MECHANICAL SYSTEMS LABORATORY

THERMAL ANALYSIS & VERIFICATION SECTION (TEC-MTV)

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For information only – any test request shall be discussed with the Laboratory manager

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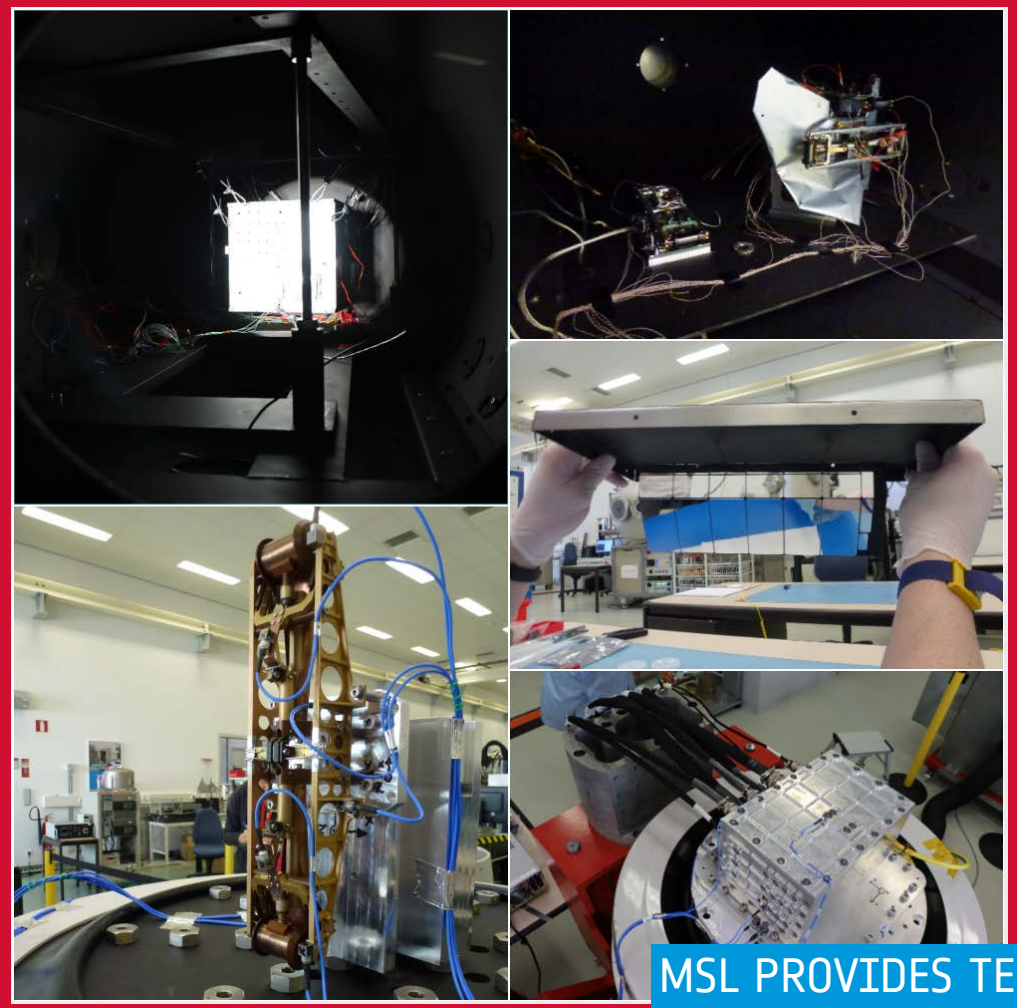

MSL PROVIDES TESTING SUPPORT FOR ALL ESA PROJECTS

Core activities:

- Thermal cycling / Thermal balance test
  - in vacuum & at ambient pressure
  - down to cryogenic temperatures
- Mechanical vibration testing (sine & random)

Testing performed for ESA projects & external customers:

- Support to design and verification of spacecraft elements
- Support to in-orbit anomaly investigations

