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LAT PROCESS SPECIFICATION	Subsystem/Office Tracker Subsystem	
Document Title **LAT Tracker Tray Panel Assembly Procedure**		

Gamma-ray Large Area Space Telescope (GLAST)

Large Area Telescope (LAT)

Tracker Subsystem

Tray Panel Assembly Procedure

for Mid Trays

Change History Log

Revision	Effective Date	Description of Changes
1	April 20, 2003	Initial draft
2	January 24, 2004	To be released for start of flight production
3	October 1,2004	TART recommendations included

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Purpose

This document describes the procedures to be followed in the industrial centers where the LAT Tracker Trays of the MID, LIGHT and HEAVY type will be assembled. A large number (~370) of these trays have to be assembled. This large quantity as well as the quality and the tools required to fabricate equipment for space applications are not easily obtained in research laboratories like those of INFN. The use of industrial vendors that have been qualified for Tray production is needed to ensure the required throughput at the certified quality.

One vendor has been qualified to perform the assembly of Trays:

- Plyform S.r.l., via Mirabella 12, Varallo Pombia (NO), Italy, http://www.plyform.it, e-mail info@plyform.it

Some of the equipment and QA procedures are vendor-specific and will be discussed throughout this specification. The Engineering-Model tray assembly effort has been used to qualify this vendor.

1. SCOPE

This procedure specifies how to assemble and do acceptance testing of the flight-production tray panels. The tray panel is composed of two composite face sheets separated by aluminum honeycomb with 4 carbon-carbon closeouts. On one side of several of the tray types there are 16 tungsten plates bonded in place. Both sides of the tray have Kapton bias circuits bonded as the final step before the trays are sent to Pisa for further assembly. An exploded view of the standard MID tray is shown in Figure 1.

There are 5 tray configurations: the standard MID tray, the LIGHT tray, the HEAVY tray, the TOP tray, and the BOTTOM tray, which acts as the interface between the Tower and the Grid. Table 1 lists the main characteristics of each of the tray types.

This document describes the assembly procedure of the MID, LIGHT and HEAVY trays. The TOP and BOTTOM tray assembly is described elsewhere.

Tray type	Honeycomb core	Face sheet Plies	Tungsten converter	Assembly Drawing	Close-out drawings
MID	1 lb/ft^3	4 plies	3% Xo	LAT-DS-00148	LAT-DS-00092/00093
LIGHT	1 lb/ft^3	4 plies	none	LAT-DS-02923	LAT-DS-00092/00093
HEAVY	3 lb/ft^3	6 plies	18% Xo	LAT-DS-00647	LAT-DS-00092/00093

TABLE 1. Tray Characteristics

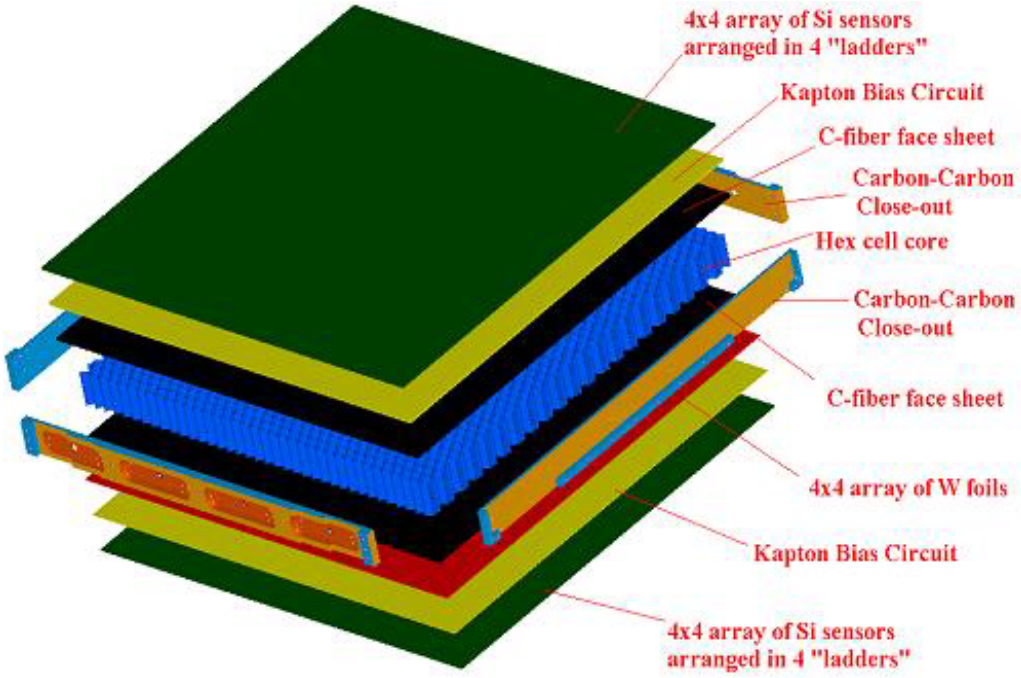

FIGURE 1. Exploded view of the standard MID tray. (Note: this procedure does not include mounting of the 4 by 4 arrays of Si sensors).

2. DEFINITIONS

ESPI	Electronic Speckle Pattern Interferometry
GLAST	Gamma ray Large Area Telescope
LAT	Large Area Telescope
Panel	Flat composite panel consisting of two composite face sheets separated by aluminum honeycomb with four Carbon-Carbon closeouts.
RMS	Root Mean Square.
SSD	Silicon Strip Detector.
Tray	Flat composite panel that supports the SSD ladders, readout electronics, and converter foils in the TKR mechanical structure.
Tower	Assembly of 19 trays, stacked vertically and held together with sidewalls, to form one TKR detector module.
μm	Micrometer (10^{-6} meter).

3. APPLICABLE DOCUMENTS

[1]	433-MAR-0001	Mission Assurance Requirements (MAR) for the Large Area Telescope
[2]	541-PG-8072.1.2	Goddard Space Flight Center Fastener Integrity Requirements
[3]	LAT-MD-00039	LAT Performance Assurance Implementation Plan
[4]	LAT-MD-00404	GLAST LAT Contamination Control Plan
[5]	LAT-SS-00017	LAT Tracker Subsystem Specification – Level-3 Specification.

[6] LAT-SS-00134 LAT Tracker Detailed Subsystem Specification – Level-4 Specification.
[7] LAT-PS-01601 LAT Tracker Tray Database
[8] LAT-PS-01918 Tracker Tray Test, Electronic Speckle Pattern Interferometry (ESPI)
[9] LAT-TD-00154 Tracker Tray Vibration Test Plan
[10] LAT-SS-00172 LAT Tracker Mechanical Parts and Materials List
[11] LAT-DS-00405 LAT Mechanical Materials and Parts List

4. DRAWINGS

4.1 TOOLING DRAWINGS

[12] LAT-DS-00730 Insert assembly tool for MID/HEAVY trays
[13] LAT-DS-00745 MID and LIGHT Tray Assembly Fixture
[14] LAT-DS-00746 HEAVY Tray Assembly Fixture
[15] LAT-DS-00749 3%Xo Tungsten Plate Assembly Tool
[16] LAT-DS-00750 18%Xo Tungsten Plate Assembly Tool
[17] LAT-DS-00751 Bias Circuit Assembly Tool

