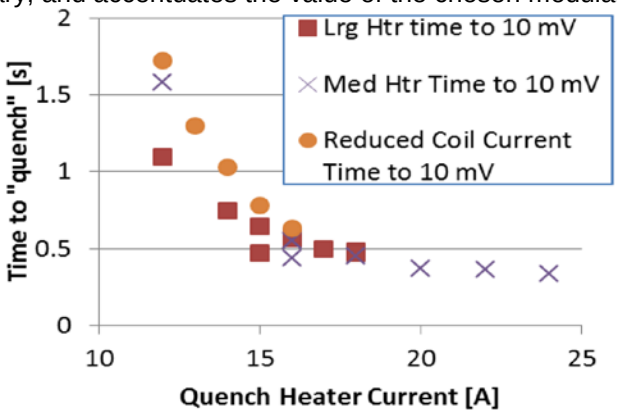

Figure 2. Time to normal zone initiation versus quench-protection heater current.

Conclusions

A six-module sub-size test coil was tested twice in backgrounds up to 20 T and successfully underwent load-cycling and quench tests. One module was replaced between tests. This gives confidence in the technology choices we have made for the 32 T coils and guidance for the detailed design and assembly. As follow-up, a larger prototype coil with full radial dimensions was designed and built along the same lines, and is nearly ready for testing.

Acknowledgements

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References

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