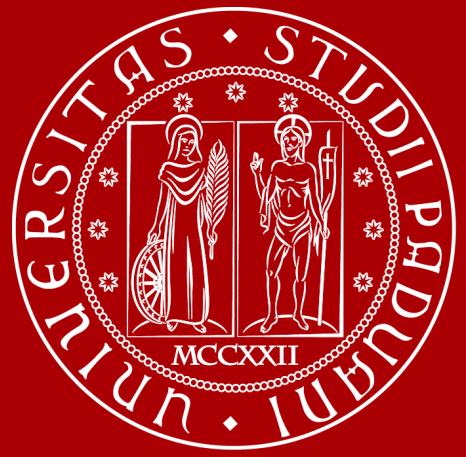

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Design and test of a radiofrequency cathode propelled with iodine

Renwei Tan - 40th Cycle

Supervisor: Prof. Daniele Pavarin Co-Supervisor: Prof. Mirko Magarotto

Admission to the first year - 13/11/2024

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Background

- Project Description
- Research Target

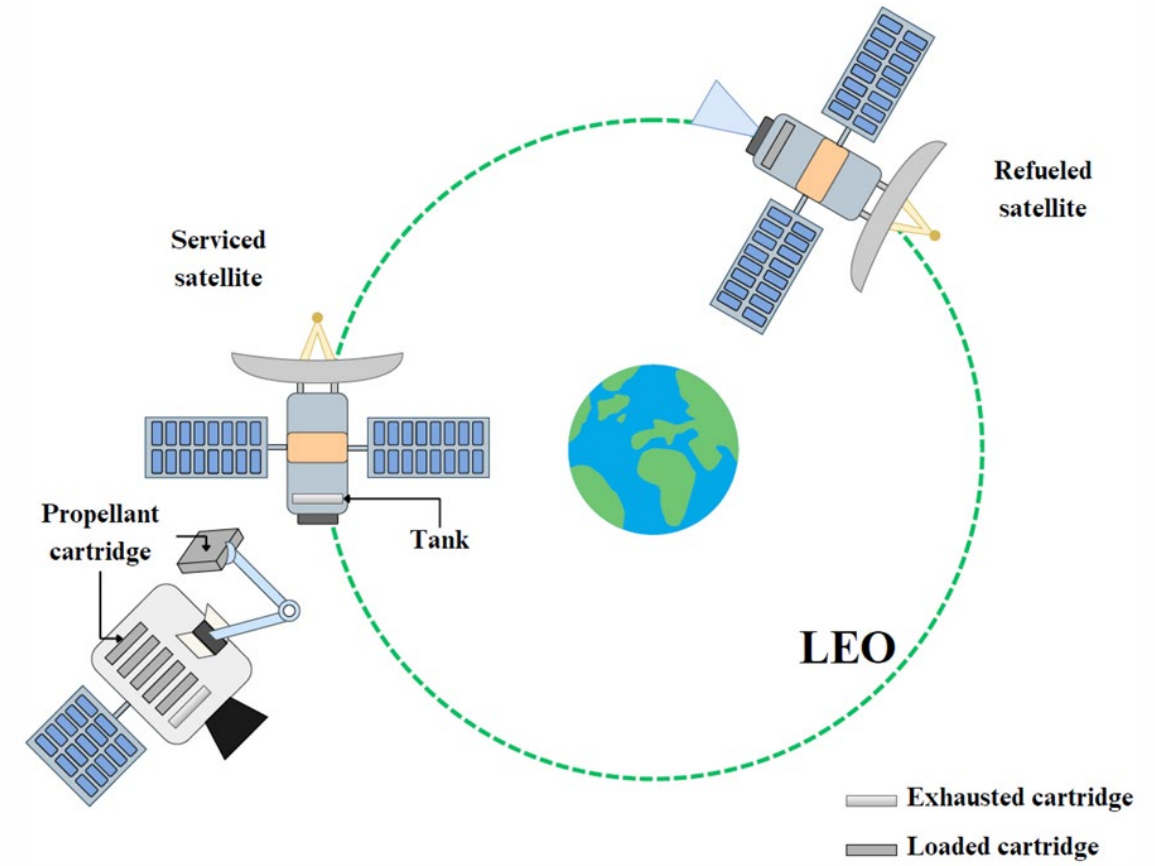
Project Description

Project Name

BOOST

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

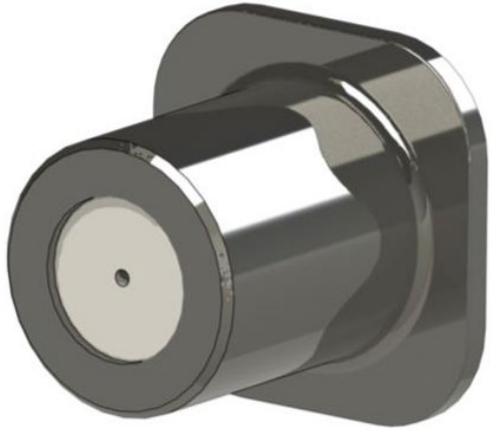


Research Target

Research Object

RF Cathode —Function→ Provide charge balance for ion thrusters

RF Cathode —Advantage (vs. Hollow Cathode)→ Lower contamination and erosion issues



