

Semion Thruster Applications

Measure the Ion Flux and Ion Energy incident on your substrate

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Measurement of ion energy distribution functions in PEGASES thruster

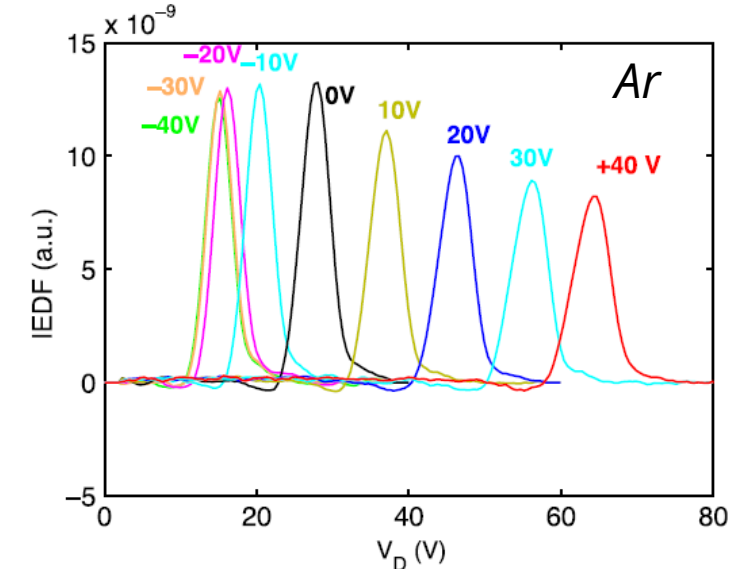
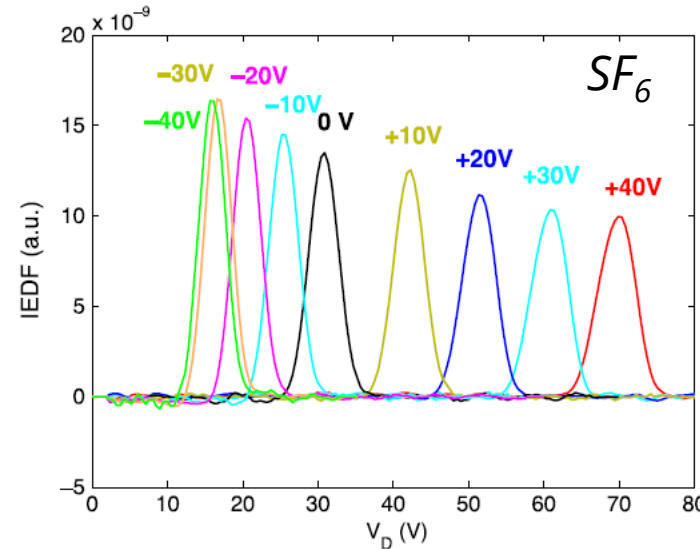
Response of an ion-ion plasma to dc biased electrodes

Lara Popelier et al, Laboratoire de Physique des Plasmas, CNRS-Ecole Polytechnique, France

DOI:<https://doi.org/10.1088/0022-3727/44/31/315203>

The objective of this paper was to investigate the possibility of plasma biasing of ion-ion plasmas in order to create beams with controllable energy/velocity.

In this regard, continuous extraction and acceleration of positive ions from the PEGASES thruster is investigated by a retarding field energy analyser.



The IEDFs measured in PEGASES thruster for positive ions in SF_6 and Argon gas for various endplates biases from -40V to +40V

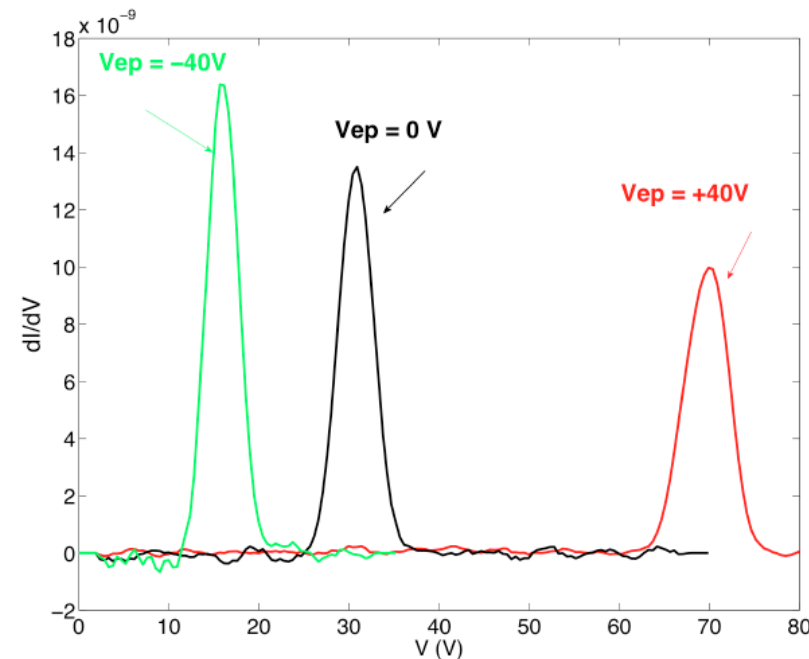
Retarding Field Energy Analyzer (RFEA) in an SF_6 plasma - PEGASES thruster

Extraction and Acceleration of Ions from an Ion-Ion Plasma

Lara Popelier et al, Laboratoire de Physique des Plasmas, CNRS-Ecole Polytechnique, France

DOI: <https://dx.doi.org/10.1063/1.3637439>

In this paper, extraction and acceleration of positive and negative ions from a strong electronegative plasma and from an ion-ion plasma is investigated in the PEGASES thruster, working with SF_6 . Retarding Field Energy Analyzer measurements are carried out along this axis.



Positive ion distribution function in an ion-ion plasma for various endplates biases

