

*LIGO Laboratory / LIGO Scientific Collaboration*LIGO- [E1100300](#)*LIGO*May 16<sup>th</sup>, 2014

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**aLIGO BSC-ISI, Pre-integration Testing report,  
Unit 7 - Phase I (post-assembly)**

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E1100300 – V2

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Distribution of this document:  
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**Table of contents:**

I. Pre-Assembly Testing.....4  
II. Tests to be performed during assembly.....6  
III. Tests to perform after assembly.....14  
IV. BSC-ISI testing Summary.....36

## ***Introduction***

The BSC-ISI testing is performed in three phases:

- 1) BSC-ISI, Pre-integration Testing, Phase I (post-assembly)
- 2) BSC-ISI, Pre-integration Testing, Phase II: Tests done after Transport (and possible storage), during mating phase with Suspensions, before insertion.
- 3) BSC-ISI, Integration Phase Testing: Procedure and results related to the commissioning in the chamber.

This document presents the series of tests (Phase I) performed on the fourth BSC-ISI assembled at LHO.

The testing procedure document E1000486-v5 was used.

All results are posted on the SVN at:

[https://svn.ligo.caltech.edu/svn/seismic/BSC-ISI/X1/Unit\\_7/](https://svn.ligo.caltech.edu/svn/seismic/BSC-ISI/X1/Unit_7/)

The following type of document can be found in the SVN:

- Excel spreadsheet (.xls)
- Data location
- Figures location
- Masses distribution scheme (ppt)

## I. Pre-Assembly Testing

### o *Step 1 - CPS Test and calibration – E1100369*

CPS sensors are tested (calibration and noise test) at MIT before being cleaned and baked at LHO. The list of installed sensors used for testing (phase I) are reported in step II.3.

All data related to the CPS testing can be found in the SVN at  
/svn/seismic/Common/Data/aLIGO\_BSC\_ISI\_CPS/

**Test result:** **Passed:**  X  **Failed:**  \_\_\_  **Waived :**

### o *Step 2 - GS13 – Inspection/Assembly – E1000058 – E1100740*

GS13 are tested and podded at LLO.

We had several GS-13s fail on this unit. Initially, 1h and 1v, then another vertical. A third vertical failed after a transfer function with too high drive.

The list of installed sensors used for testing (phase I) are reported in step II.3.

All the data related to GS-13 post podding testing can be found in the SVN at :  
/svn/seismic/Common/Data/aLIGO\_GS13\_TestData/PostMod\_TestResults\_PDFs

E1000058 and E1100740 spreadsheets provide the status of each individual GS-13 at LLO site for HAM-ISI and BSC-ISI and the installation location of the geophones.

**Test result:** **Passed:**  X  **Failed:**  \_\_\_  **Waived :**

### o *Step 3 - L4C – Inspection/Assembly – E1000136 – E1100740*

L4C are tested and podded at LLO. The list of installed sensors used for testing (phase I) are reported in step II.

One vertical L4C failed.

All the data related to L4C post podding testing can be found in the SVN  
at : /svn/seismic/Common/Data/aLIGO\_L4C\_TestData/TestResults\_PDFs/



## II. Tests to be performed during assembly

### o *Step 1 - Test stand level*

The Test Stand was transformed and re-leveled to dock a BSC-ISI.

Test result:    Passed:   X                            Failed:   \_\_\_                            Waived :   \_\_\_  

### o *Step 2 - Actuators Inventory*

The actuators S/N are reported in the table below. Further information can be found in T0900564 and T1100234.

Stage 1		Stage 2	
Actuator	Actuator S/N	Actuator	Actuator S/N
ST1 - H1	192	ST2 - H1	86
ST1 - H2	180	ST2 - H2	27
ST1 - H3	169	ST2 - H3	89
ST1 - V1	113	ST2 - V1	81
ST1 - V2	111	ST2 - V2	4
ST1 - V3	168	ST2 - V3	88

Table 1 - Actuators' inventory

Test result:    Passed:   X                            Failed:   \_\_\_                            Waived :   \_\_\_  

### o *Step 3 - Sensors Inventory*

The sensors S/N are reported in the table below.

CPS Stage 1	CPS S/N	ADE board serial #
H1	12957	
H2	12893	
H3	13189	
V1	13413	
V2	13455	
V3	13429	

Table 2 - Capacitive position sensors' inventory – Stage 1

CPS Stage 2	CPS S/N	ADE board serial #
H1	13424	
H2	12862	
H3	13434	
V1	13200	
V2	12907	
V3	13442	

Table 3 - Capacitive position sensors' inventory – Stage 2

Geophones GS13	Serial Number	POD
H1		30
H2		502
H3		19
V1		35
V2		501
V3		6

Table 4 - GS13 inventory

Geophones L4C	Serial Number	POD
H1		23
H2		24
H3		56
V1		47
V2		72
V3		45

Table 5 - L4C inventory

Geophones T240	Serial Number	POD
1		300
2		33
3		26

Table 6 - T240 inventory

Test result:

Passed:  X

Failed:  \_\_\_

Waived :  \_\_\_

**o Step 4 - Electronics Inventory**

Write down in the table below all serial numbers all the electronic equipment:

<b>Hardware</b>	<b>Ligo reference</b>	<b>S/N</b>
Interface Chassis - Corner 1	D1002432	S110223
Interface Chassis - Corner 2		S1102224
Interface Chassis - Corner 3		S1102218
Anti-aliasing Chassis - Corner 1	D1002693	S1102693
Anti-aliasing Chassis - Corner 2		S1102694
Anti-aliasing Chassis - Corner 3		S1102679
Anti-image Chassis	D070081	S1000250
Binary Input Chassis	D1001726	S1101309
Binary Input Chassis		S11031308
Binary Output Chassis	D1001728	S1101347
T240 Interface - Corner 1	D1002694	S1101040
T240 Interface - Corner 2		S1101838
T240 Interface - Corner 3		S1101839
I/O Chassis	n/a	
Coil driver Pod 1	D0902744	S1000266
Coil driver Pod 2		S1000269
Coil driver Pod 3		S110692

**Table 7 - Electronic equipment**

**Note:**

**Test result:**                                      **Passed:**   X                        **Failed:**   \_\_                        **Waived :**

**o Step 5 - Check level of Stage 0 after top-bottom plate assembly**

**Note:** This test has not been performed. The test stand was leveled before assembly began.

**Test result:**                                      **Passed:**   \_\_                        **Failed:**   \_\_                        **Waived :**   X  

**o Step 6 - Check gaps under the blade posts**



**Test result:**

**Passed: X**

**Failed:**

**Waived :**



**o Step 10 - Mass budget**

**Note:** The second version of the blade spacers was used. Consequently, the additional payload is expected to be close from design.

Six vibration absorbers were installed on stage 1. Masses on stage 2 are resting on Viton pads.

**Stage 1:**

The stage 1 payload is reported in the table below:

Corner 1            2x vib abs  
Corner 2            2x vib abs  
Corner 3            2x vib abs

<b>Stage 1</b>	
<b>Location</b>	<b>Weight (lb)</b>
Corner 1	1xt1,2xt4,3xt5,1x2613
Corner 2	1xt1,1xt2,1xt4,1x2613
Corner 3	5xt5,1xt3
<b>Total</b>	

Table 9 - Payload Stage 1

**Nominal payload on stage 1: 109Kg - 240lb**

**Nominal mass of stage 1=916Kg - 2019lb**



**o Step 12 – Cables inventory – E1100822**

The final Class A cables have been used for the testing of this Unit.

