LIGO Laboratory / LIGO Scientific Collaboration

LIGO- E1100858-V4	*LIGO*	November 25th, 2013

L1 BSC 4 BSC-ISI, Pre-integration Testing report,

Phase II

E1100858-V4

Adrien Le Roux, Céline Ramet

Distribution of this document:
Advanced LIGO Project

This is an internal working note
of the LIGO Laboratory

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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-BSC4 was moved from the Staging building to the X End early 2013. Then the ISI was placed on the test stand a few days later.

This document presents results from the series of tests (Phase II) performed on the ISI-BSC4 (ETMX) at the X End station. The tests were done with the ETMX quadruple suspension and the TMS suspension installed in their final version.

First tests started on October 23rd, 2013. The first testing phase (II-a validation before cartridge installation) was completed on October, 2013.

All results are posted on the SVN at:
https://svn.ligo.caltech.edu/svn/seismic/BSC-ISI/L1/ETMX/

The following types of documents can be found in the SVN:
- Data location
- Figures location

1. Phase II- A – Before Install

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

T240s have not been replaced since phase I testing in the staging building.

5. Cables – E1100822

No cables have been changed since phase I testing in the staging building.

   Note: The SRS cables have been added and routed on the ISI.

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.

Hardware	Ligo reference	S/N
Interface Chassis Pod 1	D1002432	S1203884
Interface Chassis Pod 2	D1002432	S1203885
Interface Chassis Pod 3	D1002432	S1203886
Anti-aliasing Chassis Pod 1	D1002693	S1203106
Anti-aliasing Chassis Pod 2	D1002693	S1203107
Anti-aliasing Chassis Pod 3	D1002693	S1203109
Binary Input Chassis 1	D1001726	S1101306
Binary Input Chassis 2	D1001726	S1101307
Binary Output Chassis	D1001728	S1101333
T240 Interface Pod 1	D1002694	S1201405
T240 Interface Pod 2	D1002694	S1201406
T240 Interface Pod 3	D1002694	S1201407
Anti-image Chassis	D070081	S0900067
Coil driver Pod 1	D0902744	S1103314
Coil driver Pod 2	D0902744	S1103336
Coil driver Pod 3	D092744	S1103360
Expansion chassis		L1seiex

Table 1 - Electronic inventory

3. Models Modifications

No model modifications were done between the beginning and the end of Phase 2a testing.

4. Mass distribution

At this point, all the final masses are installed on the BSC-ISI except the Ballast masses on top of the keel. Instead, we have a big leg element (D972213). Those ballast masses will be installed while the BSC is in chamber.

1. Seismic

Stage 1

Stage 1	HighBay (lbs)	LVEA (lbs)	LVEA (kg)
Corner 1	49.22	49.22	22.33
Corner 2	22.86	22.86	10.37
Corner 3	32.22	32.22	14.61
Total	104.3	104.3	47.31

Note: The budget mass didn't change on Stage 1 between the Highbay and the X End because on this Unit, we installed the Vibration Absorbers in the Highbay and balanced the BSC with them already on.

Stage 2
The seismic masses on BSC 4 are:

10/25/2013	D972213	D972215	D0901075 5 kg	D0901075 10 kg	D071200 00	D071200 01	D071200 02	D071200 03	D071200 04	D071200 05	D071200 06	lbs	kgs
	610	230	11	22	0.6	1.1	2.2	4.5	7.9	15.6	27.2		
A												0	0.00
B												0	0.00
C												0	0.00
D	1											610	276.69
E-1												0	0.00
E-2												0	0.00
E-3												0	0.00
F1											2	2	85.6	38.83
F2					2	1			2	3	2	119.3	54.11
F3					2	2	1			3	2	106.8	48.44
Stage 2	1	0	0	0		3	1	0	2	8	6	921.7	418.08

- On the side and on the Keel: 921.7 lbs (=418.08 kg)
- On the Optical Table (6) D1003161:   285.72 lbs (=129.6 kg)

The total of masses on Stage 2 is: 1207.42 lbs (=547.68 kg).

2. Suspension

The quad structure and the TMS Structure was weighed to be:

SUS	Weight (lbs)	Weight (kg)
Upper structure	266	120.66
Lower structure	531	240.86
Total	797	361.5128

TMS	Weight (lbs)	Weight (kg)
Total	456.14	206.9

3. Misc

- 44 lbs = quad sleeve [Betsy's alog 3621]
- 2 lbs = quad sleeve wedges [estimate]
- 5 lbs = cabling [estimate]
- 2 lbs cable brackets [estimate]
- 28 lbs = Vibration absorbers, quantity 4 [from E1000337-v2: 12.7 kg = 28 lbs]
- 3 lbs = Ring heater + brackets + cables [estimate]

Total Weight for Suspension: 906 lbs = 412 kg
Total Weight for TMS: 456.14 lbs = 206.9 kg

4. Total

Nominal mass hanging on stage 0-1 blades (without stage 2): 912Kg – 2010lb
Nominal mass hanging on stage 1-2 blades: 2830Kg – 6239lb
Nominal payload on stage 1: 109Kg – 240lb
Nominal payload on stage 2: 1185Kg – 2612lb

			Staging Bldg	X End		
		Plan	07/18/2012	Detail	Overall	Difference
Stage 1 (kg)		108.86	47.31	47.31		0.00
Stage 2 (kg)	Masses	1183.42	1155.53	547.68	1166.97	11.44
	Suspension	N/A	N/A	361.51		
	Miscellaneous	N/A	N/A	50.88		
	TMS	N/A	N/A	206.9		
Total (kg)		1292.28	1200.79	1214.28		13.49

Even if Stage 2 weight difference between the Staging Building and the X End is a little bit over the 10 kg requirement, we're still going to pass this test because the weight for the quad and the TMS structure are estimated. Overall, the mass budget is fairly consistent with what we had in the Staging Building.

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

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

1. Pressure sensors

All pressure sensors are working correctly.

*https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Static_Tests/
L1_ISI_ETMX_Pressure_Sensors_Check_Calibrated_2013_10_24_084142.mat*

	Pressure (KPa)		
Sensors	**Corner 1**	**Corner 2**	**Corner 3**
ST1-L4C-P	100.91	100.37	101.99
ST1-L4C-D	-0.70	0.13	-1.31
ST1-GS13-P	101.80	102.25	102.54
ST1-GS13-D	0.25	-0.26	-0.70
ST1-T240-P	100.75	100.95	100.85

Table 2 - Geophones Pressure sensors

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

2. Spectra

Spectra of the instrument can be found in the SVN at:
https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Spectra/Undamped/
L1_ISI_ETMX_ASD_m_LOC_CPS_T240_L4C_GS13_2013_10_24_120444.mat

https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ITMY/Data/Figures/Spectra/Undamped/
L1_ISI_ETMX_ASD_m_LOC_CPS_T240_L4C_GS13_2013_10_24_120444.fig
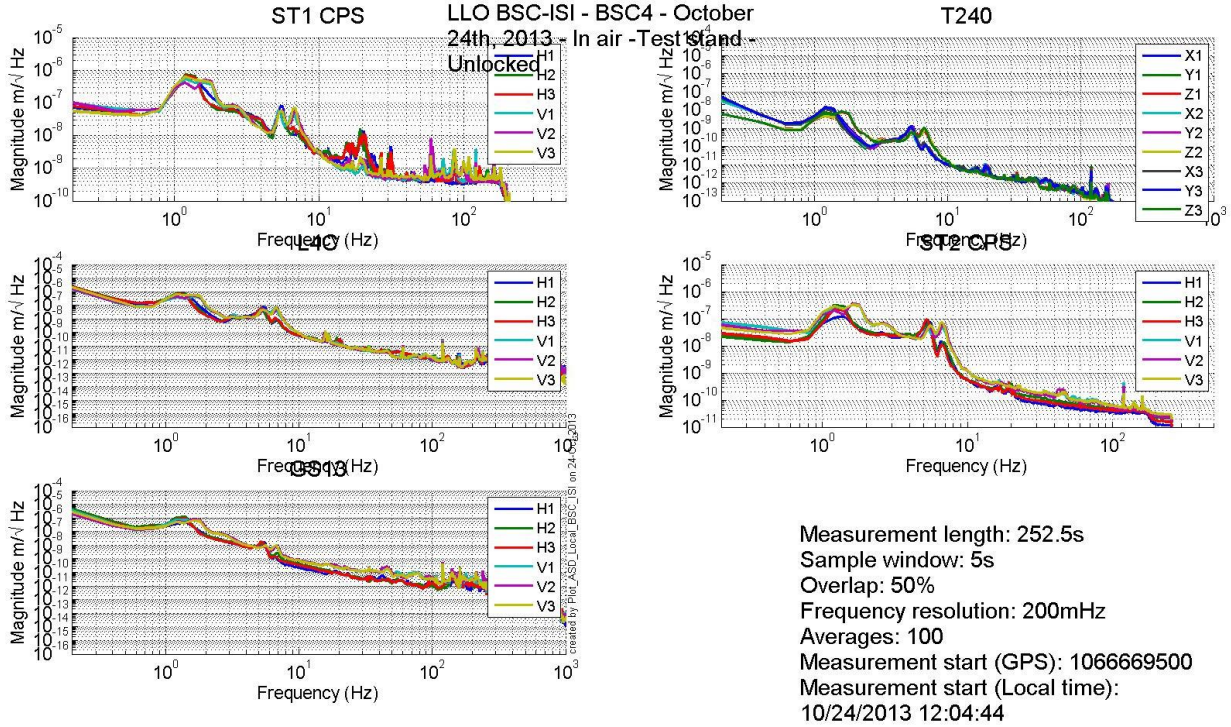
Figure 1 - Spectra inboard instruments - ISI Unlocked

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

3. Actuators-cables resistance

https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Static_Tests/

	Stage 1						Stage 2					
	H1	H2	H3	V1	V2	V3	H1	H2	H3	V1	V2	V3
Script												

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

4. Offsets CPS Unlocked vs locked

https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Static_Tests/
- L1_ISI_ETMX_CPS_Read_Back_ISI_UnLocked_2013_10_24_095724.mat
- L1_ISI_ETMX_CPS_Read_Back_ISI_UnLocked_2013_10_24_100154.mat

Sensors	Table locked		Table unlocked		Difference locked - unlocked	
	Offset (Mean)	Std deviation	Offset (Mean)	Std deviation	Offset (Mean)	mil
ST1 - H1	255.80	8.28	113.57	124.73	142.23	0.17
ST1 - H2	-39.95	5.26	288.17	102.88	-328.13	-0.39
ST1 - H3	126.76	6.45	1259.59	143.30	-1132.83	-1.35
ST1 - V1	219.47	5.22	30.00	107.37	189.46	0.23
ST1 - V2	69.60	6.47	1025.93	133.10	-956.33	-1.14
ST1 - V3	186.21	5.76	-833.42	128.01	1019.64	1.21
ST2 - H1	1038.03	102.75	-1240.21	151.05	2278.24	0.68
ST2 - H2	450.40	44.86	-1375.43	141.42	1825.83	0.54
ST2 - H3	-983.72	101.36	-1406.99	181.60	423.27	0.13
ST2 - V1	-408.11	726.67	-1375.90	261.12	967.78	0.29
ST2 - V2	-328.54	90.34	-1637.08	307.65	1308.54	0.39
ST2 - V3	313.32	480.33	1959.48	287.11	-1646.15	-0.49

Table 3 - Locked vs Unlocked Position

Note: The Standard Deviations are a little bit high on the "Table Locked" measurements, especially on Stage 2 V1 and Stage 2 V3.

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

5. Offset local drive

Note: Due to longer cables, offsets measured by CPS for a 7000 count drive are slightly lower than offsets measured in the staging building.

Results of this test can be found in the SVN at:
https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Static_Tests/
- L1_ISI_ETMX_Offset_Local_Drive_20131025.mat

		Sensors					
		ST1 - H1	**ST1 - H2**	**ST1 - H3**	**ST1 - V1**	**ST1 - V2**	**ST1 - V3**
Actuators	**ST1 - H1**	3701.37	1482.45	1497.08	48.93	-33.56	-1.78
	ST1 - H2	1496.44	3724.43	1516.44	52.18	-50.55	-44.10
	ST1 - H3	1468.61	1479.49	3661.69	32.40	-15.05	12.65
	ST1 - V1	55.29	-102.22	86.06	2927.23	-494.07	-476.11
	ST1 - V2	71.04	4.51	-137.19	-394.34	2788.68	-473.57
	ST1 - V3	-127.05	57.26	78.95	-413.50	-453.39	2828.51

Table 4 - Static Tests – Local to Local - Stage 1

		Sensors					
		ST2 - H1	**ST2 - H2**	**ST2 - H3**	**ST2 - V1**	**ST2 - V2**	**ST2 - V3**
Actuators	**ST2 - H1**	2107.61	388.27	280.63	-18.52	-75.28	-69.35
	ST2 - H2	327.28	2103.51	341.11	9.61	-1.57	-46.51
	ST2 - H3	301.56	353.75	2119.46	-30.66	-50.13	15.27
	ST2 - V1	53.34	129.39	-149.25	2445.87	325.62	40.76
	ST2 - V2	-170.12	114.95	83.92	33.98	2459.01	336.28
	ST2 - V3	57.22	-104.97	65.03	315.18	-6.71	2468.23

Table 5 - Static Tests – Local to Local - Stage 2

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

6. Offset Cartesian drive

The test was not performed because it only tests the matrices, which can be changed at any time.

