	Document # **LAT-SS-00016-R3**	Date Effective 08/24/03
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GLAST LAT SUBSYSTEM SPECIFICATION	Subsystem/Office ACD Subsystem	
Document Title **LAT ACD Subsystem Specification - Level III Specification**		

Gamma-ray Large Area Space Telescope

(GLAST)

Large Area Telescope (LAT)

Anticoincidence Detector (ACD)

Subsystem Specification/Requirements

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes	DCN #
1	1/4/02	Initial Release	LAT-XR-406.1
2	2/08/02	Eliminated pure text section of reqs and put all info in table only. Added links to level 2 reqs, corrected old info, clarified confusions. Added trigger width and delay changes initially proposed by LAT.	LAT-XR-774.1
3	3/07/03	A Collection of accumulated changes over last 12 months • Updated System description, definitions, acronyms etc • 5.11.5 Changed ±250 TBD to ~200 in 5.11.5 • 5.6 Mean Thickness - changed req from 'having a mean thickness less than 0.04 radiation lengths' to 'shall absorb less than 6% of the incident gamma radiation in the LAT field of view. Changed to description that more fits the important issue from scientists piont of view. • 5.7.1 Dead Time Requirement - Added requirement of 1 microsec ACD dead-time. This requirement was a needed clarification of more general requirement. • 5.10 adjustable from 20 to 64 MIP in steps of □1.2 MIP changed to ' at least 0 to 50 MIP in steps of □ 1 MIP'. Due to actual design of latest GAFE5 version. The requirement is driven by the need to set a threshold below the signal from carbon nuclei at 36 MIP. By restricting the range to a maximum of 50 MIP, we can have smaller step sizes on the threshold without complicating the electronics, while still allowing ample margin over the expected threshold. • 5.12.1 and 5.12.2 Low-Threshold Signal and Low-Threshold Adjustability DELETED. The Low-Level Discriminator has been replaced by Zero --Suppression Logic. • 5.19 Mass - Allocation change to 280 kg per approved CR • 5.23.2 Micrometeoroid Protection - Change mean rate of penetrations from 0.01/yr to 0.02/yr. This is the result of a CDR RFA regarding the assumptions made in intial reliability assumptions. Memo written by Steve Ritz in Feb 2003 explains change further. • 5.24 Performance Life - Added statement, "except in the case of one tile failure". Same justification as change for 5.23.2 • 5.14 Added general reliaibility req to Tiles Rel Req for consistency	LAT-XR-774.2
4	8/24/03	• 5.18 Power allocation reduced from 31W to 10.5 W average nominal • 5.20 Zaxis CG reduced to 330 mm from 393 mm	LAT-XR-??

		• 5.21 reference to LAT Env Spec added • 5.5 req modified to refer to coverage of trackers, (Steve Ritz concurrence received) • Added GEM to system description and acronym list • 5.9, 5.12 and 5.11.9 - changed AEM to GEM • 5.12 changed low threshold signal to zero suppress mode • 5.12.2 changed deleted low threshold requirement to zero suppress adjustable by channel • 5.17.6 ‘including low threshold’ to including Test Charge Injection level	

