Ion Acceleration Modes in a Miniature Helicon Thruster

Timothy A. Collard, Frans H. Ebersohn, J. P. Sheehan, and Alec D. Gallimore

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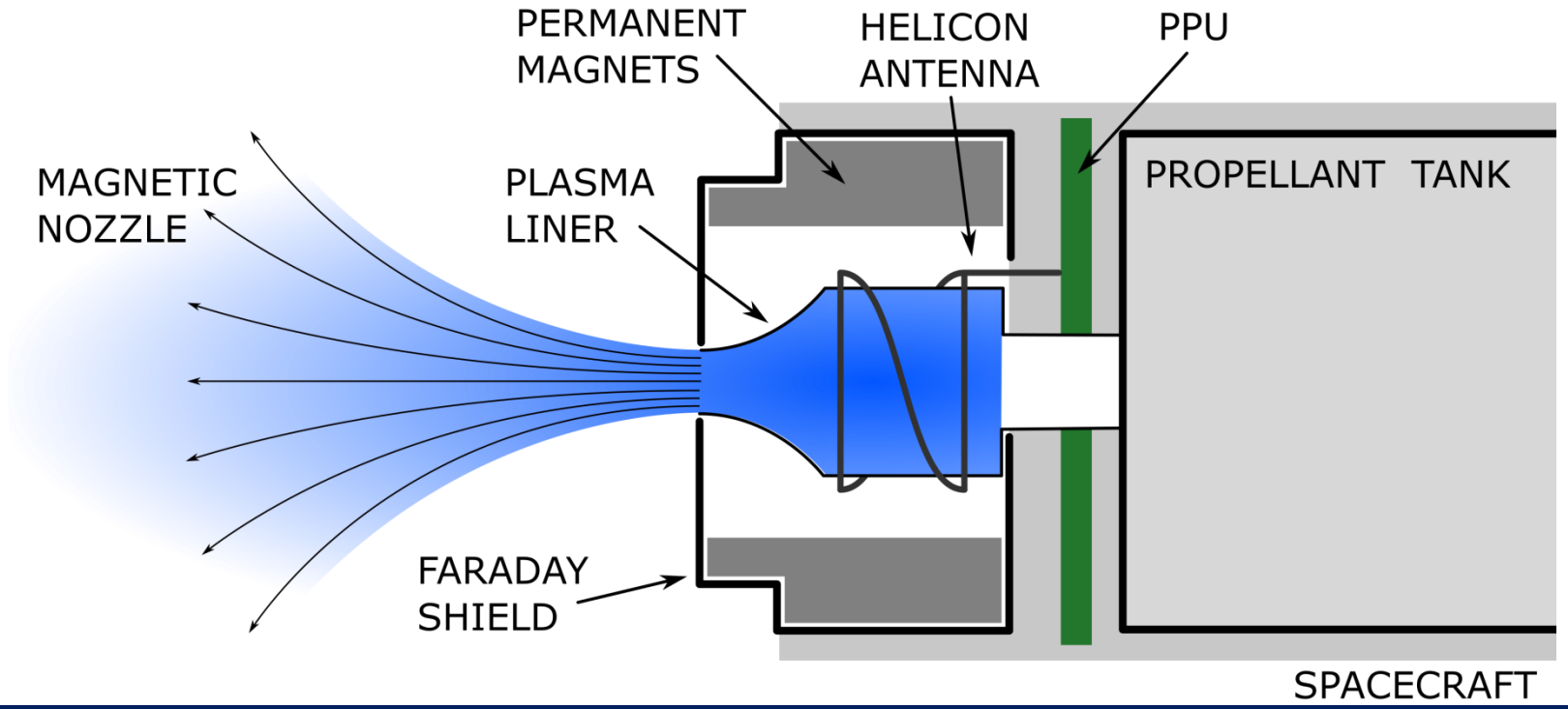
CubeSat – Affordable Platform, Limited Capabilities

- Modularized, based on 10 cm cubes
- Limited available propulsion options
- High performance propulsion is mission enabling

