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Gamma-ray Large Area Space Telescope (GLAST)
Large Area Telescope (LAT)
Calorimeter Flight Model
Pre-Electronics Module Acceptance Requirements

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1 INTRODUCTION

1.1 PURPOSE

This document defines the acceptance requirements for Flight Model (FM) Calorimeter (CAL) Pre-Electronics Modules (PEMs), which are assembled at the Naval Research Laboratory (NRL).

1.2 SCOPE

The requirements listed herein apply to all Flight Model PEMs.

1.3 APPLICABLE DOCUMENTS

The following documents and drawings are applicable to the extent specified within. Unless otherwise indicated, the latest issue in effect shall apply. In the event of a conflict between these documents and the contents of this document, those contained herein shall be considered the superseding requirement.

GE-00010	GLAST LAT Performance Specification
LAT-DS-00209	LAT Calorimeter Flight Dual PIN Photodiode Specification
LAT-DS-00820	LAT Calorimeter CsI Crystal Performance Specification
LAT-DS-00917	Top Frame
LAT-DS-00918	Composite Structure
LAT-DS-00919	Base Plate
LAT-DS-00920	Close-Out Plate, X
LAT-DS-00921	Close-Out Plate, Y
LAT-DS-00922	Nut
LAT-DS-00925	Bumper
LAT-DS-01224	PEM Assembly
LAT-DS-01230	PEM Mechanical Structure Assembly
LAT-DS-01554	CAL-TEM Stand-Off
LAT-DS-01900	Crystal Detector Element Assembly
LAT-DS-01923	Grommet
LAT-DS-02427	Shear Pin
LAT-DS-02848	Base Plate/Pin Assembly, PEM Mechanical Structure
LAT-MD-00228	Calorimeter, Tracker, and Data Acquisition Contamination Control Plan
LAT-PS-00809	LAT Calorimeter CsI Crystal Handling and Shipping Procedure
LAT-PS-01225	Calorimeter Pre-Electronics Module Assembly Procedure
LAT-PS-01231	Calorimeter Pre-Electronics Module Mechanical Structure Assembly Procedure
LAT-PS-01330	Calorimeter Flight Photodiode Assembly Soldering & Staking Process Specification
LAT-PS-01331	Calorimeter Flight Crystal to PDA Bonding Process Specification
LAT-PS-01332	Calorimeter Flight Crystal Wrapping and Capping Process Specification
LAT-PS-01534	Calorimeter Flight Model Photodiode Assembly Specification
LAT-PS-02571	CAL Crystal Detector Element Optical Test Procedure
LAT-PS-02572	Process Specification for the Bond Strength Testing of the CDE
LAT-PS-03363	Calorimeter Base Plate Assembly Procedure
LAT-SS-00010	LAT Performance Specification – Level II (b) Specification
LAT-SS-00018	LAT CAL Subsystem Specification - Level III Specification
LAT-SS-00210	LAT CAL Subsystem Specification – Level IV Specification
LAT-SS-00601	LAT Calorimeter Structure to CDE Interface Control Document
LAT-SS-01133	Calorimeter Flight Crystal Detector Element Specification
LAT-TD-00381	LAT Calorimeter CDE Light Yield Calibration Procedure

1.4 DEFINITIONS AND ACRONYMS

1.4.1 Acronyms

CAL	Calorimeter Subsystem of the LAT
CDE	Crystal Detector Element
DPD	Dual PIN photoDiode
GLAST	Gamma-Ray Large Area Space Telescope
LAT	Large Area Telescope
NCR	Non-Conformance Report
PDA	PhotoDiode Assembly
PR	Problem Record
TBD	To Be Determined
TBR	To Be Resolved

1.4.2 Definitions

Analysis	A quantitative evaluation of a complete system and/or subsystems by review/analysis of collected data
Demonstration	To prove or show, usually without measurements of instrumentation, that the project/product complies with requirements by observation of the results.
Inspection	To examine visually or use simple physical measurement techniques to verify conformance to specified requirements.
Simulation	To examine through model analysis or modeling techniques to verify conformance to specified requirements
Testing	A measurement to prove or show, usually with precision measurement or instrumentation, that the product complies with requirements.
Validation	Process used to assure the requirement set is complete and consistent, and that each requirement is achievable.
Verification	Process used to ensure that the selected solutions meet specified requirements and properly integrate with interfacing products
μm	Micrometer
mm	Millimeter

