Better understanding of dynamic plasma processes will allow improvements in simulation and prediction of electric propulsion (EP) thruster operation and erosion, and ultimately lead to advancements in thruster technology. Time-resolved measurements are needed, for example, to understand how bimodal average ion velocity distributions can arise in a Hall effect thruster (HET) [1]. For these reasons, we are developing a time-resolved laser-induced fluorescence (LIF) diagnostic to interrogate EP thrusters. In this paper we present the development and results of initial tests investigating the Hall effect thruster breathing mode. Signal-to-noise ratio (SNR) has been a problem even for time-averaged LIF studies, and it is only more challenging for time-resolved measurements. Others have developed systems based on a low speed laser modulation and photon counting technique that improves SNR by averaging over many repetitive cycles in the time domain [2]. The system being developed at PEPL uses laser modulation faster than the time scales of interest (MHz modulation compared to the HET breathing mode on the order of 10kHz), which enables the use of electronic filtering and phase sensitive detection to improve SNR. Statistical averaging over many cycles is done in the frequency domain. This technique is more complicated but can have significant advantages, including: (1) larger campaigns are enabled by shorter data acquisition time, (2) the possibility to study longer time scales without the effects of averaging decoherence, and (3) the ability to acquire data without modifying the thruster operating condition with a periodic cutoff in discharge current, which can modify the ion velocity distribution [3].


* Work supported by the Air Force Research Laboratory

Distribution A: Approved for public release; distribution is unlimited.