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Temperature Dependence of Optimal Shape and DC Current Transport Characteristics of 3T Whole Body REBCO MRI Magnet

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In this study, we report on the optimized design results of REBCO high-temperature superconducting magnets for 3T whole body MRI. That is, for the REBCO magnet consisting of the main coil, the compensation coil, and the shield coil, an optimized design using an immunogenetic algorithm is carried out with two objective functions of maximizing the magnetic field uniformity in the uniform sphere inside the coil and minimizing the 5-gauss region outside the coil, for different transport current values. The local magnetic field vector distribution of the designed coil is calculated in detail, and the local voltage was obtained using the magnetic field / temperature dependence of the electric field-current density characteristics evaluated with the short REBCO sample. Then, the voltage-current characteristic of the magnet is evaluated by adding it over the entire coil. By defining the current load factor (operating current / critical current) of the designed magnet using the above analysis results, it is possible to clarify the relationship among the operating current, the optimized magnet shape, and the required wire length with respect to the operating temperature. In particular, it is found that the required wire length and the transport current have a simple linear relationship in the range of the operating temperature of about 40 K or less.

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