2 INTRODUCTION

2.1 FM PEM COMPONENTS

The Flight PEM assembly (LAT-DS-01224) consists of the following components, which are depicted in Figure 1:

- PEM Mechanical Structure, LAT-DS-01230 (qty 1)
The PEM Mechanical Structure supports the CDEs within individual composite structure cells. This structure consists of the following components:
 - ♦ Top Frame, LAT-DS-00917 (qty 1)
 - ♦ Composite Structure, LAT-DS-00918 (qty 1)
 - ♦ Base Plate/Pin Assembly, LAT-DS-02848 (qty 1)
- Crystal Detector Elements (CDE), LAT-DS-01900 (qty 96), are the muon detectors of the CAL
Each CDE consists of the following components:
 - ♦ One FM CsI(Tl) scintillating crystal, which is a rectangular parallelepiped with a chamfer on the corners of the long dimension, as defined in LAT-DS-00820.
 - ♦ Two FM Photodiode Assemblies (PDAs), one bonded to each end of the CsI crystal. As defined in LAT-PS-01534, each PDA consists of:
 - ♦ One Dual PIN photoDiode (DPD) as defined in LAT-DS-00209, and
 - ♦ Two sets of interconnect wire pairs attached to the leads of the DPD.
 - ♦ Two optical bonds attaching the PDA assemblies, one to each CsI crystal end using a DC93-500 silicone optical adhesive in accordance with LAT-PS-01331.
 - ♦ One VM2000 Optical Reflective Wrap sealed with acrylic-adhesive Kapton tape applied in accordance with LAT-PS-01332.
 - ♦ Two Machined End Caps attached over bonded PDAs and optical reflective wrap at both ends of the crystal to close out the ends of the CDE in accordance with LAT-PS-01332.
 - ♦ One label indicating crystal serial number and orientation as defined in the FM CDE Specification (LAT-SS-01133).
- Bumper Frames, LAT-DS-00925 (qty 192), provide axial support of the CDEs within their cells
- Close-Out Plates, LAT-DS-00920 (qty 2) and LAT-DS-00921 (qty 2), secure the CDEs within their cells. Interconnect wire pairs of each CDE pass through these plates and will interface to the Analog Front End Electronics (AFEE) cards.