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

7. 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/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Static_Tests/
- L1_ISI_ETMX_Range_Of_Motion_20131025.mat

Sensor readout (counts)	Negative drive	Positive drive	Amplitude count	mil
ST1 - H1	-16136.9	15561.45	31698.31	37.73608
ST1 - H2	-15008.2	16094.72	31102.95	37.02732
ST1 - H3	-14733.4	15607.66	30341.07	36.12032
ST1 - V1	-12102.3	12540.51	24642.79	29.33665
ST1 - V2	-10705.7	13348.43	24054.09	28.63582
ST1 - V3	-12766.5	11527.18	24293.65	28.92101
ST2 - H1	-9869.56	8417.626	18287.19	5.442616
ST2 - H2	-9986.07	8101.874	18087.94	5.383315
ST2 - H3	-10012.2	8177.971	18190.17	5.413741
ST2 - V1	-11538.3	9632.988	21171.32	6.300988
ST2 - V2	-11696.5	9639.022	21335.5	6.349852
ST2 - V3	-8203.01	13097.67	21300.68	6.339489

Table 6 - Range of motion - Actuator drive in the LVEA

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

8. Linearity test

The data of the linearity test can be found on the SVN at:
https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Linearity_Test/
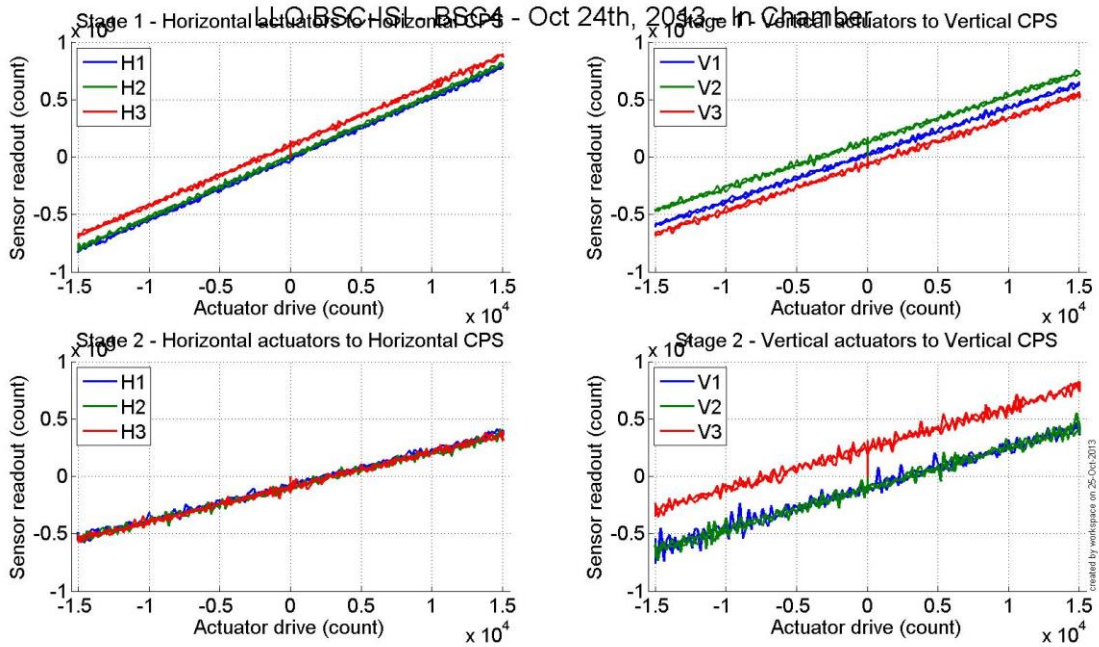- L1_ISI_ETMX_Linearity_test_20131025.mat

The figures of the linearity test can be found on the SVN at:
https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic\BSC-ISI\H2\BS\Data\Figures\Linearity_Test
- L1_ISI_ETMX_Linearity_test_20131025.fig

Figure 2 - Linearity test –L1 - BS – In LVEA

		Slope	Offset	Average slope	Variation from average(%)
Stage 1	**ST1 - H1**	0.53259	-135.3		-0.5
	ST1 - H2	0.53324	81.5	0.5297	-0.7
	ST1 - H3	0.52321	1018.7		1.2
	ST1 - V1	0.40990	221.1		-1.2
	ST1 - V2	0.40019	1340.8	0.4050	1.2
	ST1 - V3	0.40483	-632.7		0.0
Stage 2	**ST2 - H1**	0.30526	-758.0		-0.7
	ST2 - H2	0.30044	-951.0	0.3031	0.9
	ST2 - H3	0.30362	-923.0		-0.2
	ST2 - V1	0.35321	-991.9		0.7
	ST2 - V2	0.35799	-1065.1	0.3557	-0.6
	ST2 - V3	0.35597	2429.5		-0.1

Table 7 - Slope – Offset Linearity test

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

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

1. At the end station

The parameters for the measurements in the X End are slightly different from those in the staging building. We chose to have weaker excitation but longer averages in an effort to reduce risk for the attached suspension.

At this point, only the tuned mass dampers on the springs and the vibration absorbers on Stage 1 doors are installed (No Viton under the keel masses)

Measurements data can be found in the SVN at:
https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Transfer_Functions/Measurements/Undamped:
- LLO_ISI_BSC4_Data_L2L_10mHz_100mHz_ST1_ST2_20131028-115737.mat
- LLO_ISI_BSC4_Data_L2L_100mHz_700mHz_ST1_ST2_20131026-104726.mat
- LLO_ISI_BSC4_Data_L2L_700mHz_10Hz_ST1_ST2_20131025-210845.mat
- LLO_ISI_BSC4_Data_L2L_10Hz_100Hz_ST1_ST2_20131025-174154.mat
- LLO_ISI_BSC4_Data_L2L_100Hz_500Hz_ST1_ST2_20131025-155703.mat
- LLO_ISI_BSC4_Data_L2L_500Hz_1000Hz_ST1_ST2_20131025-143236.mat

Data after processing can be found in the SVN at:
https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Transfer_Functions/Simulations/Undamped
- LLO_ISI_BSC4_TF_L2L_Raw_10mHz_1000Hz_2013_10_28.mat

The transfer functions can be found in the SVN at:
https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Figures/Transfer_Functions/Measurements/Undamped/
- L1_ISI_ETMX_TF_L2L_Raw_from_ST1_ACT_to_ST1_CPS_2013_10_28.fig
- L1_ISI_ETMX_TF_L2L_Raw_from_ST1_ACT_to_ST1_L4C_2013_10_28.fig
- L1_ISI_ETMX_TF_L2L_Raw_from_ST1_ACT_to_ST1_T240_2013_10_28.fig
- L1_ISI_ETMX_TF_L2L_Raw_from_ST2_ACT_to_ST2_CPS_2013_10_28.fig
- L1_ISI_ETMX_TF_L2L_Raw_from_ST2_ACT_to_ST2_GS13_2013_10_28.fig

  Note 1: The transfer functions are measured from the Output filters bank excitation point to the input (IN1) of the input filters bank. The transfer functions presented below are raw transfer functions without any electronic compensation.

  Note 2: The L4Cs are out of phase (should be -90 before 1Hz). A minus sign is added in the calibration filters that convert count to nm/s.

  Note 3: On the ST1-ACT-H to ST1-CPS-H transfer functions, we can see the first resonances of the LVEA test stand at 21.1 Hz, 23.4Hz and 33.3Hz (matches within a few Hz our BSC 3 results).

  Note 4: We had to retake the low frequency data (10mHz to 100mHz) because the watchdog for the T240 tripped over the weekend. As we were re setting it, we noticed that we had a high gain filter on those T240 explaining why it tripped so we disengaged it. That explains the difference of

gain on Figure 5 between 10-100mHz and the rest of the Transfer Function. We also lowered the number of averages while we were retaking these measurements in order to be able to finish the report and get it approved which explains the difference in quality between 10-100mHz and the other frequencies.

   Note 5: While we were retaking the measurements on the 10 to 100mHz frequencies, the watchdog tripped but we reset it as soon as we noticed it was tripped. This explains why on Figure 6, on Stage 2 H3 we can see a slightly lower response at low frequency (<10mHz).
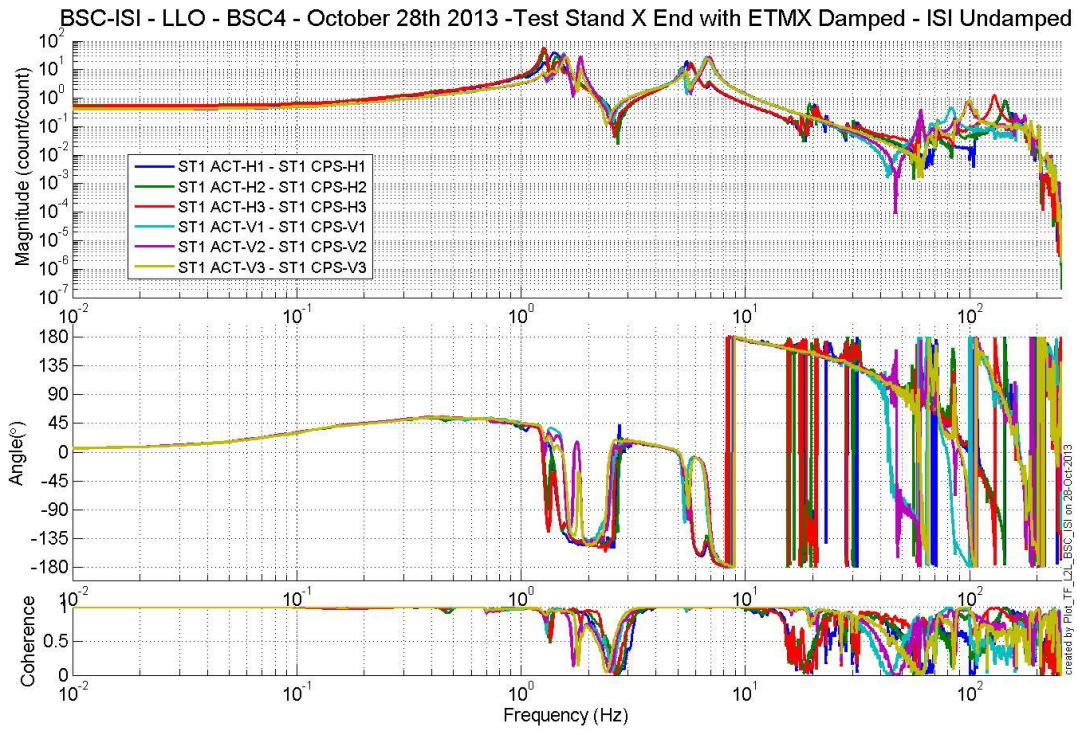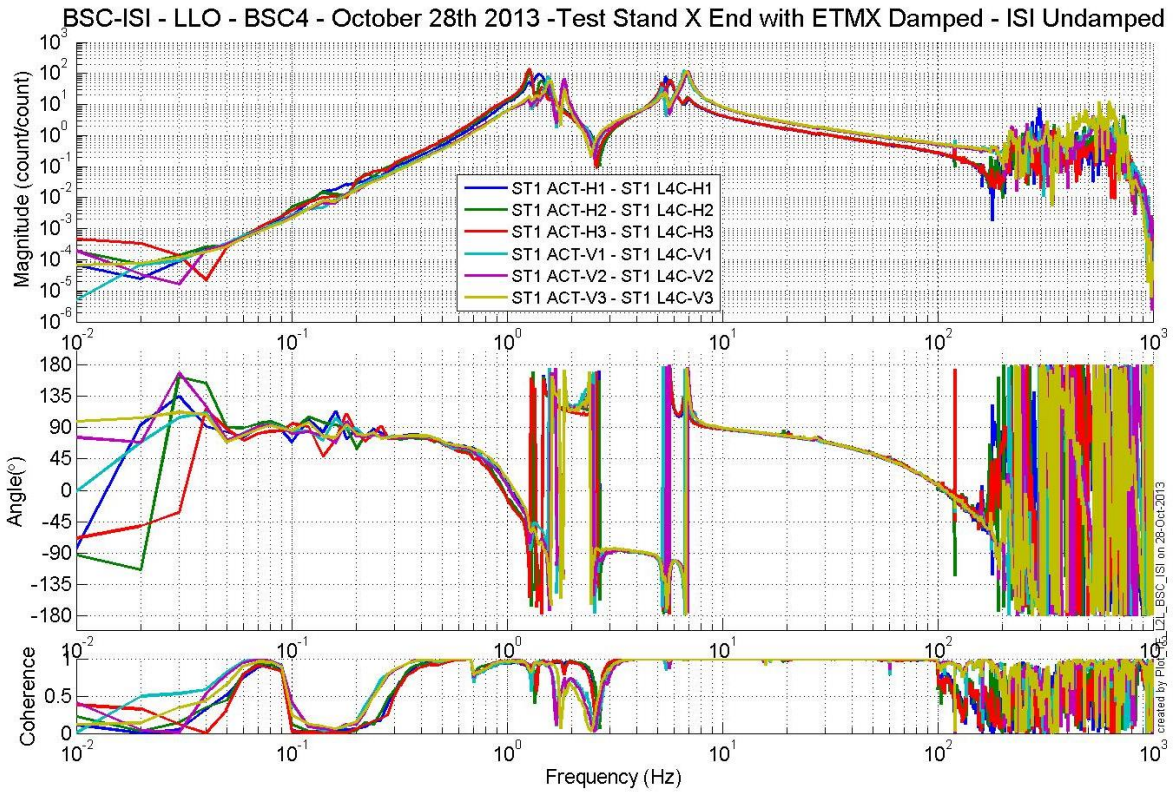

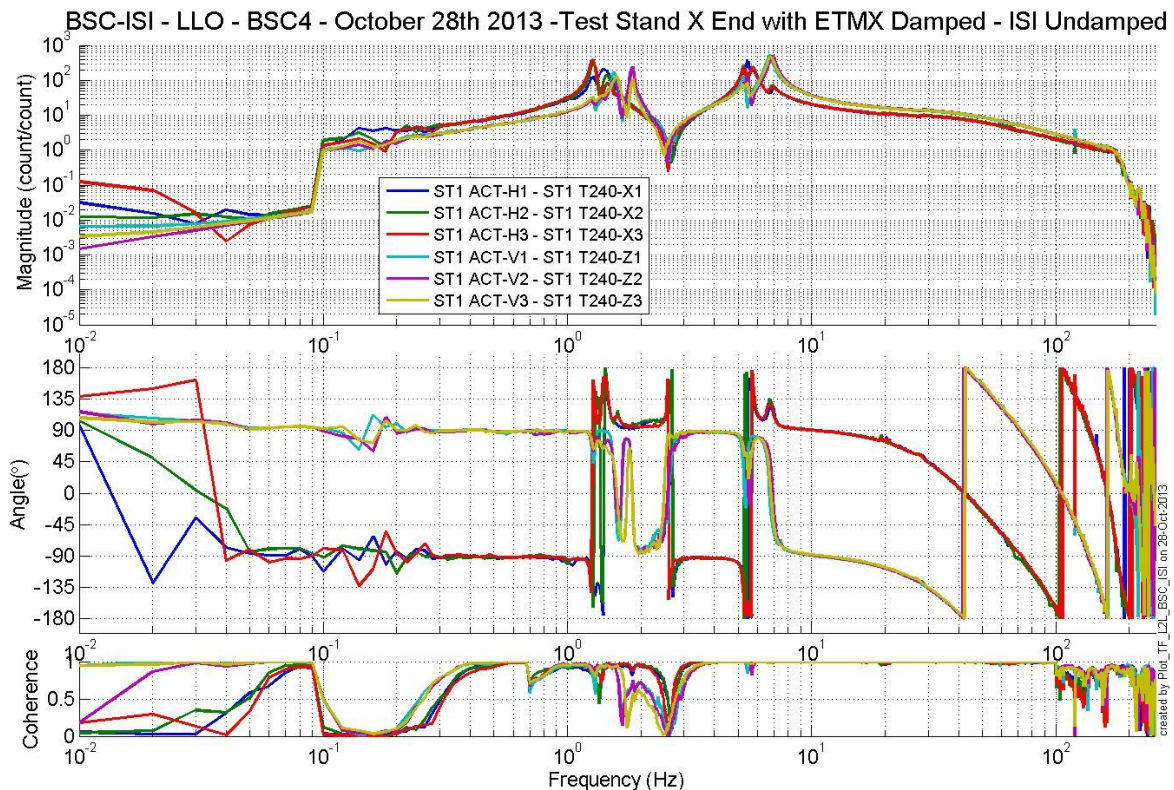**Figure 3 - TF ST1 ACT to ST1 CPS**

Figure 4 - TF ST1 ACT to ST1 L4C

Figure 5 - TF ST1 ACT to ST1 T240

BSC-ISI - LLO - BSC4 - October 28th 2013 -Test Stand X End with ETMX Damped - ISI Undamped

