Istituto Nazionale di Fisica Nucleare

INFN

## *NCR Number*

NCR/FM/INFN/RM2/2

| *Classification* | *Item name* | *Found on:* |
|---|---|---|
| major | MId Tray Assy | 6/24/2004 12:16:55 PM |

| | |
|---|---|
| ***Part number*** | LAT-DS-00180 (rev.3) |
| ***Serial number*** | 007,010,011,017 |
| ***Issued by*** | Mirco Bagni |
| ***Short NCR description*** | Bias circuits delaminations |
| ***Approved by*** | Alessandro Brez |
| ***Detected during*** | T. Vac test |
| ***Cause*** | other (see description) |
| ***NCR description*** | Bias circuits delamination found after the thermo-vacuum test. See Annex-1 |

***Action***

## *disposition*

***disposition*** ***ID:*** 1

After TVAC with new specs, as specified in NCR FM/INFN/RM2-1 Annex 2, some major discrepances have been detected on tray S/N 007,011,,017. Tray S/N 010 showed very small air bubbles after vacuum test, and the following thermal-vac cycle did not cause further discrepancies. Immediate MRB is done (Brez, Nanda Menon, Bagni) and in order to have more information about the cause evaluation, the following action have been detected:
A) repeat test in order to check stability of defects
B) To inform SLAC

***Finding***

A) Done. Two type of delamination were identified:
i) round-shaped, small bubbles (~1cm diameter), did not move after second test; these are due to air trapped in the glue and cause local debonding of the glue, that can be eliminated by cutting bubbles with a scalpel

| ***responsible*** | ***due date (mm/dd/yyyy)*** | ***closed*** |
|---|---|---|
| Alessandro Brez | 6/30/2004 | ☑ |

***disposition*** ***ID:*** 2

S/N 007,010,017 rework at INFN authorized by Plyform. Rework is cutting of small, round-shaped bubbles with scalpel

***Finding***

Done. See Annex-2

| ***responsible*** | ***due date (mm/dd/yyyy)*** | ***closed*** |
|---|---|---|
| Alessandro Brez | 6/30/2004 | ☑ |

**disposition** **ID:** 3

S/N 011 send at Plyform for rework on the Kapton, the following action have been detected:
A) to remove the old Kapton at 60℃
B) to increase rugosity on Tugsten
C) verify rework with standard flow of tests (ESPI, dimensional test, TVAC test)

**Finding**

| responsible | due date (mm/dd/yyyy) | closed |
|---|---|---|
| Alessandro Brez | 6/30/2004 | ☐ |

**disposition** **ID:** 4

Pereform ESPI test on tray S/N 007, 010, 017.

**Finding**

Done.
Results:
Mid 017 shows large debonded areas;
Mid 007 shows 4 small air bubbles;

| responsible | due date (mm/dd/yyyy) | closed |
|---|---|---|
| Alessandro Brez | 7/1/2004 | ☑ |

**disposition** **ID:** 5

1) Send Tray Mid 017 to Plyform to rework:
A) to remove the old Kapton at 60℃
B) to increase rugosity on Tugsten
C) verify rework with standard flow of tests (ESPI, dimensional test, TVAC test).

2) Mid 007 and 010 must be reworked by INFN Pisa after Plyform autorization. Rework is cutting of small, round-shaped bubbles with scalpel.
After the rework the tray can be sent to G&A to proceed with the workflow.

**Finding**

2) Done.

| responsible | due date (mm/dd/yyyy) | closed |
|---|---|---|
| Alessandro Brez | 7/2/2004 | ☐ |

| ***disposition*** | ***ID:*** | 6 |
|---|---|---|
| Proceed investigation on tungsten surface treatment as described in annex 5. | | |

***Finding***

Further investigations were performed as per annex 5. Other new investiagations are going on in Plyform on test coupons

| ***responsible*** | ***due date (mm/dd/yyyy)*** | ***closed*** |
|---|---|---|
| Aldo Troianiello | 7/15/2004 | ☐ |

