JPL

2001 Peer Review (Subsystem CDR) Results

Recommendations, Problem Areas

- Concern about level of requirements – need a delta statement at project CDR on agreement of the requirements.
- Demonstrate that we have adequate budget and schedule in the event changes to the BDA are required to accommodate higher vibration levels.
- Incorporate accelerated life and bakeout testing in qualification program.
- Need to confirm or prove status of qualification and readiness for flight fabrication – nano-connectors, staking and torquing of fixtures on the BDA.
- Report resilience of system to change in optical background for project CDR.
- Yields should be expressed end-to-end.
- JFETs need further development before flight construction.
- Software development, if at IPAC, needs to have close coordination and management control.

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CDR RFA Summary (1 of 5)

#	Statement of Concern	Recommended Action	Disp.	Response
1	No analytical evaluation of the tendency for the tendons to slip on the pulleys for an assumed acceleration level has been given. The resistance to pulley rotation is also of concern.	For 100 G evaluate T2/T1 for each pulley. Required coeficient of friction is ln(T2/T1)/theta where theta is the wrap angle. Without a wrap~=1.5 Rad and with a wrap ~=7.8 Rad. Also evaluate available coefficient of friction and resistance to pulley rota	Accepted	Agreed. Design of pulleys should be compatible with 7.8 rad wrap. Choice of wrap to be decided. Also, we will evaluate the friction coefficient at or close to operating temperature via component level testing.
2	Margins of Safety for bolts were stated (on pg. 106 of presentation materials) based on tension shear interaction. The question is that if the shear is in the threads, was the shear strength in the threads used in this interaction.	See to it that the appropriate capability is used.	Accepted	Agreed.
3	Broad notches in random testing result in a non-test if the unnotched level had a realistic basis.	Qualify using reaction limiting at room temperature. Accept notching for cryogenic testing if unavoidable.	Advisory	Advisory depending on the establishment of the final requirement. However, we will establish a recommended level based on a quasi-static equivalent requirement. Notching levels will then be derived experimentally based on load limiting testing at the B
4	If random testing is the critical design condition for kevlar bands 3 sigma quasi-static equivalent is not enough.	Determine the N Sigma value that will occur during testing based on a raliegh distribution of peaks. (See Bob Glaser).	Advisory	We will use this advice to set the requirement and the test procedure.

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CDR RFA Summary (2 of 5)

#	Statement of Concern	Recommended Action	Disp.	Response
5	Schedule reserve needed for implementation and test of modifications to pass "intermediate" launch loads (0.05 G^2/Hz to 0.12 G^2/Hz)	Identify reserve in schedule for this purpose (including program changes as necessary)	Accepted	Launch loads currently under review and design changes currently under evaluation for meeting higher loads. Recommended action agreed to.
6	Annealing of copper heat straps can be difficult to reproduce for high RRR (good thermal conductance).	Start early in getting annealed samples for flight.	Accepted	Plan is to procure all structural hardware at beginning of Phase C/D in one lot.
7	Requirement to heat U401's to >120 K is driving a lot of development effort, with important aspects of instrument performance at stake.	JFETs used to work very well at 60-75K. Test some (simple test only is required) to see if this is still true, or if some critical process change has occurred.	Accepted	We will conduct this test.
8	Thermal stresses on flex cable. Thermal mismatches between the cable and its mounting fixtures can creat large stresses.	Mount cable in realistic way for test thermal cycles	Accepted	We will have a representative test fixture.
9	Quoted yields per element (detectors, resistors, JFETS, …etc.) suggest the system level pixel yield could be less than 80%.	Review plans for quantity and testing of the array elements to be able to pick good units to integrate into the flight array.	Accepted	Agreed---Testing and redundancy is already planned.
10	Bakeout is an environment that can damage the flight hardware. The design is not fully ready for fabrication until it has been shown to survive the anticipated bakeout temperatures.	Bakeout test engineering units as soon as possible, to temperatures slightly above those specified for the flight units.	Accepted	We have modified our plans to test EM hardware, unit-level flight hardware and incorporate bakeout testing into the environmental test program.

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CDR RFA Summary (3 of 5)

#	Statement of Concern	Recommended Action	Disp.	Response
11	Partial release of tension due to wrapping kelvar on top of itself, causing inadvertant slippage.	Avoid un-necessary overlapping of string, and make sure post-vibration tests are sensitive to this problem.	Advisory	We plan to test tension after vibe on all structures. Retension and retest could be implemented in the event of a shift or loss in tension.
12	Bend cable to radius of curvature in BDA and bakeout (glue may soften and cable may fail). If you have not chosen manufacturer, how to rapidly test?	Test ASAP	Accepted	The cables were baked out on representative bends. We are seeking a vendor acceptable to QA.
13	All tests with BDAs and fake bolometers should use real devices to gain experience in handling.		Advisory	Real detectors will be incorporated into the qualification and testing plan. However, it may not be possible to do this on every test as stated.
14	Is the bias voltage range wide enough to accommodate the potential telescope loading ranges? Is the bias accuracy sufficient? How will bias be determined in flight?		Accepted	Bias range and accuracy is acceptable. Bias can be determined in flight from load curves, or optimizing sensitivity to a source.
15	Kapton cable tests must include stress at solder joints and thermal cycling.	Test.	Accepted	That is already part of the test plan.
16	Need a range of optical loading for detector design due to uncertainty in telescope temperature, emissivity, and optical transmittance	Get better numbers, or estimate the effect on bolometers of a range of optical loading.	Accepted	Although loading is not under our control, we have done an analysis of the effect of a range of optical loading.