4.2 FLIGHT DRAWINGS

[18] LAT-DS-00049 Light Tray Face Sheet Top
[19] LAT-DS-00092 MCM Closeout Wall
[20] LAT-DS-00093 Structural Closeout Wall
[21] LAT-DS-00094 Closeout Insert
[22] LAT-DS-00139 MCM Closeout Wall Assembly
[23] LAT-DS-00140 Structural Closeout Wall Assembly
[24] LAT-DS-00148 Mid Tray Composite Panel Assembly
[25] LAT-DS-00192 Bias Circuit Assembly
[26] LAT-DS-00596 Light Tray Face Sheet Bottom
[27] LAT-DS-00617 Heavy Tray Face Sheet Top
[28] LAT-DS-00618 Heavy Tray Face Sheet Bottom
[29] LAT-DS-00647 Heavy Composite Panel Assembly
[30] LAT-DS-00718 3mm Closeout Insert
[31] LAT-DS-00791 Thin Converter Foil
[32] LAT-DS-00792 Thick Converter Foil
[33] LAT-DS-02608 Grounding tube
[34] LAT-DS-02923 Mid Tray Composite Panel Assembly Without Converters

4.3 Drawing Trees

LAT-DS-00148	Mid tray panel assembly
LAT-DS-00139	MCM closeout assembly
LAT-DS-00092	MCM closeout
LAT-DS-00094	Insert
LAT-DS-00718	3mm insert
LAT-DS-00140	Structural closeout assembly
LAT-DS-00093	Structural closeout
LAT-DS-00094	Insert
LAT-DS-02608	Grounding tube
LAT-DS-00049	Light top face sheet
LAT-DS-00596	Light bottom face sheet
LAT-DS-00791	Thin tungsten
LAT-DS-00192	Bias circuit
LAT-DS-02923	Light tray panel without converters
LAT-DS-00139	MCM closeout assembly
LAT-DS-00140	Structural closeout assembly
LAT-DS-02608	Grounding tube
LAT-DS-00049	Light top face sheet
LAT-DS-00596	Light bottom face sheet
LAT-DS-00192	Bias circuit
LAT-DS-00647	Heavy tray panel assembly
LAT-DS-00139	MCM closeout assembly
LAT-DS-00140	Structural closeout assembly
LAT-DS-02608	Grounding tube
LAT-DS-00617	Heavy top face sheet
LAT-DS-00618	Heavy bottom face sheet
LAT-DS-00792	Thick tungsten
LAT-DS-00192	Bias circuit

5. PROCEDURE

INFN_LAT_MECH_006	Tungsten bonding
INFN_LAT_MECH_007	Process clenliness
INFN_LAT_MECH_008	Bias circuit preparation
INFN_LAT_MECH_009	Adhesive preparation
INFN_LAT_MECH_010	Tungsten tiles preparation

6. REQUIREMENT FLOW-DOWN

The mechanical requirements to be met by the tray assembly derive from LAT-SS-00017 and LAT-SS-00134, the Tracker subsystem specification level-3 and 4 requirements. Section 5.3.9 of LAT-SS-00134 implies that the alignment deviation of trays within a tower should not exceed about 0.3 mm. This assures a good reconstruction of the tracks and that each tower will fit within its stay-

clear, so that two adjacent towers will not come in contact during the launch vibration environment. The requirement that the SSD's on adjacent trays shall not come in contact during the launch environment imposes design requirements on the mechanical stiffness of each tray that will be verified with vibration testing of each tray (fundamental resonance mode search, LAT-TD-00154). The same stay-clear implies requirements on the planarity of the tray surfaces.

7. QUALITY ASSURANCE

The tray assembly vendor shall be certified to comply with ISO 9001 "standards for quality assurance". The procedures specific to tray assembly for assuring the quality of the finished product are described herein and are designed to comply with the LAT Performance Assurance Implementation plan LAT-MD-00039.

7.1 PERSONNEL TRAINING

All personnel involved in the assembly and test of trays, whether employees of the commercial vendor or INFN employees, shall be adequately trained in:

- Clean room procedures.
- General operation of the machines and instruments to be used by the specific personnel for tray panel assembly and test.
- The specific LAT procedures, described herein, to be used for the production of the trays.

7.2 DATABASE AND TRAVELER

Tray assembly and test is performed with the aid of a traveler system that guides the operator through the workflow of operations required to fabricate and assemble each tray panel. The operators have a written procedure that specifies the materials, instruments, assembly sequence and quality operations at each work location. The travelers are compiled, signed and stored for inspections in Plyform for 10 years at least. A database system, provided and maintained by INFN personnel, serves as a online copy of the traveler for each tray during assembly and test, as well as an archive of the as-built information on each tray. This database/traveler is described in detail in LAT-PS-01601.

For the purpose of the database, the procedure described herein is divided into self-contained steps, referred to as Working Stages (WS) ("*Istruzioni di Lavoro I.L.*" are the Italian equivalent of Working Stages).. Each WS contains a sequence of specific actions required for proper completion of the step. The list of working stages is presented in LAT-PS-01601 and can also be found in the procedure below and in Figure 2. The reference numbers in figure 2 are the Plyform internal procedures.

7.3 NON-CONFORMANCE REPORTING

The tray assembly vendor shall have a procedure in place for reporting product nonconformance to the LAT.

After a NCR is generated, the case will be judged for acceptance, reworking or rejection, by a Material Review Board (MRB) formed by the INFN tray production engineer, the INFN/LAT Quality Engineer, the Quality Manager of Plyform and the production engineer of Plyform. The rejected trays will be marked and impounded to avoid subsequent use in the Tracker construction. A written report shall be generated for any NCR. The NCR reports will be communicated to SLAC Mission Assurance.

Minor non-conformances of the sort that result in rejection or setting aside of individual trays will be reported in the database as specified in LAT-PS-01601 and will be available for review on the INFN GLAST web site. INFN personnel will generate weekly reports of production yield, quality, and progress from the database for review.

Major non-conformances will result in a halt to the production line to address the problem, with immediate notification of the relevant Tracker personnel. Major non-conformances include the following:

- Rejection during dimensional inspection of more than 4 of the trays produced out of a continuous sample of 40 trays.
- Rejection during dynamic tests of more than 4 of the trays produced out of a continuous sample of 40 trays.
- Accidents resulting in irreparable physical damage (serious enough for tray rejection) to more than 2 of the trays produced out of a continuous series of 40 trays.