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CONTENTS

1.0 Purpose …... 7

2.0 Scope ……. 7

3.0 System Description……… 8

Requirements Table Contents listed in order as they appear on the Table……13-19

5.2 Detection of Charged Particles

5.3 Adjustable Threshold on Detecting Charged Particle

5.4 Detection Efficiency

5.5 Instrument Coverage

5.6 Mean Thickness

5.7 False VETO due to Backsplash

5.8 False VETO due to Electrical Noise

5.9 High-Threshold Detection

5.10 Adjustable High-Threshold

5.11 Signals

5.11.1 Fast VETO Signal

5.11.2 Fast VETO Signal Latency

5.11.3 Logic VETO Signal

5.11.4 Logic VETO Signal Latency

5.11.5 Logic VETO Signal Timing

5.11.6 Fast VETO Signal Width

5.11.7 Fast VETO Recovery Time for Large Signals

5.11.8 High-Threshold Signal Latency

5.11.9 ACD Trigger Primitives

5.12 Performance Monitoring and Calibration

5.12.1 Low-Threshold Signal

5.12.2 Low-Threshold Adjustability

5.12.3 Signal Content

5.12.4 Pulse Digitization

5.12.5 Pulse Height Measurement Latency

5.13 Reliability - Electronics

5.14 Reliability - Tiles

5.15 Reliability - Electronics

5.16 Reliability - Mechanical/Optical

5.17 Commands

5.17.1 Detector On/Off Commands

5.17.2 Detector Gain Commands

5.17.3 Electronics On/Off Commands

5.17.4 VETO Threshold Commands

5.17.5 High-Threshold Commands

5.17.6 ACD Monitoring Commands

5.17.7 Low-Gain Mode Commands

5.18 Power Consumption

5.19 Mass

5.20 Center of Gravity

5.21 Environmental

5.22 Physical Size

5.23 Thermal Blanket/Micrometeoroid Shield

5.23.1 Areal Mass Density

5.23.2 Micrometeoroid Protection

5.23.3 Thermal Control

5.24 Performance Life

5.25 Operation in High Rate Conditions

5.25.1 Notification of Mode Change

5.25.2 Rate Requirement for Operation within Specification

Link to level 2 requirements Table and Verification Strategy …. ……...19-22

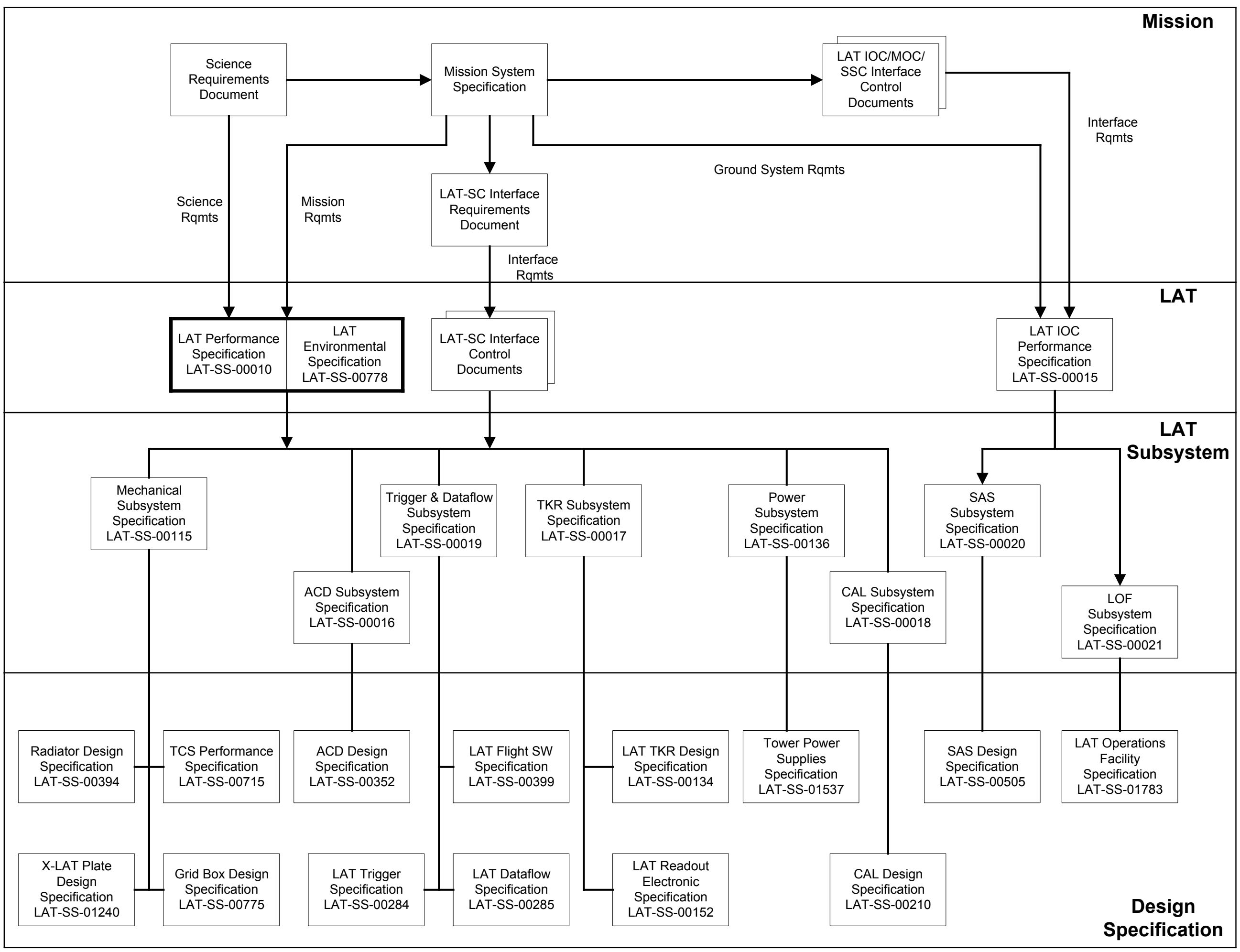
1 PURPOSE

This document defines level III subsystem requirements for the GLAST Large Area Telescope (LAT) Anticoincidence Detector (ACD).

