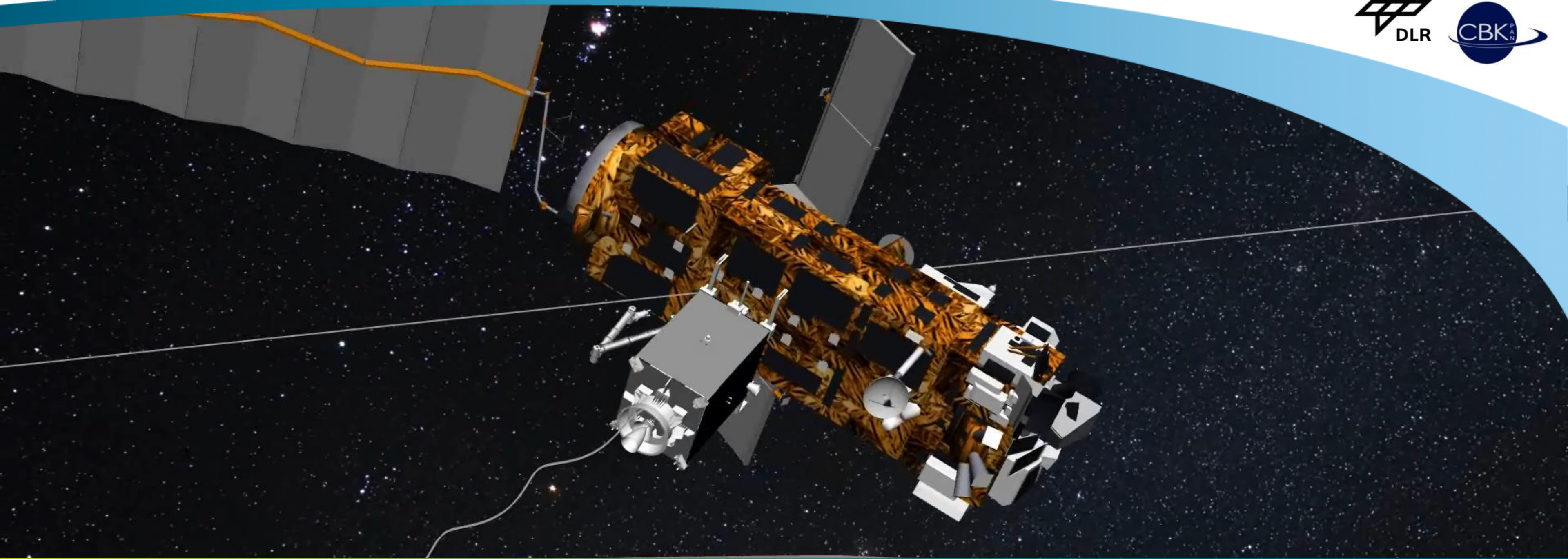
Marc Scheper, OHB System AG
24.05.2016, ESTEC Industrial Days



SPACE SYSTEMS

e.deorbit Phase B1 – System Overview

We. Create. Space.

