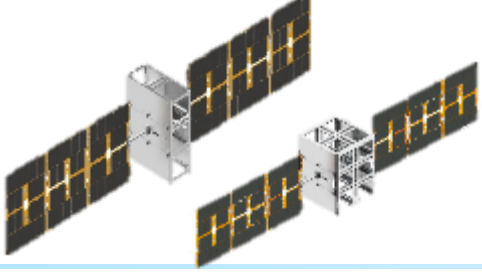


Ingegneria Marketing Tecnologia

L’impegno Italiano nel settore dei CubeSat: tecnologie e missioni future

µSADA
Miniaturised Solar Array Drive Assembly for 6U/12U CubeSAT

S. Di Filippo , A. Negri, G. Cucinella, S. Bonomo, M. Perelli

2-4 July 2024

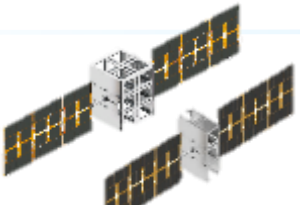
µSADA

µSADA is a GSTP program (ESA Contract No. 4000121485/17/NL/PS)

The µSADA program consists of the development and testing of a small-sized SADA (Solar Array Drive Assembly) suitable for 6U/12U CubeSat platform

The µSADA can be applied in mission where high power is required, such as:

- High transmission power
- Electrical propulsion
- High computation power



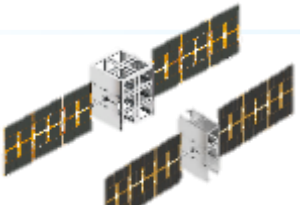
µSADA

The unit is composed by two deployable solar array wings and the control unit. µSADA is able to turn around 1 gimbal axis (1 dof - degree of freedom).

The power performance increase is mainly due to two factors :

- The deployment of 6 solar foils (3 for each wing) that increases the active area aveable for the power generation.
- Continus pointing of the solar arrays towards the Sun to reduce the “cosine loss”.

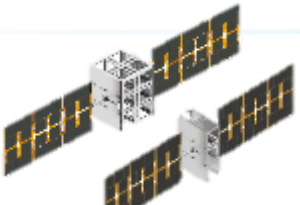
The µSADA system can move the two wings independently. In case of one wing failure, the other one can continuate to rotate, minimizing the effort.



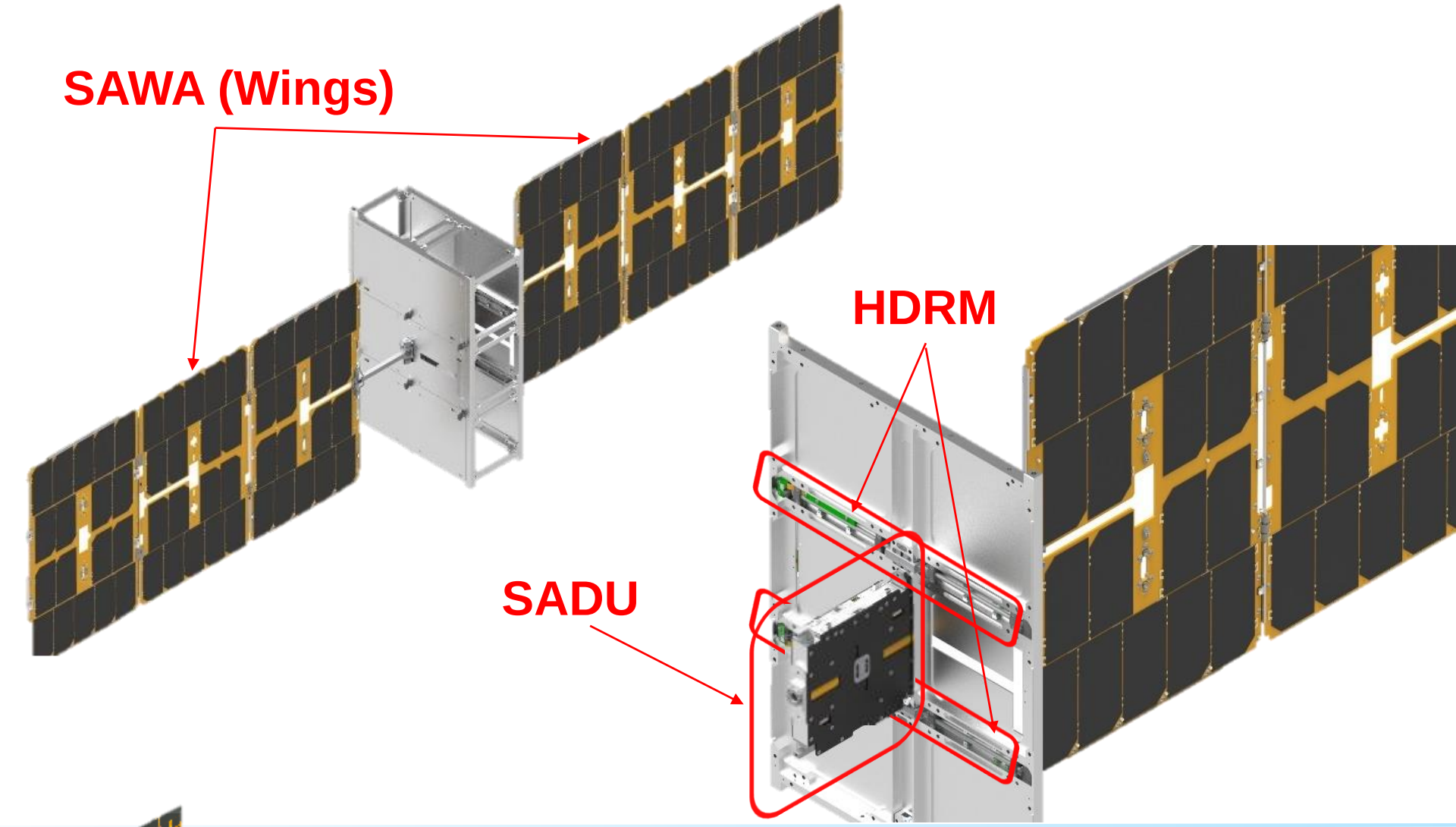
µSADA System Overview

µSADA is composed by three main subassemblies:

- ***SADU*** – Solar Array Drive Unit located internal to the satellite. The main tasks are the solar panel pointing and the generated power delivering (to the PDU). It is composed by the mechanisms (SADM) and the electrical parts (SADE).
- ***HDRM*** – Hold Down and Release Mechanism located inside the satellite, along the Structure lateral panels. It assures the Solar Panels stowed configuration and the releasing upon received command.
- ***SAWA*** – Solar Array Wing Assembly located external to the satellite. In stowed configuration, the SAWA is compliant with 10mm of clearance between Structure and Dispenser.

