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LM2 & VM2 Tests report

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List of Acronyms

AIT	Assemblage, Integration et Test
AFEE	Analog Front-End Electronic
CAL	sous-système calorimètre du LAT
CDE	Crystal-Diode Element
CEA	Commissariat à l'Energie Atomique
CNES	Centre National d'Etudes Spatiales
DCI	Dossier de Contrôle des Interfaces
DCF	Dossier de Fabrication et de Contrôle
DD	Dossier de Définition
DJD	Dossier Justificatif de la Définition
EM	Engineering Model
EMC	Electromagnetic Compatibility
EGSE	Electric Ground Support Equipment
GLAST	Gamma-Ray Large Area Telescope
LAT	Large Area Telescope
LLR	Laboratoire Leprince-Ringuet
LPNHE	Laboratoire de Physique Nucléaire des Hautes Energies
N/A	Not Applicable
NRL	Naval Research Laboratory
PCB	Printed Circuit Board
SLAC	Stanford Linear Accelerator Center
STB	Spécification Technique de Besoin
TBR	To Be Resolved
TBD	To Be Defined
TBC	To Be Confirmed

1 INTRODUCTION

1.1 OVERVIEW

GLAST is a next generation high energy gamma-ray observatory designed for making observations of celestial gamma-ray sources in the energy band extending from 20 MeV to more than 300 GeV. It follows in the footsteps of the Compton Gamma Ray Observatory EGRET experiment, which was operational between 1991-1999. The GLAST Mission is part of NASA's Office of Space and Science Strategic Plan, with launch anticipated in 2005. The principal instrument of the GLAST mission is the Large Area Telescope (LAT) that is being developed jointly by NASA and the US Dept. of Energy (DOE) and is supported by an international collaboration of 26 institutions lead by Stanford University.
The GLAST LAT is a high-energy pair conversion telescope that has been under development for over 7 years with support from NASA, DOE and international partners. It consists of a precision converter-tracker (TKR), CsI hodoscopic calorimeter (CAL), plastic scintillator anticoincidence system (ACD) and a data acquisition system (T&DF).

The GLAST LAT Calorimeter (CAL) subsystem consists of 16 identical modules arranged in a 4 × 4 array that is defined by the LAT support grid structure. Each CAL module is made of:

- 1 mechanical structure,
- 96 CDE (CsI crystal, wrapped in reflective material and equipped with dual PIN photodiodes), arranged horizontally in 8 layers of 12 crystals each. Each layer is aligned 90° with respect to its neighbors, forming an x-y array,
- 4 electronics cards for signal processing.

LLR participation in the GLAST program consists in the development and delivery of the CAL mechanical structure (see figure below), which is composed of:

- a carbon composite structure on which are attached Titanium inserts,
- an aluminum baseplate which presents the structural I/F to the LAT grid structure,
- an aluminum top frame,
- 4 aluminum close-out plates,
- 4 aluminum side panels that provide shielding.

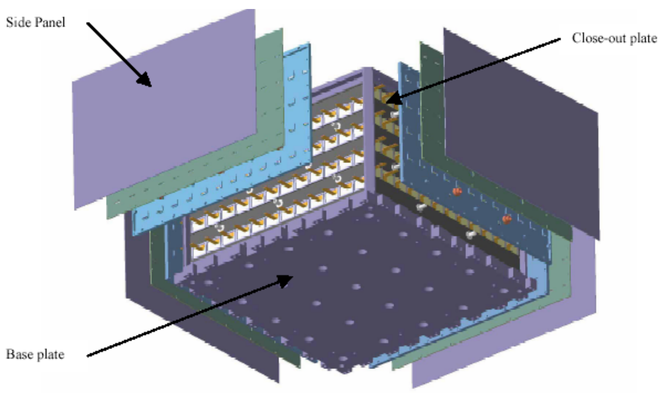

Figure 1-1 : Exploded view of CAL mechanical structure

1.2 SCOPE OF THE DOCUMENT

This document presents the tests performed on the LM2 and VM2 models.

LM2 is a model constituted of a composite structure of 12 cells disposed on 1 layer, and 12 CDE.
The complete configuration of the LM2 and the CDE is exposed in paragraph 5.1.
The principle objective of the LM2 is to validate the CDE concept to environment and performance requirements.

VM2 is a model constituted of a composite structure of 96 cells disposed on 8 crossed layers and aluminium parts (close-out plates, side panels, top frame, base plate).
As we didn't dispose of 96 CDE, these ones were replaced by dummy CDE in aluminium and steel for respectively the thermal tests (96 dummies) and the vibration tests (87 dummies and 9 CDE). The complete configurations are exposed in paragraph 6.2.2 and 6.3.2.
In the same way, the AFEE boards were replaced by dummy boards with a representative stiffness.
The principle objective of the VM2 is to validate the mechanical structure concept of the CAL module to environment requirements.

2 DOCUMENTS

2.1 APPLICABLE DOCUMENTS

All Applicable Documents are listed in the 3rd chapter of the CIDL (GLAST-LLR-LI-029).

2.2 REFERENCE DOCUMENTS

	Title	*Author*	*Reference*	*Iss*	*Rev*	Date
RD01	LM2 and VM2 performance verification plan	P. Prat CNRS/IN2P3/LLR	GLAST-LLR-E-006	B		20 mar 2002
RD02	Rapport d'essais climatique 1	EMITECH	RQ-02-60956/BLS/IM			20 dec 2001
RD03	Rapport d'essais climatique 2	EMITECH	RQ-02-60251/BLS/IM			22 may 2002
RD04	Rapport d'essais climatique 3	EMITECH	RQ-02-60251/BLS/BLS			20 jun 2002
RD05	Mesures des contraintes statiques sur prototype de module de calorimètre – Projet GLAST VM2	A. Lepape Bureau VERITAS	NT 049/VLM/LPA			12 jun 2002
RD06	Essais de vibration sur un module du calorimètre GLAST – VM2	SOPEMEA	LD31572			16 apr 2002
RD07	LM2 performance test results	G. Bogaert CNRS/IN2P3/LLR	LAT-TD-00616	01		10 dec 2001
RD08	CDE Performance Results along the LM2 & VM2 Environment Tests	Ph. Bourgois CEA/DAPNIA	SEDI-GLAST-N5600-183	A		27 jun 2002
RD09	Rapport d'essai du cyclage thermique – Laboratory Model 2	B. Horeau CEA/DAPNIA	SAp-GLAST-Y-5500-143	B		26 mar 2002
RD10	Analyse par éléments finis de la structure mécanique du calorimètre GLAST	DDL consultants	GLAST-LLR-017	A		29 may 2002

3 OBJECTIVES OF THE LM2 AND VM2 TESTS

3.1 LM2 OBJECTIVES

The LM2 objectives were to validate the CDE concept in the configuration exposed in paragraph 5.1:

–Demonstrate that photodiode bonded with DC93500 silicone can survive handling during wrapping, integration inside the cells, removal from the cells
–Demonstrate that bonding can survive qualification level mechanical and thermal loads when the CDE are mounted inside the cells with elastomeric cords and bumpers
–Demonstrate that flex cable concept used for VM2 / LM crystals can survive handling of the logs and environmental loads
–Demonstrate that light yield of CDEs, wrapped with VM2000 film, is not affected by environmental loads when the logs are mounted inside the cells
–Demonstrate that light yield of CDEs, wrapped with VM2000 film, is not affected during insertion and removal of the logs from the composite cells

The environmental requirements are defined in the RD01document "LM2 and VM2 performance verification plan".

3.2 VM2 OBJECTIVES

The VM2 objectives were to validate the mechanical structure of the CAL modules in the configuration exposed in paragraph 6.1.1 and 6.2.1:

– Demonstrate that the design of the CAL structure meets the specifications in terms of stiffness: natural frequencies above 100Hz, deflections below 0.5 mm
– Demonstrate that composite structures fabricated with current process are able to withstand both mechanical and thermal loads
– Demonstrate that the concept used to hold the CDE preserves their safety and has no impact in their performances
– Demonstrate that the current design of the mechanical structure is well matched with the dimensions of the crystal and that integration can be done without problem
The environmental requirements are defined in the RD01 document "LM2 and VM2 performance verification plan".

