Responses to RFAs
Peer Review on July 26, 2001

P-1	Steve Ritz	Status: Complete
	Reliability analysis at LAT level must address ability of other LAT subsystems to backup ACD functions. **Response** This is a LAT Systems action item.	

P-2	Steve Ritz	Status: Complete
	Effect at LAT system level on efficiency in event of one tile loss needs to be addressed. **Response** This is a LAT Systems action item.	

P-3	Bob Hartman	Status: Closed
	Quantify number of fibers that can be lost per tile before a failure mode kicks in. How many lost fibers can we withstand before a tile must be replaced? **Response** Our present knowledge indicates that the efficiency of a tile can meet (with no margin) the stated requirement (0.9997) with only one of its two PMT's operating. Thus, out of the 500-1000 fibers serviced by a single electronics board, any number could fail if the redundant set of PMT's and the redundant electronics board were available. However, if the ACD were launched with one electronics board inoperable because of broken fibers, the HVPS and the digital ASIC on the redundant board would become single-point failure threats for the entire LAT, since it is very unlikely that the LAT can meet its mission goals with 15 or 16 failed ACD tiles. The more difficult question is: "How many broken fibers can be tolerated on a tile that must be used." Recent tests (see report "Effect of broken fibers on the tile efficiency", A. Moiseev, 9/28/01, http://lhea-glast.gsfc.nasa.gov/gsfc/acd/acdpdr/Fiber_broken1.doc) indicate that several broken fibers can be tolerated, compensated via threshold reduction (e.g., from 0.35 to 0.25 MIP). The magnitude of the effect depends somewhat on the relative positions of the broken fibers; several adjacent broken fibers have a larger effect than the same number distributed widely, since that produces a "dead spot". Based on the results obtained, we are setting the following minimum requirements, leaving some margins: 1. To be qualified for ACD assembly, a tile may have NO broken fibers 2. For assembly into LAT, ACD may have tiles with a maximum of TWO broken fibers, with a minimum of two good fibers between the broken ones. There may be not more than three tiles in total with broken fibers. 3. ACD launch requirement – not more than FOUR broken fibers in any tile, with a minimum of two good fibers between any two broken ones. There may be no more than three tiles in total with broken fibers. The large tiles around the bottom of the ACD are a bigger uncertainty, mainly because the LAT simulations have not yet progressed to the point of being able to evaluate the effects of efficiency loss in those units.	

P-4 | Bob Hartman | Status: Closed

Need to address how many failures can be tolerated in each area: tiles, cables, connectors, electronics, etc.

Response

Our present knowledge indicates that the efficiency of a tile can meet the stated requirement (0.9997) with only one of its two PMT's operating. Thus even in the case of a complete failure of a single connector, single cable, single electronics board, or HVBS power supply the ACD could still function within specifications by using the redundant units.

In the worst case (excluding the large tiles around the bottom of the ACD), complete failure of a tile would reduce the ACD efficiency to about 0.985, well below the stated requirement. However, it is believed that the LAT would still be largely functional, probably at reduced effectiveness. LAT simulations are now underway to confirm this. Because of the redundancy built into the ACD design, the only credible mode for complete failure mode of a tile is a penetration of the thermal blanket / debris shield, which would open the tile to light from the Sun and/or Moon.

One of the large tiles around the bottom of the ACD represents 0.032 of the ACD area, however, the effect of the loss of one of these large tiles is not well understood. That is being studied in the LAT simulations also.

P-5 | Tony DiVenti | Status: Closed

Will the reliability estimate for the ACD ASIC (and any other estimated parts) be updated with actual lot test data for the specific device(s)? (Specifically for those devices without flight heritage). When will the reliability analysis be updated? What is the backup plan in the event of a device failure? Concern that a device failure be identified early enough to pursue a different path (if necessary) such that schedule is minimally impacted.

Response

The responses to these actions are included in the attached documents.

"ACD RFA P-05 Respo "ACD RFA P-05 PEM (

P-6	Tony DiVenti	Status: Complete

Revisit reliability allocations to establish firmness, before allocations are used to drive potentially costly design solutions.

Response

The current ACD reliability allocation is 0.96 and its associated sub-system reliability allocations are: Blanket/Shielding – 0.99, Tile Shell Assembly – 0.99, Base Electronics Assembly – 0.98. More detailed information regarding the ACD reliability allocations, and the effort involved in estimating the blanket/shielding reliability, are provided in the attached power point slide below.

"P06 Response.ppt"

For the ACD, the design has already been significantly de-scoped (e.g. reduction from 1 Power Supply per PMT to 1 Power Supply per 18 PMTs, etc.) in order to minimize short-term design costs while not adversely affecting the long term costs (e.g. unsuccessful mission) and reliability. Further de-scope, at this point, will generally result in significant reliability reductions because much of the redundancy planned for the ACD has already been removed. As an example, moving from 2 PMTs per tile to 1 PMT per tile in the Base Electronics Assembly would now result in approximately a 21% reduction in overall ACD reliability. More effort is required to determine if the 0.99 Tile Shell Assembly reliability target is achievable. Specific attention is currently being directed at the fiber optic connections.