DCC Number	Description	Serial Number	Location	Inventory date	Tested
D1100154	25-pin M-to-two 9-pin F straight		L4C corner2		YES
D1100155	25-pin M-to-two 9-pin F straight		GS-13 corner2		YES
D1100148	2-wire, 14awg 3-pin M to 3-pin F		Act St1 V3		YES
D1100148	2-wire, 14awg 3-pin M to 3-pin F		Act St2 V2		YES
D1100148	2-wire, 14awg 3-pin M to 3-pin F		Act St2 H3		YES
D1100148	2-wire, 14awg 3-pin M to 3-pin F		Act St2 H2		YES
D1100148	2-wire, 14awg 3-pin M to 3-pin F		Act St1 H2		YES
D1100150	2-wire, 14awg 2 pins to 3-pin F		Act St1 H3		YES
D1100150	2-wire, 14awg 2 pins to 3-pin F		Act St1 V3		YES
D1100150	2-wire, 14awg 2 pins to 3-pin F		Act St1 V2		YES
D1100150	2-wire, 14awg 2 pins to 3-pin F		Act St1 V1		YES
D1100150	2-wire, 14awg 2 pins to 3-pin F		Act St1 H2		YES
D1100150	2-wire, 14awg 2 pins to 3-pin F		Act St1 H1		YES
D1100151	2-wire, 14awg 2 pins to 3-pin F		Act St2 H2		YES
D1100151	2-wire, 14awg 2 pins to 3-pin F		Act St2 V2		YES
D1100151	2-wire, 14awg 2 pins to 3-pin F		Act St2 H3		YES
D1100151	2-wire, 14awg 2 pins to 3-pin F		Act St2 V3		YES
D1100151	2-wire, 14awg 2 pins to 3-pin F		Act St2 V1		YES
D1100151	2-wire, 14awg 2 pins to 3-pin F		Act St H1		YES
D1100152	25-pin F-to-25-pin F		T240 corner3		YES
D1100152	25-pin F-to-25-pin F		T240 corner1		YES
D1100152	25-pin F-to-25-pin F		T240 corner2		YES
D1100153	25-pin F-to-25-pin F		L4C corner2		YES
D1100153	25-pin F-to-25-pin F		GS-13 corner3		YES
D1100153	25-pin F-to-25-pin F		L4C corner3		YES
D1100153	25-pin F-to-25-pin F		GS-13 corner2		YES
D1100153	25-pin F-to-25-pin F		L4C corner1		YES
D1100153	25-pin F-to-25-pin F		GS-13 corner1		YES
D1100148	2-wire, 14awg 3-pin M to 3-pin F		Act St2 V3 ext		YES
D1100148	2-wire, 14awg 3-pin M to 3-pin F		Act St2 H1 ext		YES
D1100148	2-wire, 14awg 3-pin M to 3-pin F		Act St1 V1		YES
D1100148	2-wire, 14awg 3-pin M to 3-pin F		Act St1 H3 ext		YES
D1100148	2-wire, 14awg 3-pin M to 3-pin F		Act St1 H1 ext		YES
D1100148	2-wire, 14awg 3-pin M to 3-pin F		Act St1 V2 ext		YES
D1100148	2-wire, 14awg 3-pin M to 3-pin F		Act St2 V1 ext		YES
D1100154	25-pin M-to-two 9-pin F straight		L4C corner1 ext		YES
D1100155	25-pin M-to-two 9-pin F straight		GS-13 corner1		YES

D1100155	25-pin M-to-two 9-pin F straight		GS-13 corner3		YES
D1100154	25-pin M-to-two 9-pin F straight		L4C corner3		YES

Test result: **Passed:**  X  **Failed:**  \_\_\_  **Waived:**  \_\_\_

*o Step 13 - Cable routing*

The final Class A cables have been used for the testing of this Unit.

The cabling has been done following [E1101027 aLIGO BSC-ISI Cable Routing Manual](#).

Test result: **Passed:**  X  **Failed:**  \_\_\_  **Waived :**  \_\_\_

### III. Tests to perform after assembly

*o Step 1- Geophones pressure readout*

Raw pressure measured by the geophones is reported in the table below:

Sensors	Pressure (kPa)		
	Corner 1	Corner 2	Corner 3
ST1-L4C-P			
ST1-L4C-D			
ST1-GS13-P			
ST1-GS13-D			
ST1-T240-P			

Table 11 - Raw Pressure

A screenshot of the MEDM pressure screen is saved in the Misc directory for Unit 6

**Note:** The T240's chassis has the old gain for the pressure sensors.

Test result: **Passed:**  X  **Failed:**  \_\_\_  **Waived :**  \_\_\_

**o Step 2- Set up sensors gap – Locked vs unlocked position**

During this step, sensors gap are adjusted. This step considers that the lockers have been finely setup during assembly.

Sensors	Table locked		Table unlocked		Difference locked - unlocked	
	Offset (Mean)	Std deviation	Offset (Mean)	Std deviation	Offset (Mean)	mil
ST1 - H1	-101	14	54	38	-156	-0.19
ST1 - H2	70	7	509	18	-440	-0.52
ST1 - H3	-234	15	-138	23	-96	-0.11
ST1 - V1	-459	18	-649	26	190	0.23
ST1 - V2	-109	13	-56	33	53	-0.06
ST1 - V3	-550	9	-250	32	-300	-0.36
ST2 - H1	1133	55	1125	25	8	0
ST2 - H2	1669	43	1638	34	31	0.01
ST2 - H3	1160	43	1319	22	-159	-0.05
ST2 - V1	-134	43	-188	81	54	0.02
ST2 - V2	-88	59	-159	90	71	0.02
ST2 - V3	454	40	536	84	82	-0.02

**Table 12 - Capacitive position sensors readout after gap set-up**

**Acceptance criteria:**

- In the locked position, all mean values must be lower than 400 counts for stage 1 CPS and 1600 counts for stage 2 CPS on Dataviewer (a bit less than .0005”).
- In the locked position, all standard deviations below 25 counts for stage 1, 100 counts for stage 2
- Absolute values of the difference between the unlocked and the locked table must be below:
  - Stage 1**
    - o 1600 cts for horizontal sensors (~0.002”)
    - o 1600 cts for vertical sensors (~0.002”)
  - Stage 2**
    - o 6500 cts for horizontal sensors (~0.002”)
    - o 6500 cts for vertical sensors (~0.002”)
- Considering the acceptance criteria of step 2, all mean values must be lower than
  - Stage 1**
    - o 2000 cts for horizontal sensors (~0.0025”)
    - o 2000 cts for vertical sensors (~0.0025”)
  - Stage 2**
    - o 8000 cts for horizontal sensors (~0.0025”)
    - o 8000 cts for vertical sensors (~0.0025”)

**Note: The CPS will be readjusted once SUS will installed**





o *Step 4.2 - Test N°2 – Push “locally”*

Sensors	Push in negative direction	Push in positive direction	Mil	Mil	Railing	Actuator Gap Check
ST1 - H1	-18500	16000	-24	21		X
ST1 - H2	-18000	18000	-21	20		X
ST1 - H3	-19000	18500	-20	19		X
ST1 - V1	-24500	24000	-29	29		X
ST1 - V2	27000	25000	-32	30		X
ST1 - V3	-26500	25000	-32	30		X
ST2 - H1					X	X
ST2 - H2					X	X
ST2 - H3					X	X
ST2 - V1					X	X
ST2 - V2					X	X
ST2 - V3					X	X

Table 13 - Stages range of motion – “Push locally”

**Acceptance criteria:**

- The vertical sensor readout must be positive when the optical table is pushed in the +Z direction
- The horizontal sensor readout on Stage 2 must be positive when the optic table is pushed in the +RZ direction
- **Step 4.2**
  - o Absolutes value of all estimated motions must be higher than 15000counts for stage 1 (~0.018”)
  - o Absolutes value of all estimated motions must be higher than 32000counts for stage 2 (~0.010”)

**Test result:**

**Passed:**  X

**Failed:**  \_\_\_

**Waived :**

## 0 Step 5 - Sensors spectra

The geophones spectra have been measured and can be found in the SVN:

seismic/BSC-ISI/X1/Unit\_7/Data/Spectra/Undamped/

- [X1 ISI ITMX ASD m LOC CPS T240 L4C GS13 2014 05 15 125407.mat](#) (Unlocked)
- [X1 ISI ITMX ASD m LOC CPS T240 L4C GS13 2014 05 15 160721.mat](#) (Locked)

seismic/BSC-ISI/X1/Unit\_7/Data/Figures/Spectra/Undamped/

- [X1 ISI ITMX ASD m LOC CPS T240 L4C GS13 2014 05 15 125407.fig](#) (Unlocked)
- [X1 ISI ITMX ASD m LOC CPS T240 L4C GS13 2014 05 15 160721.fig](#) (Locked)

## Stage locked – unlocked

The spectra are measured in two different configurations:

- Stage 1 locked – Stage 2 locked
- Stage 1 unlocked – Stage 2 unlocked

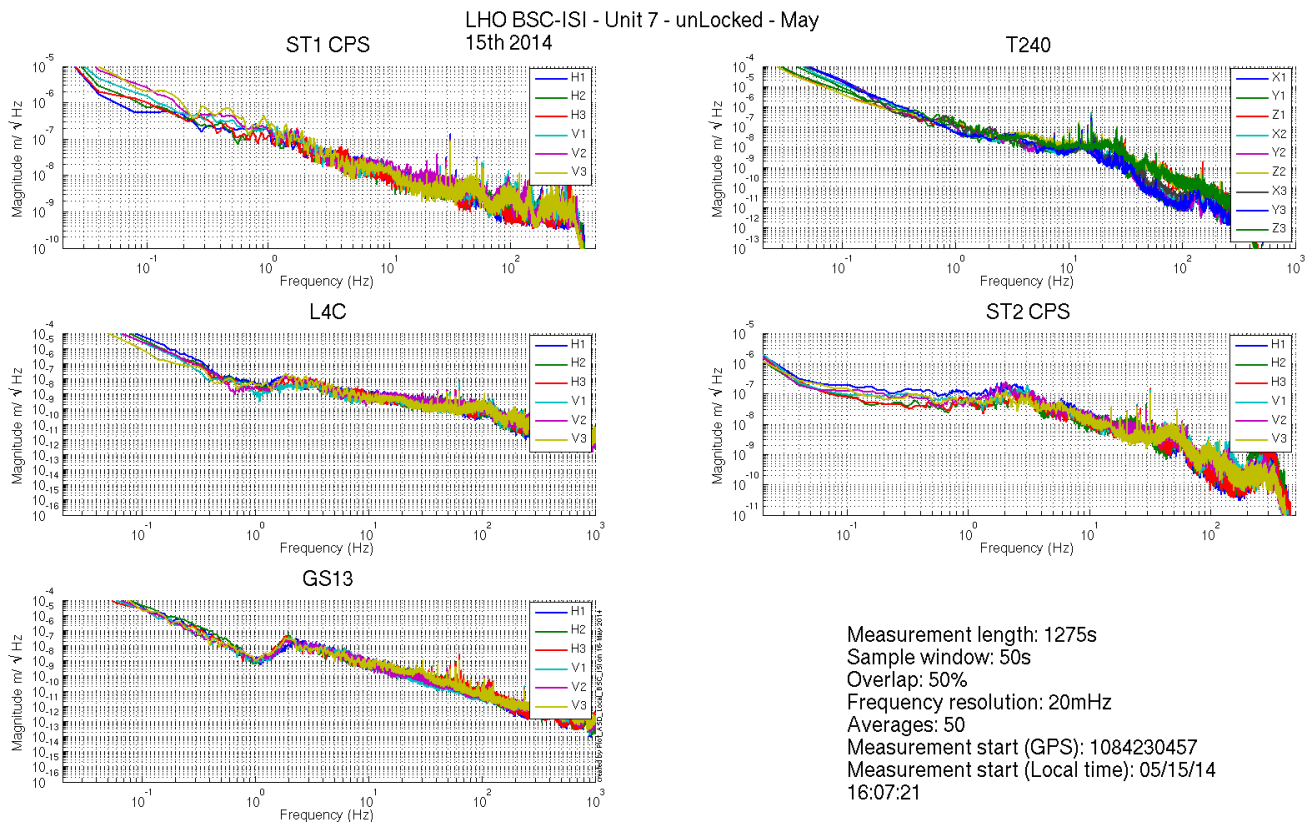
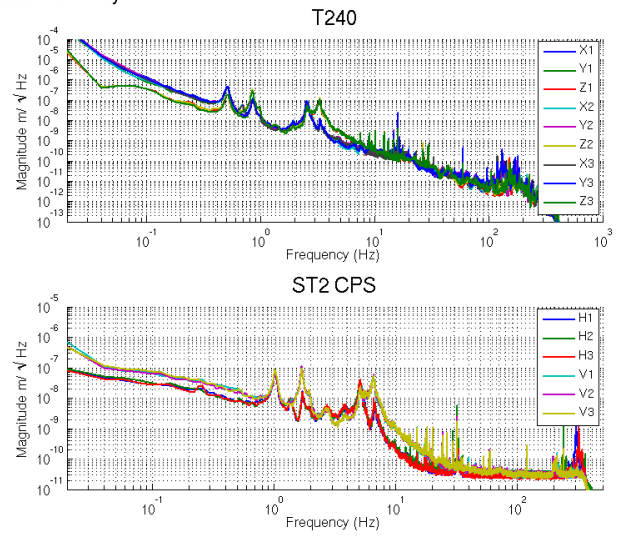
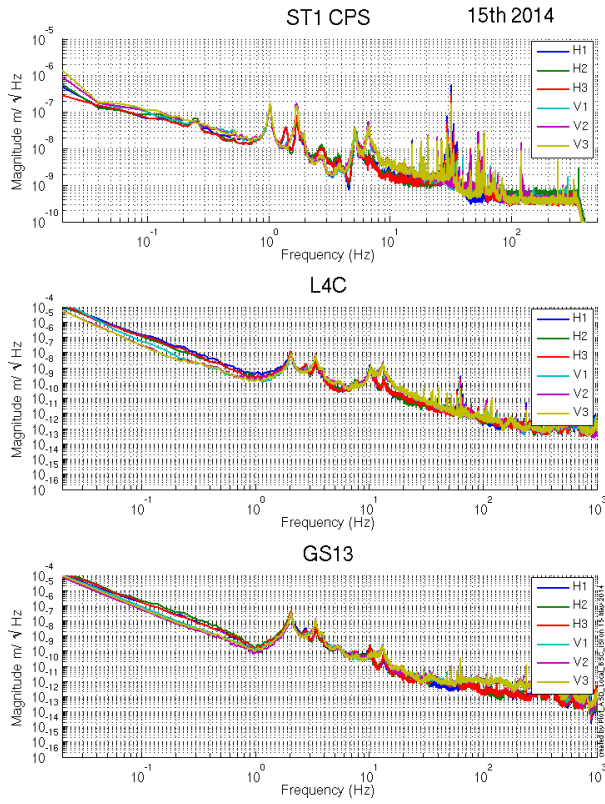


Figure 1: Calibrated Spectra Stage 1 Locked and Stage 2 Locked

LHO BSC-ISI - Unit 7 - unLocked - May  
15th 2014



Measurement length: 1275s  
Sample window: 50s  
Overlap: 50%  
Frequency resolution: 20mHz  
Averages: 50  
Measurement start (GPS): 1084218863  
Measurement start (Local time): 05/15/14  
12:54:07

Figure 2: Calibrated Spectra Stage 1 Unlocked and Stage 2 Unlocked

## Stage Tilted

The Spectra are measured when the ISI is unlocked a mass is placed on stage 2 to tilt Stage 1 and Stage 2.

The six configurations are the following in six different configurations:

- Mass placed in the actuator pocket at corner 1
- Mass placed in the pocket under the blade 0-1 at corner 1
- Mass placed in the actuator pocket at corner 2
- Mass placed in the pocket under the blade 0-1 at corner 2
- Mass placed in the actuator pocket at corner 3
- Mass placed in the pocket under the blade 0-1 at corner 3

/seismic/BSC-ISI/X1/Unit\_7/Data/Spectra/Undamped/

- [X1 ISI ITMX ASD m L4C GS13 Stage Tilted 2014 05 14.mat](#)

seismic/BSC-ISI/X1/Unit\_7/Data/Figures/Spectra/Undamped/

- [X1 ISI ITMX Tilted ASD m LOC ST1 L4C 2014 05 14.fig](#)
- [X1 ISI ITMX Tilted ASD m LOC ST2 GS13 2014 05 14.fig](#)

LHO BSC-ISI- Unit / - May 15th, 2014 - Staging building -  
ST1 - L4C Mass: Blade 0-1 Corner 1