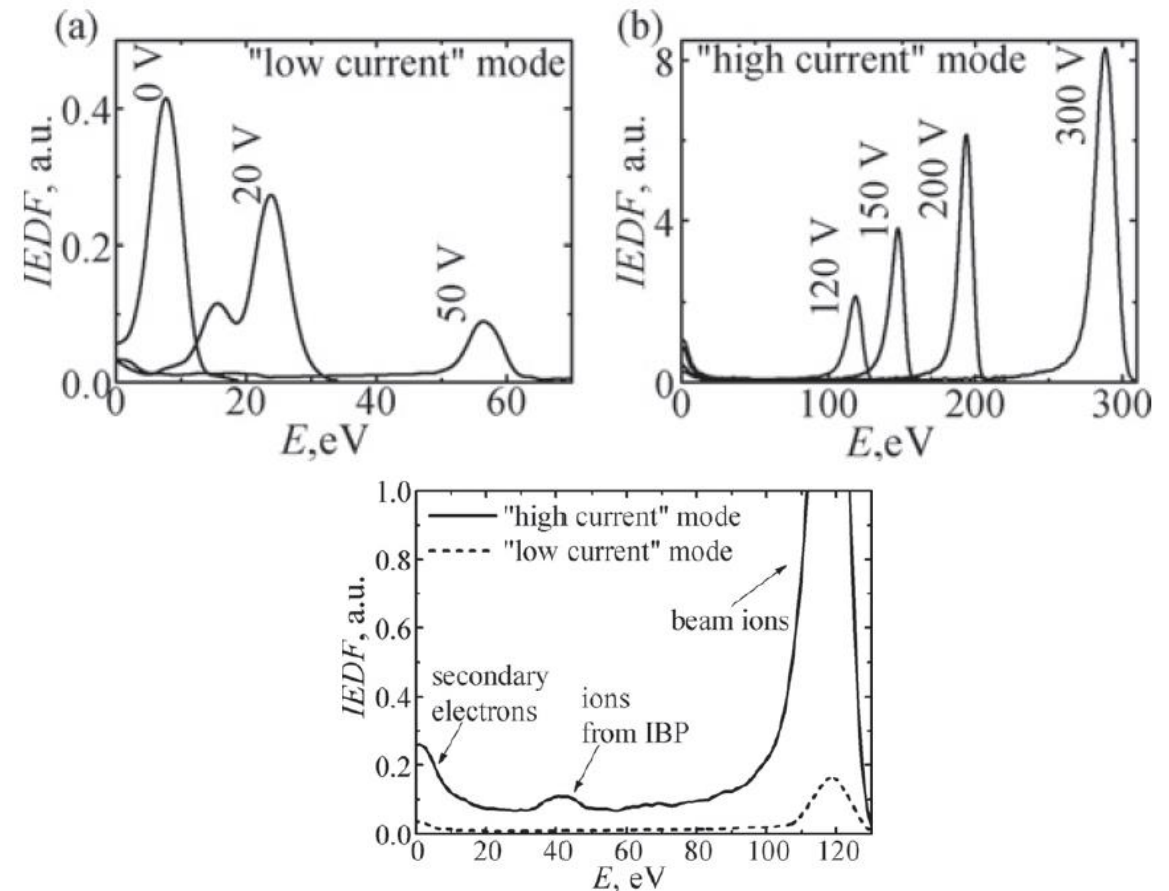
Measurement of ion energy distribution functions of the positive Ar ion beam

Hysteresis effects in the formation of a neutralizing beam plasma at low ion energy

Dmytro Rafalskyi and Ane Aanesland, Laboratoire de Physique des Plasmas, CNRS-Ecole Polytechnique - route de Saclay, France

DOI: <https://doi.org/10.1209/0295-5075/104/35004>

The objective of this paper was to investigate the PEGASES II thruster prototype and to use it as an ion source generating low-energy (< 300 eV) positive Ar ion beam, extracted without an external neutralizer. The ion energy distribution functions of the beam are measured for different regimes of ion extraction.



The IEDFs measured in PEGASES II thruster prototype using Argon gas

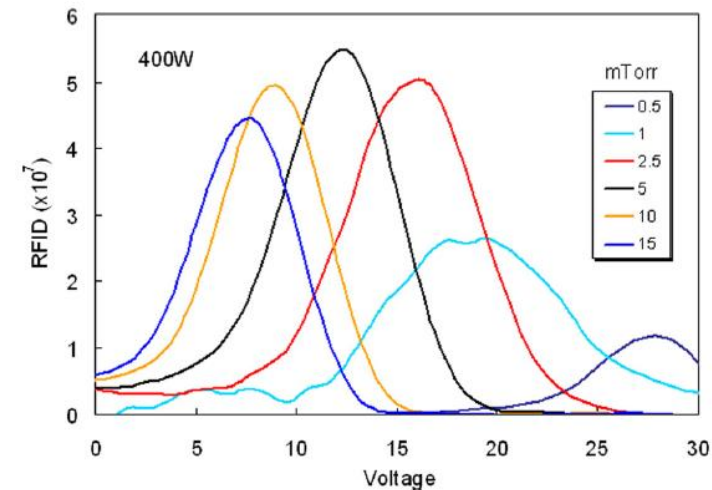
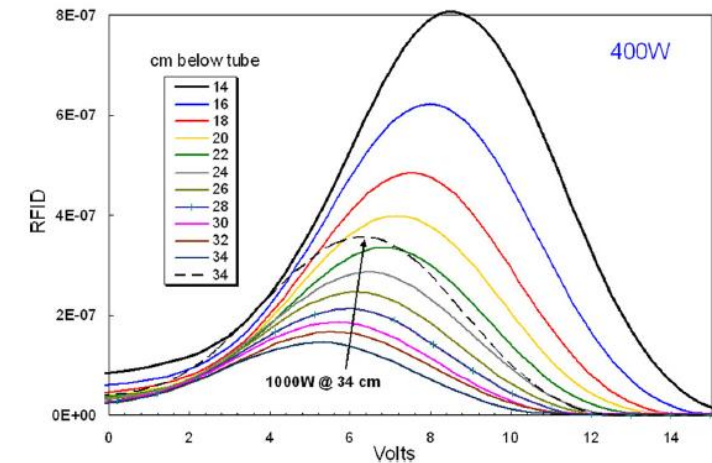
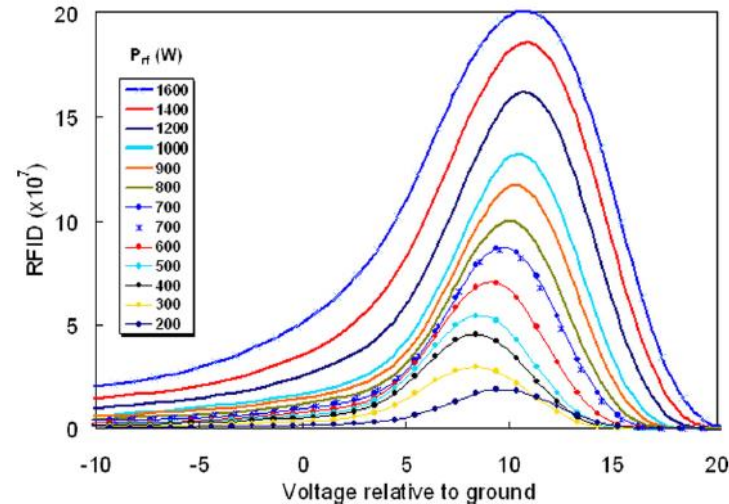
Possibility of Helicon source as an ion spacecraft thruster

Ion ejection from a permanent-magnet mini helicon Thruster

F F Chen, Electrical Engineering Department, University of California, Los Angeles, USA

DOI: <https://doi.org/10.1063/1.4896238>

The objective of this paper was to investigate a small helicon source, 5 cm in diameter and 5 cm long, using a permanent magnet (PM) to create the DC magnetic field B , for its possible use as an ion spacecraft thruster. The plasma is ejected into a large chamber, where the ion energy distribution is measured with a retarding-field energy analyzer.