Further reduction of overall 0.96 ACD reliability allocation would require an analysis by the LAT team.

P-7	Rudy Larsen	Status: Closed

Need to have a clear definition of how requirement compliance will be documented and what the deliverables to the LAT instrument and GLAST Project will be.

Response

Requirements compliance:
The ACD Level IV Electronics Requirements Document and the ACD Level IV Mechanical Requirements Document define engineering level requirements that are flowed down from the ACD Level III Requirements Document. The Electrical and Mechanical lead engineers are responding to these requirements with specifications for their hardware development.

The LAT/ACD Electrical Interface Document along with the LAT/ACD Mechanical Interface Document determines interface requirements between the LAT and the ACD. These are being generated by the functional leads of the LAT Project and are being iterated with ACD designers.

The DOORS tracking tool will be used by the project for the tracking of requirement flowdown, compliance and verification.

Deliverables/Receivables:
The ACD deliverables and receivables to the LAT have been identified and will incorporated in the PMCS scheduling and tracking tool. The ACD does not have any deliverables directly to the GLAST Project.

P-8	George Shiblie	Status: Complete
	Submit mass change to IDT/CCB. Need to establish an ACD mass allocation with reserve to prevent unnecessary work. **Response** A change request was submitted to LAT systems engineer on November 20, 2001.	

P-9	George Shiblie	Status: Closed
	ACD efficiency is required to be 99.97% (total - overall). All efficiency seemed to be allocated to detectors. How is the efficiency distributed among tiles, fibers, PMT response, noise, etc? **Response** We assume that the required efficiency of the ACD is provided by the detectors. It can be divided in two parts – one is the efficiency of particle detection if a particle crosses the sensitive part of the detector (the tile), and second is that the particle to be detected does not miss the detector (gap issue). The combination should be not less than 0.9997. Our design is such that the first part – detection efficiency itself – is dependent upon the amount of light delivered to the PMT and is allocated primarily in the tiles and the fibers which deliver the light from the tile to PMT. The fibers are designed to minimize the light loss during the delivery to PMT - this is the reason for using fiber-to-fiber connectors and clear fibers to reduce the light attenuation in the fibers. The type of PMT and its regime of operation are chosen such that it does not effect the efficiency. The noise is well below the detection level; the threshold for the signal to be considered as a detection will be set well above the noise	

P-10	Bob Hartman	Status: Closed
	A clear efficiency specification on the discriminator channel is needed. Is it 0.9997? **Response** 0.9997 is the efficiency requirement for the entire ACD. If all of the tiles have an efficiency of at least 0.9997, and then the entire ACD also has an efficiency of at least 0.9997. The efficiency of an electronics discriminator channel is dependent upon the commanded threshold (Higher threshold yields lower efficiency.); our tests have demonstrated the required efficiency at thresholds well above (at least 8x) the expected noise. Our present knowledge indicates that the efficiency of a tile can meet the stated requirement with only one of its two PMT's operating.	

P-11	George Shiblie	Status: Closed
	It appeared during presentation that all requirements have not been fixed and frozen. Is there good clear agreement between ACD and LAT on requirements? **Response** The ACD requirements shall be documented and approved in the Level III and Level IV Requirements documentation. In accordance with the LAT Systems Engineering Management Plan (LAT-MD-00066), the approved requirement documents shall document the technical baseline.	

P-12	George Shiblie	Status: Closed
	Complete the Level IV requirements and include traceability of requirement derivation. **Response** The ACD team has signed The ACD Level IV Electronics Requirements Document, LAT-SS-00352-D10. The ACD Level IV Mechanical Requirements Document is currently being worked on. The DOORS requirements management tool will be used by the GLAST project traceability of requirement derivation.	

P-13	George Shiblie	Status: Complete
	Requirements need to address the 2920-10H alternate launch vehicle (design loads, pressure venting profile, etc). Note, this comment was an advance notice from Joy Bretthauer of a possible change to the Mission System Specification. **Response** Currently, the ACD has not received direction to address the 2920-10H alternate vehicle. The ACD team recognizes that this change is possible and will address this change in our analysis and design when direction is given. Preliminary analysis shows that the loads will stay the same and the acoutics will be slightly higher. The change in launch vehicle should not affect the ACD design.	

