Università degli Studi di Padova

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UNIVERSITA' DEGLI STUDI DI PADOVA

Corso di Dottorato in Scienze, Tecnologie e Misure Spaziali

Study and Development of a Fluidic System for Iodine-fed Mini Helicon Thruster (MHT) Motors

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T4i TECHNOLOGY FOR PROPULSION AND INNOVATION

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WHY

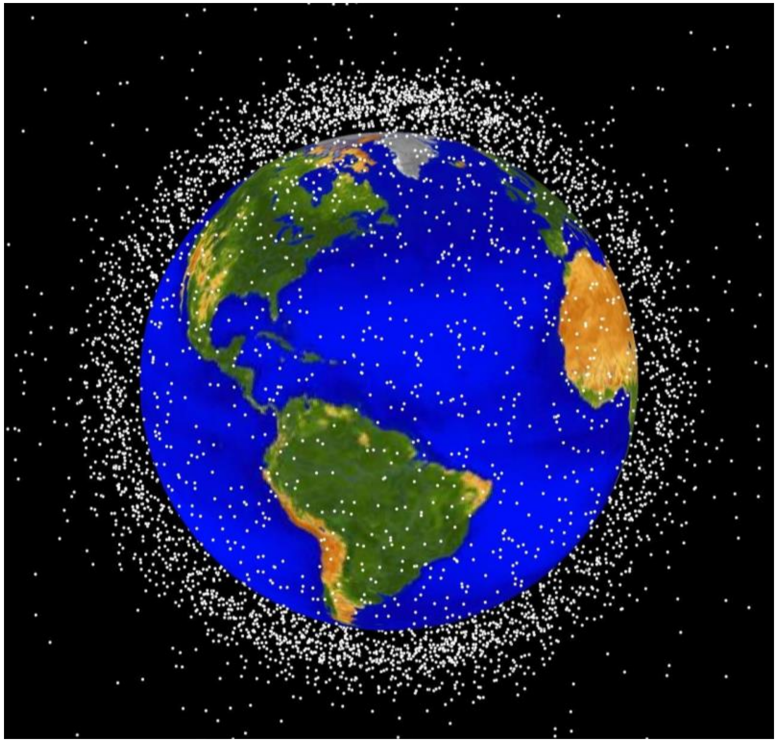
Introduction

Propulsion systems available in the market **are usually tailored for big satellites**

Mobility is currently not affordable for nano-satellites (CubeSats) mainly due to **high costs**: propulsion systems available on the market could impact for **more than 80% of the total satellite costs**

There is a **strong demand for satellite mobility**. Operators of the low cost space market are looking for new propulsion solutions which will enable:

- Formation flying satellite missions
- Satellite positioning
- Drag compensation
- Orbit raising
- Decommissioning



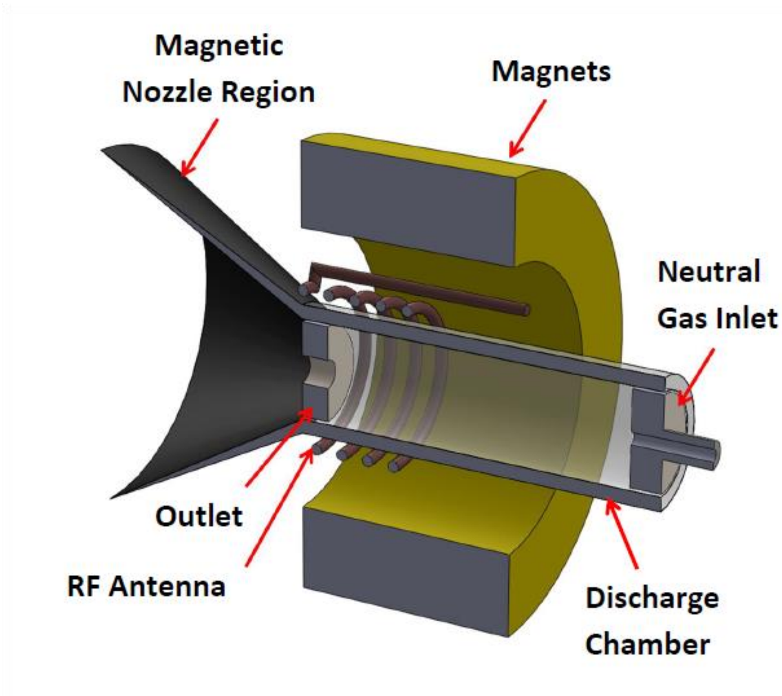
Mini Helicon Thruster

The **Mini Helicon Thruster (MHT)** is an **innovative low-cost electric propulsion system** able to increase small spacecrafts mobility, opening new unconventional mission scenarios.

