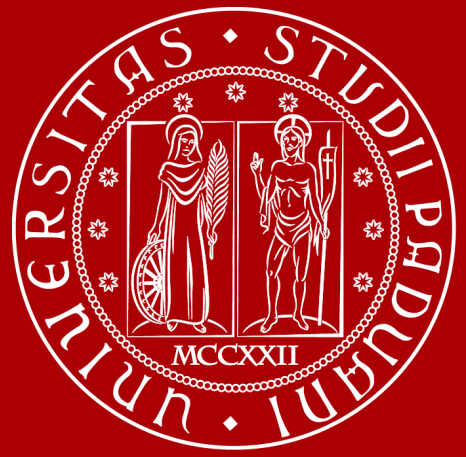

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Mitigation, protection and remediation of space debris for sustainable orbital environment

Lion Luca- 37^{th} Cycle

Supervisor: Dr. Francesco Branz

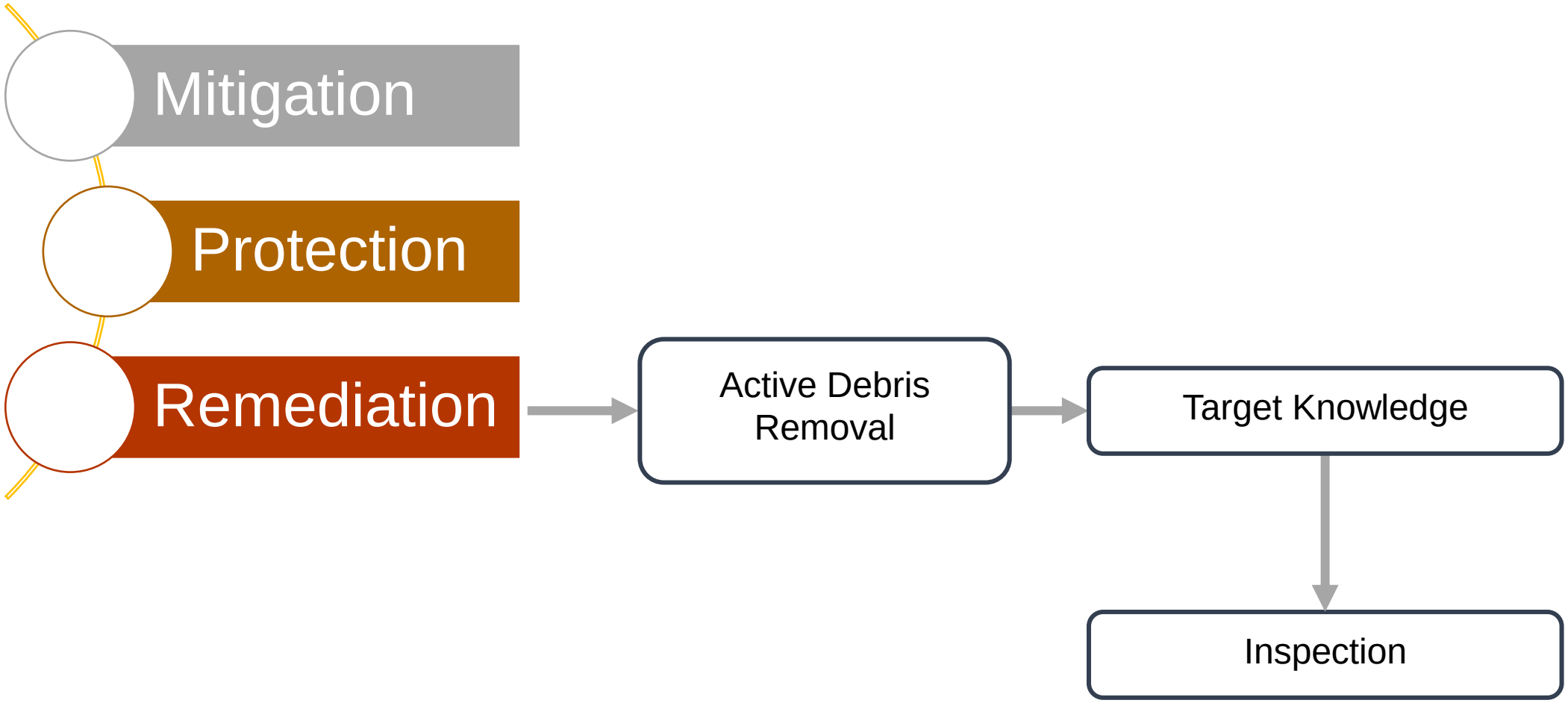
Co-supervisor: Prof. Alessandro Franesconi

Admission to the third year - 14/12/2023

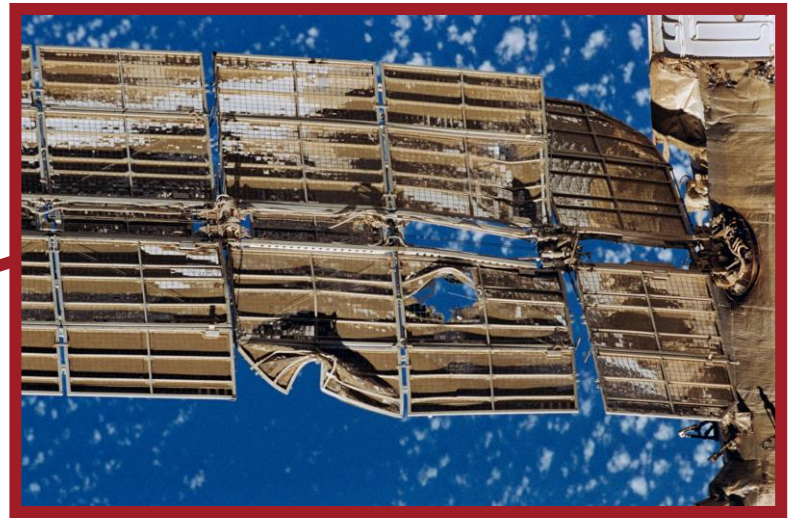
Summary

- Introduction
- Research project overview
- In Orbit Inspection
- DOCKS
- Future work

Introduction



Introduction



Target knowledge

- **Health check**
- **Visual Navigation**
- **Pose estimation**
- **Approach and capture strategy definition**