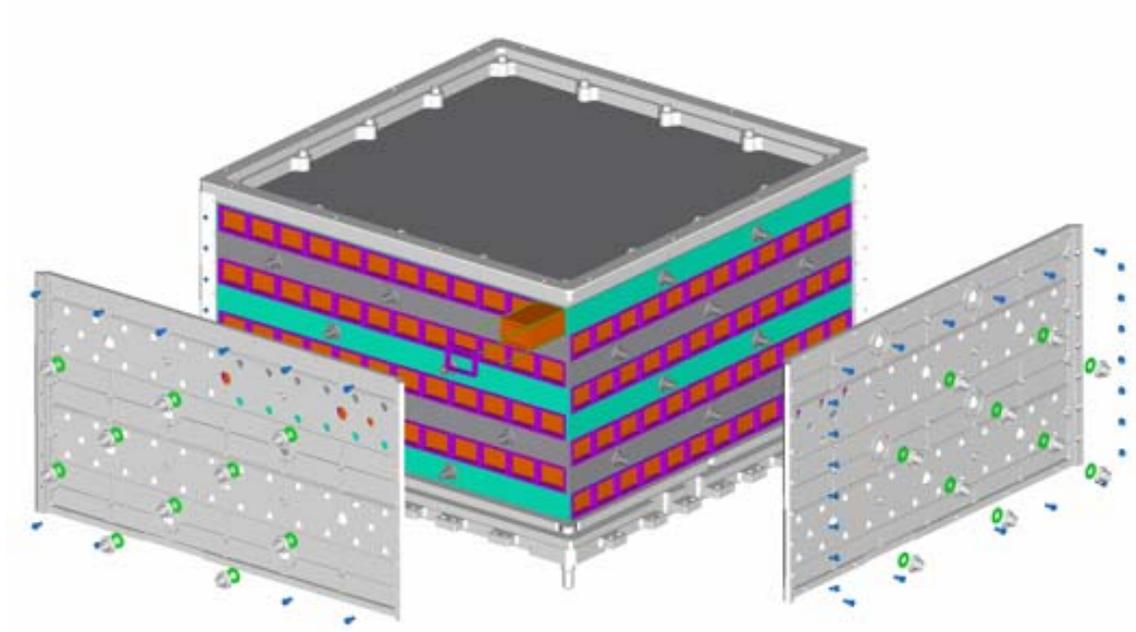


Figure 1: Pre-Electronics Module assembly. The PEM assembly drawing is LAT-DS-01224.

3 PEM ACCEPTANCE REQUIREMENTS

The acceptance requirements indicated apply to all flight PEMs. They are listed below by type. In each section, the requirements and method of reporting are listed following a brief description.

3.1 VISUAL INSPECTION

Each PEM shall be subject to in-process and final visual inspection, as listed here and within the PEM Assembly Procedure (LAT-PS-01225) and the PEM Mechanical Structure Assembly Procedure (LAT-DS-01231). The final visual inspection shall be performed after completion of the PEM Checkout Muon Optical Test (LAT-PS-03677).

3.1.1 Requirements

Prior to insertion of the CDEs into the PEM Mechanical Structure, the structure shall be visually inspected for any damaged that may have occurred during assembly.

During insertion of the CDEs into the PEM Mechanical Structure, visual inspection shall occur throughout the process.

Prior to the PEM Checkout Muon Optical Test, visual inspection of the PEM shall verify the following:

- All Interconnect Wire Pairs from the CDEs pass through their associated holes in the Close-Out Plates.
- No Interconnect Wire Pairs were visibly damaged during the PEM Assembly.
- Helicoils securing the corners of the Close-Out Plates have not exited into the Side Panel bearing surface.

Following the PEM Checkout Muon Optical Test, visual inspection of the PEM shall verify the following:

- All Grommets are properly seated on the exterior surface of the Close-Out Plates.
- All Shorting Plugs have been properly re-installed on each Wire Pair.

3.1.2 Reporting

The date and final status of the visual inspection shall be reported in the appropriate Work Order Authorization.

A PR is required if the inspection detects a failure for any of the visual inspection requirements. All PRs shall be disposed on a case-by-case basis.

The WOA and any associated PRs shall be included in the acceptance data package.

3.2 MECHANICAL INSPECTION

Each PEM shall be subject to dimensional inspection, as listed here and within the PEM Assembly Procedure (LAT-PS-01225) and the PEM Mechanical Structure Assembly Procedure (LAT-DS-01231).

External dimensions of each PEM assembly must be verified with approved and calibrated equipment.

3.2.1 Requirements

Maximum dimensional requirements of the PEM assembly are specified in LAT-DS-01230, the PEM Mechanical Structure Assembly drawing. These requirements were derived from the stay-clear volume defined in the LAT Interface Definitions Drawing (IDD), LAT-DS-00233.

3.2.2 Reporting

The date and final status of the dimensional inspection shall be reported on the appropriate Work Order Authorization.

A PR is required if the inspection detects a failure for any of the dimensional inspection requirements. All PRs shall be disposed on a case-by-case basis.

The WOA and any associated PRs shall be included in the acceptance data package.

3.3 OPTICAL PERFORMANCE

The optical performance of each CDE in the PEM shall be quantified with the PEM Checkout Electronics (CES) Muon Optical Test (LAT-PS-03677). The design and verification of the PEM CES is given in LAT-PS-01226. The muon optical test records the scintillation light produced by the passage of cosmic ray muons and measured by all four PIN photodiodes of all CDEs. The optical test reports the following parameters.

