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ANALYSES OF EARTH OBSERVATION AND TELECOMMUNICATIONS MISSION SCENARIOS WITH SMALL HALL EFFECT THRUSTERS PROPULSION

Abstract

The increasing number of Earth Observation (EO) and Telecommunications missions has brought to the fore the need for an assessment of innovative concepts and technologies to cope with the requirements of LEO and GEO mission scenarios. To address this emerging need, the study on "**Combined Telecommunication and Earth Observation Mission driven Option For Small Hall Effect Thrusters (HET) Propulsion**", funded by the ESA General Studies Programme, is being carried out to assess the application of a small-HET technology in the frame of EO and telecommunications missions.

The study is intended to outline a complete set of performance requirements imposed on the new small-HET system by a wide spectrum of missions, which might benefit from the exploitation of Electric Propulsion (EP) in terms of mission design and return or S/C design. Particular attention has been paid to the assessment of thrust level, in-orbit lifetime and total impulse needed.

The analysis of **EO mission scenarios**, encompassing Optical, LIDAR, Gravity and SAR payloads, has highlighted that EP plays a key role to allow lowering the orbit altitude and potentially to increase the mission lifetime. The high fuel efficiency of an EP system can be used to compensate for the continuous severe aerodynamic drag and counteract the rapid decay of the orbit with a low propellant consumption compared to chemical systems. EP also emerges as a fundamental enabling technology to provide the continuous drag-free attitude and orbit control capacity, as well as thrust throttability and vector stability, to meet the operational constraints at the very low altitudes required by some Gravity Missions.

The EO scenario analysis yields the envelope of mission parameters that comply with the small-HET operational regime. A thrust demand in the range between 2 mN and 20 mN is typically needed to fulfil the orbit manoeuvre requirements imposed by LEO EO missions. Mission altitude and lifetime, as well as thrusting time, have been fine-tuned to guarantee that the total impulse is compatible with the expected small-HET performance. On the other hand, specific impulse does not seem to be a driving requirement for the design of an EO mission based on the use of a small-HET, provided that this parameter is within the capabilities of the thruster (1000-1500 s).

Small GEO telecommunication platforms below 3000 kg, with a typical thrust demand in the range between 15 mN and 45 mN and with long mission lifetimes (7-15 years), could also take advantage of the high fuel efficiency of an EP system to perform station acquisition, station keeping, repositioning and end-of-life disposal. A sensitivity analysis has been performed to assess the impact of the GEO S/C mass on the small-HET operational conditions, showing that the higher the thrust-to-weight ratio, the shorter the operating time of each thruster and the smaller the total impulse.

A small-HET could also be used for hybrid transfers (chemical and electrical) from GTO to GEO, provided that the S/C mass is small enough to enable feasible transfer times and large percentages of final mass in GEO.