Introduction

Target knowledge

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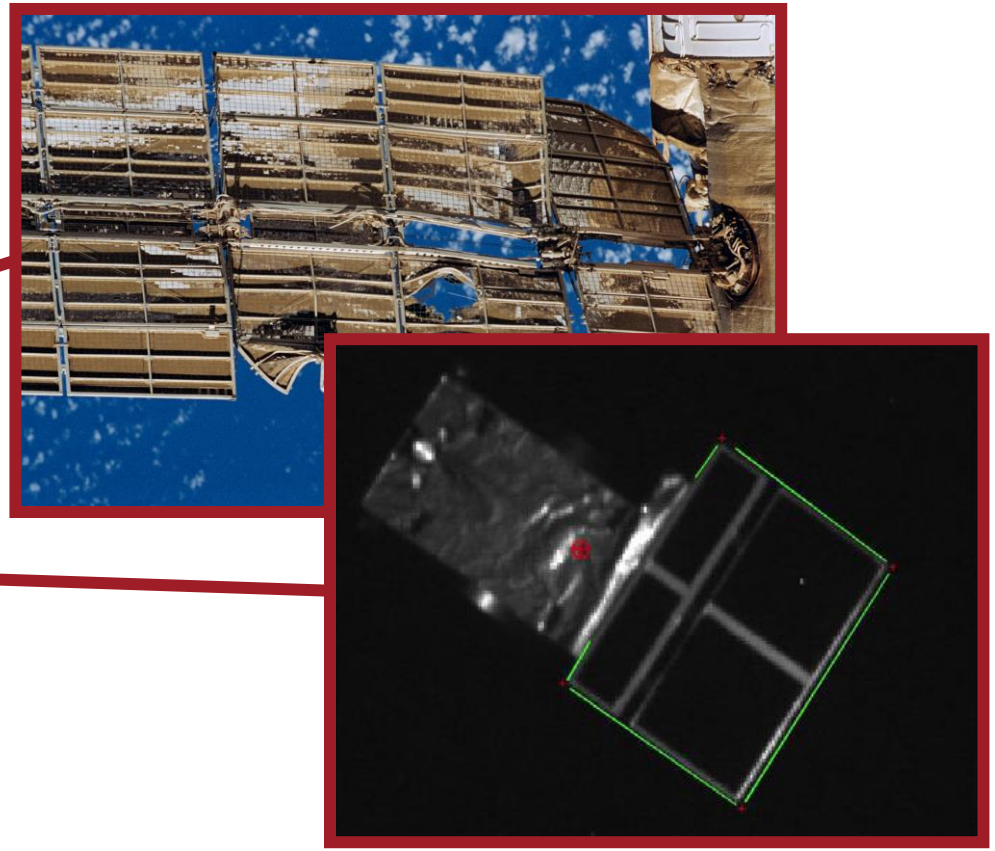

Introduction

Target knowledge

- **Health check**
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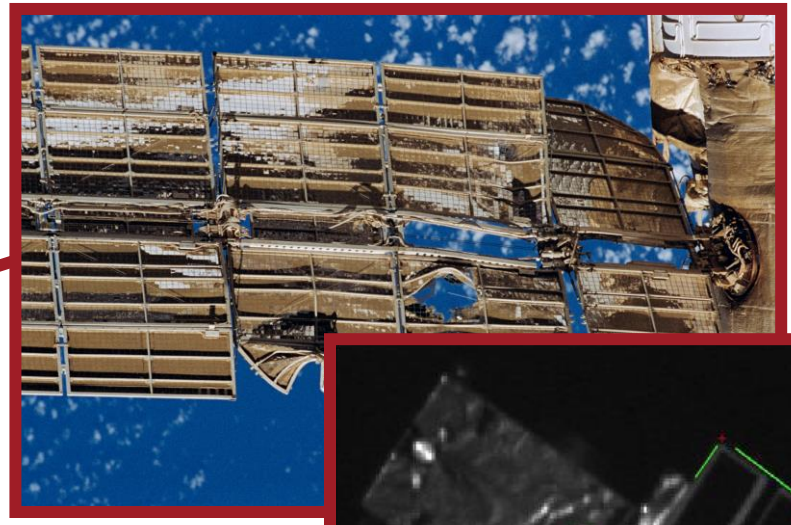
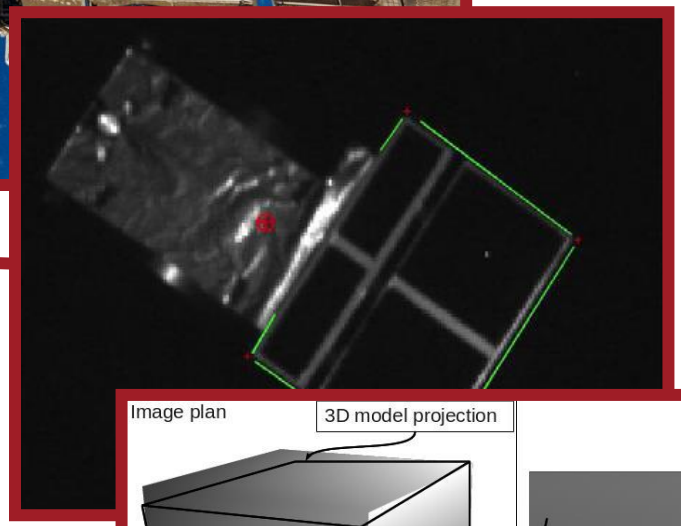
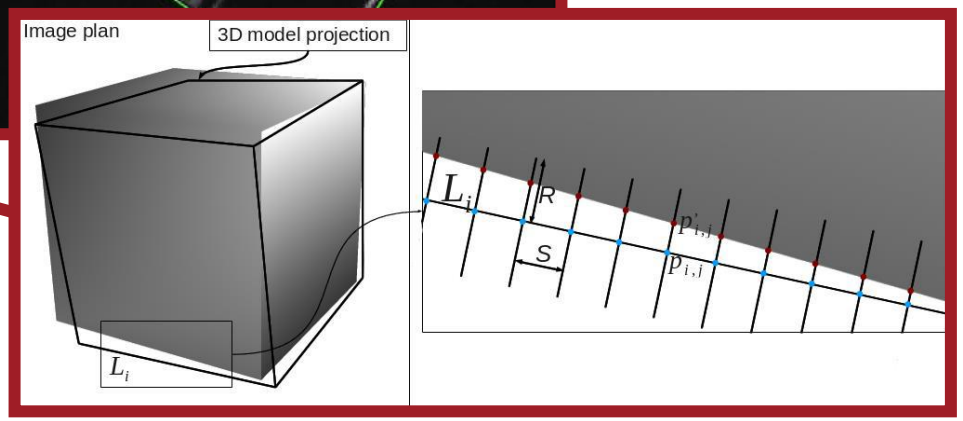
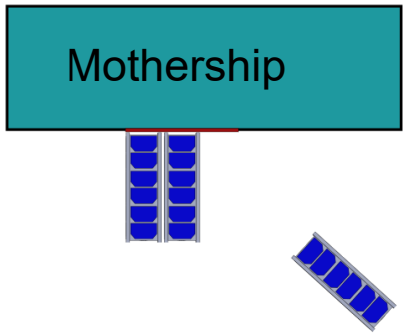






