REQUEST FOR ACTION (RFA) RESPONSE

GLAST LAT Project
Calorimeter Peer Review **17 – 18 March 2003**

Action Item:	CAL – 006
Presentation Section:	Mechanical
Submitted by:	Jim Ryan

Request: Margins of safety - For consistency, use GEVS margins of safety equations.

Reason / Comment: Margins of safety calculations should be consistent across the LAT program.

Response: 3 May 2003

Margins of safety were recalculated using the GEVS margins of safety equations. These values are summarized in Section 4 of the attached technical note, LAT-TD-02051-01 (LLR-GLAST-TN-082).

The attached view graphs, which were presented at the CAL Peer Review, have been updated to address the request of this RFA.

Quasi-Static Analysis

Load Case for Analysis

Load case	Boundary conditions
• 12g X Unidirectional • 12g Y Unidirectional • 12g Z Unidirectional • 7.5g X-Y, 8.5g Z Combined	TX, TY, TZ = 0 For 2 Nodes on Each Tab of the Base Plate (Fastener Positions)

Results

COMPONENT	MATERIAL	YIELD STRENGTH (MPa)	ULTIMATE STRENGTH (MPa)	MARGINS OF SAFETY
Composite Structure	T300 1K/M76	-	564 (1)	21.4
Base Plate	2618A-T851	390	440	7.1
Top Frame	2618A-T851	390	440	67.7
Close-Out Plates	2618A-T851	390	440	6.7
Side Panels	5754 H111	100	220	4.9
Inserts	Ti-6Al-4V	850	1000	4.3 (2)
PCB	Glass/Polyamide	-	89	6.5
CsI Log	Cesium Iodide	1.12	11.86	0.21

NOTES:
(1) Values Have Been Measured on Test Samples, Weave Direction
(2) Calculated for Lateral Inserts Only

Thermo-Mechanical Analysis

Load Case for Analysis

Load case	Boundary conditions
• +30 °C Temperature Increase • -50 °C Temperature Reduction	TZ=0 For the Nodes on the Lower Face ff the Tabs TX=0 For Y Symmetry Plane TY=0 For X Symmetry Plane

Results

COMPONENT	MATERIAL	YIELD STRENGTH (MPa)	ULTIMATE STRENGTH (MPa)	MARGINS OF SAFETY
Composite Structure	T300 1K/M76	-	564 (1)	1.6
Base Plate	2618A-T851	390	440	1.9
Top Frame	2618A-T851	390	440	3.0
Close-Out Plates	2618A-T851	390	440	1.4
Side Panels	5754 H111	100	220	3.1
Inserts	Ti-6Al-4V	850	1000	0.69 (2)
PCB	Glass/Polyamide	-	89	1.9
CsI Log	Cesium Iodide	1.12	11.86	0.21

NOTES:
(1) Values Have Been Measured on Test Samples, Weave Direction
(2) Temperature Reduction of 65 deg Cinstead of 50 deg C

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Note Technique / Technical Note			
GLAST	*GLAST LAT CAL Mechanical Structure*	Ref:	GLAST-LLR-TN-082
		Issue:	Draft
		Date:	21 April 2003
		Page :	1

Margins of safety

LAT reference : LAT-TD-02051-01

Change History log

					S. Le Quellec	O. Ferreira
Ind.	**Date**	**Modifications**	**Prepared**	**Checked**	**PA Approval**	**Project Approval**

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1 SCOPE OF THE DOCUMENTS

This document summarizes the results from the finite element analysis of the CAL structure, presenting the margins of safety for the different components.

2 MATERIALS

Component	Reference	Material
Composite structure	LAT-DS-00973	T300 1K carbon / M76 epoxy
Base plate	LAT-DS-00919	2618A T851 Aluminum alloy
Top frame	LAT-DS-00917	2618A T851 Aluminum alloy
Closeout plate X and Y	LAT-DS-00920 / 00921	2618A T851 Aluminum alloy
Side panel X and Y	LAT-DS-00923 / 00924	5757 H111 Aluminum alloy
Inserts	LAT-DS-00927 / 00928 / 00929	Ti-6Al-4V Titanium alloy
Crystals	LAT-SS-00239	Cesium Iodide
Printed circuit board	LAT-DS-01326 / 01327	Glass fiber / Polyimide resin

