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Document Title **Electronic Speckle Pattern Interferometry test operative procedure**		

Gamma-ray Large Area Space Telescope (GLAST)
Large Area Telescope (LAT)
Tracker Subsystem

ESPI TEST OPERATIVE PROCEDURE

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Change History Log

Revision	Effective Date	Description of Changes
1	05/13/04	Initial Release
2	06/25/04	Neither CI nor ODP to be insert in the database

MID TRAY, HEAVY TRAY, LIGHT TRAY

I) Pre-ESPI Test Inspection (WS1)

1) Click on Pre-ESPI Test Inspection key in the DB_ESPI Main Form.
2) Insert Tray Serial Number (S/N) in the Tray ID field in the Pre-ESPI Test Inspection form.
3) Insert Tray Type (M: Mid, H: Heavy, T: Top, B: Bottom, L: Light).
4) Weigh the Tray.
5) Insert Tray mass (g) in the field.
6) Perform the Tray Visual Inspection.
   - verify that there are no visible damages
   - verify the rightness of the position of the closeouts and define the back and front of the tray: watching the tray in front of the MCM you should see the thermal boss down and the slits on the structural closeouts down, the MCM closeout on the other side of the tray should have the thermal boss up; in this position the face sheet up is the top of the tray and this is the front side for the ESPI test, the face sheet down is on the bottom of the tray and this is the back side for the ESPI test
   - verify that no pins or glue residual are in the threaded and reference holes
   - verify that the allowable depth of threaded pins is $d \geq 6.5$ (-0.0+0.1) mm
   - verify glue presence at the corner interstices between Structural Closeouts and MCM Closeouts
   - verify that no separation occurs between face sheet and closeouts
   - by knocking gently with the finger knuckle on the face sheets, assess if large areas of crashed cell are present depending on emitted sound
7) Insert flag: if the Tray Visual Inspection is ok choose the green flag, if not, use the red flag and generate an NCR.
8) Perform the ground test
   - verify the probe to probe resistance of the multimeter
   - insert one of the two multimeter probe in the MCM supporting hole on the MCM closeout and the other multimeter probe in the venting hole on the Structural Closeout closest to the MCM supporting hole
   - measure of the resistance taking into account the probe to probe resistance

- repeat the previous two operation for the other MCM and STRL closeout
- if the two measurement values are less than 1.00 Ω insert *ok* in the grounding test field, else insert *failure* and generate an NCR.

9) Insert Sign (signature).

10) Insert date clicking on the arrow.

11) Close form clicking on the Close Form key.

II) Perform the tests

1) Click on Test data (WS2 to WS7) key in the DB_ESPI Main Form.

2) Insert Tray ID (S/N) and tray type in the form.

3) Install the two angular frame on the optical table, distance between two vertical border has to be 500 mm, free area between angular frames centered respect to the photo camera and position respect the shorter side of the optical table in function of which test has to be performed: Front or Back

NB: it is possible to decide whether to perform first the Front Test or the Back Test, the indication to follow is to perform first the ESPI Dynamic Test and after the ESPI Static Test; so the position of the two angular frame in respect to the table border will be based on the decision of which test has to be performed first

- torque the M5 fasteners to 3.6 Nm
- torque the M6 fasteners to 6 Nm

4) Tray Mounting (WS2)

- put the ESPI plate frame on the table in such a way as to leave a piece of foam inside the square free area; the foam thickness has to be as high as to sustain the tray and allows the screwing of the pin
- wear gloves and hold the tray
- place the Tray on the foam
- remove gloves
- locate the 2 L-shaped blocks (Structural Closeouts supports) near the Structural Closeouts
- insert threaded M2.5 pins into the four supports proceeding from the four corner to the centre to hold the Structural Closeouts
- finger tight the pins before final torque is applied
- locate the 2 L-shaped blocks (MCM Closeouts supports) near the MCM Closeouts without letting them touch the face sheets

- insert threaded M2.5 pins into the four supports proceeding from the corner to the centre to hold the MCM Closeouts
- install M8 screws to fix the four closeouts supports on plate frame, finger tight
- remove labels from the face sheet and put them on the closeouts support
- torque M8 fasteners to 6 Nm, in a diagonal pattern as shown in figure 1

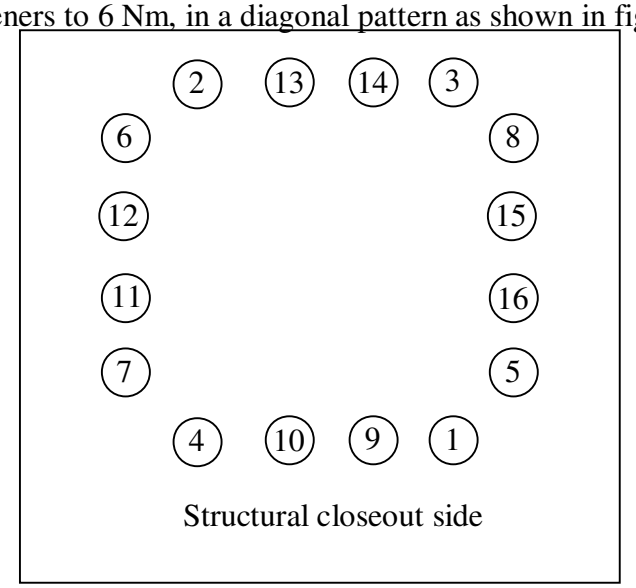

Figure 1

- clockwise, starting from one chosen point (this choice made to verify that no screws have been left unscrewed), torque once more M8 fasteners to 6 Nm
- following the same path used in installing them (i.e. from the corner to the centre and starting on the Structural Closeouts Supports), torque M 2.5 steel threaded pins to 0.4 Nm.
- clockwise, starting from one chosen point (this choice made to verify that no pins have been left unscrewed), torque M 2.5 steel threaded pins to 0.4 Nm, after the round is complete, if result necessary because of the relaxation of the threaded pin, repeat the round of torque once more

NB: do not forget to torque any of the threaded pins

- bring the assembly (tray, closeout supports and frame plate) to the frame already installed on the optical table, hold the assembly from the plate and not using closeouts support
- lean the assembly to the frame (holding it from the plate) and insert M5 screws
- finger tight the M5 screws before final torque is applied
- torque the M5 screws to 3.6 Nm

- the Tray now is mounted and the Tray Mounting (WS2) form has to be filled, insert Flag, Sign (signature) and Date in the database form, if necessary add Notes in the appropriate field.

5) Move the woofer in a centered position in respect to the Tray, near the optical table, put it in such a way that the woofer support does not touch the optical table (its distance from the table is around 5÷10 mm).

6) If unconnected, connect the woofer wires, following the colors: red pin to the connector marked with a red point, black pin to the other connector.

7) Dynamic Test (WS3 and WS5 as indicated in point [III-3)]).

8) Create new folder following the path D:\Database\Data

- for each test the folder name has to follow this indication:

$$\text{D:\Database\Data\}T\begin{Bmatrix}T\\M\\H\\L\\B\end{Bmatrix}XXX-\begin{Bmatrix}FR\\BK\end{Bmatrix}-\begin{Bmatrix}DYN\\STATIC\end{Bmatrix}-\begin{Bmatrix}MODE\ or\ DEF\\ /\qquad /\end{Bmatrix}$$

T: it is for Tray

$\begin{Bmatrix}T\\M\\H\\L\\B\end{Bmatrix}$: it depends from the Tray Type (T: Top, M: Mid, H: Heavy, L: Light, B: Bottom)

XXX: it is the Serial Number

$\begin{Bmatrix}FR\\BK\end{Bmatrix}$: it depends from the side of the tray which is analyzed (*FR*: front side, *BK*: back side)

$\begin{Bmatrix}DYN\\STATIC\end{Bmatrix}$: it depends from the type of test which is performed (*DYN*: dynamic, *STATIC*: static)

$\begin{Bmatrix}MODE\ or\ DEF\\ /\qquad /\end{Bmatrix}$: will be present only in case a Dynamic Test has to be performed. The folder named *MODE* will contain the picture of the first resonance mode, whereas the folder named *DEF* will contain the pictures of the defects resonance if found, if no defects will be found, the folder will be left empty and/or deleted.

