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FLIGHT EXPERIMENT FOR A HIGH-TEMPERATURE SUPERCONDUCTING COIL

Abstract

This paper summarises the flight experiment for a High-Temperature Superconducting (HTS) coil. Superconductors can be used in space for re-entry shielding, power management and distribution and, especially, for in-space electric propulsion. The SUPREME thruster is a superconductor-based Applied-Field Magnetohydrodynamic (AF-MPD) thruster that makes use of HTS coils to generate a magnetic field, improving the performance and thruster efficiency compared to those using conventional copper electromagnets. AF-MPD thrusters have been studied since the 1960s but their development stalled due to the lack of high-power spacecraft platforms to support the power demands of the thruster. However, the increasing commercialisation maturity of HTS is acting as a key enabler to the development of a cost-effective and highly efficient superconductor-based AF-MPD thruster. The use of HTS is accompanied by a cryogenic cooling system that maintains the superconducting coils below their critical temperatures and these two components comprise the Applied-Field module of the thruster.

As part of efforts to raise the Technology Readiness Level (TRL) of the HTS components, this research proposes a flight mission experiment to demonstrate the basic functionality, at a subsystem level, of the superconducting coil within the space environment, which would make it the first mission to fly a high-field superconducting magnet in space. In addition to testing the behaviour of the HTS in space, the use of the generated magnetic fields as a magnetic re-entry shielding will be tested as part of the flight experiment. The benefits and impact on the overall system requirements of using an inductively loading system, a flux pump, will also be addressed. Compared to current leads, the flux pump has the potential of minimising the heat loads and therefore reducing the power requirements to run the cryogenic cooling system.

This research project will develop the system requirements to design, build and fly this mission; perform a trade-off study assessing the HTS candidate technologies, cryogenic system and supporting technologies such as a flux pump system and power interfaces. A preliminary design of the flight test mission will be performed with the aim of understanding the minimum scale of the experiment, addressing preliminary design considerations such as system packaging and interfacing along with the impact on the proposed mission profile.