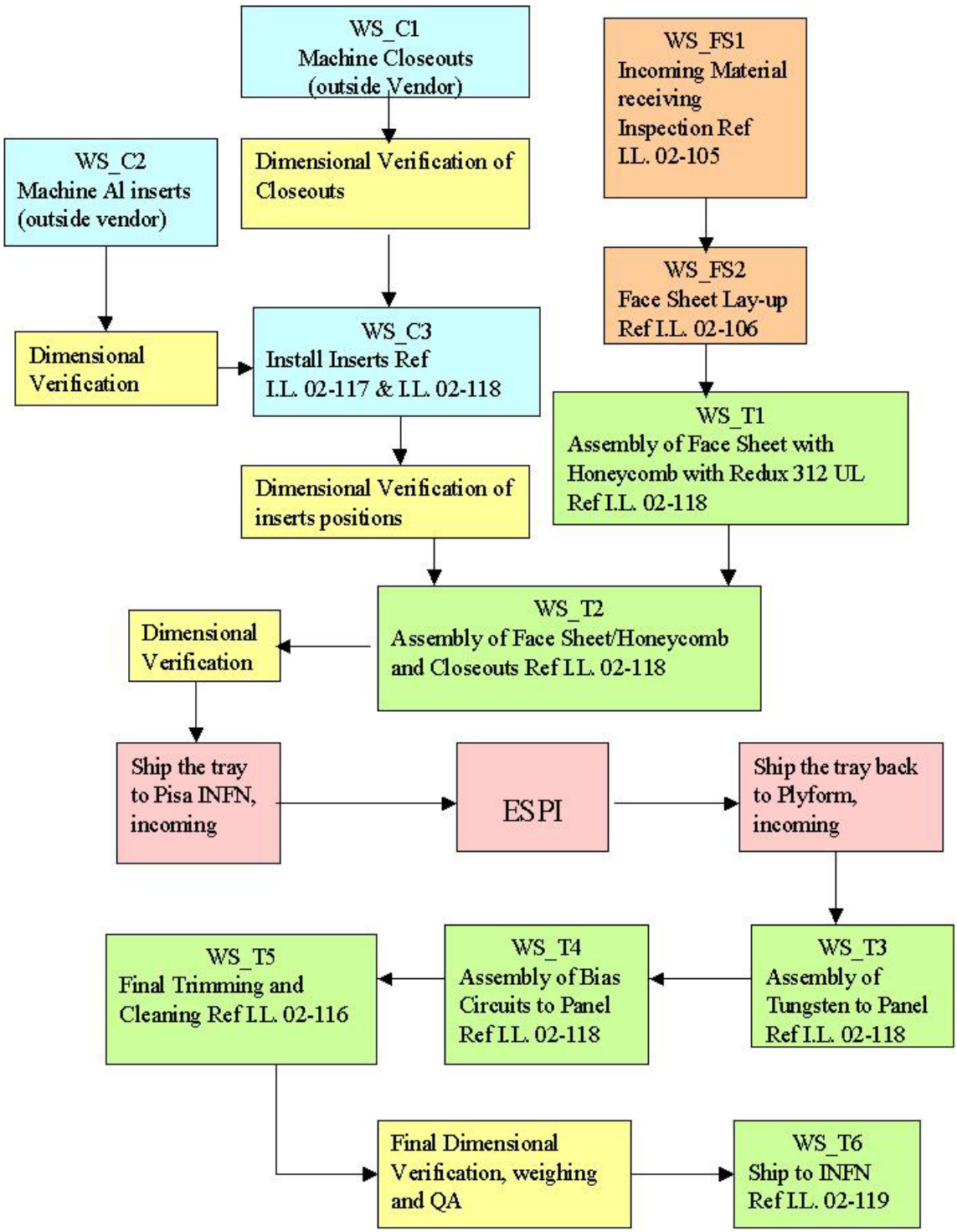

FIGURE 2. Tray production block diagram. The I.L. document numbers refer to the Plyform internal procedures.

7.4 INDEPENDENT SOURCE INSPECTION

INFN personnel will be present continuously during the tray production in the vendor factory to check the applied procedures, to control the travelers and to maintain the database.

There will be the subsequent Mandatory inspection points:

1. Tungsten tile tiles preparation
2. Bias circuit preparation
3. Cleanliness rules observation and adhesive preparation

In addition, the LAT Performance and Safety Assurance Manager will perform an inspection following the production of the first 20 flight trays.

8. PARTS AND MATERIALS

All parts and materials used in the tray assembly can be found in the Tracker mechanical parts and materials list LAT-SS-00172 as well as the LAT list LAT-DS-00405. The relevant list is reproduced here in Table 2.

8.1 MATERIAL CONTROL

All material used shall be verified against the appropriate documentation for conformance to specifications via material certification or via certificate of compliance from the manufacturer for proprietary items. All materials shall be used only within the original shelf life and stored per the manufacturer's recommendations in terms of proper containers and storage environment.

9. WORKING CONDITIONS

All the production activities shall be done in clean rooms of class 100.000 per FED-STD-209, as required by the tray fabrication vendor to meet the design requirements of the trays and in agreement with the INFN_LAT_MECH_007 procedure

TABLE 2. Tray panel parts and materials list.

ID	Item	Material	Part Number or LAT Drawing	Manufacturer
	Face sheets 4 plies	YSH50/RS3	LAT-DS-00049, LAT-DS-00198, LAT-DS-00199	Plyform
	Face sheets 6 plies	YSH50/RS3	LAT-DS-00596, LAT-DS-00617, LAT-DS-00618, LAT-DS-01903, LAT-DS-01904	Plyform
	Honeycomb 1 lb/ft^3"	5056 Aluminum	See LAT-DS-00148	Plascore
	Honeycomb 3 lb/ft^3"	5056 Aluminum	See LAT-DS-00647	Plascore
	Adhesive face-sheet, honeycomb assembly	Epoxy Adhesive Redux 312 UL	NA	Redux
	Closeout	Carbon-Carbon	LAT-DS-00074, LAT-DS-00075, LAT-DS-00356, LAT-DS-00357, LAT-DS-00800, LAT-DS-00801	Allcomp
	Closeout inserts	7075 T6 Aluminum	LAT-DS-00094, LAT-DS-00592, LAT-DS-00718, LAT-DS-00802	Plyform
	Adhesive Closeout inserts and Closeout to Closeout and to Face Sheet	Hysol EA 934 NA	NA	Hysol
	Grounding cylinder	Kapton, 0.05mm thick, with Cu-Ni-Au metal strips	LAT-DS-02608	G&A
	Adhesive Tungsten plates to face-sheet, Kapton bias circuit to face sheet, grounding cylinder closure	3M 2216 gray A/B	NA	3M
	Conductive adhesive for the grounding cylinder	CV-2646	NA	Nusil
	Tungsten 3% Xo converters	Tungsten	LAT-DS-00791	Plansee
	Tungsten 18% Xo converters	Tungsten	LAT-DS-00792	Plansee-BLG
	Primer to be applied to the tungsten tiles	BR-127	NA	Cytec
	Bias circuit	Metalized Kapton	LAT-DS-00192	Parlex
	Black paint	High emissivity epoxy paint – Z306	Z306NA	Aeroglaze
	Primer thinner	9953	NA	Aeroglaze
	Primer	9929	NA	Aeroglaze

10. BARE TRAY ASSEMBLY PROCEDURE

The tray assembly procedure follows 3 principal steps:

- Bare tray assembly
- Tungsten plates bonding
- Kapton bias circuits bonding

Each production phase is followed by dimensional, dynamic and ESPI tests that shall guarantee the conformance of the tray to the project requirements.

10.1 BARE TRAY ASSEMBLY

This procedure describes the operations to produce the bare tray components and the assembly phases:

- Face sheets production and test **(WS FS1 and WS FS2)**
- Carbon-Carbon closeouts machining and dimensional verification **(WS C1)**
- Al inserts machining and dimensional verification **(WS C2)**
- Al inserts assembly on the closeouts **(WS C3)**
- Assembly of face sheets, honeycomb core and closeouts **(WS T2)**
- Bare tray acceptance (dimensional) and testing **(ESPI)**

10.2 FACE-SHEETS PRODUCTION

The face-sheet material is YSH50/RS3; the following listed drawings define the layer sequence and cutting requirements:

LAT-DS-00049 (Mid Tray Face Sheet Top)

LAT-DS-00596 (Mid Tray Face Sheet Bottom)

LAT-DS-00617 (Heavy Tray Face Sheet Top)

LAT-DS-00618 (Heavy Tray Face Sheet Bottom)

10.2.1 Face sheets acceptance tests

The face sheet acceptance testing is per ASTM D-3529, D-3776, D-3039, D-4065, and D-2344.

10.3 HONEYCOMB CORES

The honeycomb core will be in Aluminum 5056 vented for space use. The materials and tolerances are as defined in drawings:

LAT-DS-00148 (Mid and Light Trays)

LAT-DS-00647 (Heavy Tray)

10.4 CARBON-CARBON CLOSEOUTS

The closeouts are machined from Carbon-Carbon provided by Allcomp. The inserts are provided and are installed by Plyform. The inserts are bonded to the closeouts using one of the following tools as necessary: LAT-DS-00730 or LAT-DS-00779.

