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Document Title **CAL PEM Mechanical Structure to CDE Interface Control Document**		

Gamma-ray Large Area Space Telescope (GLAST)

Large Area Telescope (LAT)

Interface Control Document between the

Pre-Electronics Module (PEM) Structure and

the CsI Crystal Detector Elements (CDE)

DOCUMENT APPROVAL

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CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
01	15 Feb 2002	Initial Release
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1 INTRODUCTION

1.1 PURPOSE

This document describes the mechanical and thermal interfaces between the CAL Structure and the CDEs. It is intended to convey the interfaces so that the CAL Structure and the CDEs are designed and built with a clear understanding of the mechanical and thermal interface requirements needed to successfully integrate the CDEs with the CAL Structure. This ICD will also serve as the requirements document from which interface test plans and procedures will be developed.

1.2 SCOPE

This ICD includes all mechanical and thermal interfaces between the CAL Structure and the CDEs.

1.3 Applicable documents

The following documents 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 LAT-SS-00601, those contained herein shall be considered the superseding requirement.

GE-00010	GLAST LAT Performance Specification
GEVS-SE	Goddard Environmental Verification Specification
GSFC433-MAR-0004	Mission Assurance Requirements (MAR) for the Large Area Telescope (LAT) Phase C/D/E, NASA Goddard Space Flight Center
NPD 8010.2B	NASA Policy Directive, Use of Metric System of Measurement in NASA Programs
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-00231	Calorimeter Performance Acceptance Standards and Tests
LAT-SS-00238	LAT-CAL Interface Control Document
LAT-SS-00240	LAT CAL Pre-Electronics Module (PEM) Specification
LAT-SS-00241	CAL Mechanical Structure Specification
LAT-SS-01133	Calorimeter CsI Detector Element Specification
LAT-PS-01225	Pre-Electronics Module Assembly Procedure
LAT-DS-00925	Calorimeter CDE Bumper Frame
LAT-DS-01160	Calorimeter CDE End Cap
LAT-SS-01226	Calorimeter PEM Electrical Test Equipment Specification
LAT-PS-00809	LAT Calorimeter CsI Crystal Handling and Shipping Procedure
LAT-MD-00228	Calorimeter, Tracker, and Data Acquisition Contamination Control Plan

1.4 Definitions and acronyms

1.4.1 Acronyms

AFEE	Analog Front End Electronics
CAL	Calorimeter Subsystem of the LAT

CDE	Crystal Detector Element
DPD	Dual PIN photoDiode
EGSE	Electrical Ground Support Equipment
GEVS	General Environmental Verification Specification
GLAST	Gamma-Ray Large Area Space Telescope
GSE	Ground Support Equipment
LAT	Large Area Telescope
MAR	Mission Assurance Requirements
MGSE	Mechanical Ground Support Equipment
PDA	PhotoDiode Assembly
PEM	Pre-Electronics Module of the CAL
RH	Relative Humidity
TBC	To Be Confirmed
TBD	To Be Determined
TBR	To Be Resolved
TEM	Tower Electronics Module

1.4.2 Definitions

Analysis	A quantitative evaluation of a complete system and/or subsystems by review/analysis of collected data
CsI(Tl)	Cesium Iodide, doped with Thallium
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.
Light Yield	Amount of light collected by a photodetector connected to a crystal, expressed in electrons per MeV of deposited energy in the crystal by ionizing rays
Simulation	To examine through model analysis or modeling techniques to verify conformance to specified requirements
Stay clear	Nominal stay clear is not to exceed dimensions. Dynamical stay clear includes maximal excursion beyond nominal stay clear
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
γ	gamma ray
cm	centimeter
kg	kilogram

mm	millimeter
nm	nanometer
µm	micrometer
µsec, µs	microsecond, 10^{-6} second
eV	electron Volt
MeV	Million electron Volt, 10^{6} eV
ph	photons
s	second

2 PRE-ELECTRONIC MODULE CONCEPT

The Pre-Electronics Module (PEM), shown in Figure 2-1, is the core component of the Calorimeter module. The PEM consists of the following:

- PEM Mechanical Structure – carbon composite structure providing the means to arrange 96 finished CDEs in a hodoscopic manner, and provides mounting interfaces for the AFEE cards, TEM, and TEM power supply
- Crystal Detector Elements – the detection unit of the Calorimeter, consisting of two Photodiode Detector assemblies bonded to opposite ends of a CsI Crystal, and wrapped with VM2000
- Elastomeric Cords – installed between the chamfers of the CDEs and the inner corners of the cells of the mechanical structure to center the CDE in the cell
- Silicone Bumper Frames – mounted between the ends of the CDEs and the inner closeout plates to minimize CDE movement

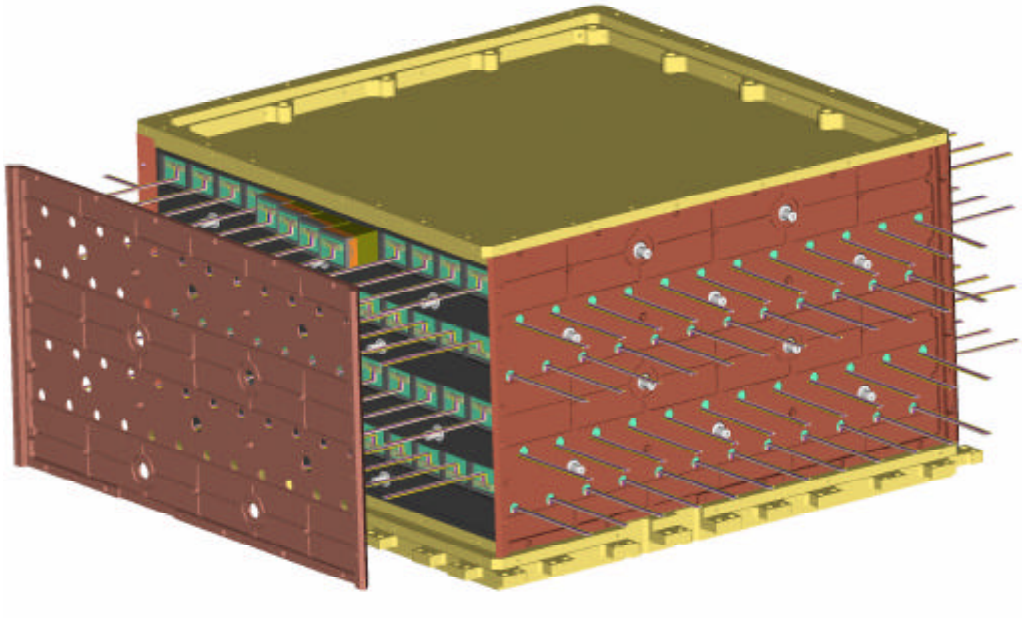

Figure 2-1 – Pre Electronics Module

2.1 Component Descriptions

2.1.1 PEM Mechanical Structure

The PEM Mechanical Structure, as shown below in Figure 2-2, is a carbon composite structure that supports and positions the 96 CDEs. This figure shows the core structure with the top frame and base plate, but does not include the close out plates or side panels.

