I hold a Ph.D. in superconducting electrical engineering from the University of the Chinese Academy of Sciences, specializing in the design theories and methodologies of superconducting magnet systems for magnetic confinement fusion devices such as tokamaks and stellarators. During my doctoral studies, I participated in a collaborative program at the Princeton Plasma Physics Laboratory, focusing on the systematic exploration of fusion superconducting magnet design and stability mechanisms. After completing my Ph.D., I joined the Institute of Plasma Physics at the Chinese Academy of Sciences. Since 2020, I've assumed the roles of Ph.D. supervisor at the University of Science and Technology of China and director of Fusion Engineering Research Division at the Institute of Plasma Physics. In 2021, I was promoted to the position of Research Professor。

Over the past decade, my endeavors have been concentrated on foundational theories and analytical models in the fields of critical characteristics, multi-scale AC losses, and stability margins of large high-field superconducting magnets. Notably, I have been responsible for the design and advancement of the superconducting magnet systems for the Chinese Fusion Engineering Testing Reactor (CFETR) and the Burning Plasma Experimental Superconducting Tokamak (BEST). Additionally, I successfully completed the development of the magnet systems for the FLARE space magnetic reconnection experiment in the United States and the pioneering KTX reversed field pinch experiment in China, both of which have been put into experimental operation. Over the past five years, I have led over ten national-level projects, encompassing pivotal international scientific and technological innovation projects under the National Key R&D Program and projects funded by the National Natural Science Foundation of China, as well as international collaboration projects with the U.S. Department of Energy.

I have achieved the following results in the research of fundamental theories and analytical methods regarding the critical characteristics of high-field HTS magnets for fusion (critical characteristic scaling law models, rapid computation methods for AC losses, and stability margin assessment models):

(1) **Large-Scale Fusion HTS Magnet AC Loss Calculation Method:** In response to core challenges such as the strong anisotropy of HTS REBCO tapes and the extremely high aspect ratio (10^5) of fusion HTS magnets, which result in significant computational element requirements in finite element models for loss calculation, a multi-scale loss calculation method was proposed. [*Jou. Sup. Nov. Mag. 29, 8 (2016), IEEE TASC 29, 4900305 (2019), IEEE TASC 29, 4702207 (2019)*]. This method significantly reduces the computational element size by introducing a macroscopic homogenization model for magnetic field calculation and a microscopic single-turn model for loss calculation. Moreover, through integrating the multi-scale approach with the traditional homogeneous medium method based on the T-A equation algorithm, the dual bottleneck in solving high aspect ratio and nonlinear exponent electromagnetic properties of HTS tapes in the same model was overcome. This breakthrough enables rapid and precise calculation of AC losses in large-scale HTS magnets for fusion reactors [*IEEE TASC, 34(2), 4300207, 2023, IEEE TASC, 34(3), 4902605 2024*].

(2) **Critical Current Calculation Model under Stress and Irradiation:** To address the impact of neutron irradiation on the critical characteristics of HTS materials in fusion environments, a Monte Carlo method-based neutron transport calculation and ion two-body collision simulation method were developed. This yielded irradiation damage parameters for HTS tapes

under different neutron irradiation energies, improving calculation accuracy by approximately 15% compared to traditional damage cross-section methods [*Supercond. Sci. Technol. 37 045013, 2024*]. Additionally, using density functional theory (DFT) to calculate the formation energy of oxygen vacancies under biaxial stress, the PAW method and GGA-PBE method were employed to investigate the relationship between the formation energy of oxygen vacancy defects and biaxial stress on different planes in HTS materials. This led to the establishment of a model describing the variation in critical performance of high-temperature superconducting materials under stress conditions [*IEEE TASC 26, 8402806 (2016)*]. Furthermore, an irradiation factor was introduced into the critical current scaling rate, resulting in the development of a critical current scaling rate model for REBCO tapes under the combined effects of irradiation and stress. [*Sci. Technol. Nucl. Ins. 2839746. (2021)*].

