Failure Mode Effect Analysis (FMEA) & Critical Items List (CIL) GLAST LAT Anti-Coincidence Detector (ACD) Report

Credit: Hytec

ACD-RPT-12001
Revision -

September 21, 2001

Goddard Space Flight Center
Greenbelt, Maryland

Check the Centralized Configuration Management System at xxxxxxxxx *to verify the latest version prior to use.*

Anti-Coincidence Detector FMEA & CIL for PDR
ACD-RPT-12001

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ACD FMEA &CIL Report
ACD-RPT-12001

REVISION PAGE

REVISION	DESCRIPTION	DATE	INITIALS
(Rev -)	Initial CM Release		

1.0 INTRODUCTION

1.1 Scope

This analysis provides an assessment for the proposed hardware configuration of the Anti-Coincidence Detector (ACD) which will be mounted over the Large Area Telescope (LAT) of GLAST.

The Failure Mode & Effect Analysis (FMEA) analysis provides a "buttoms-up" look at each ACD component in order to identify potential failures and their effects on a local, ACD, and overall LAT system level. Specific attention is given to identification of any Single Point Failures (SPFs) that could cause failure of the GLAST Mission, and to recommend corrective actions or methods to alleviate their occurrence.

This qualitative report will answer these questions as each component of the ACD is analyzed.

1. How can the component fail? (It might be possible there is more than mode of failure.)
2. What are the effects of the failure?
3. How critical are the effects?
4. How is the failure detected?
5. What are the safeguards against significant failures?

The Critical Items List (CIL) analysis provides a summary of selected hardware related items whose related failure modes can result in serious injury, loss of life (flight or ground personnel), loss of launch vehicle; or the loss of one or more mission objectives (when no redundancy exists) as defined by the GSFC project office. Specific criteria for hardware being included in the CIL are contained within this report.

This FMEA & CIL report is intended to be a living document that will be updated again, prior to CDR and possibly at other stages, to reflect changes that are being made throughout the development process.

1.2 DEFINITIONS, ACRONYMS AND ABBREVIATIONS

ACD: Anti-coincidence Detector

ADC: Analog-Digital Converter

ASIC: Application Specific Integrated Circuit

BEA: Base Electronics Assembly

Channel: A functional path between an ACD tile and the TEM.

FMEA: Failure Mode & Effect Analysis

MMS: Micrometeoroid Shield

PHA: Pulse Height Analysis

PMT: Photo Multiplier Tube

SPF: Single Point Failure

TEM: Transfer Electronics Module

TSA: Tile Shell Assembly

1.3 CONCLUSIONS AND RECOMMENDATIONS

No hardware items, with severity classifications of 2 or higher, have been identified that require placement on a Critical Items List (CIL). However, a few items (*2R Severity Classification*) have been identified where failure of redundant hardware could potentially result in the loss of one or more mission objectives as defined by the GSFC project office. A summary of these items is provided below in Table 1.3-1.

TABLE 1.4-1: CONCLUSION TABLE (2R SEVERITY CLASSIFICATION)

2R SEVERITY CLASSIFICATION – COMPONENT, FAILURE MODE AND MISSION EFFECT	FAILURE MODE ID.
Component – Scintillator Tile; **Failure Mode** – No light generation/ Outside light exposure; **Mission Effect –** Loss of DAQ Filtering Efficiency (when 2 or more tiles fail)	**5.01, 5.02**
Component – High Voltage P/S; **Failure Mode** – No power; **Mission Effect** – Loss of DAQ Filtering Efficiency (when active redundant P/S within the board pair fails)	**6.01**
Component – Digital ASIC; **Failure Mode –** No output; **Mission Effect –** Loss of DAQ Filtering Efficiency (when active redundant ASIC within the board pair fails)	**9.01**
Component – ACD_TEM Interface ASIC; **Failure Mode –** No output; **Mission Effect –** Loss of DAQ Filtering Efficiency (when active redundant ASIC within the board pair fails)	**10.01**
Component – ACD to TEM Connection; **Failure Mode –** No output; **Mission Effect –** Loss of DAQ Filtering Efficiency (when 2 of 2 connections for a board pair fails)	**11.01**
Component – Micrometeoroid Shield; **Failure Mode –** Light leakage in tile; **Mission Effect –** Loss of DAQ Filtering Efficiency (when 2 penetrations or tile failures occur)	**12.01**

It is recommended that additional focus be placed on these items as the development process continues.

2.0 FMEA AND CIL ANALYSIS METHODOLOGY

2.1 GENERAL

This functional FMEA and CIL Analysis is conducted in accordance with GSFC specification S-302-89-01, February 1990, "Procedures for Performing a Failure Mode and Effects Analysis (FMEA)" and GLAST LAT procedure LAT-MD-00039-1, "Performance Assurance Implementation Plan".

The specific process used to perform this analysis is provided below.

2.2 ASSUMPTIONS/ GROUND RULES

In order to perform the FMEA, the following assumptions/ ground rules are made:

- Failure modes will be assessed at the component interface level.
- Each failure mode will be assessed for the effect at that level of analysis, the next higher level and upward
- A failure mode will be assigned a severity category based on the most severe effect caused by a failure
- All mission phases (e.g. launch, deployment, on-orbit operation, and retrieval) will eventually be addressed as applicable. For PDR, however, the on-orbit mission phase is only addressed
- Redundancies will be analyzed to ensure that redundant paths are isolated or protected such that any single point failure that causes the loss of a functional path will not affect the other functional path(s) or the capability to switch operation to that redundant path.
- All failures with a severity classification of 2 or higher shall be placed on a Critical Item List (CIL)
- All inputs to the item being analyzed are present and at nominal values
- Temperatures are within specified limits
- Nominal power is available

2.3 MISSION SUCCESS CRITERIA

The mission success criteria section is broken out into three sub-sections: Mission Success Objectives, Reliability (Success Path) Block Diagrams and Allocations, and Refinement of Questions required for CDR. The criteria presented in this section are essential for making determinations regarding failure effects and severity classification definition.

2.3.1 MISSION SUCCESS OBJECTIVES

The mission success objectives, used for purposes of this FMEA report and analysis, are provided below in Table 2.3.1-1.

TABLE 2.3.1-1 ACD MISSION SUCCESS OBJECTIVES

OBJECTIVE	**REFERENCE PARAGRAPH**	**REFERENCE DOCUMENT**
Average detection frequency for minimum ionizing particles shall be at least 0.9997 over the entire area of the ACD	5.4	LAT ACD Subsystem Specification – Level III Specification (LAT-SS-00016-D7)
No single failure in the ACD electronics shall result in the loss of signal from more than one detector element	5.13	LAT ACD Subsystem Specification – Level III Specification (LAT-SS-00016-D7)
The loss of any one detector element (tile or ribbon) shall not result in the loss of any other detector element	5.14	LAT ACD Subsystem Specification – Level III Specification (LAT-SS-00016-D7)
The probability of the loss of both sets of veto signals from a scintillator shall be less than 1.0% (TBR). The probability of the loss of VETO signals from a scintillator ribbon shall be less than 1.0%/year (TBR).	5.15	LAT ACD Subsystem Specification – Level III Specification (LAT-SS-00016-D7)

2.3.2 RELIABILITY (SUCCESS PATH) BLOCK DIAGRAMS AND ALLOCATIONS

A top-level flow down of reliability allocations from the spacecraft to the LAT to the ACD, which was provided by SLAC, is provided below in Figure 2.3.2-1. A flow down of the 0.96 ACD Reliability Target to each of its major components, including the Base Electronics Assembly components, is provided below in Figure 2.3.2-2. Finally, a diagram showing the level of redundancy in each of the Base Electronic Assembly components is shown in Figure 2.3.2-3.

