GLAST LAT SPECIFICATION	Document # **LAT-PS-08114-01**	Date Effective Sept 11, 2006
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	Subsystem/Office Design Integration & Analyis	
Document Title **GLAST LAT Mass Properties Test Procedure**		

Gamma-ray Large Area Space Telescope (GLAST)

Large Area Telescope (LAT)

Mass Properties Test Procedure

Document Approval

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Change of History Log

Revision	Effective Date	Description of Changes
01	Sept 11, 2006	Initial Release

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1 INTRODUCTION

1.1 PURPOSE

This test procedure contains the requirements and procedures for the mass properties test of the flight integrated GLAST LAT instrument. The test results will be presented in a separate test report, GLAST LAT Mass Properties Test Report LAT-TD-08247, upon completion of the test.

1.2 OBJECTIVE

The primary objective of the mass properties testing is to measure and calculate the overall mass and CG of the fully integrated LAT, and to verify that it meets the specified IRD requirements. A secondary objective is to ensure that the measured mass properties match well when compared with the math model mass matrix.

1.3 OVERVIEW

The mass properties testing will be performed at the Naval Research Laboratory in Washington, D.C. It will consist of mounting an octagonal test plate on top of three evenly spaced load cells. The GLAST LAT instrument will then be positioned onto the test plate so readings can be taken from the load cells in order to measure the overall mass and CG of the LAT. Overall testing responsibilities will be held by the test director.

1.4 ACRONYMS

ABCL: As-Built Configuration List
CG: Center of Gravity
DSHP: Down Spout Heat Pipe
GLAST: Gamma-ray Large Area Space Telescope
GSE: Ground Support Equipment
IRD: "GLAST LAT—Spacecraft Interface Requirements Document" (433-IRD-0001)
LAT: Large Area Telescope
NCR: Non-Conformance Report
NRL: Naval Research Laboratories, Washington, D.C.
QA: Quality Assurance
SC: Spacecraft
STE: Special Test Equipment
TA: Test Article; Fully integrated Flight LAT Instrument
TC: Test Conductor
TD: Test Director
TIP: Test Interface Plate
XLHP: XLAT Heat Pipe

2 APPLICABLE SPECIFICATIONS

Documentation required to perform this test will accompany the test article, including the ABCL and traveler control sheets. The applicable documents cited in this standard are listed in this section only for reference. The specified technical requirements listed in the body of this document take precedence over the source document listed in this section.

2.1 GOVERNMENT SPECIFICATIONS

The following specifications, standards, and handbooks form a part of this document to an extent specified within.

Number	Title
GEVS-SE	General Environmental Verification Specification for STS & ELV Payloads, Subsystems, and Components
433-IRD-0001	GLAST SC-LAT Interface Requirements Document
433-SPEC-0001	GLAST Mission System Spec
433-MAR-0001	GLAST Mission Assurance Requirements Spec

2.2 NON-GOVERNMENT SPECIFICATIONS

Number	Title
LAT-MD-00404-03	LAT CONTAMINATION CONTROL PLAN
LAT-MD-00471-02	CONTROL OF NONCONFORMING PRODUCT
LAT-MD-01196-03	LAT DYNAMICS TEST PLAN
LAT-PS-07728-01	LAT ENVIRONMENTAL TEST HANDLING PROCEDURE
LAT-TD-00035-06	LAT COORDINATE AND NUMBERING SYSTEMS
N/A	INSTRUMENTATION MANUALS
LAT-TD-08247	GLAST LAT MASS PROPERTIES TEST REPORT
LAT-TD-08117	TRR SLIDE PACKAGE

2.3 DRAWINGS

Number	Title
LAT-DS-08371	LOAD CELL BASES
LAT-DS-08303	OCTAGONAL TEST PLATE
LAT-DS-06170	TEST INTERFACE PLATE
LAT-DS-06191	LAT CONFIGURATION

2.4 ORDER OF PREFERANCE

In the event that technical guidelines contained within this document conflict with other documents referenced throughout, the technical guidelines of this document take precedence. However, nothing in this document supersedes applicable laws and regulations unless a specific exemption has been obtained.

