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Thu-Mo-Po.10-03: J-A-φ formulation with homogenizing technique used to efficiently model HTS cable-in-conduit.

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The integration of high-temperature superconductors (HTS) into fusion coil systems is a key advancement for magnetic confinement fusion technology. HTS conductors provide significant benefits, including higher operational thresholds for temperature, transport current, and magnetic fields, which are pivotal for future fusion applications. A previous study introduced an innovative HTS sector cable-in-conduit conductor optimized for low losses and developed an analytical model to estimate magnetization losses during varying magnetic fields. Building on this background, the present work introduces a novel computational approach using the 2D J-A-φ formulation, significantly enhancing simulation efficiency, by reducing computational time of one order of magnitude. This improved framework, based on Finite Elements Analysis (FEA), enables practical assessment of magnetization losses under complex field conditions. The results exhibit excellent agreement with the prior analytical model and the T-A formulation, affirming both accuracy and efficiency. This approach opens new possibilities for optimizing HTS cable designs, particularly for high-performance applications like the DEMO Central Solenoid coil, where precise thermal and magnetic behavior predictions are critical during demanding plasma initiation and operation scenarios.

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