EUROPEAN EXPERIMENTAL RE-ENTRY TESTBED EXPERT: QUALIFICATION OF PAYLOADS FOR FLIGHT

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AGENDA

• Review of Payloads qualification campaign
  – Mechanical and Thermal qualification tests
  – Wind tunnel tests
  – Calibration and functional tests
  – Next tests foreseen

• Conclusions
EXPERT PAYLOADS

Nose – TPS and nose cold structure (DLR)
PL 1  – FADS Flush Air Data System (HTG)
PL 2  – PYREX Nose Heating (IRS)
PL 3  – Catalycity Experiment (IRS)
PL 4  – Natural Transition (CIRA)
PL 5  – Roughness Induced Transition (VKI)
PL 6  – SWBLI on the open flaps (DLR)
PL 7  – SWBLI upstream of open flaps (CIRA)
PL 8  – IR Thermography (RUAG)
PL 10 – Re-entry Spectrometer (IRS)
PL 11 – Catalytic jump (VKI)
PL 12 – Base Pressure and Heat Flux (ALTA)
PL 13 – Skin Friction Sensors (HTG)
PL 15 – Sharp Hot Structures (CIRA)
PL 18 – Intermetallic Tile (INASMET)
NOSE QM production and static test

Manufacturing

Nose Pressure Test:
3 bar differential pressure

Load introduction elements
TPS and cold structure
11kN >> 3.7 kN
Nose Vibration and Shock test

Vibration test: Grms 11.5

Shock test reached 1000g @1000Hz
Plasma wind tunnel test on material and PLs

Material testing for passive to active oxidation characterization
1.3 bar pressure reached in L3K
1.8 MW/m² heat flux

PL1 before and after test
MECHANICAL TESTS Pyrometers PL2/PL3

Sensor Unit during vibration 20Grms OOP and shock 1000g @ 1000Hz
Plasma wind tunnel test for Pyrometer heads PL2/PL3

Thermal load injected as per flight heat fluxes representative re-entry conditions
Calibration of Pyrometers PL2/PL3

Black body

PL02/03 SH

Fibre Optics

PL02/03 SU
Spectrometer PL10

Sensor Unit
vibration 20Grms OOP
shock 1000g @ 1000Hz

Sensor head on the Nose

Sensor head on side TPS
Plasma wind tunnel test for Spectrometer head PL10 tested in L3K at DLR

No traces of intruding plasma
Sealing concept proven
No pollution of sapphire window
Surface temperature reached 1900 °C
Plasma wind tunnel test for Spectrometer head PL10
Tested in PWK at IRS

heat flux at peak heating representative re-entry conditions

After peak heating test stopped due to excessive oxidation of fixation screw
Spectrometer PL10 calibration

- Calibration lamp
- Spectral radiance \( [W/(m^2 \text{ sr nm})] \)
  - Integration over wavelength of each camera pixel

- Radiance \( [W/(m^2 \text{ sr})] \)
  - Measured signal \( [\text{counts/s}] \)

- Sensitivity \( [\text{counts/(W s m^2 sr})] \)

[Diagram of calibration setup with labels: integrating sphere, A/D converter, spectrometer unit, sensor head, LWL]
PL4 Natural transition CFP sensor

Combined heat flux and pressure sensor
Vibration 40 Grms OOP
Shock 1000g @ 1000Hz
Plasma wind tunnel test CFP sensor PL4/PL7

functional verification of CFP sensors for pressure and heat flux

preliminary analysis of experimental data indicates a consistency of measurements with respect to the SWBLI phenomenon

experimental data analysis and numerical rebuilding are on-going at CIRA
Roughness induced transition PL5

Vibration and shock test

Test campaign in H3 at VKI to characterize transition
Different type of TCs attachment to TPS in PM1000 have been realized by VKI and tested for vibration and shock.
Flap and cavity instrumentation PL6

Pressure port vibrated

Pressure port tested in L3K
Heat load as per flight
Max heat flux 800KW/m²
Temperature 1800°C

Pyrometer head and feed-through on cavity vibrated
Electronics of PL6

Vibration and shock test of electronics on going

Due to high vibration level need PCBs have been reinforced to reduce their displacement during test
IR camera PL8 mechanical tests

Front optics assembly
Camera
DHU

Vibration shock and thermal tests performed
Calibration of IR camera

Functional tests performed

Calibration of camera on-going
MECHANICAL TESTS: PL12/PL18

PL12 pressure sensors
Vibration, shock and thermal test

PL18 Vibration, shock and Thermal tests
MECHANICAL TESTS: PL13

PL13 Vibration test
MECHANICAL TESTS: PL15

PL15 Vibration and Shock tests
Catalicity test at junctions

Plasmatron test for characterization of catalytic jump on going at VKI
Next aerothermal tests

Winglet in SCIROCCO

PL3 sensor head in PWK

Flap PL6 and PL8 in SCIROCCO
EMC tests

EMC tests of PL8, PL2, PL10 performed

EMC tests confirmed overall compliance of electronic design with EMC environment

Minor NCRs
CONCLUSIONS

• Extensive qualification campaign for EPERT Payloads QM performed (46 qualification tests)
• Extensive use of ATD facilities (DLR, CIRA, IRS, VKI, ALTA)
• No showstoppers identified BUT several lessons learned

• High vibration and shock levels from 2nd to 3d stage separation of Volna Launcher

EXPECTED COMPLETION OF QUAL REVIEW by NOVEMBER
DELIVERY OF FM MID 2009
THANK YOU