REQUEST FOR ACTION (RFA) RESPONSE

GLAST LAT Project
Calorimeter Peer Review **17 – 18 March 2003**

Action Item:	CAL – 023
Presentation Section:	Detector Elements
Submitted by:	Bill Wisniewski Rafe Schindler

Request:

Crystal – Photodiode I/Fs

1. Verify that Tl leaching/migration is not a problem with "primer" layer on crystal/photo-diode interface;
2. Bond tests for the crystal--photo-diode interface were carried through ~100 thermal cycles. This test was carried out for ~10 samples. Better identify/extrapolate failure point to verify capability over life of detector by using more than 10 test samples;
3. Investigate thermal limit for crystal – photo diode bond: test to failure.

Reason / Comment:

Bond interface is a key risk area with a history of difficulty. Should take further steps to fully stress bond and understand design limits. There is a lack of clear target for reliability and a program to achieve a knowledge of what reliability of the three joints (diode-encapsulant, encapsulant to silcone, silicone to primed xtal). Several different test ranges for temp, # of cycles and never saw a failure. Also concerned that during manufacture, bonding process errors will not be caught fast enough, leading to multiple units to be repaired and schedule loss.

Response: 2 May 2003

1. We plan to investigate old bonds for Tl content. Visual inspection of bonds formed over a year ago shows no discoloration or loss of transparency. The oldest DC93-500 bond we have is approximately 18 months. This evaluation will be completed after CDR. An updated response will be provided at the completion of that evaluation.

2. We have tested more than 80 crystal-to-photodiode bonds made with the selected silicone and primer through at least 50 thermal cycles (always over the qualification range of -30C to +50C). While it is true that only 16 of these used EM DPDs and EM crystals bonded with the EM process, the remainder used PDs of similar size and essentially identical construction. The similarity of these other test units with the EM test units -- along with the roughly order-of-magnitude margin of safety in the mechanical strength of these bonds -- gives us confidence that the thermal stresses do not approach the design limit for the EM or FM bonds.

The number of thermal cycles in these tests far exceeds the expected number of cycles for flight units. Ground testing will include 12 thermal-vacuum cycles, and following launch, the number of thermal excursions throughout the mission is expected to be zero or at most order unity. The large thermal mass and long thermal time constant of the CsI bars guarantee with certainty that the bonds will not be exposed to temperature variations on orbital or shorter timescales [a 3 degree variation of LAT GRID temperature will cause LAT alignment to go out of spec and the point spread function to deteriorate.]. Thus the thermal cycle tests we performed on these samples already represent dramatic over-testing beyond the requirements of mission life.

We also note that the bond is robust against modest variations in the bonding process. Most test samples used one of three predominant methods of primer application and amounts of primer and one of three methods of bond lay-up (or types of fixtures), and yet these various bonds maintained their integrity against thermal cycling. Furthermore, our early experiments in bonding identified some areas where deviations from the procedure (e.g. leaving inadequate time for the primer to cure) can lead to bond failures. We will communicate this experience to the bonding contractor prior to the qualification bond manufacture runs.

3. We plan to qualify the CDE processes to an increased temperature range (-30, +60 C). This larger temperature range when coupled with the number of cycles (50) should demonstrate adequate margins on the flight requirements. Given the large margin of safety on the shear strength of the bonds (×6), I'm not sure test to failure is that interesting. It may be better to do additional cycles on a few samples to even larger temperature range (-40, +70C). We believe the cycling is equally important to the temperature range.