2.3.3 REMAINING QUESTIONS

In preparation for CDR, the ACD/LAT team will need to define the effect that channel (1 of 2 assigned to a particular tile) and scintillator ribbon losses have on the overall mission success objectives.

For this particular FMEA analysis, two or more tile failures are considered a loss of mission objectives. However, the extent to which degraded tile performance is allowed before mission objectives are considered lost has not been adequately defined.

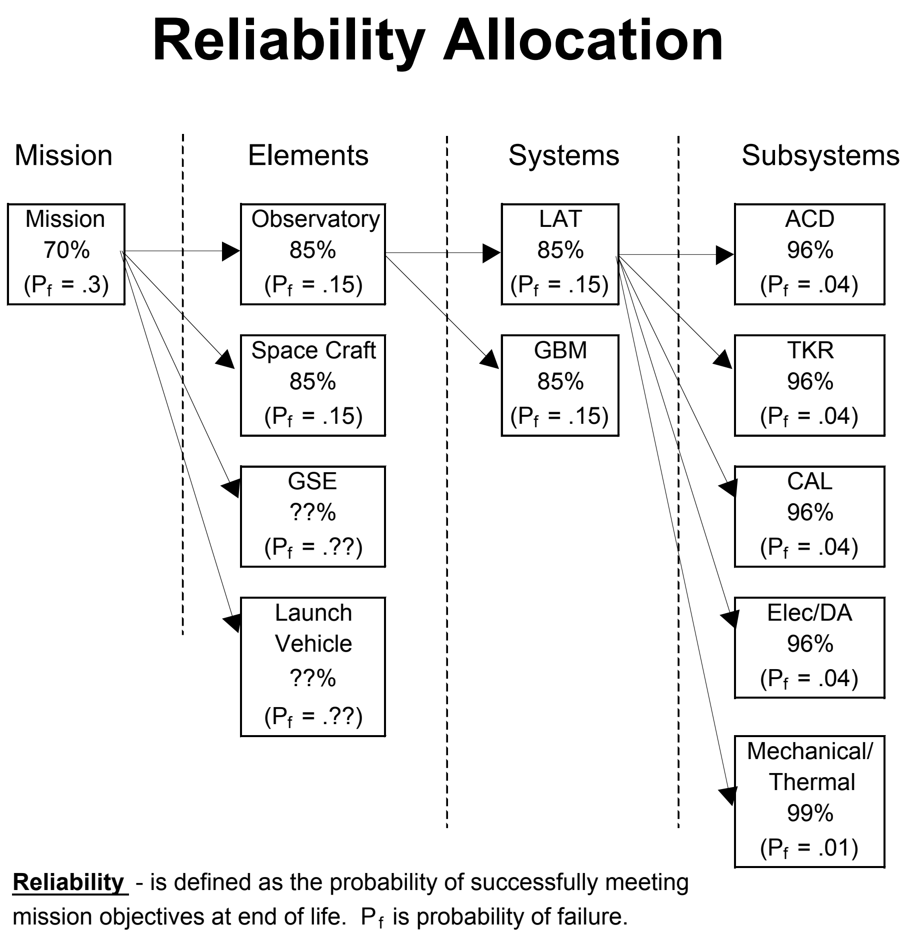

Figure 2.3.2-1 SLAC GLAST Reliability Allocation Flow Down

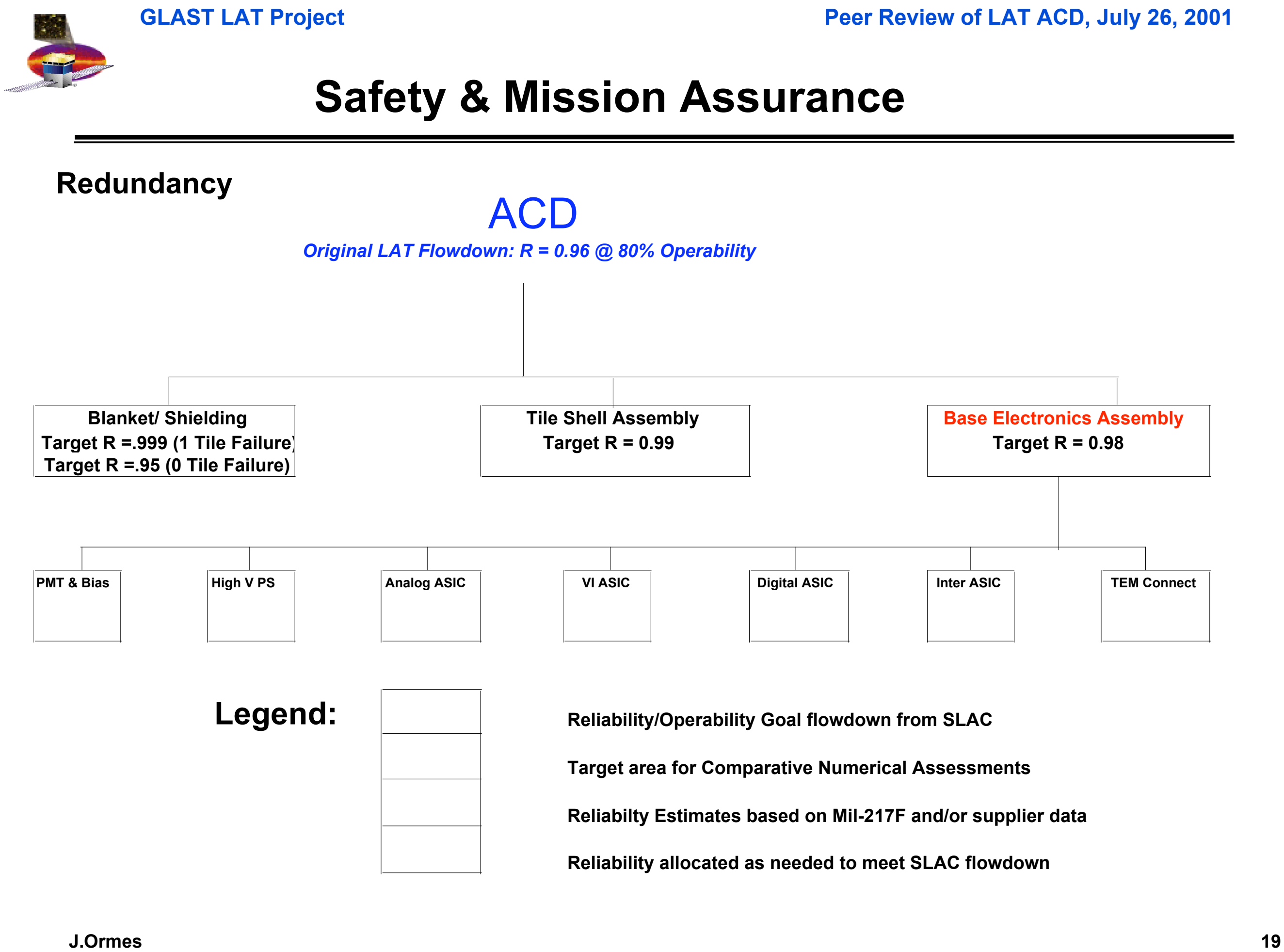

Figure 2.3.2-2 ACD Reliability Allocation Flow Down

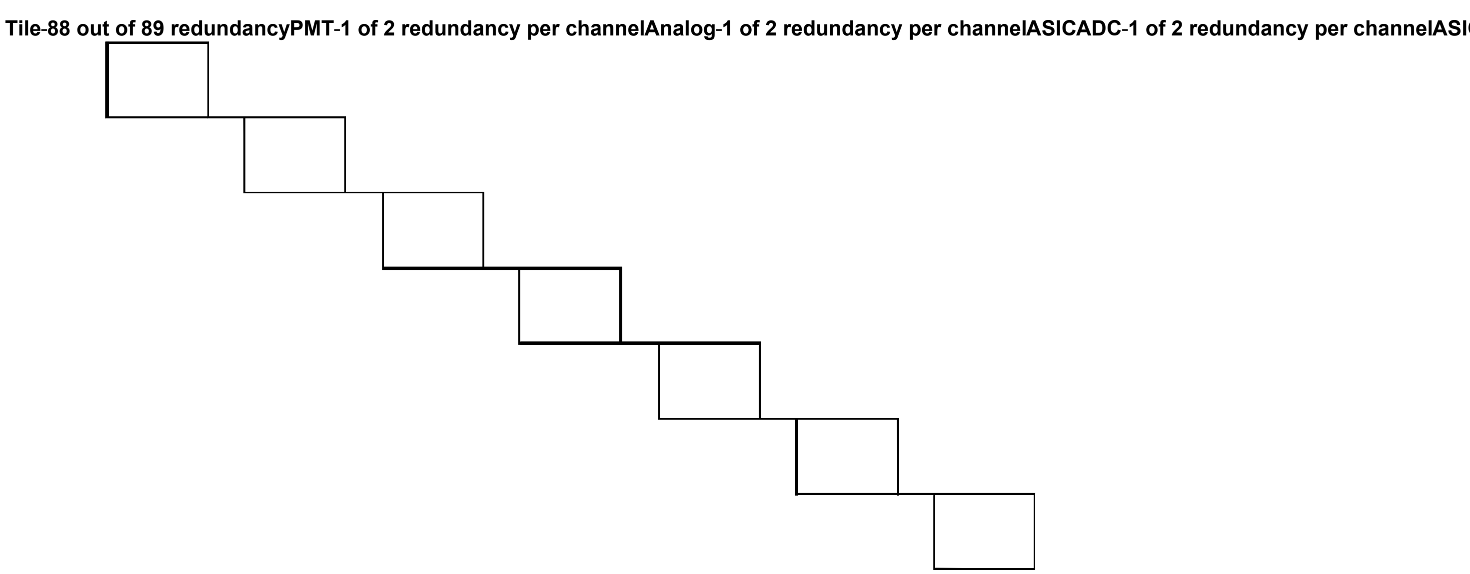

Figure 2.3.2-3 ACD Channel Redundancy Configuration

2.4 FMEA WORKSHEETS

An example of the worksheet is depicted in Figure 2.4-1. The categories addressed in the worksheet, and the process for analyzing, are as follows:

- ***Failure Mode Reference Number* –** The failure mode reference number is a unique identifying number assigned to each component of the system being analyzed
- ***Component* –** The name of the component under analysis
- ***Function* –** The function of the component being analyzed
- ***Operational Mode* –** The FMEA is conducted for the following GLAST space flight missions:
  - **All Scan Sky** – Science collection from the entire, detectable, universe in order to establish a baseline of cosmic and Gamma Ray sources
  - **Pointed mode** – Science collected from specific areas/regions in the universe where particular information is sought
- ***Failure Mode & Cause* –** Potential failure modes, for each function, are determined by examination of the functional outputs contained on the system functional block diagram. A buttoms-up approach is used where by analysis begins at the component level, followed by analysis of subsequent or higher system levels
- ***Failure Effects* –** The consequences of each postulated failure mode is identified, evaluated, and recorded on the FMEA worksheets. Most failures not only affect the function under analysis, but also impact higher indenture levels. Therefore, "Local", "Next Higher", and "End Item or Mission" levels are also examined. The "Local" effect addresses the consequences a failure mode has on the component's ability to perform properly. The "Next Higher" level effect examines the impact of the failure mode on the performance of the next higher assembly. The "Mission" effect addresses the impact relative to predefined mission success criteria
