12/09/2019

UNIVERSITA' DEGLI STUDI DI PADOVA

Corso di Dottorato in Scienze, Tecnologie e Misure Spaziali

Study and Development of a Fluidic System for Iodine-fed Magnetically Enhanced Plasma Thruster (MEPT)

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Framework and Statement of the Problem

MEPT

The **Magnetically Enhanced Plasma Thruster** (**MEPT**) is an **innovative low-cost electric propulsion system** able to increase small spacecrafts mobility, opening new unconventional mission scenarios.

THRUSTING
A DIFFERENT
FUTURE

T4i is engaged in the design and development of a complete propulsion module based on the MEPT. The module is intended for CubeSat platforms ranging in size from **6 U** to **24 U**, providing:

- 0.01-1 mN of Thrust
- Isp up to 850 s
- input power lower than 80 W

MEPT

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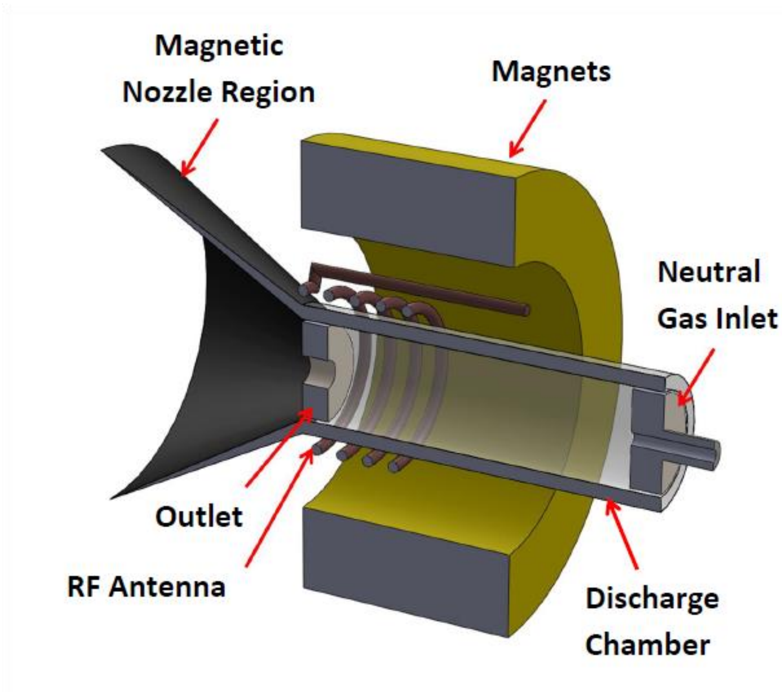
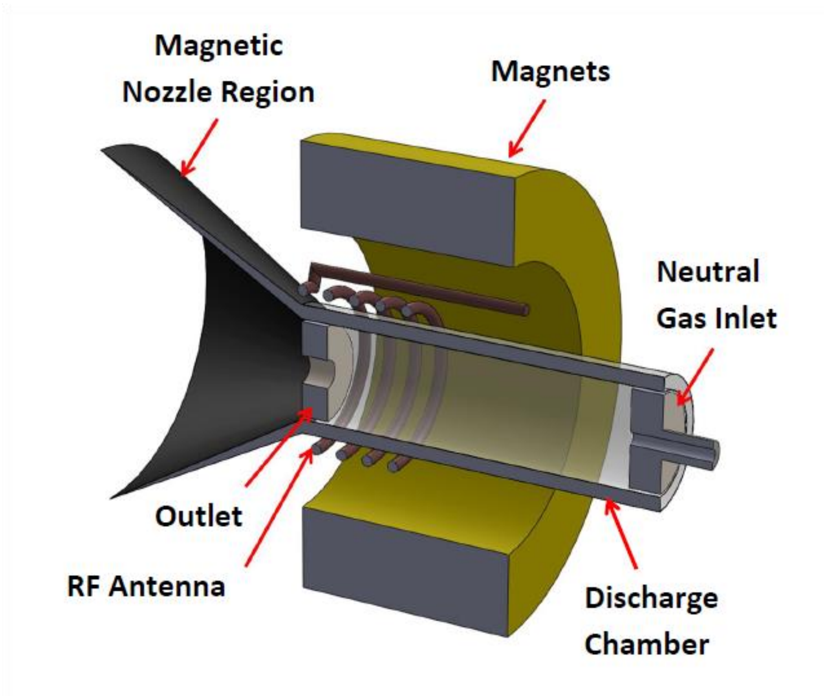


The main components of MEPT are:

- A **fluidic line** which transfers the neutral gas propellant from a storage tank to the **discharge chamber**.
- A **dielectric tube** inside which the neutral gas is ionized
- A **RF antenna**, in the MHz frequency range, which generates the electromagnetic (EM) fields for gas ionization
- **Magnets** producing a magnetostatic field to enhance the plasma confinement and provide the magnetic nozzle effect.

