HYTEC Monthly Progress Report – Submitted to SLAC

April, 2001

1. Monthly Management Review

Progress Report

Monthly progress report submitted May 7, 2001 for work performed by HYTEC during the month of April.

HYTEC Funding

HYTEC funding issues were resolved during the month of January. Funding has been secured through FY'01 (September, 2001).

2. Tracker Tower Design

Tracker Tower Alignment

Discussions with INFN have continued during the month of April, which included extensive discussions on the proper method of assembling and aligning the TKR tower. These discussions have been inconclusive as to the proper method of assembly, and have therefore led to the decision to build and test both assembly procedures and down-select from there. The HYTEC procedure uses a stacked tray concept in which the trays are stacked using corner location posts to align the trays and sidewalls are aligned to the trays using countersunk screws. The INFN approach is to stack the trays using tooling, and align the trays to the sidewalls using pins. The sidewalls are attached via pins and countersunk screws. Eight pins were originally planned, however the exact number of pins is believed to be three at this time.

The tray and tower prototype testing is expected to begin in July. At this time, both concepts will be tested and monitored using a CMM (or equivalent). A preferred approach is expected to be committed to at this time. GFRP sidewalls will be machined and qualification level testing will begin at this time.

Tracker Tower Thermal Issues

SGL has been under consideration as a replacement for Allcomp C-C. The thermal performance of the SGL material is inadequate as a thermal carrier. Analysis was performed to quantify the impact of using SGL as a closeout material. Both materials were studied and the results show that the temperature drop across one tray will be 0.124 ºC for the Allcomp as compared to 1.3 ºC for the SGL. At the bottom, where all the heat is sent through the closeout frame, the temperature drop will be 0.44 ºC as compared to 2.4 ºC for the SGL. The total temperature increase using SGL will be 3.7 ºC. Indications are that this is too high, however no decision has been made at this time.

3. Tracker Tower Level Modeling

Tracker/Instrument Modeling

The detailed TKR tower finite element model has been completed. This model has the level of detail to understand and investigate the stiffness effects of the fasteners on the tower frequency as well as the bottom tray-to-grid interface interaction. A summary report of the FEA will be available in May.

Two support conditions were investigated. The first assumes a fixed base boundary condition along the bottom surface of the bottom tray closeout frame. The second case simulates a fixed base boundary condition along the bottom edge of the flexure blades. This is the bottom tray-to-grid interface. The two boundary conditions are important to examine to better understand the impact the blade flexures have on tower stiffness.

An error was found in the tower model. The blade flexure web thickness was modeled as 7.5 mm instead of the correct value of 0.75mm. This error was corrected and the net effect on the tower stiffness was a tower fundamental frequency drop from 170 Hz down to 125 Hz. Although the stiffness loss is significant, the end tower frequency is still above the desired 100 Hz.

Mortise and Tenon Joint FEA

Analysis was performed to understand the impact of removing the mortise and tenon joint from the closeout frame design. The tray frequency did not drop in the tray model, but dropped by as much as 30% in the tower level model due to the change in boundary conditions. The stiffness loss to the tower indicated a frequency drop of 16%. The conclusions of this analysis indicated that the mortise and tenon joint should not be removed. The cost savings does not justify the reduction in tower performance and increased risk of tower-to-tower collision.

Corner joint stresses were also examined to determine the net shear forces through the corner joint. This is necessary to avoid carrying load in peel through the face sheet bond joints. The results of the static analysis will be made available in the summary report in early May.

4. TKR CAD Modeling/Drawings

Solid Model

Significant modifications to the MCM closeout wall were being incorporated into the model, therefore a new version of the closeout frame, trays and tower was developed. This version is reflected as –13 in the drawing part numbers. All changes are reflected in this version and drawings will be released with these changes. A description of the changes can be found in section 5.

Drawing Package

Version 13 standard tray drawings were released for fabrication of the closeout frame prototype components.

