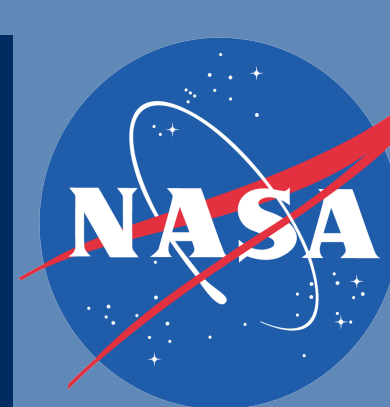
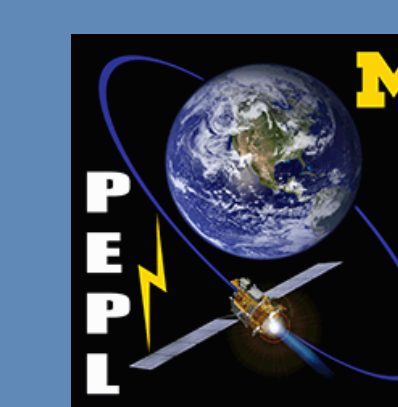


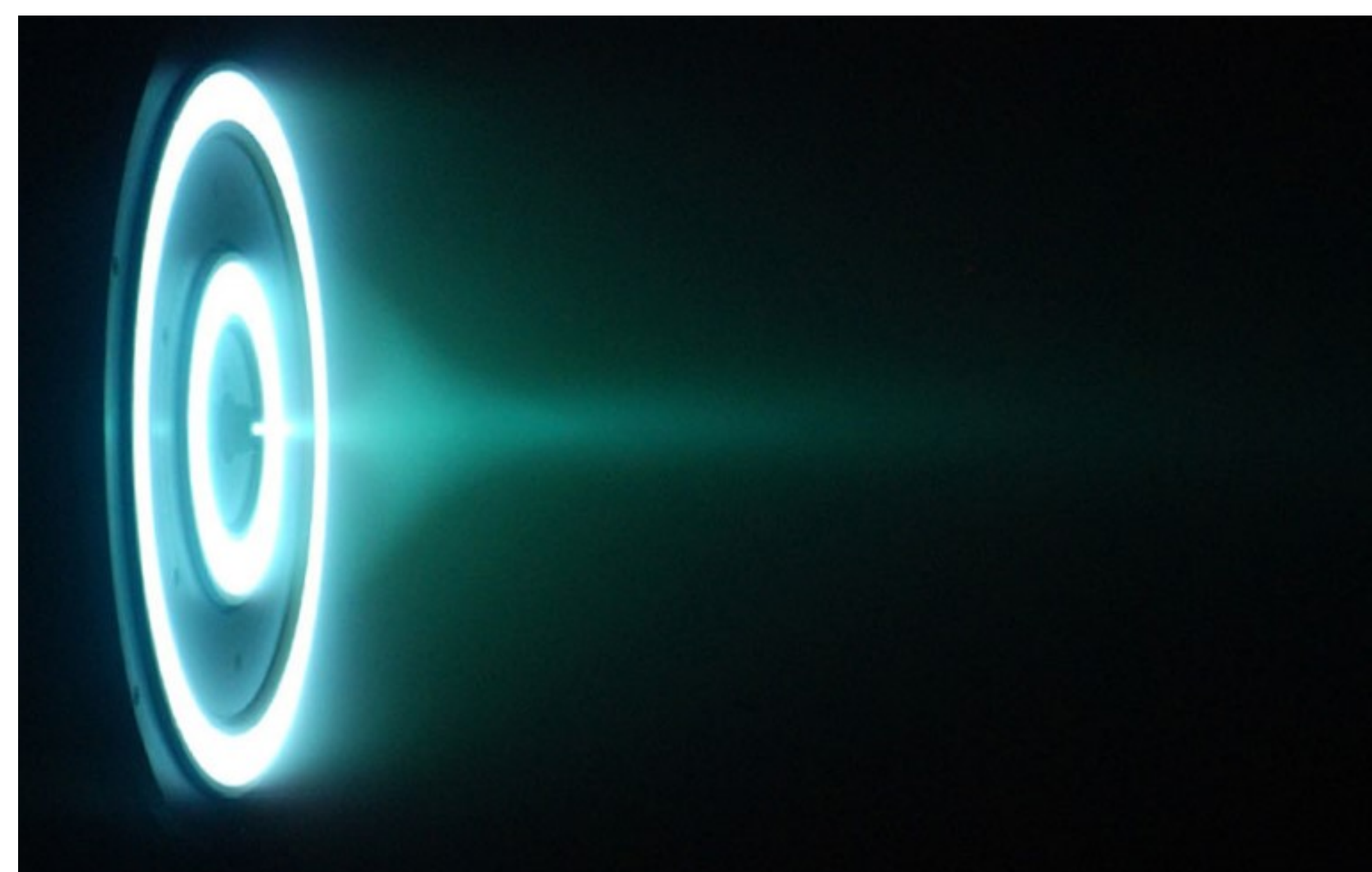
# Acceleration Region Measurements of the X2 Hall Thruster

