GLAST Large Area Telescope:

AntiCoincidence Detector (ACD) Pre-Ship Review

ACD Team
NASA Goddard Space Flight Center

Agenda
(Morning)

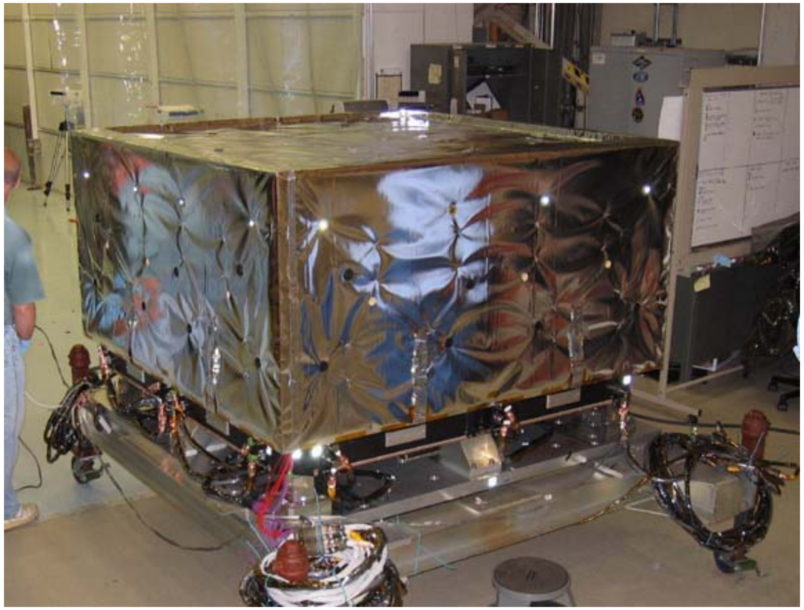
SECTION	PRESENTOR	TIME
Introduction	T. Johnson	8:00-8:10
ACD Overview	D. Thompson	8:10-8:20
Requirements, Segway into Environmental Testing	M. Amato	8:20-8:30
Environmental Testing Overview	C. Coltharp	8:30-8:35
Electrical Testing	M. Amato	8:35-8:45
Mechanical Testing Results	K. Segal	8:45-9:30
Thermal Testing Results	C. Peters	9:30-10:00
Break		10:00-10:10
CPT and Performance Testing Results	D. Thompson	10:10-10:50
Verification and Resource Margins	M. Amato	10:50-11:35
Product Assurance (PR/PFR Status)	J. Lohr	11:35-12:00
Lunch (pizza party)		12:00-1:30

Agenda
(Afternoon)

SECTION	PRESENTOR	TIME
Risk Management	T. Johnson	1:30-1:45
Project Review Activity	T. Johnson	1:45-1:50
ADP and Deliverables	C. Coltharp	1:50-2:05
Transportation	K. Harris	2:05-2:20
Safety	D. Kofeldt	2:20-2:30
PSR Summary	T. Johnson	2:30-2:35
Closeout	Review Team	2:35-3:00

Significant Accomplishments Since PER

Installing the MMS



Integrated ACD with MMS

- ***Integrated the MMS***
  - *–Challenging job was performed flawlessly, one day before a temporary stand down of critical lifts at Goddard.*

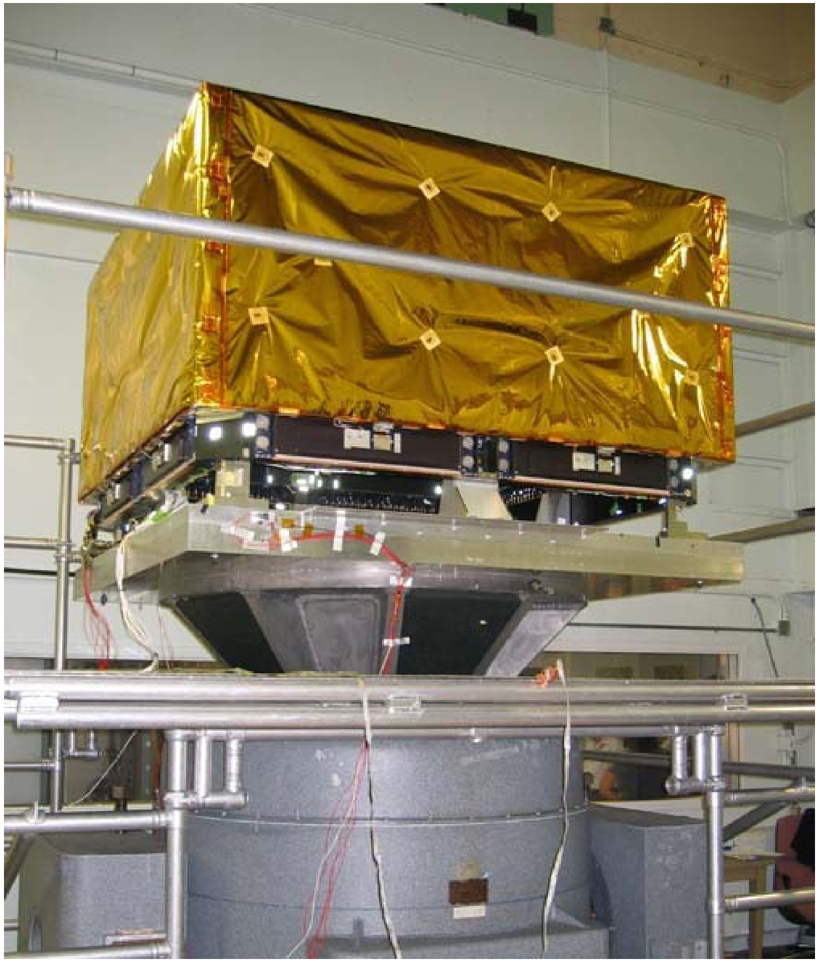
Significant Accomplishments Since PER

- ***Completed ACD functional and performance testing.***
  - *This required that the ACD be rotated on its side to orientate the side Tile Detector Assemblies perpendicular to the flux of Cosmic Ray Muons.*

ACD being rotated on its side (cover in place to provide protection from Helium exposure) for performance testing

Significant Accomplishments Since PER

◆ ***Successfully completed vibration and acoustic testing!***



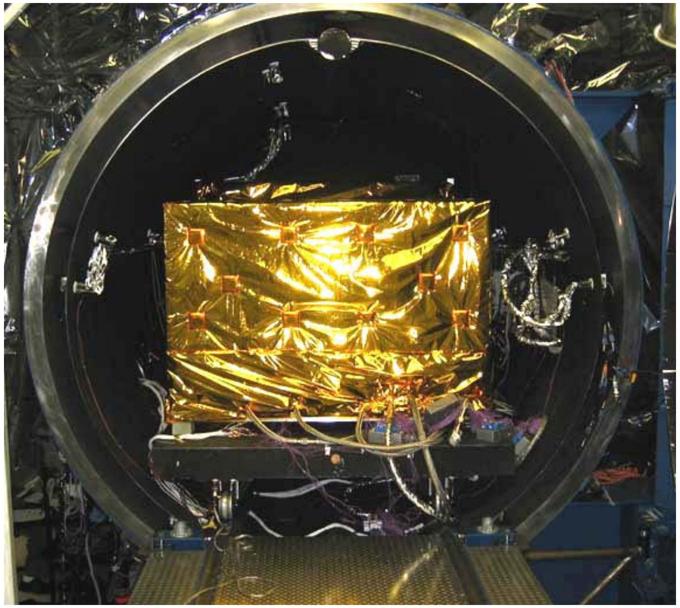
Fully integrated ACD on the C220 shaker in Building 7

The ACD in the acoustics chamber

Significant Accomplishments Since PER

Lowering the ACD over the Tracker thermal simulator (required to drive the temperature of the ACD)

- ***Successfully completed Thermal Vacuum testing***



Installed in Facility 225

- ***Prepared for the ACD Pre-Ship Review on August 8.***

Significant Accomplishments Since PER

Installed on the Mass Property Measurement Facility

- *Successfully completed Mass Property testing*

- *Prepared for today's Pre-Ship Review!*

ACD OVERVIEW

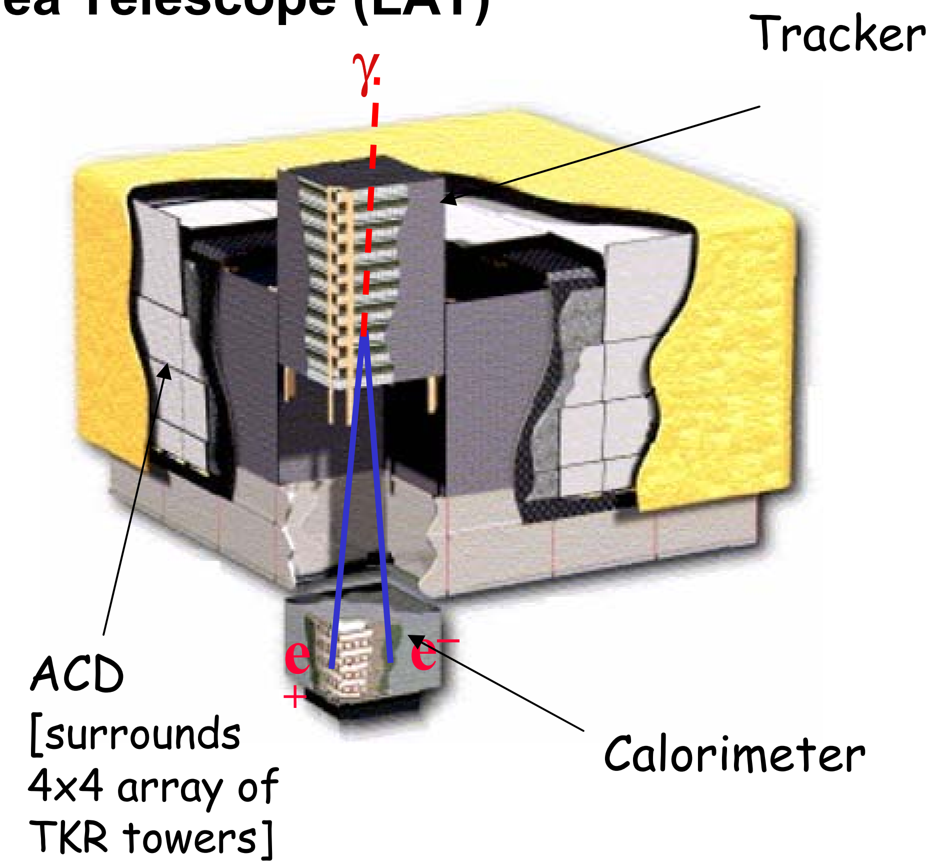
Dave Thompson

ACD Instrument Scientist

INSTRUMENT OVERVIEW

The Anticoincidence Detector (ACD) is a subassembly of the GLAST Large Area Telescope (LAT)

- *Precision Si-strip Tracker (TKR)* *18 XY tracking planes. Single-sided silicon strip detectors (228 μm pitch) Measure the photon direction; gamma ID.*
- *Hodoscopic CsI Calorimeter(CAL)* *Array of 1536 CsI(Tl) crystals in 8 layers. Measure the photon energy; image the shower.*
- ***Segmented Anticoincidence Detector (ACD)* 89 plastic scintillator tiles. Reject background of charged cosmic rays; segmentation removes self-veto effects at high energy.**
- *Electronics System* *Includes flexible, robust hardware trigger and software filters.*



Systems work together to identify and measure the flux of cosmic gamma rays with energy 20 MeV - >300 GeV.

Level III Key Requirements Summary

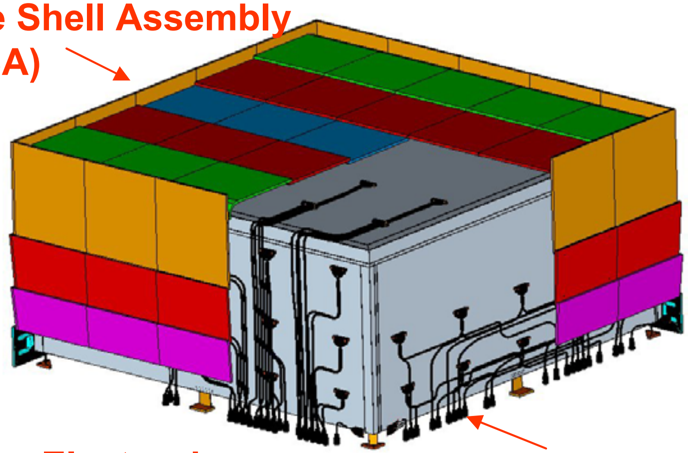
ACD PSR

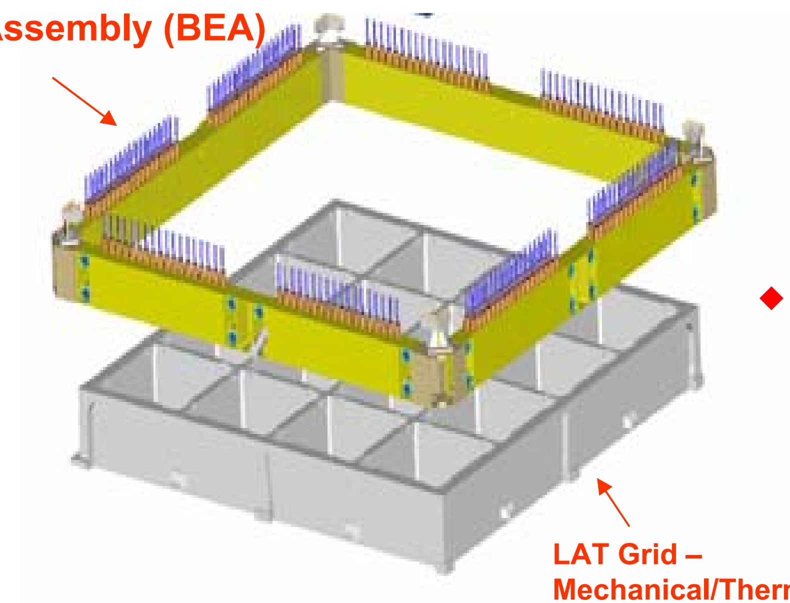
8 August 2005

Reference: LAT-SS-00016

Parameter	Requirement	Expected Performance	Verification Method
Detection of Charged Particles	**≥ 0.9997 average detection efficiency over entire area of ACD (less for bottom row of tiles)**	**≥0.9997** **≥0.99 (bottom tiles)**	**Test and Analysis**
Fast VETO signal	Logic signal 200-1600 nsec after passage of charged particle	200-1600 nsec	Demonstrate
PHA signal	For each phototube, pulse height measurement for each Trigger Acknowledge (TACK) Below 10 MIP, precision of <0.02 MIP or 5% (whichever larger) Above 10 MIP, precision of < 1 MIP or 2% (whichever larger)	< 0.02 MIP or 5% < 1 MIP or 2%	Test and Analysis
False VETO rate - backsplash	**< 20% false VETO's due to calorimeter backsplash at 300 GeV**	**< 20%**	**Test and Analysis**
False VETO rate - noise	< 1% gamma-ray rejection from false VETO's due to electrical noise	< 1%	Analysis
High Threshold (Heavy Nuclei) Detection	Detection of highly-ionized particles (C-N-O or heavier) for calorimeter calibration.	Yes	Analysis
Size	Outside: 1820 x1820 x 1050 mm 1827 x 1827 for lowest 310mm Inside Grid: 1574 x 1574 x 204.7 mm Inside TKR: 1515.5 x 1515.5 x 650 mm	<1800 x1800 x 1025 at hardpoints ~1820 x 1820 x 1050 at softpoints 1574 x 1574 x 204.7 >1515.5 x 1515.5 x 650	Demonstrate
Mass	< 295 kg	278 kg	Demonstrate
Power	< 11.5 Watts (conditioned)	<11.5 Watts	Demonstrate
Instrument Lifetime	Minimum 5 yrs	> 5 yr.	Analysis

INSTRUMENT OVERVIEW
ACD

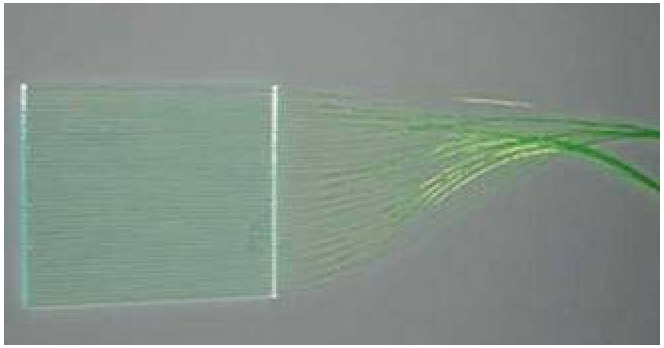




- ***TILE SHELL ASSEMBLY***
  - *89 Plastic scintillator tiles*
  - *Waveshifting fiber light collection (with clear fiber light guides for long runs)*
  - *Two sets of fibers interleaved for each tile*
  - *Tiles overlap in one dimension*
  - *8 scintillating fiber ribbons cover gaps in other dimension (not shown)*
  - *Supported on self-standing composite shell*
  - *Covered by thermal blanket + micrometeoroid shield (not shown)*

- ***BASE ELECTRONICS ASSEMBLY***
  - *194 photomultiplier tube sensors (2/tile)*
  - *12 electronics boards (two sets of 6), each handling up to 18 phototubes. Two High Voltage Bias Supplies on each board.*

Instrument Overview
TDAs



Scintillator Tile/Waveshifting Fibers

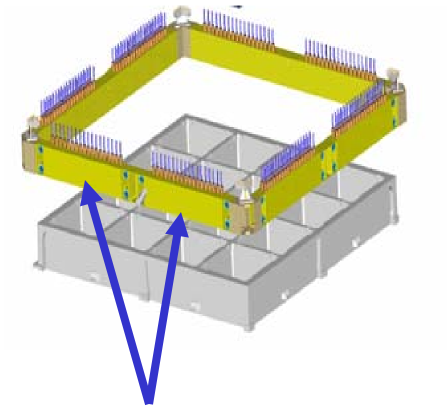
Optical Connector/Clear Fibers

Phototube/Resistor Network

INSTRUMENT OVERVIEW

Electronics Chassis

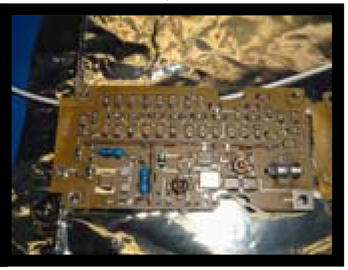
8X



Electronics Chassis (8)
(4 double and 4 single)

Photomultiplier Tube Assembly

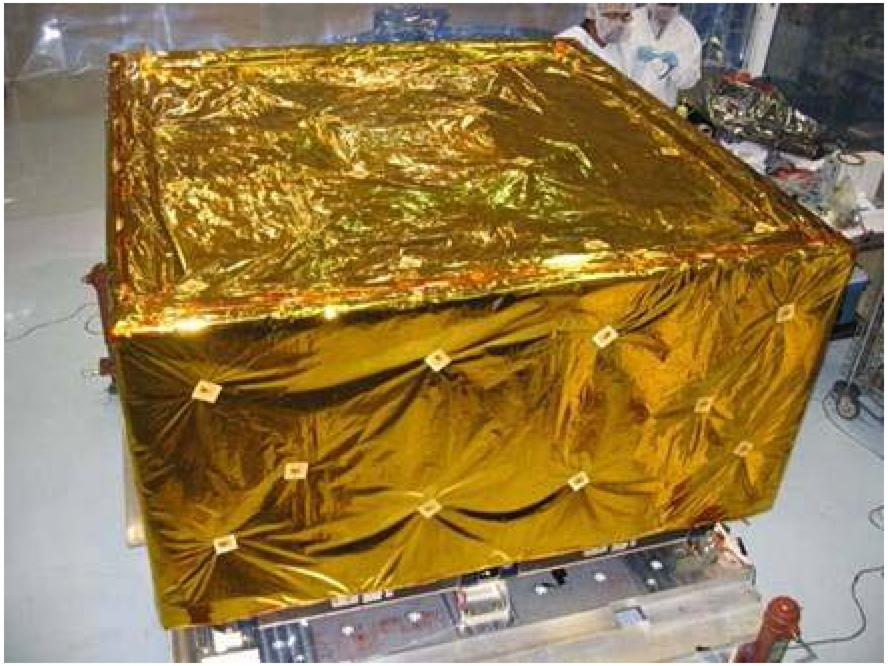
Front End Electronics (Free) Boards



High Voltage Bias Supplies (HVBS)

INSTRUMENT OVERVIEW

Completed ACD, with all detectors and electronics



ACD with Micrometeoroid Shield and Multi-Layer Insulation (except for Germanium/Kapton outer layer)

REQUIREMENTS

Michael Amato

ACD Systems Engineer

Level III Key Requirements Summary

Reference: LAT-SS-00016

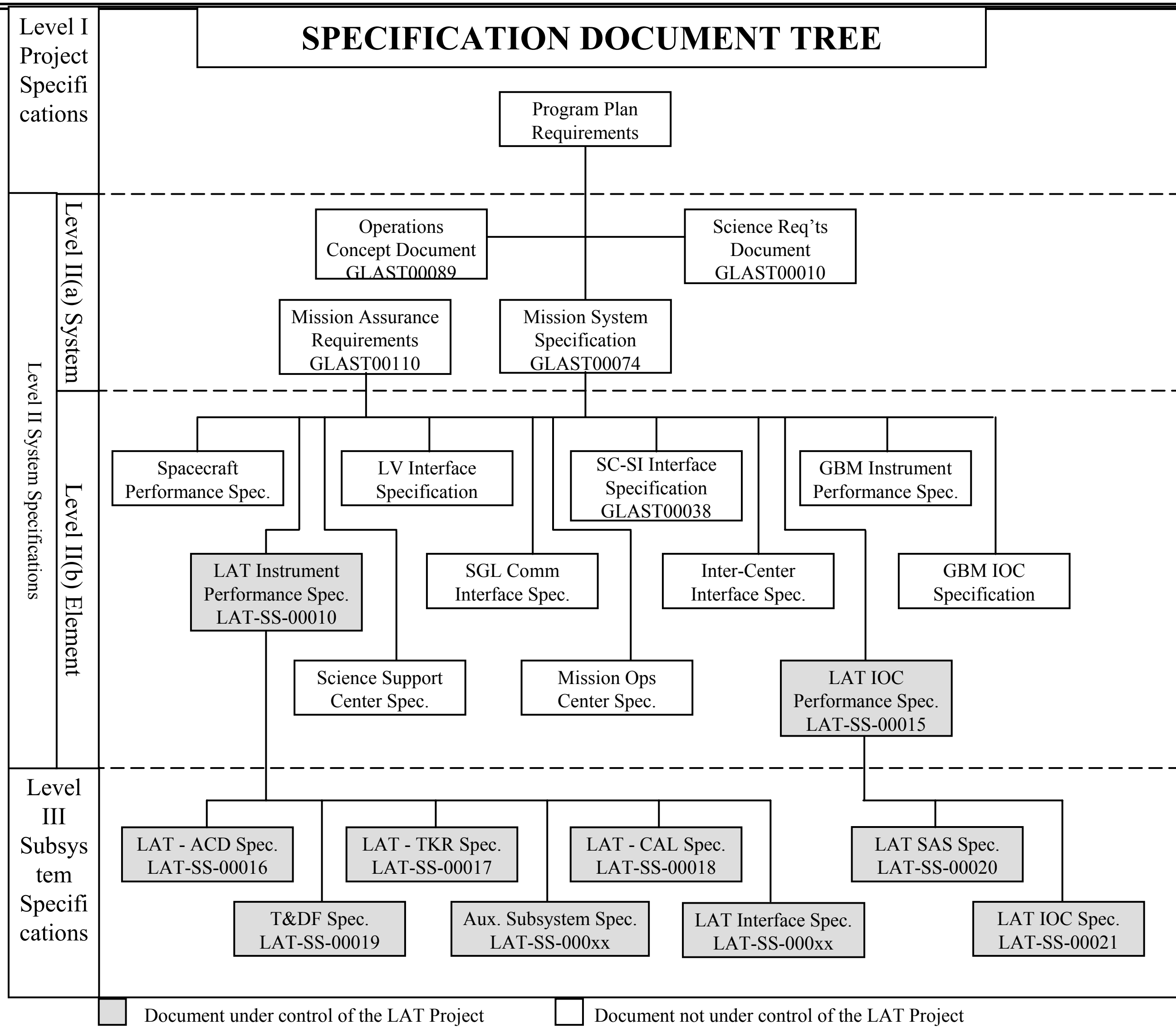
Parameter	Requirement	Expected Performance	Verification Method
Detection of Charged Particles	**≥ 0.9997 average detection efficiency over entire area of ACD (less for bottom row of tiles)**	**≥0.9997** **≥0.99 (bottom tiles)**	**Test and Analysis**
Fast VETO signal	Logic signal 200-1600 nsec after passage of charged particle	200-1600 nsec	Demonstrate
PHA signal	For each phototube, pulse height measurement for each Trigger Acknowledge (TACK) Below 10 MIP, precision of <0.02 MIP or 5% (whichever larger) Above 10 MIP, precision of < 1 MIP or 2% (whichever larger)	< 0.02 MIP or 5% < 1 MIP or 2%	Test and Analysis
False VETO rate - backsplash	**< 20% false VETO's due to calorimeter backsplash at 300 GeV**	**< 20%**	**Test and Analysis**
False VETO rate - noise	< 1% gamma-ray rejection from false VETO's due to electrical noise	< 1%	Analysis
High Threshold (Heavy Nuclei) Detection	Detection of highly-ionized particles (C-N-O or heavier) for calorimeter calibration.	Yes	Analysis
Size	Outside: 1820 x1820 x 1050 mm 1827 x 1827 for lowest 310mm Inside Grid: 1574 x 1574 x 204.7 mm Inside TKR: 1515.5 x 1515.5 x 650 mm	<1800 x1800 x 1025 at hardpoints ~1820 x 1820 x 1050 at softpoints 1574 x 1574 x 204.7 >1515.5 x 1515.5 x 650	Demonstrate
Mass	< 295 kg	278 kg	Demonstrate
Power	< 11.5 Watts (conditioned)	<11.5 Watts	Demonstrate
Instrument Lifetime	Minimum 5 yrs	> 5 yr.	Analysis

Key Level III Requirement Changes Since CDR

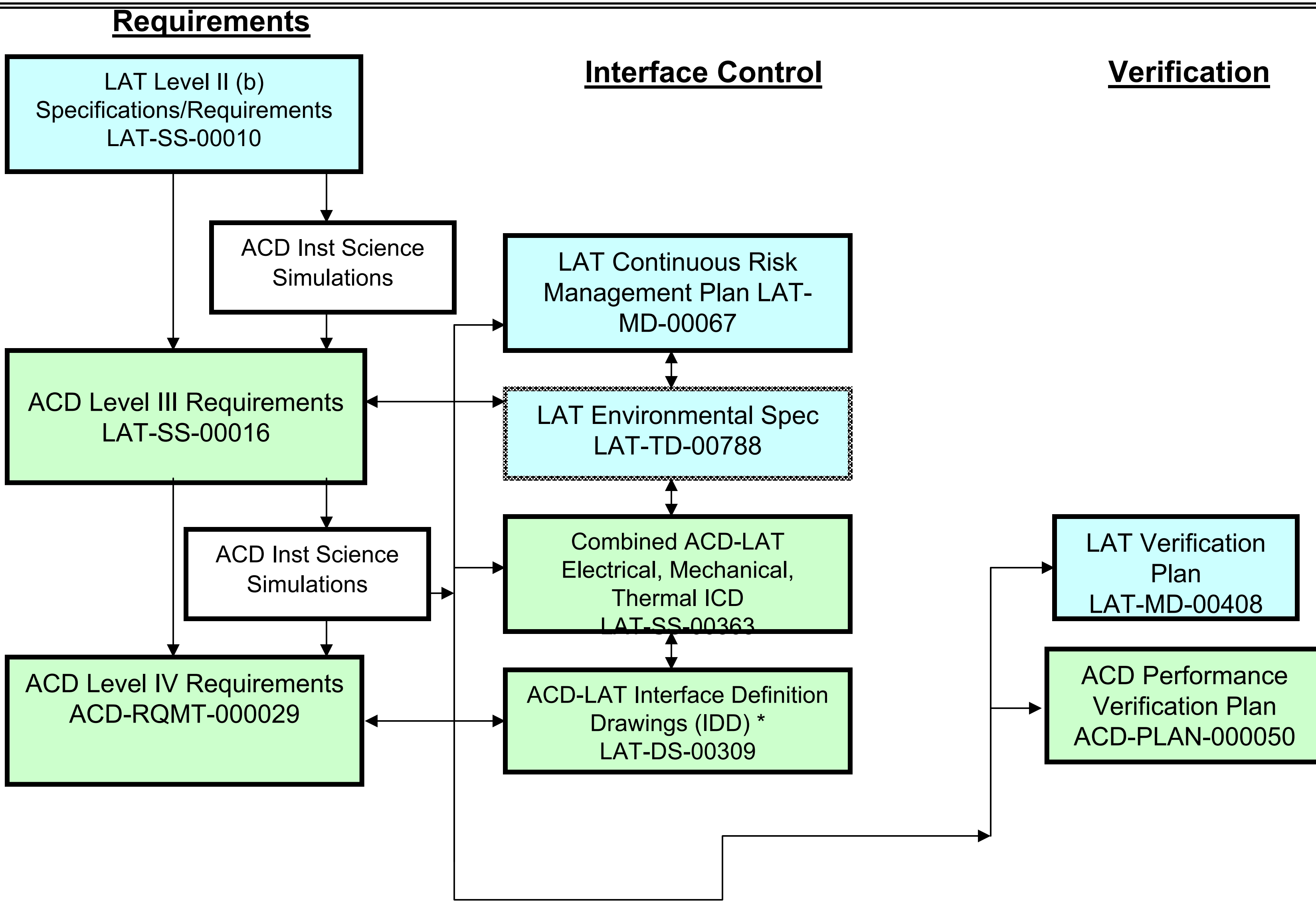
Reference: LAT-SS-00016

Parameter	Requirement at CDR	Current Requirement
Detection of Charged Particles	≥ 0.9997 average detection efficiency over entire area of ACD (less for bottom row of tiles)	No change since CDR
Fast VETO signal	Logic signal 200-1600 nsec after passage of charged particle	No change since CDR
PHA signal	For each phototube, pulse height measurement for each Trigger Acknowledge (TACK) Below 10 MIP, precision of <0.02 MIP or 5% (whichever larger) Above 10 MIP, precision of < 1 MIP or 2% (whichever larger)	No change since CDR
False VETO rate - backsplash	< 20% false VETO's due to calorimeter backsplash at 300 GeV	No change since CDR
False VETO rate - noise	< 1% gamma-ray rejection from false VETO's due to electrical noise	No change since CDR
High Threshold (Heavy Nuclei) Detection	Detection of highly-ionized particles (C-N-O or heavier) for calorimeter calibration.	No change since CDR
Size	**Outside: 1796 x1796 x 1050 mm** **1806 x 1806 for lowest 310mm** **Inside Grid: 1574 x 1574 x 204.7 mm** **Inside TKR: 1515.5 x 1515.5 x 650 mm**	**Outside: 1820 x1820 x 1050 mm** **1827 x 1827 for lowest 310mm** **Inside Grid: 1574 x 1574 x 204.7 mm** **Inside TKR: 1515.5 x 1515.5 x 650 mm**
Mass	**< 280 kg**	**< 295 kg**
Power	**< 31 Watts (conditioned)**	**< 11.5 Watts (conditioned)**
Instrument Lifetime	Minimum 5 yrs	No change since CDR