Figure 6 - TF ST2 ACT to ST2 CPS

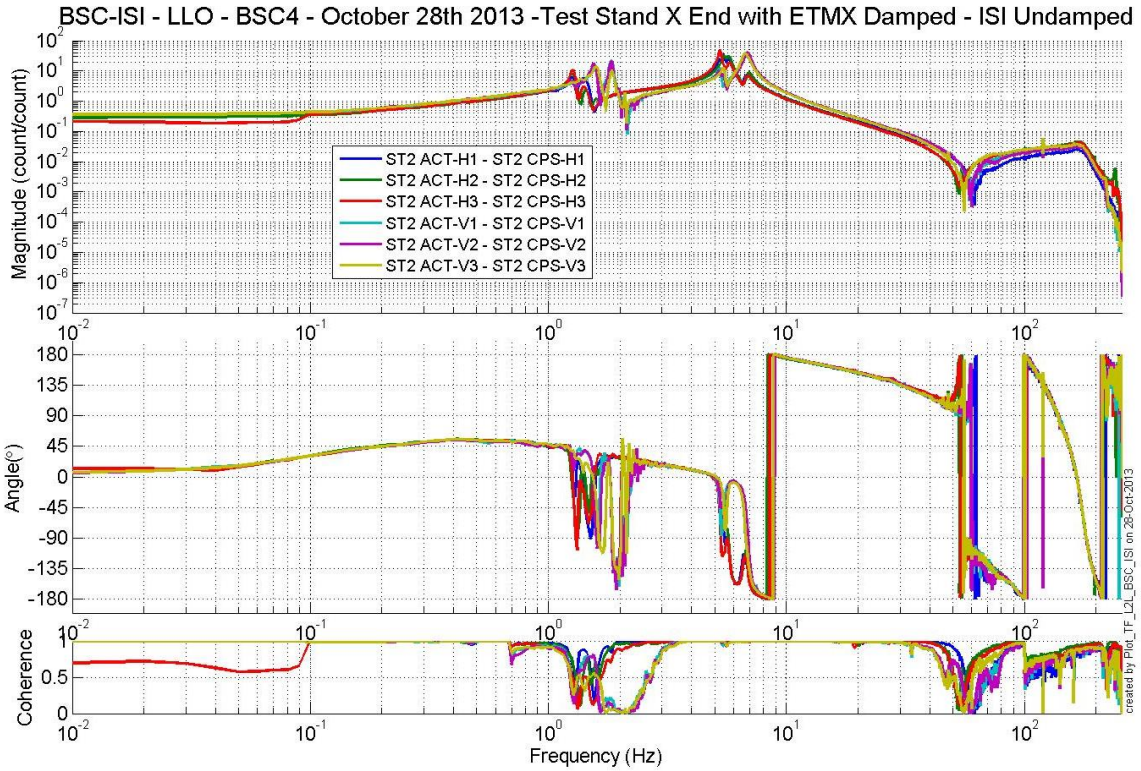BSC-ISI - LLO - BSC4 - October 28th 2013 -Test Stand X End with ETMX Damped - ISI Undamped
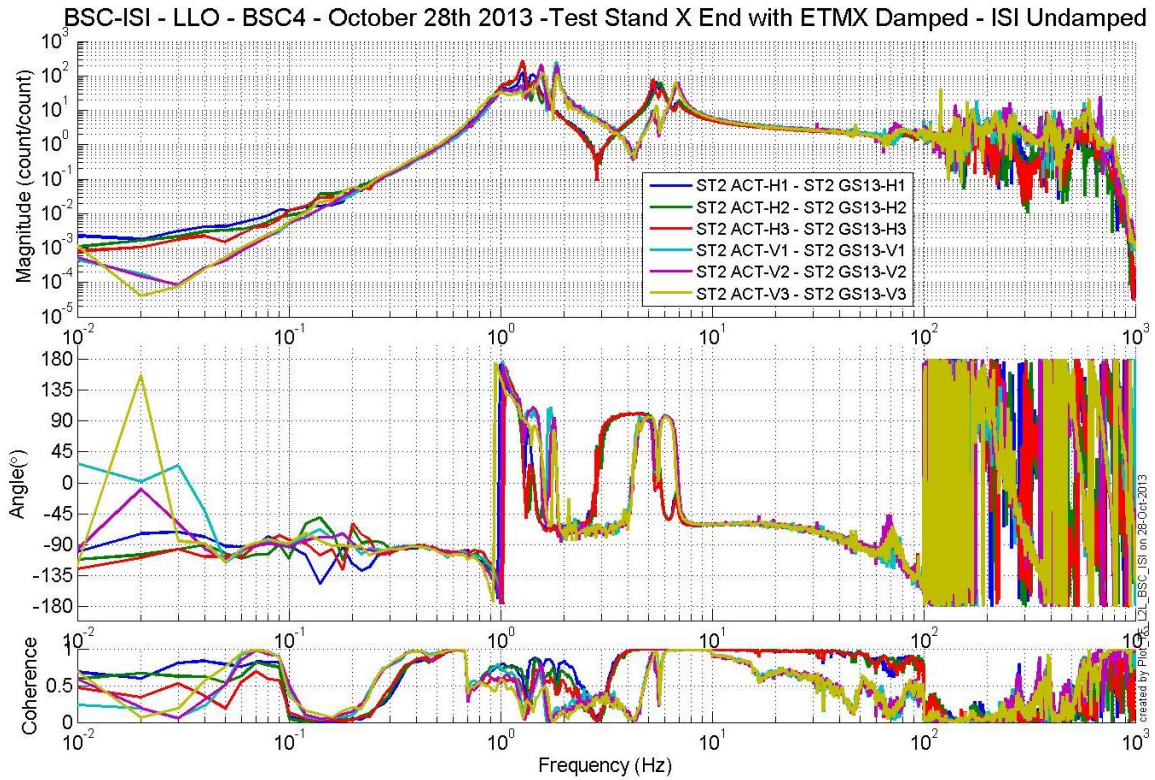

Figure 7 - TF ST2 ACT to ST2 GS13

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2. Comparisons with LHO ETMX

The script used to compare transfer function can be found in the SVN at:
https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Scripts/Control_Scripts
- Comparison_TF_L2L_LLO_ISI_BSC4.m

The figure that shows the comparison between the transfer functions of L1 & H1 ETMX are located in the SVN at:
https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Figures/Transfer_Functions/Comparisons/L2L
- L1_ISI_BSC4_TestStand_X-End_Comparison_TF_L2L_ST1_ACT_H_to_ST1_CPS_H_20130405_vs_20121216.fig
- L1_ISI_BSC4_TestStand_X-End_Comparison_TF_L2L_ST1_ACT_V_to_ST1_CPS_V_20130405_vs_20121216.fig
- L1_ISI_BSC4_TestStand_X-End_Comparison_TF_L2L_ST1_ACT_H_to_ST1_L4C_H_20130405_vs_20121216.fig
- L1_ISI_BSC4_TestStand_X-End_Comparison_TF_L2L_ST1_ACT_V_to_ST1_L4C_V_20130405_vs_20121216.fig
- L1_ISI_BSC4_TestStand_X-End_Comparison_TF_L2L_ST2_ACT_H_to_ST2_CPS_H_20130405_vs_20121216.fig
- L1_ISI_BSC4_TestStand_X-End_Comparison_TF_L2L_ST2_ACT_V_to_ST2_CPS_V_20130405_vs_20121216.fig
- L1_ISI_BSC4_TestStand_X-End_Comparison_TF_L2L_ST2_ACT_H_to_ST2_GS13_H_20130405_vs_20121216.fig
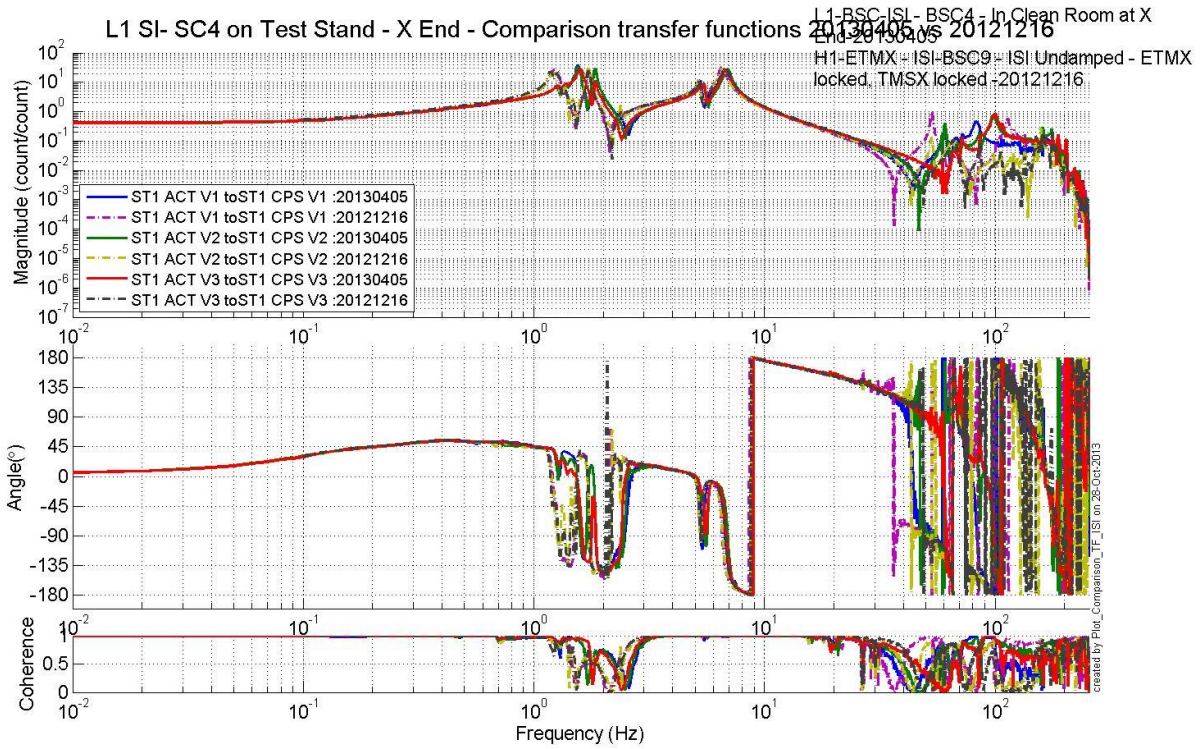- L1_ISI_BSC4_TestStand_X-End_Comparison_TF_L2L_ST2_ACT_V_to_ST2_GS13_V_20130405_vs_20121216.fig
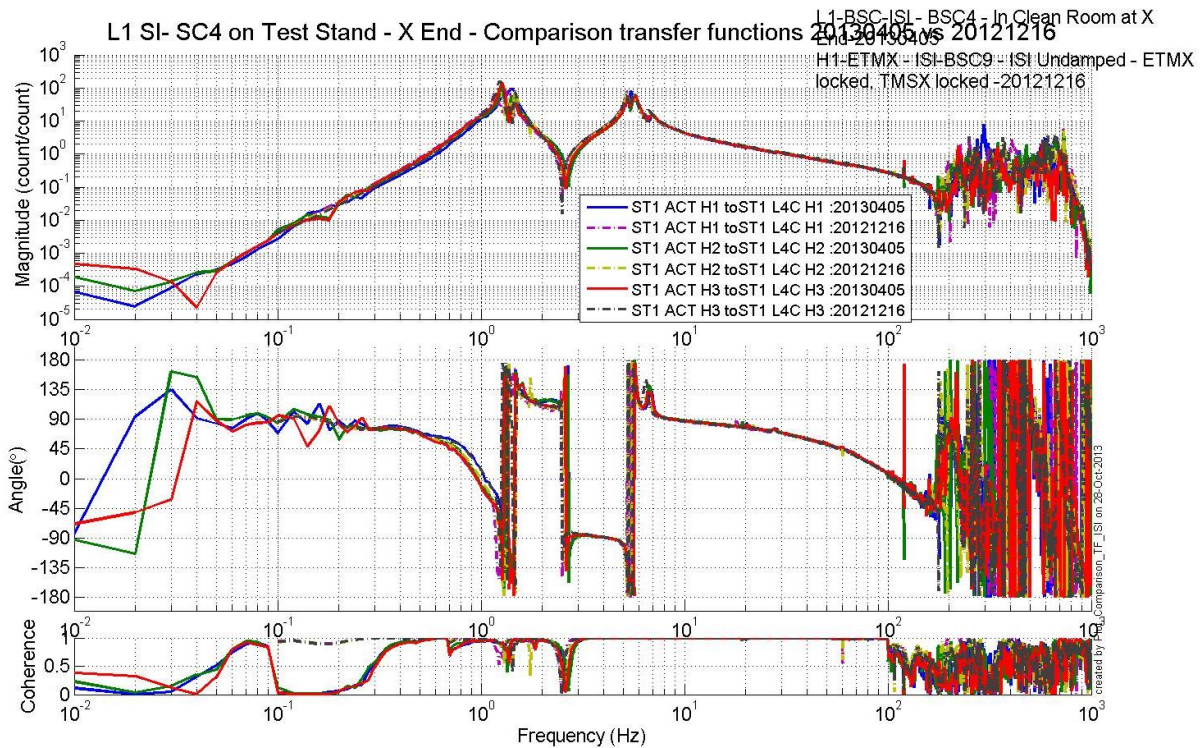
Figure 8 - Transfer functions comparison - ST1 ACT to ST1 CPS
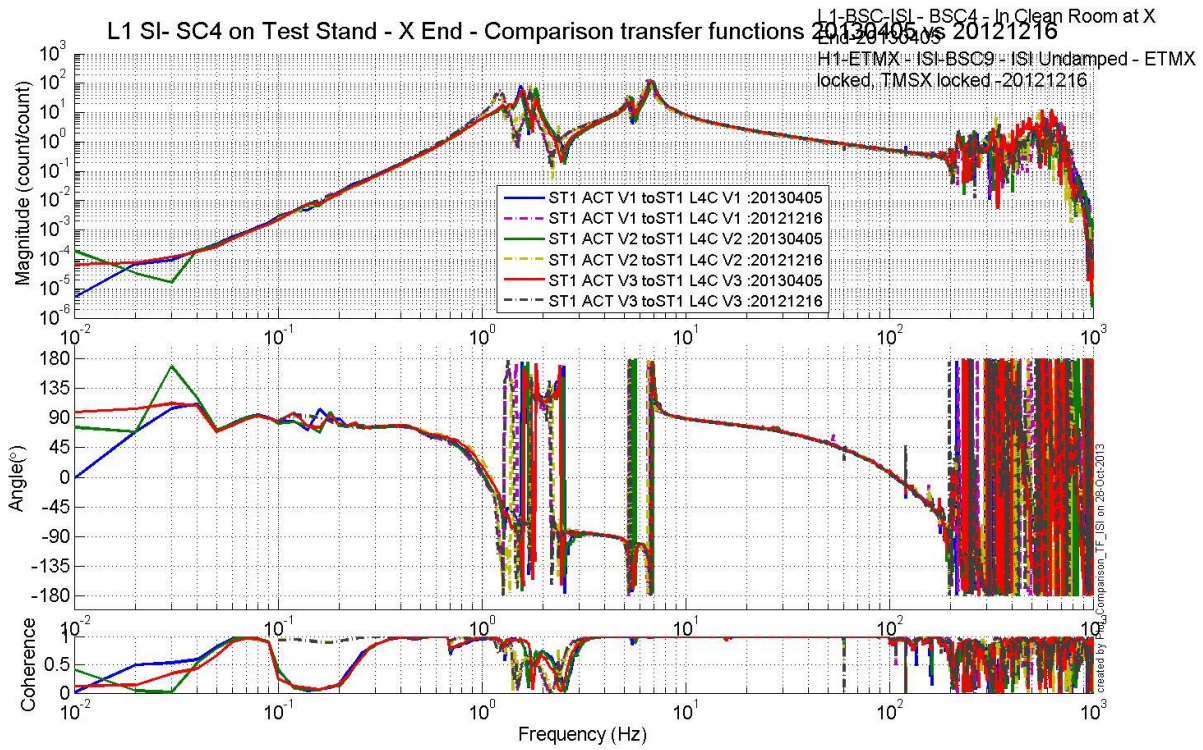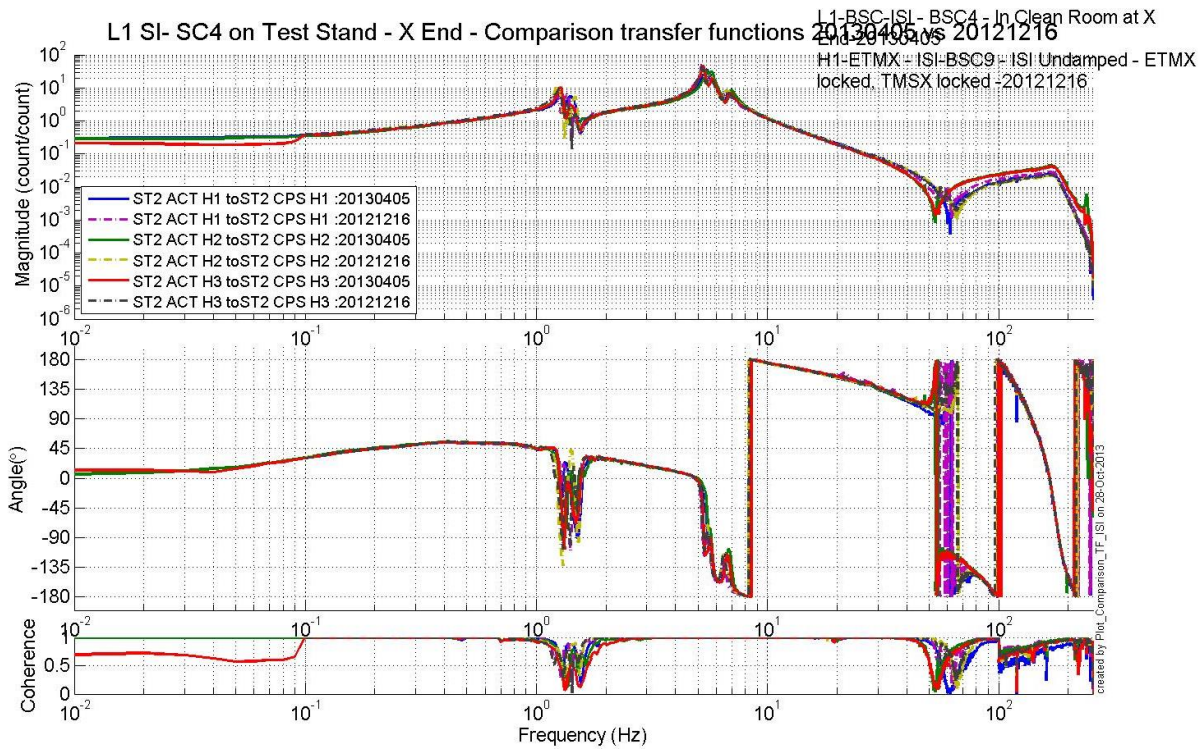
Figure 9 - Transfer functions comparison - ST1 ACT to ST1 L4C