3 MATERIAL PROPERTIES

3.1 COMPOSITE MATERIAL

T300 1K carbon / M76 epoxy	Longitudinal	Transverse	Transverse
Tensile modulus (MPa)	101458	9126	9126
Shear Modulus (MPa)	4200	4200	4200
Tensile strength (MPa)	1532	154	154
Compression strength (MPa)	1452	947	947
Shear strength (MPa)	260	130	130
Poisson's ratio	0.3	0.3	0.3
CTE (10^{-6}/°C)	0.28	34.8	34.8
Density (Kg/m^3)	1310		

All the values in the table have been measured on test coupons, cured in an oven at 135°C for 4 hours. The fiber to resin content of the samples is 48% in volume. A void ratio of 5 to 6% has been measured. The values are well below the vendor specifications, which have been verified on autoclave cured samples, with a void ratio of 2%.
The calculated margins of safety are conservative. The composite structure will be fabricated with an autoclave process with an expected fiber content equivalent to the one obtained on the vendor samples.

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3.2 METALLIC PARTS

Property	2618A T851	5754 H111	Ti-6Al-4V
Yield strength 0.2% (MPa)	390	100	828
Ultimate tensile strength (MPa)	440	220	895
Shear strength (MPa)	270	130	-
Elongation at break (%)	8.5	10	10
Young's Modulus	74000	70000	110000
Poisson's ratio	0.33	0.33	0.31
Brinell hardness	135	50	-
CTE (10^{-6}/°C)	22.3	23.8	9.0
Thermal conductivity (W/m°C)	146	132	6.6
Density (Kg/m^3)	2760	2670	4420

3.3 CESIUM IODIDE

Property	Average	Min	Max
Yield tensile strength (MPa)	1.86	0.73	2.28
Ultimate tensile strength (MPa)	4.05	2.24	11.86
Compression strength (MPa)	1.12	0.28	2.4
Tensile Modulus (MPa)	12100	11000	13500
Compression modulus (MPa)	12000	4000	30000
Shear modulus (Mpa)	6800	6200	7930
Poisson's ratio	0.26	0.21	0.30
CTE (10^{-6}/°C)	54	-	-
Thermal conductivity (W/m°C)	1.54	-	-
Density (Kg/m^3)	2760	2670	4420

The values are from NASA Technical Memorandum NASA TM X-64741: Scintillator handbook with emphasis on Cesium Iodide (April 13th 1973). Measurements show large variations from sample to sample, particularly on compression strength. The variations can be attributed to flaws in the crystalline structure. They should be related to the position of the sample in the boules and to fabrication process of the vendor.

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4 MARGINS OF SAFETY

4.1 STATIC LOAD CASES

Component	Factor of safety		12g X or Y		12g Z		7.5g X-Y 8.5g Z	
	Yield	Ultimate	Yield	Ultimate	Yield	Ultimate	Yield	Ultimate
Composite structure	-	1.5	-	27.6	-	21.4	-	26.1
Base plate	1.25	1.4	9.2	8.1	11.6	10.3	8.0	7.1
Top frame	1.25	1.4	75.9	67.7	191.9	171.2	91.0	81.1
Closeout plate	1.25	1.4	8.6	7.6	17.1	15.2	7.6	6.7
CsI log	1.25	1.4	0.21	-	0.56	-	0.38	-
Side panel	1.25	1.4	5.6	4.9	17.3	15.3	8.8	7.7
Printed circuit board	-	1.5	-	6.5	-	15.2	-	9.2

4.2 THERMAL LOAD CASES

Component	Factor of safety		DT-50°C		DT+30°C	
	Yield	Ultimate	Yield	Ultimate	Yield	Ultimate
Composite structure	-	1.5	-	1.6	-	3.5
Base plate	1.25	1.4	2.2	1.9	4.3	3.8
Top frame	1.25	1.4	3.5	3.0	6.4	5.6
Closeout plate	1.25	1.4	1.7	1.4	3.7	3.2
CsI log	1.25	1.4	-	-	0.21	-
Side panel	1.25	1.4	3.6	3.1	5.8	5.1
Printed circuit board	-	1.5	-	1.9	-	2.5

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5 REACTION LOADS

Top frame – side panel			
Base plate – side panel			
Base plate – PCB tab			
Closeout plate – side panel			
Closeout plate – closeout plate			
Closeout plate - PCB			
Base plate – closeout plate			
Top frame – closeout plate			
Nuts – closeout plates			
Lateral inserts – composite structure			
Top inserts – composite structure			
Base inserts – composite structure			
Tabs			

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