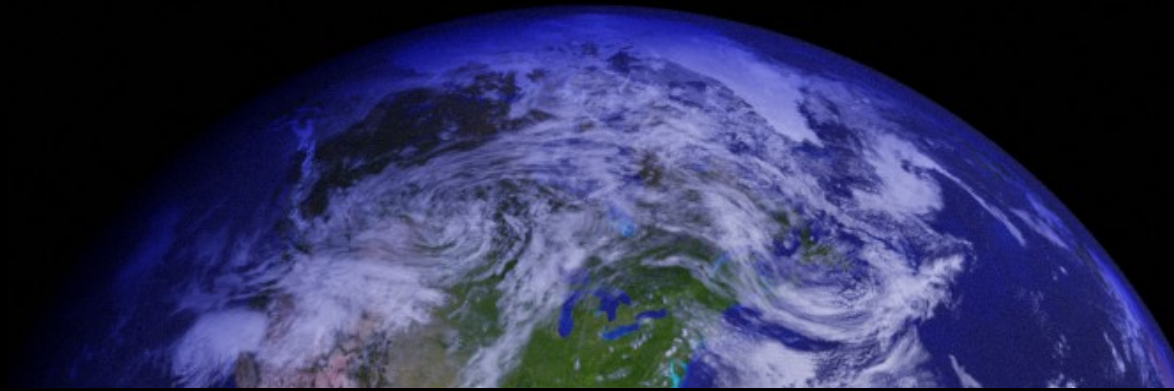
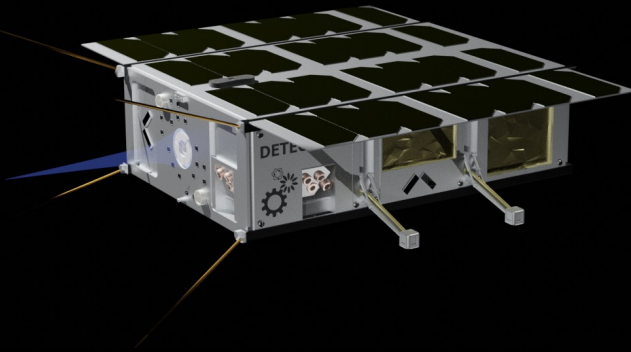
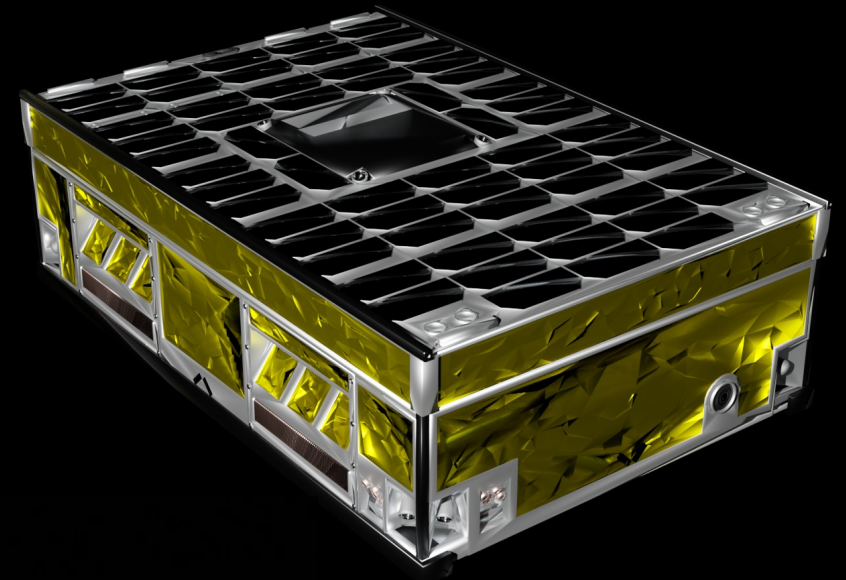


DEBRIS – A Small Satellite Approach to Active Debris Removal

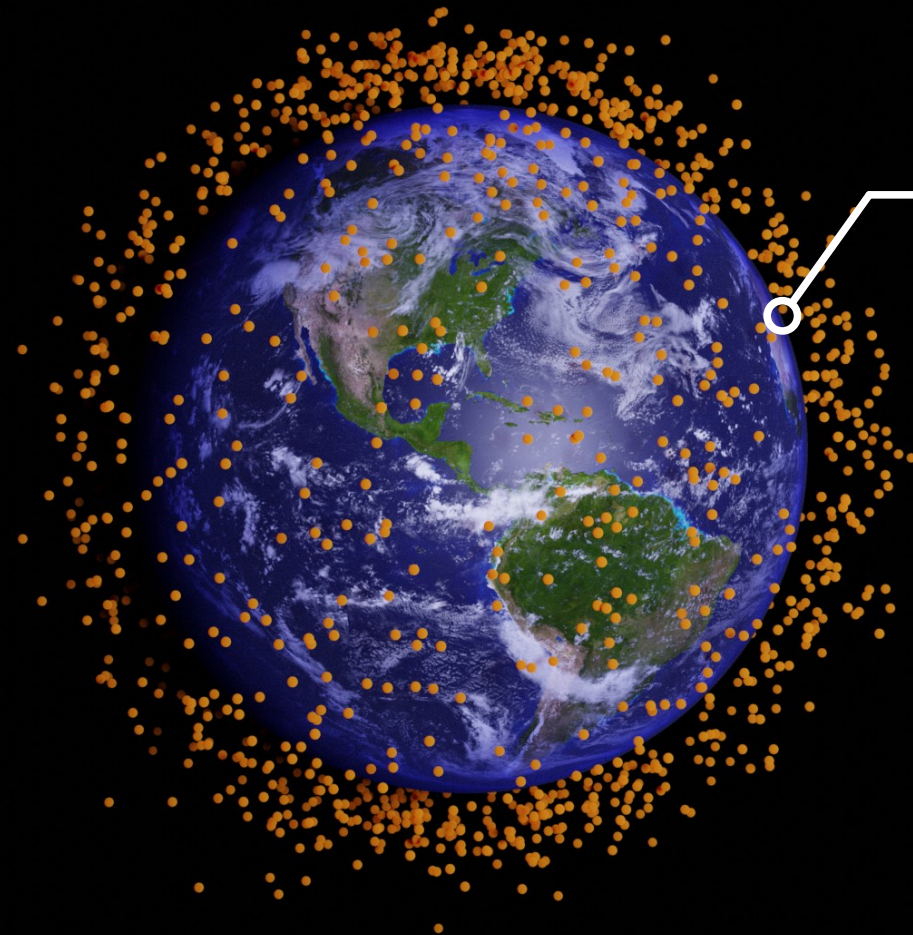
Presented by

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- Tilman Hoffbauer
- Louisa Gerhard

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tilman.hoffbauer@juforum.de
louisa.gerhard@juforum.de