P-14	George Shiblie	Status: Closed
	Provide the rationale by which using the green waveshifting fibers are worth the risk of having the additional 89 waveshifting/clear fiber connectors. Those connectors may prove problematic due to process control, workmanship, thermal cycling and vibe. **Response** The green waveshifting fibers (WSF) are not optional. Because of the ACD segmentation and efficiency requirements, they are the only way we have to read out the scintillation light from the tiles. What might be considered optional is the transition from WSF to clear fibers. This is planned because of light loss in very long runs of WSF, as well as mechanical handling difficulties if the TDA's were to be made without the WSF-to-clear transition. Where the fiber runs are not very long the WSF-fiber will not be transitioned to the clear fiber. If we transmit the light only by WSF, for the central top tiles (the most important for the experiment) the loss of the light would be ~ 40%, which is very critical for the ACD operation. Therefore our plan is to shift from Wave Shifting Fibers to Clear Fibers. The clear fibers have an attenuation length of 12 meters while the WSF have an attenuation length of ~ 3 meters. It has been shown that a similar type of connector can provide a light transmission of 85-90% with a uniformity of 2.5-3.1%, and a reproducibility of 1% (Nuclear Instruments and Methods in Physics Research, Section A, Development of fiber-to-fiber connectors for scintillating tile/fiber calorimeters). Not only do these connectors provide a higher light yield, but they also make the testing, handling, and integration of the Tile Detector Assemblies much more manageable. With a long bundle of fiber extending off of the TDA, the point at which the single fibers come out of the TDA would be subject to damage. The connector provides a much smaller length of fibers coming off of the TDA as well as providing a mechanical interface point to secure the fibers to the shell. This provides a strain relief for the fibers at the most critical fiber joint (i.e. where the fibers exit the tile). By using a fiber connector the TDA's can be tested and verified at a much higher level of assembly. Because of the complex nature of routing the fibers, a mockup of the ACD will be required to route and terminate the photo multiplier end of the fibers. This would mean that the TDA's could not be tested at their place of fabrication and assembly and would have to be tested and verified after delivery to GSFC.	

P-15	Tom Johnson	Status: Closed
	Does the process for terminating fibers into the fiber connectors ensure a good-to-high yield with a low probability of defects due to: cracking, scratching, breaking, contamination, which can be realized after flight qualification testing the connector? **Response** Yes. Similar fiber connectors have been used extensively for ground based detectors. While our geometric design is not identical to existing designs our overall design (including materials) is similar to connectors which are currently in use. We will use the same process for terminating the fiber connectors, which is currently used for thousands of connectors.	

P-16	Tom Johnson	Status: Closed
	Need a detailed plan for qualification of optical connector. Address statistical probabilities in test samples and analysis. **Response** A draft plan for qualifying the optical connectors is detail in the attached document. A final draft will be completed prior to CDR. "Propos[illegible]er Conr	

P-17	Tom Johnson	Status: Closed
	How do fiber connectors maintain alignment after they are assembled? **Response** Bolting the connector together at both ends controls movement along the axis of the fiber. Using alignment pins prevents lateral shifting between the two faces of the connector. Furthermore, the alignment pins are different size diameters so that the connectors can not be reversed. Similar connectors have been shown to have a light yield variation of <1% for mate/demate operations.	

P-18	Tom Johnson	Status: Closed
	How is the integrity of the fiber connection verified after a demate/mate? **Response** Qualification testing of prototype fiber connectors shall be performed to ensure that the performance of the fiber connection does not degrade after numerous demate/mates. Furthermore, every TDA with its associated fiber cable will be bench tested prior to being integrated onto the ACD. This will provide a performance baseline for every TDA/fiber cable assembly. During integration of the TDA and fiber cable onto the ACD, the fiber cable will go through one demate/mate cycle. After completing the integration of the TDA/fiber cable assembly onto the ACD, it will undergo a bench test identical to the test performed prior to being integrated to the ACD. These test results will be compared to the original performance baseline to verify that the TDA, fiber connector, and fiber cable were not damaged during integration. Every time the fibers go through a demate/mate cycle the entire TDA/fiber cable assembly will undergo a performance test to verify that it still meets its performance requirements. Similar connectors have been shown to have a light yield variation of <1% for mate/demate operations	

P-19	Tom Johnson	Status: Closed
	How are fibers and harnesses protected from damage due to tight bend radius, handling damage, etc. during routing? **Response** The minimum bend radius for the fibers and the electrical harness has been defined by NASA standards and manufacturers specifications, and they will not be exceeded. Additionally, the fiber bundles and electrical harnesses will be secured using tie-downs along the entire length of fiber or cable. Care must be used in the handling, routing, and termination of the fiber bundles and the personnel assigned to this task will be trained in the proper handling of the fibers. After the single fibers are grouped into bundles of ~30 fibers they form a rugged fiber bundle which is not easily subject to damage.	

P-20	Tom Johnson	Status: Complete
	How are the following issues with the fiber connectors addressed? a. molding fabrication, tolerances, shrinkage, misalignment, curing, etc. **Response** The connector will be built to print. Therefore it will be the responsibility of the vender to meet the tolerances specified on the drawing. If the vendor can not provide the tolerances specified on the drawing the parts will be rejected. It is the responsibility of the selected vendor to use the proper process needed to produce the specified part within its tolerances. b. Thermal expansion of molded pieces and their impact on fiber alignment. **Response** The fiber alignment is affected by fiber diameter tolerance, connector tolerance, and thermal effects. The clear fiber diameter is 0.20 mm larger than the wave shifting fiber diameter, so there is a total of 0.20 mm of tolerance available to account for fiber misalignment. The fiber alignment budget is allocated as follows: 0.08 mm for connector, 0.06 for fibers, and 0.06 for thermal effects. c. Failure and reliability analyses? **Response** A Reliability and Failure Analysis process will have to be fully integrated with Qualification and Screening. It is imperative that all connector, connector assembly (including fibers and wrapping), and Tile Detection Assembly (TDA) failures are analyzed to the extent necessary to determine root cause, relevance to mission parameters, and corrective actions (as applicable). Without the luxury of having flight data history for our particular connector/ connector assembly; the Qualification and Screening Program must utilize lessons learned from other space missions. The Qualification and Screening tests must be geared towards precipitating failures modes/ failure mechanisms expected from prior experiences related to fiber optic assemblies.	

