

Numerical and experimental investigation into the performance of plasma sources for space propulsion systems

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Helicon
Plasma
Sources

Mirko
Magarotto

Framework
& Statement
of the
Problem

Innovation

Methodology

Main
Expected
Results

- 1 Framework & Statement of the Problem
- 2 Innovation
- 3 Methodology
- 4 Main Expected Results

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Advantages

- high specific impulse
- high thrust efficiency

State of the Art

- ion thruster
- Hall-effect thruster



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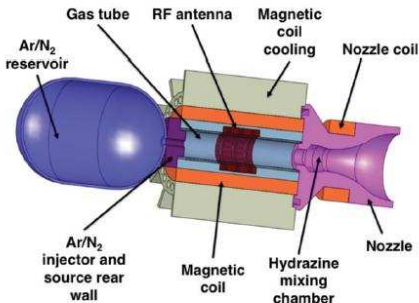
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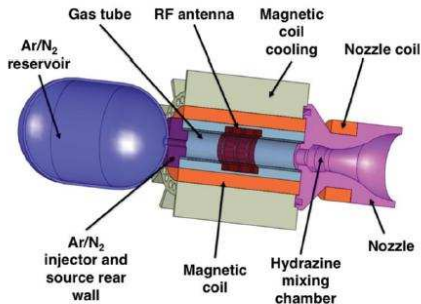
Main components

- cold gas tank
- plasma source
- magnetic nozzle



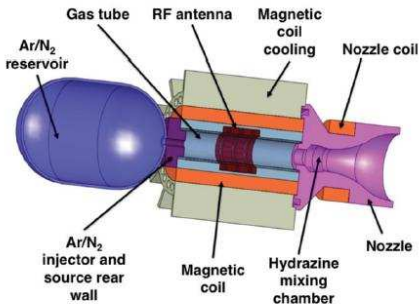
Advantages

- long life (no electrodes)
- higher specific thrust



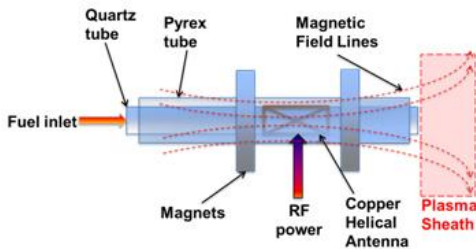
Some international projects

- HPH.COM
 $P_w < 100 \text{ W}$
- SAPERE
 $P_w > 1 \text{ kW}$



Main components

- dielectric cylinder
- RF antenna
- magnetic coils



Physics Processes

- 1 plasma generation
- 2 wave-plasma coupling
- 3 plasma transport

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Classical Models

- 1 electromagnetic simulations coupled to kinetic models
- 2 electromagnetic simulations coupled to PIC models

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Problem in High-Power Sources

computational burden

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Development of a **FLUID SOLVER** numerical tool in order to have

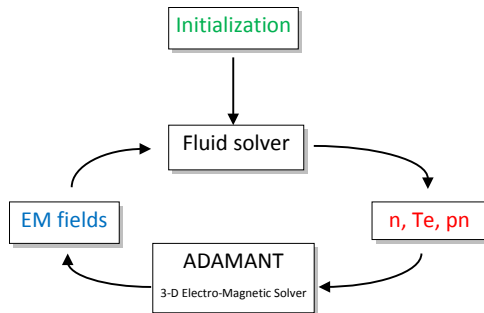
- 1 accurate reproduction of the transport in high-density plasma
- 2 computational cost at bay

Analytical Models

- 1D radial model
- 2D radial-axial model

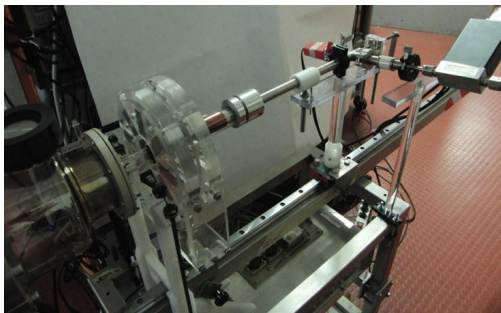
Numerical Tools

- develop a new fluid solver for plasma transport
- validation of the new tool
- coupling the new tool with ADAMANT



Diagnostic System

fiber-optic spectrometer and a Langmuir probe to characterize the plasma



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Diagnostic System

Faraday probe and a Retarding Potential Analyzer to measure Specific Impulse and Thrust



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Results

- 1 physical investigation into magnetized high-density plasma discharge
- 2 development of a new numerical tool aimed at the study and optimization of customized high-power plasma sources
- 3 design, development, and testing of an high-power Helicon plasma source
- 4 technology exploitation