3 TEST DESCRIPTION

3.1 TEST OBJECTIVE

The LAT will be secured to the octagonal test plate and mounted on top of the load cells to accomplish two objectives. The first objective will be to measure the overall mass and CG of the fully integrated LAT and to verify the following three IRD requirements:

1) Mass is less than 3000 kg

2) Z-cg is a maximum of 185mm above the LAT Interface Plane (LIP) – This requirement Is calculated, with confidence level based on X-cg and Y-cg results

3) X-cg and Y-cg are within 20mm of the LAT Coordinate System (LCS) Z-axis

A secondary objective is to verify that the measured mass properties coordinate with the math model mass matrix.

3.2 TEST METHODOLOGY

After an instrumentation check, in which dummy masses are used to verify the instrumentation is working properly, the LAT is aligned on the test platform. The overall mass and centers of gravity are measured 5 times, where the LAT is rotated 90 degrees after each measurement. The average of the first four measurements will be considered the overall mass and CG for the LAT. The fifth measurement is to check alignment repeatability.

3.3 TEST ARTICLE DESCRIPTION

3.3.1 Deviations from Flight

The LAT is fully integrated for the mass properties testing excluding the radiators and some miscellaneous hardware used to ground fly-away instrumentation. A picture of the LAT before the radiators and GSE are removed can be seen in Figure 3.1. Cover plates are used to constrain the down-spout heat pipes (DSHPs) and X-LAT heat pipes (XLHPs). A complete list is shown in Section 7.

3.3.2 Interface to Test Plate

The LAT is mounted to the Test Interface Plate (TIP) using a flight configuration bolted joint that simulates the flight connection to the SC. The TIP is then mounted to the octagonal test plate which is securely attached on the load cells. A screw is driven through a load cell base plate and into the load cell itself, securely stabilizing the cells. Note that the LAT Z-axis is vertical at all times during the mass properties testing.