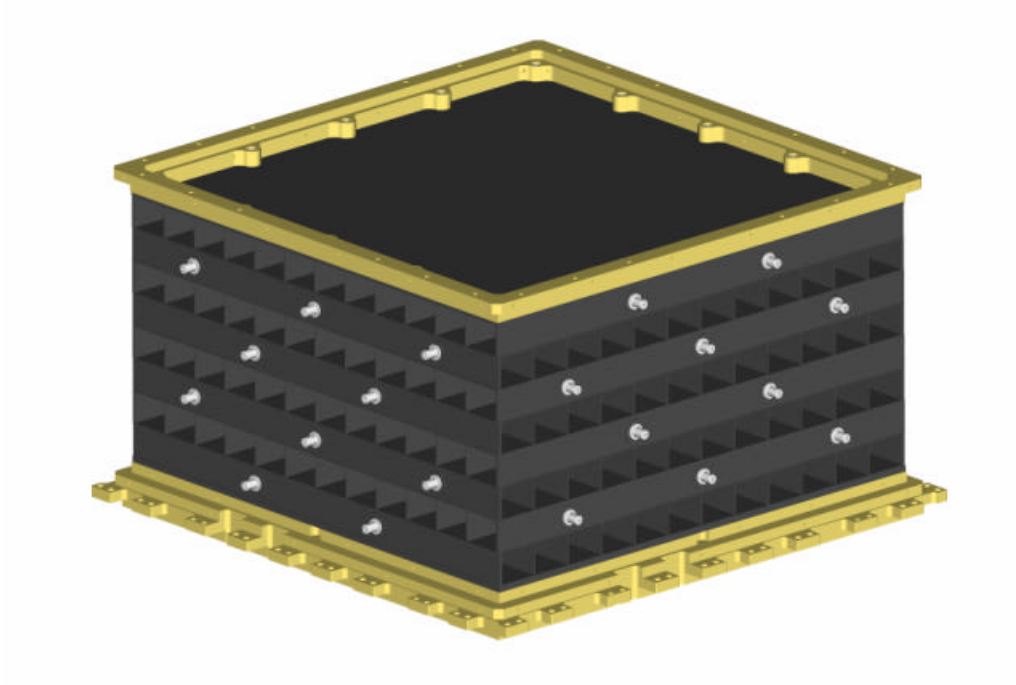

Figure 2-2 – PEM Mechanical Structure

2.1.2 Crystal Detector Element

The Crystal Detector Element (CDE), shown in Figure 2-3 below, is the detection unit of the Calorimeter. It consists of one CsI(Tl) crystal wrapped in reflective material to improve light collection at the crystal ends. Each end of the crystal has bonded onto it a dual PIN photodiode (DPD) for the purposes of measuring the energy deposited within the crystal. Each DPD has two pairs of wires soldered to its pins. The diodes provide analog signals to the AFEE boards, which are mounted around the exterior of the structure.

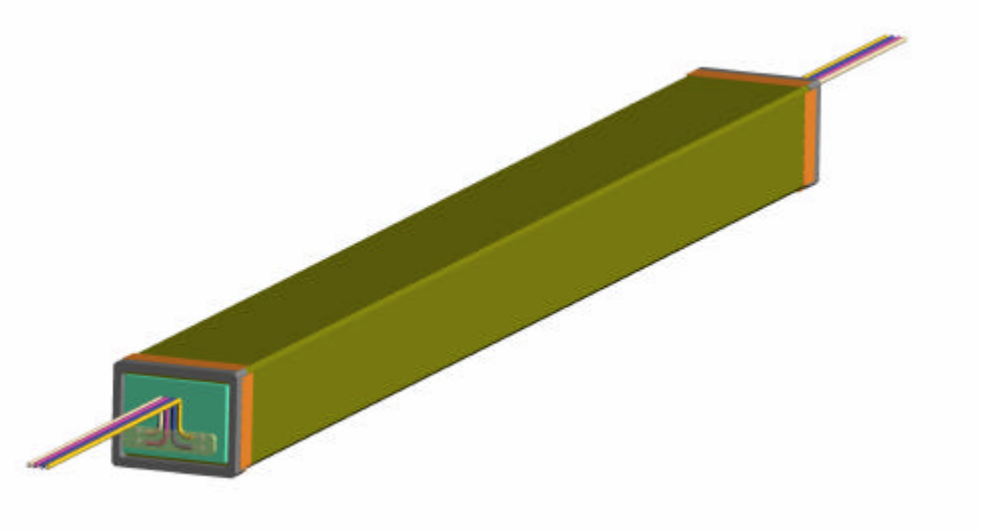

Figure 2-3 – Crystal Detector Element

2.2 Coordinate System

Figure 2-4 below shows the coordinate system with respect to the CAL Structure and CDEs.

