GLAST Large Area Telescope:

Tracker Subsystem
WBS 4.1.4

Tracker EM Vibration Test Status
Engineering Meeting
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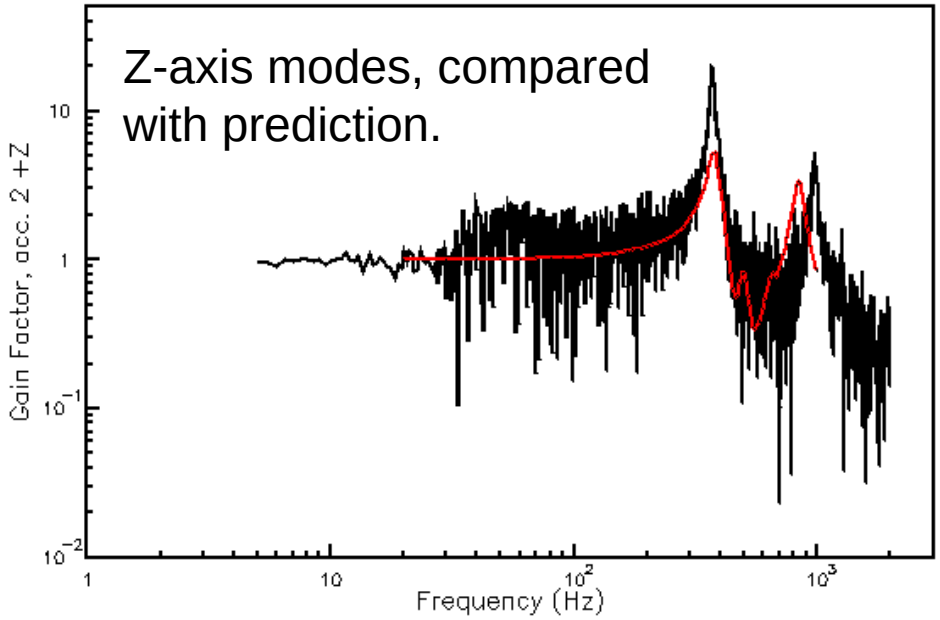
Alenia Test Facility in Rome

Tracker EM tower mounted on the vibration table, with the lifting fixture still attached.

Test Summary

- Z-axis low-level signature sweep (<0.15g, 20 to 2000 Hz)
  - Excellent agreement with predicted fundamental frequency
- Z-axis sine vibration from 5 to 50 Hz, up to 5g. No issues.
- Z-axis random vibration
  - Only completed to the –6dB level, due to lateness of coupon test results from the sidewall production.
  - No problems. Minor decrease in resonant frequency at high level.

