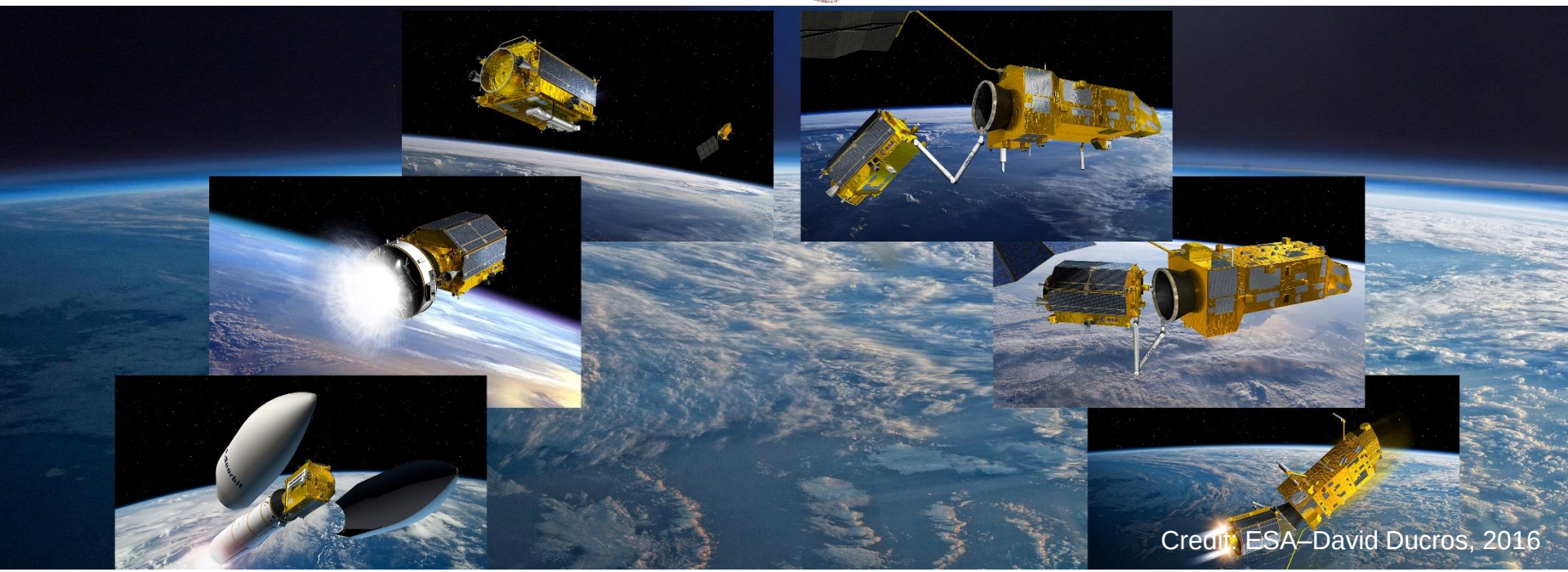
e.deorbit Phase B1 and Consolidation Phase



Development of the clamping mechanism

for Active Debris Removal missions

Aeroespacial

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Agenda

1. **Introduction**

2. **Clamping scenarios**

3. **Overview of the clamping mechanism**
   - *Clamps with Fixing Mechanism*
   - *Alignment Mechanism*
   - *Sensors*

4. **Summary of development process**

5. **Future activities**

Introduction

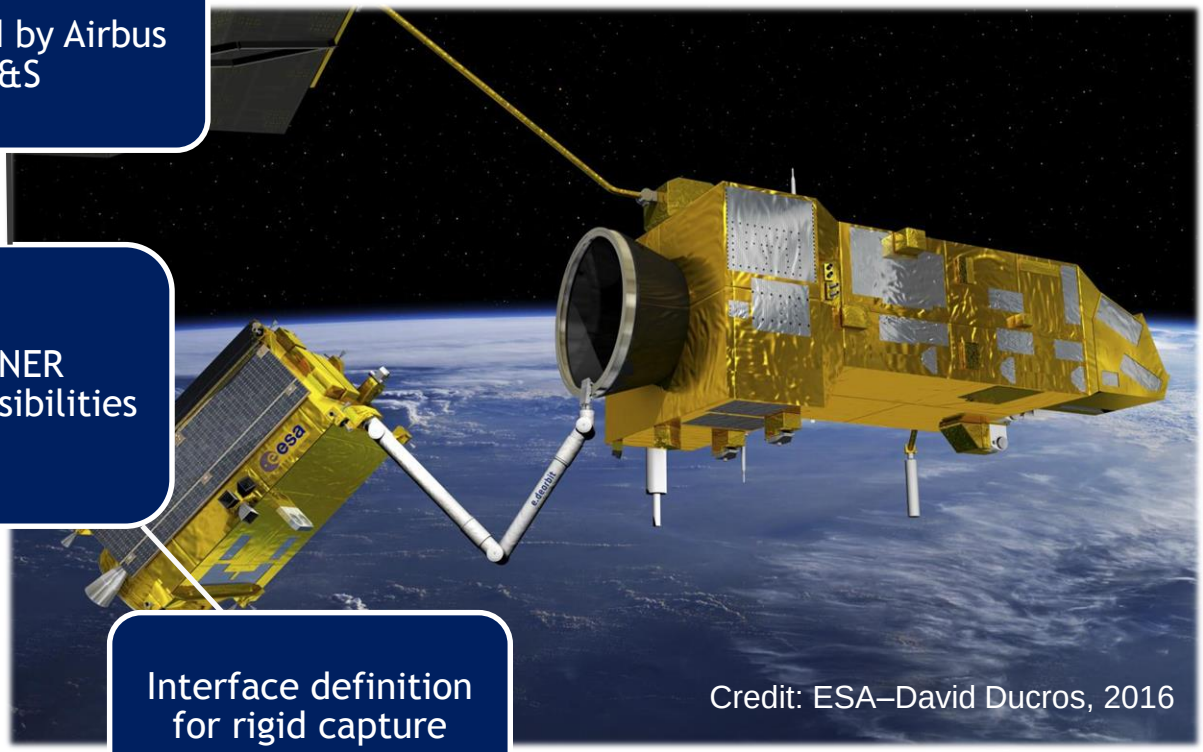
e.Deorbit Phase B1 and Consolidation Phase

