IAF SPACE PROPULSION SYMPOSIUM (C4)
New Missions Enabled by New Propulsion Technology and Systems (9)

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PLATFORM AND SYSTEM DESIGN STUDY OF A VLEO SATELLITE PLATFORM USING THE IRS RF HELICON-BASED PLASMA THRUSTER

Abstract

To achieve a feasible lifetime of several years, most satellites are deployed in orbits higher than 400 km. Drag of residual atmosphere causes a slow orbit decay, resulting in the deorbit of the spacecraft. However, e.g. optical instruments or communication devices would significantly benefit from lower altitudes in the range of 150-250 km. A solution to achieve this could be the application of atmosphere breathing electric propulsion (ABEP), where the residual atmosphere is used to generate continuous thrust that compensates the drag. Within the EU-funded DISCOVERER project, the Institute of Space Systems (IRS) developed an electrode-less RF Helicon-based Plasma Thruster (IPT) suitable for such applications. Ignition and preliminary discharge characterizations of the IPT have been carried out at IRS facilities, using Argon, Nitrogen and Oxygen as propellant. A follow-on activity is the plasma plume characterization. Two measurement methods have been selected to perform the experiments in the frame of this project. First, a method to derive thruster related properties is employed. The momentum flux in the plasma jet is measured by means of a torsional pendulum. A plate facing the thruster exit plane direction is fixed to the balance arm to counteract the plume jet, allowing for local momentum flux detection. Second, a method of characterizing the IPT as a source of propagating helicon waves is of high scientific interest. This is to be performed by using a three-axes magnetic inductive probe (B-dot probe), where the time-varying magnetic fields in the plume can be extracted. Furthermore, various intake designs to collect atmospheric particles were investigated, opening the possibility to conduct studies on potential satellite designs. Using the above mentioned ABEP system, a design study of a satellite for Earth Observation and Telecommunication applications in the altitude range of 150 to 250 km and prolonged mission durations of up to 12 years is currently being carried out. The first system assessment focused on the comparison of different spacecraft configurations ("slender body" configurations, similar to GOCE's design, and "flat body" configurations with several ABEP systems next to each other) and intake designs (using specularly or diffusely reflecting materials) with regard to overall drag and ABEP performance requirements. Drag coefficients for these configurations were determined using panel method calculations and the particle-based simulation code PICLas.