2 SCOPE

This specification captures the GLAST LAT requirements for the ACD. This encompasses the subsystem level requirements and the design requirements for the ACD. The verification methods of each requirement are identified. This specification is identified in the specification tree of Figure 2-1.

Figure 2-1 LAT Specification Tree



3 SYSTEM DESCRIPTION

System Description

The LAT science instrument consists of an Anticoincidence Device (ACD), a silicon-strip detector tracker (TKR), a hodoscopic CsI calorimeter (CAL), and a Trigger and Dataflow system (T&DF). The principal purpose of the LAT is to measure the incidence direction, energy and time of cosmic gamma rays. The measurements are streamed to the spacecraft for data storage and subsequent transmittal to ground-based analysis centers. Signals produced by the ACD are used by the T&DF system to identify cosmic ray electrons and nuclei entering the instrument.

The ACD detects energetic cosmic ray electrons and nuclei for the purpose of removing these backgrounds. It is the principle means for detection of that background. This detector array covers the top and 4 sides of the TKR. It consists of an array of 89 plastic scintillator tiles (25 on the LAT top, 16 on each of the 4 sides, various sizes), plus 8 scintillating fiber "ribbons" that cover the gaps between the tiles. Each scintillator tile is read by 2 PMT's (baseline: Hamamatsu R4443; designated "A" and "B") via waveshifting fibers (and in some cases, clear optical fiber extensions).

The PMT's and the ACD electronics will be located around the base of the ACD, in the Base Electronics Assembly (BEA). The 50 waveshifting fiber bundles and associated clear fiber extensions from the ACD Top will be routed down 2 opposite sides of the ACD (24 and 26), so that those two sides of the BEA will be more heavily populated than the remaining two sides. Each assembly of one tile plus the two associated waveshifting fiber bundles and clear fiber extensions denoted as a Tile Detector Assembly (TDA).

On each of the two opposite LAT, the BEA will house two ACD electronics boards, one for "A" PMT's and one for "B" PMT's. On each of the remaining two LAT sides, the BEA will house four ACD electronics boards, two associated with "A" PMT's and two associated with "B" PMT's. Each ACD electronics board will be capable of servicing 18 PMT's, although they will vary with regard to numbers of unused electronics channels. All 12 of the ACD electronics boards are nominally identical.

Each ACD electronics board will receive power from redundant high voltage bias supply (HVBS), which is capable of providing the necessary high voltage for all 18 associated PMT's. All 18 PMT's associated with a specific board will receive the same high voltage.

Each ACD electronics board will contain 18 channels of analog, analog-to-digital, and digital processing electronics, as well as command reception and distribution logic and data collection and transmission logic.

Each ACD electronics board interfaces to the LAT via the ACD Electronics Module (AEM) and the Global Trigger Electronics Module (GEM). The AEM/GEM receive all signals and data from the ACD and sends commands to the ACD. All digital communications between the ACD and the AEM will be via standard LVDS protocol.

Science signals from the TDA's and their associated PMT's are defined in terms of MIP's, the signal generated by a minimum-ionizing singly-charged particle traversing a tile in a direction normal to its surface. To provide a meaningful electronics specification, the definition of a MIP must be normalized to the electrical charge delivered by each of the two PMT's in response to a MIP. The following parameters are assumed for the MIP calculation:

10 photoelectrons per PMT per MIP

PMT gain of 400,000

The result is that **1 MIP** produces a PMT anode signal of **0.64 pC**.

4 Definitions, Acronyms and Reference Documents

Acronyms

ACD - Anticoincidence Detector

AEM – ACD Electronics Module

FOV – Field of View

FREE – FRont End Electronics

GLAST – Gamma-ray Large Area Space Telescope

GEM – Global Trigger Electronics Module

HLD – High Level Discriminator

IOC – Instrument Operations Center

IDD – Interface Definition Drawing

IRD – Interface Requirements Document

LAT – Large Area Telescope

LET – Linear Energy Transfer

MIP – Minimum Ionizing Particle (see definition below)

MSS – Mission System Specification

PI – Principal Investigator

PMT – Photo Multiplier Tube

SEU – Single Event Upset

SAS – Science Analysis Software

SI/SC IRD – Science Instrument – Spacecraft Interface Requirements Document

SRD – Science Requirements Document

SSC – Science Support Center

TACK – Trigger ACKnowledge

TBD - To Be Determined

TBR – To Be Resolved

TCI – Test Charge Injection

Definitions

μsec, μs – Microsecond, 10^{-6} second

Acceptance Tests: The validation process that demonstrates that hardware is acceptable for flight. It also serves as a quality control screen to detect deficiencies and, normally, to provide the basis for delivery of an item under terms of a contract.

Analysis – A quantitative evaluation of a complete system and /or subsystems by review/analysis of collected data.