IEDF profiles with large magnets in Helicon thruster (Argon gas, 27.12 MHz)

Measurement of Ion energy distributions in Compact Helicon thruster

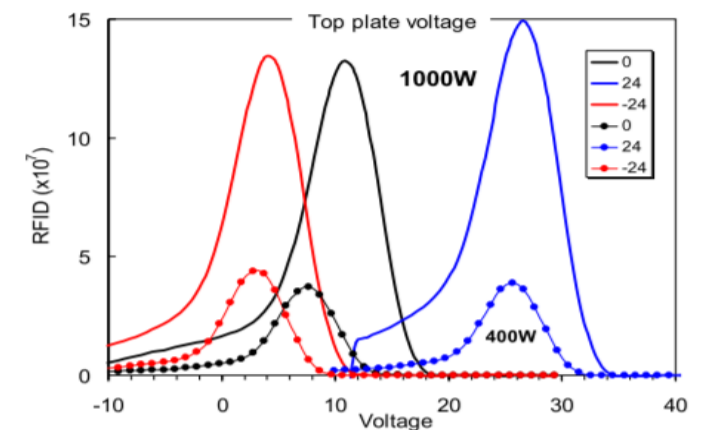
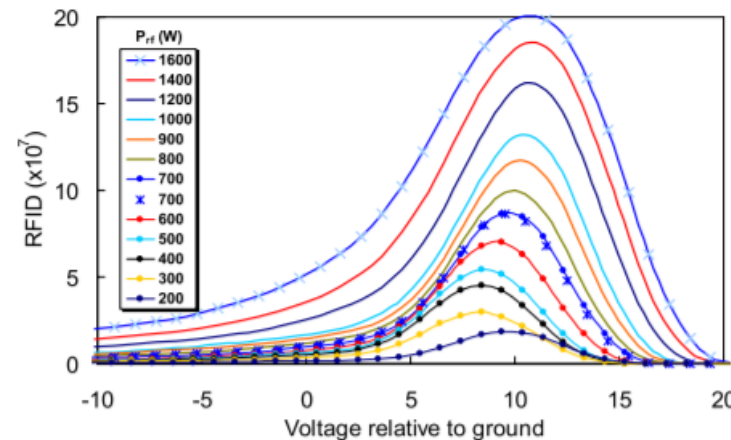
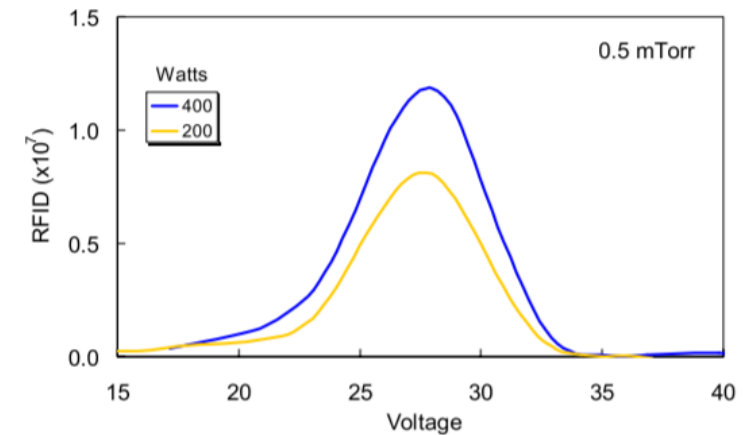
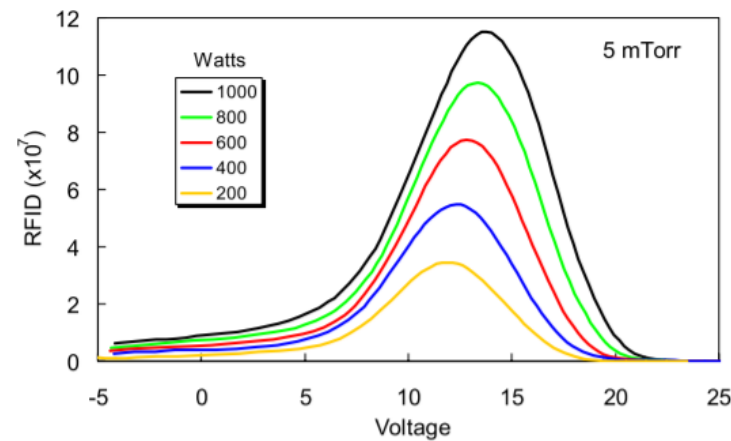
A Compact Permanent-Magnet Helicon Thruster

F F Chen, Electrical Engineering Department, University of California, Los Angeles, USA

DOI: <https://doi.org/10.1109/TPS.2014.2361476>

The objective of this paper was to investigate a small helicon source using a permanent magnet. It has been tested for possible application as a spacecraft thruster.

Ion energy distributions measured with a retarding-field ion analyzer show that ions are ejected with energies of $\sim 5 kT_e$.



IEDF profiles in Helicon compact thruster (Argon gas, 27.12 MHz)

Characterization of Thruster plume in a micro-propulsion system

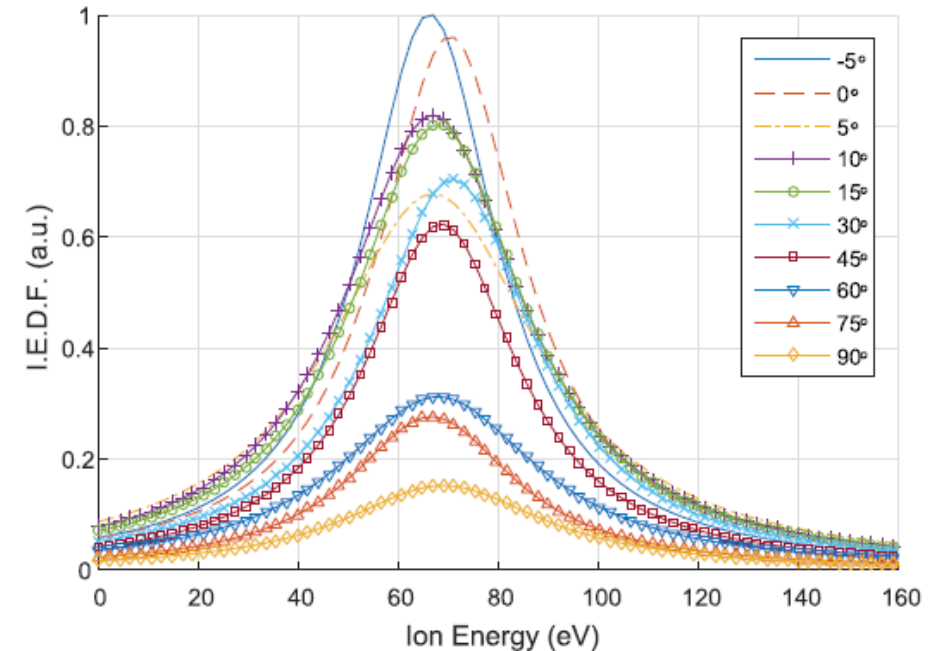
Experimental Characterization of the Inline-Screw-Feeding Vacuum-Arc-Thruster Operation

Igal Kronhaus et al, Aerospace Plasma Laboratory, Faculty of Aerospace Engineering, Technion-Israel Institute of Technology, Israel

DOI: <https://doi.org/10.1109/TPS.2017.2776839>

App note: <https://impedans.com/semion-pdc-application-note-se15>

The objective of this paper was to investigate a prototype inline-screw-feeding vacuum arc thruster (ISF-VAT) that was operated continuously for 12 h, permitting the characterization of thruster erosion processes.