5. Tracker Tray Closeout Development

Particulate Pollution Issues

Investigating tests to verify the minimum required thickness to survive launch loads. The principle concern is with wearing of the surface that will expose the C-C and release particulates. Several tests have been identified and are expected to be completed in May.

Carbon-Carbon Material Procurement

The final shipment of C-C material has arrived at HYTEC. This material will be sent to GMSI for fabrication as closeout frame components. A small portion of this material will be sent to INFN. INFN will use this material to understand and familiarize themselves with the machinability of this C-C and supply them with material to fabricate two closeout frames for their development work.

INFN material will be shipped in early May.

An alternate C-C material vendor was contacted here in the states to develop a competitive procurement of the material. The vendor was unable to develop a C-C material that would be competitive with Allcomp.

Closeout Frame Development

Modifications were recommended to the collaboration to increase the wall thickness of the MCM closeout walls to 5mm. This recommendation was solely to reduce the machining cost of the individual parts and did not consider the impact to science. To avoid any negative impact on science, the thickness modifications were maintained to reduce machining costs and increase component stiffness, but weight-reducing pockets were included to minimize the mass and material. The current MCM closeout design mass is only slightly higher than the 3mm design, and will be reduced further after the current prototyping.

Several other modifications were incorporated into the MCM closeout wall design. First, the mortise and tenon joint was turned around. The mortise is now located on the MCM wall and the tenon is on the structural wall. The tenon will be stronger because the fibers run along the length of the tenon. The mortise will be stronger because there will be more material to support the load. A second modification was the addition of two 2mm location holes to support INFN design efforts. A third change was to eliminate the MCM fastener inserts. Tests indicate that the strength of the threads cut directly into the C-C closeout wall will be sufficient to support the MCM's. And finally, the locating hole and slot used to position the inserts have been removed. The new plan is to use the center slot and the bottom surface to locate the inserts. The inserts will be located using the same features used to locate the closeout walls relative to the tray components.

Closeout Wall Threaded Inserts/Fasteners

Tests verified that the strength of threads cut directly into the C-C material will be sufficient to support the MCM's during launch. For this reason, the metallic inserts were removed for all MCM attachment holes.

Galling and strength tests on the aluminum inserts were performed. These tests indicate that galling will not be an issue. The strength of the aluminum threads proved to be sufficient enough to carry the launch loads and there was no indication of strength degradation as a result of repeated fastener installation up to the required torque levels.

Pullout and shearout tests were performed to verify the strength of the C-C material with the installation of aluminum inserts. The tests indicated that the strength should be sufficient, however one erroneous data point left some doubt in the tests. For this reason, additional shearout testing is planned for May to be certain that the strength of the inserts is sufficient to meet launch requirements.

Alternate fasteners are being investigated because the offset cruciform head is prone to stripping when being backed out after installation to the required torque level. Several head designs are available and are being considered. Also, a 90º countersunk is being considered to give a greater number of options from off-the-shelf products. Some pullout tests are planned for May.

Closeout Frame Prototyping and Testing

Mortise and Tenon Joint Testing

Four closeout walls were fabricated to test the strength of the mortise and tenon joint to handling and fabrication loads. The closeout walls contained the features necessary to test the bonding fixture as well as the mortise and tenon joints themselves. The test verified the strength of the frame when subjected to a racking deflection. The test indicted that the joint is sufficiently strong to support the handling loads.

Closeout Wall Prototyping

An order was placed with GMSI to verify the machinability of the C-C material. Four MCM and structural closeout walls were procured with all the features of a standard tray. These components will be used in the first two prototype trays.

The finished parts looked quite good with the exception of the porosity of the material. Examination of these parts indicate that the resin impregnation is not sufficient at the center of the C-C plates. The impact of this porosity will be a reduction in the strength of the material. For this reason, it is important to correct this issue. A test panel will be sent to Allcomp in early May to try and re-impregnate the C-C panels. The approach will be to cut the panels into smaller pieces and impregnate. It is believed that the smaller pieces will allow better penetration of the resin into the center of the material.