MEPT



Advantages:

- Absence of electrodes immersed in the plasma
- Good power scalability
- Adaptability to different propellants
- No need for a neutralizer

Disadvantage:

- High thermal load due to plasma

MEPT: Iodine Propellant

MEPT can work with different propellants (such as Ar, Kr, Xe, Air, CO_2). Because of this last feature it seems extremely promising to investigate the employment of **Iodine as propellant**, which is particularly appealing for space applications.

Why Iodine Propellant?

- It costs only 1/5 compared to Xenon
- It can be stored as solid
- High density
- No pressurized tank

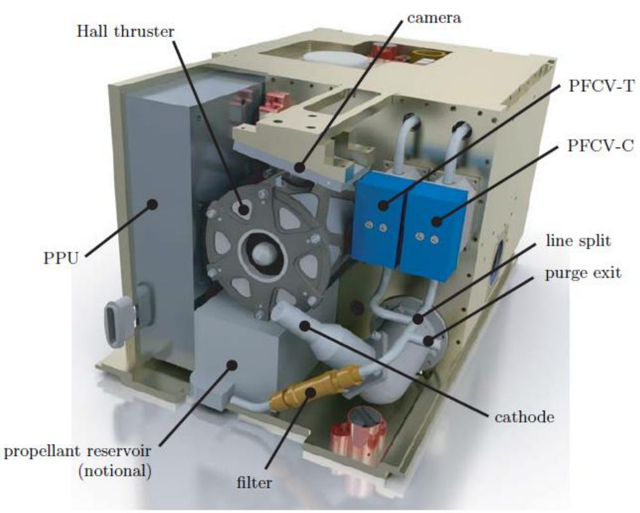
Disadvantages:

- Chemically reactive
- Never flown before

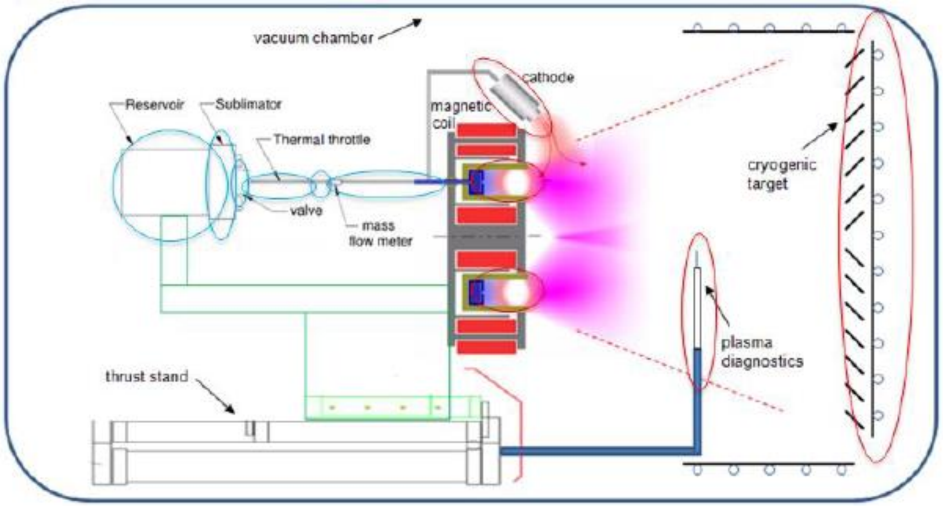
Recently, some companies have implemented a Iodine Fed-System for Hall Effect Thruster or Ion Thruster.