10.4.1 Inserts machining

The inserts shall be in conformity with the drawings: LAT-DS-00094, lAT-DS-00592, LAT-DS-00718, and LAT-DS-00801. The inserts shall meet the fasteners integrity requirements in compliance with 541-PG-8072.1.2 "Goddard Space Flight Center Fastener Integrity Requirements"

10.4.2 Closeout Machining

The closeout raw material machining shall be in conformity for material and tolerances with the following drawings:

LAT-DS-00092 (Mid/Heavy Tray MCM Closeout)

LAT-DS-00093 (Mid/Heavy Tray Structural Closeout)

10.4.3 Insert bonding

The inserts will be bonded into the closeouts by means of dedicated tooling in conformity with the following drawing: LAT-DS-00730 (assembly tool of the inserts for the MID/HEAVY trays)

The surface of the inserts shall be cleaned and sanded following the internal procedure I.L.02-117. The adhesive, Hysol EA-934NA, shall be cured in agreement with the data sheets and following the internal procedure I.L.02-117 and.I.L.02-118 of the vendor.

10.4.4 Inserts bonding test coupon

A coupon that will be tested per ASTM 100299 will accompany each closeout bonding lot. The coupons will be stored by the supplier until the completion of the work and then sent to SLAC.

10.4.5 Final Acceptance of the closeouts

Each closeout will be dimensionally tested to verify its conformity to the drawings. An identifying serial number will be placed on the inside surface of each closeout. The traveler of each closeout will register the closeout serial number, the final dimensional measurement data, the ID number of the raw bar of material used, and the assembly tool ID number. These data and the results of the dimensional tests will be recorded in the INFN database.

The data to be recorded are:

1. Closeout and assembly tool identification
2. Dimensional acceptance test data prior to insert bonding
3. Final Closeout mass

10.4.6 Closeout identification

On each closeout will be taped on an identifying label attached as referenced in figures 3 and 4. The labels will be removed before the tray is painted (see par. 11.3)

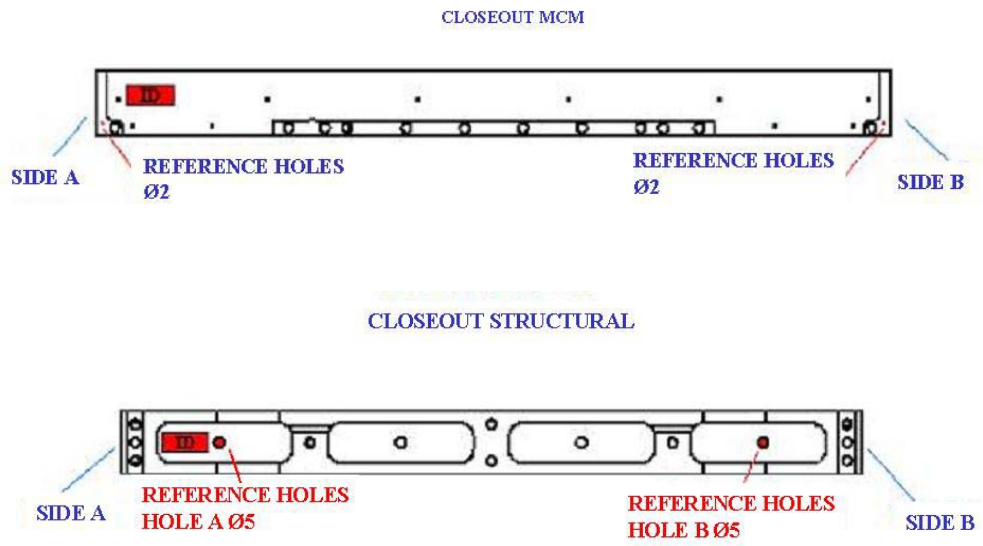

FIGURE 3. Identifying label placement

Closeout MCM

MCM	**Number**	***S***
LAT-DS-00092-rel		

Closeout Structural

STR	**Number**	***S***
LAT-DS-00093-rel		

FIGURE 4. Closeout identifying label; S identify the standard closeouts from top and bottom closeouts. "Rel" is the release number of the drawing.

10.4.7 Closeout measurements

The measurement points shall be taken with a CMM and the results shall be registered in the database. The measurements are described in Figure 5 and 6 and are listed in Table 3.

