DPP16-2016-020014

Abstract for an Invited Paper
for the DPP16 Meeting of
the American Physical Society

Cathode-less gridded ion thrusters for small satellites[1]

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Electric space propulsion is now a mature technology for commercial satellites and space missions that requires thrust in the order of hundreds of mN, and with available electric power in the order of kW. Developing electric propulsion for SmallSats (1 to 500 kg satellites) are challenging due to the small space and limited available electric power (in the worst case close to 10 W). One of the challenges in downscaling ion and Hall thrusters is the need to neutralize the positive ion beam to prevent beam stalling. This neutralization is achieved by feeding electrons into the downstream space. In most cases hollow cathodes are used for this purpose, but they are fragile and difficult to implement, and in particular for small systems they are difficult to downscale, both in size and electron current. We describe here a new alternative ion thruster that can provide thrust and specific impulse suitable for mission control of satellites as small as 3 kg. The originality of our thruster lies in the acceleration principles and propellant handling. Continuous ion acceleration is achieved by biasing a set of grids with Radio Frequency voltages (RF) via a blocking capacitor. Due to the different mobility of ions and electrons, the blocking capacitor charges up and rectifies the RF voltage. Thus, the ions are accelerated by the self-bias DC voltage. Moreover, due to the RF oscillations, the electrons escape the thruster across the grids during brief instants in the RF period ensuring a full space charge neutralization of the positive ion beam. Due to the RF nature of this system, the space charge limited current increases by almost a factor of 2 compared to classical DC biased grids, which translates into a specific thrust two times higher than for a similar DC system. This new thruster is called Neptune and operates with only one RF power supply for plasma generation, ion acceleration and electron neutralization. We will present the downscaling of this thruster to a 3cm diameter unit well adapted for a CubeSat or SmallSat mission.

[1]This work was supported by Agence Nationale de la Recherche under contract ANR-11-IDEX-0004-02 (Plas@Par) and by SATT Paris-Saclay