Keywords: Competence, quick reaction time and high flexibility

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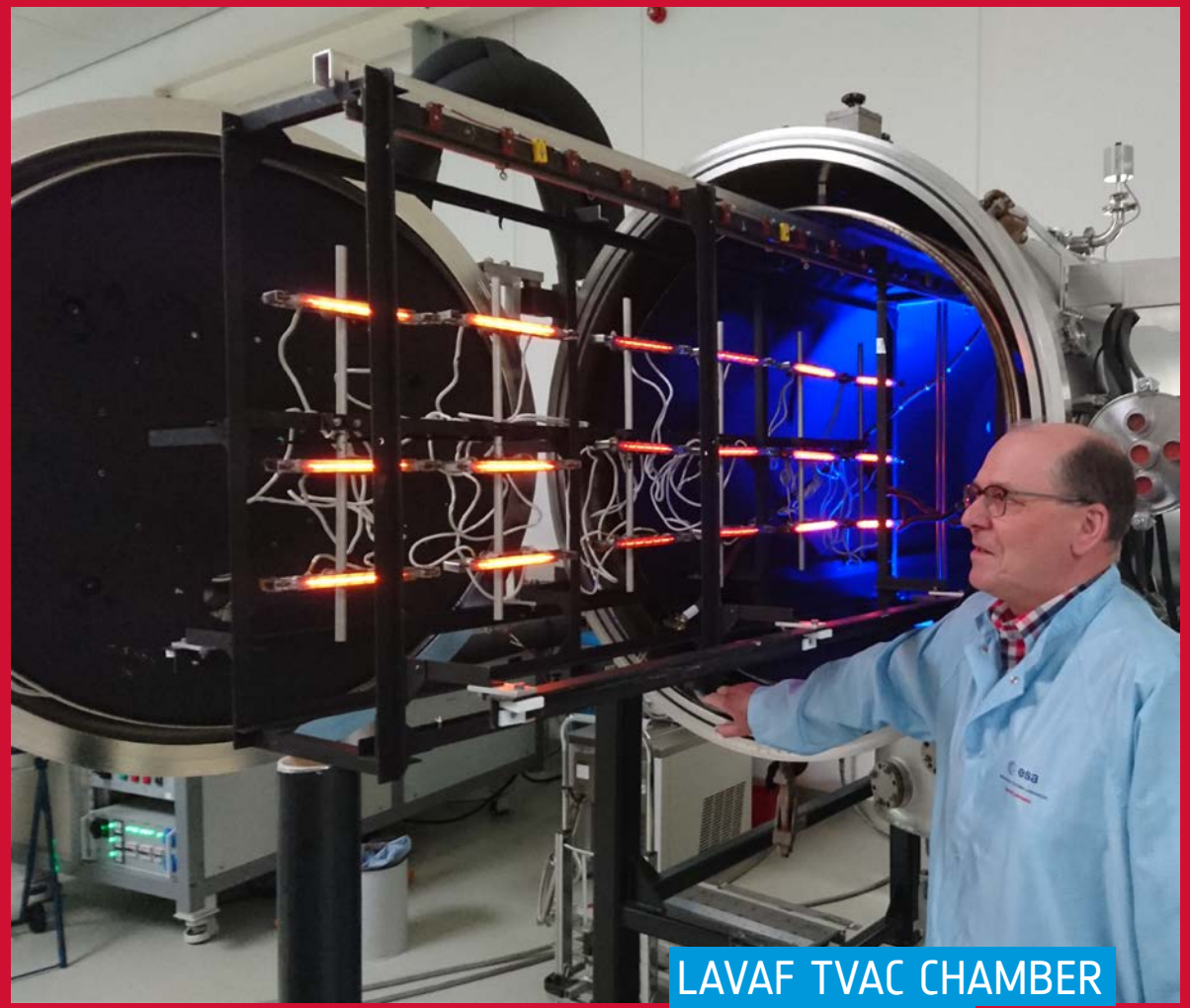

LAVAF TVAC CHAMBER WITH IR RACK INSTALLED

→ Environmental testing ~ 70 tests / year

→ 300m² clean room Class ISO 8

Test methods:

→ Thermal cycling & thermal balance of space equipment

→ Thermal conductivity of materials & joints down to cryogenic temperatures

→ Mechanical vibration testing - sine and random

→ Multi Layer Insulation (MLI) performance measurements (2D and 3D)