Busek – Ion Thruster

iSAT/NASA – Hall Thruster



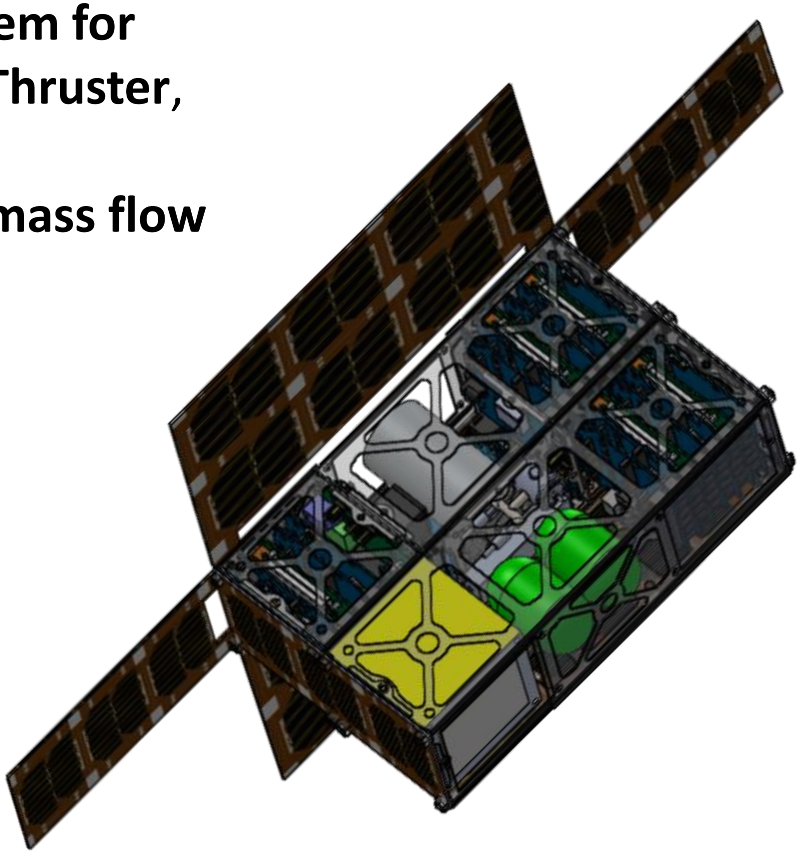
SITAEL – Hall Thruster

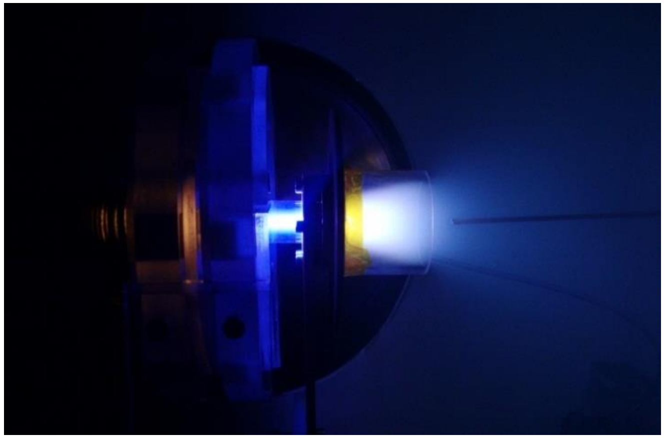


Research Project

Aim of the Project

The research program will be focused mainly on the design of an innovative **low cost fluidic system for Iodine fed Magnetically Enhanced Plasma Thruster**, in order to use it on a Cubesat platform.
The fluidic subsystem must provide a **fixed mass flow rate of 0.1 mg/s ±10%** to the thruster.





Research Activity

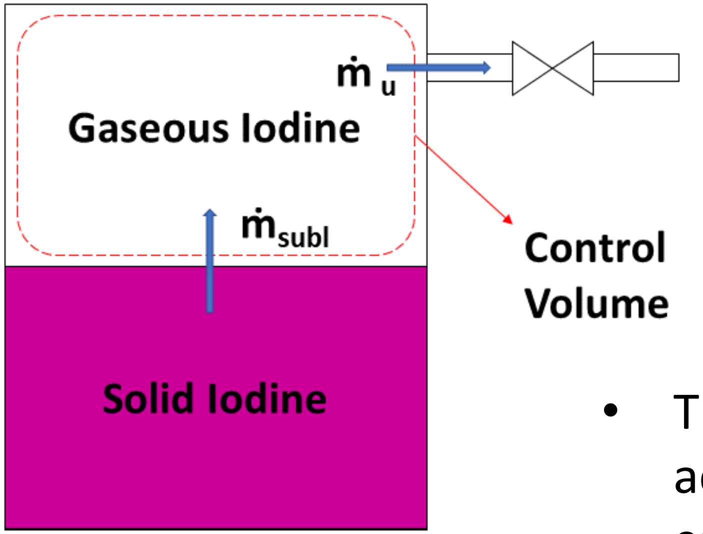
1. Development and testing of an innovative low cost **Mass Flow Meter** for **Iodine fed MEPT**.

