Through-wall Excitation of a Magnet Coil by an External-rotor HTS Flux Pump

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Abstract — High Temperature Superconducting (HTS) magnet systems conventionally require normal-conducting current leads, which connect between the HTS circuit and an external power supply located at room temperature. These current leads form a thermal bridge across the cryostat wall, and they represent the dominant heat load for many magnet applications. Superconducting flux pump devices are an alternative approach to the excitation of a magnet coil which can eradicate this parasitic heat load, as such devices do not require direct physical connection to the HTS circuit. However, previously proposed flux pump designs have required power-dissipating active components to be located within the cryogenic envelope, thus imposing their own parasitic heat load.

Here we report the successful demonstration of a mechanically-rotating HTS flux pump which operates entirely outside of the cryogenic envelope. This prototype device projects flux across a cryostat wall, leading to the injection of DC current into a thermally-isolated closed HTS circuit. This is achieved through the implementation of a flux-concentrating magnetic circuit employing ferromagnetic yoke pieces, which enables flux penetration of the HTS circuit at large flux gaps. We have demonstrated the injection of DC currents of > 30 A into a closed HTS circuit whilst operating this device across a cryostat wall.

Keywords (Index Terms) — Flux pump, HTS dynamo, coated conductor, current leads, YBCO, superconducting generator.