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

- 0.8 mN of Thrust
- Isp up to 900s
- input power lower than 60 W

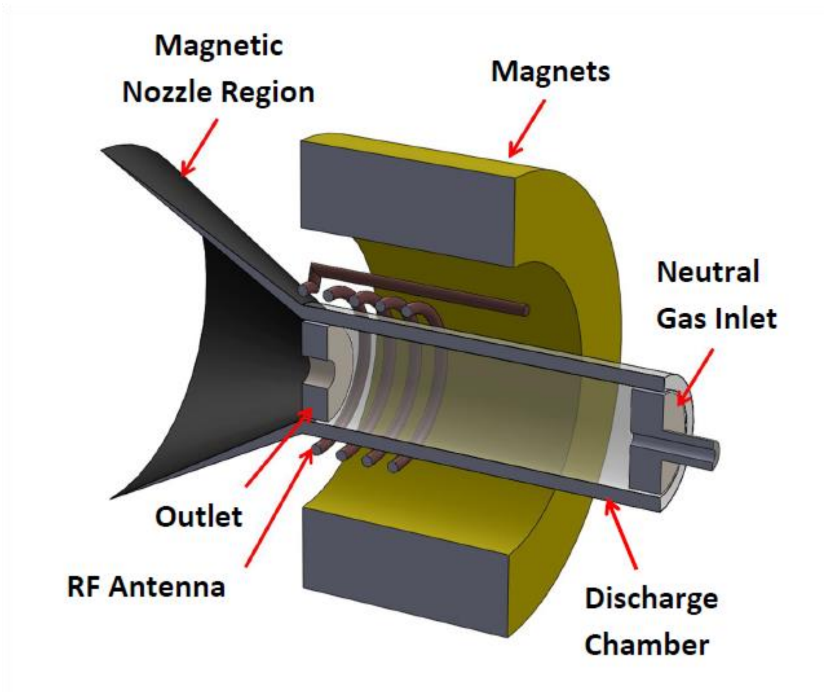
Mini Helicon Thruster



The main components of MHT 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.

Mini Helicon Thruster



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

Iodine Propellant

MHT can work with different propellants (such as Ar, Kr, Xe, Air, CO2). 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

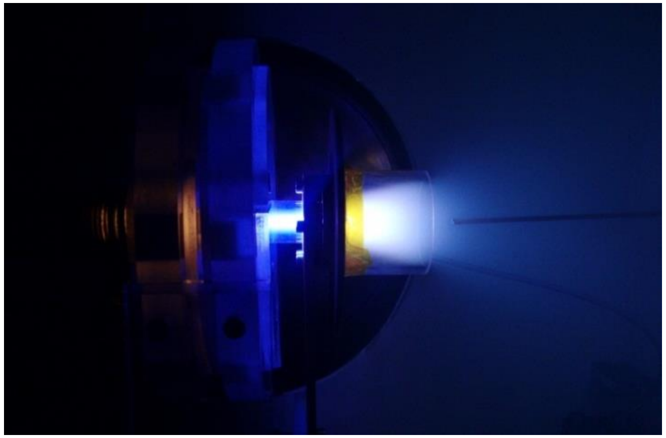
Disadvantages:

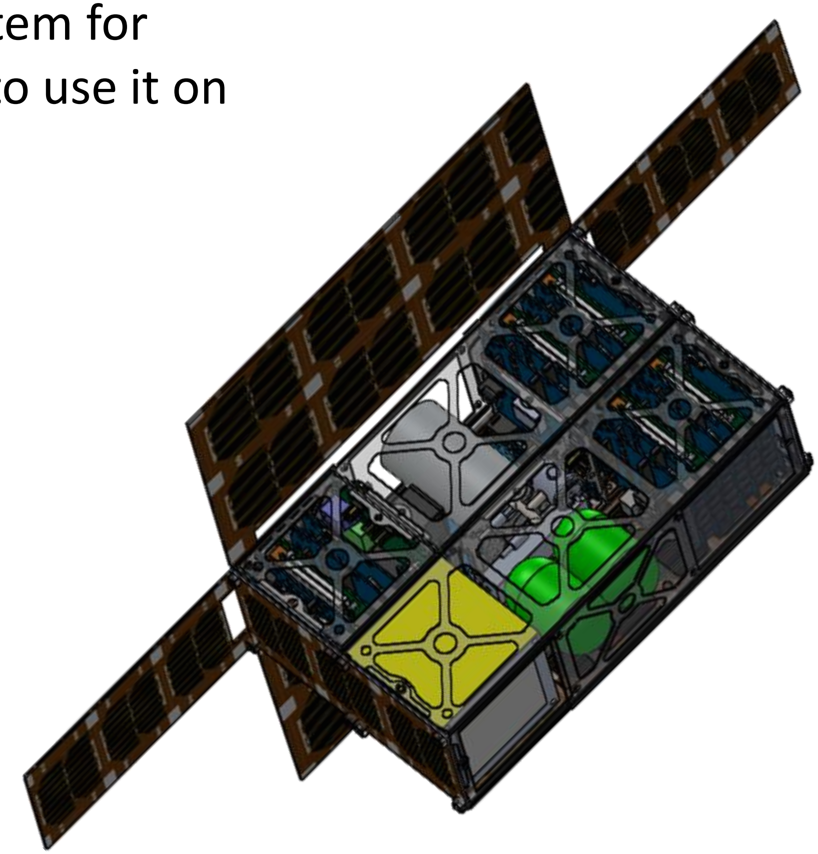
- Chemically reactive
- Never flown before

WHAT

Aim of the Project

The research program will be focused mainly on the design of an **innovative** low cost fluidic system for **Iodine fed Mini Helicon thruster**, in order to use it on a **Cubesat** platform.





Research Activity

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1. Development of an innovative low cost **Mass Flow Meter** for **Iodine fed MHT**.

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

3. Design and Optimization of the complete **Fluidic System,** also taking into account the coupled thermal and **plasma** problem**.**

4. Testing of **Iodine**.

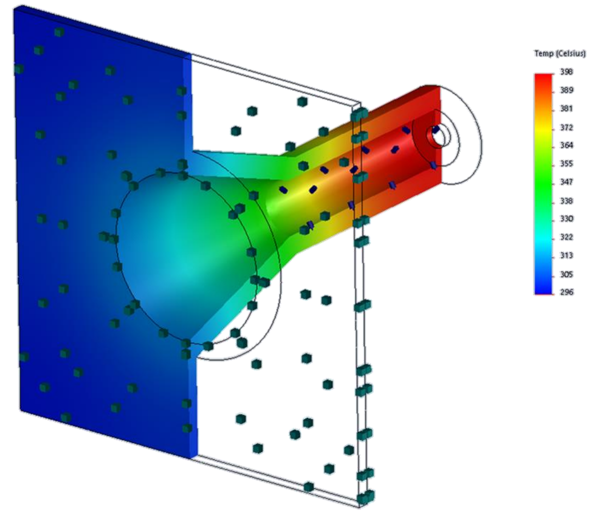
The system will be developed and optimized following a rigorous **numerical-experimental methodology**.