P-21	Tom Johnson	Status: Closed
	Manufacturing and assembly processes need to be documented and reviewed. **Response** We are currently working with industry to develop and fabricate the fiber connector. The companies that we are dealing with have experience with fiber connectors and have worked with similar connectors. All manufacturing and assembly processes will be review and approved by the GSFC Fiber Optics Group (Code 562).	

P-22	George Shiblie	Status: Complete

What is the schedule risk associated with a failure during environmental testing?

Response

The attached spreadsheet shows the schedule risk associated with each type of failure during environmental testing.

"Risk of Failure in InT

P-23	Rudy Larsen	Status: Complete

GSE, simulators and their needed delivery dates need identification for all ACD subsystems.

Response

All of the MGSE and mass simulators, as well as their delivery dates are in the Schedule/WBS.

The following EGSE is required to the development of the ACD Electronics. The deliverable and receivable dates are currently being incorporated into the Schedule/WBS.

(1) **ACD-TEM (AEM)** for tests of the ACD Event Processor digital interface. Five AEMs are need for Event Processor board development and I&T.

(2) **Event Simulator** for Event Processor (as detailed on p.146 of peer review package). This unit will simulate the input of the 18 phototubes for the event processor board, allowing timing, coincidence, and spectroscopy tests to be performed on the electronics. This unit is a custom-designed circuit board assembly, a computer (& software), and laboratory test equipment, such as pulse generators, multimeters, and oscilloscopes. This is need prior to functional testing of the Event Processor boards.

(3) **High Voltage Bias Supply Test Fixture**. This GSE is required to test the flight HVBS prior to integration with the BEA. The components required and interconnections are shown in the peer review package on page 148. This is needed prior to vacuum testing the HVBS.

(4) **ASIC Test Stations (2)**. We will require a test station for the evaluation of the analog ASIC and a test station for the evaluation of the digital ASIC. This will be a combination of a custom-designed circuit board with a computer and COTS lab equipment. This is needed for the screening of the ASICs.

<table>
<tr><td rowspan="2">P-24</td><td>Jim La</td><td>Status: Closed</td></tr>
<tr><td colspan="2">Assembly and integration sequence for ACD should be detailed. Show minimum plan to address removal of each LAT subsystem for rework, after full-up integration complete. Identify and special GSE, etc for these operations.

Response
The ACD will be lifted off of its handling dolly, translated to a position above the LAT, and lowered down over the LAT. The fasteners used to attach the ACD to the LAT will be installed and then the electrical cables between the LAT and ACD will be installed. The only special ACD MGSE required for this task is the ACD Handling Dolly and ACD Lift Sling. A crane with sufficient hook height will be required as well. The task of mechanically integrating the ACD to the LAT is estimated to take from 4-8 hours. The LAT Team should address the removal of the other LAT subsystem.

All handling and integration procedures will be documented and coordinated with the LAT team prior to CDR.</td></tr>
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<tr><td rowspan="2">P-25</td><td>Jim La</td><td>Status: Closed</td></tr>
<tr><td colspan="2">Address detail of shipping to SLAC and integration at SLAC. Will ACD team perform integration? Is this scheduled and costed?

Response
The ACD will be mounted on a custom designed isolation system and placed in a shipping container. The shipping container will be placed in an environmentally controlled air-ride tractor-trailer for transportation from GSFC to SLAC. A loading dock or a forklift will be required to remove the ACD from the trailer at SLAC. See action item 24 for information on integration at SLAC. The ACD Team will support integration of the ACD to the LAT, however the LAT Team will have overall control of the operation. All handling and integration procedures will be documented and coordinated with the LAT team prior to CDR.

In addition to shipping, container and materials expenses, close to 2,500 Civil Service and Contractor hours with travel have been budgeted for the ACD flight unit I&T with the LAT Instrument at SLAC. ACD personnel to support the LAT instrument integration with the spacecraft has also been budgeted at approximately 900 hours of Civil Service labor.</td></tr>
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<tr><td rowspan="2">P-26</td><td>Tom Johnson</td><td>Status: Closed</td></tr>
<tr><td colspan="2">Crane height at SLAC appears to be an issue. (This should be addressed in the Integration and Test Plan and with handling fixtures used for both assembly and integration).

Response
I totally agree. It definitely needs to be addressed in the I&T Plan and with handling fixtures, however there is a very high probability that the 10 foot hook height that SLAC is providing will not be sufficient. It is definitely not sufficient to use standard lifting equipment such as Hydra-Sets and load cells to reduce risk when performing critical lifting operations. The LAT team will work with the ACD I&T team to resolve this issue before CDR.</td></tr>
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P-27	Tom Johnson	Status: Closed
	Who will do integration of the tiles to structure to electronics to GSE, etc? Who has the responsibility for delivery of the tiles? **Response** Code 543 (mechanical) will be responsible for selecting and providing the technicians to mechanically integrate the ACD. This would include mounting the TDA's to the shell, mounting the TSA to the BEA, and all handling operations. Code 543 is also responsible for the delivery of the TDA's. Code 564 (electrical) will be responsible for selecting the technicians to electrically integrate ACD electronics to EGSE.	