GLAST Requirements Flow



ACD Requirements Flow/Relationships



ACD Requirements Database

• ACD uses our Requirements Database in DOORS to Track Requirements

ID	LAT ACD Subsystem Level III Requirements, LAT-SS-00016	Parent req Link Comments	Link Action Items
	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).		Latest GAP analysis h been sent to Alex for e simulation update
ACD3-21	**5.5 Instrument Coverage**		
ACD3-22	The ACD shall cover the top and sides of the LAT tracker down to the top of the CsI. 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		

ACD Level III Requirement Database (DOORS)

Active Links between Requirements

ACD-LAT ICD DOORS Database

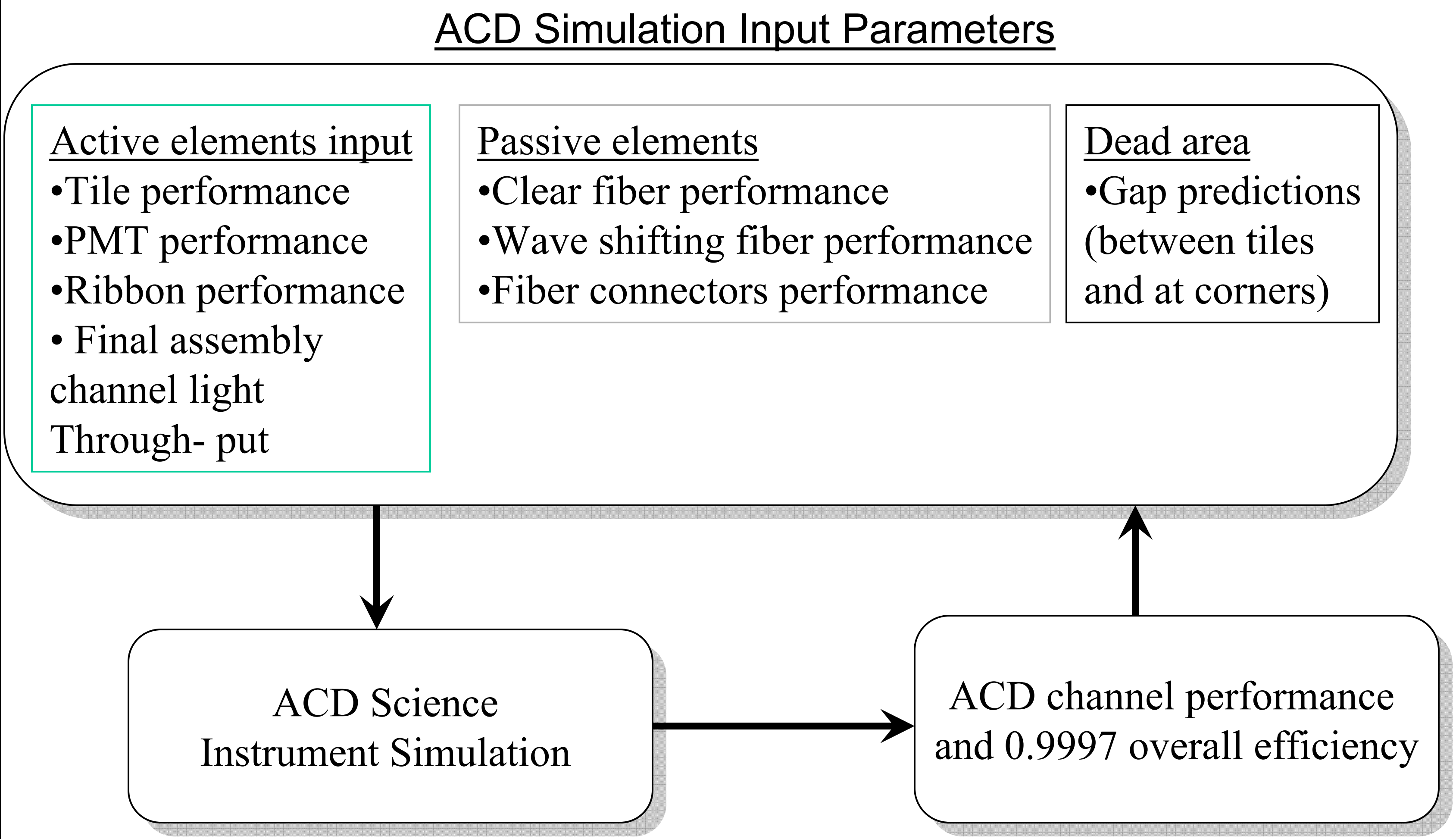
Active Links between Requirements

ID	LAT ACD Subsystem Level IV Requirements and Verification Table, LAT-SS-00352	In-links at depth 1	Req Action item	Req
ACD4-89	**5.10.5 HVBS Input Power**			
ACD4-90	Each HVBS shall operate from a supply voltage of 28V ± 1V, with possible input ripple of 10 mV (frequency range 50 Hz to 50 MHz). The noise shall be less than 100 mV RMS from DC to 1.0 MHz.	ACD ICD LAT-SS-00363 ACDICD-45		
ACD4-91	**5.10.6 HVBS Line and Load Regulation**			
ACD4-92	The HVBS output voltage shall be regulated to ±0.5% for all combinations of input voltage and load current. (This produces ~5% change in PMT gain).	ACD Level III Requirements LAT-SS-00016 ACD3-18 ACD Level III Requirements LAT-SS-00016 ACD3-20		
ACD4-93	**5.10.7 HVBS Output Ripple**			
ACD4-94	The HVBS output voltage ripple shall be compatible with the ACD ASIC design. The HVBS output voltage ripple shall not exceed ±2 mV p-p over the frequency range 100 Hz to 50 MHz	ACD Level III Requirements LAT-SS-00016 ACD3-16		

ACD Level IV Requirement Database (DOORS)

ACD Requirements

- Some important requirements flow through a science simulation



ACD Requirements – Changes since CDR

- **CHANGES IN THE LAT ICD**

CHANGE REQUEST	*DESCRIPTION*	*REASON*
LAT-XR-842-03 *(Pre-LAT CDR)*	1. *Updated CG requirement* 2. *Connector specifications* 3. *Flight and test instrumentation (thermal and vibration) specifications* 4. *Clarification on optical survey and measurement* 5. *Added helium mitigation plan*	1. *Correct known errors* 2. *Clarification and finalization of requirements.* 3. *Finalize requirements* 4. *Finalize requirements* 5. *Required for PMTs*
LAT-XR-774-02	1. *Dead Time Requirement* 2. *Adjustable High Threshold* 3. *Low Threshold signal and adjustment* 4. *Mass allocation* 5. *Micrometeoroid protection*	1. *Clarification* 2. *Adjusted slightly* 3. *Deleted. Replaced by zero suppression* 4. *Increase required* 5. *Relaxed requirement due to new reliability assessment*

ACD Requirements – Changes since CDR

- CHANGES IN THE LAT ICD

CHANGE REQUEST	*DESCRIPTION*	*REASON*
LAT-XR-02469-01	1. *Power allocation reduced* 2. *Z-axis CG lowered* 3. *Detector coverage of Trackers*	1. *Reduced from 31W to 10.5W average nominal* 2. *Reduced from 393mm to 330mm* 3. *Clarified position of detectors with respect to the LAT*
LAT-XR-03019-01	*Helium limitation requirement*	*Helium exposure limit increased*
LAT-XR-04774-01	*BEA survival temperature*	*Increased from -40C to -30C due to concern about PMT glass failure*
LAT-XR-03304-01	1. *Connector locations* 2. *Added external triggers* 3. *MLI interface* 4. *Vent path*	1. *Changed location of some connectors* 2. *Required to test ACD* 3. *Clarified* 4. *Clarified*

ACD Requirements – Changes since CDR

- CHANGES IN THE LAT ICD

CHANGE REQUEST	DESCRIPTION	REASON
LAT-XR-04696-01	1. ACD mass 2. Bottom Tile Detector Assembly location 3. Connector location 4. GARC Reset 5. LVDS termination resistor tolerance 6. Cable impedance 7. Power supply voltage range 8. 28V and 3.3 V power supply current limiting and monitoring requirements added 9. Grid surface	1. Increase required 2. Better definition required. 3. Detail added 4. Solution for GARC reset issue implemented 5. Tolerance was not previously specified 6. Requirement added 7. Changed requirement from 27-29 V to 24-29 V 8. Required for safety and monitoring of ACD 9. Changed from alodine to black anodize

ACD Requirements – Changes since CDR

- CHANGES IN THE LAT ICD

CHANGE REQUEST	*DESCRIPTION*	*REASON*
LAT-XR-05240-01-01	1. *ACD mass* 2. *Z-axis CG*	1. *Increase required* 2. *Increased from 330mm to 340mm*
LAT-XR-06717-01	1. *Interface cable design* 2. *Grounding* 3. *Maximum power* 4. *MLI grounding*	1. *Updated to reflect current design* 2. *Updated FREE board to chassis ground details* 3. *Updated maximum power dissipation* 4. *Added detail*

- CHANGES IN LAT IDD -
  - More defined stay clears, connector locations, hardware
  - Change in location of blanket interface – moved up from bottom of ACD
  - Addition of ACD blanket ground plate and probable harness run paths
  - Insert call out change

TESTING OVERVIEW

Test Verification Matrix

ACD PSR

8 August 2005

Note : Many tests needed by items are done at a higher subassembly, so also look up in higher assemblies for a test.

Green rows - flight, yellow - eng model, white - spares or development

--Not done at P.E.R., Complete now

--Descoped

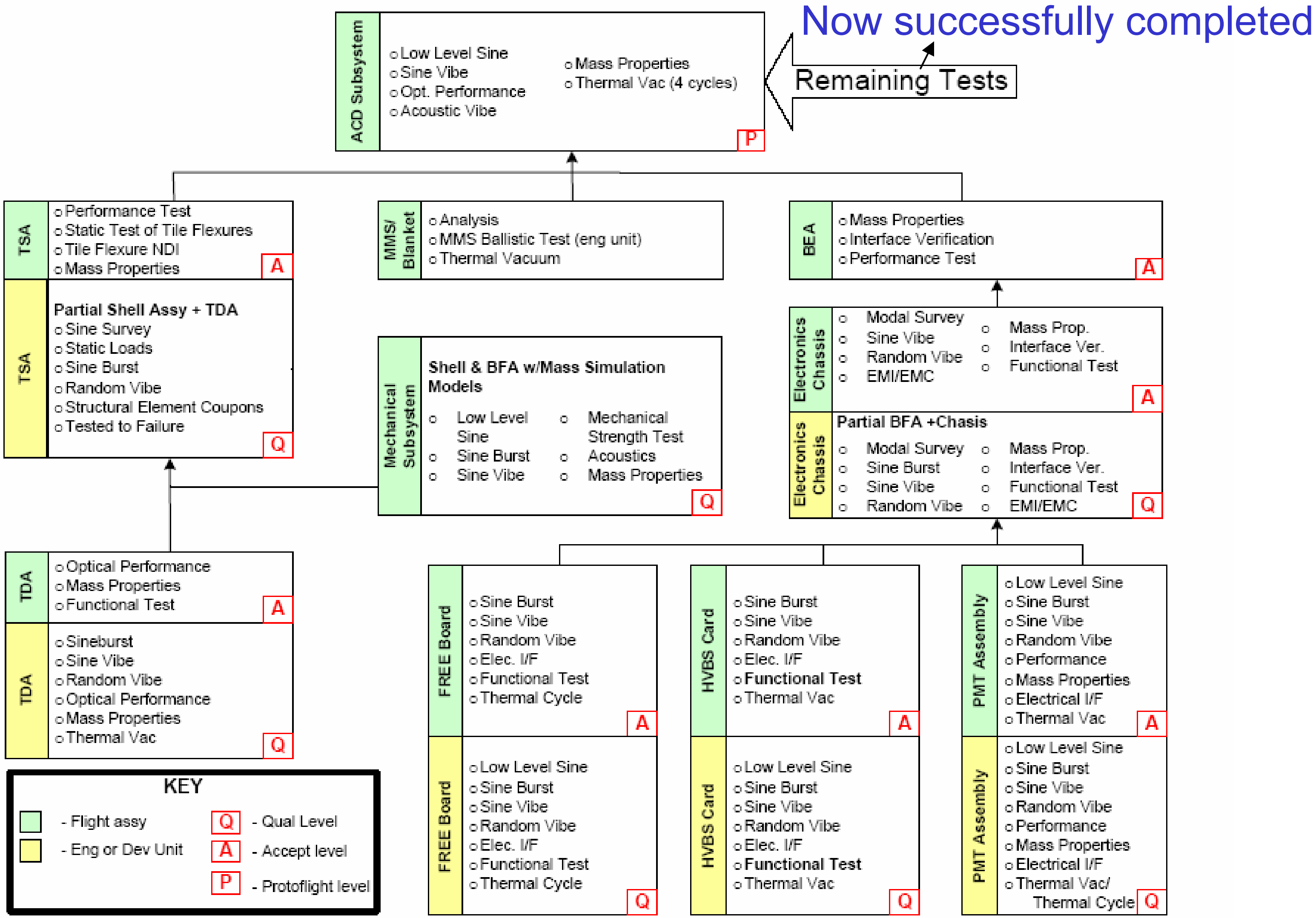
Note : Electronics board components and other small part qualification and testing (i.e Garc, GAFE, HVBS cpacitors, Mech fastners etc..) is captured in the ACD parts program plan

Green rows - Flight component rows Yellow rows - Engineering Model rows Item - major subassemblies in bold	Level of Assembly	Unit Type	Supplier	Test Levels	Test Status	Modal Survey (low level sine survey)	Static Loads	Sine Burst	Sine Vibration	Random Vibration	Mechanical Function/	Optical Performance Testing	Acoustics	Mass Properties	Interface Verif.	EMC/EMI	ESD Compat (Grounding?)	Magnetics	Screening Process	Aliveness (A) / Functional (F) / Comprehensive (C)	# of 12 cyc for qual, 4 for accpt)	Thermal Cycle	Thermal Balance	IMPORTANT NOTES
FULLY INTEGRATED ACD	S	F	GSFC	Prtoflt		X		*	X			X	X	X	X	*	X			C	4		X	Protoflight Levels - qualification levels at reduced durations, possibly notched. Acoustic to qual tiles, i.e. "sine burst and EMI descoped at this level pending waiver, need to determine exactly which props measured in mass prop
Tile Shell Assembly	SA	F	GSFC	Acpt										X										
Tile Shell Assembly - partial	SA	D	GSFC	Qual		X	X	X	X	X	X			X							6			All qual units need total of 12 cycles, TDA already has seen 6, making exception for some purely mech subsystems
ACD Mechanical Subsystem (no	S	F	GSFC	Qual		X-e		X-e	X-e		X		X	X										ACD Structure w/mass sims, no elect or det, LAT mass simulator needed ?
Shell	C	F	TBD	N/A										X										Do thermal vac because you have to bake out anyway
Shell - partial	P	D	GSFC	Qual			X-b																	
Tile Detector Assembly	SA	F	Fermilab	Acpt								X		X						A, F				69 Flt TDAs one flt unit may see therm vac before assemb to shell
Tile Detector Assembly	SA	S	Fermilab	Acpt				X	X			X	X	X							12			24 spares
Tile Detector Assembly	SA	EM	Fermilab	Qual				X	X	X-m		X		X						F	6			20 TDAs. The 6 therm vac cycles should have been 12, we may need to do 6 more to qual
Tile Detector Assembly	SA	D	Fermilab	Qual								X									12			Functional testing code660
TDA Tiedown (Flexure)	P	F	GSFC	Prtoflt																				Test bonded joint
TDA Tiedown (Flexure)	P	EM	GSFC	Qual			X ?	X	X	X-m	X			X										Test bonded joint
TDA Tiedown (Flexure)	P	D	GSFC	Qual			X-b																	Characterize flexures
WSF/Clear Fiber Connector	C	F	GSFC	Acpt								X		X						A, F				
WSF/Clear Fiber Connector	C	EM	GSFC	Qual			X	X	X	X-m	X	X		X						F				
WSF/Clear Fiber Connector	C	D	GSFC	Qual								X								A		8		Several development models
Base Frame	C	F	GSFC	Qual			X				X			X	X									Lift interface at this level, could also be done at ACD mech subsystem level
Partial BFA & Electronics Chassis	SA	EM	GSFC	Qual				X?	X?	X?-m					X	X	X			F				Corner or one side BFA, BEA assemb. T.V.deleted. All other testing in the base frame may be eliminated except for EMI
Base Frame - partial	C	D	GSFC	Qual																				No env tests planned at this time
Shield & Thermal Blanket	C	F	GSFC											X								X"		Similarity to dev. Model, " therm cyccle is really bakeout
Shield & Thermal Blanket -see rema	C	EM	GSFC											X										May not build Eng Model, Similarity to dev. model
Shield & Thermal Blanket	C	D	JSC, GSF	Qual																				Characterize thermal perf., particle impact
Clear fiber cable assembly	SA	F	GSFC	Qual								X								A				
PMT/Fiber Connector	C	F	GSFC									X								A				any spares not in a TDA wil need to see testing
PMT/Fiber Connector	C	EM	GSFC	Qual					X	X	X	X								F	6			
PMT/Fiber Connector	C	D	GSFC	Qual								X								F		8		Several development models
Base Electronics Assembly	S	F	GSFC	Acpt										X	X					F				
Electronics Chassis	SA	F	GSFC	Acpt		X			X	X-m				X	X					F	4			(FREE, HVBS, PMT)
Electronics Chassis	SA	S	GSFC	Qual		X		X	X	X-m				X	X					F	12			(FREE, HVBS, PMT), Same testing as flight units but qual requires 12 T.V. cycles, this is the first flight chassis we build, used as qual
Electronics Chassis	SA	EM	GSFC	Qual		X		X	X	X-m				X	X					F	4			(FREE, HVBS, PMT), All qual units usually need total of 12 cycles, the thinking is that this is not flight like enough to use for qual so spare (first flight chassis built) is qual unit, may go to 12 cycles anyway. **HOWEVER first flight chassis built (probably the spare) will go through same qual tests specified for EM unit**
Electronics Chassis	SA	D	GSFC	N/A											X					F				(FREE, HVBS, PMT), thermal vac wont be done here if EM is almost ready

Top Level Environmental Test Flow (from matrix UPDATE)

ACD PSR

8 August 2005



Testing Descopes

- ***EMI tests on the full ACD were moved to LAT level. Tests on all chassis were done but tests on the full ACD with the noisy GASU EGSE were not likely to be useful and they were expensive***
- ***Waivers approved***
  - ***EMI at ACD system level waiver (reasons covered in PER)***
  - ***Thermal Balance waiver (covered in PER, the result is that a few ICD thermal interface requirements are only verified via analysis and only indirectly from thermal vacuum results, LAT not very sensitive to ACD thermal interface number variances)***

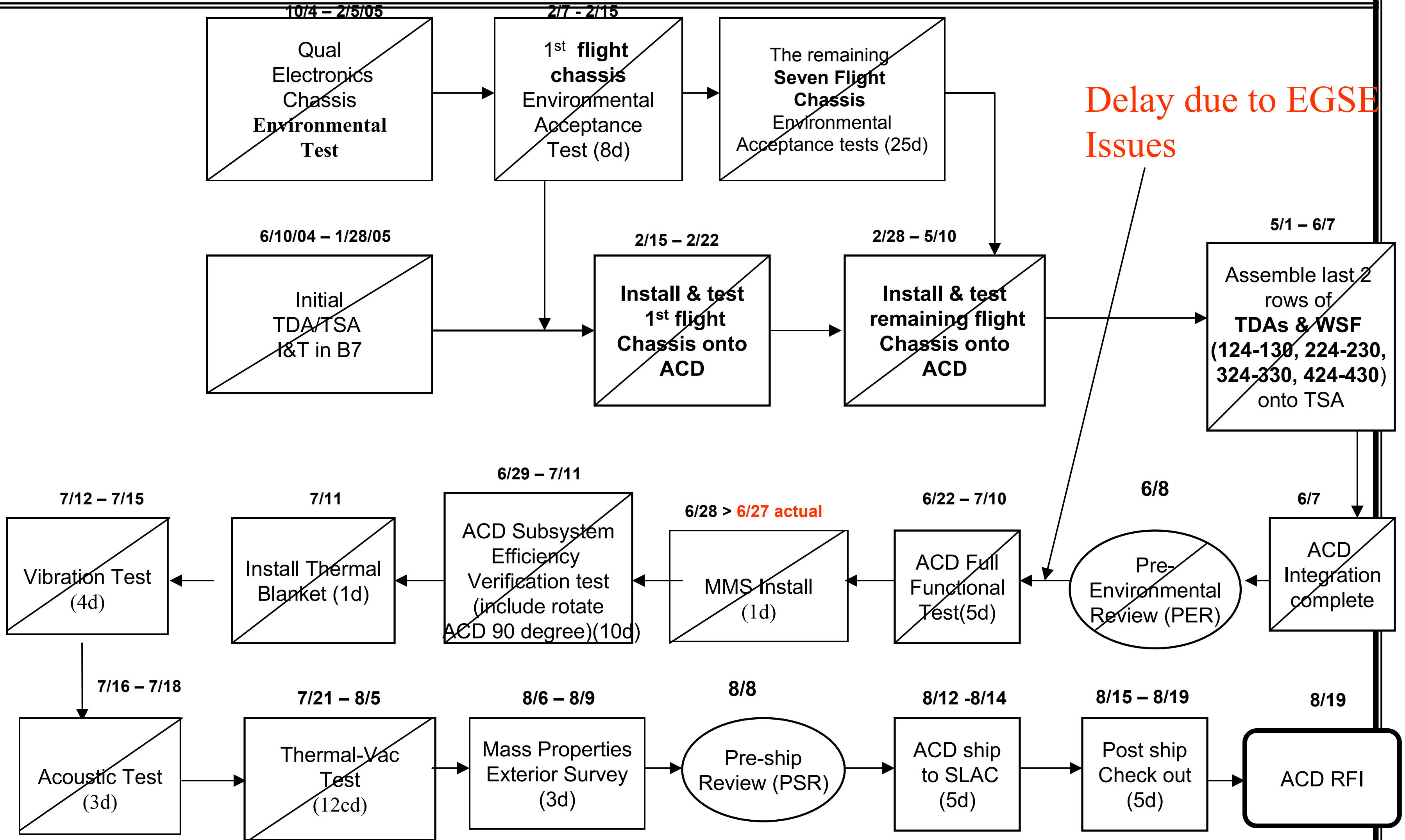
Environmental Test Flow

And

Functional Testing Results

Craig Coltharp
Integration and Test Manager, Code 568

ACD - Schedule Flow (as of 8/5)



Test Facilities Used

- *Vibration Facility*
  - *GSFC's MB C-220 Exciters (4,082Kg)*
  - *performed ACD TSA structural verification*
- *Acoustics Facility*
  - *GSFC's Acoustic Facility*
- *Thermal Vacuum Facility*
  - *Chamber 225*
    - *9' dia X 14' long*
    - *-310F to 302F*
- *Mass Properties*
  - *GSFC's MPMF (4,536Kg)*

PLANS

- GLAST LAT ACD Subsystem Verification Plan ACD-PLAN-000050
- ACD Configuration Management Plan ACD-PLAN-000107
- ACD Helium Monitor and Control Plan ACD-PLAN-000152
- ACD Integration and Test Plan ACD-PLAN-000350
- ACD-On-Ground Science Performance Calibration and Monitoring ACD-PLAN-000332
- ACD Flight Instrument Protoflight Vibration Test Plan ACD-PLAN-000334
- ACD Flight Instrument Protoflight Acoustic Test Plan ACD Flight Thermal Vacuum Test Plan ACD-PLAN-000347
- GLAST ACD Instrument and GSE Packaging, Handling, and Transportation Plan

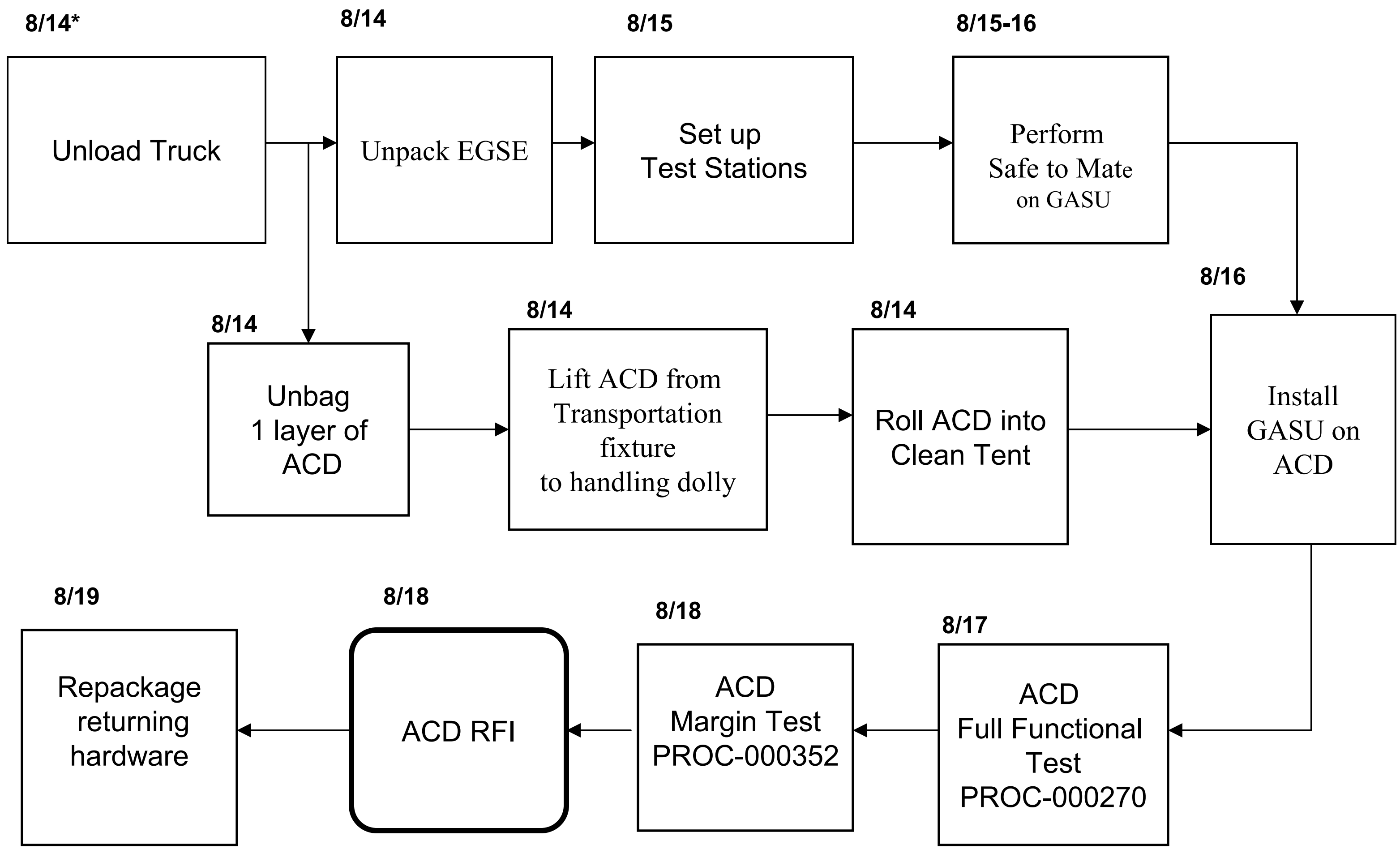
Procedures

ACD Mechanical Handling Procedure	ACD-PROC-000195
GLAST ACD Light Tight Test Procedure	ACD-PROC-000252
Comprehensive Performance Test Procedure	ACD-PROC-000270
ACD Redline Procedure for Engineering Documentation	ACD-PROC-000284
GASU #8 Safe to Mate Procedure	ACD-PROC-000333
ACD GN2 Purge Structure Removal Procedure	ACD-PROC-000336
ACD-Monitor Operational Test Procedure	ACD-PROC-000346
Aronson Table Operation Procedure	ACD-PROC-000349

Operational Hours Accumulated

- *Prior to environmental testing during functional & performance testing*
  - *approx 300 hours*
- *Hours accumulated during environmental test flow*
  - *Prior to TVAC* *24 hours*
  - *TVAC* *131 hours*
  - *Post TVAC* *8 hours*

