https://www.h2020-pulsar.eu

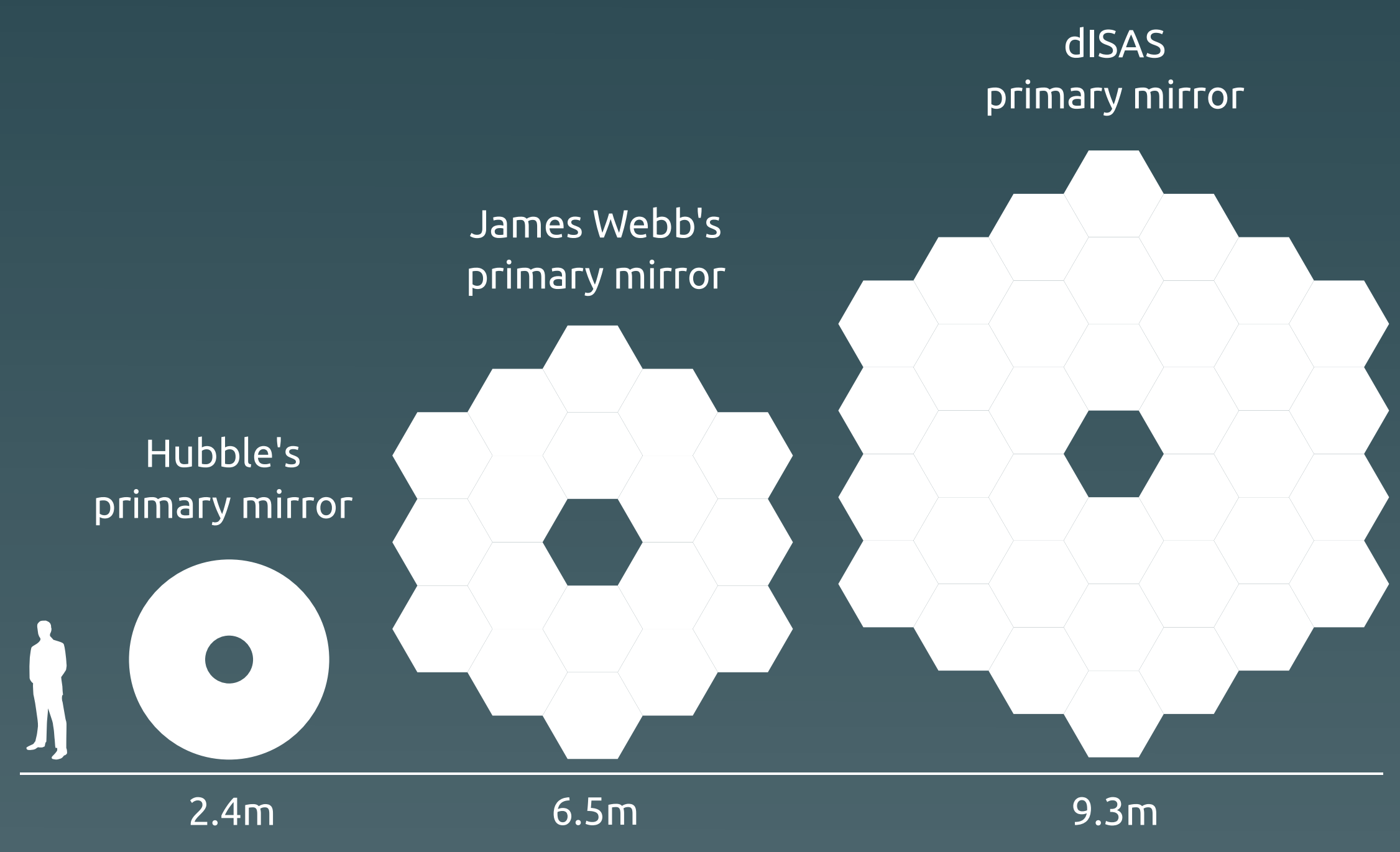
A SIMULATION TOOL FOR IN-ORBIT ASSEMBLY OF LARGE STRUCTURES

V. Bissonnette[1], T. Germa[1], C. Bazerque[1], S. Trinh[1], C. Porte[1], G.Arcin[1], M. Rognant[2], J.-M. Biannic[2], C. Cumer[2], T. Loquen[2], X. Pucel[2]
[1]Magellium, 31520 Ramonville Saint-Agne, France, vincent.bissonnette@magellium.fr
[2]ONERA-The French Aerospace Lab, 31055 Toulouse, France, mathieu.rognant@onera.fr

Taking Space Telescopes Further into the Future

Autonomous assembly of large structures in space is a key enabling technology for future missions which will require structures of increasing size, exceeding the capacity of modern launch vehicles. The James Webb Space Telescope (JWST), planned for launch is 2021, is a good example of how constraints of the launch vehicle affect the complexity of spacecraft design, with the need for a large number of release mechanisms to deploy its 6.5m segmented primary mirror.

