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Electromagnetic-structural analysis of a superconducting magnet with active shielding for a rotating gantry

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In heavy particle radiotherapy, a rotating gantry enables charged particles to be delivered to a tumor with great accuracy. Therefore, cancer therapy that minimizes unnecessary damage to a patient can be realized by using the rotating gantry. The world's first rotating gantry composed of superconducting magnets was developed in Japan. Using superconducting magnets instead of conventional magnets, it became possible to make a smaller, lighter gantry.

A superconducting magnet for the rotating gantry is composed of a cosine-theta superconducting coil surrounded with an iron yoke which is the heaviest part of the magnet's weight. The weight of one superconducting magnet reaches several tons, and the rotating gantry is equipped with ten superconducting magnets. Precise rotation control is required under the condition that several ten tons are mounted on the frame of the rotating gantry. In this study, a superconducting magnet composed of an active shield coil for the gantry has been proposed to simplify the control system and the frame structure of the rotating gantry by reducing its weight. Using an active shield coil instead of an iron yoke to shield the stray magnetic field, the magnet's weight can be reduced.

The previous study indicated the possibility that the superconducting magnet with active shielding can significantly reduce the magnet weight compared to the superconducting magnet with an iron yoke. However, the support structure of the superconducting magnet with active shielding was not taken into account in the previous study. Considering the coil support structure, hence, the design study of the superconducting magnet with active shielding was conducted based on the coil cross-section designed in the previous study. In this paper, the electrical-structural analysis of the superconducting magnet with active shielding is described. Additionally, the weight of the magnet is evaluated.

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