CPI Trip Summary (Ken Premo-6/8/2010)

Trip Date: 6/2/2010

Location: CPI, Beverly Microwave Division, 150 Sohier Road, Beverly MA.

Meeting Objectives: To address various TTF3 power coupler manufacturing issues, to improve communication with CPI, and to gain an understanding of the coupler manufacturing process.

Attendance:	Tug Arkan	FNAL	Engineer
	Andrei Lunin	FNAL	Engineer
	Ken Premo	FNAL	Engineer
	Tom Nieland	SLAC	Tech
	Steve Einarson	CPI	Mechanical Engineering Manager
	Dr. Todd Treado	CPI	VP of Engineering
	Dianne Sarkisian	CPI	QA Engineer

Meeting Summary:

Overall, the meeting was very productive and the response from the CPI personnel was positive and accommodating. The 6 hour meeting consisted of a discussion of issues followed by a tour of the plant. The issues of concern were addressed and in most cases agreement and resolutions were found. In addition, a greater understanding of the manufacturing process and quality controls was reached. CPI has agreed to provide QA data that they produce during the manufacturing process. Also, CPI will look at adjusting/modifying some of their tooling and process in order to address FNAL concerns. Many of the quality issues experienced by SLAC and FNAL on the original order of couplers have already been resolved and solutions implemented on couplers currently being produced by CPI.

Following is a copy of the meeting agenda including a summary of resolutions or agreements made.

MEETING AGENDA

CPI Coupler manufacturing issues

The following issues were addressed during the visit to CPI:

ISSUES/CONCERNS

Assurance that antennae is concentric with and perpendicular to flange.

Assurance that flanges are concentric with each other when flanges are parallel.

Assurance that the bellows are brazed so that the flanges are concentric and parallel with each other.

FINDINGS

There are 3 major sub-assemblies that are prepared prior to final welding of the cold end assembly: 1)the CF100 flange, bellows, and 40mm flange, 2)the ceramic window with SS rings brazed on each end for welding to the CF100 flange and antennae, 3)copper antennae with SS ring for welding to the ceramic window. The sub-assemblies are pre-fabricated and then assembled using a fixture that holds them in place for e-beam welding. E-beam welding is used rather than TIG for the final assembly due to heating concerns for the ceramic. Perpendicularity of the antennae to the CF100 flange is not specified by a tolerance on any of the existing drawings. Prior to welding of the antennae is clamped in position by a specialized positioning system that is designed to hold the base of the antennae concentric to the CF100 flange and the tube. In theory the clamp would also hold the antennae perpendicular to the flange also. However, because the position of the clamp is relatively close to the flange there could possibly be error in the antennae position. At this point it is not known that there is a problem with the antennae alignment. CPI has agreed to measure the final position of the antennae relative to the CF 100 flange and the 40mm flange to assure that it is concentric and perpendicular . If measurements indicate a problem with alignment they will consider fixture changes.

Currently the concentricity, perpendicularity, and straightness of the individual sub-assemblies are determined by the fit up and tolerances of the individual components prior to fabrication of the assembly. There are tolerances specified on the detail drawings of the individual components, but not for the sub-assemblies. The parts are fit together and held from moving by fixtures during the TIG welding or brazing processes. No attempt has been made to confirm concentricity, perpendicularity, or straightness either before or after the fabrication of the sub-assemblies. The vendor has agreed to examine their fixtures and modify them (if required) so that the components are fixed in proper alignment as well as possible prior to welding or brazing. This might help to reduce or eliminate any possible problems with the final assembly.

ISSUES/CONCERNS

Cold end bellows restraint does not hold bellows well and allows for movement.

Cold end bellows restraint forces the flange to be non-concentric with antennae.

FINDINGS

The problem is that the bellows restraint does not necessarily hold the 40mm flange concentric to the antennae axis. The reasons for this are not clearly understood. Typically the length of the bellows in the free state is not the same as the nominal length of the clamp system. The bellows are longer because they must be stretched out for the copper plating process and must then be returned to a length close to nominal by compressive deformation. This is not an exact process and is subject to error. Therefore it is not easy to attach the clamp without putting a compressive force on the bellows. This puts a preload force on the clamp and flange. Due to the design of the clamp, the bellows and flange are free to rotate slightly in one direction even when tightened. The spring force in the bellows and clamp forces the rotation of the flange into a non-concentric position relative to the antennae. CPI does not have any control over the design of the clamp. However, they will make an effort to put the bellows as close to the nominal length to reduce the spring loading. In addition, the fixture that positions the clamp mounting boss to the coupler body for brazing will be checked to assure proper alignment.

ISSUES/CONCERNS

Ceramic windows vary in color and appearance, metallization on ceramic, dark discoloration spots.