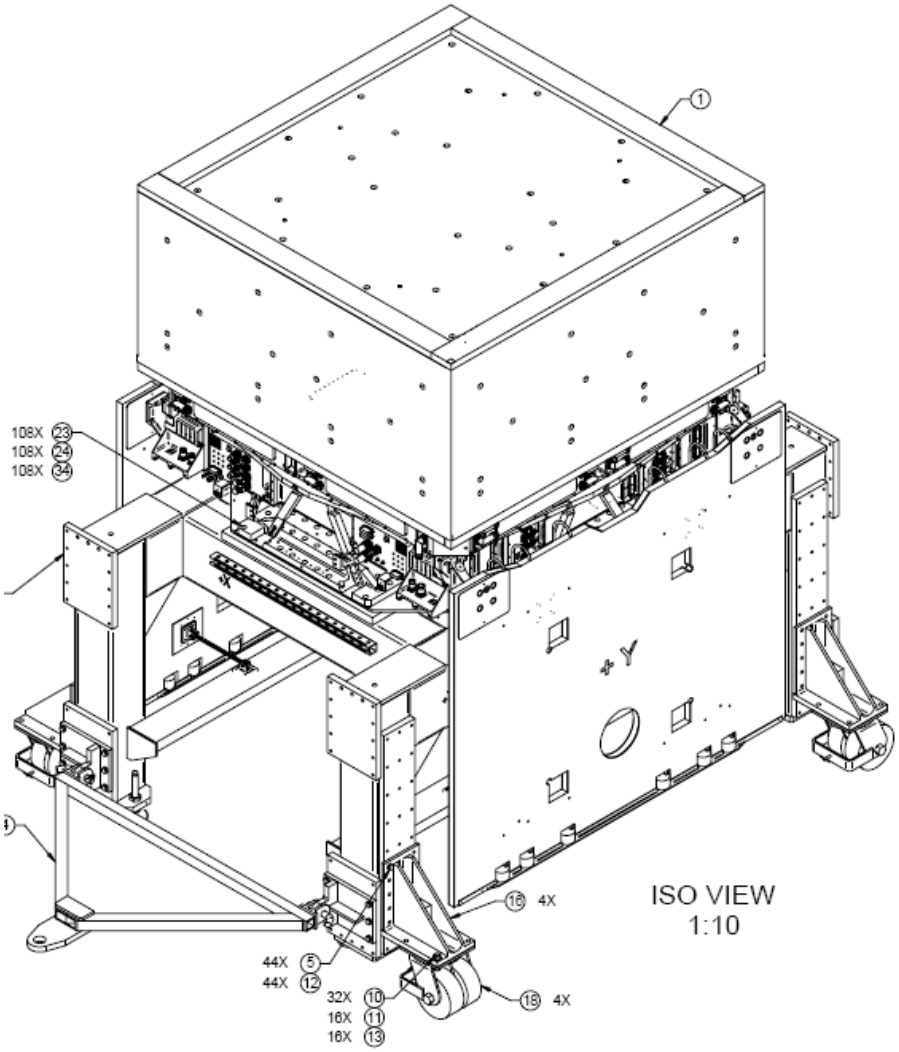

Figure 3.1 – LAT in full flight configuration. For the mass properties testing, the radiators and GSE handling equipment will be removed.

4 TEST RESPONSIBILITIES

4.1 TEST PERSONNEL

The test personnel responsible for the procedures of the test and their contact information are listed in Table 4.1.

Table 4.1 - Test Personnel

Role	Name	Telephone Number
Project Representative	Scott Clough	(301) 286-7007
Test Director	John Ku	(408) 910-4139
Test Conductor, Primary	Bob Haynes	(202) 404-7139
Instrumentation/Data Support	Bob Haynes	(202) 767-0705
Analysis Support	Paul Baird	(301) 902-4529
Quality Assurance Support	Joe Cullinan	(650) 926-5034
Facilities Logistical Support	Bill Raynor	(202) 767-0704
High Bay Logistical Support	Paul Dizon	(202) 404-7139

4.1.1 Project Representative

The Project Representative represents the GLAST project and will have the responsibility to ensure that no violations of project procedures or LAT handling procedures take place.

4.1.2 Test Director

The Test Director (TD) will have primary responsibility for directing test activities, maintaining the log, documenting the test schedules, coordination of resources, and preparation and close-out of all non-conformances. The TD will also have the primary responsibility for all data collection and evaluation during the test for the final test report. The TD will be responsible for coordinating the inputs from the Test Conductors and Quality Assurance representatives, developing the as-run test file, and for executing the as-run test approval sheet. This includes assuring that all NCRs have been properly prepared and correctly executed.

4.1.3 Test Conductor

The Test Conductor(s) will be responsible for a specific activity being conducted. The Primary Test Conductor will also be responsible for the entire laboratory, installation and check-out of instrumentation, data acquisition, and data reduction. The other TC(s) will be responsible for executing their specified test procedures. The TC(s) is also responsible for the preparation, operation of test equipment, and the scheduling of daily activities mentioned in the test procedure.

4.1.4 Support Personnel

Support Personnel are responsible for specific activities supporting installation of instrumentation, managing data, and providing real-time data analysis support.

4.2 CONFIGURATION VERIFICATION

Upon completion of the test setup, the Test Director, Test Conductor and Quality Assurance representative must inspect and approve the test configuration and test conditions, prior to the start of the testing and at any key phases of the test.

4.3 TEST DISCREPENCY RESOLUTION

In event of a test discrepancy, which indicates the potential of damage to equipment, a failure of the test article, or a failure of test equipment, testing will be stopped and the condition of the hardware and test setup preserved.

If a test discrepancy occurs, the test will be interrupted and the discrepancy verified. The Test Conductor and Test Director will determine which report needs to be prepared and executed, in accordance with LAT-MD-00471, GLAST LAT Control of Nonconforming Product.

In conducting the failure analysis, the Test Director can select and re-run in any sequence, any portion of the full functional test within this procedure. Any test steps, conditions, or procedures that are not a portion of this approved test procedure that needs to be included must first be approved by the TD and QA and an NCR generated before they are performed. The results are to be included or referenced in the NCR and included in the as-run appendix.

5 GENERAL TEST PROGRAM REQUIREMENTS

5.1 TEST SETUP

5.1.1 Test Location

The mass properties testing will be performed on the Modal Survey Plate at the Payload Check-out Facility, Building A-59, of the Naval Research Laboratory, Washington, D.C.