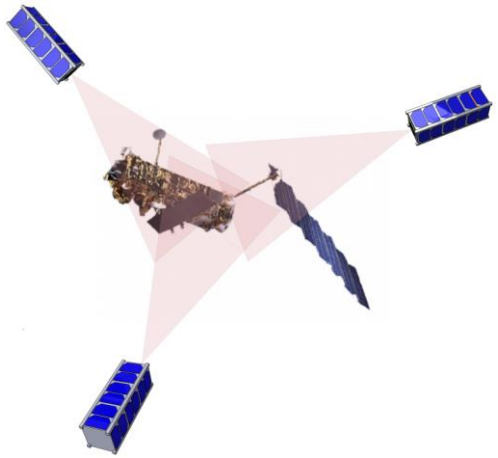
Research project overview

A



Deployment

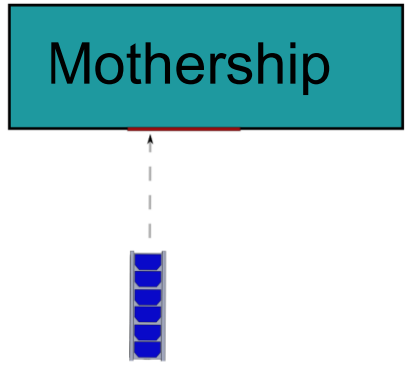
B



Inspection

- Image acquisition
- Raw data handling

C



Docking

- Data transfer
- Data processing
- 3D model generation

In Orbit Inspection

Contact based 3D scanners ✗

Structured light ✗

LiDAR 👎

- Speciality payload
- No COTS available for CubeSats
- Higher volume, mass and power consumption

Photogrammetry 👍

- Only cameras are needed
- COTS are available
- The same camera could act as a navigation camera

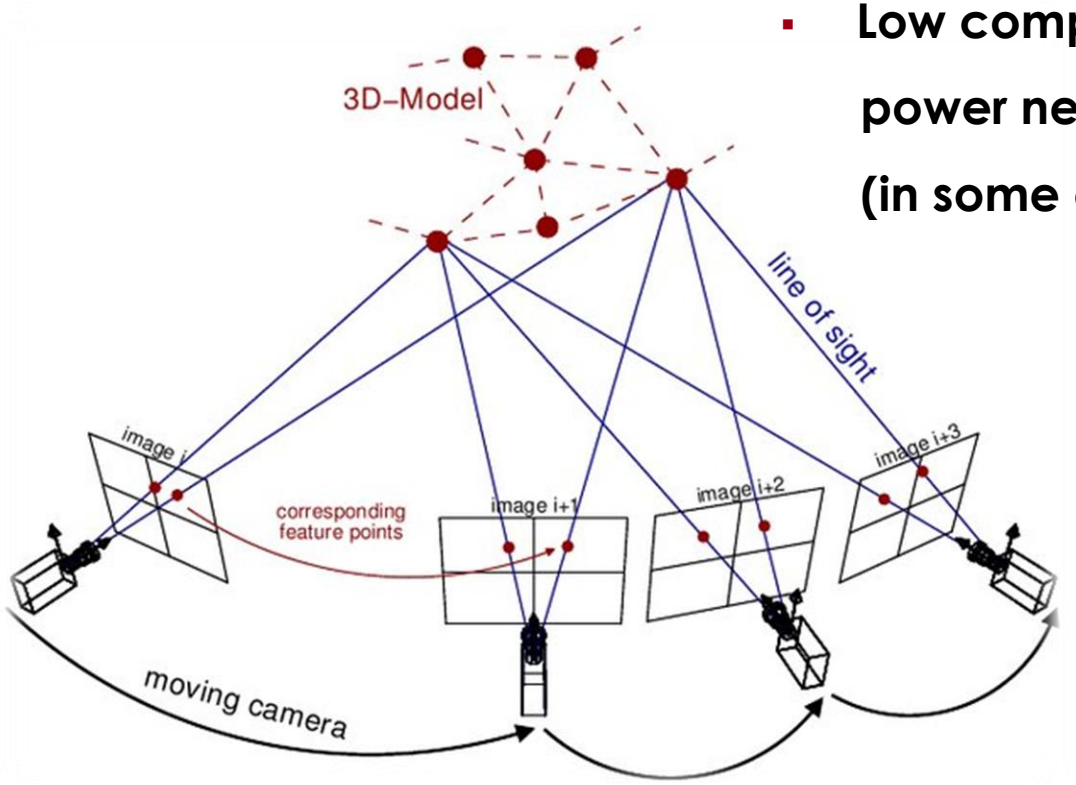
In Orbit Inspection

Photogrammetry

- Only cameras are needed
- COTS are available
- The same camera could act as a navigation camera

Structure from motion

- **Industry standard**
- **Widely used**
- **Low computational power needed (in some cases)**



In Orbit Inspection

Target:

Space Rider (ESA)

~8m long

~11m wide with the solar panels deployed

Challenges:

Black painted parts

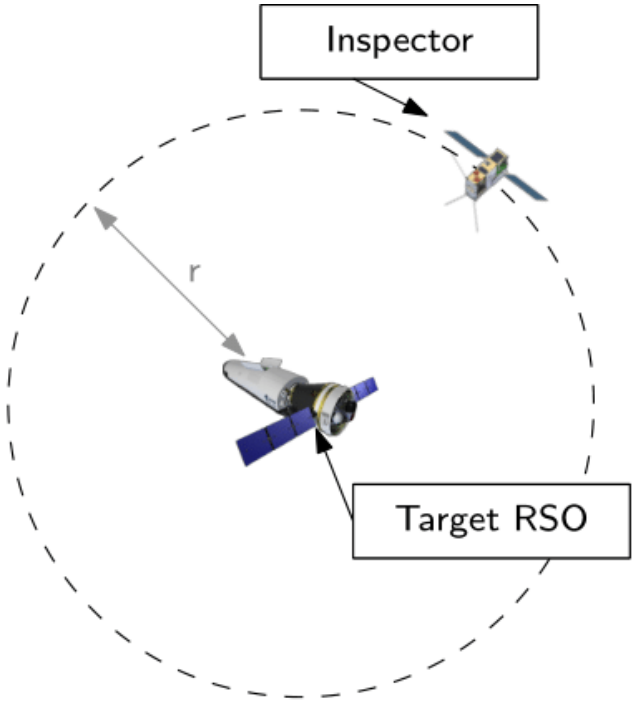
Thin features e.g. doors of the bay

Roundness of the body

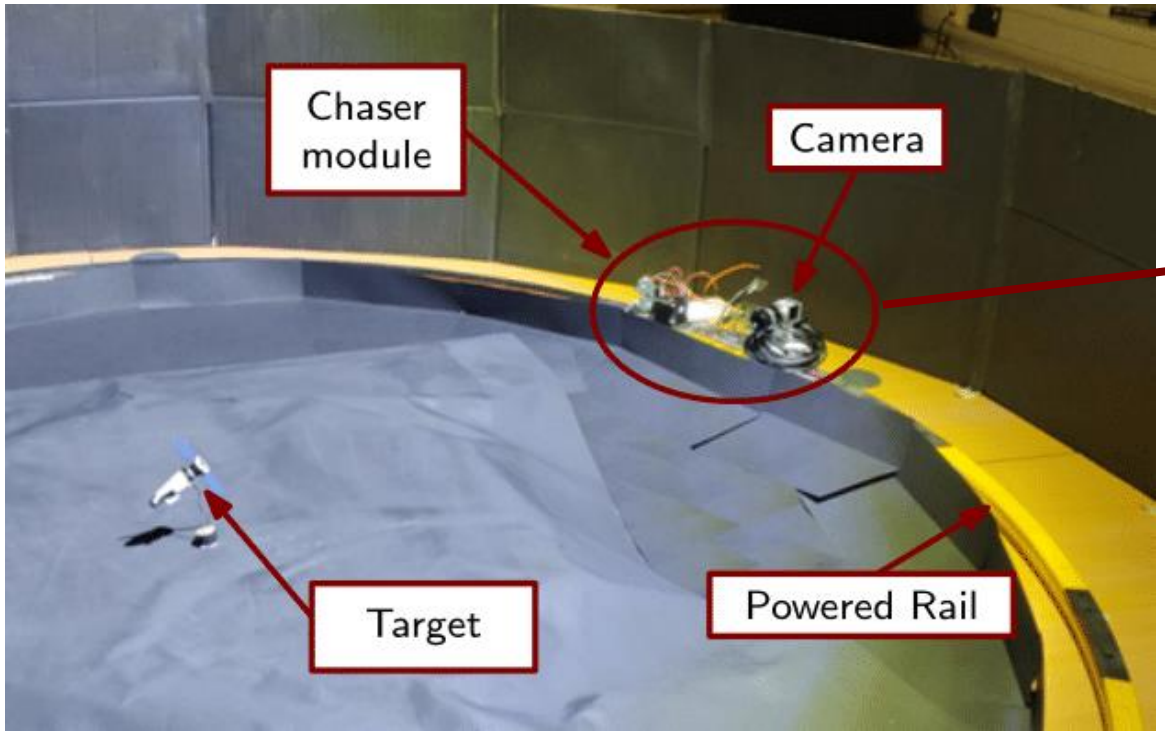
Inspection orbit:

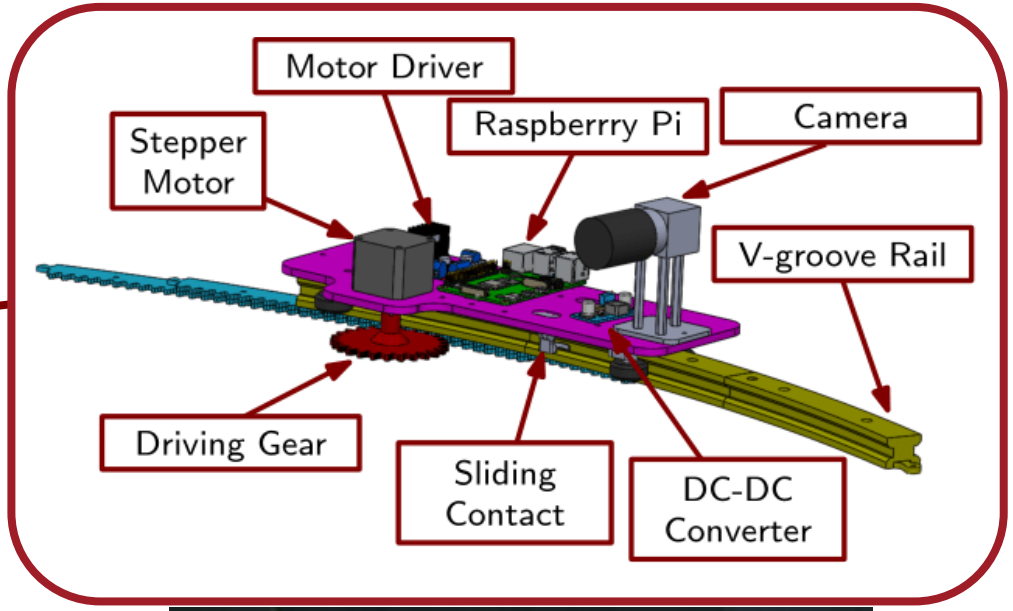
Fly around «football» orbit

The inspector keeps a constant distance of 100 m from the target, resulting in a circular relative motion

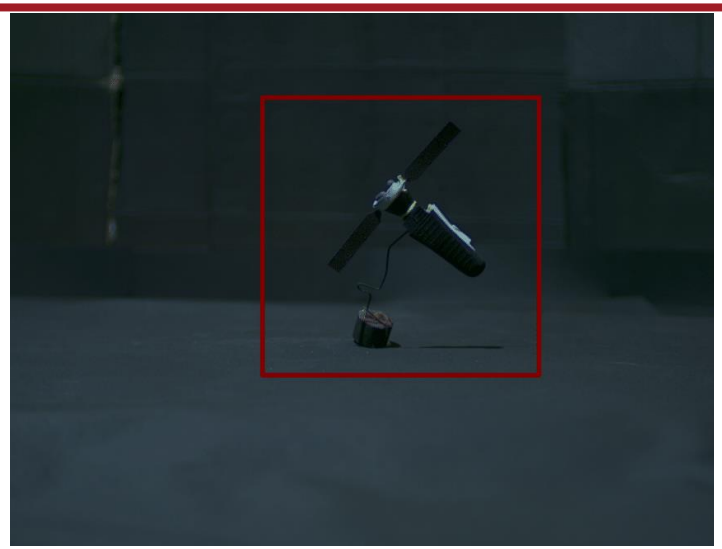


In Orbit Inspection



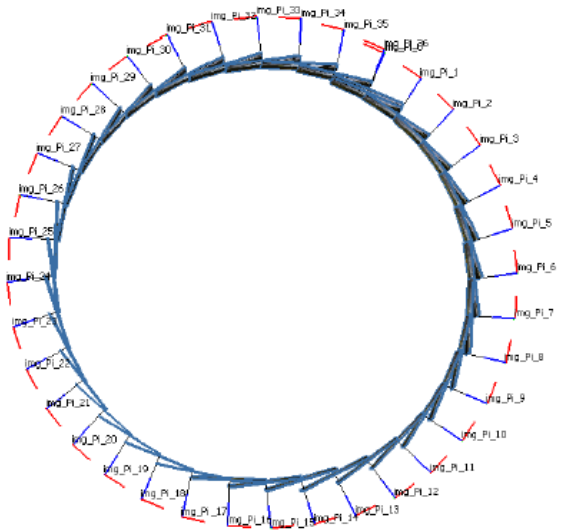


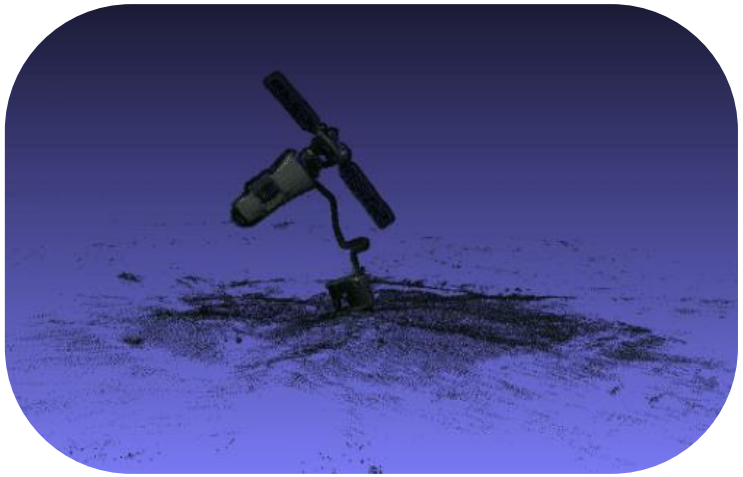
- Basler acA4024-29uc equipped with a 16 mm fixed focus lens
- Raspberrypi 4 – 4gb