P-28	George Shiblie	Status: Closed
	Can ACD be totally tested without ACD-TEM and ACD-computer? **Response** No. The AEM is absolutely essential for all tests of the Event Processor electronics. It represents the single electrical interface (power, commands, data, housekeeping) that the ACD has to the LAT. In fact, to "totally test" the ACD, we need two AEMs. The testing diagrams on p. 146 and 147 of the peer review presentation show this detail. Refer to RFA P-23 for details on AEM needs.	

P-29	Tom Johnson	Status: Closed
	Where are the lifting points for the MGSE sling? How tall is the sling/ACD combination? **Response** The lifting points are at the four corners of the Base Electronics Assembly (BEA). The preliminary design height for the sling/ACD combination (with Hydra-Set and load cell) shall not exceed 4.22 meters. Drawing will be provided at a later date. (Refer to RFA P-26)	

P-30	---	Status: Closed
	Monte Carlo Simulation tells that: 1. 300 MeV electrons will leak thru cal. Corner and the ACT/TKR gap. The rate is > 0.01 cts/sec. 2. 100 MeV electrons will leak thru cal corner and the ACD/TKR gap. The rate is > 0.1 cts/sec or a few x $10^{-5}/cm^2 \cdot s$, or a few x extragalactic diff background. There should be some ACD coverage all around cal near the top of cal. Probably down to 5-10cm from the top of cal. Then the background 1), 2) will be $\leq 10^{-5}/cm^2 \cdot s$. **Response not required** This is a LAT Systems action item which is addressed in the IDT Action Items list A-027.	

P-31	---	Status: Closed
	Science team needs to quantify impact of gap between ACD and CAL. **Response not required** This is a LAT Systems action item which is addressed in the IDT Action Items list A-027.	

P-32	---	Status: Closed
	Mechanical trade activity should be opened to evaluate feasibility of closing gap between the ACD and calorimeter. This should be addressed at LAT mechanical system level as well. **Response not required** This is a LAT Systems action item which is addressed in the IDT Action Items list A-027.	

P-33	---	Status: Closed
	Bottom tile overlap with CAL depends on pending analysis, but this has big potential impact on mechanical and electronics packaging of ACD. Can bottom tile be extended down without impacting ACD packaging? **Response not required** This is a LAT Systems action item which is addressed in the IDT Action Items list A-027.	

P-34	George Shiblie	Status: Closed
	Clearly define the operating temperature. **Response** Event board i/f operating temp limits are -10 to +40 C (-20 to +50 C qual) PMT operating temp limits are -10 to +35C (-20 to +45 C qual)* Scintillating tile operating temp limits are -50 to +40 C (-60 to +50 C qual)	

P-35	Carlton Peters	Status: Complete
	Establish and document thermal operating and survival environments and required conduction paths. Address the need for thermal gaskets **Response** The LAT instrument is required to point anywhere at anytime for extended time durations during nominal mission operations. During a safe-hold condition, the GLAST Observatory will be in a solar inertial attitude with the +X axis oriented to the solar vector. Required conduction paths are identified through the analysis and the thermal interface materials will be used where it is deemed necessary. Cotherm will be used for the interface material.	

P-36	Carlton Peters	Status: Closed
	Why are survival heaters needed? The LAT has limited power for survival heaters. This must be coordinated with Gunther, Since it impacts power, and Martin, since it impacts LAT Thermal design. **Response** Assuming the that TDA temperatures will be permitted to go down to -60C for survival, analysis at time of Peer Review showed that there was no need for survival heaters	

P-37	Carlton Peters	Status: Closed
	Need more accurate thermal modeling of thermal blanket, micrometeorite shield, ACD tiles, and shell to tie in with LAT- level thermal analysis. **Response** The thermal model fidelity has been increased since Peer Review and will be included in PDR, future reports and analyses.	

P-38	Carlton Peters	Status: Closed
	The mass budget includes an allocation for heaters and thermostats. How are these used, how much power do they require, where are they located, and how are they controlled? Where are the temperature monitors mounted that are referenced by the thermostats. (PDR chart 104) **Response** Refer to the response of action item number 36	

P-39	Carlton Peters	Status: Closed
	How are the TBD temperature requirements going to be resolved and when? (PDR chart 111) **Response** The TBD temperature requirements have been resolved by the systems engineer, The Event Boards will operate between -10 and +40 C, while the tiles will operate from -50 to +40 C	

P-40	Tom Johnson	Status: Closed
	The thermal conduction path between the boards and the grid is to be modulated by thickening the frame. Does the current mass estimate include sufficient margin to accommodate the expected thickening? (PDR chart 112) **Response** At this point we have not been given any mass margin. The entire ACD mass margin is being controlled at the LAT System level. However, the mass budget chart shown on page 104 does include sufficient mass margin for modulating the thickness of the frame.	