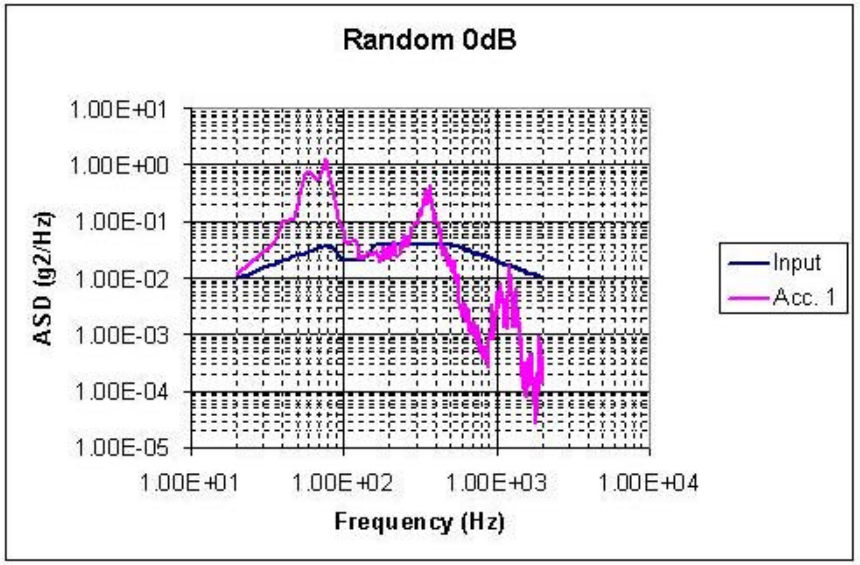


Test Summary

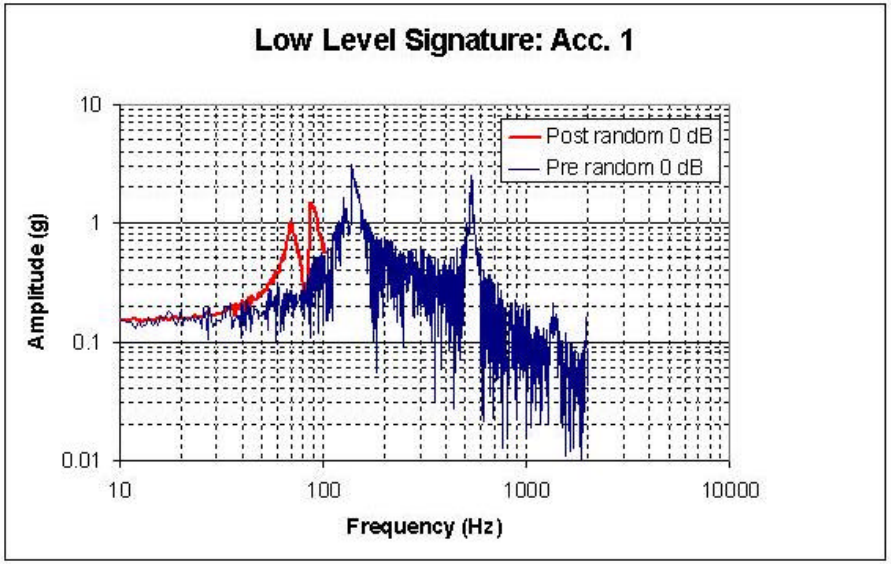
- X-axis low-level signature sweep.
  - Fundamental was about 140 Hz, compared with original 180 Hz prediction. Hytec said that this was consistent with the softer bottom-tray response seen in the static tests done in Los Alamos.
- X-axis random vibration
  - GSFC authorized a –3dB notch at the fundamental for all Tracker testing (by intervention of Tom Venator).
  - The –6dB run with no notch was followed by a –3dB run with notch. The latter showed a –10 Hz downward movement of the peak.
  - The 0dB (full level) with notch was completed, but the following sine signature sweep showed a major drop and bifurcation of the fundamental mode. The test was terminated at this point.

X-Axis Random Vibration Anomaly

- Accelerometer data from the full-level random vibration in X.



- Accelerometer data from the sine sweeps before and after the 0dB random vibration in X. The post-random sweep was terminated just above 100 Hz.

