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Design study of an HTS magnet with REBCO coils for heavy ion beam-line experiments

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A project to develop fundamental technologies for accelerator magnets using REBCO coated conductors is currently underway funded by the Japan Science and Technology Agency (JST).
In this project, an FFAG (fixed field alternating gradient) accelerator for the carbon cancer therapy system is one of the primary applications. In the first step of this project, REBCO coils with complicated winding shapes were fabricated and a reduced-size test magnet was developed to verify the winding technology required for the HTS accelerator magnets. In the following stage, there are plans to develop an another experimental REBCO magnet for the performance evaluations in the beam line of the HIMAC (Heavy Ion Medical Accelerator in Chiba) at NIRS (National Institute of Radiological Sciences). This development has two main objectives; demonstration of beam guiding characteristics and stability verification of the magnet against beam loss. For these experiments, a cryocooler-cooled magnet with REBCO coils has been developed to generate dipole field in the room temperature bore. The magnet consisting of multiple REBCO pancake coils with racetrack shapes was designed. The coils were designed to generate a peak field of 2.3 T at the beam orbit and also designed to meet the target value of the field accuracy. A cryostat structure and a layout of the coils have been studied to verify the stability against beam loss as compared with the Monte Carlo simulation. In the experiments, magnetic field distribution in a beam duct will be also evaluated to reveal the effect of the magnetization behavior of coated conductors. This paper describes design and fabrication results of the REBCO coils, magnetic field calculation, and simulation of ion beam transport in the dipole field.
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