→ Coefficient of Thermal Expansion (CTE) measurements

→ Vacuum Gauges Calibration

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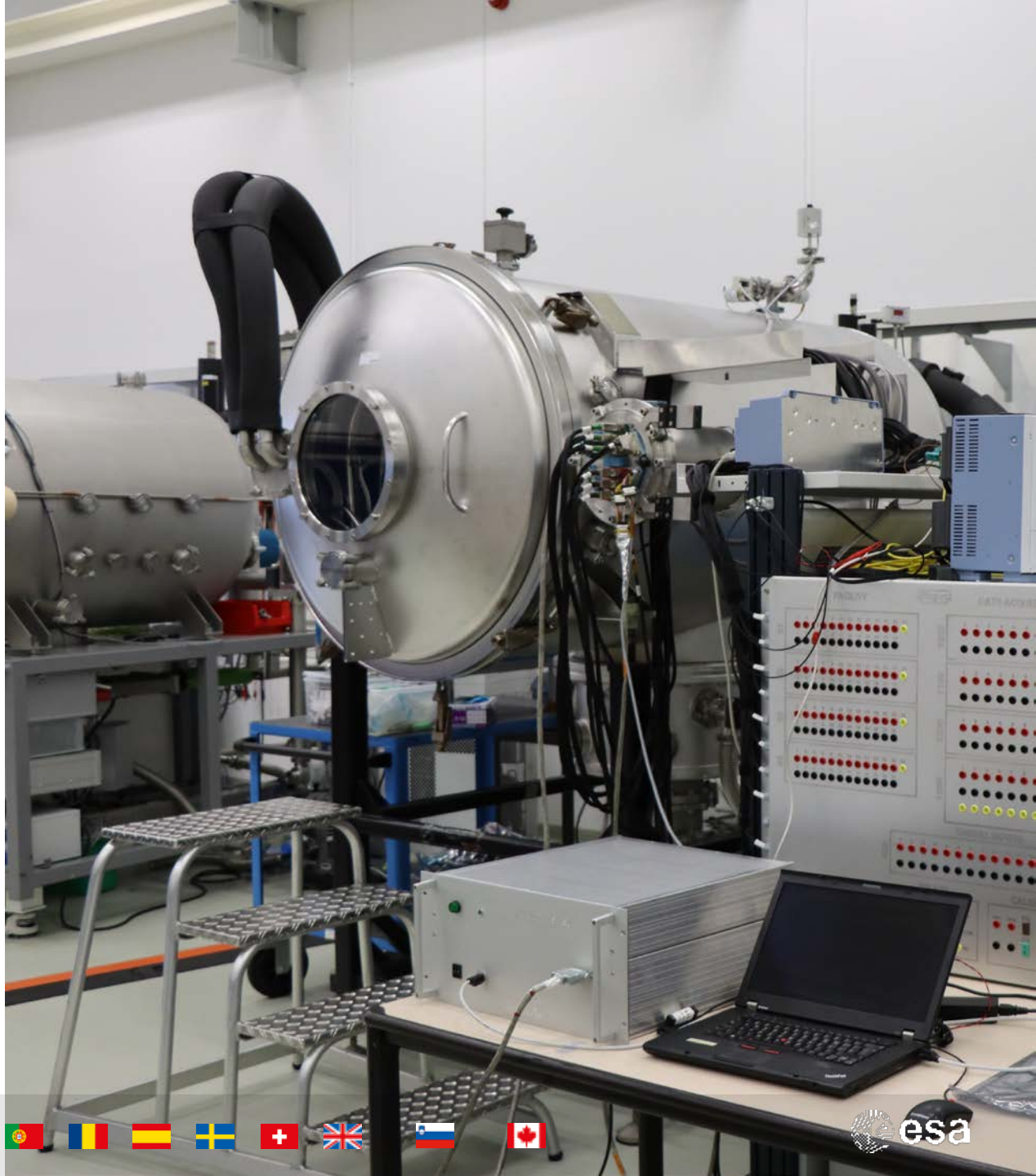
LAVAF (Large Vacuum Facility):

Purpose	: Thermal cycling/thermal balance with solar illumination
Shroud	: Ø 850mm, 1.7m long
Solar simulator	: Ø 300mm
Max sun intensity	: 2800 W/m^2(±3%)
Temperature range	: -170°C/+100°C (cold plate & shroud) +250C by means of Infrared lamps
Infrared lamp field	: 3 independent sections
Vacuum limit	: < 5x10^{-6} mbar
Data acquisition	: 120 channels for temperature/voltage measurements



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MEVAF (MEdium VAcuum Facility):

Purpose	: Thermal cycling/thermal balance with solar illumination
Particularity	: Allows non-intrusive temperature mapping with infrared camera
Shroud	: Ø 800mm, 1.2m long
Solar simulator	: Ø 300mm
Max sun intensity	: 2800 W/m^2(±3%)
Temperature range	: -170°C/+120°C (shroud) -80°C/+80°C (cold plate)
Vacuum limit	: < $5x10^{-6}$ mbar
Data acquisition	: 120 channels for temperature/voltage measurements

MEVAF WITH SOLAR ILLUMINATION

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LIVAF (LIttle VAcuum Facility):