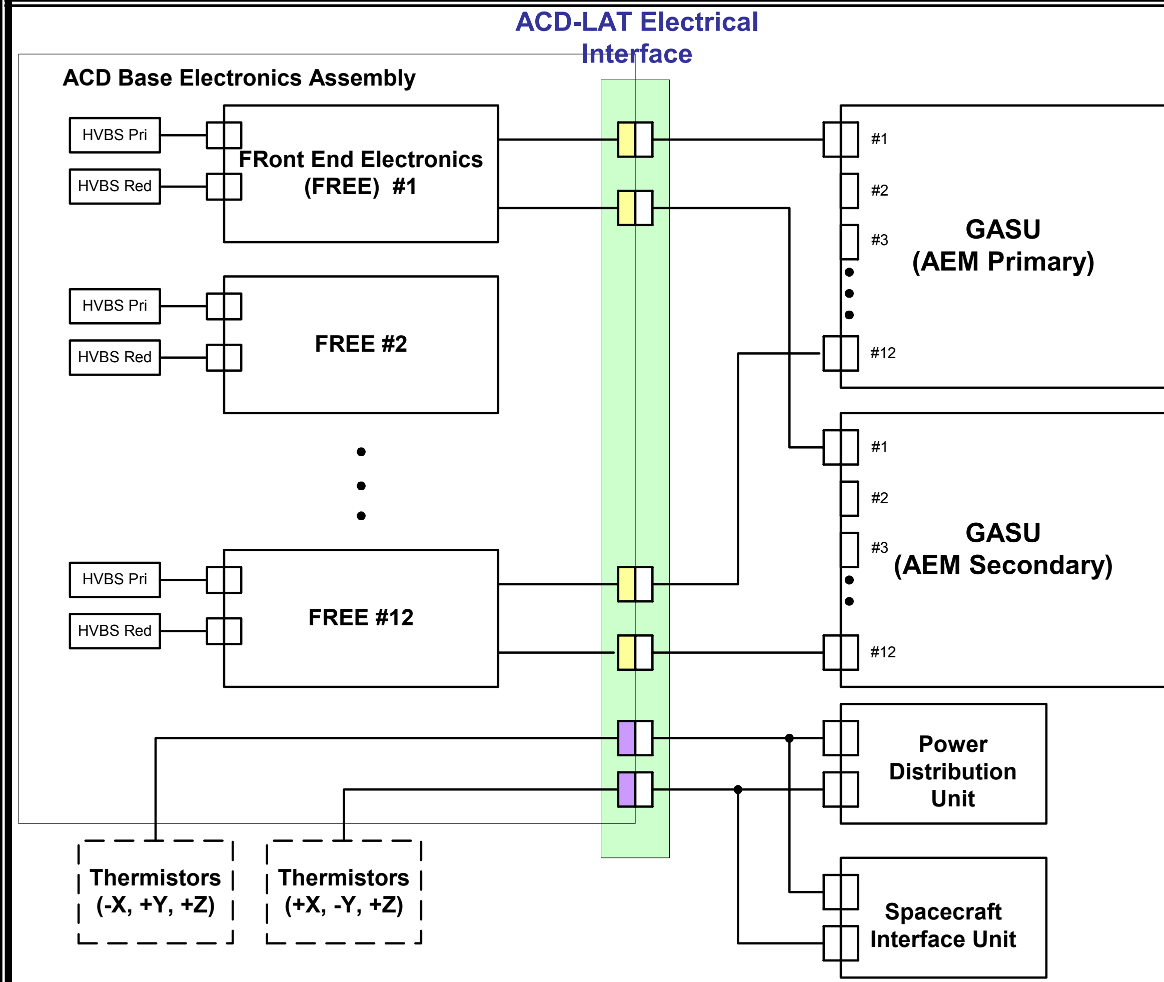
ACD - Post Delivery Flow (as of 8/5)



***- Based on ship date of August 12, could ship as early as August 10.**

TESTING -ELECTRICAL

Electrical Interface



- **24 identical robust circular connectors (38999, series 2) & 2 circular housekeeping connectors (38999, series 2)**
- **Parts, pin outs, signal def, grounding all defined in ICD**

DATA PRODUCTS
(defined in Reqs. and specified in ICD)

- **Channel specific charged particle VETOs**
- **VETO hit maps**
- **Pulse Height Analysis (PHA)**
- **Diagnostics**
- **Housekeeping (thermistor output, voltage monitor output, direct to AEM)**

Electrical Testing Summary

- ***Please recall that all electrical testing on individual chassis was complete and covered at P.E.R. There is no interdependency or connections between chassis. All that was left was to test all of then at once with the EGSE GASU instead of one at a time and to get overall performance data.***
- ***Partial Summary of the tests done -***
  - *ASIC part life, thermal cycle, burn in, and radiation testing*
  - *PMT and PMT subassembly performance, qualification and acceptance testing*
  - *FREE board performance, qualification and acceptance testing*
  - *HVBS board performance, qualification and acceptance testing*
  - *Complete Electronic Chassis performance, qualification and acceptance testing*

ACD Mechanical Pre-Ship Review

Aug 2005

ACD Mechanical Team

Ken Segal / Code 543, ACD Lead Mechanical Engineer

Ryan Simmons / Code 542, ACD Lead Mechanical Analyst

ACD Mechanical PER Presentation Outline

- ***ACD Mechanical Verification Testing***
  - *Test Levels*
  - *Sine Vibration and Acoustic Test Configurations*
  - *Sine Vibration Test*
  - *Acoustic Test*
  - *Dimensional Survey*
  - *Mass Properties Tests*
- ***Conclusions***

Test Levels

- ***Swept sine and acoustic protoflight levels***
  - *Sine testing will be limited to structural qualification test responses if required*
    - *X and Y-axes = 3.5g on the TSA*
    - *Z-axis = 4.0g on the TSA*

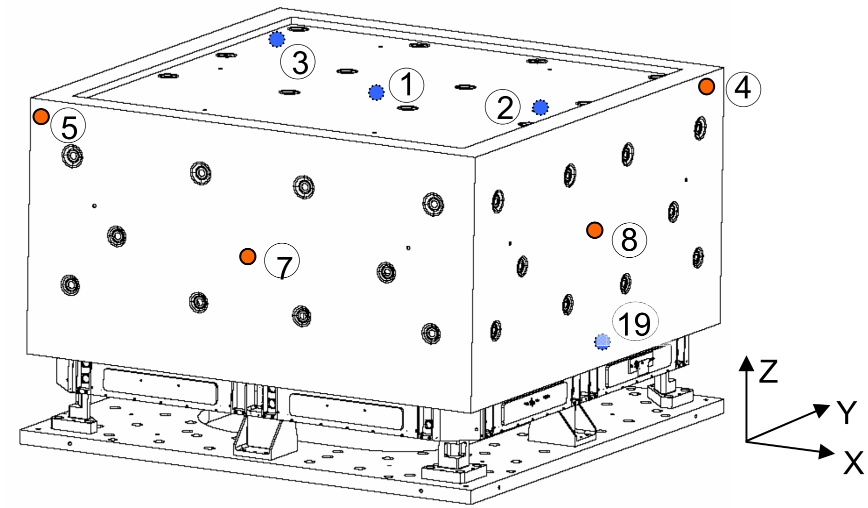
X & Y Axes Sine Sweep Protoflight Level		
Frequency (Hz)	Level (g, 0-pk)	Sweep Rate (oct/min)
5-15	2.5	4.0
15-25	0.9	4.0
25-35	0.9	1.5
35-40	0.9	4.0
40-50	1.9	4.0

Z Axis Sine Sweep Protoflight Level		
Frequency (Hz)	Level (g, 0-pk)	Sweep Rate (oct/min)
5-15	0.4	4.0
15-25	1.2	4.0
25-35	2.7	1.5
35-50	0.7	4.0

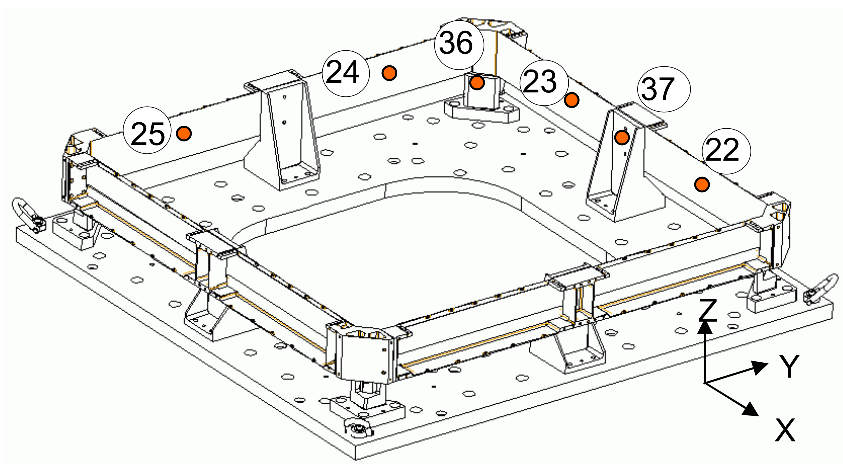
Acoustic Protoflight Level	
1/3 Octave Center Frequency	Protoflight Test Levels
(Hz)	(dB)
31.5	127.4
40	130.3
50	134.2
63	135.1
80	137.4
100	134.9
125	133.6
160	131.6
200	132.4
250	129.6
315	126.4
400	122.9
500	122.1
630	119.6
800	120.5
1000	120.2
1250	121.4
1600	122.0
2000	120.0
2500	120.3
3150	118.6
4000	116.0
5000	111.9
6300	107.9
8000	104.8
10000	102.8
Overall Sound Pressure Level (OASPL)	**143.8**
Duration	**60 sec.**

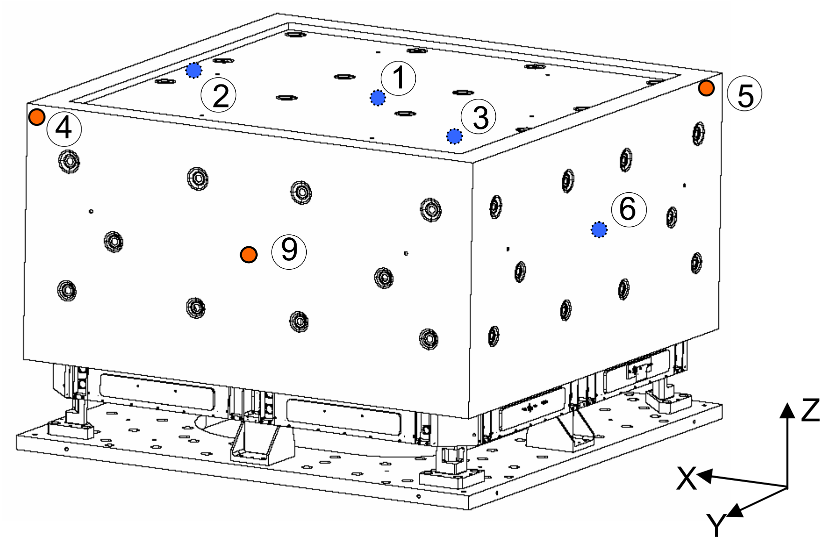
Test Configuration
Sine Vibration and Acoustic Tests

- ***BFA and TSA shown on the vibration fixture***
  - *2" plate*
  - *Eight mounting posts representing LAT I/F*
- ***Not Shown***
  - *Additional 3" plate for thrust axis vibration*
- ***Tested Configuration***
  - *Full ACD assembly minus GeKapton outer layer 0.83Kg (1.84lbs), MLI Velcro 0.3Kg*



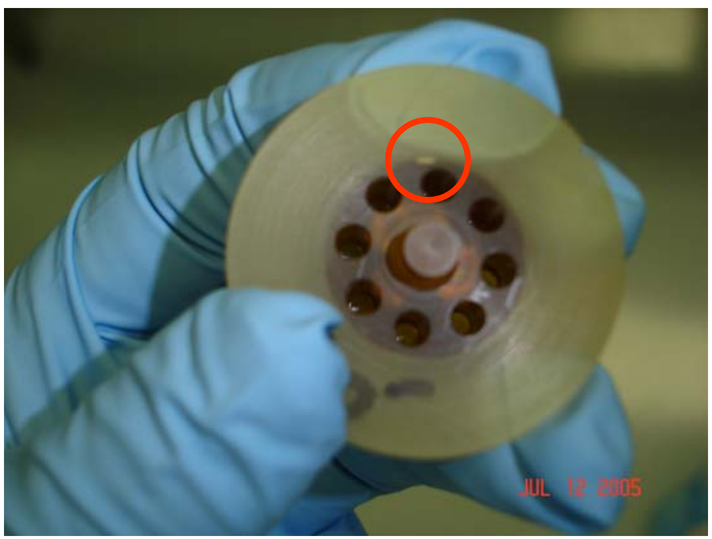
● Removable accelerometer locations (accels located on inside of TSA)
● Fly-away accelerometers

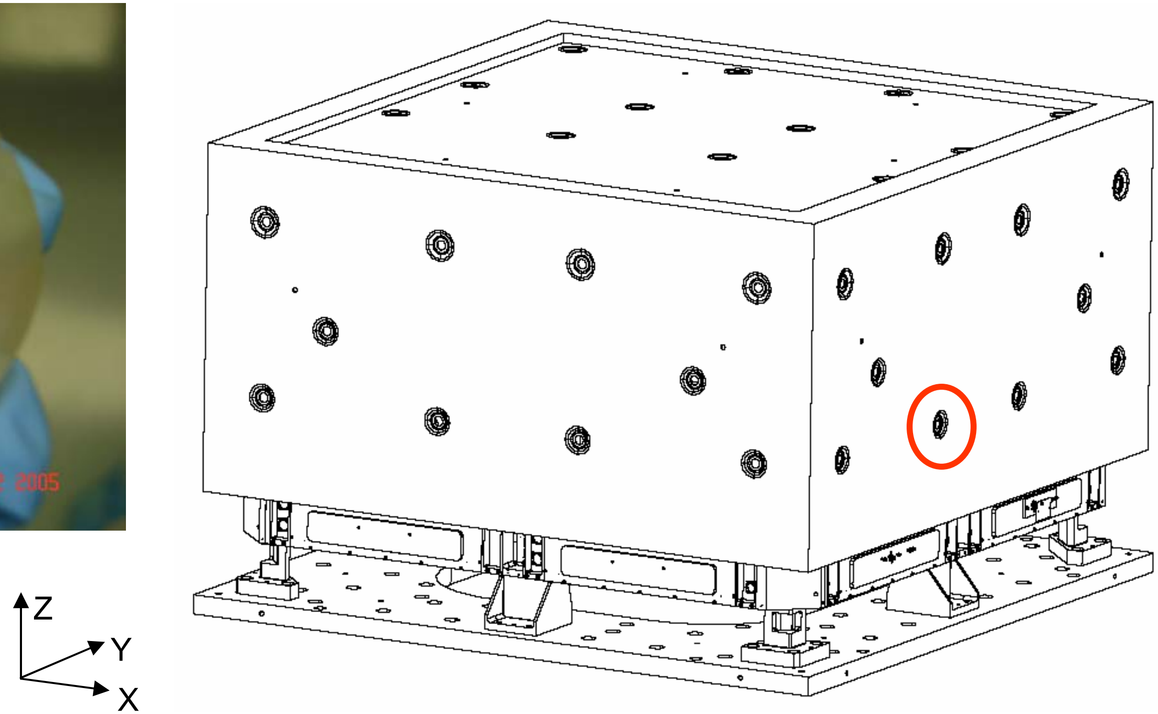




Test Configuration
Sine Vibration and Acoustic Tests

- ***Tested Configuration (Cont)***
  - ***MMS Post Configuration***
    - *One cracked MMS post in place on +X side as shown*
      - *Passed test without catastrophic failure*
      - *Will replace with acceptance tested post*
    - *Drawing Configuration could not be met with hardware delivered*
      - *EO produced to reflect what we tested and what will fly*



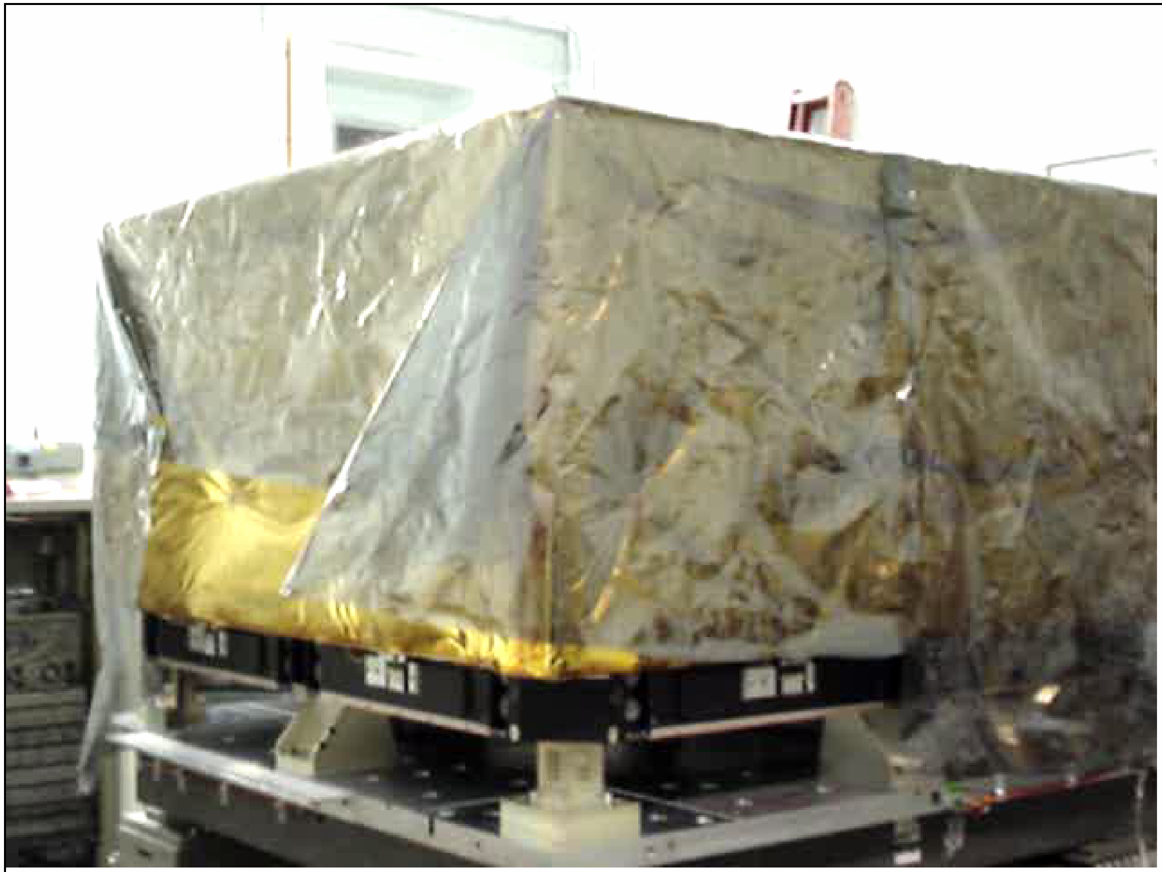


ACD Sine Vibration- Test Configuration

- ***ACD Shown in Z- Axis Test Configuration on the vibration fixture***
  - *2" plate and additional 3" plate for thrust axis vibration (z-axis only)*
  - *Eight mounting posts representing LAT I/F*

ACD Sine Vibration Testing

- *Lateral Axis Test and Test Configuration Shown*

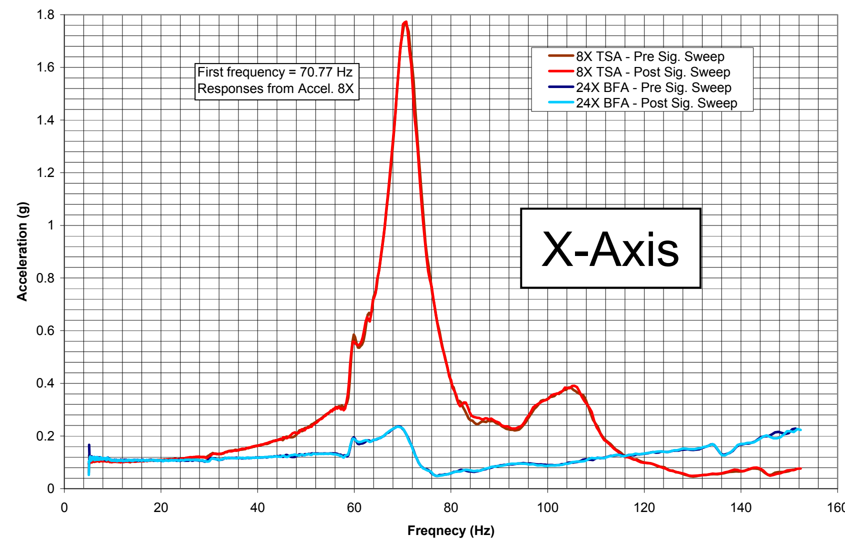


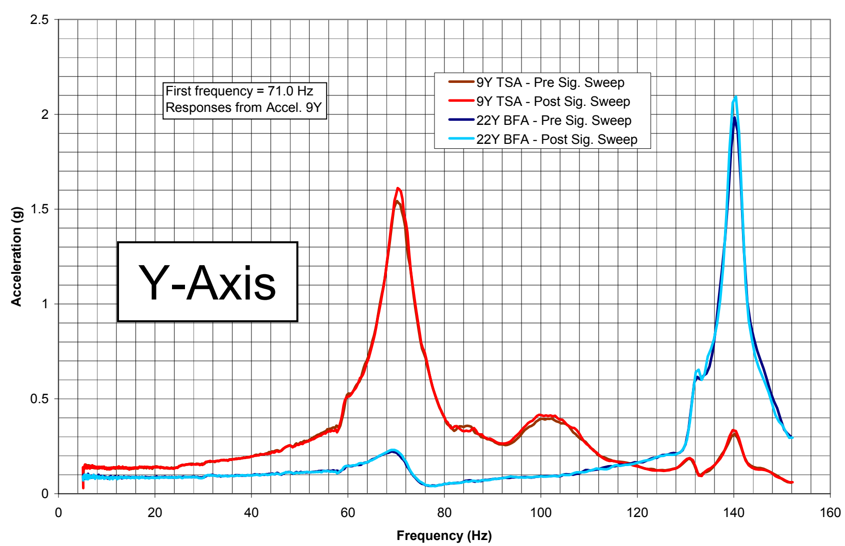
MOV00631

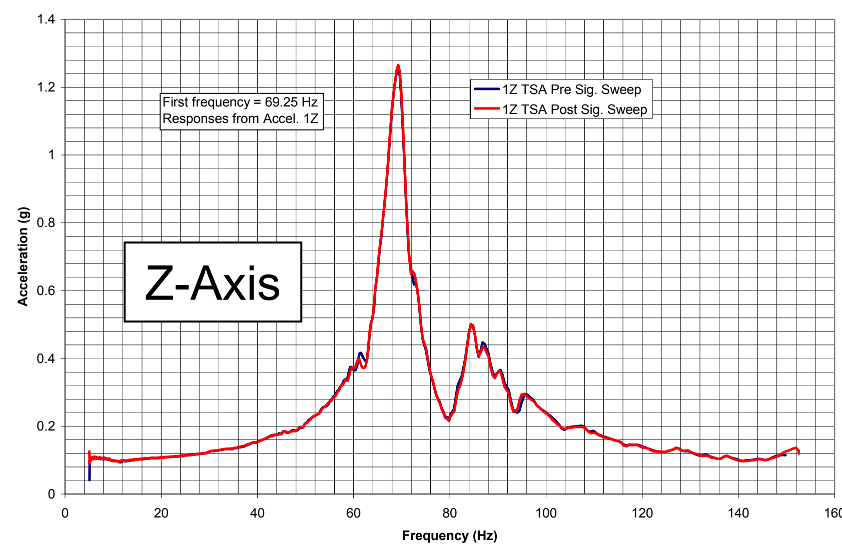
ACD Sine Vibration Test Results

- ***Signature Sine Sweep: 0.1g from 5-150 Hz***
- ***Natural Frequencies***
  - *X = 70.77 Hz*
  - *Y = 71.0 Hz*
  - *Z = 69.25*

All first modes are on the TSA

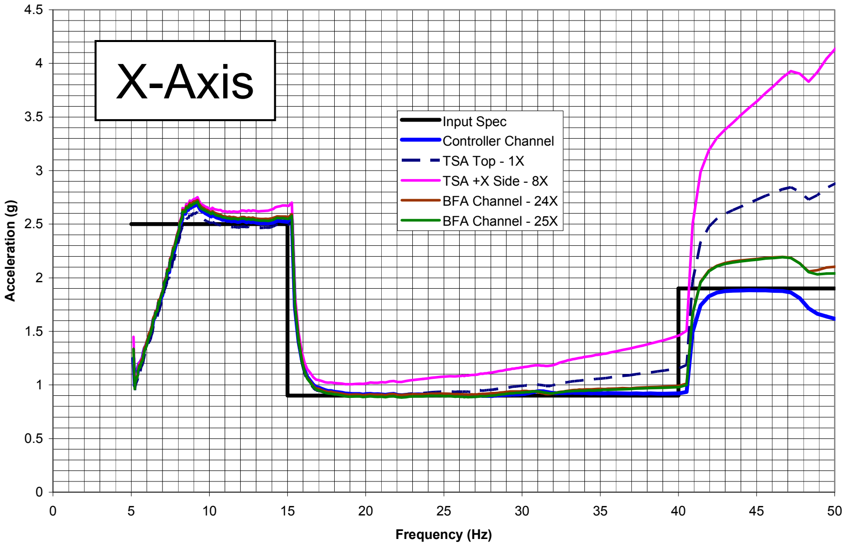


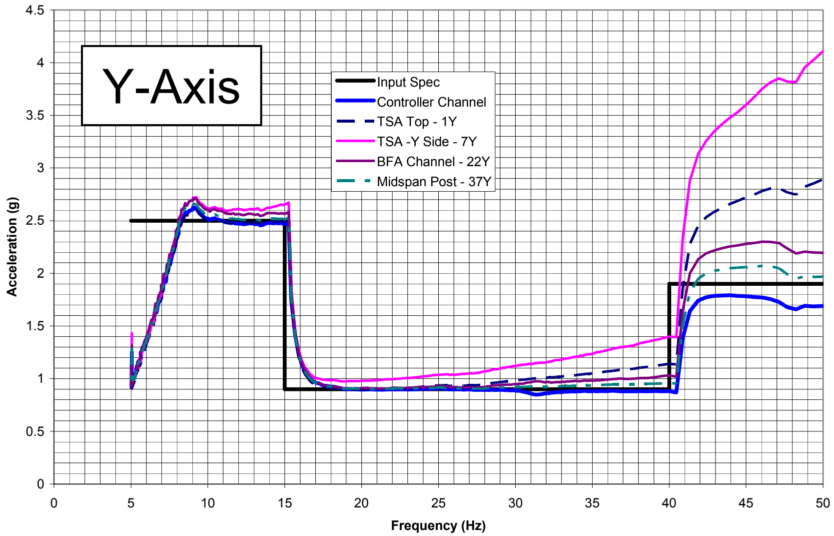


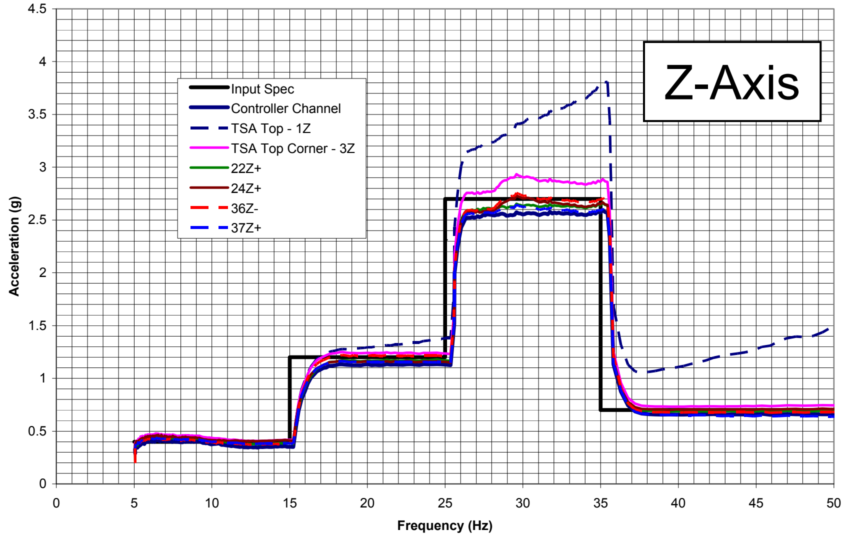


ACD Sine Vibration Test Results

- *Protoflight sine levels were successfully achieved*
- *No limits were reached*





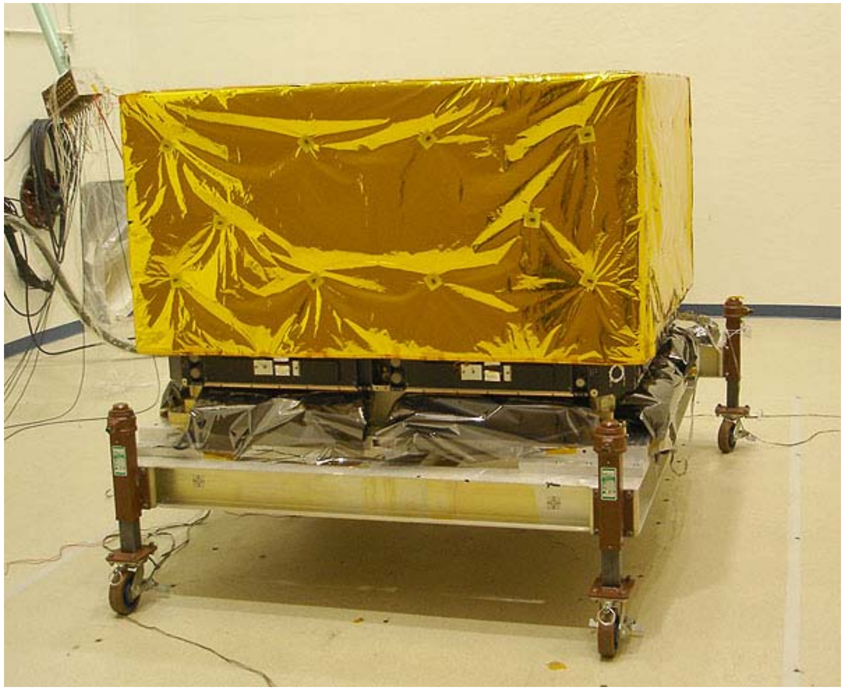


ACD Sine Vibration Test Results

- *ACD Passed Sine Vibration Tests - No Problems Detected*
  - *Structurally OK*
  - *Pre and Post Performance Assessment – Good*
  - *Documented in test report ACD-RPT-000363*

