STEREO IMPACT

PR Numbers: 1xxx=UCB, 2xxx=Caltech/JPL, 3xxx=UMd, 4xxx=GSFC/SEP, 5xxx=GSFC/Mag, 6xxx=CESR, 7xxx=Keil, 8xxx=ESTEC, 9xxx=MPAe

Assembly : SIT Instrument	**SubAssembly : Telescope/SSD and Foil assembly**
Component/Part Number:	**Serial Number: 02**
Originator: Walpole	**Organization: UMd**
Phone : 301-405-6217	**Email : Walpole@sampex.umd.edu**

Failure Occurred During (Check one √)

□ Functional test □ Qualification test □ S/C Integration □ Launch operations

Environment when failure occurred:

x Ambient □ Vibration □ Shock □ Acoustic
□ Thermal □ Vacuum □ Thermal-Vacuum □ EMI/EMC

Problem Description

During disassembly of the FM2 telescope for the installation of a replacement SSD (see PR-3008) it was noted that the ceramic "Detector Insulator", drawing number D05, was broken: all four corners were cracked off, in varying size triangular pieces (0.460 x 0.560", 0.270 x 0.330", 0.400 x 0.190", 0.340 x 0.325"). The smallest piece was further broken in two. The insulator is made of 0.012" thick ADS-995 ceramic and is approximately 4" x 1.3" in size.

A similar, but more complicated, ceramic piece performs the same function at the foil end of the telescope. This assembly was disassembled at the foil end and found that it was also cracked – broken into one large- and two medium-sized pieces. As before, all pieces were contained until disassembly.

Analyses Performed to Determine Cause

There was some difficulty in removing all the 0-80 screws holding the detector assembly to the housing. Considerable force had to be applied to the last screw being removed and it is possible that the housing got skewed at this point enough to break a corner of the ceramic. The pieces of the telescope were examined for any stress points that might explain the breakage – holes with burrs, places inserted screws might damage the insulator - but came up with nothing.

We do not know the cause, but given two out of two pieces are broken and that the unit has not been mishandled we must assume that there is a design problem overstressing the parts, probably during the assembly process itself or during normal handling thereafter.

The ceramic piece was submitted for failure analysis (Len Wang). The cause of the ceramic cracks are most likely mechanical overload. In addition, the structure of the ceramic pieces indicate that these pieces are very old, that the overall structure is not desirable - resulting in poor mechanical performance.

Corrective Action/ Resolution

□ Rework □ Repair □ Use As Is □ Scrap

Replaced both ceramic pieces with new pieces made out of G10. G10 has thermal and electrical insulating properties "similar" to the ceramic pieces – in case that somehow affects the design – and is mechanically tough enough not to snap into pieces if stressed. It is also easily available.

Date Action Taken:3/31/2005 **Retest Results** Alpha test performed on both flight units successful.
Corrective Action Required/Performed on other Units x Serial Number(s): __FM1_____

STEREO IMPACT

Closure Approvals

Subsystem Lead: _____ Date:_____
IMPACT Project Manager: _____ Date _____
IMPACT QA: _____ Date:_____
NASA IMPACT Instrument Manager: _____ Date:_____

From: Len Wang <lwang@mscmail.gsfc.nasa.gov>
Date: Tue, 03 May 2005 10:32:07 -0400
To: Michael D Jones <mijones@pop700.gsfc.nasa.gov>,
<swasserzug@swales.com>
Cc: <Charles.C.He.1@GSFC.NASA.GOV>
Subject: Stereo-Impact, MCP alumina holder fracture

I did not see any indication of electric discharge. The cause of the failure is apparently mechanical over load, likely local bending over load due to over clamping. The microstructure of the material can be seen at the fracture surfaces -- attached images. Very large grains (tens of microns) are mixed with small grains (1 to 2 microns). This is not a desirable structure. Charles He is our ceramic expert. He pointed out that such microstructure indicates the material experienced a secondary grain growth during the sintering, which will substantially drop the strength of the material. The material was made during the time when secondary grain growth control technique was not widely available, probably in the 70's, as Steve told us. We had similar problem with HST gyro rotors and thruster plates that were made of the alumina during the 70's with large grains and showed poor mechanical performance.

