

Mechanical System Laboratory

Thermal Analysis & Verification Section (TEC-MTV)

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

Contact: Laboratory Manager
MSLmanager@esa.int

Core activities:

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



Testing performed for ESA projects and 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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- Environmental testing ~ 70 tests / year
- 300m² clean room Class ISO 8

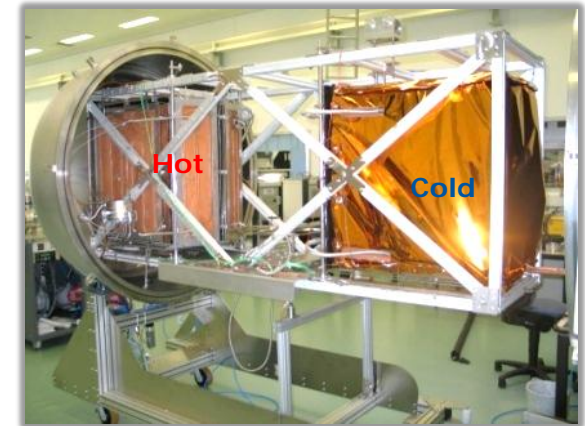


Test methods:

- 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
- Coefficient of Thermal Expansion (CTE) measurements
- Vacuum Gauges Calibration

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 : $< 5 \times 10^{-6}$ mbar
- Data acquisition : 60 channels for temperature/voltage measurements



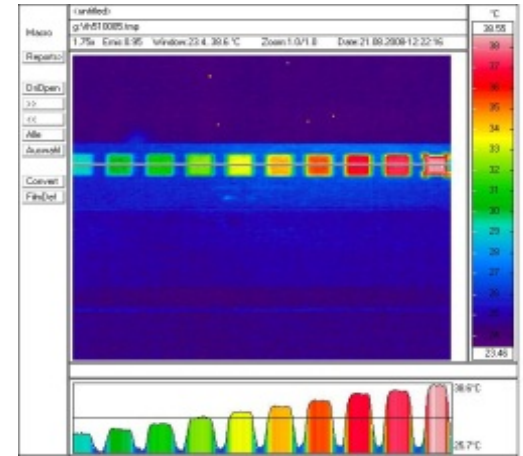
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LAVAF (Large Vacuum Facility):

- Purpose : Thermal cycling/thermal balance
- Shroud : Ø 850mm, 1.7m long
- Solar simulator : Ø 300mm
- Max sun intensity : 2800 W/m²
(uniformity at 2.9m for 1400W/m²)
- Temperature range : -170°C/+100°C (cold plate & shroud)
- Infrared lamp field : 3 independent sections
- Vacuum limit : < 5x10⁻⁶ mbar
- Data acquisition : 120 channels for temperature/voltage measurements





IR Picture

MEVAF (Medium Vacuum Facility):

- Purpose : Thermal cycling/ thermal balance with solar illumination
- Particularity : Allows non-intrusive temperature mapping with infra red camera
- Shroud : Ø 800mm, 1.2m long
- Temperature range : -170°C/+120°C (Shroud) / -80°C/+80°C (cold plate)
- Solar simulator beam : Ø 300mm
- Max sun intensity : 2800 W/m² (±3% uniformity at 2.9m for 1400W/m²)
- Vacuum limit : < 5x10⁻⁶ mbar
- Data acquisition : 120 channels for temp./voltage measurements



LIVAF (Little Vacuum Facility):

Purpose	: Thermal cycling/thermal balance of space equipment
Shroud	: Ø 550mm, 1m long
Temperature range	: -170°C/+80°C (cold plate & shroud)
Vacuum limit	: $< 5 \times 10^{-6}$ mbar
Data acquisition	: 60 channels for temperature/voltage measurements



LOVIB:

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 : $< 5 \times 10^{-6}$ mbar

Temp. range : -80°C/+80°C (cold plate)

