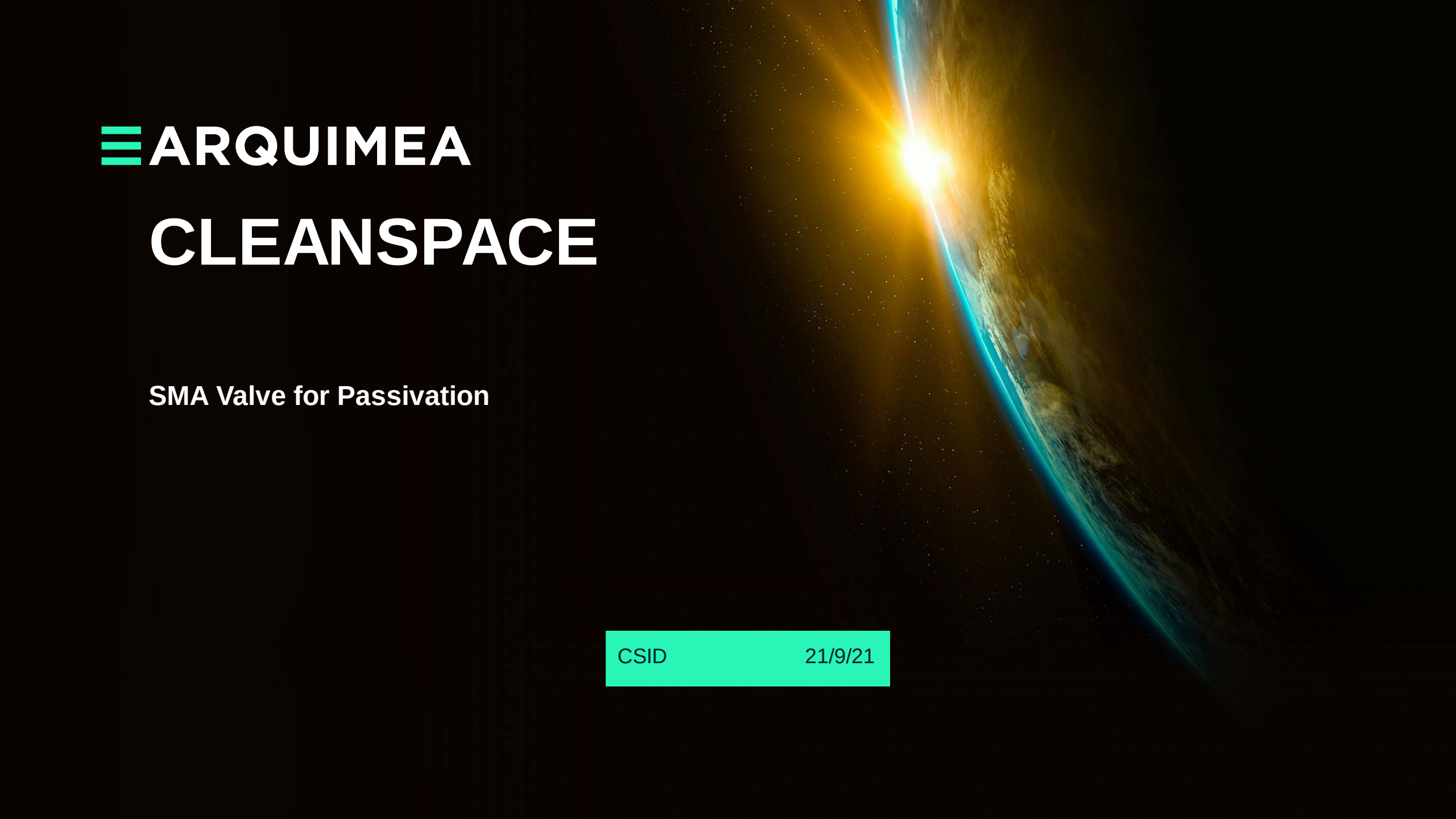
ARQUIMEA

CLEANSPACE

SMA Valve for Passivation



CSID 21/9/21

ARQUIMEA Aerospace & Defence

Engineering company specialized in **parts** and **systems** for **Space, Aeronautics, Defence, Hi-Rel Industrial** and **Science**