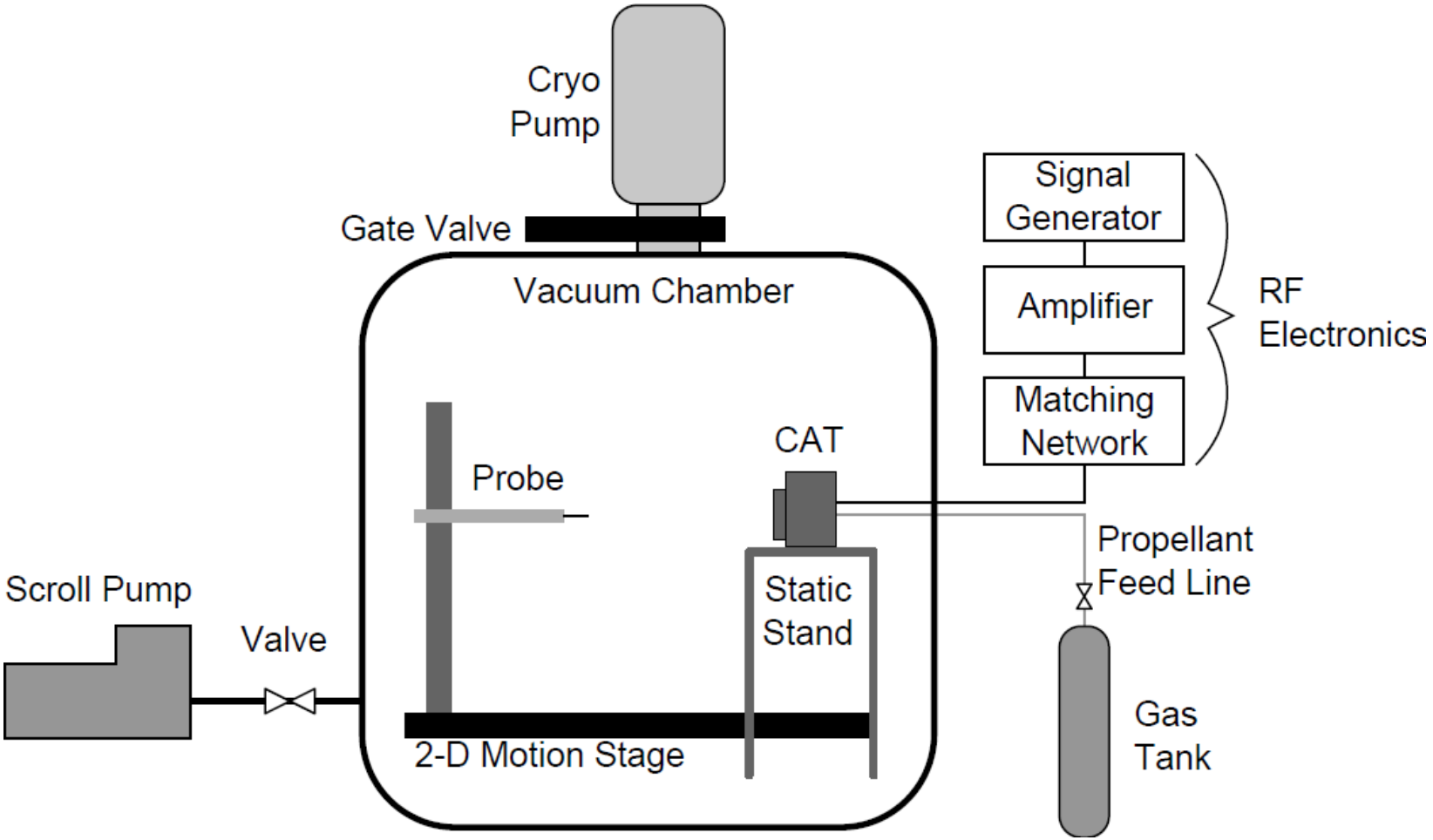
CubeSat Ambipolar Thruster (CAT)

- Electrodeless, permanent magnet, helicon
- Volume without propellant tank < 1U
- ΔV > 1000 m/s



