

## Proof of Concept Testing for a Cryogenic Propulsion Unit

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**Abstract**— Superconducting propulsion powertrain for a hydrogen-based aircraft is an enabling concept to provide the high-power density required to power passenger aircraft above 100-seat level. Under the support of the UK Royal Academy of Engineering, a pioneering 10 kW cryogenic propulsion unit has been developed and tested as a proof of concept for future hydrogen-based electric aircraft. The propulsion unit consists of an axial flux motor and a cryogenic rectifier. The axial flux motor equips with two permanent magnet rotors and an HTS armature disk. The unique design of a double-layer cryogenic chamber enables the calorimetric measurement of AC losses of the HTS armature windings under a rotational magnetic field. Different types of HTS windings have been tested for AC loss, and a new narrow multi-filament HTS cable technology has been tested as an effective way to reduce AC loss of HTS armature. Machine efficiencies with different types of HTS windings are presented. Transient tests for the cryogenic propulsion were carried out, with a short circuit event created in the cryogenic rectifier. The quench progress of the HTS armature was recorded, providing an understanding of the transient response of the cryogenic propulsion unit.

**Keywords (Index Terms)** — Superconducting Propulsion Powertrain, electric aircraft, superconducting motor, axial flux motor, hydrogen, cryogenic rectifier.

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