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Design and Test of a Superconducting Lens for an Ultra-Stable Electron Microscope

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Superconducting magnets are capable of producing exceptionally stable magnetic fields when operating in "persistent current"mode. In this approach, a superconducting switch disconnects the power source from the magnet circuit, allowing the magnet current to flow in a closed superconducting loop free of power supply noise. We present the design, fabrication, and test of a 1.9 T iron-dominated, round lens seeking to probe the limits of this persistent mode superconducting magnet technology for use in an electron microscope. First, we give an overview of the design and fabrication of a prototype magnet, superconducting switches, and superconducting joints. We then present the results of testing this lens system in liquid helium, with a focus on temporal field stability. Sources of remaining field perturbations, such as external noise and drift due to small residual circuit resistances, are characterized using cryogenic hall probes and SQUID magnetometry. Active methods for further stabilization of the lens, such as inductive flux transfer and other techniques, are compared and evaluated experimentally. Finally, strategies for shielding external noise are explored, including the use of a superconducting shield.

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