(3) Assessment Model of Stability Margin for Large-Scale Fusion HTS Magnets: Utilizing AC loss as dynamic input, a three-dimensional quench propagation and temperature margin analysis model suitable for fusion multi-coil HTS magnets was developed by coupling neutron analysis, electromagnetic analysis, and thermo-hydraulic analysis [*Int. Jou. Ene. Res. 41, 1277 (2017)*]. This model allows for rapid localization of the minimum temperature margin based on peak thermal load and magnetic field, enabling precise and swift evaluation of temperature and energy margins under extreme disturbances such as neutron-induced nuclear heating and AC loss heating. Additionally, a quench analysis method was proposed to precisely calculate lateral heat conduction between turns in three-dimensional shaped coils [*Fus. Eng. Des. 95, 13 (2015), Physica C: Sup. And app. 566(15), 1353523 (2019)*]. By establishing a three-dimensional coil parameterized path analysis model and an inter-turn heat conduction characteristic mathematical model, accurate simulation of local and macroscopic heat conduction processes during the quenching of superconducting coils was achieved [*IEEE TASC 30, 4700507 (2020)*]. This development addresses the challenge of precise stability margin assessment for large fusion high-temperature superconducting magnets under rapid magnetic field changes and dynamic plasma responses.

Based on the aforementioned research results on the stability evaluation and AC loss calculation models for large-scale fusion HTS magnets, significant achievements have been made in the development of large-scale fusion HTS magnet systems and key technologies for next-generation HTS magnets:

(1) Fusion High-Field HTS Magnet System: Building on the critical characteristic theories and analysis models of fusion HTS magnets, the design of a compact central solenoid for the CFETR was completed. This design achieves high volt-second capacity (>300 V.s), high energy margin (>300 mJ/cc), and a large tritium breeding blanket space (>1m). Additionally, the high stability margin design for the 14.5T fusion hybrid superconducting magnet of the CFETR was finalized [*IEEE TASC, 33(4), 3250421, 2023*], providing a theoretical foundation for the temperature margin evaluation of the ITER poloidal field superconducting magnets. In the field of high-current HTS, a variable helical angle CORC-CICC conductor design was proposed. By adjusting the tape incident angle to control inductive impedance, the internal current distribution and loss can be controlled, resulting in a 31% reduction in loss compared to a constant angle helix [*Supercond. Sci. Technol. 36(11): 115032, 2023*]. Meanwhile, a new tenon-and-mortise modular conductor structure (TMMC) was introduced. By adjusting the stagger angle and stacking interval of sub-conductors according to the magnetic flux penetration in stacked tapes, the magnetic flux shielding effect on the inner superconducting tapes was optimized, suppressing magnetization losses under high background fields. The TMMC conductor short sample achieved a critical current of 13.69kA at 77K in a self-field [*Supercond. Sci. Technol. 37 065006, 2024*], laying a technical foundation for the development of large-scale fusion HTS magnet systems.

(2) Application of Key Technologies in HTS Magnets: The research on stability margin evaluation of HTS magnets has been extended to optimize the topology configuration and accurately evaluate the stability margin of HTS magnet systems under dynamic levitation conditions. This achieved stable levitation of 10mm in a HTS maglev system at a rated operating current of 70A [*IEEE TASC, 33(1), 4900205, 2023*]. The development of a HTS motor for aerospace electric propulsion systems was also completed, proposing a stacked low-loss ironless stator winding design, achieving an innovative design and flight validation of a high-efficiency (98%) ironless HTS motor. Furthermore, an MJ-level HTS energy storage magnet system capable of carrying 10kA-class current was developed, providing a feasible technical pathway for rapid charge-discharge (kA/s) and energy compensation in large scientific devices like accelerators [*Supercond. Sci. Technol. 35 125001, 2022*].

Based on these research achievements, 59 papers have been published as the first/corresponding author in authoritative SCI journals in the superconducting field, such as *Superconductor Science and Technology* and *IEEE Transactions on Applied Superconductivity*. Additionally, 55 invention patents have been granted (35 as the first inventor, including 5 international patents in the US and Japan). I was selected for the “MIT Technology Review Innovators Under 35” (MIT TR 35 Global) in 2021 and the “Outstanding Member of the Youth Innovation Promotion Association” of the Chinese Academy of Sciences in 2019. Over the past five years, I have been invited to deliver nine reports (including three plenary talks) at international conferences such as the International Magnet Technology Conference (MT), the European Conference on Applied Superconductivity (EUCAS), the Applied Superconductivity Conference (ASC), and the IEEE International Conference on Applied Superconductivity and Electromagnetic Devices (ASEMD). Additionally, I serve as a member of the IEEE NPSS Transnational Committee on Nuclear and Plasma Sciences, the IEEE China Superconductivity Committee, and the Electrical Theory and New Technology Committee of the Chinese Society for Electrical Engineering. Furthermore, I have filled the role of a technical committee member for the 28th International Magnet Technology Conference, the 30th International Fusion Engineering Conference, and the 26th and 28th International Magnet Technology Conferences, as well as a session chair at the 15th European Conference on Applied Superconductivity and the ASC.

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