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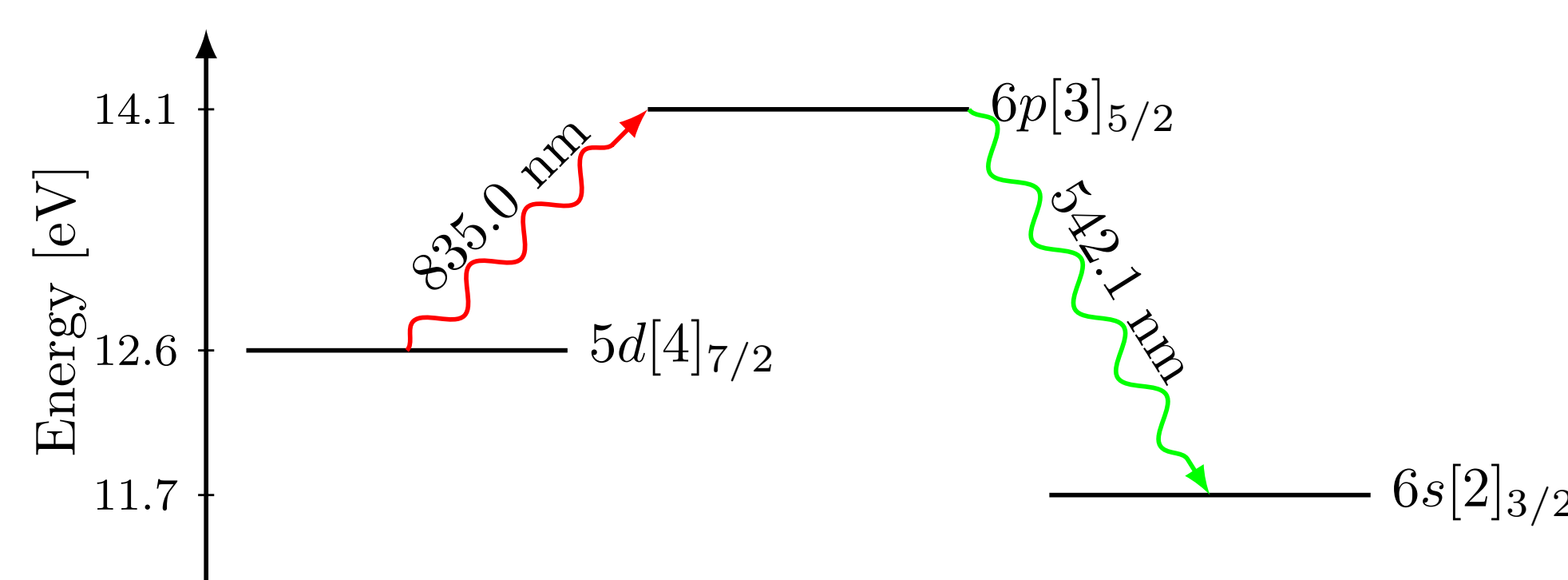
## Abstract

The X2 is a nested Hall thruster developed by the University of Michigan in conjunction with the Air Force Office of Scientific Research (AFOSR). This thruster has two concentric channels that can be operated together or independently. The performance of this thruster was initially characterized by Liang and showed that there exists a discrepancy between the thrust measured in dual channel mode and the sum of the thrust from the individual channels.[1] **This work investigates this phenomenon by examining the shape and location of the acceleration region in these operating conditions using laser-induced fluorescence.**