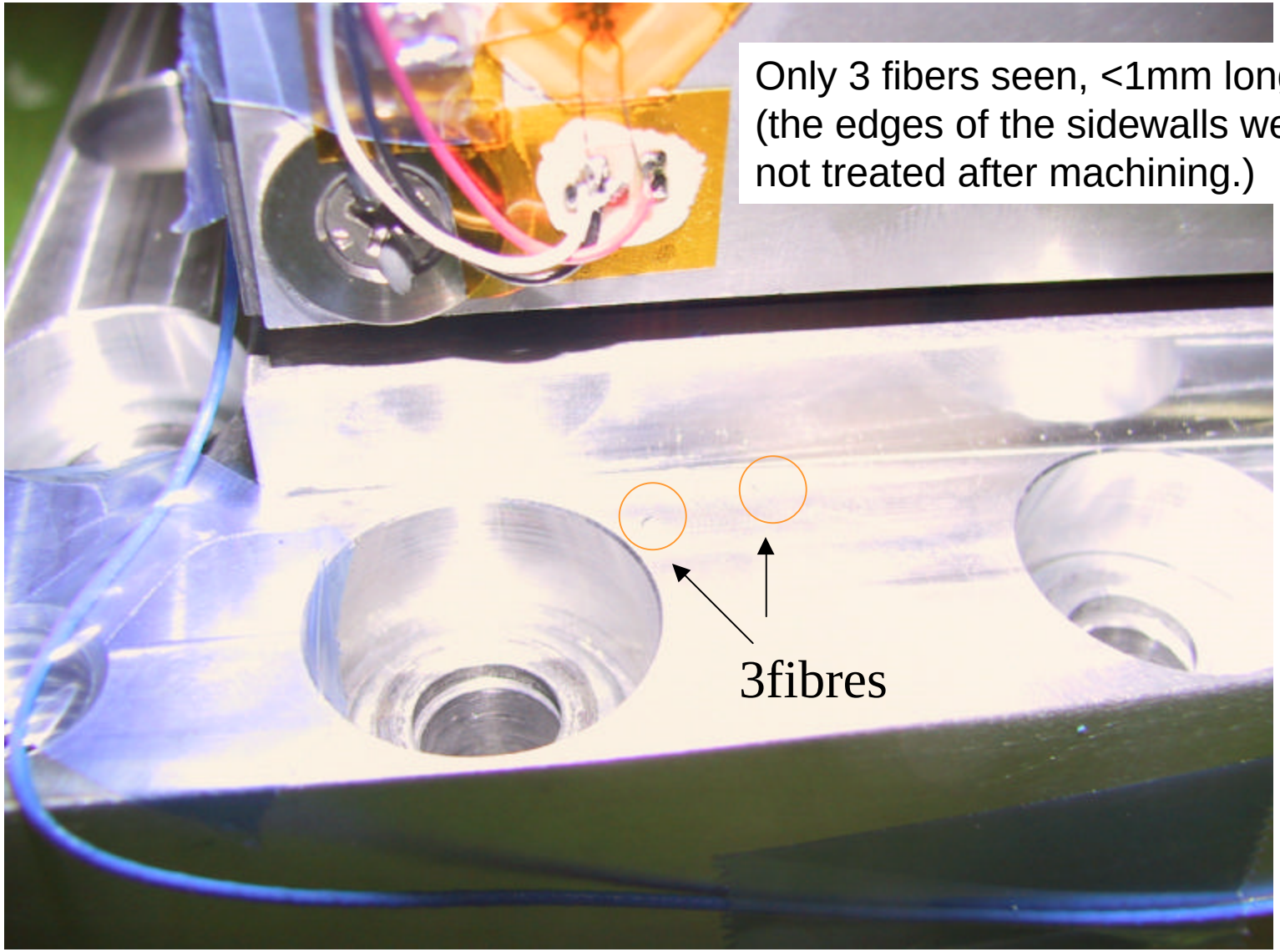


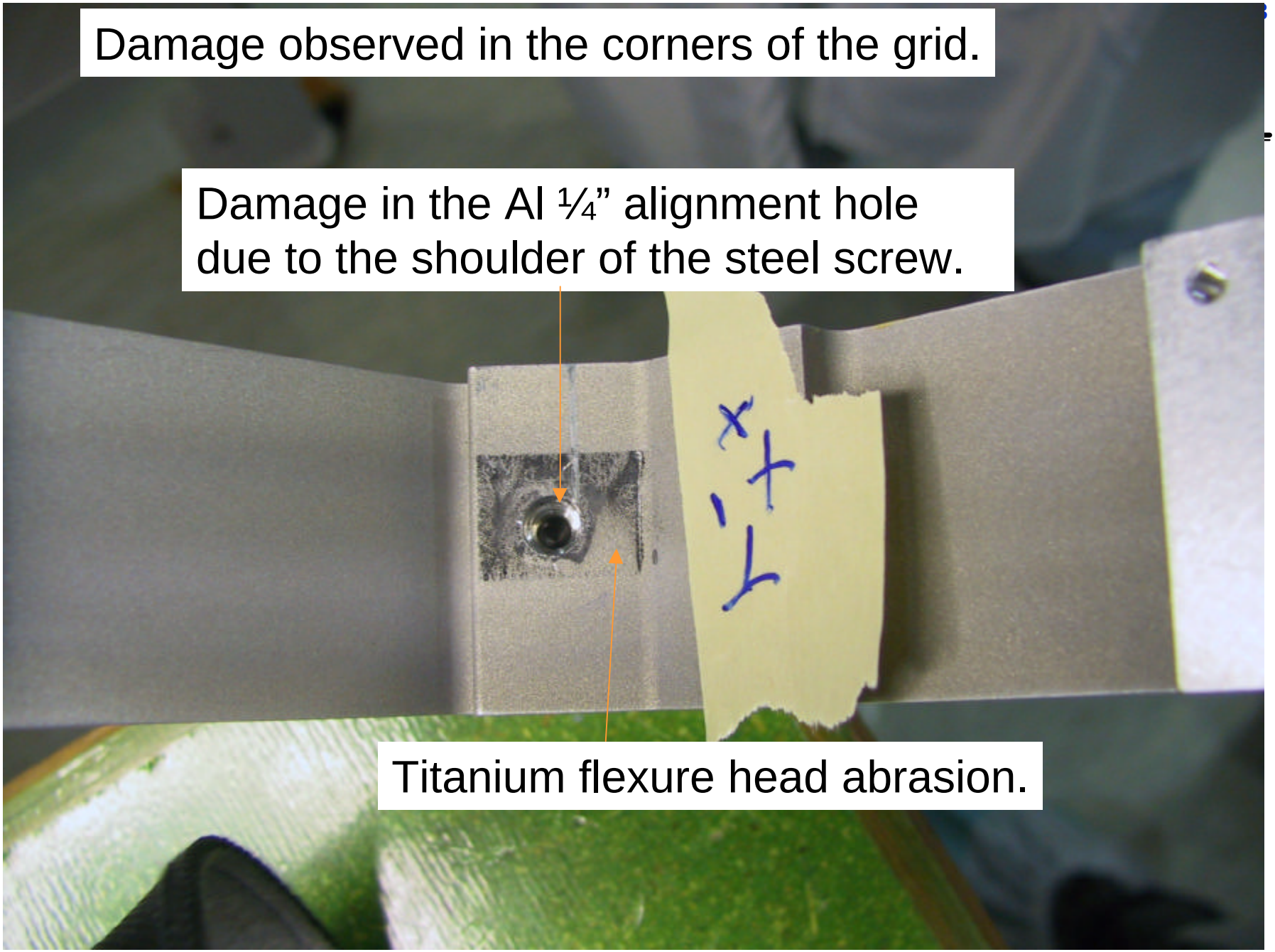
Post-Test Inspection

- Complete loss of torque in all 4 bolted joints between the titanium flexures and the aluminum vibration fixture (Grid simulator).
- Complete loss of torque in 2 out of 8 of the side-flexure bolts.
- Remaining 6 bolts still held the original 2.9 N-m torque.
- Damage to the bolt holes on the fixture side where there was a loss of torque.
- Abrasion of the aluminum fixture by the slipping titanium flexures.

