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OPTIMIZATION OF THE IGNITION DELAY OF A XENON MINIATURIZED GRIDDED ION THRUSTER

Abstract

The ignition delay is becoming a critical parameter for small size satellites using electric propulsion, having generally a lack of available power and therefore very restricted time slots for firings. In particular it dictates the collision avoidance reaction time of the system. This key parameter is mainly driven by the propulsion system architecture and propellant management characteristics of the satellite. Nonetheless, their designs are strongly affected by the miniaturization constraint of the system, questioning their capability of propellant regulation to ensure thrust and plasma stability with minimal time losses after firings.

The present work describes the design and development of a 2U gridded ion xenon thruster together with an adapted miniaturized xenon propellant management system (XFS), and their impact on the ignition delay. The NPT30-Xe propulsion system, based on the miniaturized gridded RF ion thruster technology, operates at a mass flow rate of 0.05-0.1 mg/s of Xenon, having a significant influence on the design of the fluid lines and the valves used for the system. It achieves a thrust of 0.4-1.1 mN, with a maximum total impulse close to 3100 N·s, and an input power between 30-60W depending on the operation mode. The developed XFS can fit in a 1U Cubesat factor form unit with 200 grams of propellant, and has been conceived to regulate the propellant injection in the plasma chamber for the ionization. Together with the 1U module containing the ion thruster and the entire PPU, it forms a 2U standalone propulsion system.

The testing campaign, which has extended over 100 hours of firing and over 500 propellant ignition cycles, has provided an insight on the ionization characteristics of the system, the plume composition and the thrust stability. This helped to evaluate the capability of the propulsion system coupled with the XFS propellant management system to induce the ignition of the plasma and achieve a steady state of

operation in less than 3 minutes.

The data presented aims at providing a useful insight to the propulsion community on the development of fast ignition miniaturized systems, especially by emphasizing the elements that were optimized for the minimization of the firing time, such as the filament-based cathodes, high response regulation valves and the adaptive intelligent control of the subsystems.