In Orbit Inspection

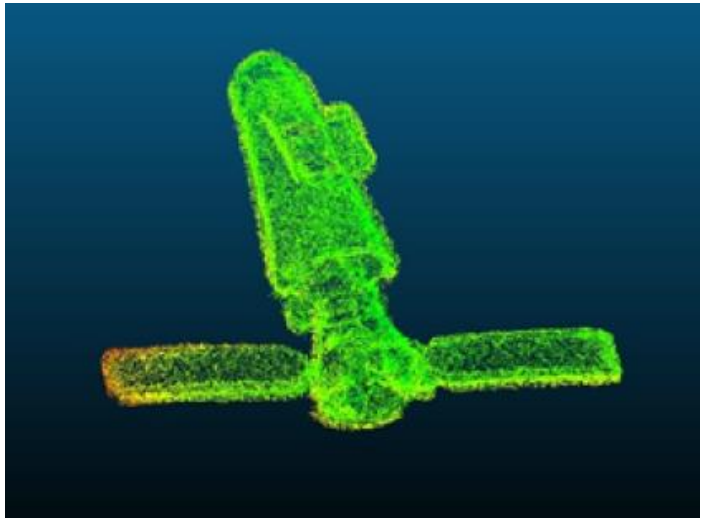
Pose estimation → **Dense point cloud** → **Dense point cloud cleaned**