4 TESTS SEQUENCE

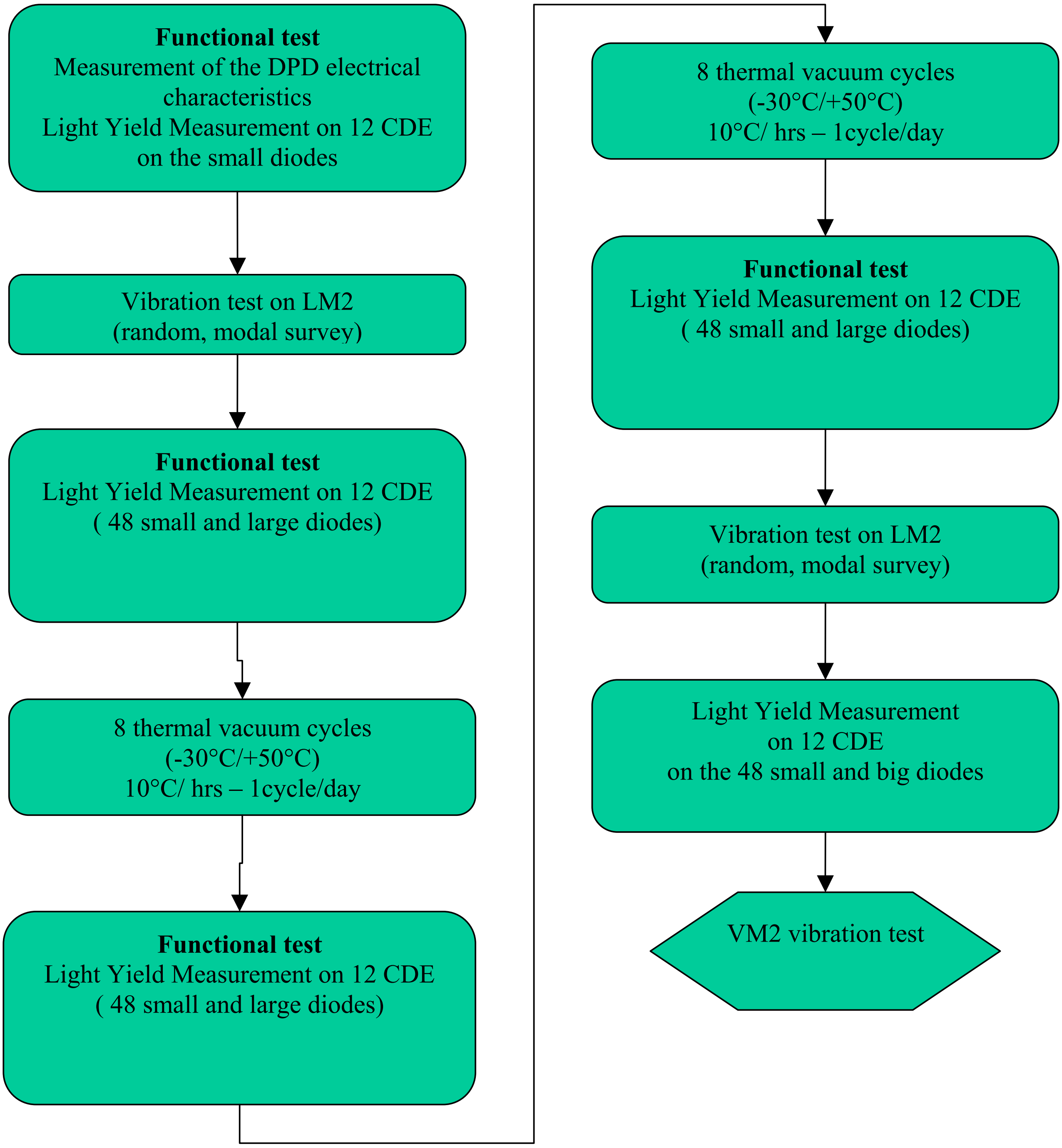

Figure 4-1 : LM2 test sequence

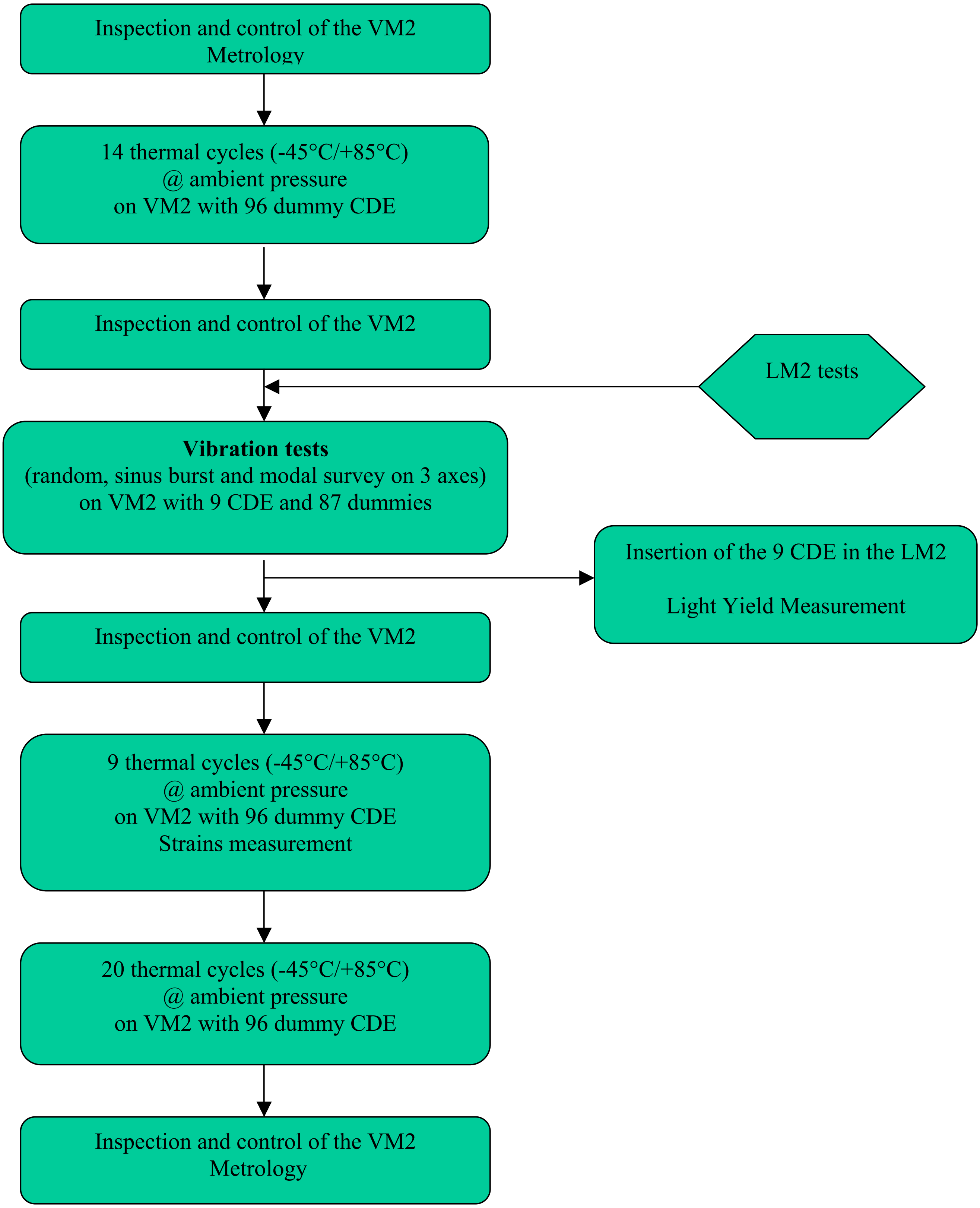

Figure 4-2 : VM2 test sequence

5 LM2 TESTS

5.1 LM2 TESTS CONFIGURATION

The configuration test is the same for the following test:

- thermal vacuum test and depressurization
- vibration test
- light-yield measurement

LM2 composition:
The LM2 is composed of:

- 1 composite structure : 1 layer of 12 cells in HEXCEL M10/50%/G814NT composite material
- 2 lower and 2 upper aluminium fixture parts
- 2 side panel
- 12 CDE maintened longitudinally by 2 elastomer frames at each extremity and laterally by 2 elastomer cords

Figure 5-1 : LM2

CDE composition :
The CDE of LM2 consist of:

- AMCRYS crystal, 333mm long and 19.9x26.7mm2 section. The chamfers have been redone by LLR. The four long sides are depolished for tapering.
- DPDs (S8576) have been glued by “College de France” at each end of the crystal using primer and Dow-Corning 93500 silicon glue (about 0.6mm thick).
- Then the crystal has been wrapped with VM2000 by LLR (standard method with a recovering of about 2 to 3mm on one of the larger face and two sheets of white adhesive tape, the first about 1cm wide and the 2nd one 2.5cm)
- White frames at each end of the CDE surrounding the DPD, have been used to fix the CDE in both LM2 and VM2 structure.

The Table 1 summaries the constituted elements of the 12 CDEs and their position in LM2 (including the calibration parameter):

						PIN A		PIN B	
Xtal	DPD #	Wrapping	End Frame	Position	Pin	a (e/ch.)	b (e)	a (e/ch.)	b (e)
167P3-40-2	52 58	VM2000	White	1	C1-G C1-D	35,22 36,48	2561,7 2281,3	142,64 144,60	10518,0 11050,0
32K4-5-1	72 70	VM2000	White	2	C2-G C2-D	34,76 36,53	2517,1 2819,2	140,79 140,52	10574,0 11119,0
32K4-4-8	67 69	VM2000	White	3	C3-G C3-D	33,27 32,64	2312,3 2806,8	128,22 133,59	9073,2 9432,6
32K4-2-7	71 68	VM2000	White	4	C4-G C4-D	35,35 34,14	3086,7 2365,9	130,01 143,52	7412,8 9822,8
32K4-4-1	64 75	VM2000	White	5	C5-G C5-D	32,26 33,84	2838,0 3235,9	142,52 140,15	12187,0 9774,6
32K4-5-5	53 56	VM2000	White	6	C6-G C6-D	31,48 31,53	2171,8 2825,9	142,93 144,79	11976,0 11446,0
32K4-4-2	57 54	VM2000	White	7	C7-G C7-D	34,47 36,39	2663,4 2284,4	144,11 151,55	10333,0 10906,0
32K4-3-1	80 82	VM2000	White	8	C8-G C8-D	34,76 36,53	2517,1 2819,2	140,79 140,52	10574,0 11119,0
32K4-2-1	79 78	VM2000	White	9	C9-G C9-D	33,27 32,64	2312,3 2806,8	128,22 133,59	9073,2 9432,6
32K4-2-2	65 73	VM2000	White	10	C10-G C10-D	35,35 34,14	3086,7 2365,9	130,01 143,52	7412,8 9822,8
32K4-2-4	83 66	VM2000	White	11	C11-G C11-D	32,26 33,84	2838,0 3235,9	142,52 140,15	12187,0 9774,6
167P3-4-13	74 81	VM2000	White	12	C12-G C12-D	31,48 31,53	2171,8 2825,9	142,93 144,79	11976,0 11446,0

Table 5-1 : CDE composition and test setup parameter

5.2 LM2 TEST SEQUENCE

– Assembly of the 12 CDEs inside the composite structure
– Light yield measurements
– Vibration test: random vibrations, qualification level
– Light yield measurements
– 8 thermal vacuum cycles, survival temperature range
– Light yield measurements
– 8 thermal vacuum cycles, survival temperature range
– Light yield measurements
– Vibration test: random vibrations, qualification level
– Light yield measurements
– Removal of the CDE from the cells
– *Integration inside VM2, vibration test, removal from VM2*
– Assembly of the 12 CDEs inside the composite structure
– Light yield measurements

5.3 THERMAL VACUUM TEST

The thermal cycle test was achieved according to the 'LAT Mechanical Performance Specification' (Table 6.2-2) with Survival Qualification temperature Ranges.
The number of cycle is determined according to the GEVS standard (§2.6.2.4), 16 cycles for the total number of cycle:
- 4 at the payload/Spacecraft level,
- 4 the Subsystem/Instrument level (LAT),
- 8 at the Component/Unit level (CAL module).

Condition	***Vacuum***
Temperature Min	***-30°C***
Temperature Max	***+50°C***
Cycle number	***16 = 8 + 8***
DT/dt	***10 °C /hrs***
Hold time	***4 hrs***
Cycle duration	***24 hrs***

Table 5-2 : LM2 thermal vacuum test characteristics

The RD09 document of Benoît Horeau "Rapport d'essai du cyclage thermique du *LM2"* , presents the thermal vacuum test performed on the LM2.

5.3.1 Pressure profile

LM2 shall withstand the time rate of change of pressure in the LV fairing according to the DELTA Payload Planner's Guide (Figure 4.2, Section 4.2.1).

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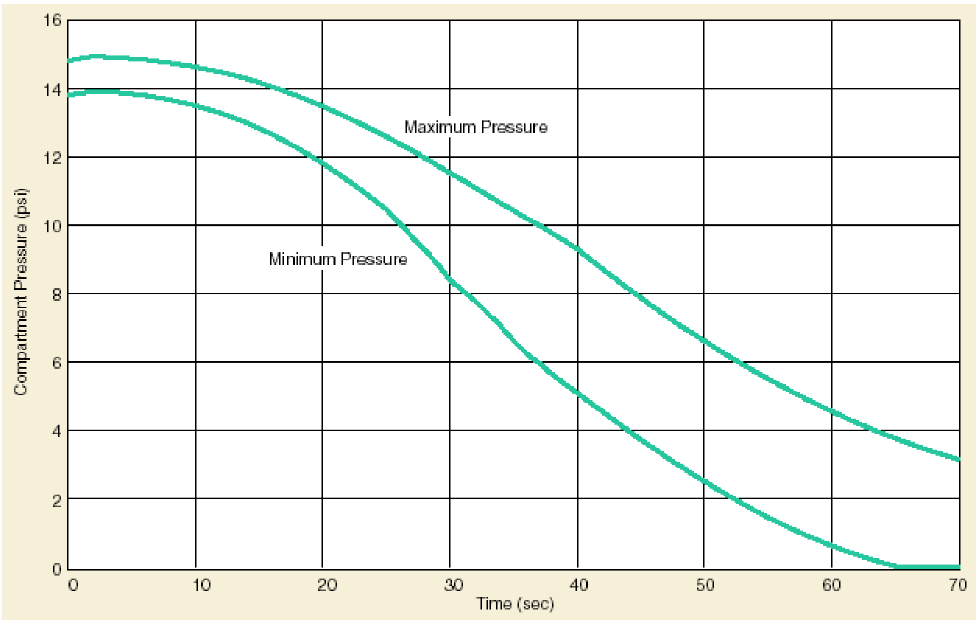


Figure 4-6. Delta II Payload Fairing Compartment Absolute Pressure Envelope

Figure 5-2 : LM2 Delta II Payload Fairing Compartment Absolute Pressure Envelope

This test was achieved during the thermal vacuum test. The figure below represents the profile of depressurization:

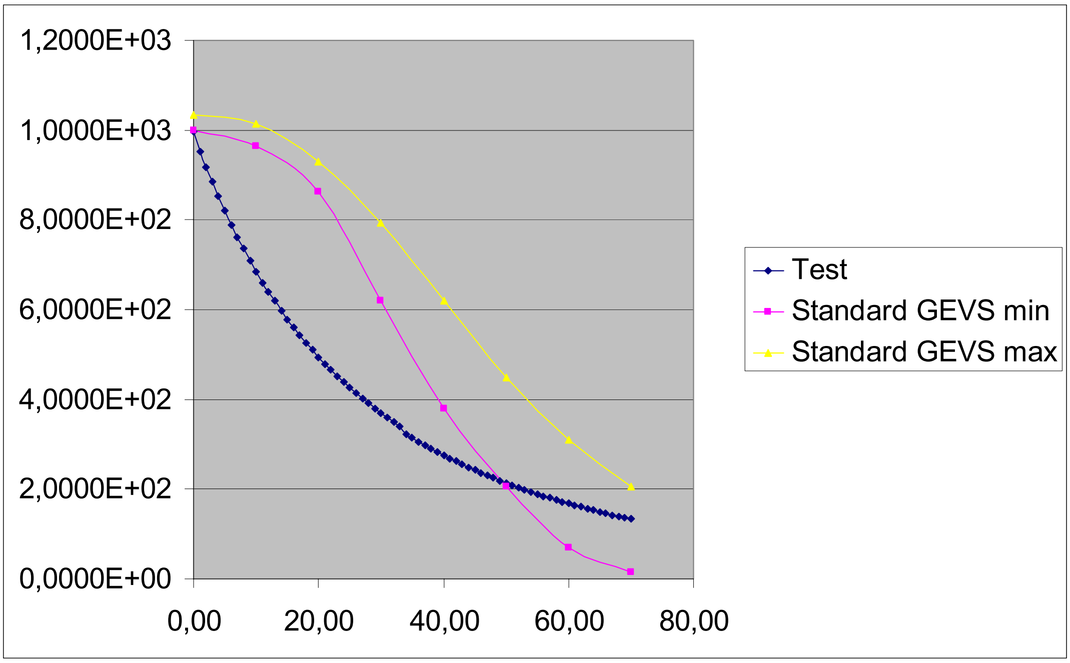


Figure 5-3 : LM2 pressure profile during thermal vacuum-test

The depressurization test performed is harder than the GEVS standard.
No failure on the CDE has been noticed after this test
.