## *MRB disposition*

| | |
|---|---|
| ***Approval date*** | |
| ***Signature*** | |
| ***Customer approval date*** | |
| ***NCR status*** | open |

## *Annex*

| ***annex N°*** | ***Identification*** |
|---|---|
| 1 | photos |

| ***annex N°*** | ***Identification*** |
|---|---|
| 2 | Plyform autorization for defect rework by INFN |

| ***annex N°*** | ***Identification*** |
|---|---|
| 3 | ESPI test results |

| ***annex N°*** | ***Identification*** |
|---|---|
| 4 | Plyform reply |

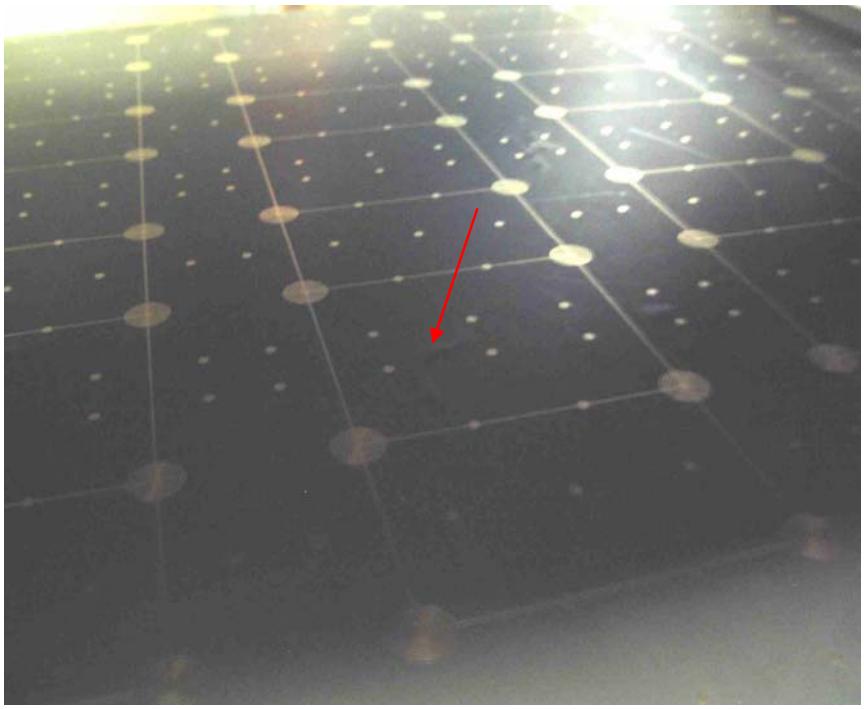
| ***annex N°*** | ***Identification*** |
|---|---|
| 5 | summary of performed investigations |