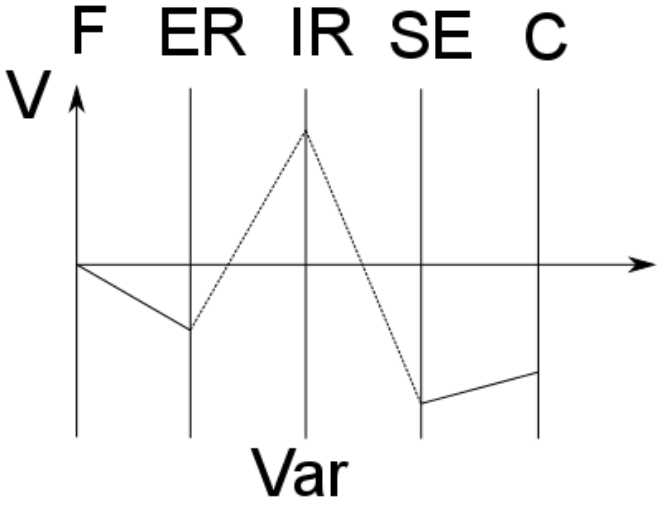
Experimental Setup

- 1200 L/s pumping speed on argon

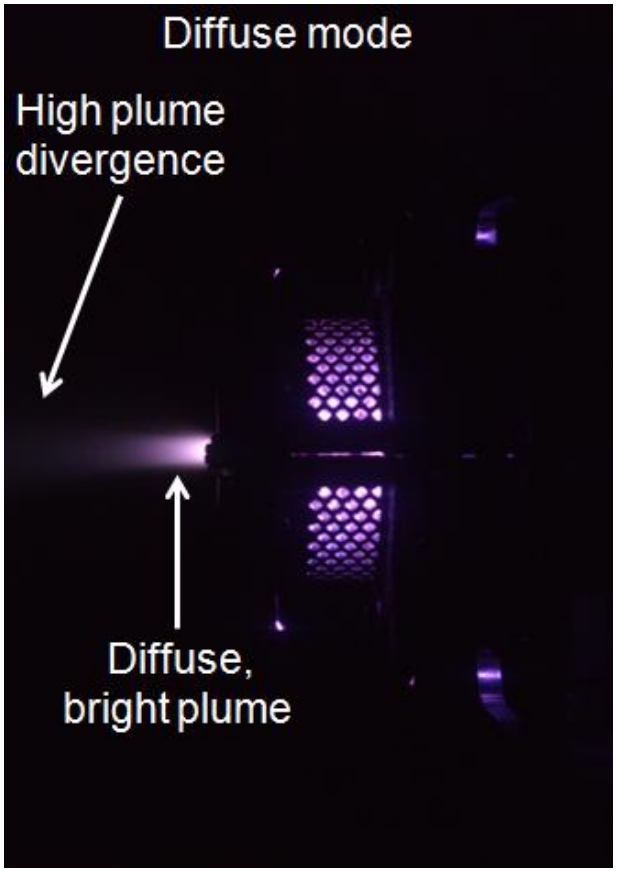


Diagnostics

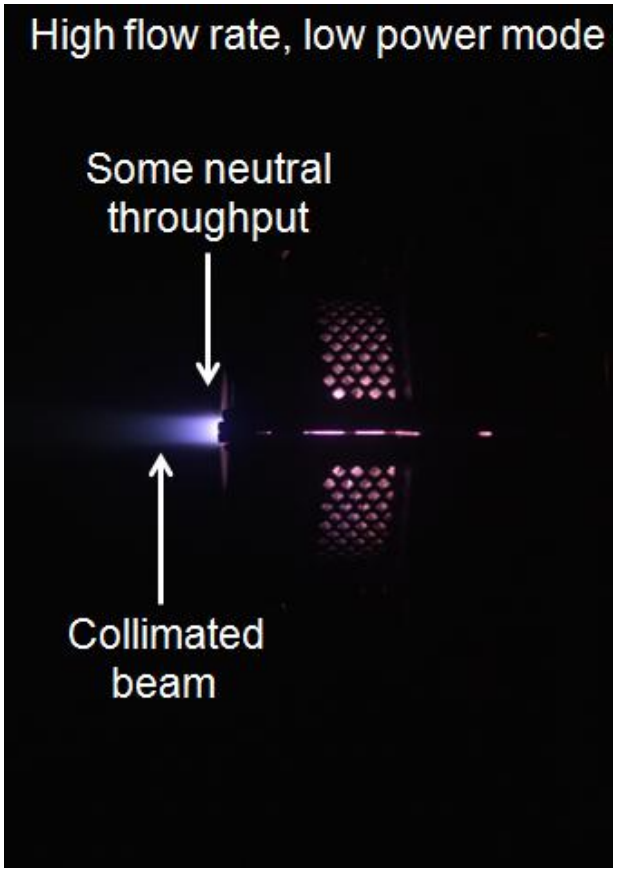
- RPA measured ion energy distribution
- Emissive probe measured plasma potential



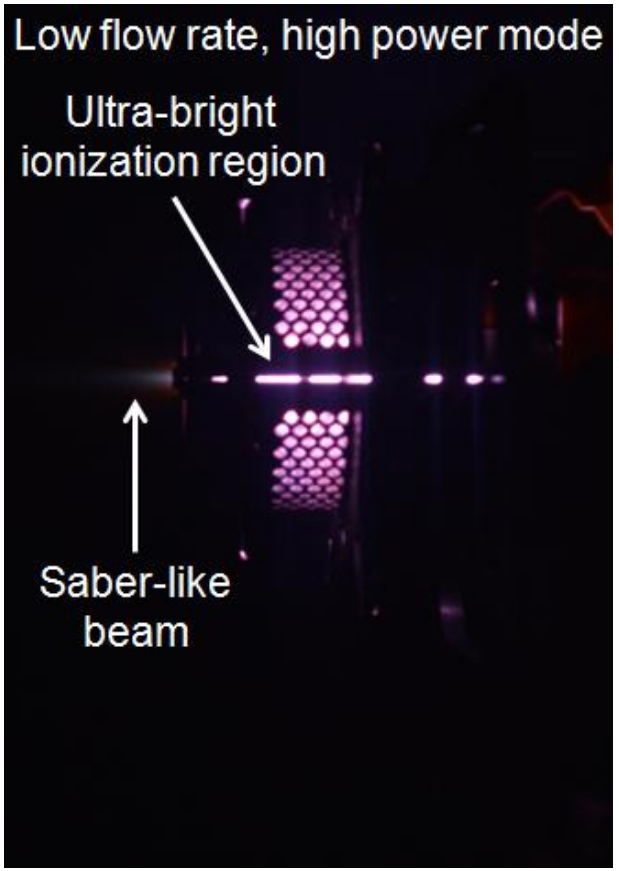
Three Operational Modes – Two with Energetic Ions



