GLAST Large Area Telescope:
Tracker Subsystem
WBS 4.1.4

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Outline

• Technical Status- last month’s accomplishments
  – Issues identified and closure plans
  – Status of flight hardware
• Cost and Schedule Status
  – Tower A Campaign
  – Winning the War
    • Delivery schedule for Tower B—Tower 16
Accomplishments and Issues Identified in July/Aug Tower A Build

- Fabricated 19 Trays: flight design, process and procedures
  - 36 layers with MCMs
  - 27 layers with silicon
- Bias Circuit Bonding Failure
  - During tray panel fabrication in July and August problems were found with bonding Kapton bias circuits to W converter foils
    - Delaminations occurred in tray T/V testing at 55C
    - Preventative measures (pre-cuts to bias circuits) resulted in HV shorts on trays
    - <50% yield on tray fabrication due to this problem
Bias Circuit Bonding Failure

Fig. 1

Fig. 2

Fig. 3
Accomplishments and Issues Identified in July/Aug Tower A Build

• Bias Circuit Bonding Failure (cont.)
  – Tracker Anomaly Resolution Team (TART) formed
    • Chaired by Neil Johnson
    • Primary recommendations:
      – Improved surface prep of W and Kapton
      – Improved process cleanliness and controls, and QA
      – Improved bond joint compression
  – Tracker Team developed plan and schedule for recovery plan based on TART recommendations
  – Critical steps in recovery plan:
    • Etched primed W tiles with good coupon tests must be produced in sufficient quantity
    • Clean controlled work area at Plyform and recommended cleanliness steps
    • New procedures, process controls and MIPs
    • Test articles
  – On track with plan to resume flight production 10/4
  – Bare panel production has continued
  – Plyform committed to 20 bare panels (full tower) ready for kapton bonding starting Monday 10/4.
Accomplishments and Issues Identified in July/Aug Tower A Build

• Wire bond encapsulation issue
  – 0% yield of heavy trays in thermal cycling after wire bond encapsulation (silicon to MCM) due to breaking of many wire bonds
  – Root cause not fully understood
  – Encapsulation will be eliminated from MCM-Si joint, design changes in process
Accomplishments and Issues Identified in September “Tower 0” Assembly

- In parallel with execution of recovery plan, moved forward with assembly of 19 trays (all but 6 non-flight) into ‘Tower 0’
  - Train operators
  - Validate assembly procedures including alignment
- Currently have successful operation of the full tower
  - 23 active layers
- Identified interference between connector on MCM and sidewall on many trays
  - Connector on tray violates stay clear by up to 200 microns
  - Issue being resolved with process change in G&A assembly
  - For Tower 0 alignment exercise, we are using Al sidewalls made to check the drill pattern, relieved to avoid interference
    - Tower 0 has been aligned successfully
- One readout chain (out of 8) is not working
  - Root cause to be determined after alignment of Tower 0
Pictures of Tower 0
Accomplishments and Issues Identified in MCM Production

- 342 units delivered to SLAC
  - 241 through burn in and final test at SLAC
  - Need 686 for 18 towers + electronics group

- MCM Issues
  - Novocap capacitors
    - NCR is closed
    - Tracker will use existing capacitors on existing boards
    - Replacements at Teledyne being kitted for production
  - Pitch adaptor
    - 13.5% drop out at MIP 1 due to broken traces (visual inspection)
    - Brittle Ni plating cracks easily in bend region, sometimes also cracking Cu
    - Two new pitch adaptor concepts in work to eliminate problem
    - New electrical test fixture in fabrication
Accomplishments and Issues Identified in MCM Production

- MCM Issues (cont.)
  - Conformal Coating
    - Issues identified in QA with peeling, contamination and bubbles
    - Detailed specification for inspection and rework under review
    - Critical path to getting MCM’s for Tower A to Italy
  - MCM board HV shorts
    - 6 boards have developed low resistance between 2 layers (120V and 0V planes) of the multilayer board during burn-in.
    - Test in process to determine root cause
    - Accelerated life test in progress to evaluate risk
  - Data readback errors
    - Some MCMs are too sensitive to clock duty factor
    - Bad MCMs being screened out while investigations continue
Accomplishments and Issues Identified in EM Tower Testing