P-41	Carlton Peters	Status: Closed
	The thermal analysis as performed was based on conduction only. What is the radiatively coupled environment? Does analysis justify this approach. (PDR chart 114) **Response** The thermal analysis at the time of the Peer Review assumed conduction only and since Peer Review radiation couplings have been implemented into the model. LAT was asked and verbally agreed to have a highly emissive surface on the grid. Through analysis the benefit is shown to be approximately 5 C. This verbal agreement needs to be incorporated and formalized in the Mechanical Systems ACD-ICD, LAT-SS-00241.	

P-42	Alex Moiseev	Status: Closed
	Can only one PMT be used as baseline? Is there enough margin? If two are needed, how do they operate together? Clarification and failure modes analysis is needed. (Note, chart 58 of the presentation seemed to indicate a possibility that one PMT per tile could be used, but Jonathan Ormes stated in the review that two PMTs per tile will be used.) **Response** Our most recent efficiency measurements with optimized tile design demonstrate that with one PMT the required efficiency of 0.9997 can be achieved with the threshold of 0.3 MIP. Thus the requirement is met, but with no margin. The efficiency can be improved by reducing the threshold, but we'd like to stay with the higher threshold to be above any noise (our own and environmental); also higher threshold reduces self-veto caused by backsplash. The light signal will be reduced by light loss in transmission from tile to PMT (estimated as 10-15% with the use of clear fibers connected with WSF). So the baseline is to run two PMTs, with the possibility of using only one PMT with lower threshold to save the life-time (decision to be made during the experiment depending on the noise conditions and tile performance). The two PMTs will operate independently and their signals will be added in logical "OR". This yields higher efficiency than adding the analog signals. Our tests show that the required efficiency can be achieved with the threshold 0.4-0.45 MIPs, so we have margins. If one PMT or the corresponding electronic channel fails, we can run the other PMT and be at the required efficiency level (or very close), depending the threshold chosen in view of the noise level and occupancy.	

P-43	Alex Moiseev	Status: Complete
	What is the specific light yield specification for tile to PMT? How is this related to Inst performance? What is performance reqt of PMT? What margin is there between design and minimum design reqmts? **Response** The light yield is not specified. It is derived from the required efficiency of particle detection. The key processes in the efficiency are fluctuations in the light output of the scintillator, mainly in the last step when the light from the scintillator converts to photoelectrons in PMT photocathode. If there were no fluctuations, any single-charged relativistic particle (designated MIP) which have the same path in the tile, would produce the same number of scintillation photons and consequently photoelectrons, and therefore the same PMT signal. So, setting a threshold a bit below this value, we would get efficiency very close to 1. But due to the fluctuations some signals are less than the mean MIP signal. Higher mean light yield from MIP gives smaller relative fluctuations, and fewer events will drop below some given threshold measured in the units of MIP signal. We require that less than 3 events of 10,000 should drop below 0.3 MIP signal (corresponds to the 0.9997 efficiency). The required light yield is derived directly from this requirement, using Poisson statistics. But we will be measuring the efficiency to meet the requirements, because the light yield is not the only factor that affects it. The PMT requirements are listed in "PMT Solicitation 5-09742", http://procurement.nasa.gov/cgi-bin/EPS/synopsis.cgi?acdid=98231. Although the PMT procurement is open, Hamamatsu R4443 baselined and meets all our requirements for use in the ACD.	

P-44	Bob Hartman	Status: Closed
	What is the worst case gain/ degradation for the actual PMTs selected for the mission estimated over 10 years. Is the answer sufficient to support the 10 yr GLAST mission goal? **Response** For the 5-year mission requirement, the ACD design accommodates the expected worst-case PMT degradation by having a large range of adjustability in the PMT HVPS. For the 10-year mission goal, some of the PMT's might degrade so much that the maximum HV does not produce the required PMT gain. In that case, it would be necessary to reduce the electronic discriminator level to achieve the required efficiency. If the noise levels are as expected, there is a factor of at least 3-4 (downward) adjustment available in that threshold.	

P-45	Dave Thompson	Status: Closed
	How many PMTs failed on SOHO? (PDR chart 67) **Response** The two Hamamatsu 4444 phototubes on SOHO are still functioning after more than five years in operation. You will find attached a memo more detail on the SOHO phototubes and also a statistical statement of confidence on the sample size of phototubes. "GOLF photomultiplie"P045 backup.ppt"	

P-46	Alex Moiseev	Status: Closed
	Fabrication and qualification of fiber ribbons needs to be detailed **Response** Fiber ribbon (approximately 3 meters long) is made of 5 scintillating fibers, 2mm square BCF-12. These scintillating fibers are the same basic space-qualified material used for the scintillator tiles. Fibers are glued together by a qualified urethane to create a ribbon. The ribbon is wrapped by black tape or placed into black light-tight bag/sleeve, similar to the wrapping used for the scintillator tiles. This ribbon is bent to the needed shape (with preheating) to fit around the ACD. The ribbons are placed under the tiles' butt joints to seal the gaps between tiles. The PMTs are attached to both ribbon ends similarly to that for the fibers from tiles. Before going into the ACD assembly the ribbons are tested on the subject of light tightness. We have made and tested sample ribbons in the laboratory. Due to the relatively small number of ribbons required, we will fabricate and test them in house. A qualification procedure will be documented prior to CDR.	