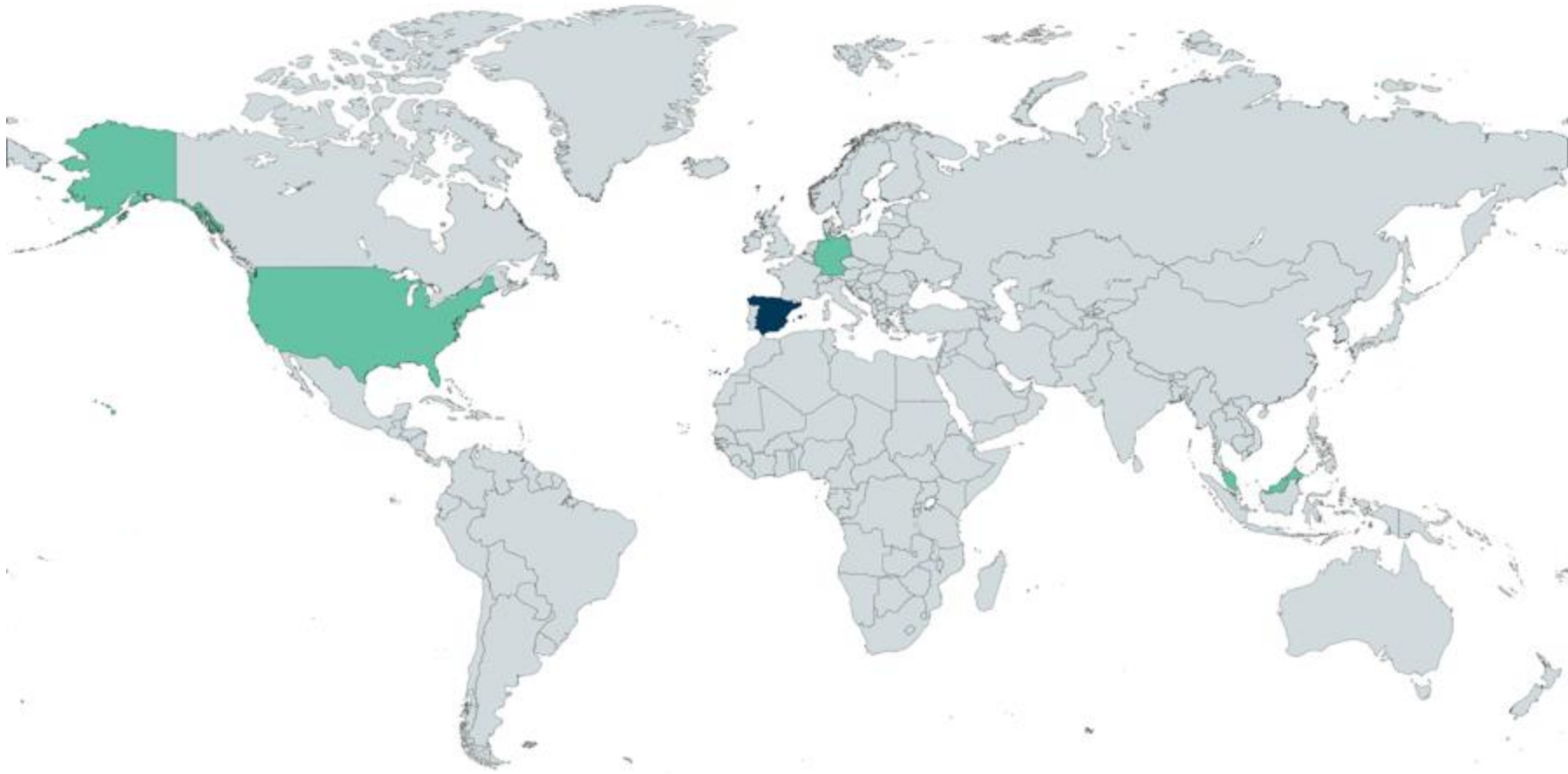
Suppliers of **electronics, microelectronics, mechanisms, software, robotics** and **drones**

End-to-end engineering capabilities. In-house mechanisms workshop, labs and clean room facilities

Strong **R&D** activity and **product-oriented** strategy

HQ in Madrid (Spain)

Commercial offices in Germany, USA and Malaysia



22M€ revenues in FY20

80 employees

AENOR ER Registered Company ISO 9001 · IQNet · AENOR ER Aerospace Quality UNE-EN 9100

Mechanisms

One-stop-shop for space-qualified mechanisms and ground support equipment

SHAPE MEMORY ALLOYS

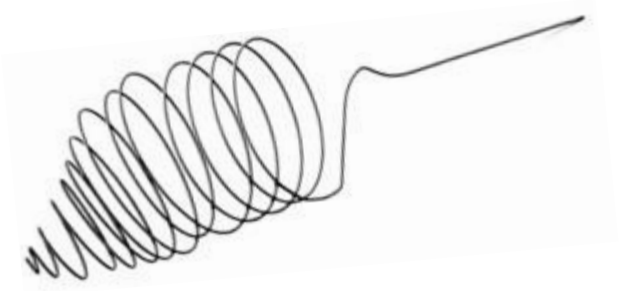
Own-proprietary high-temperature shape memory material → **SMARQ**

