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Thu-Af-Po.02-03: A Fast and Accurate Method for electromagnetic analysis of a CS Magnet Wound with Multilayer Cables

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High-temperature superconducting Conductor on Round Core（CORC）cable, with advantages of strong current-carrying capacity, low loss, light weight, and good bending performance, has become an excellent choice for winding high-field magnets and meeting the requirements of magnetic field shaping. In particular, CORC cable has great potential in manufacturing the Central Solenoid magnet (CS magnet) in nuclear fusion devices. The CS magnet is a crucial component of the nuclear fusion device and is generally located at the center of the device.

For electromagnetic design of a CS magnet, especially for a magnet wound by CORC cables with multilayer, due to the complex helical structure of the cables and the uneven current distribution on the superconducting tapes, the modeling process is complicated, and the calculation process consumes excessive resources and time. Currently, the main methods mostly use the finite element method, which models through three-dimensional or two-dimensional models with H-Formula or T-A method to obtain the magnetic field distribution and inductance of the CS magnet with alternating current.

Based on the Biot-Savart law and the Neumann Formula, this paper established an analytical calculation model for the inductance and magnetic field of the CS magnet considering the complex helical winding structure of the CS magnet and the current distribution in the width direction of the superconducting tape, proposing a fast and accurate method for calculating the magnetic field distribution on the CS magnet wound by CORC cables with multilayer at a transit alternating current and inductance of it. Compared with the existing methods, this method features a simpler modeling method and process, a faster calculation speed, and more accurate calculation results.

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