Purpose	: Thermal cycling/thermal balance of space equipment
Shroud	: Ø 550mm, 1m long
Temperature range	: -170°C/+80°C (shroud & cold plate) up to +250°C (with IR Rack)
Vacuum limit	: < $5x10^{-6}$ mbar
Data acquisition	: 120 channels for temperature/voltage measurements

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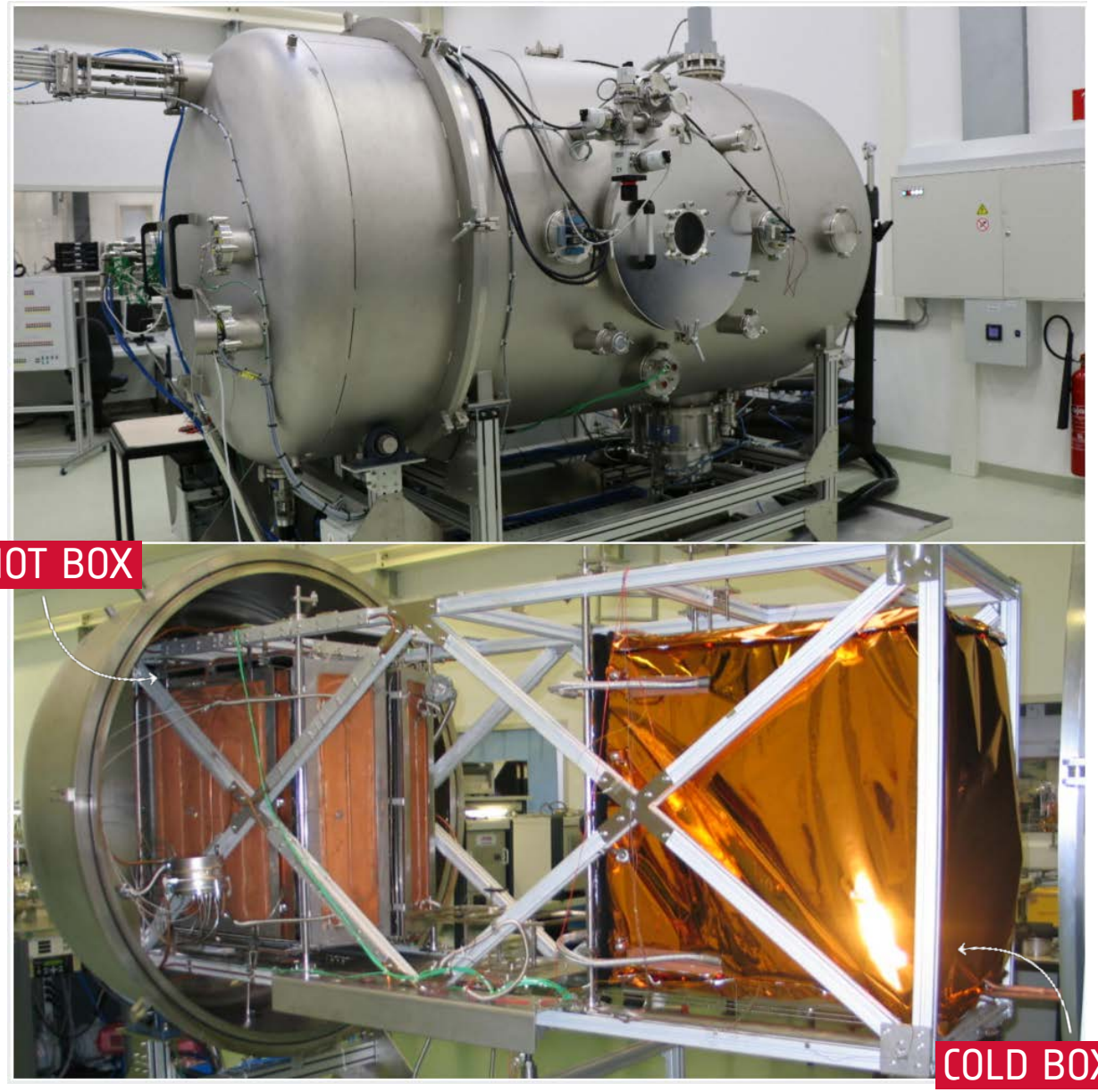
FTV (Fast Thermal Vacuum):