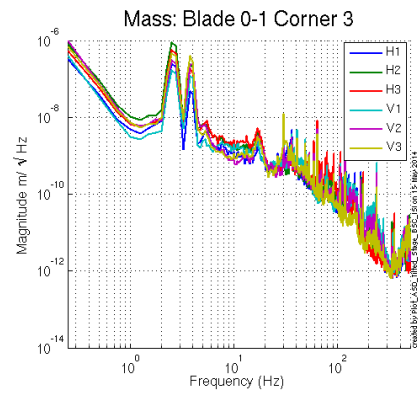
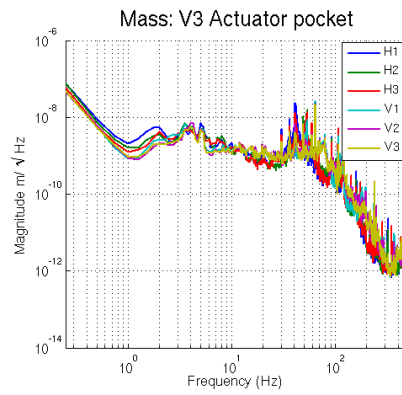
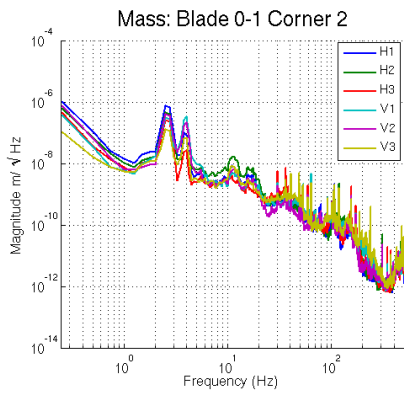
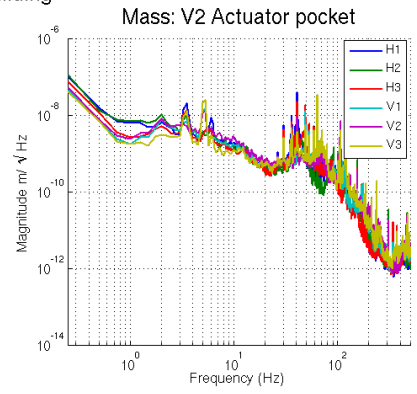
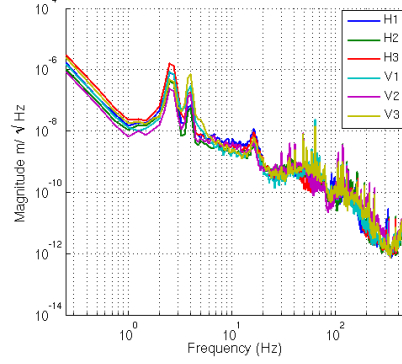
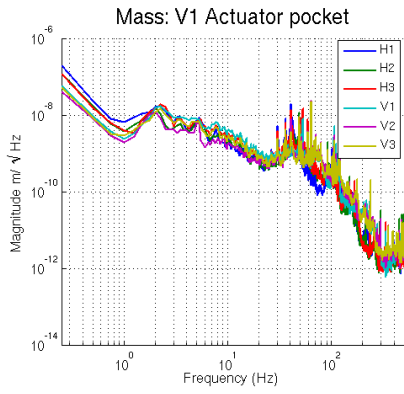


Figure 3 - ST1 L4C - Tilted

LHO BSC-ISI- Unit 7 - May 15th, 2014 - Staging building - ST2 - GS13 Mass: Blade 0-1 Corner 1

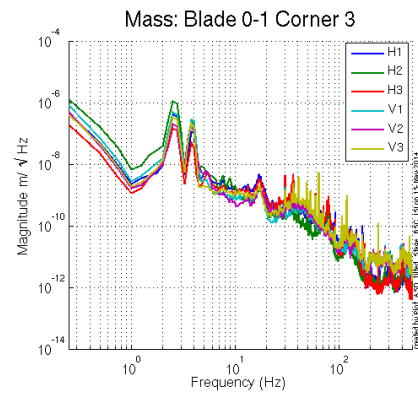
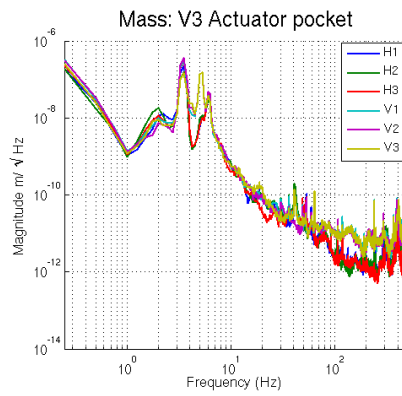
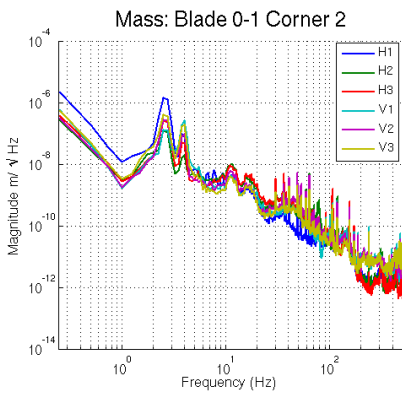
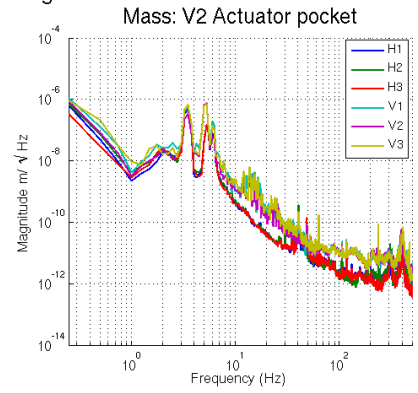
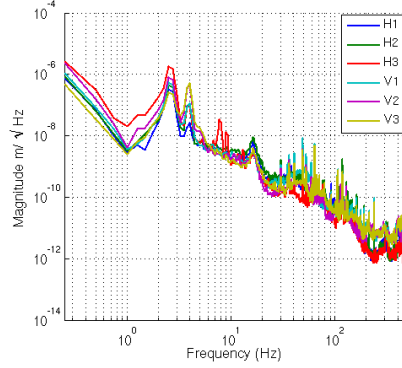
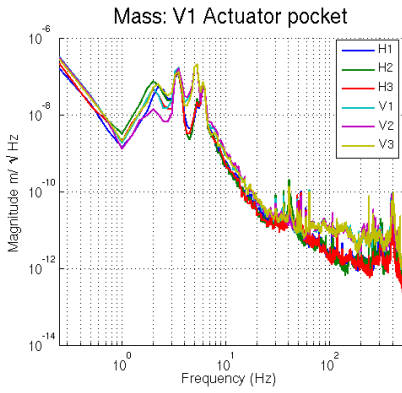


Figure 4 - ST1 GS13 – Tilted

Test result:

Passed:  X

Failed:    

Waived :

**o Step 6 - Coil Driver, cabling and resistance check**

Resistances of the couple (actuators + in vacuum cables) were measured using the voltage and current the coil drivers read back. Resistances of the couple actuator + in-vacuum cables are reported in the table below:

<b>Actuator</b>	<b>Resistance (<math>\Omega</math>)</b>
<b>ST1 H1</b>	<b>6.5</b>
<b>ST1 H2</b>	<b>6.5</b>
<b>ST1 H3</b>	<b>6.3</b>
<b>ST1 V1</b>	<b>6.3</b>
<b>ST1 V2</b>	<b>6.1</b>
<b>ST1 V3</b>	<b>6.4</b>
<b>ST2 H1</b>	<b>10.5</b>
<b>ST2 H2</b>	<b>10.1</b>
<b>ST2 H3</b>	<b>9.8</b>
<b>ST2 V1</b>	<b>10.6</b>
<b>ST2 V2</b>	<b>10.2</b>
<b>ST2 V3</b>	<b>10.4</b>

**Table 14 - Actuator Resistance**

**Acceptance criteria:**

- For the actuators of stage 1, the measured resistance between the middle pin and one side pin must be 6.3 +/-0.5 ohms
- For the actuators of stage 2, the measured resistance between the middle pin and one side pin must be 10.3 +/-0.5 ohms
- Actuator neutral pins must be connected on pin #1 (left side pin of the plug)
- Actuator drive pins must be connected on pin #2 (middle pin of the plug)
- Actuator ground shield pins must be connected on pin #3 (right pin of the plug)
- All LEDs on the coil driver front panel must be green the binary input bit must be in the upper state.