Study led by Airbus D&S

SENER responsibilities

Design and development of the clamping mechanism

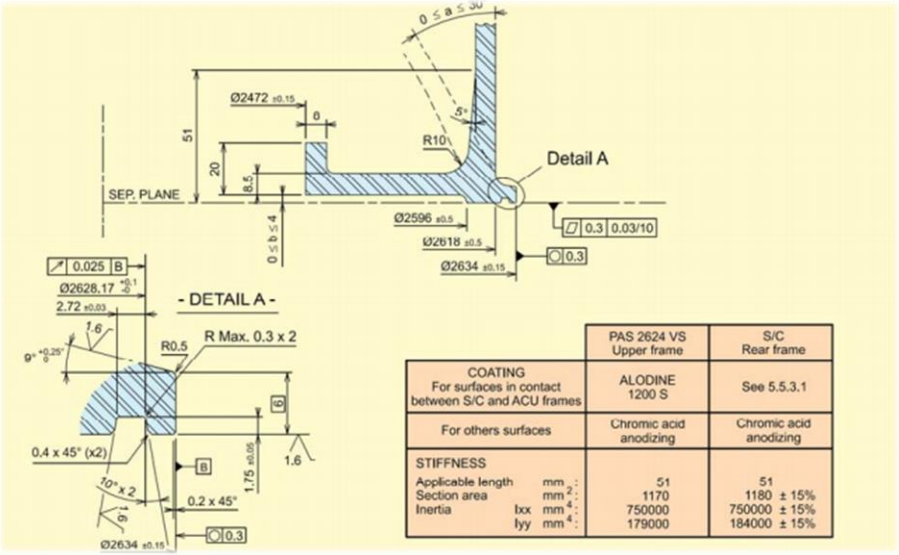
Interface definition for rigid capture



Clamping scenarios

Interface: Launch Adapter Ring (*PAS 2624VS*)

- Alternative scenarios examined in the Phase B1 including Envisat's HDRMs
- LAR turned to be the most suitable solution as it provides **stiff, clean and unambiguously defined** interface



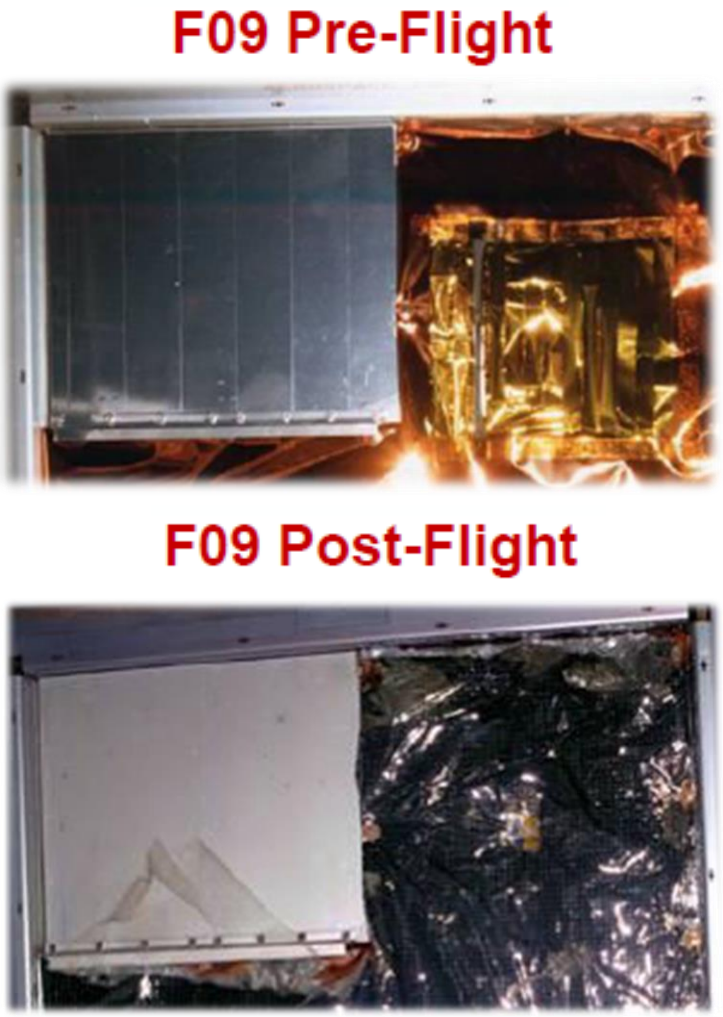
	PAS 2624 VS Upper frame	S/C Rear frame
COATING For surfaces in contact between S/C and ACU frames	ALODINE 1200 S	See 5.5.3.1
For others surfaces	Chromic acid anodizing	Chromic acid anodizing
STIFFNESS		
Applicable length mm	51	51
Section area mm²	1170	1180 ± 15%
Inertia Ixx mm⁴	750000	750000 ± 15%
Iyy mm⁴	179000	184000 ± 15%

LAR interface on the spacecraft's side

Clamping scenarios

LAR degradation:

- Contribution to **degradation of silvered Teflon layer during handling has to be considered** (risk of debris generation)
- **Degradation impacts on optical properties** (the exposed leading edge blanket surfaces appeared uniformly foggy or clouded - impacts optical & thermal properties of the LAR)
- **Teflon degrades when samples are exposed to both AO and UV radiation.** It was confirmed during LDEF mission where the sun-exposed Teflon has shown the increased signs of degradation.
- **Decrease of tensile strength** of Teflon (30%) and its elongation (25%).