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CDR RFA Summary (4 of 5)

#	Statement of Concern	Recommended Action	Disp.	Response
17	New design of kelvar capture is not tested on prototype.	Build/test.	Accepted	Fixtures will be tested on EM, qual, and/or STM before adopting.
18	Horn measurements not yet completed to determine horn and bolometer contributions to efficiency, choice of manufacturer, statistics, QA proceedure for large number of horns.	Test different horn arrays with bolometers, come up with a screening proceedure.	Accepted	Tests are already intended to kepp bolometer array fixed to test the horns. We intend to implement some sort of screening test on horn fabrication at unit level prior to assembly.
19	Handing of liquid helium is an esoteric proceedure that requires specialized training that includes contingency proceedures.	Be sure all relevant personnel are thoroughly trained in contingencies.	Accepted	All personnel are experienced with liquid helium and have taken the cryogenic safety class. Our test program does not employ pumping on liquid helium, mitigating the most worrisome safety concern. We have redundant test hardware.
20	Optical screening of individual feedhorns may produce false positives unless completely reproducible and insensitive to misalignment.	Implement simple test with rigid fixture to prevent mis-alignment. To reduce alignment sensitivity, use diffuse source, reimage waveguide with optics with excess throughput.	Accepted	We intend to implement a unit-level screening test and accept your advice.
21	The tests on flight bolometers and horns require an objective for spectroscopy, and an acceptance crtieria.	Define goals of the tests and identify actions to be taken.	Accepted	Agreed that we should identify actions in our test proceedures. However, all preformance testing is for characterization and not to meet test/fail requirements.
22	Issue of measuring alignment of detectors after system-level shake	Try to add metrology measurement of some kind after instrument level testing.	Advisory	We will suggest optical alignment testing prior ro and after vibration, but it may be difficult to implement.

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CDR RFA Summary (5 of 5)

#	Statement of Concern	Recommended Action	Disp.	Response
23	A number of requirements (such as the vibration level) have been defined by JPL but have not been formally approved and signed off.	Try to reach rapid agreement on the final levels.	Accepted	Agreed.
24	No definition of who leads the approval or review of packaging materials and components such as connectors, fasteners, flex cables, etc.	Define and assign an appropriate person to lead the effort.	Accepted	This is clearly the responsibility of MA. Our attempts to get dedicated personnel, or at least a fixed technical contact, in MA have not been met.
25	Fasteners staking failure.	Go back and review cleaning process used prior to bonding. If the current process is not compatible with materials used on BDA, consider alternatives such as selathane.	Accepted	Agreed. Since selathane failed we intend to use a spring washer where possible.
26	Use of nano connectors on flight unit without test data or plan to qualify the connector.	Assess test data to see if it meets the SPIRE envirnoment. If test data are insufficient, adopt a qualification program.	Accepted	Mission assurance is responsible for reviewing suitability of all components.
27	Environmental requirements communication breakdown between JPL and ESA.	Add attached JPL ERD to SSSD for item for agreement between JPL and ESA.	Advisory	We have elected to not attach the ERD, but have devised a list of agreed documents to capture all requirements. The ERD must comply with these requirements.

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Risks and Mitigation Plan

Risk Element	Impact	Mitigating Activities
Changes to the BDA design to accommodate higher vibration levels.	Schedule, budget.	Kevlar strength and friction pre-testing. Assembly and testing of STM unit. Implementation of back-up design not feasible.
Aging, bakeout	Detector performance in flight.	Use Planck qualification program to flag possible problems with detectors, or bakeout temperature. Aging tests incorporated as part of the qualification program.
JFET membrane thermal isolation	Higher power dissipation or reduced performance	Design compliant, but no thermal margin. 1. Trade dissipation for noise (15 % margin). 2. Isolate JFET rack (up to 50 % margin). 3. Turn off pixels for some operating modes (17 % margin).
JFET, load resistor yield	Performance	Develop high-yield process, incorporate redundancy.
Kapton cable yield, thermal conductance	Performance	Increased linewidths to improve yield. Measure cable thermal conductance to optimize yield.
MDL detector yield	Schedule, budget.	Use Planck engineering wafer to improve yield. More freedom to optimize bolometers for yield with SPIRE. CQM units do not require high yield.
JFET, load resistor, kapton cable EM2 development	Schedule, budget.	Basic technology has been demonstrated. CQM units do not require high yield.
Fracture of detector array	Single-point failure	Bond to thick backing wafer.