5.4 VIBRATION TEST

5.4.1 Random vibration

The LM2 was tested according to the acceleration spectral density (ASD) given in the table 2.4-4 of GEVS standard, with qualification levels corrected for unit mass.

Assuming a mass of 25 kg, the levels are shown in the table and the figure below.

Frequency	ASD
20 Hz	0.026 g²/Hz
20 – 50 Hz	6 dB/oct
50 – 800 Hz	0.16 g²/Hz
800 – 200 Hz	-6 dB/oct
2000 Hz	0.026 g²/Hz

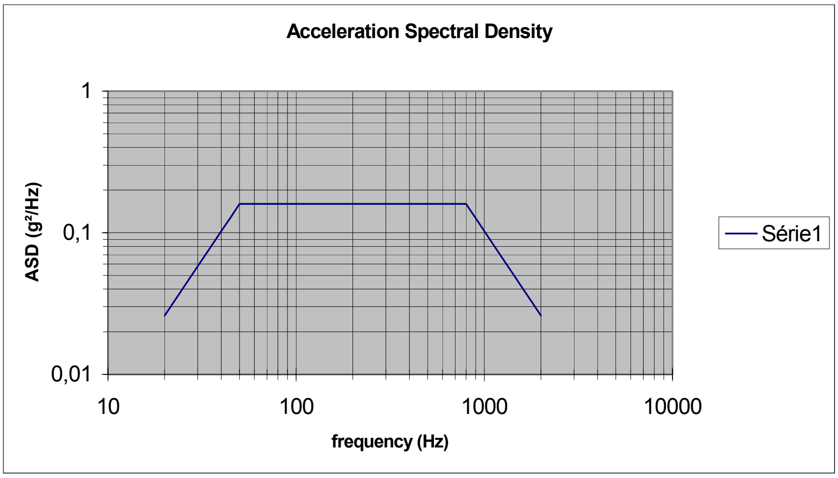


Table 5-3 : LM2 random vibration test levels

- ➔ Axis: x, y, z
- ➔ Duration: 2 mn / axis

5.4.2 Low level sinus sweep

A modal survey test was achieved on the LM2. A low level sine sweep is an appropriate method in order to determine the fundamental frequency.

Frequency	Level	Sweep speed	Axis
10-2000 Hz	0.5 gpk	1 oct/mn	x, z, z

Table 5-4 : LM2 sinus vibration test characteristics

5.4.3 Tolerances

➔ Accelerations:	+/- 10%	
➔ Duration:	+/- 5s	
➔ Sweep speed:	+/- 2% for f > 50 Hz	
➔ Frequencies:	+/- 2% for f > 50 Hz	
	+/- 1 Hz for f < 50 Hz	
➔ ASD:	20Hz-500Hz	+/- 1.5dB
	500Hz – 2000Hz	+/- 3dB
	gRMS global	+/- 10%
➔ Control levels:	+/- 10%	

5.4.4 Vibration tests sequence

The tests were achieved on the 3 axes x, y and z of the LAT coordinate system defined in the document referenced LAT-TD-00035-01 'LAT coordinate System'.

* Transverse axis (x):

- accelerometers positioning along the x axis
- instrumentation verification 0.25 gpk @ 20 Hz
- sinusoidal sweep 0.5 gpk 10-2000 Hz : 1 oct/mn
- random level 20-2000 Hz : 2 mn
- sinusoidal sweep 0.5 gpk 10-2000 Hz : 1 oct/mn
- verification (visual inspection + measurement data analysis)

* Transverse axis (y):

- accelerometers positioning along the y axis
- instrumentation verification 0.25 gpk @ 20 Hz
- sinusoidal sweep 0.5 gpk 10-2000 Hz : 1 oct/mn
- random level 20-2000 Hz : 2 mn
- sinusoidal sweep 0.5 gpk 10-2000 Hz : 1 oct/mn
- verification (visual inspection + measurement data analysis)

* Thrust axis (z):

- accelerometers positioning along the z axis
- instrumentation verification 0.25 gpk @ 20 Hz
- sinusoidal sweep 0.5 gpk 10-2000 Hz : 1 oct/mn
- random level 20-2000 Hz : 2 mn
- sinusoidal sweep 0.5 gpk 10-2000 Hz : 1 oct/mn
- verification (visual inspection + measurement data analysis)

5.4.5 Structure instrumentation

The positions of the 4 measurement points were the following:

➔ 1 accelerometer centered on the top edge of the structure

➔ 1 accelerometer centered on one lateral edge of the structure

➔ 2 accelerometers fixed on one aluminum close-out plate

5.4.6 Performance test

Performance tests were performed at ambient temperature before and after each environmental test phase. A cosmic muon test bench was used for performance tests. The following performance characteristics were measured:

- Single crystal light yield obtained for the large and small diodes
- Tapering characteristics calculated with the light yields of the 2 dual-diodes of each single crystal, for large and small diodes.

The performance results are synthetized in the RD08 report document of Philippe Bourgeois "CDE PERFORMANCE RESULTS ALONG THE LM2 & VM2 ENVIRONMENT TESTS.

The figure below, taken from this document, summarizes the average variation of the Light-Yield along the environmental tests.

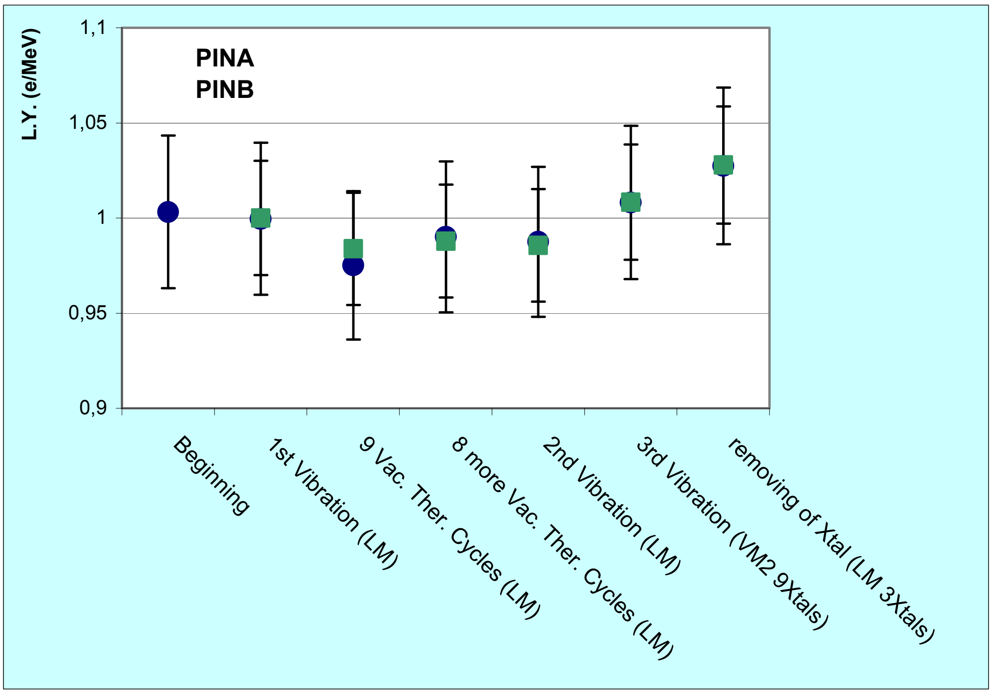


Figure 5-4 : Relative L.Y. versus environment test

The conclusion of this report is :

"The measured performances on the CDEs in LM2 structure answer the CDE specification:

- L.Y. 910 and 5600 e/MeV respectively for PIN A and B.
- The energy resolution 5.8 and 2.6% respectively for PIN A and B.
- The Tapering between 0.14 - 0.22 for PIN A and 0.15 - 0.24 for PIN B.

Note: we have to be wary with the tapering which seems to be very dependent of the setup."

Remark 1:
The double operation of transfert of the CDE (from the LM2 to the VM2 for the VM2 vibration test, from the VM2 to the LM2 for the CDE performance test) has surely contributed to the variation of the CDE performances. The fixture of the reflecting material at both end of the crystal logs was different: after the VM2 vibration test, for the re-insertion of the CDE in the LM2, an adhesive tape was added in order to fix the wrapping and to facilitate the insertion. This adhesive tape was kept for the final light-yield measurement.

Remark 2:
Handling problems occurred which caused the failure of 2 flexs. These problems are related in the LLR NCR referenced GLAST-LLR-FA-002.

- CDE n°3 – Left DPD – A and B diode : connexion failure on the flex
- CDE N°9 – Right DPD – A diode : flex pad removed

So, the corresponding CDE performances weren't verified after the incident which occurred after the 2nd LM2 vibration test.

6 VM2 TESTS

6.1 VM2 TEST SEQUENCE

The following sequence test was achieved on the VM2 model:

–Assembly with 96 dummy aluminum logs
–Thermal cycling, atmospheric pressure
  • 14 cycles between -45°C to +85°C
–Removal of dummy aluminum logs
–Assembly of steel dummies with silicone cords and 9 CDEs
–Vibration test: modal survey, random vibrations, sine burst
  •Qualification level x 1.2 load factor
–Removal of CDEs and steel dummies
–Assembly with 96 dummy aluminum logs
–Thermal cycling, atmospheric pressure
  • 9 cycles between -45°C to +85°C
  •Composite structure instrumented with strain gauges
–Thermal cycling, atmospheric pressure
  • 20 cycles between -45°C to +85°C, fatigue test

6.2 THERMAL CYCLE TEST

6.2.1 Objectives

The test must allow to check the behaviour of the mechanical structure and more particularly of the metal inserts when they are subjected to:
- the mechanical strains during integration of modules,
- the thermomechanical strains during variations in temperature.

The efforts come from:
- the pre-stressing of the elastomer shock bumpers during the integration of the CDE in order to guarantee a blocking in translation whatever the length of crystals in their interval of 0/-0.6 mm tolerance;
- the strains on the cover plates of the cells due to the expansion of the crystals during the temperature rise, effort in particular transmitted to the lateral inserts;
- the strains due to the differential expansion between the aluminium parts and the composite material of the honeycomb structure when the temperature of the parts goes away from the assembly temperature.

Remark:
The tests must allow to simulate the maximum resulting strains in the mechanical structure in the survival temperature range.
The maximum expansion of 333 mm length CsI crystal subjected to a temperature rise of 30°C is 0.54mm (dilation coefficient of 54 10-6 °K). In order to assure a blocking in translation of all the crystals, a pre-stressing lower than 0.3 mm on each elastomer shock absorber is necessary. In assuming an asymmetrical length increase of the crystals in dilation, the strains on each cells close-out plate are provided by a 0.6 mm compression of the

shock bumpers. Thus, the most unfavourable case is taken into account: all the crystals are with the maximum dimension.
The length increase of the aluminium logs is 0.47 mm in a temperature range of 60 °C. In taking into account the integration pre-strain, we obtain a crushing of the elastomer frames equal to 0.735 mm +/- 0.15 mm, approximately 20% higher than with the CsI logs in the survival temperature range.