FINDINGS

The concern is that the difference in coloration could be indicative of a defect or an inconsistency in the performance of the ceramic as a RF window. The possible reason for yellowish ceramic color is the difference in the TiN coating thickness and its combination with various Alumina brands. CPI stated that they did not think that there would be a performance issue due to difference in coloration of the ceramic. CPI obtains the ceramic components from a separate vendor. CPI or the ceramic vendor can provide some samples of the window ceramics to FNAL for testing at the lab upon request.

ISSUES/CONCERNS

Wave Guide insufficient soldering (Gaps at joints).

FINDINGS

No longer an issue. CPI has increased the fillet size and inspects to assure there are no voids.

ISSUES/CONCERNS

Copper plating quality.

FINDINGS

CPI has implemented a QA plan for the plating. The proprietary plan includes visual inspection procedures and standards for acceptance or rejection. Many of the inspection points were determined from what was learned from LAL. Included are also areas and features not necessarily contained in the formal product specification but were determined to be important by experience.

DOCUMENTATION ISSUE

Is there a set of production drawings showing manufacturing tolerances that we can have?

We are primarily concerned with brazed assembly drawings showing allowable tolerances.

FINDINGS

CPI is currently building the couplers based upon DESY drawings. These drawings are produced to a European standard and text is in German. Special manufacturing drawings are not used. FNAL has copies of the drawings that are used. There are detail drawings for the individual components and final assembly drawings. Allowable manufacturing tolerances are primarily specified on the detail drawings. The assembly drawings do not contain a great deal of specific tolerance information related to the final assembly. To some extent the specification of the final assembly could be considered incomplete. CPI manufactures the best product they can and base much of their quality checks and measurements upon previous experience with LAL and DESY. Important dimensions and other quality related issues are not necessarily specified formally in the documentation, but are nevertheless followed.

CPI stated that they would like to have a complete set of drawings that are drawn to a US standard. Additional tolerance information and/or specifications would be added to the drawings. CPI proposed that they would produce the drawings (at no additional cost to FNAL) using Solidworks. The drawings would be available to FNAL. The drawings and subsequent revisions would have to be approved by FNAL. CPI also proposed that the drawings (not the design) would be proprietary to CPI and there would be restrictions on the use of the drawings beyond CPI and FNAL use. It was agreed that decisions regarding the drawings and their use would be determined by management at a later date.

DOCUMENTATION ISSUE

Are there inspection reports /measurements created during the production process?

Is there final inspection documents produced prior to shipment?

What documentation do they provide to DESY for their couplers?

FINDINGS

To date the only documentation received by FNAL with the couplers has been inspection reports and conditioning data generated by SLAC when they do their work on the couplers. Inspection and quality data related to manufacture has not been provided by CPI. However, CPI has a quality plan in place and the data is being generated. Currently, each coupler has a package of data (they call it "the Green Folder") and retains all pertinent inspection data. This data could be provided with the shipment. Inspection data for couplers that have already been shipped exists but it is not as complete as what is currently being produced. The inspection reports have not been provided because they have not been requested. A change in the CPI internal shipping documentation is all that is required to assure that the inspection documentation is sent with the shipment.

CPI agreed to make the internal shipping documentation changes required to provide a copy of the inspection data with all future shipments. In addition CPI will provide the inspection data for all couplers that have already been received.

PROCESS

Description of the manufacturing steps and process.

Documents outlining the manufacturing process.

Fixtures used during fabrication.

Clocking tooling/jigging during fabrication. How the stack-up tolerances are meet?

FINDINGS

CPI provided an overview of the production process. A tour of the plant covered most of the facilities from receiving to shipping. Documents outlining the manufacturing process were not viewed. Fixtures and tooling used for fabrication of the sub-assemblies and final assembly were examined. Overall, the fixtures and tooling appear to be of good quality and well thought out. Possible modifications to the tooling that might improve alignment and antennae/flange concentricity were discussed and CPI agreed to consider changes if they were deemed necessary.

QUALITY ASSURANCE

Quality controls in process. Is there a quality assurance plan in place for the fabrication.

Inspection of all Couplers parts during the fabrication process and end item. How is this done?

Test samples deliverables per "High Power Input Coupler TTF-III, Technical Specification, W.-D. Moller, DESY 06.04.2006". Will these be before Coupler delivery?

FINDINGS

There is a quality assurance plan in place. The plan documentation gathers data for the entire production process from parts receiving to product shipment. Currently, there are 6 to 7 critical dimensions for the assembly that are checked and recorded. There is also a 29 point visual inspection that is performed for the assembly and copper plating.

Test samples per the spec are available upon request.

PACKAGING & SHIPPING

Are the Couplers cold and warm purged with N2 during packaging, how is this process done?

How will the hardware be packaged? Last shipment paper was used and is not allowed for SLAC shipment. Define process and material?

FINDINGS

The couplers are purged with N2 for shipping. The hardware is packaged in plastic after cleaning for shipment. Paper is no longer used for packaging.