**Test result:**

**Passed:**   X  

**Failed:**     

**Waived :**





Stage 2 - Platform move for 32K counts drive:

3.59 mil

**Note:** The range of motion in the case of a “local drive” is in agreements with the measurements done on the previous units.

**Test result:** Passed:  X  Failed: \_\_\_ Waived :

**o Step 8 - Vertical Sensor Calibration**

Not done.

**Test result:** Passed: \_\_\_ Failed: \_\_\_ Waived : X

**o Step 9 - Vertical Spring Constant**

This test is realized by loading the ISI when one stage is locked and using the capacitive position sensors as reference.

The stiffness measurements of the spring are reported in the tables below. The nominal blade stiffness are:

- Stage 1: 1241lb/in
- Stage 2: 1465lb/in

**Blade Stage 0-1**

Stage 2 Locked & Stage 1 Unlocked. Stage 2 is loaded with 3 x 10kg masses and the measurements are repeated three times (by rotating the masses).

	<b>Mean No load</b>	<b>Mean Load</b>	<b>Diff</b>
<b>V1</b>	88	-14728	14816
<b>V2</b>	-3704	-18105	14401
<b>V3</b>	855	-15103	15868

15028 count  
18.1 mil  
1219 lb/in  
-1.7 %

## Blade Stage 1-2

Stage 1 Locked & Stage 2 Unlocked. Stage 2 is loaded with 3 x 5Kg masses and the measurements are repeated three times (by rotating the masses).

	Mean no load	Mean load	Diff 1
<b>V1</b>	493	-25864	26357
<b>V2</b>	272	-26023	26296
<b>V3</b>	679	-25304	25984

26212 count  
7.9 mil  
1386 lb/in  
-5.4 %

**Test mitigation:** Blades are softer than design.

**Test result:** Passed: X Failed: \_\_ Waived :

### o Step 10 - Static Testing (Tests in the local basis)

The static tests results are reported in the SVN at :

seismic/BSC-ISI/X1/Unit\_7/Data/Static\_Tests/

- X1\_ISI\_ITMX\_Offset\_Local\_Drive\_20131210.mat

The table below shows the main and the cross-coupling when the actuators are driven in the local basis:

		Sensors					
		ST1 - H1	ST1 - H2	ST1 - H3	ST1 - V1	ST1 - V2	ST1 - V3
Actua tors	ST1 - H1	4204	1713	1681	16	-9	-39
	ST1 - H2	1608	4176	1689	-7	9	-6
	ST1 - H3	1701	1660	4123	-19	-11	-2
	ST1 - V1	-51	-192	39	3451	-649	-648
	ST1 - V2	86	76	-152	-626	3450	-634
	ST1 - V3	-173	111	41	-639	-600	-3363

Table 16 - Static test - Local to local - Stage 1

		Sensors					
		ST2 - H1	ST2 - H2	ST2 - H3	ST2 - V1	ST2 - V2	ST2 - V3
Actuators	ST2 - H1	2401	359	354	-5	-37	0.9
	ST2 - H2	369	2371	354	-35	-14	-16
	ST2 - H3	354	347	2315	-47	-26	-5
	ST2 - V1	77	130	-229	-2880	288	-47
	ST2 - V2	-200	83	130	-57	2844	293
	ST2 - V3	125	-205	83	271	-79	2815

Table 17 - Static test - Local to local - Stage 2

**Acceptance criteria:**

- Main couplings readout must be positive
- Comparison with the reference tables:
  - o Main coupling differences mustn't exceed 200 counts
  - o Cross coupling differences mustn't exceed 50 counts

**Test result:** Passed:  X  Failed: \_\_\_ Waived :

- o *Step 11- Static Testing - In the general coordinate basis (Static test - CPS)*

Not performed.

**Test result:** Passed: \_\_\_ Failed: \_\_\_ Waived : X

- o *Step 11.2 – Base change matrices from Cartesian to Cartesian*

Not performed.

**Test result:** Passed: \_\_\_ Failed: \_\_\_ Waived : X

### o Step 12 - Linearity test

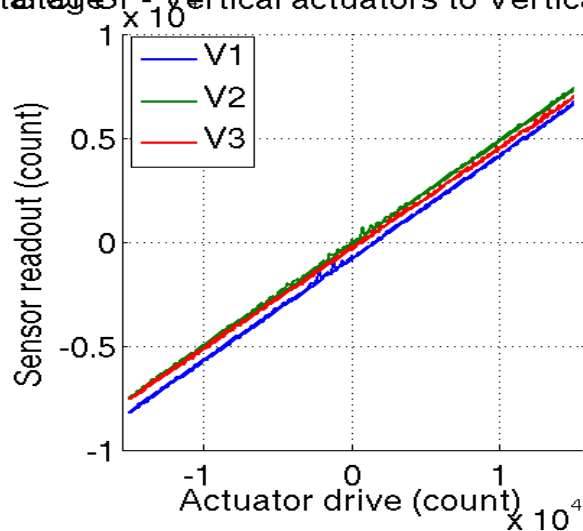
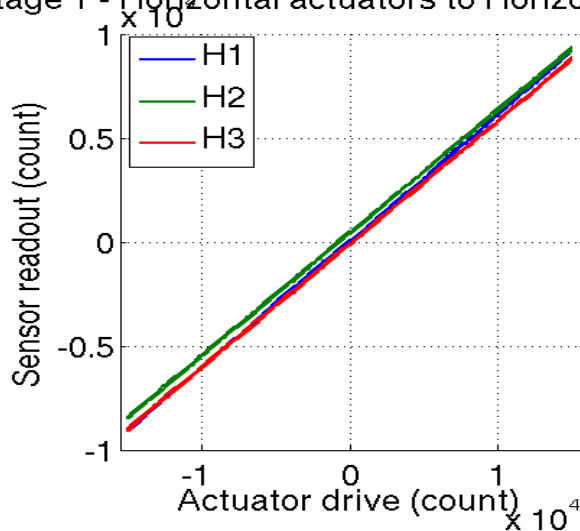
The "Linearity test" was performed twice (rearranging the cables). The second time, all corners seemed to respond similarly.

The linearity test data can be found in the SVN at:  
/seismic/BSC-ISI/X1/Unit\_7/Data/Linearity\_Test/  
[X1 ISI ITMX Linearity test 20140515.mat](#)

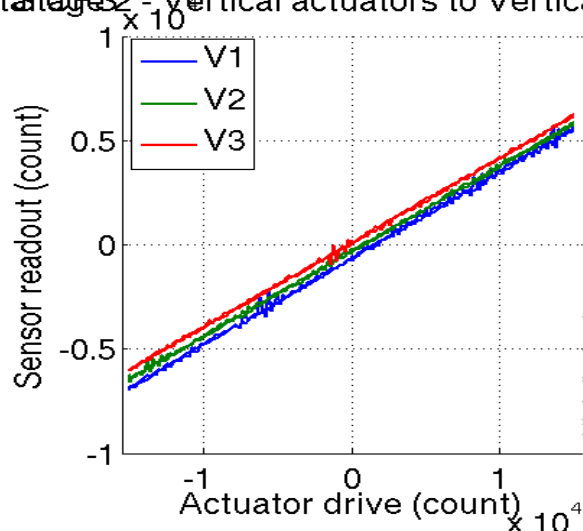
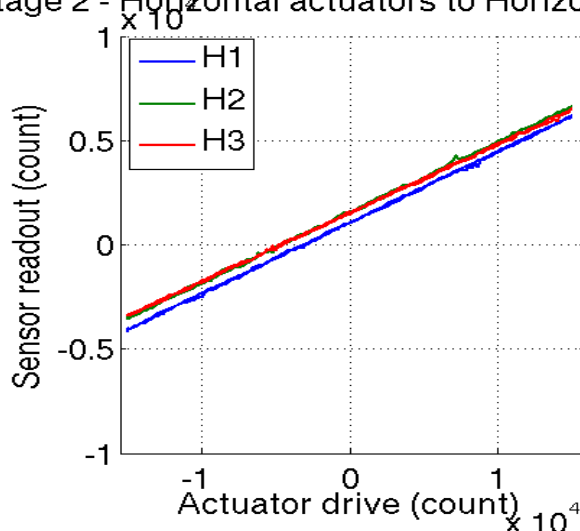
The linearity test figures can be found in the SVN at:  
/seismic/BSC-ISI/X1/Unit\_7/Data/Figures/Linearity\_Test/  
[X1 ISI ITMX Linearity test 20140515.fig](#)

