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Wed-Mo-Po.01-08: Hybrid Nb3Sn/Bi-2212 SMCT Magnet Analyzed with Heterogeneous Rutherford Cable Model

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It is known that Bi-2212 strands withstand higher external magnetic fields than LTS superconductors, allowing higher current density when allocated in the innermost layers of a high-field magnet. For this reason, the first stress-managed cosine-theta insert based on Bi-2212 Rutherford cable was designed at Fermilab within the U.S. MDP and is currently in the realization process. The HTS insert has a 16 mm aperture and will be positioned within the 120 mm aperture of the LTS SMCT outer coil made of 2 layers of Nb3Sn Rutherford cables. This article first introduces the hybrid magnet structure's design and main parameters obtained from the axial and transversal cross-section optimization performed on ROXIE. It then reports the magnetic and mechanical FEM analysis of the hybrid magnet assembly. Magnet simulation requires multi-physics analysis where geometrical, electromagnetic, and thermal aspects deeply interact to describe the system behavior. For this reason, in this paper, the entire 4-layer hybrid magnet was modeled using a more detailed geometry description of the Rutherford cable in Ansys APDL. This heterogeneous cable model allows a higher resolution to investigate the stress and strain state in each LTS/HTS superconductor component better and to obtain more accurate information on mechanical solicitation and displacements within the Stress Management structural elements. All results are collected and reported for the entire hybrid magnet structure after current powering at 4.2 K.

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