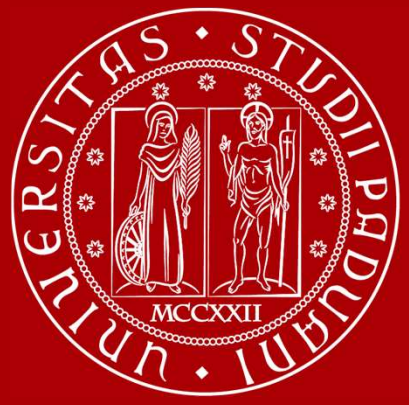

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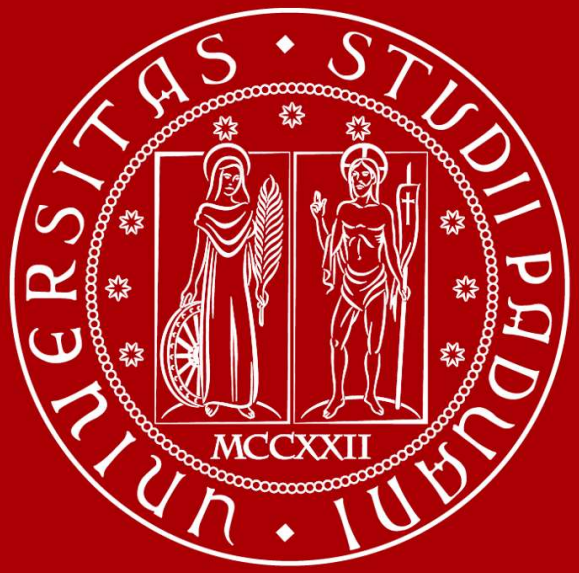
Study of innovative propellants for space electric propulsion

Lorenzo Tonon - 41th Cycle

Supervisor: Dr. Mirko Magarotto

Co-supervisor: Prof. Daniele Pavarin

Admission to the first year - 12/11/2025



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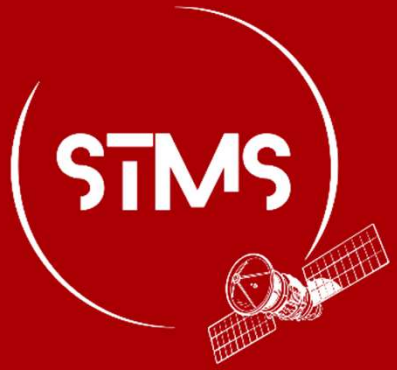


Background

- Project Description

- Research Target

Project Description

Project Ambition

Consolidate and promote the iodine electric propulsion technology as a key factor to boost the market of SmallSats and the development of future missions of on-orbit refueling

Project Ambition

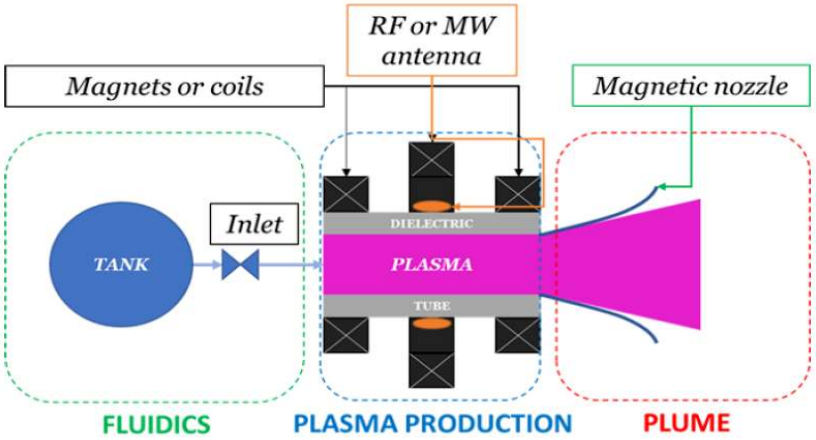
Pave the way for the future utilization of Water-based Electric Thrusters in the commercial SmallSat market and deep-space exploration.