# ANNEX 1 to NCR/FM/INFN/RM2/002

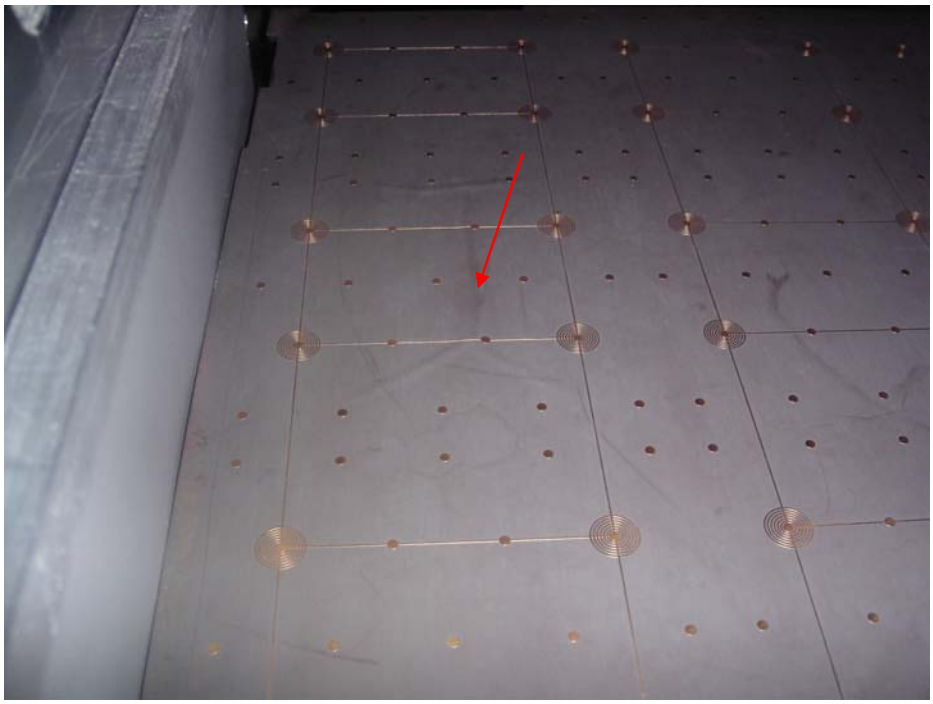
Thermo-vacuum test results

The following images shows the effect of the test on the trays Mid 007, Mid 011, Mid 017.

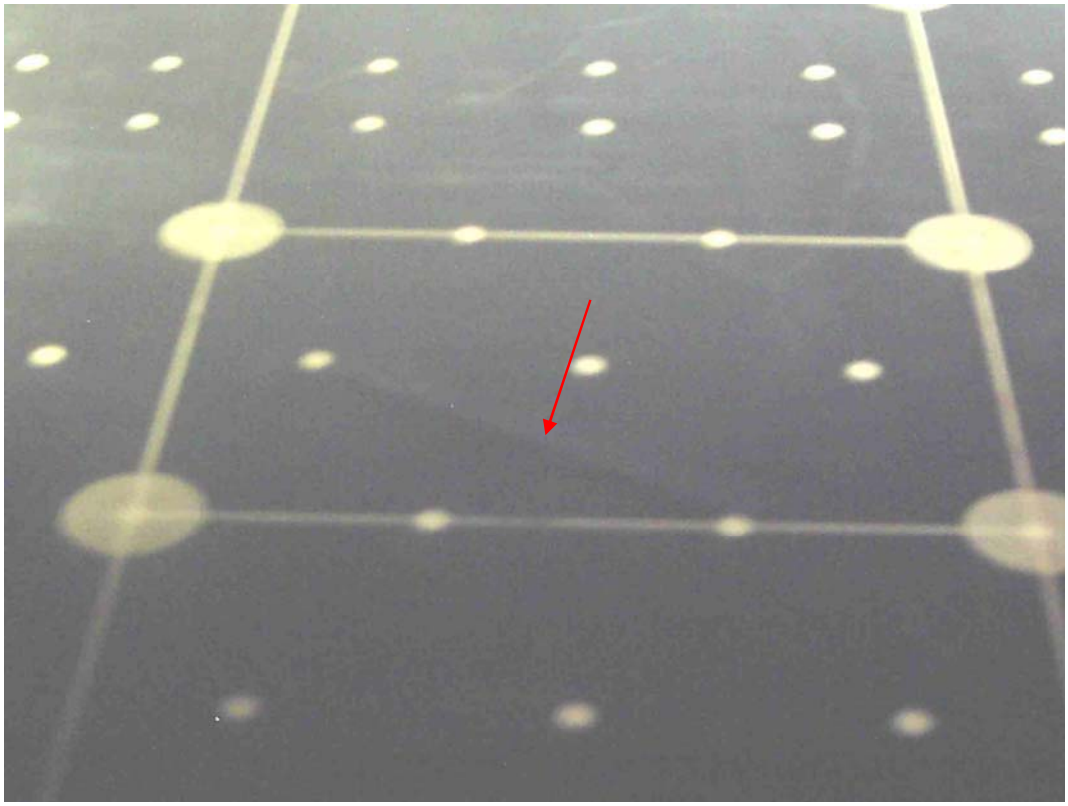
Tray Mid 007:



Tray Mid 011:



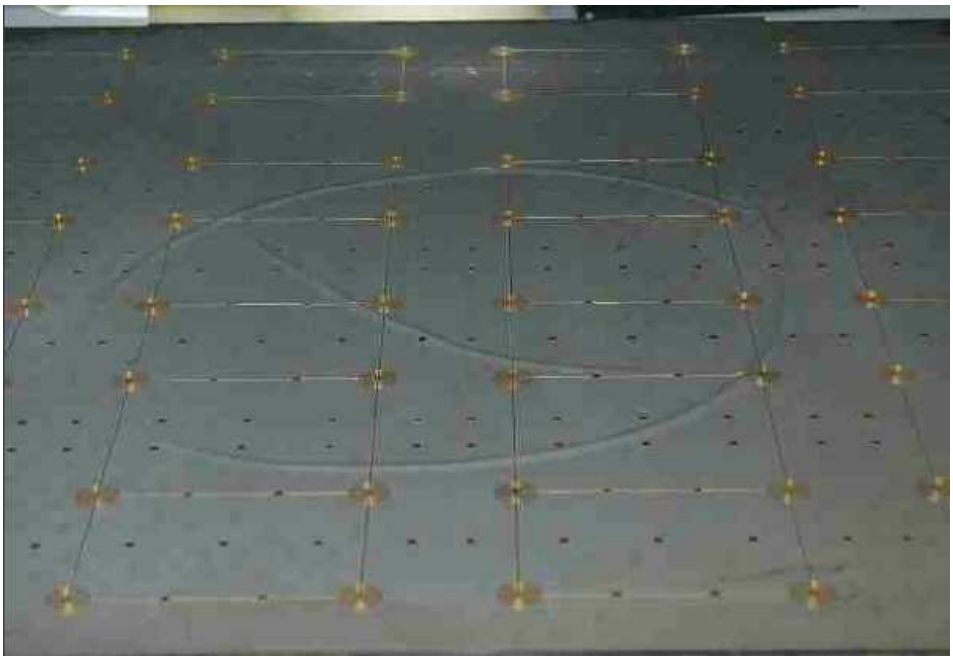
Tray Mid 017:



## <u>Annex 2</u> to NCR/FM/INFN/RM2/001

The Thermo Vacuum Test of the trays Mid006, Mid008, Mid015, failed. The bonding between the Bias Circuit Foils and the panels relaxed and the foils showed a large surface wrinkling (see picture 1, 2, 3, 4):

**Mid006 Bottom Surface**



**Mid008 Top Surface**

**Mid008 Bottom Surface**

**Mid008 Bottom Surface**

These large debonding areas seem induced by the CTE differences between Cu shield layer (CTE $=17*10^{-6}$ 1/°C) and the tray (CTE≈ 0). The Shear Stress overcame The shear strength of the adhesive with regular and uniform deformations.

The Glue used for this bonding is the **3M Scotch-Weld 2216**, the Bias Circuit is similar to the one used for the Top and the Bottom tray in the EM tower. The assembly procedure and tools are the same used for the EM Trays.

The EM Tower has been successfully tested in the following temperature range: **-30°C +50°C** .

The Inspections of the EM trays don't show any failure.

The Thermo Vacuum Procedure has a temperature range that exceeds the design test range for the LAT Tracker Specifications (min –30°C, max +50°C).

The Peak temperature of this test is 85 °C; the **3M Scotch-Weld 2216** epoxy glue data sheet shows a relevant decrease of the typical Shear Properties (see table below):

| Test Temperature | Overlap Shear (psi) |
|---|---|
| 24 °C | 3200 |
| 82°C | 400 |

We suggest to decrease the Peak temperature of the Thermo Vacuum test of the trays from 85°C to 55°C, 5°C Higher than the requested max temperature as for LAT-TD-03651.