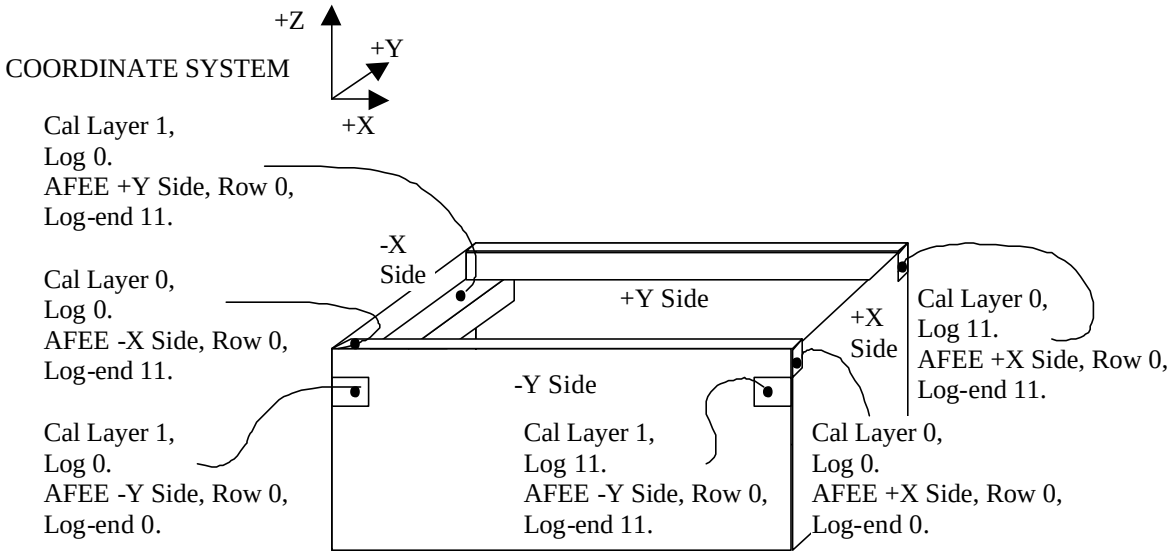

Figure 2-4 – Calorimeter Coordinate System

NOTE: The long axis of the top layer of crystals defines the X axis. The Y axis is parallel to the long axis of the second layer of crystals. The Z axis points upward from the bottom layer to the top layer of crystals.

2.3 Interface Description

2.3.1 General Description

The PEM Mechanical Structure is the primary mechanical interface for the CDE. It provides structural support for the CDE as well as the stable alignment of the crystal layers within the mounting system. The structure also provides the primary means by which the heat generated within the components of the PEM is transferred to exterior surfaces.

2.3.2 Mechanical Systems Responsibilities

Flight hardware development, fabrication and testing of the carbon composite structure, base plate, top frame, closeout plates, side panels, mounting bolts, Silicone elastomeric cords and damper frames and I&T GSE is the responsibility of IN2P3.

2.3.3 Thermal Systems Responsibilities

Analysis of the thermal conditions within the PEM to assure that the temperature of the structure and CDE are maintained within the design limits of the components is the responsibility of IN2P3.

3 MECHANICAL INTERFACES

3.1 Dimensions

3.1.1 CDE Dimensions

CDE dimensional requirements are specified in the CAL Flight CDE Specification, LAT-SS-01133. The dimensions contained in the specification are found below in Table 3-1. The relevant dimensions for the purpose of this ICD are the CDE Cap-to-Cap length, End Cap height, and End Cap width, and Total Chamfer distance. These dimensions allow for a minimum 0.1 mm clearance between the CDE and the structure cell walls. A drawing of the CDE End Cap is found in Figure 3-1.