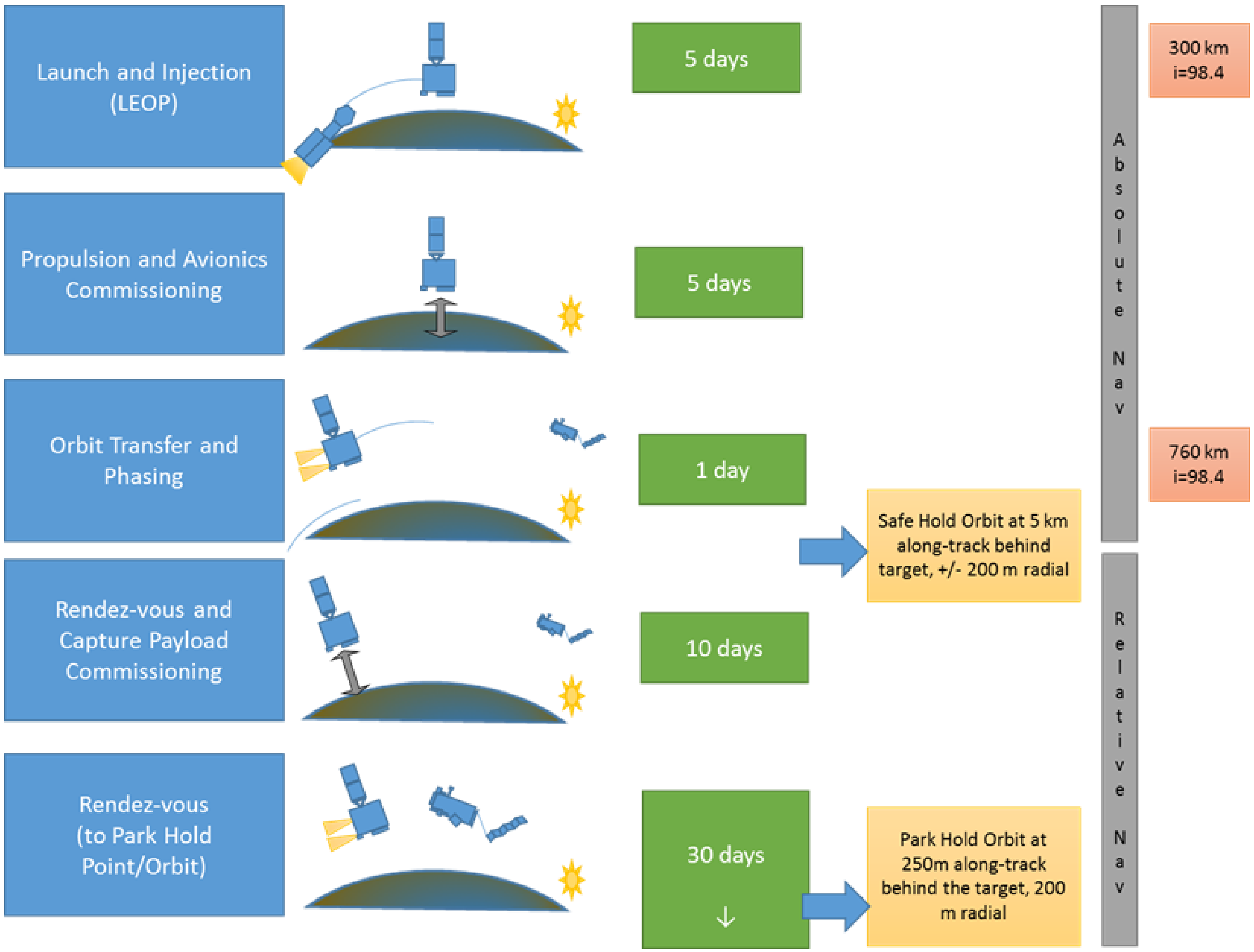
The consortium

Customer: esa

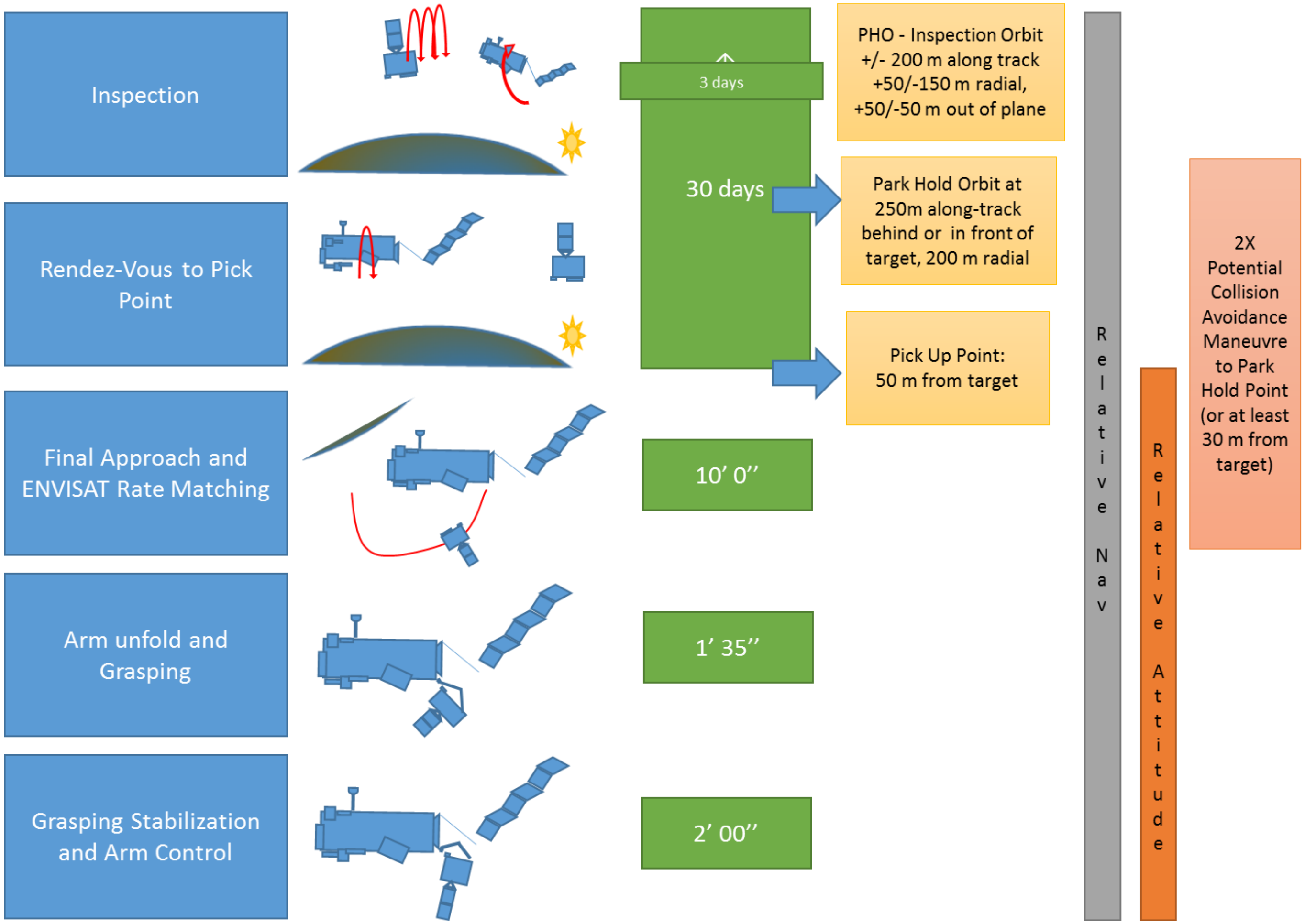
Prime Contractor (OHB): Requirements, Systems Engineering, Target Analysis, Mission Analysis, Operations Concept, Payload Architecture, Gripper, PA, DDV & Programmatics