Space Debris



1,700 possible targets

→ Small Satellite
technology

● Space
Debris

DEBRIS
Probe

Far
Approach

Near
Approach

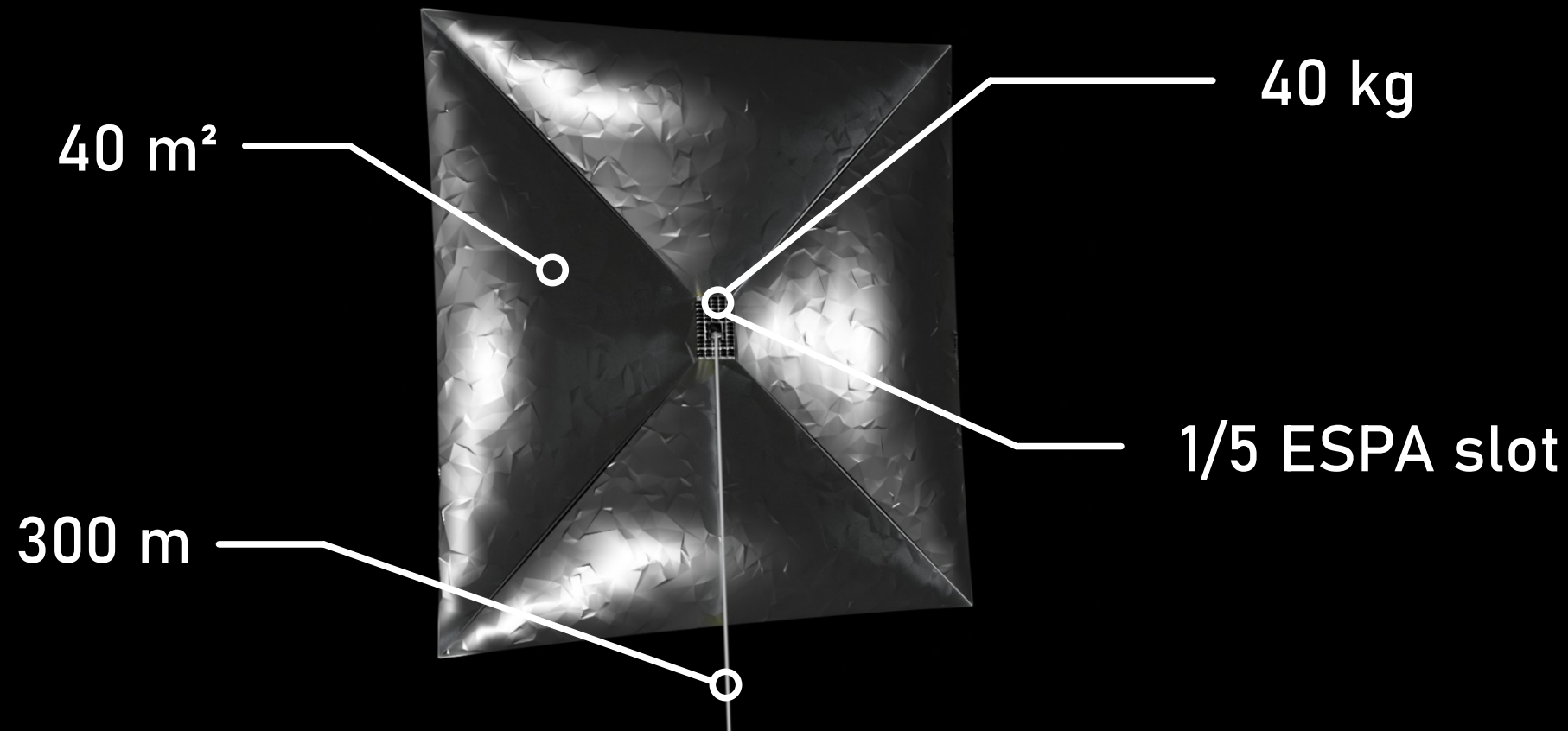
Remote
Sensing

Capturing

Influence

DETECTOR

The DEBRIS Probe



Space
Debris

● DEBRIS
Probe

Far
Approach

Near
Approach

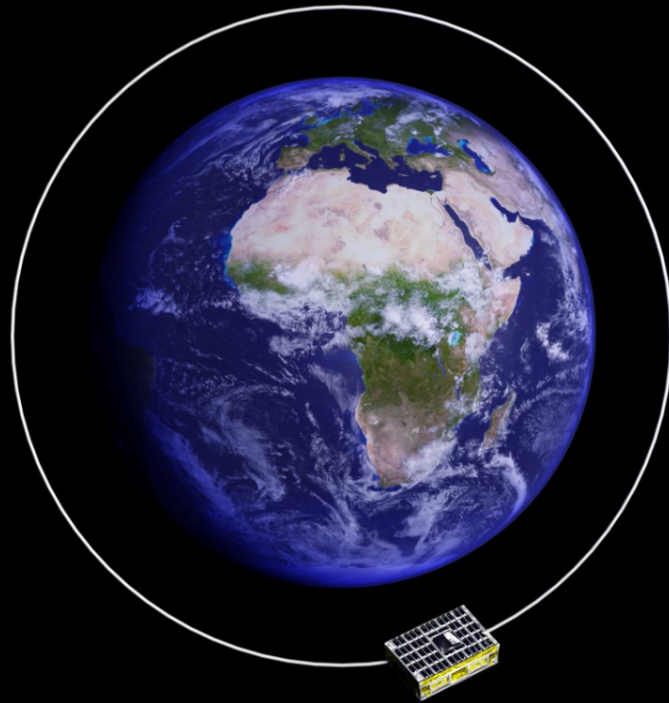
Remote
Sensing

Capturing

Influence

DETECTOR

Far Approach



Space
Debris

DEBRIS
Probe

● Far
Approach

Near
Approach

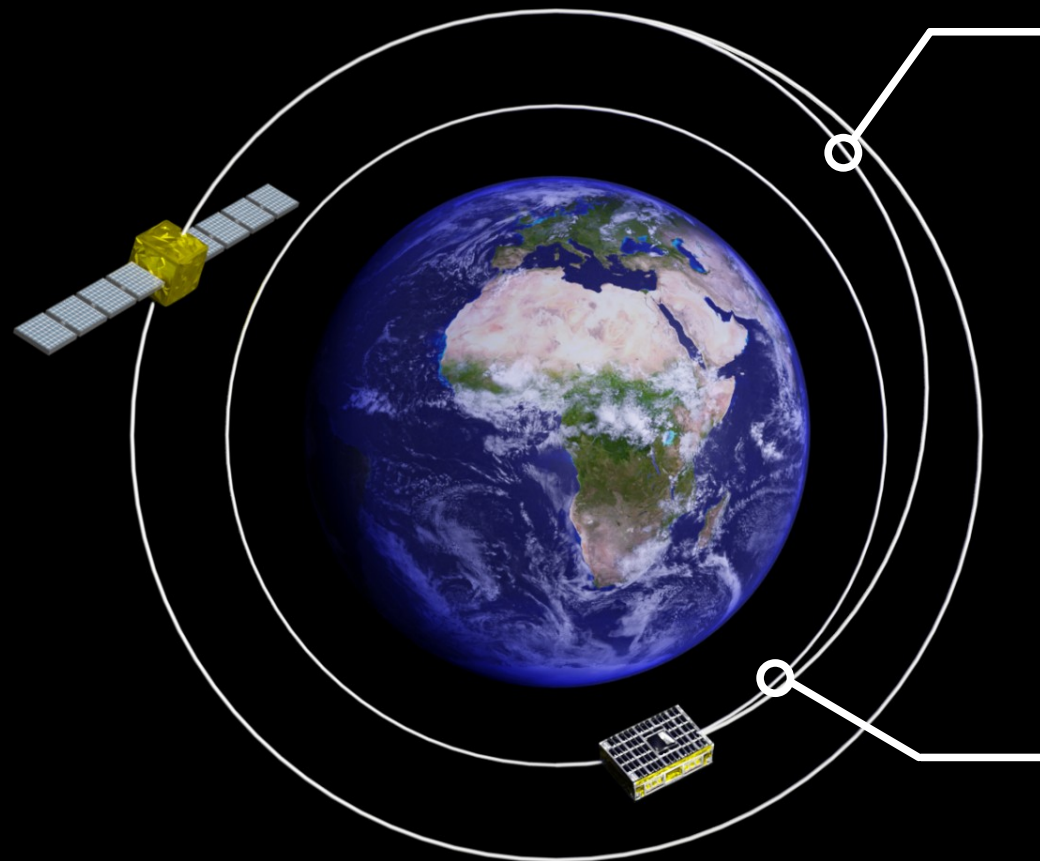
Remote
Sensing

Capturing

Influence

DETECTOR

Far Approach



Orbit heights
350 – 2000 km

Inclination change
