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Electromagnetic design of the superconducting magnet for a compact heavy-ion synchrotron

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A project to develop a compact heavy-ion therapy device has been initiated at the National Institutes for Quantum and Radiological Science and Technology. The therapy device uses a 430-MeV/u synchrotron with superconducting bending magnets as a main accelerator. In order to reach the required output of the heavy-ion beam, the bending magnets have been designed to be operated alternately from 0.3 T (for injection) to 3.5 T maximum (for extraction) at the ramping rate of 0.6 T/s. The 3D electromagnetic design of the synchrotron bending magnet has been performed. The magnetic length is 1.49 m for 45-degree bending angle, and curvature radius is 1.89 m. The superconducting coil consists of a low-loss NbTi wire with a 1-mm diameter, and the maximum operating current is 265A. To suppress the magnetomotive force, the cross-sectional coil design adopted an elliptical-shaped arrangement. The coil and iron yoke designs were optimized for the uniformity of the magnetic field in the required area. In addition, a short-straight model with a magnetic length of 400 mm was fabricated for the feasibility demonstration. The results of the excitation test as well as the electromagnetic design will be reported.

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