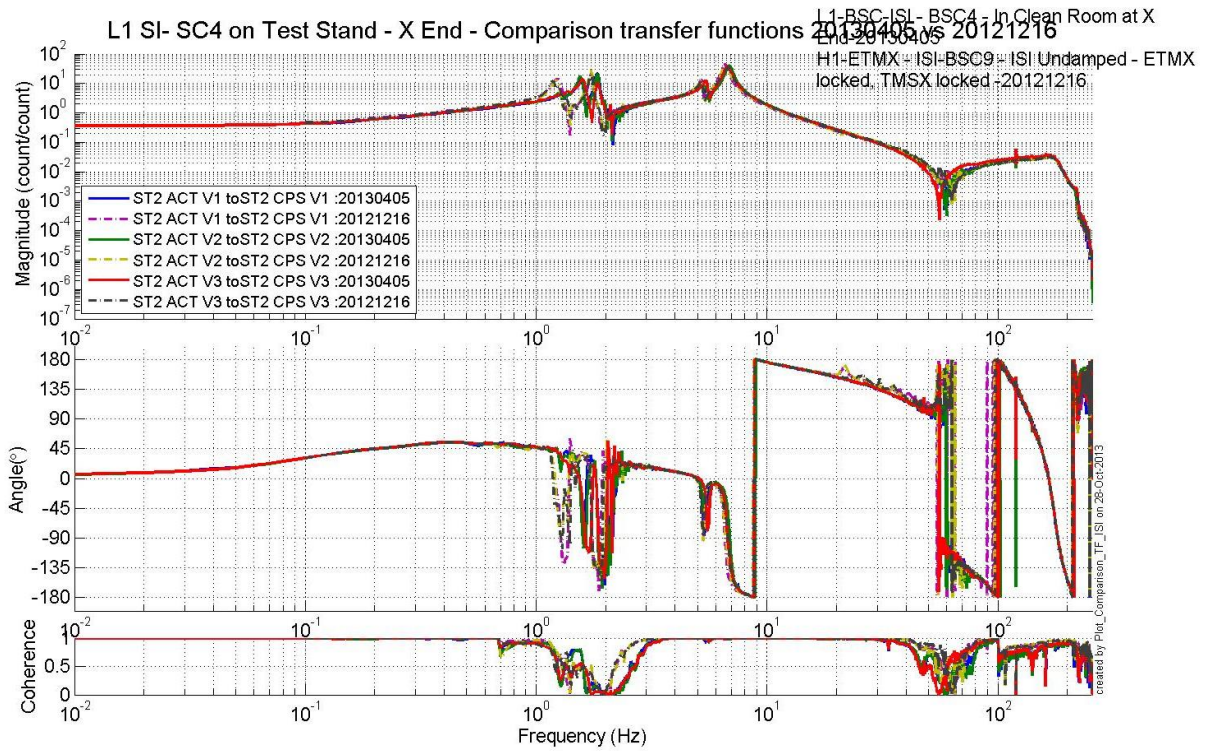**Figure 10 - Transfer functions comparison - ST2 ACT to ST2 CPS**

Figure 11 - Transfer functions comparison – ST2 ACT to ST2 GS13

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

3. Comparisons with measurements in the Staging Building

The script used to compare transfer function can be found in the SVN at:
https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Scripts/Control_Scripts
- Comparison_TF_L2L_LLO_ISI_BSC4.m

The figure that shows the comparison of L1 BSC 4 Transfer Functions before and after the install of the Quad and TMS, are located in the SVN at:
https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Figures/Transfer_Functions/Comparisons/L2L
- L1_ISI_BSC4_TestStand_X-End_with_BSC3_Comparison_TF_L2L_ST1_ACT_H_to_ST1_CPS_H_20130405_vs_20121216.fig
- L1_ISI_BSC4_TestStand_X-End_with_BSC3_Comparison_TF_L2L_ST1_ACT_H_to_ST1_L4C_H_20130405_vs_20121216.fig
- L1_ISI_BSC4_TestStand_X-End_with_BSC3_Comparison_TF_L2L_ST1_ACT_V_to_ST1_CPS_V_20130405_vs_20121216.fig
- L1_ISI_BSC4_TestStand_X-End_with_BSC3_Comparison_TF_L2L_ST1_ACT_V_to_ST1_L4C_V_20130405_vs_20121216.fig
- L1_ISI_BSC4_TestStand_X-End_with_BSC3_Comparison_TF_L2L_ST2_ACT_H_to_ST2_CPS_H_20130405_vs_20121216.fig
- L1_ISI_BSC4_TestStand_X-End_with_BSC3_Comparison_TF_L2L_ST2_ACT_H_to_ST2_GS13_H_20130405_vs_20121216.fig
- L1_ISI_BSC4_TestStand_X-End_with_BSC3_Comparison_TF_L2L_ST2_ACT_V_to_ST2_CPS_V_20130405_vs_20121216.fig
- L1_ISI_BSC4_TestStand_X-End_with_BSC3_Comparison_TF_L2L_ST2_ACT_V_to_ST2_GS13_V_20130405_vs_20121216.fig