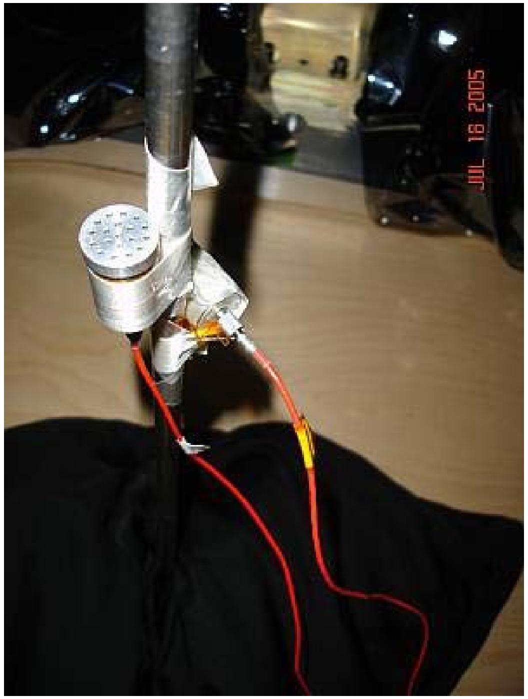
ACD Acoustic Test Configuration

- ***Test configuration***
  - ***Structure on the ACD dolly***
  - ***TSA cavity closed out at the vibe fixture (see next slide)***
  - ***Internal microphones installed (see next slide)***
  - ***Accelerometers same as in vibration tests***
    - *Accel #9 on the TSA +Y face detached prior to testing*
  - ***MMS and MLI installed***
    - *Again outer MLI layer of Germanium Kapton was not installed*
    - *Velcro for the LAT interface (along the bottom edge of the blankets) has not been installed.*
  - ***MMS Posts as described previously***



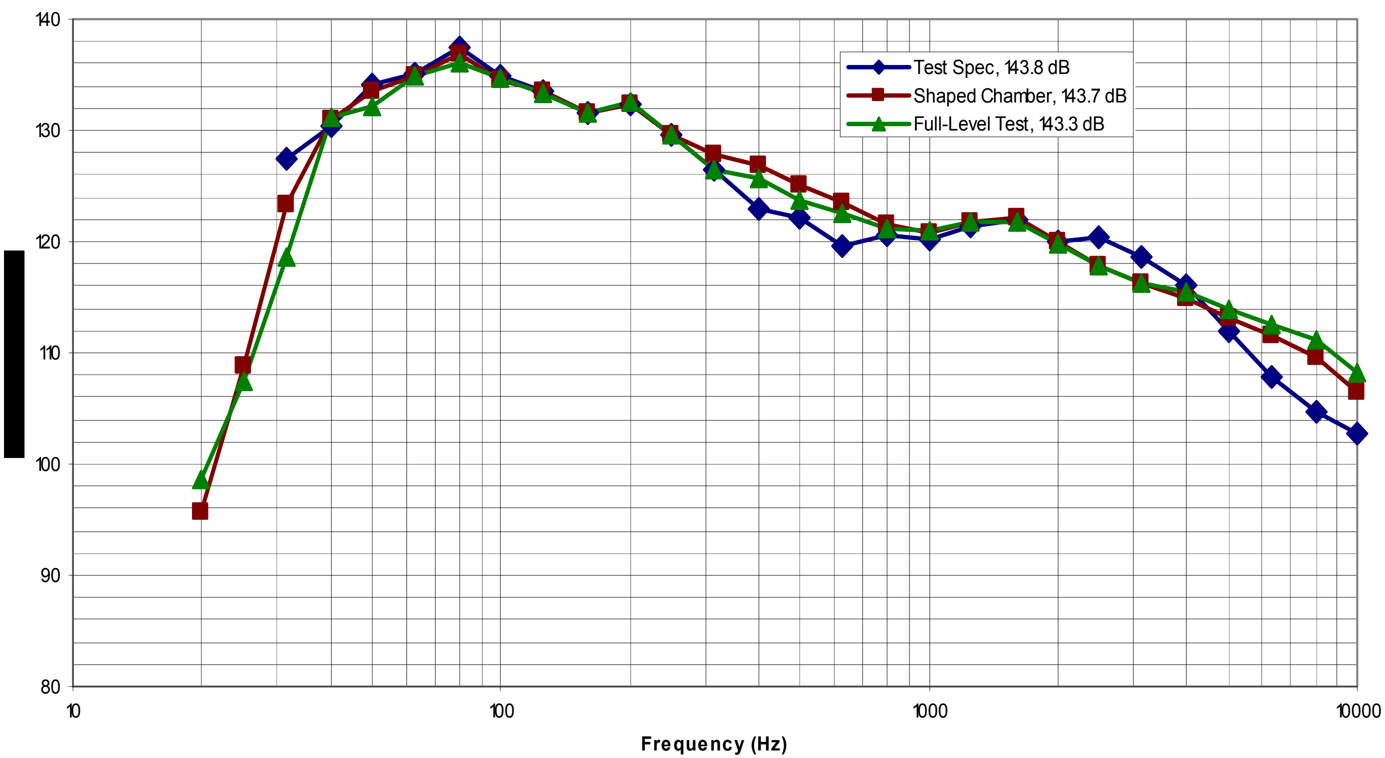
ACD Acoustic Test Configuration

- Two internal microphones where placed inside the ACD cavity
- Sandbags were used to close out the cavity to simulate the presence of LAT



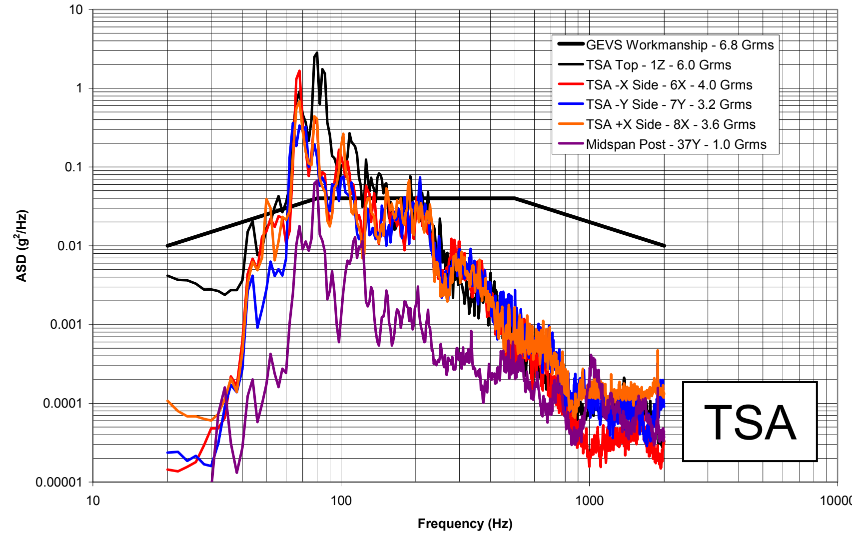
ACD Acoustic Test Results

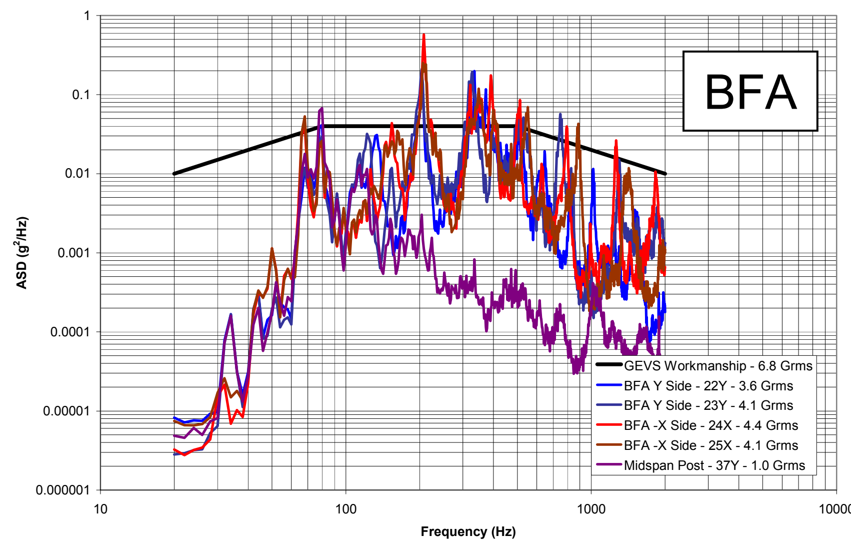
- ***Acoustic input was within protoflight specification***
  - *Input spec 143.8 dB*
  - *Shaped chamber at 143.7 dB (prior to bringing ACD in)*
  - *Final level 143.3 dB, well within the ±3dB limits*



ACD Acoustic Test Results

- ***ACD acoustic tests were nominal***
- ***All responses were as expected***
  - *Prior component random vibration testing was to GEVS minimum workmanship level of 6.8 Grms (shown on plots)*
  - *Acoustic results show that minimum workmanship levels were conservative*
- ***Chris Fransen, the GLAST acoustic analyst, is satisfied with the test results***
- ***One post-test issue found*** *(see next slide)*





ACD PSR

ACD Acoustic Test
PR 02324-001

8 August 2005

- ***One Issues to Report***
  - ***PR 02324-001***
    - *A Nut Plate like those used to secure tiles to tile flexure was found on floor in ACD +X, -Y corner after testing was completed.*
    - *Assessment*
      - *The Nut plate is believed to have been on ACD dolly before testing started. The nut plate in question had debonded from the angled shim it was mounted to during TDA installation and was inadvertently left behind. During acoustic tests it shook free. If this came off the flight assembly, analyses show that a tile mounted with 3 fasteners shows positive margin of safety.*

Where do nutplates reside?

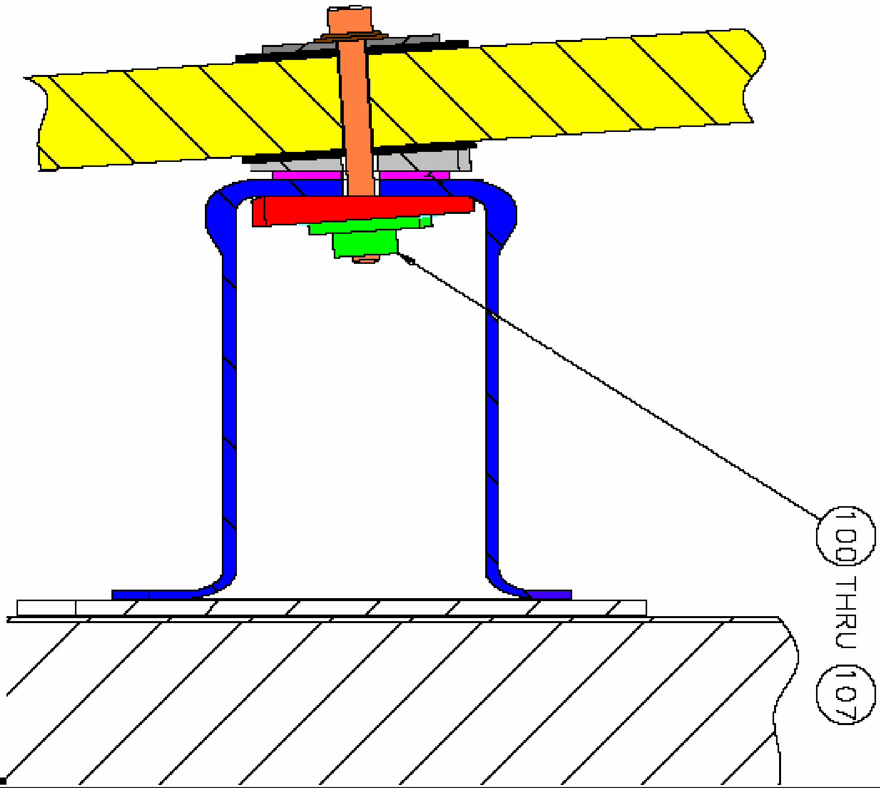
Where did this one come from?

Is it a structural or performance issue?

Where do nutplates reside?

In Tile flexures at 508 locations on ACD to hold 89 tiles to the structure.

- ***PR 02324-001***
  - *A Nut Plate like those used to secure tiles to tile flexure was found on floor in ACD +X, -Y corner after testing was completed.*
  - ***Where did this nutplate come from? An angled shim used on 2nd and 3rd row side tiles (40).***



Evidence-

The epoxy on the nutplate found has the impressions common to Angled Tile shims machining marks.

These are found in 160 places on the ACD.

ACD Acoustic Test
PR 02324-001

- ***PR 02324-001***
  - ***Assessment***
    - *A Nut Plate like those used to secure tiles to tile flexure was found on floor in ACD +X, -Y corner after testing was completed.*
  - ***Where did this nutplate come from? The nut plate is not from the ACD flight structure.***
  - ***Evidence:***
    - *Nut plates have a locking feature that requires 0.5 in-lbs to overcome the locking feature. The locking feature is not likely to be overcome through vibration or acoustic loadings.*
    - *One is being passed around for you to feel the locking grip.*

ACD Acoustic Test
PR 02324-001

- ***PR 02324-001***
  - ***Assessment***
    - *A Nut Plate like those used to secure tiles to tile flexure was found on floor in ACD +X, -Y corner after testing was completed.*
  - ***Where did this nutplate come from? The nut plate is not from the ACD flight structure.***

Evidence:

Nut plate is captured within a flexure by tape that surrounds each flexure to provide light tight seal. Light tight seal is validated through light tight testing.

Meaning: It is unlikely that a loose nutplate would get 'free'

Example of a taped

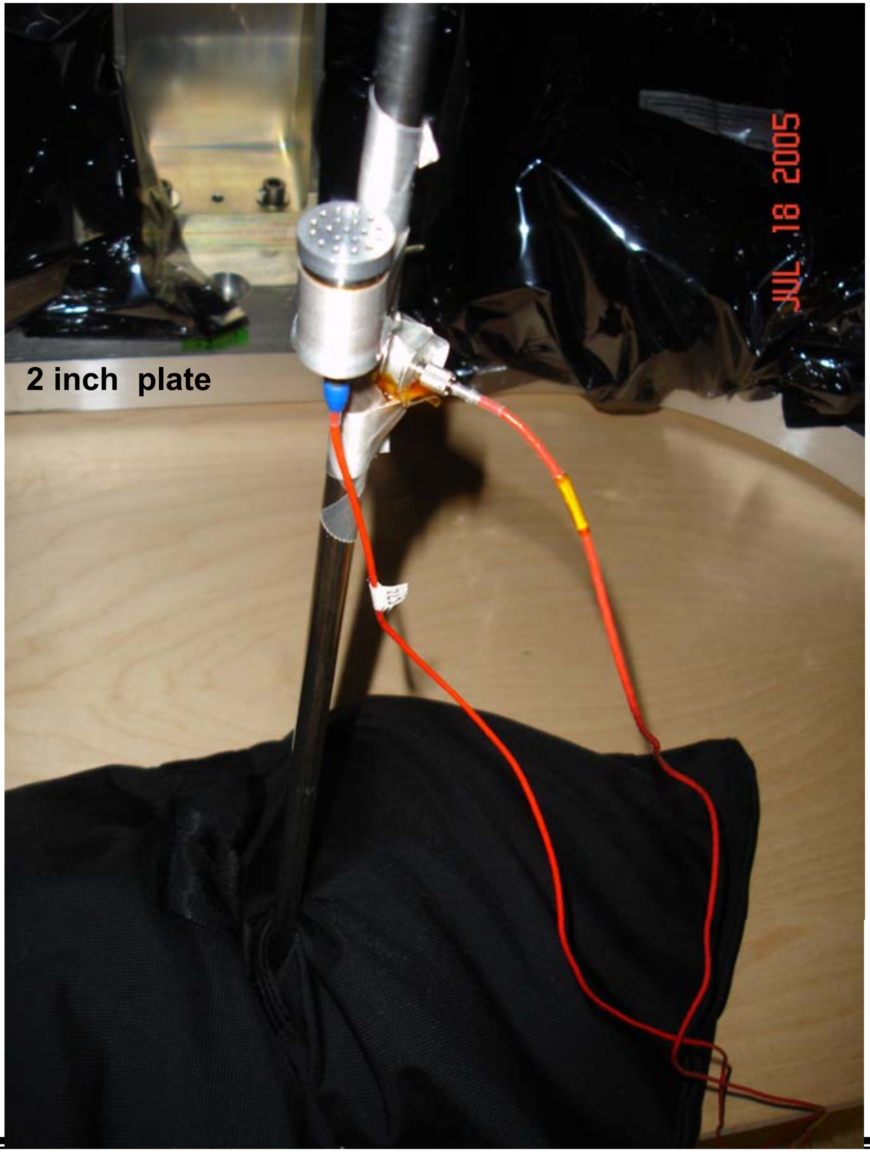
Flexures are Shown

ACD PSR

ACD Acoustic Test
PR 02324-001

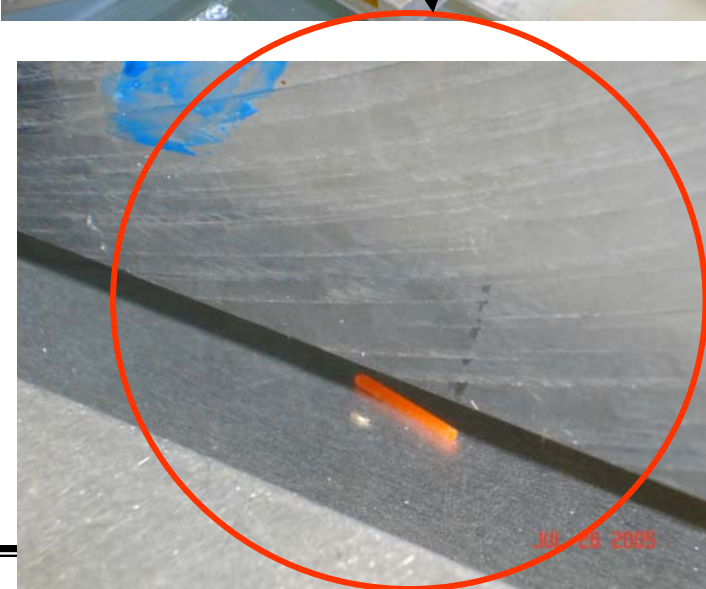
8 August 2005

- ***PR 02324-001***
  - ***Assessment***
    - *A Nut Plate like those used to secure tiles to tile flexure was found on floor in ACD +X, -Y corner after testing was completed.*
  - ***Where did this nutplate come from?*** ***The nut plate is not from the ACD flight structure.***
  - ***Evidence***
    - *The ACD had closeouts between the ACD and the 2" plate and covering the hole in the 2 inch plate*
    - *Picture shows inside the ACD for the Acoustic test.*
      - *Notice: the wooden plywood used to closeout the 2" plate and the closeouts in place between the ACD and the 2" plate*



ACD Acoustic Test
PR 02324-001

- ***PR 02324-001***
  - ***Assessment***
    - *A Nut Plate like those used to secure tiles to tile flexure was found on floor in ACD +X, -Y corner after testing was completed.*
  - ***Where did this nutplate come from?***
    - *The Nut plate is believed to been on ACD dolly before testing started. The nut plate (one of 6) debonded from the angled shim it was mounted to during TDA installation.*
  - ***Evidence:***
    - Post Acoustic Test Inspection result:
    - nutplate installation tool found in the +x, -y corner of the ACD dolly
  - **Meaning**
    - A nutplate replacement is likely to have occurred in this location and the nutplate may have been in this location and it was missed during cleanup.



ACD Acoustic Test
PR 02324-001

- ***PR 02324-001***
  - ***Assessment***
    - *If the nutplate came off the flight structure…..*Is it a structural or performance issue?
    - Analyses has been done for a tile mounted with 3 fasteners
      - *Results show positive margin of safety for*
        - ***Fasteners***
        - ***Flexures***
        - ***Tiles***
- ***PR 02324-001 Conclusion***
  - ***The flight structure most probably did not shed any parts, and if one fastener is loose it does not pose a performance problem: therefore, proceed with ACD shipping.***

ACD Environmental Vibration Summary

- ***All mechanical test levels achieved.***
- ***One post-test issue – nutplate found on floor***
- ***ACD Passed All Tests***
  - *Structurally - Pre- and post-test signature sine sweeps agree excellently for swept sine testing*
  - *No indication of damage following acoustic testing (see previous slide)*
  - *Pre and Post performance assessment – Good*
  - *Results documented in test report ACD-RPT-000363*

ACD Mass Properties Results

- ***ACD Mass***
  - ***Mass Requirement < 295Kg***
  - ***Mass Measured = 283.2Kg (Margin of 11.8Kg)***
  - ***Mass Liens***
    - *SUBTRACT – Thermal testing instrumentation, connector caps, Llumalloy cover.*
    - *ADDITIONAL - Ge Kapton*
      - *~0.83Kg spread over outer area*
    - *ADDITIONAL - Velcro interface to MLI (for LAT MLI to ACD MLI interface)*
      - *~ 0.3 Kg is below CG*
- ***ACD CG***
  - ***Requirement is***
    - *X and Y < 6mm*
    - *Z<340mm where Z=0 is the LAT Frame of Reference*
  - ***Configuration***
    - *ACD Secured to Vibration Test Setup and 3" plate*
  - ***Measured CG***
    - *X= +0.3mm*
    - *Y= -1.3mm*
    - *Z = +310.2mm*

ACD Dimensional Survey

- ***Dimensional Survey Is To Be Completed***
- ***Requirements:***
  - *Bottom Edge of ACD Bottom Tile Detector = 158.17 ± 0.50mm (6.227 ± 0.020) in the +Z direction from the ACD-LAT interface plane.*
  - *Stay-clear Volumes IAW LAT-DS-00309, ACD-LAT Interface Definition Drawing*
- ***Bottom Edge of ACD Bottom Tile Detector Verified to be 6.187"***
  - *Out of Requirement - Tile is too low by 0.020"*
  - *Based on measurements:*
    - *6.045 Channel Max Allowable Height*
    - *0.125 Installation Measurement Tile Wrapping to Channel*
    - *0.017 Tile Wrapping Measurement*
  - *ACD Team Believes the minus tolerance is in error (should be infinite)*
  - *WAIVER TO BE GENERATED*

ACD Dimensional Verifications
Interior Stay Clear Volume Violations

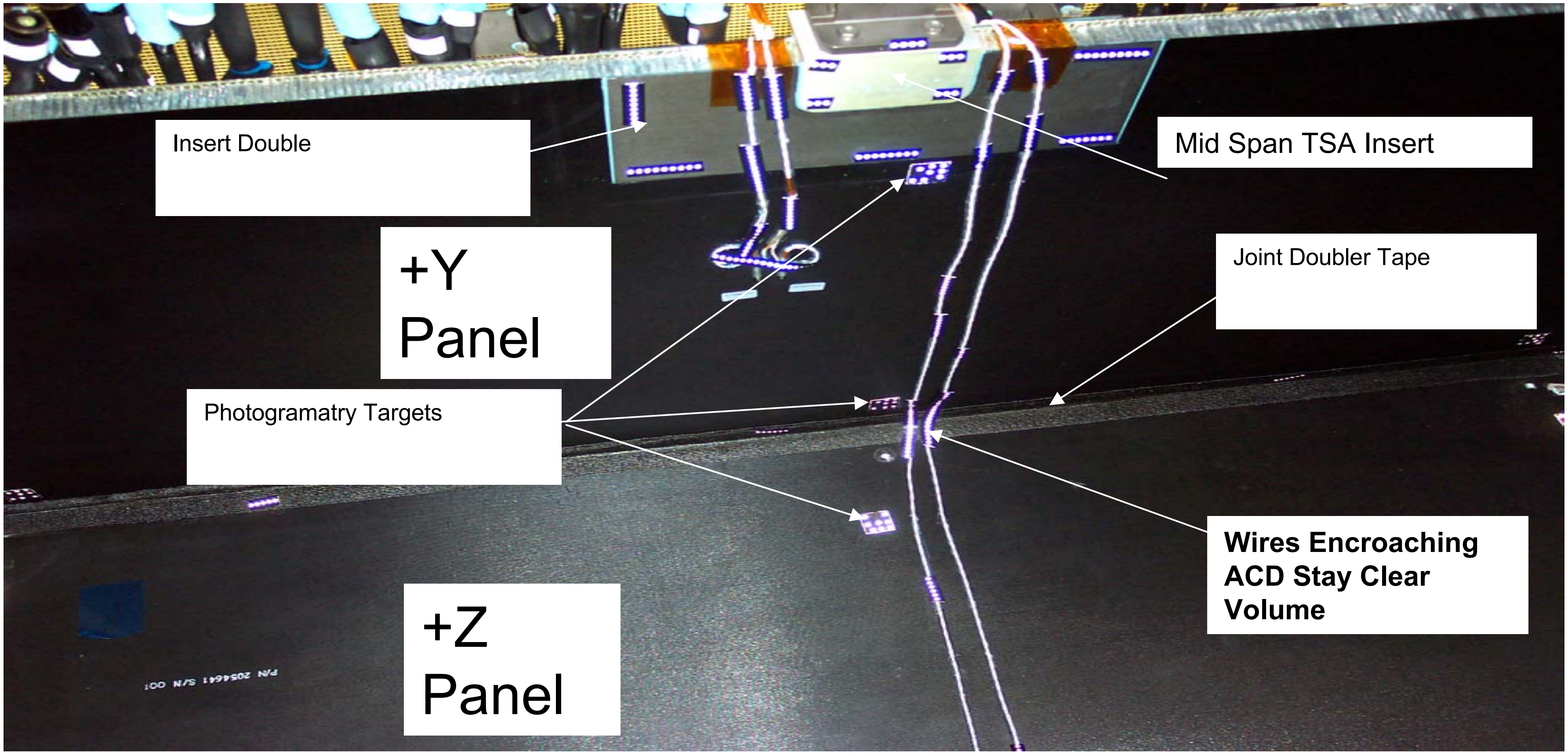
- ***Interior Stay Clear Volume Measurement Complete***
  - *Two violations established issues being addressed*
    - *Interior Wire on Tile Shell Assembly (TSA) inside Surface*
    - *Base Frame Assembly (BFA) Inside Surface*

ACD Dimensional Verifications

Interior Stay Clear Volume Violation-TSA

ACD PSR

8 August 2005

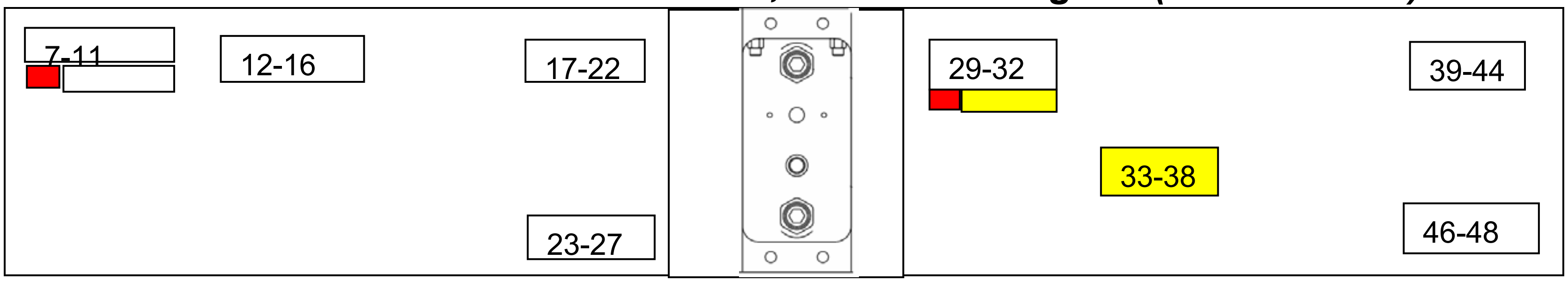


- ***An Interior Wire violates Interior Stay Clear by as much as 0.022"***
  - ***A waiver has been written, sent to LAT, and waiver is in the signature cycle.***

ACD Dimensional Verifications

Interior Stay Clear Volume Violation-BFA

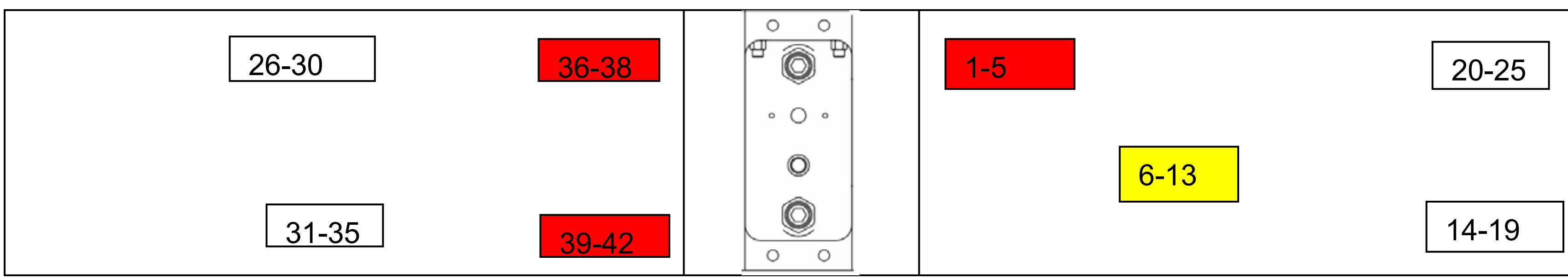
- ***BFA Violations- Red is out of tolerance, Yellow is marginal (.002-.004 out)***



