PRE-DEVELOPMENT OF A CLAMPING MECHANISM FOR ADR

Cleanspace Industrial days 24-26/10/2017

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SET-UP IN 2006

HIGHLY QUALIFIED PERSONNEL
(80% MSc, MEngs and PhDs)

TÜV CERTIFICATES
ISO 9001
EN 9100

+3000 m^2 FACILITIES

- Clean room
- Temperature controlled assembly rooms
- Work-shops
- 5-axis CNCs

MODELLING DETAILED-DESIGN ANALYSIS PROCUREMENT MANUFACTURING ASSEMBLY INTEGRATION TEST

"OUR SUCCESS OUR PEOPLE"

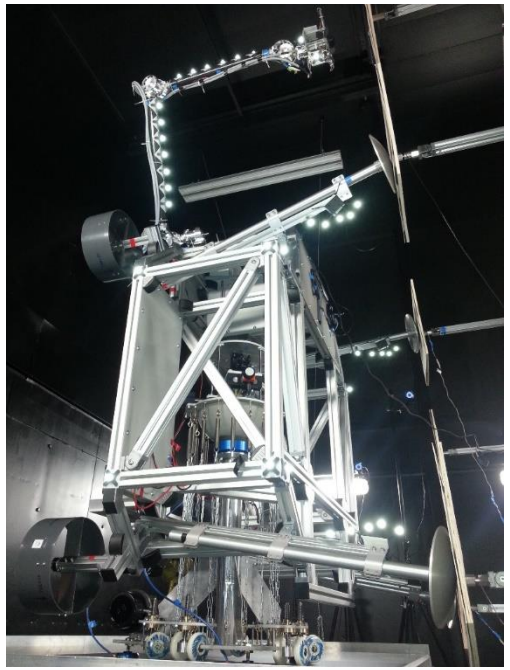
"FROM CONCEPT TO COMMISSIONING"

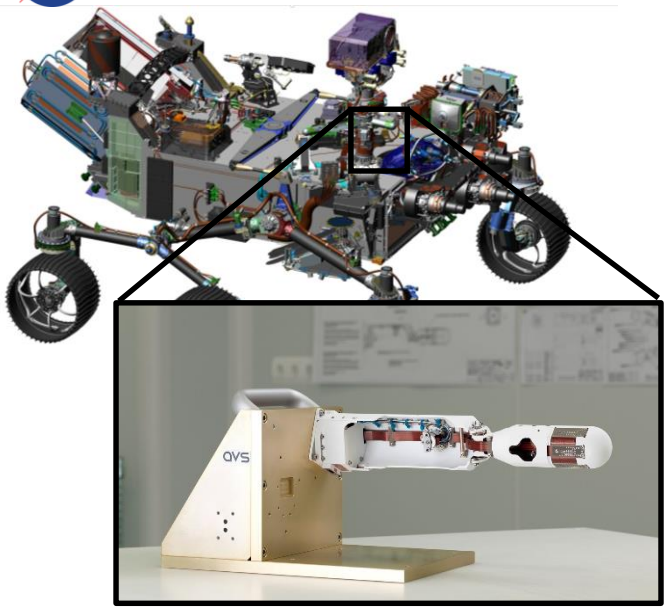
KNOW-HOW

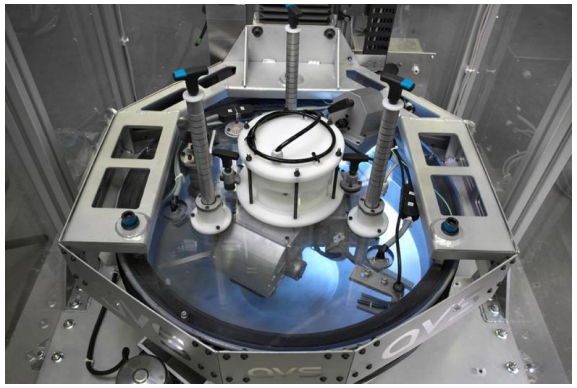
CRYOGENICS UHV - VACUUM RADIATION PRECISION MICRO-MECHANICS LARGE-MECHANICS OPTO-MECHANICS