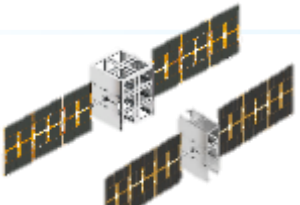


µSADA System Overview



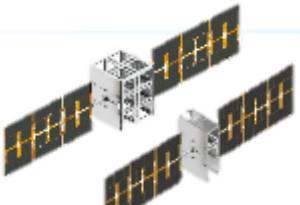
µSADA main Features

- Rad Tolerant or Automotive Grade qualification for Microcontroller and CAN BUS PHY. The same design is compliant with the both solutions, depending by the mission requirements
- All EEE components are already used in other space programs and radiation characterization data are available
- A full assessment of EEE parts has been done as far as quality and radiation behaviour
- SEE protection assured by design using Anti-Latchup circuits
- 15 slip ring channels for each Wing. Each ring can be used for data or power lines
- Redundant contacts for each slip ring
- Full SAWA rotation without cable saturations
- Two deployable Solar Array composed by 3 solar panels each one (generated power up to 118W). Possibility to improve at 5 panels for each wing (generated power up to 190W)

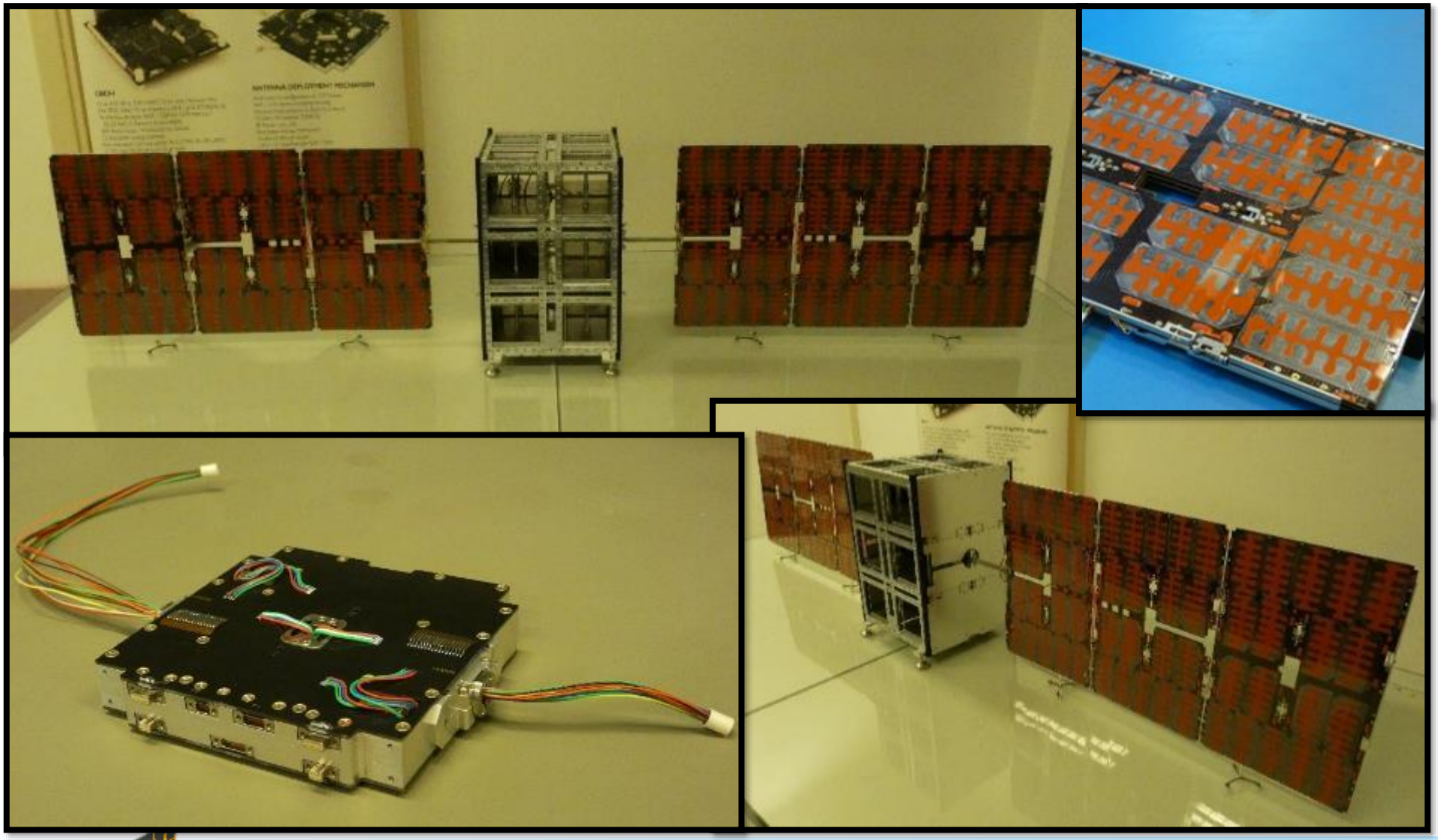


µSADA main Features

- Double configuration for the generated power delivering: one powered line for each array (18S6P configuration) or one powered line for each solar panels (6 x 18S). Power Generation assured (by the outer panel) in stowed configuration
- The Encoder located at each SAWA shaft transmission provides the angle position with accuracy < 0.5°
- Each SAWA has a dedicated Mechanisms and Electronics to assure the main functions in case of failure to the other one
- The motor coils and the driver unit are redundant
- Redundant burn resistor for the deployment
- Metal shielding (from ATOX, UV, RADIATION) for the harness between SAWA and SADU
- Several deployment telemetries to assure the knowledge of the final configuration of the solar panels
- Compliant for CubeSAT 6U and 12U, ISIS and GOMSPACE Structure



