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HTS Shim Coils Energized by a Flux Pump for the MIT 1.3-GHz LTS/HTS NMR magnet: Design, Construction, and Results of a Proof-of-Concept Prototype

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In this paper we present design, construction, and preliminary test results of a proof-of-concept (POC) prototype, high-temperature superconductor (HTS) shim coils energized, for the first time ever, by a flux pump. For high-resolution NMR spectroscopy the spatial magnetic field must be uniform to within <0.1 ppm over a given region of interest (ROI). Field shimming is indispensable for achieving the required uniformity. For conventional NbTi shim coils, placed outside a magnet containing an HTS insert, the shim field is not only attenuated by the diamagnetic wall effect of the insert, but also distorted when it reaches the ROI. Therefore, we propose to develop HTS shim coils, placed inside the cold-bore of the innermost HTS coil of LTS/HTS or all-HTS NMR magnets, as a means to minimize the diamagnetic wall effect. For operation of HTS shim coils at 4.2 K, a flux pump improves cryogenic efficiency because it does not require high-current leads. As a POC, we built and operated, at 77 K, flux-pump-energized Z1 and Z2 prototype HTS shim coils of 2-mm wide REBCO tape; final versions of these shim coils will be installed inside the bore of the MIT 1.3-GHz LTS/HTS NMR magnet.
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