Point 8: 0.014

Point 29 0.005

+X BFA



Points 1-5 : 0.014

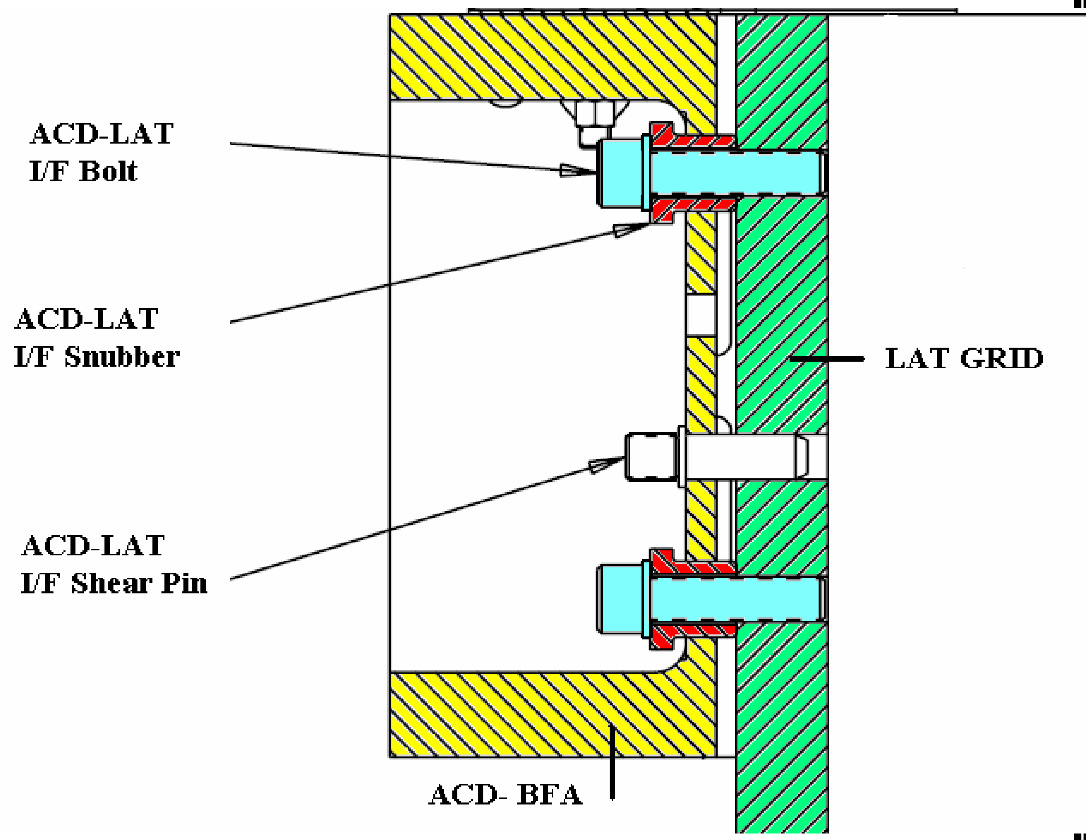
Points 36-38: 0.015

Point 39-42 : 0.005

+Y BFA

ACD Dimensional Verifications
Interior Stay Clear Volume Violation-BFA

- ***BFA Interior Measurement Violations***
  - *Violations at the Midspan – where ACD interfaces to LAT*
  - *Not Considered a problem*
    - *PASSED BFA Assembly dimensional inspection.*
    - *BFA sucessfully fit checked to the LAT Grid-*
  - *Error likely due to Snubber positioning*
  - *A waiver is being written for this violation*



- ***ACD Exterior Dimensional Survey To Be Completed***

Conclusions

- ***VIBRATION ENVIRONMENTAL TESTS***
  - ***ACD Passed All Tests***
    - *All test levels achieved.*
    - *Results documented in test report ACD-RPT-000363.*
    - *One post-test issue detected and addressed*
- ***OPEN ISSUES***
  - ***Complete CG Testing***
  - ***Complete Dimensional Survey***
  - ***Write and Get Dimensional Violation Waivers Signed***

System Test Planning
Thermal Test Overview

ACD Thermal Subsystem

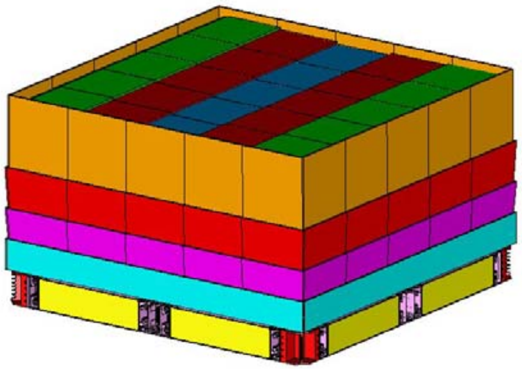
Carlton V. Peters

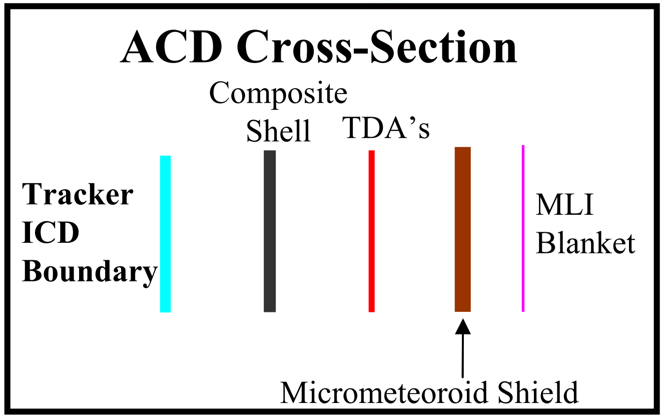
ACD Thermal Engineer

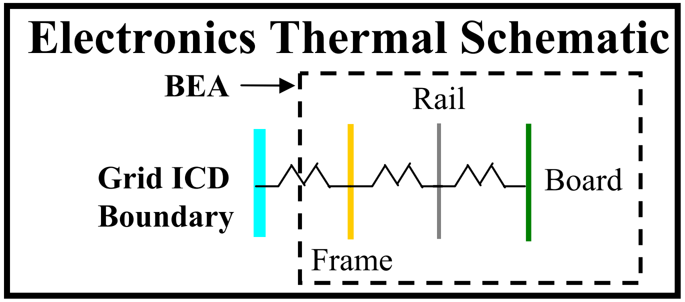
GSFC, Code 545

ACD Design Configuration

- *Anticoincidence Detector covers all five external sides of the LAT*
- *External MLI Blanket has 3 mil Germanium Black Kapton outer layer and is composed of 14 blanket layers*
- *Blanket will be attached using a combination of standard blanket attachments such as double sided tape and blanket buttons.*
- *Micrometeoroid shield includes approximately 3 cm of Solomide foam, Kevlar and Nextel layers*
- *Thin composite, low conductivity shell provides ACD structural support*
- *High emittance tracker exterior surfaces provide radiative path between tracker and ACD Shell interior*
- *Electronics Boards mounted to BEA Rail*
- *No dedicated radiator*
- *BEA mounted to grid at the 4 corners via corner fittings and at the center of each side by mid-span connectors*







Thermal Design Approach

Tile Detector Assembly

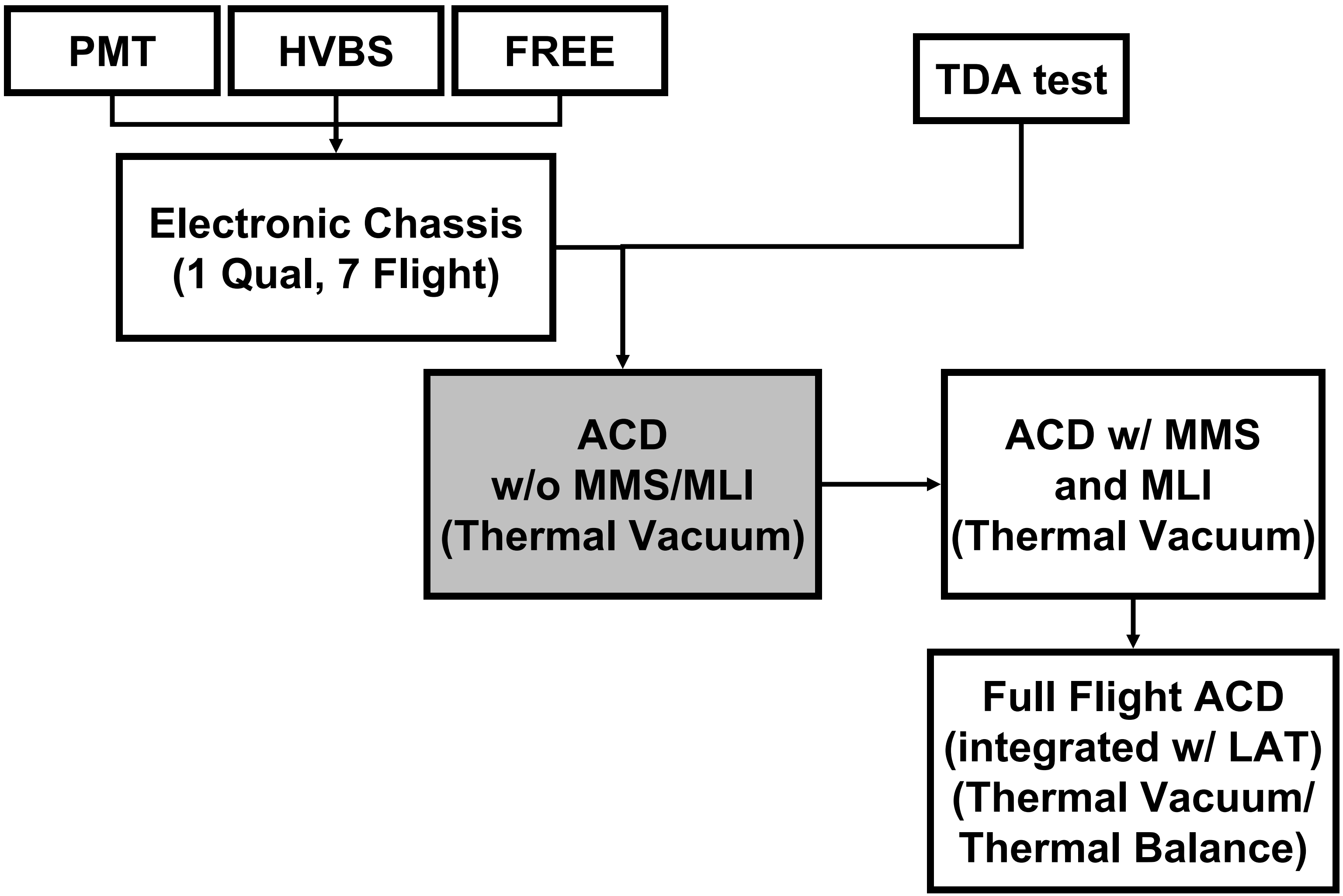
- ***Passive thermal design approach***
- ***The following ACD characteristics argue for a thermal design approach based on local thermal environment considerations for any of the five sides:***
  - *LAT Point anywhere anytime viewing requirements*
  - *TDA's located on all five ACD exterior sides*
  - *Poor lateral thermal conduction characteristics through the ACD TDA structural support (low conductivity composite shell)*
  - *No dedicated radiator*

Electronics Board Interface

- ***Passive thermal design approach without survival heaters***
- ***Electronics board interface temperatures are driven by the grid cold sink boundary temperature since heat transfer from the board interface to the grid is through a radiative heat transfer path and a series conduction heat transfer path.***

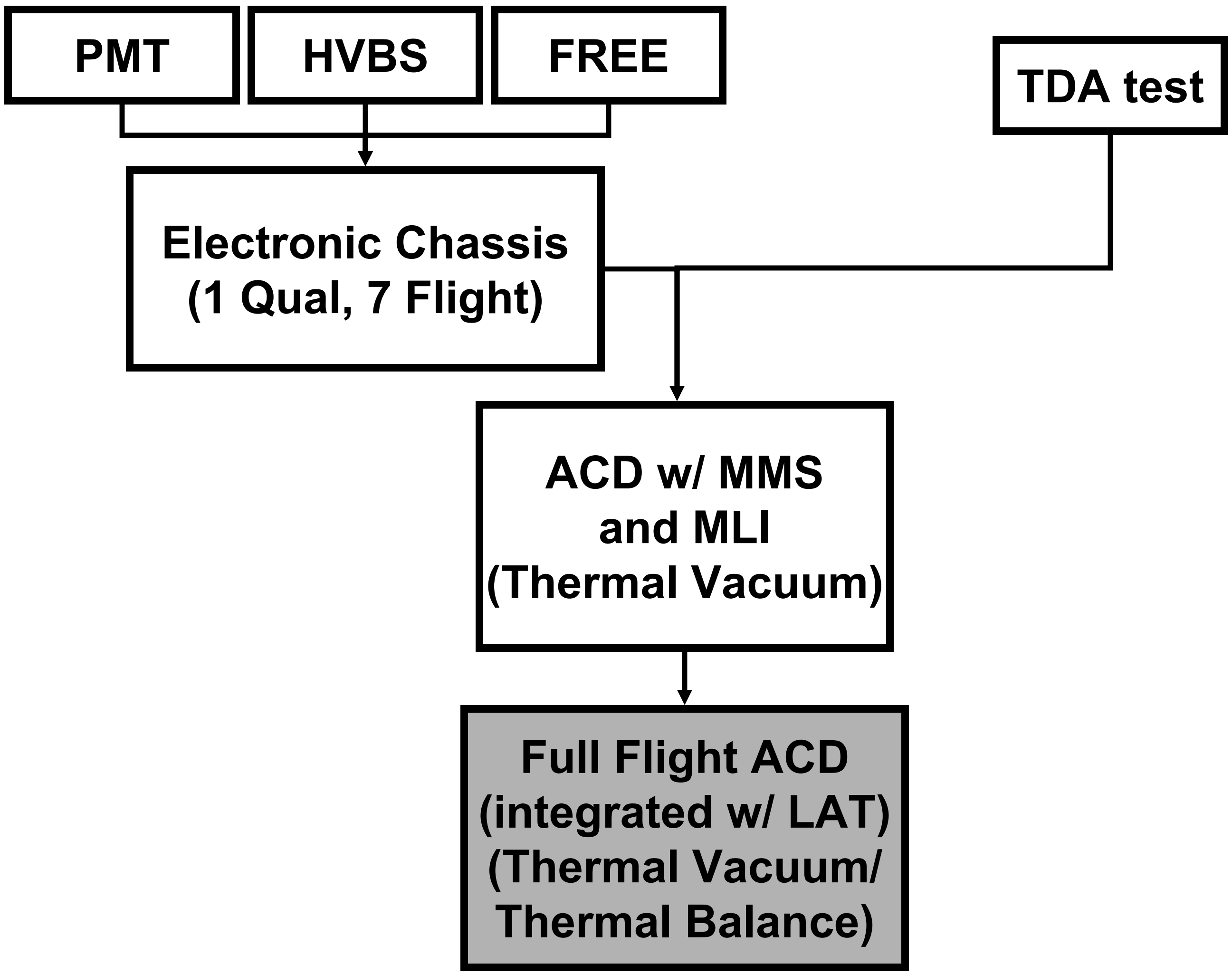
System Test Planning
Thermal Test Overview (PER)

- ***Thermal test tree***



System Test Planning
Thermal Test Overview

- ***Thermal test tree***



System Test Planning
Thermal Test Overview

- ***Thermal Vacuum test levels***
  - ***Qualification***
    - *TDA: -40 °C to +45 °C*
    - *PMT: -30 °C to +40 °C*
    - *Free Board: -30 °C to +40 °C*
    - *HVBS: -30 °C to +40 °C*
    - *Electronic Chassis: -30 °C to +40 °C*
    - *ACD: -25 °C to +40 °C (Per LAT-SS-00778-02 – LAT Environmental Specification)*
  - ***Acceptance***
    - *TDA: -30 °C to +35 °C*
    - *PMT: -20 °C to +35 °C*
    - *Free Board: -20 °C to +35 °C*
    - *HVBS: -20 °C to +35 °C*
    - *Electronic Chassis: -20 °C to +35 °C*
    - *ACD: -20 °C to +35 °C (Per LAT-SS-00778-02 – LAT Environmental Specification)*

System Test Planning
Thermal Test Overview

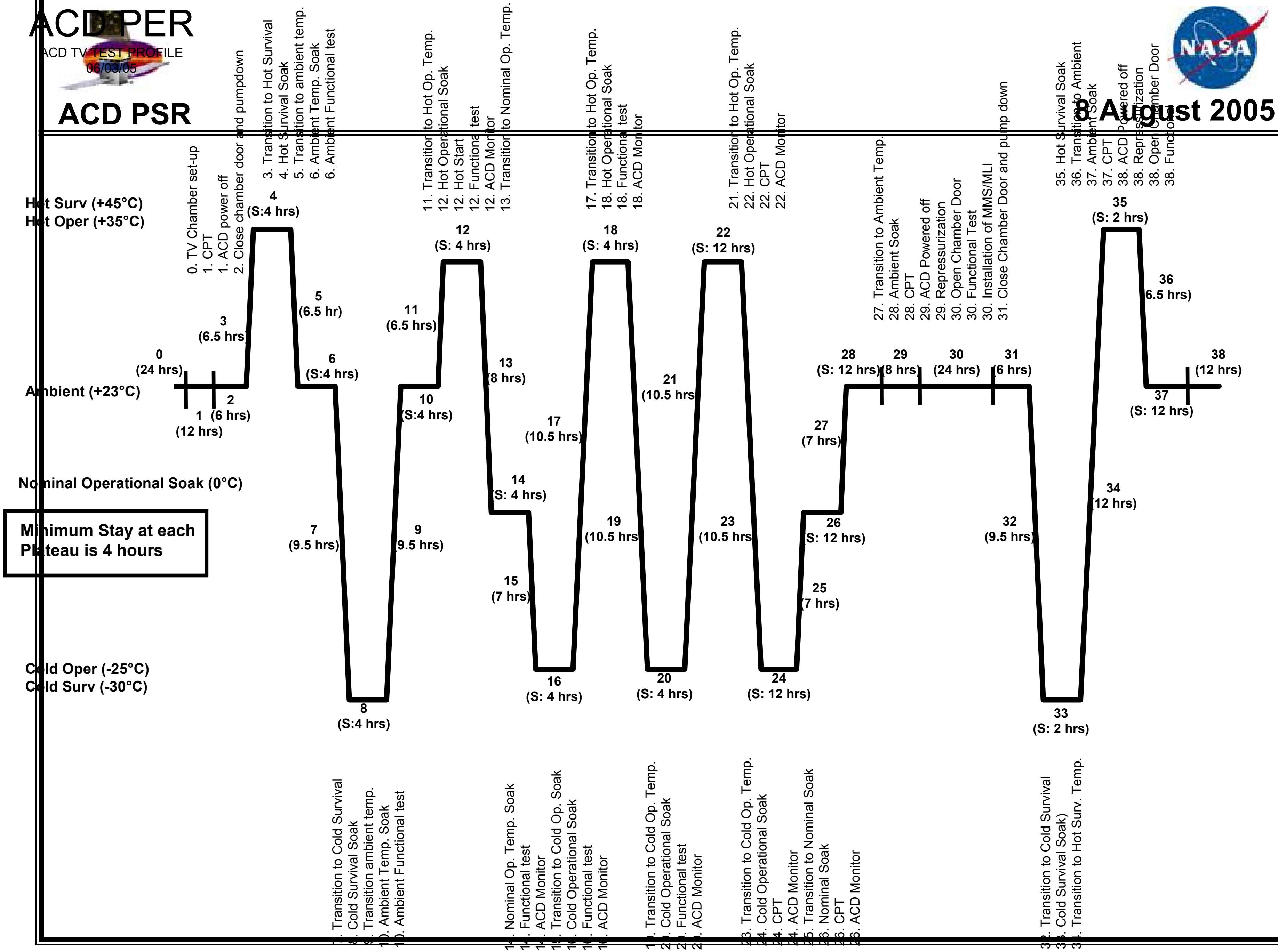
- ***Discussed at PER***
  - ***PMT Assembly – Thermal Vacuum Tested***
    - *Engineering units and Flight units: 2.5 cycles from -30 °C to +40 °C*
  - ***FREE and HVBS – Thermal Cycle Tested***
    - *Engineering models: -30 °C to +60 °C*
    - *Flight Models: -20 °C to +50 °C*
    - *Tested under vacuum with Electronic Chassis*
  - ***Electronic Chassis – Thermal Vacuum Tested***
    - *Engineering Model: 12 cycles from -30 °C to +40 °C*
    - *Flight units: 4 cycles from -20 °C to +35 °C*
  - ***Tile Detector Assembly – Thermal Vacuum Tested***
    - *Engineering model: 5.5 cycles from -60 °C to +45 °C*
- ***PSR Discussion***
  - ***ACD Flight Unit***
    - *PER: 5 cycles, 4 without MMS/MLI, 1 cycle with MMS/MLI*
    - *Thermal Vacuum Tested, 4.5 cycles from -30 °C to +40 °C*

System Test Planning
Thermal Test Overview (PER)

- ***ACD Flight unit (Thermal Vacuum)***
  - ***ACD Flight TV Test Plan (ACD-Plan-000347)***
  - ***ACD Thermal Vacuum test will be performed in Facility 290 in building 10 in June of 2005***
    - *Backup is facility 225 located in building 7*
  - ***The ACD will be in it's flight configuration without the Micrometeoroid shield and Multi-Layered insulation for part of the test and will be in it's flight configuration with the MMS but without the MLI for part of the test***
  - ***Test Flow***
    - *For the first four cycles of the ACD TV test, the ACD without the MMS and MLI, will be cycled to qualification temperatures*
    - *First cold and first hot cycles will be to survival limits*
    - *After 4th TV cycle there will be a chamber break to install MMS and MLI on ACD*
    - *Fifth and final cycle will be to temperature extremes to fully mechanically stress ACD MMS and MLI mechanical support attachments*

ACD PSR

8 August 2005



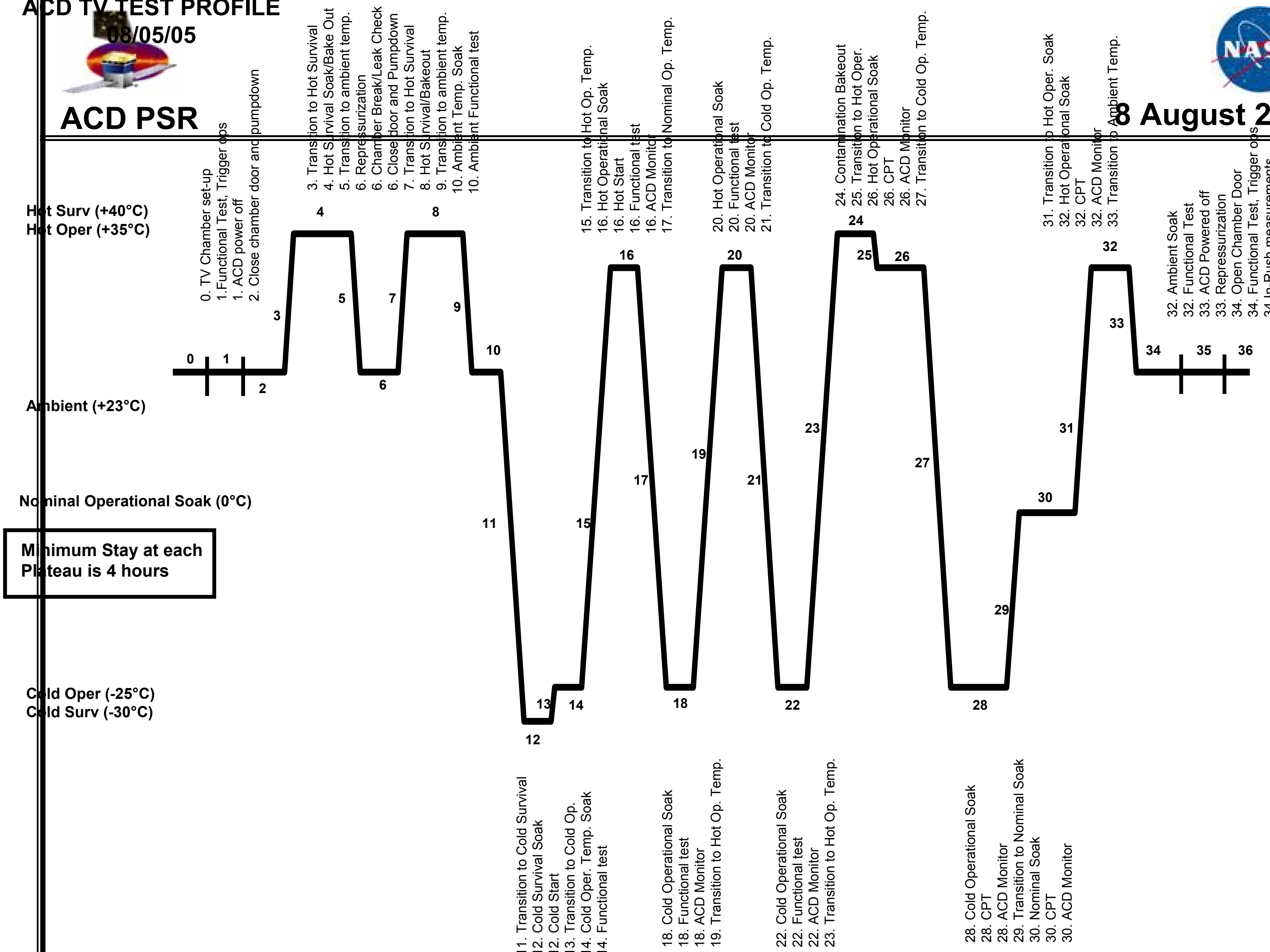
System Test Planning
Thermal Test Overview (Actual Test Program)

- ***ACD Flight unit (Thermal Vacuum)***
  - ***ACD Flight TV Test Plan (ACD-Plan-000347)***
  - ***ACD Thermal Vacuum test was performed in Facility 225 in building 7 from July 21st through August 5th of 2005***
  - ***The ACD was in it's flight configuration with the Micrometeoroid shield and Multi-Layered insulation (without the GBK outer layer) for the entire test***
  - ***Test Flow***
    - *First hot transition to contamination Bakeout*
    - *Chamber break to fix suspected leak*
    - *Transition to Hot Bakeout and Hot non-operational (survival) soak*
    - *Transition to Ambient soak*
    - *Transition to Cold non-operational (survival) soak*
    - *4 total hot and cold operational soaks, one Nominal soak prior to final hot operational soak*
    - *Ambient soak prior to Repressurization*