Figure 12 - Transfer functions comparison - ST1 ACT to ST1 CPS
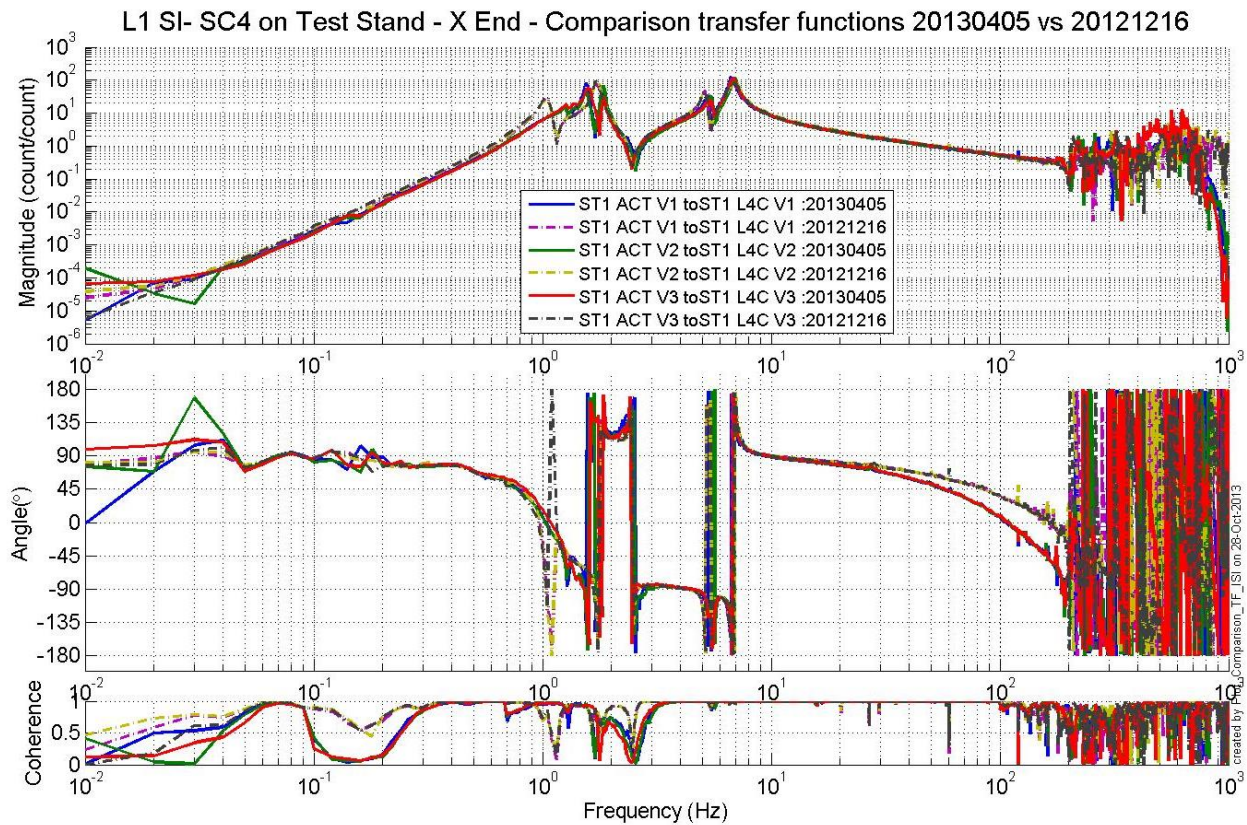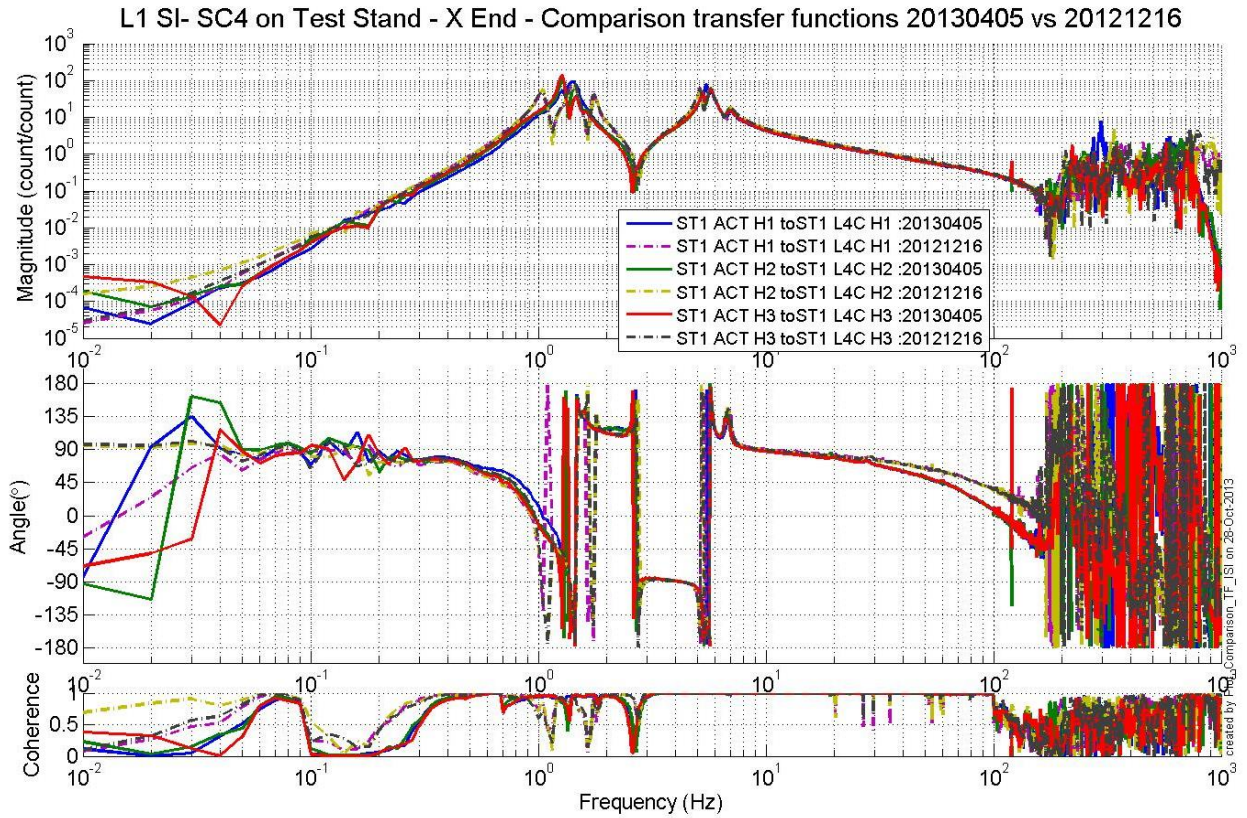
Figure 13 - Transfer functions comparison - ST1 ACT to ST1 L4C
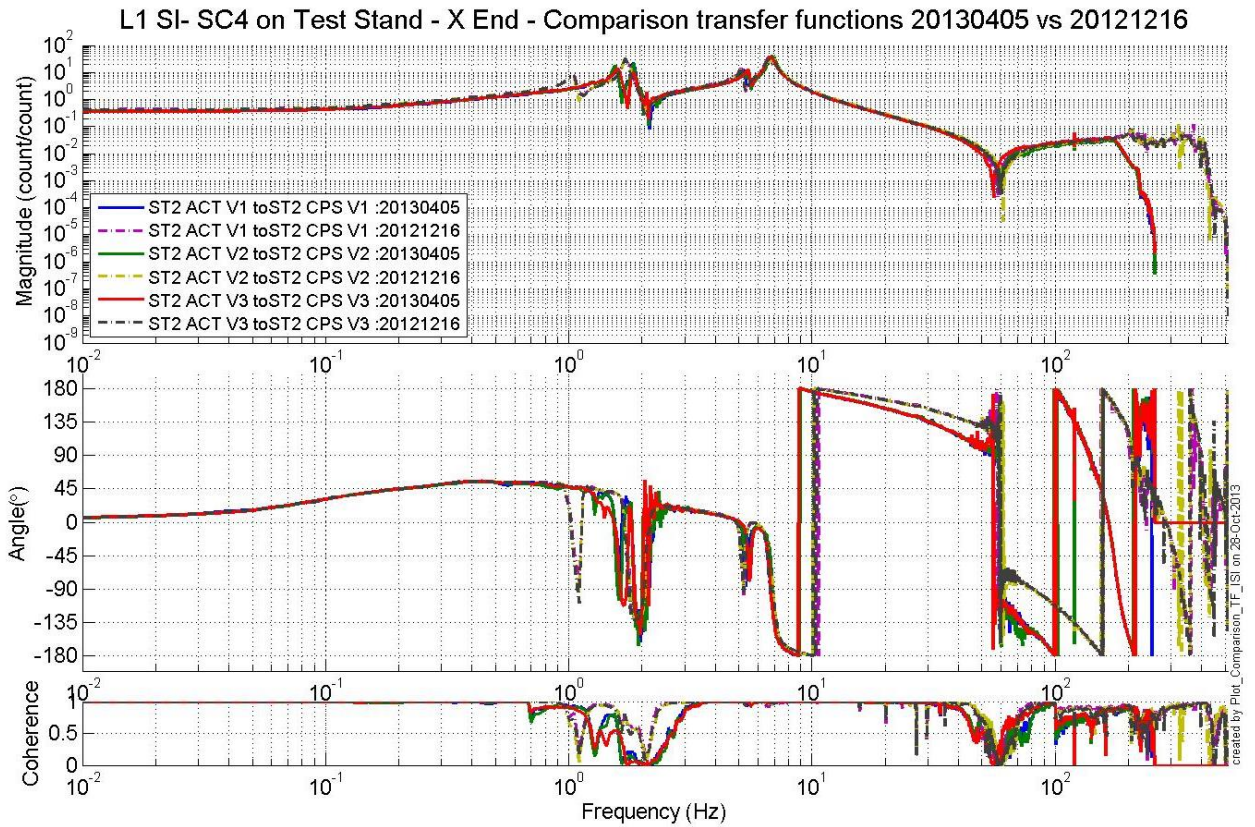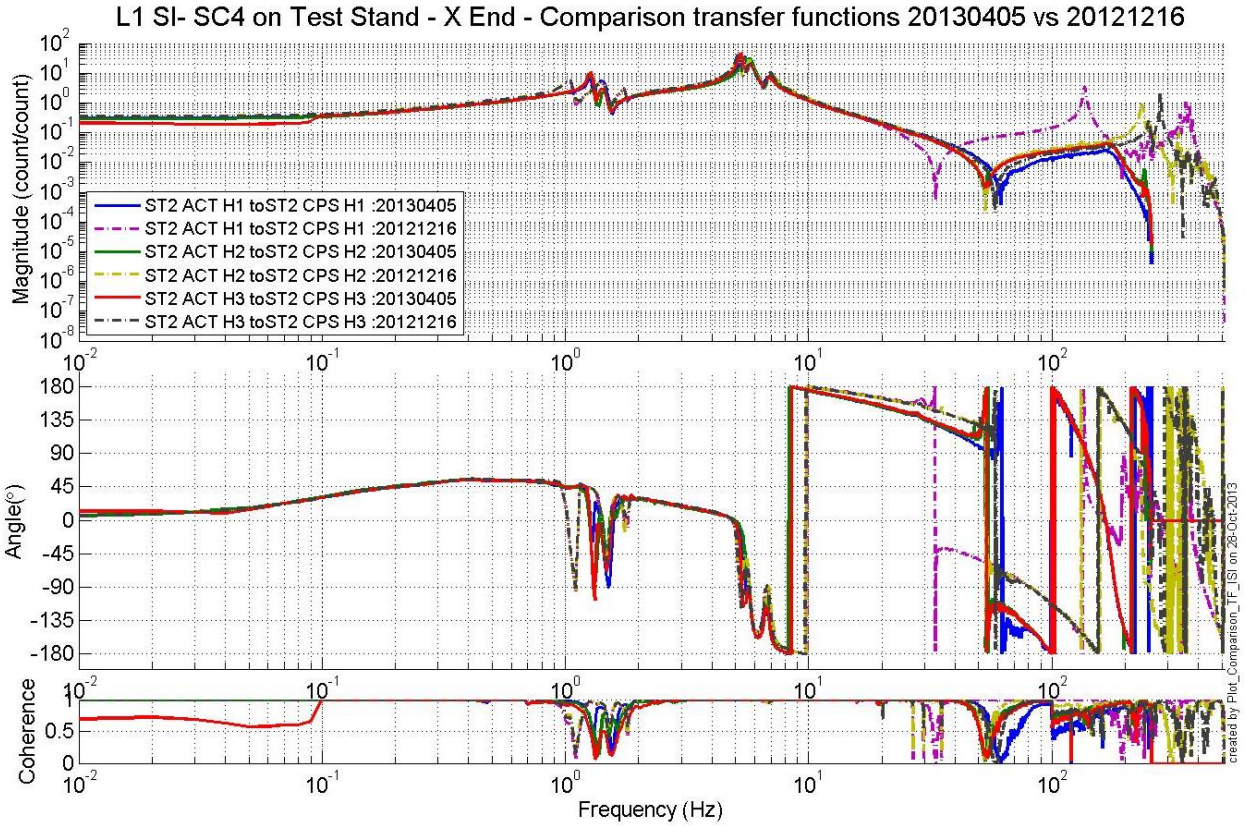
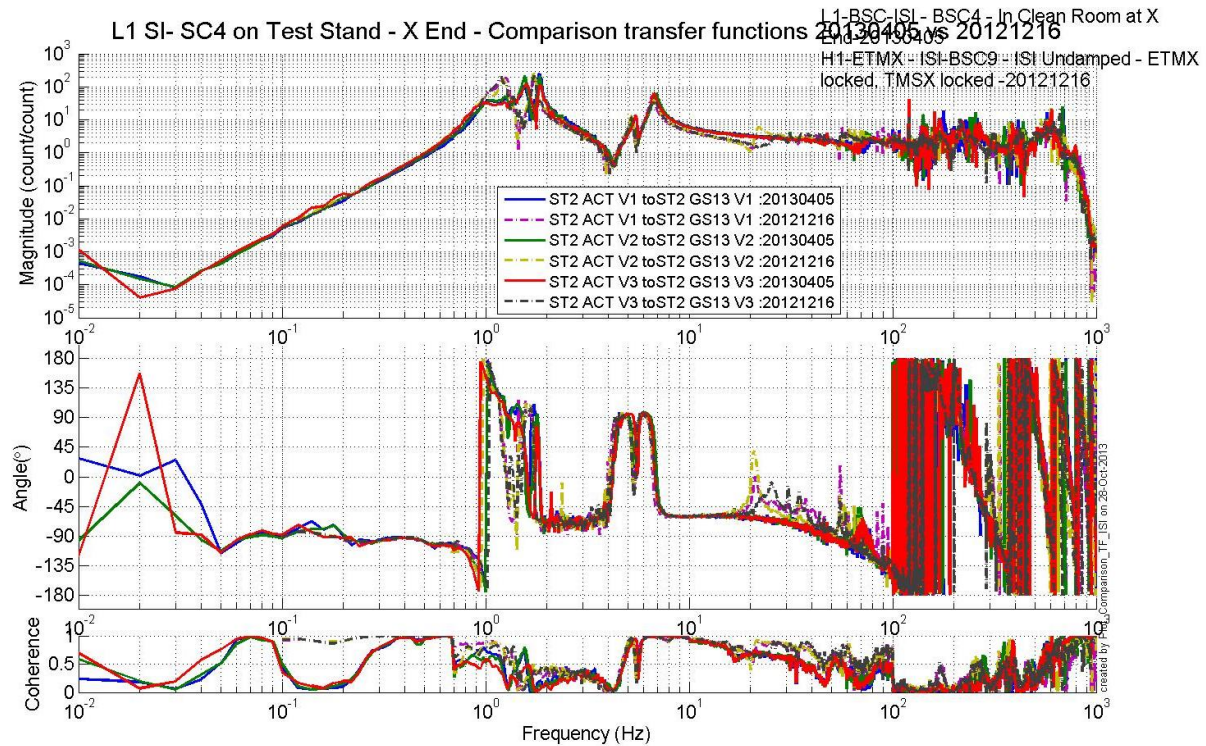**Figure 14 - Transfer functions comparison - ST2 ACT to ST2 CPS**

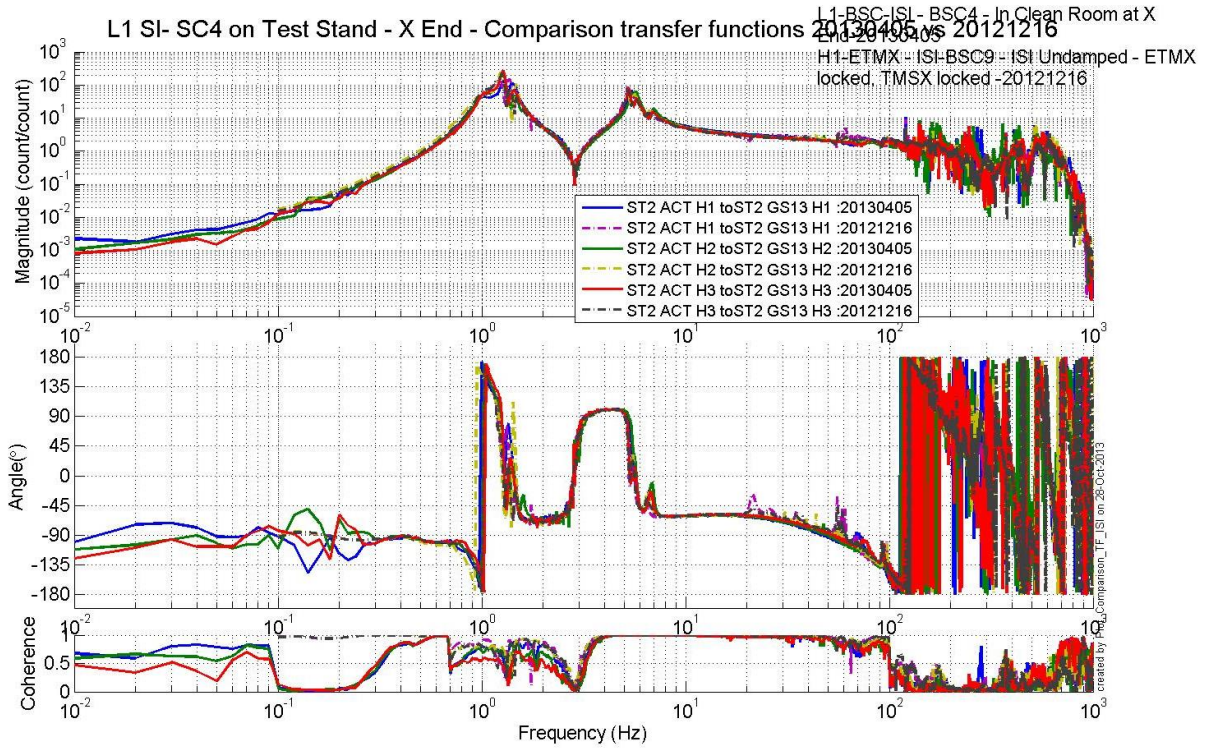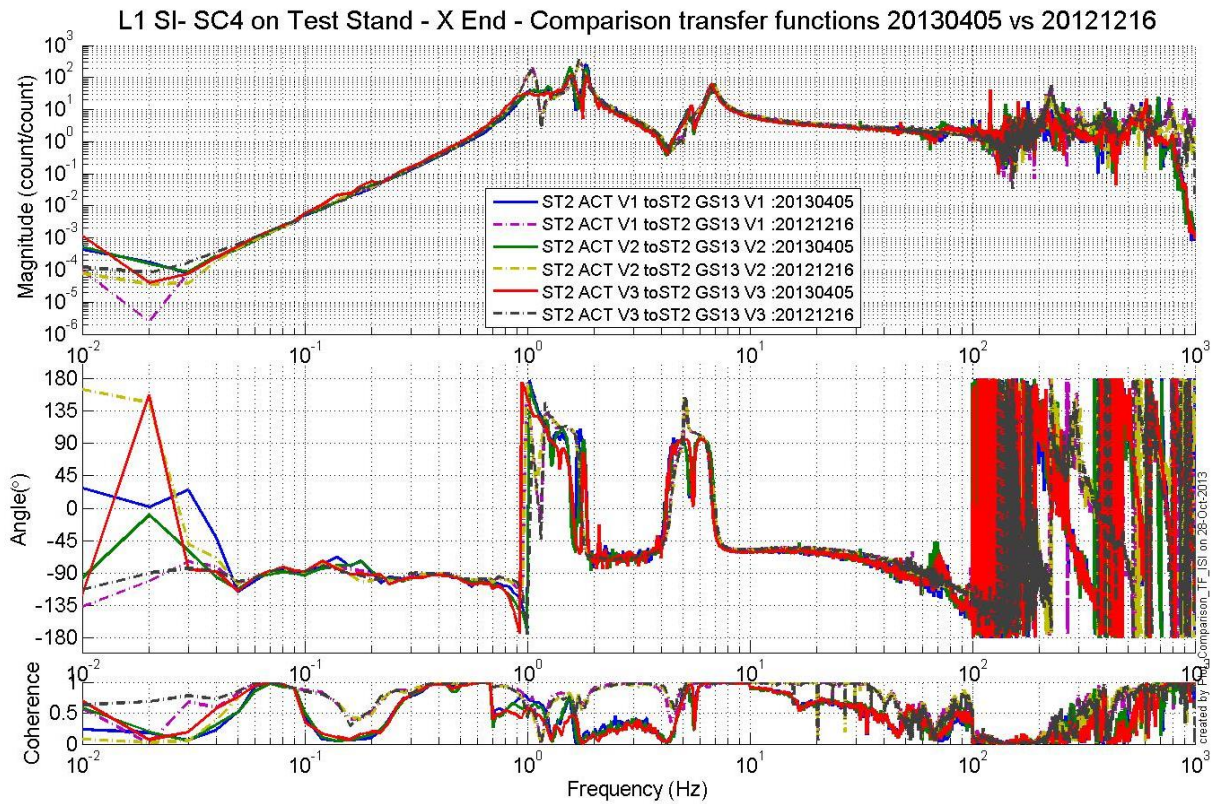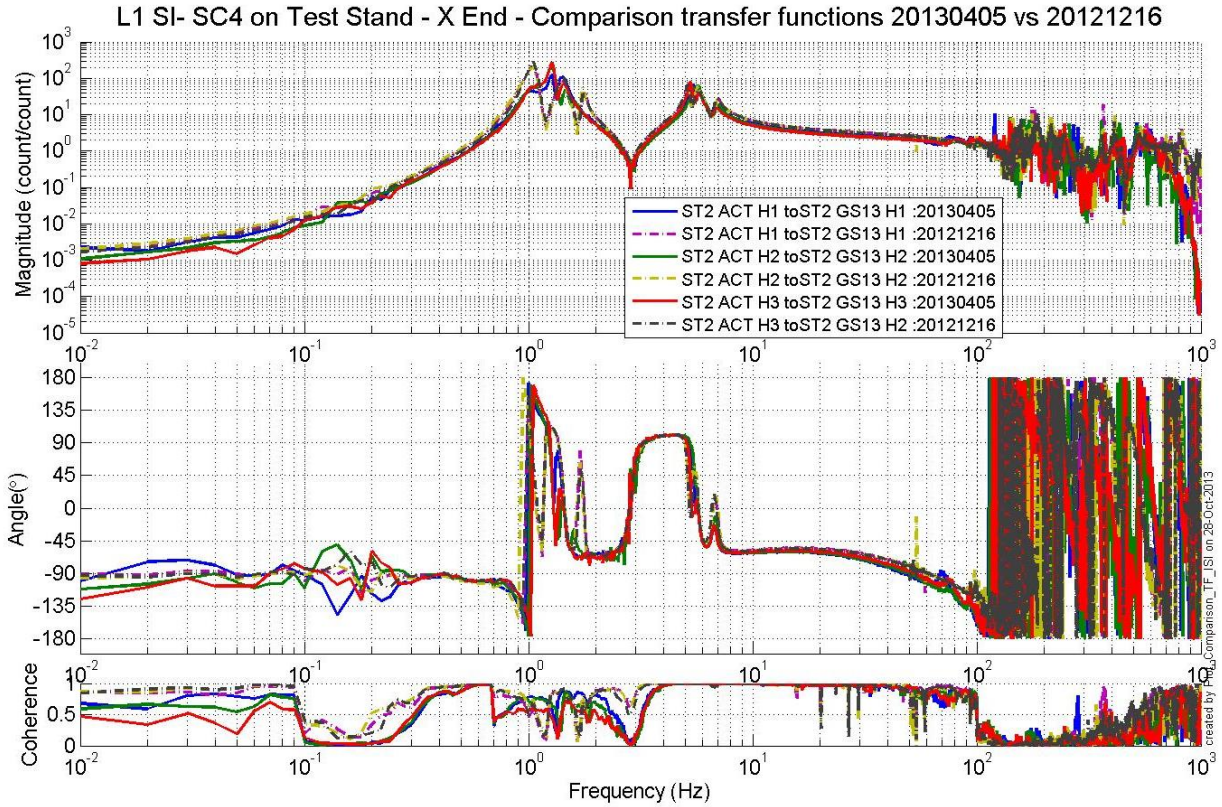**Figure 15 - Transfer functions comparison – ST2 ACT to ST2 GS13**