1° – 3°

Space
Debris

DEBRIS
Probe

● Far
Approach

Near
Approach

Remote
Sensing

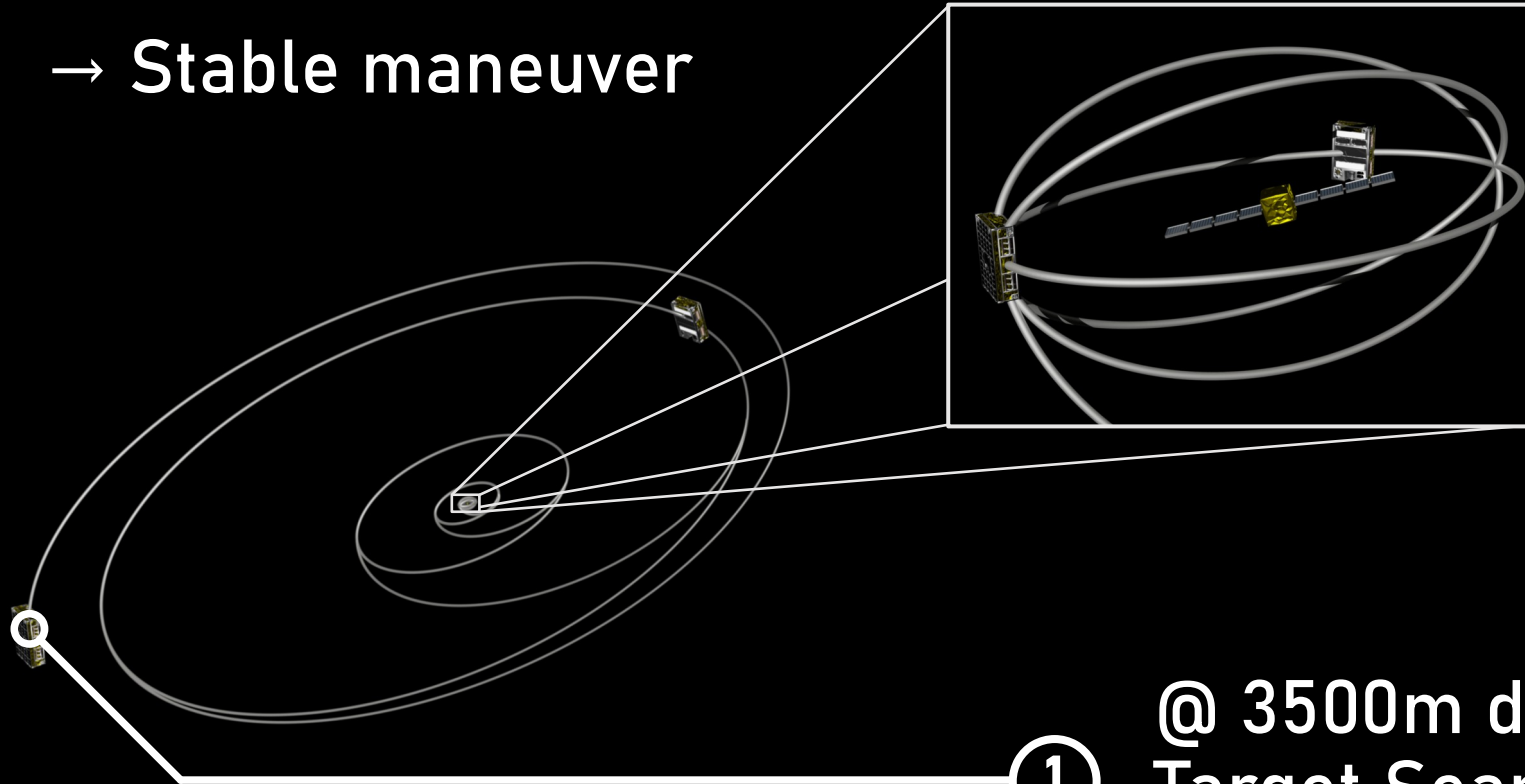
Capturing

Influence

DETECTOR

Near Approach

→ Stable maneuver



① @ 3500m distance
Target Search
→ RADAR active

Space
Debris

DEBRIS
Probe

Far
Approach

● Near
Approach

Remote
Sensing

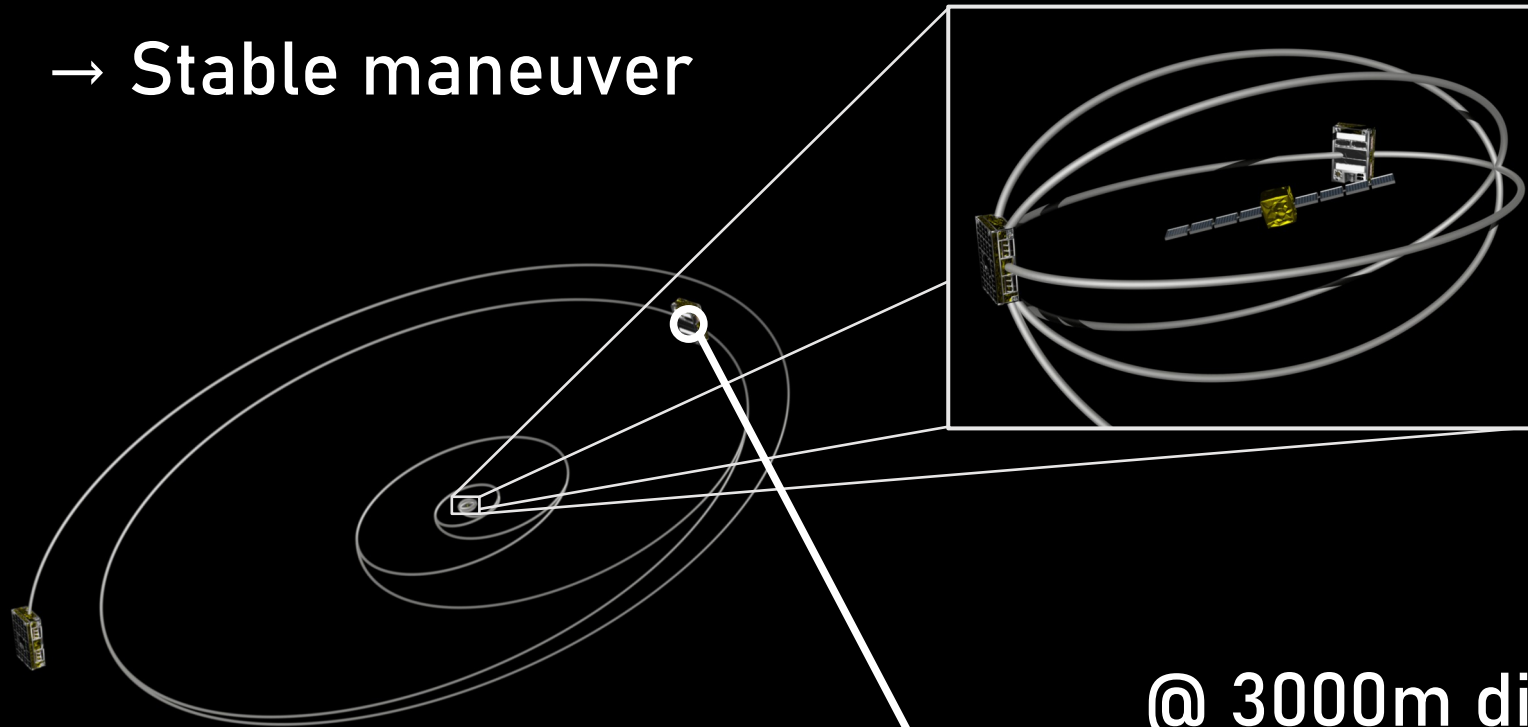
Capturing

Influence

DETECTOR

Near Approach

→ Stable maneuver



@ 3000m distance
Target found
→ Iterative approach

Space
Debris

DEBRIS
Probe

Far
Approach

● Near
Approach

Remote
Sensing

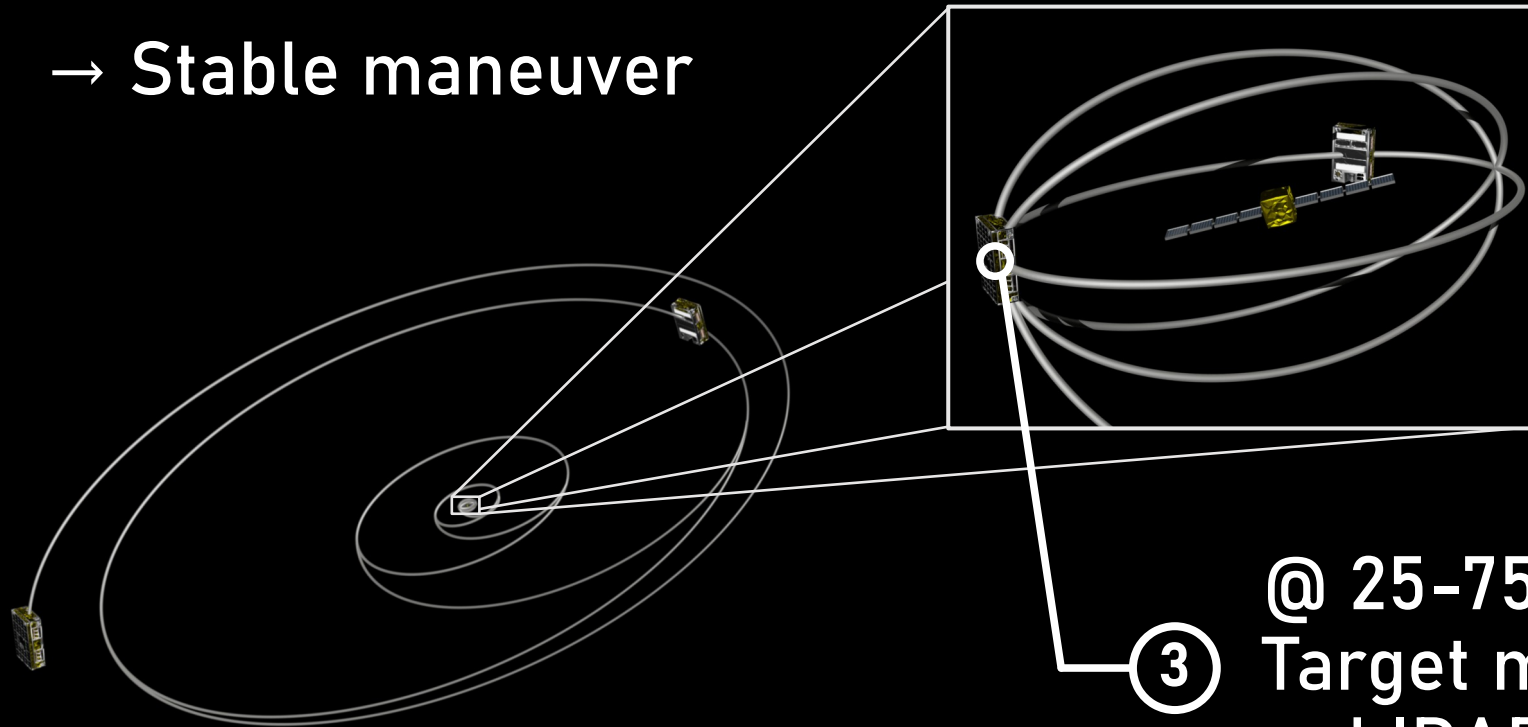
Capturing