- ***Severity Classification* –** Using the definitions provided in section 2.5, the effects of each component failure mode are analyzed and the appropriate classification is assigned. Mission success criteria and redundancy schemes must be included as part of this analysis
- ***Detections/ Redundancy Screens/ Compensating Provisions* –** Provisions such as redundancy, workarounds, etc
- ***Remarks/ Actions* –** Pertinent comments, references, or actions

TABLE X.X-1: FAILURE MODES AND EFFECTS ANALYSIS

MISSION: **DATE:**

SYSTEM: **SUBSYSTEM:**

PERFORMED BY:

REFERENCE NUMBER	COMPONENT	FUNCTION	OPERATIONAL MODE	FAILURE MODE AND FAILURE CAUSE	FAILURE EFFECTS	SEVERITY CLASS	DETECTIONS AND COMPENSATING PROVISIONS	REMARKS/ ACTIONS
0.00				Failure Mode: Failure Cause:	Local Effect: Subsystem Level Effect: Mission Level Effect:		Detections/ Redundancy Screens Compensating Provisions	
0.00				Failure Mode: Failure Cause:	Local Effect: Subsystem Level Effect: Mission Level Effect:		Detections/ Redundancy Screens Compensating Provisions	

Figure 2.4-1 A Failure Modes & Effects Analysis Worksheet

2.5 SEVERITY CLASSIFICATION DEFINITIONS

The following section presents definitions for the various Severity Classifications:

- ***Category 1*** – Catastrophic failure modes that could result in serious injury, loss of life (flight or ground personnel), or loss of launch vehicle
- ***Category 1R*** – Failure modes of identical or equivalent redundant hardware items that, if all failed could result in category 1 effects
- ***Category 1S*** – Failure in a safety or hazard monitoring system that could cause the system to fail to detect a hazardous condition to fail to operate during such condition and lead to Severity Category 1 consequences
- ***Category 2*** – Critical failure modes that could result in loss of one or more mission objectives as defined by the GSFC project office
- ***Category 2R*** – Failure modes of identical or equivalent redundant hardware items that could result in Category 2 effects if all failed
- ***Category 3*** – Significant failure modes that could cause degradation to mission objectives
- ***Category 4*** – Minor failure modes that could result in insignificant or no loss to mission objectives

3.0 FUNCTIONAL DESCRIPTION OF THE ACD

3.1 GENERAL

The ACD is part of the LAT science instrument, and is the LAT's first line of defense against the enormous charged particle background from cosmic ray primary and Earth albedo secondary electrons and nuclei.