Alumina with such microstructure can only be used under compressive load, it can only sustain very limited bending or tensile load if there should be any. Extreme care must be taken during the assembly. Over clamping, as Steve told us, will cause local bending and tensile stress that could fail the part. Mis-alignment, hard contact, or particle contaminants will also cause local bending or indentation and could potentially fail the part.

Len

To: Lil Reichenthal

From: Peter Walpole, Glenn Mason, Tycho von Rosenvinge, Sandy Shuman

Date: 29 Mar 2005

STEREO IMPACT

Subject: SIT FM2 Telescope – Broken Ceramic Pieces

Lil,

1. Problem

In the process of disassembly of the SIT FM2 telescope for the purpose of replacing the suspect SSD, it was noted that a thin (0.012") ceramic insulator was cracked in four places, causing the four corners to separate from the main piece. This insulator lies between the detector assembly and the telescope housing and in the heritage instrument separated the SSD ground from chassis ground. In the current instrument it functions primarily as a spacer. All pieces were contained – compressed between the detector assembly and the telescope back wall – until the disassembly process freed them. There is a possibility that some of the damage may have occurred during disassembly, as one of the screws was tight enough that it required some effort to remove. Nevertheless, it is hard to see how this could account for all the observed damage.

As noted in PFR PR-3009, we examined the pieces of the telescope to see if we could find any stress points that might explain the breakage – holes with burrs, places inserted screws might damage the insulator - but came up with nothing.

A similar, but more complicated, ceramic piece performs the same function at the foil end of the telescope. We disassembled the foil end this morning (after our phone conversation) and found that it was also cracked – broken into one large- and two medium-sized pieces. As before, all pieces were contained until disassembly.

We do not know the cause, but given two out of two pieces are broken and that the unit has not been mishandled we must assume that there is a design problem overstressing the parts, probably during the assembly process itself or during normal handling thereafter.

2. Concern

The breaks in the ceramic pieces are not in themselves a problem. As long as the components remain in position, they continue to perform their spacing function.

If the pieces should become dislodged, however, for example during vibration or launch, then we have a serious problem. Ceramic pieces are not conductive but they could easily damage the thin foils or possibly even scratch the SSD. They could also block ions and electrons from portions of the SSD or MCPs causing anomalous performance.
There is no evidence that this has contributed to the problem with the FM2 SSD. All the pieces were contained rather than rattling around in the telescope and a visual inspection of the SSD showed no signs of damage. We are in the process of taking an alpha run at GSFC with the suspect SSD and should know more this afternoon.

3. Recommendation

We have spare ceramic pieces that could be used to replace the broken units. However, given the unknown cause for the problem this is probably not a good solution except in the case where schedule has become a truly over-riding concern and no other options are available.

Instead, we propose to build new insulators out of G10 for both the detector and foil ends of the telescope. This will probably take several days. To minimize schedule hit we have already begun the process – parts out for quote, we should know more this afternoon.
We propose to build enough pieces for both telescopes (plus spares) but to replace the ceramic parts only in FM2, leaving the option open to change FM1 later as opportunity/necessity arises.

4. Rationale

Material – we could use aluminum, but G10 has thermal and electrical insulating properties "similar" to the ceramic pieces – in case that somehow affects the design – and is mechanically tough enough not to snap into pieces if stressed. It is also easily available.

FM1 – There is some risk in taking apart the telescope to the extent necessary to replace the ceramic pieces. Heaters have to be removed, thermostats moved, cables disturbed and disconnected, many internal connections broken, and many 000/120 screws removed. It is not clear that the unknown risks- are the ceramic pieces in FM1 broken?, if so will they shake free and if free will they cause damage? – balance the known risks – will we create new problems in opening the telescope?. For FM2 we have already paid the price: the telescope is open and will need to be alpha tested at UMd and re-staked, screwed and taped back at GSFC before we can proceed. FM1 is known to be fully functioning but may – possibly- have some broken ceramic pieces. In principle, it could go to vibration at any time.