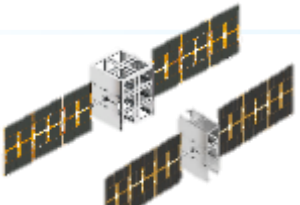
µSADA



IMT
Ingegneria Marketing Tecnologia

µSADA Main Performances

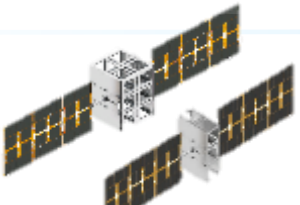
SADU Main Performances	
Power Consumption: - Drive - Stand-By - During the Release Phase	2W 500 mW 4.5W (Simultaneous Deployment)
OBC Interface	CAN Bus (I2C as redundant **) I2C ** UART **
Mechanical I/Fs:	Fully compliant with: - ISIS 6U Structure ** - ISIS 12U Structure - GomSpace 6U Structure ** - GomSpace 12U Structure **
Radiation and Redundancy	
TID:	>15 Krads
SEL:	Latch-up protections for critical components
Microcontroller:	Automotive Grade or Rad Tolerant: ** - No Single Event Latch-up Below an LET Threshold of 60 MeV.cm2 /mg @125°C - Total Ionizing Dose of 30 krad (Si)
Redundancy:	- Stepper Motor with redundant windings - Independent Drive mechanism for each Wing - Two burn resistors for each release mechanism



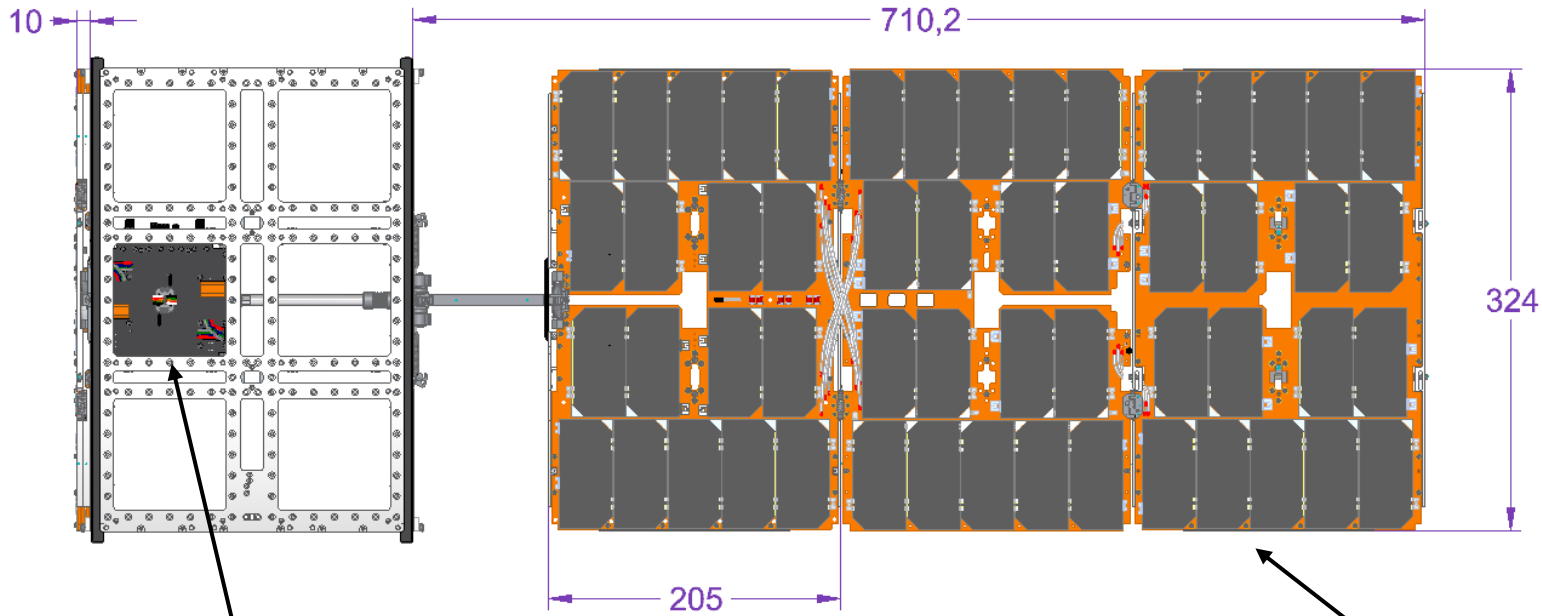
IMT
Ingegneria Marketing Tecnologia

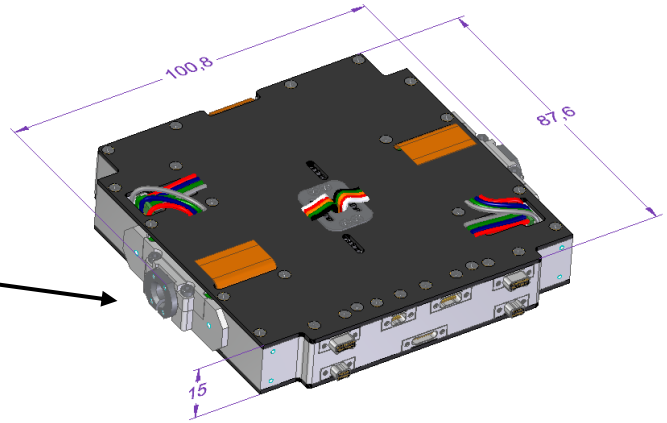
µSADA Main Performances

Pointing Mechanism	
Pointing Accuracy:	±0.3° with zero reference
Drive direction:	Forward and reverse rotation (endless rotation)
Nominal Speed Range:	± 0,07 °/s (selectable by digital command)
Max. Rotation Speed:	± 0,4 °/s
Motor	
Steps	Full to 1/16 µsteps (suggested 1/8 and 1/16 µsteps for long life e.g., 17000 cycles and low vibration disturbance)
Continuous Torque	>170 mNm
Maximum Backlash	Max 3°
Slip Rings	
Number of lines	15 for each Wing
Max. Current	0.5A for each contact
Max Voltage	60V for each contact
Powered Rings:	4 pairs for each WING