The ACD detects energetic cosmic ray electrons and nuclei for the purpose of removing these backgrounds. It is the principle source for detection of other than gamma-ray particles. This detector element can be thought of a cap that covers the LAT Tracker towers.

The ACD is made up of three primary functional elements: tiles, electronics, and Tower Electronics Module (TEM) interface. The tiles consist of an array of 89 plastic scintillator tiles (1 cm thick, various sizes), plus 12-16 scintillating fiber "ribbons" that cover the gaps between the tiles.

A top-level functional block diagram for the ACD is shown in figure 3.1-1.

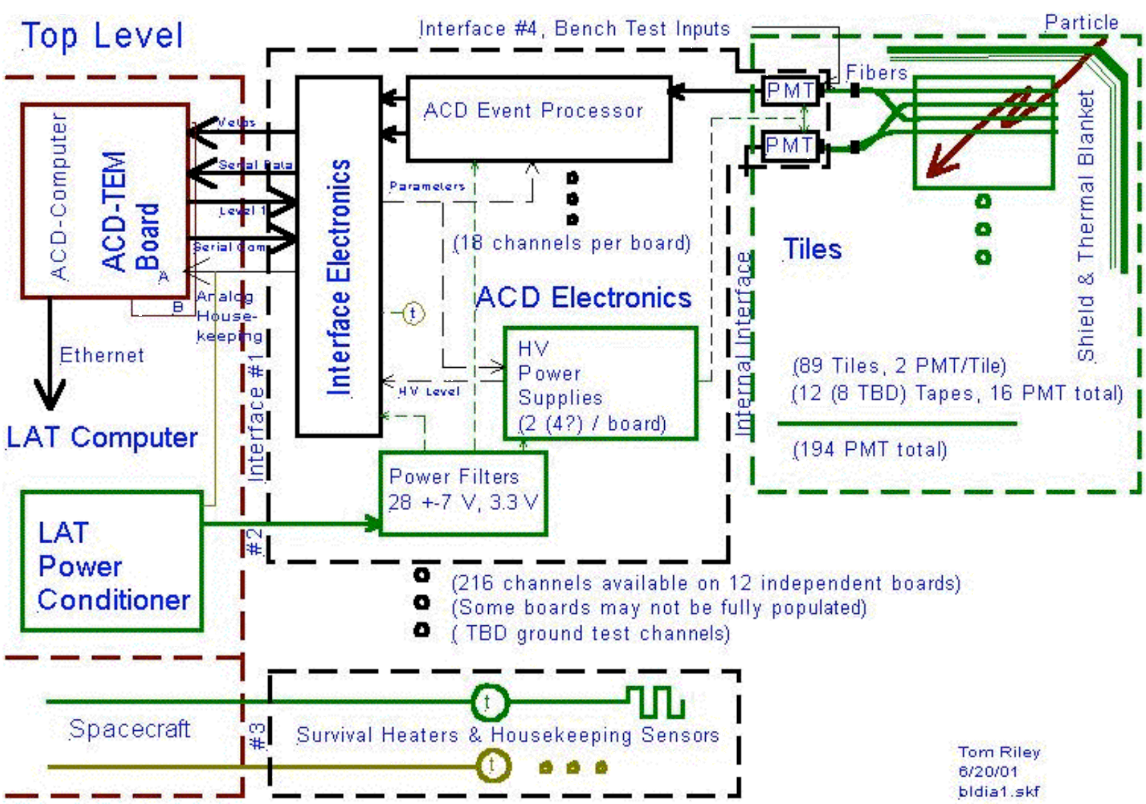

Figure 3.1-1 ACD Functional Block Diagram

3.2 TILES / MICROMETEROID SHIELD (MMS)

The Tiles/Micrometeoroid Shield section is shown in more detail in Figure 3.2-1, GLAST ACD Electronic Functional Block Diagram, Level 2, Tiles. Most of the scientific requirements placed on the ACD instrument fall on the design of the tiles. These requirements are subsequently passed on to the ACD Electronics Boards through the internal Interface.

The tiles are covered with a micrometeoroid shield and thermal blanket. This protects them from orbital debris damage and stabilizes the internal temperature.

The tiles scintillate when a subatomic particle passes through them, but not when a gamma ray does the same. This allows particle events to be discarded, or vetoed, from the science readings.

The photons from the tiles are picked up by wave shifting fibers that convert them to a wavelength most suitable to the PMT. Long fibers are joined to clear fibers to reduce loses. An event important to science may consist of only a few photons.

The fibers are grouped at the face of the PMT. The PMT has a high voltage supply and dynode string. The high voltage may be adjusted for groups of 18 PMTs to compensate for differences in tube gain and aging, but only as a group.

