LIGO Laboratory / LIGO Scientific Collaboration

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aLIGO BSC-ISI, Pre-integration Testing report, Phase II (before and after cartridge install)

E1100846 – V3

Jim Warner

Distribution of this document:
Advanced LIGO Project

This is an internal working note
of the LIGO Laboratory

California Institute of Technology
LIGO Project – MS 18-34
1200 E. California Blvd.
Pasadena, CA 91125
Phone (626) 395-2129
Fax (626) 304-9834
E-mail: info@ligo.caltech.edu

Massachusetts Institute of Technology
LIGO Project – NW22-295
185 Albany St
Cambridge, MA 02139
Phone (617) 253-4824
Fax (617) 253-7014
E-mail: info@ligo.mit.edu

LIGO Hanford Observatory
P.O. Box 1970
Mail Stop S9-02
Richland WA 99352
Phone 509-372-8106
Fax 509-372-8137

LIGO Livingston Observatory
P.O. Box 940
Livingston, LA 70754
Phone 225-686-3100
Fax 225-686-7189

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Introduction

The BSC-ISI testing is performed in three phases:
1) BSC-ISI, Pre-integration Testing, Phase I (post-assembly, in the staging building)
2) BSC-ISI, Pre-integration Testing, Phase II: Final tests done before insertion in the chamber
3) BSC-ISI, Integration Phase Testing: Procedure and results related to the commissioning in the chamber.

The ISI-BSC10 was moved from the Staging building to the VEA test stand July 2013.

This document presents results of tests (Phase II) performed on the ISI-BSC10 (ETMY) before installation in the chamber.

All results are posted on the SVN at:
https://svn.ligo.caltech.edu/svn/seismic/BSC-ISI/H1/ETMY/

The following type of document can be found in the SVN:
- Excell spreadsheet (.xls)
- Data location
- Figures location
- Masses distribution scheme (ppt)

1. Phase II-a

1. Hardware changes

1. CPS – E1100369

CPS have not been replaced since phase I testing in the staging building.

2. GS13 – E1100740

GS13 have not been replaced since phase I testing in the staging building.

3. L4C – E1100740

L4C have not been replaced since phase I testing in the staging building.

4. T240 – E1100740

T240 have not been replaced since phase I testing in the staging building.

5. Cables – E1100822

The cables installed on ISI-BSC3 are reported in the table below. Further information can be found in E1100822.

6. Misc

No hardware changes since phase I testing in the staging building.

2. Electronic Inventory

This table reports the electronic equipment used in the LVEA.

3. Models Modifications

The model was updated and recompiled since MEDM screens were modified

4. Mass distribution

Here is the payload distribution of the ISI. SUS-QUAD and TMS are installed.

Stage 1

Location	Mass Type	Weight (lb)	Weight (Kg)
Corner 1	**D0902616 - 2,3,4,4**	13	6.0
Corner 2	**D0902616 - 2,2,2,3,3,1**	10	4.6
Corner 3	**D0902616 - None**	0	0.0
	6 vibration absorbers (60Kg)	90	41.2
		113	51.8

Table 1 - Payload Stage 1

Stage 2

Location	Mass Type	Weight (lb)	Weight (Kg)
Corner 1	**D071200 - 1,1,1,5,5**	33	15
Corner 2	**D071200 - 5,5,6**	58	27
Corner 3	**D071200 - 1,1,6**	29	13
	Keel Masses (D1003136)	600	275
	Ballast Masses (6x46lb)	276	126
	Total	**997**	**457**

Table 2 - Payload Stage 2

This is the Stage 2 Seismic payload. Add ~900 lbs for a quad and ~450 for the TMS and the total payload is 2347lb.

Test result: **Passed: _X_** **Failed: ___** **Waived: ___**

5. Basic functionalities just after installing the BSC-ISI on the teststand

▯▯ Pressure sensors

All pressure sensors are working.

ISI Pods Pressure Sensors - ETMY

P REF 100
P DEV 3
P DIF 3

	Corner 1	Corner 2	Corner 3	
ST1 L4-C Direct Pressure	96	98	98	KPa
ST1 L4-C Differential Pressure	-1	0	0	KPa
ST2 GS-13 Direct Pressure	98	100	100	KPa
ST2 GS-13 Differential Pressure	0	0	0	KPa
ST1 T240 Direct Pressure	100	100	100	KPa

Table 3 - Geophones Pressure sensors

Test result: **Passed: _X_** **Failed: ___** **Waived: ____**

i. Spectra

Spectra of the instrument can be found in the SVN at:
seismic/BSC-ISI/H1/ETMY/Data/Spectra/Undamped/

- H1_ISI_ETMY_ASD_m_LOC_CPS_T240_L4C_GS13_2020_02_20_4 7:2:.mat

https://svn.ligo.caltech.edu/svn/seismic/BSC-ISI/H1/ETMY/Data/Figures/Spectra/Undamped/

- H1_ISI_ETMY_ASD_m_LOC_CPS_T240_L4C_GS13_2020_02_20_4 7:2:.fig

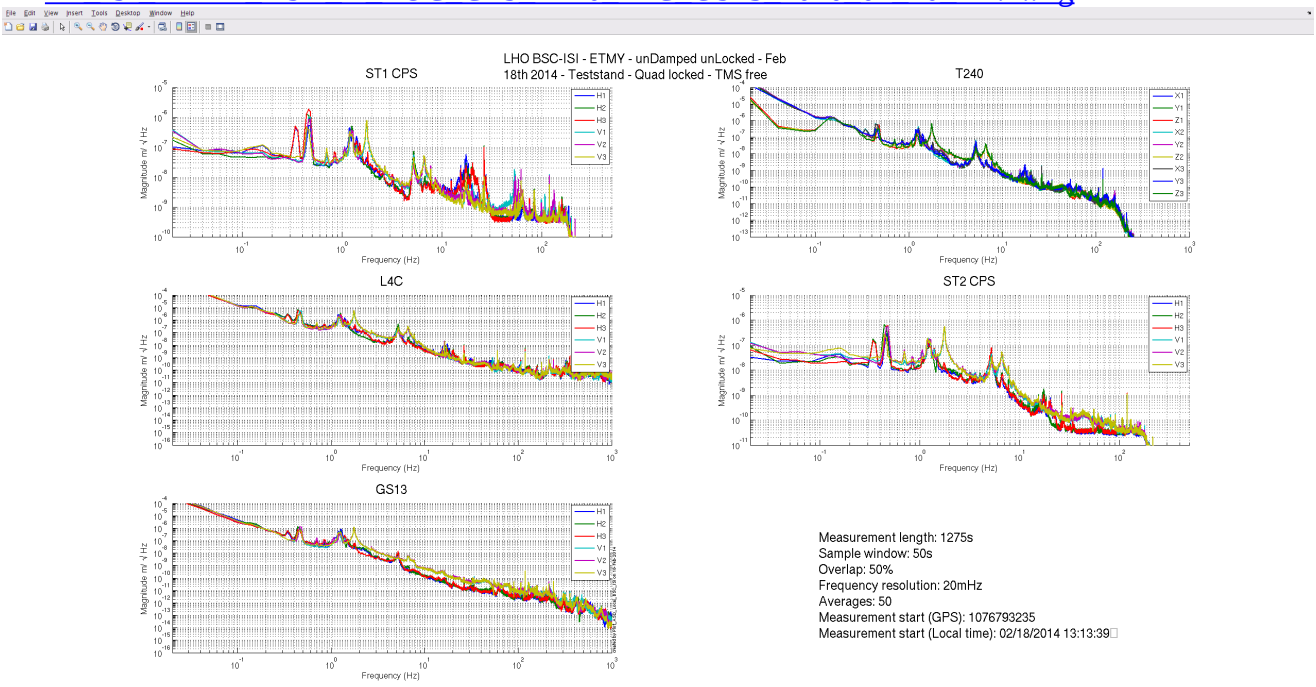

Figure 1 - Spectra inboard instruments - ISI Unlocked

Test result: **Passed: _X_** **Failed: ___** **Waived: ____**

ii. Actuators-cables resistance

Not done. Can be completed outside the chamber if needed.