ACD TV TEST PROFILE
08/05/05

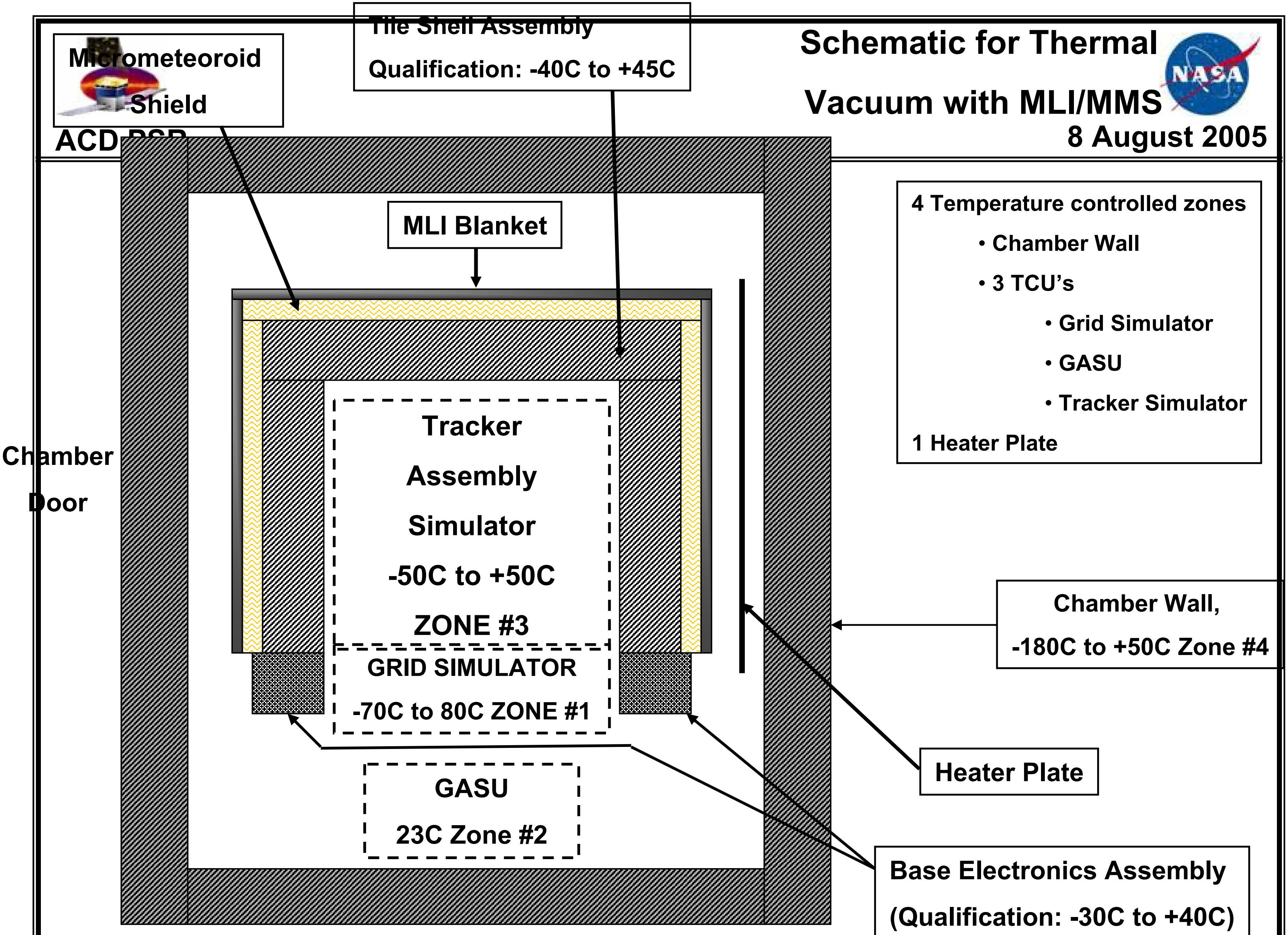
ACD PSR

8 August 2005

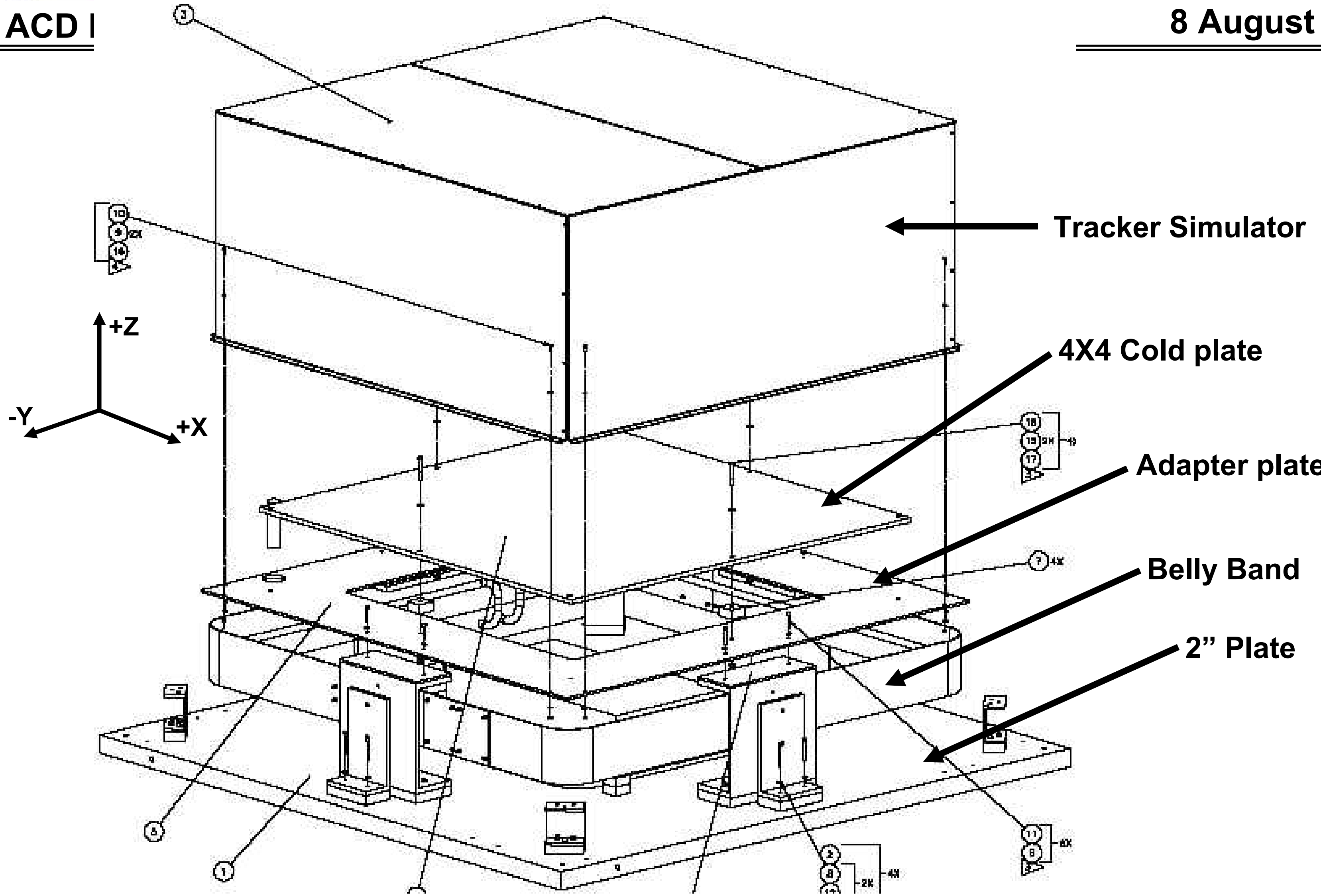


Schematic for Thermal Vacuum with MLI/MMS

8 August 2005



ACD GSE ASSEMBLY



Summary

- ***ACD subsystem tested to the specified levels***
- ***No RFA's out of PER to address***
- ***Required 4 cycles hot and cold completed***
  - ***Temperatures monitored via 100+ thermocouples located on the ACD instrument and GSE***
  - ***Less than 10% of test telemetry failed during test***
    - *No critical thermocouples failed*
  - ***1 Flight sensor anomaly***
    - *Non-critical, redundant sensor exists and functioning correctly*
    - *Read out temperature correctly a few days after failure and for remainder of test*
    - *Sensor will be examined post test*
  - ***Flight Telemetry data correlated with test telemetry data within 2 °C during soak periods***

Contamination Control

Chris Lorentson

ACD Contamination Engineer

- ***ACD external structure and MMS were cleaned prior to integration (closeout) for environmental testing***
- ***ACD internal structure will be cleaned following thermal vacuum testing***
- ***ACD system will be cleaned and double bagged prior to shipping to SLAC***
- ***ACD system was baked out during the system level thermal vacuum test***
- ***Two TQCMs, a cold finger and a scavenger plate were used to monitor the test in chamber 225 at GSFC***
  - ***TQCM #1 was a 15 MHz TQCM located outside the ACD structure***
    - *Outgassing certification requirement was 610 Hz/hr*
    - *Outgassing certification measurement at acceptance was 42Hz/hr*

- ***TQCM #2 was a 10 MHz TQCM located within the ACD structure***
  - *Outgassing certification requirement was 270 Hz/hr*
  - *Outgassing certification measurement at acceptance was not possible due to extremely high deposition rates.*
    - *The enclosure around this TQCM was more tightly sealed than anticipated. This causes the contaminants to be trapped within the enclosure and falsely raise the TQCM deposition rate*
      - ***Requirements development for the test assume free flow of molecular species***
    - *The low deposition rate on the external TQCM indicated that these contaminants were not reaching the external structure*
    - *ACD internal outgassing is vented out the aft of the observatory, not in the direction of contamination sensitive hardware*
    - *External structure outgassing is the primary concern for contamination of sensitive surfaces*
  - *Results of this TQCM were not considered in test acceptance for the above reasons*
- ***Cold finger and scavenger plate analysis will be available upon completion***

CPT and Performance Testing Results

Completed Verification Results Summary - *Comprehensive Performance Test*

- A successful Comprehensive Performance Test of the fully integrated flight system has been performed before and after vibration/acoustics and at four temperatures: +35 C, +23 C, 0 C, and -25 C.
- Document numbers are ACD-PROC-000270 (functional/performance) and ACD-PROC-000352 (margin).
- The test covers all aspects of the ACD functional areas such as
  - Voltages, currents, temperatures
  - Electronics performance (discriminators, PHA, timing)
  - Detector operation and performance
  - Commanding
  - Margin testing (varying electronics voltages and clock frequencies)
- Almost all of our electrical requirements verification at system level is done by this test.

Open Issues from Testing

- In the course of numerous functional tests, some anomalies have been seen for which we have not been able to find good explanations.
- Although none of these appear to affect the basic performance of the ACD, they represent residual risks, primarily in the area of reliability.
- The status of these anomalies, the testing we have done, and the possible impacts are described on the following pages.

HldCal Testing Anomaly
PR ACD-ACD-INT-02269-001

- **The calibration test script for the ACD High Level Discriminator produces repeatable errors on one of the 12 FREE cards when the test is performed on the whole ACD simultaneously.**
- **The test always works when only two FREE cards (including the one that produced errors in the full run) are tested.**
- **We have been unable to trace this problem to any software changes, although it did appear between software updates.**
- **Troubleshooting included swapping cables. The problem did not move with the ACD cable, but remained with the input port of the LAT interface electronics box (GASU), which is not part of the ACD. We plan to re-check this at the LAT level with the flight GASU.**
- **Because we have an adequate workaround, and because this test involves only a calibration of a secondary aspect of the ACD, we have not pursued additional troubleshooting.**
- **Our solution for now is "use as is."**

Unexpected Counts Testing Anomaly
PR ACD-02334-009

- **During each of the cold cycles during the thermal vacuum test, we observed 2-4 excess counts on one electronics channel of the ACD during a test.**
- **The test was done using charge injection and was a test of a high VETO threshold (5 strobes; should have recorded no counts).**
- **Either the VETO threshold was not set properly, or the test charge was larger than expected.**
- **The excess counts appeared on the last GAFE of the last GARC, suggesting a possible end-of-test-cycle clearing error, possibly due to timing, but we have no way to confirm this suspicion.**
- **It is also possible that we have a channel with an instability, because this same error was seen on this channel in chassis cold tests.**
- **The operational performance of this channel is excellent at all temperatures.**
- **If we found excess VETO rate in orbit, we could re-set the threshold. It has very wide dynamic range.**

High Rate Testing Anomaly
PR ACD-02334-016

- During two of the four transitions from hot to cold during the thermal vacuum test, we observed high rates (up to 5 KHz) on one tile detector of the ACD. Temperature was between 10 C and –15 C.
- The high rate in both cases settled down to a normal rate (< 100 Hz) by the time temperature stability was achieved.
- The test script that was running collected only rate data, so we have no other information about the output from that tile. We do not even know which of the two phototube signals might have given the high rate, because the hardware counters sum the signals.
- This channel (both phototubes) produces good data in every functional test we have done, including a run at 0 C.
- Because it is a transient problem, not even seen in every transition, we have been unable to diagnose this problem. Generally noise decreases with lower temperature. It was not seen in chassis tests.
- If a high rate on a channel appeared in orbit, we have the option of disabling a phototube signal. Loss of one signal would be acceptable for ACD performance.

TDA Light Yield determination – results of ACD Performance Test

- *Approach is given in ACD-PLAN-000332 "ACD On-Ground Science Performance Calibration and Monitoring"*
- *The idea is based on determining the light yield (L.Y.) for 3 arbitrarily selected TDA's (012, 021, and 022) by carefully measuring their efficiency and deriving L.Y. from obtained efficiency value. From these measurements we determined the ADC sensitivity A_{fl},*

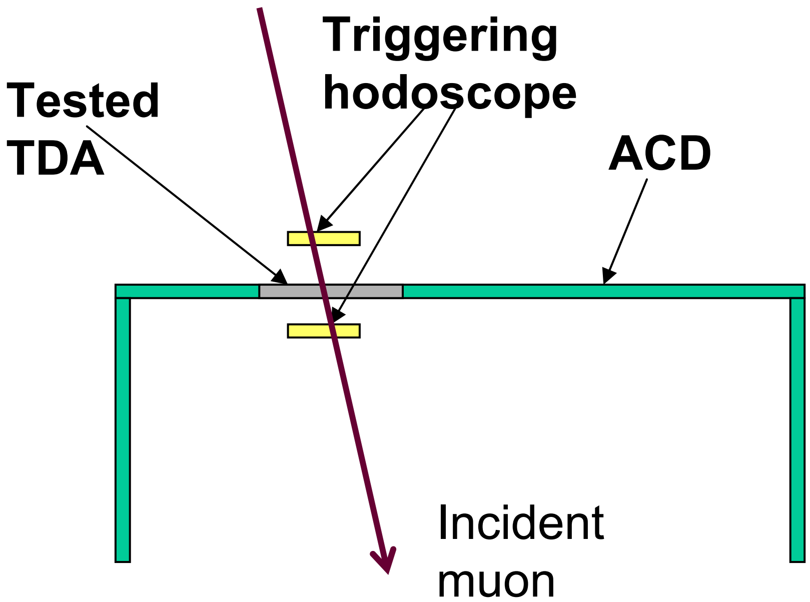
$$A_{fl} = \frac{1}{6} \times \sum_{i=1}^{6} \frac{P_i}{LY_i \times G_{i,fl}}$$

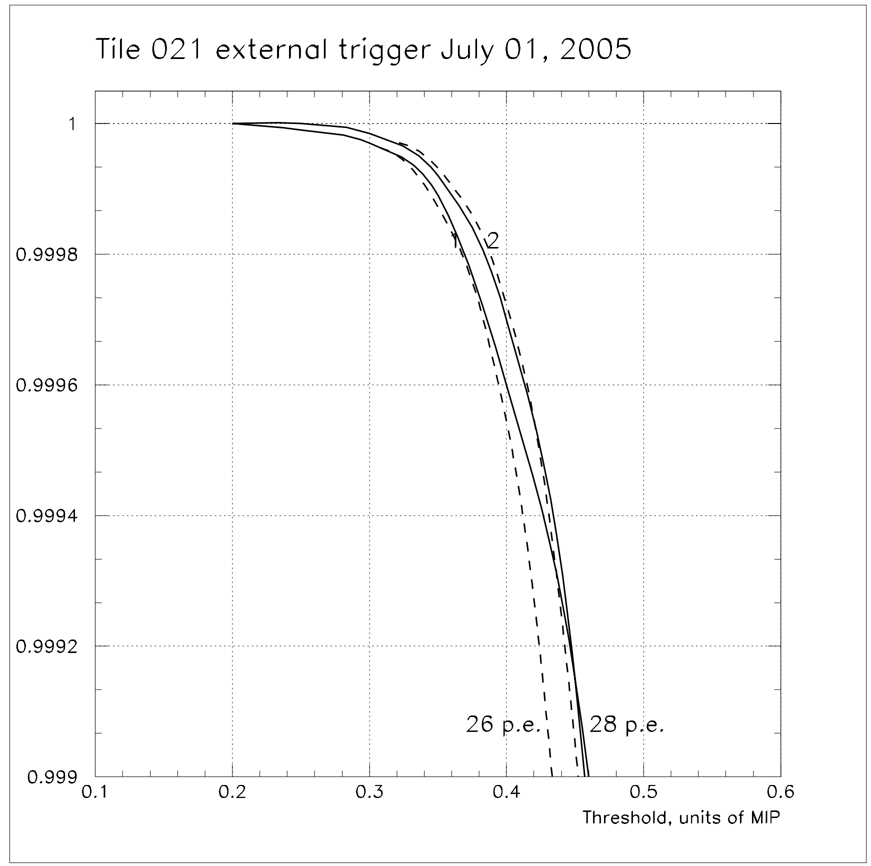
and after that determined L.Y. for all remaining TDA channels as

$$LY = \frac{P}{A_{fl} \times G_{fl}}$$

where P is the MIP peak position obtained in performed tests, G is the given PMT gain (taken from PMT data sheets)

Performance Validation Approach





Results obtained in ACD Performance Test:

All obtained L.Y. values (can be found in "Light Budget Table") were put in ACD Performance Simulation model to determine ACD entire efficiency.

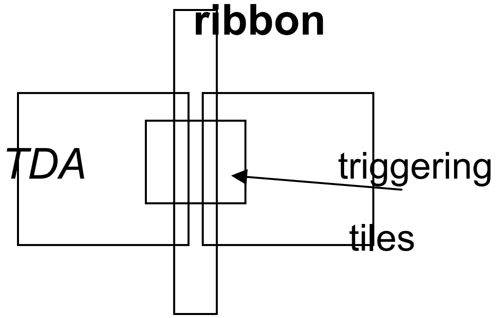
Sample - Light Yield, determined in this test

Tile Number	Cable # [PMT #]	Pedestal @ 700	Pedestal @ 750	Pedestal @ 800	Mean Pedestal	via Landau fit	using Landau fit	via polynomia		reference, TOP	coeff. Applied	position for	previous but	PMT Gain at 1250V	Flight PMT Q.E.	L.Y. with reference	L.Y., inferred
020	0-020	445.5	445.5	445.5	445.5	1169.39	723.89	1101.68		660.07	0.92	607	607	15.7	22.1	16	26.9
	1-020	214.5	213.5	213.5	213.8	1209.48	995.68	1132.26		916.4	0.92	843	739	20.7	20.3	16.3	24.9
021	0-021	265.5	265.5	265.5	265.5	1036.91	771.41	972.228		707.976	0.82	579	579	18	20	16	22.4
	1-021	512.5	512.5	512.5	512.5	1465.25	952.75	1426.67		910.17	0.82	746	654	19.5	20	16.7	23.4
022	0-022	520.5	520.5	520.5	520.5	1369.83	849.33	1343.74		790.61	0.73	577	577	18.5	18.7	16.3	21.7
	1-022	496.5	496.5	496.5	496.5	1365.8	869.3	1333.81		826.49	0.73	603	529	14.9	18.6	16.5	24.7
023	0-023	204.5	204.5	204.5	204.5	756.982	552.482	705.823		499.8	0.82	410	283	8.1	21.8	17.3	24.3
	1-023	153.5	150.5	150.5	151.5	798.43	646.93	762.939		614.1	0.82	503	406	10	21.4	17	28.3
024	0-024	120.5	120.5	120.5	120.5	668.028	547.528	622.373		499.51	0.92	460	317	9	20.3	17.3	24.6
	1-024	109.5	109.5	109.5	109.5	901.267	791.767	839.302		729.4	0.92	671	541	11.8	19.9	14.5	32
010	0-010	189.5	189.5	189.5	189.5	704.501	515.001	664.391		472.3	0.92	434	434	19	20.1	14	15.9
	1-010	728.5	728.5	728.5	728.5	1333.15	604.65	1313.11		581.83	0.92	535	469	14.4	23.7	13.8	22.7
011	0-011	140.5	141.5	141.5	141.5	709.57	568.07	679.382		533.5	0.82	437	437	15.6	18.8	15.2	20.4
	1-011	219.5	219.5	219.5	219.5	729.833	510.333	692.2		471.8	0.82	386	339	14.5	18.2	14.4	16.3
012	0-012	173.5	174.5	176.5	174.8	1008.07	833.27	926.294		745	0.82	611	647	18.3	22.2	15.8	24.6
	1-012	372.5	372.5	372.5	372.5	1222.07	849.57	1166.74		790.87	0.82	649	497	14.9	21.4	16.4	23.2
013	0-013	196.5	197.5	197.5	197.2	771.264	574.064	732.644		534.9	0.82	439	465	15.2	21.5	17.5	21.3
	1-013	172.5	172.5	171.5	172.2	905.555	733.355	847.513		669.2	0.82	548	420	13.6	21.3	15.8	21.5
014	0-014	501.5	501.5	502.5	501.8	1150.17	648.37	1099.3		597.2	0.92	549	582	16.3	22.2	14.6	24.9
	1-014	396.5	395.5	395.5	395.8	1293.7	897.9	1244.37		846.3	0.92	778	596	17.8	21.1	16.4	23.3
030	0-030	174.5	176.5	176.5	175.8	894.538	718.738	866.488		687	0.92	632	415	15	18.7	14.4	19.2
	1-030	134.5	134.5	134.5	134.5	841.562	707.062	801.26		664.67	0.92	612	469	14.6	21.6	14.1	22.3
031	0-031	599.5	599.5	599.5	599.5	1290.09	690.59	1221.78		615.84	0.82	505	331	11.3	21.6	14.1	20.3
	1-031	162.5	162.5	162.5	162.5	699.638	537.138	651.966		489.2	0.82	401	307	14.9	20.1	14.9	14.4
032	0-032	195.5	195.5	195.5	195.5	981.309	785.809	916.545		715.3	0.82	586	384	10.5	21.7	16.5	25.5
	1-032	684.5	683.5	683.5	683.8	1555.4	871.6	1494.17		806.8	0.82	662	507	13.3	21.4	16.6	26.6
033	0-033	150.5	150.5	151.5	150.8	715.075	564.275	665.606		513	0.82	421	290	9.4	21.2	18.2	21.5
	1-033	210.5	211.5	211.5	211.2	761.241	550.041	704.267		495.6	0.82	407	328	14.2	18.1	17	16.1

Ribbon Light Yield Determination

- *by design the ribbon performance is lower than that of the tiles.*
- *ACD would never achieve required performance without proper functioning ribbons*
- *required L.Y. from the ribbons is 3 p.e. from the ribbon center (average for both ends) and 6 p.e. at the crown tile level*

▪ *Approach to the measurement was similar to that used for the TDA's. Triggering hodoscope was installed such a way to cover the ribbon and both adjacent TDA's*



▪ *Each of 8 ribbons was tested in 2 points to confirm light attenuation along the ribbon*

Ribbons Light Yield

Ribbon	PMT	End (level of crown tiles)	Center	End (level of crown tiles)	Attenuation coefficient
500	0	11.1		2.0	0.18
	1	2.7		12.0	0.23
501	0	10.7		1.7	0.16
	1	2.2		11.4	0.19
502	0	1.3 ?		8.5	0.15
	1	11.9		1.1	0.09
503	0	2.3		10.0	0.23
	1	11.4		1.8	0.16
600	0	10.1	2.8		0.28
	1	1.6	4.1		0.39
601	0	1.6	4.1		0.39
	1	8.5	2.4		0.29
602	0	8.9	2.7		0.30
	1	1.7	3.8		0.45
603	0	1.5	3.8		0.39
	1	12.9	3.3		0.26

Ribbons Performance test data demonstrates that all they meet L.Y. requirements. Obtained data put in ACD Performance Simulation model

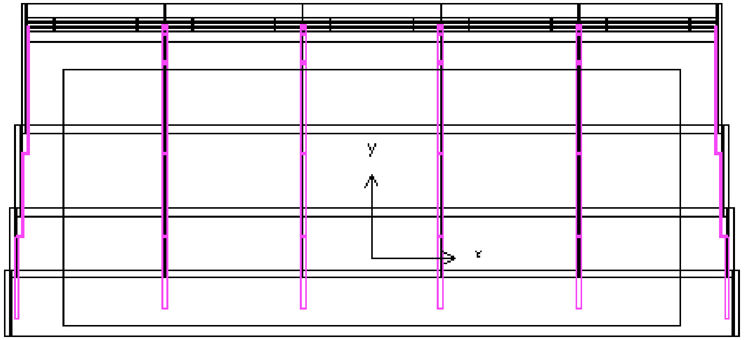
ACD Mechanical Properties

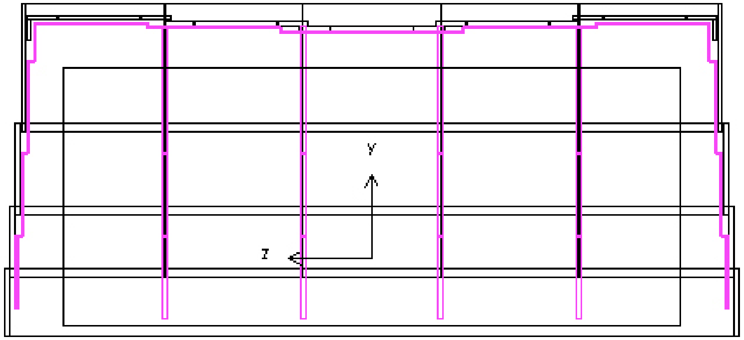
- All gaps and clearances between TDA's and ribbons were carefully measured on the flight unit
- The gap requirements at room temperature were as follows:

  - tile butt joints – 2 mm
  - tile vertical gaps – 3 mm
  - tile – to ribbon gaps 2 mm except bending and corner areas
  - corner gaps 4 mm

- All gaps measured at room temperature were corrected to -20C, lowest operating temperature expected.
- Measured gap values (increased for the lower temperature) were put in ACD Performance Simulation model.
- Measured gaps are found to be better than required (on average)

Simulation Model

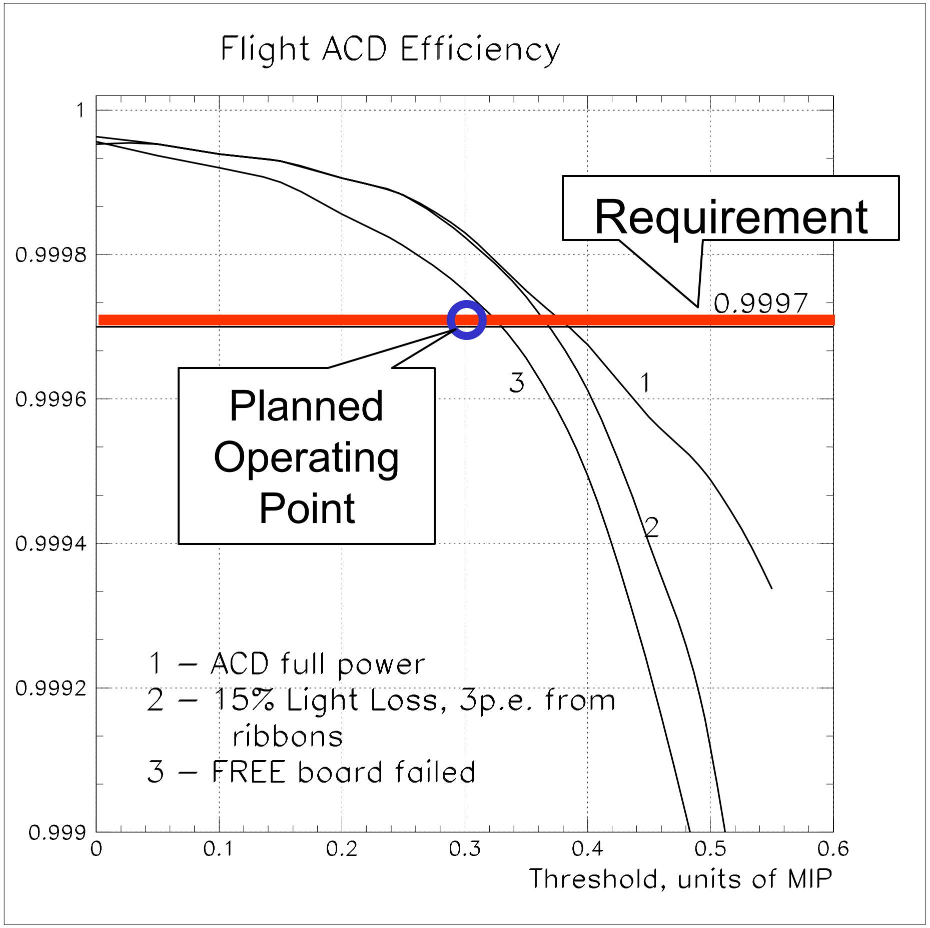




Full ACD Efficiency

Simulations were performed for the following cases:

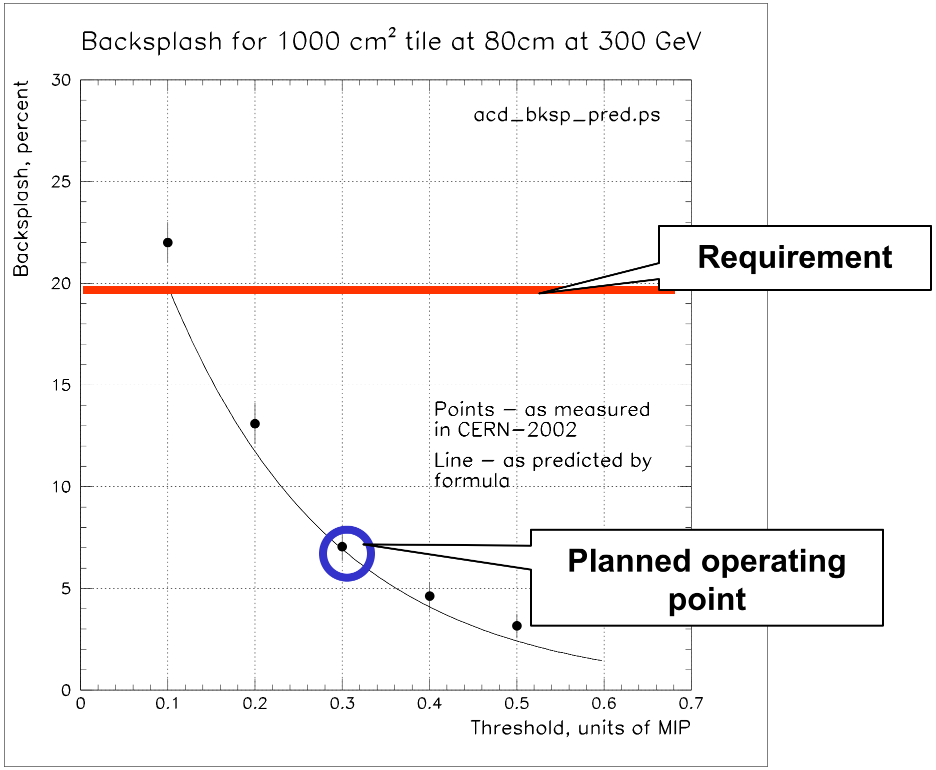
- all determined L.Y. values; ribbon L.Y. 4 p.e. from the ribbon center – line 1
- 1 FREE board failed; 17 tiles operate with only 1 PMT (including 8 tiles on the top) – line 3
- L.Y. from every detector is reduced by 15%; L.Y. from the ribbon center is 3 p.e. – line 2



ACD does meet particle detection efficiency requirement with margins (ACD-RPT-000372)

ACD Science Requirements Verification - Backsplash

- A set of tiles and calorimeter emulators was taken to CERN in 2002.
- Measurements were made of the energy, angle, and material dependence of the backsplash.
- These measurements were compared to a simulation of the same geometry.
- The same simulation was used for the ACD geometry
- The calculated backsplash at 300 GeV is 7%, well below the 20% requirement.
- Even at a threshold of 0.12 MIP, ACD would meet its requirement.



Moiseev et al. 2004, Astroparticle Physics 22, 275

Performance Results Summary

- **Efficiency**
  - ACD meets its efficiency requirement with margin, including loss of light or even loss of up to 17 phototubes (or one FREE card).
- **Backsplash**
  - The ACD is substantially less susceptible to backsplash than required. The operating threshold could be lowered if needed to gain additional efficiency.

VERIFICATION

ACD Science Requirements Verification Summary- 1

- Some important requirements flow through a science simulation, because direct measurement is impractical (no calibrated source of cosmic rays).

ACD Simulation **Measured** Input Parameters

Active elements
- Tile performance
- PMT performance
- Ribbon performance
- Flight configuration channel light through-put

Passive elements
- Clear fiber performance
- Wave shifting fiber performance
- Fiber connectors performance

Dead area
- Gaps between tiles and at corners

ACD Science Instrument Simulation

Key Requirement #1:
ACD 0.9997 overall efficiency

ACD Science Requirements Verification Summary- 2

• Some important requirements flow through a science simulation, because direct measurement is impractical (no calibrated source of cosmic rays).