> 10 sccm, > 20 W

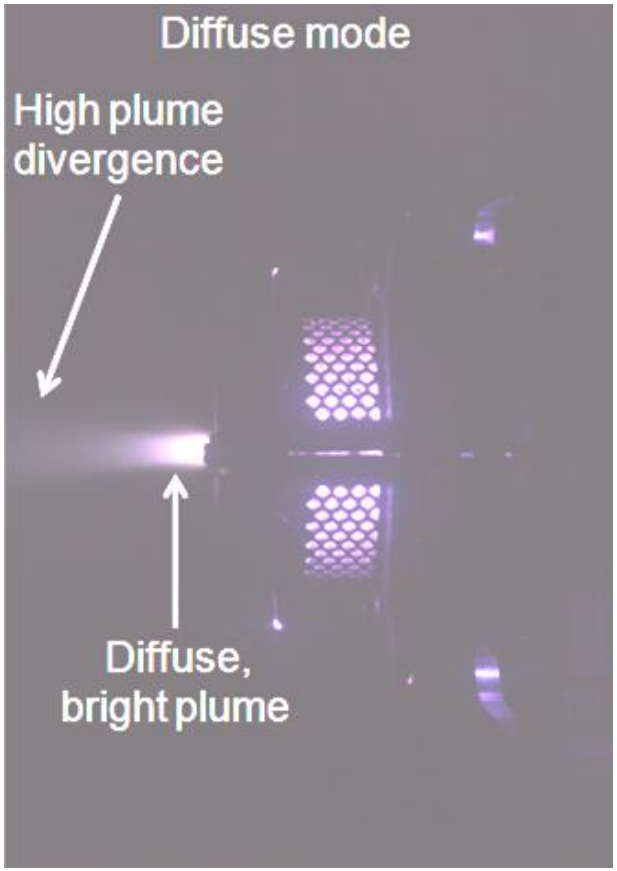


3 - 15 sccm, < 15 W

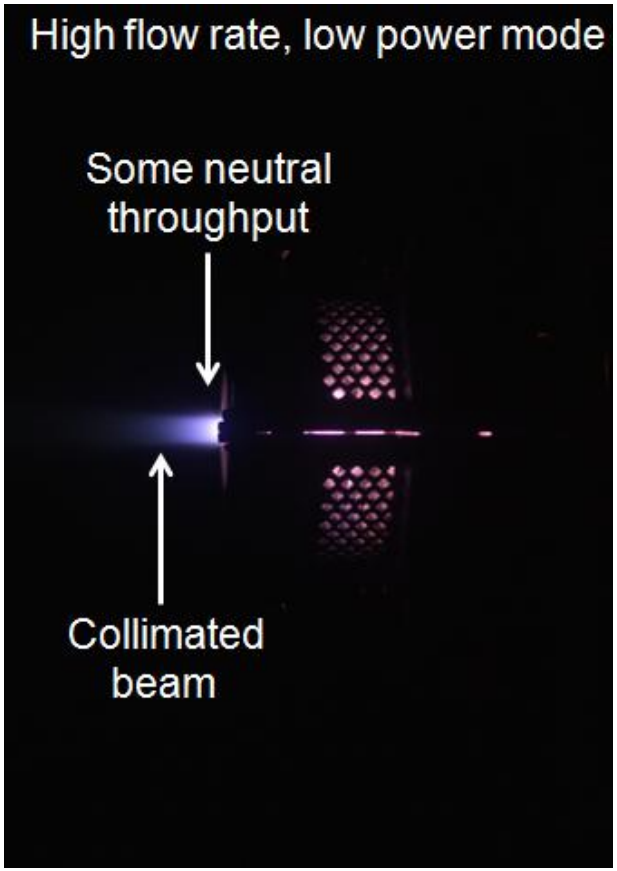


< 0.3 sccm, > 50 W

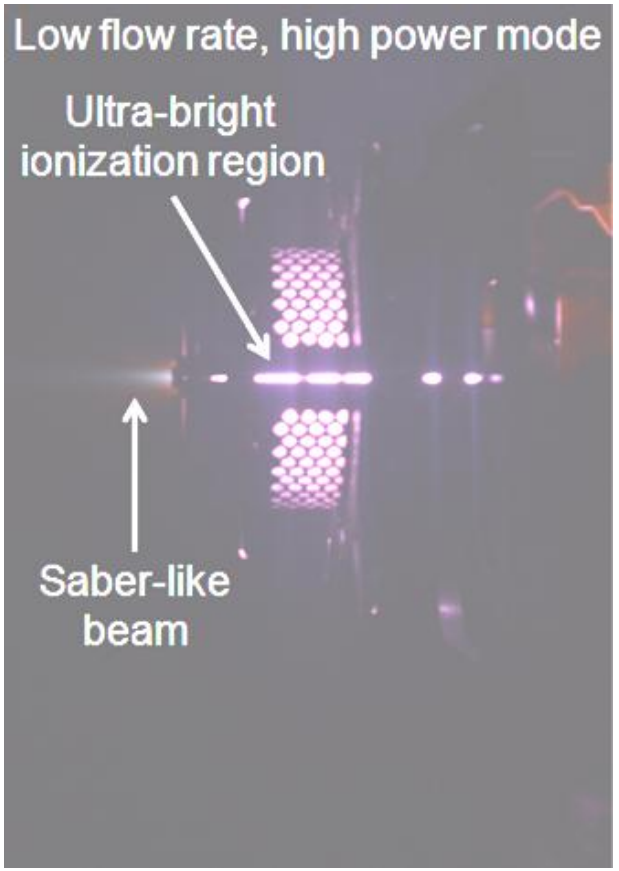
Operational Mode – High Flow Rate, Low Power Mode