- **Sub-contractor** (OHB Sweden): GNC
- **Sub-contractor** (Thales Alenia Space): Chaser Design, Comms Architecture, De-Orbit Analysis
- **Subcontractor** (DLR): Robotic Arm
- **Subcontractor** (MDA): Clamping Mechanism
- **Subcontractor** (CBK PAN): Clamping Mechanism & Gripper Support

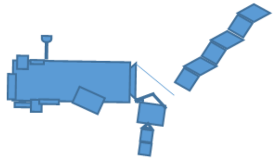
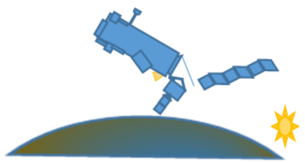
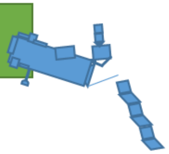
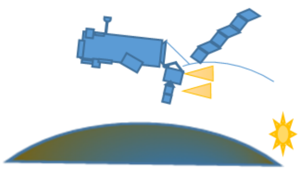
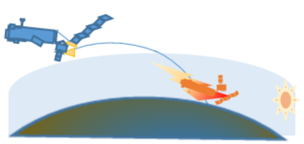
Mission overview



Mission overview



Mission overview

Capture (Clamping)		5/20'' (TBC)
Stack Stabilization (Sun Pointing)		2-5 h
Stack Commissioning and Thrust Calibration		5 days 
De-orbit manouvres (3 firings)		4 days (TBC)
Re-entry manouvre and Disposal (1 firing)		1 day (TBC)

Rel Att

Absolute Nav

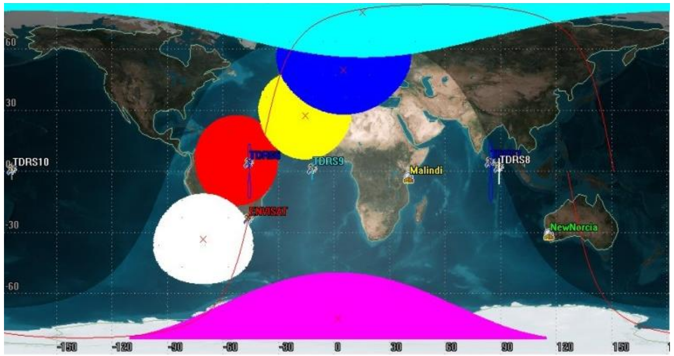
3 burns up to

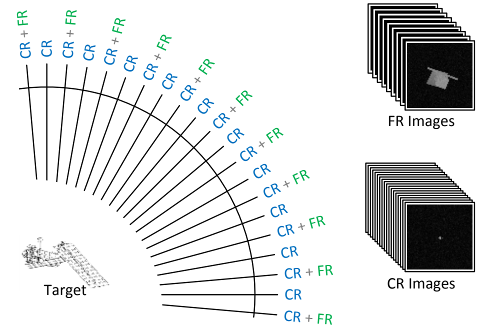
760 km
200 km

Last burn > Entry in atmosphere

System Trade-offs

Trade-off	Options	Baseline
Communications Architecture	• Relay architecture • Direct-To-Earth Communication	Direct-To-Earth Communication (Up- and Downlink in S-Band)
Rendezvous Payload Architecture	• Camera-based navigation • Lidar-based navigation • Combination of camera- and Lidar-based navigation	Lidar-based navigation
Inspection Data Generation and Downlink Strategy	• Both Cameras, active • Close-Range Camera • Far-Range Camera • Both Cameras active, selection of images • Configurable duty cycle	Configurable duty cycle



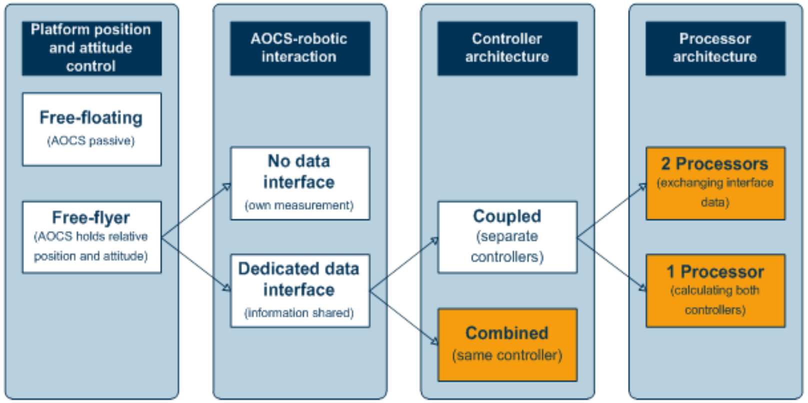


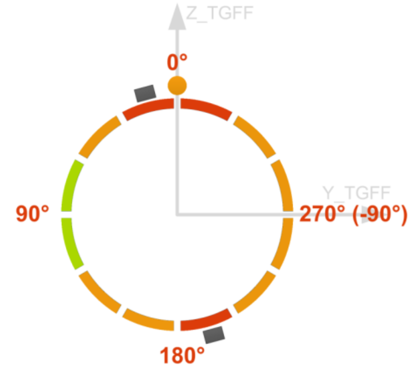
System Trade-offs

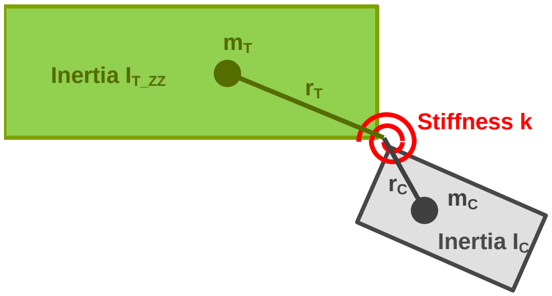
Trade-off	Options	Baseline

Control Architecture of GNC and Robotic Arm	• Combined control
	  • 1 processor
	  • 2 processors
	• Coupled control
		Coupled, 2 processors

