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	Subsystem/office Calorimeter Subsystem	
Document tilte **Calorimeter CsI Detector Element Specification**		

Gamma-ray Large Area Space Telescope (GLAST)
Large Area Telescope (LAT)
Calorimeter subsystem

Calorimeter CsI Detector Element Specification

CHANGE HISTORY LOG

Revision	Effective date	Description of Changes	DCN#
1		Initial Release	
2			

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1.Introduction

1.1PURPOSE

This document describes the requirements for the CDE part of the Pre Electronic Module (PEM) of the Calorimeter (CAL) derived from level 4 detailed system requirements for the GLAST Large Area Telescope (LAT) Calorimeter (CAL)

1.2SCOPE

This document is one level below the LAT-CAL-PEM Specification LAT xxxxx

This specification captures the LAT overall requirements for the CDE. This encompasses the subsystem level requirements and the design requirements for the CAL.

1.3APPLICABLE DOCUMENTS

Documents that are relevant to the development of the GLAST LAT PEM and its requirements include the following:

GE-00010	'GLAST LAT Performance Specification', August 2000
GLAST00110	'Mission Assurance Requirements (MAR) for Gamma-Ray Large Area Telescope (GLAST) Large Area Telescope (LAT)' , NASA Goddard Space Flight Center, Current Draft Sept 20, 2000
NPD 8010.2B	' NASA Policy Directive, Use of Metric System of Measurement in NASA Programs'
LAT-SS-00018-D4	'LAT CAL Subsystem Specification - Level III Specification', 20 March 2001
LAT-DS-00072-03	' Specification for the Calorimeter PIN Photodiode Assembly', 20 February 2001
LAT-DS-00095-03	'LAT Calorimeter Csi Crystal Specification', 5 April 2001
LAT	LAT Subsystem Mechanical Interface Control Document
LAT	Conceptual Design of the Glast Calorimeter Front-End Electronics (GCFE) ASIC
GEVS	

1.4DEFINITIONS AND ACRONYMS

1.4.1Acronyms

ACD	Anticoincidence Shield
AFEE	Analog Front End Electronics of the CAL
CAL	the Calorimeter subsystem of the LAT
CDE	Crystal Detector Element of the PEM
GEVS	General Environmental Verification Specification
GLAST	Gamma-Ray Large Area Telescope
IRD	Interface Requirements Document
I&T	Integration and Test
LAT	Large Area Telescope
MAR	Mission Assurance Requirements
MSS	Mission System Specification
PEM	Pre electronic module of the CAL
TBR	To Be Resolved

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1.4.2Definitions

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 project/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

γ	Gamma Ray
µsec,µs	microsecond, 10^{-6} second
nm	nanometer

µm	micrometer
mm	millimeter
eV	Electron Volt
MeV	Million electron Volt, 10^6 eV
ph	photons

2REQUIREMENTS

2.1CDE CONCEPT

The Crystal Detector Element is the detection unit of the calorimeter subsystem. It uses the scintillation properties of the CsI(Tl) to determine with excellent accuracy the energy deposited by interacting particles . The main characteristics of the CDE is the Light Yield, expressed in terms of electrons/MeV at the output of the read out system (photodiodes)

2.2DESIGN OVERVIEW

Crystals are wrapped in reflective material strips (film VM2000 from 3M company) that cover the crystal side faces. These strips are attached together and to the crystal by adhesive tapes to prevent any shift of the wrapping material. The adhesion of these adhesive tapes on crystal chamfers is improved by the rubber band pressure. The 3M strips end flush the crystal edges. Crystal end faces are used for both mechanical stability and light readout.
The PIN Diode elements (15 x 19 mm) are bonded to the crystal ends by optical adhesive system which has two functions :

Optical contact between the crystal (index 1.8) and the PIN diodes epoxy (index 1.54)
Mechanical assembly of PIN diode and crystal

The crystal end face free area around the PIN diode is the interface area with the elastomeric Bumpers mounted on the Close Out Plate to maintain the crystal at its position.

2.3CDE COMPOSITION

CDE will be composed of the following parts :

- CsI scintillation crystal. It will be rectangular parallelepiped with a chamfer on the edges of the long dimension
  Length = 333,0 mm ; Height = 19,9 mm and width = 26,7 mm.
- 2 dual pin photodiodes at both ends of the CsI crystal.
  External dimensions 22,3 mm x 15,0 mm x 1,8 mm.
  Pin photodiodes are gluing on CsI using an optical epoxy or silicon glue (TBD)
  Pin photodiodes are equipped with kapton cable before gluing.
- Wrapping.

2.4GENERAL REQUIREMENT :LIGHT YIELD

2.4.1 Absolute Light Yield requirements

The light yield produced by cosmic muons crossing crystal in its middle shall produce 4000 electrons per MeV for the large diode and 700 electrons per MEV for the small diode. The goal is 5000 e/MeV and 800 e/MeV respectively.

2.4.2 Energy resolution

The energy resolution must be better than 1% (TBR)

2.4.3 Light Yield Asymmetry

For muons crossing the 2 last centimeters of any crystal, the ratio of light yield between most distant and nearest large diode shall be 60 % within 10 % accuracy

2.4.4 Light Tapering

The light yield variation must be monotonic with energy deposition position along the crystal.