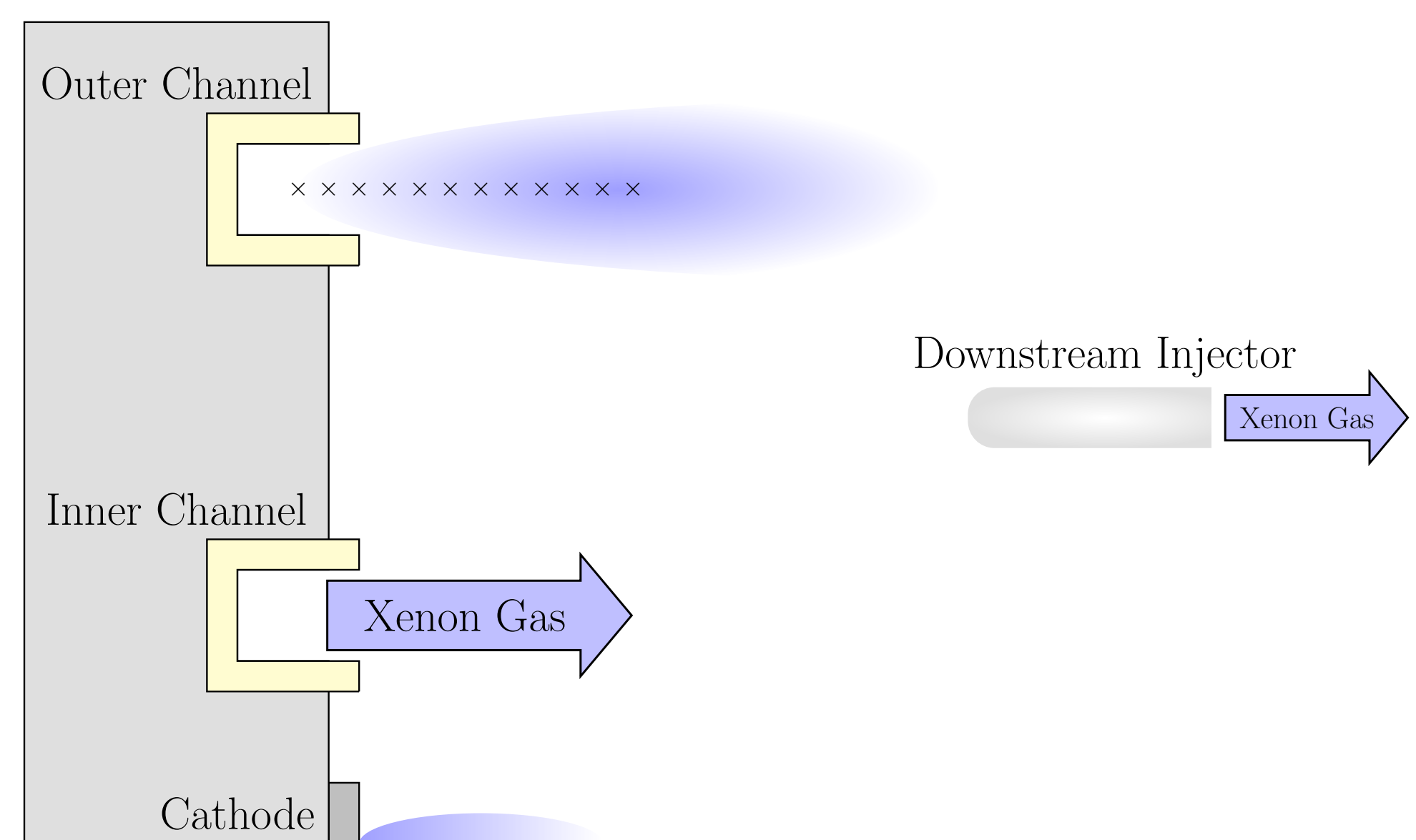
## Laser Induced Fluorescence

Laser-induced fluorescence (LIF) is a spectroscopic plasma diagnostic which can measure the ion or neutral velocity distribution function (VDF). This is accomplished by exciting an electronic transition with a diode laser and measuring a fluorescence signal. By sweeping the laser wavelength about the transition and taking advantage of the Doppler effect, the VDF is measured.



## Test Conditions

The X2 thruster can be fired in either dual channel or single channel mode. However, the operating pressure in the test facility is different depending on the operating condition. The chamber pressure during dual channel operation was  $5.5 \times 10^{-5}$  Torr. Baseline measurements were taken as low as the facility allows. During inner channel operation the pressure was  $1.6 \times 10^{-5}$ . During outer channel operation, the pressure was  $3.4 \times 10^{-5}$ . To isolate chamber pressure as a variable, the chamber pressure during single the channel tests was elevated to  $5.5 \times 10^{-5}$  Torr using Xe gas injection either downstream or through the non-operating channel.