Purpose	: Fast Thermal cycling of space equipment
Two Compartments	: hot up to +600°C/ cold down to -245°C motion system for automatic cycling
Test item envelope	: 0.5m x 0.35m x 0.68m
Vacuum limit	: < $5x10^{-6}$ mbar
Data acquisition	: 60 channels for temperature/voltage measurements



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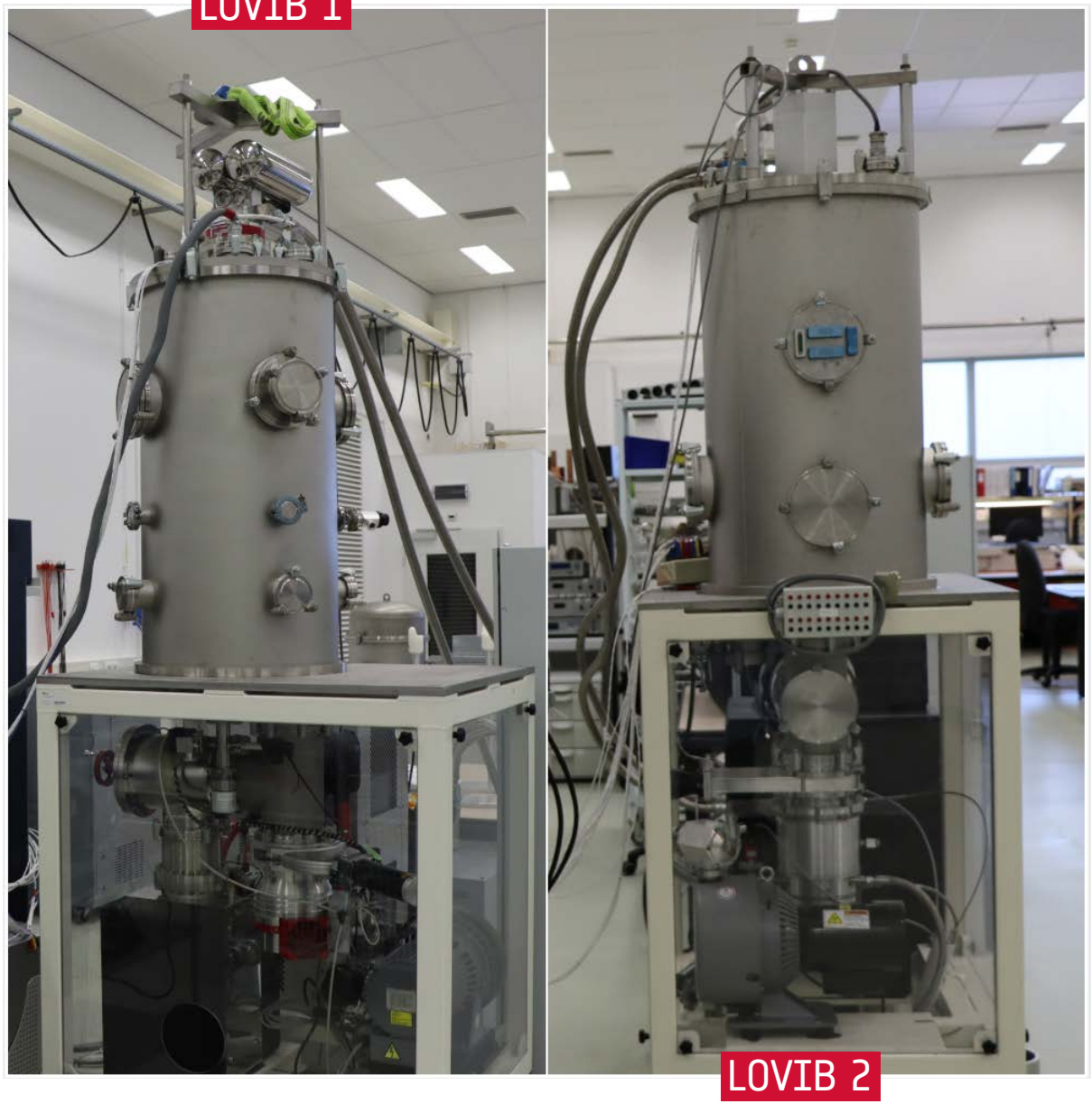
LOVIB 1 & 2 (LOw VIBration Facility):

Purpose	: Thermal cycling/ Thermal balance at cryogenic temperatures
Particularity	: used to perform thermal conductivity measurement of materials and joints down to cryogenic temperatures
Vacuum limit	: < $5x10^{-6}$ mbar
Temperature Range	: -263°C/+30°C (2 stage cryo-cooler)
	-80°C/+80°C (for CP available in LOVIB 1)