IEDF profiles in azimuthal positions ranging from -5° to 90°

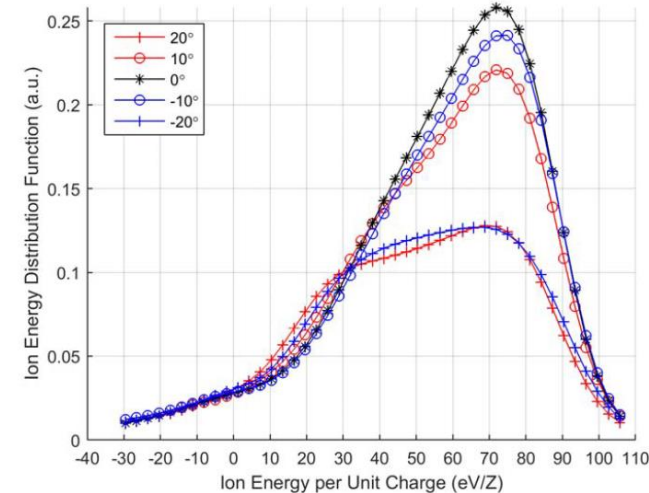
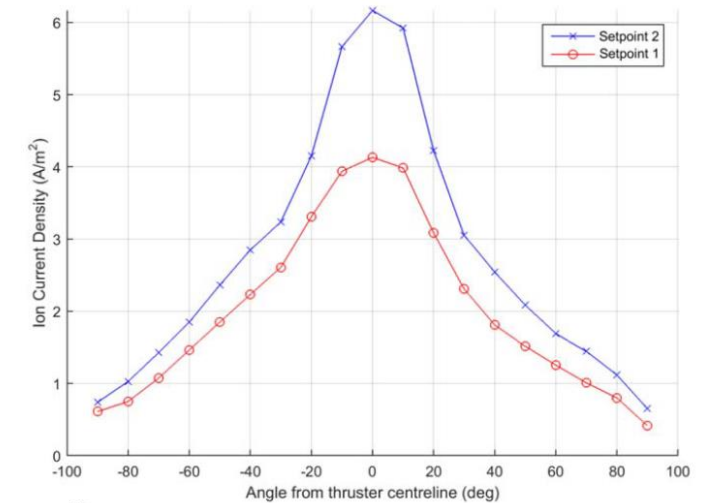
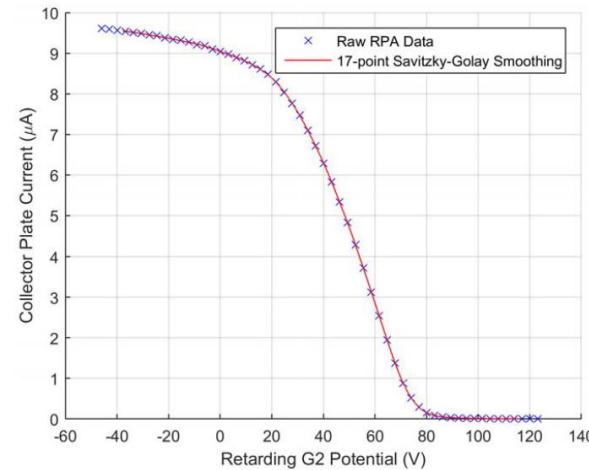
Measurement of ion current density of the NCHT plume

Experimental characterization of the narrow channel Hall thruster

Igal Kronhaus and Alexander Linossier, Faculty of Aerospace Engineering, Technion—Israel Institute of Technology, Israel

DOI: <https://doi.org/10.1088/1361-6595/aaec65>

The objective of this paper was to demonstrate a very low power and low voltage operation of an narrow channel Hall thruster (NCHT). The NCHT prototype was operated successfully at power levels of 15 W–30 W, producing a thrust level in the 1 mN range. The thruster anode efficiency is between 6%–8%. The NCHT ion beam was characterized using a retarding potential analyzer.



IEDF profiles measured in very low power and low voltage NCHT plume using Xenon gas

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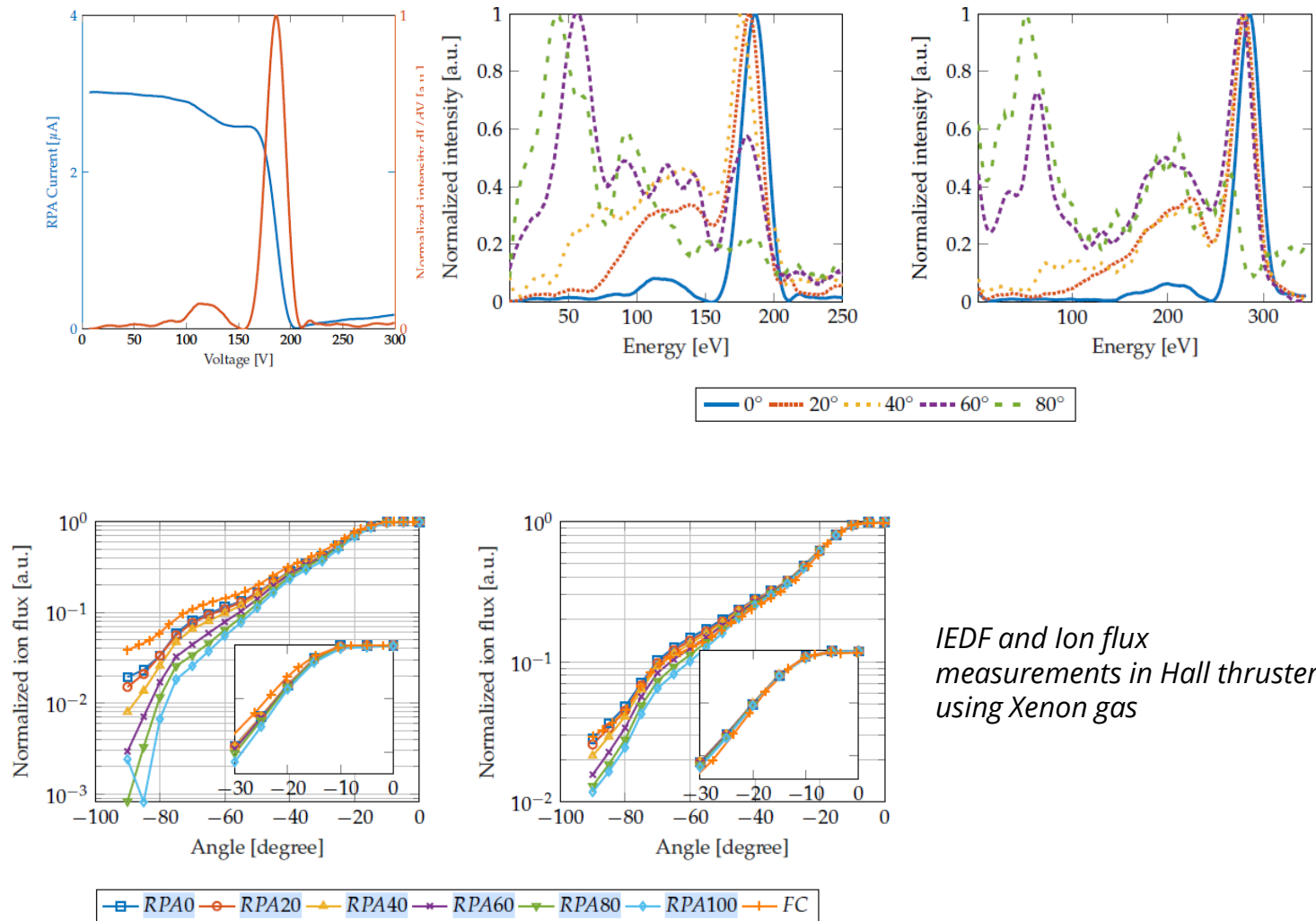
Measurement of ion energy distribution functions in Hall thruster