Background Rejection – The ability of the instrument to distinguish gamma rays from charged particles.

Backsplash – Secondary particles and photons originating from very high-energy gamma-ray showers in the calorimeter giving unwanted ACD signals.

cm – centimeter

Contamination: The presence of materials of molecular or particulate nature that degrade the performance of hardware.

Cosmic Ray - Ionized atomic particles originating from space and ranging from a single proton up to an iron nucleus and beyond.

Dead Time – Time during which the instrument does not sense and/or record gamma ray events during normal operations.

Demonstration – To prove or show, usually without measurement of instrumentation, that the project/product complies with requirements by observation of results.

eV – Electron Volt

Electromagnetic Compatibility (EMC): The condition that prevails when various electronic devices are performing their functions according to design in a common electromagnetic environment.

Electromagnetic Interference (EMI): Electromagnetic energy that interrupts, obstructs, or otherwise degrades or limits the effective performance of electrical equipment.

Field of View – Integral of effective area over solid angle divided by peak effective area.

Functional Tests: The operation of a unit in accordance with a defined operational procedure to determine whether performance is within the specified requirements.

GeV – Giga Electron Volts. 10^9 eV

Inspection – To examine visually or use simple physical measurement techniques to verify conformance to specified requirements.

Level of Assembly: The following levels of assembly are used for describing test and analysis configurations

a. **Part**: A hardware element that is not normally subject to further subdivision or disassembly without destruction of design use. Examples include resistor, integrated circuit, relay, connector, bolt, and gaskets.

b. **Subassembly**: A subdivision of an assembly. Examples are wire harness and loaded printed circuit boards.

c. **Assembly**: A functional subdivision of a component consisting of parts or subassemblies that perform functions necessary for the operation of the component as a whole.

d. **Component or Unit**: A functional subdivision of a subsystem and generally a self-contained combination of items performing a function necessary for the subsystem's operation. Examples are TKR tower, CAL logs, ACD tiles, electronic boxes, e.g., GASU power supplies, SIU, etc. For the purposes of this document, "component" and "unit" are used interchangeably.

e. **Subsystem**: A functional subdivision of a payload consisting of two or more components. Examples are Structure, TKR, CAL, ACD, Electronics. Also included as subsystems of the payload are the science instruments or experiments.

f. **Instrument**: A spacecraft subsystem consisting of sensors and associated hardware for making measurements or observations in space. For the purposes of this document, the LAT and GBM are considered to be instruments.

g. **Observatory**: See Payload.

h. **Payload**: An integrated assemblage of modules, subsystems, etc., designed to perform a specified mission in space. For the purposes of this document, Payload, Observatory, and Spacecraft are used interchangeably.

i. **Spacecraft**: See Payload.

MeV – Million Electron Volts, 10^6 eV

Minimum Ionizing Particle (MIP) – The mean signal from cosmic ray produced air shower muons at sea level normally incident on a scintillator tile. It corresponds to approximately 1.9 MeV per cm of scintillator.

nsec, ns – Nanosecond, 10^{-9} second

ph – photons

Protoflight – see hardware

Qualification Test - Tests intended to demonstrate that the test item will function within performance specifications under simulated conditions more severe than those expected from ground handling, launch, and orbital operations. Their purpose is to uncover deficiencies in design and method of manufacture. They are not intended to exceed design safety margins or to introduce unrealistic modes of failure. The design qualification tests may be to either "prototype" or "protoflight" test levels.

Redundancy (of design): The use of more than one independent means of accomplishing a given function.

s, sec – seconds

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 measurements or instrumentation, that the project/product complies with requirements.

Thermal-Vacuum Test: A test conducted to demonstrate the capability of the test item to operate satisfactorily in vacuum at temperatures based on those expected for the mission. The test, including the gradient shifts induced by cycling between temperature extremes, can also uncover latent defects in design, parts, and workmanship.

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.

VETO - The signal from an individual ACD scintillator tile that indicates an energy deposit of at least ~0.3 MIP (~500 keV) in an ACD scintillator tile, or about 20% of that amount in one of the scintillating fiber ribbons. This threshold is set to be exceeded for a very high fraction of MIPs in the presence of all fluctuations in their energy deposit in the scintillator tiles. The VETO signals from individual tiles and ribbons are combined with information from the tracker and calorimeter to decide whether or not to reject events as background.