9) Verify that the laser is off (switch (key) on the power supply on 0).

10) Verify that the energy switch on the wall is on, if not turn it on.
11) Turn the photo camera on, turning on the switch of the power supply (CL200BIOD).
12) Turn the PA400 amplifier on and set this values if they are not already the same:

MASTER VOLUME	TONE	PHONO/AUX	MIC2	MIC1
10	5^{th} dot starting from LOW	HIGH	4^{th} dot starting from MIN	3^{rd} dot starting from MIN

13) Write on the logbook Tray Type, S/N and prepare three columns to report frequency (Hz), number of fringes and amplitude (mVpp).
14) Turn the laser on by flipping the switch (key) on 1.
15) Turn off the neon room lights.
16) Start the ESPI on line.
17) Click on Modal Analysis.
18) Turn the Agilent 33220A Waveform Generator on (click the key ⏻).
19) Set the Sine Waveform (if not already set) clicking on *sine* key.
20) Set the initial frequency at 600 Hz (to set the frequency use the Menu Operation Softkeys to highlight the frequency field, the keys below the knob to move the cursor left or right and rotate the knob to change a digit (clockwise to increase), see Agilent 33220A Waveform Generator User's Guide for reference).
21) Set the amplitude at 400 mVpp (to set the amplitude use the Menu Operation Softkeys to highlight the amplitude field, the keys below the knob to move the cursor left or right and rotate the knob to change a digit (clockwise to increase), see Agilent 33220A Waveform Generator User's Guide for reference).
22) Wear headphones.
23) Turn the Agilent 33220A Waveform Generator output on (click the key *output* on), (if some sound distortion is heard, click the key *output* off and adjust the position of the woofer support and/or the connections, after that operation turn the Agilent *output* on).
24) Starting from 600Hz the operator has to vary the frequency at a 1Hz step till 1400 Hz have been reached, during this operation the operator detects the resonance

frequency as the frequency at which the maximum number of fringes is detected, if the same maximum number of fringes is seen at two different level of frequency, the operator has to modify the amplitude raising it (for example at 600 mVpp) to determine which is the first mode resonance frequency.

25) After detection, store the frequency and the fringe pattern clicking on the image and saving it into the right folder, naming it as *XXXX*Hz where *XXXX* is the value of the resonance frequency

NB: the first storing of the image will produce two .bmp files named: *XXXX*HzObject and *XXXX*HzMP101. The next images (saved by clicking on them), will be named *XXXX*HzMP102, *XXXX*HzMP103, *XXXX*HzMP104 and so on. For this reason after the first saving, if the third saved image is of a different frequency respect to the *XXXX* Hz the operator has to modify the name substituting the *XXXX* value with the *YYYY* actual value and deleting the extension MP103, this operation has to be repeated for every image saved, deleting of course the extensions MP*ZZZ*. Another possible case is that the saved image is an image kept at a different amplitude value respect to 400 mVpp, the only way to store this information (the amplitude value) is by putting it in the file name, it has been decided that if the amplitude is 400 mVpp this value is not written in the file name, if it differs from 400 mVpp it has to be written in the file name; such information on the amplitude is important because the number of fringes seen depends on it.

If other different studies are performed (i.e. changing some procedure's constant: amplitude, torque …), the stored images have to be put in different folders trying to describe as accurately as possible all the changes made.

26) From 1400 Hz vary the frequency at 10 Hz step till 4500 Hz, at this frequency store the image clicking and it an naming it in the way explicated above

NB: steps [II-24)] to [II-26)] are performed to identify delamination or assembly defects, if some defects resonance is found the operator has to save all the worthy images, storing them into the appropriate folder naming them as described above.

TABLE 1 Frequency ranges

Tray Type	**Tray Aspect Mass (gr.)**	**First mode frequency (Hz) EXPECTED RANGE***		
		Aspect Value ν_0	**Allowable - $\Delta\nu_0$ %**	**Min**
MID tray LIGHT tray	444	1335	-15%	1140

HEAVY tray	577	1270	-10%	1140

*The Expected Range is determined by FEM simulation, these values should be regarded as provisional only.
First flight prototype trays have to ensure conformance to the predicted values or give a trend values.

If the first mode is found at a frequency outside the expected range (TABLE 1), a NCR is generated.

If delamination or an assembly defect is found, the fringe pattern is stored and a NCR is generated.

27) Turn the Agilent 33220A Waveform Generator output off (click the key *output* off).

28) Turn the Agilent 33220A Waveform Generator off (click the key ⏻).

29) Remove headphones.

30) Stop ESPI on line Modal Analysis.

31) Turn the laser off (flip the switch (key) to 0).

32) Go back to the Database DB_ESPI Main Form and go to the Test WS2 WS7 form.

33) Fill the fields in the Test WS2 WS7 form, in the Tray Mounting WS2 insert flag, sign (signature) and date, also fill notes field if necessary.

34) On the basis of which test has been performed, i.e. Front or Back, fill respectively Dynamic Test Side Front (WS3) or Dynamic Test Side Back (WS5).

35) for the Dynamic Test case
    - click on the first mode search key and follow the instructions
    - verify tray ID (S/N) field, tray type field and side field
    - verify test type field
    - insert date by clicking on arrow
    - insert mode of vibration (1^{st}, 2^{nd} or 3^{rd})
    - insert resonance frequency (Hz)
    - insert number of fringes seen (remember to introduce the 400 mVpp data)
    - verify Image directory field
    - verify Image extension field
    - modify Image file field substituting #### with the name of the image chosen
    - click the CLICK TO GET IMAGE button
    - close form
    - if some defect has been found click on the defect search button and follow the instruction which are very similar to the previous one

- close form
- insert flag (green if the test is good, red if not), insert sign (signature) and date, fill notes field if necessary.

36) Static Test (WS4 and WS6 as indicated in point [II-3)]).

37) Put the 50W lamp in the right position, in a manner that permits the light to be generated very close to the center of the tray near the face sheet surface (30 mm from the surface), do not leave the lamp between the tray surface and the laser source.

38) Start the ESPI on line Static Analysis.

39) Turn the laser on (flip the switch (key) to 1).

40) Click on Acquire Reference button and wait for a while then click on Update Reference to repeat this operation, wait for a while, watch if the speckle is quite uniform, if not, click on Update Reference to close the previous image and to have the possibility of perform a new Acquire Reference.

41) When the speckle is quite steady, start the test clicking on Update Reference button, on Acquire Reference button and click on the image, in this way the first reference image is stored, choose the right folder (already created) and
    - save the image as (for example) START in the STATIC folder
    - as soon as possible move the lamp very close to the tray as mentioned on step [II-37)] and go to the next step.
42) At time zero, defined as t_0, turn the light on (pay attention the laser is still on) and hold it on for 30 sec, after this period turn the light off and remove the lamp (i.e. do not leave it between the tray surface and laser source).
43) At t_0 +50sec click on the image
44) At t_0 +80sec click on the Update Reference button and perform a new Acquire Reference clicking on the button
45) Choosing the images to be stored click on them until it is deemed significant
46) If deemed necessary, to verify that the tray is still loosing heat, click on Update Reference and perform a new Acquire Reference clicking on the button, if it is needed to save the new images, click on them
47) If the information obtained from the ESPI are no more significant, stop ESPI on line and click on quit button, do not save changes.