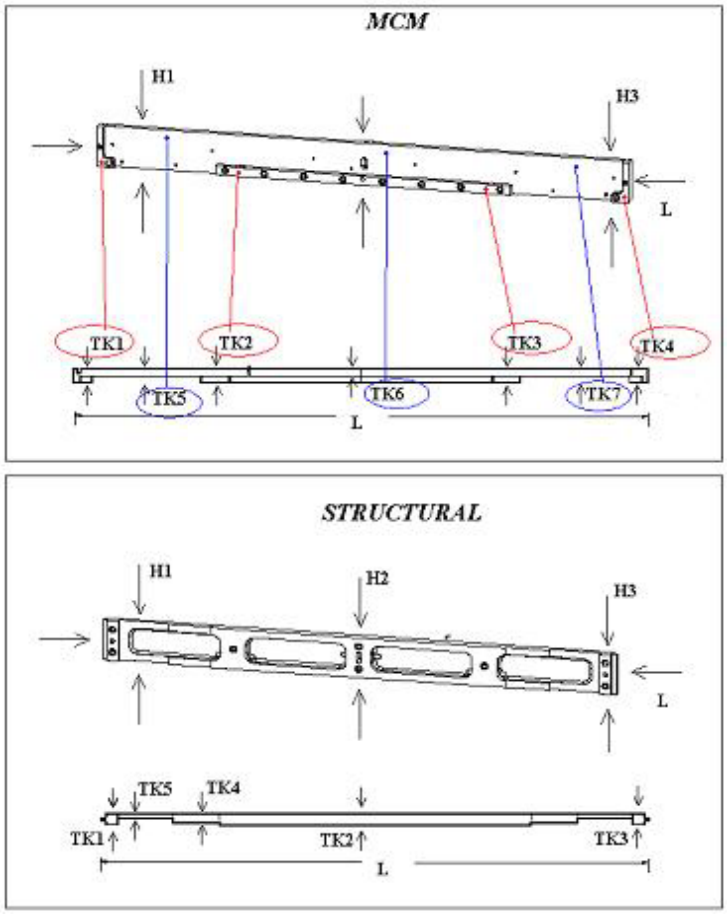

FIGURE 5. Measurement points on the Carbon-Carbon closeouts

ID	H1	H2	H3	L1	L2	L3	TK1	TK2	TK3	TK4	TK5	TK6	TK7

TABLE 3. Example of data table for measurements taken in Figure 5

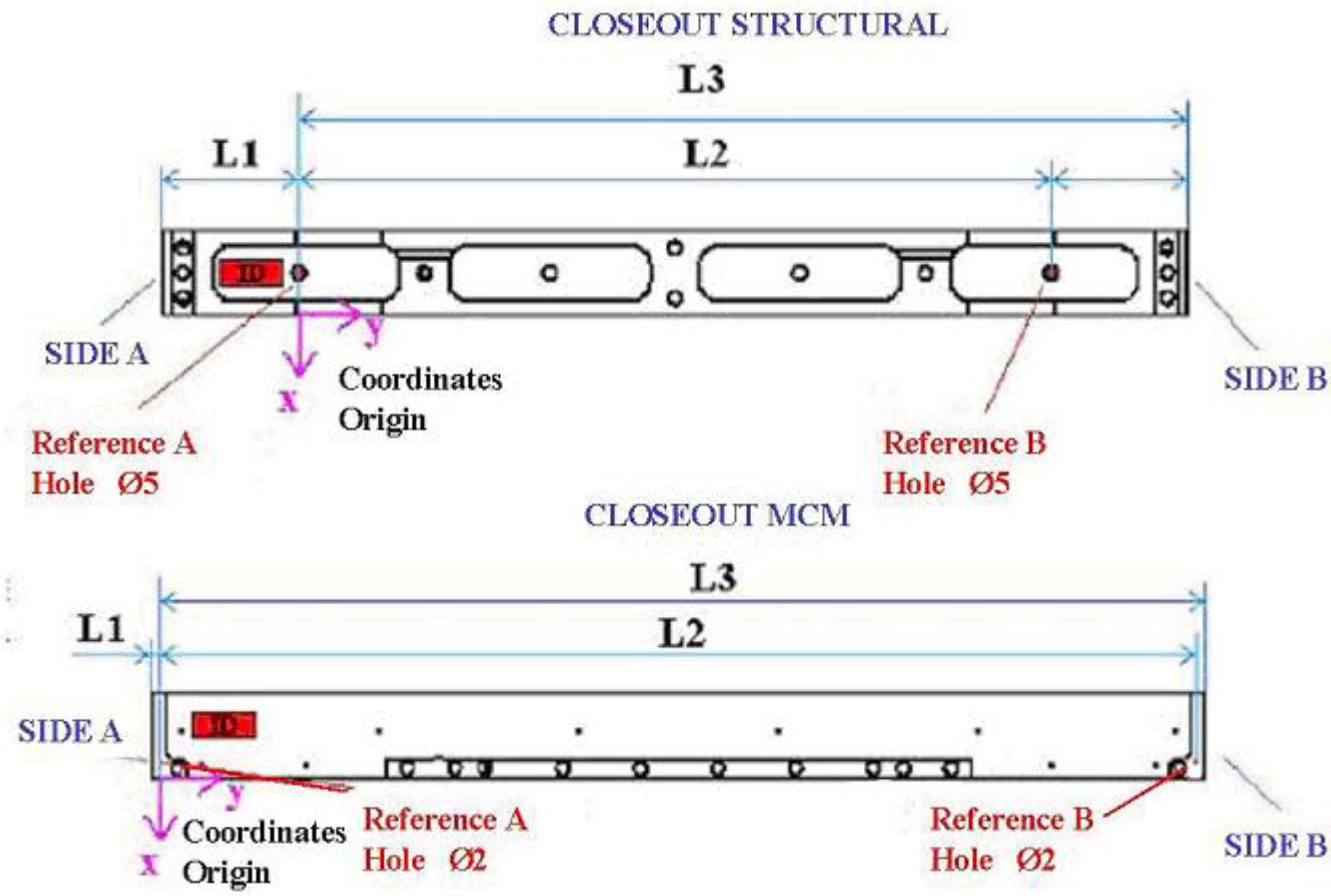

FIGURE 6. Measurement origins and definitions

10.4.8 Measurements of insert placement.

Figure 7 describes the measurements that shall be taken after the insert bonding. Table 4 lists the data to be recorded in the database.

ID	Insert assembly tool number		Check measurements System origin in C hole		
	Toll ID	Row number	A hole position	B hole position	D hole position

TABLE 4. Example of database for Figure 7.

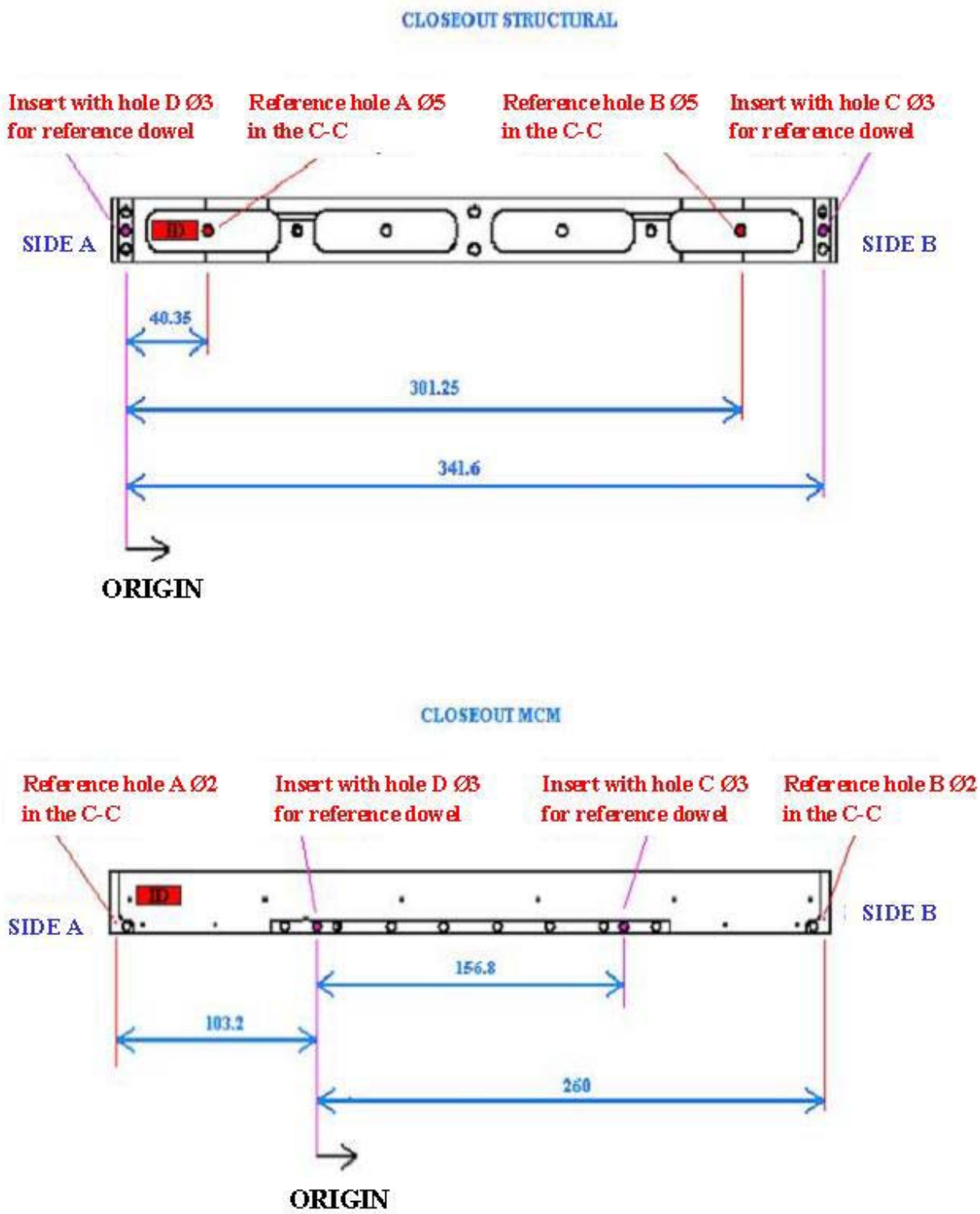

FIGURE 7. Definitions of the origin and of the point to be measured after insert bonding.

10.4.9 Inner closeout face coating

The inner side of the closeout shall be primed with Aeroglaze9953 and Aeroglaze9929 and painted with Aeroglaze Z306 paint to prevent carbon dust release.. The carbon dust release will be checked with a Texwipe tissue. The paint shall be applied after masking the inserts and the areas where the conductive glue will be applied to ground the honeycomb and at the extremities of the MCM closeouts where the structural adhesive is applied. (see figure 9) [22,23].