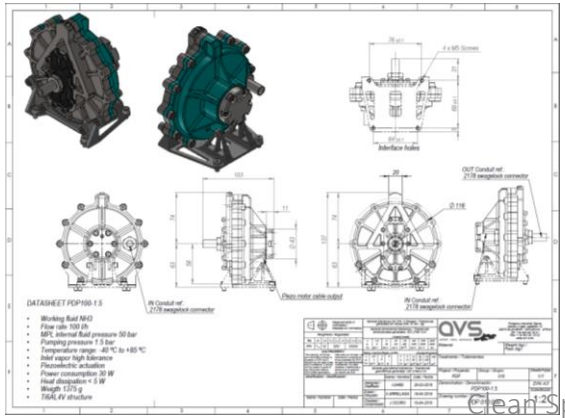
SPACE

EXPLORATION SCIENCE EARTH OBSERVATION TELECOM CUBESATS GROUND SUPPORT EQUIPMENT ELECTRIC PROPULSION









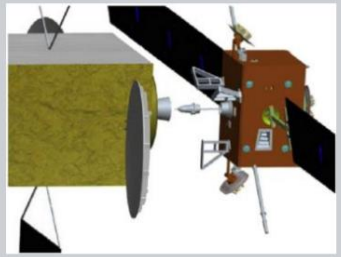
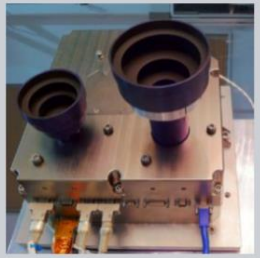
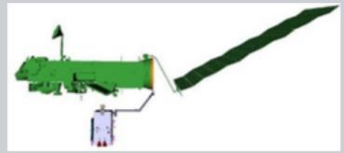
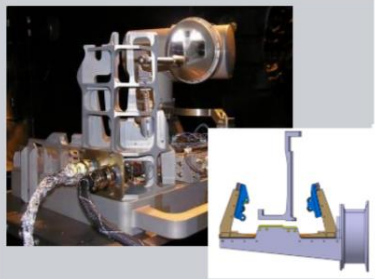
OHB

Leading player in Europe's space business and in particular in the development of scientific payloads & instruments.

Specific experience directly related with this activity higlighted in the table:

Concepts and Products for Orbital Robotic Systems

Capture, Manipulation, Docking, Servicing and De-orbiting

Orbital Life Extension	Orbital Servicing	Vision-based Navigation	Deorbiting	Gripping, grasping and manipulation
				
• OLEV: ESA co-funded study led by OHB for orbital life extenson vehicle • Robotic P/L: Vision-based approach, capture and docking • BB docking tests performed (TRL4)	• DEOS: OHB-led Phase A/B1 mission study (TRL3) • DEOS Phase B2: Design concept for a Berthing and Docking mecha-nism (TRL3)	• VIBANASS: Versa-tile rendez-vous and docking ca-mera system incl. illumination (TRL4) • three ranges • Op. temperature: -40 … 60 degC • Lifetime: 12 years	• eDeorbit: Phase B system study for approach, capture and de-orbiting of a non-cooperative satellite (ENVISAT) • Sound mission concept including MAIT developped (TRL3)	• ROKVISS robotic arm installed on ISS: led by OHB (TRL9) • OHB-internal con-cept study for self-adapting LAR gripper (TRL3)