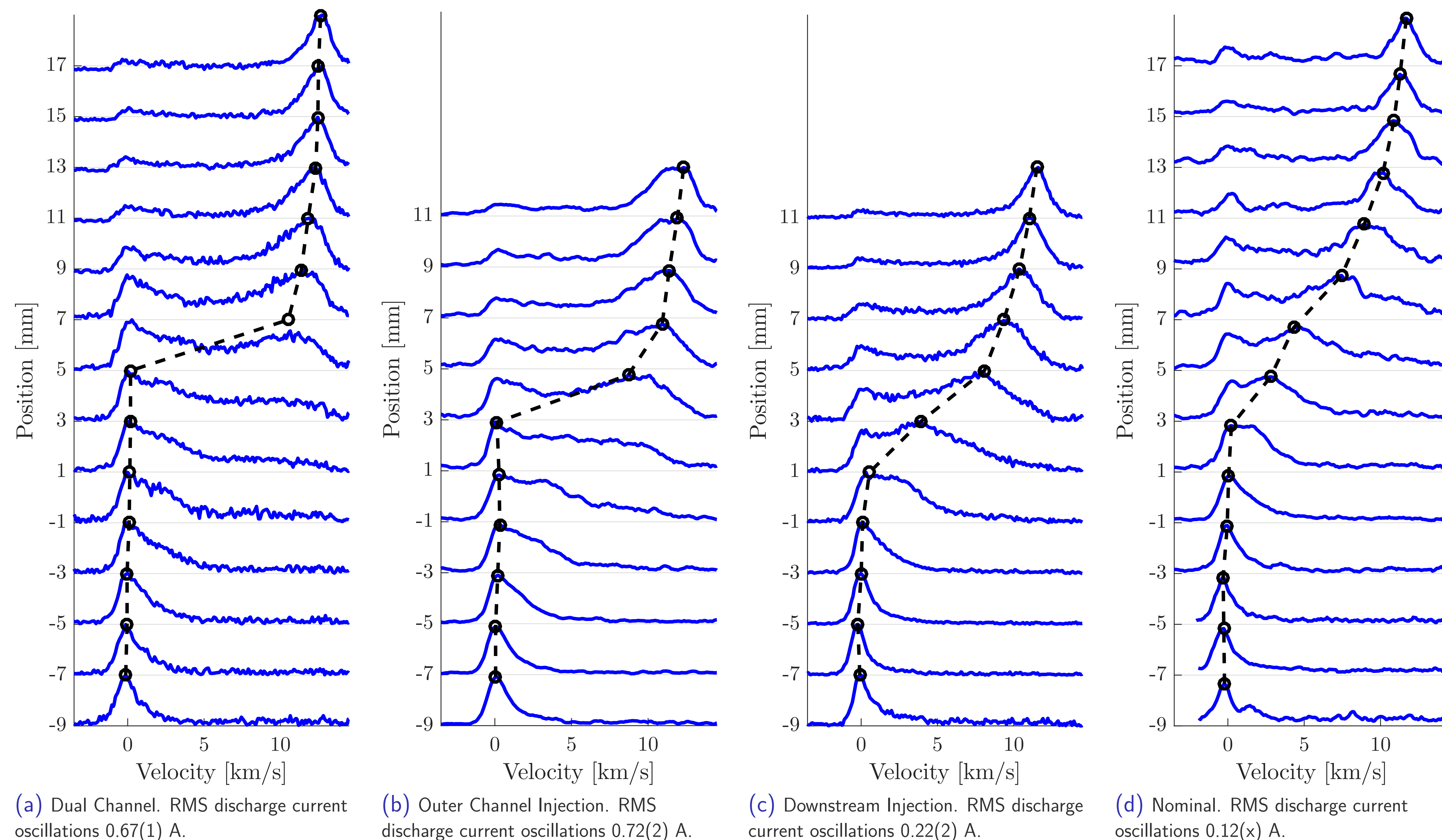


## Acknowledgments & Bibliography

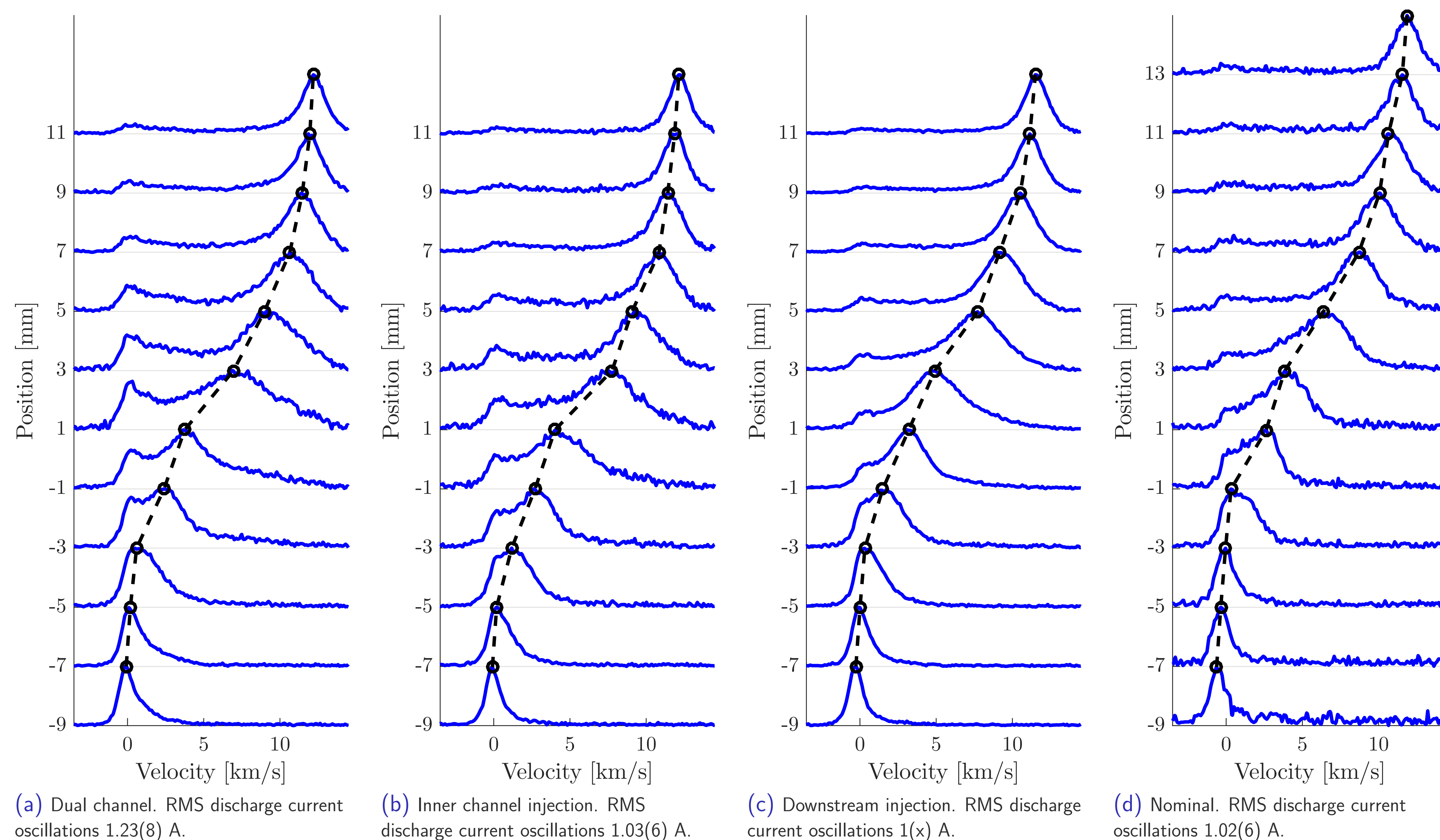
This work was supported by NASA Space Technology Research Fellowship grant number NNX15AQ37H. The authors would like to thank Chris Durot and Timothy B. Smith for their assistance with the LIF setup.

[1] Liang, R. and Gallimore, A. D., "Far-field plume measurements of a nested-channel hall-effect thruster," *AIAA Paper*, Vol. 1016, 2011.

## Inner Channel VDF Maps



## Outer Channel VDF Maps



## Conclusions

- ▶ Inner Channel:
  - ▶ At the nominal condition the acceleration region is smooth.
  - ▶ Increasing the background pressure with downstream injection moves the acceleration region inward
  - ▶ Increasing the local pressure near the thruster with gas injection changes the discharge oscillations and creates bi-modal ion velocity distributions.
  - ▶ Dual channel mode results in a difference in the acceleration region as a result of both increases in pressure and discharge oscillations.
- ▶ Outer Channel:
  - ▶ The acceleration region of the outer channel is largely unaffected by the presence of the inner channel.
  - ▶ The acceleration region was unaffected by the chamber pressure, within the bounds of this experiment.