Influence

DETECTOR

Near Approach

→ Stable maneuver



③

@ 25-75m distance
Target mapping
→ LIDAR + Camera

Space
Debris

DEBRIS
Probe

Far
Approach

● Near
Approach

Remote
Sensing

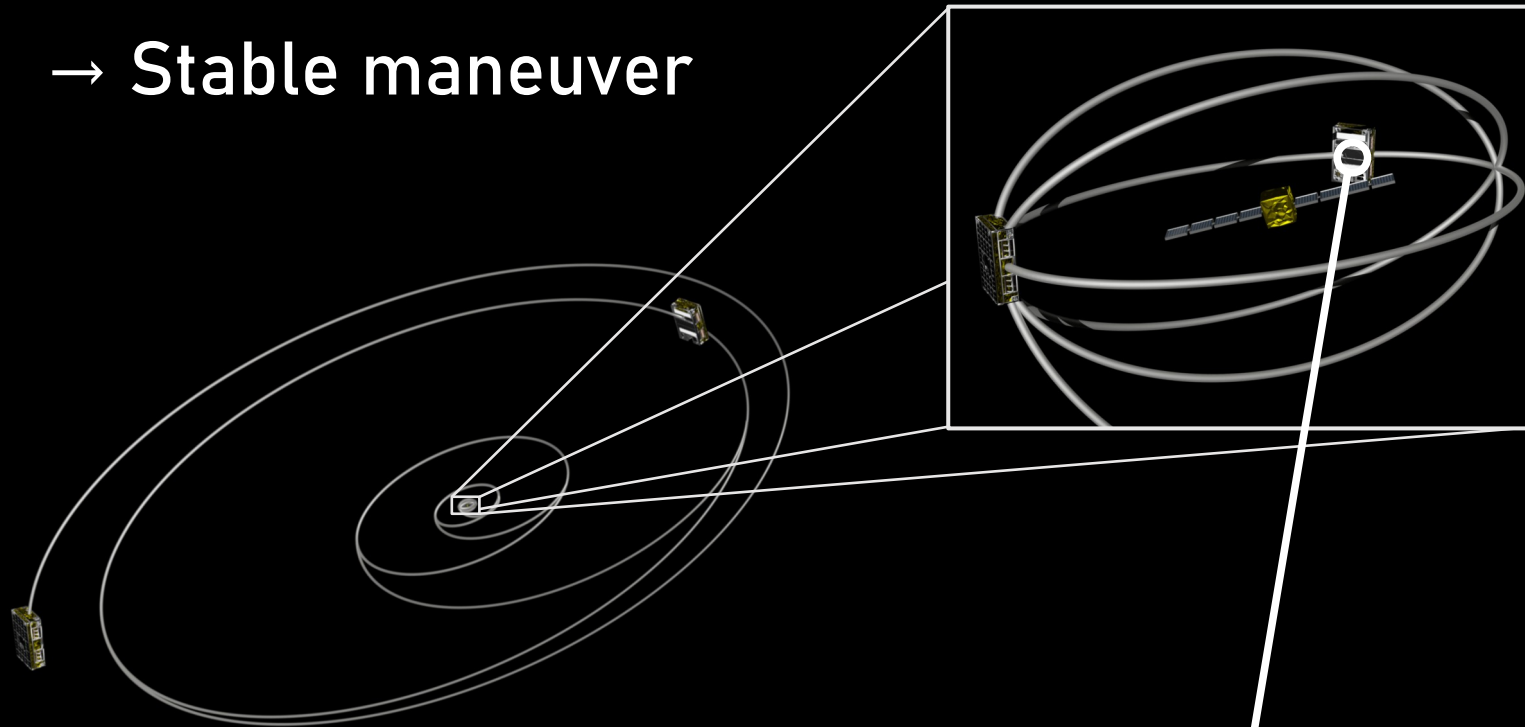
Capturing

Influence

DETECTOR

Near Approach

→ Stable maneuver



@ Same orbit, later
Go/No-Go capturing
→ Ground station

④

Space
Debris

DEBRIS
Probe

Far
Approach

● Near
Approach

Remote
Sensing

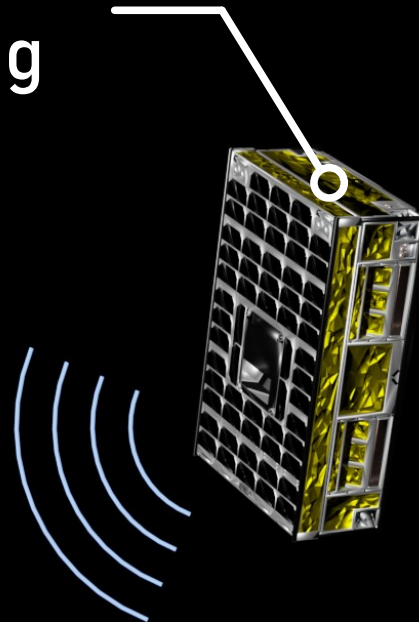
Capturing

Influence

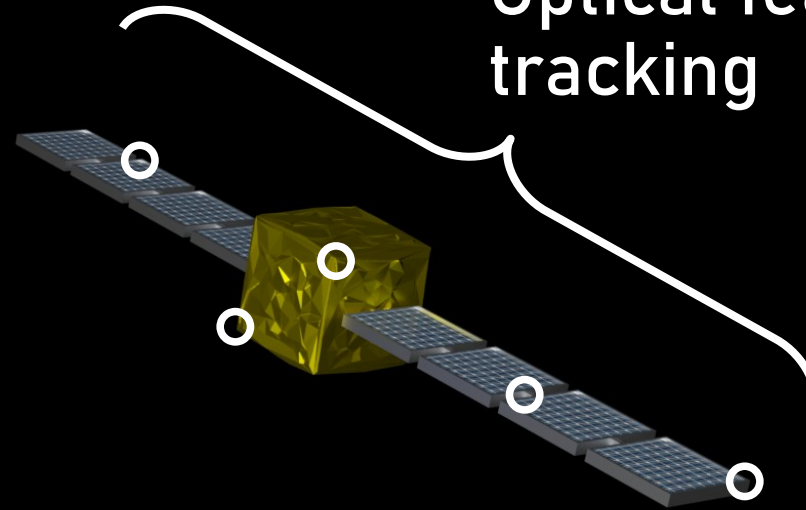
DETECTOR

Target Mapping & Remote Sensing

FPGA-accelerated
computing



Optical feature