### LHO BSC-ISI - Unit 7 - May 15th, 2014 - Staging Building

Stage 1 - Horizontal actuators to Horizontal CPS      Stage 1 - Vertical actuators to Vertical CPS



Stage 2 - Horizontal actuators to Horizontal CPS      Stage 2 - Vertical actuators to Vertical CPS



created by Linearity\_Test\_Avishwan\_BSC\_ISI on 15 May 2014

**Figure 5 - Linearity Test**

**Slope – Offset:**

		Slope	Offset	Average slope	Variation from average(%)
<b>Stage 1</b>	ST1 - H1	0.61	55	0.60	1.72
	ST1 - H2	0.59	451		-0.99
	ST1 - H3	0.59	-88		-0.73
	ST1 - V1	0.49	-799	0.49	0.71
	ST1 - V2	0.49	-56		0.77
	ST1 - V3	0.48	-292		-1.48
<b>Stage 2</b>	ST2 - H1	0.34	1060	0.34	1.63
	ST2 - H2	0.34	155		0.44
	ST2 - H3	0.33	1527		-2.06
	ST2 - V1	0.42	-642	0.41	1.41
	ST2 - V2	0.41	-312		-0.39
	ST2 - V3	0.41	101		-1.03

**Table 18 - Slopes and offset of the triplet Actuators - BSC-ISI – Sensors**

**Acceptance criteria:**

- Horizontal and vertical slopes of the triplet actuators x BSC-ISI x sensors: Average slope +/- 2.5%

**Test result:**

**Passed:**   X  

**Failed:**   \_\_\_  

**Waived :**

### ***o Step 13 – Transfer functions – Local to Local***

**Note:** two vibration absorbers were installed in corner 1 and 2 vibration absorbers were installed in corner 3. No TMDs were installed on the stage 0-1 blades.

#### **Data files measurement of local to local transfer functions in SVN at:**

seismic/BSC-ISI/X1/Unit\_7/Data/Transfer\_Functions/Measurements/Undamped/

- [X1 ISI ITMX TF L2L Raw from ST1 ACT to ST1 CPS 2014 05 14.mat](#)
- 
- [X1 ISI ITMX TF L2L Raw from ST1 ACT to ST1 T240 2014 05 14.mat](#)
- [X1 ISI ITMX TF L2L Raw from ST1 ACT to ST2 CPS 2014 05 14.mat](#)
- [X1 ISI ITMX TF L2L Raw from ST1 ACT to ST2 GS13 2014 05 14.mat](#)
- [X1 ISI ITMX TF L2L Raw from ST2 ACT to ST1 L4C 2014 05 14.mat](#)
- [X1 ISI ITMX TF L2L Raw from ST2 ACT to ST1 T240 2014 05 14.mat](#)
- [X1 ISI ITMX TF L2L Raw from ST2 ACT to ST2 CPS 2014 05 14.mat](#)
- [X1 ISI ITMX TF L2L Raw from ST2 ACT to ST2 GS13 2014 05 14.mat](#)
- 
- 
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- 

#### **Script file for processing and plotting local to local transfer functions in SVN at:**

/seisvn/seismic/BSC-ISI/X1/Unit\_7/Scripts/Control\_Scripts

- Step\_1\_TF\_L2L\_Raw\_X1\_ISI\_TST.m

#### **Figures of local to local transfer functions (Main couplings) in SVN at:**

/seismic/BSC-ISI/X1/Unit\_7/Data/Figures/Transfer\_Functions/Measurements/Undamped/

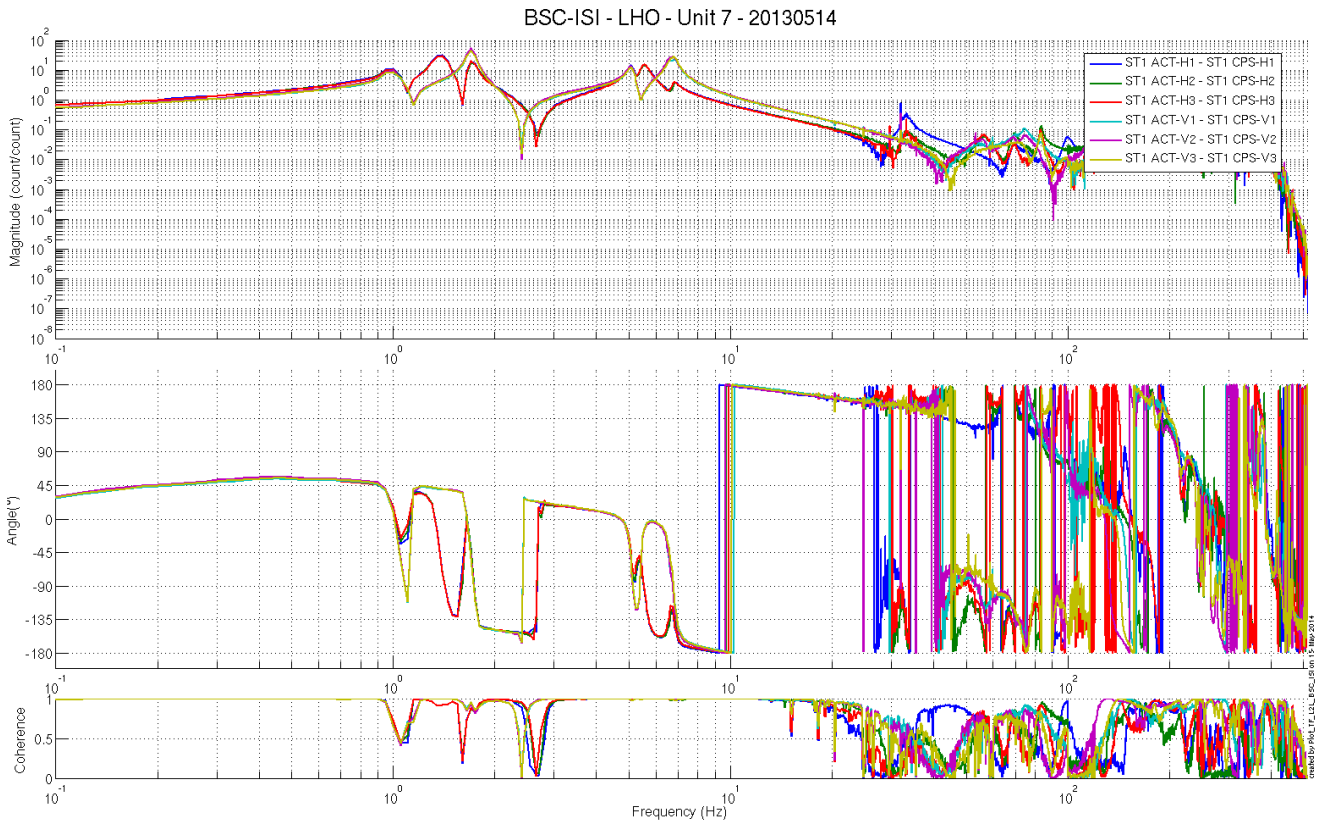
- [X1 ISI ITMX TF L2L Raw from ST1 ACT to ST1 CPS 2014 05 14.fig](#)
- [X1 ISI ITMX TF L2L Raw from ST1 ACT to ST1 L4C 2014 05 14.fig](#)
- [X1 ISI ITMX TF L2L Raw from ST1 ACT to ST1 T240 2014 05 14.fig](#)
- [X1 ISI ITMX TF L2L Raw from ST1 ACT to ST2 CPS 2014 05 14.fig](#)
- [X1 ISI ITMX TF L2L Raw from ST1 ACT to ST2 GS13 2014 05 14.fig](#)
- [X1 ISI ITMX TF L2L Raw from ST2 ACT to ST1 L4C 2014 05 14.fig](#)
- [X1 ISI ITMX TF L2L Raw from ST2 ACT to ST1 T240 2014 05 14.fig](#)
- [X1 ISI ITMX TF L2L Raw from ST2 ACT to ST2 CPS 2014 05 14.fig](#)
- [X1 ISI ITMX TF L2L Raw from ST2 ACT to ST2 GS13 2014 05 14.fig](#)

#### **Measured of local to local transfer functions in the SVN at:**

/svncommon/seisvn/seismic/BSC-ISI/X1/Unit\_7/Data/Transfer\_Functions/Simulations/Undamped

- [X1 ISI ITMX TF L2L Raw 2014 05 14.mat](#)

**Note 1:** The transfer functions are measured from the Output filter bank (excitation variable) to the input (IN1) of the input filter bank. The transfer functions presented below are raw transfer functions without any electronic compensation of the sensor electronic. The actuator and the coil driver electronic compensation are introduced in these transfer functions.