10.5 ASSEMBLY OF THE HONEYCOMB CORE TO THE FACE SHEETS

The tools to assemble the face sheets with the honeycomb core are described in the drawings:

LAT-DS-00745 (MID and LIGHT trays)

LAT-DS-00746 (HEAVY tray)

The lower face sheet is positioned on the base plate of the tool and is fixed by means of the 4 walls. The fixation walls have a profile to keep in place the face sheets borders. A foil of Redux 312UL adhesive is deposited on the face sheet. The honeycomb core is placed in between the walls that define its position. The upper face sheet is placed on the cover plate of the tool and is fixed with 4 bars. An adhesive layer is placed on the second face sheet. The cover plate is positioned over the honeycomb guided by the 4 dowels at the corners. The glue is cured in agreement with the adhesive data sheets and following the internal procedure I.L.02-118 of the vendor.

10.5.1 Sandwich gluing test

The face sheets shall be uniformly bonded to the honeycomb core. A coupon per ASTM 100299 will accompany each lot of tray sandwiches. The coupons will be stored by the supplier until the completion of the work and then delivered to SLAC.

10.6 ASSEMBLY OF THE CLOSEOUTS TO THE SANDWICH

The tools to assemble the closeouts to the sandwich are described in the drawings:

LAT-DS-00745 (MID Tray)

LAT-DS-00746 (HEAVY Tray)

The walls and bars to fix the face sheets are removed. The closeouts are mounted onto 4 reference walls by means of dowels and screws. The conductive adhesive Nusil CV2646 is deposited on the cylinders for honeycomb grounding and on the relative surfaces of the closeouts and honeycomb. The cylinders are put in place against the honeycomb (see fig. 7 and 8). The adhesive, Hysol EA 934NA is uniformly deposited on the closeout edges and on the face sheets in the bonding areas. The 4 closeouts are put in place using reference surfaces and hole-dowel couplings.

The adhesive is cured in agreement with the adhesive data sheets and following the internal procedure I.L.02-118 of the vendor.

The bare tray so obtained shall be in conformity with the following drawings:

LAT-DS-00148 (MID and No Converter Trays)

LAT-DS-00647 (HEAVY Trays)

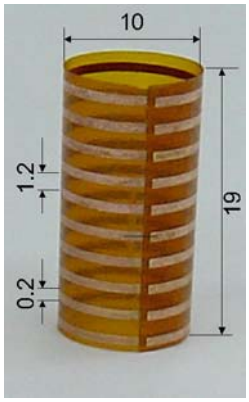

FIGURE 8. The kapton cylinder [23] used to electrically connect the honeycomb (units mm). The kapton is 50μm thick, the lines are Cu(35μm)+Ni(4μm)+Au. The joint adhesive is 3M 2216

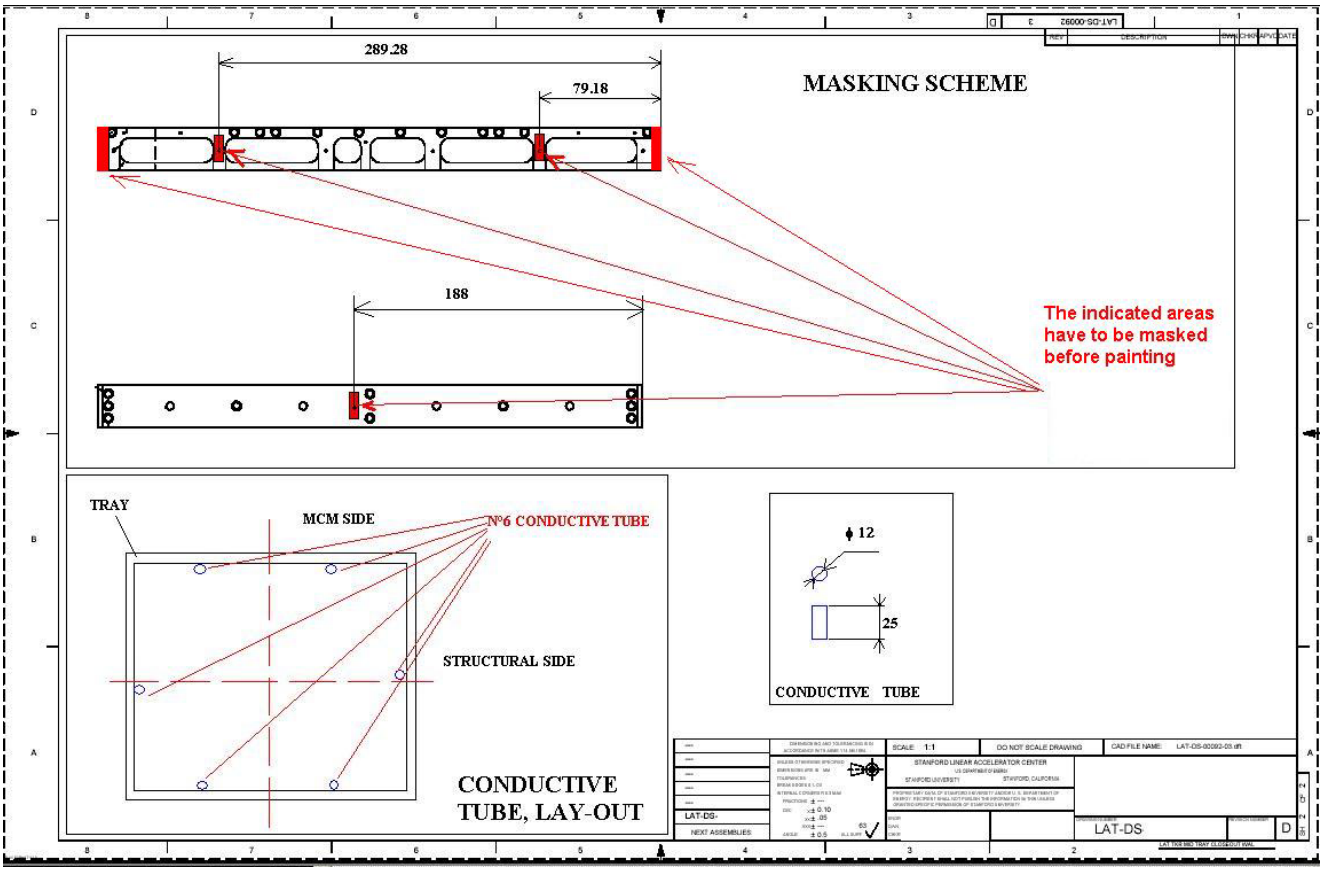

FIGURE 9. Assembly scheme of the grounding cylinders.

10.6.1 Closeout assembly test

A coupon per ASTM 100299 will accompany each tray lot. The coupons will be stored by the supplier until the completion of the work then delivered to SLAC.

A visual inspection shall verify the continuity of the adhesive overflow along the bond lines.

An ESPI test (LAT-PS-01918) with thermal charge will detect the bonding defects (ply to ply, face sheets to honeycomb, face sheets to closeouts). Trays with bonding defects too large will be rejected, as specified in LAT-PS-01918.

A dynamic ESPI test will measure the main resonance frequencies over the 20-2000 Hz range. A difference of the main frequency from the nominal values by too much, as specified in LAT-PS-01918, will be considered to be a structural problem. This nonconformity will cause the rejection of the tray.

10.6.2 Electrical continuity test.

The electrical continuity of the tray will be tested. All the closeouts shall show a <1Ω resistance towards the honeycomb, contacting the closeouts surface and the honeycomb through the venting holes.