2.4.5 Light Yield Uniformity

The scattering of absolute light yield values for all crystals must be smaller than 20% (3 sigma's) (TBR)

2.4.6Mission life

Performances must not change by more than 20 % over the mission life. (TBD)

2.5SPECIFICATIONS

2.5.1CSI(TI) CRYSTAL

The crystal specifications are given in LAT-DS-00095-01

2.5.1.1 Crystal dimension specification

Each crystal as following dimension and tolerances

Length of $333.0^{+0.0}_{-0.6}$ mm, Width $26.7^{+0.0}_{-0.4}$ mm, Height $19.9^{+0.0}_{-0.4}$ mm.
The maximal value are maximum dimensions of the envelope.

CDE must be inserted in the crystal cell. The clearance between crystal and Cell walls is at least 0.32 mm (for maximal value of crystal size).

2.5.1.2 Depolishing of crystal ends

The crystal end are depolished with Ra roughness parameter Ra between 3 an 6 micrometers. To increase the strength of the bonding (TBD)

2.5.2WRAPPING

The crystal is wrapped with VM 2000 film strips that are attached together and to the crystal chamfers by four adhesive tapes.

Thickness of the VM2000 film: 0.065 mm,
Thickness of the adhesive tape: 0.04 mm .

2.5.2.13M specifications

The reflectivity of 3M VM200 is given in the product technical specification to be higher than 95 % between 400 and 1000 nm.

2.5.2.2 Wrapping strip dimensions

The 3M strips have 333.0 * 19.9 mm and 333.0 * 26.7 mm respectively. They are positioned in order to be flush the crystal end.

2.5.2.3 Wrapping Flatness.

The wrapping must be free of folds, bubbles, cracks.

2.6DUAL PIN DIODES

The Dual PIN Diodes specifications are in document xxxxx.
These specifications apply for EM diodes, and are expected not to be changed for flight.

2.7DUAL PIN DIODES BONDING

The Dual PIN Diodes are attached to the crystal ends with transparent bonding system.

2.7.1Glue maximal thickness

The thickness of the bonding is less than 1mm.

2.7.2Transparency

The bonding system must be optically clear.

2.7.3Mission life

The light yield must be unaltered by less than 20% at the end of the mission life (TBD)

2.7.4 Mechanical properties

The maximal stress on the bonding comes from the thermal expansion of CsI(Tl), that might cause the diode bounding break and diode not in contact any more with Crystal.
The light yield must be unchanged after 120 (TBD) cycles.

2.7.5 Positioning

The DPD are centered in the crystal face within 0.1 mm accuracy (3 sigma's) (TBR)

2.8 INTERFACE WITH PEM STRUCTURE

For protection of CDE purpose, no part of CDE must be or enter in direct contact with the PEM structure.
The mechanical interface is made by rubber band at the chamfers and bumpers at the crystal ends
Requirements are in doc Structure requirements document.

2.9 INTERFACE WITH CAL AFEE

The PEM interface with AFFE requirements are in doc xxxx

2.9.1 Mechanical Interface

The PIN diode and the soldering pad of the AFFE PCB must be aligned within 0.4 mm (TBR)

2.9.2 Electrical interface

The flex conductive strips must not enter in electrical contact with the Close Out Plate

2.9.3 EMI protection

The PIN diode must be shielded against AFFE electronic noise by the Close Out Plates

2.10 OUTGASING AND CONTAMINATION

2.10.1 Outgassing

All materials used in the PEM shall meet the NASA outgassing requirements. (see list xxxx)

2.10.2 Contamination

Contamination is caused by particles generated from materials, machining and assembly procedures. Care will be taken to keep contamination to a minimum.

2.11 CDE MANIPULATION

2.11.1 Procedures

CDE must be manipulated by controlled procedures that guaranty care is paid on the CDE to minimize exposure to structural and mechanical load.

2.11.2 Gloves

CDE must be manipulated with powder free gloves

2.11.3 Manipulation of PIN Diode and Kapton flex.

Fingers manipulate CDE without pulling on the Kapton flex, nor the diode. Contact with these CDE parts must be restricted by the procedures.

2.12LOGISTIC CONSTRAINTS

2.12.1CDE Ground environmental

The CDE shall be housed in environmental controlled and monitored facilities during all phases of ground processing.

2.12.1.1 Surface flatness

The CDE must be stored and transported on flat surfaces, with flatness better than 0.1 mm.

2.12.1.2CDE Transportation

CDE must be transported in dedicated boxes. The transportation box must hold in place the CDE elements with no contact on CDE ends
Transportation and storage container detailed specifications are given in xxx

2.12.1.3CDE Environment Cleanliness

The CDE environment shall be free of dust at the level defined by ISO 7 norm.

2.12.1.4CDE environment Temperature

Temperature environment which the instrument may be exposed during ground operations is in the range 19 to 24 °C (TBR).

2.12.1.5 CDE environment Humidity

Humidity environment which the instrument may be exposed during ground operations must be lower than 40 % HR.

2.12.2Identification and marking

TBD

3Verification strategy

The table 3.1 indicates the methods of verification employed to verify the CDE performances

Table 3.1 : verification matrix

Req't #	Title	Summary	Verif. Method