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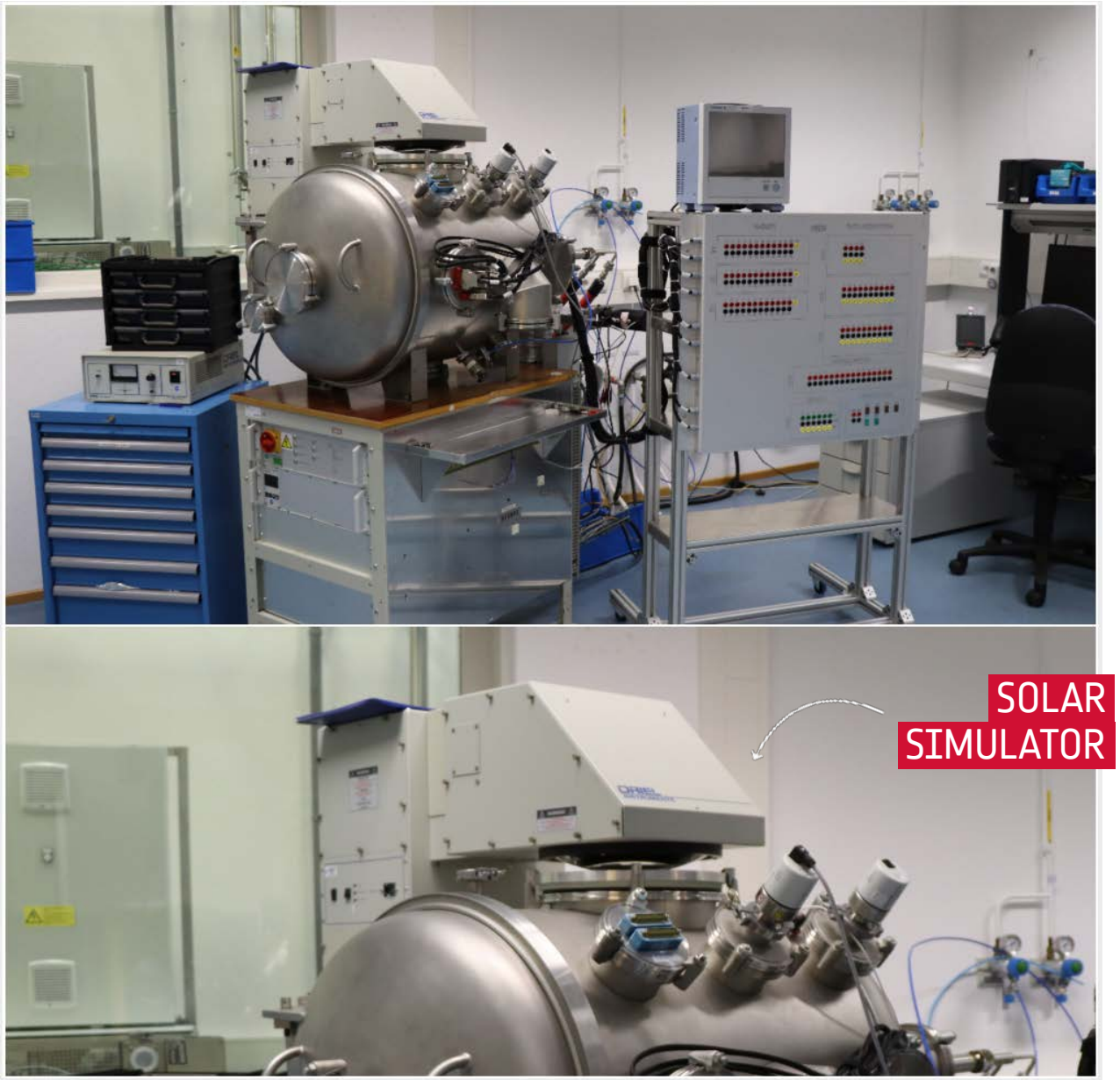
MARSIM 1 (MARS SIMulation Facility):

Purpose	: Thermal cycling/ Thermal balance with Solar illumination.
Particularity	: Developed to reproduce Mars environment (10 mbar CO_2)
Max sun intensity	: 1400 W/m^2
Vacuum limit	: < $5x10^{-6}$ mbar
Temperature Range	: -80°C/+150°C (CP and shroud in series)
Data acquisition	: 80 channels for temperature/voltage measurements



MECHANICAL SYSTEMS LABORATORY

MARSIM 2 (MARS SIMulation Facility):