P-47	Alex Moiseev	Status: Closed
	Based on EGRET number of incidents (stated to be extremely low), is the incorporation of the crown feature of the tiles worth the added design complexity and cost? Could this go on descope list? **Response** The crown feature on the ACD is needed and cannot go on the descope list. The "number of incidents" is required to be extremely low to meet the GLAST LAT scientific objectives. The sensitivity of GLAST is much higher than that of EGRET; one of the most important goals for GLAST is to study low flux diffuse gamma radiation where contribution from the background could be significant. We must minimize any possible background sources. One of the potential sources of gamma background is cosmic ray protons, which can produce background gamma-rays when passing through the micrometeoroid blanket at small angles, such that they go through a significant amount of material. These protons can interact in the blanket material, and there is a chance that one product will be a photon which moves toward the tracker, with the primary proton exiting the blanket undetected. This photon would be a background photon, absolutely undistinguishable from real celestial photons. The way to protect against these events is to have a "crown" in ACD that would detect such protons and veto these background events. So, removing the "crown" would add undesirable background and would limit GLAST sensitivity (ref "Does the ACD need a Crown", http://lhea-glast.gsfc.nasa.gov/acd/acdpdr/Crown.doc.	

P-48	Tom Johnson	Status: Closed
	Address 4 pt vs 3pt mount of tiles, to shell. **Response** We will be doing stress analysis to see if we can use a 3-pt mount before PDR.	

P-49	Rudy Larsen	Status: Closed
	Has risk of building to cost been assessed and accepted by project. Will the ground rules be changed later? **Response** It is recognized that there have been severe budget constraints imposed on the LAT Project and then, in turn, onto the ACD Subsystem. Both FY '02 and FY '03 have been constrained as well as the total program allocation for the ACD. Due to cost constraints the ACD Engineering Model has been reduced to only building and testing the components required to verify key critical elements such as Tile Detector Assemblies and their mounting hardware and electronics. A full sized Engineering Model with live and dummy tiles was originally planned to undergo environmental testing, but this has been deleted. The leads have assessed the risks taken by eliminating the ACD Engineering Model. These risks include: • Lessons must be learned on the flight unit. As a result mistakes will be more costly and time consuming. • No back-up in the event a catastrophic event occurs to the flight unit, • Verification performance results post launch would require additional mock-ups. At this point there is no intention to change the ground rules by the LAT Project.	

P-50	Chris Lorentson	Status: Closed
	Perform contamination control survey based on current design. Identify potential problems with material selections/ processes. **Response** We have preformed a survey of the ACD system to assess the contamination concerns earlier this year to determine the ACD need for a project contamination control plan. These results will be included in the contamination control plan. As the needs have been evolving as the project progresses, this survey will again be performed to update those requirements. This will be done before the contamination control plan is updated later this year (Oct/Nov).	

P-51	George Shiblie	Status: Closed
	Is TSA conductive? The shell needs to bleed off charge. It should have resistivity of about < 1MΩ/square. **Response** The TSA is conductive and requires a resistivity to the Grid of <10KΩ/square. All grounding requirements for the ACD will be documented in the ACD Grounding and Shielding Plan.	

P-52	Alex Moiseev	Status: Complete
	Aging of the adhesive between fibers and scintillators needs to be evaluated. Adhesive aging could lead to cracking and loss of light. INTEGRAL IBIS experienced such problems. Need test with large numbers of thermal cycles for example. **Response** The baseline adhesive is BC-408, which has the best matching index to the scintillator; currently we rely on accelerator experiments experience in using this adhesive as well as the manufacturer's recommendations. The thickness of the adhesive between fibers and scintillator is very small, and we believe that the cracks in this layer and consequently the light loss during penetration into the fibers from the scintillator are unlikely. ~~But the~~ Thermal cycling and thermal vacuum tests are currently under way. If problems are found, other adhesives will be considered. We could sacrifice some refractive index matching (it should not be very significant) to improve the adhesive lifetime.	

P-53	Dave Sheppard	Status: Complete
	Are there significant shaping times and 'memory' times associated with the ACD that could cause pile-up problems for ACD signals? (see J. J. Russell's email in Appendix A.) **Response** There are two signal paths for charged particles in the ACD electronics - a fast channel used for threshold discrimination and a slow channel used for spectroscopy. The signal from the fast discriminator is used to generate the VETO and has no additional shaping. This pulse is stretched by ~200ns to allow for baseline recovery. We do not expect a pile-up problem at the expected science-mode operational rates of 3 kHz and below, as specified in the Level IV Electronics Requirements. The signal from the slow channel is shaped to a peaking time of approximately 3 microseconds for analog-to-digital conversion in response to a trigger acknowledge. This section of the circuitry is not involved in the VETO or hit map information.	

P-54	George Shiblie	Status: Closed
	Why is the separate spacecraft analog housekeeping cable listed as an internal ACD interface and not part of the external harness? What signals are on this cable? (PDR chart 27) **Response** This reference to the s/c analog housekeeping cable as an internal cable is a mistake. This cable is an external spacecraft interface cable consisting of temperature sensors that we expect the spacecraft will require.	