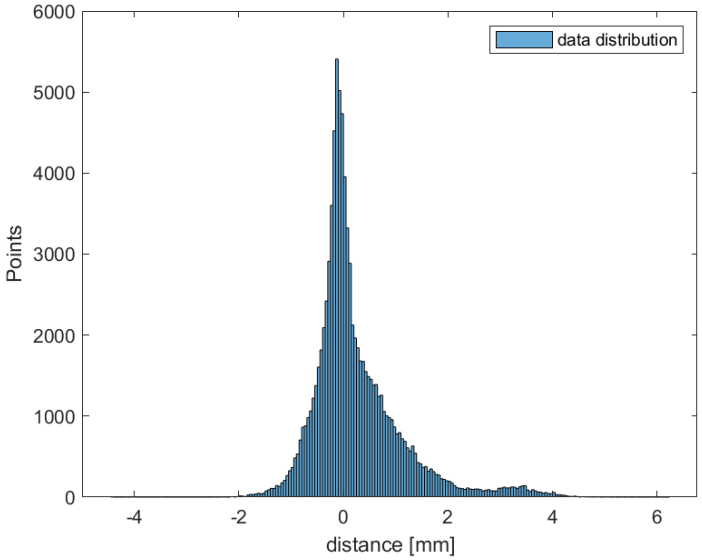




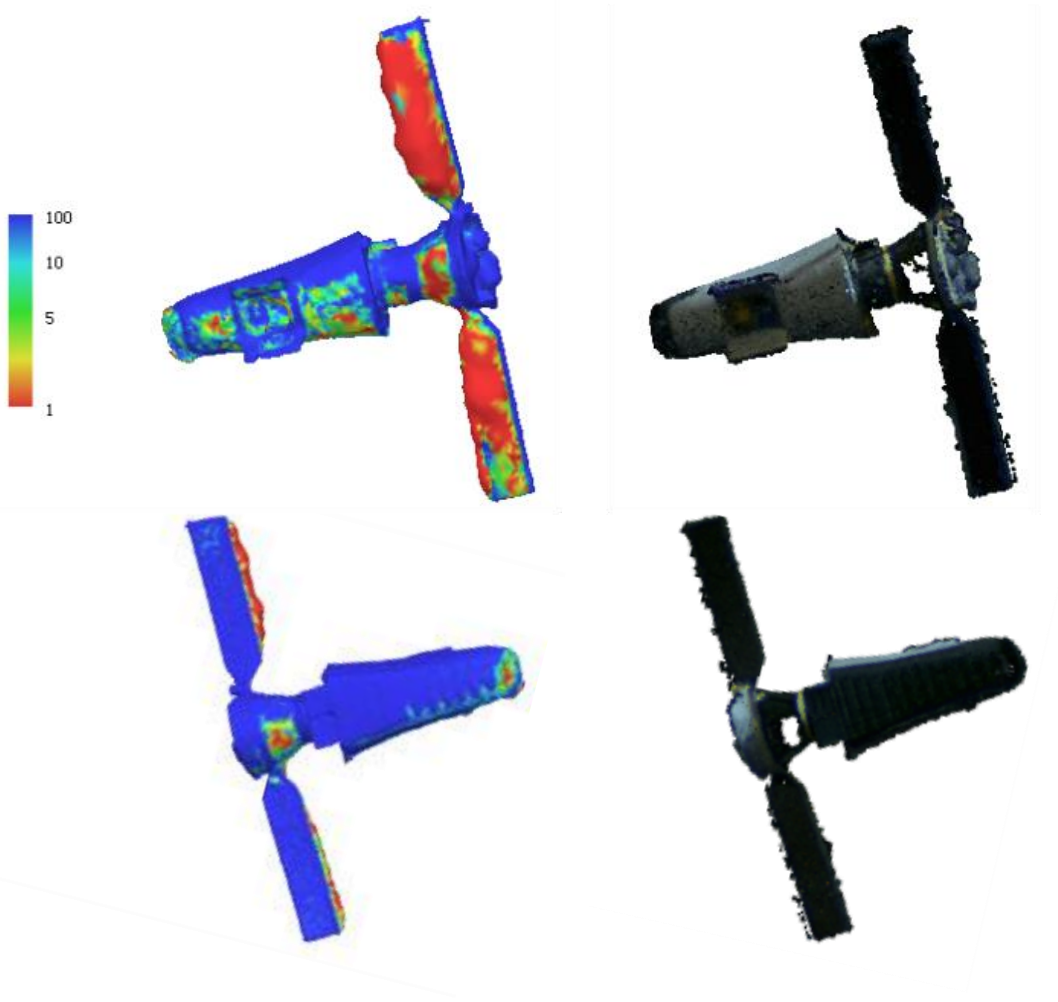
In Orbit Inspection

Comparison with the original CAD model

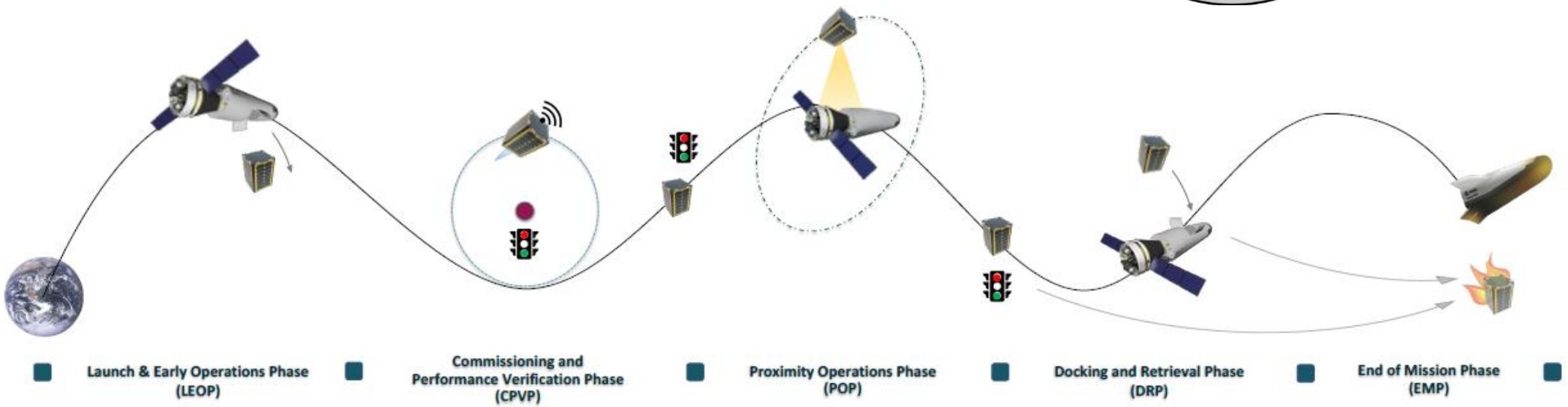




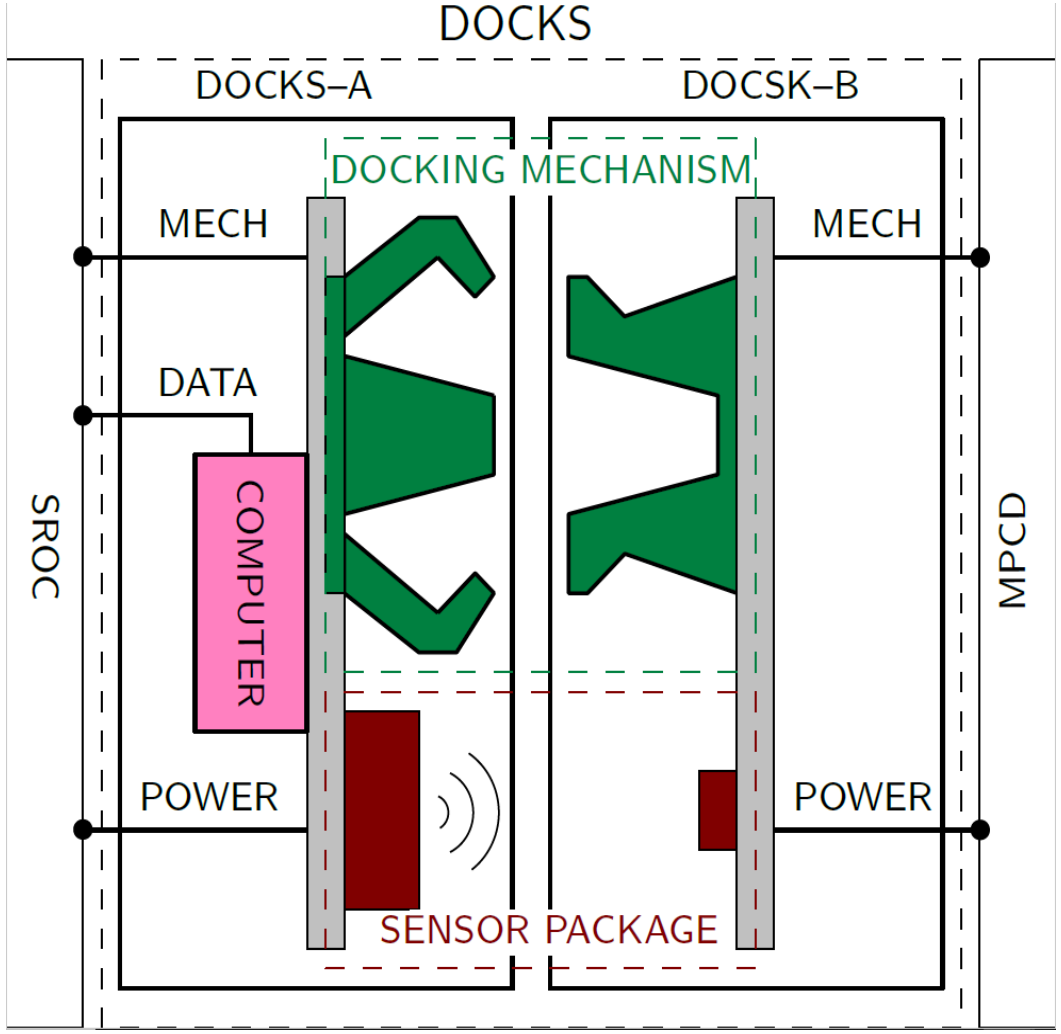
Reconstruction confidence level



Space Rider Observer Cube



DOCKS



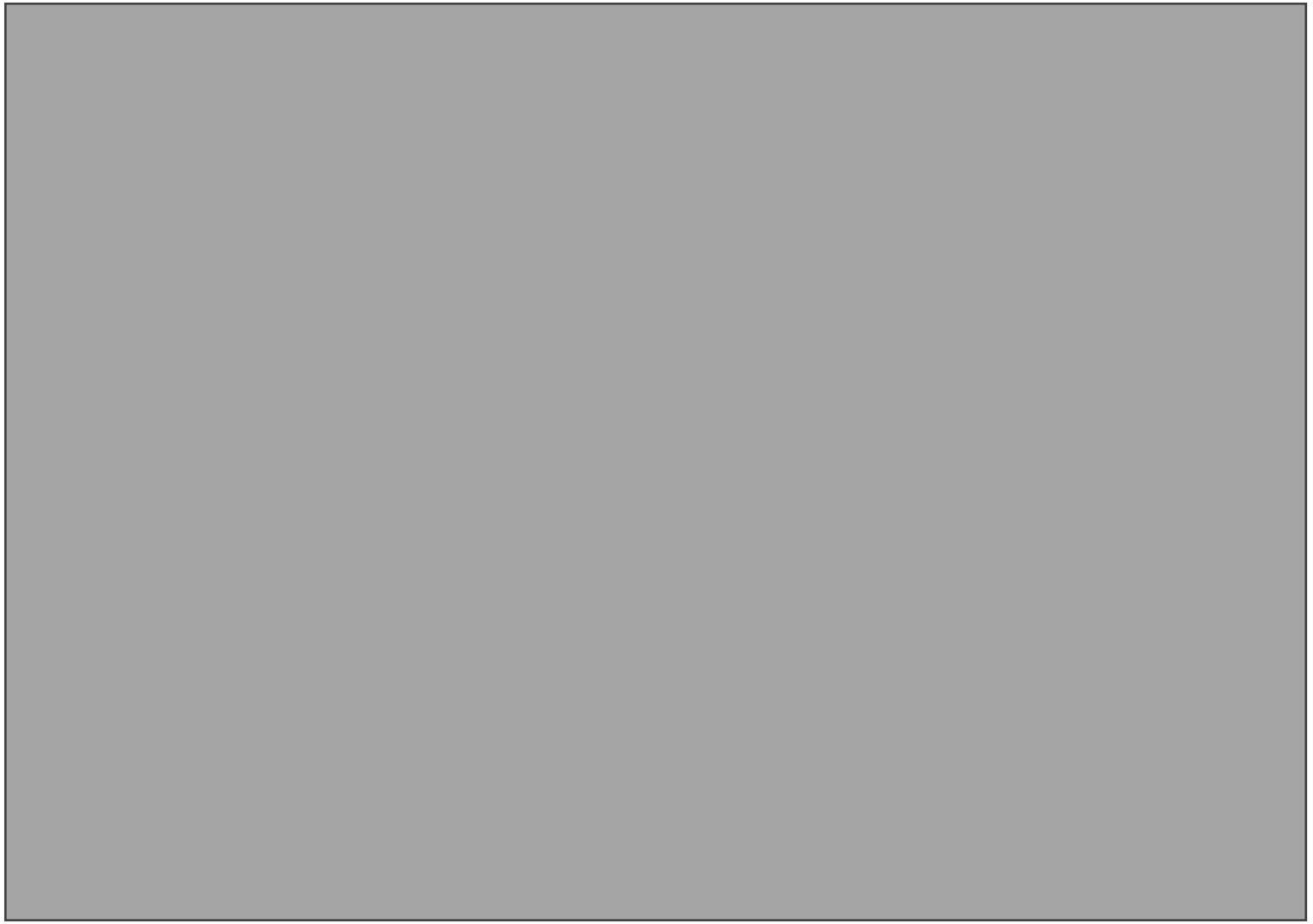
PHASE B1

- Standalone system
