GEC15-2015-000599

Abstract for an Invited Paper
for the GEC15 Meeting of
the American Physical Society

Laser Diagnostics for Spacecraft Propulsion

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Over the past several decades, a variety of laser diagnostic techniques have been developed and applied to diagnose spacecraft propulsion devices. Laser diagnostics are inherently non-intrusive, and provide the opportunity to probe properties such as temperature, concentration or number density of plume species, and plume velocities in the harsh environments of combustion and plasma discharges. This presentation provides an overview of laser diagnostic capabilities for spacecraft propulsion devices such as small monopropellant thrusters, arcjets, ion engines and Hall thrusters. Particular emphasis is placed on recent developments for time-resolved ion velocity measurements in Hall thruster plumes. Results are presented for one such diagnostic method, a time-synchronized CW-laser induced fluorescence (LIF) technique based on a sample hold scheme. This method is capable of correlating measured fluorescence excitation lineshapes with high frequency current fluctuations in the plasma discharge of a Hall thruster and is tolerant of natural drifting in the current oscillation frequency [1].

[1] N. A. MacDonald, M. A. Cappelli, and W. A. Hargus Jr., Review of Scientific Instruments, 83 (2012) 113506.