Purpose	: Thermal cycling/ Thermal balance
Vacuum limit	: < $5x10^{-6}$ mbar
Temperature Range	: -80°C/+100°C (CP and shroud in series)
Max. change rate	: 25°C/min
Data acquisition	: 80 channels for temperature/voltage measurements

Heritage from MARSIM 1

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CTE 1000 (Coefficient of Thermal Expansion):

Purpose	: Determination of coefficient of thermal expansion of materials
Measurement Accuracy	: 0.1 µm
Temperature Range	: -120°C/+80°C (CP and shroud in series)
Measurable CTE	: >10^{-8}m/K
Test sample length	: 900mm / 700mm (3 samples max.)

Undergoing upgrades

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gN2 Facilities (Large & Small):

Purpose	: Fast thermal cycling at ambient pressure
Test space dimensions	: 1200x500x600mm (Large) 800x500x600mm (Small)
Temperature range	: -180°C/150°C
Temperature change rate	: ±10°C/min
Data acquisition	: 40 channels for temperature/voltage measurements

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VIRAC Facility:

Purpose	: automatic fast thermal cycling using motion system with solar illumination (max 1400W/m^2) and radiative temperature controlled hot plate
Application	: e.g. solar cells life test (in cooperation with ESA power lab)
Temp. range	: -170°C /+130°C
Vacuum limit	: < 5x10^{-6} mbar
Data acquisition	: 30 channels for temperature/electrical measurements
Temperature control	: motion system triggered on temperature or time

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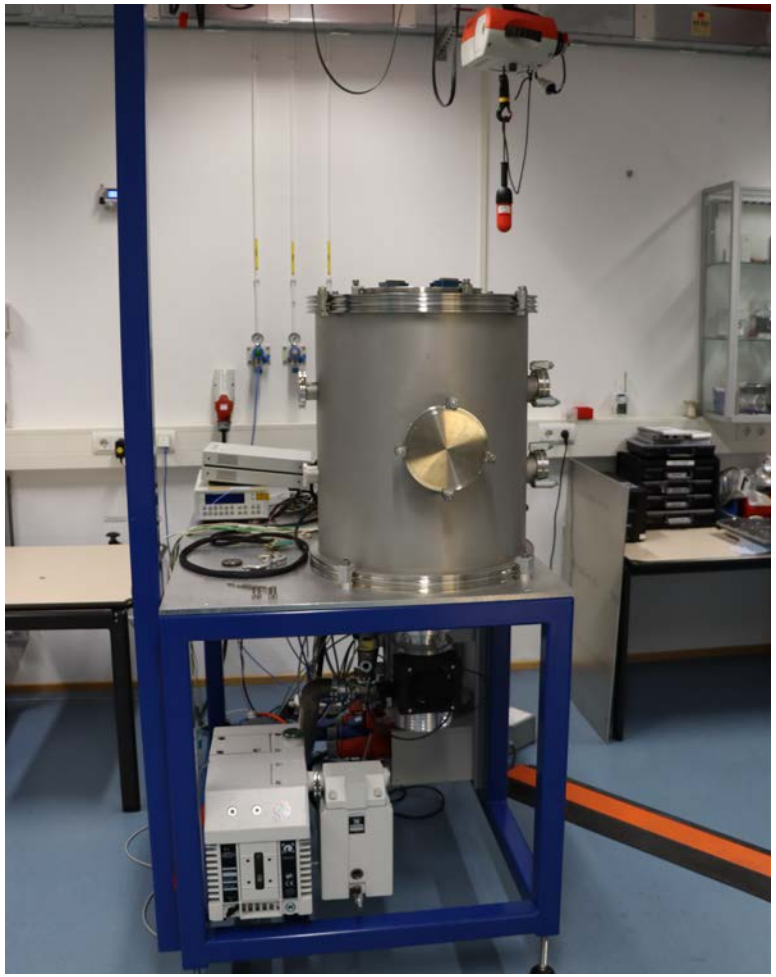
CRYO40K Facility:

Purpose	: Thermal cycling/thermal balance at cryogenic temperatures
Temp. range	: +50°C /-230°C (single stage cryocooler)
Vacuum limit	: < $5x10^{-6}$ mbar
Data acquisition	: 8 channels for temperature measurements (diodes/PT100/PT1000)
Temperature control	: LabVIEW application - fully automatic cycling from -120°C to -230°C



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22kN Combo Vibration System:

Purpose	: Vibration in sine and random
Force max.	: 22kN (Slip table 600mmx600mm)
Frequency range	: 5–4000 Hz
Acceleration max.	: 95g
Displacement max.	: 50.8mm
Data acquisition	: 40 channels (acceleration/force);
	Active accelerometers (ICP) ;
	Laser vibrometer; Force measurement.

