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DEVELOPMENT OF A MINIATURIZED ELECTRIC PROPULSION SYSTEM FOR THE E-SAIL PROJECT

Abstract

The Electric Sail (E-Sail) is an innovative space propulsion concept relying on the solar wind momentum for producing thrust through the interaction of solar wind protons with a number of very long (20 km), electrically charged tethers. The main spacecraft is equipped with a solar-powered electron gun used to maintain the spacecraft and the wires at about +20 kV with respect to ambient plasma. With such long wires, centrifugal force alone is not sufficient to ensure complete deployment of the assembly. Furthermore, in order to assure the mechanical stability of the structure, auxiliary wires are used to interconnect the tips of the main tethers. Therefore, "Remote Units" are to be mounted at the tip of the main charged tethers containing the auxiliary wire reels and a small thruster to increase/decrease the angular velocity and, accordingly, determine centrifugal force during tether deployment. Each Remote Unit should weight a few hundred grams, with linear dimensions of a few tens centimeters.

Alta is in charge of developing the Remote Unit thrusters in the context of an European Commission's Seventh Framework Programme contract. The propulsion system has to be compact, light, and easy to interface with other subsystems within the Remote Unit. Thrust magnitude is in the 100 micronewton range, with propellant mass consumption at a premium. A long-life device with limited propellant mass consumption could also be used after the deployment phase, to modify the spin rate of the structure at will during the E-Sail cruise.

In consideration of such stringent requirements, a variant of the Field Emission Electric Propulsion (FEEP) system has been selected including some solutions to simplify the system and reduce cost, such as the use of ionic liquids as propellant, instead of alkali metals. The paper discusses the unique challenges posed by the development of the E-Sail Remote Unit thruster system; thruster arrangement, interfaces, and system-level integration issues are presented. The envisaged simplified ionic liquid FEEP has a large potential for utilization on a variety of micro- and nano- satellite platforms, from Cubesats to Earth observation small satellites, to future scientific missions.