To validate the test we plan to perform the following tests:

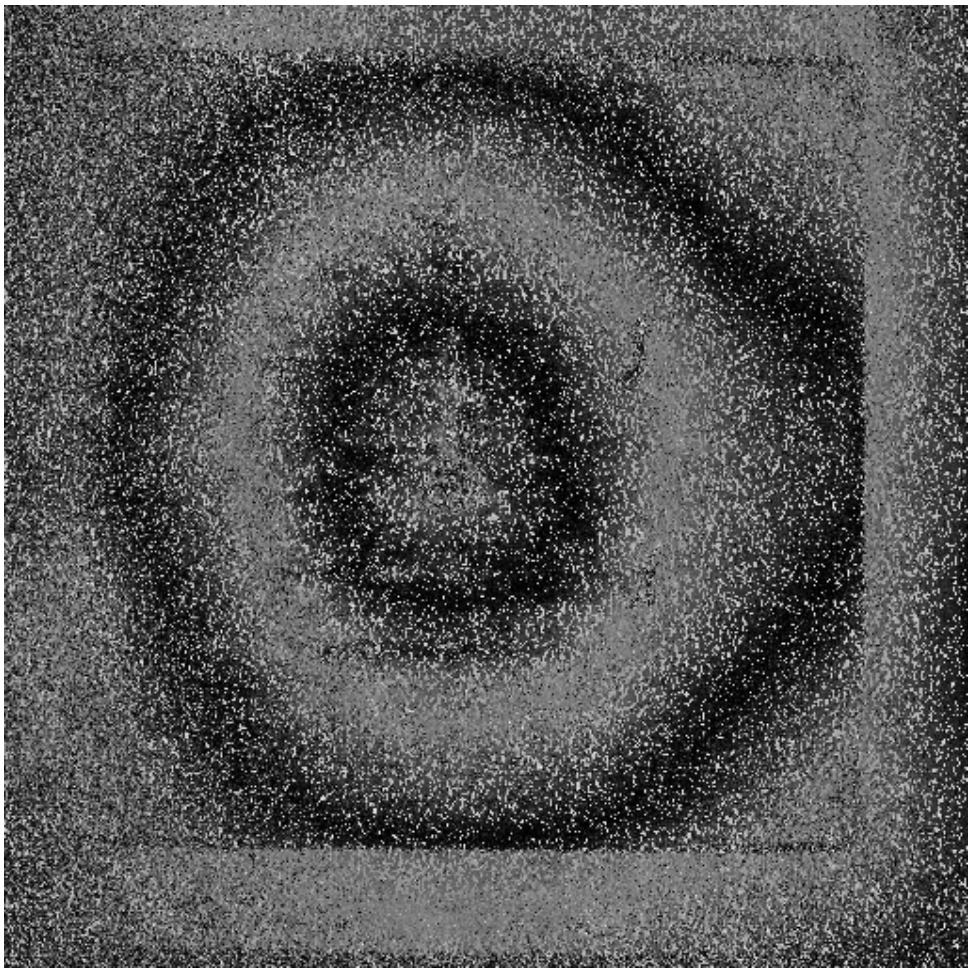
1) Vacuum test of 4 trays at room temperature
2) If no debonding will be observed, perform a Vacuum test @ 55°C for 4 hours

Due to the relevance of the peak temperature a revision of the Set-Up and Test Procedure will be done.