10.6.3 Dimensional checks on the bare tray

On each tray the following measurements will be performed to guarantee the conformity of the trays to the relative drawings:

1. Weight, which shall be in the range specified in table 5
2. Measurements of the tray outer dimensions
3. Measurements of the tray tolerances

Tray type	Weight Kg	Tolerance Kg
MID – LIGHT	0.495	±0.02
HEAVY	0.623	±0.02

TABLE 5. Weight of the bare trays

10.6.4 Measurements of the tray outside dimensions

The tray is positioned on the CMM plane using 3 supporting points. At least 12 points are measured on the face sheet surface and 8 on each closeout wall. The outside dimensions of the trays are listed in Table 6 and are described in Figure 11.

Tray ID	L1	L2	L3	L4	LM1	LM2	LM3	LM4

TABLE 6. Example of database for outer tray dimensions

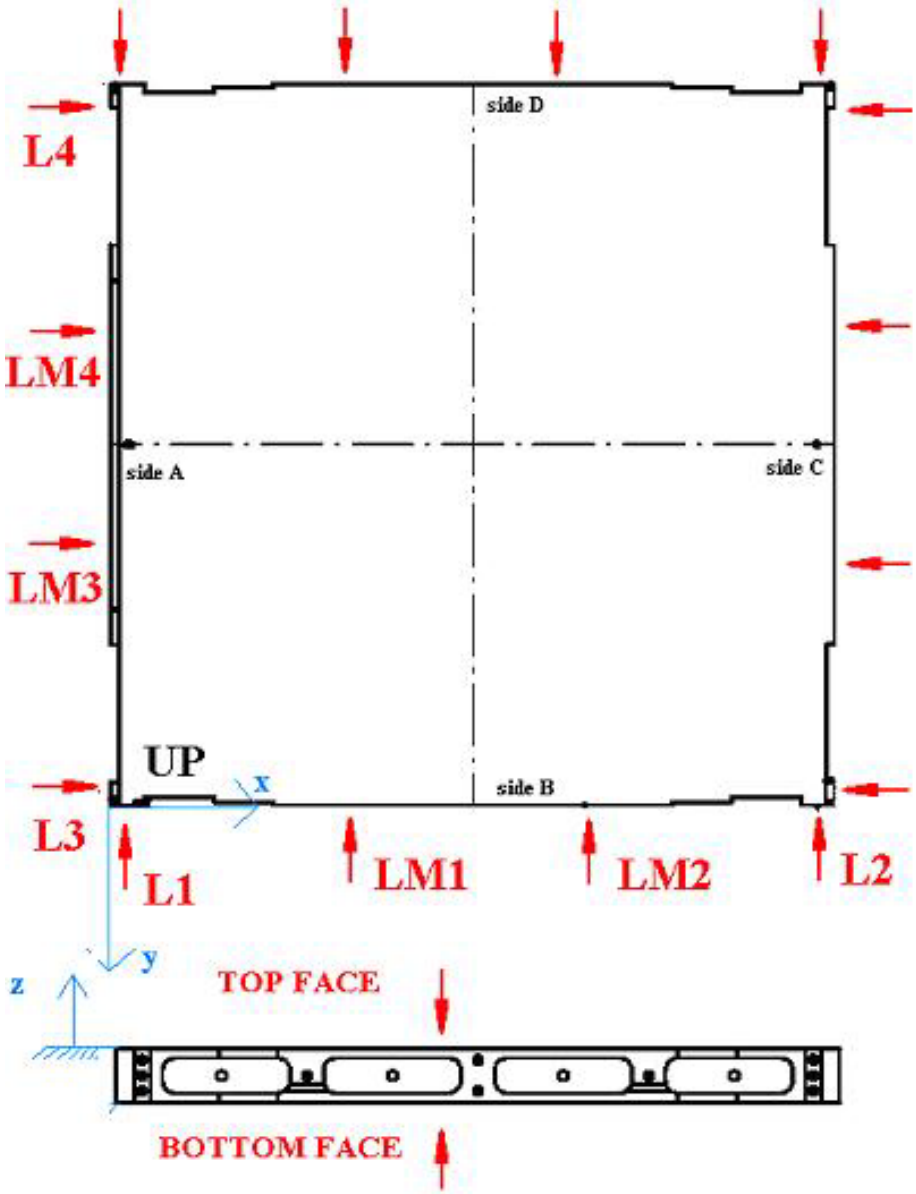

FIGURE 11. Location points of the CMM measurements

10.6.5 Bare tray tolerances.

The measurements described in the previous paragraph shall be used to define the tray tolerances (planarity, parallelism, orthogonality of the trays surfaces). The geometrical tolerances are described in Table 7.

TRAY GEOMETRICAL TOLERANCES		
TOP FACE	TOP FACE	⏥
BOTTOM FACE	BOTTOM FACE	⏥
SIDE A		⏥
SIDE A	MCM surface	⏥
SIDE B		⏥
SIDE C		⏥
SIDE C	MCM surface	⏥
SIDE D		⏥
TOP FACE	SIDE A	⊥
TOP FACE	SIDE B	⊥
TOP FACE	SIDE C	⊥
TOP FACE	SIDE D	⊥
BOTTOM FACE	SIDE A	⊥
BOTTOM FACE	SIDE B	⊥
BOTTOM FACE	SIDE C	⊥
BOTTOM FACE	SIDE D	⊥
SIDE B	SIDE A	⊥
SIDE B	SIDE C	⊥
SIDE D	SIDE A	⊥
SIDE D	SIDE C	⊥
SIDE B	SIDE D	//
SIDE A	SIDE C	//
TOP FACE	BOTTOM FACE	//

Table 7. Geometrical tolerances database

11. ESPI TEST

Each tray is sealed with desiccant bags in a polyethylene envelope and packed in a container safe for shipping. The trays are sent to INFN Pisa where the ESPI test is performed according to the procedure LAT-DS-01918. The trays that pass the incoming INFN inspection and the ESPI test are then sent back in the same packages to Plyform, where an incoming inspection is performed to check for possible damage of the trays and of the container itself before completion of the assembly.

12. PAYLOAD ASSEMBLY

12.1 ASSEMBLY OF THE TUNGSTEN PLATES

The tungsten plates are as for drawings LAT_DS_0749 (3%Xo plates) and LAT_DS_0750 (18%Xo plates). The plates shall be prepared as for INFN_LAT_MECH_010 procedure. The weight of the 16 plates will be registered in the database.

The tools used to bond the tungsten plates on the lower face of the trays are described in the drawings:

- LAT-DS-00749 (assembly tool of the 3%Xo Tungsten plates)
- LAT-DS-00750 (assembly tool of the 18%Xo Tungsten plates)

The Tungsten plates are glued over the bottom face of the trays following the procedure INFN_LAT_MECH_006. The 3M2216 adhesive is prepared per INFN_LAT_MECH_009.

12.1.1 Tungsten gluing test

An adhesive sample for verification of adhesive cure for ASTM D2240-91 will accompany each lot of tungsten plates assembled. The coupons will be stored by the supplier until the completion of the work and then delivered to SLAC.

12.1.2 Mandatory inspection point

The INFN QA shall check the status of samples of the tungsten tiles before bonding.

12.2 ASSEMBLY OF THE KAPTON BIAS CIRCUITS

The Kapton bias circuits LAT_DS_00751 will be prepared as for INFN_LAT_MECH_008

The tools used to bond the Kapton bias circuits on the faces of the trays are described in the following drawings:

LAT-DS-00751 (tool to assemble the Kapton foils on the MID/LIGHT/HEAVY trays)

The tools have 2 vacuum plates with reference holes to position the Kapton foils. The holes are placed so that the Kapton foils will be mounted in the right direction. 10 grams of adhesive, 3M Scotchweld 2216, are rolled over each Kapton foil. The adhesive is prepared per INFN_LAT_MECH_009. The same quantity is rolled over each face of the tray. A sandwich is formed with the first vacuum chuck as base, the tray in the middle and the second vacuum plate as cover. The tray is positioned by means of a steel reference wall. The upper vacuum plate has holes in correspondence with 4 dowels on the base vacuum plate. The adhesive is cured at in a vacuum bag at 35°C for 18h min.