NB: during steps [II-41)] to [II-46)] the images are stored in .txt format and named automatically in this way:

The first saved image (saved clicking on it) after the start of ESPI on line ➔ Static Analysis, will be identified by the name imposed by the operator, (following this procedure the name will be START) followed by the extension Ph100.txt and Ph101.txt, without spaces (STARTPh100.txt and STARTPh101.txt), when the operator saves another image (clicking on it) the new file will be named with the extension Ph102.txt (STARTPh102.txt) an so on for the successive images (Ph103.txt, Ph104.txt…); all the images with the extension Ph1XX, where XX is not 00 or 01 have been kept using as reference the Ph100; the file which is saved is the difference respect to the reference image, kept using the difference between Ph100 and Ph101, the image that the operator sees on line is the comparison of the actual in respect to the Ph100 kept as reference.

When the operator makes a new Update Reference, the following new Acquire Reference and click on the image to save it, the new saved files will have the extension 1Ph100, 1Ph102 (note the space in the name ex: START 1Ph100.txt).

If the operator continues with Update Reference, Acquire Reference and click on image the file extensions will be 2Ph100, 2Ph102 and so on.
To review the stored images and to compare two different moments of the heat down it is necessary to perform a post processing job using the code named ESPI off line.

48) Start the ESPI off line
49) Click on Fringe Viewer key
50) Choose the two images to be compared inserting their path string clicking on *select SP 1* and *select SP 2*, and choosing the right .txt file
51) Chose the image to save, click on it and store it in the right folder (now the stored image will be a .bmp file), the operator has to name it *static_test* if no damages are seen, and if damages have been identified the file has to be named in a way to describe them.

NB: this ESPI Static Tests are performed to identify delamination or assembly defects, if some defects is found the operator has to save all the worthy images, storing them into the appropriate folders naming them in a adequate manner. If delamination or an assembly defect is found, the fringe pattern is stored and a NCR is generated, if no damages are found however a significant image has to be stored to prove the success of the test, this image will be named (for example) *static_test.bmp*

52) Click on Stop and Quit ESPI off line, do not save changes.
53) Turn the laser off.
54) Go back to the Database DB_ESPI Main Form and go to the Test WS2 WS7 form
55) Fill the fields in the Test WS2 WS7 form. On the basis of which test has been performed, i.e. Front or Back, fill respectively Static Test Side Front (WS4) or Static Test Side Back (WS6); for the Static Test case:
    - click on the get static test data key and follow the instructions
    - verify tray ID (S/N) field, tray type field and side field
    - insert date clicking on arrow
    - verify Image directory field
    - verify Image extension field
    - modify Image file field substituting #### with the name of the image chosen
    - click the CLICK TO GET IMAGE button
    - close form

- returning to the WS form insert flag (green if the test is good, red if not), insert signature an date, fill notes field if necessary.

NB: As already mentioned, steps [II-5)] to [II-55)] have to be performed for both the Front and Back Tests and to pass from one kind of test to the other the frame has to be dismounted from the optical table The following instruction refers to this operation

56) Move apart the woofer, disconnecting the connectors.
57) Move amplifier to enlarge work area.
58) Unscrew the M6 fasteners and rotate the frame in order to pass from the Front Test position to the Back Test position or vice versa
    - torque the M6 fasteners to 6 Nm
59) perform steps [II-5)] to [II-57)]
60) Uninstall Tray from the frame
    - unscrew the M5 fasteners which are holding the assembly (tray, closeout supports and frame plate) on the frame (these are the screws which fix the plate to the frame), remember to hold the assembly touching only the plate
    - bring the assembly (tray, closeout supports and frame plate) to the table
    - lower the assembly horizontally, in such a way as to leave the piece of foam inside the square free area (remember that the foam thickness has to be as high as to sustain the tray and allow the unscrewing of the pin)
    - reinstall the labels
    - unscrew the 20 threaded pins which connect the MCM Closeouts to the two MCM Closeouts supports
    - unscrew 12 of 16 threaded pins which connect the Structural Closeouts to the two Structural Closeouts support, the pins on the top corner (top in the horizontal position of the assembly, one pin for each left and right corner) of the Structural Closeouts supports have to be left screwed
    - unscrew the 4 M8 fasteners which connect a MCM Closeouts Support to the plate
    - hold the support so as not let it fall it on the face sheet and remove it from the plate

- unscrew the 4 M8 fasteners which connect the other MCM Closeouts Support to the plate
- hold the support so as not let it fall it on the face sheet and remove it from the plate
- unscrew as simultaneously as possible the 4 remaining threaded pins which connect the Structural Closeouts to the two Structural Closeouts support in the corners

NB: now the Tray is supported by the foam

- unscrew the 8 M8 fasteners which connect the Structural Closeout Supports to the plate
- remove the 2 Structural Closeouts supports from the plate without letting them touch the face sheet

61) Tray visual inspection and packaging (WS7)
   - Verify that no damages have been occurred on the tray
   - Pack the tray carefully with foam, writing on the packaging the tray S/N and if no NCR have been generated and/or no problems have been found with that tray, write "ESPI tested"; if problems have been found, pack the tray and put a label on the packaging describing which kind of problem has been found.
62) Place the packed tray in a safe place.
63) Fill the Tray Dismounting and Packaging (WS7) in the DB_ESPI form
   - insert Flag, Sign (signature) and Date in the database form, if necessary add Notes in the appropriate field
64) Close form clicking on the Close Form key
65) To save hard disk delete the *XXXX*HzObject.bmp file, if the .bmp files have been obtained from them, delete the STARTPhXXX.txt files
66) Copy as back up the stored folder in "\\Glastserver\Database\DataTransfer\back-up ESPI Images dd-mm-yy" and update date for the folder name
67) The operator now is ready to perform a new ESPI test

TOP TRAY

I) Pre-ESPI Test Inspection (WS1)

1) Click on Pre-ESPI Test Inspection key in the DB_ESPI Main Form.
2) Insert Tray Serial Number (S/N) in the Tray ID field in the Pre-ESPI Test Inspection form.
3) Insert Tray Type (T: Top).
4) Weigh the Tray.
5) Insert Tray mass (g) in the field.
6) Perform the Tray Visual Inspection.
   - verify that there are no visible damages
   - verify the rightness of the position of the closeouts and define the back and front of the tray: watching the tray on its front side the operator should see the MCM closeout with the lowest S/N, the slits on the structural closeouts down; in this position the face sheet up is the top of the tray and this is the front side for the ESPI test, the face sheet down is on the bottom of the tray and this is the back side for the ESPI test, (top of the Top Tray is the side which will be the top of the Tracker Tower); watching the top of the tray the operator will have the right structural closeout on his/her right hand and the leftt structural closeout on his/her left hand, back MCM closeout will be the one with higher S/N.
   - verify that no pins or glue residual are in the threaded and reference holes
   - verify that the allowable depth of threaded M2.5 pins is $d \geq 6.5$ (-0.0+0.1) mm
   - verify that no glue residuals are in all the M4 holes
   - verify glue presence at the corner interstices between Structural Closeouts and MCM Closeouts
   - verify that no separation occurs between face sheet and closeouts
   - by knocking gently with the finger knuckle on the face sheets, assess if large areas of crashed cell are present depending on emitted sound
7) Insert flag: if the Tray Visual Inspection is ok choose the green flag, if not, use the red flag and generate an NCR.
8) Perform the ground test
   - verify the probe to probe resistance of the multimeter

closeout and the other multimeter probe in the venting hole on the Structural Closeout closest to the MCM supporting hole

- measure of the resistance taking into account the probe to probe resistance
- repeat the previous two operation for the other MCM and STRL closeout
- if the two measurement values are less than 1.00 Ω insert *ok* in the grounding test field, else insert *failure* and generate an NCR.

9) Insert Sign (signature).