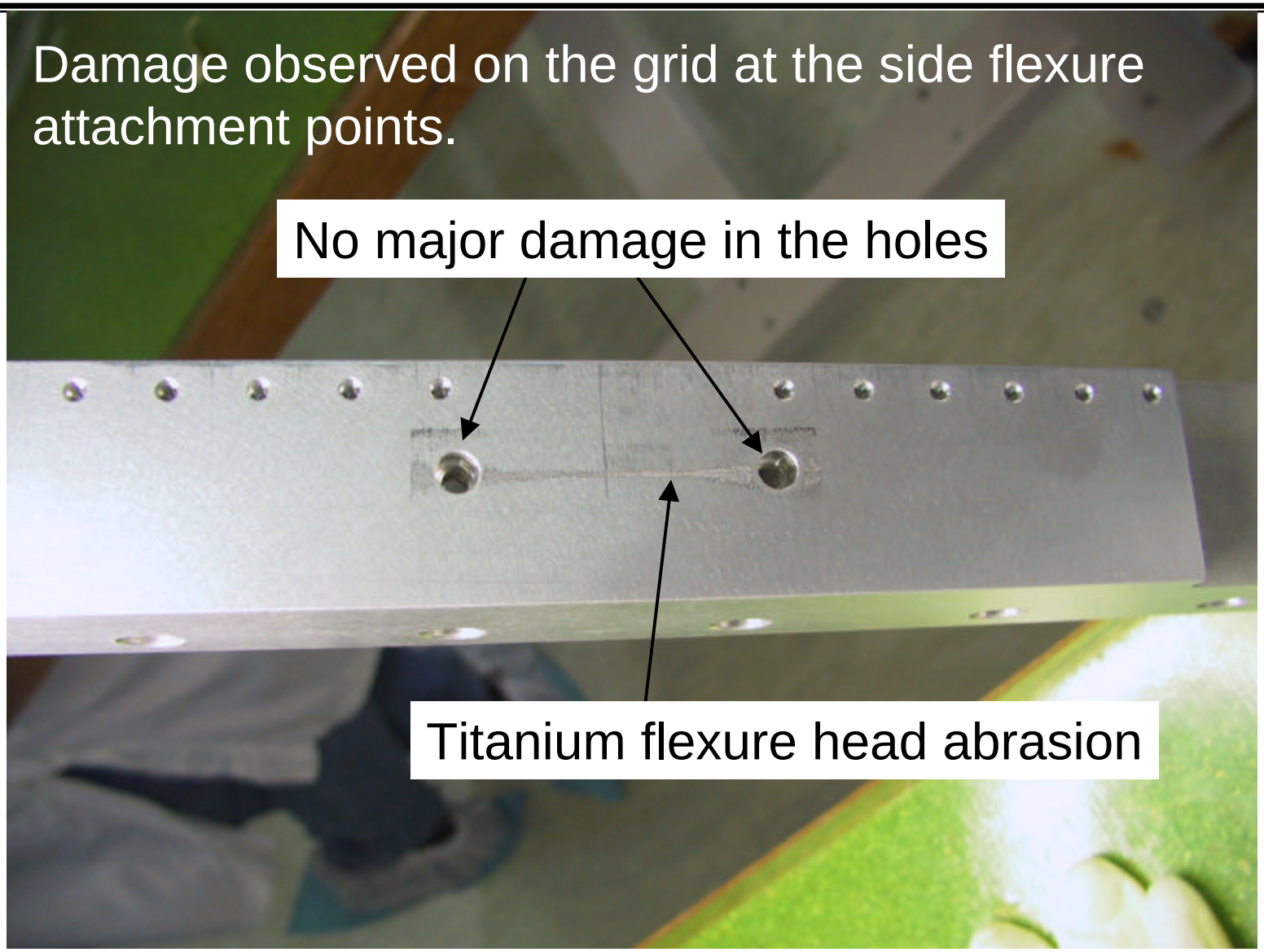
- No damage observed to the tower (including the flexures).
- No movement of any fasteners on the tower (torque stripes).
- One sidewall was removed so far
  - All screws were first tested for torque, with no loss observed.
  - No visible damage.

Post Test Inspection




Damage observed in the corners of the grid.
Damage in the Al ¼” alignment hole due to the shoulder of the steel screw.
Titanium flexure head abrasion.

Post Test Inspection



Issues

- My personal non-engineer take on the issues and root causes:
  - The bolt shoulders have a diameter 100 microns less than that of the flexure holes.
  - This amount of clearance was demonstrably essential for successful assembly of the article. Reducing it would require a high-precision match-drill fixture for flexures and Grid.
  - But the clearance prevents the shoulder from acting as an effective shear pin, especially during vibration.
  - Therefore, only Ti-Al friction can prevent slippage within this clearance during vibration, but no engineering was done to ensure that the friction was adequate to prevent all slippage or that the movement would not cam out the bolts.
  - The torque spec of 2.9 N-m is maybe limited by the helicoils but does not ensure very high friction or resistance to unscrewing.
  - A locking mechanism on the bolts may have prevented the loss of torque, but none was used.

Closure Plan

- Independent engineering reviews are underway - ECD Dec 5
  - All test data were captured and are being analyzed, for both the vibration and the static tests.
  - Torque, bolt size and type, Grid inserts, and tolerance buildup all need to be looked at.
  - Secondary locking mechanisms must be implemented. For example:
    - Polymer material or device in the threads.
    - Staking of the bolt head with epoxy.
  - The schedule cannot tolerate any redesign on the Tracker side of the interface, except possibly to increase the size of the bolt hole in the flexure.
- Critical: decision on design modifications – 10 Dec
  - Unlikely to impact Tracker production if we hold to this.
- Coordination with the test facility (Alenia) for 15 Dec or 5 Jan start
- Information will be posted on the Tracker web page
  - http://www-glast.slac.stanford.edu/Tracker-Hardware/ART/vibe/vibe.html