tracking



Shape & kinematic
properties calculation

Space
Debris

DEBRIS
Probe

Far
Approach

Near
Approach

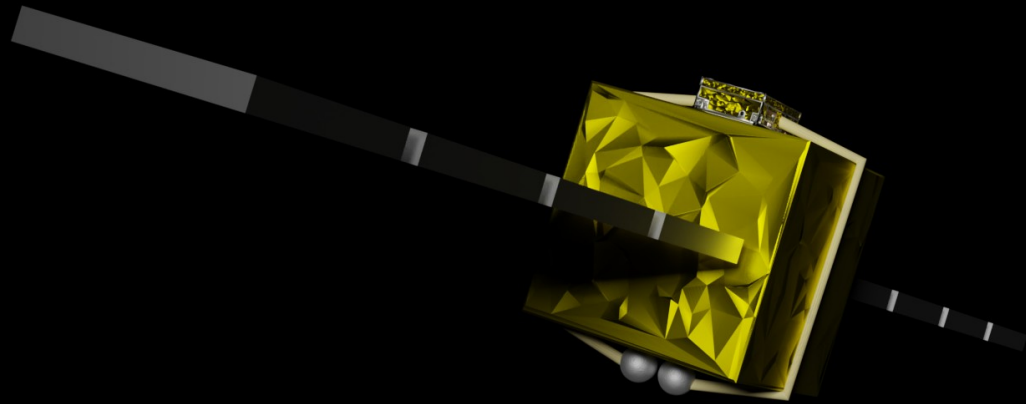
● Remote
Sensing

Capturing

Influence

DETECTOR

Capturing



SmallSat requirements

- > Power (20 W)
- > Mass (6kg)
- > Volume (3U)
- > Operational

→ need of a novel capturing mechanism for small satellite applications

Space
Debris

DEBRIS
Probe

Far
Approach

Near
Approach

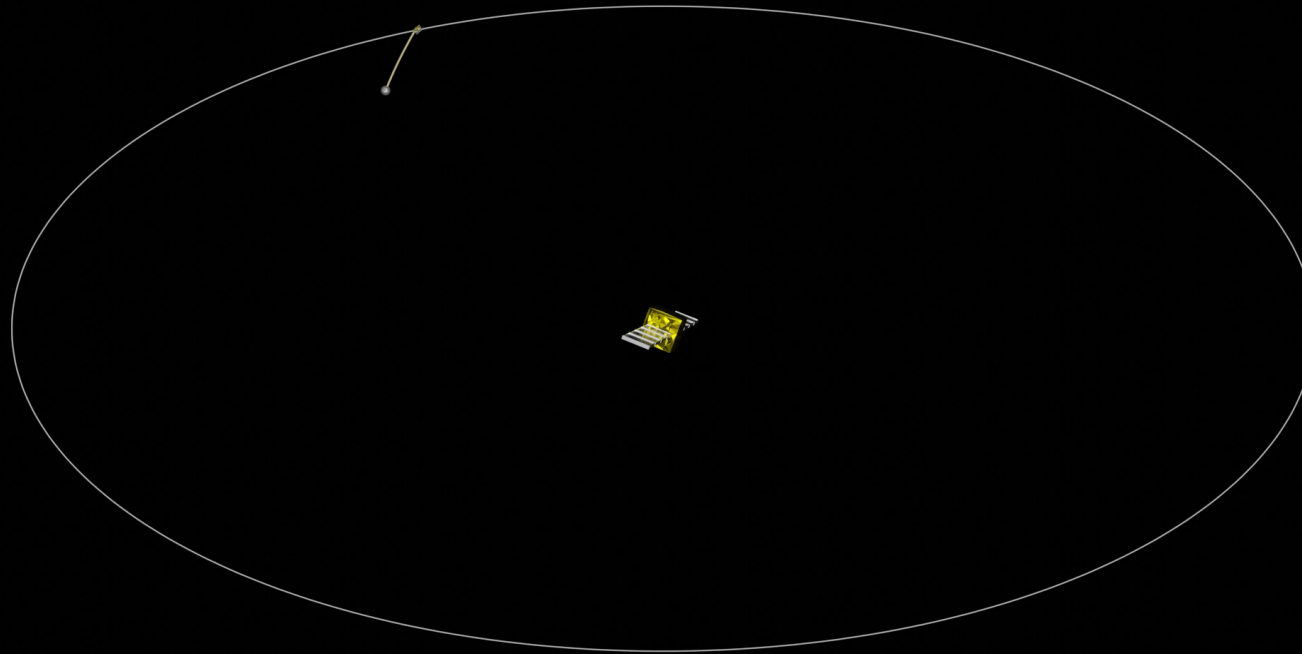
Remote
Sensing

● Capturing

Influence

DETECTOR

Capturing



Ejection of magnetic projectiles
(velocities between 0.1 and 1 m/s)

