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OPTIMISATION AND DURABILITY ASSESSMENT OF RF HELICON-BASED PLASMA THRUSTER (K-2) FOR VERY LOW EARTH ORBIT AIR-BREATHING ELECTRIC PROPULSION

Abstract

This paper presents the successful parametric optimisation and durability assessment of the RF helicon-based plasma thruster (IPT) prototype, K-2, developed by Kreios Space in collaboration with the Institut für Raumfahrtsysteme (IRS). As a component of the Air-Breathing Electric Propulsion (ABEP) system, the IPT plays a crucial role in facilitating Very Low Earth Orbit (VLEO) missions.

The K-2 prototype was specifically engineered for versatile experimentation, allowing for adjustments to birdcage antenna geometry, discharge tube length, and solenoid position and characteristics. Rigorous tests in IRS vacuum chamber facilities validated the thruster's adaptability to diverse design parameters, with successful ad-hoc ignition with 5 different antenna geometries.

Despite challenges associated with degraded printed circuit boards (PCBs) and RF cables due to intense heating during operation, the K-2 prototype showcased a very good reliability. The paper highlights the addressed durability issues, emphasising the critical role of antenna design, material durability, and thermal management.

Notably, the K-2 prototype demonstrated a remarkable operational endurance of 90 minutes at 150W. This achievement underscores the robustness of the ABEP system and its potential to revolutionise VLEO missions, offering unprecedented benefits to the aerospace industry. The successful ignition with multiple antenna designs and the extended operational duration positions the K-2 as a promising candidate for the advancement of next-generation electric propulsion technologies in the pursuit of VLEO exploration.