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Numerical evaluation of electromagnetic behavior of multi-stacked no-insulation REBCO coil system assuming applications to high-field whole-body MRIs and medical cyclotrons

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We have been studying the No-insulation coil (NI coil) for applications to medical cyclotrons for cancer therapy and high-magnetic-field whole-body MRIs. Since the layers in NI coil winding are not electrically insulated from each other, the current can be bypassing the adjacent layers when a local defect or normal transition occurs in the coil. Therefore, NI coil is expected to realize both high current density and high thermal stability. In this study, we numerically investigated the electromagnetic behavior of large diameter (m-class) multi-stacked coil system, which consists of NI-REBCO double pancake coils, when local defect or normal transition occurs in one pancake coil. It is known that the behavior of NI coil systems is different from that of normal insulated coils because the generated magnetic field changes due to the varying current distribution in the coil even in the condition of the constant current carrying. In the previous study, the electromagnetic behavior analysis based on the PEEC (Partial Element Equivalent circuit) model has been conducted. This model is an equivalent circuit model that divides the NI coil winding into small elements and takes into account electrical resistance due to local defect or normal transition, turn-to-turn contact electrical resistance between layers, and the self and mutual inductance between elements. In order to analyze the behavior of the target multi-stacked NI-REBCO coil system, the computer program based on the PEEC model was modified to reduce the calculation time while maintaining the calculation accuracy. In this presentation, we will report the results of analysis and evaluation of the magnetic field of 10 T and operating temperature of 30 K (conduction cooling), assuming the application to high field MRI and medical cyclotron.
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