APPLICABLE DOCUMENTS

Documents that are relevant to the development of the ACD concept and its requirements include the following:

- LAT –SS-00352, ACD-RQMT-000031, "LAT ACD Subsystem Spec – Level IV Requirements/Specifications"
- LAT-GE-00009, "LAT Science Requirements Document–Level II Specification", August 6, 2000.
- LAT-SS-00010, "GLAST LAT Performance Specification", August 2000
- LAT-SS-00047, "LAT Mechanical Performance Specification"
- LAT-SS-00363, "ACD Mechanical, Thermal, and Front End Electronics to ACD Electronics Module Interface Control Document"
- LAT-TD-00430, "LAT ACD Assembly, Integration, and Test Plan"
- LAT-MD-00408, "LAT Instrument Performance Verification Plan"
- GSFC 433-MAR-0001, "Mission Assurance Requirements (MAR) for Gamma-Ray Large Area Telescope (GLAST) Large Area Telescope (LAT)", June 9, 2000.
- "GLAST Large Area Telescope Flight Investigation: An Astro-Particle Physics Partnership Exploring the High-Energy Universe", proposal to NASA, P. Michelson, PI, November, 1999.

5 REQUIREMENTS

System Description and Level III Requirements Table

The ACD level III requirements are listed in Table 1 below. The LAT level IIb requirements from which they derive are listed in Table 2 which follows.

Table 1. Requirements Table

Note: Verification methods are T = Test, A = Analysis, D = Demonstrate, I = Inspect

ACD3-11	REQUIREMENTS	
ACD3-12	5.1 System Description and Level III Requirements Table	
ACD3-13	The LAT science instrument (SI) consists of an Anticoincidence Device (ACD), a silicon-strip detector tracker (TKR), a hodoscopic CsI calorimeter (CAL), and a Trigger and Dataflow system (T&DF). The principal purpose of the SI is to measure the incidence direction, energy and time of cosmic gamma rays. The measurements are streamed to the spacecraft for data storage and subsequent transmittal to ground-based analysis centers.	
ACD3-14	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 covers the TKR. It consists of an array of 89 plastic scintillator tiles (1 - 1.2 cm thick, various sizes), plus 8 scintillating fiber "ribbons" that cover the gaps between the tiles. Each tile is read out by two PMT's. Signals produced by the ACD are used by the T&DF system to identify cosmic ray electrons and nuclei entering the instrument. The ACD level III requirements along which LAT level IIb requirements or other sources from which they derive are listed in the Requirements Table below.	
ACD3-15	5.2 Detection of Charged Particles	

ACD3-16	The ACD shall detect energy deposits with energies of above an adjustable threshold nominally at 0.3 MIP (minimum ionizing particle) (see 5.3 below) and produce VETO signals.	
ACD3-17	**5.3 Adjustable Threshold on Detecting Charged Particle**	
ACD3-18	The threshold for VETO detection of charged particles shall be adjustable from 0.1 to 2.0 MIP, with a step size of □0.05 MIP. (0.1 to 0.6 MIP would have been range if no degradation was expected)	
ACD3-19	**5.4 Detection Efficiency**	
ACD3-20	The average detection efficiency for minimum ionizing particles shall be at least 0.9997 over the entire area of the ACD (except for the bottom tiles on each side, for which the efficiency shall be at least .99 , simulation confirmation of this number is desired at some point).	
ACD3-21	**5.5 Instrument Coverage**	
ACD3-22	The ACD shall cover the top and sides of the LAT tracker with vertical distance to ~2 cm below the lowest SSD in the tracker and to within 2 mm of the top of the CsI in the calorimeter. The top of all 4 sides of the ACD scintillator shall be extended upward so as to be at least as high as the highest point in the micrometeoroid/debris shield for the top ACD tiles.	
ACD3-23	**5.6 Mean Thickness**	
ACD3-24	The ACD, support structure, and micrometeoroid shield shall absorb	

	less than 6% of the incident gamma radiation in the LAT field of view.	
ACD3-25	5.7 False VETO due to Backsplash	
ACD3-26	The ACD shall be segmented so that no more than 20% of otherwise-accepted gamma-ray events at 300 GeV shall be rejected by false VETOs due to calorimeter backsplash.	
ACD3-427	5.7.1 Dead Time	
ACD3-430	The dead time shall be less than 1 □sec per event.	
ACD3-27	5.8 False VETO due to Electrical Noise	
ACD3-28	The false VETO signal rate due to noise shall result in a rejection of no more than 1% of triggered gamma rays.	
ACD3-29	5.9 High-Threshold Detection	
ACD3-30	The ACD shall detect highly-ionizing particles (carbon-nitrogen-oxygen or heavier nuclei, denoted High-Threshold) depositing energy greater than 25 times a MIP and shall provide a signal to the GEM (for CAL calibration - I.e. energy res, -also see Level 4 req 5.8.7 discriminator masking req)	
ACD3-31	5.10 Adjustable High-Threshold	
ACD3-32	The High-Threshold shall be adjustable from 20 to 64 MIP in steps of □1.2 MIP.	
ACD3-424	5.11 VETO Signal	