2. Development of the **mass flow control system** by means of thermal management strategy, in order to grant the proper **sublimation rate** and to avoid **the re-condensation**.

3. Testing of **the mass flow control system with Iodine propellant**.

Activities up to now

Sublimation



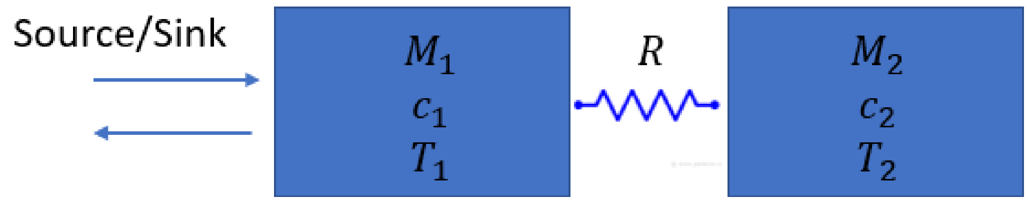
$$\frac{dm_{subl}}{dt} = \dot{m}_{subl} = \alpha A_{exp} \sqrt{\frac{M_m}{2\pi R T_{sol}}} (P_{vap} - P_g)$$

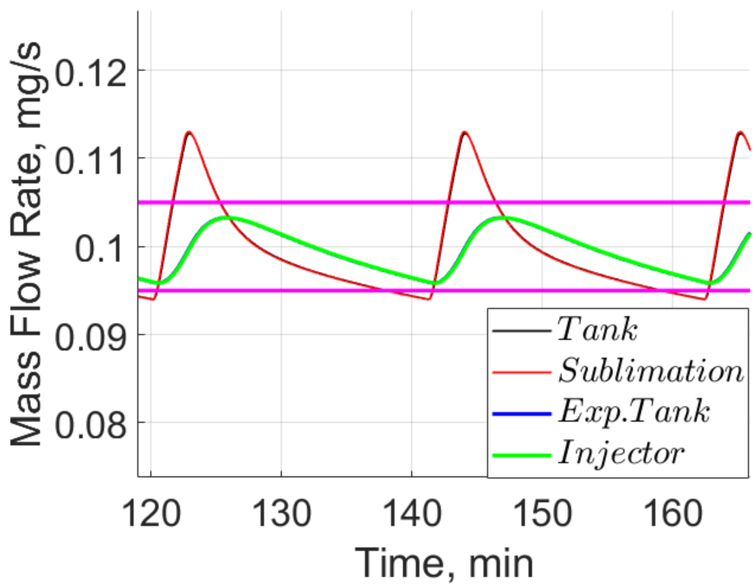
- The experimental coefficient *α (α = 0÷1)* takes into account the efficiency with which the gas that comes in contact with the solid surface condense
- A_{exp} represents the sublimation surface of the solid at the temperature T_{sol}

Numerical Approach

A Thermal Lumped Parameter Model was developed in order to simulate the thermal behaviour of the system.

$$M = mass$$
$$c = specific\ heat$$
$$T = Temperature$$
$$R = radiative/conductive\ resistance$$





A Fluidic Model, coupled with the thermal one, was developed and is used to design the mass flow control system.

Future Work

Future Work

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1. To set up the experimental apparatus;
2. To test and calibrate the Mass flow meter.
3. To test and characterize the thermal and mass flow control system.

Summary of Activities

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- ✓ **Bibliography Research**
  - ✓ **International Paper**
- ✓ **Numerical Models**
  - ✓ **Thermal Model**
  - ✓ **Fluidic Model**
- ▪ **Design and Development**
  - ▪ **Mass Flow Meter**
  - ▪ **Mass Flow Control System**
- ❑ **Calibration and Test**
  - ❑ **Mass Flow Meter**
  - ❑ **Mass Flow Control System**

Legend

- ✓ Finished
- ▪ In progress
- ❑ To start

Thanks for your attention…

… any questions?