Test result: **Passed: __** **Failed: ___** **Waived: _X__**

iii. Offsets CPS Unlocked vs locked

	Table locked		Table unlocked		Difference locked - unlocked	
Sensors	Offset (Mean)	Std deviation	Offset (Mean)	Std deviation	Offset (Mean)	mil
ST1 - H1	-49	9	-193	110	-144	.17
ST1 - H2	2290	5	1824	138	-466	.56
ST1 - H3	270	5	-2776	123	-3047	3.63
ST1 - V1	372	31	1552	80	1180	1.4
ST1 - V2	1570	11	576	95	-994	1.18
ST1 - V3	342	17	975	115	-1317	1.57
ST2 - H1	695	31	-307	199	-1003	.30
ST2 - H2	1854	33	1273	224	-580	.17
ST2 - H3	2253	20	2172	117	-81	.02
ST2 - V1	161	20	200	207	39	.01
ST2 - V2	-290	22	-123	227	167	.05
ST2 - V3	3923	21	3758	275	-165	.05

Table 4 - Locked vs Unlocked Position

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

iv. Offset local drive

Skipped due to time.

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

v. Offset Cartesian drive

Skipped due to time.

vi. Range of motion

The range of motion of the table is measured by pushing on the table in a direction collinear to the CPS. The Static tests results can be found on the SVN at:
https://svn.ligo.caltech.edu/svn/seismic/BSC-ISI/H1/ETMY/Data/Static_Tests/

Sensor readout (counts)	Negative drive	no drive	Positive drive	Amplitude count	mil
ST1 - H1	-15612	-193	16542	32169	**38**
ST1 - H2	-15628	1824	16948	32150	**38**
ST1 - H3	-14882	-2776	14759	28784	**34**
ST1 - V1	-11694	1552	13890	26027	**31**
ST1 - V2	-12381	576	13739	26276	**31**
ST1 - V3	-14945	-974	11519	25983	**31**
ST2 - H1	-10347	-307	9150	19280	**5.7**
ST2 - H2	-8289	1273	11022	19381	**5.8**
ST2 - H3	-7700	2172	11844	19315	**5.7**
ST2 - V1	-12616	199	10781	22504	**6.7**
ST2 - V2	-11426	-122	10823	23188	**6.9**
ST2 - V3	-9812	3758	13120	22479	6.7

Table 5 - Range of motion - Actuator drive in the LVEA

Test result: **Passed: _X_** **Failed: ___** **Waived: ____**

vii. Linearity test

Skipped due to time.

Note:

Test result: **Passed: _X_** **Failed: ___** **Waived: __**

6. Transfer functions and Comparison with measurements done in the staging building.

1. At the end station

Measurements data can be found in the SVN at:
SeiSVN/seismic/BSC-ISI/H1/ETMY/Data/Transfer_Functions/Measurements/Undamped:

- H1_ISI_ETMY_Data_L2L_500Hz_1000Hz_ST1_ST2_20140219-055819.mat
  H1_ISI_ETMY_Data_L2L_100Hz_500Hz_ST1_ST2_20140219-032326.mat
  H1_ISI_ETMY_Data_L2L_100mHz_700mHz_ST1_ST2_20140219-003031.mat
  H1_ISI_ETMY_Data_L2L_10Hz_100Hz_ST1_ST2_20140219-183606.mat
  H1_ISI_ETMY_Data_L2L_700mHz_10Hz_ST1_ST2_20140219-153718.mat
-

Once the data are processed, they can be found in the SVN at:
/seismic/BSC-ISI/H1/ETMY/Data/Transfer_Functions/Simulations/Undamped/
- H1_ISI_TST_TF_L2L_Raw_2014_02_21.mat

The transfer functions can be found in the SVN at:
seismic/BSC-ISI/H1/ETMY/Data/Figures/Transfer_Functions/Measurements/Undamped/

- H1_ISI_TST_TF_L2L_Raw_from_ST1_ACT_to_ST1_CPS_2014_02_21.fig
- H1_ISI_TST_TF_L2L_Raw_from_ST1_ACT_to_ST1_L4C_2014_02_21.fig
- H1_ISI_TST_TF_L2L_Raw_from_ST1_ACT_to_ST1_T240_2014_02_21.fig
- H1_ISI_TST_TF_L2L_Raw_from_ST1_ACT_to_ST2_CPS_2014_02_21.fig
- H1_ISI_TST_TF_L2L_Raw_from_ST1_ACT_to_ST2_GS13_2014_02_21.fig
- H1_ISI_TST_TF_L2L_Raw_from_ST2_ACT_to_ST1_L4C_2014_02_21.fig
- H1_ISI_TST_TF_L2L_Raw_from_ST2_ACT_to_ST1_T240_2014_02_21.fig
- H1_ISI_TST_TF_L2L_Raw_from_ST2_ACT_to_ST2_CPS_2014_02_21.fig
- H1_ISI_TST_TF_L2L_Raw_from_ST2_ACT_to_ST2_GS13_2014_02_21.fig