The future Large UV Optical Infrared Surveyor (LUVOIR), targets even larger primary mirrors, further increasing the required launch vehicle volume.

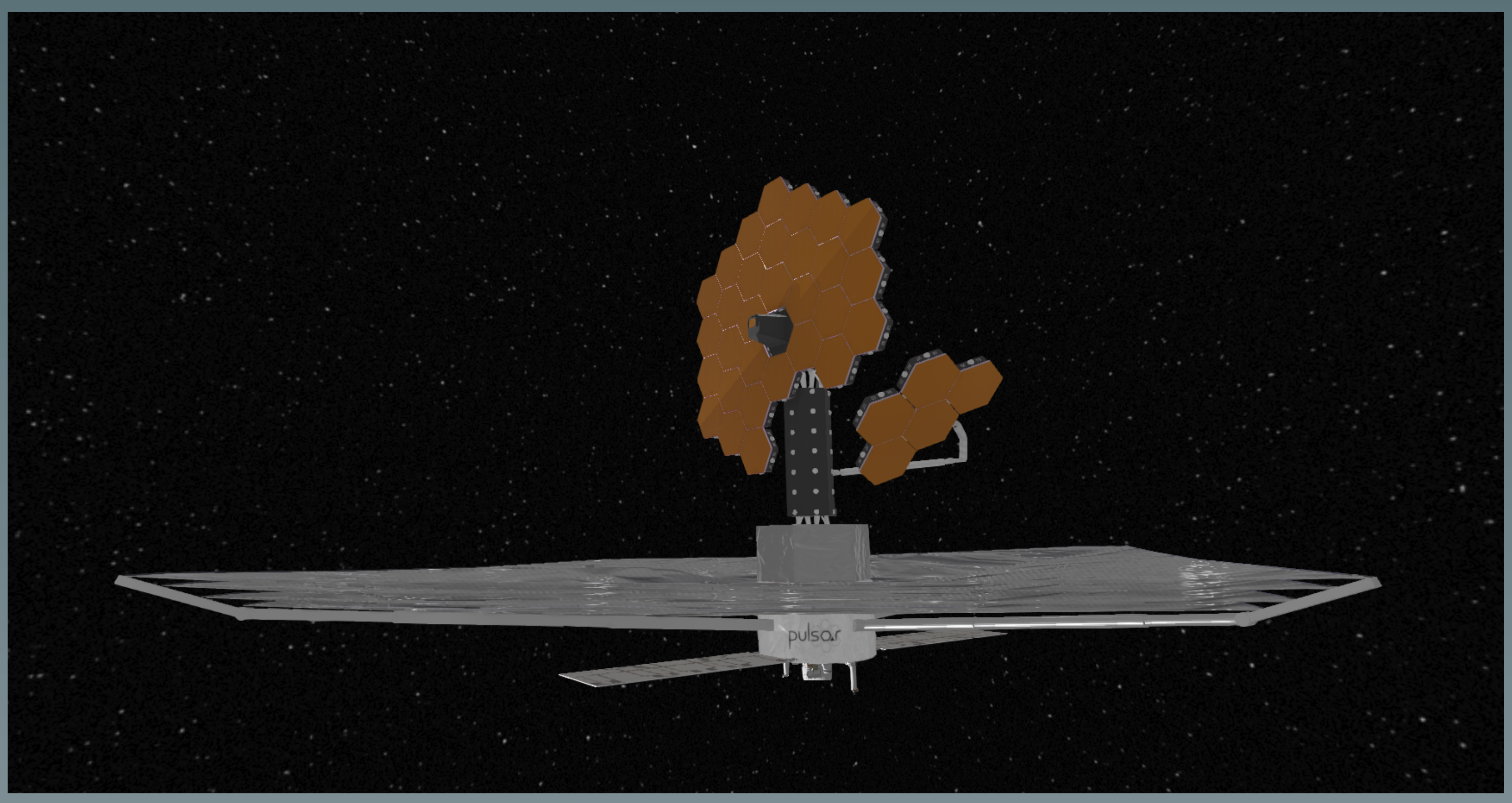


The H2020-PULSAR Project

A paradigm shift is required to enable this increase in spacecraft size, and in-orbit assembly has the potential to fulfill this need. To this end, the European Commission, through its Space Robotics Technologies Strategic Research Cluster (SRC), has funded the PULSAR (Prototype for an Ultra Large Structure Assembly Robot) project. It aims at developing and demonstrating core technologies enabling the in-orbit assembly of the 8m-diameter primary mirror of a space telescope with an autonomous robotic system.