10) Insert date clicking on the arrow.

11) Close form clicking on the Close Form key.

II) Perform the tests

12) Click on Test data (WS2 to WS7) key in the DB_ESPI Main Form.

13) Insert Tray ID (S/N) and tray type in the form.

14) Install the two angular frame on the optical table, distance between two vertical border has to be 500 mm, free area between angular frames centered respect to the photo camera and position respect the shorter side of the optical table in function of which test has to be performed: Front or Back

NB: it is possible to decide whether to perform first the Front Test or the Back Test, the indication to follow is to perform first the ESPI Dynamic Test and after the ESPI Static Test; so the position of the two angular frame in respect to the table border will be based on the decision of which test has to be performed first

- torque the M5 fasteners to 3.6 Nm
- torque the M6 fasteners to 6 Nm

15) Tray Mounting (WS2)

- put the ESPI plate frame on the table in such a way as to leave a piece of foam inside the square free area; the foam thickness has to be as high as to sustain the Top Tray and allows the screwing of the pin, the Top Tray will be installed upside down respect of the position used for Heavy, Mid and Light Tray, the foam will be in contact of the top side of the tray.
- wear gloves and hold the tray
- place the Tray on the foam
- remove gloves
- locate the 2 L-shaped blocks (Structural Closeouts supports) near the Structural Closeouts

- insert threaded M2.5 pins into the four supports proceeding from the four corner to the centre to hold the Structural Closeouts, pay attention to the fact that the support will never have to be hanged on the tray by the pins
- finger tight the pins before final torque is applied
- locate the 2 L-shaped blocks (MCM Closeouts supports) near the MCM Closeouts without letting them touch the face sheets
- insert threaded M2.5 pins into the four supports proceeding from the corner to the centre to hold the MCM Closeouts
- install M8 screws to fix the four closeouts supports on plate frame, finger tight
- remove labels from the face sheet and put them on the closeouts support
- torque M8 fasteners to 6 Nm, in a diagonal pattern as shown in figure 1

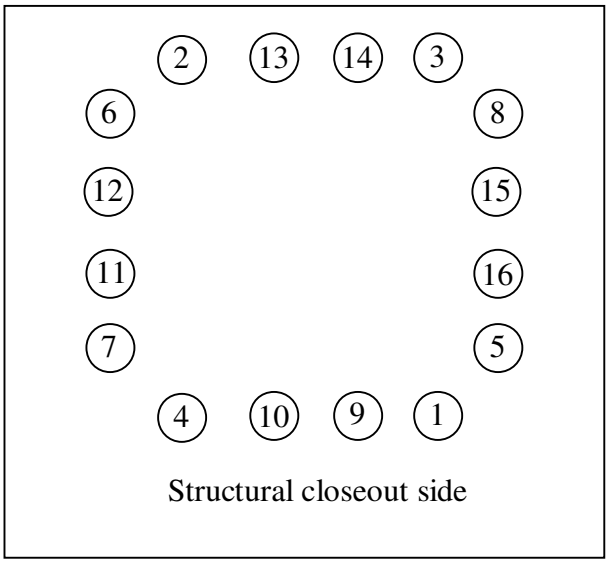

Figure 1

- clockwise, starting from one chosen point (this choice made to verify that no screws have been left unscrewed), torque once more M8 fasteners to 6 Nm
- following the same path used in installing them (i.e. from the corner to the centre and starting on the Structural Closeouts Supports), torque M 2.5 steel threaded pins to 0.4 Nm.
- clockwise, starting from one chosen point (this choice made to verify that no pins have been left unscrewed), torque M 2.5 steel threaded pins to 0.4 Nm, after the round is complete, if result necessary because of the relaxation of the threaded pin, repeat the round of torque once more

NB: do not forget to torque any of the threaded pins

installed on the optical table, hold the assembly from the plate and not using closeouts support

- lean the assembly to the frame (holding it from the plate) and insert M5 screws
- finger tight the M5 screws before final torque is applied
- torque the M5 screws to 3.6 Nm
- the Tray now is mounted and the Tray Mounting (WS2) form has to be filled, insert Flag, Sign (signature) and Date in the database form, if necessary add Notes in the appropriate field.

16) Move the woofer in a centered position in respect to the Tray, near the optical table, put it in such a way that the woofer support does not touch the optical table (its distance from the table is around 5÷10 mm).

17) If unconnected, connect the woofer wires, following the colors: red pin to the connector marked with a red point, black pin to the other connector.

18) Dynamic Test (WS3 and WS5 as indicated in point [III-3)]).

19) Create new folder following the path D:\Database\Data

- for each test the folder name has to follow this indication:

$$\text{D:\Database\Data\}T\begin{Bmatrix}T\\M\\H\\L\\B\end{Bmatrix}XXX\_\begin{Bmatrix}FR\\BK\end{Bmatrix}-\begin{Bmatrix}DYN\\STATIC\end{Bmatrix}-\begin{Bmatrix}MODE\ or\ DEF\\ /\qquad /\end{Bmatrix}$$

T: it is for Tray

$\begin{Bmatrix}T\\M\\H\\L\\B\end{Bmatrix}$: it depends from the Tray Type (T: Top, M: Mid, H: Heavy, L: Light, B: Bottom)

XXX: it is the Serial Number

$\begin{Bmatrix}FR\\BK\end{Bmatrix}$: it depends from the side of the tray which is analyzed (*FR*: front side, *BK*: back side)

$\begin{Bmatrix}DYN\\STATIC\end{Bmatrix}$: it depends from the type of test which is performed (*DYN*: dynamic, *STATIC*: static)

$\begin{Bmatrix}MODE\ or\ DEF\\ /\qquad /\end{Bmatrix}$: will be present only in case a Dynamic Test has to be performed. The folder named *MODE* will contain the picture of the first resonance mode, whereas the

folder named *DEF* will contain the pictures of the defects resonance if found, if no defects will be found, the folder will be left empty and/or deleted.

20) Verify that the laser is off (switch (key) on the power supply on 0).

21) Verify that the energy switch on the wall is on, if not turn it on.

22) Turn the photo camera on, turning on the switch of the power supply (CL200BIOD).

23) Turn the PA400 amplifier on and set this values if they are not already the same:

MASTER VOLUME	TONE	PHONO/AUX	MIC2	MIC1
10	5^{th} dot starting from LOW	HIGH	4^{th} dot starting from MIN	3^{rd} dot starting from MIN

24) Write on the logbook Tray Type, S/N and prepare three columns to report frequency (Hz), number of fringes and amplitude (mVpp).

25) Turn the laser on by flipping the switch (key) on 1.

26) Turn off the neon room lights.

27) Start the ESPI on line.

28) Click on Modal Analysis.

29) Turn the Agilent 33220A Waveform Generator on (click the key ⏻).

30) Set the Sine Waveform (if not already set) clicking on *sine* key.

31) Set the initial frequency at 600 Hz (to set the frequency use the Menu Operation Softkeys to highlight the frequency field, the keys below the knob to move the cursor left or right and rotate the knob to change a digit (clockwise to increase), see Agilent 33220A Waveform Generator User's Guide for reference).

32) Set the amplitude at 400 mVpp (to set the amplitude use the Menu Operation Softkeys to highlight the amplitude field, the keys below the knob to move the cursor left or right and rotate the knob to change a digit (clockwise to increase), see Agilent 33220A Waveform Generator User's Guide for reference).

33) Wear headphones.

34) Turn the Agilent 33220A Waveform Generator output on (click the key *output* on), (if some sound distortion is heard, click the key *output* off and adjust the position of the woofer support and/or the connections, after that operation turn the Agilent *output* on).

have been reached, during this operation the operator detects the resonance frequency as the frequency at which the maximum number of fringes is detected, if the same maximum number of fringes is seen at two different level of frequency, the operator has to modify the amplitude raising it (for example at 600 mVpp) to determine which is the first mode resonance frequency.