6.2.2 Test configuration

•Composite structure
- •96 cell solid composite structure
  - –SEAL CC 120 ET 441 prepreg
    - »Plain fabric 122 g/m², HS 1K carbon fibers
    - »ET441 epoxy resine, cure temperature 125°C
- •2017A aluminum alloy inserts

•Dummy circuit boards
- •1.5 mm aluminium plates

•Aluminum parts
- •2618A aluminum alloy machined parts
  - –Base plate design: very close to EM design
  - –Large openings on close-out plates to escape the pins photodiodes
  - –Flat 0.8 mm flat side panels

•Polymeric parts
- •Delrin plastic frames (or plates)
- •Silicone rubber cords: diameter 1 mm
- •RTV 141 silicone bumpers: durometer 55 shore A

•Dummy logs
- •96 2017A aluminium dummy logs with slots to adjust weight
  - –Transverse dimensions: 20 x 20mm ±0.05mm
  - –Length: 333 ±0.1mm

•Preload on log end during integration
- –Preload is provided by the compression of the silicone bumpers between the end of the logs and the close-out plate
- –Dummy logs:
  - •0.2 to 0.4 mm of compression for the bumpers

6.2.3 Thermal tests levels

The thermal cycle test was achieved according to the 'LAT Mechanical Performance Specification' (Table 6.2-2). The temperature range is calculated for giving the same structural loads on the VM2 equipped with dummy CDE as a CAL module equipped with real CDE within the Survival Qualification temperature Range.
The total number of cycles is higher than 40.

Condition	***Ambient pressure***
Temperature Min	***-45°C***
Temperature Max	***+85°C***
Cycle number	***14 + 9 + 20 = 43***
DT/dt	***2°C /minute***
Hold time	***7 hrs***
Cycle duration	***16 hrs***

Table 6-1 : VM2 thermal vacuum test characteristics

Structural loads were measured during 9 cycles with strain gauges. The position of these strain gauges was determined according to the results of the thermo-mechanical analysis performed on a simulation model.

6.2.4 Thermal test analysis and results

The verification were of 2 kinds:
- during the test, by measurement of the strains by means of strains gauges measurements,
- after the test, by measurement of the dimensions of the composite structure.

The dimensions measurements are reported on §6.3 "Dimensions verification"

The static strains measurement have been achieved by the Bureau Veritas Company. The results of the analysis are presented in the RD05 document of Mr Lepape (Bureau Veritas) "Mesures des contraintes statiques sur un prototype de module de calorimètre".

The figure below shows the locations of the strains gauges on the top of the structure:

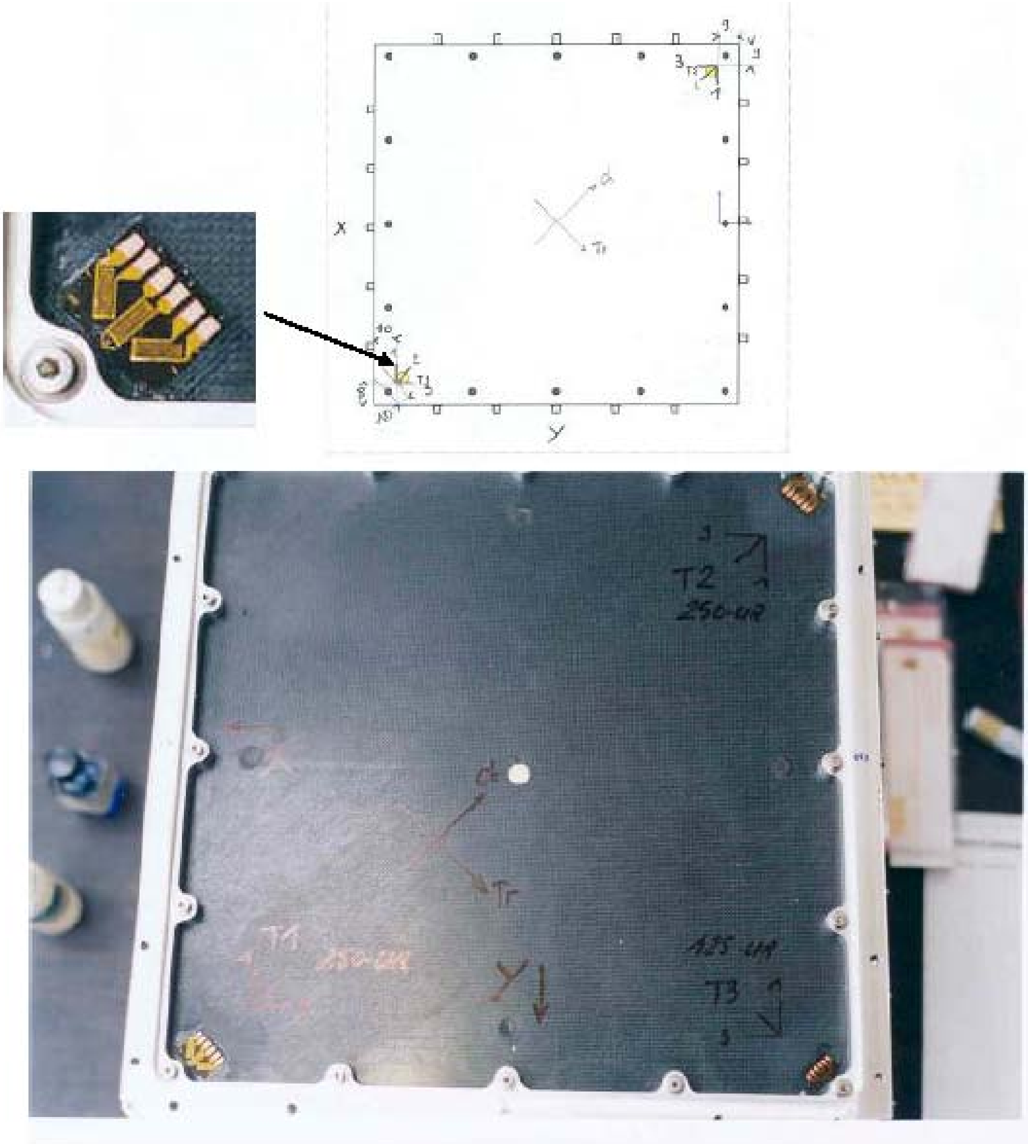


Figure 6-1 : Gauges strains location on the top of the structure

The 2 figures below shows the locations of the strains gauges on the X and Y faces of the structure:

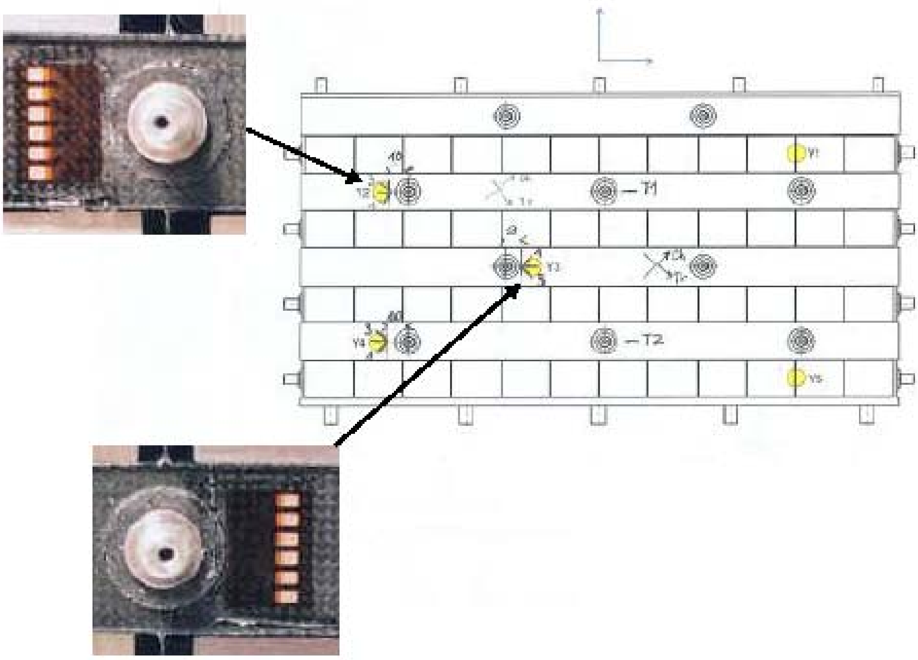


Figure 6-2 : Gauges strains location on the Y face of the structure

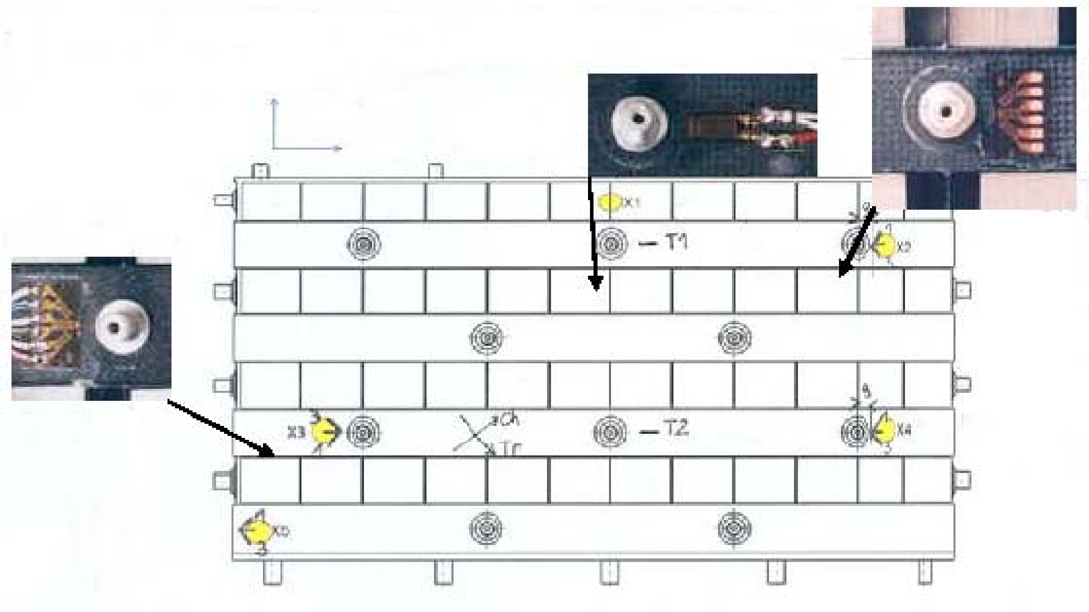


Figure 6-3 : Gauges strains location on the X face of the structure

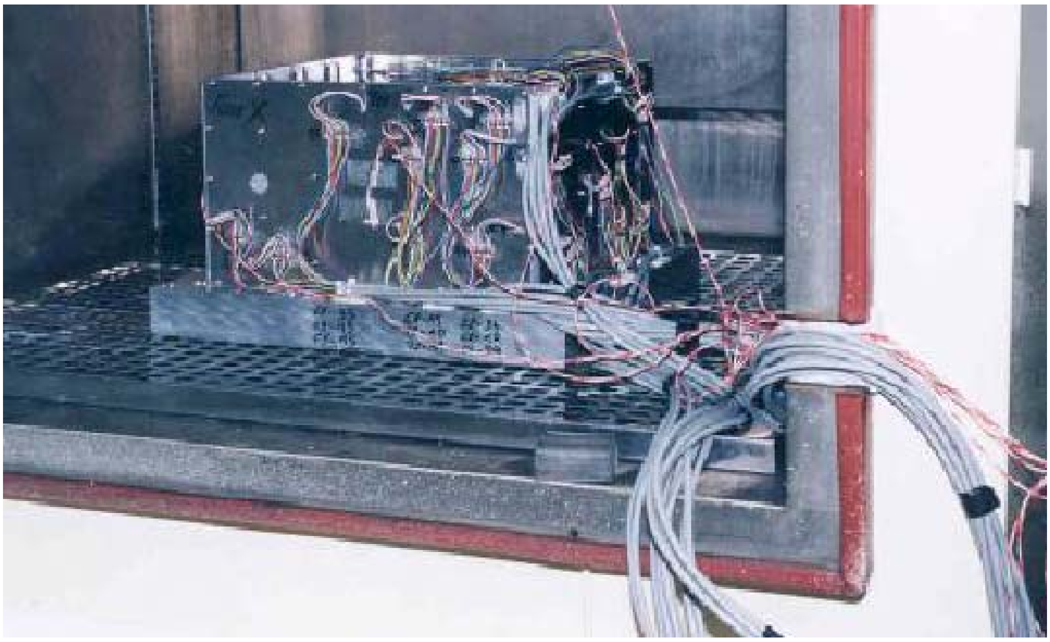


Figure 6-4 : VM2 structure in the thermal chamber at EMITECH company

The conclusions of the Bureau VERITAS report are:

The max strains measured in the warp and weft direction of the composite and the corresponding errors are:

Part	σ max (MPa)	$\pm 2xS_\sigma$ (MPa)
Top Face	50	2
Cells wall	20	8
Inserts face X	33	5
Inserts face Y	34	4

Table 6-2 : VM2 static strains max values

It is to be noted than the measured values are comparable with the simulation results achieved by the DDL Consultants company: cf RD10 document.