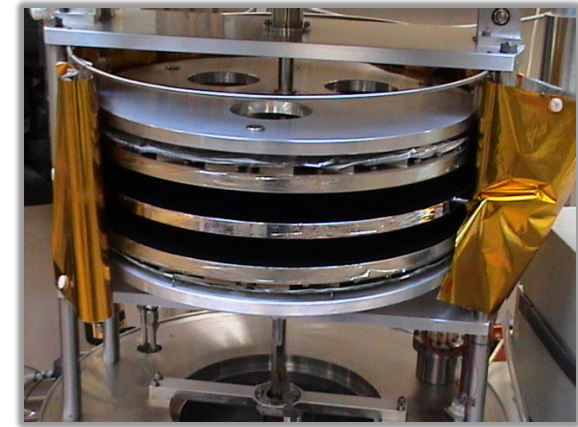
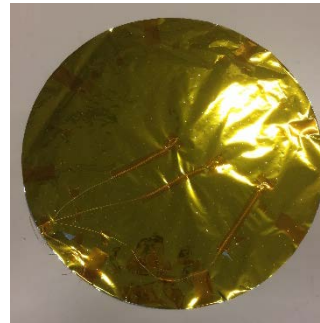
-233°C/+30°C (single stage cryocooler)

-263°C/+30°C (2 stage cryocooler)



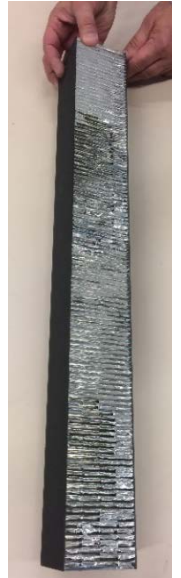
MLI Calorimeter (Multi Layer Insulation):

Purpose : MLI performance measurement
Temp. range : -230°C /+160°C
Vacuum limit : $< 5 \times 10^{-6}$ mbar
MLI blankets : \varnothing 480mm
Thickness : < 30 mm



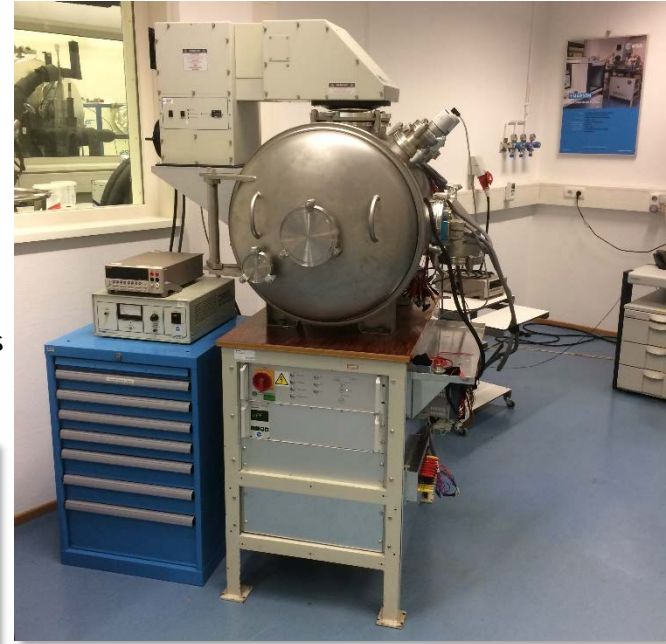
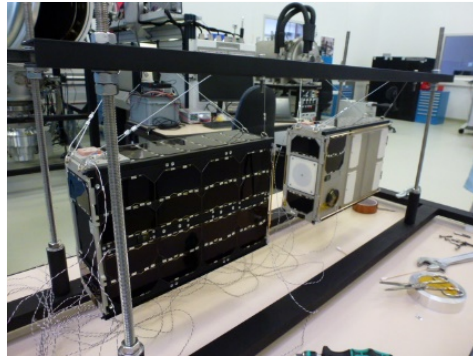
CTE1000 (Coefficient of Thermal Expansion):

- Purpose : Determination of the coefficient of thermal expansion of materials
- Temperature range : -120°C/80°C
- Test sample length : 900mm / 700mm (5 samples max.)
- Measurable CTE : $>10^{-7}$ m/K
- Measurement accuracy: 0.1 μ m



MARSIM:

- Purpose : Thermal cycling/thermal balance with solar illumination
- Temperature range : $-80^{\circ}\text{C}/+60^{\circ}\text{C}$ (Cold plate/shroud in series)
- Max sun intensity : 1400 W/m^2
- Vacuum limit : $< 5 \times 10^{-6}\text{ mbar}$
- Data acquisition : 30 channels for temperature/voltage measurements
- Historically developed to reproduce Mars environment (10mbar CO_2)
- Further modified to speed up test for cubesats



gN2 Facilities

Purpose : Fast thermal cycling at ambient pressure

Test space dimensions : W1200xD500xH600mm

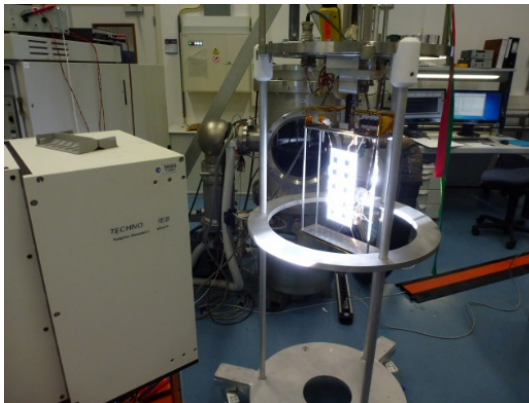
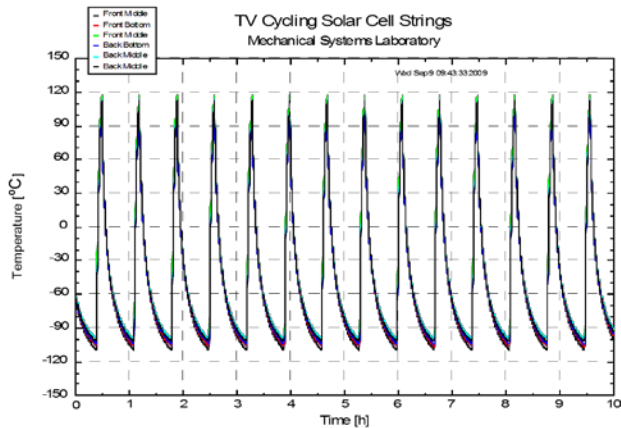
Temperature range : -180°C/150°C

Temperature change rate : $\pm 10\text{K}/\text{min}$

Data acquisition : 30 channels for
temperature/voltage
measurements

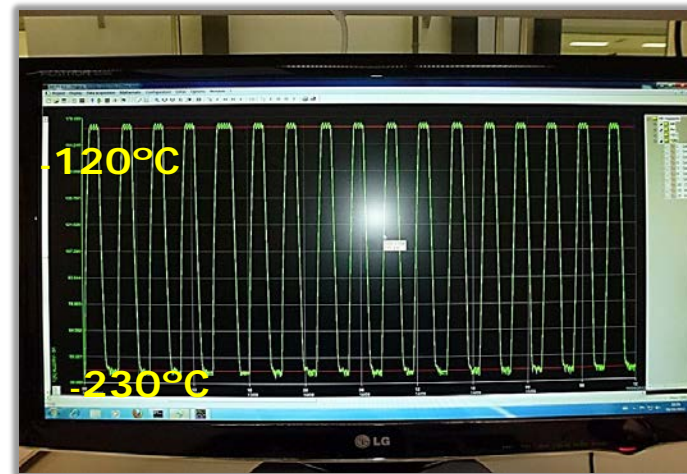


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VIRAC:

- Purpose : automatic fast thermal cycling using motion system
with solar illumination (max 1400W/m²) 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
- Temp. control : motion system triggered on temperature or time



CRYO40K:

- Purpose : Thermal cycling/thermal balance at cryogenic temperatures
- Temp. range : +50°C /-230°C (single stage cryocooler)
- Vacuum limit : $< 5 \times 10^{-6}$ mbar
- Data acquisition : 8 channels for temperature measurements (diodes/PT100/PT1000), lakeshore
- Temp. control : Labview application - fully automatic cycling from -120°C to -230°C

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/strain/force)
- Active accelerometers (ICP) – Laser vibrometer – force measurement