Recent developments: eDeorbit, LAR Gripper, DEOS, VIBANASS, ROKVISS, OLEV

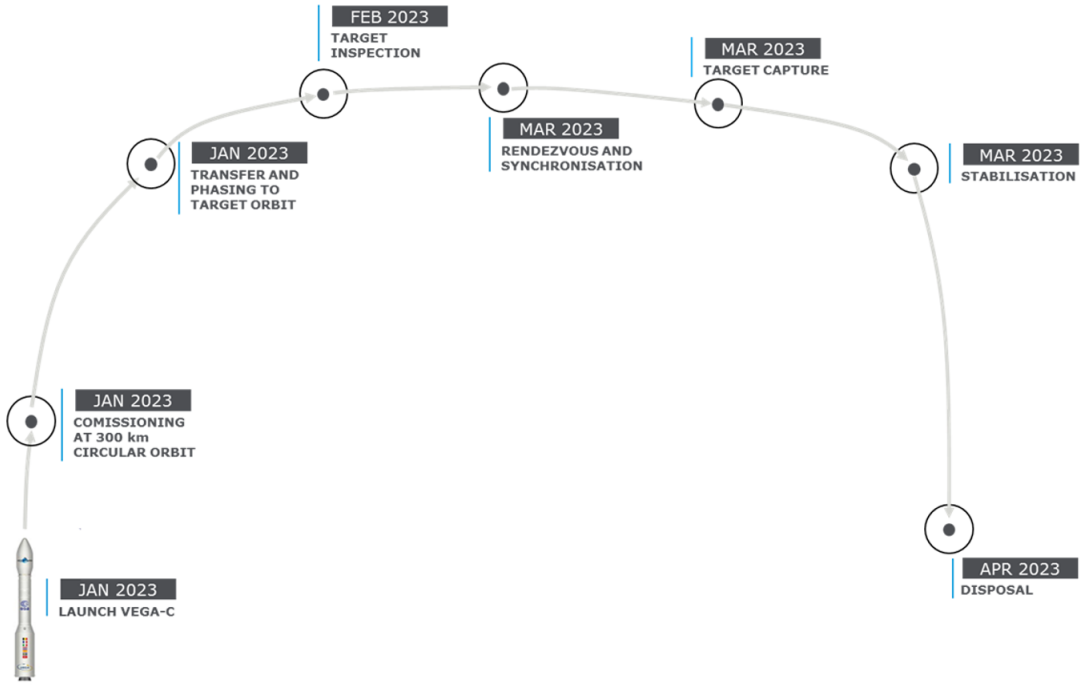
Flight heritage: ROKVISS

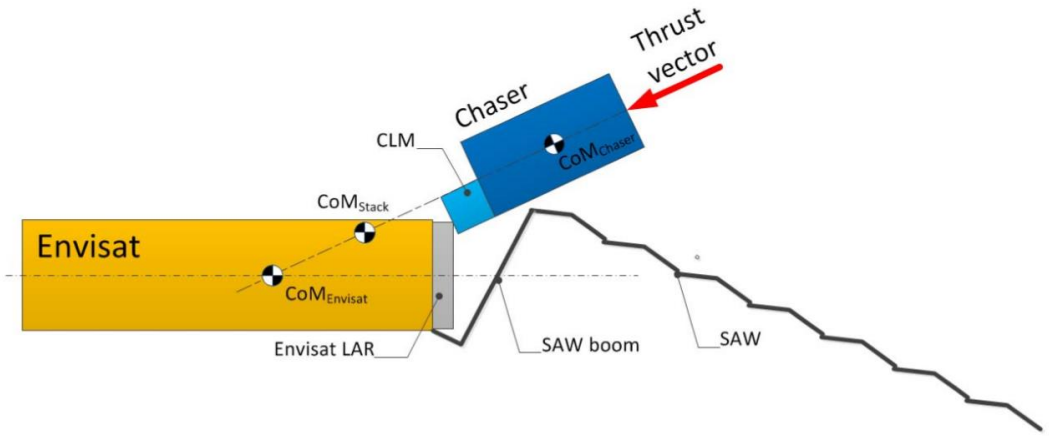
Mission background

Introduction

ESA's Clean Space Initiative for the sustainable use of space

- e.Deorbit mission: capture Envisat and remove it from LEO protected zone
  - Chaser S/C equipped with of robotic arm to grasp & maouvre
    - High thrust to controlled re-entry
      - **Clamping mechanism** (CLM) needed to withstand the loads





… e.Deorbit mission *delayed*

but development still relevant
(potential application to Space Servicing Vehicles)

Objectives of the activity

Main objectives of the activity:

- To design a clamping mechanism (CLM) for clamping a chaser spacecraft to an interface on a Launch Adapter Ring (LAR) of Envisat spacecraft during a debris removal mission. The design shall allow maturation into space-flight comparable design.
- Manufacture a breadboard of the CLM
- Test the breadboard of the CLM
  - Functional
    - Clamping & un-clamping to the LAR with residual positional error & loads
    - Repositioning of the chaser-target S/C under load
  - QSL in clamped position
  - Stiffness test

Target TRL at the end of the activity: **TRL 4** by the **end of 2018**

Framework

- Previous developments of the Clamping mechanism during mission studies (Phases A & B1)
  - ESA set current activity under **TRP** program
    - Proposal **lead by AVS** with the **collaboration** of **OHB** selected

Activity coordination
Design & development
Manufacture & Assembly
Test

Internal customer role (system engineering & mission control)
Advice & relevant knowledge transfer