- One side of the system is passive, able to work on non cooperative target
- Able to manage the docking phase from <1m until safe connection, managing ultra close proximity navigation and docking

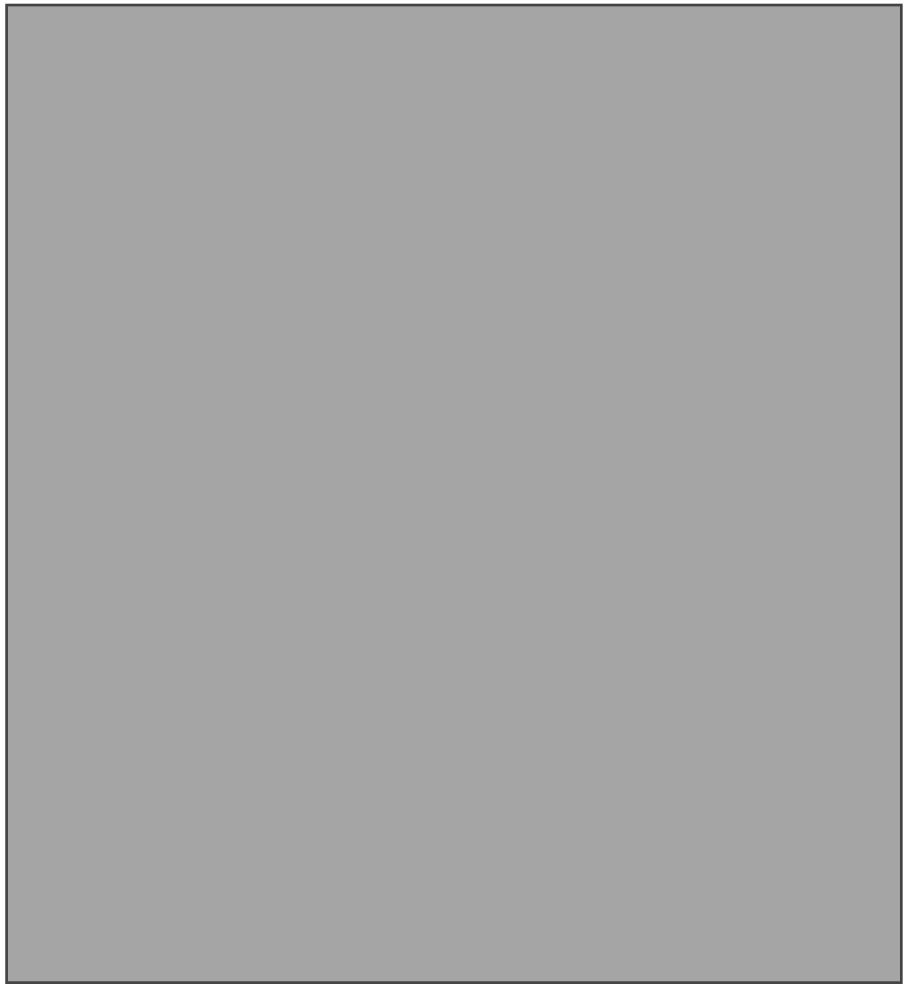
PHASE B2

- Key new feature development
- Space components selection
- Design definition towards Critical Design Review