Capture sequence	• Detumbling before rigidisation • Detumbling after rigidisation	Detumbling after rigidisation
Target clamping position	• Launch Adapter Ring (from 0° to 360°) • ENVISAT's body	Launch Adapter Ring (preferred at 90°)
Stack stiffness design (Width of clamping mechanism)	• 300 mm • 430 mm • 540 mm • 650 mm	650 mm

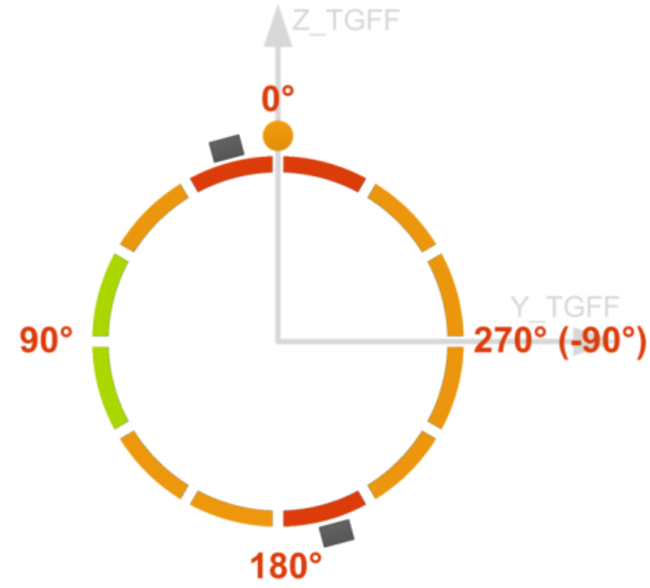


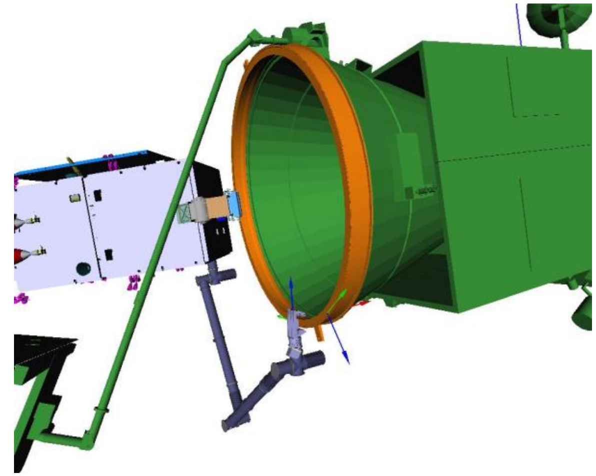




Target clamping position

Aspect	Clamping on LAR	Clamping elsewhere
Knowledge of exact geometry	Good	Poor
Mechanical stiffness of I/F	High	Medium
Knowledge of mechanical stiffness	Good	Poor
Achievable stack stiffness	Medium – High	Medium
Thrust alignment with stack CoM	Possible	Possible
Attitude control authority	High	Medium
Stack attitude during manoeuvres	Feasible	Favourable
Technical design of Clamping Mechanism	Delta design of existing Breadboard	New design





