Field Mapping of a Test Coil in Preparation for a 24+ T Enhanced Homogeneity Magnet with $REBa_2Cu_3O_{7-x}$ Tape Conductor

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Introduction

$REBa_2Cu_3O_{7-x}$ (REBCO) coated conductors have substantially improved as a number of successful record coil attempts carried out by several research groups have shown [1, 2]. Being essentially a highly-aspected single filament conductor REBCO coated conductors develop significant screening currents that are induced by the radial field components in tape-wound coils that affect their field profile. For high homogeneity magnets it is necessary to quantify field distortions and correct for these. We investigated the extent of their impact with a test coil whose field we mapped using an array of Hall sensors, and we developed an analytical model to compare with the experimental data with the goal to predict field profiles in future coated conductor wound coils.

Experiments and Results

A test coil was built and its field profile was mapped using an array of Hall sensors, **Figure 1**. Four 3-axis calibrated Hall sensors were placed at various radii on a bar that was mounted on a spindle, actuated by a stepper motor. This sensor array then mapped the distance between center of field and the end of the coil. Using a critical current distribution developed by Brandt and Indenbom [3] that takes screening currents into account, an analytical model was developed to predict the field profiles in realistic coated conductor wound coils. The analytical model is based on the summation of field contributions of single wire loops using Biot-Savart's law. Additionally a functional dependence for the field field-angle dependence of the critical current was developed and both, the current distribution across the tape width as well as the current field-angle dependence were applied in the whole model [4]. The experiments revealed that the field profiles affected by screening currents in the coil windings are moderate. **Figure 2** shows the magnetic field differences between the experimental data as well as the screening current affected model data and the model data of a magnet with the same specifications that is not affected by screening currents. The analytical model qualitatively reproduced the measured data but needs to be improved for a better quantitative fit.

Conductor	Superpower "M3-894-2 MS" 1192.68-1322.68m
Width [mm]	4.02
Thickness [mm]	0.096
Insulation	Shrink tube
Thickness init. [μm]	12.7
Coil	
ID [mm]	84
OD [mm]	88.2
Height [mm]	128
Layers [-]	14
Turns/Layer [-]	29
Turns total [-]	406
Cond. Length [m]	110
Joints	none
Coil Constant [mT/A]	3.3
Inductance [mH]	7
Homogeneity (10 mm DSV) [ppm]:	1981

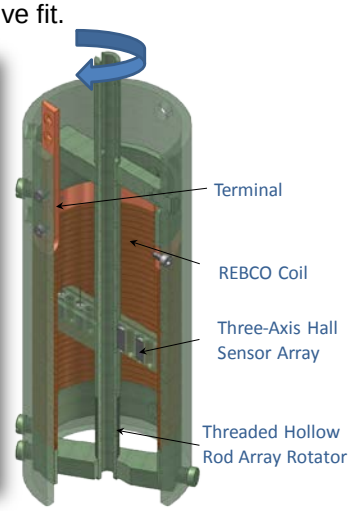

Figure 1. Coil specifications and schematic view of the coil instrumented with the Hall sensor array.

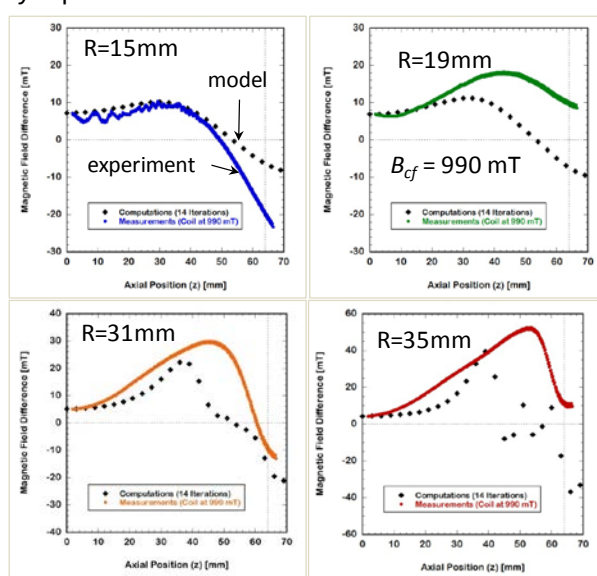

Figure 2. Comparison of the magnetic field difference vs. axial position of the measured (solid lines) and theoretically derived data (dotted lines).

Acknowledgements

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References

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