Far-Field Plume Characterization of a 100-W Class Hall Thruster

Hallouin T and Mazouffre S et al, Centre National de la Recherche Scientifique, France
Exotrail, France

DOI: <https://doi.org/10.3390/aerospace7050058>

In this paper, the 100 W-class ISCT100-v2 Hall Thruster (HT) has been characterized in terms of far-field plume properties. By means of a Retarding Potential Analyzer, the ion energy distribution function have been measured over a 180° circular arc for different operating points.



*IEDF and Ion flux
measurements in Hall thruster
using Xenon gas*

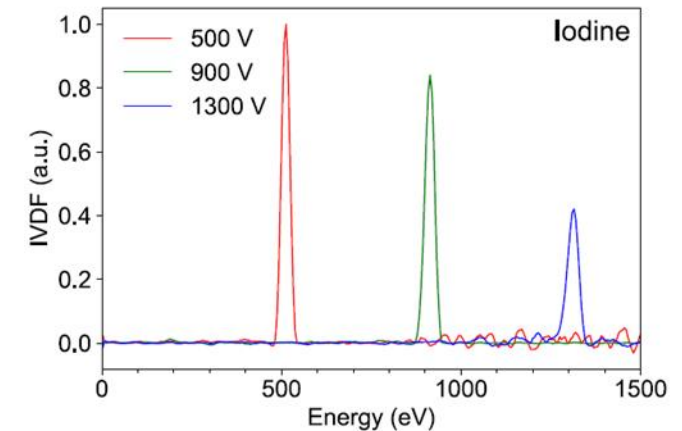
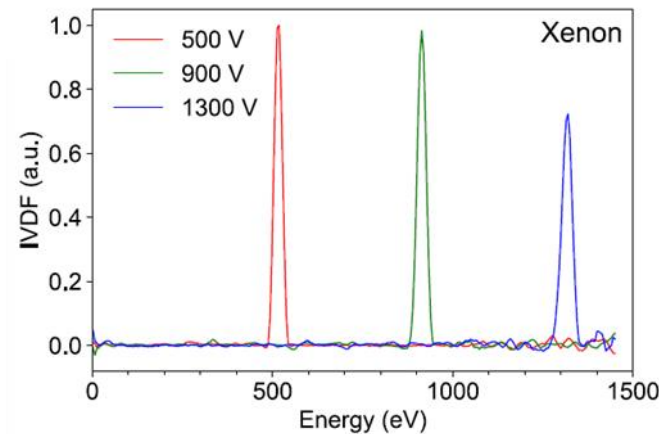
Measurement of ion velocity distribution functions in electric propulsion systems

Ion beam diagnostic for the assessment of miniaturized electric propulsion systems

Habl L et al, Laboratoire de Physique des Plasmas, CNRS,
Ecole Polytechnique, Sorbonne Université, Université Paris-Saclay, France
ThrustMe, France

DOI: <https://doi.org/10.1063/5.0010589>

This paper presents the development and testing of a new diagnostic tool making use of an array of small probes for ion beam mapping in low-power electric propulsion (EP) systems. To demonstrate the operation of the diagnostic system, a series of experiments were conducted with a low-power gridded ion thruster using xenon and iodine propellants.



Ion velocity distribution function (IVDF) in energy units for different values of the screen grid voltage

First ever flight test of an ion thruster fueled by iodine - ThrustMe

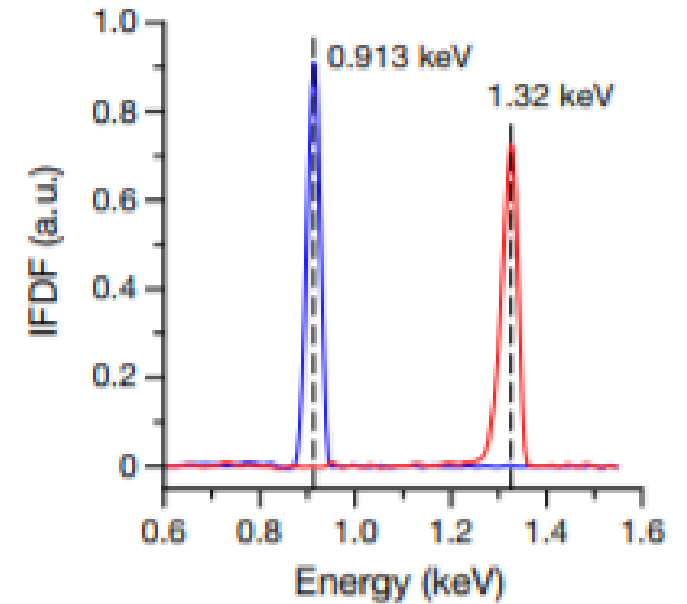
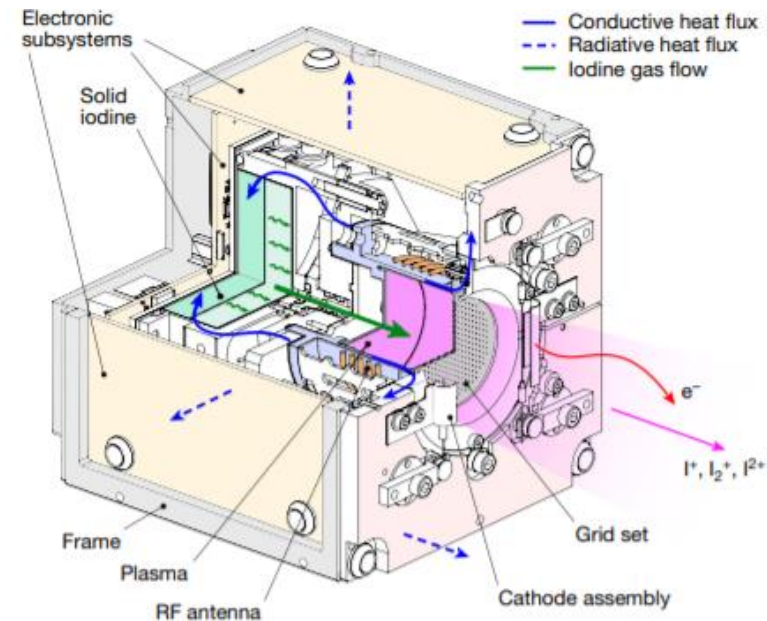
In-orbit demonstration of an iodine electric propulsion system

Rafalskyi D et al, ThrustMe, Verrières-le-Buisson, France
Laboratoire de Physique des Plasmas, CNRS, Ecole Polytechnique, Sorbonne Université, Université Paris-Saclay, France

DOI: <https://doi.org/10.1038/s41586-021-04015-y>

This article talks about the in-orbit demonstration of an iodine electric thruster just published in the Nature journal.