ACD Simulation **Measured** Input Parameters

Active elements
- Tile performance
- PMT performance
- Flight configuration channel light through-put

Passive elements
- Calorimeter (source of backsplash that produces self-veto)

Geometry
- Tile locations with respect to calorimeter

ACD Science Instrument Simulation

Key Requirement #2:
ACD < 20% self-veto at 300 GeV

Completed Verification Results Summary- Important System performance results

Important system performance analysis

- **Efficiency – requirement 0.9997**
  - Verified - Simulation using as-measured inputs shown above. While the inputs have been verified the overall efficiency cannot be fully measured on the ground. The simulation has been reviewed and is in CM. The repeated performance tests confirm input to the simulation.
- **False veto rate – requirement <20% backsplash, <1% noise**
  - Verified – backsplash <10% was measured in runs at CERN, using ACD-type detectors and LAT-like calorimeter, plus simulation of detailed ACD geometry. Noise was measured during CPT.
- **Fast veto signal – requirement – discriminator pulses, variable width**
  - Verified – CPT verified logic pulses, bench tests verified widths
- **PHA signal – requirement – Minimum Ionizing Pulses (MIP), CNO pulses**
  - Verified – CPT verified PHA for MIP; Test Charge Injection verified CNO

Completed Verification Results Summary- Test-to-Test Variation

- **Temperature Dependence**
  - As expected from component and chassis tests, some electronics parameters such as pedestal and some performance parameters such as light throughput have a temperature dependence (more light at lower temperatures, which is where the ACD will operate). These variations have been tabulated for use in on-orbit adjustment of ACD parameters.
- **Other Observed Changes**
  - The light throughput on a few of the 194 channels shows some test-to-test variation, up to about 10%, with both positive and negative changes, but no trend. Part of this is likely to be fitting of data with limited statistics, but part may be to vibration and CTE causing small position shifts of the light-transmitting fiber runs and at the faces of the phototubes. Changes at this level have no measurable impact on the overall ACD performance.

Completed Verification Results Summary-Verification Status

- *Requirement verification tests complete*
- *135 Level 4 requirements and 95 ICD areas*
- *Any LAT Environmental Specification and LAT Verification Plan requirements are captured and referred to by level 4 and ICD requirements*
- *Performance characterization, pre and post environmental functional and performance tests now complete.*
- *Verification sections of delivery data package being prepared as well as test result data packages.*
- *The ACD system also lent itself to a great deal of subsystem verification. Most requirements also verified prior to final tests.*
- *Since CDR the full set of ACD requirements has been repeatedly reviewed internally (science team, leads, systems, etc..) for testing weaknesses and any other issues.*

Completed Verification Results Summary- Verification table status

MECHANICAL SUMMARY

- ***Most of the mechanical requirements are verified at the subsystem level via subsystem engineering and flight unit vibration, thermal and strength tests. (see environmental test flow for subsystem flight and engineering units)***
- ***Mechanical requirements not yet verified at PER;***
  - *Final mass properties, Mass and Center of Gravity - Mass OK, C.G. see mechanical testing section*
  - *Fully assembled ACD system level Sine Vibration, Acoustic and thermal vacuum tests – tested successfully*
  - *Final stay clear survey – Minor (0.5mm) inside violation, PFR ACD-021 written and forwarded to LAT. Informal approval by LAT Mechanical Systems Engineer (M. Nordby) through email. Formal change request (LAT-XR- 07058-01) out for approval. All external hard points, including thermal blanket attachment points have been measured and fall well within stay clear. "Soft point" (ie. Thermal blanket) stay clear being measured today, August 8.*
  - *MGSE - MMS lift sling verification test - completed*
  - *Thermal Performance of MLI blanket – low risk and sensitivity. There is a waiver (LAT-XR-06769-01 CR) for thermal balance test that would have been of low value but high cost.*
  - *All mechanical requirements now verified except C.G., external stay clear measurement and MMS/MLI final density measurements. (procedures and WOAs used for actual verification recorded in table)*
    - *See requirements section for small list of waivers and Margins section for verified margins*

Completed Verification Results Summary- Verification table status

ELECTRICAL SUMMARY

- ***Full subsystem verification successfully completed.***
  - *The electronic chassis operate completely independently and have been fully tested and exercised in their flight assembled configuration, as has each Tile Detector Assembly.*
  - *They function the same on the assembled ACD; in fact the functional test is basically the same. There is no interdependency between channels.*
- ***Full ACD Pre and post-environmental functional and performance tests completed.***
  - *The system level tests allow for optimization of settings, determining the ability to meet the efficiency requirement and exercising the GASU side of the interface for multiple chassis. Almost all requirements and performance verified by CPT (ACD-PROC-000270) and associated margin test. Refer back to CPT testing section for EGSE software scripts issues.*

Completed Verification Results Summary- Verification table status

ELECTRICAL SUMMARY

- ***Electrical requirements not yet verified at PER;***
  - ***Overall Efficiency – Our most important requirement, refer to earlier slides. Functional and performance tests results have been analyzed and inserted into science simulation runs***
    - ***Light through-put performance of channels between the scintillating detectors and PMTs in their as-assembled condition. This is one of many inputs into the above efficiency requirement.***
    - ***Meets requirements. Estimated efficiency is greater than 0.9997***
      - *See CPT and efficiency slides*
- *All electrical requirements now verified (procedures and WOAs used for actual verification recorded in table)*
  - *See system level EMI testing waiver (earlier) and non conformance slide (to come)*

Completed Verification Results Summary- Verification table status

ELECTRICAL SUMMARY

- ***Electrical requirements that were not yet verified at PER;***
  - ***ICD interfaces have been verified at the chassis level, and the full ACD has been run with the EGSE GASU#8. All tests successful***
  - ***Some minor anomalies associated with electrical testing are long running issues with the EGSE system remain – see CPT and PR sections***

Completed Verification Results Summary - Verification Status

ACD PSR

8 August 2005

- **Important verification sub-tables**
  - **<u>Table of requirements to be re-verified at system level.</u>**
- **These are all verified at chassis level, and there is no difference in function after assembled and in the basic functional test itself. Hard copy of complete table available**

•ACD verifies at level 4 requirement level. Any level 3 requirements that did not decompose to level 4 where carried down as is to facilitate complete verification at one level. <u>All level 4 requirements have been successfully verified.</u>

Reqt ID	LAT ACD Level IV Requirement	Verification Method	ACD System Verification Procedure	Planned Test
ACD4-25	5.1 Charged Particle Detection			
ACD4-26	The ACD shall produce both fast and logic (hitmap) VETO signals in response to PMT signals resulting from charged particles traversing the ACD tiles and ribbons.	Test	ACD Comprehensive Performance Test (CPT) (ACD-PROC-000270)	Efficiency test & T/V
ACD4-27	5.2 Adjustable Threshold on VETO Detection of Charged Particles			
ACD4-28	The threshold for detecting charged particles shall be adjustable from 0.064 to 1.28 pC (0.1 to 2 MIP), with a step size of <0.032 pC (0.05 MIP).	Test	ACD Comprehensive Performance Test (CPT) (ACD-PROC-000270 Chassis Full Functional Test	Efficiency test & T/V
ACD4-29	5.3 False VETO due to Electrical Noise			
ACD4-30	The total ACD false VETO trigger rate due to noise shall be less than 10 kHz (~46Hz per channel) at 0.096 pC (0.15 MIP) threshold (assuming 1 us VETO pulses).	Analysis Test Simulation	ACD Comprehensive Performance Test (CPT) (ACD-PROC-000270)	Efficiency test & T/V
ACD4-31	5.4 High Threshold Detection			
ACD4-32	The ACD shall detect pulses due to highly ionizing particles (carbon nitrogen oxygen or heavier nuclei), which produce signals from 31.2 - 200 MIP (20 pC to 128 pC) with a goal of 1000 MIP (640 pC). The ACD is required to detect, via the High Level Discriminator (HLD), all signals above the High-Level threshold (nominally 25 MIP's); it is required to digitize (PHA) signals up to 200 MIP's (128 pC). The current design actually allows for digitization of signals up to 1000 MIP's (640 pC). Each ACD electronics board shall OR up to 18 HLD outputs (selected via command) to generate a single HLD_OR signal for transmission to the AEM.	Test Simulation	ACD Comprehensive Performance Test (CPT) (ACD-PROC-000270) up to ~200 MIP	Efficiency test & T/V
ACD4-34	5.5 Adjustable High-Threshold			
ACD4-35	The High Level Threshold shall be adjustable for PMT signals from 12.8 to 40.96 pC (20 to 64 MIP) in steps of 0.64 pC (1 MIP) _20%. HOWEVER As of Oct 2003 the GAFE 5G and GAFE 7, one of which should be our flight chip, do not quite meet this requirement as stated. On those chips The High Level Discriminator is adjustable from 0 - 130 MIP in steps less than 1.6 MIP/step. This adjustablility still allows us to meet all of our related requirements. So this is likely to be our flight performance. See related NCR	Test	ACD Comprehensive Performance Test (CPT) (ACD-PROC-000270)	Efficiency test & T/V
ACD4-37	The ACD electronics shall accept from the GEM a	Test	ACD Comprehensive	

Completed Verification Results Summary - Verification status

- **Important verification sub-tables**
  - **<u>Table of requirements only verified at the subsystem level.</u>**
- **These are not directly verifiable at system level, only indirectly. Hard copy of complete table available. <u>All have been successfully verified</u>.**

The following table is a list of requirements that must be verified at a lower level of assembly than Electronic Chassis.

No	*DOORS ID*	*LAT-SS-00352 ID*	*Verified*	*ACD WOA*	*Rationale*
1	ACD4-39,40	5.7.1 Fast VETO Signal Latency	FREE Comprehensive Performance Test, ACD-PROC-000051, Section 11.4	ACD-WOA-00021 through ACD-WOA-00036	This test requires an oscilloscope on the GAFE output to make a direct measurement.
2	ACD4-41,42	5.7.2 Fast VETO Signal Width	FREE Comprehensive Performance Test, ACD-PROC-000051, Section 11.5	ACD-WOA-00021 through ACD-WOA-00036	This test requires an oscilloscope on the GAFE output to make a direct measurement.
3	ACD4-43,44	5.7.3 Fast VETO Retriggering	GARC Comprehensive Performance Test, ACD-PROC-000051, Section 11.4, Discriminator Input Minimum Width Test	ACD-WOA-00021 through ACD-WOA-00036	This test requires an oscilloscope on the GAFE output to make a direct measurement.
4	ACD4-66,67	5.8.4 Pulse Height Measurement Latency	GLAST LAT ACD Interface Digital Timing Measurements, ACD-RPT-000274	Not applicable to this report.	This test requires an oscilloscope on the GAFE output to make a direct measurement.
5	ACD4-70,71	5.8.6 Differential Non-Linearity	FREE Comprehensive Performance Test, ACD-PROC-000051, Section 11.20	ACD-WOA-00021 through ACD-WOA-00036	This test requires the use of an external pulse generator.
6	ACD4-85,86	5.9.3 HVBS Limiting Output Current	HVBS Functional Test, ACD-PROC-000064, Sect. 4.5, Tables 3, 4, 5	ACD-WOA-00321 through ACD-WOA-00353	This test requires application of a non-flight load in the lab for verification.
7	ACD4-87,88	5.9.4 HVBS Output Voltage Adjustment	HVBS Functional Test, ACD-PROC-000064, Sect. 4.5, Tables 3, 4, 5	ACD-WOA-00321 through ACD-WOA-00353	Verification for this section requires both an oscilloscope and the application of a non-flight load.

Completed Verification Results Summary - *Non conformances, hard to verify tests*

- **Summary of Non-conformances**
  - **Minor stay clear violations mentioned earlier (ACD4-215) – Change Request (LAT-XR- 07058-01*)* is in the approval process.**
  - **ACD4-92, 90, 100 – HVBS line and load regulation % target, temperature stability, output ripple, not a major issue, could contribute to temperature performance changes. Tracking down more detailed test results to confirm – Non-conformance will be written if needed.**
- **For a few requirements, we have not yet confirmed the correct system level verification test.**
  - **Some ICD items in section 9 (command and data handling) were not included in the 'only verifiable at the subsystem level' category, but may fall into that category because they are only indirectly tested at the system level. Reviewing tests to update verification table.**

Completed Verification Results Summary

borderline areas

- **Summary of requirements where conformance is border line**
  - **ACD4-220 - Distance from lower tile to ACD interface plane distance tolerance not met. The important distance is covered in level 4 requirement and can only be verified at LAT. The requirement as written should not have had a negative tolerance. We beat the science intent of the requirement which is coverage relative to tracker and calorimeter – lower is better!**
  - **ACD4-73 - Temperature performance stability. On average we meet the requirement but some channels don't. Requirement written for average and overall there is no science concern as long as behavior is known.**
  - **ACD4-224 – The ACD shall cause interaction of less than 6% of the incident gamma radiation within the LAT field of view.**
    - This is a difficult requirement to verify by analysis. A variety of analyses have been completed with results varying from 5.8 to 6.4%. This requirement was more of a design guideline and the overall science impact due to small variabilites in this number is minimal (note the significant digits of the requirement). The LAT science team has been informed of this potential non-conformance.
  - **ACD4-226 - The thermal blanket/micrometeoroid shield shall have a mass per unit area of ~<0.32 g/cm^2 which should minimize secondary gamma-ray production by undetected cosmic ray interactions.**
    - This requirement is difficult to determine with high accuracy, however it is estimated that the "as-built" thermal blanket/micrometeoroid shield has an overall average density of ~3.6 g/cm^2 (12.5% higher than goal of ~<0.32 g/cm^2). This variance is due to the additional layers of Kevlar added to the MMS, which was required by an update to ORDEM2000 (Orbital Debris Environment Model), so that the more important requirement of having a Probability No Penetration (PNP) >.95. A change request will be submitted to the LAT Instrument Project Office.

Completed Verification Results - *Summary*

- All of our subsystem testing verification is complete and all major anomalies addressed.
- System level verification is complete.
- Final analysis and optimization of system settings and final channel performance inputs complete.
- Post environmental functional tests and performance tests completed. Tests also successful with few problems or non conformances.

RESOURCE MARGINS

ACD Technical Budget Summary

Technical Resources –

- ***ACD Mass***
  - *Allocation* — *295 kg*
  - *ACD measured mass* — *282 kg*
  - *ACD mass margin* — *14 kg*

- ***ACD Power***
  - *Can not accurately measure the full power of ACD in its assembled state due to limitations in the EGSE. Power measurements performed on each flight electronics chassis and the High Voltage Bias Supplies provides a nominal power of:*
    - *Measured* — *11.9 W*
    - *Allocation* — *12.5 W*
    - *Margin* — *0.6 W*
  - **ACD meets power specifications and requirements when operated nominally at specified limits. By using relative power measurements taken during thermal vacuum testing, it is estimated that the ACD will use 0.1 W less power at hot operating temperature and 0.4 W more power at cold operating temperature.**

ACD Technical Budget Summary

Technical Resources –

- ***<u>Thermal Interface</u> (max dissipation across ACD-LAT interface)***
  - ***Dissipation Allocation*** ***16 W***
  - ***Dissipation Analysis*** ***<14 W***
    - *Not directly measurable with requested de-scope of thermal balance, however analysis is very complete and simple with no significant uncertainties*
    - *LAT is not sensitive to small errors in this number*

- ***<u>FREQUENCY MARGIN</u>***
  - ***All analysis and tests of all subsystems exceed 50 Hz min requirement. Lowest frequency result from tests is ~70 Hz for TSA and ~100 Hz for the electronic chassis.***

Mission Assurance

James Lohr

GLAST SAM

OPEN PR's

ACD-2336-003 *07/27/2005 18:10*	*A cracked –9 EO #4 post (1) was used in the left middle position marked "E" as per MMS Installation Assembly, GE2054591on the +X Side of the MMS. This was instead of a -7EO#4 post.*	◆*The fabrication shortage and test schedule drove decision to substitute existing posts for the redesigned posts, some of which arrived with cracks and were rejected.* ◆*However, the best of the cracked –9 EO #4 posts (1) was used in the left middle position marked "E" as per MMS Installation Assembly, GE2054591on the +X Side of the MMS.* ◆*This decision was strictly for test and the post is planned for replacement with a flight tested post after Environmental testing is complete.* ◆*Environmental qualification tests on replacement posts completed.*
ACD-02334-016 *08/05/2005 08:14*	*During two of the four transitions from hot to cold during the ACD thermal vacuum test, we observed high count rates in the ACDMonitor script. In each case, these rates exceeded 1000 Hz. The temperature range was approximately -10 C to -15 C. Because hardware counters were used, we only know that it was one of the data channels from phototubes attached to tile 320 - i.e. GARC 6, GAFE 16 or GARC 7, GAFE 17. By the time the temperature had stabilized at -25 C, the rates had returned to their normal values of less than 100 Hz. No problems have been seen with either phototube signal in any functional test at any temperature.*	◆*The test script that was running collected only rate data, so we have no other information about the output of that channel. We do not even know which of the two phototube signals might have given the high rate, because the hardware counters sum the signals.* ◆*This channel (both phototubes) produces good data in every functional test we have done.* ◆*Because it is a transient problem, not even seen in every transition, we have been unable to diagnose this problem. Generally noise decreases with lower temperature.* ◆*If a high rate on a channel appeared in orbit, we have the option of disabling a phototube signal. Loss of one signal would be acceptable for ACD performance.*

OPEN PR's

ACD-02334-009 *07/26/2005 15:45*	*AcdVetoHitmapPha failed: Garc 11 Gafe 17: High TCI level channel received unexpected HW Count of 2 (expected 0)*	◆*During each of the cold cycles during the thermal vacuum test, we observed 2-4 excess counts on one electronics channel of the ACD during a test.* ◆*The test was done using charge injection and was a test of a high VETO threshold (should have recorded no counts).* ◆*Either the VETO threshold was not set properly, or the test charge was larger than expected.* ◆*The excess counts appeared on the last GAFE of the last GARC, suggesting a possible end-of-test-cycle clearing error, possibly due to timing, but we have no way to confirm this suspicion.* ◆*If we found excess VETO rate in orbit, we could re-set the threshold. It has very wide dynamic range.*

OPEN PR's

ACD-ACD-INT-02324-001 *07/22/2005 14:54*	*During a visual inspection of the ACD after the completion of the Acoustic test, it was noticed that a nutplate with adhesive, like the the parts used to capture the screws that mount the TDAs to the ACD structure, was found on the floor of the test cell under the ACD Dolly. The location where the nutplate was found was under the +X, -Y corner.*	◆*The Nut plate is believed to have been on ACD dolly before testing started.* ◆*The nut plate in question had debonded from the angled shim it was mounted to during TDA installation and was inadvertently left behind. During acoustic tests it shook free.* ◆*Nut plates have a locking feature that requires 0.5 in-lbs to overcome the locking feature. The locking feature is not likely to be overcome through vibration or acoustic loadings.* ◆*Nut plate is captured within a flexure by tape that surrounds each flexure to provide light tight seal. Light tight seal is validated through light tight testing.* ◆*The ACD had closeouts between the ACD and the 2" plate and covering the hole in the 2 inch plate.* ◆*Post Acoustic Test Inspection revealed nutplate installation tool found in the +x, -y corner of the ACD dolly.* ◆*If this came off the flight assembly, analyses show that a tile mounted with 3 fasteners shows positive margin of safety.*

OPEN PR's

ACD-02334-004 *07/21/2005 17:55*	*While running the Thermal Monitoring system, the readout for Yp_Inshell_S was reading around 23 degrees at startup and started flunctuating between 5 degrees to a negative 50.*	◆*Will perform visual inspection after removal from chamber to assess condition.* ◆*No impact if it does not work.*

OPEN PR's

ACD-ACD-INT-02322-001 *07/20/2005 14:16*	*HldCal output for GARC5 is faulty when this test in run for all GARCs simultaneously. Extra triggers are being seen on all GAFE channels on GARC5, and the script resets the counter during the run. The calibration function, which should be a straight line, shows a peak. Troubleshooting on this problem: 1. This problem was not seen during the full functional test on 6/13/05. 2. This problem has been seen on all full functional tests since 6/17/05. 3. Running with only GARC2 and GARC5 enabled produces good results (consistent with the 6/13 run. 4. Running with only GARC4/GARC5 or GARCs 2, 3, 4, 5, 6, 7 also produces good results. 5. Running with all GARCs except GARC5 enabled produces similar nonlinear performance in GARCs 1,2,3,4, but not GARC 0 or GARCs 6-11. 6. If the cables for GARC5 and GARC2 are swapped, the nonlinear behavior still appears in the data labeled GARC5 (which came from GARC2 in this case). 7. Changing back to the HldCal software used on 6/13 does not solve the problem. 8. Changing back to the gGEM software used on 6/13 does not solve the problem.* *This PR now consolidates the following PRs, all of which describe the identical problem: ACD-02334-011, ACD-02334-002, ACD-02322-005, ACD-02322-001. These other PRs will be edited to reference this one, so that they can be closed. This PR should be left open for now, so that it can be carried to the next level of assembly.*	◆ *The problem does not appear to be in the ACD hardware, since it shows up on the same data channels when cables are swapped.* ◆ *This is a problem of calibration or operating conditions, not a problem of performance, as best we can tell.* ◆ *We have found no adequate explanation of how the data are being garbled, but software seems to be a likely candidate.* ◆ *We have an adequate workaround to obtain this calibration, by a run using just two GARCs.* ◆ *The whole topic of calibrating the High Level Discriminator is a secondary issue for the ACD, since the only goal of the HLD is to send trigger signals for possible high-Z cosmic rays.* ◆ *We are proceeding with this as an open issue.*

OPEN PFR (Green)

ACD-021 *07/05/2005 19:49*	*Measurements show that one thermistor wire installed onto the interior surface of the TSA violates the ACD stay-clear volume.*	◆*Stay clear violation is very minimal and does not cause an interference between the LAT and ACD.* ◆*Waiver LAT-XR- 07058-01 submitted to LAT. It is in the approval process.* ◆*Preliminary approval received via email.*

ACD PSR

Risk Management

Tom Johnson
Instrument Manager, Code 556

Risk

- *If failures occur the ACD is designed to fail ‘gracefully’. Major failures result in incremental steps in performance. Other than a major micrometeoroid hit, it takes multiple failures to fail a detector channel. Complete detector channel failures leave holes in coverage.*
- *Micrometeoroid shield penetration is the only in orbit single point failure risk. ACD fails to meet the efficiency requirement with one tile destroyed by micrometeoroid penetration. The only other way to lose a entire detector channel is for multiple failures of other components.*
- *A GARC failure results in loss of up to 17 PMTs leaving 17 detector tiles operating on one PMT. The ACD meets the efficiency requirement in this scenerio.*
- *Each Tile Detector Assembly and Ribbon Detector has fibers leading to two separate PMTs on separate electronic chassis. PMTs are powered by separate HVBSs.*
- *Each electronic chassis has redundant HVBSs.*
- *High Voltage for the PMTs can be adjusted in orbit to counteract PMT gain degradation over time.*

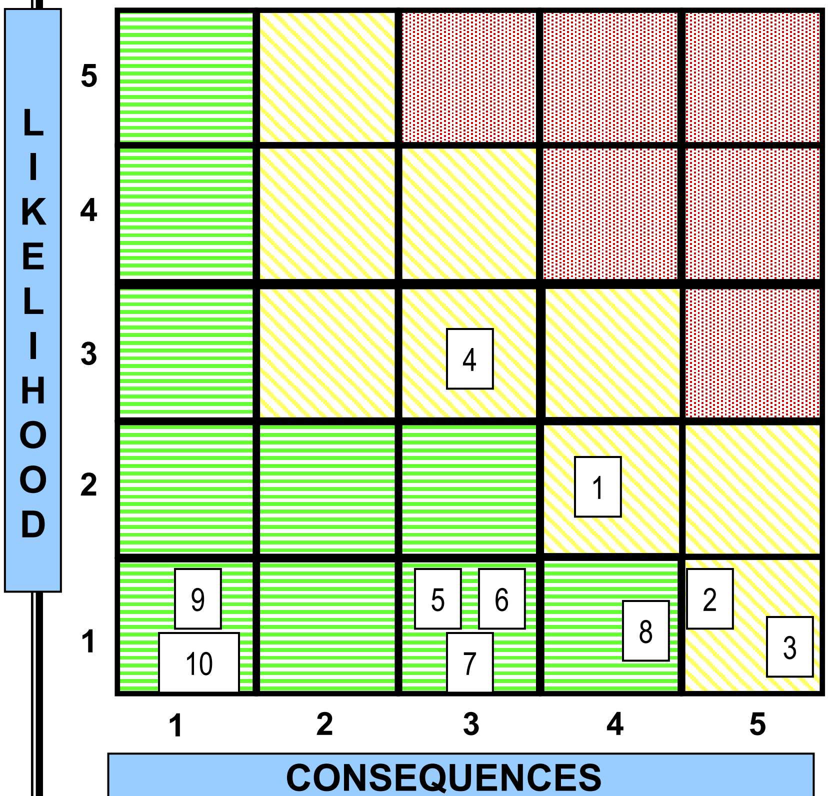
Risk

- *As part of the reliability/risk mitigation program, the following activities have been performed:*
  - *Failure Modes and Effect Analysis and Critical Items List ACD-RPT-000042* (LAT-TD-00913)
  - *Limited-Life Item Analysis (LAT-TD-00523)*
  - *Reliability Assessments and Worse Case Analysis (ACD-RPT-000071)*
  - *Fault Tree (ACD-RPT-000072)*
  - *Parts Stress and De-rating Analysis*
  - *Continuous Risk Management Plan (LAT-MD-000067)*

ACD RISK ASSESSMENT

ACD PSR

8 August 2005



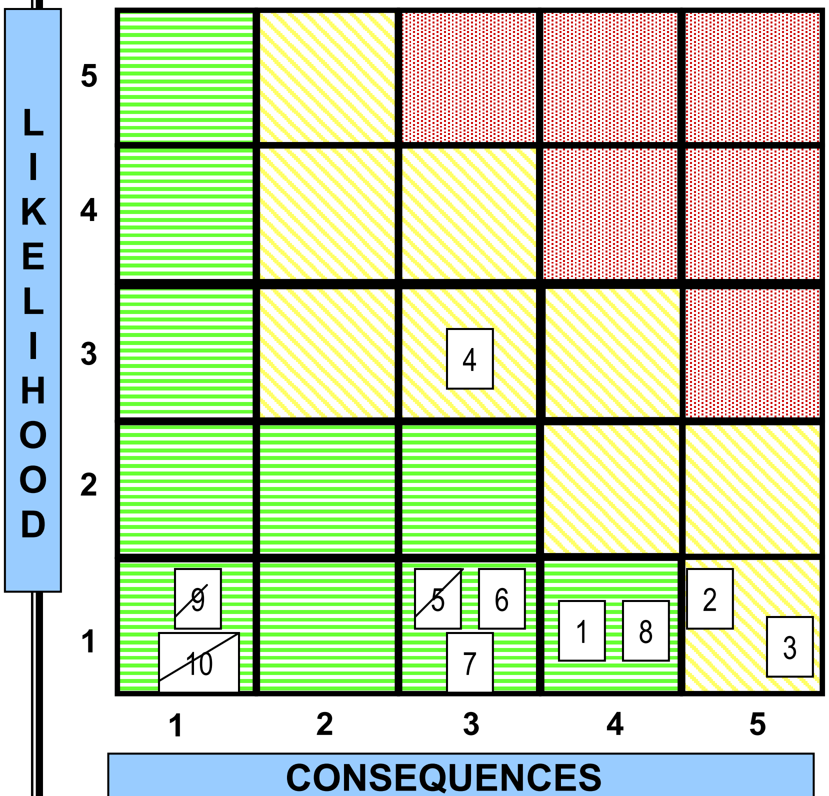
Criticality	Approach
High	M - Mitigate
Med	W - Watch
Low	A - Accept
	R - Research

Rank	Approach	Risk Title
1	M,R	Damage and/or light leak to Tile Detector Assembly
2	M,R	Electronics component failure (incl PMT subassembly)
3	M	EEE Part Failure
4	M	EGSE failure or malfunction
5	R,M	Facility problem.
6	M	Corona around high voltage during vacuum testing
7	M	Secondary structural failure during environmental testing
8	M	Damage to ACD during handling or test set up operations (including ESD)
9	M,A	ACD EMI/EMC Test Descope
10	R,A	ACD Thermal Balance test descope

ACD PSR

ACD RISK ASSESSMENT – AT PSR

8 August 2005



Criticality
- High
- Med
- Low

Approach
- M - Mitigate
- W - Watch
- A - Accept
- R - Research

Number /Trend	Approach	Risk Title
1 ↓	M,R	Damage and/or light leak to Tile Detector Assembly
2 ↓	M,R	Electronics component failure (incl PMT subassembly)
3 ↓	M	EEE Part Failure
4 →	M	EGSE failure or malfunction/LAT interface issue.
5 ↓	R,M	Facility problem. (RETIRED)
6 ↓	M	Corona around high voltage during vacuum testing
7 ↓	M	Secondary structural failure during environmental testing
8 ↓	M	Damage to ACD during handling or test set up operations (including ESD)
9 ↓	M,A	ACD EMI/EMC Test Descope (RETIRED)
10 ↓	R,A	ACD Thermal Balance test descope (RETIRED)

Project Review Activities

Tom Johnson
Instrument Manager, Code 556

Monthly Reviews

- ***AETD Champion Team Review – Representatives from all applicable divisions within AETD review our status on the first Monday of every month. They also serve as our "champion" within their respective division and help us to resolve issues.***

- ***Goddard Monthly Status Review (MSR) – Issues, risks, schedule, milestones, cost, reserves, and accomplishments presented to the Goddard Program Management Council monthly.***

- ***GLAST/LAT Monthly Cost and Schedule Review – Technical issues, accomplishments, and cost and schedule variances and corrective actions presented to the LAT and GLAST Project Offices monthly***

Major Reviews – Past (except PER)