Strength tests are scheduled for early may to measure both the tensile and flexural strength of this material to ensure that the material is meeting expectations.

6. Face Sheet & Core Development

Face Sheet Material Distribution

The INFN face sheets were sent in March, however the duty on this material was too high and the material was sent back to HYTEC. The ten 6-ply face sheets were sent a second time in April, and have arrived at INFN.

Face Sheet Material Performance

One 4-ply face sheet was taken to Plyform to impress upon them the difficulty in dealing with these face sheets. It was recommended that Plyform begins fabricating these 4-play face sheets and assembling sandwich structures with them to ensure that they have developed repeatable and quality bonds.

Core Material Procurement

HYTEC was given an action item to purchase the core material for all the HYTEC mechanical prototypes and some core material for INFN prototyping. Additional core material for the SuperGLAST trays will be purchased if economical.

7. Tracker Tray Sidewall Design

Material Procurement

A quote for the flight quantity of sidewall materials was verbally received from PCI. The material estimates originally quoted did not contain the cost of the YS-90A fabric. The quote came in very high. The latest numbers indicate that the flight quantity will cost $267 K. Alternatives are available, however material qualification will be required, which will reduce the net savings. In the end, the cost savings will not justify the schedule impact. HYTEC is planning to proceed with YS-90A fabric for the sidewall material selection.

EMI Shielding

Gr/Ce sidewall samples were sent to Ion Edge corporation for vapor/vacuum deposit of three metals. Aluminum, copper, and nickel was deposited on the sidewall samples to a thickness of 0.050 mm. Samples were received back and are awaiting EMI shielding tests and thermal/mechanical tests to verify the EMI performance as well as the robustness of the plating to the launch/space environment.

Thermal/mechanical tests are planned for late May-early June to verify the coating to the thermal environment as well as the mechanical environment. The coating thickness has been set at 0.075 mm.

8. Contact Resistance between Sidewall and Closeout

No progress to report.

9. Tower Clearance & Alignment and Silicon-to-Tray Alignment

No progress to report.

10. Top Tray Design

No progress to report.

11. Bottom Tray Attachment to Grid

Samples of most of the CoTherm® interface products was received. There are several options available, however analysis is necessary to understand the

coupling between the grid and tower that may result from using this material as a thermal interface between the two subsystems.

12. Tray Assembly Tooling

Graphite Tooling

The graphite tooling has undergone extensive modifications to improve the tooling concept and final tray product. The thickness of the tool has been increased to 2 inches to improve the stability and repeatability. All four closeout walls will be constrained and located by the tooling. The will improve the repeatability of the trays as well as correct the bending issues discovered in the closeout material. The tooling design and drawings will be finished in early May and the graphite tool will be purchased immediately after.

13. Vendor Tours/Visits

Plyform, Italy

Robert Johnson (UCSC), Tom Borden (SLAC), Ossie Milligan (SLAC), Erik Swensen (HYTEC), Steve Ney (HYTEC), and Allesandro Brez (INFN) visited Plyform on April 24th. The visit included a presentation of their capabilities and past experience. A tour of their facilities followed. The general impression is that Plyform has some experience with sandwich structures, but is limited in nature to structures with minimal precision required. A significant portion of their business was driven towards the automotive industry.

Plyform has no experience with 4-ply face sheets balanced about the core. This experience will need to be developed during the coming months. A 4-ply face sheet was shown to Plyform to demonstrate the severity of the problem. Plyform will begin making 4-ply face sheets and develop the required skills.

14. Tracker Meetings and Tracker Technical Discussions

Weekly Tracker Meetings

HYTEC participated in all weekly tracker technical meetings with SLAC and UCSC, during the month of April.

Weekly Instrument Meetings

HYTEC has participated in all the weekly instrument integration meetings with SLAC to discuss Tracker to Grid integration issues.

Engineering Meetings

An engineering meeting was scheduled at INFN for April 26th and 27th. This meeting was to discuss the current assembly procedure and future plans for TKR tower development.