In this new article, ThrustMe presented the development, performance characterization, and, for the first time, the flight test of an ion thruster fueled by iodine.



Schematic of the NPT30-I2 iodine electric propulsion system. Example of Ion flux distribution functions (IFDF) in the plume for acceleration voltages of 900 V and 1,300 V.

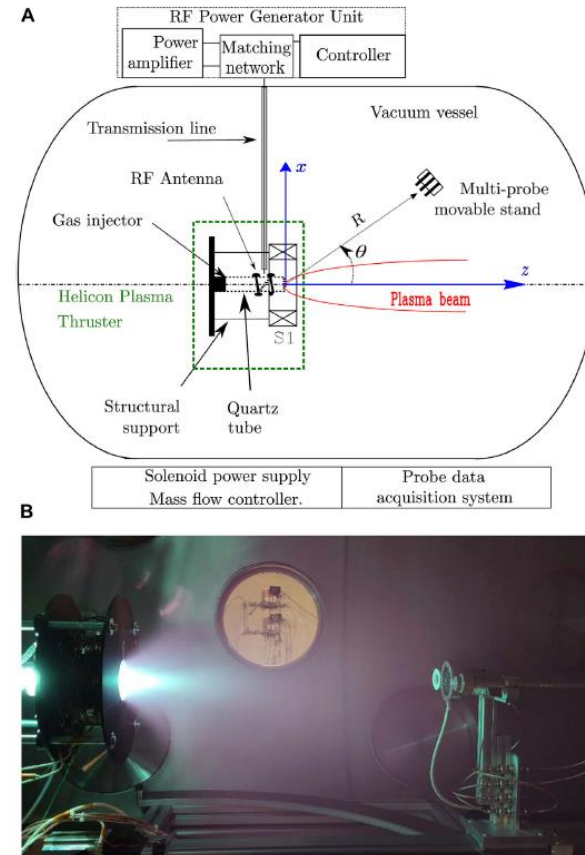
Validation of numerical models for magnetic nozzle using Semion measurements

Magnetic Nozzle and RPA Simulations vs. Experiments for a Helicon Plasma Thruster Plume

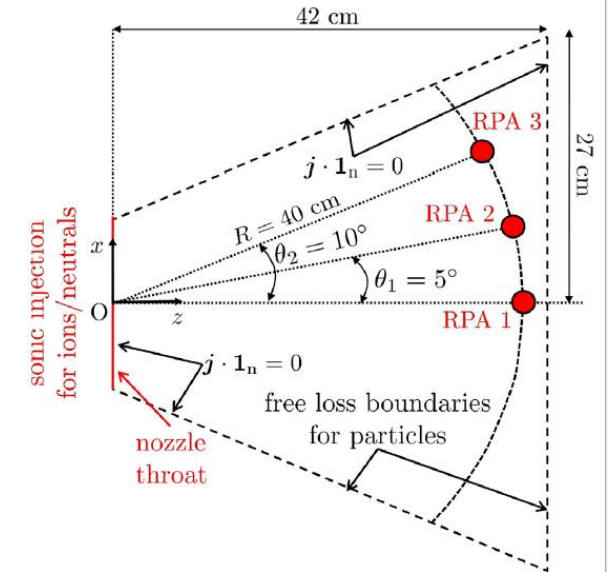
Cichocki F et al, Institute for Plasma Science and Technology (ISTP, CNR), Italy
Equipo de Propulsión Espacial y Plasmas (EP2), Universidad Carlos III de Madrid, Spain
Departamento de Bioingeniería e Ingeniería Aeroespacial, Universidad Carlos III de Madrid, Spain

DOI: <https://doi.org/10.3389/fphy.2022.876684>

This work attempts to reproduce numerically a plasma plume emitted by a Helicon thruster prototype, which has been characterized experimentally using a Retarding Potential Analyzer (RPA).

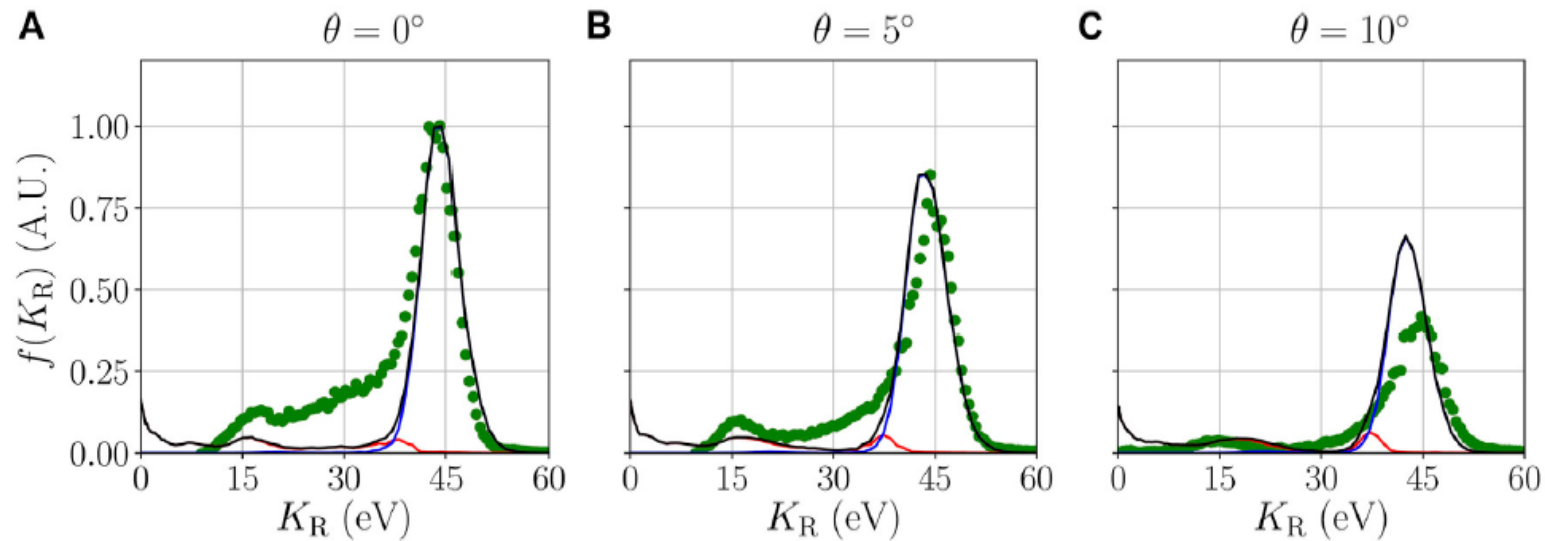


A) Experimental setup sketch (not in scale), and (B) HPT05M under test, firing with Xenon. The RPA is mounted on the multi-probe movable arm. In subplot (B), the probes arm holder includes the RPA at the center and two different Faraday probes at its sides.