6.3 VIBRATION TESTS

6.3.1 Objectives

The vibration tests must allow to verify or to measure:
- the withstanding of the CAL mechanical structure to the environmental mechanical qualification requirement. A margin of 20% on tests levels was taken for these validation tests; 9 CDE were mounted in the structure in cells location exposed on figure 6.1. 87 dummy steel logs were mounted in the others cells. So, the withstanding of the CDE to representative vibration levels was tested.
- Accelerations and displacements in different locations of the structure.

6.3.2 Test configuration

•Composite structure
- •96 cell solid composite structure
  - –SEAL CC 120 ET 441 prepreg
    - »Plain fabric 122 g/m², HS 1K carbon fibers
    - »ET441 epoxy resine, cure temperature 125°C
- •2017A aluminum alloy inserts

•Dummy circuit boards
- •1.5 mm aluminium plates

•Aluminum parts
- •2618A aluminum alloy machined parts
  - –Base plate design: very close to EM design
  - –Large openings on close-out plates to escape the pins photodiodes
  - –Flat 0.8 mm flat side panels

•Polymeric parts
- •Delrin plastic frames (or plates)
- •Silicone rubber cords: diameter 1 mm
- •RTV 141 silicone bumpers: durometer 55 shore A

•Dummy logs
- •87 steel dummy logs with slots to adjust weight
  - –Transverse dimensions: 26.5 x19.5 mm ±0.05mm
  - –Length: 332.9 and 332.7 mm ±0.05mm (half / half)
  - –Weight: 0.765 Kg ±0.010 Kg

•CDE
- •9 CDEs with photodiodes at both ends equipped with flex cables
- •3M VM2000 film
- •Logs wrapped at LLR
  - –1 layer of VM2000 with overlap
  - –3M 850 white tape: 5 mm strip + 20 mm strip (2 layers on top of overlap)

•Preload on log end during integration

–Preload is provided by the compression of the silicone bumpers between the end of the logs and the close-out plate

–Dummy logs:

•0.2 to 0.4 mm of compression for the bumpers

–CDE

•0.3 mm of compression on the bumper

•No preload on CDE 4-7, longitudinal motion possible

Figure 6-5 : VM2 structure with dummy CDE

6.3.3 Interfaces

The VM2 was fixed on a framework which dimensions are 450 x 450 mm.

Holes machined on the dummy boards and side panel to easily mount the accelerometers without disassembling the structure

Handling of VM2 model:
Model lifted from the top with 4 blocs bolted to the top frame and equipped with rings

Interface with the shaker:
Aluminum frame to support the module only by the tabs of the base plate: same configuration as interface with the grid
72 M3 bolts to attach the base plate to the frame

6.3.4 Vibration test levels

6.3.4.1 Random vibration test

The vibration levels are determined according to the GEVS standard: table 2.4.4. The VM2 was tested according to the acceleration spectral density (ASD) given in Farhad Tahmasebi note (ref: Farhad Tahmasebi/542-2/25/02) , with **qualification levels increased of 20%** corrected for unit mass.¨

Assuming a mass of 90kg, the levels are shown in the table and the figure below.

Frequency	ASD
20 Hz	0.012 g²/Hz
20 – 50 Hz	4.69 dB/oct
50 – 800 Hz	0.05 g²/Hz
800 – 200 Hz	-4.69 g²/Hz
2000 Hz	0.012 g²/Hz

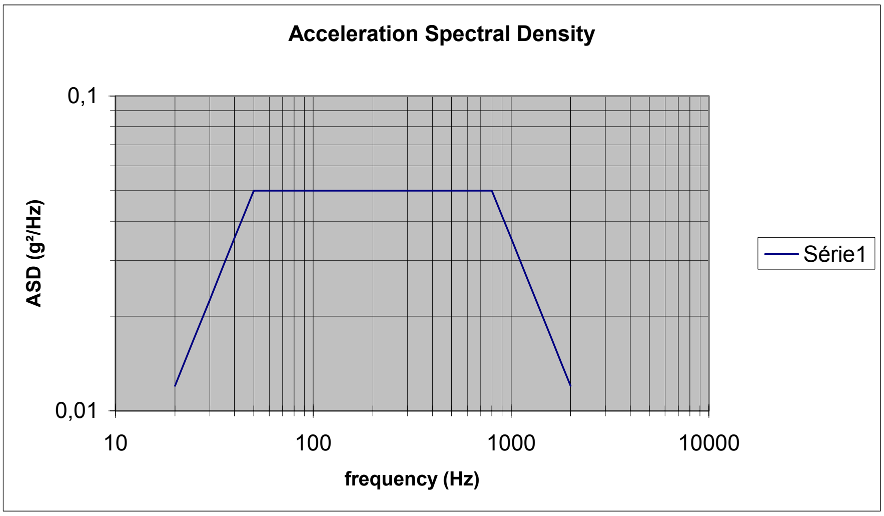


Table 6-3 : VM2 random vibration test levels

- ➔ Axis: x, y, z
- ➔ Duration: 2 mn / axis

6.3.4.2 Sinus burst test

VM2 was tested with a static-equivalent acceleration level applied to each axis independently according to the sinus-burst method.
Max Qualification Levels are given by the Farhad Tahmasebi note (ref: Farhad Tahmasebi/542-2/25/02):
➔ Lateral Axis: +/- 7.5 g
➔ Thrust Axis: 8.5 g
On VM2, a factor of 1.2 is applied on the qualification levels.

Axis	Frequency	Acceleration	Time	Number
Lateral axis (x,y)	25 Hz	± 9.0 g's0-pk	720 ms	1 cycle
Thrust axis (z)	25 Hz	± 10 g's0-pk	720 ms	1 cycle

Table 6-4 : VM2 sinus burst test levels

6.3.4.3 Low level sinus sweep

A modal survey test was achieved on the VM2. A low level sine survey is an appropriate method in order to determine the fundamental frequency.

Frequency	Level	Sweep speed	Axis
10-2000 Hz	0.5 gpk	4 oct/mn	x, y, z

Table 6-5 : VM2 sinus vibration test characteristics

6.3.4.4 Tolerances

➔ Accelerations:	+/- 10%	
➔ Duration:	+/- 5s	
➔ Sweep speed:	+/- 2% for f > 50 Hz	
➔ Frequencies:	+/- 2% for f > 50 Hz	
	+/- 1 Hz for f < 50 Hz	
➔ ASD:	20Hz-500Hz	+/- 1,5dB
	500Hz – 2000Hz	+/- 3dB
	gRMS global	+/- 10%
➔ Control levels:	+/- 10%	

6.3.5 Vibration sequence test

The tests were achieved on the 3 axes x, y and z of the LAT coordinate system defined in the document referenced LAT-TD-00035-01 'LAT coordinate System'.

* Transverse axis (x):

- accelerometers positioning along the x axis
- sinusoidal sweep 0.5 gpk 10-2000 Hz : 4 oct/mn
- random level 20-2000 Hz: 2 mn
- sinusoidal sweep 0.5 gpk 10-2000 Hz : 4 oct/mn
- sine burst 3 gpk @ 25 Hz
- sinusoidal sweep 0.5 gpk 10-2000 Hz : 4 oct/mn
- sine burst 6 gpk @ 25 Hz
- sinusoidal sweep 0.5 gpk 10-2000 Hz : 4 oct/mn

* Transverse axis (y):

- accelerometers positioning along the y axis
- sinusoidal sweep 0.5 gpk 10-2000 Hz : 4 oct/mn
- random level 20-2000 Hz: 2 mn
- sinusoidal sweep 0.5 gpk 10-2000 Hz : 4 oct/mn
- sine burst 6 gpk @ 25 Hz
- sinusoidal sweep 0.5 gpk 10-2000 Hz : 4 oct/mn

* Thrust axis (z):

- accelerometers positioning along the z axis
- sinusoidal sweep 0.5 gpk 10-2000 Hz : 4 oct/mn
- random level 20-2000 Hz: 2 mn
- sinusoidal sweep 0.5 gpk 10-2000 Hz : 4 oct/mn
- sine burst 10 gpk @ 25 Hz
- sinusoidal sweep 0.5 gpk 10-2000 Hz : 4 oct/mn

* Light-yield measurement:
The 9 CDE were mounted in the LM2 and their light-yield and tapering characteristics were measured.

6.3.6 Verification

The instrumentation was composed of:

- 22 mono-axial accelerometers
- 2 control tri-axial accelerometers fixed on the fixture framework

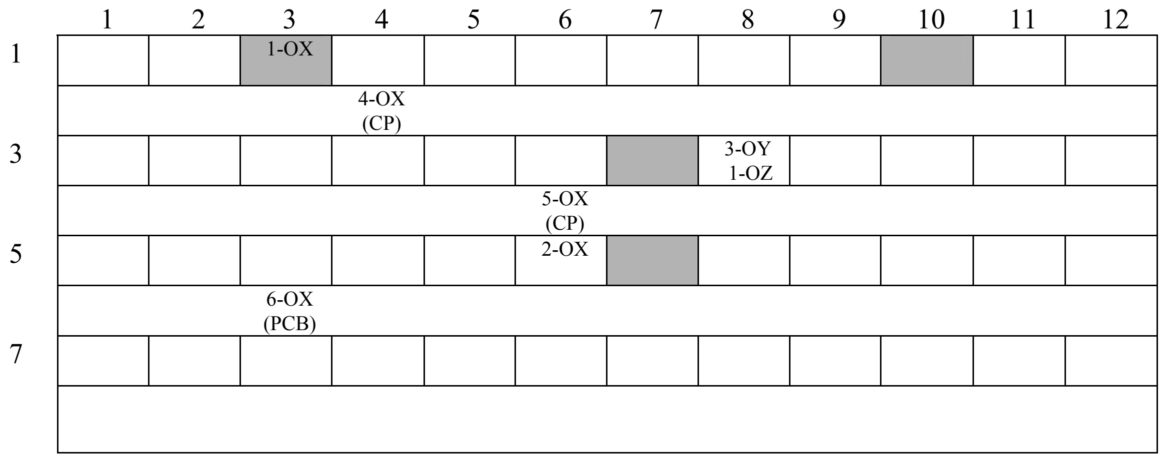


Figure 6-6 : VM2 accelerometer and CDE location on X face

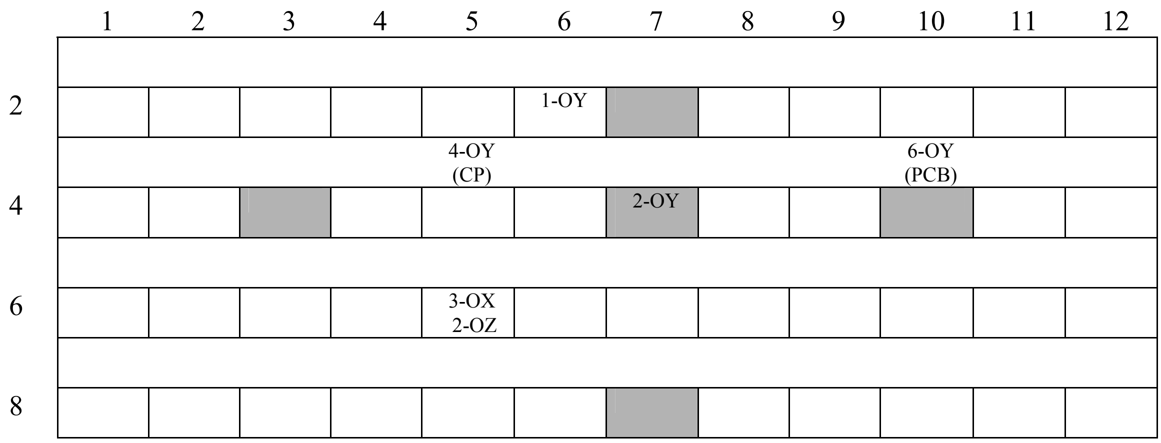


Figure 6-7 : VM2 accelerometer and CDE location on Y face

Accelerometer ref.	Position
1-OX	CDE 1-3
2-OX	Dummy log 5-6
3-OX	Dummy log 6-5
4-OX	X^+ close-out plate – near 1-OX
5-OX	X^+ close-out plate – near 2-OX
6-OX	X^+ dummy PCB – bottom left
7-OX	X^- Side-panel – center
8-OX	X^- Side-panel – top
9-OX	Y^- Side-panel – center

Table 6-6 : OX axis accelerometers location

Accelerometer ref.	Position
1-OY	Dummy log 1-3
2-OY	CDE 4-7
3-OY	Dummy log 3-8
4-OY	Y^+ close-out plate – near 1-OY
5-OY	Y^+ close-out plate – near 2-OY
6-OY	Y^+ dummy PCB – top left
7-OY	X^- Side-panel - center
8-OY	X^- Side-panel - top
9-OY	Y^- Side-panel - center

Table 6-7 : OY axis accelerometers location

Accelerometer ref.	Position
1-OZ	Top of the structure
2-OZ	Bottom of the structure
3-OZ	Dummy log 6-5
4-OZ	Dummy log 3-8

Table 6-8 : OZ axis accelerometers location

6.3.7 Vibration test analysis and results

The overall vibration tests results performed at SOPEMEA company are detailled in the RD06 document "Essais de vibration sur un module calorimètre". The following paragraphs summarizes the results.