Table 3-1 – CDE Dimensions

Parameter	Maximum Value (mm)	Minimum Value (mm)
Crystal Length	326.00	325.40
Bonding Thickness	0.80 (x2)	0.60 (x2)
DPD Carrier Thickness	1.96 (x2)	1.60 (x2)
DPD Pin Contact Length	2.00 (x2)	1.80 (x2)
CDE Total Length	**335.52**	**333.40**
CDE End Cap Thickness	2.8 (x2)	2.7 (x2)
CDE Cap-to-Cap Length (see note)	**331.60**	**330.80**
Crystal Height	19.90	19.50
Kapton Tape	0.002	0.002
Wrapping Thickness	0.13 (x3)	0.13 (x3)
CDE Total Height	**20.29**	**19.89**
CDE End Cap Height (see note)	**20.35**	**20.30**
Crystal Width	26.70	26.30
Wrapping Thickness	0.13 (x2)	0.13 (x2)
CDE Total Width	**26.83**	**26.43**
CDE End Cap Width (see note)	**27.20**	**27.15**
Distance between Opposing Chamfers	31.78	31.58
Wrapping Thickness	0.13 (x2)	0.13 (x2)
Total Chamfer Distance	**32.04**	**31.84**

Note: Also included in Table 3-1 are the dimensions for the molded end cap that is to be used to close out the wrapping of the CDE. Since the DPD Pin Contact length protrudes through the end cap, the use of the end cap does not affect the total length of the CDE. Even though the height and width of the End Cap are larger than the wrapped crystal, the CDE Total Height and Width values are the relevant dimensions for CDE Verification.