uSADA Dimensions



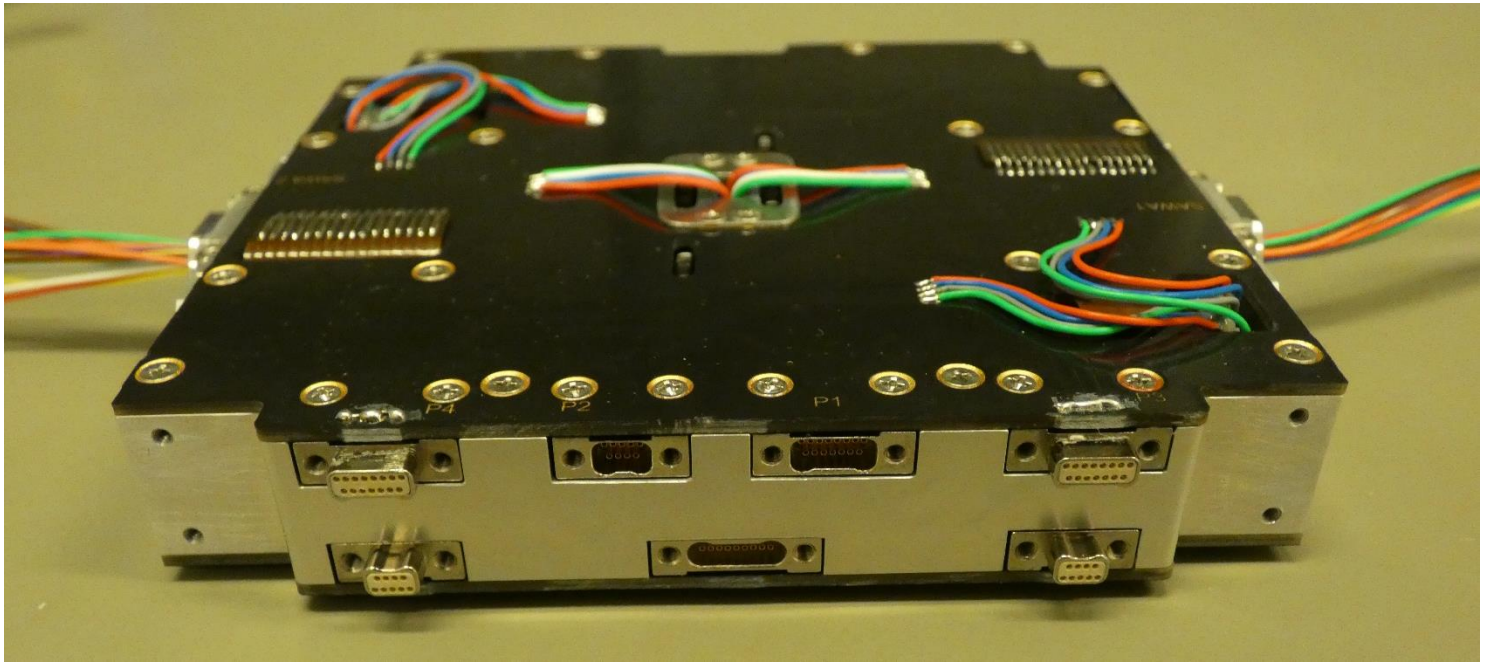


SADU

SAWA

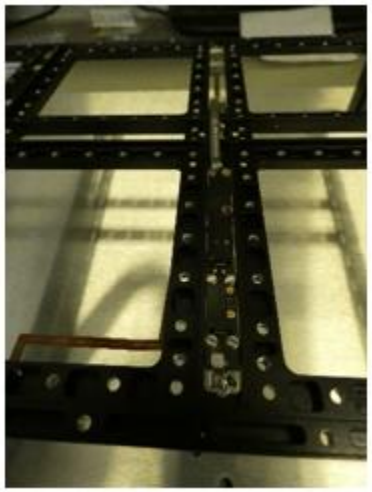
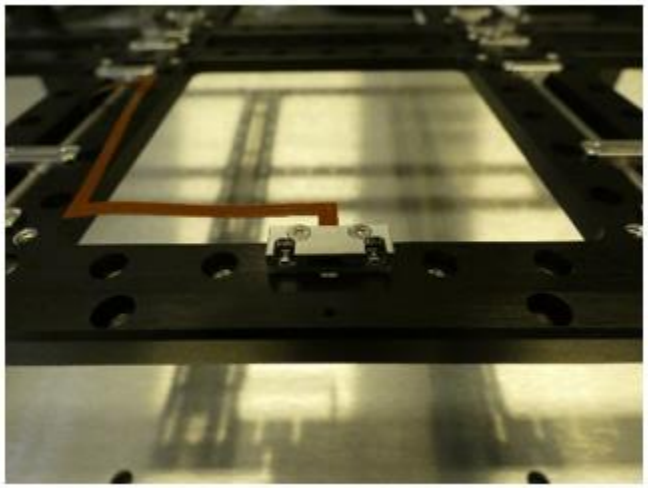
IMT
Ingegneria Marketing Tecnologia

SADU



- Slip-ring Technology
- Redundant contacts for each ring
- 0.5A current rating for each ring
- 15 Channel for each Sip-ring
- Indipendent driveline for each Slip-ring
- Redundant motor coils and driver unit

HDRM

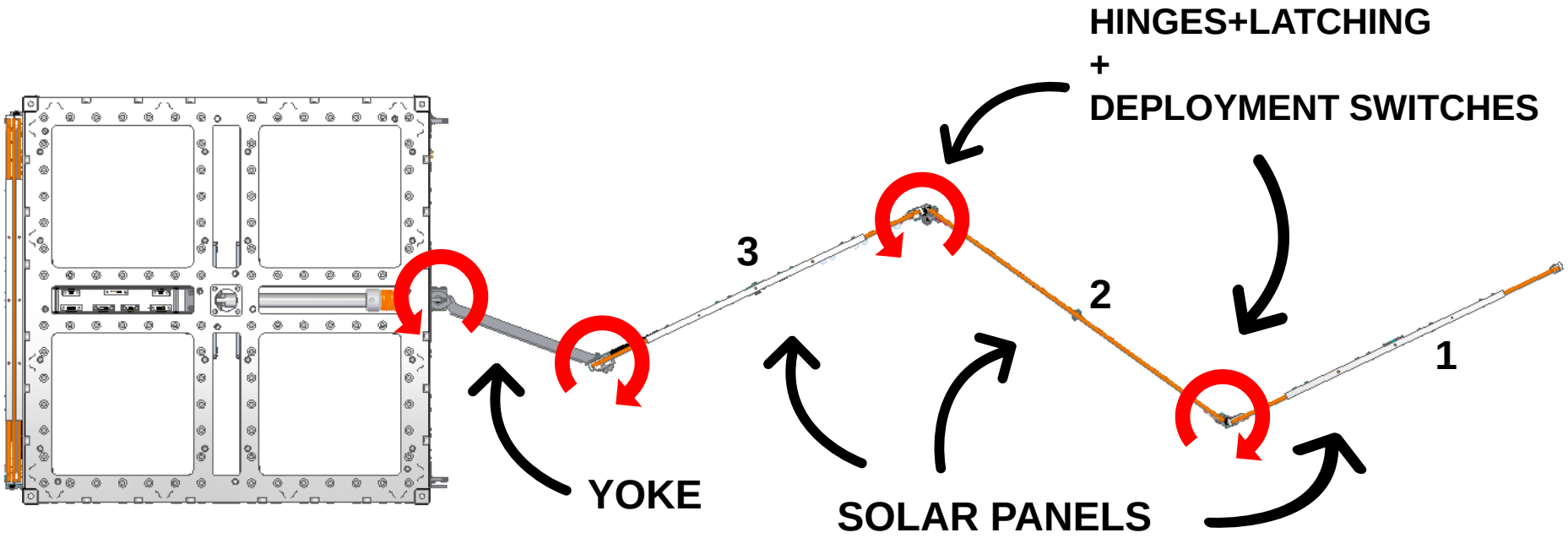




Feedback Sensors:

- Wire cut detection: to detect if the wire has been burned after the proper DEPLOYMENT COMMAND.
- Mechanism unlock detection: to detect if the locking mechanism has been released after the wire cutting.
- Release panel detection: to detect if the solar panels are separated from the structure.

