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Michigan Institute for Plasma Science and Engineering

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Room 1017
Dow Building

Dr. Richard Hofer

Jet Propulsion Laboratory

Magnetic Shielding in Hall Thrusters: Breakthrough Space Propulsion Technology for the 21st Century

Electron transport and channel erosion are major technical challenges that have persisted since the invention of the Hall thruster (HT). The first relates to anomalous cross-field electron current that is necessary to sustain the discharge but also limits performance. While a predictive theory has yet to emerge, methods have been devised to regulate the electron current and achieve high-performance. The second is erosion of the channel walls that limits service life. Sufficient improvements have been made in this area to position HTs to dominate near-Earth missions. However, in the civil space sector, lifetimes have not yet reached sufficiently high levels for HTs to be widely used on deep-space missions. Recently, we proposed a new technique to reduce erosion of the channel walls in HTs that would essentially eliminate this failure mode and radically extend service life. Termed "magnetic shielding" the technique exploits fundamental properties of the plasma discharge to achieve conditions at the channel walls that greatly reduce the flux and energy of ions that impact the wall such that erosion rates are reduced by orders of magnitude. In this talk, we will describe how the theory of magnetic shielding in HTs was developed through the use of simulation and validated through laboratory experiments. In the experiments, the magnetic field near the walls of was modified to enable magnetic shielding while maintaining the magnetic field topology necessary to retain efficient operation. Practically erosion-free operation has been achieved for the first time. The implications for HT design and the infusion of this technology on NASA missions will also be discussed. By achieving high-performance and long-life, the role for HTs increases to most, if not all, missions that would benefit from electric propulsion for the next several decades.

About the Speaker: Richard R. Hofer is a Senior Engineer at the Jet Propulsion Laboratory where he is the technology lead responsible for the development and qualification of Hall thrusters for deep space missions. He received the B.S.E. in ME and the B.S.E., M.S.E, and Ph.D. degrees in Aerospace Engineering from the University of Michigan in 1998, 1998, 2000, and 2004. Dr. Hofer is a recognized expert in Hall thruster design, having designed several advanced Hall thrusters ranging in power from 1 to 100 kW. Thruster technology developed by Dr. Hofer is now used in every internal Hall thruster development of the United States Government. Since joining JPL in 2005, Dr. Hofer's work has focused on research aimed at radically extending the performance and life of Hall thrusters and he leads activities at JPL to qualify Hall thrusters for use on NASA missions. In recognition of these efforts, in 2011 he received the NASA Exceptional Achievement Medal and the JPL Lew Allen Award for Excellence. Dr. Hofer is an Associate Fellow of the AIAA and a member of the AIAA Electric Propulsion Technical Committee. He has two patents with one patent pending and has authored over 65 technical publications on electric propulsion.