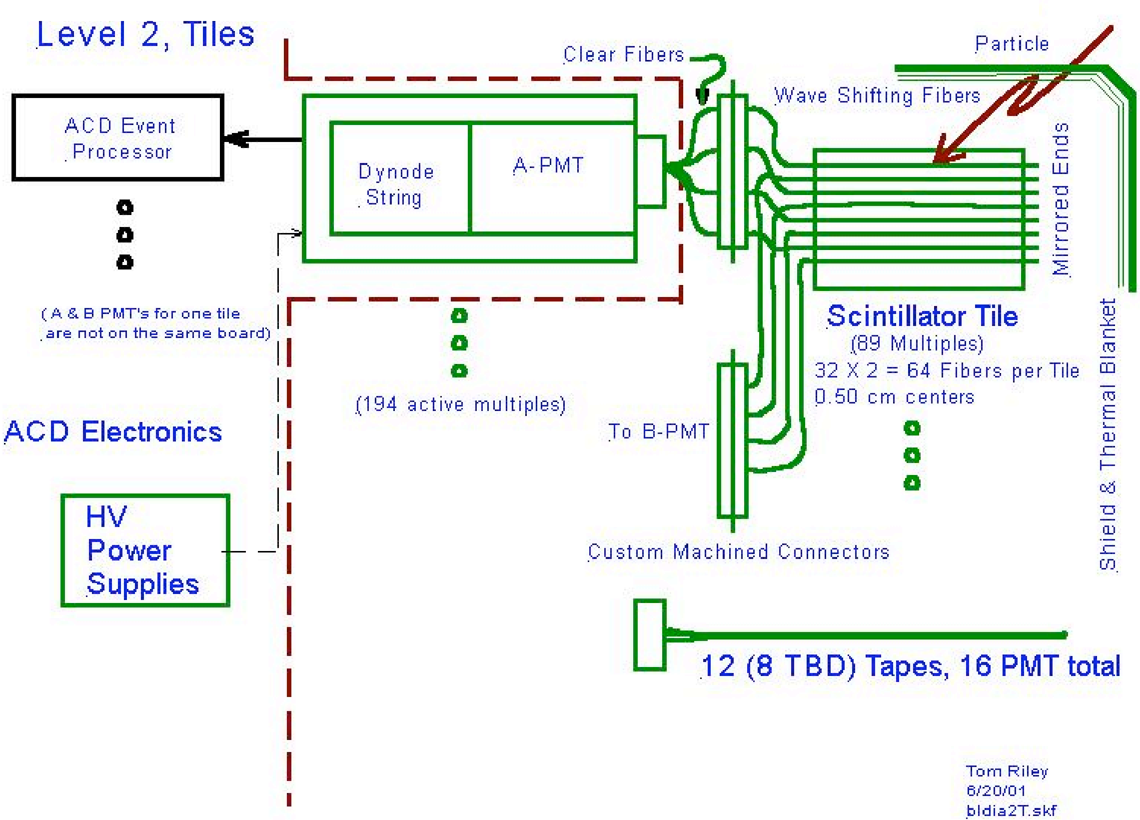

Figure 3.2-1 ACD Tile Electronic Functional Block Diagram

3.3 ACD ELECTRONIC'S SECTION (BASE ELECTONICS ASSEMBLY)

The ACD Event Processor circuit, by way of receiving a PMT signal, measures event intensity and can detect if a particle event occurred by comparing pulse height levels to thresholds. The gain of the circuit and levels may be adjusted in flight in order to compensate for signal variation/degradation over time. The ACD Electronics section is shown in more detail in Figure 3.3-1. A functional block diagram for the ACD Event Processor board is shown in Figure 3.3-2.

Each ACD Event Processor board, mounting 18 PMTs (generally assigned to 18 distinct tiles), contains one High Voltage (HV) power supply that supports all 18 PMT electronic channels. Each board is paired with an identical partner in order to provide a single level of active channel electronics redundancy; while paired boards working simultaneously provide for higher quality signaling and increased processing efficiency. The HV may be commanded off, to a low level for passage through the SAA, and to any level in the effective high voltage range of the PMT. Power to the board is filtered. The HV power supplies run off 28 volts. All other electronics run off 3.3 volts.

There are a total of 12 Event Processor boards distributed around the bass of the ACD, but not all boards need be fully populated.

