Quench Analysis of the NHMFL 32T All-superconducting Magnet

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Introduction

The development of a 32 T, 32 mm cold bore all-superconducting magnet with high temperature superconducting (HTS) REBCO inner high field coils (insert) is underway at the NHMFL (Fig. 1). In order to develop a quench-protection system for the magnet, and especially that of its innovative HTS insert, a sophisticated quench- simulation is required. A quench-code is being developed at the NHMFL to perform the necessary computer simulations of the magnet quench behavior in a number of case scenarios, which may take place in reality.

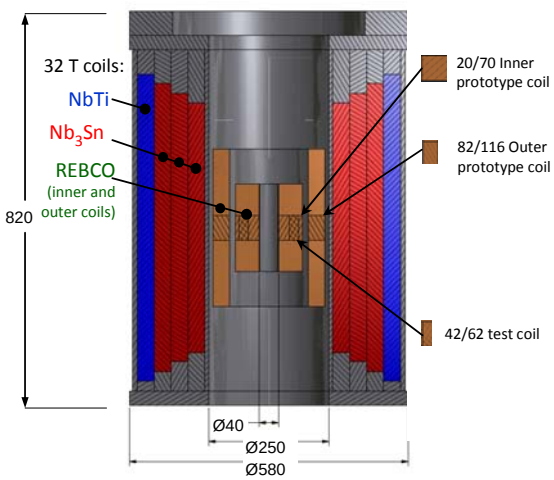

Fig. 1. Cross-section of the 32T magnet with the LTS outsert (schematic) and the HTS insert REBCO coils. The model and prototype coils are shown, too. The LTS outsert is to be built by Oxford Instruments, Ltd.

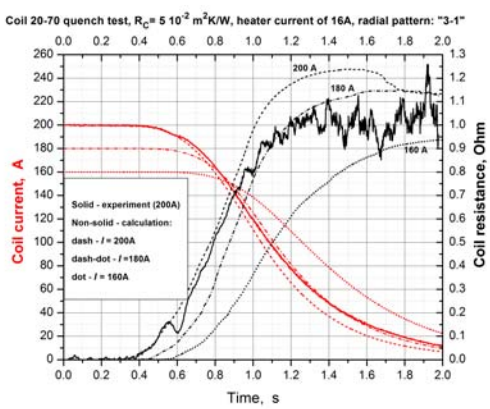

Fig. 2. Current and resistance of the model coil 20/70 during quench tests in comparison with the calculations.

The quench-code

The quench-code, whose development is nearly completed, is supposed to take into account the actual layout and discrete structure of the REBCO coil windings with due regard for the measured current-carrying capacity and other properties of the REBCO tapes supplied by SuperPower, Inc. and used to wind the coils. Such a comprehensive quench analysis is assumed to provide a detailed picture of the magnet quench behavior with a view to adjusting the quench-protection system parameters and checking its serviceability. The active quench-protection system of the insert includes tailor-made quench heaters to normalize the coils promptly in the event of quench. The heaters' operation is simulated appropriately by the quench code. A small HTS model coil and a two-coil HTS prototype (shown in Fig. 1) were tested to study the heaters efficiency and quench propagation process. A comparison of the measured voltages in the coils and other parameters with the calculation results is made to improve the quench code. Fig. 2 shows a good agreement between the calculations and measurements reached recently. The final, complex version of the quench code is supposed to include both the LTS outsert and HTS insert with due regard for most relevant elements of the entire magnet quench protection system.

Acknowledgement

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Reference

[1] Gavrilin, A.V., *et al.*, presented at the Applied Superconductivity Conference of 2014, Charlotte, NC, August 2014