Main challenges

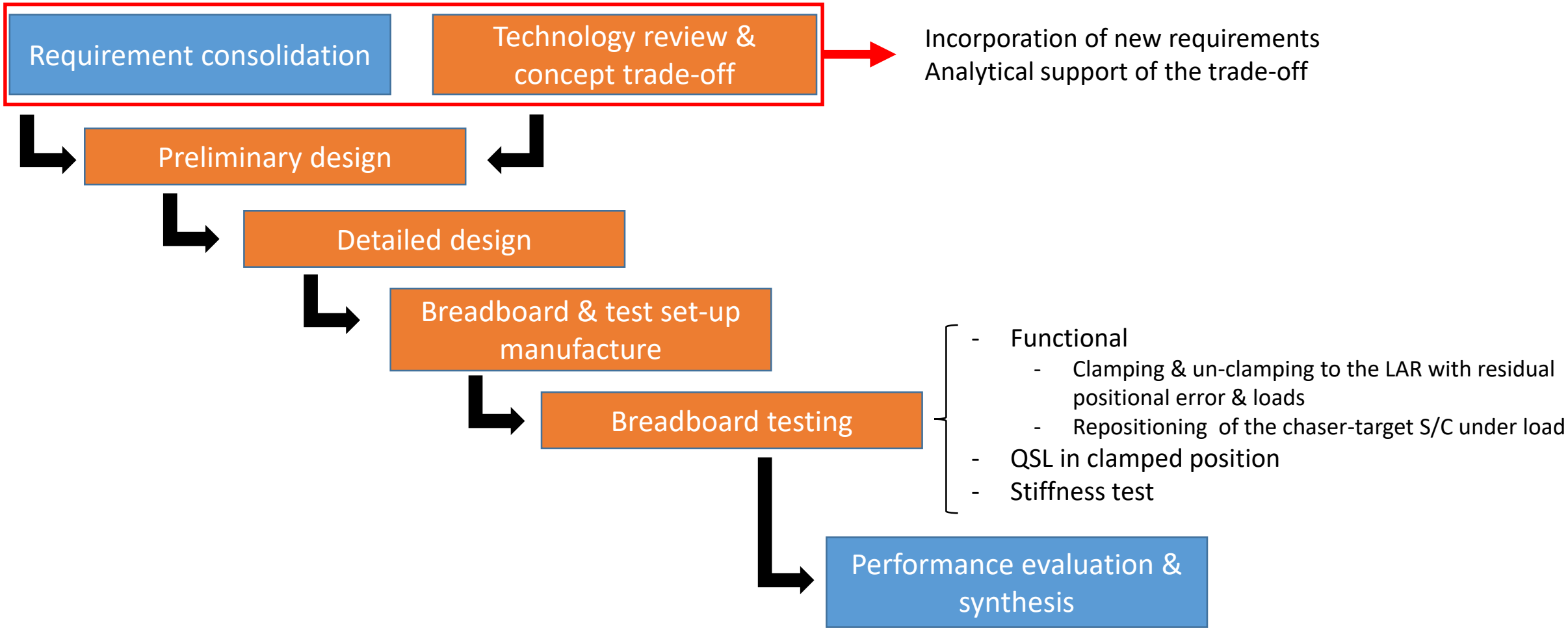
High complexity of the task:

- Uncertainties regarding the status of the LAR surface
  - Dents from MMOD collisions
  - Presence of reflective metalized polymer tapes (potentially degraded)
  - Thermal expansion due to thermal range [–140 ºC, 140 ºC]
  - Unknow friction properties
- LAR misalignment
  - +/- 25 mm & +/- 2.5 deg
- Stiffness & preload
  - Envisat/chaser stack 1st eigenfrequency 4-8 Hz
  - Max angular deflections 0.3/0.65 under steady/transient loads
- High loads
  - Residual torques up to 80 N.m
  - De-orbit burn thrusts
    - Up to 5 burns
    - Up to 880 N
- Alignment requirements
  - 0.1 deg resolution & 0.25 accuracy
- Lifetime: 1000 cycles (including 50 in-orbit cycles)

Suitable modelling & analysis approach required

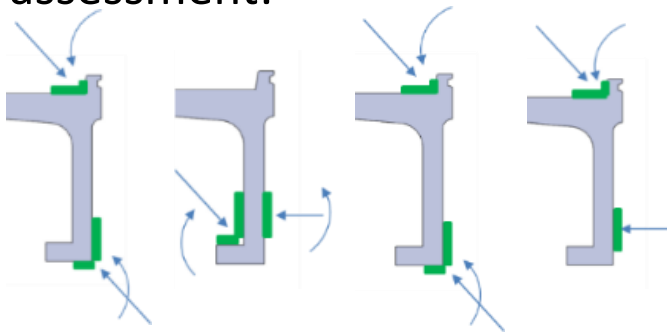
Work logic

1 year activity with the following tasks:



Concept trade-off approach

The decision to clamp at the LAR is clear but several aspects under assessment:



- Clamping region
  - Compromise between stiffness & availability

- Clamping strategy:
  - References from previous related developments
    - Gripper designs
    - Clamping designs from Phase A & Phase B1
  - But very wide approach to any potential clamping concept

- Preliminary trade-off already performed at proposal level to be enhanced by analysis to support the decisions:
  - Concepts selection
    - Preliminary (simplified) models development
      - Multibody-analysis with Design of Experiments (DoE)
        - Including forces & torques, misalignment range, etc.

} Analytical metrics for the trade-off

On-going task!

Conclusions

- Clamping mechanism pre-development for eDeorbit mission on-going
  - High complexity of the task due to uncertainties regarding LAR status & high structural capacity required
  - **TRP** activity lead by AVS with the collaboration of OHB
  - Design & MAIT of breadboard up to **TRL 4** by the **end of 2018**

- Potential application to other in-orbit service missions such as Space Tug

Thanks for your attention

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