5.1.2 Test Article Installation and Configuration

The mass properties configuration is shown in LAT-DS-06191, Mass Properties Configuration Drawing. The LAT is fully integrated for the mass properties testing and in its flight configuration, except for the parts listed in Section 3.3.1. The LAT will NOT be bagged for contamination control; rather cleanliness requirements will be instituted.

Prior to the mass properties testing, the testing area shall be thoroughly inspected to ensure that there is no loose debris or equipment lying around. The LAT will also be inspected to ensure there is no loose hardware.

The LAT is mounted to the Test Interface Plate STE using the flight configuration bolt joint that simulates the flight connection to the SC. The TIP is resting on the octagonal mass properties plate, which rests on the three load cells. This forms the test platform from which all measurements are taken. When the test platform load cells have been zeroed out and confirmed to be operating correctly, the LAT and TIP will be lowered onto the platform, marking the commencement of the test.

The test configuration can be seen in Figure 5.1 on the next page.

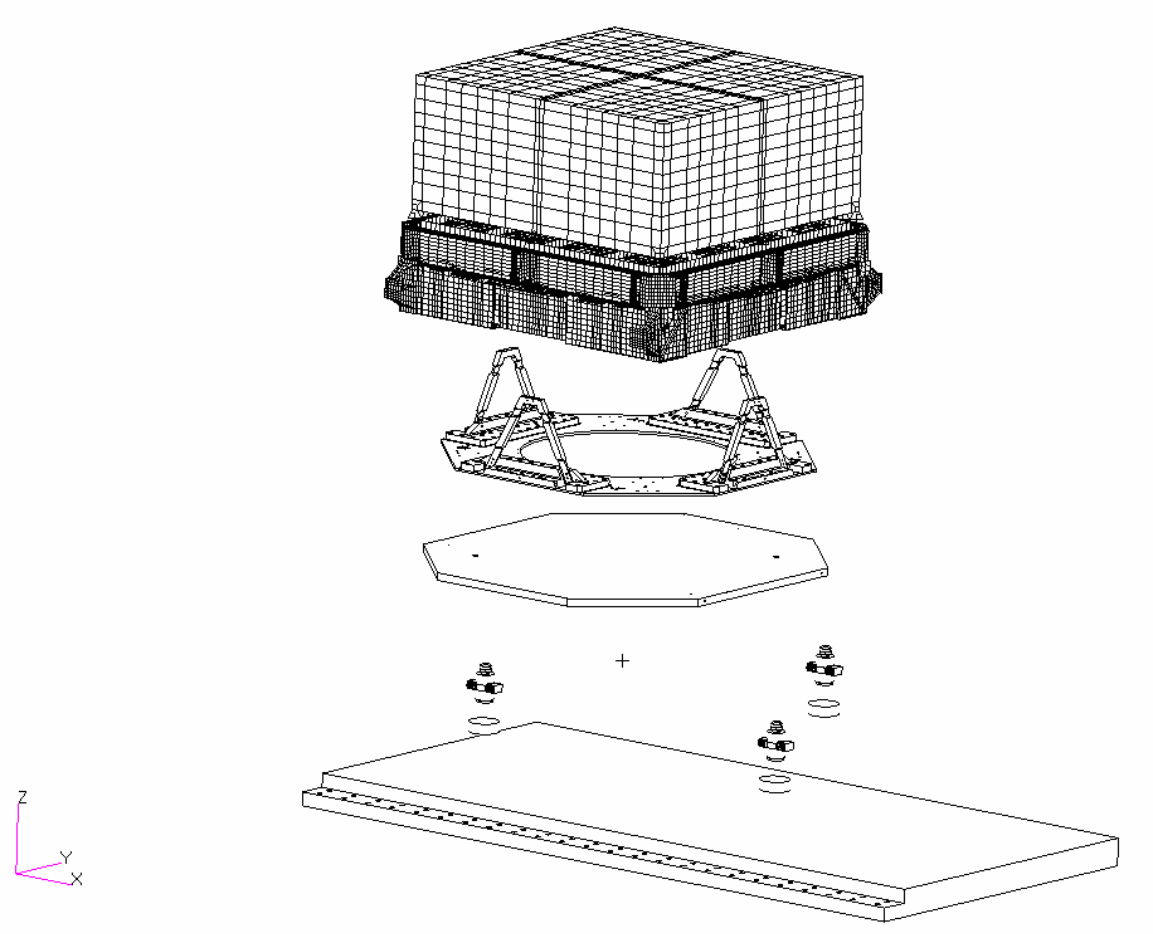

Figure 5.1 – Exploded view of the mass properties testing configuration.

