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FEM Modelling Studies of 3 T Cryogen Free MRI Magnet based on MgB2 conductor

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This work describes magnetic, mechanical, and thermal Finite Element Modeling (FEM) studies in support of a whole body 3 T MRI magnet based on conduction cooling. As a strand, both 1G and 2G MgB2 conductors were considered. An optimization code to design the main coil segment layout and winding size was used. Thermal FEM modeling was used to estimate the temperature gradient on the coils in order to determine the critical surface of magnet operation. Mechanical and thermal FEM modeling was used to determine stresses, thermal expansion of different materials as well as required cooling power and cooling time of the magnet. Material parameters and their temperature dependencies used as inputs in the modeling were taken from experiments performed in our laboratory or taken from available material data bases. We used a Wire In Channel (WIC) design for the conductor to have a well-protected system, and also perform quench and protection studies on the magnet system (in this case at the individual coil level). Coil sizes, field homogeneities, temperature gradients, and coil protection are discussed. The influence of 1 G vs 2G conductor choice is also discussed.

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