ACD3-33	5.11.1 Fast VETO Signal	
ACD3-34	For each PMT, a fast VETO signal shall be generated when the its VETO threshold is exceeded.	
ACD3-35	5.11.2 Fast VETO Signal Latency	
ACD3-36	The fast VETO signal latency shall be commandable from 200 - 1600 nsec after particle passage.	
ACD3-37	5.11.3 Logic VETO Signal	
ACD3-38	A map of the tiles that produce VETO signals shall be generated for each Level 1 Trigger Acknowledge (TACK).	
ACD3-39	5.11.4 Logic VETO Signal Latency	
ACD3-40	The map of VETO signals shall be latched by the time the ADC's conversions are completed	
ACD3-41	5.11.5 Logic VETO Signal Timing	
ACD3-42	The logic VETO map shall represent the state of all ACD discriminators at the time of the particle passage (~200 nsec) causing the Level 1 Trigger Acknowledge (TACK).	
ACD3-43	5.11.6 Fast VETO Signal Width	
ACD3-44	The fast VETO output signal shall have a commandable width of 50 – 400 nsec, after 'de-glitching' on 2 successive clock pulses. The leading and trailing edges must be synchronous with clock pulses.	
ACD3-45	5.11.7 Logic VETO Recovery Time for Large Signals	
ACD3-46	For a signal equivalent to 200 MIP's,	

	the logic VETO signal shall be no longer than 10 microseconds (current design will be <5 microseconds).	
ACD3-47	5.11.8 High-Threshold Signal Latency	
ACD3-48	A highly-ionizing particle hitting the top or upper side row of tiles of the ACD shall produce a High-Threshold fast signal to the hardware trigger logic with latency timing characterized as required in specification 5.11.2 and 5.11.6	
ACD3-49	5.11.9 ACD Trigger Primitives	
ACD3-50	The ACD will produce no trigger primitives internally. The VETO signals caused by the individual PMT's will be transmitted to the LAT GEM's, where they will be OR'ed together (for each tile or ribbon), and used by the the GEM's to generate trigger primitives.	
ACD3-51	5.12 ACD Performance Monitoring	
ACD3-52	The ACD electronics shall collect and transmit sufficient pulse height, and temperature information to monitor the status and performance of the ACD system and maintain its calibration to 5%. The LAT GEM's will generate and transmit count rates for ACD signals. A zero suppress mode will allow zero suppression of the pulse height data transmission to the data acquisition system. ACD voltages and currents will be monitored on the LAT side of the interface. Current thermal information is one single thermistor per board, we are considering more thermistors on structure.	

ACD3-53	5.12.1 Low-Threshold Signal	
ACD3-54	Requirement deleted.	
ACD3-55	5.12.2 Zero Suppress Adjustability	
ACD3-56	The zero suppress (PHA threshold) level shall be adjustable by channel.	
ACD3-57	5.12.3 Signal Content	
ACD3-58	When a Level 1 Trigger Acknowledge (TACK) is received, the ACD electronics shall collect and transmit sufficient information to determine the pulse height up to 200 MIP (was previously 1000,) with the following precision: --for a pulse below 10 MIP, precision of <0.02 MIP or 5%, whichever is larger; --for a pulse above 10 MIP, precision of <1 MIP or 2%, whichever is larger.	
ACD3-61	5.12.4 Pulse Digitization	
ACD3-62	Upon a Level 1 Trigger Acknowledge (TACK), all tile and ribbon pulses shall be digitized.	
ACD3-63	5.12.5 Pulse Height Measurement Latency	
ACD3-64	The pulse height measurements shall be completed within 18.5 microseconds after a Level 1 trigger is received. (Transmission not included in 18.5 microseconds.)	
ACD3-65	5.12.6 Housekeeping	
ACD3-66	ACD shall make available other housekeeping and monitoring as	

	deemed needed or required in ICD.	
ACD3-67	5.13 Reliability – Electronics	
ACD3-68	No single failure in the ACD electronics shall result in the loss of signal from both PMT's on any single tile. The probability of the loss of both VETO signals from any scintillator tile due to electronics failures shall be less than 1% in 5 years. The probability of the loss of VETO signals from any scintillator ribbon due to electronics failures shall be less than 5% in 5 years. The ACD reliability allotment from LAT is currently .96 over 5 years.	
ACD3-69	5.14 Reliability – Tiles	
ACD3-70	The loss of any one detector element (tile or ribbon) shall not result in the loss of any other element.	
ACD3-71	5.15 Testability	
ACD3-72	ACD shall be testable to confirm performance and requirements are met (except when cost and complexity of creating direct testability very clearly outweighs benefit)	
ACD3-73	5.16 Reliability - Mechanical/Optical	
ACD3-74	The probability of the loss of both VETO signals from any scintillator tile due to mechanical or optical failures shall be less than 1% in 5 years. The probability of the loss of VETO signals from any scintillator ribbon due to mechanical or optical failures shall be less than 5% in 5 years. The ACD reliability allotment from LAT is currently .96 over 5	