Space
Debris

DEBRIS
Probe

Far
Approach

Near
Approach

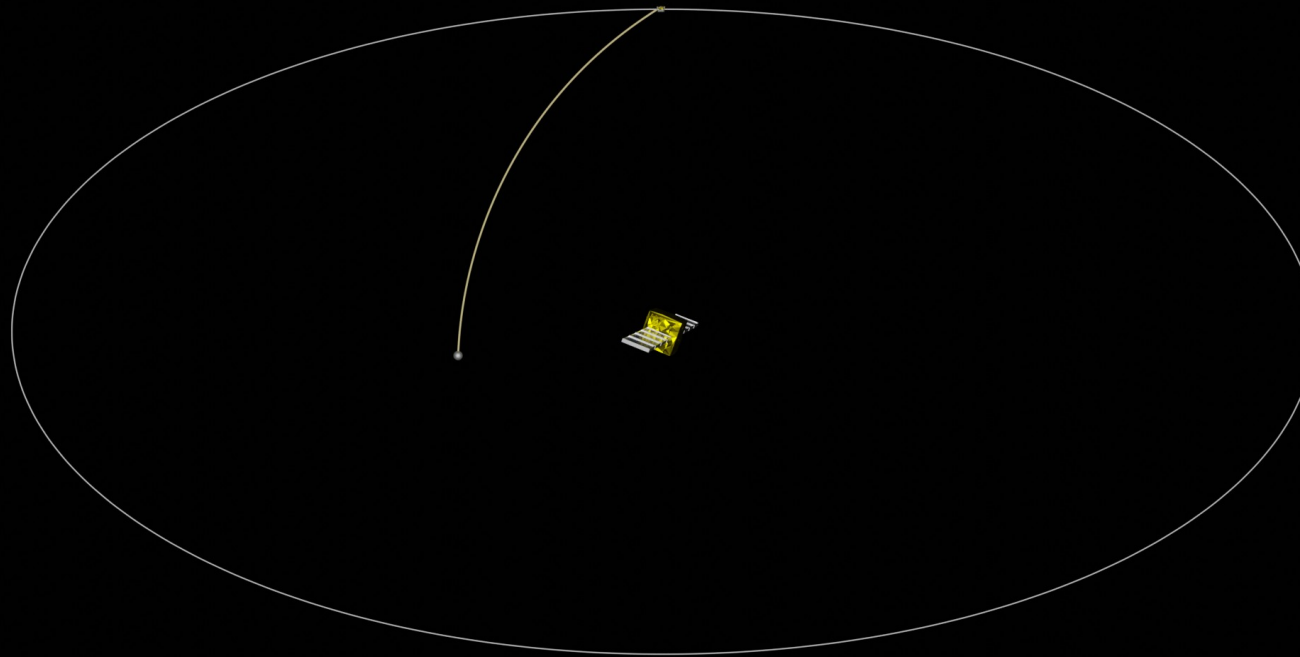
Remote
Sensing

● Capturing

Influence

DETECTOR

Capturing



Initial aim through magnetic deflection
(precision of 0.5° as a secondary application of magnetorquer)