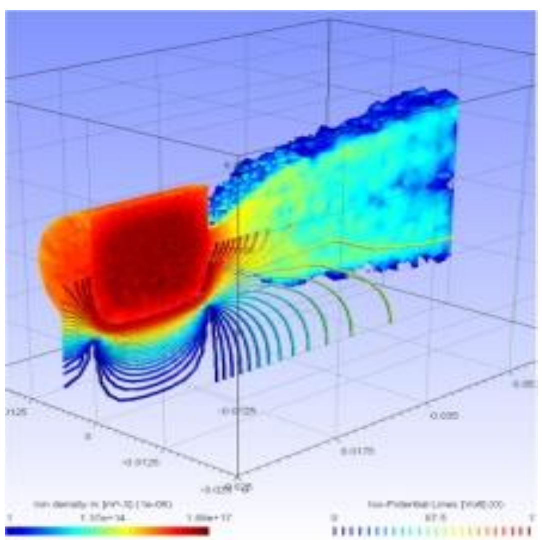
HOW

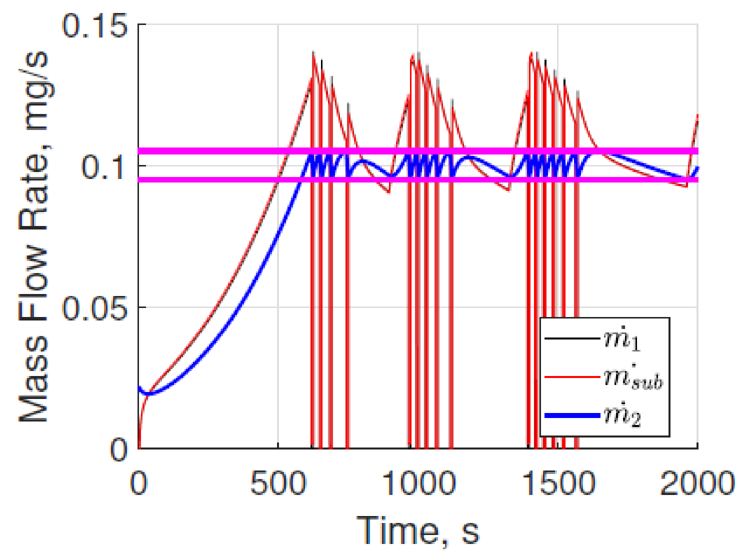
Methodology

1. **Bibliography Research**
   - International Papers

2. **Numerical Models**
   - Fluidic Models
   - Thermal Models



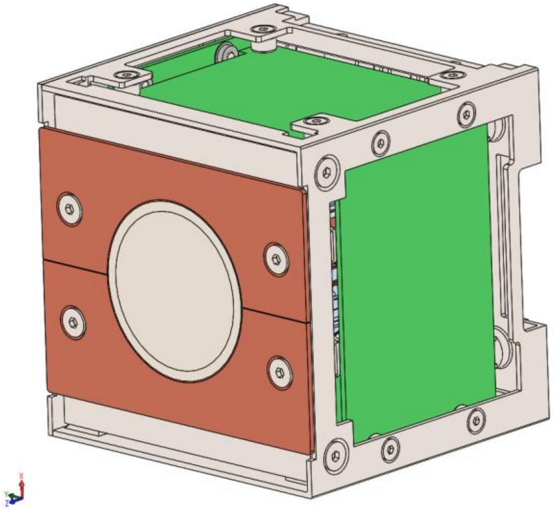




Methodology

3. **Design and Development**
   - Mass Flow Meter
   - Mass Flow Control System
   - Fluidic System

4. **Calibration and Test**
   - Mass Flow Meter
   - Mass Flow Control System
   - Fluidic System



Timing

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GANTT CHART

PHD STUDENT	Marco Minute	DATE	26/10/2018
PHD THESIS	Study and Development of a Fluidic System for Iodine fed Mini Helicon Thruster (MHT) motors	ADMISSION TO	First Year

WBS NUMBER	TASK TITLE	% OF TASK COMPLETE
1	State of Art Activity	
1.1	Bibliography Reseach	50%
1.2	Method of Numerical Analysis	0%
1.3	Method of Experimental Analysis	0%
2	Numerical Analysis	
2.1	Definition of the Driving Parameters	0%
2.2	Time-Dependent Fluidic Model	0%
2.3	Thermal Lumped Parameter Model	0%
2.4	Finite Element Analysis	0%
3.0	Design and Development	
3.1	Design of the Mass Flow Meter	0%
3.2	Design of the Mass Flow Control SubSystem	0%
3.3	Design of the Fluidic System	0%
4	Testing	
4.1	Test Campaign (Mass Flow meter)	0%
4.2	Test Campaign (Mass Flow Control Subsystem)	0%
4.3	Test Campaign (Fluidic System)	0%
5.0	Thesis	0%
…	…	0%

FIRST YEAR												SECOND YEAR												THIRD YEAR											
T1			T2			T3			T4			T1			T2			T3			T4			T1			T2			T3			T4		
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Thanks for your attention…

… any questions?