P-55	Rudy Larsen	Status: Closed
	It appears that the engineering model and calibration units are delivered only a few months prior to the flight unit. This does not appear to leave time for implementation of any changes determined from the EM. Can the EM delivery be accelerated or the flight unit delayed? (PDR chart 30) **Response** It is important to distinguish the different purposes of the various ACD units: There will be no full-scale engineering model as originally planned, however, qualification units will be built and test early in the schedule. If changes are required based on the qualification units, these changes can be implemented in the flight unit. We believe these tests are done early enough to allow possible changes in the flight design. The calibration units are to be used for performance verification, not for environmental testing. They will be built with non-flight parts but will be functionally equivalent to the flight articles. There will be no design changes based on the calibration units. They simply measure how the LAT will work. The flight unit will incorporate all changes determined from the qualification units. It is essentially independent of the calibration units and can be built in parallel with them.	

P-56	Dave Sheppard	Status: Complete
	How many TEM boards and EGSE configurations is the ACD team requesting and on what schedule? **Response** See response to RFA P-23.	

P-57	Alex Moiseev	Status: Closed
	How does the design provide minimum gaps between tiles? (PDR chart 39) **Response** The effect of gaps between TDA's has been simulated in detail and the results were presented in the ACD Peer Review (charts 43 -50) and can be found at http://lhea-glast.gsfc.nasa.gov/gsfc/acd/acdpdr/ACD_transparency.pdf. What we learned from these simulations was used in the mechanical design. The gaps between the TDA's are minimized using two different methods. The first method used is to layer the TDA's much the same way that shingles are layered. The TDA's are overlapped by 1 cm and this allows the gap to be eliminated in one dimension. A second method is used to cover the gaps in the second dimension. This method uses scintillating fiber ribbons to cover the gaps. The combination of these two methods eliminates or minimizes the majority of gaps between the TDA's. The only gaps between the TDA's that are not covered are on the top and side edges, but these gaps have negligible effect on the ACD hermeticity.	

P-58	Tom Johnson	Status: Complete
	Is it possible to represent the shingling approach in a side view? Are there fiber guides supporting the shingled tiles? (PDR chart 96) **Response** There are not any fiber guides supporting the shingled tiles. The attached power point link shows a side view of the ACD tiles. 	

P-59	Tom Johnson	Status: Closed
	What provisions have been made for venting the ACD? Is the design supported by analysis? (PDR chart 97) **Response** PDR chart 97 refers to the design of the Tile Shell Assembly. The Korex core used in the construction of the shell does not come vented. However it has been used in several GSFC programs and several methods of venting the core have been developed. The core will be vented and analysis and testing will show the venting to be adequate.	

P-60	Tom Johnson	Status: Closed
	How do the TDA tie downs accommodate the shingling overlap of the tile? Are there fiber guides underneath the shingled TDA in compression? Do the fiber guides provide the resistance against TDA slip in shear? (PDR chart 101) **Response** The TDA tie downs will be spaced at different heights to account for the shingling of the tiles. At no time will the fibers from one TDA come into contact with another TDA. There are not any "fiber guides" underneath the shingled TDA's. The fibers will be held in place by the fiber connector and the tile (see drawing, which will be attached later). Both the tile and fiber connector are secured to the same structure so there will be minimal movement (due to thermal and mechanically induced loads) between the tile and fiber connector. The fibers between the tile and the fiber connector have a large service loop built in to allow this movement. A qualification unit will be tested to verify that the fibers do not experience any detrimental stresses.	

P-61	Tom Johnson	Status: Closed
	How is the micrometeorite shield/thermal blanket attached to the TDA/shell combination? Are standoffs used? How far down the ACD/GRID does the micrometeorite shield go? How about the thermal blanket? (PDR chart 103) **Response** The micrometeoroid shield/thermal blanket is attached to the TSA using one of the four studs that attach each TDA's to the shell. This will provide 25 attachment points on the top and 16 for each side. The micrometeoroid shield/thermal blanket will come down to the top of the BEA (i.e. bottom of the tiles) and the thermal blanket will continue down the BEA and wrap around the bottom of the BEA and terminate at the inside edge of the BEA. The thermal blanket will be secured to the BEA using standard blanket buttons.	

P-62	Tom Johnson	Status: Closed
	On a shuttle program the structure for the instrument was identified as secondary structure. A rule was applied that the design loads were to be the superposition of the quasi-static loads and the equivalent random vibration loads. Can you confirm that this approach is not required here? (PDR chart 105) **Response** The combination of quasi-static loads and random vibration loads is not required for the Delta II launch vehicle. The reason for this is that the peak acoustic inputs do not occur at the same time as the launch events that are drivers for quasi-static loads on the spacecraft. The peak acoustic levels within the Delta II fairing occurs at 2 – 3 seconds after liftoff while the peak dynamic loading at liftoff occurs within the first second. This timing difference makes it unnecessary and overly conservative to combine the quasi-static loads predicted from a liftoff analysis with the equivalent random vibration loads due to acoustic input. The approach of treating launch loads separately from acoustically driven random loads is consistent with what has been done on previous Goddard missions that have launched on a Delta II.	