36) After detection, store the frequency and the fringe pattern clicking on the image and saving it into the right folder, naming it as *XXXX*Hz where *XXXX* is the value of the resonance frequency

NB: the first storing of the image will produce two .bmp files named: *XXXX*HzObject and *XXXX*HzMP101. The next images (saved by clicking on them), will be named *XXXX*HzMP102, *XXXX*HzMP103, *XXXX*HzMP104 and so on. For this reason after the first saving, if the third saved image is of a different frequency respect to the *XXXX* Hz the operator has to modify the name substituting the *XXXX* value with the *YYYY* actual value and deleting the extension MP103, this operation has to be repeated for every image saved, deleting of course the extensions MP*ZZZ*. Another possible case is that the saved image is an image kept at a different amplitude value respect to 400 mVpp, the only way to store this information (the amplitude value) is by putting it in the file name, it has been decided that if the amplitude is 400 mVpp this value is not written in the file name, if it differs from 400 mVpp it has to be written in the file name; such information on the amplitude is important because the number of fringes seen depends on it.

If other different studies are performed (i.e. changing some procedure's constant: amplitude, torque …), the stored images have to be putt in different folders trying to describe as accurately as possible all the changes made.

37) From 1400 Hz vary the frequency at 10 Hz step till 4500 Hz, at this frequency store the image clicking ond it an naming it in the way explicated above

NB: steps [II-24)] to [II-26)] are performed to identify delamination or assembly defects, if some defects resonance is found the operator has to save all the worthy images, storing them into the appropriate folder naming them as described above.

TABLE 1 Frequency ranges

Tray Type	**Tray Aspect Mass (gr.)**	**First mode frequency (Hz) EXPECTED RANGE***		
		Aspect Value ν_0	**Allowable - $\Delta\nu_0$ %**	**Min**
TOP tray	750	1310	-15%	1115

First flight prototype trays have to ensure conformance to the predicted values or give a trend values.

If the first mode is found at a frequency outside the expected range (TABLE 1), a NCR is generated. If delamination or an assembly defect is found, the fringe pattern is stored and a NCR is generated.

38) Turn the Agilent 33220A Waveform Generator output off (click the key *output* off).

39) Turn the Agilent 33220A Waveform Generator off (click the key ⏻).

40) Remove headphones.

41) Stop ESPI on line Modal Analysis.

42) Turn the laser off (flip the switch (key) to 0).

43) Go back to the Database DB_ESPI Main Form and go to the Test WS2 WS7 form.

44) Fill the fields in the Test WS2 WS7 form, in the Tray Mounting WS2 insert flag, sign (signature) and date, also fill notes field if necessary.

45) On the basis of which test has been performed, i.e. Front or Back, fill respectively Dynamic Test Side Front (WS3) or Dynamic Test Side Back (WS5).

46) for the Dynamic Test case

- click on the first mode search key and follow the instructions
- verify tray ID (S/N) field, tray type field and side field
- verify test type field
- insert date by clicking on arrow
- insert mode of vibration (1^{st}, 2^{nd} or 3^{rd})
- insert resonance frequency (Hz)
- insert number of fringes seen (remember to introduce the 400 mVpp data)
- verify Image directory field
- verify Image extension field
- modify Image file field substituting #### with the name of the image chosen
- click the CLICK TO GET IMAGE button
- close form
- if some defect has been found click on the defect search button and follow the instruction which are very similar to the previous one
- close form
- insert flag (green if the test is good, red if not), insert sign (signature) and date, fill notes field if necessary.

47) Static Test (WS4 and WS6 as indicated in point [II-3)]).

very close to the center of the tray near the face sheet surface (30 mm from the surface), do not leave the lamp between the tray surface and the laser source.

49) Start the ESPI on line Static Analysis.
50) Turn the laser on (flip the switch (key) to 1).
51) Click on Acquire Reference button and wait for a while then click on Update Reference to repeat this operation, wait for a while, watch if the speckle is quite uniform, if not, click on Update Reference to close the previous image and to have the possibility of perform a new Acquire Reference.
52) When the speckle is quite steady, start the test clicking on Update Reference button, on Acquire Reference button and click on the image, in this way the first reference image is stored, choose the right folder (already created) and
    - save the image as START in the STATIC folder
    - as soon as possible move the lamp very close to the tray as mentioned on step [II-37)] and go to the next step.
53) At time zero, defined as t_0, turn the light on (pay attention the laser is still on) and hold it on for 30 sec, after this period turn the light off and remove the lamp (i.e. do not leave it between the tray surface and laser source).
54) At t_0 +50sec click on the image
55) At t_0 +80sec click on the Update Reference button and perform a new Acquire Reference clicking on the button
56) Choosing the images to be stored click on them until it is deemed significant
57) If deemed necessary, to verify that the tray is still loosing heat, click on Update Reference and perform a new Acquire Reference clicking on the button, if it is needed to save the new images, click on them
58) If the information obtained from the ESPI are no more significant, stop ESPI on line and click on quit button, do not save changes.

NB: during steps [II-41)] to [II-46)] the images are stored in .txt format and named automatically in this way:

The first saved image (saved clicking on it) after the start of ESPI on line ➔ Static Analysis, will be identified by the name imposed by the operator, (following this procedure the name will be START) followed by the extension Ph100.txt and Ph101.txt, without spaces (STARTPh100.txt and STARTPh101.txt), when the operator saves another image (clicking on it) the new file will be named with the extension Ph102.txt (STARTPh102.txt) an so on for the successive images (Ph103.txt, Ph104.txt…); all the images with the extension Ph1XX, where XX is not 00 or 01 have been kept using as reference the Ph100; the file which is saved is the difference respect to the reference image,

kept using the difference between Ph100 and Ph101, the image that the operator sees on line is the comparison of the actual in respect to the Ph100 kept as reference.

When the operator makes a new Update Reference, the following new Acquire Reference and click on the image to save it, the new saved files will have the extension 1Ph100, 1Ph102 (note the space in the name ex: START 1Ph100.txt).

If the operator continues with Update Reference, Acquire Reference and click on image the file extensions will be 2Ph100, 2Ph102 and so on.

To review the stored images and to compare two different moments of the heat down it is necessary to perform a post processing job using the code named ESPI off line.

59) Start the ESPI off line
60) Click on Fringe Viewer key
61) Choose the two images to be compared inserting their path string clicking on *select SP 1* and *select SP 2*, and choosing the right .txt file
62) Chose the image to save, click on it and store it in the right folder (now the stored image will be a .bmp file), the operator has to name it *static_test* if no damages are seen, and if damages have been identified the file has to be named in a way to describe them.

NB: this ESPI Static Tests are performed to identify delamination or assembly defects, if some defects is found the operator has to save all the worthy images, storing them into the appropriate folders naming them in a adequate manner. If delamination or an assembly defect is found, the fringe pattern is stored and a NCR is generated, if no damages are found however a significant image has to be stored to prove the success of the test, this image will be named (for example) *static_test.bmp*

63) Click on Stop and Quit ESPI off line, do not save changes.
64) Turn the laser off.
65) Go back to the Database DB_ESPI Main Form and go to the Test WS2 WS7 form
66) Fill the fields in the Test WS2 WS7 form. On the basis of which test has been performed, i.e. Front or Back, fill respectively Static Test Side Front (WS4) or Static Test Side Back (WS6); for the Static Test case:
    - click on the get static test data key and follow the instructions
    - verify tray ID (S/N) field, tray type field and side field
    - insert date clicking on arrow
    - verify Image directory field
    - verify Image extension field

- click the CLICK TO GET IMAGE button
- close form
- returning to the WS form insert flag (green if the test is good, red if not), insert signature an date, fill notes field if necessary.