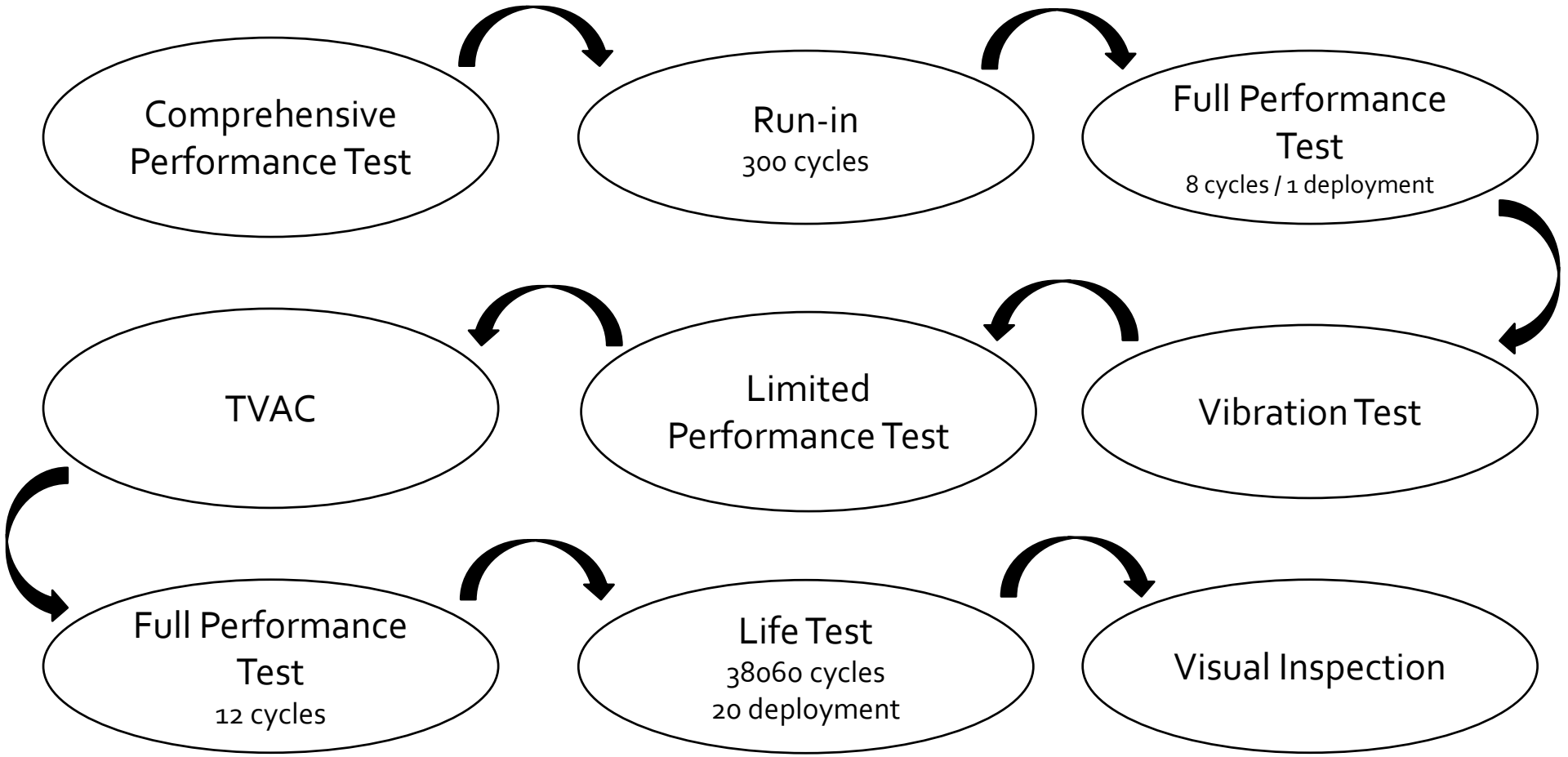
SAWA

- 2 Hinges for each solar panel
- 2 Hinges for the Yoke
- Latching system for each hinge
- Switches on panels for deployment feedback