5.1.3 Test Equipment

The following test equipment and systems will be used in the execution of this test:

- Steel Base Plate: NRL modal test plate
- Load Cell Bases: Document LAT-DS-08371
- Load Cells: Beowulf model 200-S; P/N -LC2030
- Octagonal Test Plate: Document LAT DS-08303
- Test Interface Plate: Document LAT-DS-06170

All of the equipment mentioned above can be seen interconnecting in Figure 5.1 and LAT-DS-06191. Any substitution of the designated test equipment will require the approval of the TD and/or the TC, and QA. Such substitutions will be noted as part of the test data and submitted with the test report.

5.1.4 Handling and Control of Equipment

Handling of the TA will be under the direction of the TD and/or TC. The protocol to safely handle the equipment involved in the mass properties testing, including transportation into, during, and out of the testing area, can be viewed in the document LAT-PS-07728.

5.2 INSTRUMENTATION AND DATA LOGGING

5.2.1 Instrumentation

Instrumentation for the mass properties testing amounts to three load cells supporting a base plate. The octagonal base plate will rest on top of the load cells and the load cells will be zeroed out once the octagonal plate is in place. The location of the load cells can be seen in Figure 5.2. The positions of the load cells is designed such that the centroid of the load cell positions is coincident with the LAT coordinate system. This was done in order to have uniform readings.

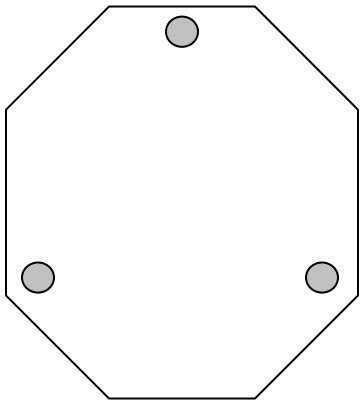

Figure 5.2 – Location of the three load cells under the octagonal test plate

5.2.2 Calibration

Standard laboratory calibration techniques will be used to calibrate the load cells. Prior to the testing, the octagonal plate will be placed on top of the load cells. The load cells will then be zeroed out to exclude the mass of the plate from the overall mass calculation of the LAT.

5.2.4 Test Log

The Test Conductor will maintain a test log of the daily activities during the test. The test log shall contain at a minimum the date and time of each test activity, a brief description of the activity, a description of any deviation from the planned procedure, and any other information known to be significant to the test, such as photographs. Furthermore, the

Test Director shall maintain a master copy of the procedure. All deviations from the procedure shall be noted as "red lines" in this master copy.

5.2.5 Test Report

The results of the test will be documented in a separate test report after completion of the testing. The report shall contain all test data, photographs, a complete description of the test and a description of any deviation from this procedure.

6 TEST PROCEDURE

6.1 MASS PROPERTIES ENVIRONMENT TEST FLOW

DATE OF TEST

Time	Approximate Duration	Task
	1 hour	Position LAT on the octagonal plate, get load cell reading
	1 hour	Lift LAT off plate, rotate 90 degrees, remount to plate, get load cell reading
	1 hour	Lift LAT off plate, rotate 90 degrees, remount to plate, get load cell reading
	1 hour	Lift LAT off plate, rotate 90 degrees, remount to plate, get load cell reading
	1 hour	Lift LAT off plate, rotate 90 degrees, remount to plate, get load cell reading

The handling procedure required to position the LAT for the five load cell readings mentioned above, is documented in LAT-PS-07728, LAT Environmental Test Handling Procedure.