NB: As already mentioned, steps [II-5)] to [II-55)] have to be performed for both the Front and Back Tests and to pass from one kind of test to the other the frame has to be dismounted from the optical table The following instruction refers to this operation

67) Move apart the woofer, disconnecting the connectors.
68) Move amplifier to enlarge work area.
69) Unscrew the M6 fasteners and rotate the frame in order to pass from the Front Test position to the Back Test position or vice versa
    - torque the M6 fasteners to 6 Nm
70) perform steps [II-5)] to [II-57)]
71) Uninstall Tray from the frame
    - unscrew the M5 fasteners which are holding the assembly (tray, closeout supports and frame plate) on the frame (these are the screws which fix the plate to the frame), remember to hold the assembly touching only the plate
    - bring the assembly (tray, closeout supports and frame plate) to the table
    - lower the assembly horizontally, in such a way as to leave the piece of foam inside the square free area (remember that the foam thickness has to be as high as to sustain the tray and allow the unscrewing of the pin)
    - reinstall the labels
    - unscrew the 20 threaded pins which connect the MCM Closeouts to the two MCM Closeouts supports
    - unscrew 12 of 16 threaded pins which connect the Structural Closeouts to the two Structural Closeouts support, the pins on the top corner (top in the horizontal position of the assembly, one pin for each left and right corner) of the Structural Closeouts supports have to be left screwed
    - unscrew the 4 M8 fasteners which connect a MCM Closeouts Support to the plate
    - hold the support so as not let it fall it on the face sheet and remove it from the plate
    - unscrew the 4 M8 fasteners which connect the other MCM Closeouts Support to the plate
    - hold the support so as not let it fall it on the face sheet and remove it from the plate

- unscrew as simultaneously as possible the 4 remaining threaded pins which connect the Structural Closeouts to the two Structural Closeouts support in the corners

NB: now the Tray is supported by the foam

- unscrew the 8 M8 fasteners which connect the Structural Closeout Supports to the plate
- remove the 2 Structural Closeouts supports from the plate without letting them touch the face sheet

72) Tray visual inspection and packaging (WS7)
- Verify that no damages have been occurred on the tray
- Pack the tray carefully with foam, writing on the packaging the tray S/N and if no NCR have been generated and/or no problems have been found with that tray, write "ESPI tested"; if problems have been found, pack the tray and put a label on the packaging describing which kind of problem has been found.

73) Place the packed tray in a safe place.

74) Fill the Tray Dismounting and Packaging (WS7) in the DB_ESPI form
- insert Flag, Sign (signature) and Date in the database form, if necessary add Notes in the appropriate field

75) Close form clicking on the Close Form key

76) To save hard disk delete the *XXXX*HzObject.bmp file, if the .bmp files have been obtained from them, delete the STARTPhXXX.txt files

77) Copy as back up the stored folder in "\\Glastserver\Database\DataTransfer\back-up ESPI Images dd-mm-yy" and update date for the folder name

78) The operator now is ready to perform a new ESPI test

BOTTOM TRAY

I) Pre-ESPI Test Inspection (WS1)

1) Click on Pre-ESPI Test Inspection key in the DB_ESPI Main Form.
2) Insert Tray Serial Number (S/N) in the Tray ID field in the Pre-ESPI Test Inspection form.
3) Insert Tray Type (B: Bottom).
4) Weigh the Tray.
5) Insert Tray mass (g) in the field.
6) Perform the Tray Visual Inspection.
   - verify that there are no visible damages
   - verify the rightness of the position of the closeouts and define the back and front of the tray: watching the tray in front of the closeout the operator should see the narrow flexure (+X direction of the tracker tower) and on his/her right hand side the operator should see the narrow (+Y) flexure; in this position the face sheet up is the top of the tray and this is the front side for the ESPI test, the face sheet down is on the bottom of the tray and this is the back side for the ESPI test
   - verify that no pins or glue residual are in the threaded and reference holes
   - verify that the allowable depth of threaded M2.5 pins is $d \geq 6.5$ (-0.0+0.1) mm
   - verify that the allowable depth of threaded M4 pins is $d \geq 6.5$ (-0.0+0.1) mm except that for the holes on the structural closeouts at corner on top side of the panel, for these holes the depth has to be $d \geq 4.5$ (-0.0+0.1) mm
   - verify glue presence at the corner interstices between Structural Closeouts and MCM Closeouts
   - verify that no separation occurs between face sheet and closeouts
   - by knocking gently with the finger knuckle on the face sheets, assess if large areas of crashed cell are present depending on emitted sound
7) Insert flag: if the Tray Visual Inspection is ok choose the green flag, if not, use the red flag and generate an NCR.
8) Fill the ground test field with N/A because the ground will be obtained later in production
9) Insert Sign (signature).
10) Insert date clicking on the arrow.
11) Close form clicking on the Close Form key.

II) Perform the tests

12) Click on Test data (WS2 to WS7) key in the DB_ESPI Main Form.
13) Insert Tray ID (S/N) and tray type in the form.

14) Install the two angular frame on the optical table, distance between two vertical border has to be 500 mm, free area between angular frames centered respect to the photo camera and position respect the shorter side of the optical table in function of which test has to be performed: Front or Back

NB: it is possible to decide whether to perform first the Front Test or the Back Test, the indication to follow is to perform first the ESPI Dynamic Test and after the ESPI Static Test; so the position of the two angular frame in respect to the table border will be based on the decision of which test has to be performed first

- torque the M5 fasteners to 3.6 Nm
- torque the M6 fasteners to 6 Nm

15) Tray Mounting (WS2)

- put the four aluminum support on the ESPI plate frame and put these tools on four blocks of foam (at the corner of the plate), in such a way as to leave enough gap to let the Bottom Tray be placed on the eight flexures and at the same time allows the screwing of the pin
- wear gloves and hold the tray
- place the Tray on the table
- remove gloves
- locate the 2 L-shaped blocks (Structural Closeouts supports) nearer the Structural Closeouts
- locate the 2 L-shaped blocks (MCM Closeouts supports) nearer the MCM Closeouts without letting them touch the face sheets
- insert threaded M4 screws (M4 l=30) (use washers) into the two structural supports proceeding from the four corner to the centre to hold the Structural Closeouts
- finger tight the screws before final torque is applied
- move these pieces (ESPI plate frame, aluminum support and tray) on two other pieces of foam, this foam have to be rigid and high enough to sustain the plate and the tray in such away to do not let touch the flexures on the table
- insert M4 screws (for M4 l=30 using washers and M4 l=14) into the two structural supports
- insert M4 screws (M4 l=30 and M4 l=26) (use washers) into the two MCM closeout supports proceeding from the corner to the centre to hold the MCM Closeouts
- insert all threaded M2.5 pin, finger tight before final torque
- install M8 screws to fix the four closeouts supports on plate frame, finger tight

- torque M8 fasteners to 6 Nm, in a diagonal pattern as shown in figure 1

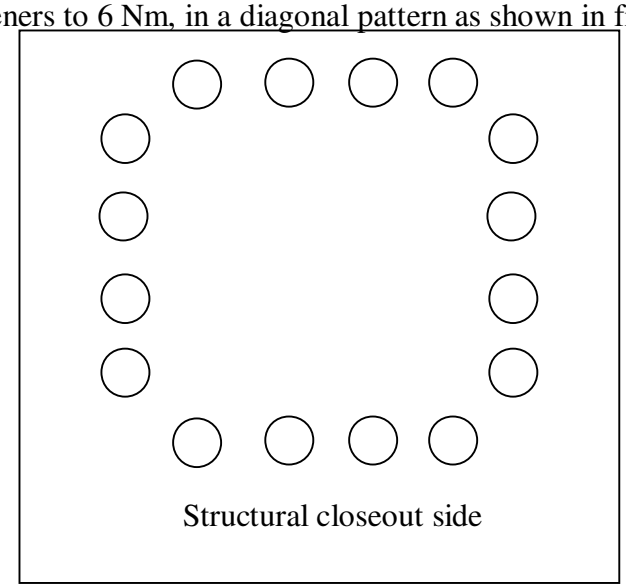

Figure 1

- clockwise, starting from one chosen point (this choice made to verify that no screws have been left unscrewed), torque once more M8 fasteners to 6 Nm
- following the same path used in installing them (i.e. from the corner to the centre and starting on the Structural Closeouts Supports), torque M4 to 1.8Nm and torque M 2.5 steel threaded pins to 0.8 Nm.
- clockwise, starting from one chosen point (this choice made to verify that no pins and or screws have been left unscrewed), if result necessary because of the relaxation of the threaded pin and screws, repeat the round of torque once more