**Figure 6: TF L2L Raw - ST1 Act to ST1 CPS**



BSC-ISI - LHO - Unit 7 - 20130514

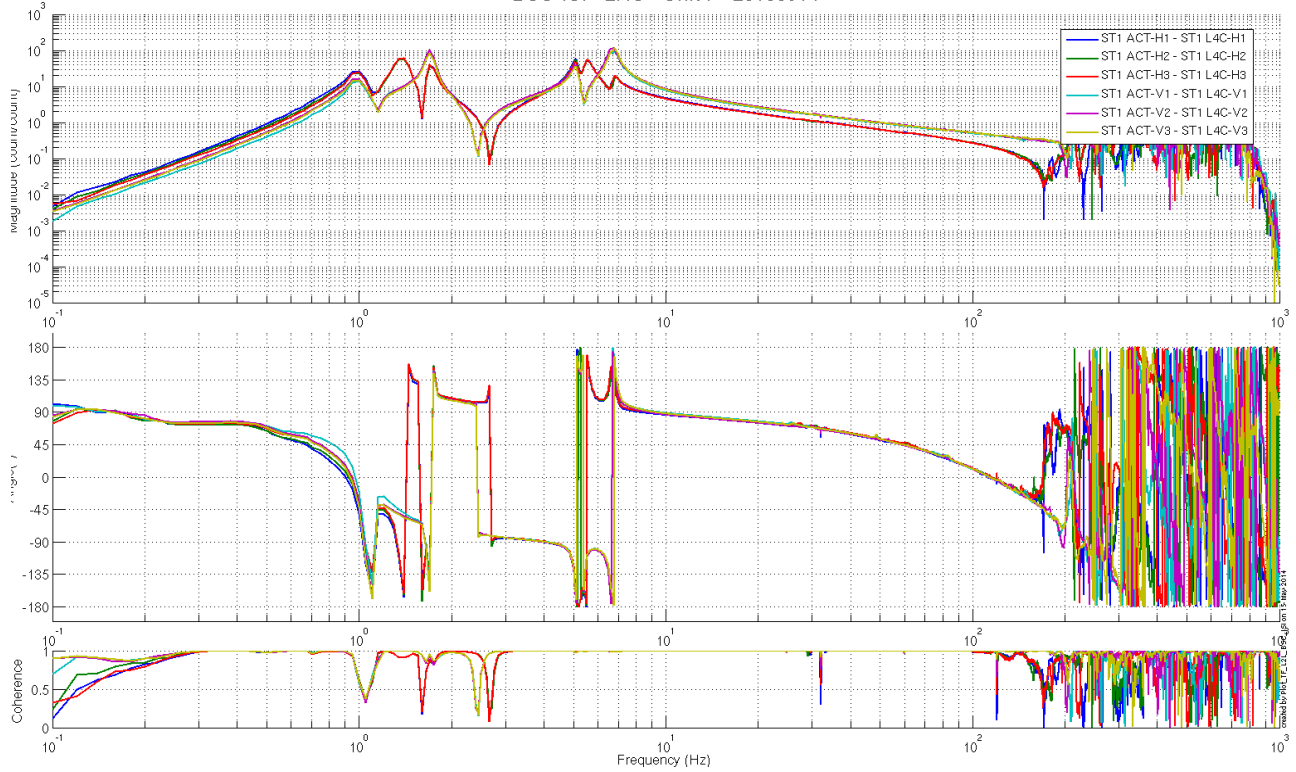


Figure 7: TF L2L Raw - ST1 Act to ST1 L4C

BSC-ISI - LHO - Unit 7 - 20130514

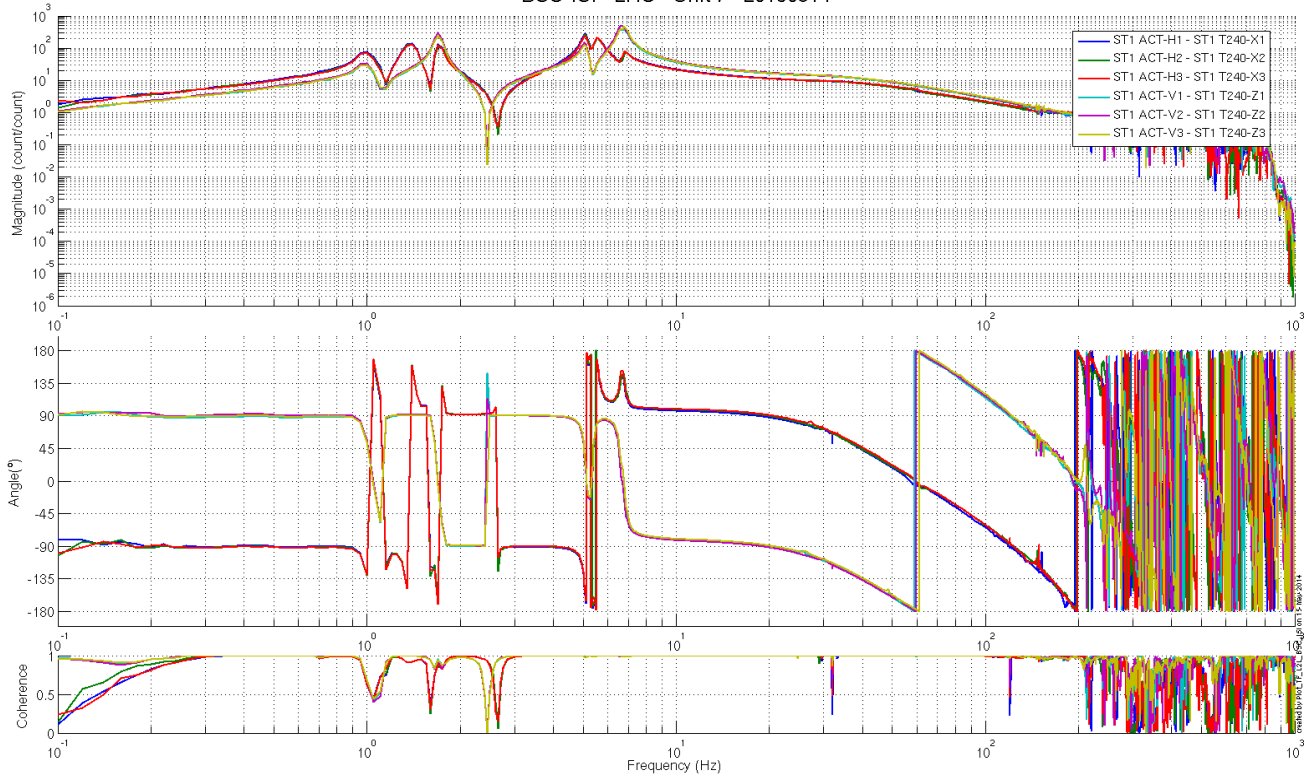


Figure 8 - TF L2L Raw - ST1 Act to ST1 T240

BSC-ISI - LHO - Unit 7 - 20130514

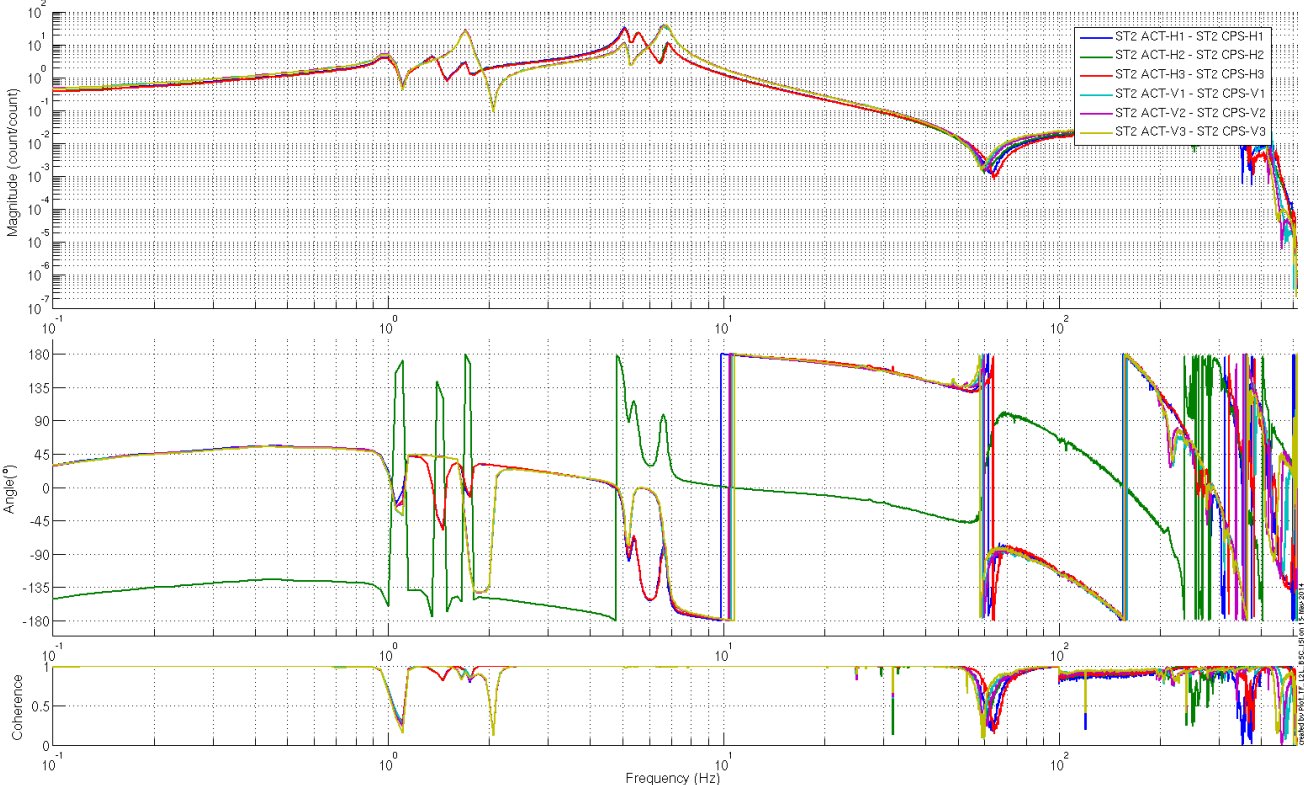
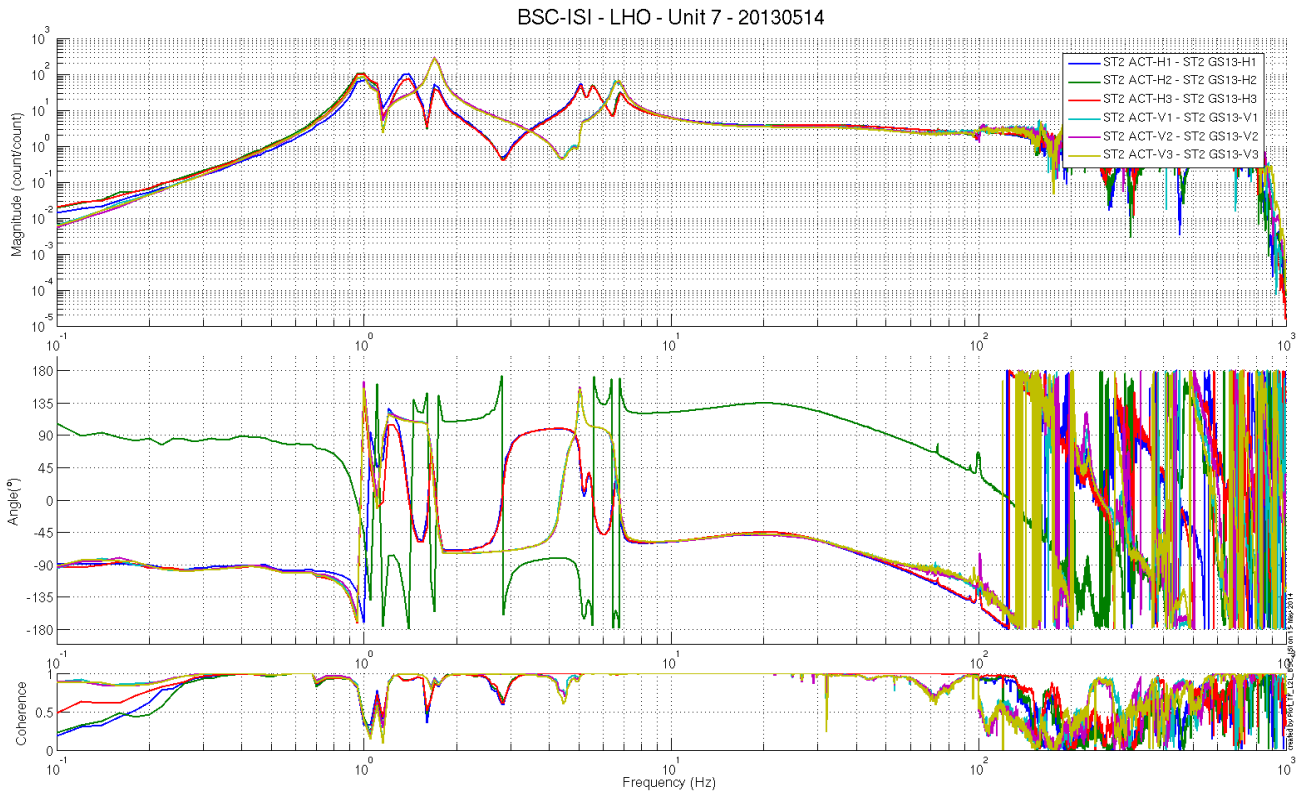


Figure 9: TF L2L Raw - ST2 Act to ST2 CPS



**Figure 10: TF L2L Raw - ST2 Act to ST2 GS13**

**Test result:** **Passed:**  X  **Failed:**     **Waived :**

#### **IV. BSC-ISI testing Summary**

This is the third “aLigo BSC-ISI” tested at LHO. The testing procedure document E1000483-v5 was used. Tests were done during in March 2013.

The LHO ISI-BSC Unit 5 is validated per the tests presented in this report. All results are posted on the SVN at:

[https://svn.ligo.caltech.edu/svn/seismic/BSC-ISI/X1/Unit\\_7/Data](https://svn.ligo.caltech.edu/svn/seismic/BSC-ISI/X1/Unit_7/Data)

#### **FAILED AND WAIVED TESTS**

##### **1- List of tests that failed/waived and won't be redone**

- **Step III.9 – Spring constant** – The blades are slightly softer than the design. However, the blade softness's are in good agreements with what was measured on the other units.

##### **2- List of tests that failed/waived, that need to be re-done during phase 2**

**3- List of tests skipped that won't be performed because not feasible during phase II (i.e. stage 0 leveling)**

- **Step II.5** – Check level of Stage 0 after top-bottom plate assembly
- **Step II.8** – Blade 0-1 Post Launch Angle – No need for this test, the budget mass looks good and we already reposition the Blades after noticing a gap between the Blade and its Spacer on Stage 0-1 (see comment on Step 9 – Vertical Spring Constant).
  
- **Step III.3 – Measure the Sensor gap** - This test was not performed. The sensor gaps have not been measured. These sensors have already been checked at LASTI. Moreover, risks of scratching the target are so high that we preferred not performing this test. In the future, this test will be removed from the testing procedure.
- **Step III.8 – Vertical sensor calibration** - The test is not realized in a proper way to evaluate accurately the calibration of the vertical CPS.

**4- Lists of tests skipped that needs to be done during phase II.**

- **Step III.14 – Symmetrization – Calibration**
- **Step III.17 – Lower Zero Moment Plan**
- **Step III.18.1 – Damping Loops – Stage 2**
- **Step III.18.2 – Damping Loops – Stage 1**
- **Step III.20 – Isolation loops**