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Design of a Cryogen-free 6 T 320 mm All-REBCO MRI Magnet

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In September 2020, a 4-year national project was embarked on to develop a conduction-cooled 6 T 320 mm all-HTS magnet for MRI with support from the Korea Medical Device Development Fund. It is a collaborative R&D effort led by SuperGenics, Co. Ltd., in participation with Changwon National University, Korea Electrotechnology Research Institute, Korea Maritime and Ocean University, Korea University, Kunsan National University, Seoul National University, and Sungkyunkwan University. As the first step of the project, this paper reports a design of the magnet that consists of a stack of double-pancake coils wound with REBCO tapes. The target operating temperature is 20 K under a conduction-cooling environment. The winding diameter is set to be 320 mm, while a patient bore is expected to be 200 mm or greater with an estimated field of view (FOV) to be around 120 mm. The well-known metallic insulation technique is considered together with other advanced winding techniques such as multi-width and/or multi-thickness HTS windings. This paper reports key design parameters and performance analysis results on: (1) magnetic field homogeneity in consideration of screening current-induced field; (2) mechanical stresses in consideration of screening current-induced stress with our latest new E-J model; (3) charging simulations; and (4) post-quench analysis in consideration of the induced overcurrent stress during an NI-type magnet quench.

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