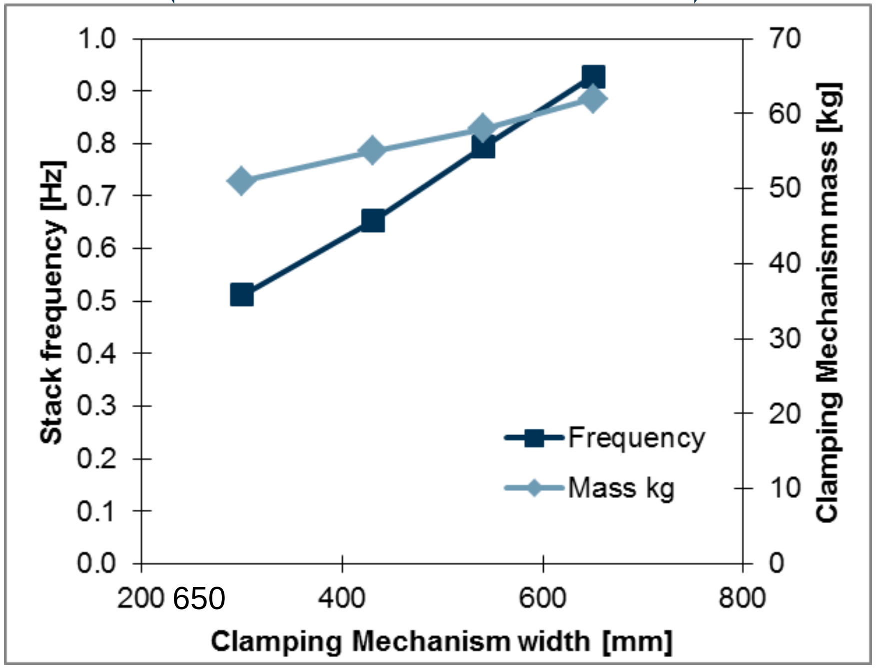
Stack Stiffness Design

Simple GNC Design

High stiffness

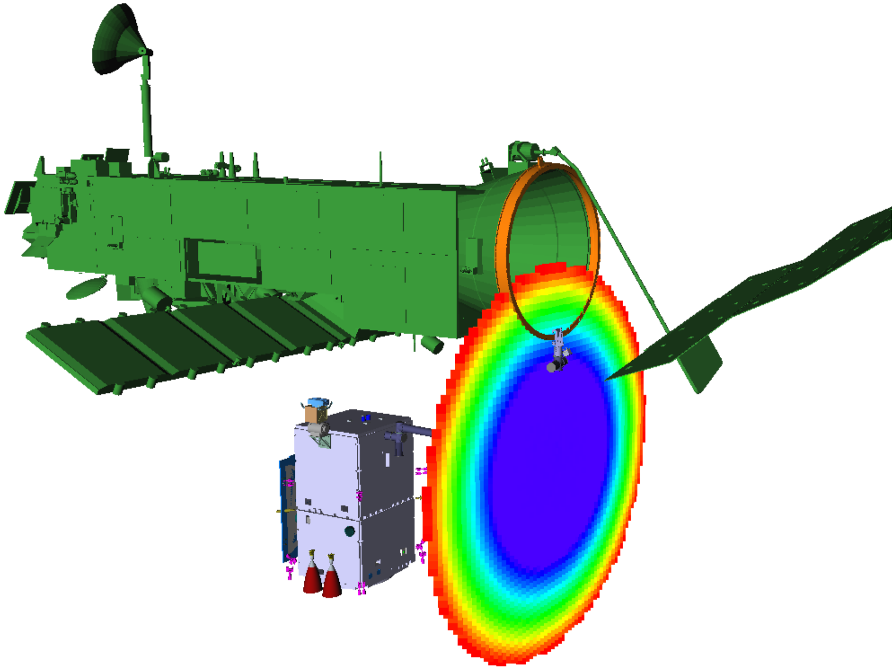
Low stiffness

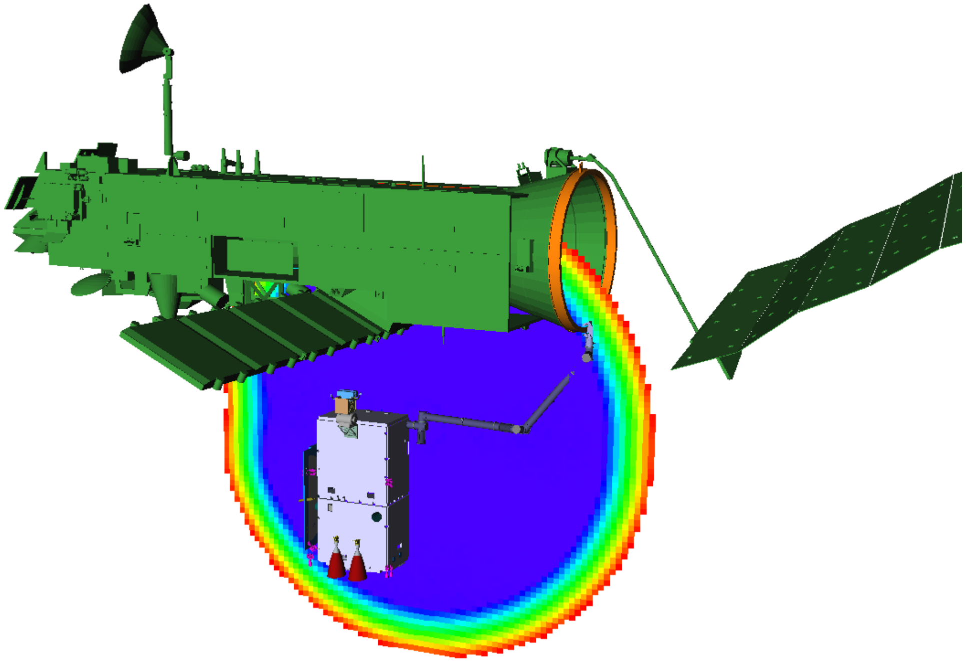
Low mechanism mass



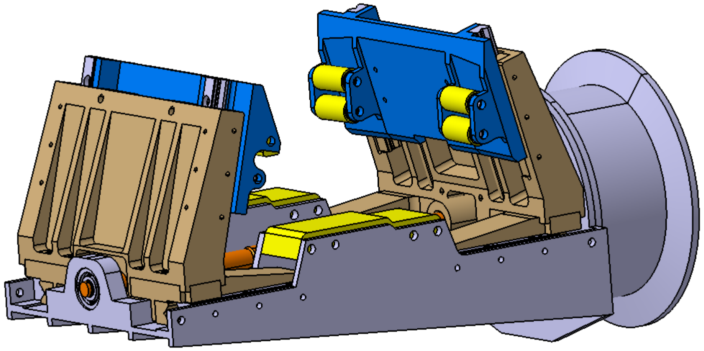
Reachability: Capture Configuration

- Analysis of arm capability for specific configurations (grasp, clamp)
- Feasible clamping positions