> 10 sccm, > 20 W

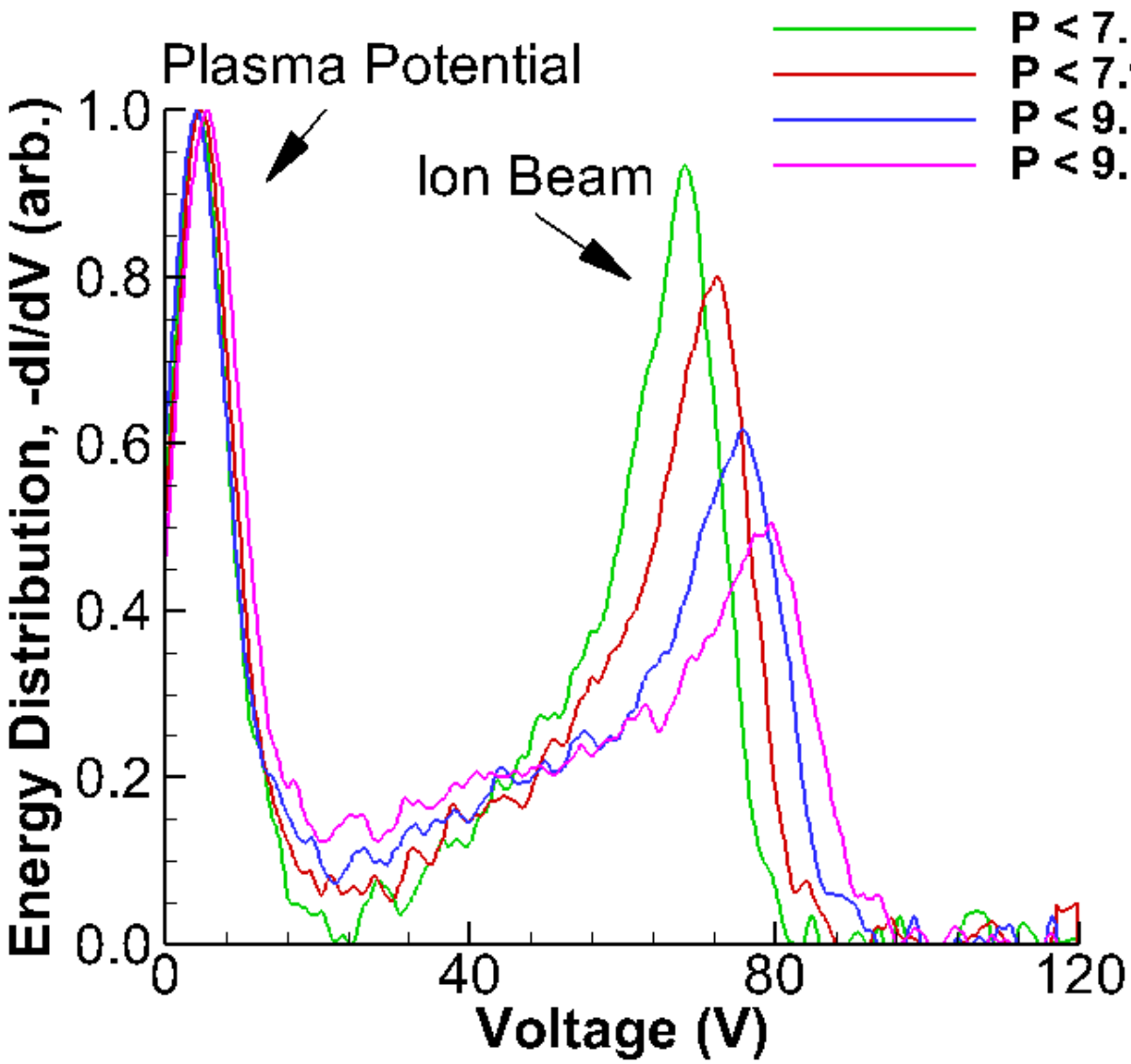


3 - 15 sccm, < 15 W

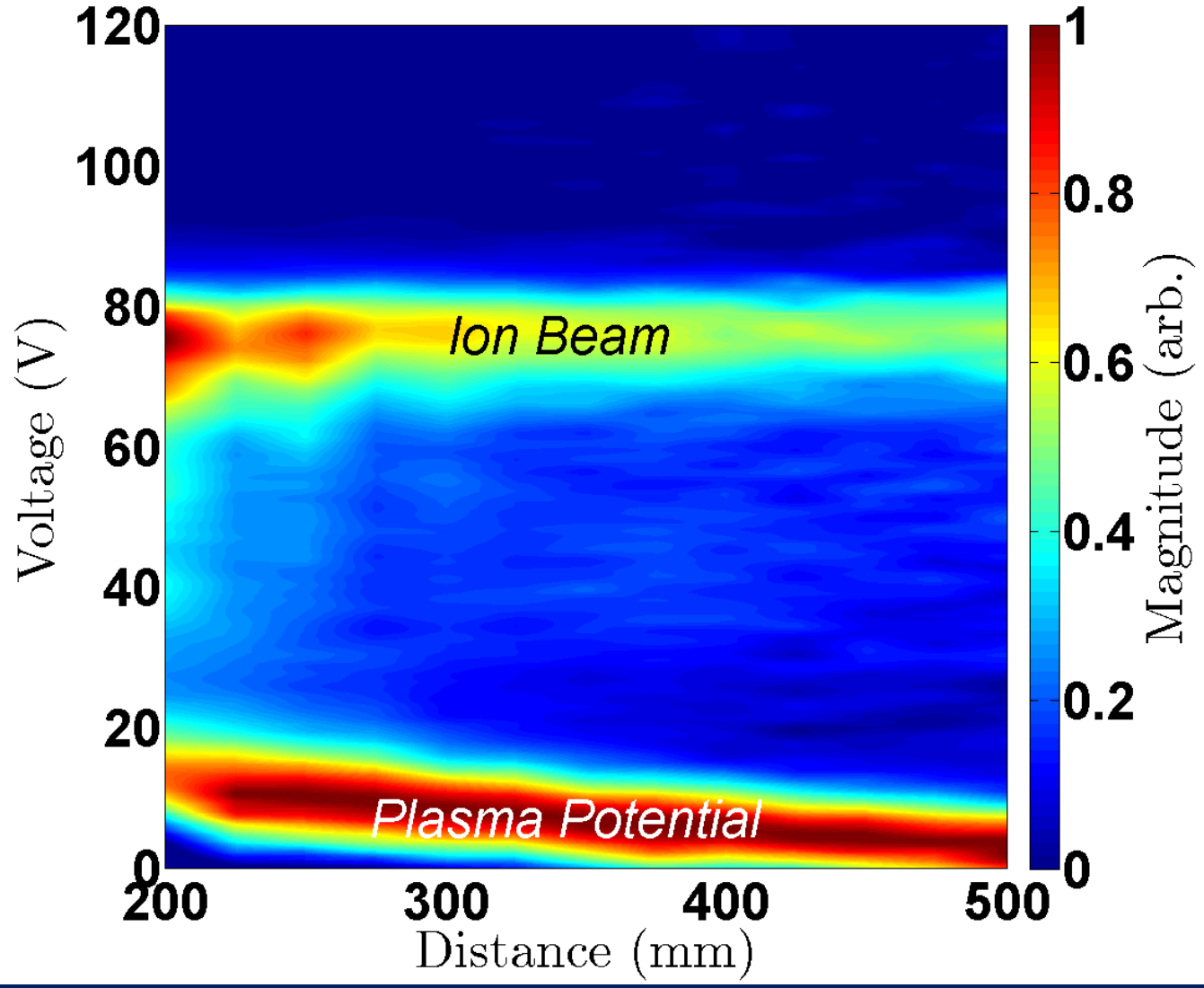


< 0.3 sccm, > 50 W

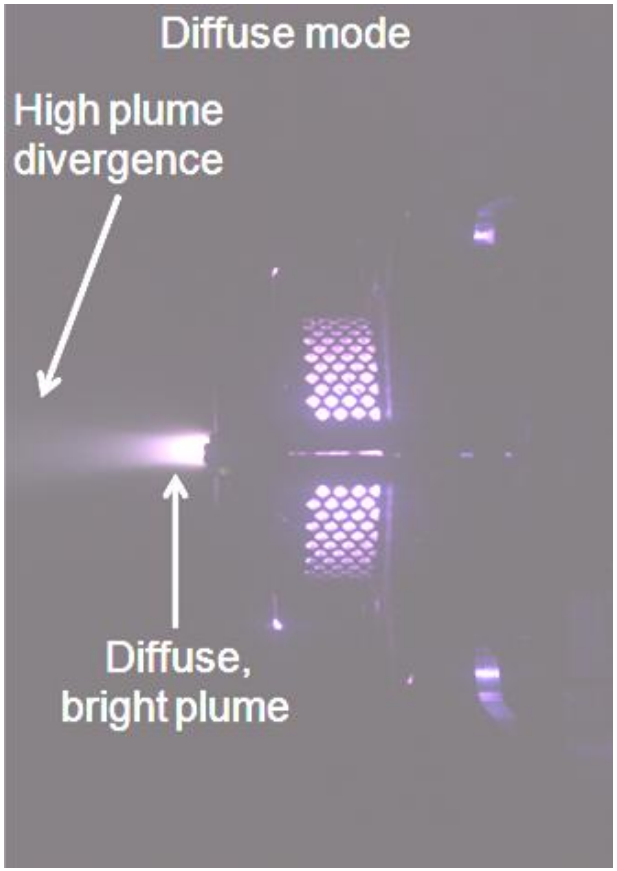