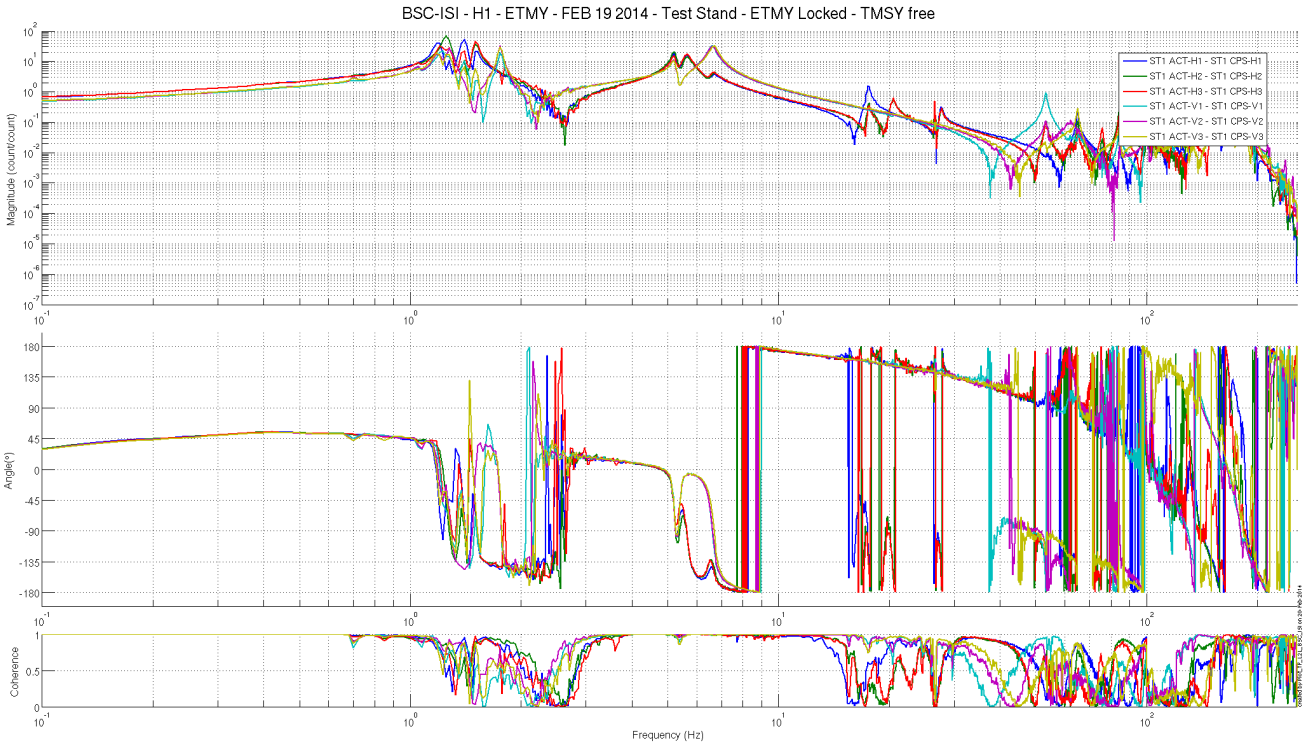

Figure 2 - TF ST1 ACT to ST1 CPS

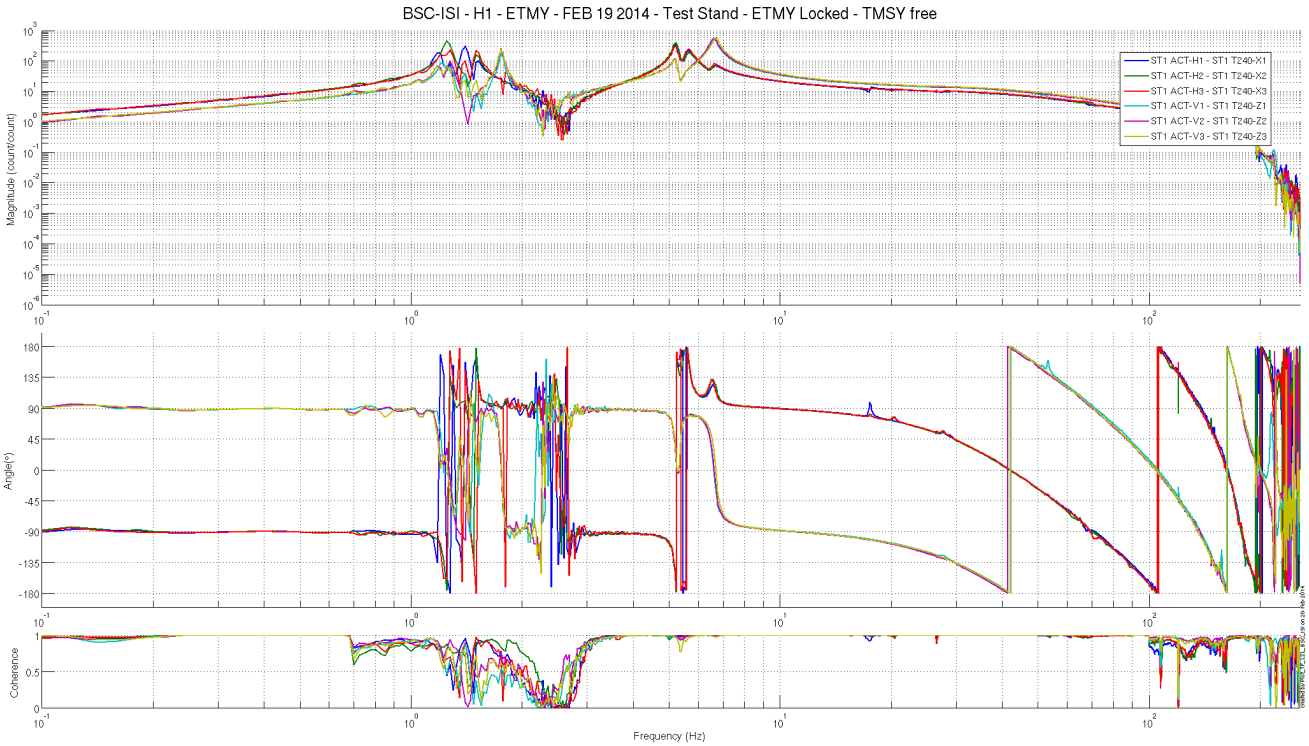

Figure 3 - TF ST1 ACT to ST1 T240

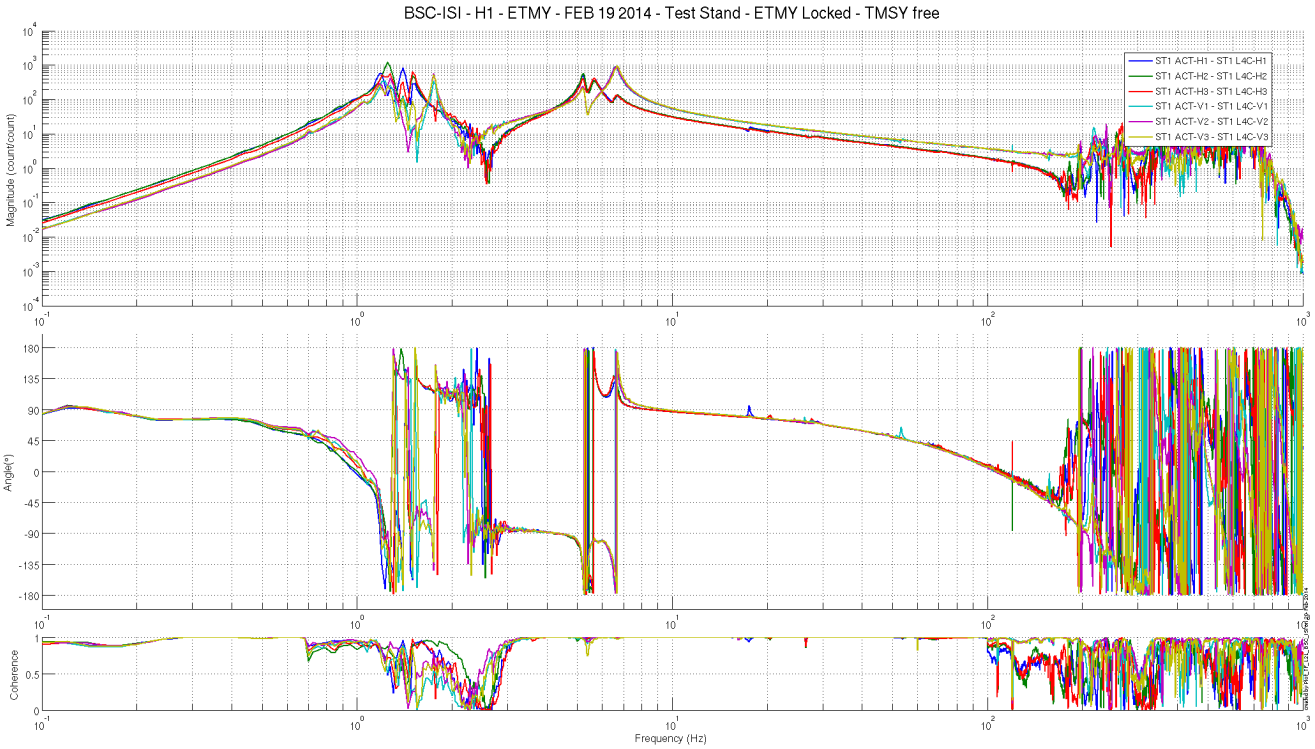

Figure 4 - TF ST1 ACT to ST1 L4C

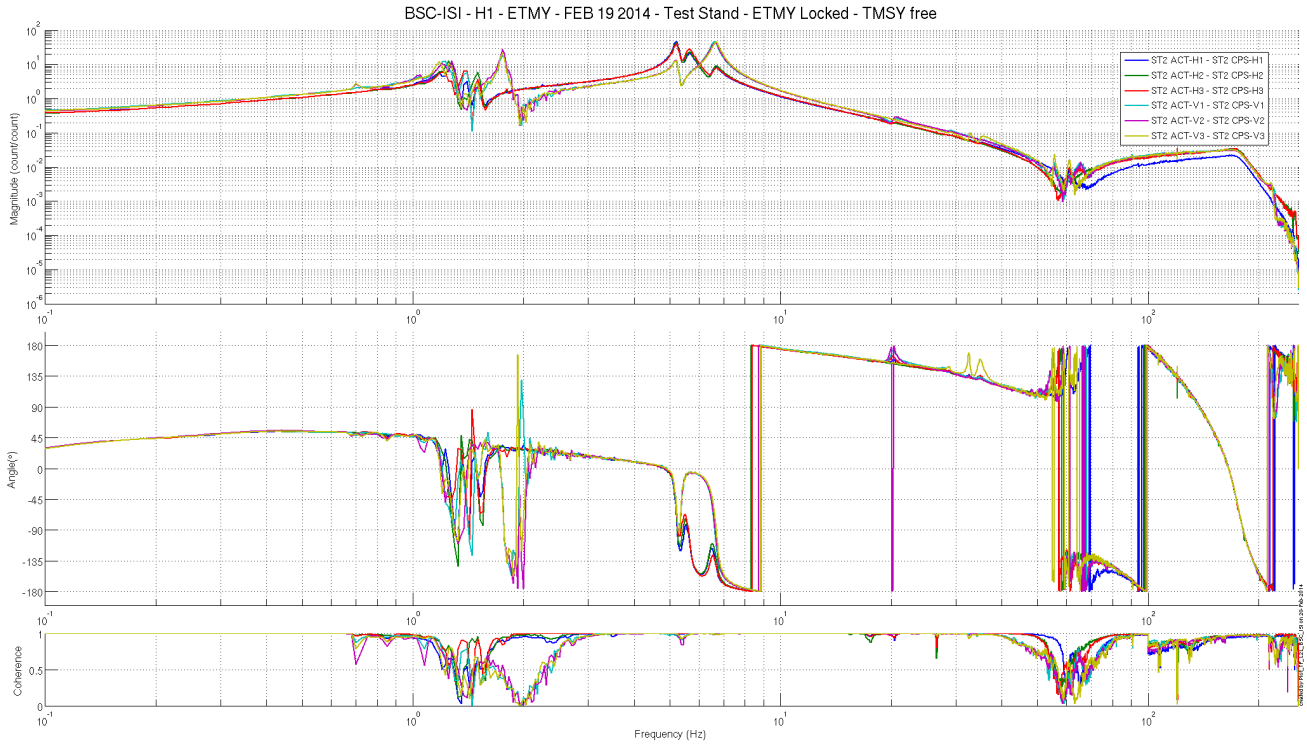

Figure 5 - TF ST2 ACT to ST2 CPS

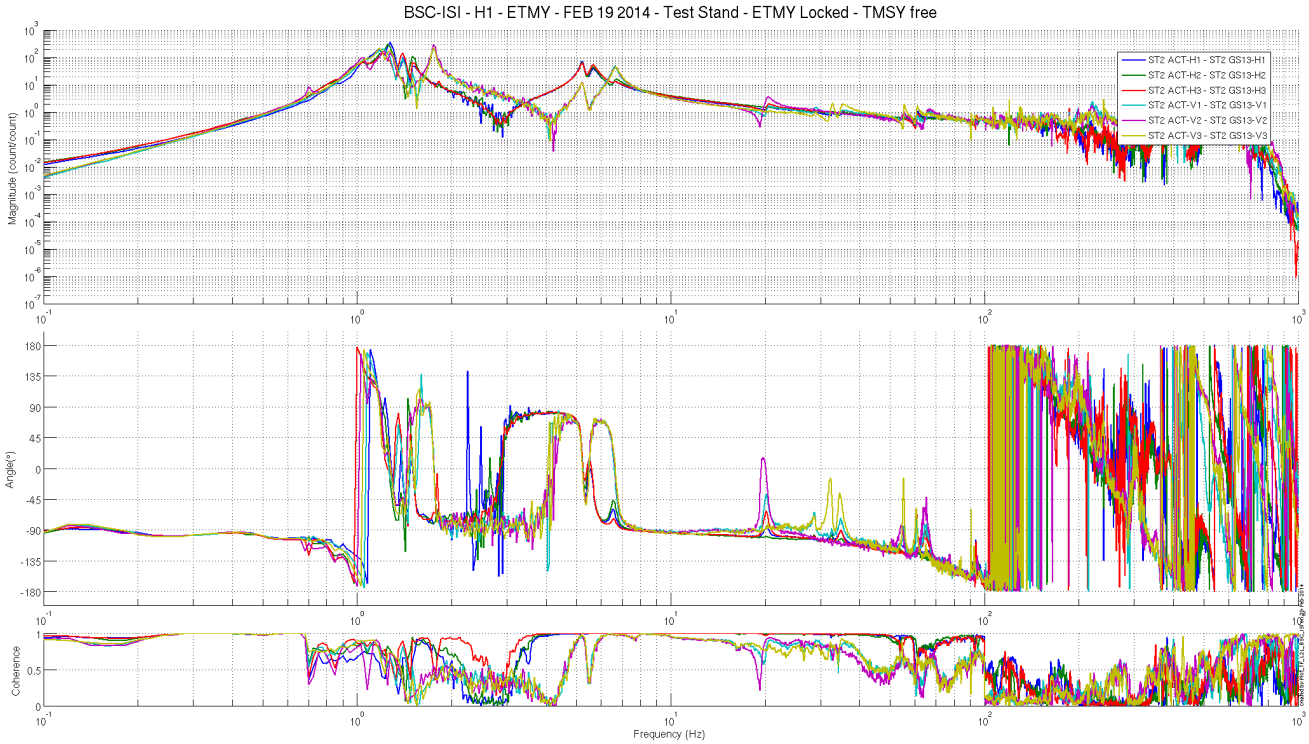

Figure 6 - TF ST2 ACT to ST2 GS13

The tests show some noise and extra peaks between 1 & 100 hz. These were probably due to an improper set up of the TMS, and were resolved in-chamber.

Test result: **Passed: _X__** **Failed: ___** **Waived: ____**

7. Conclusion Phase II-a

Tests performed during Phase II-a don't show any major anomalies on ISI-BSC10.

Test result: **Passed: _X_** **Failed: ___** **Waived: ___**

Phase IIb Tests after Cartridge Install

Basic Functionality after Cartridge Installation

1. Pressure Sensors

All pressure sensors are working.

ISI Pods Pressure Sensors - ETMY

		Corner 1	Corner 2	Corner 3	
P REF 100	ST1 L4-C Direct Pressure	96	98	98	KPa
P DEV 3	ST1 L4-C Differential Pressure	-1	0	0	KPa
P DIF 3	ST2 GS-13 Direct Pressure	98	100	100	KPa
	ST2 GS-13 Differential Pressure	0	0	0	KPa
	ST1 T240 Direct Pressure	100	100	100	KPa

Test result: **Passed: _X_** **Failed: ___** **Waived: ___**

2. Spectra

Spectra of the seismometers can be found in the svn at:

seismic/BSC-ISI/H1/ETMY/Data/Spectra/Undamped/

H1_ISI_ETMY_ASD_m_LOC_CPS_T240_L4C_GS13_2020_03_17_4 7:7:.mat

https://svn.ligo.caltech.edu/svn/seismic/BSC-ISI/H1/ETMY/Data/Figures/Spectra/Undamped/H1_ISI_ETMY_ASD_m_LOC_CPS_T240_L4C_GS13_2020_03_17_4 7:7:.fig