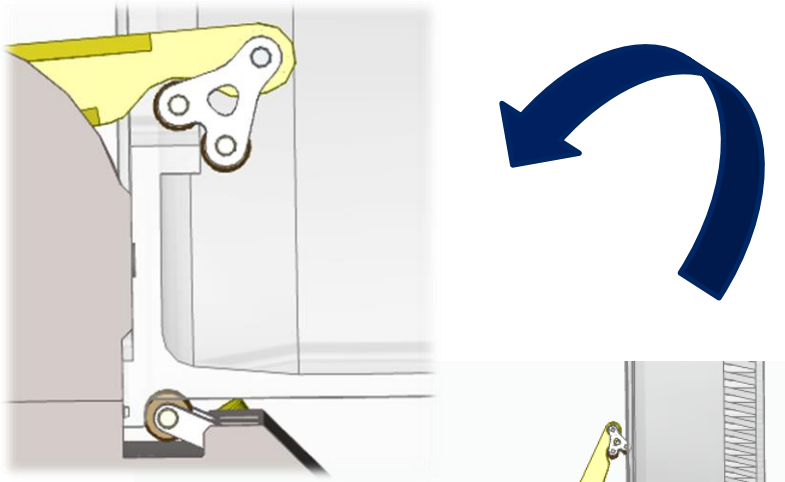
Pre and post-flight pictures of the radiator panel covered with the silvered Teflon coating

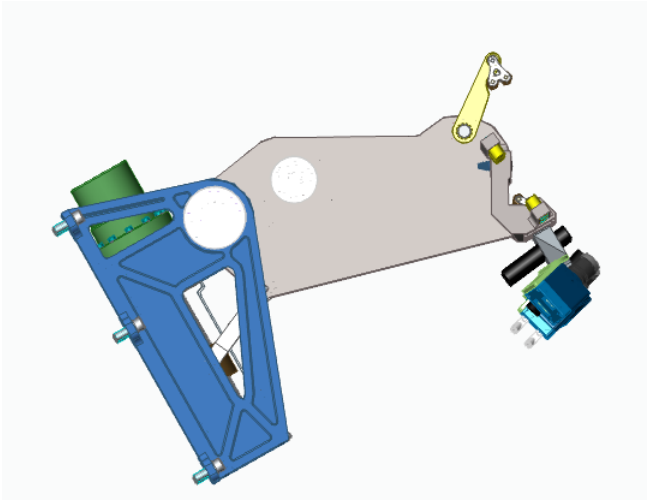
Clamping scenarios

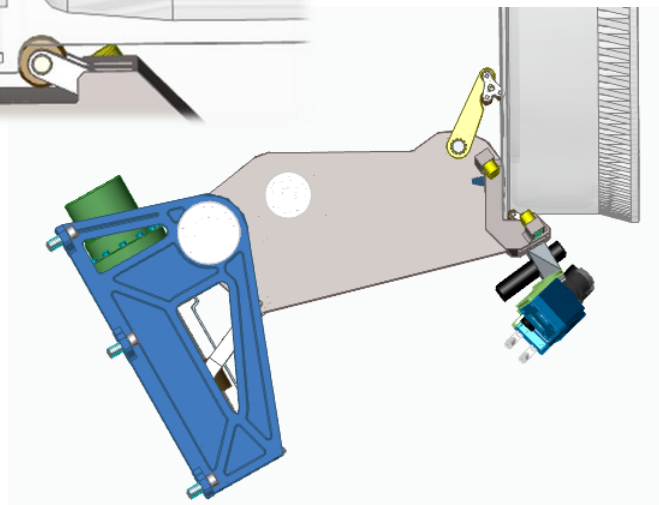
Selected approach to the LAR

- Approach leads to the edge of the LAR first – better from the operational as well as from the clamps self-alignment points of view

- Relatively low risk of hitting solar array boom or solar array itself





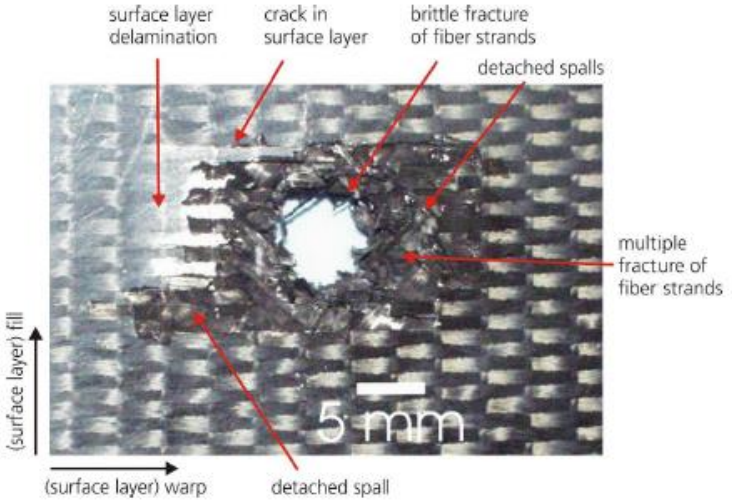


Clamping scenarios

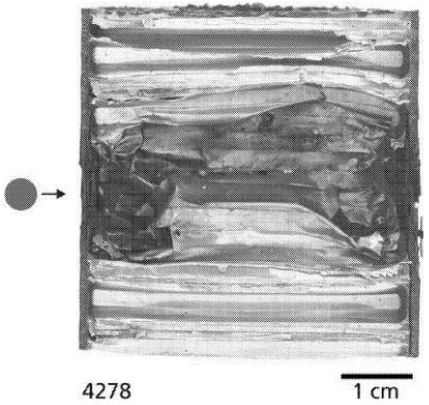
Structural Degradation of ENVISAT

CFRP degradation:

- **Degradation of CFRP due to atomic oxygen seems to be insignificant** as particles density in Envisat's orbit is relatively small, maximum erosion is expected to **be lower than 50 µm** (the same material was tested during LDEF mission).
- Analysis performed in the SPENVIS software indicated that the atomic erosion of epoxy is approximately 50 times lower in case of Envisat than in case of LDEF.
- **Collision with debris or micrometeoroids may result in significant degradation of CFRP**: fiber breaking, matrix breakage, and layer delamination.

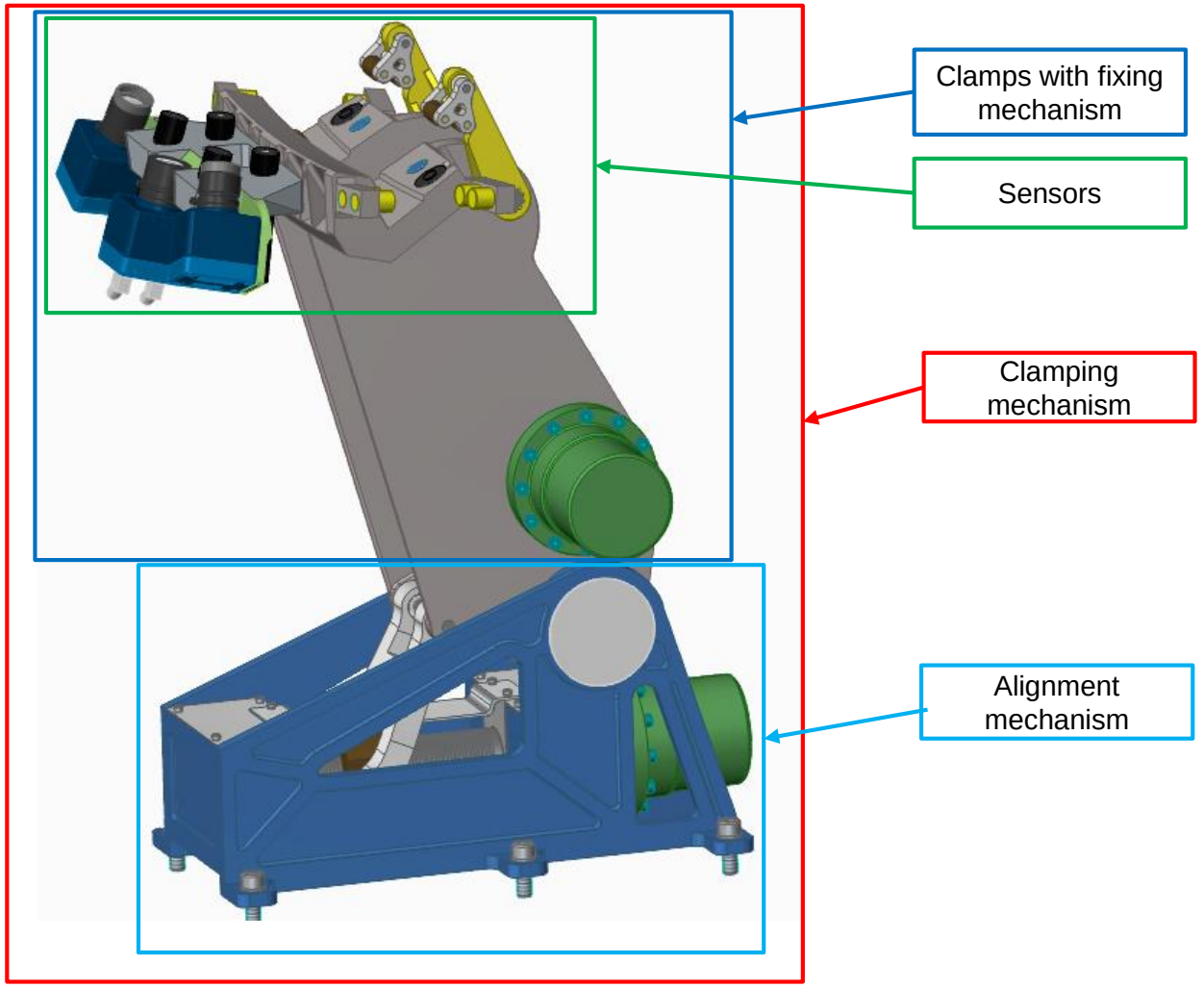