High Flow Rate, Low Power Mode – Vary Input Power, $P \approx 1x10^{-4}$ Torr, Ar



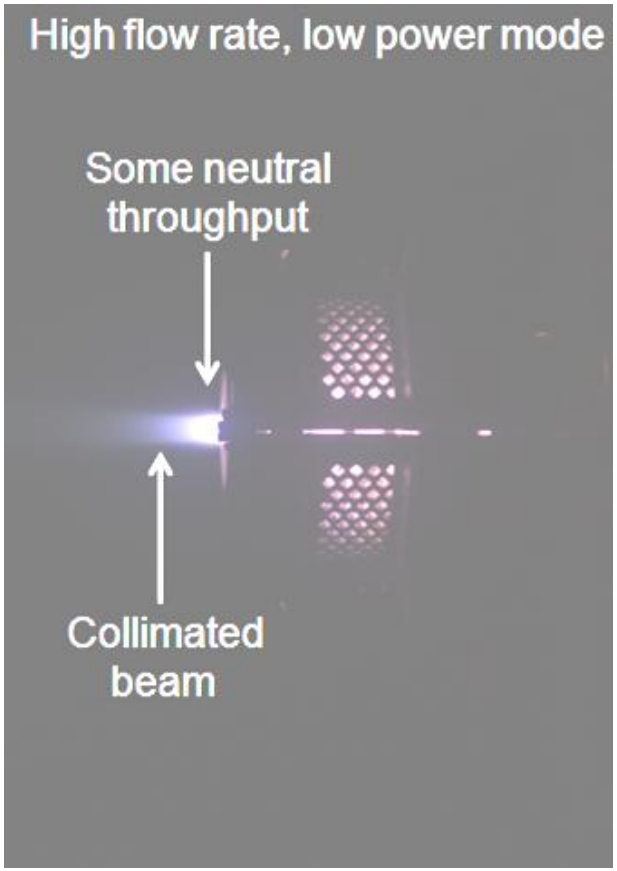
High Flow Rate, Low Power Mode – Vary RPA Position, $P \approx 1x10^{-4}$ Torr, Ar