New mathematical channels (Force summation etc.)

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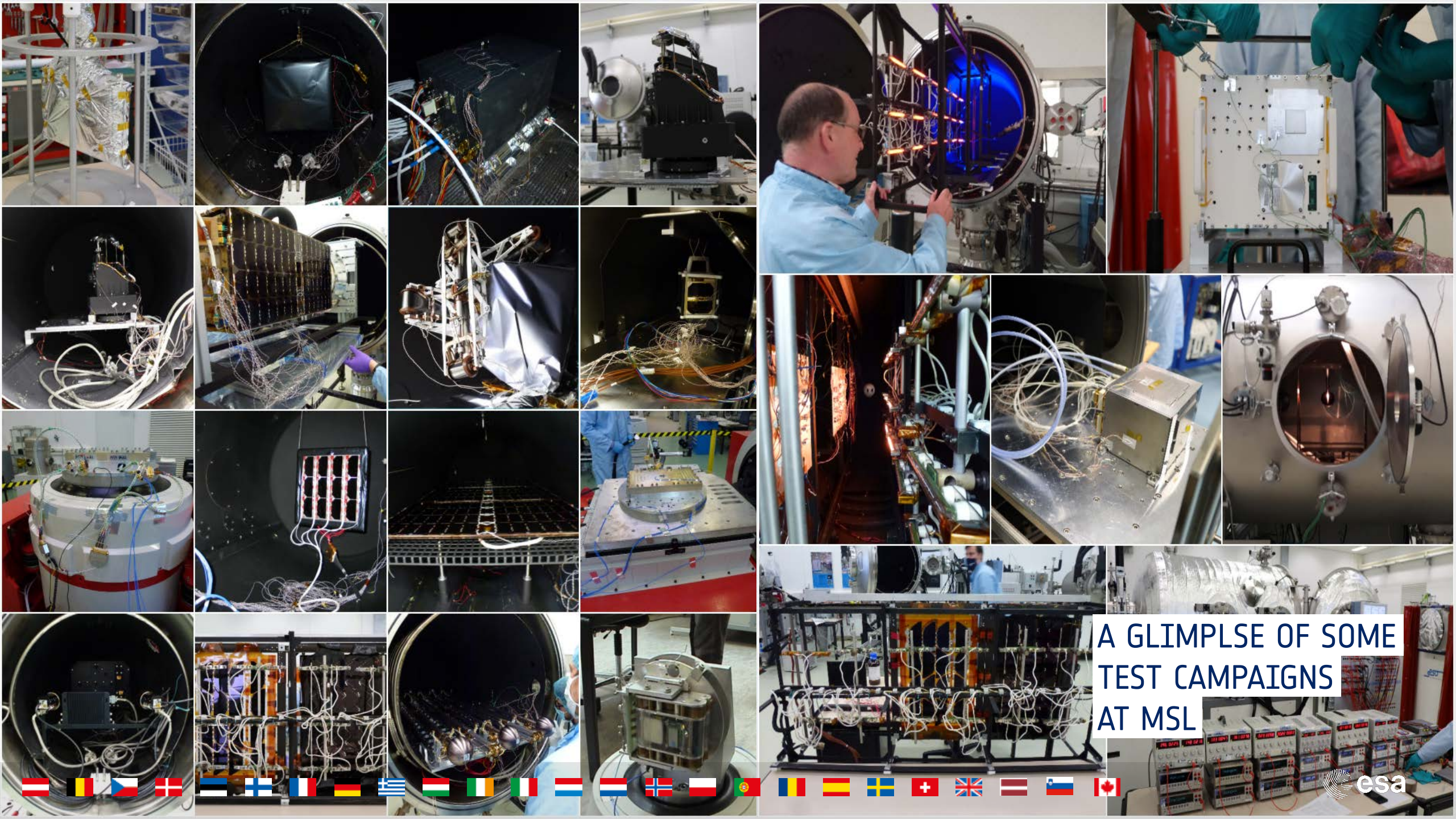
Showcase of flexibility in design of special test setups:

Vibration at Cryogenic Temperatures

- Developed for Huygens to understand a surprising measurement of the HASI boom during the probe descent in Titan atmosphere


A GLIMPLSE OF SOME
TEST CAMPAIGNS
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