NB: do not forget to torque any of the fasteners

- bring the assembly (tray, closeout supports and frame plate) to the frame already installed on the optical table, hold the assembly from the plate and not using closeouts support
- lean the assembly to the frame (holding it from the plate) and insert M5 screws
- finger tight the M5 screws before final torque is applied
- torque the M5 screws to 3.6 Nm
- the Tray now is mounted and the Tray Mounting (WS2) form has to be filled, insert Flag, Sign (signature) and Date in the database form, if necessary add Notes in the appropriate field.

16) Move the woofer in a centered position in respect to the Tray, near the optical table, put it in such a way that the woofer support does not touch the optical table (its distance from the table is around 5÷10 mm).

17) If unconnected, connect the woofer wires, following the colors: red pin to the connector marked with a red point, black pin to the other connector.

18) Dynamic Test (WS3 and WS5 as indicated in point [III-3)]).

19) Create new folder following the path D:\Database\Data

- for each test the folder name has to follow this indication:

$$\text{D:\Database\Data\}T\begin{Bmatrix}T\\M\\H\\L\\B\end{Bmatrix}XXX\_\begin{Bmatrix}FR\\BK\end{Bmatrix}-\begin{Bmatrix}DYN\\STATIC\end{Bmatrix}-\begin{Bmatrix}MODE\ or\ DEF\\/\qquad /\end{Bmatrix}$$

T: it is for Tray

$\begin{Bmatrix}T\\M\\H\\L\\B\end{Bmatrix}$: it depends from the Tray Type (T: Top, M: Mid, H: Heavy, L: Light, B: Bottom)

XXX: it is the Serial Number

$\begin{Bmatrix}FR\\BK\end{Bmatrix}$: it depends from the side of the tray which is analyzed (*FR*: front side, *BK*: back side)

$\begin{Bmatrix}DYN\\STATIC\end{Bmatrix}$: it depends from the type of test which is performed (*DYN*: dynamic, *STATIC*: static)

$\begin{Bmatrix}MODE\ or\ DEF\\/\qquad /\end{Bmatrix}$: will be present only in case a Dynamic Test has to be performed. The folder named *MODE* will contain the picture of the first resonance mode, whereas the folder named *DEF* will contain the pictures of the defects resonance if found, if no defects will be found, the folder will be left empty and/or deleted.

20) Verify that the laser is off (switch (key) on the power supply on 0).

21) Verify that the energy switch on the wall is on, if not turn it on.

22) Turn the photo camera on, turning on the switch of the power supply (CL200BIOD).

23) Turn the PA400 amplifier on and set this values if they are not already the same:

MASTER VOLUME	TONE	PHONO/AUX	MIC2	MIC1
10	5th dot starting from LOW	HIGH	4th dot starting from MIN	3rd dot starting from MIN

number of fringes and amplitude (mVpp).

25) Turn the laser on by flipping the switch (key) on 1.

26) Turn off the neon room lights.

27) Start the ESPI on line.

28) Click on Modal Analysis.

29) Turn the Agilent 33220A Waveform Generator on (click the key ⏻).

30) Set the Sine Waveform (if not already set) clicking on *sine* key.

31) Set the initial frequency at 600 Hz (to set the frequency use the Menu Operation Softkeys to highlight the frequency field, the keys below the knob to move the cursor left or right and rotate the knob to change a digit (clockwise to increase), see Agilent 33220A Waveform Generator User's Guide for reference).

32) Set the amplitude at 400 mVpp (to set the amplitude use the Menu Operation Softkeys to highlight the amplitude field, the keys below the knob to move the cursor left or right and rotate the knob to change a digit (clockwise to increase), see Agilent 33220A Waveform Generator User's Guide for reference).

33) Wear headphones.

34) Turn the Agilent 33220A Waveform Generator output on (click the key *output* on), (if some sound distortion is heard, click the key *output* off and adjust the position of the woofer support and/or the connections, after that operation turn the Agilent *output* on).

35) Starting from 600Hz the operator has to vary the frequency at a 1Hz step till 1500 Hz have been reached, during this operation the operator detects the resonance frequency as the frequency at which the maximum number of fringes is detected, if the same maximum number of fringes is seen at two different level of frequency, the operator has to modify the amplitude raising it (for example at 600 mVpp) to determine which is the first mode resonance frequency.

36) After detection, store the frequency and the fringe pattern clicking on the image and saving it into the right folder, naming it as *XXXX*Hz where *XXXX* is the value of the resonance frequency

NB: the first storing of the image will produce two .bmp files named: *XXXX*HzObject and *XXXX*HzMP101. The next images (saved by clicking on them), will be named *XXXX*HzMP102, *XXXX*HzMP103, *XXXX*HzMP104 and so on. For this reason after the first saving, if the third saved image is of a different frequency respect to the *XXXX* Hz the operator has to modify the name substituting the *XXXX* value with the *YYYY* actual value and deleting the extension MP103, this operation has to be repeated for every image saved, deleting of course the extensions MP*ZZZ*. Another possible case is that the saved image is an image kept at a different amplitude value respect to 400

mVpp, the only way to store this information (the amplitude value) is by putting it in the file name, it has been decided that if the amplitude is 400 mVpp this value is not written in the file name, if it differs from 400 mVpp it has to be written in the file name; such information on the amplitude is important because the number of fringes seen depends on it.
If other different studies are performed (i.e. changing some procedure's constant: amplitude, torque …), the stored images have to be putt in different folders trying to describe as accurately as possible all the changes made.

37) From 1500 Hz vary the frequency at 10 Hz step till 4500 Hz, at this frequency store the image clicking ond it an naming it in the way explicated above

NB: steps [II-24)] to [II-26)] are performed to identify delamination or assembly defects, if some defects resonance is found the operator has to save all the worthy images, storing them into the appropriate folder naming them as described above.

TABLE 1 Frequency ranges

Tray Type	**Tray Aspect Mass (gr.)**	**First mode frequency (Hz) EXPECTED RANGE***		
		Aspect Value ν_0	**Allowable - $\Delta\nu_0$ %**	**Min**
BOTTOM tray	1900	1405	-15%	1190

First flight prototype trays have to ensure conformance to the predicted values or give a trend values.

If the first mode is found at a frequency outside the expected range (TABLE 1), a NCR is generated.
If delamination or an assembly defect is found, the fringe pattern is stored and a NCR is generated.

38) Turn the Agilent 33220A Waveform Generator output off (click the key *output* off).
39) Turn the Agilent 33220A Waveform Generator off (click the key ⏻).
40) Remove headphones.
41) Stop ESPI on line Modal Analysis.
42) Turn the laser off (flip the switch (key) to 0).
43) Go back to the Database DB_ESPI Main Form and go to the Test WS2 WS7 form.
44) Fill the fields in the Test WS2 WS7 form, in the Tray Mounting WS2 insert flag, sign (signature) and date, also fill notes field if necessary.