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

2. Phase II-B – After Install

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

T240s have not been replaced since phase I testing in the staging building.

5. Cables – E1100822

No cables have been changed since phase I testing in the staging building.

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.

Hardware	Ligo reference	S/N
Interface Chassis Pod 1	D1002432	S1203884
Interface Chassis Pod 2	D1002432	S1203885
Interface Chassis Pod 3	D1002432	S1203886
Anti-aliasing Chassis Pod 1	D1002693	S1203106
Anti-aliasing Chassis Pod 2	D1002693	S1203107
Anti-aliasing Chassis Pod 3	D1002693	S1203109
Binary Input Chassis 1	D1001726	S1101306
Binary Input Chassis 2	D1001726	S1101307
Binary Output Chassis	D1001728	S1101333
T240 Interface Pod 1	D1002694	S1201405
T240 Interface Pod 2	D1002694	S1201406
T240 Interface Pod 3	D1002694	S1201407
Anti-image Chassis	D070081	S0900067
Coil driver Pod 1	D0902744	S1103314
Coil driver Pod 2	D0902744	S1103336
Coil driver Pod 3	D092744	S1103360
Expansion chassis		L1seiex

Table 8 - Electronic inventory

Note: No changes.

3. Models Modifications

No model modifications were done between the beginning and the end of Phase 2a testing.

4. Mass distribution

At this point, all the final masses are installed on the BSC-ISI.

1. Seismic

Stage 1

Stage 1	HighBay (lbs)	LVEA Test Stand (lbs)	LVEA Chamber (lbs)	LVEA Chamber (kg)
Corner 1	49.22	49.22	46.72	21.19
Corner 2	22.86	22.86	24.86	11.28
Corner 3	32.22	32.22	31.72	14.39
Total	104.3	104.3	103.30	46.86

Note: The budget mass on Stage 1 changed a little bit between the Test Stand and in Chamber, it is probably due to some cablings that have been re-routed.

Stage 2

The seismic masses on BSC 4 are:

11/15/2013	D972213	D972215	D1003136	D0901075		D071200							lbs	kgs
				5 kg	10 kg	00	01	02	03	04	05	06		
	610	230	50	11	22	0.6	1.1	2.2	4.5	7.9	15.6	27.2		
A													0	0.00
B													0	0.00
C													0	0.00
D			13										650	294.83
E-1													0	0.00
E-2													0	0.00
E-3													0	0.00
F1						1	2	1	1		1	2	79.5	36.06
F2						2			2	2	2	2	111.6	50.62
F3						2	1				4	1	91.9	41.69
Stage 2	0	0	13	0	0	5	3	1	3	2	7	5	933	423.20

- On the side and on the Keel: 933 lbs (=423.20 kg)
- On the Optical Table (6) D1003161:   285.72 lbs (=129.6 kg)

The total of masses on Stage 2 is: 1218.72 lbs (=552.8 kg).

2. Suspension

The quad structure and the TMS Structure was weighed to be:

SUS	Weight (lbs)	Weight (kg)
Upper structure	266	120.66
Lower structure	531	240.86
Total	797	361.5128

TMS	Weight (lbs)	Weight (kg)
Total	456.14	206.9

3. Misc

- 44 lbs = quad sleeve [Betsy's alog 3621]
- 2 lbs = quad sleeve wedges [estimate]
- 5 lbs = cabling [estimate]
- 2 lbs cable brackets [estimate]
- 28 lbs = Vibration absorbers, quantity 4 [from E1000337-v2: 12.7 kg = 28 lbs]
- 3 lbs = Ring heater + brackets + cables [estimate]

Total Weight for Suspension: 906 lbs = 412 kg
Total Weight for TMS: 456.14 lbs = 206.9 kg

4. Total

Nominal mass hanging on stage 0-1 blades (without stage 2): 912Kg – 2010lb
Nominal mass hanging on stage 1-2 blades: 2830Kg – 6239lb
Nominal payload on stage 1: 109Kg – 240lb
Nominal payload on stage 2: 1185Kg – 2612lb

			Staging Bldg	X End		X End (Chamber)		
		Plan	07/18/2012	Detail	Overall	Detail	Overall	Difference
Stage 1 (kg)		108.86	47.31	47.31		46.86		-0.45
Stage 2 (kg)	Masses	1183.42	1155.53	547.68	1166.97	552.80	1172.09	5.12
	Suspension	N/A	N/A	361.51		361.51		
	Miscellaneous	N/A	N/A	50.88		50.88		
	TMS	N/A	N/A	206.9		206.9		
Total (kg)		1292.28	1200.79	1214.28		1218.95		4.67

The weight difference between the Test Stand and the In Chamber Mass Budget is under the 10 kg requirement. The weight for the quad and the TMS structure are estimated. Overall, the mass budget is consistent with what we had in the Staging Building.

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

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

1. Pressure sensors

All pressure sensors are working correctly.

https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Static_Tests/
L1_ISI_ETMX_Pressure_Sensors_Check_Calibrated_2020_11_11_3 5:3:.mat

	Pressure (KPa)		
Sensors	**Corner 1**	**Corner 2**	**Corner 3**
ST1-L4C-P	100.77	100.20	102.01
ST1-L4C-D	-0.57	0.20	-1.33
ST1-GS13-P	101.72	102.19	102.46
ST1-GS13-D	0.22	-0.30	-0.76
ST1-T240-P	100.54	100.66	100.74

Table 9 - Geophones Pressure sensors

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

2. Spectra

Spectra of the instrument can be found in the SVN at:
https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Spectra/Undamped/
L1_ISI_ETMX_ASD_m_LOC_CPS_T240_L4C_GS13_2013_11_13_160436.mat

https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-
ISI/L1/ITMY/Data/Figures/Spectra/Undamped/
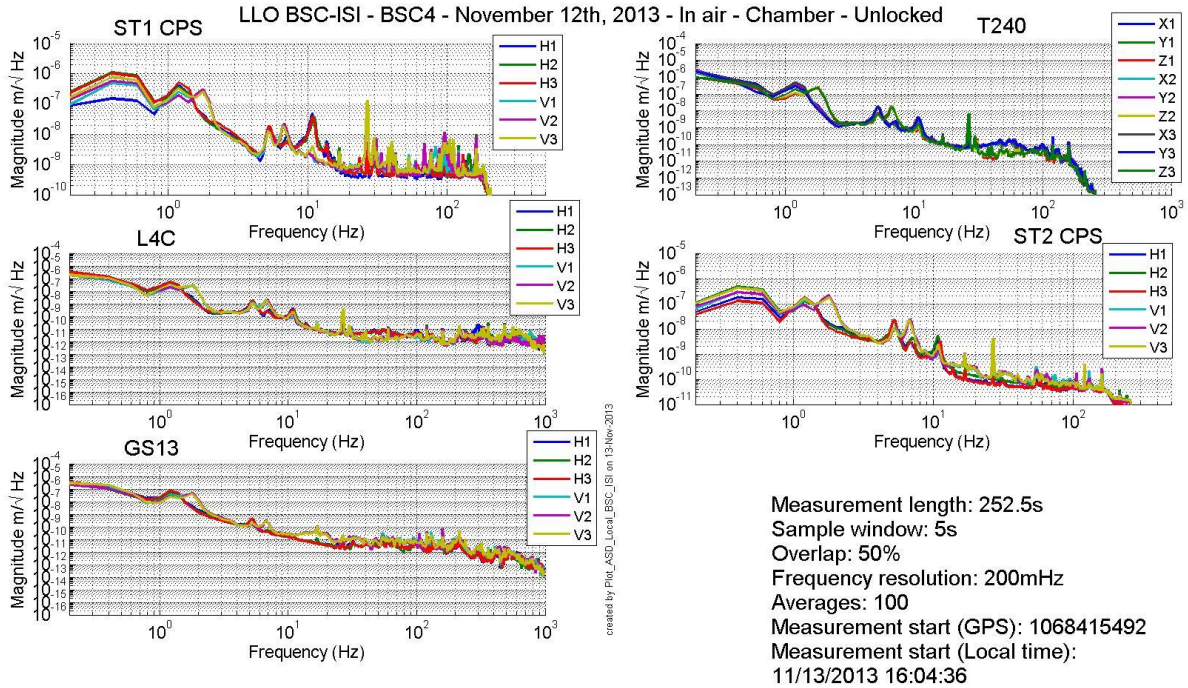*L1_ISI_ETMX_ASD_m_LOC_CPS_T240_L4C_GS13_2013_11_13_160436.fig*

Figure 16 - Spectra inboard instruments - ISI Unlocked

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

3. Actuators-cables resistance

https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Static_Tests/
L1_ISI_ETMX_Actuators_Resistance_20131112T102441.mat

	Stage 1						Stage 2					
	H1	**H2**	**H3**	**V1**	**V2**	**V3**	**H1**	**H2**	**H3**	**V1**	**V2**	**V3**
Script	6.65	6.79	6.94	6.70	6.89	6.71	10.39	10.60	10.83	10.47	10.50	10.53

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

4. Offsets CPS Unlocked vs locked

https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Static_Tests/
- L1_ISI_ETMX_CPS_Read_Back_ISI_Locked_2013_11_13_154209.mat
- L1_ISI_ETMX_CPS_Read_Back_ISI_UnLocked_2013_11_13_154804.mat

Sensors	Table locked		Table unlocked		Difference locked - unlocked	
	Offset (Mean)	Std deviation	Offset (Mean)	Std deviation	Offset (Mean)	mil
ST1 - H1	-126.90	3.94	-478.19	53.35	351.29	0.42
ST1 - H2	29.25	4.27	-1433.28	187.56	1462.53	1.74
ST1 - H3	-271.37	4.05	-679.61	99.82	408.24	0.49
ST1 - V1	129.49	5.10	189.55	110.58	-60.06	-0.07
ST1 - V2	-91.21	8.52	-1291.51	69.55	1200.30	1.43
ST1 - V3	280.67	6.24	253.75	106.65	26.92	0.03
ST2 - H1	988.94	8.33	-190.83	163.03	1179.78	0.35
ST2 - H2	-702.24	11.57	-2007.25	230.40	1305.01	0.39
ST2 - H3	-1176.33	19.86	-1753.94	68.32	577.60	0.17
ST2 - V1	-233.46	17.25	-1249.38	242.67	1015.92	0.30
ST2 - V2	126.95	15.82	-510.76	161.26	637.70	0.19
ST2 - V3	-1154.53	19.85	-318.12	216.05	-836.41	-0.25

Table 10 - Locked vs Unlocked Position

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

5. Offset local drive

Note: Due to longer cables, offsets measured by CPS for a 7000 count drive are slightly lower than offsets measured in the staging building.