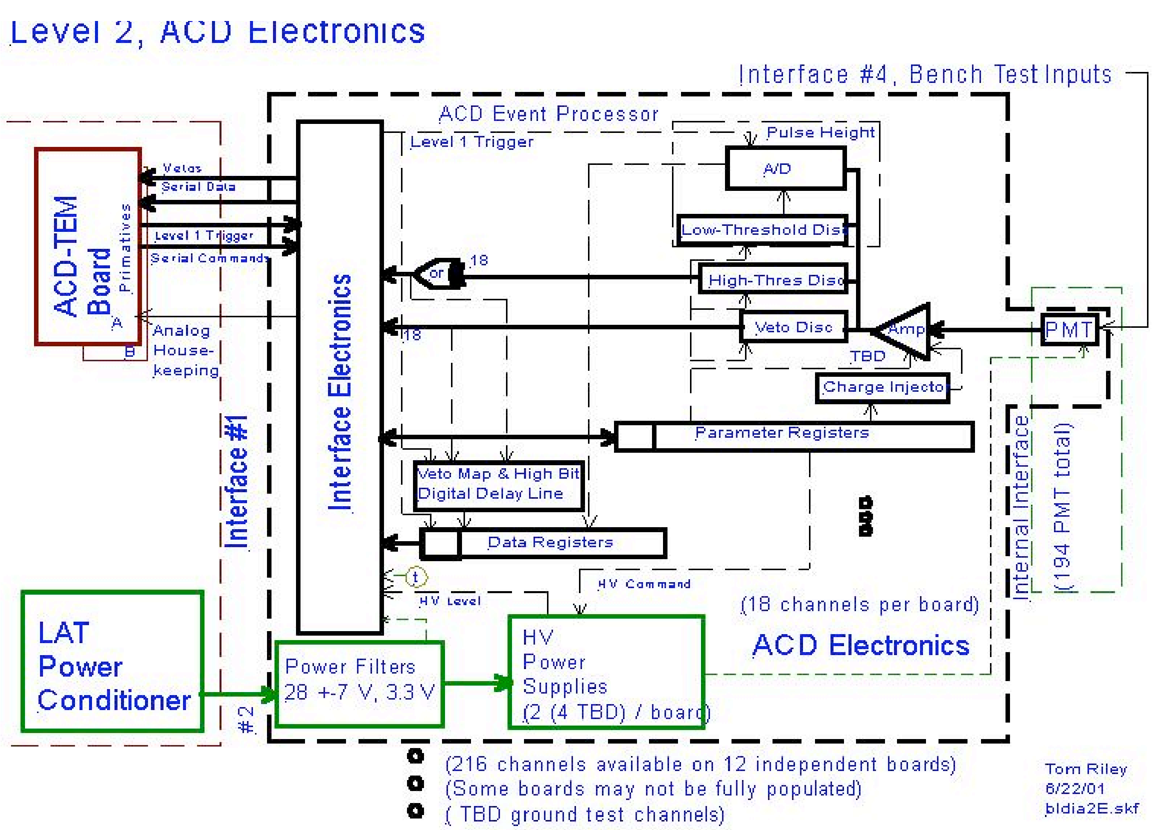

Figure 3.3-1 ACD Electronics Section

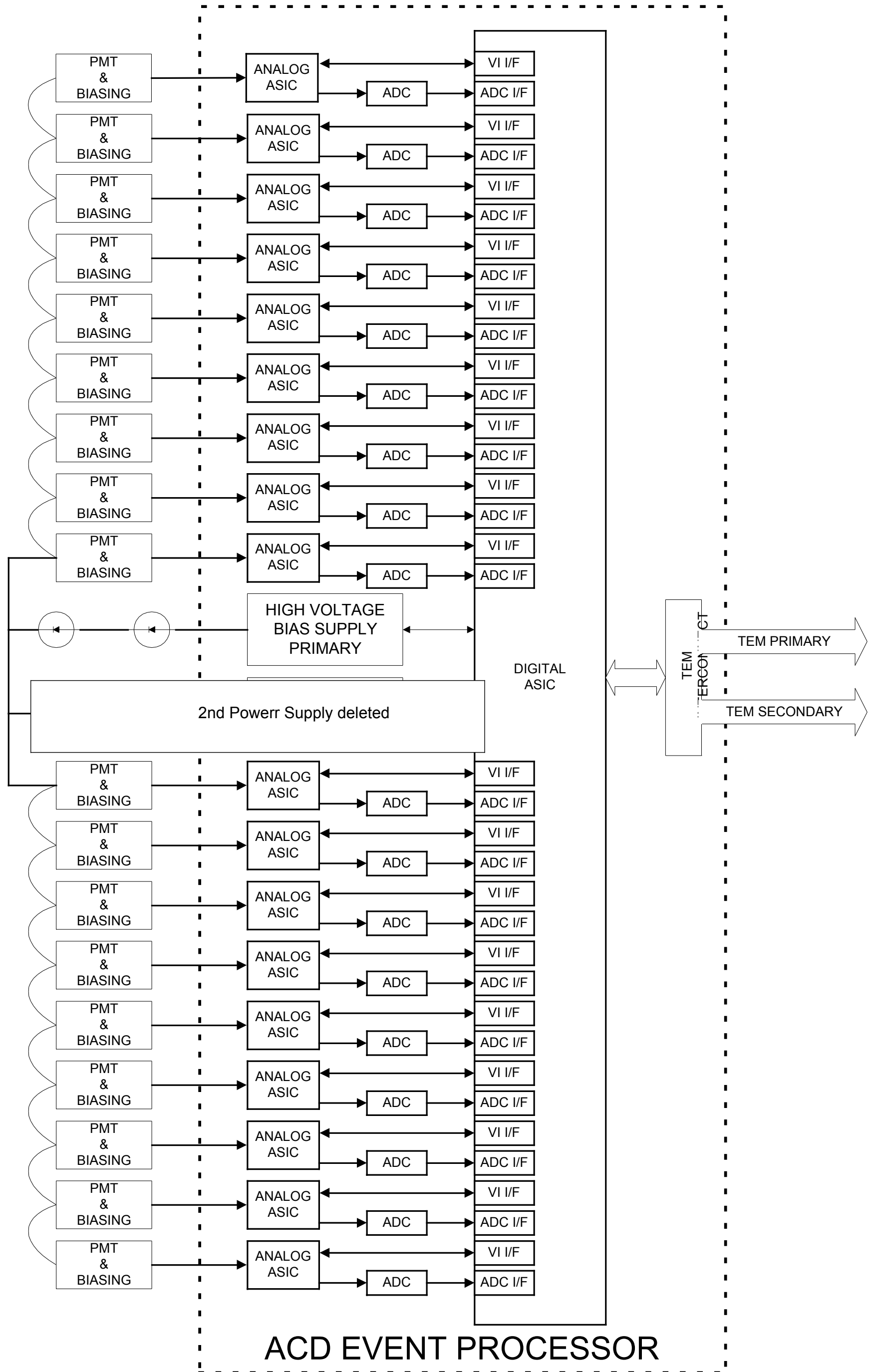

Figure 3.3-2 ACD Event Processor Board Functional Block Diagram

3.4 COMPUTER INTERFACE

Figure 3.4-1 shows the interface between the ACS Electronics board and the ACD-Computer ACD-TEM Board. All data interfaces between the ACD and GLAST go through this interface. The ACD-Computer is provided by SLAC and is a generic design used for all of the instruments on the spacecraft. The B ACD-TEM board is a cold backup but has a full set of cables. All data lines are high speed, low power current loops running on a pair of copper wires.

When any tile connected to a board detects an event, a signal on the corresponding Veto line is quickly sent. If any event on the board exceeds the high threshold, the adjacent (OR) line is also triggered.

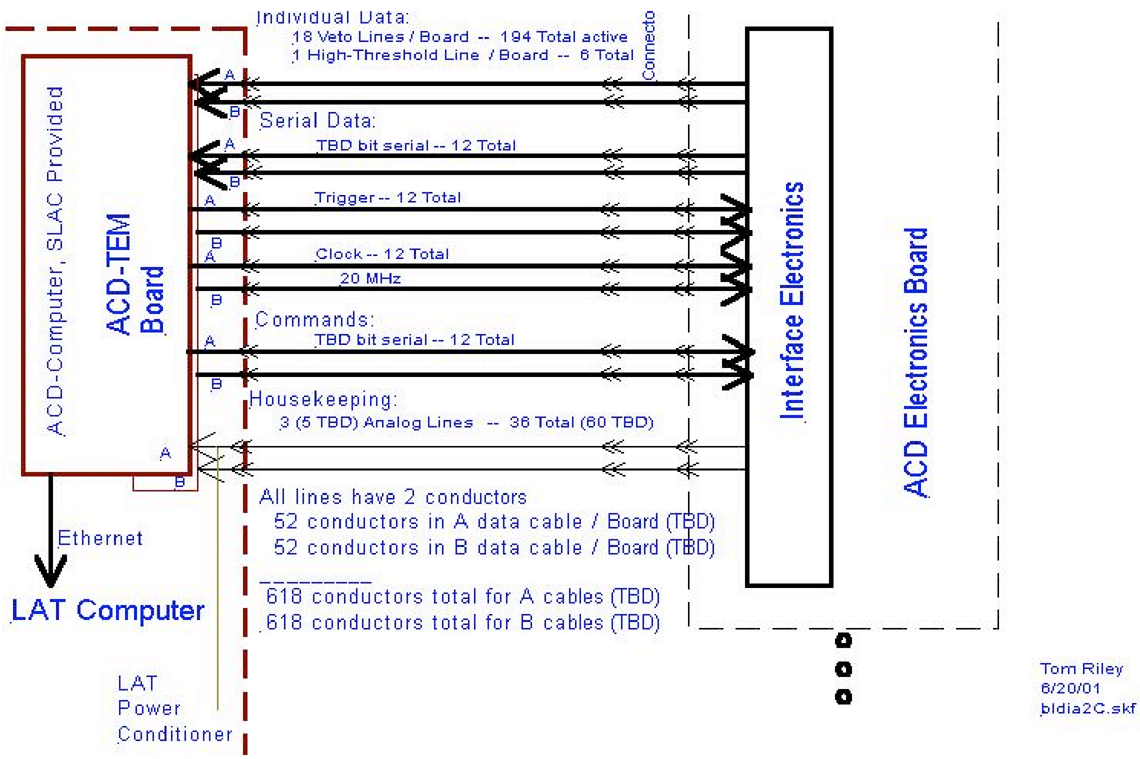

Figure 3.4-1 ACD Computer Interface

3.5 MECHANICAL SYSTEM (TILE SHELL ASSEMBLY)

An illustration of the ACD Mechanical System is shown in Figure 3.5-1. The ACD is mechanically mounted only to the instrument base plane. The ACD does not touch the other instruments, nor does it touch the launch vehicle fairing.

The active part of the instrument is completely covered with tiles. The tiles are supported by a composite grid structure. Each tile is wrapped and the few gaps are covered with scintillator ribbons and kapton tape.

The electronics boards are mounted on the ACD around the base of the instrument.

All heat from the ACD radiates through the base of the instrument.