6.2 POST-STRUCTURE ENVIRONMENT FUNCTIONAL TESTING

At the conclusion of the mass properties testing the LAT will be subjected to an aliveness test to be sure all components and subsystems are working properly after the test.

6.3 PASS/FAIL CRITERIA

The GLAST LAT will have successfully completed the mass properties testing if the following objectives are accomplished:

1. Measure the overall mass and CG (X and Y only) of the fully integrated LAT

2. Verify the following three IRD requirements:
    a. Total mass is less than 3000 kg
    b. Z-cg (calculated) is a maximum of 185mm above the LAT Interface Plane (LIP)
    c. X-cg and Y-cg are within 20mm of the LAT Coordinate System (LCS) Z-axis

7 SUMMARY OF DEVIATIONS FROM FLIGHT

Parts Not Installed					
FROM ASSY OR USED ON	**ITEM NO.**	**PART NUMBER**	**DESCRIPTION**	**QTY**	**NOTES**
LAT-DS-05210	58	085A40	SINGLE AXIS SHORTING PLUG	13	
LAT-DS-05210	61	080M388	TRIAXAL SHORTING PLUG	5	
LAT-DS-05210	62	LAT-DS-06589	JL264,JL266 SHORTING PLUG	2	
LAT-DS-05210	63	LAT-DS-08016	JL39 CONNECTOR COVER	1	
LAT-DS-05210	63	500-017M100MHN	JL69 CONNECTOR COVER	1	
LAT-DS-01624	29	AMP 322366	RING LUG #10	100	
LAT-DS-01624	26	NAS620C10	FLAT WASHER #10	50	
LAT-DS-01624	27	NAS1351N3LB6	SHCS 10-32 X .375LG	50	
LAT-DS-01624	8	LAT-DS-07711	RAD MOUNT BOLT	16	
LAT-DS-01624	7	LAT-DS-07683	CONDUCTIVE SHIM	4	
LAT-DS-01624	6	LAT-DS-08270	TITANIUM WASHER	16	
LAT-DS-01624	5	LAT-DS-08211	INSOLATOR RAD MOUNT	4	
LAT-DS-01624	3	2A15743-503	-Y RADIATOR	1	
LAT-DS-01624	2	2A15743-501	+Y RADIATOR	1	
LAT-DS-01624	24	2A18061-501	-Y RADIATOR BLANKET	1	
LAT-DS-01624	23	2A18061-503	-Y RADIATOR BLANKET	1	
LAT-DS-01624	22	2A18062-501	+Y RADIATOR BLANKET	1	
LAT-DS-01624	21	2A18062-503	+Y RADIATOR BLANKET	1	
LAT-DS-01624	16	NAS1352N08LB16	SHCS 10-32 X 1.00LG	108	
LAT-DS-01624	15	NAS1352N08LB10	SHCS 10-32 X .625LG	12	
LAT-DS-01624	14	24117-12-SS	BELLVILLE WASHER	120	
LAT-DS-01624	13	NAS1149E0363R	FLAT WASHER 3/16ID X 1/2OD	120	
LAT-DS-01624	38	NUSIL CV2946	THERMAL CONDUCTIVE SILICONE	AR	
LAT-DS-01624	39	NUSIL CF1-135	PRIMER SILICONE CLEAR	AR	
LAT-DS-01624	40	MS-122B	RELEASE AGENT	AR	
LAT-DS-01624	41	602584	.004 DIA SPACER BEADS	AR	
Parts that may be Installed that do not Fly					
CONFIG ASSY'S		LAT-DS-04498	GRID CHILL BARS	2	
LAT-DS-01624		942L004M14G35P	CONNECTOR SAVERS LM RADIATORS	8	
LAT-DS-01624		942L004M18G35S	CONNECTOR SAVERS LM RADIATORS	4	
LAT-DS-01624		942L004M22G35P	CONNECTOR SAVERS LM RADIATORS	4	
WE WILL NEED TO CHECK ALL CONNECTOR PANELS FOR ANY OTHER CONNECTOR SAVERS THAT MAY BE INSTALLED					

8 PRE-TEST ANALYSIS & TRR SLIDE PACKAGE