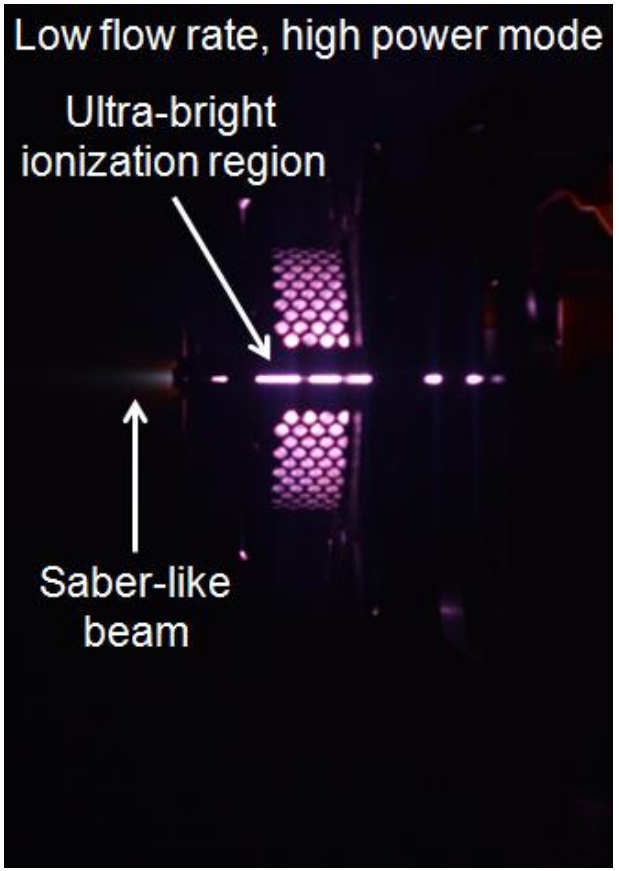
Operational Mode – Low Flow Rate, High Power Mode