Research Target

Research Object

RF Plasma source → Helicon Plasma Thruster

RF Plasma source → RF Cathode



Research Propellant

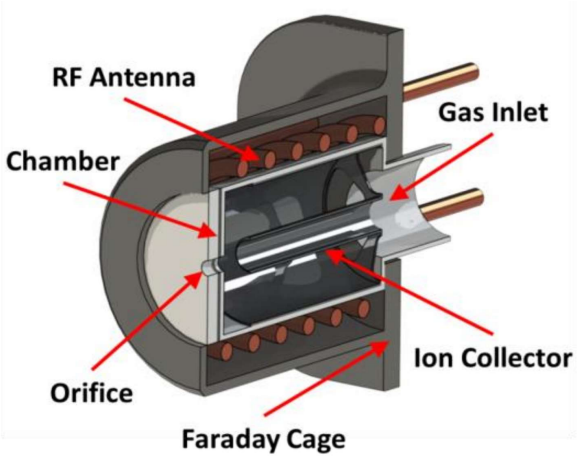
Iodine and Water → (Advantage vs. Xenon)

- Easy storage
- Cost-effectiveness

Problem ↓

Iodine and Water compatibility

- Material corrosion
- Sublimation energy loss



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Research content

- Research Objective
- Methodology
- Training Project
- Project Timeline

Research Objective

Primary Goal

Design and optimize an RF plasma source prototype compatible with iodine or water for small satellites

Specific Objectives

- Optimize RF plasma source prototype design for higher performance

(Thrust or neutralization current)

- Develop iodine or water resistant prototype

- Model iodine and water plasma dynamics for better design

Expected Results

- New insights into plasma dynamics in iodine and water based RF plasma source
- Design a RF plasma source prototype fed with iodine or water

Methodology

1. Preliminary Design

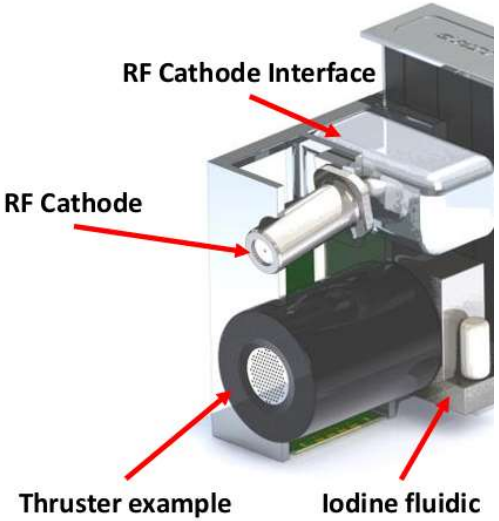
Literature review → Structure design and material selection

Simulation { Global model; Plasma Fluid solver } → Benchmarked with literature experimental results

Prototyping → The best performing RF plasma source (Helicon Plasma Thruster /RF Cathode) and propellant (Iodine/Water)

Methodology

2. Detailed Design



Experiment → Prototype building and initial testing

Using experimental data as a reference

Simulation { Global model / Plasma Fluid solver } → Refine and validate the model

Methodology

3. Optimization and Validation

Simulation → Simulation the performance with different structures

→ Obtaining RF prototype structures with optimal performance

Experiment → Validation of real performance

4. Final Design

Change RF prototype for real-world use

Training Project

Technical Skills:

-Plasma Fluid simulation and MATLAB coding

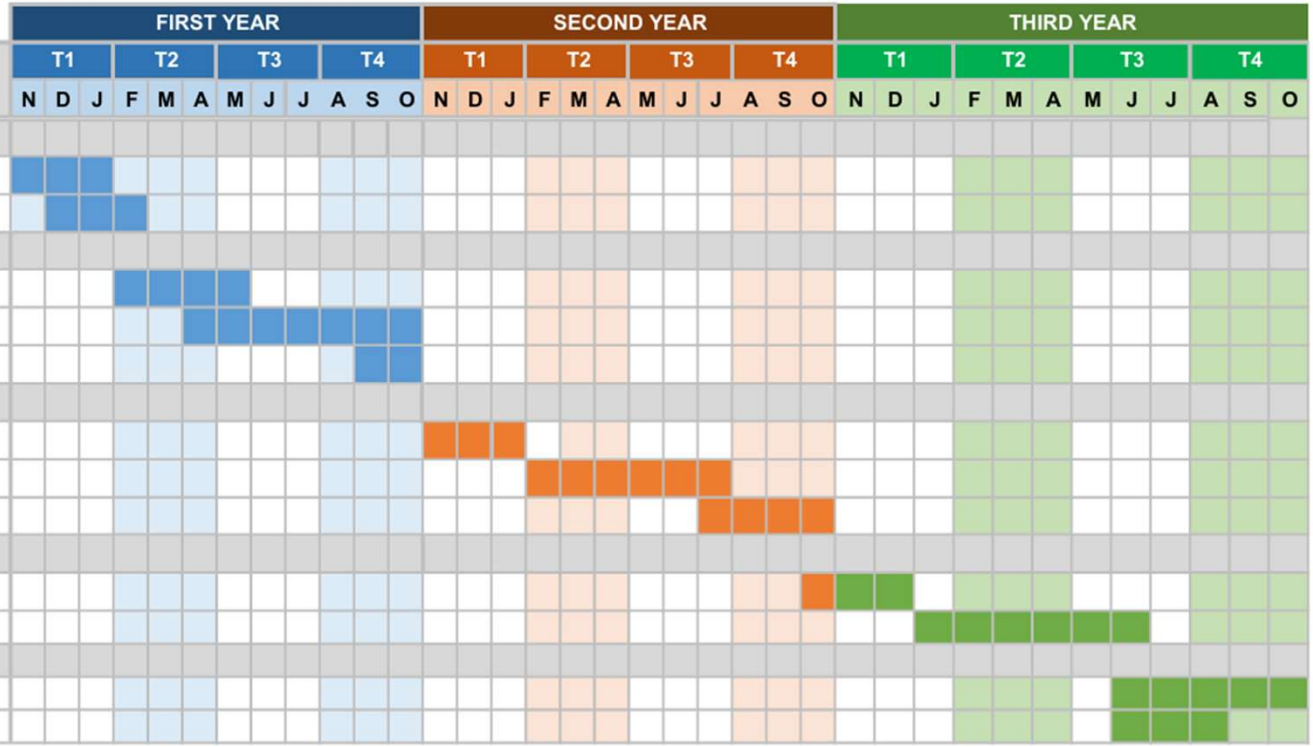
- RF system design
- Plasma diagnostics
- Experimentation

Professional Development:

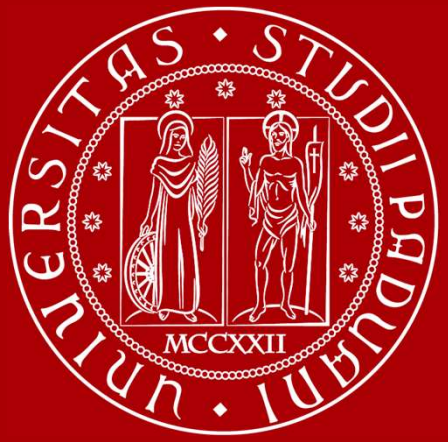
- Collaborate with research institutes
- Take part in conferences

Project Timeline

WBS NUMBER	TASK TITLE	% OF TASK COMPLETE
1	State-of-art review	
1.1	Analysis of Water and Iodine thruster systems	0%
1.2	Theoretical model of the RF plasma source	0%
2	Numerical model	
2.1	Numerical model of the Iodine RF source	0%
2.2	Numerical model of the Water RF source	0%
2.3	Analysis of the best propellant and technologies for a prototype	0%
3	Preliminary prototype design	
3.1	Preliminary design of the propulsive system prototype	0%
3.2	Experimental testing of the propulsive system prototype	0%
3.3	Experimental validation of the numerical model	0%
4	Prototype design optimization	
4.1	Optimization of the propulsive system prototype	0%
4.2	Experimental testing of the propulsive system optimazed design	0%
5	Conclusive analysis	
5.1	Thesis writing	0%
5.2	Exploitation	0%



Thanks for the attention



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