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Fri-Mo-Po.03-01: Design of a DC-Coil for MRI magnet using second-generation high-temperature superconducting tapes

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Magnetic Resonance Imaging (MRI) is a technique that generates high-resolution volumetric images of the body using a strong magnetic flux density. The image quality directly depends on the magnetic field homogeneity. Commercial superconducting magnets have a magnetic field homogeneity below two parts per million (ppm) and use Nb-Ti magnets. However, they need to be cooled at 4 K. It is costly to achieve and keep this temperature, and two cryocooler stages are necessary. The second-generation (2G) high-temperature superconducting (HTS) tapes are a possible technical-economical solution to address the abovementioned points, as they can be cooled to temperatures between 20 to 77 K. But these tapes are susceptible to the magnetic field. Therefore, to correctly design a magnet made of HTS tapes, it is necessary to simulate the device. The finite element model (FEM) is the chosen numerical method in this case. This study simulated the design of a 0.5 T MRI magnet with a patient bore of 70 cm, considering space for the gradient and radiofrequency (RF) body coils. The J-A formulation, a new and easily implementable formulation, and the power law are used to simulate the DC-coil. A commercial 12 mm wide 2G HTS tape is simulated using the data available from the Robinson Research Institute. It has considered the current density and n-value characteristics in relation to the magnetic flux density. Passive and active shims were not represented in this work. The final results obtained a magnetic field homogeneity of less than 20 ppm in a diameter spherical volume (DSV) of 10 cm, which we consider acceptable.

Author: DE SOUZA, Rafael (Fluminense Federal University)

Co-authors: SANTOS, Bárbara (Rio de Janeiro State University); Dr MARTINS, Flavio (Fluminense Federal University); DOS SANTOS, Gabriel (Electrical Engineering Department, Rio de Janeiro Federal University, Rio de Janeiro, Rio de Janeiro, Brazil); SOTELO, Guilherme (Fluminense Federal University)

Presenter: DE SOUZA, Rafael (Fluminense Federal University)

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