Example – debris damage due to 3 mm Al-sphere at 4550 m/s



Example – debris damage due to 3 mm Al-sphere at 4490 m/s

Overview of the clamping mechanism

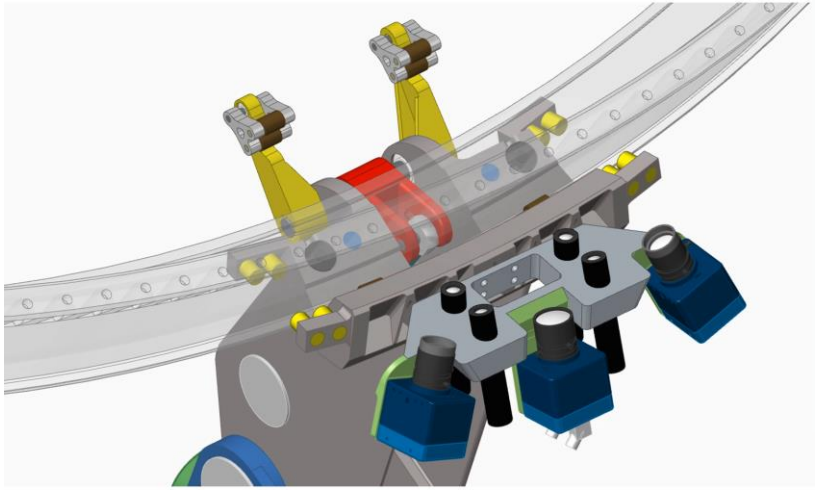


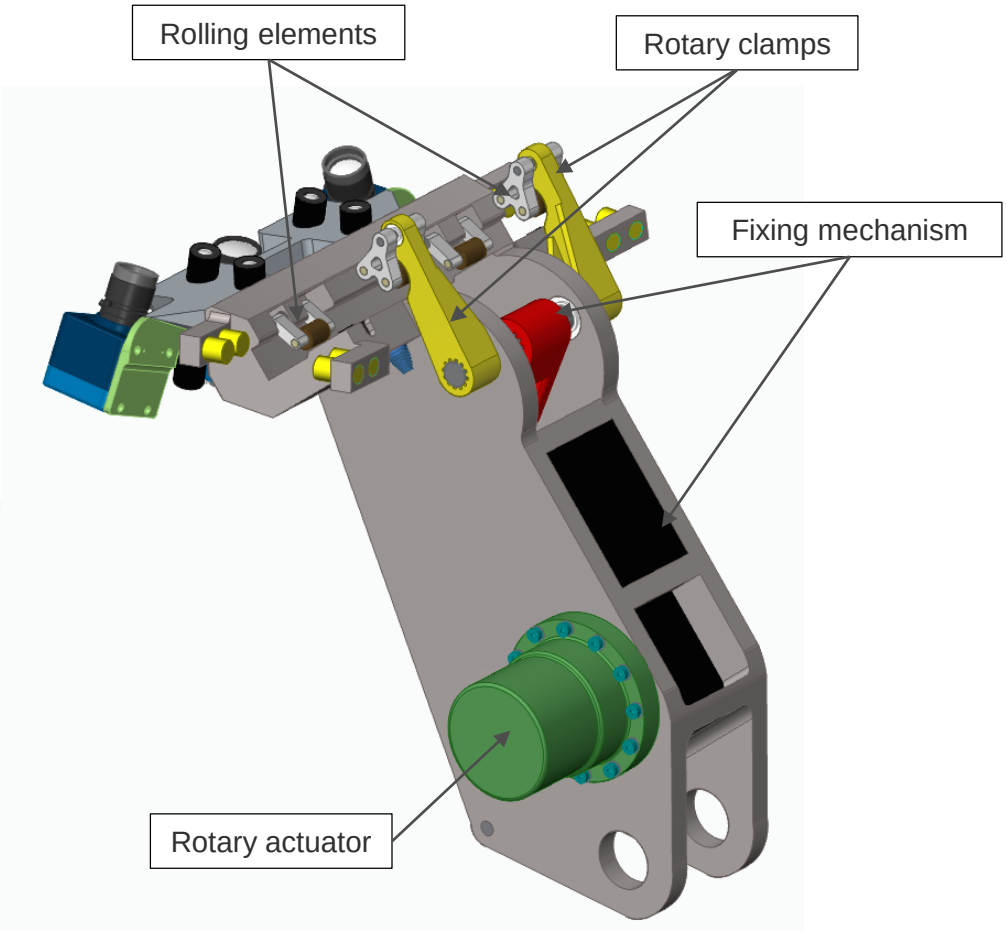
Overview of the clamping mechanism

Clamps with Fixing Mechanism

The clamps' main components:

- Space Tug to target interface (Launch Adapter Ring – LAR interface)
- Rotary actuator
- Fixing and preloading mechanism (incl. linkages and lead screw)



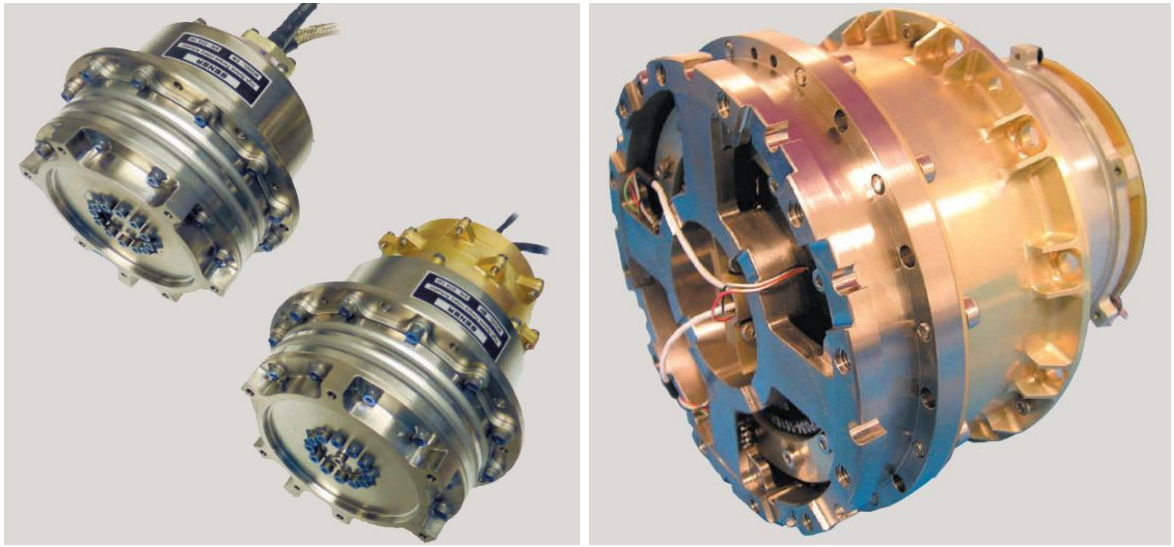


Overview of the clamping mechanism

Rotary actuator– SENER's heritage

Existing development:

- Harmonic Drive Rotary Actuator (HDRA, achieved TRL 9 in previous projects)
- Motorized Robotic Hinge (Engineering Model – TRL 5-6 can be assumed)



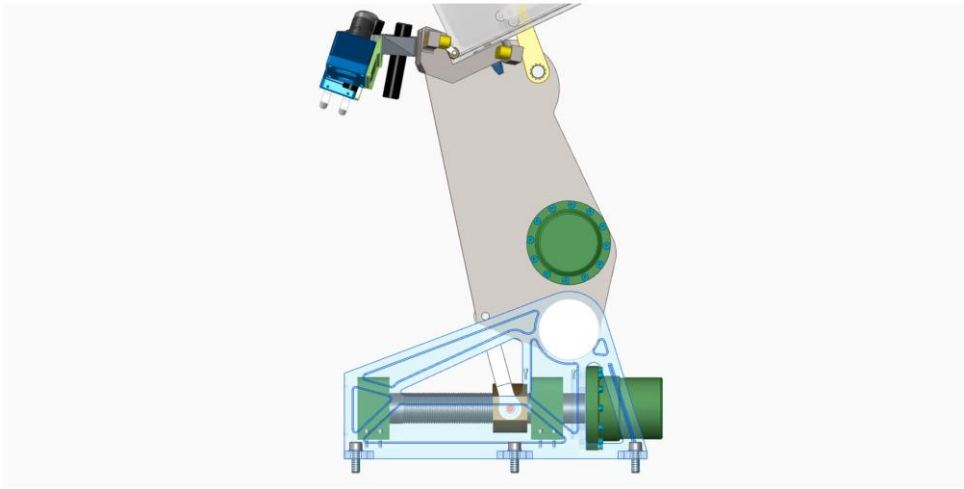
Detent Torque Actuator – DTA (left) and Robot Motorized Hinges – RMH (right)

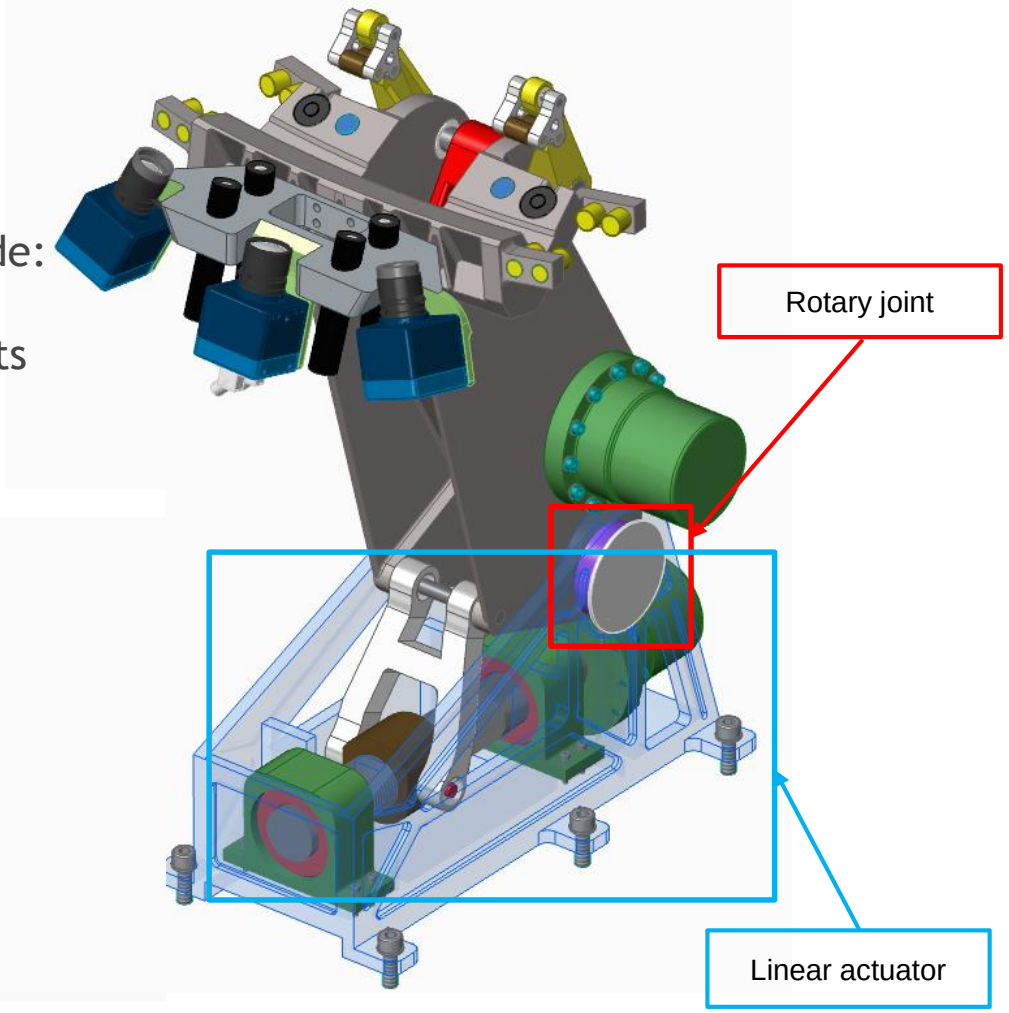
Overview of the clamping mechanism

Alignment Mechanism

Provides ability to align Envisat's and chaser's CoGs before de-orbit burns.
The mechanism's main components include:

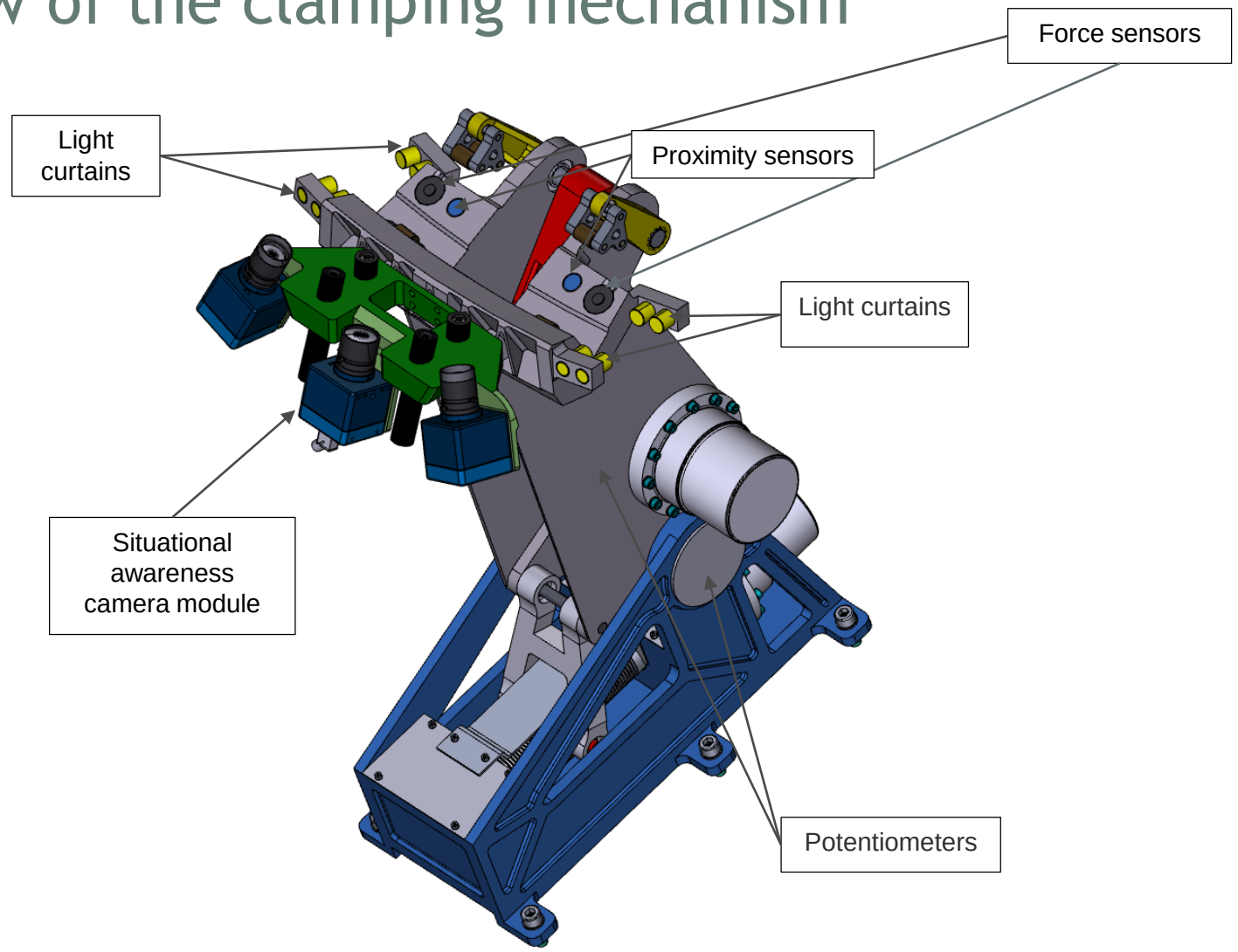
- Linear actuator (with link that connects its carrier with the fixed clamp)
- Rotary joint



