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Fri-Mo-Po.04-01: Construction and Test Results of a Cryogen-Free, Iron-Shielded 23.5-T REBCO Magnet for Benchtop 1-GHz NMR Spectroscopy

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In this paper, we present the finalized design, construction, and test results of a cryogen-free, iron-shielded 23.5-T/28-mm room-temperature bore REBCO magnet, developed for use in benchtop 1-GHz microcoil NMR spectroscopy. This benchtop magnet is composed entirely of REBCO conductors and operates at ~ 10 K in a conduction-cooled cryostat, featuring an external iron cylinder outside the vacuum chamber for fringe field shielding. The magnet employs a surface-shunting no-insulation (NI) winding technique, with copper cooling sheets attached to each winding surface to mitigate quenching risks from potential fault modes, thereby enabling self-protection. The design was modified to include 32 double pancake coils using 4-mm-wide REBCO tape. This change was implemented to align with the manufacturer's standard dimensions, addressing the conductor thickness uniformity issues encountered during winding. The coils are co-wound with Hastelloy tapes to reduce overall current density, lower stress, and enhance structural strength within the winding pack. Additionally, the top and bottom winding surfaces are shunted with low-temperature solder to improve thermal and electrical performance. We detail the construction process, including winding, surface-shunting, jointing, and assembly into a custom-developed, vibration-isolated, iron-shielded, conduction-cooled cryostat. The paper concludes with the initial test results and performance evaluation of the magnet.

Author: Dr PARK, Dongkeun (Massachusetts Institute of Technology)

Co-authors: DONG, Fangliang; HU, Jintao; BASCUNAN, Juan (Massachusetts Institute of Technology); Dr SHAO, Liangjun (MIT PSFC); SADDE, Patricia (Massachusetts Institute of Technology); IWASA, Yukikazu (M)

Presenter: Dr PARK, Dongkeun (Massachusetts Institute of Technology)

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