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C2Po3A-06: Thermal design of conductive superconducting magnet for MRI system with thermal buffer

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MRI (Magnetic Resonance Imaging) is a non-invasive medical imaging technique that uses strong magnetic fields to produce detailed images of the body's. which is generated by the superconducting magnet generates typical at low field, 1.5T, 3T, and 7T (typical for ultra-high field) in clinical practice. The traditional magnet is cooled by liquid helium, with safety features including gas evacuation and monitoring systems to prevent hazards.
The global helium shortage poses a significant challenge to hospitals reliant on MRI technology, as liquid helium is crucial for cooling the superconducting magnets in MRI systems, leading to increased costs and potential disruptions in MRI services and the quench emergency evacuation system limits the installation. It becomes more and more important to develop the conductive cooling superconducting magnet technology.
When examining the scenarios involving superconducting magnets in MRI systems, we must consider processes such as ramping up, quench recovery, scanning, and power down. It's important to note that the superconducting coil does not exist in an ideal adiabatic environment; rather, it is subject to heat leaks from the cryostat and heat induced by the gradient coil during scanning. The cooling capacity provided by a single cold head restricts the usability of the superconducting magnet, and the magnet's thermal vulnerability increases as the thermal buffer develops.
In this study, we will utilize high-pressure helium gas as a thermal buffer. The research will focus on the most widely used 1.5T superconducting magnet as the target. The cryocooler design will be grounded on a two-stage system with a capacity of 1.25W @ 4.2K. Furthermore, we will perform thermal calculations based on different scenarios to assess performance.
The results will be meticulously analyzed and compared against those of traditional liquid helium-based superconducting magnets. Specifically, our computational findings will be juxtaposed with the experimental outcomes of a purely conductive 1.5T system, highlighting the advantages of incorporating a thermal buffer. Additionally, the analysis will delve into the disparities between the conventional superconducting magnets and the 1.5T conductive superconducting magnet, offering insights and recommendations for improvement.

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