Quasi 2D PIC Model of a Magnetically Enhanced Plasma Thruster

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36th International Electric Propulsion Conference (IEPC), Vienna (Austria), 2019

Comparison against experimental measurements

Magnetically Enhanced Plasma Thruster

Main Components:
- RF antenna for heating and ionizing plasma
- Magnets for confining magneto-static field
- Dielectric tube inside which the neutral gas is ionized

Main Advantages:
- No grids or neutralizers
- Low cost, simple geometry

Numerical Model

Main Features:
- Electrostatic-magneto-static PIC
- Axial symmetrical geometry
- Axial symmetrical magneto-static field
- Magnetic cusps can be handled
- 1D PIC model along the axial direction
- Analytical relations along the radial direction

Numerical Validation

- Validation against theoretical results: Bohm sheath criterion
- Validation against the results of a 1D hybrid code

Theoretical: monitored the potential and the total energy by varying the mesh size, the time step and the super particle’s dimension.

Experimental Results

- The system is operated with Xenon gas,
- the propellant mass flow rate is 0.3 mg/s
- the working frequency is 2 MHz

Comparison between Numerical and Experimental results

We have compared the three magnetic configurations with respect to the normalized thrust.

- The normalized experimental thrust $F_{\text{exp}}$ was computed from the angular coefficient of the respective experimental interpolation line
- $F_{\text{num}}$ represents the normalized numerical thrust.

Conclusions & Future Works

Conclusions: magnetic cusp regions and two dimensional effects simulated successfully; the code can be employed for the preliminary design of MEPT.

Future works: we manage to introduce the ion-neutral collision mechanism and the power source for the heating region, in order to extend the relevant physics captured by the simulation.