- ***Past Reviews: All Action Items closed***
  - *LAT Internal Review of the ACD – January, 1999*
  - *Pre-PDR/Baseline Review – February, 2001*
  - *LAT System Requirement Review (SRR)- May 2001*
  - *ACD Peer Review – July, 2001*
    - *62 RFA's – All closed out*
  - *LAT PDR/Baseline Review – January, 2002*
    - *12 RFA's – All closed out*
  - *LAT Internal Stanford Linear Accelerator Center Review - April, 2002*
  - *LAT Delta PDR/Baseline Review - July, 2002*
    - *3 RFA's – All closed out*
  - *ACD Critical Design Review – January 7 & 8, 2003*
    - *19 RFA's – All closed out*
  - *LAT Critical Design Review (CDR) – May 12 - 16 2003*
    - *2 RFA's – All closed out (both ASIC related)*
  - *DOE/NASA Independent Review – March, 2004*
  - *PMT Mounting Design Peer Review – August 30, 2004*
    - *18 RFA's – All closed out, zero PMT glass enclosures have failed using new mounting design*
  - *ISO Audit – November, 2004*
    - *2 Observations, no findings or RFA's*

Request for Action - PER

ACD PSR

8 August 2005

RFA	Action/Question	Response	Status
1	a) Successful completion of ACD full functional/performance testing.	The ACD full functional is currently 90% complete. It will be completed when one test is re-run with an updated test script. ACD vibration testing will begin following the successful completion of the final test. Vibration testing is scheduled to begin on Tuesday, July 12.	CLOSED
	b) Complete review of TV test configuration given that new plan (back to baseline) require disintegration of MMS prior to TV (reflected on chart 88) with ACD Champion team.	Due to facility and hardware availability constraints, the ACD had planned to deviate from the original baseline and perform thermal vacuum testing prior to vibration testing. The four cycle thermal vacuum test was to be performed without the Micrometeoroid Shield (MMS)/Thermal Blanket (TB) and then the MMS/TB would be installed and one thermal cycle would be performed to verify the structural integrity of the MMS/TB mechanical attachment points. Hours prior to the ACD PER, it was realized that the ACD would not have to deviate from the original baseline. Therefore, the ACD will perform all testing with the MMS/TB installed. Vibration testing will be performed first followed by thermal vacuum testing. No de-integration of the MMS/TB will be performed during the environmental testing flow. One slight deviation is that the Germanium Kapton outer layer will not be installed during ACD environmental testing. This deviation has been evaluated by both the ACD mechanical and thermal leads and is an acceptable and/or preferable deviation due to the fragile nature of the material. It will be installed prior to LAT level thermal vacuum testing.	CLOSED
	c) Ensure hat a reliable EGSE SW/LATTE SW baseline version is frozen to ensure consistent performance testing evaluation throughout the environmental test program.	Will do. Several updates have been made to LATTE since the ACD PER. These updates were required to successfully run the ACD functional and performance tests.	CLOSED

Request for Action - PER

RFA #	Action/Question	Response	Status
2	Get a fiber optics expert's opinion on the integrity of the fiber optic bundle that had the broken fiber on it (Detector Assembly 230). Could there be any residual stress that could predispose other fibers in the bundle to fail?	Status and visual inspection result. It was found that in TDA 230 (long tile on –Y side) one green fiber (wave-length shifting fiber) is broken just at the entry point into the fiber bushing. The first impression after careful visual inspection is that due to some reason this single fiber was not bonded to all other fibers (20 in total) to create a strong bundle in the entering point into the bushing, but was accidentally bonded by some remaining epoxy leaked out from the bushing to the black tubing, and during tubing taping to the bushing some rotation of the tubing caused the fiber to break. All other fibers (20 in total) are bonded together at the length of approximately 0.5" from the bushing and create a solid bundle. Careful visual inspection did not show any visible damage to any of other fibers. Normally damaged fibers are easily seen by presence of bright rings, which were not found in this fiber bundle. Also the inspection of both fiber bundles of this TDA was performed according to "Clear Fiber Cable Post-Installation Test Procedure" ACD-PROC-000294 and did not reveal any damages to the fibers. Mitigation: Special tests were performed (at the time of ACD design) to measure the TDA performance dependence on the number of broken fibers, and it was found that up to 4 broken fibers are allowed in the TDA to still meet the performance requirement. This test was for the TDA's which are required to have 0.9997 efficiency, but the long tile has an efficiency requirement of only 0.999. So, a single broken fiber has no effect on the operation of this TDA. Performance test of long TDA (notes "Performance test results for the bottom row tile", AM, 11/06/2002) demonstrated that even with one fiber bundle completely failed, this TDA would still meet the requirement with lowering the detection threshold to 0.2. This fact ensures us that single broken fiber in 230 in the current situation is absolutely acceptable. As was already said above, visual inspection did not show any more damaged fibers. Analysis: We can not quantitatively predict the stress on a single fiber, however, under vibration environments the fiber bundle can experience a 60g acceleration (reference, chassis qualification chassis vibration testing). This can result in a 470psi stress on the fiber bundle and this stress is low compared to bulk scintillator material. Therefore, fibers are not likely to fail during environmental testing. Finally, five detectors were tested in their flight configuration during qualification of the flight ACD mechanical structure without a single fiber failure.	OPEN – Waiting on approval from orininator. The performance of the TDA's has remained constant throughout environmental testing of the ACD, which indicates that the plastic fibers did not break during testing.

Recommendations – PER

#	Recommendation	Response	Status
1	During ACD TV Testing, run the GASU baseplate temperature at a level that will give equivalent ambient boundary point temperatures. GASU #8 has not been tested in vacuum at temperature and may experience some temperature sensitivity during TV testing that may affect ACD testing. This problem was experienced during Tracker TV testing using a TEM box had not been tested in vacuum @temperatur	It has always been the plan to maintain the GASU at ambient temperature during thermal vacuum testing. A thermal control plate has already been provided for the GASU and it will be blanketed for the test. Both the thermal control plate and GASU will be instrumented with thermocouples and will be controlled using a Temperature Conditioning Unit (TCU) provided by the Environmental Testing Group (Code 549). Additionally, since GASU #8 has not been tested in vacuum, a thorough review has been performed by the ACD and LAT teams and it was concluded that it was a very low risk to perform testing on the ACD using a GASU that has not been tested under vacuum conditions. A report documenting this issue has been written and submitted in the ACD configuration management library (ACD-RPT-000359). Code 560 has reviewed this issue as well and came to the conclusion that the risk of failure was very low and therefore vacuum testing on GASU #8 is not required (email confirmation from C. Coltharp on June 21, 2005).	CLOSED – GASU was held at ambient temperature during TVAC testing.

Recommendations – PER

#	Recommendation	Response	Status
2	While the PMT high voltage power supplies have been well designed and people commanding the instrument or spacecraft will be careful, please consider implementing a hardware or software lockout that would prevent turning high voltage on during pump down, launch, or prior to completing outgassing. Corona or Passion high voltage breakdown might occur during pump down, launch, or prior to completing outgassing. Such a breakdown might produce EMI or transients that could damage instrument or spacecraft bus electronics. A hardware or software lockout of high voltage might prevent an accidental command that might damage the spacecraft if it were sent at a critical time.	The ACD currently implements a hardware lockout that requires three commands to apply a voltage to the PMTs. This works in the following way: Any time the GARC ASIC is reset (for example, at power-up or by command), the high voltage enable bits are reset to the inactive state, the bias level DAC is commanded to a zero level, and the high voltage level registers are cleared. To apply voltage to the PMTs, three commands are needed: (a) enable the high voltage supply (this is an active high bit) (b) supply a value for the high voltage level to be used (c) direct the GARC to send this level to the DAC. The enable commands each consist of three bits with a best two-of-three voting logic for the bit status. This triple modular redundancy provides additional protection against single event upsets. Additionally, there is an additional failure mode that has been covered related to power supply sequencing. The GARC ASIC requires +3.3V power to actively control the state of the high voltage bias supplies. In the absence of +3.3V power while +28V is applied to the ACD (a non-standard mode), there is a pull-down resistor on the FREE board to passively inhibit the operation of the supplies. While it is true that proper care should be exercised by both test conductors and software lockouts, the hardware does provide the basic mechanisms to prevent a voltage level from inadvertently being applied to the phototubes.	OPEN – Waiting on response from originator

Recommendations – PER

#	Recommendation	Response
3	For historical reason, the PMT high voltage power supplies are capable of being commanded to an output of 1150 Vdc even though it has been determine that the maximum required output is 950 Vdc. Further, no system level testing is planned above 950 Vdc. Please consider implementing a hardware or software lockout that would prevent accidental commanding of the high voltage to a voltage level above which was tested at the spacecraft/instrument level for both I&T and on-orbit operations. Increased voltage may produce corona or H. V. breakdown that could damage T/M or components. Never allow orbital ops that have not been tested on the ground.	This addresses the issue of the original design of the ACD system having a specification of 1300 V, but having a recent desire to limit the voltage to 1150 V. Since all of the flight electronics had been built, tested, and qualified prior to this change, it remains capable of 1300 V operation. (In fact, the great majority of the phototubes in the flight ACD system have already been tested and characterized at 1300 V). Any maximum level lockout would have to be accomplished in software at this point. This is most simply done using the command sequence detailed in section (2). After writing the high voltage level to be used in step (b), this value is read back from the GARC. If the value read back corresponds to a value greater than 1150V, then step (c) is not initiated. If the software performs this check, a voltage higher than 1150 V could not be commanded without an explicit operator override.

Recommendations – PER

#	Recommendation	Response
3	For historical reason, the PMT high voltage power supplies are capable of being commanded to an output of 1150 Vdc even though it has been determine that the maximum required output is 950 Vdc. Further, no system level testing is planned above 950 Vdc. Please consider implementing a hardware or software lockout that would prevent accidental commanding of the high voltage to a voltage level above which was tested at the spacecraft/instrument level for both I&T and on-orbit operations. Increased voltage may produce corona or H. V. breakdown that could damage T/M or components. Never allow orbital ops that have not been tested on the ground.	This addresses the issue of the original design of the ACD system having a specification of 1300 V, but having a recent desire to limit the voltage to 1150 V. Since all of the flight electronics had been built, tested, and qualified prior to this change, it remains capable of 1300 V operation. (In fact, the great majority of the phototubes in the flight ACD system have already been tested and characterized at 1300 V). Any maximum level lockout would have to be accomplished in software at this point. This is most simply done using the command sequence detailed in section (2). After writing the high voltage level to be used in step (b), this value is read back from the GARC. If the value read back corresponds to a value greater than 1150V, then step (c) is not initiated. If the software performs this check, a voltage higher than 1150 V could not be commanded without an explicit operator override.

Recommendations – PER

#	Recommendation	Response	Status
4	Consider GSFC personnel escort for cross country road trip of ACD to SLAC. There was talk of an active purge system being used. There should be shock and temperature sensors. A knowledgeable technician along for the ride could be beneficial. Commercial truck drivers should be more conservative with an escort.	Providing a cross country escort for the transportation of the ACD from the GSFC to SLAC was not included in the baseline plan due to cost constraints. The baseline plan is to transport the ACD in an environmentally controlled air ride tractor trailer using dual drivers. The ACD will be mounted on a shipping dolly that is vibration isolated and it will be instrumented and monitored for shock and temperature. It will be bagged and purged to provide additional humidity and contamination control. The ACD is not particularly sensitive to temperature or contamination. The temperature limits are +40C on the high side and the low side is constrained primarily by condensation, which is mitigated by the environmental control system with redundant control provided by the purge. Contamination will be controlled by double bagging with the purge providing additional backup capability. As noted in the recommendation, the primary benefit of an escort would be to ensure that the truck operators drive responsibly and conservatively. With all of that said, the ACD Team does agree that there would be some benefit to escorting the ACD from Goddard to SLAC. Therefore, we will submit a request to the LAT project requesting the additional funding (estimated to be $30K) required to support a cross country escort for the ACD	CLOSED – Transportation plan and contingencies are in place to transport the ACD to SLAC without an escort.

Reviews – Future

- ***Future Reviews:***
  - *ACD Pre-Ship Review (PSR) – TODAY, August 8, 2005*
  - *LAT Pre-Environmental Review (PER) – January 2006*
  - *LAT Pre-ship Review (PSR) – May 2006*

I&T Deliverables

Craig Coltharp
Integration and Test Manager, Code 568

Deliverables

Flight Hardware

- ***Anti Coincidence Detector (ACD) GE2054500***
- ***¼" bolts (quantity 12)***
- ***3/8" bolts, (quantity 8)***

Deliverables

As defined by ACD-LAT ICD- (LAT-SS-00363-07):

- Lifting Harness, etc:
  - **ACD Lift Brackets:** **GE2057546 Machining, Lift Sling GLAST GSE**
  - **ACD Lift Sling:** **GE2068104 Lift sling assembly BEA configuration**
- Handling Dolly:
  - **ACD Dolly:** **GE2057516 BEA Handling Dolly**
- Drill Templates:
  - **none**
- MMS/Thermal Blanket removal tools:
  - **Will not be delivered**
- ACD multi purpose test fixture:
  - **2" Plate Assembly:** **GE2068109 Universal Fixture, Assembly GLAST GSE**
- Hydraset if needed:
  - **Not enough hook height**
- Helium Monitoring equipment:
  - ***(Loan) Inficon model: 12206 Protec***

ACD Subsystem to LAT I&T Deliverables MOU (LAT-TD-04542-01):

- **3.1.1 Users Manual:** ACD Comprehensive Performance Test Procedure (ACD-PROC-000270) and GLAST ACD G3 EGSE Script Summary (ACD-LIST-000282)
- **3.1.2 Test Scripts:** All have been put into CVS repository at SLAC
- **3.1.3 Algorithms:** GLAST ACD G3 EGSE Script Summary (ACD-LIST-000282)
- **3.1.4 SVAC Plan:** To Be Provided
- **3.1.5 MGSE:**
  - *Drawings, Inspections, Proof Tests, Certifications: Will be provided on CDs and/or DVDs from ACD CM Library.*
- ***3.1.6 EGSE:***
  - *None*

Deliverables

ACD Acceptance Test Data Package Contents Requirements (LAT-TD-04349-01):

- **We are working on completing the ATDP by 15 Sep 2005.**

ACD TRANPORTATION
Preship Review

Aug 2005

ACD Mechanical Team

Kenny Harris / Code 543, ACD Mechanical Engineer

ACD Mechanical PER Presentation Outline

- ***Instrument Transportation***
  - *Requirements*
  - *Documentation*
  - *Transporter Personnel*
  - *Roles*
  - *System Description*
  - *Analysis Results*
  - *Certification Tests*
  - *Contingencies*
  - *GLAS vs GLAST Comparison*

REQUIREMENTS

– *Transport the ACD Instrument from GSFC to SLAC*
– *Maintain temperature of 70±10°F*
– *Maintain Relative Humidity of < 60%*
– *Supply Continuous Purge to ACD at 10 CFH*
– *Record Shock and vibration data during trip.*
– *Mechanical Load Environment Not to Exceed Tested Values for All Components*

Documentation

- *ACD Instrument and Ground Support Equipment Packaging, Handling, and Transportation Plan ACD-PLAN -369*
- *ACD Instrumentation Plan ACD -000-371*
- *Shipping Configuration Drawing*
- *WOA for transport to SLAC is pending*

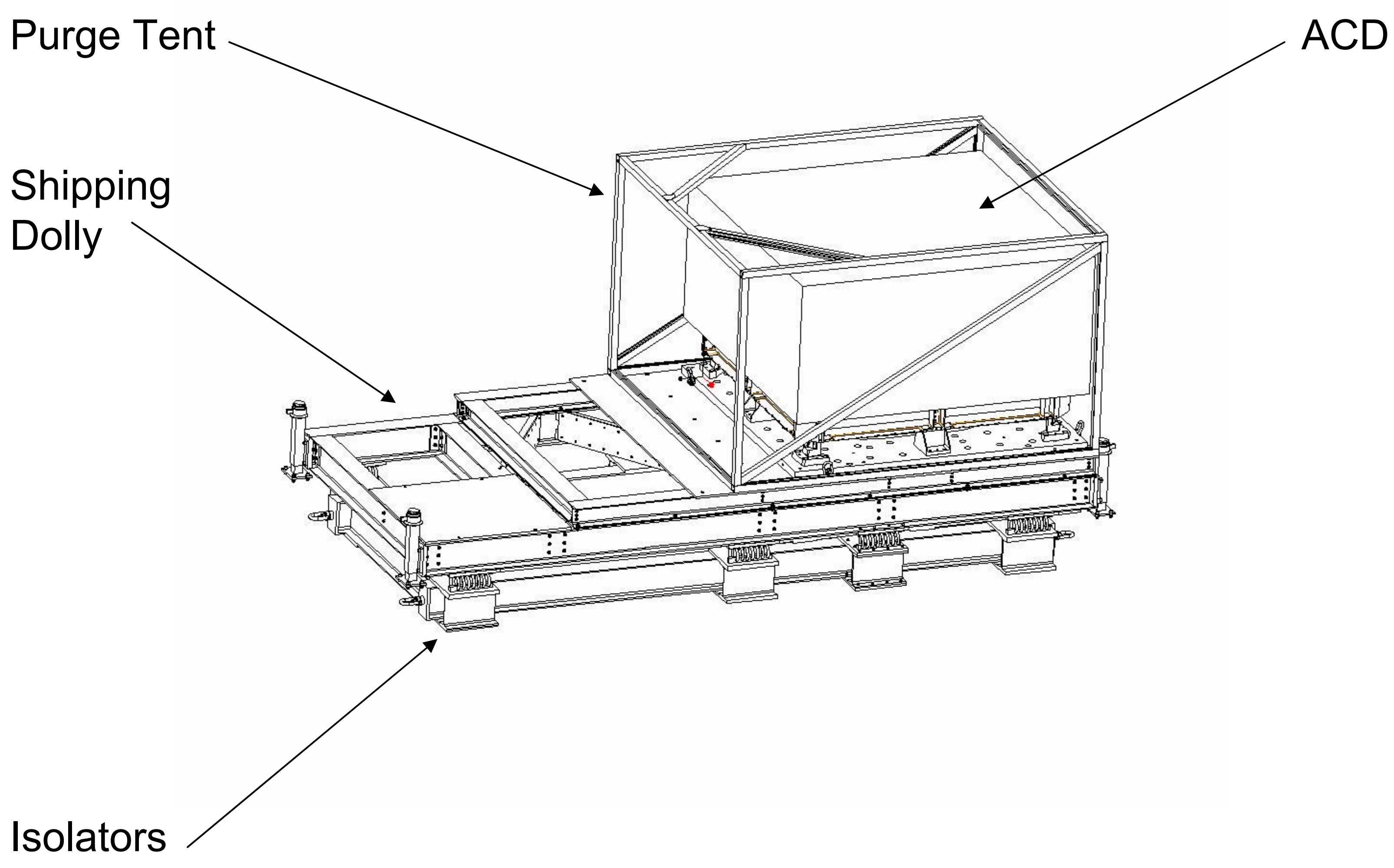
Transportation Personnel

Al Strojny	*TRAX Mechanical Engineer*
Steve West	*Instrumentation*
Ryan Simmons	*ACD Lead Analyst*
William Chambers	*Analyst*
Kenny Harris	*ACD Mechanical Engineer*
Al Lacks	*Quality Assurance*
Andrew Kolfeldt	*Safety*
Bill Hensley	*Logistics*
Steve Harper	*Technician*
Paul Haney	*Technician*
Mike Lenz	*Technician*
Mike Taylor	*Logistics*
Walt Carel	*Packaging*
Steve White	*Designer*
Rick Eichen	*Traffic Manager*
Ken Segal	*Mechanical Lead*
Craig Colthorp	*ACD I&T Manager*

Roles

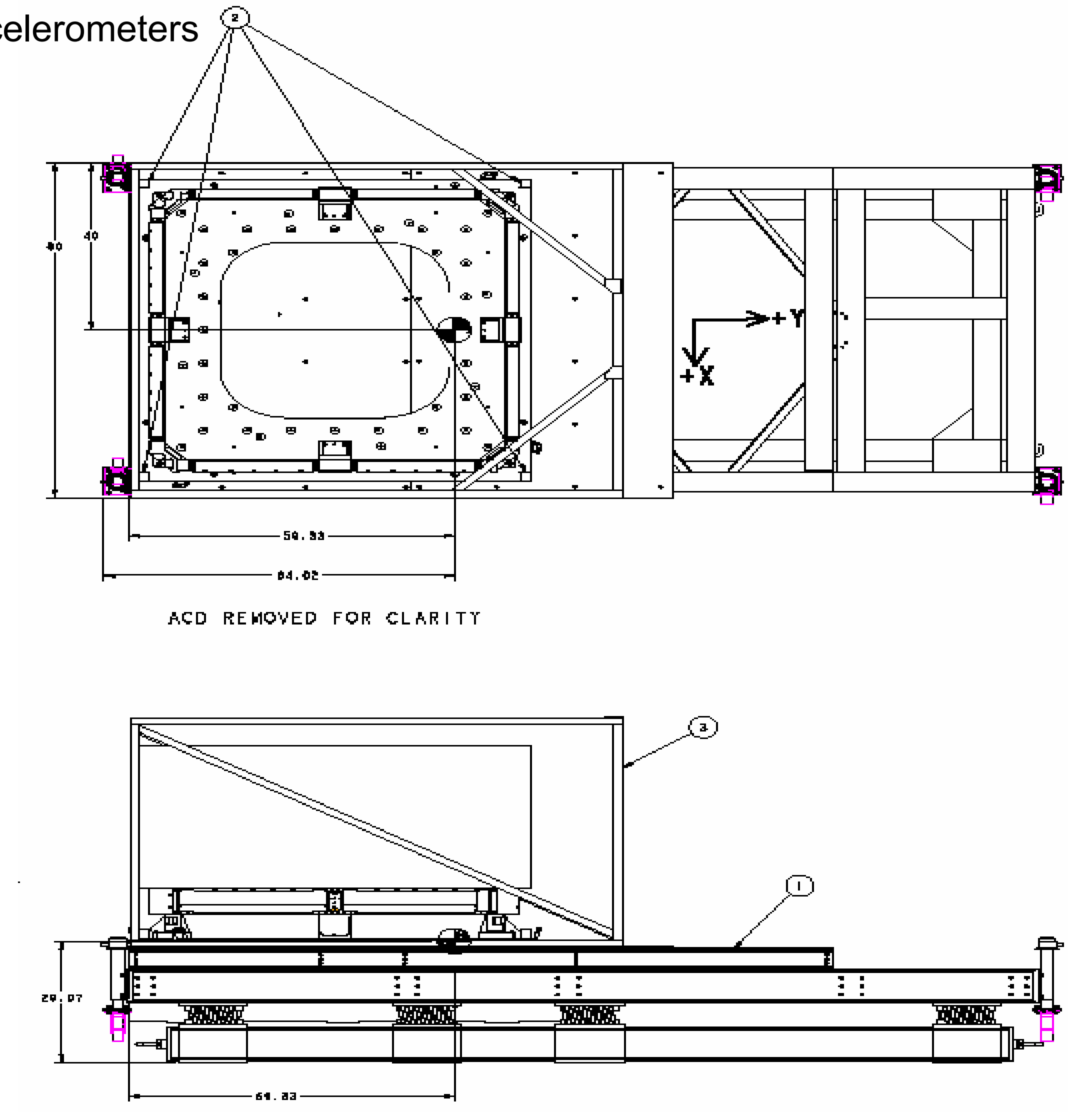
- *GSFC is responsible for shipment to SLAC*
- *SLAC will be responsible for providing operator assistance for cranes and forklifts in removing ACD from truck*
- *GSFC will perform functional test at SLAC before buyoff*
- *GSFC is responsible for packaging and shipping return items back to GSFC from SLAC*
- *Code 230 will be stay in contact with the truck drivers and update the project with a status every 12 hours and 4 hours before arrival to SLAC*

System Configuration



System Configuration

4 Accelerometers



Direction of travel →

TRANSPORTATION DESIGN LOADS

These Design Loads Were Used to Analyze All Structural Components in the Transportation Assembly.

Air Ride Transportation loading:

Longitudinal (g's)	*Lateral (g's)*	*Vertical (g's)*
$\pm$ 1.5 G's Forward (along direction of travel)	*$\pm$ 0.5 G's Lateral*	*+2.5/-1.5 G's Vertical (positive towards the ground)*

Structural Analysis Results

Component	Material	Loading	Stress (psi)	F.S.y	Page
2” vib plate attch ½”-13	Unbrako	combined	42758	3.9	7
½” plate attch 5/16”-18	Unbrako	combined	42603	3.9	8
½” plate attch 5/16”-18nut	140ksi ult	Thrd shr	18373	3.1	8
Isolator I beam buckling	Alum	buckling	Sig crit=17ksi	13.9	10
Isolator plates	Alum	bending	362	96.7	11
Isolator/plate I/f 3/8”-unf	unbrako	combined	44220	3.8	13
Tie down straps	na	na	Pmax = 4.5 kips	na	16
WF8x5 I beams (fork loads)	Alum	bending	1575	22.2	18

TRANSPORTATION ANALYSIS RESULTS

Finite Element Model Factor of Safety Summary

Need picture of model or delete

Item	Load Case	Stress (psi)	F.S.yield	Page
Pallet Plate Stresses v.m.	1	383	91.4	A1
Pallet Beam End A max comb.	1	368	95.1	A2
Pallet Beam End A min comb.	1	-445	78.7	A3
Pallet Beam End B max comb.	1	402	87.1	A4
Pallet Beam End B min comb.	1	-391	89.5	A5
Pallet Plate Stresses v.m.	2	383	91.4	A6
Pallet Beam End A max comb.	2	382	91.6	A7
Pallet Beam End A min comb.	2	-373	93.8	A8
Pallet Beam End B max comb.	2	394	88.8	A9
Pallet Beam End B min comb.	2	-463	75.6	A10
Pallet Plate Stresses v.m.	3	342	102.3	A11
Pallet Beam End A max comb.	3	413	84.7	A12
Pallet Beam End A min comb.	3	-383	91.4	A13
Pallet Beam End B max comb.	3	359	97.5	A14
Pallet Beam End B min comb.	3	-453	77.3	A15
Pallet Plate Stresses v.m	4	383	91.4	A16
Pallet Beam End A max comb.	4	359	97.5	A17
Pallet Beam End A min comb.	4	-370	94.6	A18
Pallet Beam End B max comb.	4	376	93.1	A19
Pallet Beam End B min comb.	4	-389	90.0	A20

CERTIFICATION TESTS

- ***Shipping Dolly Static Load Test to 1.25g***
- ***Shipping Dolly Fork-Lift Test to 1.25g***
- ***Trailer Maintenance***
- ***Route Survey Two Weeks Prior to Ship***
- ***Road test waived due to similarities to GLAS shipment***

CONTINGENCIES

EVENT	ACTION
• Severe Weather during transport	Use driver's discretion
• Severe Weather at SLAC upon arrival	Wait to unload
• Flat Tire	Repair
• Tractor Mechanical Problems	Repair/Replace
• Sick Driver	Dual Drivers
• Climate Control Unit Fails	Redundant
• Isolator Coil Fails	Multi-Redundant Coils Per Isolator
•	Minimal Impact On Isolation
• Low Purge Supply	100% margin during trip; Bottles coupled with manifold
• Emergency Road Closure	Contact State Transportation Authorities/ or Local Police

GLAS vs. GLAST Comparison

No Road Test Justification

	GLAS	GLAST
# of coil isolators	6	8*
Isolation frequency	13 Hz	13 Hz
Center of gravity	77” from rear	64.02” from rear
Weight	3000 lbs	3466 lbs

Modifications performed for GLAST shipment

- *Added 2 plates to support ACD*
- *Added 2 channels to support forklift*
- **Added 2 isolators to reach desired stiffness*

ACD PSR

Safety

Jim Anderson/Andrew Kofeldt
Systems Safety Engineer
SRS Technologies/Code 302

Safety

ACD PSR HAZARDS

- ***Transportation***
  - *ACD will be shipped single bagged with the Purge Tent as a cover*
    - *Purge is dry air, no asphyxiation hazard*
    - *Protect unit from objects falling against or on cover*
  - *Transportation is in an enclosed vehicle*
  - *ACD transportation dolly has been proof tested and certified for use*
- ***SLAC Operations***
  - *GSFC has had regular contact with SLAC Safety through periodic phone calls and face-to-face meetings*
  - *SLAC aware of all ACD safety issues through contacts and preparation of the overall LAT Preliminary Hazard Analysis*

Safety

ACD PSR HAZARDS

- SLAC lifting & handling procedures will be reviewed by GSFC Safety
  - The initial lift of the ACD at SLAC will be witnessed by GSFC Safety as well as SLAC
  - Initial removal from Transport Vehicle uses Forklift
    - ACD personnel/SLAC vehicle operator and Procedure
  - First crane lift is from Shipping fixture onto ACD Dolly
    - ACD personnel and Procedure/SLAC crane operator
  - Lifting hardware has gone through all required analysis and certification and is inspected for possible damage before each use
  - All lifting operations are supported by safety and are conducted in accordance with a safety-approved hazardous operations procedure

Safety

Applicable Documents

- ***GLAST ACD Instrument and Ground Support Packaging, Handling and Transportation Plan, GLAST ACD Plan-001***
  - *Reviewed and Approved*
- ***NASA-STD-8719.9 NASA Standard Lifting Standard***
  - *All hazardous operations procedures and work order authorizations are reviewed and approved by project safety prior to use*

ACD PSR

SUMMARY

Tom Johnson
ACD Instrument Manager
Code 556

SUMMARY

- The ACD successfully passed all environmental and performance testing!
- The ACD demonstrated it meets its performance requirements, with significant margin!
- The few anomalies seen during testing do not significantly impact the performance of the ACD and will be addressed at LAT level testing using new interface hardware and software.
- All open liens/non-conformances have been identified and a close out plan has been developed for each one.
- Following final stay clear measurements, thermal blanket removal, and cleaning, the ACD will be ready for installation on its shipping dolly.
- The Team is fully prepared to ship the ACD to the Stanford Linear Accelerator Center!

Let's get ACD on the road to SLAC!!!