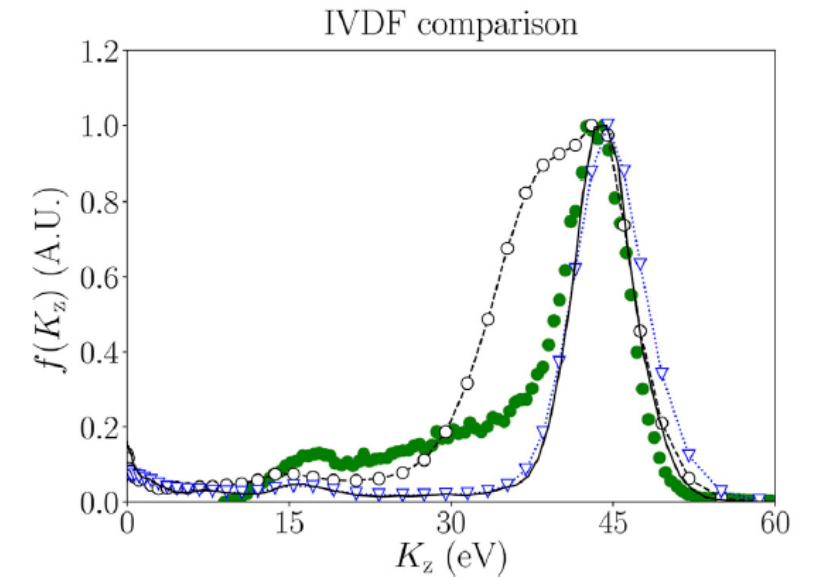


Simulation domain for the magnetic nozzle expansion simulation, shown at the $y = 0$ plane. The expansion is along the z axis, while the magnetic nozzle throat is at the left upstream boundary.

Validation of numerical models for magnetic nozzle using Semion measurements



Comparison between magnetic nozzle simulations (red solid line refers to slow ions, blue solid line to injected ions and black solid lines to the sum of the two populations) and experiments (green circles) of the IVDF as a function of the kinetic energy K_R along the R direction, at $R = 40$ cm, for (A) $\theta = 0^\circ$, (B) $\theta = 5^\circ$ and (C) $\theta = 10^\circ$.



Comparison between magnetic nozzle simulations (black solid lines), experiments (green circles) and RPA simulations (blue dotted and grey dashed lines) of the IVDF along the z direction ($\theta = 0$).

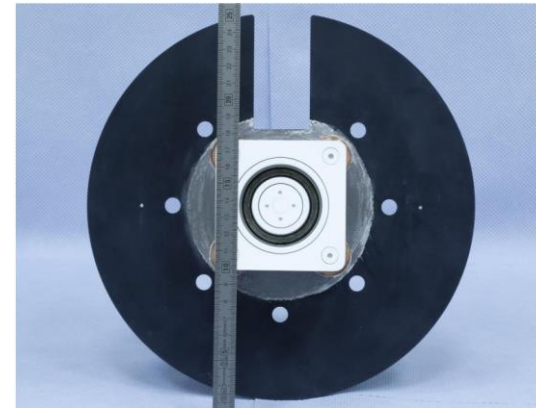
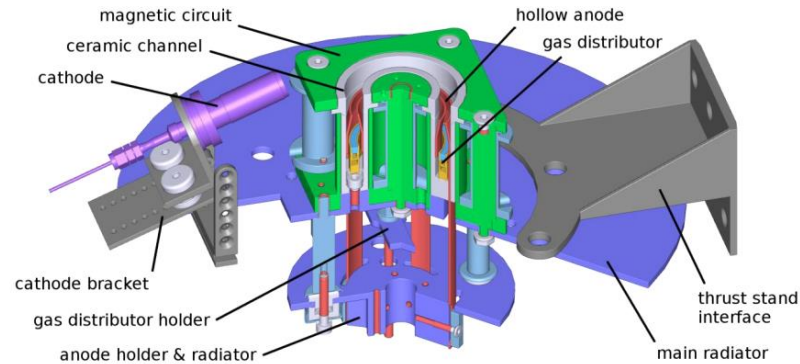
Performance estimation of small Krypton thruster in a wide range of operating conditions using Semion

Experimental Optimization of Small Krypton Hall Thruster for Operation at High Voltage

Maciej Jakubczak et al, Institute of Plasma Physics and Laser Microfusion (IFPiLM), Poland

DOI:https://www.researchgate.net/publication/361590599_Experimental_Optimization_of_Small_Krypton_Hall_Thruster_for_Operation_at_High_Voltage

This work presents design and the performance of a new version of 500 W-class krypton Hall thruster. The plasma plume was probed with Semion Retarding Potential Analyzer, mounted on an arm rotating in horizontal plane which allowed to take measurements in the range from -90° to $+90^\circ$ from the thruster axis.