*sizes not to scale, results investigated via DART physics engine

Space
Debris

DEBRIS
Probe

Far
Approach

Near
Approach

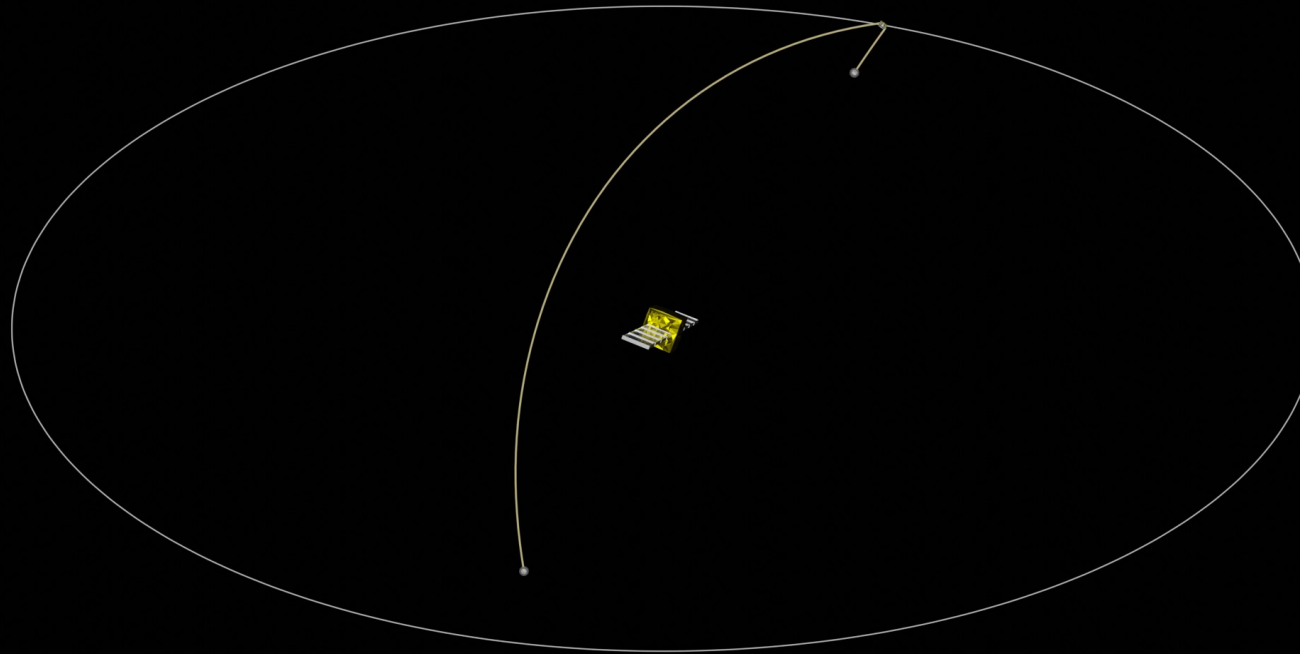
Remote
Sensing

● Capturing

Influence

DETECTOR

Capturing

Space
DebrisDEBRIS
ProbeFar
ApproachNear
ApproachRemote
Sensing

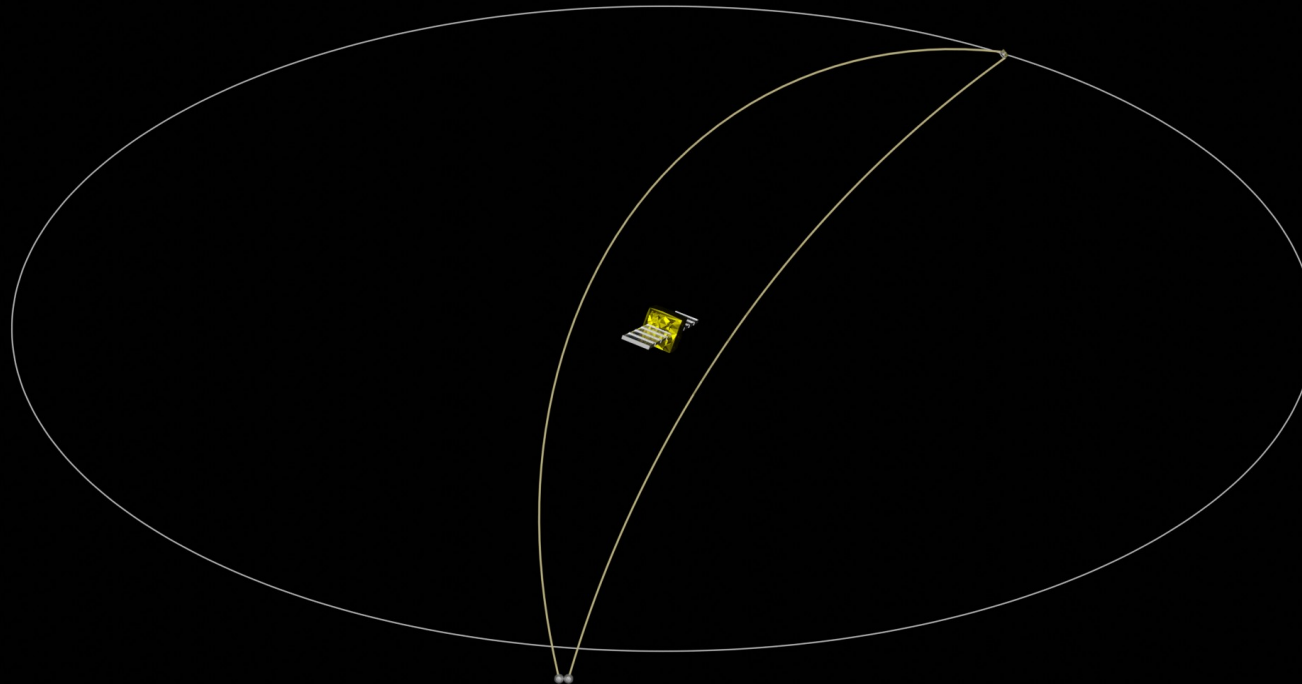
● Capturing

Influence

DETECTOR

Flightpath adjustment and connection due to magnetic forces

Capturing



Tightening of connection by rope retraction
→ **compensation of need for flight precession on cm-level**