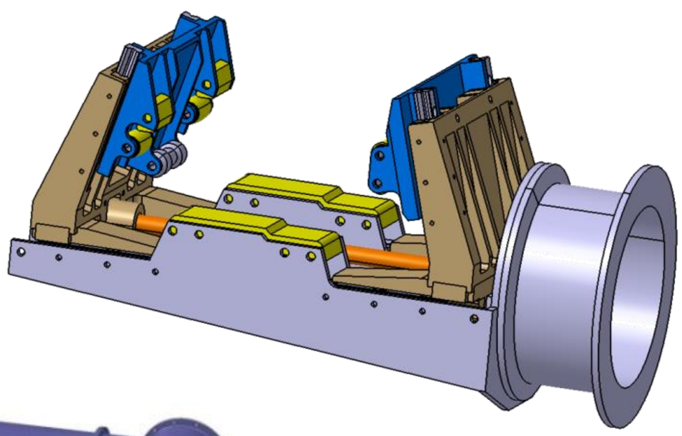


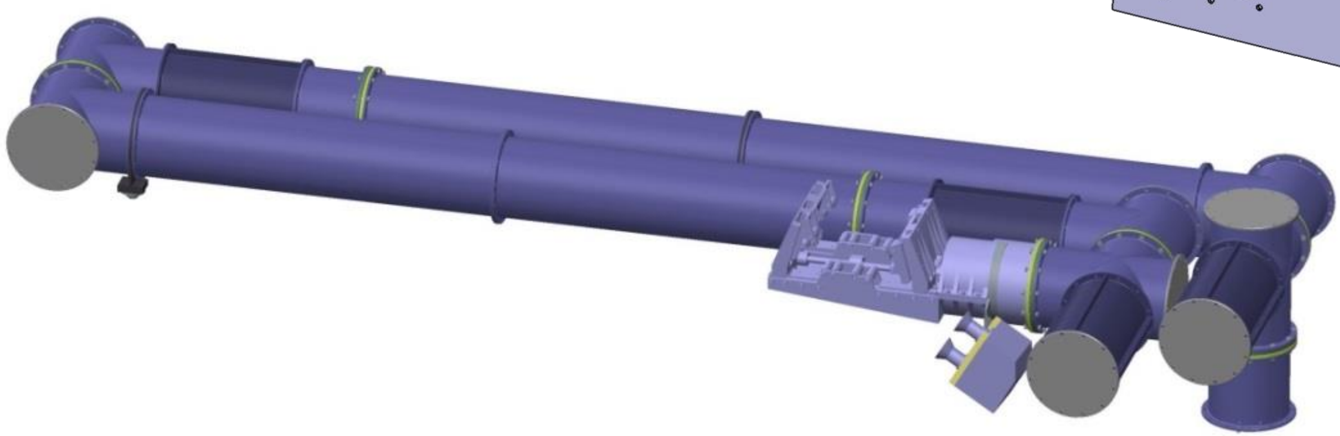


Gripper design

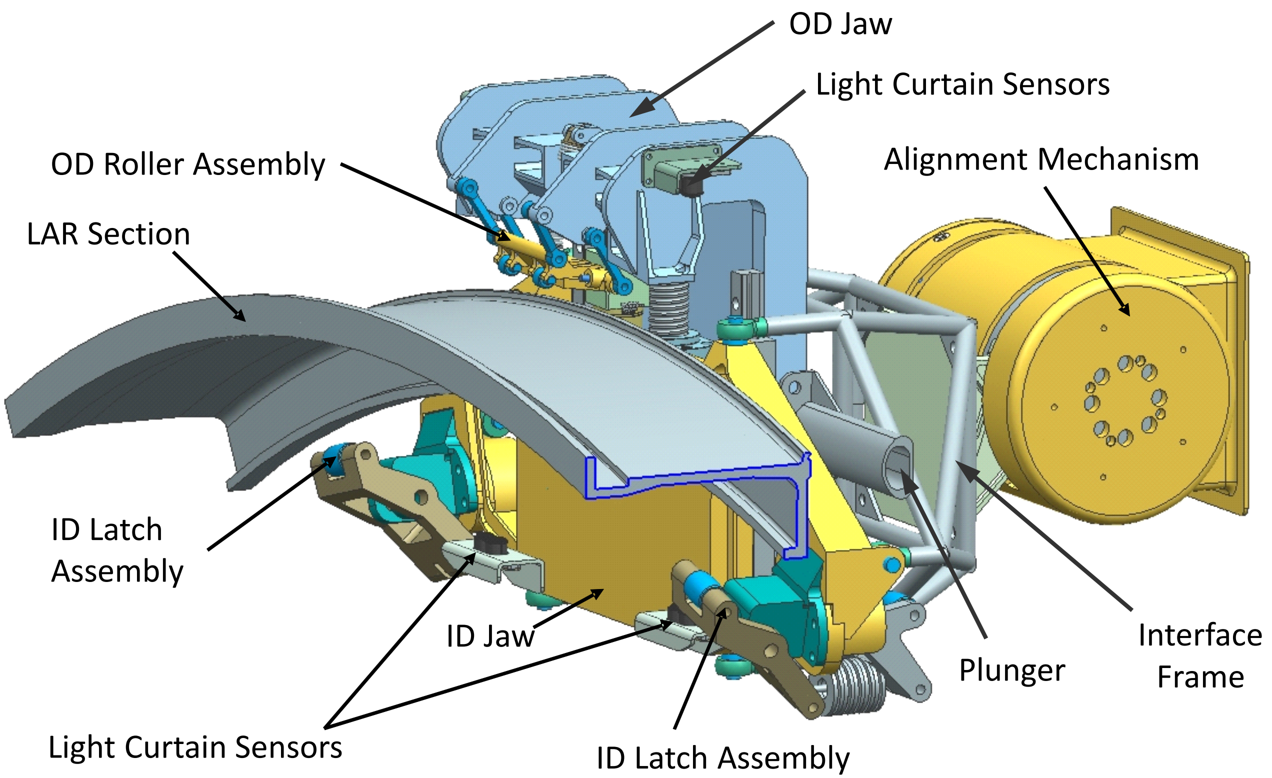


- Two spindle driven gripper brackets on spindle with right and left thread
- Spring driven, inclined (15deg) grip jaw on each grip bracket
- Contact between gripper and LAR only on dedicated rolls
- Motor with internal break and gear (TBC)

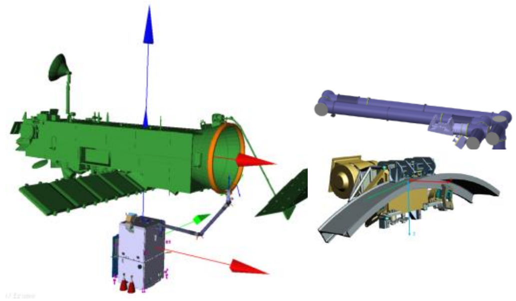




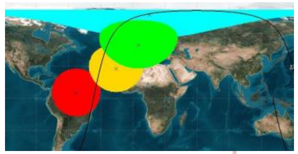
Clamping Mechanism Overview



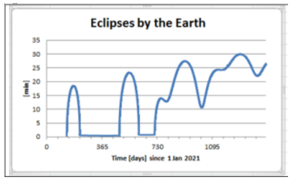