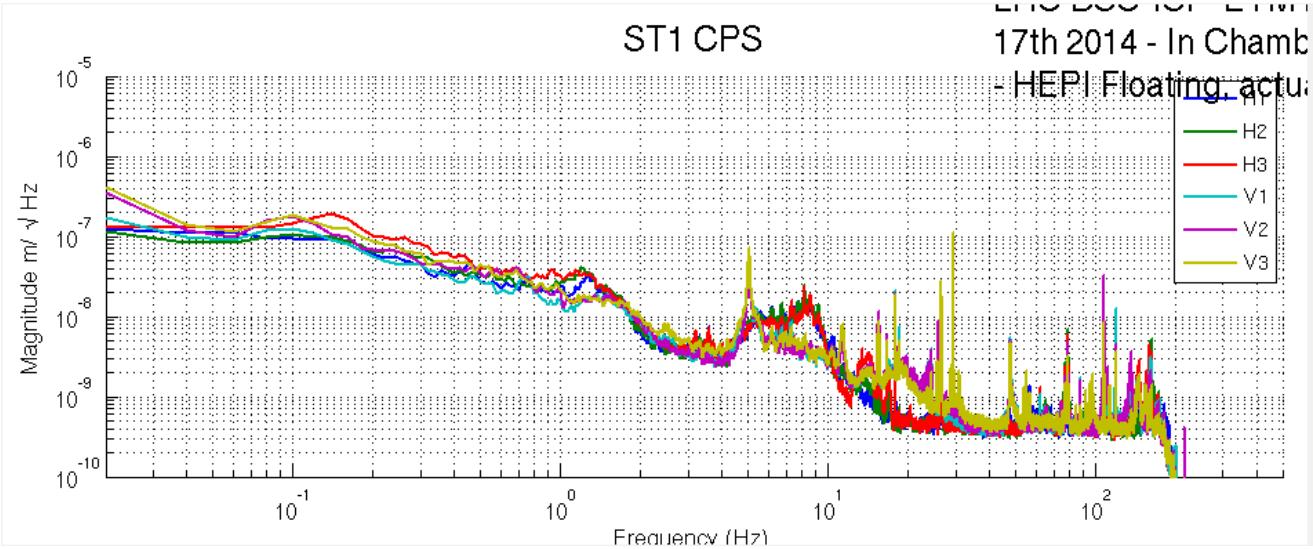

Figure 7 - St1 CPS Power Spectra

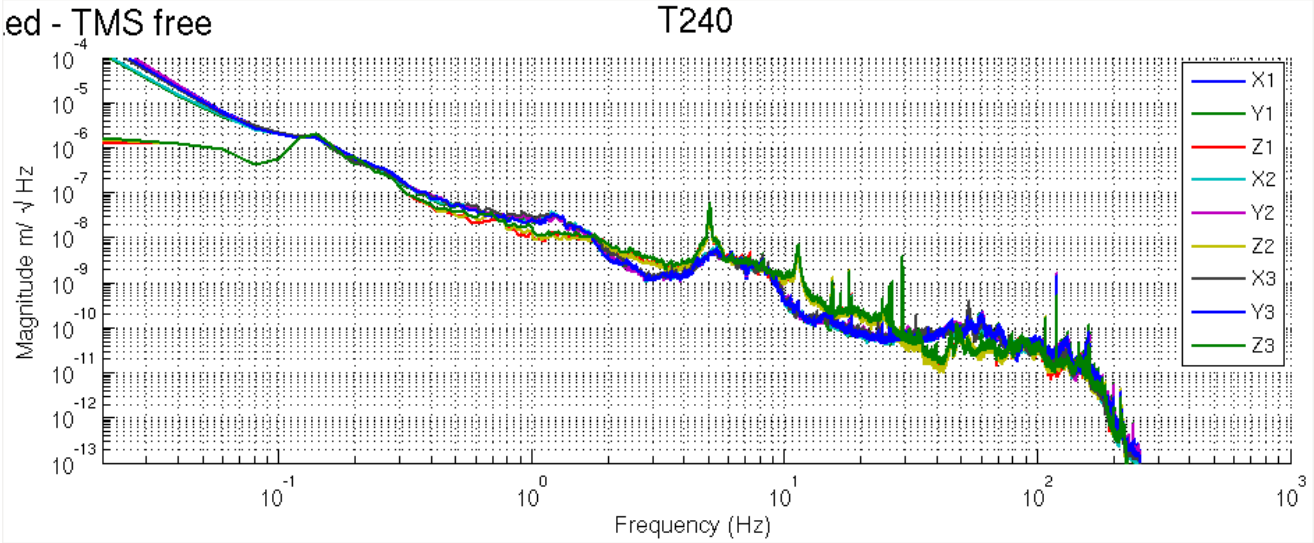

Figure 8 - St1 T240 Power Spectra

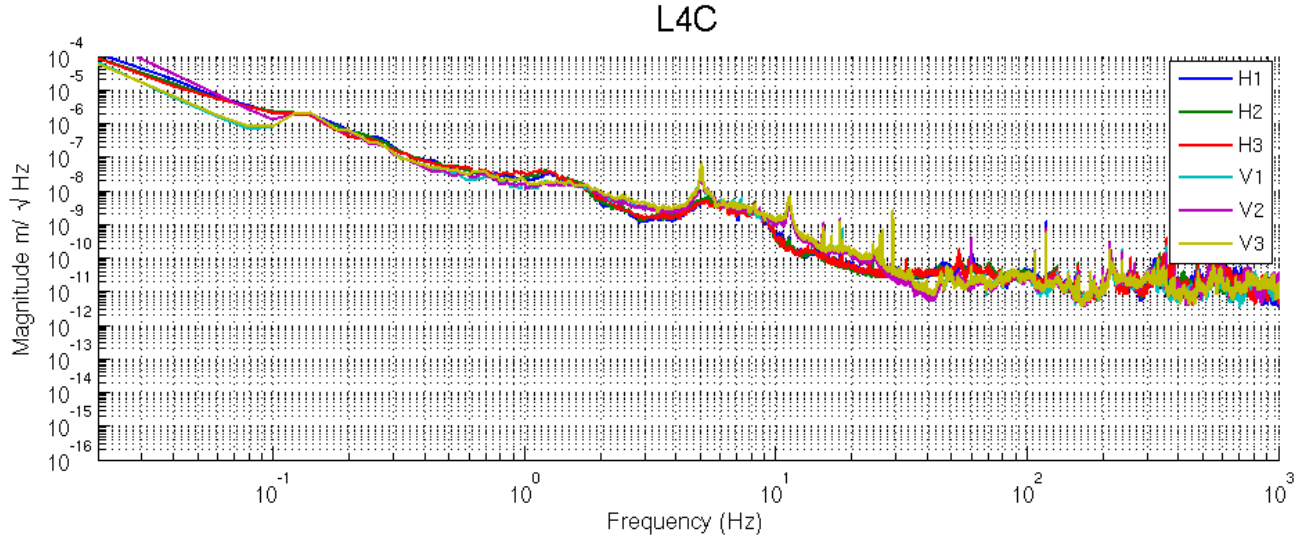

Figure 9 - St1 L4C Power Spectra

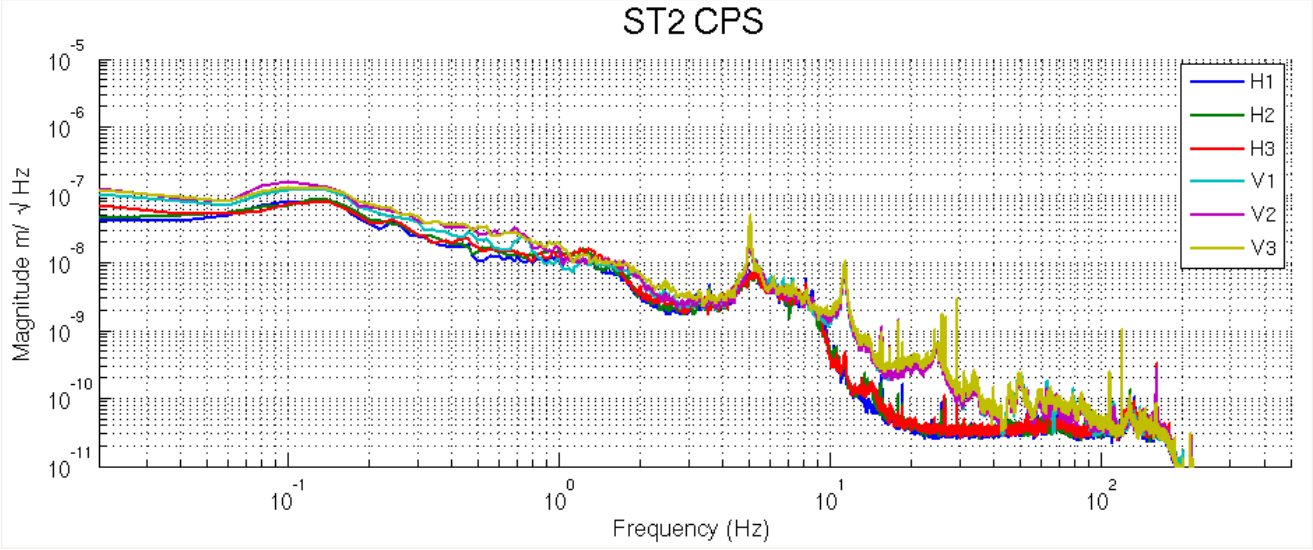

Figure 10 - St2 CPS Power Spectra

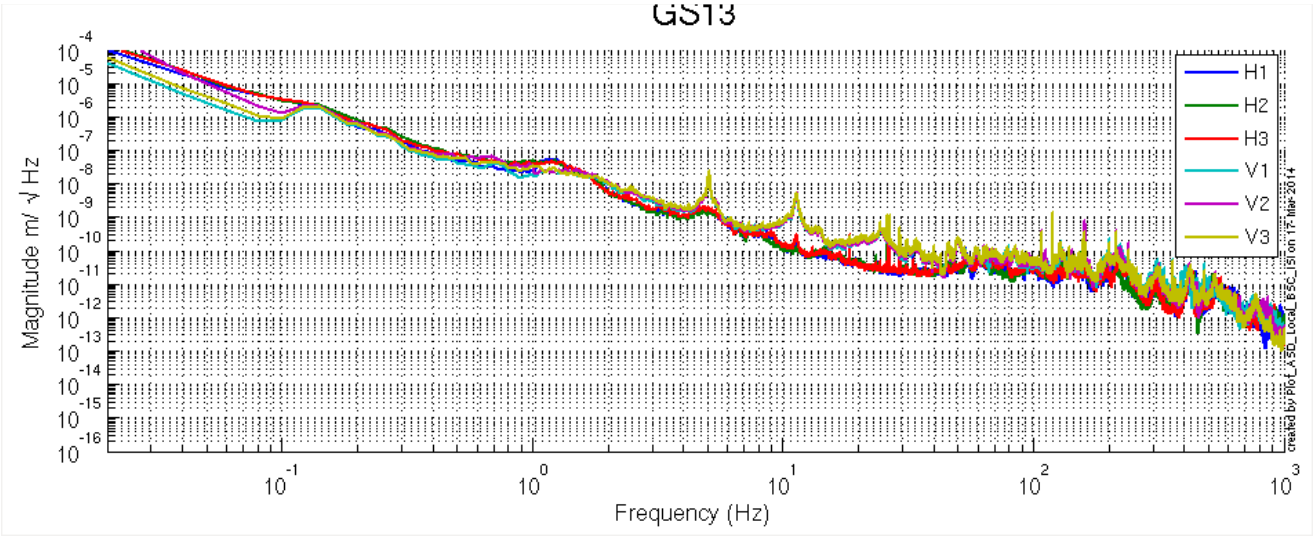

Figure 11 - St2 GS13 Power Spectra

All the seismometers are functioning normally.

Test result: **Passed: _X_** **Failed: ___** **Waived: ___**

3. Lock-Unlock Shifts

	Table locked		Table unlocked		Difference locked - unlocked	
Sensors	**Offset (Mean)**	**Std deviation**	**Offset (Mean)**	**Std deviation**	**Offset (Mean)**	**mil**
ST1 - H1	278	3.6	425	21	-146	**.17**
ST1 - H2	776	11	-127	21	905	**1.08**
ST1 - H3	388	6	-231	21	619	**.74**
ST1 - V1	-970	5	-1243	21	273	**.33**
ST1 - V2	592	5	188	25	405	**.48**
ST1 - V3	-830	4	-603	36	-226	**.27**
ST2 - H1	-524	86	-520	36	-5	**0!**
ST2 - H2	-194	33	188	37	-383	**.11**
ST2 - H3	-265	64	231	36	-497	**.15**
ST2 - V1	90	148	64	63	27	**.01**
ST2 - V2	619	37	1181	62	-562	**.17**
ST2 - V3	1403	98	1622	74	-219	**.07**

Table 6 - Lock/Unlock Shifts.

Locker shifts are within spec.

Test result: **Passed: _X_** **Failed: ___** **Waived: ___**

4. Range of motion

Sensor readout (counts)	Negative drive	no drive	Positive drive	Amplitude count	mil
ST1 - H1	-16065	-210	16038	23169	**38**