Results of this test can be found in the SVN at:
https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Static_Tests/
- L1_ISI_ETMX_Offset_Local_Drive_20131112.mat

		Sensors				
		ST1 - H1	**ST1 - H2**	**ST1 - H3**	**ST1 - V1**	**ST1 - V2**	**ST1 - V3**
Actuators	**ST1 - H1**	3943.87	1599.22	1590.61	-31.08	-15.00	26.18
	ST1 - H2	1584.30	3969.92	1605.17	3.16	-10.78	1.08
	ST1 - H3	1557.03	1576.15	3870.52	-36.84	6.48	14.04
	ST1 - V1	8.38	-128.47	70.39	2965.50	-500.15	-446.42
	ST1 - V2	67.33	11.20	-135.44	-451.42	2956.52	-493.36
	ST1 - V3	-116.69	84.93	48.19	-453.71	-471.60	3011.11

Table 11 - Static Tests – Local to Local - Stage 1

		Sensors				
		ST2 - H1	**ST2 - H2**	**ST2 - H3**	**ST2 - V1**	**ST2 - V2**	**ST2 - V3**
Actuators	**ST2 - H1**	2202.20	331.22	337.90	9.01	-8.52	-18.83
	ST2 - H2	311.54	2211.21	329.80	8.38	-28.38	-16.66
	ST2 - H3	349.95	334.23	2215.81	27.00	-13.33	-7.23
	ST2 - V1	71.37	106.48	-151.34	3131.97	316.20	45.22
	ST2 - V2	-163.52	75.84	88.94	24.24	2594.10	328.84
	ST2 - V3	106.25	-148.87	54.49	446.25	12.29	2592.81

Table 12 - Static Tests – Local to Local - Stage 2

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

6. Offset Cartesian drive

The test was not performed because it only tests the matrices, which can be changed at any time.

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

7. 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/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Static_Tests/
- L1_ISI_ETMX_Range_Of_Motion_20131114.mat

Sensor readout (counts)	Negative drive	Positive drive	Amplitude count	mil
ST1 - H1	-16337.6	15347.3	31684.9	37.7
ST1 - H2	-15441.0	15558.5	30999.5	36.9
ST1 - H3	-15342.9	15952.1	31295.0	37.3
ST1 - V1	-12814.8	13297.3	26112.2	31.1
ST1 - V2	-14052.3	11664.9	25717.2	30.6
ST1 - V3	-12497.1	13356.9	25854.0	30.8
ST2 - H1	-9814.7	9292.3	19107.0	5.7
ST2 - H2	-11541.5	7443.2	18984.6	5.7
ST2 - H3	-11313.2	7682.6	18995.7	5.7
ST2 - V1	-11711.4	10043.1	21754.5	6.5
ST2 - V2	-11246.7	10991.4	22238.1	6.6
ST2 - V3	-11103.3	11155.4	22258.7	6.6

Table 13 - Range of motion - Actuator drive in the LVEA

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

8. Linearity test

The data of the linearity test can be found on the SVN at:
https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Linearity_Test/
- L1_ISI_ETMX_Linearity_test_20131114.mat

The figures of the linearity test can be found on the SVN at:
https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic\BSC-ISI\H2\BS\Data\Figures\Linearity_Test
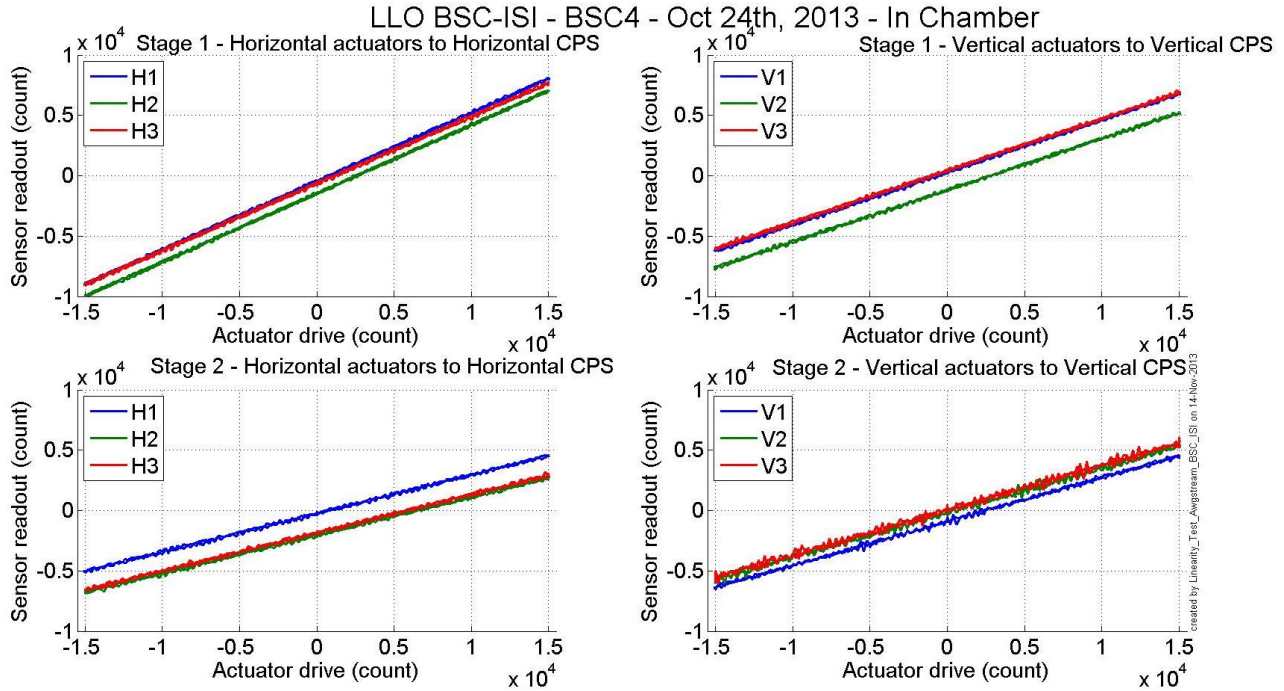- L1_ISI_ETMX_Linearity_test_20131114.fig

Figure 17 - Linearity test –L1 - BS – In LVEA

		Slope	Offset	Average slope	Variation from average(%)
Stage 1	**ST1 - H1**	0.56723	-458.7	0.5635	-0.66
	ST1 - H2	0.56788	-1476.9		-0.77
	ST1 - H3	0.55547	-662.9		1.43
	ST1 - V1	0.43374	258.0	0.4306	-0.73
	ST1 - V2	0.42761	-1200.8		0.69
	ST1 - V3	0.43042	428.5		0.04
Stage 2	**ST2 - H1**	0.31916	-248.1	0.3175	-0.51
	ST2 - H2	0.31658	-2049.8		0.30
	ST2 - H3	0.31683	-1834.2		0.22
	ST2 - V1	0.36355	-914.0	0.3687	1.38
	ST2 - V2	0.37058	-174.6		-0.52
	ST2 - V3	0.37183	46.6		-0.86

Table 14 - Slope – Offset Linearity test

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

6. Transfer functions and Comparison with measurements done on H1 BSC9 ETMX.

1. In Chamber Quad Locked (Dome off)

The parameters for the measurements in the X End are slightly different from those in the staging building. We chose to have weaker excitation but longer averages in an effort to reduce risk for the attached suspension.

Note: the following transfer functions have been taken with the ISI in Chamber, with the dome off, the TMS Structure Unlocked but the **Quad locked**. The suspension team was busy welding ETMY at the time and we had some time to test ETMX so we decided to go ahead and do the transfer functions. This will eventually allow us to put the dome back on ETMX before Thanksgiving.

At this point, all the tuned mass dampers are on (on Stage 0-1 springs, the vibration absorbers on Stage 1 doors & Viton under the keel masses).

Measurements data can be found in the SVN at:
https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Transfer_Functions/Measurements/Undamped:
- LLO_ISI_BSC4_Data_L2L_10mHz_100mHz_ST1_ST2_20131116-091020.mat
- LLO_ISI_BSC4_Data_L2L_100mHz_700mHz_ST1_ST2_20131116-052642.mat
- LLO_ISI_BSC4_Data_L2L_700mHz_10Hz_ST1_ST2_20131115-210713.mat
- LLO_ISI_BSC4_Data_L2L_10Hz_100Hz_ST1_ST2_20131115-185936.mat
- LLO_ISI_BSC4_Data_L2L_100Hz_500Hz_ST1_ST2_20131115-173404.mat
- LLO_ISI_BSC4_Data_L2L_500Hz_1000Hz_ST1_ST2_20131115-162447.mat

Data after processing can be found in the SVN at:
https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Transfer_Functions/Simulations/Undamped
- LLO_ISI_BSC4_TF_L2L_Raw_10mHz_1000Hz_2013_11_16.mat

The transfer functions can be found in the SVN at:
https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Figures/Transfer_Functions/Measurements/Undamped/
- L1_ISI_ETMX_TF_L2L_Raw_from_ST1_ACT_to_ST1_CPS_2013_11_16.fig
- L1_ISI_ETMX_TF_L2L_Raw_from_ST1_ACT_to_ST1_L4C_2013_11_16.fig
- L1_ISI_ETMX_TF_L2L_Raw_from_ST1_ACT_to_ST1_T240_2013_11_16.fig
- L1_ISI_ETMX_TF_L2L_Raw_from_ST2_ACT_to_ST2_CPS_2013_11_16.fig
- L1_ISI_ETMX_TF_L2L_Raw_from_ST2_ACT_to_ST2_GS13_2013_11_16.fig

Note 1: The transfer functions are measured from the Output filters bank excitation point to the input (IN1) of the input filters bank. The transfer functions presented below are raw transfer functions without any electronic compensation.

Note 2: The L4Cs are out of phase (should be -90 before 1Hz). A minus sign is added in the calibration filters that convert count to nm/s.
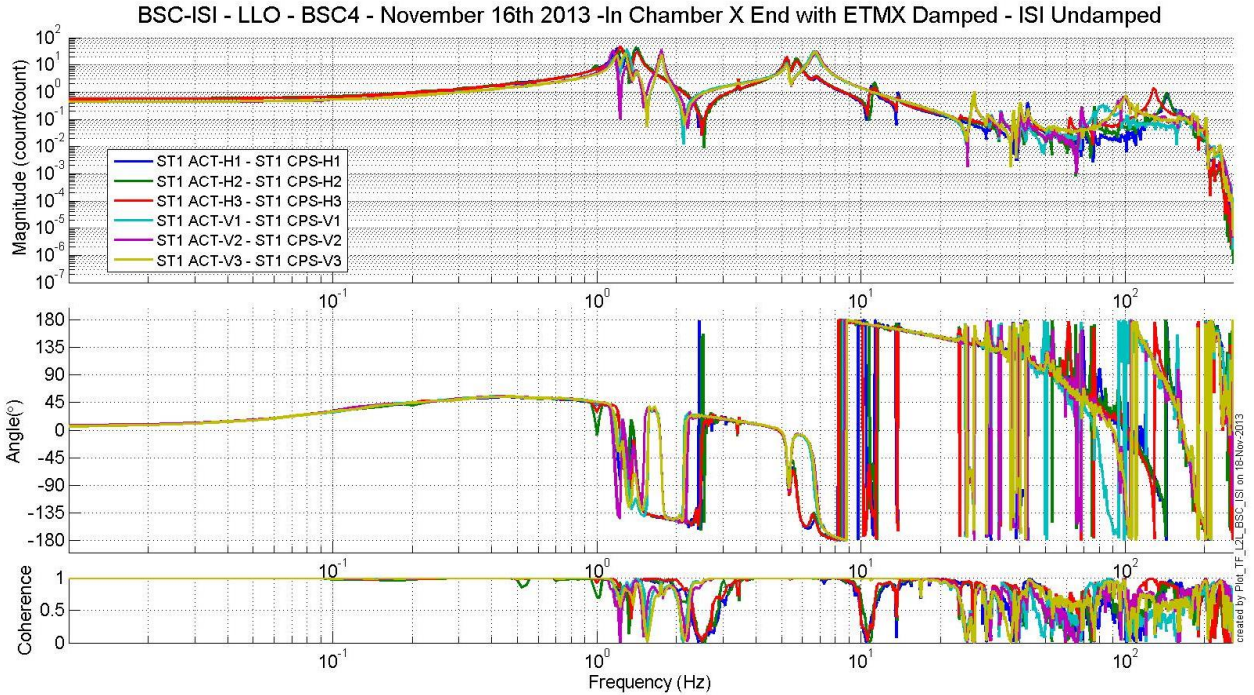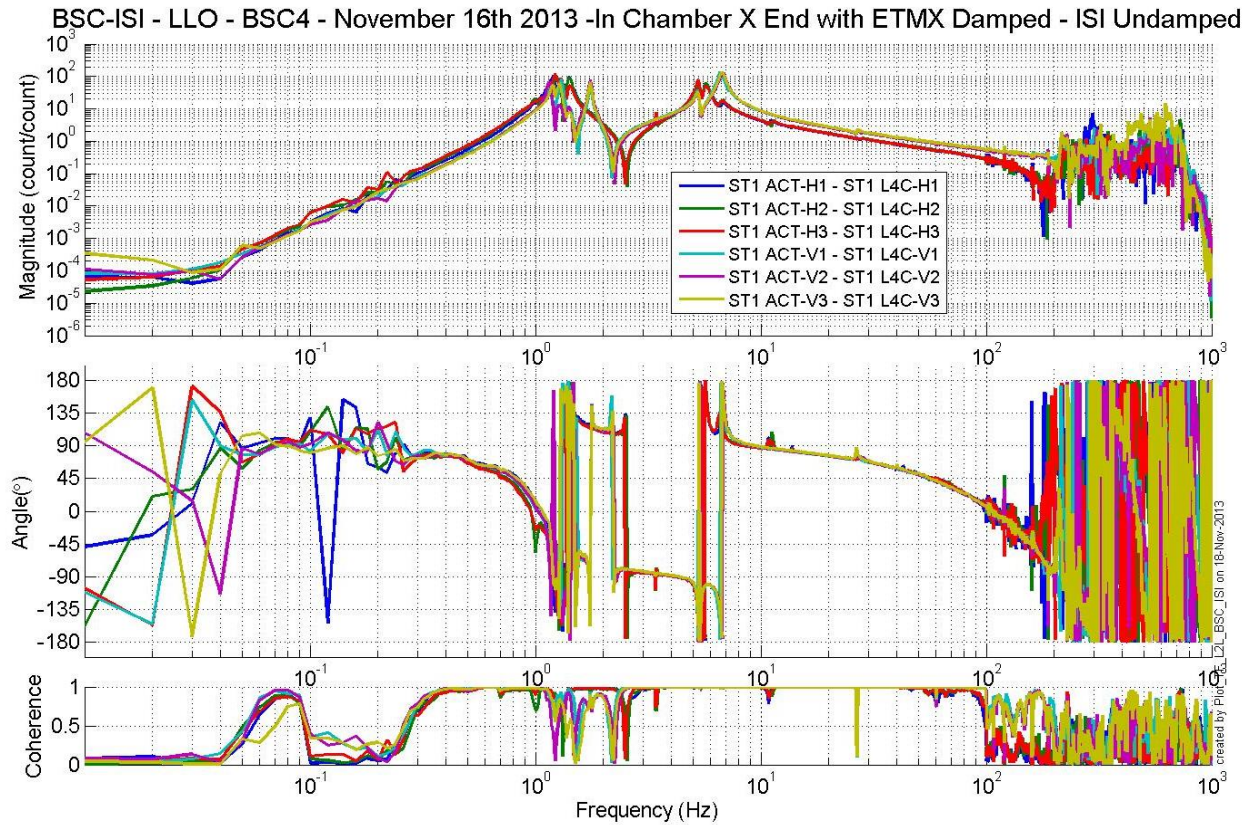
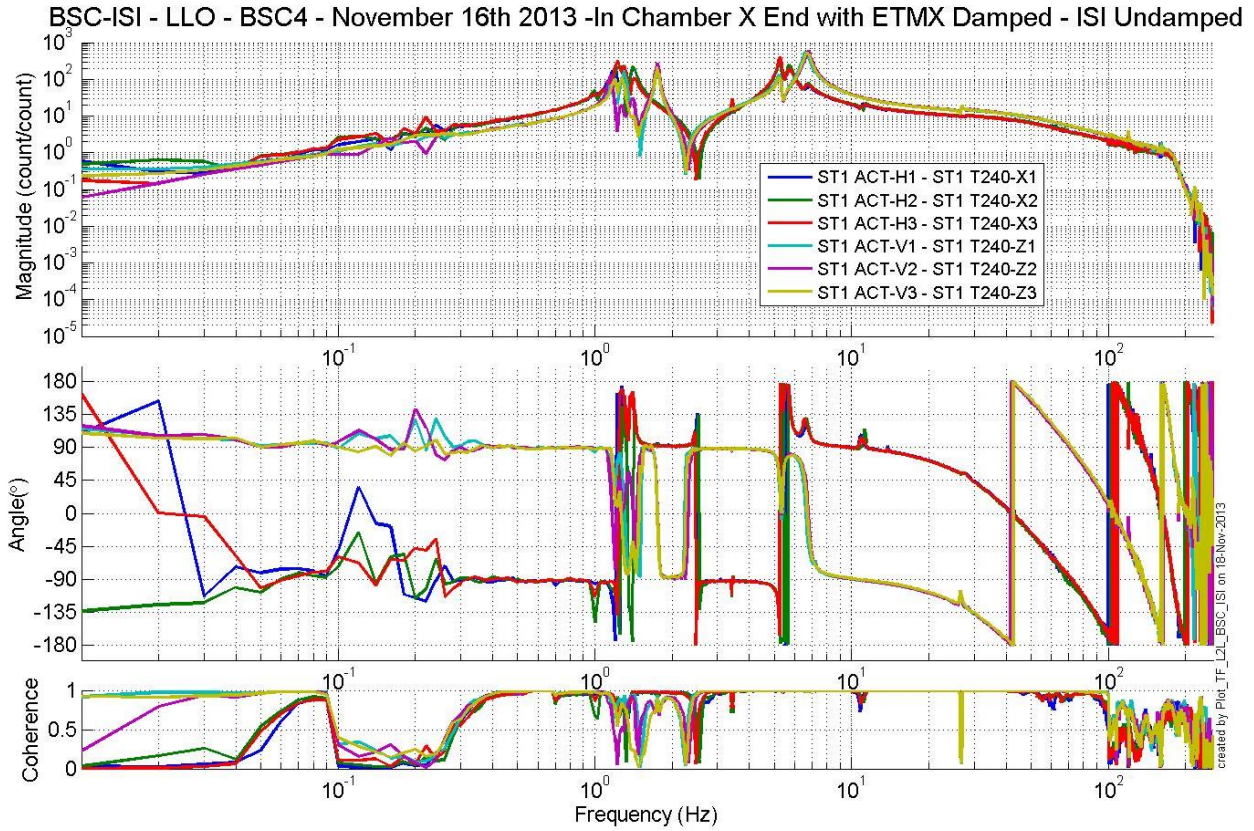**Figure 18 - TF ST1 ACT to ST1 CPS**