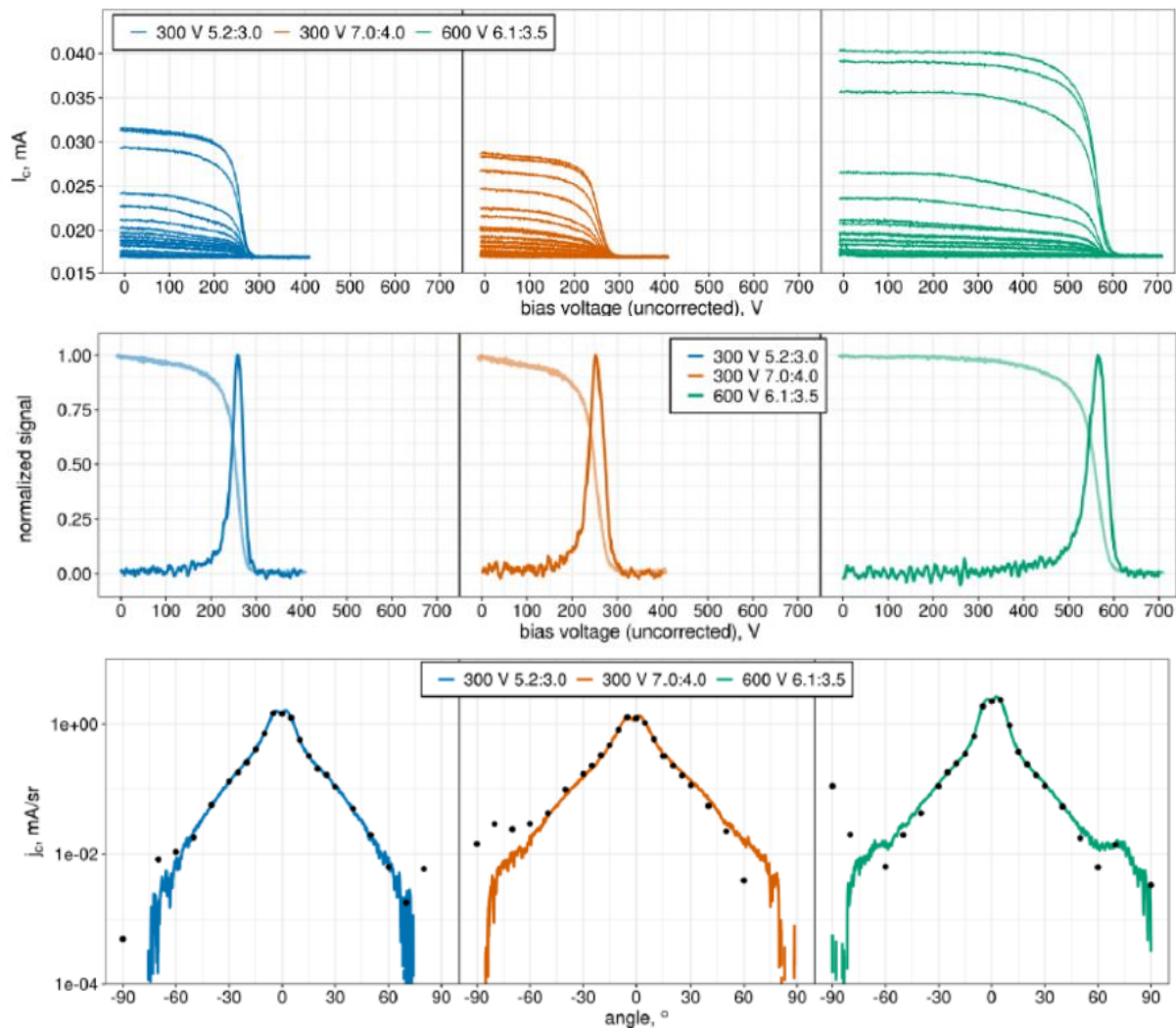


(up) Cross-section of the second version of HIKHET (the model is rotated counterclockwise by 90° with respect to its position on the thrust balance). (down) Front view of the assembled thruster



Retarding Potential Analyzer (RPA) and Faraday Cup (FC) mounted on the rotating arm.

Performance estimation of small Krypton thruster in a wide range of operating conditions using Semion



RPA current-voltage characteristics. Each panel contains 25 curves – one for each angular position.

RPA current-voltage characteristics (shaded) and its derivative (solid) on the thruster axis

Ion current density angular profiles measured by Faraday Cup (Savitzky-Golay smoothed signal), and rescaled RPA signal (black dots) in logarithmic scale.

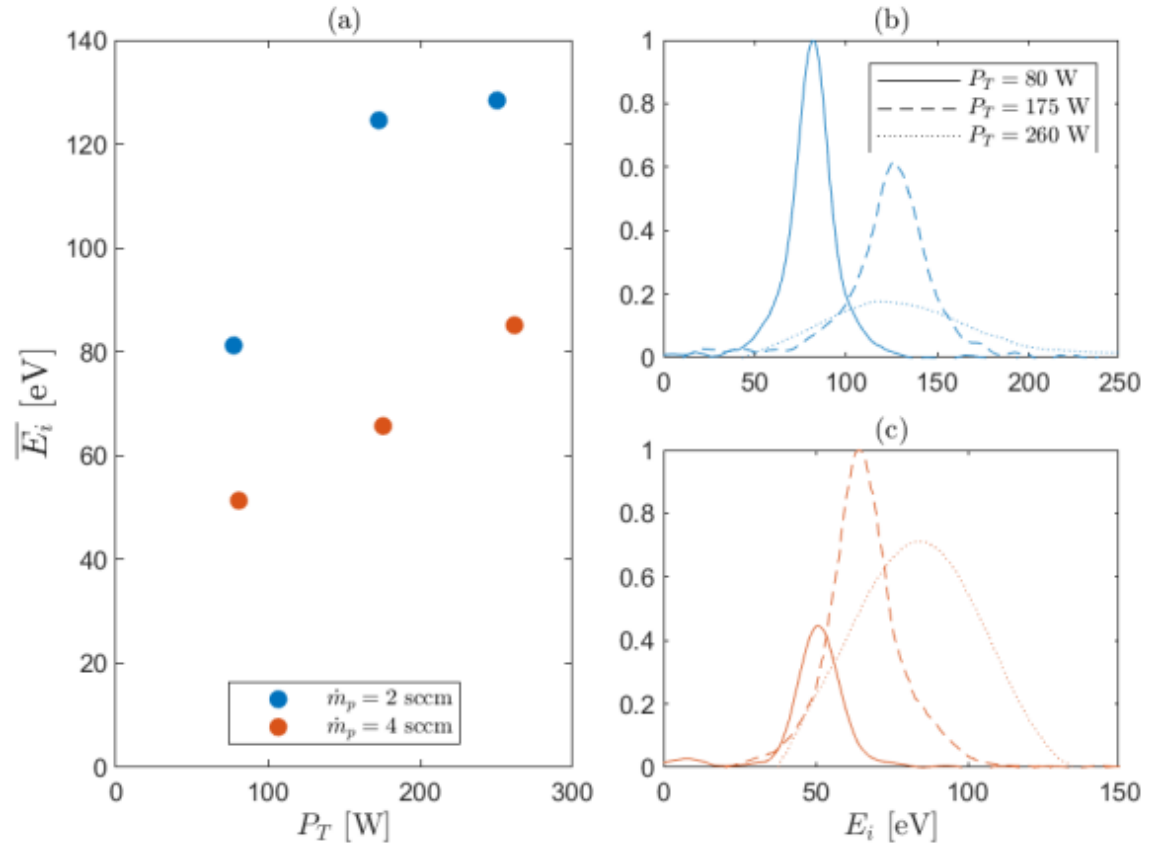
IED measurements on a Xe fed ECR Thruster operating at 5.8 GHz

Direct Thrust Measurements of a circular waveguide Electron Cyclotron Resonance Thruster

Inchingolo M. R et al, Equipo de Propulsión Espacial Plasmas, Universidad Carlos III de Madrid, Leganés, Madrid, Spain

DOI:https://www.researchgate.net/publication/362280004_Direct_Thrust_Measurements_of_a_circular_waveguide_Electron_Cyclotron_Resonance_Thruster

Direct thrust measurements were performed on a waveguide-based electrodeless ECR thruster working at the 5.8 GHz microwave frequency using an amplified displacement pendulum thrust balance. Retarding Potential Analyser, Semion, was used as well to assess partial efficiencies.



Retarding Potential Analyzer (RPA) results for different working points. (a) Mean ion energy, (b-c) Ion energy distribution functions for $\dot{m}_p = 2 - 4$ sccm respectively.

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