ST1 - H2	-15086	-106	17221	32150	**38**
ST1 - H3	-14274	-191	17491	28783	**34**
ST1 - V1	-13524	545	12711	26027	**30**
ST1 - V2	-13758	684	12284	26275	**31**
ST1 - V3	-14712	394	11741	25982	**31**
ST2 - H1	-9997	407	9762	19280	**5.7**
ST2 - H2	-9655	827	9762	19381	**5.7**
ST2 - H3	-10027	982	9552	19315	**5.7**
ST2 - V1	-10934	-37	12746	22504	**6.7**
ST2 - V2	-11336	-323	11032	23187	**6.9**
ST2 - V3	-11006	1289	11947	22478	**6.7**

Table 7 - Range of motion under actuator drive

Range of motion is within spec.

Test result: **Passed: _X_** **Failed: ___** **Waived: ___**

5. CPS Linearity Test

Test result: **Passed: ___** **Failed: ___** **Waived: _X__**

2. Transfer Functions after Cartridge Install

Reference transfer functions L2L with ETMY, TMSY, ACB and all ISI viton damping elements.

Transfer Functions are located in the SVN at:

/SeiSVN/seismic/BSC-ISI/H1/ETMY/Data/Transfer_Functions//Undamped/
- **-H1_ISI_ETMY_Data_L2L_700mHz_10Hz_ST1_ST2_20140313-191146**.mat
- -H1_ISI_ETMY_Data_L2L_10Hz_100Hz_ST1_ST2_20140313-221042.mat
- -H1_ISI_ETMY_Data_L2L_100mHz_700mHz_ST1_ST2_20140314-011735.mat
- -H1_ISI_ETMY_Data_L2L_100Hz_500Hz_ST1_ST2_20140314-041028.mat
- -H1_ISI_ETMY_Data_L2L_500Hz_1000Hz_ST1_ST2_20140314-061519.mat

L2L concatenated
/SeiSVN/seismic/BSC-ISI/H1/ETMY/Data/Transfer_Functions/Simulations/Undamped/
- -H1_ISI_ETMY_TF_L2L_Raw_2014_03_14.mat