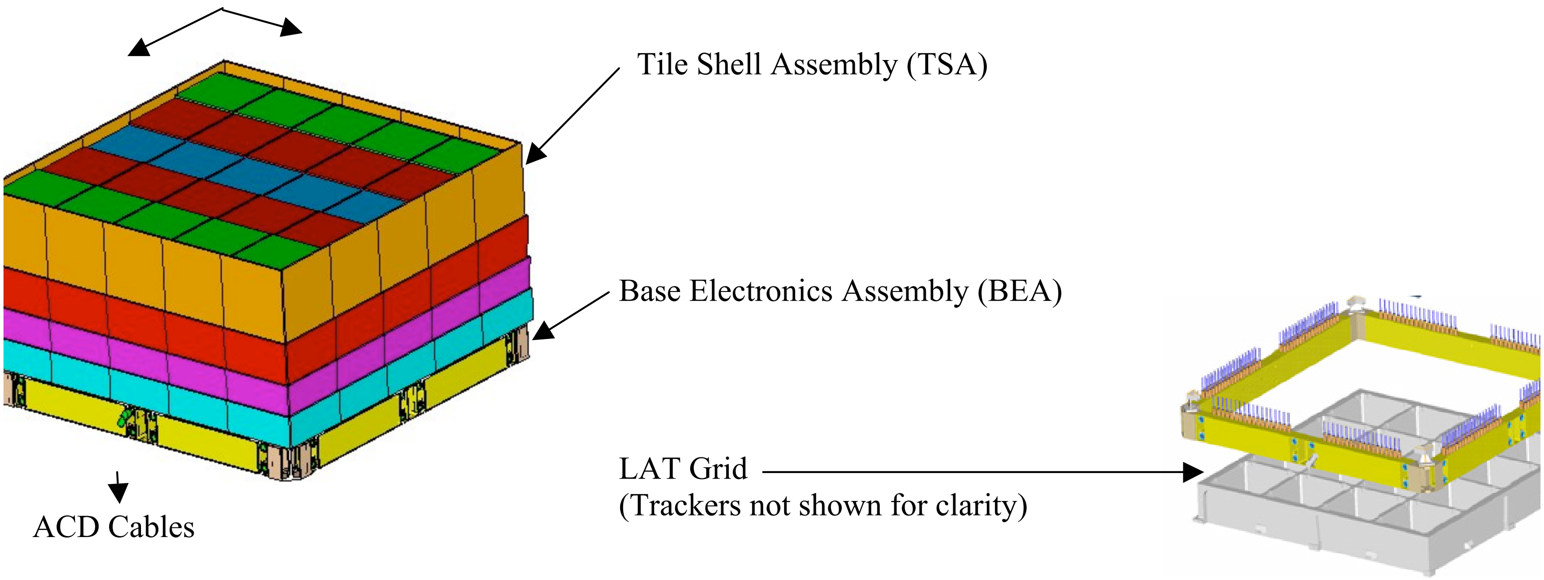

Figure 3.5-1 ACD Mechanical System

4.0 ACD FMEA ANALYSIS - PDR

4.1 GENERAL

The ACD FMEA Analysis, performed to date in preparation for PDR, are provided in Table 4.1-1 below.

TABLE 4.4-1 FAILURE MODES AND EFFECTS ANALYSIS

MISSION: Space Flight **DATE:** 8/27/01

SYSTEM: Glast **SUBSYSTEM:** ACD

PERFORMED BY: T. DiVenti

REFERENCE NUMBER	COMPONENT	FUNCTION	OPERATIONAL MODE	FAILURE MODE AND FAILURE CAUSE	FAILURE EFFECTS	SEVERITY CLASS	DETECTIONS AND COMPENSATING PROVISIONS	REMARKS/ ACTIONS
1.01	PMT	Translates light energy from the optical fibers into an associated current.	All Sky Scan; Pointed Mode	Failure Mode: Gain degradation Failure Cause: Degradation is inherent over time	Local Effect: Current signal degradation Subsystem Level Effect: Slight sensitivity reduction to Cosmic Ray detection Mission Level Effect: None	4	Detections/ Redundancy Screens Compensating Provisions 1) Raise voltage or lower Cosmic Ray detection thresholds; 2) Provide adequate PMT burn-in screening and selection	
1.02	PMT	Translates light energy from the optical fibers into an associated current.	All Sky Scan; Pointed Mode	Failure Mode: No output Failure Cause: Cracked/damage PMT or Power Supply connection	Local Effect: No current signal Subsystem Level Effect: 1) Efficiency loss from 0.9997 to 0.997 for one tile (if 1 PMT fails); 2) Loss of tile function (if 2 corresponding PMTs fail) Mission Level Effect: Some loss of DAQ filtering efficiency (if 2 corresponding PMTs fail)	3	Detections/ Redundancy Screens 2 PMTs per tile Compensating Provisions LAT level software	

MISSION: Space Flight **DATE:** 8/27/01

SYSTEM: Glast **SUBSYSTEM:** ACD

PERFORMED BY: T. DiVenti

REFERENCE NUMBER	COMPONENT	FUNCTION	OPERATIONAL MODE	FAILURE MODE AND FAILURE CAUSE	FAILURE EFFECTS	SEVERITY CLASS	DETECTIONS AND COMPENSATING PROVISIONS	REMARKS/ ACTIONS
2.01	Optical Fiber	Transport light energy from the Scintillator-Optical fiber coupling to the PMT	All Sky Scan; Pointed Mode	Failure Mode: Signal loss Failure Cause: Damaged or disconnected cable	Local Effect: Current signal degradation Subsystem Level Effect: Slight sensitivity reduction to Cosmic Ray detection Mission Level Effect: None	4	Detections/ Redundancy Screens 32 fibers per PMT Compensating Provisions None	
3.01	Scintillator Fiber	Transport light energy from the scintillator tile to the fiber coupling	All Sky Scan; Pointed Mode	Failure Mode: Signal loss Failure Cause: Damaged or disconnected cable	Local Effect: Current signal degradation Subsystem Level Effect: Slight sensitivity reduction to Cosmic Ray detection Mission Level Effect: None	4	Detections/ Redundancy Screens 64 fibers per tile Compensating Provisions None	

MISSION: Space Flight | **DATE:** 8/27/01

SYSTEM: Glast | **SUBSYSTEM:** ACD

PERFORMED BY: T. DiVenti

REFERENCE NUMBER	COMPONENT	FUNCTION	OPERATIONAL MODE	FAILURE MODE AND FAILURE CAUSE	FAILURE EFFECTS	SEVERITY CLASS	DETECTIONS AND COMPENSATING PROVISIONS	REMARKS/ ACTIONS
4.01	Fiber Coupling	Transfer light energy from the scintillator fibers to the optical fibers	All Sky Scan; Pointed Mode	Failure Mode: No transfer Failure Cause: Damaged or disconnected cable	Local Effect: No current signal Subsystem Level Effect: 1) Efficiency loss from 0.9997 to 0.997 for 1 tile (when 1 coupling fails); 2) Loss of tile function (when 2 corresponding couplings fail) Mission Level Effect: Some loss of DAQ filtering efficiency (when 2 corresponding couplings fail)	3	Detections/ Redundancy Screens 2 couplings per tile Compensating Provisions LAT level software	
5.01	Scintillator Tile	Detect charged particles via scintillator light	All Sky Scan; Pointed Mode	Failure Mode: No light generation Failure Cause: Cracked/Corroded tile	Local Effect: Inability to distinguish between Gamma and Cosmis rays Subsystem Level Effect: Loss of tile function Mission Level Effect: 1) Some loss of DAQ filtering efficiency; 2) Failure to complete mission objectives due to loss of DAQ efficiency (2 tiles fail)	2R	Detections/ Redundancy Screens 88 out of 89 tile redundancy Compensating Provisions LAT Level Software	