	years.	
ACD3-75	5.17 ACD Commanding	
ACD3-76	5.17.1 Detector On/Off Commands	
ACD3-77	The ACD shall implement commands to allow each group of 18 PMT's to be separately powered on and off.	
ACD3-78	5.17.2 Detector Gain Commands	
ACD3-79	The ACD shall implement commands to allow the HV of each group of 18 PMT's to be separately adjusted.	
ACD3-80	5.17.3 Electronics On/Off Commands	
ACD3-81	The ACD shall implement commands to allow each electronics board to be separately powered on and off.	
ACD3-82	5.17.4 VETO Threshold Commands	
ACD3-83	The ACD shall implement commands to set the VETO threshold for each PMT.	
ACD3-84	5.17.5 High-Threshold Commands	
ACD3-85	The ACD shall implement commands to set the High-Threshold for each PMT.	
ACD3-86	5.17.6 ACD Monitoring Commands	
ACD3-87	The ACD shall implement commands to allow the Instrument Operator to adjust the monitoring functions of the ACD electronics, including the Test Charge Injection level	
ACD3-88	5.17.7 Low-Gain Mode Commands	
ACD3-89	The ACD shall implement commands to switch the ACD PMT's into and out	

	of low-gain mode for high counting rate conditions.	
ACD3-90	5.18 Power Consumption	
ACD3-91	The ACD total electronics power consumption shall not exceed an orbital average of 10.5 W conditioned (reduced from 31 W max in May 2003).	
ACD3-92	5.19 Mass	
ACD3-93	The total mass of the ACD and micrometeoroid shield shall not exceed 280 Kg.	
ACD3-94	5.20 Center of Mass	
ACD3-95	The center of mass of the ACD and micrometeoroid shield shall be located within 330 mm of the top of the mechanical grid structure. (Note: was 400 mm, then 393 mm), x and y dimension reqs never specified by LAT until early 2003, +/- 10mm for both from center of grid.	
ACD3-96	5.21 Environmental	
ACD3-97	The ACD shall meet the structural, thermal, EM and radiation environment requirements defined in the LAT Environmental Specification, LAT-SS-00778, and the LAT-ACD ICD, LAT-SS-363	
ACD3-98	5.22 Physical Size	
ACD3-99	The dimensions of the ACD plus the micrometeoroid shield shall conform to the requirements in the ICD, LAT-SS-363, and LAT dwgs LAT-DS-0038 and 00309.	

ACD3-100	5.23 Thermal Blanket/Micrometeoroid Shield	
ACD3-101	5.23.1 Thermal Blanket/ Micrometeoroid Shield Areal Mass Density	
ACD3-102	The thermal blanket/micrometeoroid shield shall have mass per unit area which minimizes secondary gamma-ray production by undetected cosmic ray interactions.	
ACD3-103	5.23.2 Micrometeoroid Protection	
ACD3-104	The thermal blanket/micrometeoroid shield shall minimize the probability that micrometeoroids and space debris will penetrate and create a light path to the ACD scintillators. The mean rate of such penetrations over the entire shield shall be less than 0.02/yr.	
ACD3-105	5.23.3 Thermal Control	
ACD3-106	The thermal blanket/micrometeoroid shield shall have thermal properties (absorptance, reflectance, and transmittance) as required to maintain the temperatures described in the LAT ICD - LAT-SS-00363.	
ACD3-107	5.24 Performance Life	
ACD3-108	The ACD shall maintain the specified performance for a minimum of five years in orbit, except in the case of one tile failure .	
ACD3-109	5.25 Operation in High Rate Conditions	

ACD3-110	The ACD photomultiplier bias supplies shall switch into a low-gain mode to protect the phototubes in very high intensity particle conditions (> 10 kHz in an individual tile) such as the South Atlantic Anomaly. (Accomplished by HVBS command from AEM to GARC).	
ACD3-111	5.25.1 Notification of Mode Change	
ACD3-112	The ACD shall be able to tell (via voltage monitoring and command log) when it switches into low-gain mode for high counting rate conditions.	
ACD3-113	5.25.2 Rate Requirement for Operation within Specification	
ACD3-114	Each ACD PMT and its associated electronics shall be capable of operating within the specifications above at MIP rates up to 3 kHz.	
ACD3-412	6 VERIFICATION STRATEGY	
ACD3-413	The verification strategy will test, analyze (may include modeling/simulation), inspect, or demonstrate all requirements of section 5 to ensure that the instrument meets the requirements of this specification. The verification column above indicates the basic verification method for each requirement. See the ACD integration and test plan document (LAT-TD-00430) for the test matrix, verification matrix and more detail.	