- Concerns were raised about events with large numbers of hits in the tracker EM tower
  - Potential source of excess noise and data rate in tracker
  - Studies done to eliminate cross talk and other sources of multiple hits in readout chain
  - Sources of multiple hits identified
    - Showers
    - VDG bursting
  - Issue will be closed with release of document describing testing and results
Flight Hardware Drawings Status

- Top/Bottom Tray Panels (including flexures)
  - All drawings complete and released.
- Interface Hardware
  - All complete and released.
- Mid Tray Panels
  - Some rework and improvements of the drawings to reflect as-built condition are in work.
- Tray Assembly (Bonding MCMs + Ladders to tray panels)
  - All complete and released.
- Sidewall Drawings
  - All complete and released.
- Heat Straps
  - Complete and released.
Flight Hardware Drawings Status

- Flex-Circuit Cables
  - All complete and released. Drawing revision to match as built in progress
- Top Mount Cable Retainer and Alignment Hardware
  - All complete and released.
- Tower Assembly Drawing
  - Complete and in release cycle
- Electronics, including SSDs, MCMs, Bias Circuits, ASICs, etc.: all complete and released.
  - Ladder drawing revised to match as built.
    - Ready for release
## Status of Parts & Materials from SLAC

<table>
<thead>
<tr>
<th>Item</th>
<th>Status</th>
<th>Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCMs</td>
<td>~40 in will be hand carried to Italy Friday for Tower A</td>
<td>Resolution of conformal coat issues have delayed shipment</td>
</tr>
<tr>
<td>Flex-Circuit Cables</td>
<td>No complete flight sets in hand; C4 and C5 missing from 2 partial sets</td>
<td>Plating problem at Parlex; Delayed coupon testing</td>
</tr>
<tr>
<td>Ti Corner Brackets &amp; Flexures</td>
<td>Flight order complete</td>
<td></td>
</tr>
<tr>
<td>Bottom-tray closeouts</td>
<td>Flight order complete</td>
<td></td>
</tr>
<tr>
<td>Interface cones &amp; studs</td>
<td>The Tower-A set is ready and the remainder is in fab</td>
<td></td>
</tr>
<tr>
<td>Hex nut</td>
<td>In hand</td>
<td></td>
</tr>
<tr>
<td>Shims</td>
<td>Enough in hand for Tower A, but working on Ni plating</td>
<td></td>
</tr>
</tbody>
</table>
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<th>Item</th>
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<tbody>
<tr>
<td>Corner Brackets</td>
<td>In fabrication</td>
<td></td>
</tr>
<tr>
<td>Sidewall Prepreg</td>
<td>Italy purchased enough already for at least 2 or 3 towers. SLAC has a PO for the rest.</td>
<td></td>
</tr>
<tr>
<td>Ti Sidewall washers</td>
<td>Sufficient quantities are in Italy</td>
<td></td>
</tr>
<tr>
<td>Sidewall Fasteners</td>
<td>All are in hand and verified</td>
<td></td>
</tr>
<tr>
<td>Cytec BR-127 Primer</td>
<td>A large quantity was shipped last week and arrived okay</td>
<td></td>
</tr>
<tr>
<td>Bias Circuits</td>
<td>Plenty in Italy for tray mass production to begin</td>
<td>Waiver of coupon via plating thickness</td>
</tr>
</tbody>
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<tr>
<td>Heat straps</td>
<td>Tower A set plus spares are in Italy</td>
<td></td>
</tr>
<tr>
<td>Locktite 401 for heat straps</td>
<td>Being shipped to Italy</td>
<td></td>
</tr>
<tr>
<td>Solithane (for locking screws)</td>
<td>Being shipped to Italy</td>
<td></td>
</tr>
<tr>
<td>Nusil silicone adhesives</td>
<td>Sufficient quantities now in Italy</td>
<td>Replacement being ordered</td>
</tr>
<tr>
<td>Aeroglaze paint and primer</td>
<td>Sufficient quantities now in Italy</td>
<td></td>
</tr>
<tr>
<td>Honeycomb</td>
<td>In Italy except for the remaining bottom-tray cores (shipping this week)</td>
<td></td>
</tr>
<tr>
<td>Carbon Carbon for Tray Closeouts</td>
<td>Full flight order is in Italy</td>
<td></td>
</tr>
</tbody>
</table>
# Status of GSE from SLAC