6.3.7.1 Quasi-static test

Sinus burst 9 g – X axis:

Accelerometer	Acceleration
1 - CDE 1-3	11.2 g / -11.4 g
2 - Dummy log 5-6	10.1 g / -10.4 g
3 - Dummy log 6-5	(1)
4 -Close-out plate 1	10.8 g / -11 g
5 -Close-out plate 2	11.0 g / -12.2 g
6 - Dummy circuit board	10.6 g / -11.1 g
7 - X Side panel center	12.2 g / -12.2 g
8 - X Side panel top	10.4 g / -10.1 g
9 - Y side panel center	10.0 g / -10.1 g

Table 6-9 : OX axis accelerations on sinus-burst test

(1) accelerometer disconnected during the test

Sinus burst 9 g – Y axis:

Accelerometer	Acceleration
1 – Dummy log 2- 6	10.2 g / -10.3 g
2 - CDE 4-7	17.6 g / -18.9 g
3 - Dummy log 3-8	10.1 g / -10.8 g
4 -Close-out plate 1	10.3 g / -10.5 g
6 - Dummy circuit board	10.2 g / -10.7 g
7 - Y Side panel center	10.9 g / -10.8g
8 - Y Side panel top	10.2 g / -10.5g
9 - X side panel center	9.9 g / -9.9 g

Table 6-10 : OY axis accelerations on sinus-burst test

Sinus burst 10 g – Z axis:

Accelerometer	Acceleration
1 – Dummy log 6 - 5	11.2 g / -11.4 g
2 – Dummy log 3 - 8	11.8 g / -12.3 g
3 – Base plate	11.2 g / -11.3 g
4 – Top of structure	13.7 g / -13.6 g

Table 6-11 : OZ axis accelerations on sinus-burst test

Relative Displacements:

Position	Reference	Axis	Displacement (mm)	Comment
CDE 1-3	Close-out plate	OX	0.047	CDE longitinal displacement
Dummy log 5-6	Close-out plate	OX	0.08	CDE longitinal displacement
X PCB	Side panel	OX	0.035	
Center X Side panel	Fixture frame	OX	0.12	
Top X Side--panel	Fixture frame	OX	0.057	
Dummy log 2-6	Close-out plate	OY	0.008	CDE longitinal displacement
CDE 4-7	Close-out plate	OY	0.32	CDE longitinal displacement
Dummy log 3-8	Fixture frame	OY	0.14	CDE lateral displacement
Y PCB	Side panel	OY	0.075	
Center Y Side panel	Fixture frame	OY	0.024	
Dummy log 6-5	Fixture frame	OZ	0.12	CDE lateral displacement
Dummy log 3-5	Fixture frame	OZ	0.26	CDE lateral displacement
Top of the structure	Fixture frame	OZ	0.036	
Base plate	Fixture frame	OZ	0.036	

Table 6-12 : Relative displacements on sinus-burst test

The 2 following figures shows the accelerations levels for the sinus burst test for the XY-axis and Z-axis.

Scale :

- **abscissa: time (s)**
- **ordinate: acceleration (g)**

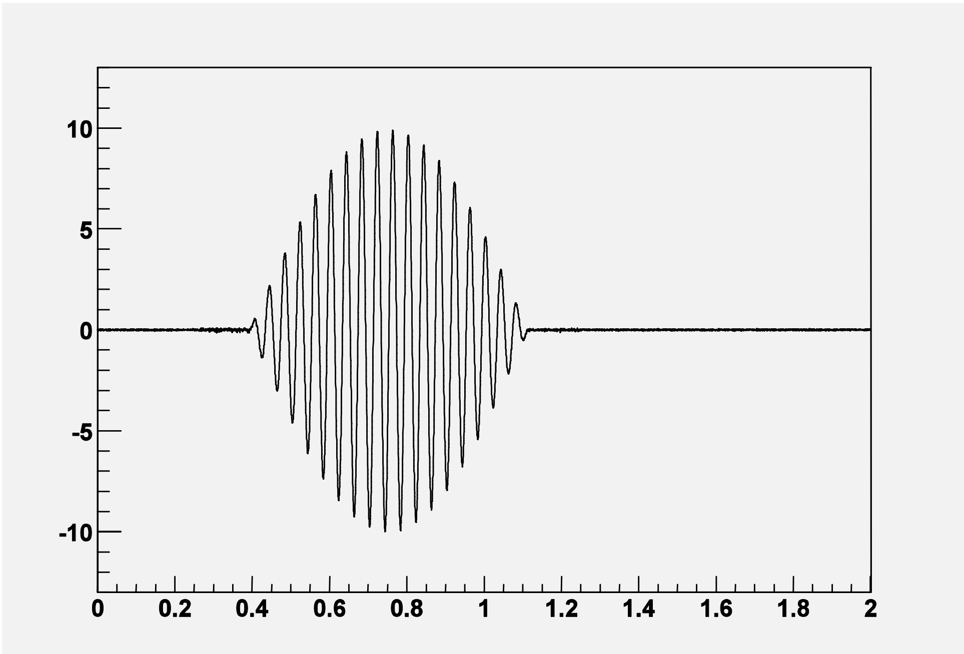


Figure 6-8 : X and Y axis sinus-burst acceleration level

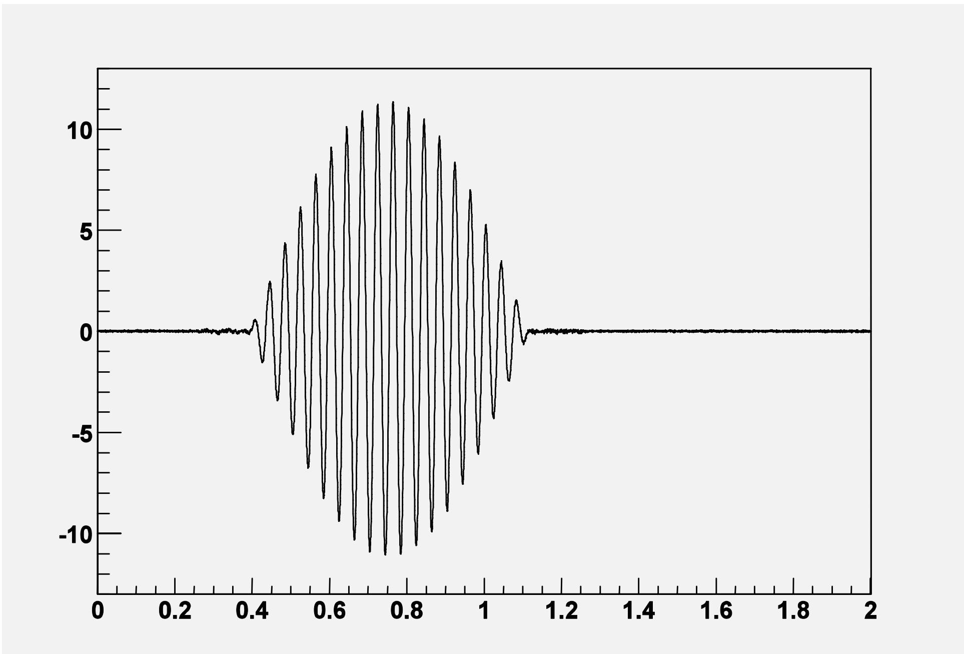


Figure 6-9 : Z axis sinus-burst acceleration level

6.3.7.2 Random vibration test

X axis :
Input level : acceleration : 8.2 gRMS
displacement : 0.235 mm RMS

Accelerometer	Acceleration gRMS	Displacement (mm RMS)
1 – CDE 1- 3	6.76 g	0,291
2 – Dummy log 5- 6	9.15 g	0,293
3 - Dummy log 6- 5	8.25 g	0,313
4 -Close-out plate 1	12.08 g	0,277
5 -Close-out plate 2	14.45 g	0,284
6 - Dummy circuit board	16.05 g	0,272
7 - X Side panel center	23.39 g	0,278
8 - X Side panel top	11.75 g	0,264
9 - Y side panel center	9.10 g	0,252

Table 6-13 : OX axis accelerations and displacement on random vibration test

Y axis :
Input level : acceleration : 8.2 gRMS
displacement : 0.235 mm RMS

Accelerometer	Acceleration gRMS	Displacement (mm RMS)
1 – Dummy log 2- 6	7.76 g	0,269
2 - CDE 4-7	5.48 g	0,277
3 - Dummy log 3-8	8.34 g	0,266
4 -Close-out plate 1	16.19	0,257
5 -Close-out plate 2	No measurement	No measurement
6 - Dummy circuit board	13.96 g	0,251
7 - X Side panel center	30.00 g	0,250
8 - X Side panel top	24.85 g	0,240
9 - Y side panel center	7.53 g	0,234

Table 6-14 : OY axis accelerations and displacement on random vibration test

Z axis :
Input level : acceleration : 8.2 gRMS
displacement : 0.235 mm RMS

Accelerometer	Acceleration gRMS	Displacement (mm RMS)
1- Dummy log 6-5	22,00	0,277
2- Dummy log 3-8	35,59	0,317
4- Top of the structure	10,60	0,245
5- Base plate	24,53	0,288

Table 6-15 : OZ axis accelerations and displacemnt on random vibration test

6.3.7.3 Modal survey

–X axis
•First natural frequency: 180 Hz to 200 Hz depending on accelerometers, position of first peak nearly identical for logs and structural parts
•No significant evolution of the spectrum after random vibrations of sine burst loading for all the measurements

–Y axis
•Similar to X axis, first peak at 180 to 200 Hz for all the accelerometers
•No evolution after random vibrations or sine burst

–Z axis
•First peak at around 220 Hz, except for accelerometer on dummy log 3-8, 2 peaks 140 Hz and 220 Hz
•After random vibrations, only one peak at around 170 Hz for log 3-8, no evolution after sine burst
–No problem noticed on log 3-8 when removing the log from the cell, possibly one rubber band not accurately positioned in the chamfer during integration

On the 2 following pages, are presented graphics of sine sweep in the configurations:
- CDE 1-3; X axis;
- Dummy log 3-8; Z axis

X axis –
Abscissa: frequency (Hz) – Ordinate: acceleration (g)
Plot 1 :initial sine sweep
Plot 2 : after 1st sinus burst 3g – X axis
Plot 3: after 2nd sinus burst 9g – X axis
Plot 4 : after random vibration – X axis

Z axis :
Abscissa: frequency (Hz) – Ordinate: acceleration (g)
Plot 1 :initial sine sweep
Plot 2 : after sinus burst 10g – Z axis
Plot 3 : after random vibration – Z axis

