Seminar

Institute for Plasma Research

Title : Exploring Thruster Potential of Compact ECR Plasma Source

Speaker: Dr. Anshu Verma
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Date : 22nd December 2021 (Wednesday)

Time : 03.30 PM

Venue : Online - Join the talk: https://meet.ipr.res.in/Dr.AnshuVerma_PDFTalk

Abstract :

Electric thrusters are used for altitude control and station keeping of small satellites in low earth orbits, orbit raising of medium and large platforms to geostationary earth orbits or deep space exploration missions. However, the use of high voltage ion acceleration grids and beam neutralizers limits the life of an electric thruster since they are prone to erosion. Electrodeless thrusters have distinct advantage over the conventional ones that avoids erosion problem thereby enhancing their active life. Accordingly, a novel plasma thruster using Compact ECR Plasma Source (CEPS) is proposed as a competitive candidate, satisfying the electrodeless condition since microwave power is coupled to the plasma through a dielectric window as opposed to via an immersed electrode. Quasineutral plasma containing energetic ions is expelled outwards to impart momentum to the vehicle omitting the requirement of neutralizers.

The CEPS is a novel ECR plasma source (patented by IIT Delhi) employing a unique magnetic field configuration created by a set of NdFeB ring magnets. The performance of plasma thruster is assessed for efficient propulsion by analysing the unique characteristics of plasma produced by the CEPS. To this end, CEPS was attached coaxially to two different sizes of expansion chamber, namely Small Volume Plasma System (SVPS, ID = 15 cm, Length = 37 cm) and Medium Volume Plasma System (MVPS, ID = 48.2 cm, Length = 75 cm). The results from SVPS experiments are considerably different from those obtained using the MVPS. These results have some very unique features which will be presented in the talk. It is seen in the later experiments that CEPS not only produce high density plasma but offers very efficient electron heating leading to the development of plasma potential drop near CEPS exit which leads to ion acceleration suitable for thrusters. In addition to this, results from a zero dimensional, 2-zone global model of the plasma flow, where zone-1 and zone-2 represent the CEPS and expansion chamber (MVPS) respectively will be presented. The computed thrust by the model under actual space-like conditions for xenon and argon are ≈ 80 mN and ≈ 45 mN respectively at 600 W of microwave power.