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Mechanical and thermal analysis of an HTS superconducting magnet for an achromatic gantry for proton therapy

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The innovative concept of using a combination of two identical superconducting bend magnets working at a fixed field in a proton therapy gantry, allows for a light and compact design, while being able to deliver protons over a range of 70-230 MeV. In this concept, the gantry is conceived as achromatic, allowing the magnets to operate at a constant field, and therefore avoiding the technical challenges and risks of the fast-field ramping required in other designs to accommodate various beam energies.
The proposed design of the superconducting magnets consists of a series of straight, double-pancake coils embedded in an iron yoke. These coils are made of Bi-2223/Ag (DI-BSCCO) tape, and produce a maximum magnetic field of about 3 T at 12 K, with a multi-stage conduction cooling system. This paper presents the mechanical and thermal analysis of the magnet, based on finite element simulations. The main components of the mechanical structure, winding of the coils, assembly, and values of stress in the conductor due to the electromagnetic forces are discussed. Furthermore, the cooling design, along with the expected temperature gradients within the superconducting coils are also addressed.

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