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<th>Item</th>
<th>Status</th>
<th>Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vibration Fixture</strong> (Grid Simulator)</td>
<td>First deliveries from Humboldt this week, so SLAC-built fixture used for the EM vibe will not be used for Tower A</td>
<td></td>
</tr>
<tr>
<td><strong>Inner Shipping Container</strong></td>
<td>Tower-A container is hand and is being proof tested</td>
<td></td>
</tr>
<tr>
<td><strong>Cable Holding Plate</strong></td>
<td>In hand and being proof tested this week</td>
<td></td>
</tr>
<tr>
<td><strong>Static Test Grid Simulator</strong></td>
<td>In Italy, already used for Tower A</td>
<td></td>
</tr>
<tr>
<td><strong>Lifting Fixture</strong></td>
<td>One is in hand and proof tested. 2 more will also be made for use in Italy.</td>
<td></td>
</tr>
<tr>
<td><strong>Outer Shipping Container</strong></td>
<td>On order</td>
<td>Delivery in October</td>
</tr>
</tbody>
</table>
Status of GSE from SLAC

<table>
<thead>
<tr>
<th>Item</th>
<th>Status</th>
<th>Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable Bending Tool</td>
<td>Prototype completed, production model in design</td>
<td></td>
</tr>
<tr>
<td>Tools for Cone Alignment and Extraction</td>
<td>Enough tools are in hand for Tower A assembly in Italy</td>
<td></td>
</tr>
<tr>
<td>EGSE Sets</td>
<td>4 sets are in Italy. One more for T/V testing is under test at SLAC prior to shipping.</td>
<td></td>
</tr>
<tr>
<td>Long EGSE Cables for T/V Test</td>
<td>1 set delivered to Italy. 2 more are in work</td>
<td></td>
</tr>
<tr>
<td>C0 Cables for Stacked Tray Tests</td>
<td>Enough in hand for Tower A</td>
<td>Need to equip 3 more test sets in Italy with a less expensive version, in work</td>
</tr>
<tr>
<td>Breakout Boxes for Tray Testing</td>
<td>2 are in Italy</td>
<td></td>
</tr>
</tbody>
</table>
PMCS Schedule & Cost Variance

• August: our schedule variance increased from -$635k to -$716k on a total $14,761 budgeted cost of work scheduled.
  – Most of the cumulative variance is due to the production delays of TMCMs, which started up slowly in April but which then went at almost the planned rate. Fewer than planned were produced in August resulting in the increase in the variance.
    • A week was spent qualifying new pitch adaptors
    • More delaminations than usual
  – Keep in mind that most of the Tracker assembly work is to be done in Italy and is therefore not tracked by this schedule variance calculation.

• Cumulative Cost Variance: $237k
  – While the cost variance looks good, our commitments are almost equal to the total final budget and unexpected costs keep coming in.
Schedule Status: Tower A Campaign

- The Tracker team is focused on delivery of Tower A to I&T
  - Updated plan: Tower A ships Nov 30
Schedule Status: Tower Delivery Schedule

- Updated plan:
  - Start production 10/4
  - Plyform produces 4 trays/day starting 11/1
  - G&A going to 2 shifts
    - Extra CMM
    - Extra Wire bonder
  - Tower 13,14 arrive in May

<table>
<thead>
<tr>
<th>TKR Tower prod. Flow: PlyForm 4 trays/day from November - G&amp;A 3 trays/day from dec</th>
<th>Months</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>July</td>
</tr>
<tr>
<td>PlyForm tray</td>
<td>0</td>
</tr>
<tr>
<td>Trays vibe Test / ESPi</td>
<td>0</td>
</tr>
<tr>
<td>Bake out</td>
<td>0</td>
</tr>
<tr>
<td>G&amp;A installation</td>
<td>0</td>
</tr>
<tr>
<td>Env. Test on tray</td>
<td>0</td>
</tr>
<tr>
<td>Stacked Test</td>
<td>0</td>
</tr>
<tr>
<td>INFN-I assembling tower</td>
<td>EM</td>
</tr>
<tr>
<td>T/V &amp; vibe test at Alenia</td>
<td>EM (vibe)</td>
</tr>
<tr>
<td>Delivery/shipping</td>
<td>A</td>
</tr>
</tbody>
</table>

Note: 2 weeks at least are necessary for a tower assembly (included performance tests)
Note: Delivery/shipping is foreseen at the end of month