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Thu-Af-Or23-04: Optimal Design of HTS/LTS Hybrid Magnet for 25T NMR

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With the increase of the magnetic field of NMR, the traditional LTS materials cannot meet the requirements of ultrahigh field NMR magnet design. In recent years, with the development of high-temperature superconducting tapes (especially ReBCO tapes), hybrid magnets with HTS magnets as interpolating magnets have become an important choice for designing ultrahigh field NMR magnets.
International research on the design optimization of ultrahigh field magnets is extensive, but most studies often do not fully consider the various limitations in magnet design, and the computational efficiency of the program is not ideal. In order to optimize the design of ultrahigh field NMR magnets in a more comprehensive, fast and efficient manner, in this paper, a code for design optimization of ultrahigh field NMR magnets based on HTS/LTS hybrid magnets was developed. The code is divided into global optimization phase and local optimization phase. The global optimization adopts Nondominated Sorting Genetic Algorithm II (NSGA-II) algorithm, and the local optimization adopts nonlinear programming NLP algorithm. The new code has a few differences compared to previous code:
1)Considering the problem that the helium gas bubble is trapped by liquid helium, which requires that the product of B_z and (dB_z)/dz is less than -2100T^2/m;
2)Considering the anisotropy of the ReBCO strip, the Br at the top and bottom of the magnet needs to be less than 2.85T;
3)More ReBCO tapes options, when designing HTS insert magnets, you can choose a hybrid design with different width (4/6/8/12mm) ReBCO tapes;
4)Structural optimization of the original code with parallel acceleration, which improves computational efficiency and saves computation time
In this paper, we optimized the design of the HTS/LTS hybrid NMR magnet with a central magnetic field of 25T (15T LTS background magnet + 10T HTS interpolated magnet) and a cold hole diameter of 32mm using the developed code. The design results were verified by commercial finite element software. The results show that the design of the magnet meets the basic design requirements

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