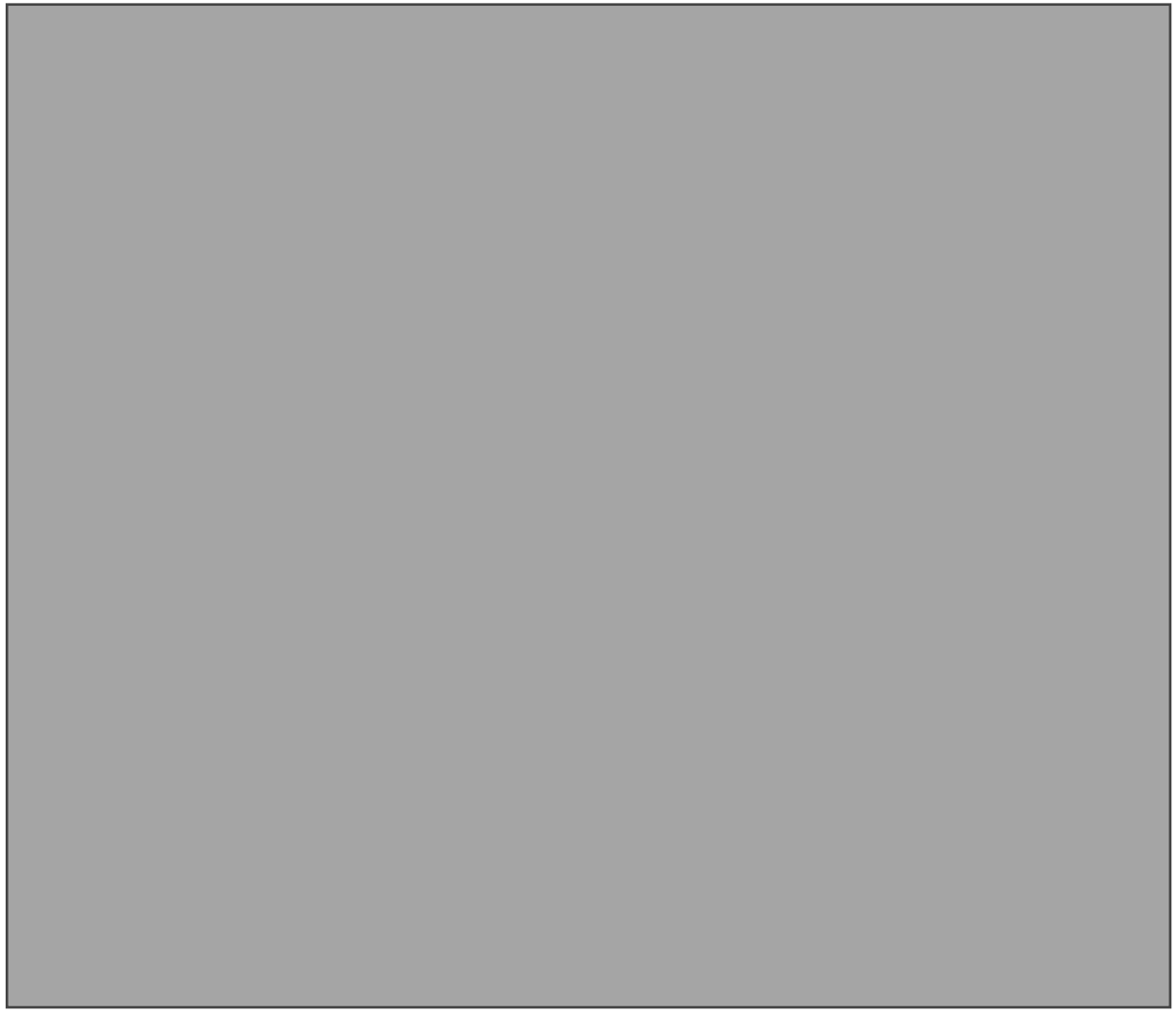
Electro Static Discharge management



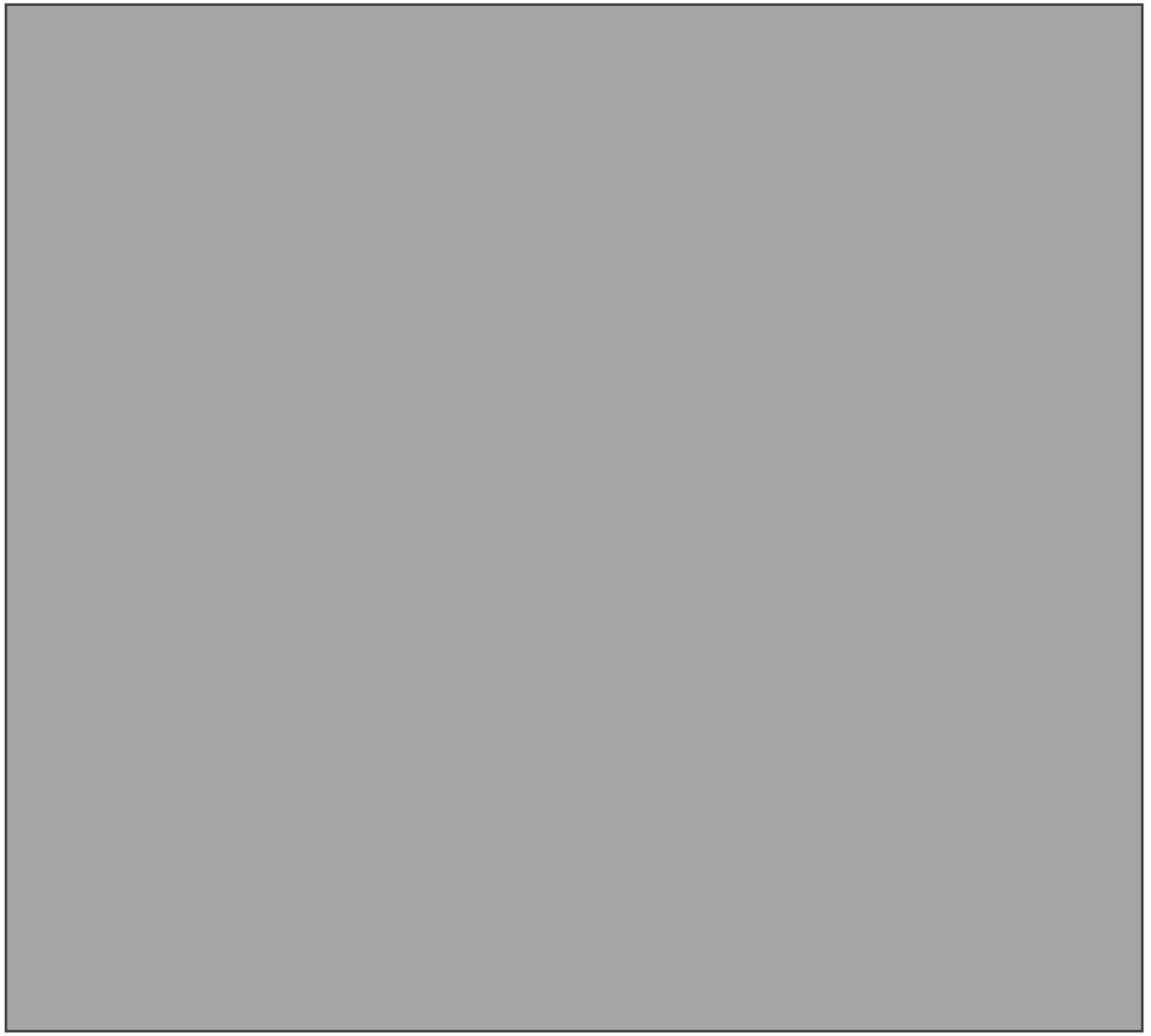
“Auto locking” feature



Emergency Release



Shock Absorber System



Future Works

STELLAR PROJECT

Internship (~6 months)
January – June 2024

- Planned activities:
  - DOCKS development to reach the Critical Design Review
  - Industrial experience

Thanks for the attention

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