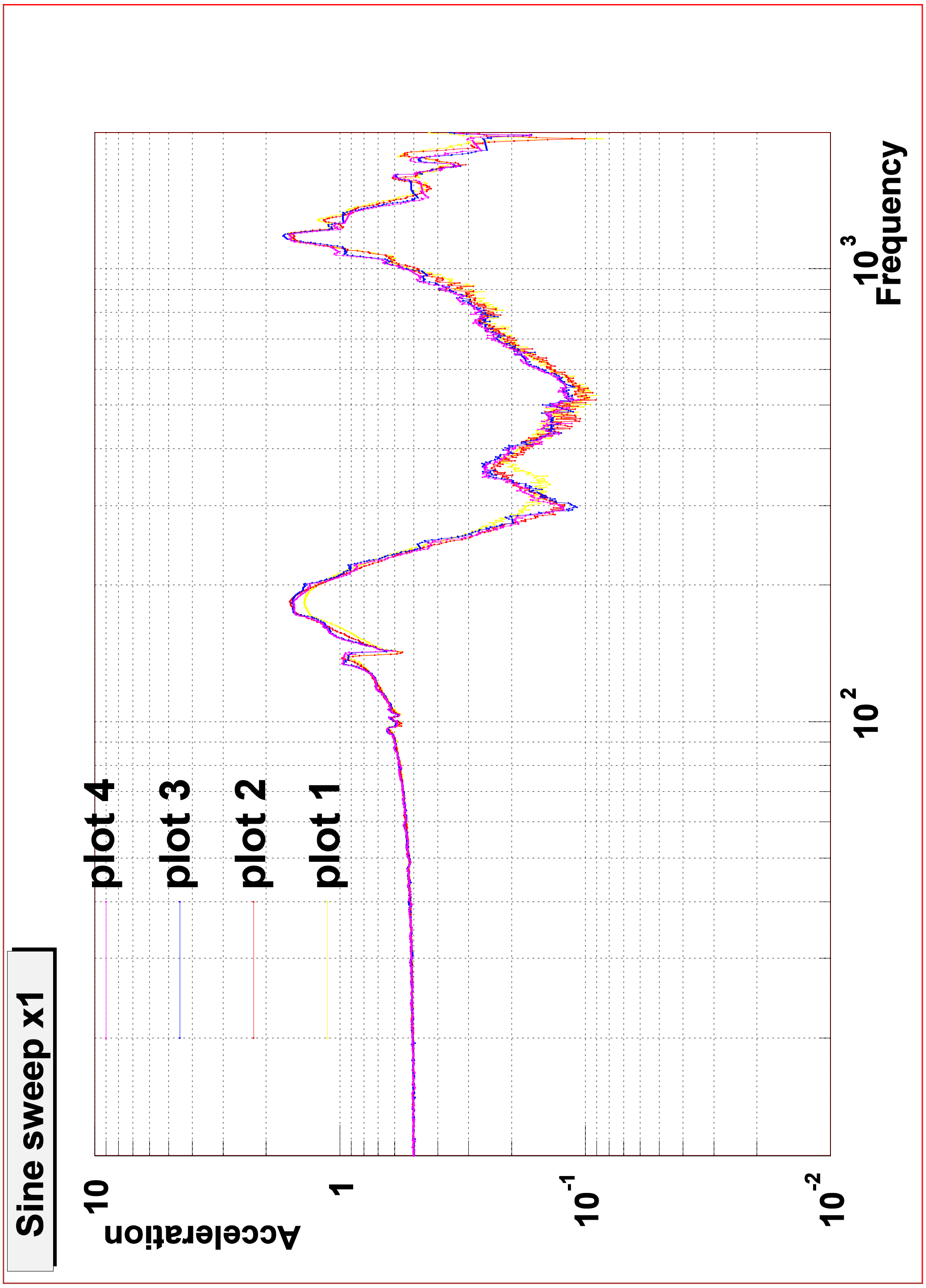


Figure 6-10 : Sine sweep on dummy CDE 1-3 location – X axis

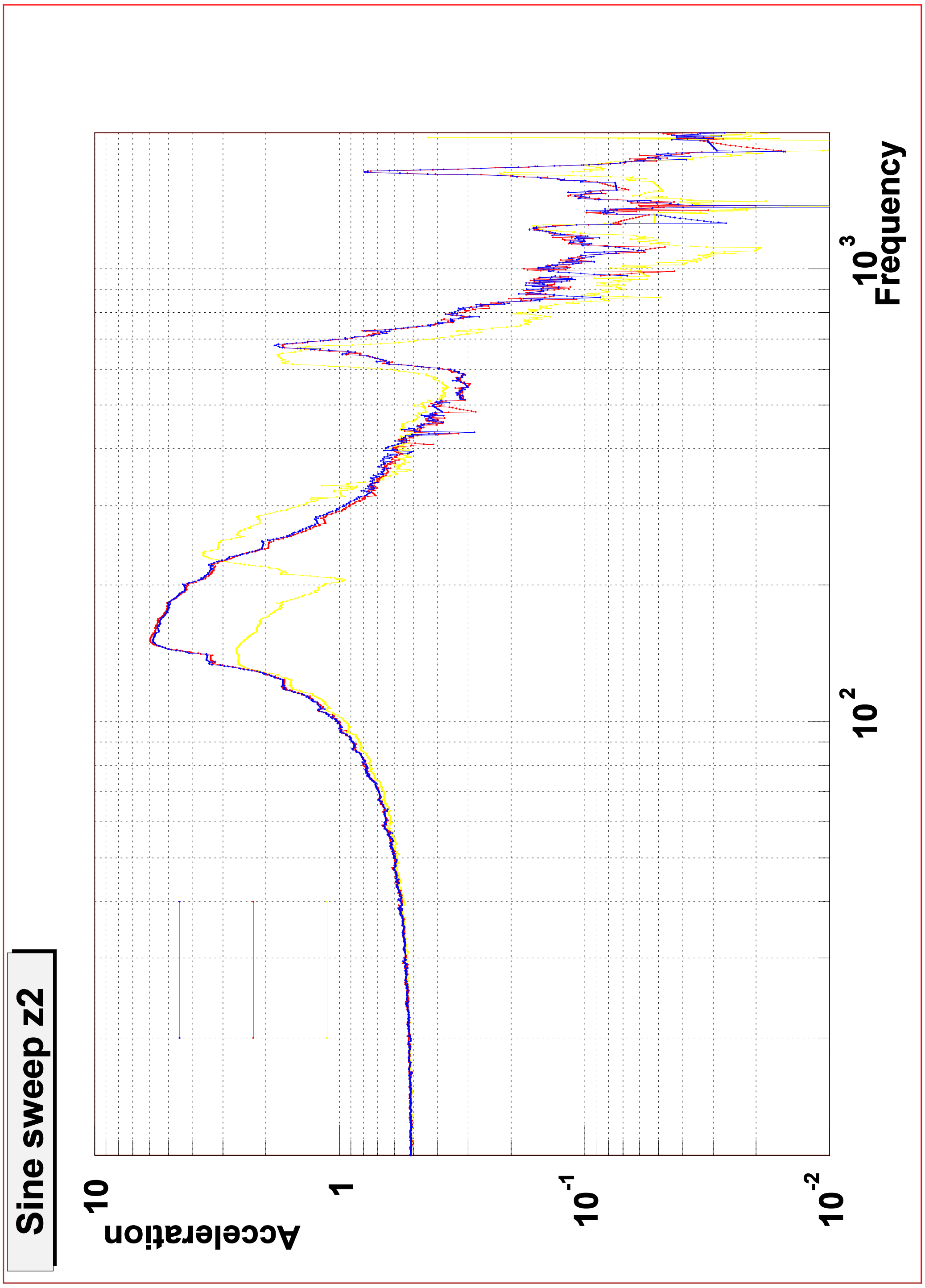


Figure 6-11 : Sine sweep on dummy log 3-8 location – Z axis

6.4 DIMENSIONS VERIFICATION

The dimensions of the VM2 structure were measured before and after the environmental tests:

6.4.1 External dimensions

Width (W) : dimension measured between shoulders of opposite lateral inserts: cf appendix 1 figure 8-1, dimension C1. The location of the inserts are explained on appendix 1, figure 8-2 and figure 8-3.

Specification : $W = 341^{0}_{-0.2}$

Height (H): dimension measured between the lower face and the upper face of the composite structure; cf appendix 1 figure 8-1, dimension C2.
Specification: $H = 176.8 \pm 0.2$

Layer	Specification min	Specification max	Initial measurements			Final measurements		
			Insert 1	Insert 2	Insert 3	Insert 1	Insert 2	Insert 3
1	340.8	341	340.45	340.45		340.52	340.50	
2	340.8	341	340.45	340.51	340.57	340.55	340.57	340.55
3	340.8	341	340.61	340.46	340.45	340.66	340.52	340.58
4	340.8	341	340.44	340.51		340.46	340.49	
5	340.8	341	340.49	340.46		340.54	340.50	
6	340.8	341	340.58	340.49	340.45	340.53	340.51	340.52
7	340.8	341	340.56	340.50	340.55	340.61	340.55	340.61
8	340.8	341	340.45	340.49		340.50	340.54	

Table 6-16 : Measurements of the composite structure width dimensions

The width is lower than the min specification. A NCR sheet has been written which the reference is GLAST-LLR-FA-005 (cf appendix 2). For the EM, the curing temperature increase (100°C to 135°C) would brought an width increase of 0.2mm: the average width would be 340.7 mm which is still lower than the min specification. So, a mold modification would be foreseen for the following models in taken into account the results obtained on the EM.

	Specification min	Specification max	Initial measurements				Final measurements			
			Corner 1	Corner 2	Corner 3	Corner 4	Corner 1	Corner 2	Corner 3	Corner 4
Height (mm)	176.6	177.0	176.95	176.90	177.01	176.96	176.94	176.92	176.95	176.94

Table 6-17 : Measurements of the composite structure height dimensions

The height is close to the max specification. A NCR sheet has been written which the reference is GLAST-LLR-FA-006 (cf appendix 2). This dimension is not critical. So, the nominal dimension has been changed for the EM composite structure. The tolerance is not changed: Heigth = 177 ± 0.2 mm

6.4.2 Planeity of the faces

Planeity was measured before the environmental tests on the 4 lateral faces X^+ X^- Y^+ and Y^- on the 10 inserts at shoulders levels.

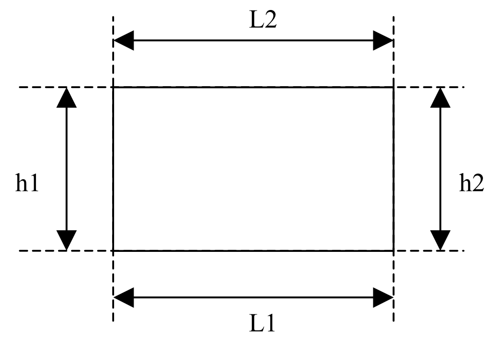
	Initial measurements			
	Face 1	Face 2	Face 3	Face 4
1	0.0	0.44	0.40	0.15
2	0.04	0.44	0.37	0.12
3	0.17	0.40	0.38	0.16
4	0.08	0.40	0.29	0.19
5	0.07	0.41	0.28	0.17
6	0.06	0.37	0.31	0.29
7	0.11	0.39	0.23	0.22
8	0.24	0.20	0.22	0.22
9	0.15	0.35	0.19	0.25
10	0.14	0.42	0.21	0.23
Planeity (mm)	0.24	0.24	0.21	0.17

Table 6-18 : Measurements of the composite structure faces planeity

Measured planeity ≤ 0.25 mm - No specification on the planeity at the moment.

6.4.3 Cells dimensions

Definitions:



Specified dimensions:

27.35 ± 0.05 x 20.50 ± 0.05

$27.30 \leq L \leq 27.40$

$20.45 \leq h \leq 20.55$

Figure 6-12 : Composite structure cells dimensions

3 cells were measured on 3D controller.
15 cells were verified with a slide caliper.
The location of the cells is explained on appendix 1 , figure 8-4 and figure 8-5.

	Min specification	Max specification	Initial measurements			Final measurements		
			Cell 8-12	Cell 8-6	Cell 8-1	Cell 8-12	Cell 8-6	Cell 8-1
L1 (mm)	27.30	27.40	27.35	27.31	27.29	27.35	27.30	27.31
L2 (mm)	27.30	27.40	27.35	27.29	27.29	27.35	27.30	27.30
h1 (mm)	20.45	20.55	20.48	20.45	20.47	20.46	20.46	20.48
h2 (mm)	20.45	20.55	20.48	20.46	20.49	20.45	20.46	20.48

Table 6-19 : Measurements of the composite structure cells dimensions

Dimensions are close to the lower limit of the tolerance interval. Some cells are slightly lower than the inferior limit.. A NCR sheet has been written which the reference is GLAST-LLT-FA-004 (cf appendix 2).