Demonstrator for in-orbit assembly simulation

In the scope of PULSAR, a demonstrator of In-Space Assembly in Simulation (dISAS) is developed. The demonstrator addresses the complete autonomous assembly of a primary mirror composed of 36 Segmented Mirror Tiles (SMT), using an on-board robotic manipulator. The displacement of SMTs by the robotic arm from their container to their assembled position induces large disturbance torques and changes in inertial properties of the spacecraft. The large size of the solar panels, the sunshield, and the primary mirror also induce flexibility effects and vibrations. These disturbances are then managed by its Attitude and Orbit Control System (AOCS) to maintain pointing requirements.



Architecture

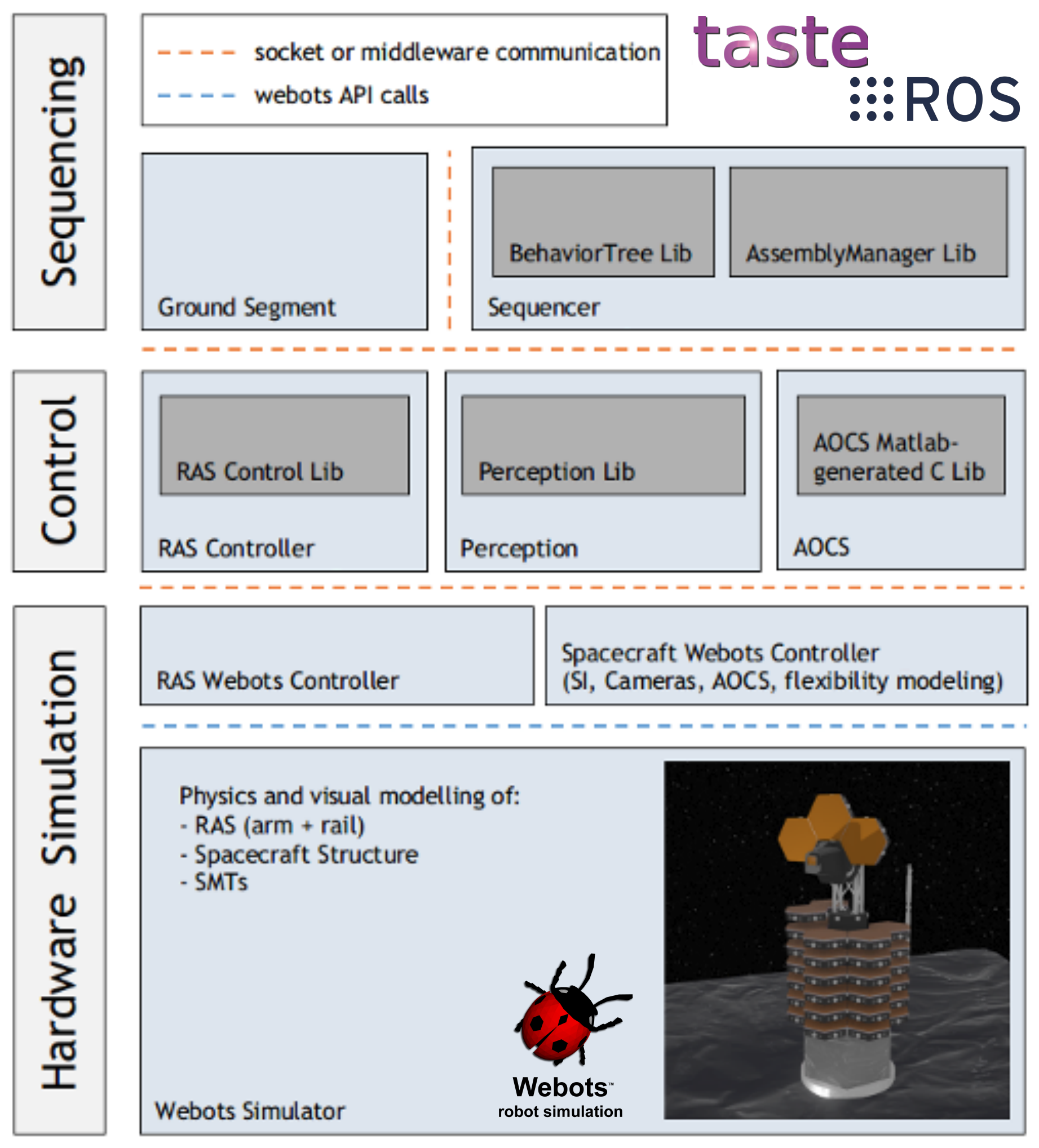
At software level, dISAS is organized in three main layers:

- Simulation layer: 3D virtual environment in microgravity, physics, visual rendering, and simulated hardware components using the Webots engine (https://www.cyberbotics.com/)

- Functional layer: high-level functionalities of the autonomous assembly system. Contains components for the robotic arm path planning and control, perception functions for visual monitoring and arm servoing, and the platform AOCS controller

- Autonomy layer: Software components responsible for the specification and execution of the assembly sequence. Behavior Trees are used to compose complex sequences from atomic actions.

The system is implemented in C++ and Python, and integrated in ROS, or TASTE, an ESA software framework targeted towards space robotics (https://taste.tools/).



Features

Flexible Appendage Simulation

Realistic Rendering

Realistic Sensor Modeling

AOCS Sensors Actuators

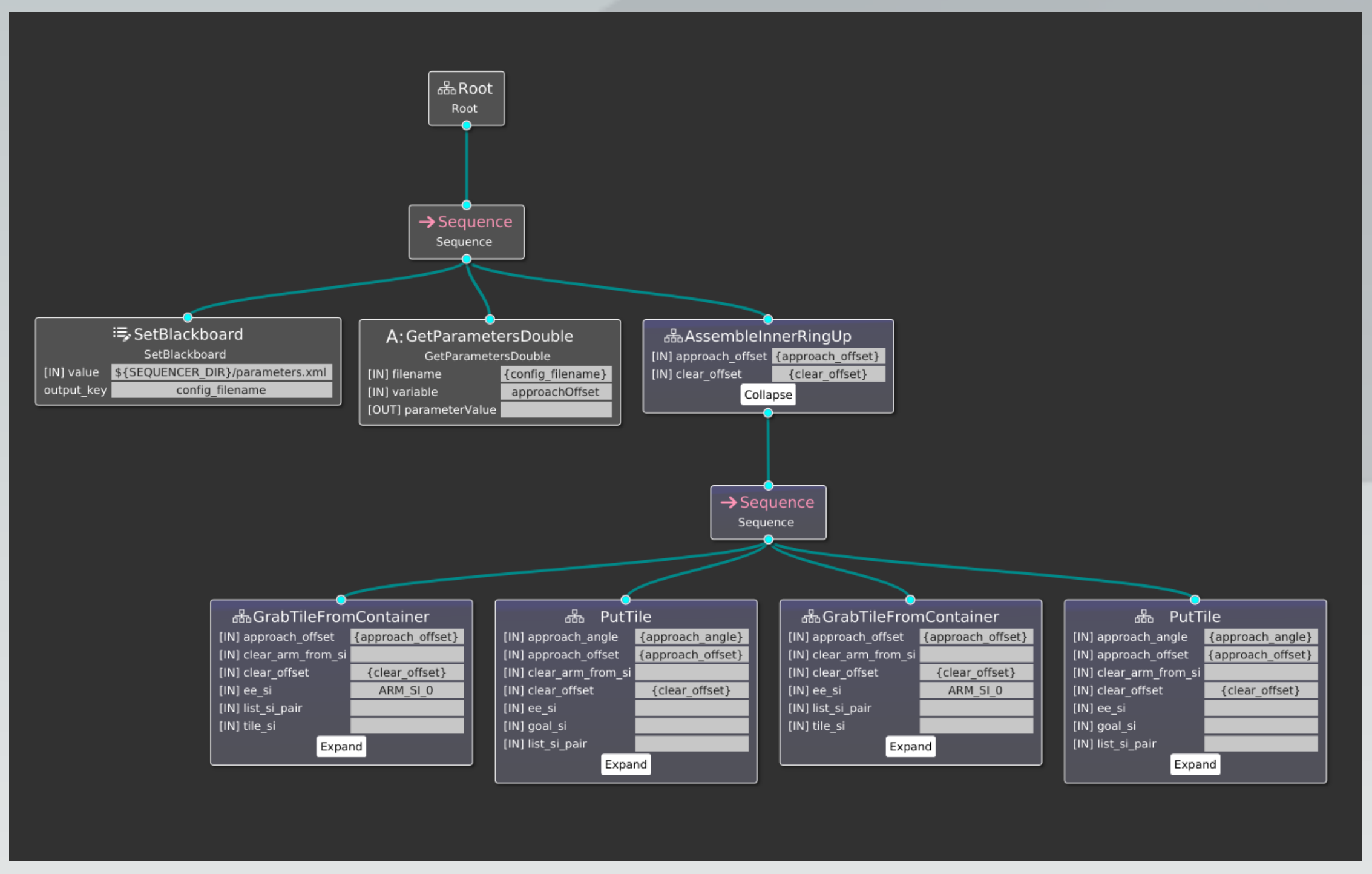
Robotic Arm Motion Planning & Control

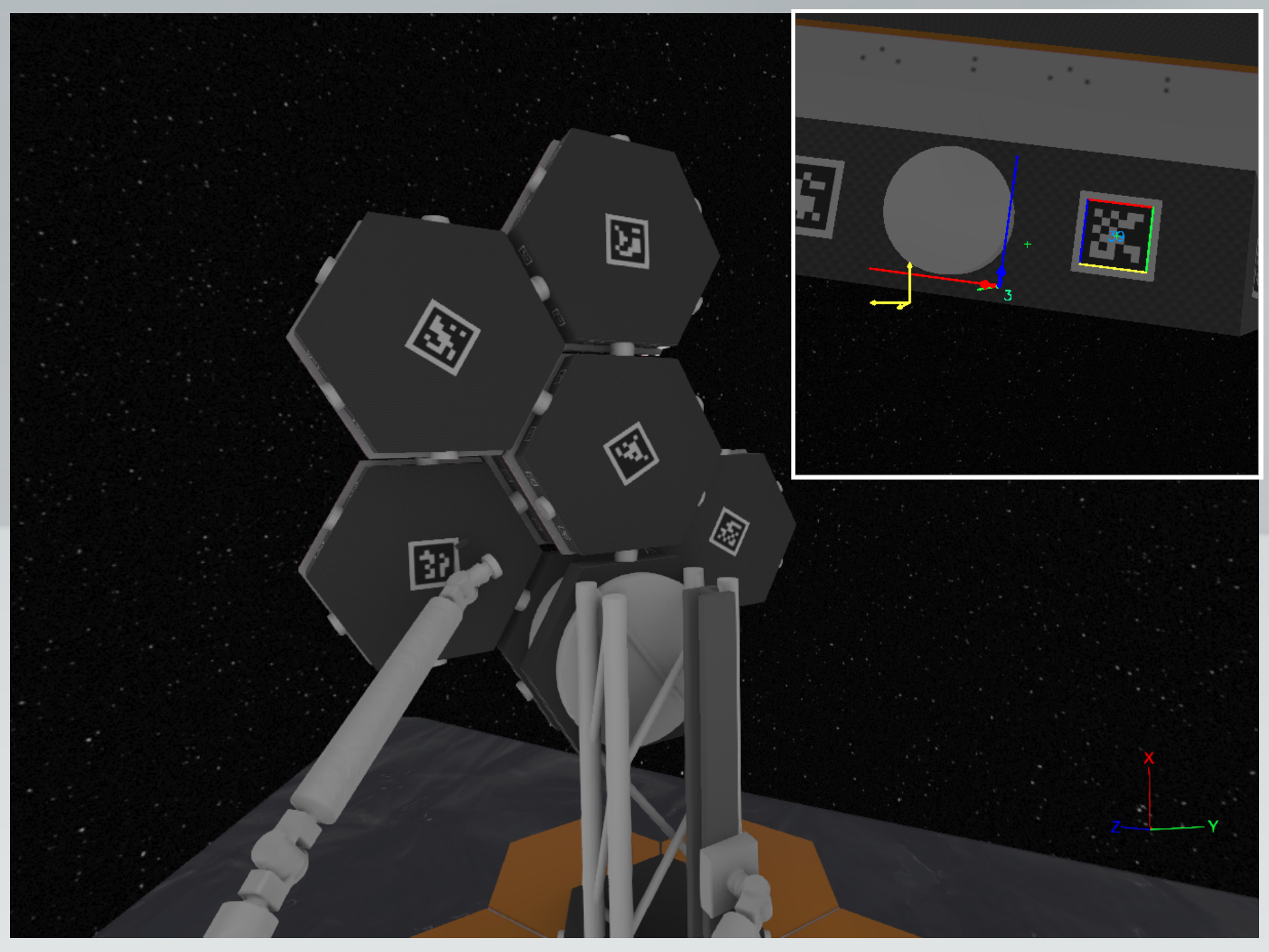
Sequencing & Autonomy with BehaviorTree

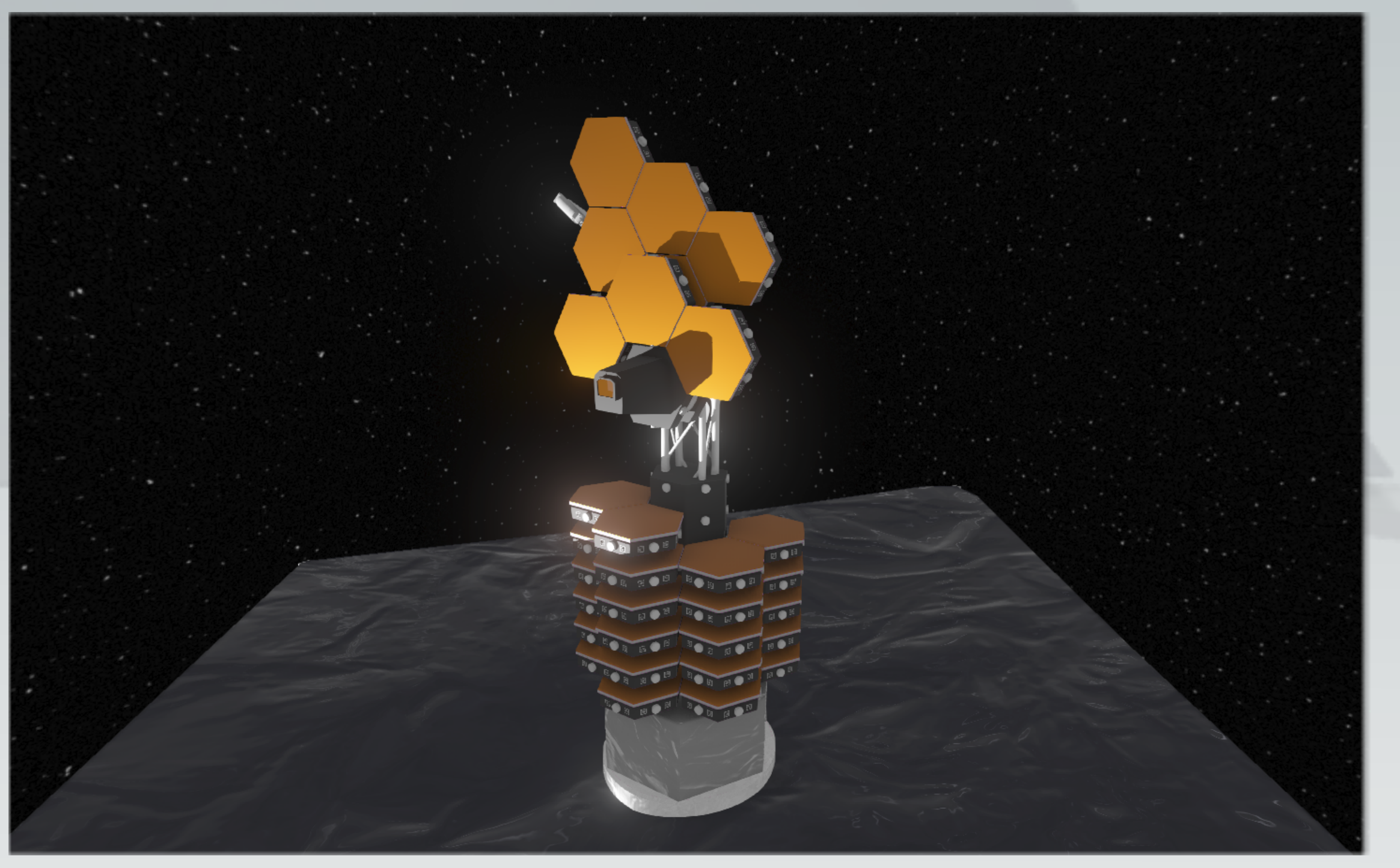
Eye-In-Hand Visual Servoing

Eye-To-Hand Visual Servoing

Complex Multibody System Simulation







PULSAR is funded under the European Commission's Horizon 2020 Space Strategic Research Cluster Operational Grant 821858

See dISAS in action