Table 2. Level 2 requirements from which the level III requirements derive.

Req't #	Title	LAT L2(b) Req flow
5.2	Detection of Charged Particles	L2(b) 5.2.12, & Sci. Sim.
5.3	Adjustable Threshold on Detecting Charged Particle	L2(b) 5.2.12 & Sci. Sim
5.4	Detection Efficiency	L2(b) 5.2.12 & Sci. Sim
5.5	Instrument Coverage	L2(b) 5.2.12 & Sci. Sim
5.6	Mean Thickness	L2(b) 5.2.3 & Sci. Sim
5.7	False VETO due to Backsplash	L2(b) 5.2.1 & Sci. Sim
5.7.1	Dead Time	L2(b) 5.2.1 & Sci. Sim
5.8	False VETO due to Electrical Noise	L2(b) 5.2.3 & Sci. Sim
5.9	High-Threshold Detection	L2(b) 5.2.2
5.10	Adjustable High-Threshold	L2(b) 5.2.2
5.11.1	Fast VETO Signal	L2(b) 5.2.12, & L3 5.2
5.11.2	Fast VETO Signal Latency	L2(b) 5.2.3 & Sci. Sim
5.11.3	Logic VETO Signal	L2(b) 5.2.3 & Sci. Sim
5.11.4	Logic VETO Signal Latency	L2(b) 5.2.3 & Sci. Sim
5.11.5	Logic VETO Signal Timing	L2(b) 5.2.3 & Sci. Sim
5.11.6	Fast VETO Signal Width	L2(b) 5.2.3 & Sci. Sim
5.11.7	Logic VETO Recovery Time for Large Signals	L2(b) 5.2.3 & Sci. Sim
5.11.8	High-Threshold Signal Latency	L2(b) 5.2.2 & Sci. Sim *
5.11.9	ACD Trigger Primitives	L2(b) 5.2.12, L2(b) 5.2.3, & Sci. Sim
5.12	ACD Performance Monitoring	L2(b) 5.2.12 & Sci. Sim
5.12.1	Low-Threshold Signal	

5.12.2	Low-Threshold Adjustability	
5.12.3	Signal Content	L2(b) 5.2.12
5.12.4	Pulse Digitization	L2(b) 5.2.12
5.12.5	Pulse Height Measurement Latency	L2(b) 5.2.12
5.12.6	Housekeeping	L2(b) 5.3.4, ICD
5.13	Reliability - Electronics	L2(b) 5.3.2
5.14	Reliability - Tiles	L2(b) 5.3.2
5.15	Testability	
5.16	Reliability - Mechanical/Optical	L2(b) 5.3.2
5.17.1	Detector On/Off Commands	L2(b) 5.3.2
5.17.2	Detector Gain Commands	L2(b) 5.3.2
5.17.3	Electronics On/Off Commands	L2(b) 5.3.2
5.17.4	VETO Threshold Commands	L2(b) 5.3.2
5.17.5	High-Threshold Commands	L2(b) 5.3.2
5.17.6	ACD Monitoring Commands	L2(b) 5.3.2
5.17.7	Low-Gain Mode Commands	L2(b) 5.3.2
5.18	Power Consumption	L2(b) 5.3.10, ICD
5.19	Mass	L2(b) 5.3.6, ICD -
5.20	Center of Mass	L2(b) 5.3.7, ICD
5.21	Environmental	L2(b) 5.3.12, L2(b)?, ICD
5.22	Physical Size	L2(b) 5.3.8, ICD
5.23.1	Thermal Blanket/ Micrometeoroid Shield Areal Mass Density	L2(b) 5.2.12
5.23.2	Micrometeoroid Protection	L2(b) 5.3.2

5.23.3	Thermal Control	L2(b) 5.3.11
5.24	Performance Life	L2(b) 5.3.2
5.25	Operation in High Rate Conditions	L2(b) 5.3.2
5.25.1	Notification of Mode Change	L2(b) 5.3.2
5.25.2	Rate Requirement for Operation within Specification	L2(b) 5.3.2

7 VERIFICATION STRATEGY

The verification strategy will test, analyze (may include modeling/simulation), inspect, or demonstrate all requirements of section 5 to ensure that the instrument meets the requirements of this specification. Many requirements are verified at the level 4 requirements level (LAT –SS-00352, ACD-RQMT-000031). See that document for more information. The ACD Verification Plan (ACD-PLAN-000050) lists the specific tests or procedures used to verify most requirements. See the above mentioned ACD Verification Plan or the ACD integration and test plan document (LAT-TD-00430) for the test matrix and more detail.