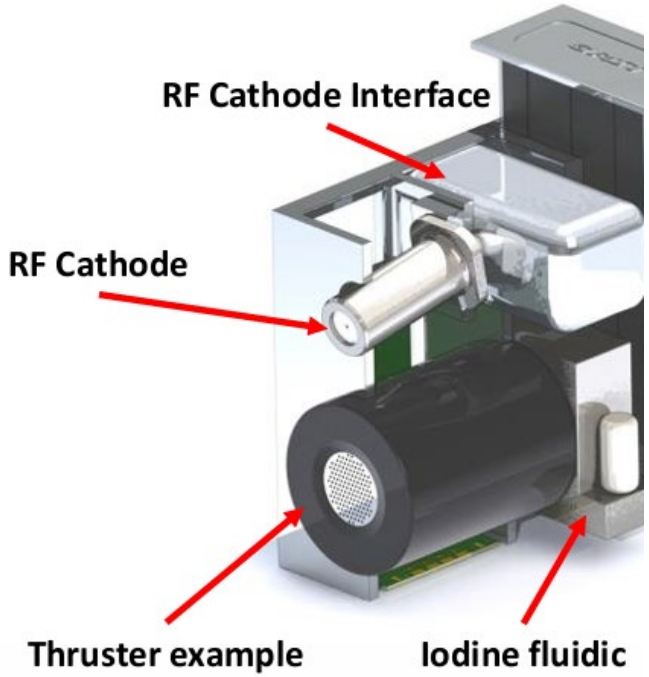
Research Propellant

Iodine —Advantage (vs. Xenon)→ Easy storage

Cost-effectiveness

Iodine —Problem→ Iodine 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 cathode compatible with iodine for small satellites

Specific Objectives

- Optimize cathode design for higher ion currents
- Develop iodine-resistant materials
- Model iodine plasma dynamics for better design

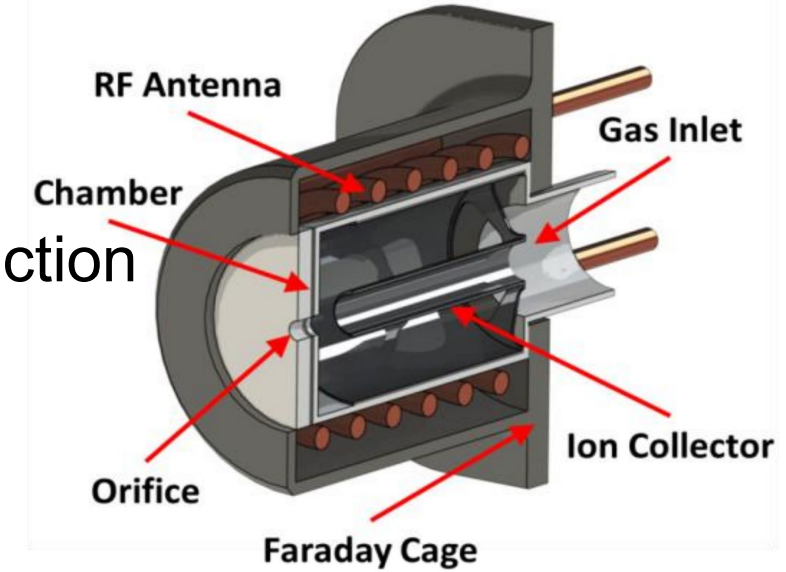
Expected Results

- New insights into plasma dynamics in iodine-based cathodes
- Scalable design of RF cathodes adaptable to various space missions

Methodology

1. Preliminary Design

Literature review → Structure design and material selection



2. Detailed Design

Experiment → Prototype building and initial testing

Using experimental data as a reference

Simulation { Global model; Particle in cell (PIC) } → Modify and validate the model

Methodology

3. Optimization and Validation

Simulation → Simulation the performance with different structures

→ Obtaining RF cathode structures with optimal performance

Experiment → Validation of real performance

4. Final Design

Change cathode for real-world use

Training Project

Technical Skills:

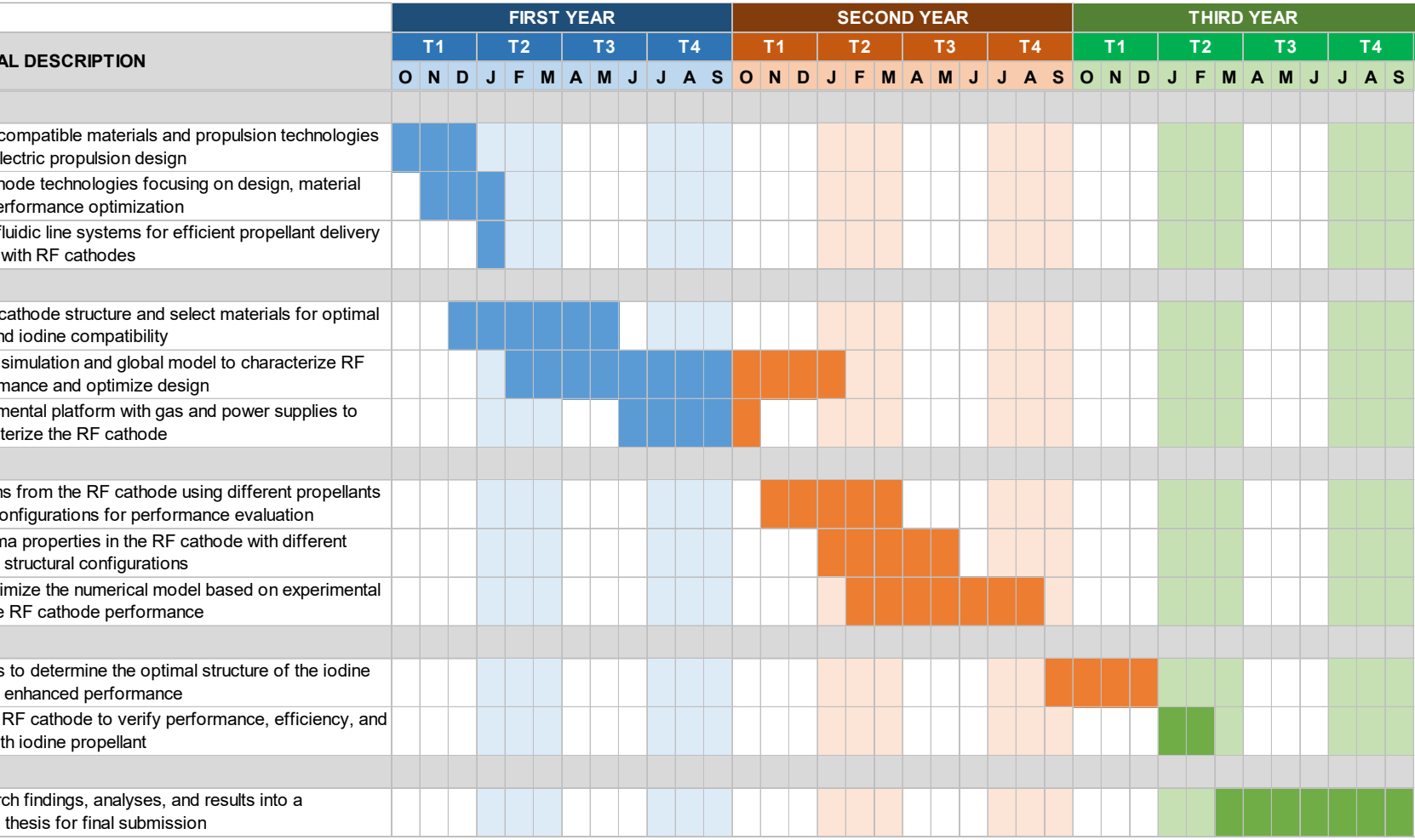
- PIC simulation and MATLAB coding
- RF system design
- Plasma diagnostics
- Experimentation

Professional Development:

- Collaborate with research institutes
- Take part in conferences

Project Timeline

WBS NUMBER	TASK TITLE	WP TECHNICAL DESCRIPTION
1	Review	
1.1	Review iodine technology (materials and propulsive systems)	Review iodine-compatible materials and propulsion technologies for optimized electric propulsion design
1.2	Review RF cathode	Review RF cathode technologies focusing on design, material choices, and performance optimization
1.3	Review iodine fluidic line	Review iodine fluidic line systems for efficient propellant delivery and integration with RF cathodes
2	Preliminary design	
2.1	Design RF cathode (Structure and Material)	Design the RF cathode structure and select materials for optimal performance and iodine compatibility
2.2	Develop a PIC simulation/Global model of the RF cathode	Develop a PIC simulation and global model to characterize RF cathode performance and optimize design
2.3	Build an experimental platform (Gas and power supply)	Build an experimental platform with gas and power supplies to test and characterize the RF cathode
3	Experiments and model validation	
3.1	Extract electron at different (Propellant and Structure) RF cathode	Extract electrons from the RF cathode using different propellants and structural configurations for performance evaluation
3.2	Diagnose plasma at different (Propellant and Structure) RF cathode	Diagnose plasma properties in the RF cathode with different propellants and structural configurations
3.3	Modify and optimize the numerical model	Modify and optimize the numerical model based on experimental data to improve RF cathode performance
4	Simulation with numerical model and final design	
4.1	Determine the optimal structure of Iodine RF cathode by simulation	Use simulations to determine the optimal structure of the iodine RF cathode for enhanced performance
4.2	Test the Iodine RF cathode	Test the iodine RF cathode to verify performance, efficiency, and compatibility with iodine propellant
5	Thesis	
5.1	Thesis writing	Compile research findings, analyses, and results into a comprehensive thesis for final submission



Thanks for the attention

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