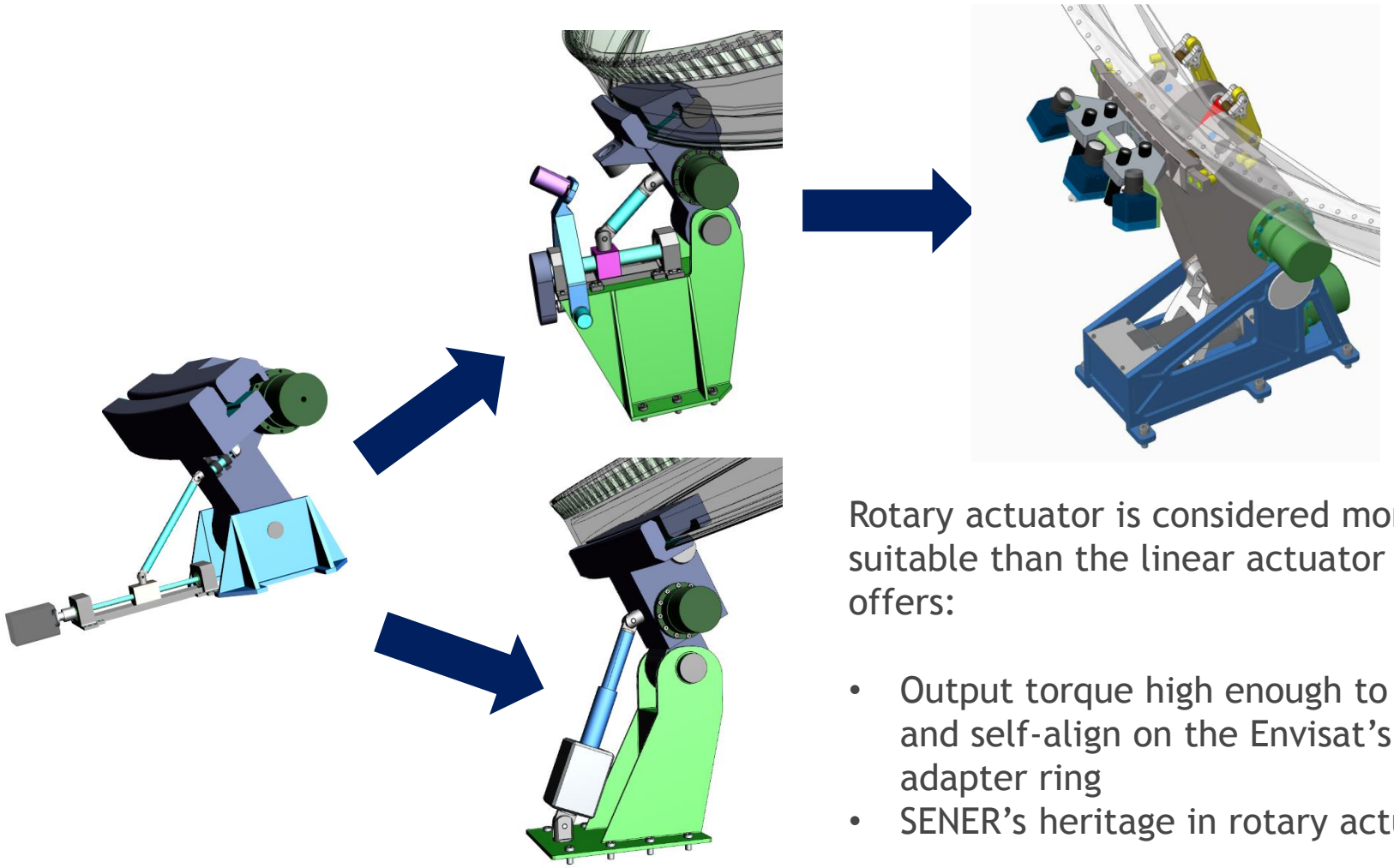


Overview of the clamping mechanism

Sensors



Summary of the development process



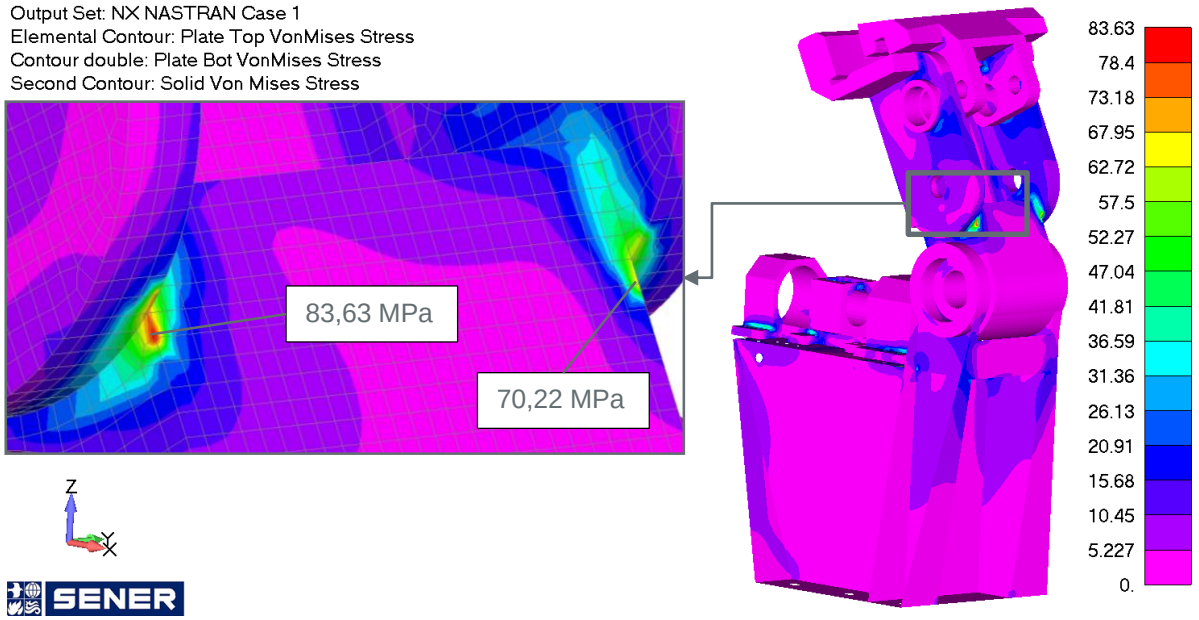
Rotary actuator is considered more suitable than the linear actuator as it offers:

- Output torque high enough to clamp and self-align on the Envisat's launch adapter ring
- SENER's heritage in rotary actuators

Future activities

Finalisation of e.deorbit study:

- Update of the structural analyses
- Further optimisation of the design
- Thermal flux analysis



Sample results of structural analysis from the previous phase

Dziękuję
Thank you

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