The VM2 structure was polymerized at 100°C. With the improvement of the curing process in order to reach 135°C, we should have an increase of 15 µm on the EM. Moreover, the nickel plating of the mandrels will be 35µm instead of 15µm; so the dimensions will be increased by 40 µm. **The total dimensions increase would be about 55µm for the EM.**

6.4.4 Results analysis

The dimensions are not centered on the nominal values. The curing temperature change will diminue this variation. A mandrels modification is foreseen for the EM and a mold modification for the following models in order to adjust cells dimensions and overall dimensions.

No significant variation is to be noted between the initial measurements and the final mesurements.

7 CONCLUSIONS

• Design of VM2 / LM CDEs is robust
–the logs have been handled quite a lot, inserted several times in the composite cells, gone through heavy environmental testing, no bond failure has been noticed, no significant light yield variation measured

• Structural design is sound
–VM2 structure survived environmental testing with performance within specifications
• Compatibility problems between the structure and the crystal exist but should be solved by a revision of the crystal specifications
• A better control of the parameters that define the integration of the logs is needed (elastomeric parts), but the news specs of the crystal should help solving the problem
• The cells dimensions shall be adjusted on the EM model with a best control of the polymerization temperature and a modification of the mandrels plating thickness
• the structure width (taken at the insert shoulders level) shall be adjusted by a modification of the mold for the following models.

A correct agreement between experimental results and simulations (cf RD10 study report of the DDL consultants company) is obtained for the thermo-mechanical strains and the displacements in static acceleration conditions.
However, a variation is to be noted for the simulated fundamental modal frequencies which are higher than the measured ones (376 Hz for the lower mode instead of 180-200 Hz) : the dynamic simulation model doesn't take into account the CDE fundamental modes of vibration.

8 APPENDIX 1

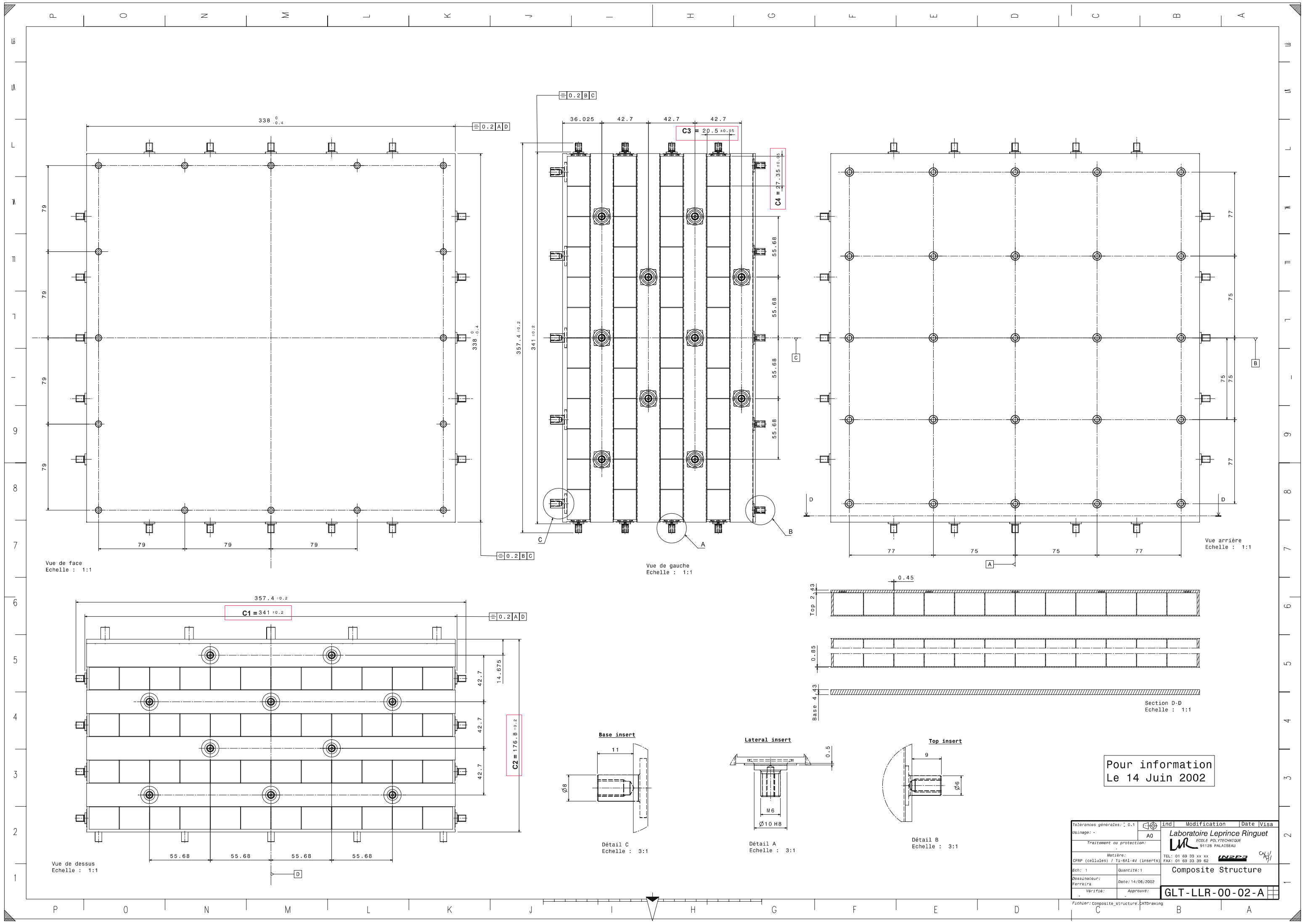


Figure 8-1 : Structure composite drawing

Couches	Inserts											
1	Cell 1-1											
2			**1 (A)**				**2 (B)**					**3 (C)**
3												
4					**1 (D))**				**2 (E)**			
5												
6			**1 (F)**				**2 (G)**					**3**
7												Cell 7-12
8					**1 (H)**				**2 (I)**			

Figure 8-2 : Location of the composite structure inserts on the X^+ plan

Couches	Inserts											
1				**1 (A)**					**2 (B)**			
2	Cell 2-1											
3			**1 (C)**			**2 (D)**					**3**	
4												
5				**1 (E)**					**2 (F)**			
6												
7			**1 (G)**				**2 (H)**				**3 (I)**	
8												Cell 8-12

Figure 8-3 : Location of the composite structure inserts on the Y^+ plan

Couches	1	2	3	4	5	6	7	8	9	10	11	12
1	Cell 1-1	Cell 1-2	Cell 1-3	Cell 1-4	Cell 1-5	Cell 1-6	Cell 1-7	Cell 1-8	Cell 1-9	Cell 1-10	Cell 1-11	Cell 1-12
3	Cell 3-1	Cell 3-2	Cell 3-3	Cell 3-4	Cell 3-5	Cell 3-6	Cell 3-7	Cell 3-8	Cell 3-9	Cell 3-10	Cell 3-11	Cell 3-12
5	Cell 5-1	Cell 5-2	Cell 5-3	Cell 5-4	Cell 5-5	Cell 5-6	Cell 5-7	Cell 5-8	Cell 5-9	Cell 5-10	Cell 5-11	Cell 5-12
7	Cell 7-1	Cell 7-2	Cell 7-3	Cell 7-4	Cell 7-5	Cell 7-6	Cell 7-7	Cell 7-8	Cell 7-9	Cell 7-10	Cell 7-11	Cell 7-12

Figure 8-4 : Location of the composite structure cells on the X^+ plan

Couches	1	2	3	4	5	6	7	8	9	10	11	12
2	Cell 2-1	Cell 2-2	Cell 2-3	Cell 2-4	Cell 2-5	Cell 2-6	Cell 2-7	Cell 2-8	Cell 2-9	Cell 2-10	Cell 2-11	Cell 2-12
4	Cell 4-1	Cell 4-2	Cell 4-3	Cell 4-4	Cell 4-5	Cell 4-6	Cell 4-7	Cell 4-8	Cell 4-9	Cell 4-10	Cell 4-11	Cell 4-12
6	Cell 6-1	Cell 6-2	Cell 6-3	Cell 6-4	Cell 6-5	Cell 6-6	Cell 6-7	Cell 6-8	Cell 6-9	Cell 6-10	Cell 6-11	Cell 6-12
8	Cell 8-1	Cell 8-2	Cell 8-3	Cell 8-4	Cell 8-5	Cell 8-6	Cell 8-7	Cell 8-8	Cell 8-9	Cell 8-10	Cell 8-11	Cell 8-12

Figure 8-5 : Location of the composite structure cells on the Y^+ plan

9 APPENDIX 2

Centre National de la Recherche Scientifique — IN2P3 — Ecole Polytechnique

Fiche d'Anomalie
Non Conformance Report Sheet

Reference : GLAST-LLR-FA-004
Page 1/2

Date : 05 july 2002 Initiator name: Pierre Prat

NCR Title Cells dimensions close to minimum tolerance

Equipment information

Model VM2

Item Name&ref Composite structure

Item name&ref:

Statement phase and environmental conditions

☐ Manufacturing ☐ Acceptance ☐ Integration ☒ Test ☐ Other

☒ Ambient ☐ Thermal Vacuum ☐ Vibration ☐ Pressure/ Vacuum ☐ Other

Non-Conformance Description :

When dimensions controls have been made on VM2 (Drawing GLT.05.03.02), we noted that cells dimensions (height and width) were close to minimum dimensions:
Requirements: $27.30 \le L \le 27.40$; $20.45 \le h \le 20.55$
Average controlled values : L=27.30 and h=20.46

Analyze :

First VM2 polymerization temperature was 100°C. For the other models it will be 135°C, so dimensions of cells will be increased by 17 µm in width and by 13 µm in heigth.

Classification ☐ ***Major*** ☒ ***Minor***

Corrective Actions:

Preventive Actions:

Make new logs width transverse dimensions increased.

NB: This corrective action will only apply for Flight models (Not applicable for the EM)

Recommendations :

Centre National de la Recherche Scientifique — IN2P3 — Ecole Polytechnique

Fiche d'Anomalie
Non Conformance Report Sheet

Reference : GLAST-LLR-FA-005
Page 1/2

Date : 05 july 2002 Initiator name: Pierre Prat

NCR Title
Composite structure with out of specification

Equipment information

Model VM2

Item Name&ref Composite structure

Item name&ref:

Statement phase and environmental conditions

☐ Manufacturing ☐ Acceptance ☐ Integration ☒ Test ☐ Other

☒ Ambient ☐ Thermal Vacuum ☐ Vibration ☐ Pressure/ Vacuum ☐ Other

Non-Conformance Description :

When dimensions controls have been made on VM2 (Drawing GLT.05.03.02), we noted that composite structure width dimensions were lower than specified min dimensions:

Requirement : $340.8 \leq L \leq 341{,}2$

Example of measured value: Layer 1 – Insert 1; L = 340.45

Analyze :

VM2 polymerization temperature was 100°C. For the other models it will be 135°C, so structure dimensions will be increased by 0.2 mm.

Classification ☐ *Major* ☒ *Minor*

Corrective Actions:

Preventive Actions:

Change tolerances: 341.0 +0/-0.4, Update drawing GLT-LLR-00-02

Recommendations:

Centre National de la Recherche Scientifique — IN2P3 — Ecole Polytechnique

GLAST	**Fiche d'Anomalie** **Non Conformance Report Sheet**	**Reference :** **GLAST-LLR-FA-006** **Page 1/2**

Date : 05 july 2002 Initiator name: Pierre Prat

NCR Title Composite structure height close to maximum specification

Equipment information

Model VM2

Item Name&ref Composite structure

Item name&ref:

Statement phase and environmental conditions

☐ Manufacturing ☐ Acceptance ☐ Integration ☒ Test ☐ Other

☒ Ambient ☐ Thermal Vacuum ☐ Vibration ☐ Pressure/ Vacuum ☐ Other

Non-Conformance Description :

When dimensions controls have been made on VM2 (drawing GLT.05.03.02), we noted that composite structure height dimensions were close to max dimensions:
Requirement : $176.6 \leq H \leq 177.0$
Example of measured value : Corner 3 ; H = 177.0

Analyze :

VM2 height dimensions are close to max dimensions.
Moreover, VM2 polymerization temperature was 100°C whereas the other models polymerization temperature will be 135°C. So the heigth will be increased by 0.10 mm.
As there are no requirements on composite structure height, we will change nominal value on drawing.

Classification ☐ ***Major*** ☒ ***Minor***

Corrective Actions:

Preventive Actions:

Modify the composite structure height nominal value on new drawing (GLT-LLR-00-02)

Recommendations :