# Annex 3 to NCR/FM/INFNRM2/2
## ESPI TEST RESULTS

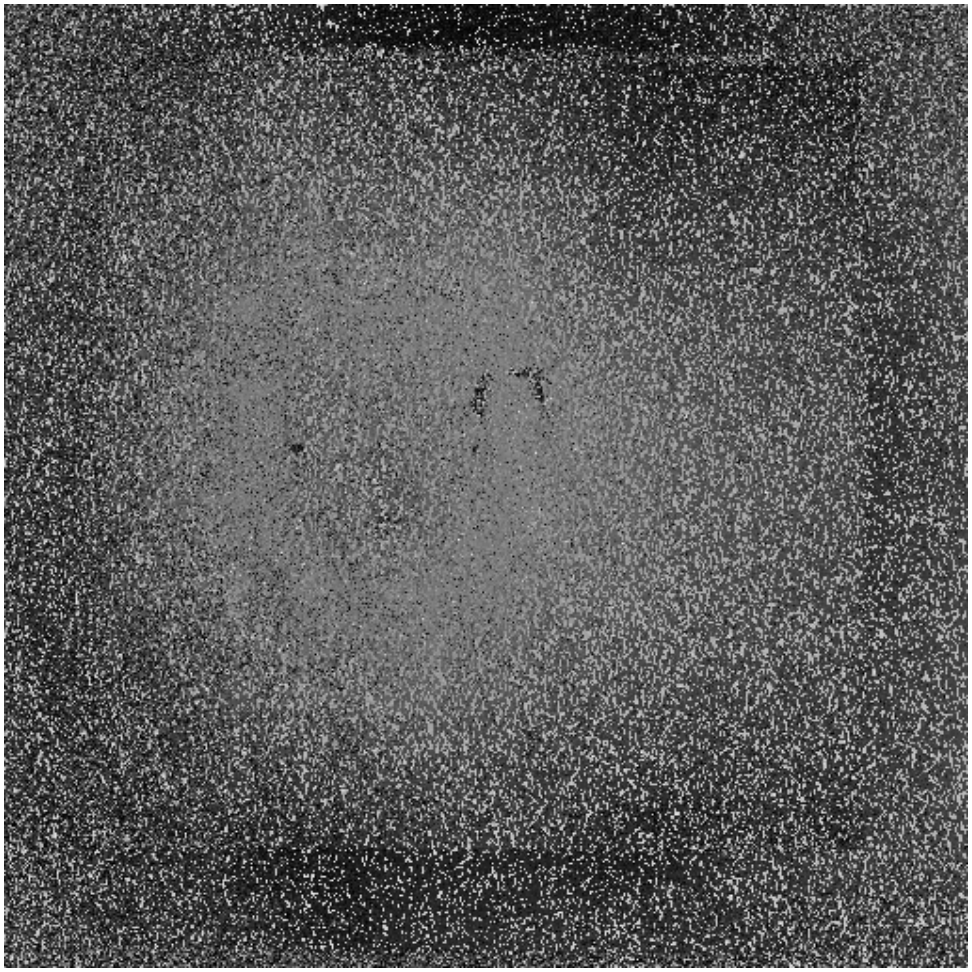
Those are results of the ESPI test performed on the Trays number Mid 007, Mid 010, Mid 017.

Mid 007:



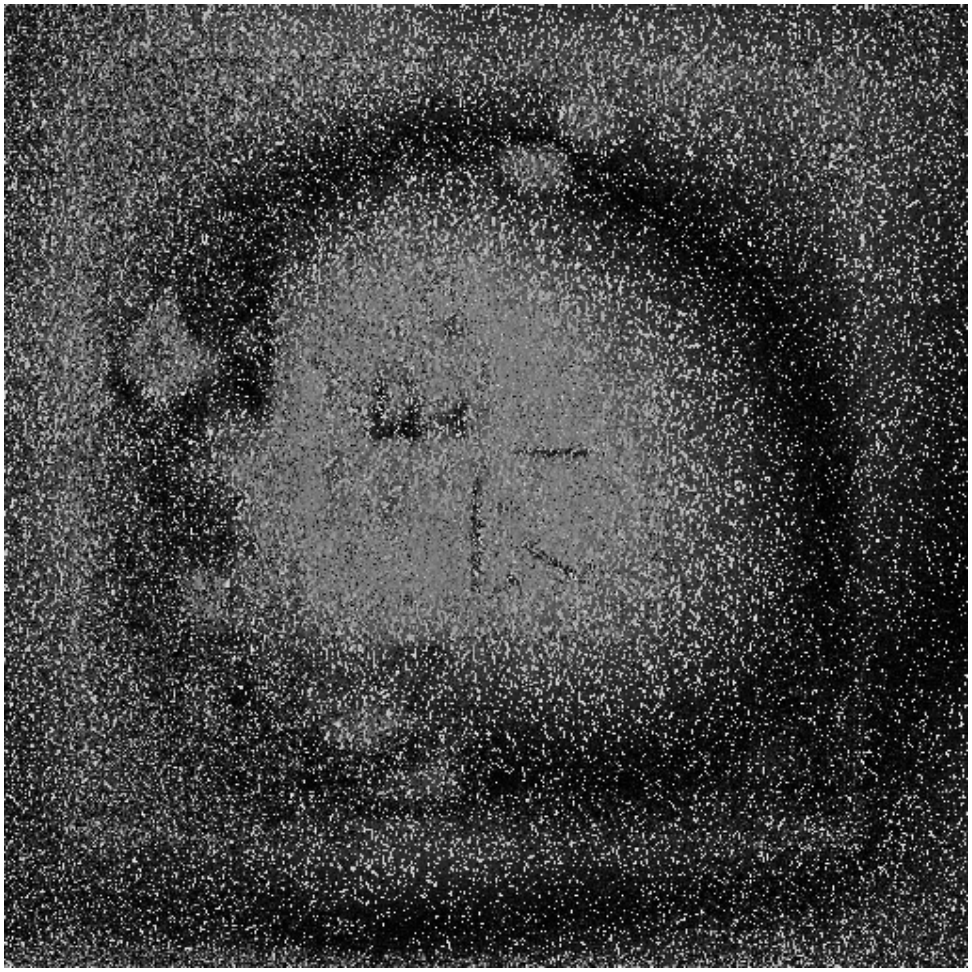
4 small debondin area bubbles

Mid 010



2 defects in the middle of the panel.

Mid 017



4 (or more) large area defects

# SEGNALAZIONE NON CONFORMITÀ

| ID cliente / fornitore | Anno | | Progressivo | | |
|---|---|---|---|---|---|
| INF | 0 | 4 | 0 | 7 | 0 |

| ☐ NC Interna | ☐ NC Fornitura | | ☒ NC Cliente | |
|---|---|---|---|---|
| Plyform/Fornitore/Cliente | Imputazione | | Causale NC | |
| *INFN (Pisa)* | ☐ 01 Laminazione | ☐ 06 Decapaggio | ☐ Materiale | ☐ Attrezzature |
| Denominazione: *Mid Tray Comps. P.A.* | ☐ 02 Polimerizzazione | ☐ 07 Modelleria | ☐ Operatore | ☐ Ciclo di lavoro |
| Part Number: *LAT-DS-00180 (Rev.3)* | ☒ 03 Finitura | ☐ 08 Magazzino | ☒ Processo | ☐ Altra documentazione |
| Quantità Lotto: 4 | ☐ 04 Verniciatura | ☐ 09 Laboratorio | ☐ Impianti | ☐ Movimentazione |
| Quantità NC: 4 ***S/N 007-010-011-017*** | ☐ 05 Termoformatura | ☐ 10 Controllo Qualità | ☐ Altro: ……. | |
| Doc. di Rifer.: *NCR/../RM2/1* | ☐ 11 Fornitore: | ☐ 12 Altro: Cliente | | |

| Descrizione Non Conformità | Codice NC | *0* | *3* | *J* | Ripetitiva ☒ SI ☐ NO |
|---|---|---|---|---|---|

*Il circuito(Foglio in kapton) risulta distaccato dal pannello.*
*S/N 007-010- zone limitate @ 1 cm*
*S/N 011-017 zone estese*

Data: *29.06.04* Firma: M.Rinaldi

Analisi causa NC:

*Scarsa aderenza tra piastre di tungsteno e foglio di kapton.*

*Note:*

*a) Si evidenzia che la Plyform non ha cambiato nessun parametro di processo e che le piastre di tungsteno vengono carteggiate fino ad ottenere una rugosità Ra 0,45 mm, come evidenziano i Vs. test, pari alla Vs. sabbiatura leggera;*
*b) L'unico parametro cambiato rispetto al "Engeneering Model" è il fornitore del foglio di kapton, fornito a Plyform in c/l;*
*c) I pannelli S/N 007 – 010 saranno riparati in INFN su delega di Plyform;*
*d) I pannelli S/N 011 - 017 saranno rilavorato in Plyform*

