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OPTIMISATION OF MINIATURE PULSED PLASMA THRUSTERS FOR ATTITUDE AND ORBIT CONTROL OF CUBE AND NANOSATS.

Abstract

Applications and mission capabilities of cube and nanosats will be significantly enhanced by the availability of low cost, mass, power and volume propulsion systems. The university of Southampton, Mars Space Ltd and Clyde Space Ltd have developed PPTCUP, which is such a device capable of delivering a total impulse of 42Ns, specific impulse of around 600s, impulse bit of 38μNs all within a volume of 90x96x31mm and consuming only 400mW. The first flight of this system is scheduled for later this year on a university of Brasilia cubesat. Various enquiries for different configurations and performance requirements have led the consortium to investigate the possibilities of optimising the design for a specific set of requirements using a numerical model instead of the current empirical approach which needs vast amounts of data from extensive testing and many iterations in the design. The paper will present the methodology behind the development of this tool, focussing on the plasma modelling and in particular three key aspects of this modelling: 1) how the current sheet attaches at the electrodes 2) how the geometry of the current sheet changes as electrons tends to diffuse away 3) what assumptions are made in terms of the thermodynamic state of the plasma The former two are closely related to the calculation of the dimensions of the current sheet whilst the latter deals with the fact that the plasma is unlikely to be in a state of equilibrium (LTE) but in a highly non-equilibrium state with the electrons far from being Maxwellian. If one couples these three together one can arrive at the plasma resistance, which is a key input to the overall numerical model (a modified snowplow model) which represents the PPT as an RLC circuit but with parameters that vary in both space and time.