
Contribution ID: **523** Type: **Poster**

# Sat-Mo-Po.09-03: Research on the Stability of Miniaturized High-Temperature Superconducting Magnets Under Extreme Operating Conditions

*Saturday 5 July 2025 09:30 (1h 45m)*

To fulfill the demand for high-performance magnetic fields in extreme environments, such as those found in maglev trains, the implementation of superconducting magnets with high cur-rent-carrying density offers a lightweight alternative to traditional copper or permanent magnets. This is particularly significant for enhancing the safety and cost-effectiveness of high-speed maglev trains. In this paper, we introduce a novel design for a miniaturized high-temperature superconducting magnet structure, which employs Stirling conduction cooling to provide the necessary refrigeration for the magnet. This innovative approach replaces the traditional use of liquid helium or GM refrigerators equipped with large compressors, thereby reducing the weight of the superconducting magnet from approximately 150 kg to around 50 kg. Moreover, we con-ducted stability simulation analysis and calculations for the miniaturized high-temperature su-perconducting magnet under background magnetic fields ranging from 0.5T to 2T, using the T-A numerical analysis method. These calculations took into account the thermal load working conditions of the magnet during accelerations of 5-10g and during operation. The results re-vealed that, even at a maximum operating current of 60A, the stability margin of the supercon-ducting magnet exceeded 1000 mJ/cc. Additionally, through AC loss analysis, we found that the superconducting magnet would only experience quenching when the current frequency sur-passed 250 Hz, thereby satisfying the requirements for high-frequency excitation operation of superconducting magnets. Finally, cooling and energization tests were performed to validate the low-temperature characteristics of the Stirling conduction-cooled high-temperature supercon-ducting magnet. The magnet maintained stable operation for more than 8 hours under conduc-tion cooling, with a temperature difference not exceeding 1K. This confirms the feasibility of the miniaturized conduction-cooled superconducting magnet scheme proposed in this paper, laying a solid foundation for the safe operation of superconducting magnets in extreme condi-tions of high-speed maglev trains in the future.

**Author:** LIU, Haiyang (Institute of Plasma Physics, Hefei Institutes of Physical Science, Chinese Academy of Sciences)

**Co-author:** Prof. ZHENG, Jinxing (Institute of Plasma Physics, Hefei Institutes of Physical Science, Chinese Academy of Sciences)

**Presenter:** LIU, Haiyang (Institute of Plasma Physics, Hefei Institutes of Physical Science, Chinese Academy of Sciences)

**Session Classification:** Sat-Mo-Po.09 - Energy Storage/SMES, Levitation and Magnetic Bearings