Operatore esecutore: *R. Ceratti* Data: *29.06.04* Firma responsabile area: L. Vigiani

## DISPOSIZIONI

| ☐ PLYFORM | | | ☒ CLIENTE | |
|---|---|---|---|---|
| ☐ DECL | ☐ SCA | ☒ RIL N° PLYFORM CLIENTE | ☐ RIP CONC. N | ☐ ACC CONC. N° |

| RICHIESTA AC: ☐ NO ☐ SI N° RAC: // | DATA: // | FIRMA: // |
|---|---|---|

Mod. 0007-0

# Annex 5 to NCR/FM/INFN/RM2/002

Summary of performed investigations

23 June

The four trays were subjected to TV tests at +55 °C chamber temperature. There is ~5°C difference between the chamber temperature and the tray panel.

24 June
Bumps in the trays were observed on two of the four trays.

It was decided between INFN/SLAC to perform another TV cycle exactly the same as the first one to see the if continued exposure would cause the propagation of the defect.

25 June
The same two trays presented the defects however on one of them the original defect had disappeared and a new defect was noticed. These have been documented in detail.

It was decided (INFN/SLAC/NASA) to take the trays back to Pisa and perform further experiment on the Tungsten surface treatment prior to gluing of the Kapton.

The 3 initial trays were also transported to Pisa for investigations into the possibility of recovering the bare panels by stripping the Kapton.

29 June
Samples of the Tungsten were taken by INFN to a surface treatment company in Bologna for Aluminum oxide surface blasting. The blasting operation was performed for 4 different surface abrasion depths to a maximum of 1 micron. The samples were taken to Plyform to test the properties of the gluing of the kapton to these samples and to perform Lap-Shear tests of the sample.

Post Abrasion Tungsten Surface Treatment.

There has been various suggestions of the required surface cleaning & treatment of the Tungsten tiles after the abrasion. The final definition of this is awaiting the results of the Plyform tests.

Visual inspection of the surfaces after the treatment was exceptionally good and the surface was found to be contaminant free under microscopic inspection (was there any cleaning performed?)

The possibility of Tile surface oxidation is also under discussion and it is not clear at this time if there is any limitations that would require primer (BR127 type) treatment of the surface. The surface treatment company has agreed to deliver the treated tiles in separate plastic bags with a Nitrogen purge. If there is an exposure time related problem then the surface will have to be treated due to the fact that the tiles are glued on to the bare tray and allowed to cure for ~24 hours before the Kapton is glued on.

If the tests at Plyform are successful then the plan is to have all the tiles (surfaces) treated with the Aluminum oxide blasting in a single epoch and taken to Plyform for integration into the trays. There has been no discussion of any alternate causes for the observed defects as of this date.

Plyform has been instructed to stop the gluing of the Tungsten on to the bare trays till this issue has been resolved.

The test results from Plyform will be available on Friday 2 July.

All the trays including the ones already assembled will be TV cycled at +55°C as a screening process per the original baseline.

Status as of 12 July 2004

The test results from Plyform were not complete in that the test samples broke before reliable data could be taken. However inspection of the samples showed that the epoxy between the tungsten and the kapton was very uniform for the samples that had the Al2O3 blasting compared to those samples with the manual sand paper.

INFN has taken another 16 tiles to NORBLAST for 1 micron depth Al2O3 blasting and delivered them to Plyform for the build-up of a complete tray. This tray will be subjected to a TV test at the INFN Rome chamber for further validation of the problem hypothesis and the solution.

Plyform has performed a peel test on 5 samples that were sanded manually and the peel strength was found to be 1.7Nmm mean. There is no real comparison to the Al2O3 blasted tiles as the samples were damaged during test. Plyform is doing further tests of the peel strength for the 1 micron depth Al2O3 blasted tiles.

The schedule for the above 2 tests have not been defined as of now.