- The absolute light yield of all four diodes measured at the center of each CDE.
- The large-to-small diode light yield ratio, PIN B / PIN A for each PDA, and the end-to-end light yield ratio for the large diode, PIN B(plus) / PIN B(minus), measured at the center of each CDE.
- The energy resolution of both large diodes for muons at the center of the CDE.
- The light asymmetry from the large diodes for muons approximately 12 cm on either side of the center of the CDE.

3.3.1 Requirements

Optical performance requirements for individual Crystal Detector Elements are given in the CAL Flight Model Crystal Detector Element Specification, LAT-SS-01133, in which these parameters are defined in some detail. All CDEs are tested to more stringent requirements in accordance with the CDE Acceptance Test Plan, prior to delivery to NRL. The optical performance of all CDEs shall be retested at the PEM level. Table 3-1 lists the PEM optical performance requirements to be tested and the respective maximum and minimum values, as appropriate.

All CDEs in a PEM must pass all optical performance requirements.

Parameter	Minimum Value	Maximum Value
Light yield, large PIN (e/MeV)	5500	NA
Light yield, small PIN (e/MeV)	950	NA
Light yield ratio	4.5	8.0
Light asymmetry change	0.18	0.75
End-to-end light yield ratio, large PIN	0.75	1.33
Muon energy resolution (rms)	NA	8%

Table 3-1. Optical performance requirements

3.3.2 Reporting

The PEM-CES muon optical test analysis software generates a test report that contains the CDE serial number, the date and test technician's name, the optical performance values, and the pass/fail status for each requirement.

A PR is required if a failure occurs for any of the performance requirements. All PRs shall be disposed on a case-by-case basis.

The WOA and any associated PRs shall be included in the acceptance data package.

3.4 QUALITY ASSURANCE

After completion of the PEM Checkout Muon Optical Test (LAT-PS-03677), Quality Assurance personnel shall review supporting documentation for PEM assembly and test as defined here. This review shall

ascertain that all PEM assembly and test operations are completed, that PEM requirements are met, and that all operations have been properly documented.

3.4.1 Requirements

The QA review shall ascertain that

- All As-Built Procedures and Assembly Drawings exist.
- All PEM Work Order Authorizations have been executed and are closed.
- All Problem Records associated with these WOAs are resolved and closed.
- The PEM Muon Optical Test Report has been reviewed.

3.4.2 Reporting

Certification of the QA review shall be included in the acceptance data package.

4 ACCEPTANCE DATA PACKAGE

QA personnel shall create a PEM acceptance data package with the following contents.

4.1 REPORTING

Data and documentation supporting visual and mechanical inspection and optical test are as follows:

- As-Built Procedures and Assembly Drawings:

LAT-PS-01225	Calorimeter Pre-Electronics Module Assembly Procedure
LAT-PS-01231	Calorimeter Pre-Electronics Module Mechanical Structure Assembly Procedure
LAT-PS-03363	Calorimeter Base Plate Assembly Procedure
LAT-DS-01224	PEM Assembly
LAT-DS-01230	PEM Mechanical Structure Assembly
LAT-DS-02848	Base Plate/Pin Assembly, PEM Mechanical Structure
- Associated Work Order Authorizations pertaining to the build:
 - ♦ Base Plate Assembly
 - ♦ Preparation of Fasteners for PEM Mechanical Structure
 - ♦ Preparation of Composite Structure
 - ♦ Assembly of PEM Mechanical Structure
 - ♦ Preparation of Elastic Cords
 - ♦ Cleaning of Bumper Frames for PEM Assembly
 - ♦ Cleaning of Grommets for PEM Assembly
 - ♦ Preparation of Fasteners for PEM Assembly
 - ♦ CDE Insertion, Y-Face and associated CDE Insertion Map (MS Excel spreadsheet)
 - ♦ CDE Insertion, X-Face and associated CDE Insertion Map (MS Excel spreadsheet)
 - ♦ PEM Close-Out Plate Assembly, X and Y
 - ♦ PEM Check-Out Electronics Installation
 - ♦ PEM Check-Out Muon Optical Test
 - ♦ PEM Check-Out Electronics Disassembly
- PEM Muon Optical Test Report
 - ♦ HTML-format report
 - ♦ CSV-format summary table
 - ♦ PDF-format data summary plots