12.2.1 Kapton adhesive test

An adhesive sample for verification of adhesive cure for ASTM D2240-91 will accompany each lot of tungsten plates assembled. The coupons will be stored by the supplier until the completion of the work and then delivered to SLAC..

12.2.2 Mandatory inspection point

The INFN QA shall check the status of samples of the kapton bias circuits before bonding. The INFN QA on a regular basis shall check the adhesive status and the adhesive coupons

12.3 TRAY FINISHING

The edges of the trays are trimmed by means of a cutting machine with computerized control. The structural adhesive integrity shall be guaranteed using a set of plates that will hold the tray and help guide the trimming tool.

After the trimming, a protective tape is placed on the tray edge in correspondence to the bonding pads on the Kapton bias circuits. All the thread holes and the reference holes also are protected. The closeouts shall be primed with Aeroglaze9953 and Aeroglaze9929 and painted with Aeroglaze Z306 paint to prevent carbon dust release The area of Carbon-Carbon that remains uncovered near the MCM closeout edge will later be covered by the adhesive used to attach the MCM and by the encapsulation.

The tray in its final shape shall conform to one of the following assembly drawings, as appropriate:

LAT-DS-00148 (MID Tray)

LAT-DS-02923 (LIGHT Mid Tray No Converter)

LAT-DS-00647 (HEAVY Tray)

12.4 DIMENSIONAL TESTS ON THE FINISHED TRAY

Each tray shall be measured to guarantee its conformity to the relative drawings:

1. Weight of the tray
2. Measurements of the tray outer dimensions
3. Measurements of the tray tolerances
4. Measurement of the reference holes positions

The weight of each tray shall be in the range of ± 50 grams from the nominal value, taking into account the weight of the used parts (closeouts, Tungsten plates, Kapton foils).

The measurements 2) and 3) follow the same scheme as in paragraph 10.5.3 and 10.5.4.

12.4.1 Measurement of the reference hole positions

The positions of the reference holes are measured by laying the tray on 3 points and with the same reference system as for the outer dimension and tolerance measurements. Figure 12 defines the coordinates of the axis of the holes and the inter-axis lengths. Tables 8 and 9 are examples of the database used to record the position of the holes and the inter-axis lengths.

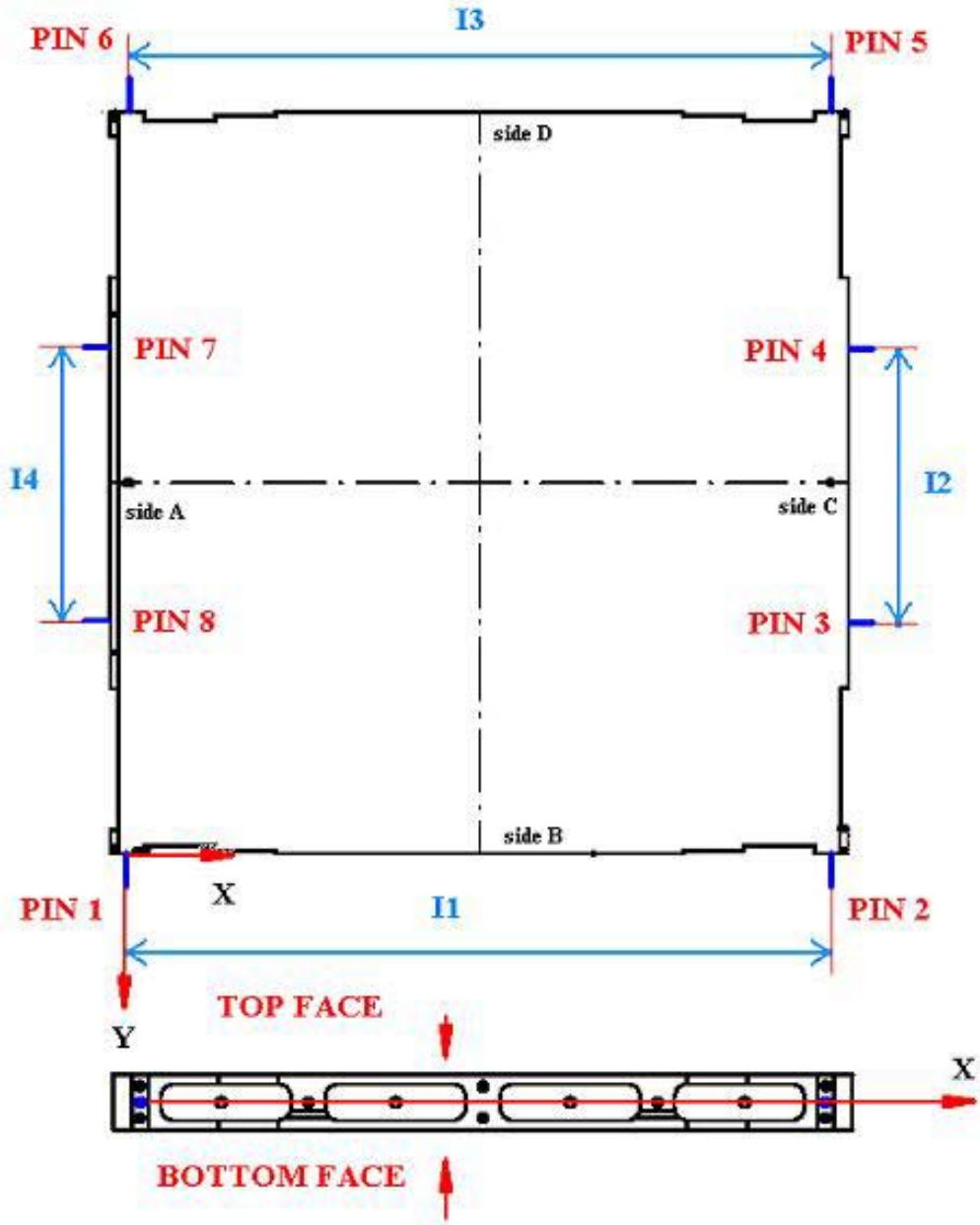

FIGURE 12. Reference pin location measurement

Pin Position						
	Y	X	Z	Rotond.	ϕ	ΔZ
PIN 1						
PIN 2						
PIN 3						
PIN 4						
PIN 5						
PIN 6						
PIN 7						
PIN 8						

TABLE 8. Example of database for pin location.

INTERAXIS	
I1 - I2	
I3 - I4	
I5 - I6	
I7 - I8	

TABLE 9. Example of the database for inter-axis length

13. TRAY RECEIVING-INSPECTION AND SHIPPING

An INFN representative shall perform at Plyform a receiving-inspection on each tray and its associated End-Item Data Package (EIDP) prior to packing and shipping. The inspector shall check over the relevant travellers, to verify that all processes were completed, and then check that all components of the EIDP are present. The required EIDP items are

1. A title page per lot shipped that identifies the trays to which the EIDP applies and provides space for the acceptance signature of the INFN representative.
2. A Plyform certificate stating the compliance of the trays to the product requirements.
3. Copies of all NCRs related that relate to the trays, if any.
4. The complete set of database entries for the trays (electronic).

The finished tray will be cleaned with clean-room tissues and isopropyl alcohol. The trays will then be sealed in polyethylene envelopes with desiccant bags and packed in boxes with foam to prevent damage and contamination.