SMAs are **artificial muscles** commonly used as force, linear and rotary actuators, springs and valves

Lightweight, solid-state **alternative to pyro-actuators, hydraulic and pneumatic systems**

Typically used in automotive, industrial, healthcare, aeronautics…

Stable operation in **harsh thermal environments** from -40 to +150ºC



OFF-THE-SHELF ACTUATORS

HDRMs, Valves & Pin Pullers

Hold-down and release of solar arrays, antennas, cover doors, booms, heat shields, scientific instruments, etc. in spacecraft

Low-shock, non-explosive, resettable

Extended operation temperature range

Solar Array Deployment Mechanisms

HDRM + deployment mechanism for small satellite platforms

MECHANISMS MAIT

Full manufacturing capabilities: precision machining, mechano-welding, milling, lathes, EDM, robotic cell

90sqm clean room with thermal vacuum chamber (under construction)

Turnkey solutions. **Custom design of equipment, tools and GSE**

60+ years' experience in aerospace. Over 30,000 devices supplied.

SMA Valve for Propulsion Passivation

Development of a SMA valve for passivation of propulsion system at the end of missions.

The valve will also be suitable for isolation applications at the beginning of life.

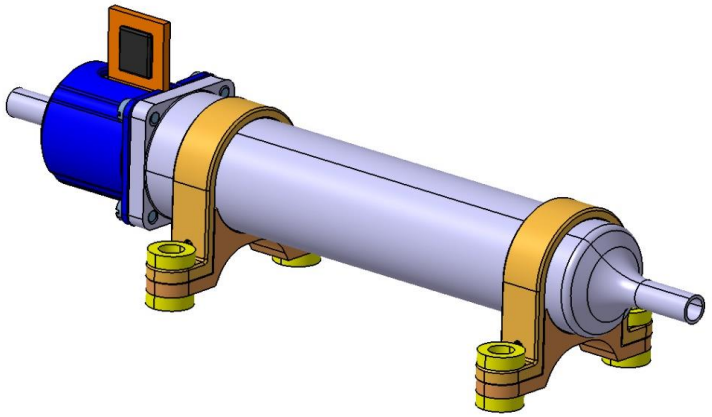
TARGET SPECIFICATIONS

- Normally closed valve, commanded by Shape Memory Alloy
- Suitable for Propellants (N_2H_4, MON, MMH, LPM-103s), Inert gases (Kr, Xe, He, Ar) and all propellant vapors
    - Long-term compatibility with propellants such as N_2H_4 is critical
- Environmental operating temp.: -30 to +60°C (gas application), 0°C to +60°C (liquid storable propellant application)
- Environmental nonoperating temp.: -50°C to +90°C (gas application), -2°C to +90°C (liquid storable propellant application)
- Inlet operating pressure: MEOP = 310 bar
- External leak: < $1x10^{-6}$ scc/sec GHe at worst-case conditions (during min and max non-op temperature)
- Mass < Pyrovalve (410g not including harness)
- Lifetime on ground + on orbit = 25years.

Development and Qualification of a Shape Memory Alloy Valve for Propulsion Passivation
(ESA Contract No. 4000126106/18/NL/LvH)

SMA Valve for Propulsion Passivation

- Design based on the complete isolation of the SMA actuator from the propellant flow.
  - All-Ti design for wetted parts
  - Isolation of active elements ensured by welding
  - Ensures long-term compatibility with propellants during the whole life (25 years)



- Frangible design
  - SMA actuation produces the fracture of a blind pipe, which once broken allows the propellant flow to the outlet.

Parameter	Value	Compliance
Mass	337 gr	C
Envelope	Body: 147mm length, 31x31mm section	C
Op. Temperature	-30 to 60°C (gas) 0°C to 60°C (liquid)	C
Op. Pressure	310 bar	C
Power	<20W at 24V	C
Pressure drop	100mbar at 100g/s H2O	C
Actuation times	Min: 40s @65ºC @32V Max: 340s @-30ºC @24V	C
Leakage	< 1 x 10-6 scc/sec GHe	C