Space
DebrisDEBRIS
ProbeFar
ApproachNear
ApproachRemote
Sensing

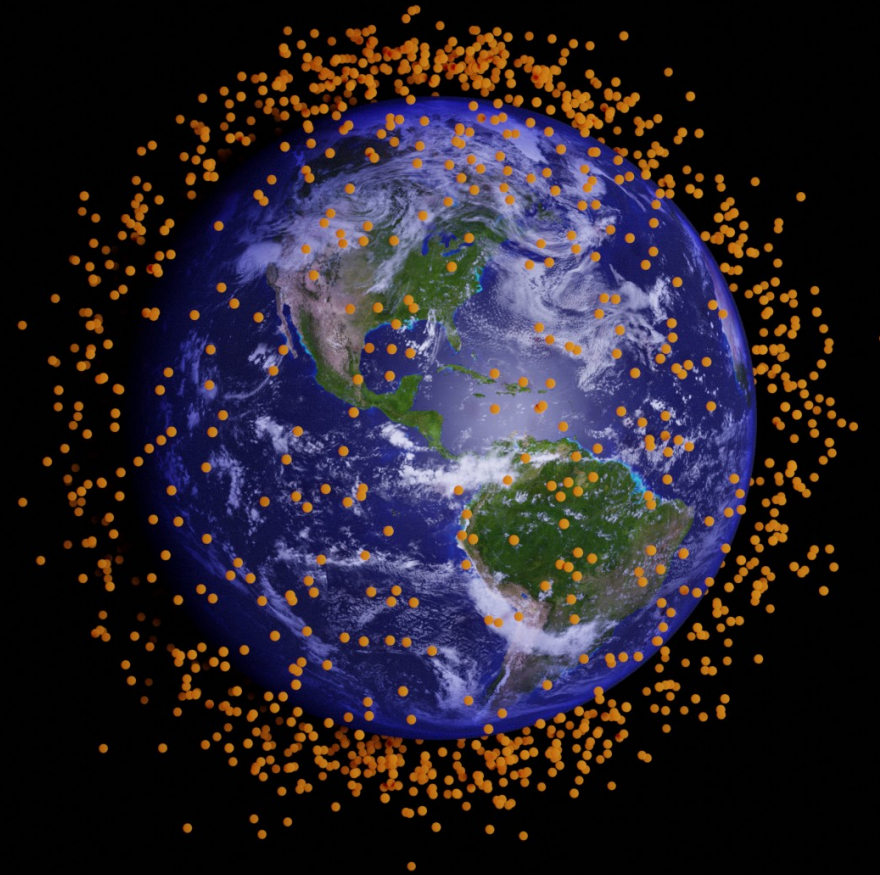
● Capturing

Influence

DETECTOR

Influence

Scaleable solution:
Prevention of Kessler's syndrom



Space
Debris

DEBRIS
Probe

Far
Approach

Near
Approach

Remote
Sensing

Capturing

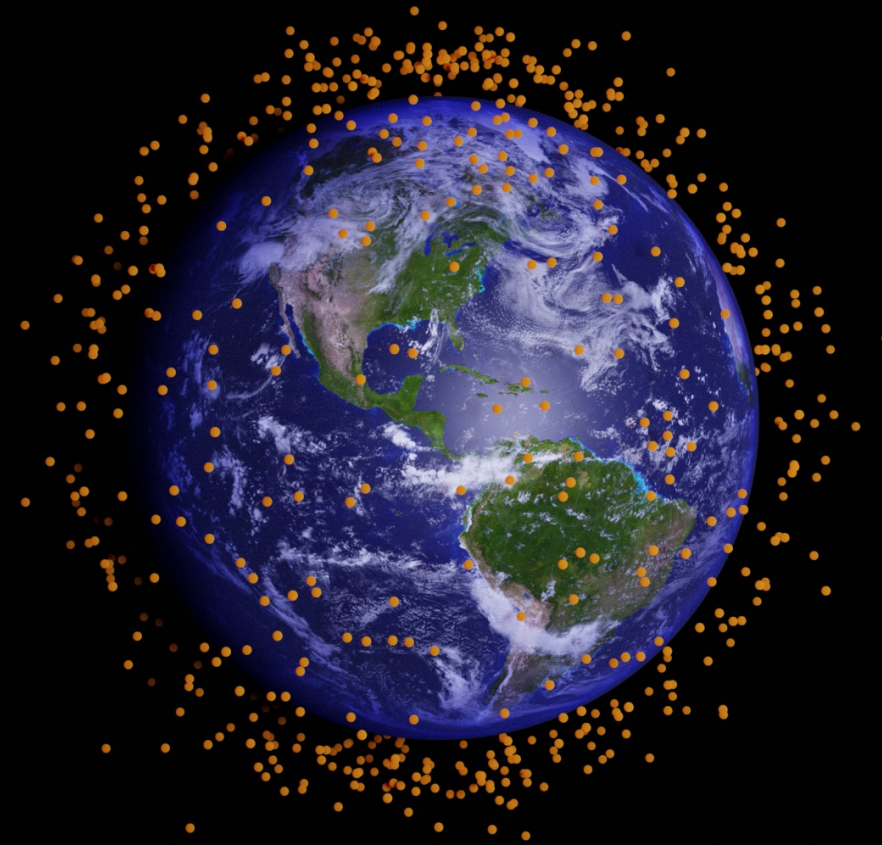
● Influence

DETECTOR

Influence

Scaleable solution:
Prevention of Kessler's syndrom

Fast response time through
low launcher requirements



Space
Debris

DEBRIS
Probe

Far
Approach

Near
Approach

Remote
Sensing

Capturing

● Influence

DETECTOR

Influence

Scaleable solution:
Prevention of Kessler's syndrom

Fast response time through
low launcher requirements

Exploration of key technologies for
future orbital servicing activities



Space
Debris

DEBRIS
Probe

Far
Approach

Near
Approach

Remote
Sensing

Capturing

● Influence

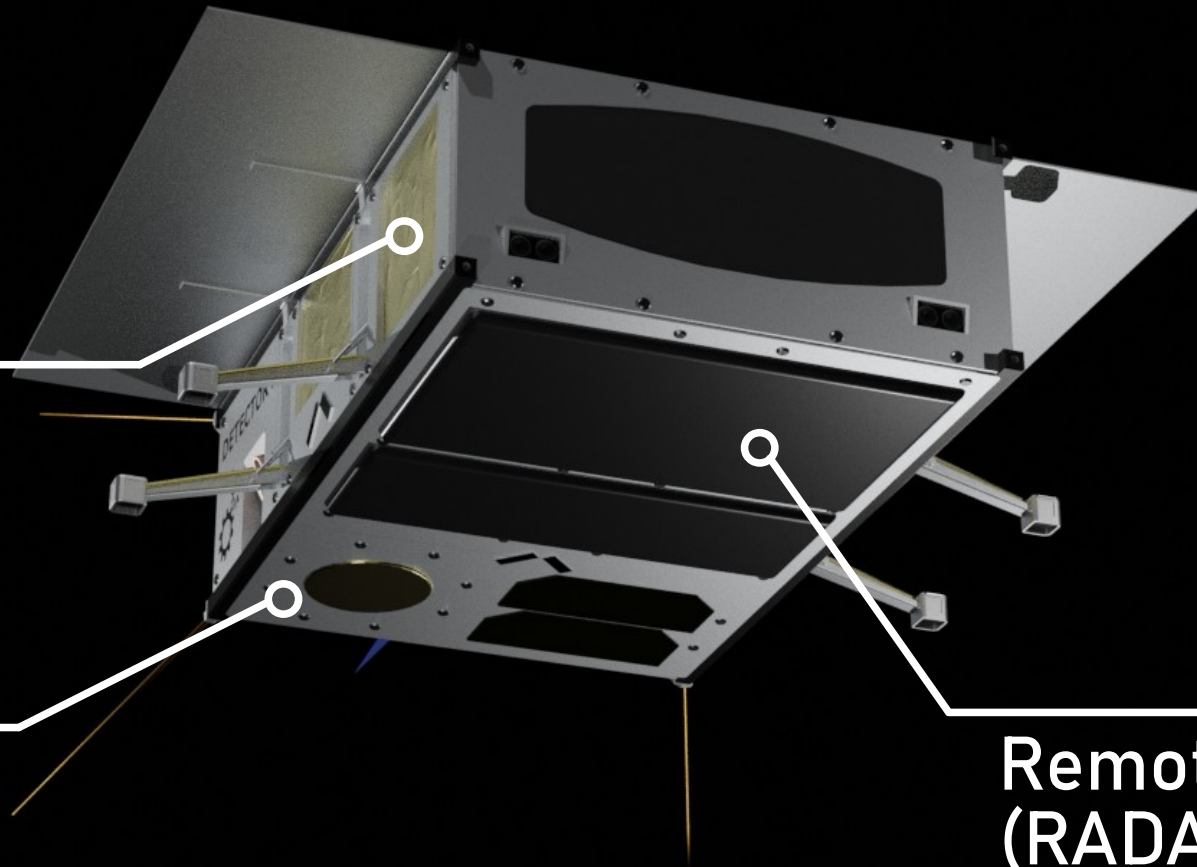
DETECTOR

DETECTOR I

Novel OBC
qualification

DEBRIS
components

Remote sensing
(RADAR, LIDAR,
cameras)



Space
Debris

DEBRIS
Probe

Far
Approach

Near
Approach

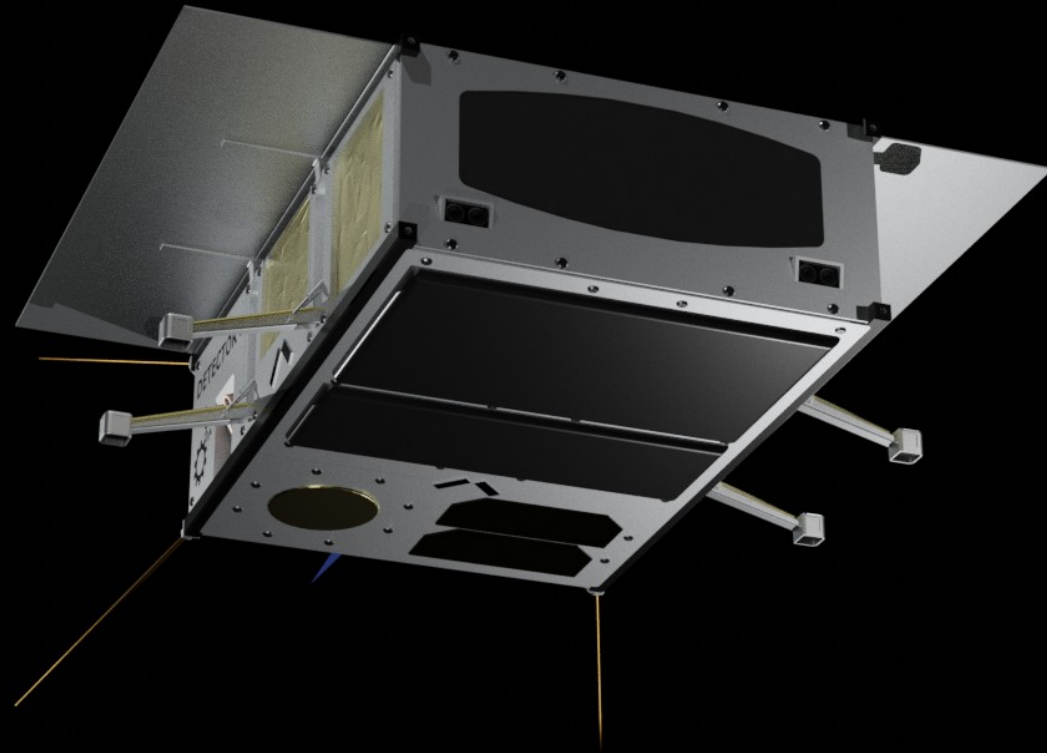
Remote
Sensing

Capturing

Influence

● DETECTOR

DETECTOR I



a 6U technology demonstration

- › Test remote sensing
- › Act as „orbital software-testbed“
- › Investigate CONOPS

→ paving the way to DEBRIS and orbital servicing!

Space
Debris

DEBRIS
Probe

Far
Approach

Near
Approach

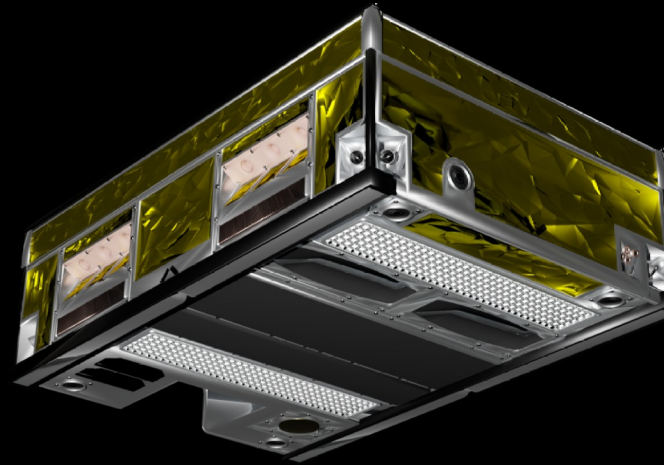
Remote
Sensing

Capturing

Influence

● DETECTOR

Question Time



Thank you for your attention!

Space
Debris

DEBRIS
Probe

Far
Approach

Near
Approach

Remote
Sensing

Capturing

Influence

DETECTOR