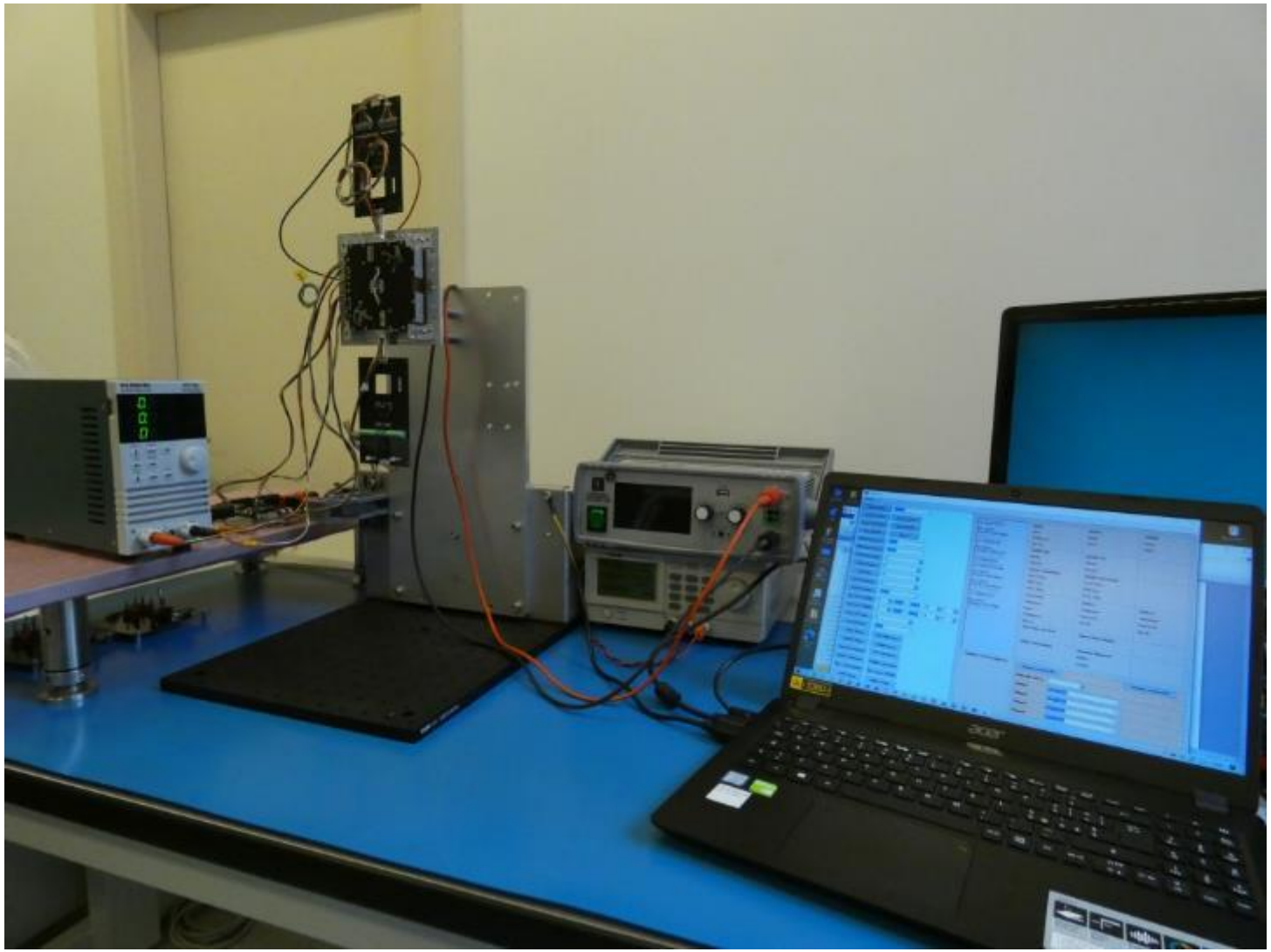
IMT
Ingegneria Marketing Tecnologia

Test Plan

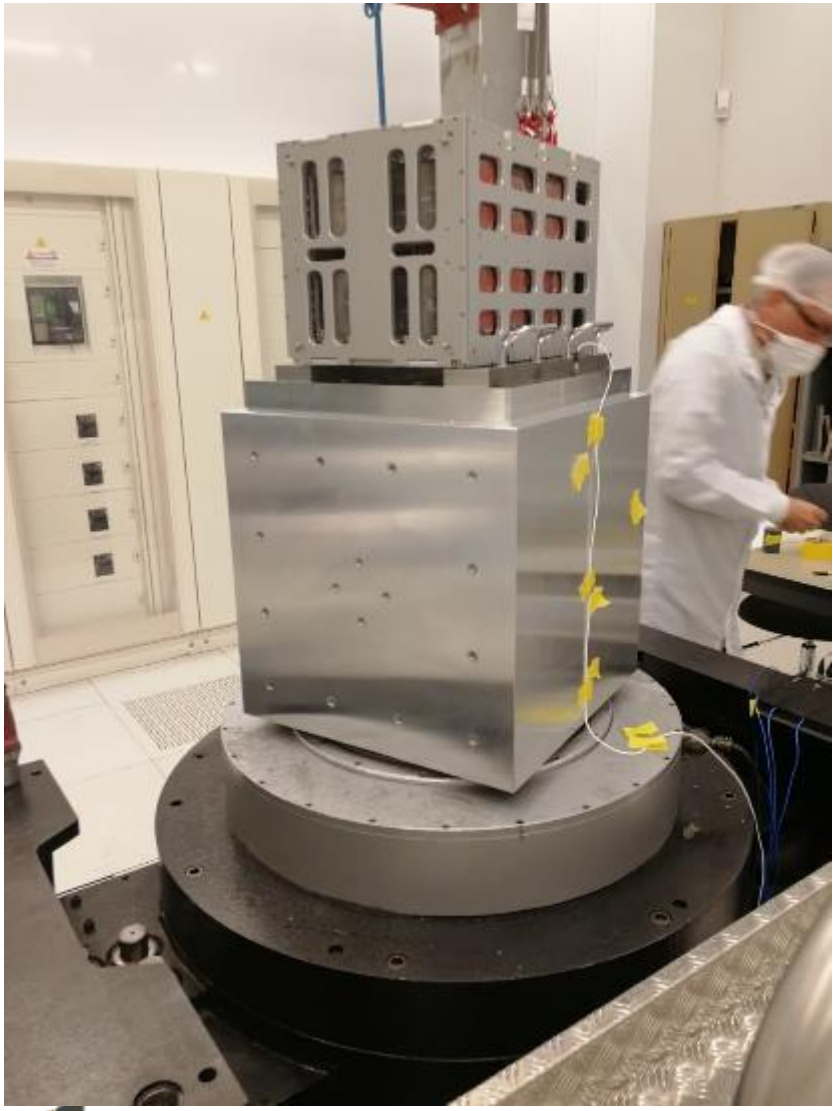


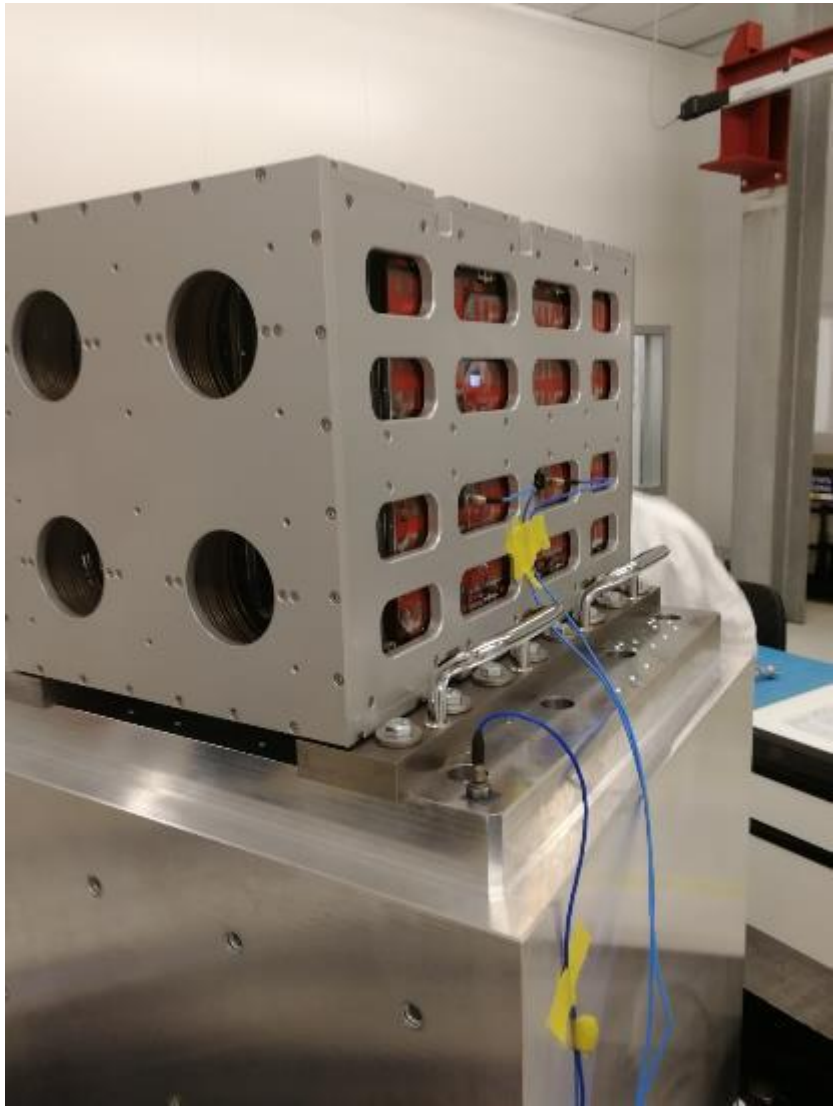
IMT
Ingegneria Marketing Tecnologia

Comprehensive Performance Test

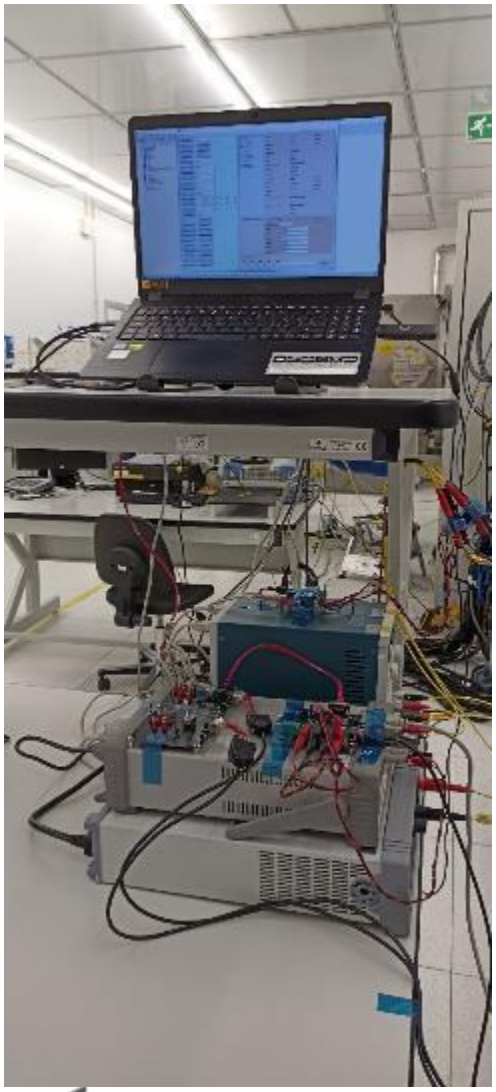


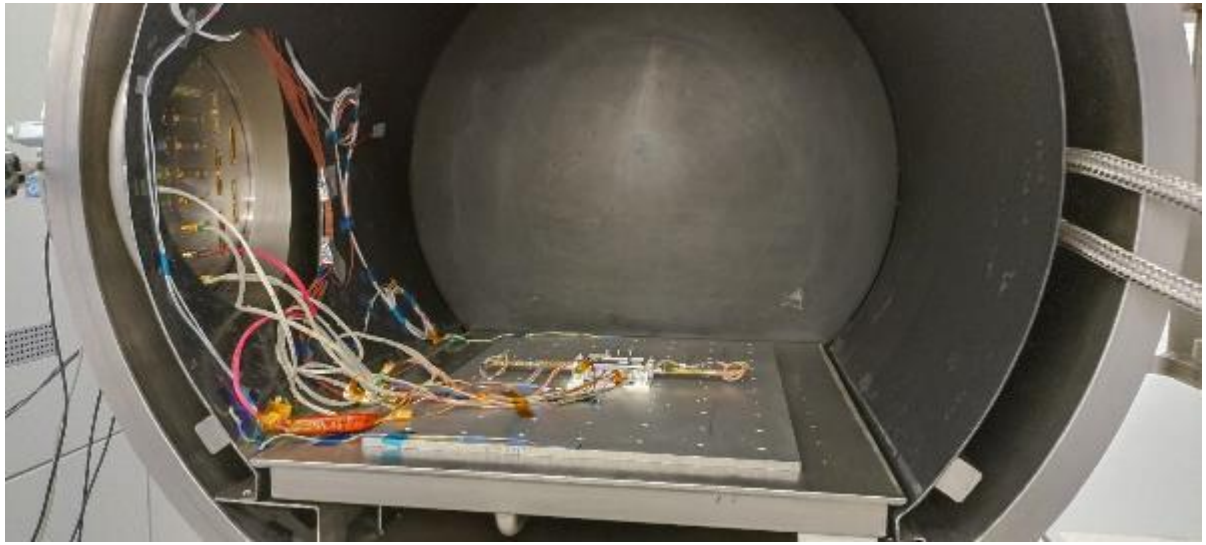
Vibration test



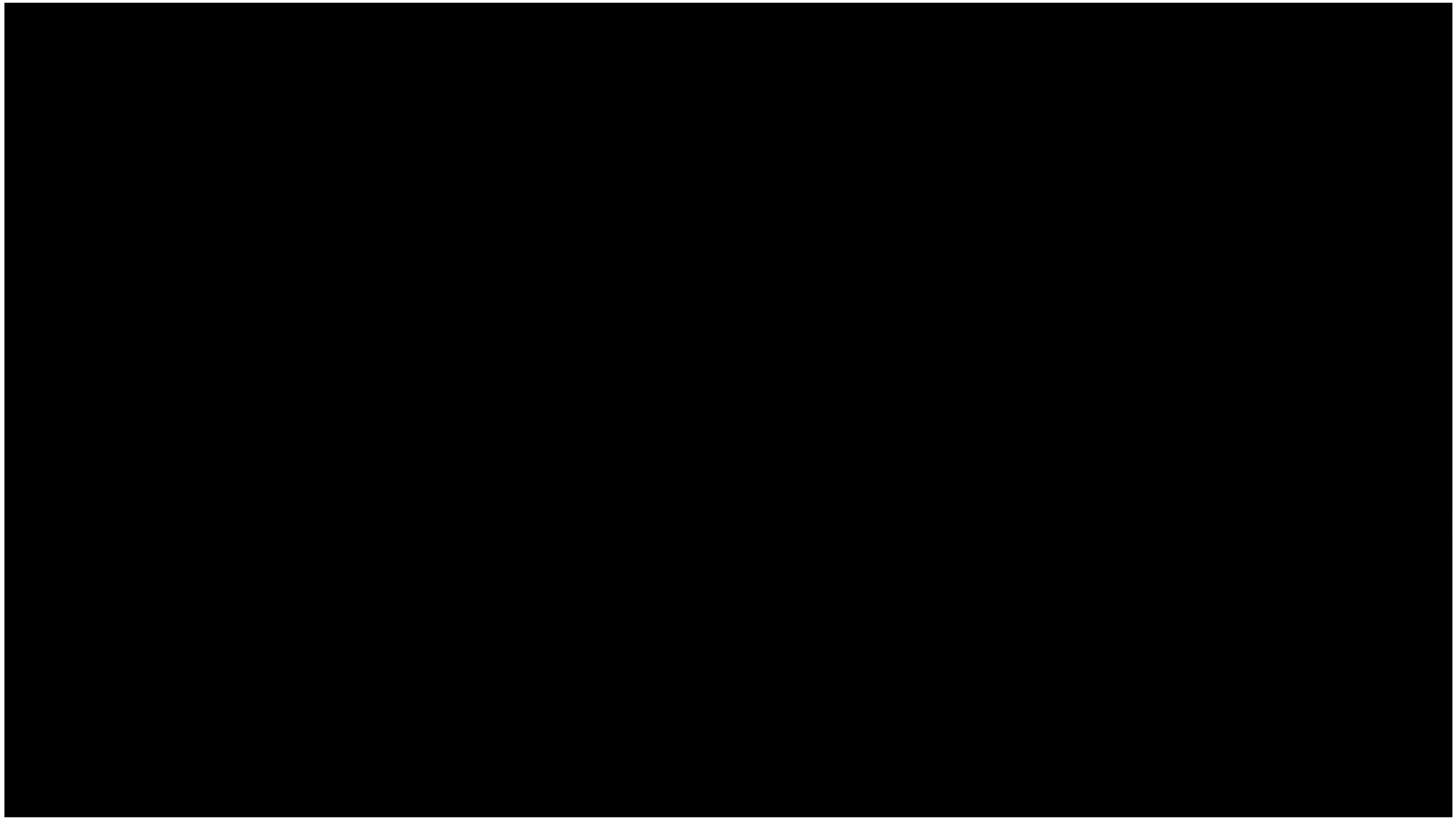


TVAC SADU