SMA Valve for Propulsion Passivation

DM Test samples

EM Design 1

PDR-A

New DM Test samples

EM Design 2

PDR-B

EM Mnf

EM Testing

Processes Validation

QM Design

CDR MPCB

MRR

QM Mnf

QTRR

QM Testing

QR

09/2021

03/2022

09/2022

03/2023

SMA Valve for Propulsion Passivation

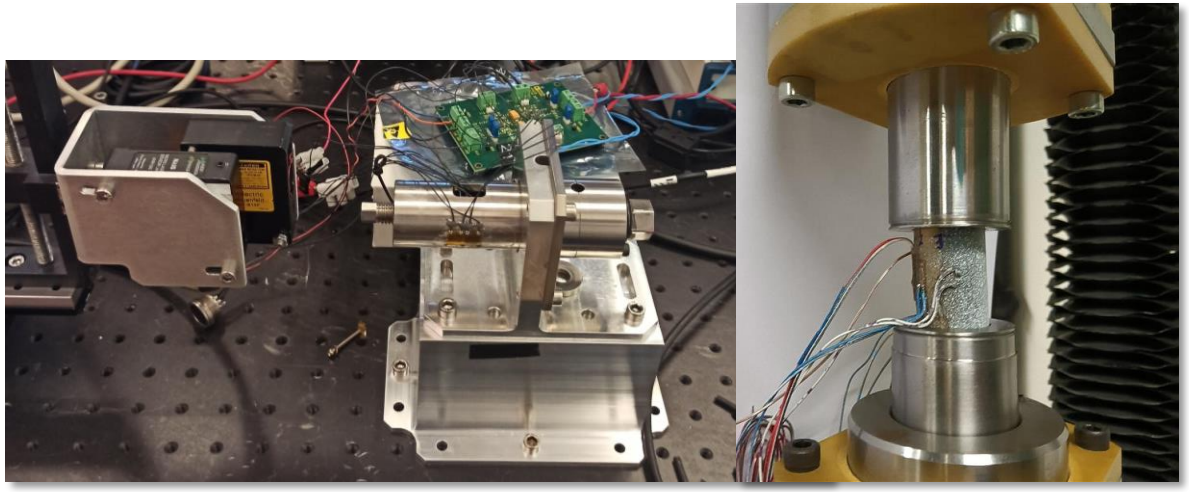
CURRENT STATUS & ROADMAP

- PDR completed
- Design Models tests completed
  - Validation of frangible elements
  - Key design elements validated
    - Elastic tests
    - Welded parts tested: leakage tightness
    - SMA characterization
- Critical processes validation on going
- EM manufacturing being completed

➢ EM tests planned in Q4 2021

➢ CDR foreseen in Q1 2022

➢ Qualification campaign start foreseen on Q3 2022



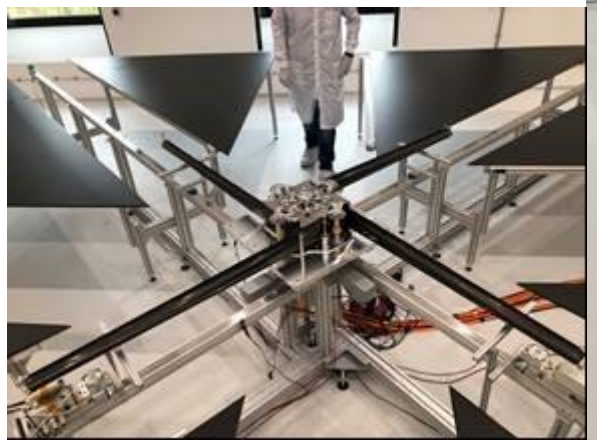
OTHER CONTRIBUTIONS TO CLEANSPACE

Other contributions to CleanSpace

REACT HDRM for the release of a drag sail

ADEO – Passive Deorbit Subsystem. Deployable Drag Sail

- Drag sail subsystem constituted by a boom and a membrane for passive deorbiting of satellites. It recognizes when the satellite has come to the end of its mission or has failed and then slowly unfurls a large aluminum-coated polyamide membrane, attached to four carbon-fibre reinforced booms.
- The membrane acts as a sail, to create a drag effect causing the spacecraft to decrease its orbit much faster, catching at the atmosphere to slow the worn-out spacecraft enough that it will burn up entirely.
- ARQUIMEA is supplier of the HDRM release nuts for the demonstration model.



Other contributions to CleanSpace

REACT HDRM for the release of booms for the removal of space debris

ClearSpace – Space Debris removal

- In 2025, ESA's ClearSpace-1 demonstration space mission will be launched to validate the technologies needed for the future removal of space debris. This programme aims to build a sustainable commercial service that will enable satellite operators to maintain orbital slots reliably and securely.
- The mission will rely on a system with large booms to retrieve elements abandoned in space.
- ARQUIMEA is supplier of the HDRM release nuts for the deployment of the booms of ClearSpace-1 demonstration mission.