MISSION: Space Flight **DATE:** 8/27/01

SYSTEM: Glast **SUBSYSTEM:** ACD

PERFORMED BY: T. DiVenti

REFERENCE NUMBER	COMPONENT	FUNCTION	OPERATIONAL MODE	FAILURE MODE AND FAILURE CAUSE	FAILURE EFFECTS	SEVERITY CLASS	DETECTIONS AND COMPENSATING PROVISIONS	REMARKS/ ACTIONS
5.02	Scintillator Tile	Detect charged particles via scintillator light	All Sky Scan; Pointed Mode	Failure Mode: Outside light exposure Failure Cause: Penetration of light-tight wrap	Local Effect: Inability to distinguish between Gamma and Cosmic rays or due to constant noise (i.e. light) Subsystem Level Effect: Loss of tile function Mission Level Effect: 1) Some loss of DAQ filtering efficiency (when 1 tile fails); 2) Failure to complete some mission objectives due to loss of DAQ filtering efficiency (when 2 tiles fail)	2R	Detections/ Redundancy Screens 88 out of 89 tile redundancy Compensating Provisions LAT Level Software	
6.01	High Voltage P/S	Activate 18 PMTs	All Sky Scan; Pointed Mode	Failure Mode: No power Failure Cause: Loss of 18 PMTs	Local Effect: No power signal Subsystem Level Effect: 1) Efficiency loss from 0.9997 to 0.997 for 18 tiles (when P/S fails); 2) Loss of 18 functioning tiles (when 1 active redundant P/S fails) Mission Level Effect: 1) Some loss of DAQ filtering efficiency 2) Failure to complete some mission objectives due to loss of DAQ filtering efficiency (when 1 active redundant P/S fails)	2R	Detections/ Redundancy Screens Stand-by redundant P/S for each PMT; Active redundant P/S for Tile PMT pair Compensating Provisions None	

MISSION:	**Space Flight**	**DATE:**	**8/27/01**
SYSTEM:	**Glast**	**SUBSYSTEM:**	**ACD**
PERFORMED BY:	**T. DiVenti**		

REFERENCE NUMBER	COMPONENT	FUNCTION	OPERATIONAL MODE	FAILURE MODE AND FAILURE CAUSE	FAILURE EFFECTS	SEVERITY CLASS	DETECTIONS AND COMPENSATING PROVISIONS	REMARKS/ ACTIONS
7.01	Analog ASIC	Processesthe PMT analog current signal into the appropriate digital signal	All Sky Scan; Pointed Mode	Failure Mode: Erroneous or no output Failure Cause: Loss of power signal or internal ASIC failure	Local Effect: No signal transfer between the Analog & ADC ASICs Subsystem Level Effect: Loss of a board channel Mission Level Effect: None	4	Detections/ Redundancy Screens Compensating Provisions Lower Cosmic Ray detection threshold for the redundant PMT	
8.01	ADC ASIC	Controls translation of analog information into the appropriate digital signals	All Sky Scan; Pointed Mode	Failure Mode: Erroneous or no output Failure Cause: Loss of power signal or internala ASIC failure	Local Effect: No Pulse Heigth Analysis (PHA) of the analog signal Subsystem Level Effect: Loss of a board channel Mission Level Effect: None	4	Detections/ Redundancy Screens Compensating Provisions Lower Cosmic ray detection threshold for the redundant PMTs	

MISSION: **Space Flight** **DATE:** **8/27/01**

SYSTEM: **Glast** **SUBSYSTEM:** **ACD**

PERFORMED BY: **T. DiVenti**

REFERENCE NUMBER	COMPONENT	FUNCTION	OPERATIONAL MODE	FAILURE MODE AND FAILURE CAUSE	FAILURE EFFECTS	SEVERITY CLASS	DETECTIONS AND COMPENSATING PROVISIONS	REMARKS/ ACTIONS
9.01	Digital ASIC	Takes information from the ADC ASICs and sends the appropriate signals to the TEM interconnect	All Sky Scan; Pointed Mode	Failure Mode: No output Failure Cause: Loss of power signal or internal ASIC failure	Local Effect: No digital signal transfer to the TEM Interconnect Subsystem Level Effect: Loss of 18 board channels Mission Level Effect: 1) Some loss of DAQ filtering efficiency (when 1 of 2 ASICs in a board pair fail); 2) Failure to complete some mission objectives due to loss of DAQ filtering efficiency (when digital 2 of 2 ASICs fail within a board pair)	2R	Detections/ Redundancy Screens 2 redundant Digital ASICs for 18 channels within a board pair (but no redundancy on a given board) Compensating Provisions	
10.01	ACD-TEM Interface ASIC (now resides in the Digital ASIC)	Signal Interface between each Event Processor Board & the ACD Computer	All Sky Scan; Pointed Mode	Failure Mode: No output Failure Cause: No power signal/ internally damaged ASIC	Local Effect: No signal transfer to the TEM Subsystem Level Effect: Loss of all 18 board channels Mission Level Effect: 1) Some loss of DAQ filtering efficiency (when 1 of 2 ASICs in a board pair fail); 2) Failure to complete some mission objectives due to loss of DAQ filtering efficiency (when digital 2 of 2 ASICs fail within a board pair)	2R	Detections/ Redundancy Screens 2 redundant ACD-TEM Interface ASICs for 18 channels within a board pair (but no redundancy on a single board) Compensating Provisions	

MISSION: Space Flight **DATE:** 9/20/01

SYSTEM: Glast **SUBSYSTEM:** ACD

PERFORMED BY: T. DiVenti

REFERENCE NUMBER	COMPONENT	FUNCTION	OPERATIONAL MODE	FAILURE MODE AND FAILURE CAUSE	FAILURE EFFECTS	SEVERITY CLASS	DETECTIONS AND COMPENSATING PROVISIONS	REMARKS/ ACTIONS
11.01	ACD to TEM Connection	Provide Event Processor Board information to the Tower Electronics Module	All Sky Scan; Pointed Mode	Failure Mode: No output Failure Cause: Damaged/disconnected cables or connectors	Local Effect: No information transfer to the TEM Subsystem Level Effect: Loss of all 18 board channels Mission Level Effect: 1) Some loss of DAQ filtering efficiency (when 1 of 2 connections in a board pair fail); 2) Failure to complete some mission objectives due to loss of DAQ filtering efficiency (when 2 of 2 connections for a board pair fail)	2R	Detections/ Redundancy Screens 2 redundant connections for 18 channels within a board pair. Compensating Provisions	
12.01	Micrometeoroid Shield (MMS)	Protects the ACD from orbital debris	All Sky Scan, Pointed Mode	Failure Mode: Light leakage in tile Failure Cause: Penetration (hole) in tile	Local Effect: Inability to distinguish between Gamma and Cosmic rays or due to constant noise (i.e. light) Subsystem Level Effect: Loss of tile function Mission Level Effect: 1) Some loss of DAQ filtering efficiency (when 1 tile fails); 2) Failure to complete some mission objectives due to loss of DAQ filtering efficiency (when 2 penetrations occur/ tiles fail)	2R	Detections/ Redundancy Screens 1 penetration or tile failure allowed. Compensating Provisions LAT Level Software	