> 10 sccm, > 20 W

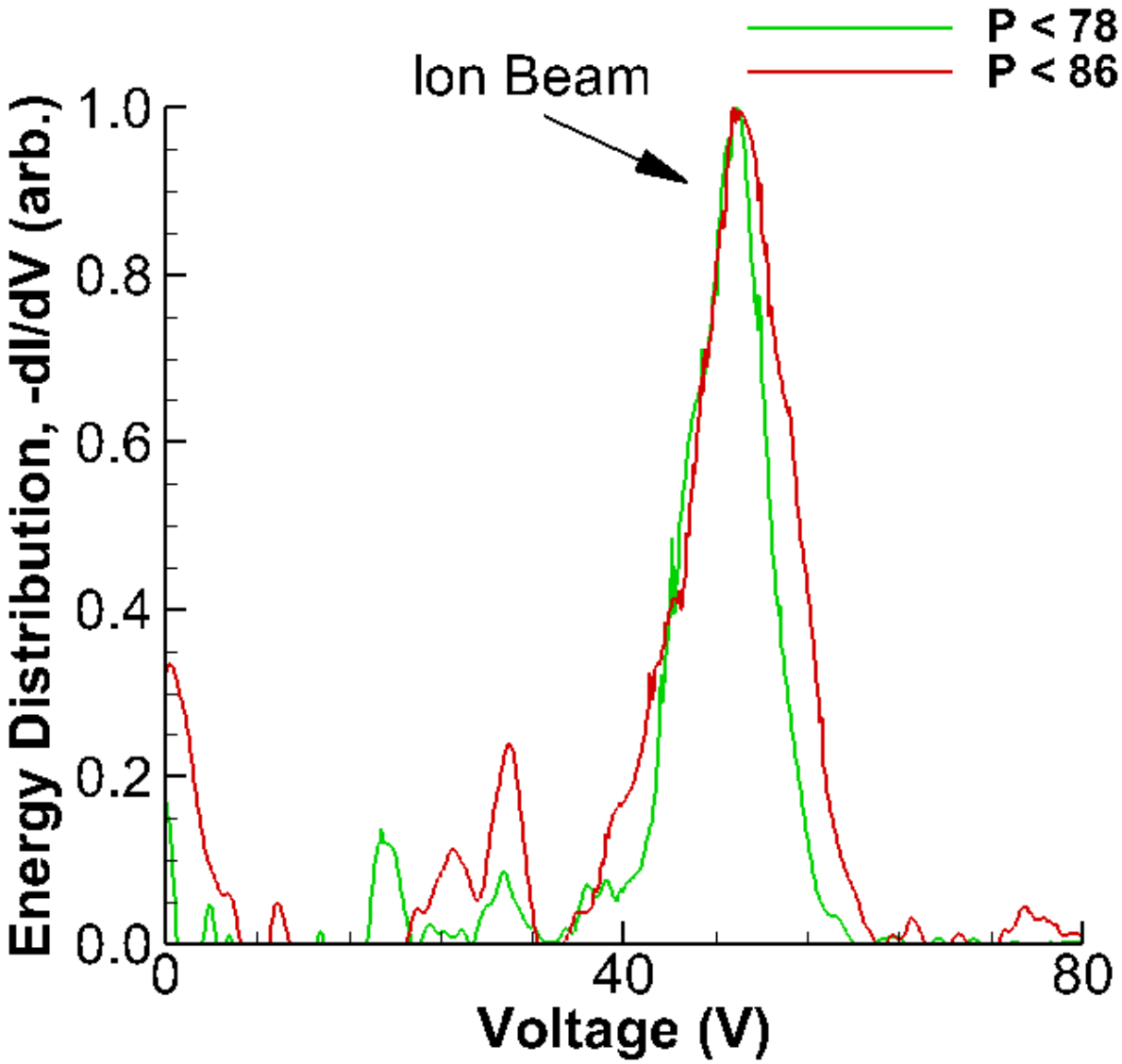


3 - 15 sccm, < 15 W

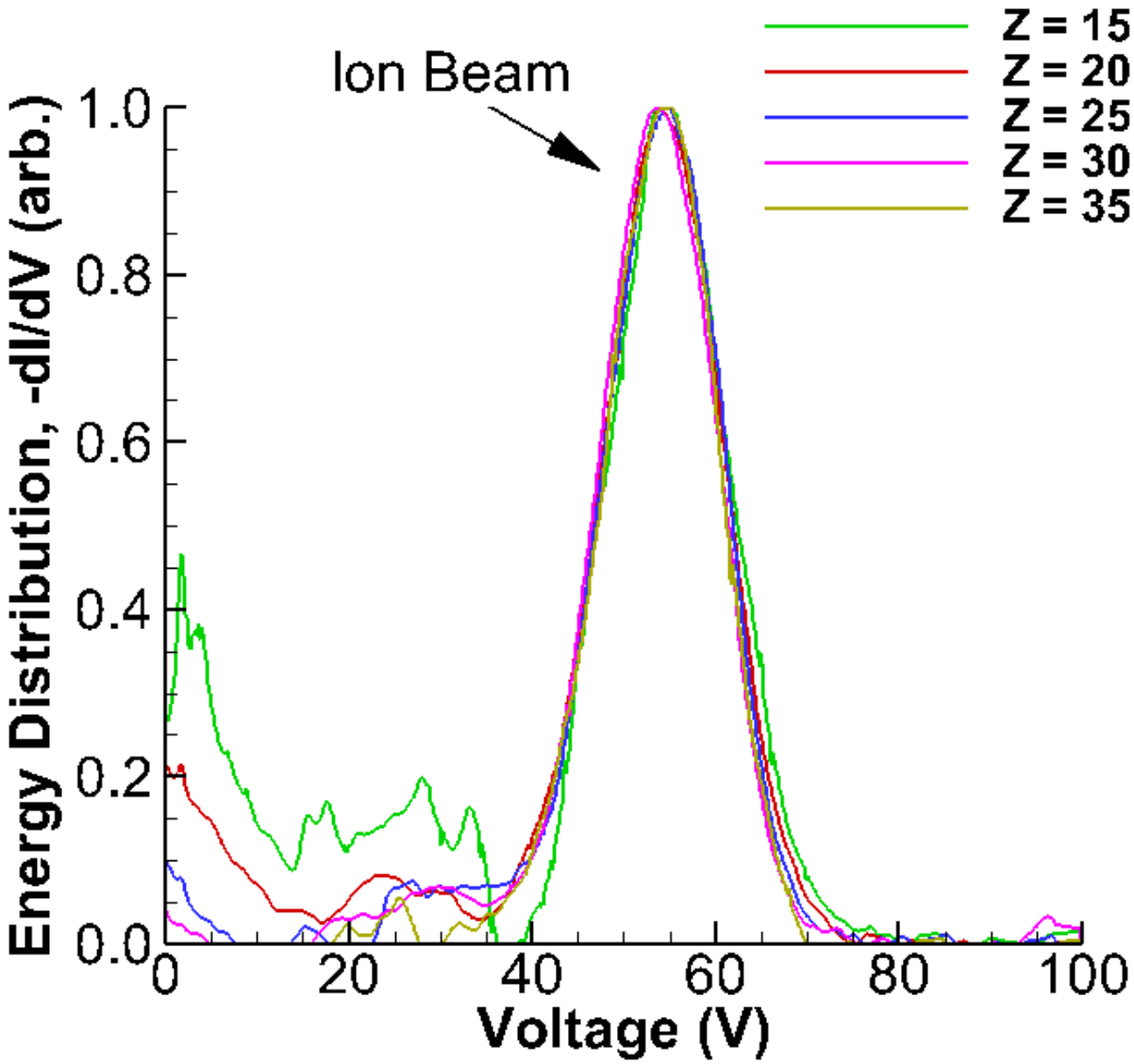


< 0.3 sccm, > 50 W

Low Flow Rate, High Power Mode – Vary Input Power, $P \approx 1x10^{-6}$ Torr, Xe



Low Flow Rate, High Power Mode – Vary RPA Position, $P \approx 1x10^{-6}$ Torr, Xe



Conclusions

- Multiple significantly different modes observed
  - Different operational parameters
  - Different plume structures
  - Different ion energies
- Two of three modes show promising characteristics
  - Possible high specific impulse modes

Future Work

- 2D plume mapping
  - Plasma potential
  - Density
  - Electron temperature
- Determination of plume composition
- Direct thrust and specific impulse measurement
- Measurement of efficiency

Acknowledgements

Thank you for your time!

Questions?

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