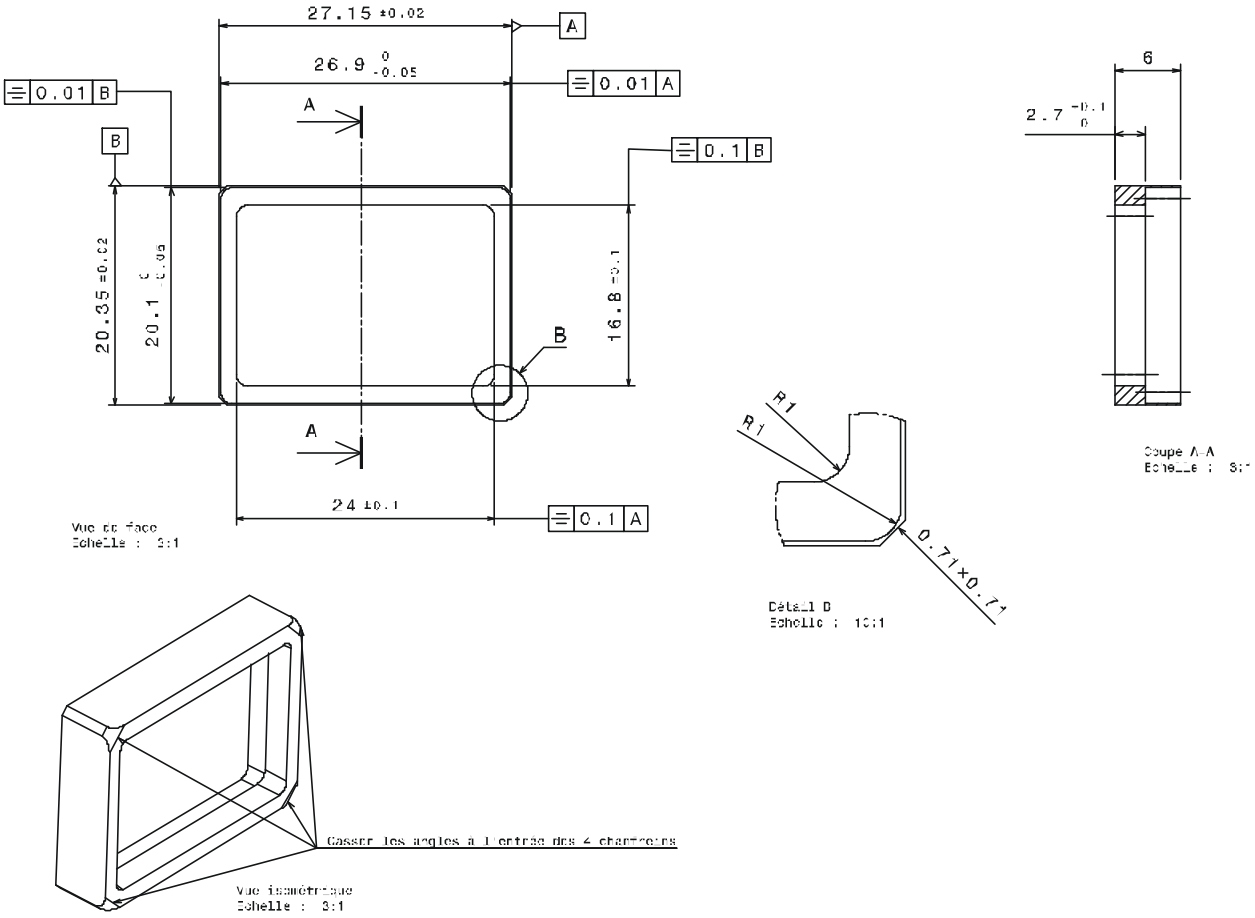

Figure 3-1 – CDE End Cap

3.1.2 Mounting Cell Dimensions

PEM Mounting Cell dimensional requirements are specified in the CAL Mechanical Structure Specification, LAT-SS-00241. The dimensions contained in the specification are found below in Table 3-2.

Table 3-2 – Mounting Cell Dimensions

Parameter	**Maximum Value (mm)**	**Minimum Value (mm)**
Composite Cell Length	338.00	337.60
Inner Close Out Plate Offset	0.55 (x2)	0.45 (x2)
Mounting Cell Length	**339.10**	**338.50**
Mounting Cell Height	**20.55**	**20.45**
Mounting Cell Width	**27.40**	**27.30**

3.2 Mounting Configuration

The mounting of the CDE into the CAL Structure uses a unique process in order to preclude the CDE from coming into contact with the CAL Structure. A CDE is inserted into the cell of the structure and then positioned and supported inside the cell by four Silicone elastomeric cords placed between the corners of the cell and the chamfers of the crystals. The longitudinal displacement of the logs is stopped by two Silicone elastomeric damper frames, which are placed between the ends of the CDEs and the closeout plates. Figure 3-2 details the silicone Bumper Frame.

