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Latest results on numerical superconducting coil simulations

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Improving the inertial sensitivity of the Lunar Gravitational Wave Antenna (LGWA) directly enhances its detection sensitivity. By exploiting the Meissner effect, superconducting thin-film dual-coil designs enable sub-femtometer precision sensing and high-precision actuation with negligible heat dissipation, thereby reducing required cooling capacity, radiator area, total weight, and mission costs. We present a deposition-based design methodology for thin-film coils compatible with higher operating temperatures than conventional wirewound coils, offering greater flexibility for LGWA's operating temperature range. Fabricated niobium nitride (NbN) coils achieved a critical temperature of 15.6 K and demonstrated persistent currents scalable up to the ampere-level in thin films. COMSOL-optimized designs confirm that the actuator coils can exert sub-micronewton forces on a superconducting surface fully maintained in the Meissner state, while the sensor coils generate the expected signal currents required to achieve sub-femtometer sensitivity. These results demonstrate the feasibility of a new generation of superconducting sensing and actuation solutions.

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