Main Chaser Design Requirements and Constraints



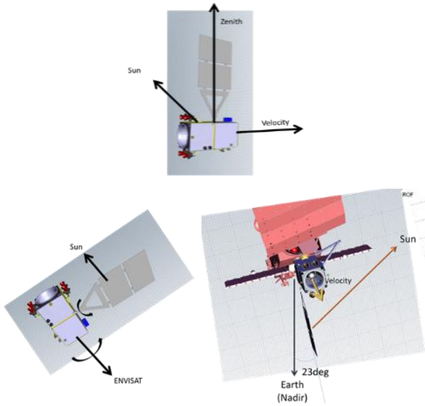
Capture Technique and related equipment
(Robotic Arm, Clamping Mechanism, Battery powered capture)



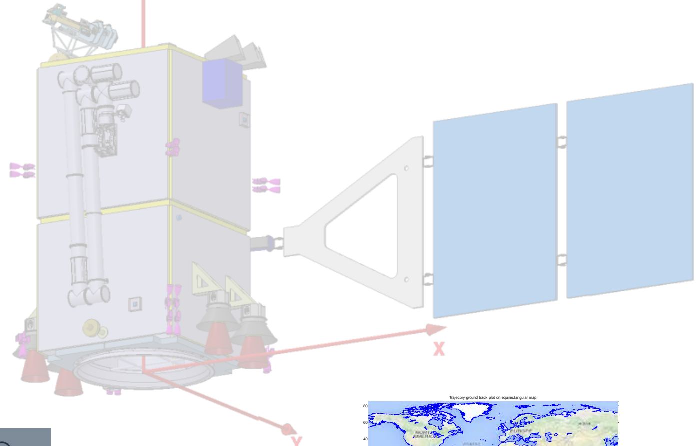
Communications

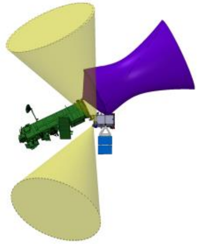


Mission Timeline
(80º-45º Beta Angle, 3-6 month Duration)



Chaser Attitude
(from Optical Sensors reqs, Thrust Direction, Earth/Sun position)

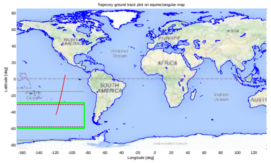




Stack Configuration
(ENVISAT SA uncertainties, Blockage for Sun on SA and Earth comms)