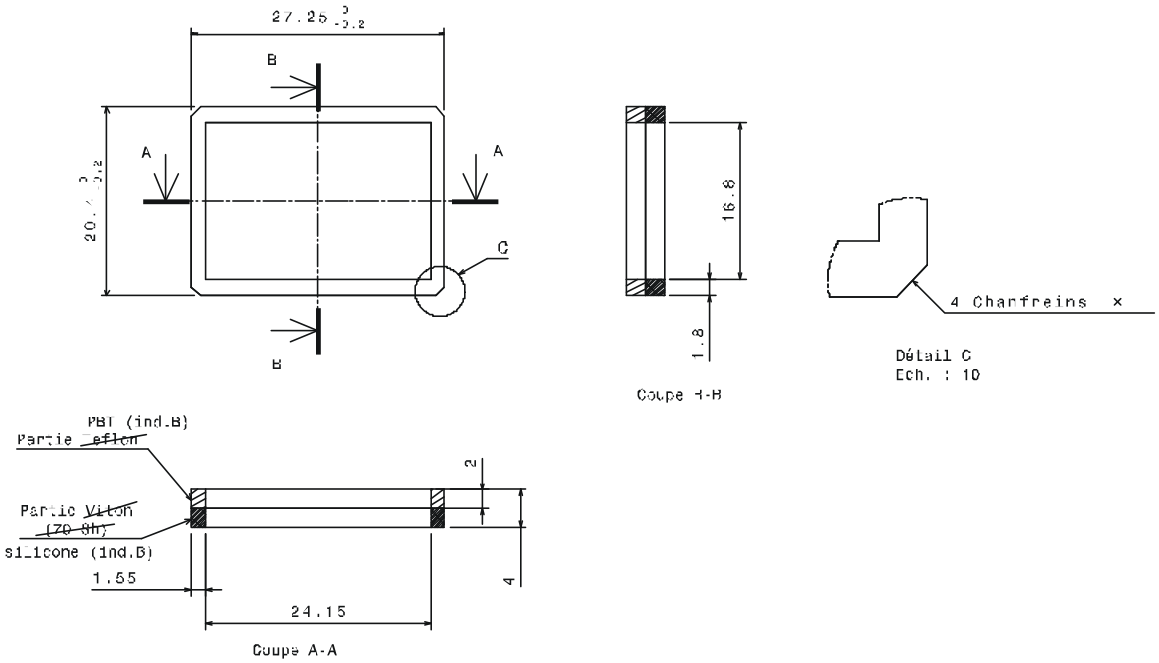

Figure 3-2 – Silicone Bumper Frame

Details of the insertion of CDEs into the PEM structure is found in the Pre-Electronics Module Assembly Procedure, LAT-PS-01225.

3.3 Mass Properties

3.3.1 CDE

The mass of a CDE as specified in the CAL Flight CDE Specification, LAT-SS-01133, is 0.7965 kg. The mass summary contained in the specification is found below in Table 3-3.

Table 3-3 – CDE Mass Summary

Component	Quantity	Unit Mass (kg)	Total Mass (kg)
CsI Crystal	1	0.7850	0.7850
Dual Photodiodes	2	0.0016	0.0032
Optical Bonds	2	0.0002	0.0004
Interconnect Wires	8	0.0002	0.0016
Staking	2	0.0008	0.0016
Optical Reflective Wrap	1	0.0033	0.0033
Molded End Caps	2	0.0014	0.0014
TOTAL			**0.7965**

3.3.2 PEM Mechanical Structure

The mass of the PEM Mechanical Structure does not exceed 9.5 kg (TBC). The position of the center of gravity of the structure is known within a precision of 5 mm (TBC). The first moment of inertia about the 3 axes of the structure is known within a precision of 10%. This data is for reference only, data is specified in document, LAT-SS-00241.

3.4 Alignment

The longitudinal position of the CDE within the structure shall be positioned to within 1 mm of center.

3.5 Handling Operations and Lift Points

CDEs must be handled in accordance with the Crystal and CDE Handling Procedure, LAT-SS-00809, so as to minimize the exposure to structural and mechanical load. CDEs must be supported in such a manner to maintain its integrity during handling. All ESD sensitive components should be transported in antistatic packaging.

3.6 Access

After integration of the CDE and attachment of the closeout plates there is no provision to access the CDE.

4 THERMAL INTERFACES

4.1 Design Responsibility

The CAL lead thermal engineer will be responsible for designing the thermal interface so that the temperature of the CAL Structure, CDEs and AFEE are within the operations range during all integration phases. In addition, the thermal engineer will monitor temperatures adequately during ground integration to assure that no temperature limits have been exceeded during all phases of the integration program.

4.2 Temperature Requirements

The temperature environment, which the module can be exposed to during integration, is in the range 20 to 25^{o}C (TBR).

4.3 Thermal Interface Requirements

The thermal design will preclude a temperature change greater than 5^{o} (TBR) per hour in the PIN photodiodes by conducting AFEE heat through the bottom plate of the CAL Structure.

5 INTEGRATION AND TEST INTERFACES

5.1 Integration Stay-Clears and Access Requirements

A restricted area that is maintained at the cleanliness requirements of the components will be secured for the integration process. This integration area will provide ESD protected benches and mats. Personnel must be trained in ESD and cleanliness practices prior to being given access to the integration area.

5.2 Ground Alignment Requirements

Unique fixtures will be used during the CDE insertion process that will maintain the alignment of the CDE. These items include TBD.

5.3 Environmental Control

The temperature environment of the integration area in which the CAL Structure and CDE are integrated must be in the range of 20 to 25°C (TBR). The humidity of the room will be maintained between 35% RH (TBR) and 50% RH (TBR). These requirements are defined in the LAT Contamination Control Plan, LAT-MD-00228.

5.4 Contamination Control

The integration environment will be free of dust at the level defined by ISO 7 norm. All personnel will wear dust free gloves when handling the components of the CAL module. The detailed requirements are defined in the LAT Contamination Control Plan, LAT-MD-00228.