Dynamic Test Side Front (WS3) or Dynamic Test Side Back (WS5).

46) for the Dynamic Test case
    - click on the first mode search key and follow the instructions
    - verify tray ID (S/N) field, tray type field and side field
    - verify test type field
    - insert date by clicking on arrow
    - insert mode of vibration (1^{st}, 2^{nd} or 3^{rd})
    - insert resonance frequency (Hz)
    - insert number of fringes seen (remember to introduce the 400 mVpp data)
    - verify Image directory field
    - verify Image extension field
    - modify Image file field substituting #### with the name of the image chosen
    - click the CLICK TO GET IMAGE button
    - close form
    - if some defect has been found click on the defect search button and follow the instruction which are very similar to the previous one
    - close form
    - insert flag (green if the test is good, red if not), insert sign (signature) and date, fill notes field if necessary.
47) Static Test (WS4 and WS6 as indicated in point [II-3)]).
48) Put the 50W lamp in the right position, in a manner that permits the light to be generated very close to the center of the tray near the face sheet surface (30 mm from the surface), do not leave the lamp between the tray surface and the laser source.
49) Start the ESPI on line Static Analysis.
50) Turn the laser on (flip the switch (key) to 1).
51) Click on Acquire Reference button and wait for a while then click on Update Reference to repeat this operation, wait for a while, watch if the speckle is quite uniform, if not, click on Update Reference to close the previous image and to have the possibility of perform a new Acquire Reference.
52) When the speckle is quite steady, start the test clicking on Update Reference button, on Acquire Reference button and click on the image, in this way the first reference image is stored, choose the right folder (already created) and
    - save the image as START in the STATIC folder
    - as soon as possible move the lamp very close to the tray as mentioned on step [II-37)] and go to the next step.

53) At time zero, defined as t_0, turn the light on (pay attention the laser is still on) and hold it on for 30 sec, after this period turn the light off and remove the lamp (i.e. do not leave it between the tray surface and laser source).
54) At t_0 +50sec click on the image
55) At t_0 +80sec click on the Update Reference button and perform a new Acquire Reference clicking on the button
56) Choosing the images to be stored click on them until it is deemed significant
57) If deemed necessary, to verify that the tray is still loosing heat, click on Update Reference and perform a new Acquire Reference clicking on the button, if it is needed to save the new images, click on them
58) If the information obtained from the ESPI are no more significant, stop ESPI on line and click on quit button, do not save changes.

NB: during steps [II-41)] to [II-46)] the images are stored in .txt format and named automatically in this way:

The first saved image (saved clicking on it) after the start of ESPI on line ➔ Static Analysis, will be identified by the name imposed by the operator, (following this procedure the name will be START) followed by the extension Ph100.txt and Ph101.txt, without spaces (STARTPh100.txt and STARTPh101.txt), when the operator saves another image (clicking on it) the new file will be named with the extension Ph102.txt (STARTPh102.txt) an so on for the successive images (Ph103.txt, Ph104.txt…); all the images with the extension Ph1XX, where XX is not 00 or 01 have been kept using as reference the Ph100; the file which is saved is the difference respect to the reference image, kept using the difference between Ph100 and Ph101, the image that the operator sees on line is the comparison of the actual in respect to the Ph100 kept as reference.

When the operator makes a new Update Reference, the following new Acquire Reference and click on the image to save it, the new saved files will have the extension 1Ph100, 1Ph102 (note the space in the name ex: START 1Ph100.txt).

If the operator continues with Update Reference, Acquire Reference and click on image the file extensions will be 2Ph100, 2Ph102 and so on.

To review the stored images and to compare two different moments of the heat down it is necessary to perform a post processing job using the code named ESPI off line.

59) Start the ESPI off line
60) Click on Fringe Viewer key

and *select SP 2*, and choosing the right .txt file

62) Chose the image to save, click on it and store it in the right folder (now the stored image will be a .bmp file), the operator has to name it *static_test* if no damages are seen, and if damages have been identified the file has to be named in a way to describe them.

NB: this ESPI Static Tests are performed to identify delamination or assembly defects, if some defects is found the operator has to save all the worthy images, storing them into the appropriate folders naming them in a adequate manner. If delamination or an assembly defect is found, the fringe pattern is stored and a NCR is generated, if no damages are found however a significant image has to be stored to prove the success of the test, this image will be named (for example) *static_test.bmp*

63) Click on Stop and Quit ESPI off line, do not save changes.
64) Turn the laser off.
65) Go back to the Database DB_ESPI Main Form and go to the Test WS2 WS7 form
66) Fill the fields in the Test WS2 WS7 form. On the basis of which test has been performed, i.e. Front or Back, fill respectively Static Test Side Front (WS4) or Static Test Side Back (WS6); for the Static Test case:
    - click on the get static test data key and follow the instructions
    - verify tray ID (S/N) field, tray type field and side field
    - insert date clicking on arrow
    - verify Image directory field
    - verify Image extension field
    - modify Image file field substituting #### with the name of the image chosen
    - click the CLICK TO GET IMAGE button
    - close form
    - returning to the WS form insert flag (green if the test is good, red if not), insert signature an date, fill notes field if necessary.

NB: As already mentioned, steps [II-5)] to [II-55)] have to be performed for both the Front and Back Tests and to pass from one kind of test to the other the frame has to be dismounted from the optical table The following instruction refers to this operation

67) Move apart the woofer, disconnecting the connectors.
68) Move amplifier to enlarge work area.
69) Unscrew the M6 fasteners and rotate the frame in order to pass from the Front Test position to the Back Test position or vice versa

- torque the M6 fasteners to 6 Nm

70) perform steps [II-5)] to [II-57)]

71) Uninstall Tray from the frame

- unscrew the M5 fasteners which are holding the assembly (tray, closeout supports and frame plate) on the frame (these are the screws which fix the plate to the frame), remember to hold the assembly touching only the plate
- bring the assembly (tray, closeout supports and frame plate) to the table
- lower the assembly horizontally on two pieces of foam, this foam has to be rigid and high enough to sustain the plate and the tray in such away to do not let touch the flexures on the table
- remove all the M2.5 threaded pins
- remove M4 screws from MCM closeout supports
- remove M4 l=14 screws from structural closeout supports
- remove not all the M4 l=30 from structural closeout supports: the 4 screws in the corners have to remain, at this time, installed but not torqued
- remove M8 screws from MCM closeout supports
- remove MCM closeout supports
- remove M8 screws from structural closeout supports
- put ESPI plate frame, Bottom Tray and structural closeout supports on four corner blocks of foam
- put MCM closeout supports on plate frame, at this point the weight of the parts has to leave enough gap to let the Bottom Tray be placed on the eight flexures and at the same time allows the complete unscrewing of the four M4 screws

NB: now the Tray is supported by the foam

- reinstall the labels
- remove the Bottom Tray from this work area
- remove the 2 Structural Closeout supports
- remove the 2 MCM Closeout supports
- remove plate from the foam and foam
- Tray visual inspection and packaging (WS7)
- Verify that no damages have been occurred on the tray

NCR have been generated and/or no problems have been found with that tray, write "ESPI tested"; if problems have been found, pack the tray and put a label on the packaging describing which kind of problem has been found.

72) Place the packed tray in a safe place.

73) Fill the Tray Dismounting and Packaging (WS7) in the DB_ESPI form

- insert Flag, Sign (signature) and Date in the database form, if necessary add Notes in the appropriate field

74) Close form clicking on the Close Form key

75) To save hard disk delete the *XXXX*HzObject.bmp file, if the .bmp files have been obtained from them, delete the STARTPhXXX.txt files

76) Copy as back up the stored folder in "\\Glastserver\Database\DataTransfer\back-up ESPI Images dd-mm-yy" and update date for the folder name

77) The operator now is ready to perform a new ESPI test