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An Optimal Configuration Method of Superconducting Magnet with Iron Shield using Model Order Reduction

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The R&D project of compact high-temperature superconducting (HTS) cyclotron system for radioisotope production is ongoing, supported by Japan Science and Technology Agency (JST) and Japan Society of the Promotion of Science (JSPS). This HTS cyclotron has two major features: (1) the magnet has no iron core (air-core), and (2) the output energy is variable. The developing HTS cyclotron system is named 'Skeleton Cyclotron,' and consists of main coils for isochronous field generation and triangle coils for azimuthally varying field (AVF). With progress of this project, we need to design a magnet system with iron shield, because leakage field and radiation must be suppressed. Note, in conventional AVF cyclotron magnets, iron is also used for the purpose of generating AVF; however, in the proposed system, iron shield is not for that purpose.
When designing Skeleton Cyclotron magnet with iron shield, the finite element method (FEM) or the magnetic moment method is commonly used for magnetic field simulation, and a large-scale system of equations must be solved. In addition, field computations with many iterations are required in an optimization design process. To accelerate an optimization computation, the model order reduction (MOR) method, which reduce the dimensions of system of equations, is employed. In our case, the magnetic moment method is employed as a field computation method, and 52,080 dimensions could be decreased into 4 using the MOR. The simulated annealing is used as an optimization method. Finally, it was successful to greatly shorten the optimization computation time.
In the full paper, we will present the detail of MOR and the optimized configuration of Skeleton Cyclotron magnet with iron shield.

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