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Numerical evaluation of screening current-induced magnetic field in HTS coil system of Skelton Cyclotron for targeted alpha-particle therapy

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Targeted alpha-particle therapy is a cancer treatment method using alpha-emitting radioisotope (RI), and is expected as a treatment method for progressive cancer. We are conducting research toward the development of a High-temperature-superconducting Skeleton Cyclotron (HTS-SC), which is an ultra-compact and high-intensity accelerator capable of stably producing the alpha-emitting radioisotope, 211At used in targeted alpha-particle therapy. In the HTS-SC, the high magnetic field and high precision magnetic field required for particle acceleration is generated only by air-core REBCO coil system without the use of iron cores. For cyclotron, high-precision magnetic field distribution and temporal stability of the magnetic field are required on the particle acceleration surface, but the magnetic field caused by the screening current induced in the REBCO coated conductor deteriorates the quality of the generated magnetic field spatially and temporally. Therefore, we plan to conduct experiments scheduled for 2022 to investigate the electromagnetic, thermal, and mechanical behavior of the Ultra-Baby-Skeleton-Cyclotron (UBSC), which is a small demonstration model of REBCO coil system for HTS-SC. So far, we have numerically analyzed and evaluated the effect of the screening current induced magnetic field (SCIF) on the generated magnetic field for UBSC. It has been confirmed that the influence of the SCIF can be suppressed by controlling the energization pattern. We are aiming to realize a multifunctional accelerator that can produce 211At for targeted alpha-particle therapy as well as RI for positron emission tomography (PET) and neutron irradiation for boron neutron capture therapy (BNCT). In this study, we evaluated the effect of SCIF when changing the output energy for multi-functionality and investigated the reduction method of the effect of SCIF by optimizing the excitation pattern for a full-scale HTS-SC for these actual applications.

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