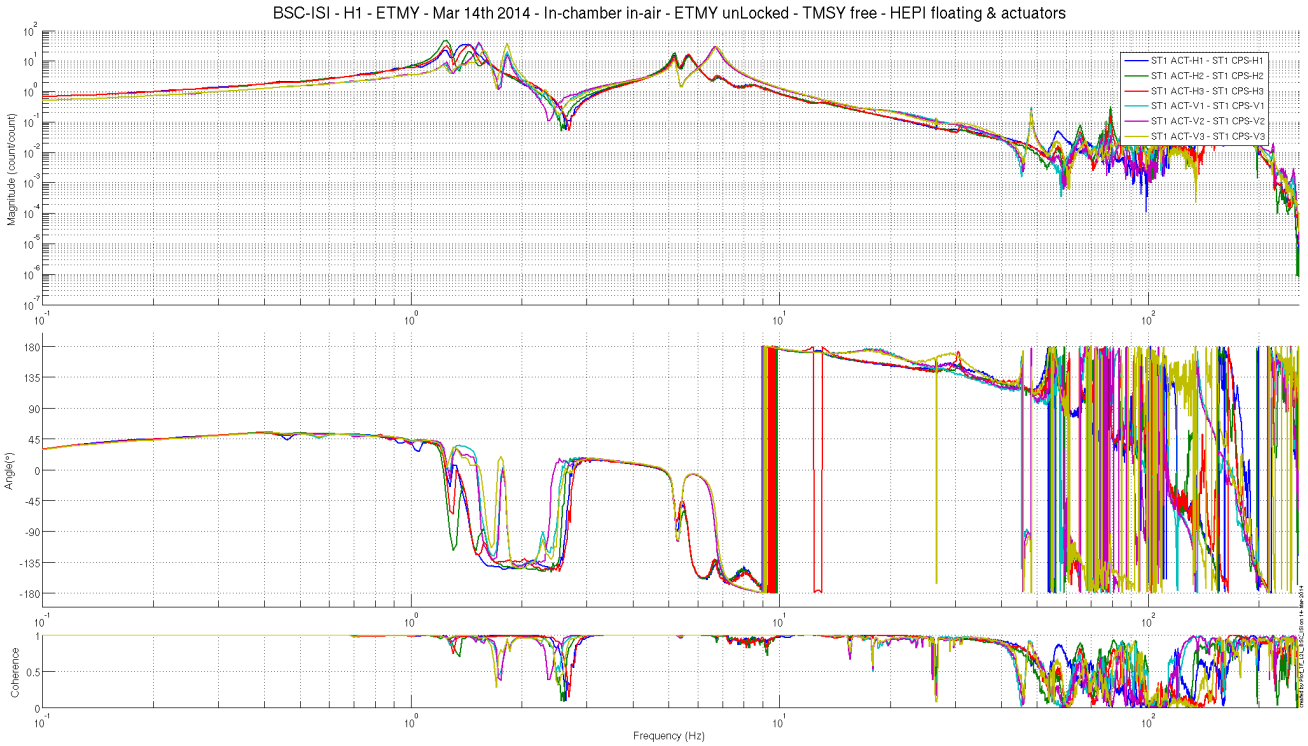

Figure 12 St1 Act to St1 CPS

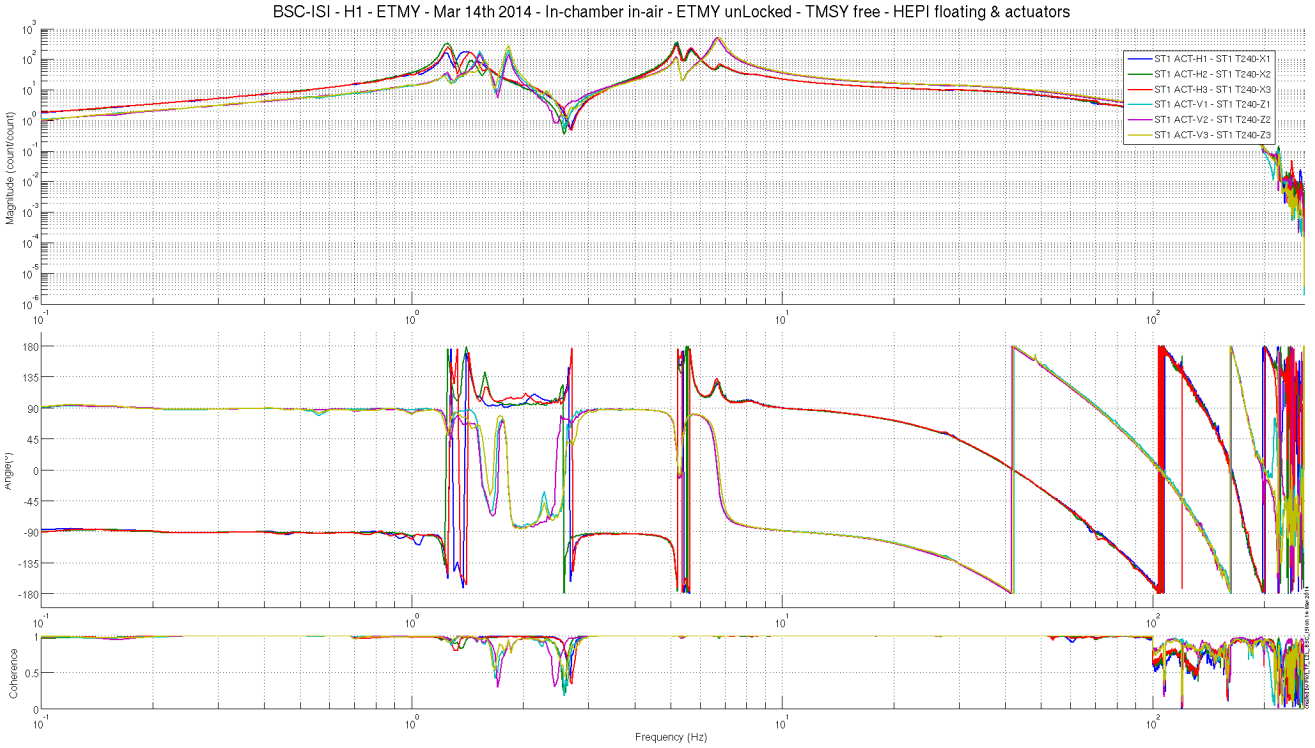

Figure 13 St1 Act to T240

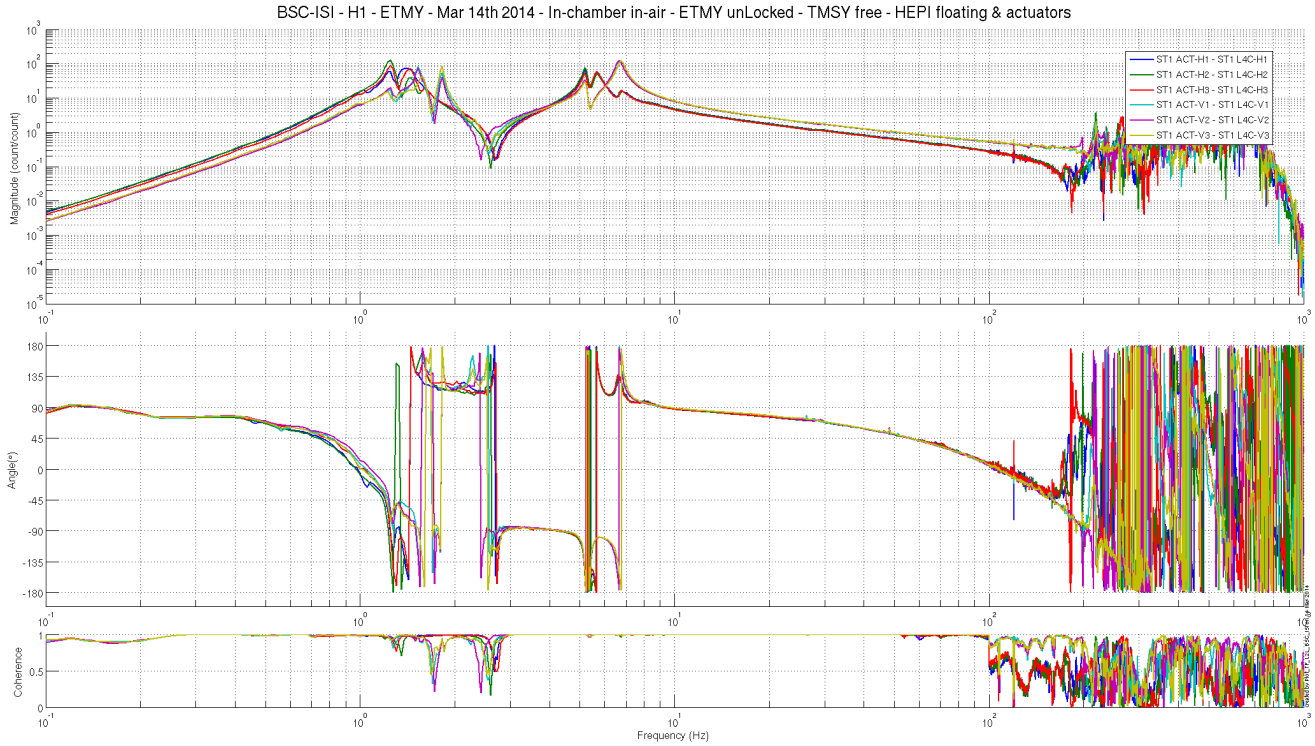

Figure 14 St1 Act to L4C

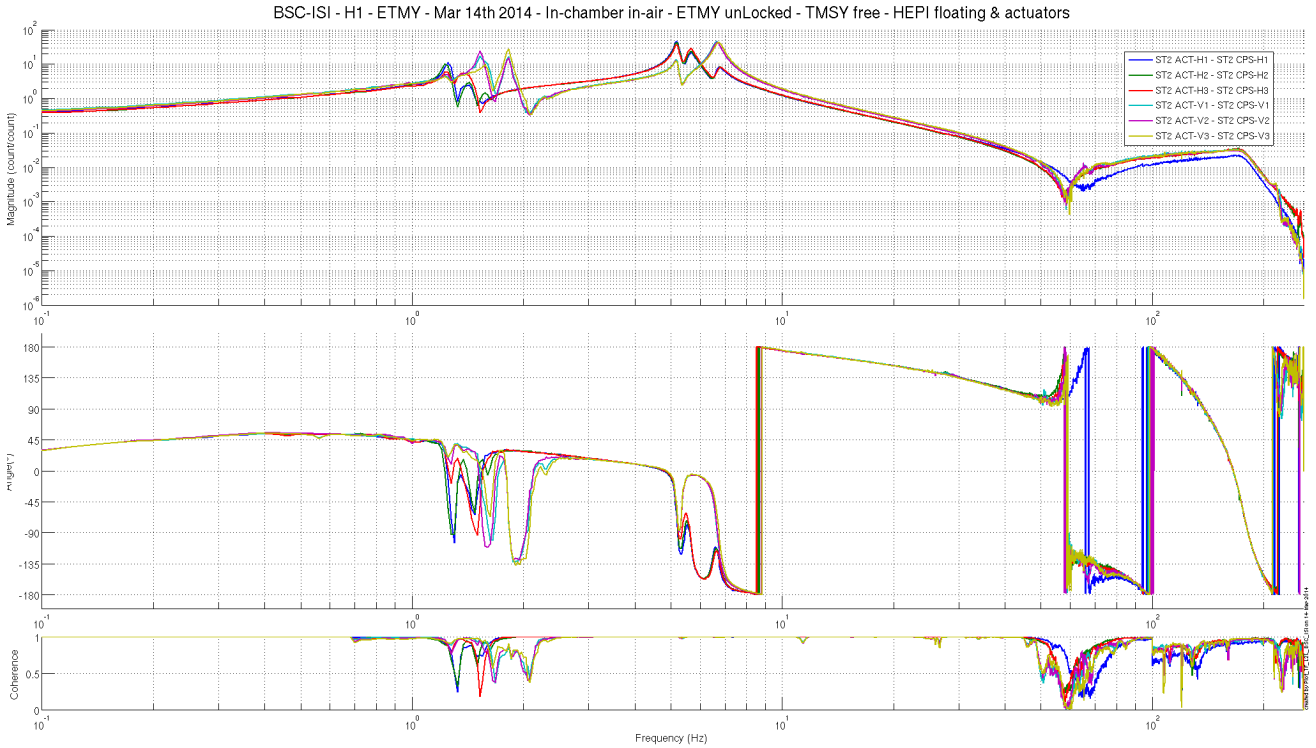

Figure 15 St2 Act to GS13

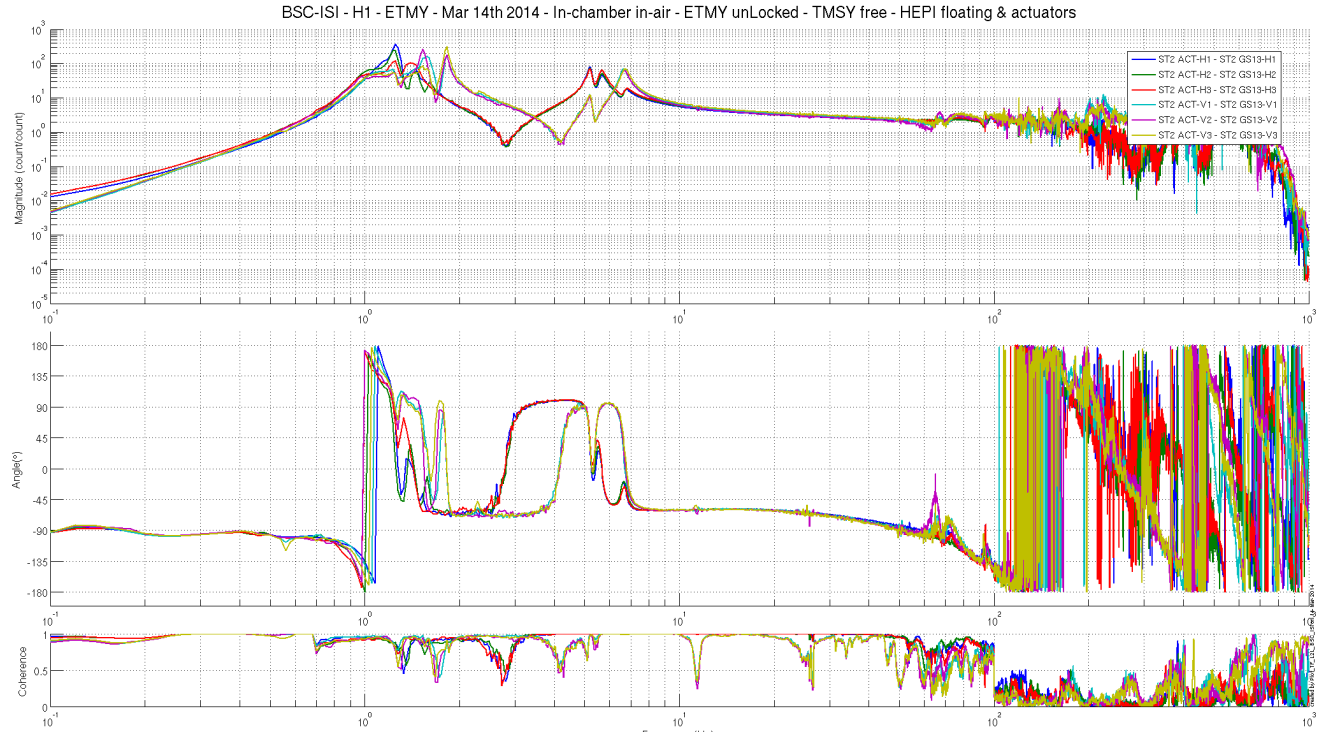

Figure 16 St2 Act to St2 CPS

Transfer functions look healthy.

Test result: **Passed: _X_** **Failed: ___** **Waived: ___**

3. Conclusion Phase II-b

Tests performed during Phase II-b don't show any anomalies on ISI-BSC10.

Test result: **Passed: _X_** **Failed: ___** **Waived: ___**