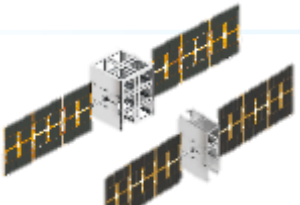


µSADA deployment and pointing



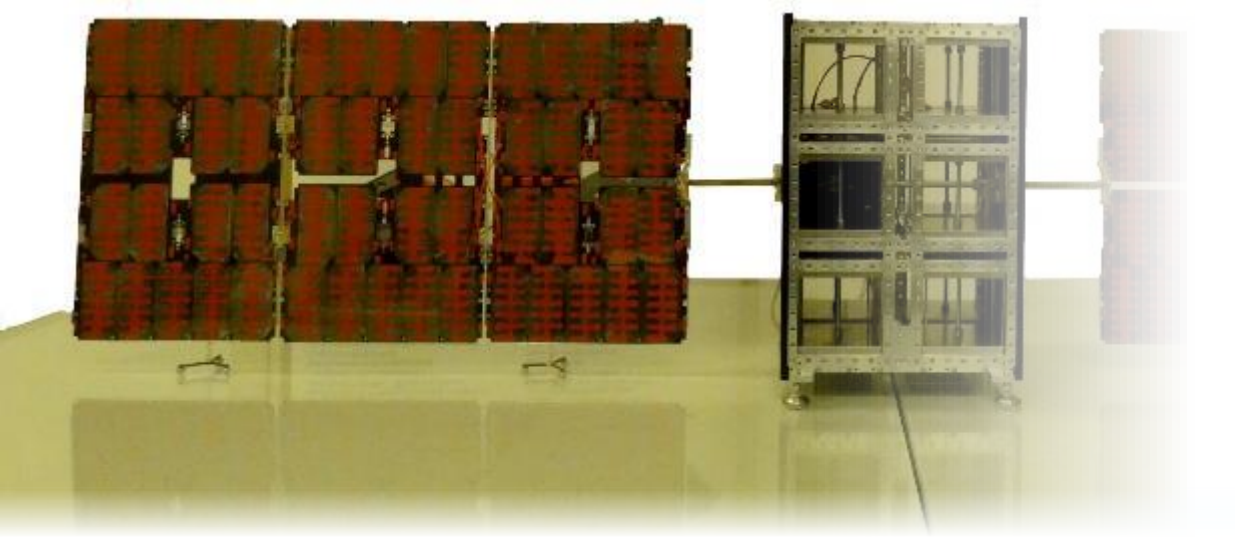
µSADA in the future missions

Currently, the µSADA has been selected for **LUMIO** (Lunar Meteoroid Impact Observer – ESA mission), it is candidate for **HENON** (HEliospheric pioNeer for sOlar and interplanetary threats defeNceASI/ESA mission), as part of ALCOR Program, and for **M-ARGO** (Miniaturised – Asteroid Remote Geophysical Observer – ESA mission)



Ingegneria Marketing Tecnologia

Thank You for your attention



Main Contacts:

Giovanni Cucinella
Project Manager
giovanni.cucinella@imtsrl.it

Andrea Negri
Technical Manager and System Engineer
andrea.negri@imtsrl.it

Simone Di Filippo
Mechanical Engineer
simone.difilippo@imtsrl.it

µSADA
Miniaturised Solar Array Drive Assembly for 6U/12U

(ESA Contract No 4000121485/17/NL/PS)