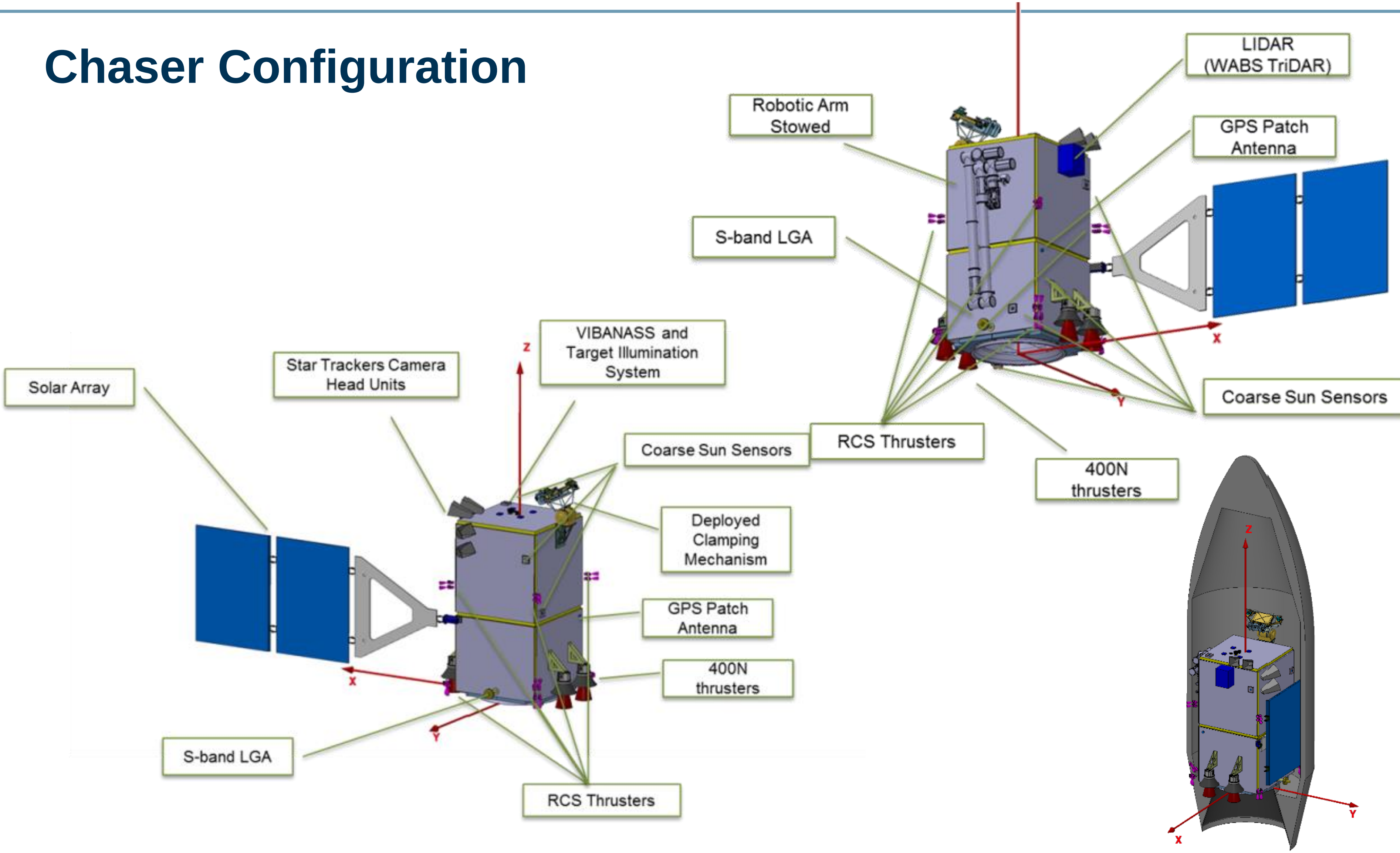
Inspection, RdV and other Sensors Req's
(Field of View, Generated Data)

Cost and Schedule Constraints
(target cost, launch 2021/24)



Risk Reduction
(risk of collision, risk of casualties, programmatic risk)

Chaser Configuration



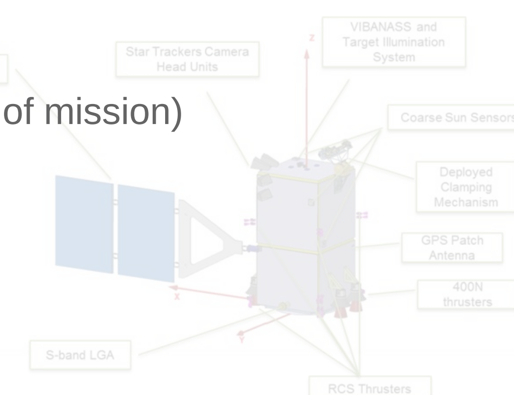
PLATFORM (1/2)

Structure:
- Based on PRIMA platform
- SVM with central cone and platform equipment accommodation
- PLM with cruciform panels, tanks and payload support

Thermal Control
- Passive Concept (MLI on external side, radiators, electrical resistance heaters controlled by thermistors)

Electrical Power:
- Solar Array Wing, 2 panels, 1140 W EOL, 4,2 m^2 (4,15 x 1,73 m)
- SADM to have maximum illumination
- Li-Ion Battery 1541 Wh EOL
- 28 V unregulated Power Bus

Attitude and Orbit Control
- 4 Star Trackers (1+1 first half of mission, 2+2 during inspection, 1+1 end of mission)
- 7 Coarse Sun Sensors
- Accelerometers and Gyros
- GPS Receivers and Antenna (1+1 antenna for different attitude)



PLATFORM (2/2)

Propulsion
- 2 tanks fuel MMH, 2 tanks oxidizer MON, 1 tank pressurant He
- 2+2 400 N thrusters (LAE)
- 10+10 22 N thrusters (RCS)

Telemetry Tracking & Command:
- S-band architecture (transponders, RFDN)
- 2 LGA with supports for omnidirectional coverage

OBDH
- Main Functions: Standard OBDH Platform-level functions (C&DH, HK data, etc.), GNC Control with PDPU inputs during relative nav., Storage of Inspection and other Payload data
- Spacecraft Management Unit (SMU), platform MIL-STD-1553B bus and P/L SpaceWire bus
- Mass Memory 64 Gb BOL

Main Characteristics
- Mass: 1650 kg target mass, 755 kg target dry (current 830 kg)
- Size (spacecraft body): 2.6 x 1.35 x 1.35 m