Example of achievement: Vibration at cryogenic temperatures

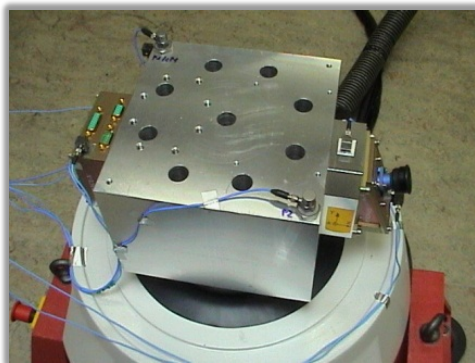
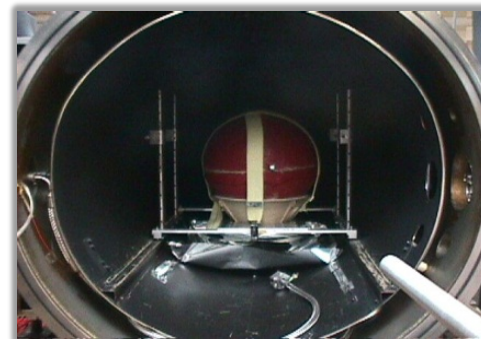
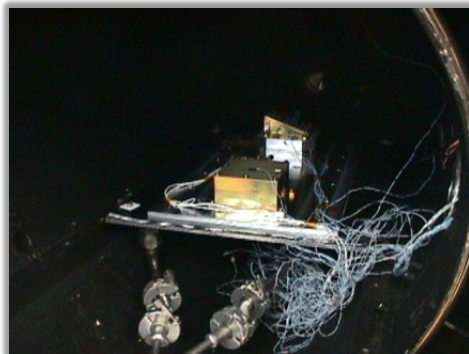
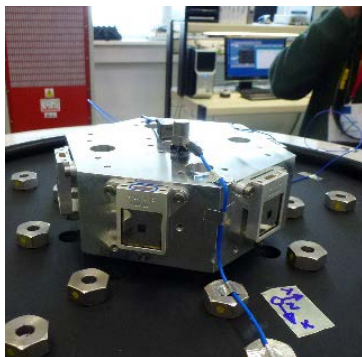
Developed for Huygens to understand a surprising measurement of the HASI boom during the probe descent in Titan atmosphere



Also static test of the boom at cryogenic temperature

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Examples of Thermal/Vibration Test Campaign



Bison 64 sun sensors

Proba-2 X-cam FM

YES2 Fotino FM

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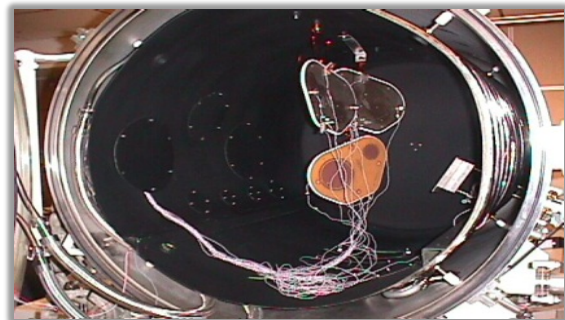
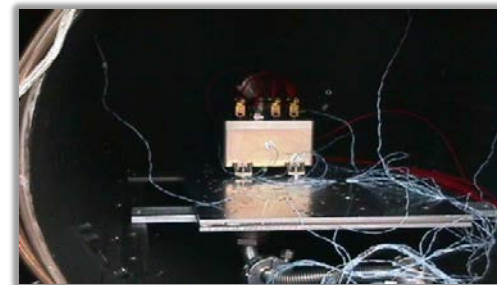
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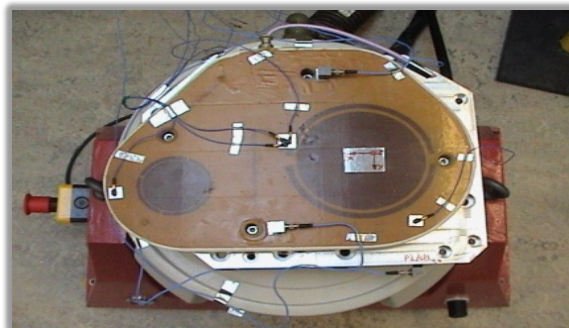
Examples of Thermal/Vibration Test Campaign



Proba-V EPT EQM



Colombus ARISS Antenna QM



EuTEF EuTEMP FM

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A dedicated, competent and customer focused team at your service



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