Figure 19 - TF ST1 ACT to ST1 L4C

BSC-ISI - LLO - BSC4 - November 16th 2013 -In Chamber X End with ETMX Damped - ISI Undamped

Figure 20 - TF ST1 ACT to ST1 T240

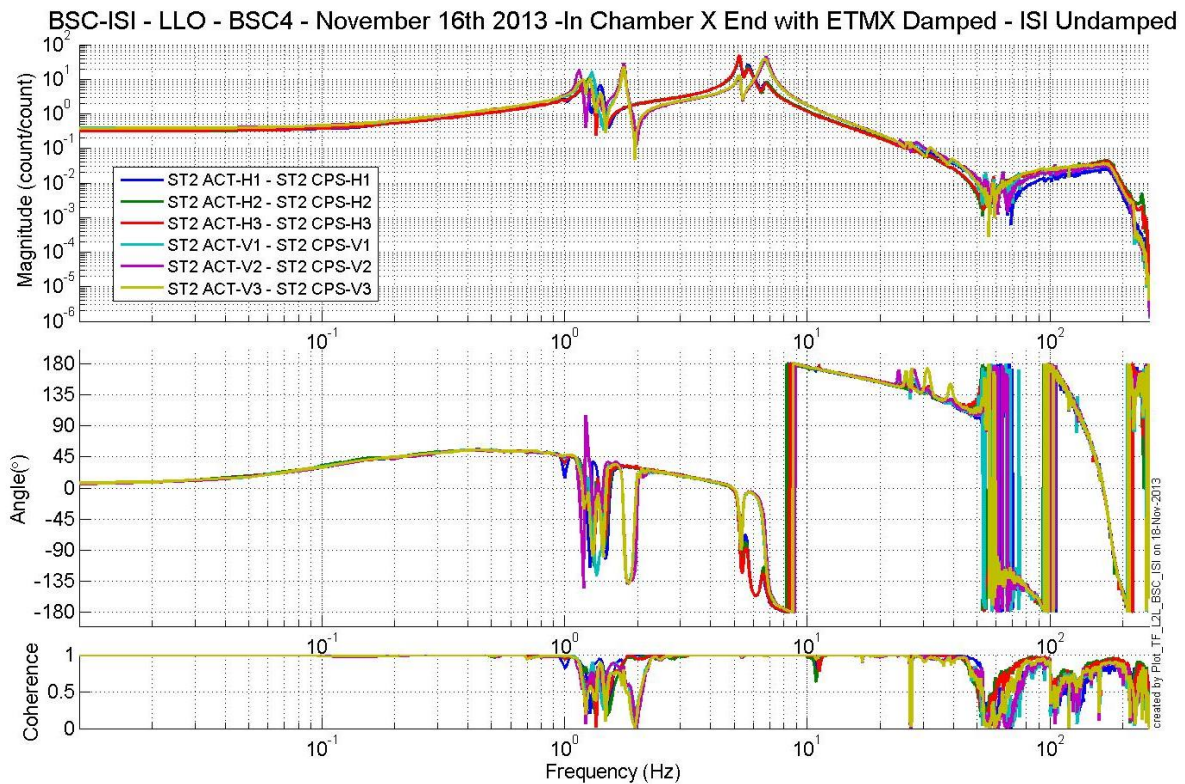BSC-ISI - LLO - BSC4 - November 16th 2013 -In Chamber X End with ETMX Damped - ISI Undamped

Figure 21 - TF ST2 ACT to ST2 CPS
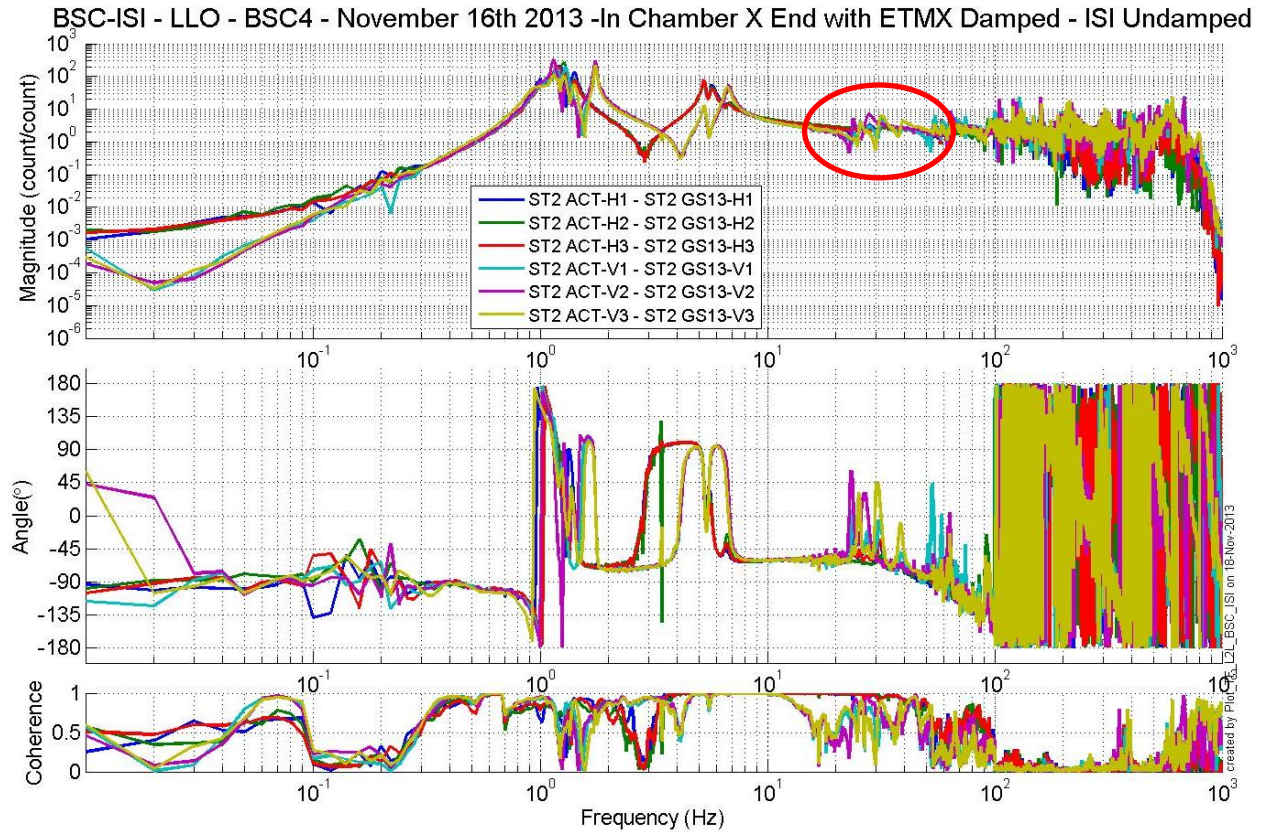
Figure 22 - TF ST2 ACT to ST2 GS13
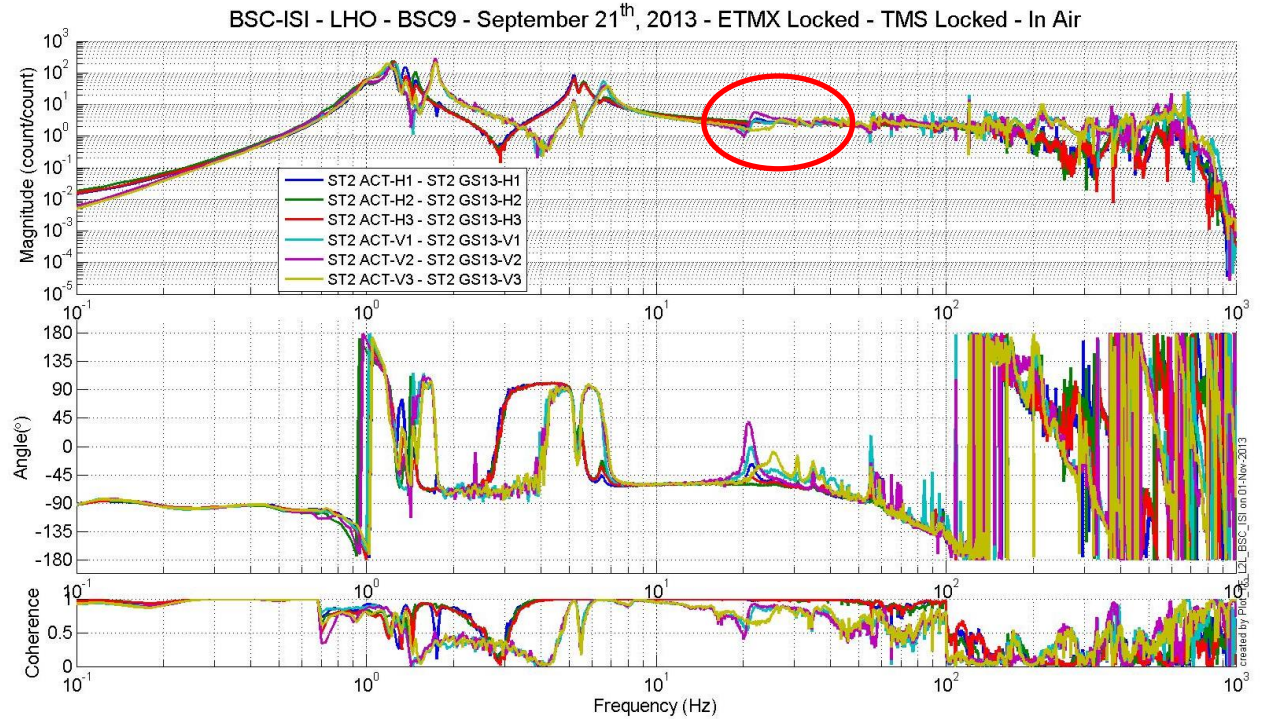
Figure 23: H1 BSC9 ETMX TF ST2 ACT to ST2 GS13 (Quad & TMS Locked)

2. In Chamber Quad Unlocked (Dome off)

**Note:** the following transfer functions have been taken with the ISI in Chamber, with the dome off, the TMS Structure Unlocked but the **Quad unlocked**.

At this point, all the tuned mass dampers are on (on Stage 0-1 springs, the vibration absorbers on Stage 1 doors & Viton under the keel masses).

Measurements data can be found in the SVN at:
_https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Transfer_Functions/Measurements/Undamped:_
- LLO_ISI_BSC4_Data_L2L_10mHz_100mHz_ST1_ST2_20131123-090401.mat
- LLO_ISI_BSC4_Data_L2L_100mHz_700mHz_ST1_ST2_20131123-034107.mat
- LLO_ISI_BSC4_Data_L2L_700mHz_10Hz_ST1_ST2_20131122-220223.mat
- LLO_ISI_BSC4_Data_L2L_10Hz_100Hz_ST1_ST2_20131122-185521.mat
- LLO_ISI_BSC4_Data_L2L_100Hz_500Hz_ST1_ST2_20131122-172030.mat
- LLO_ISI_BSC4_Data_L2L_500Hz_1000Hz_ST1_ST2_20131122-160402.mat

Data after processing can be found in the SVN at:
_https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Transfer_Functions/Simulations/Undamped_
- L1_ISI_ETMX_TF_L2L_Raw_2013_11_22.mat

The transfer functions can be found in the SVN at:
_https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Figures/Transfer_Functions/Measurements/Undamped/_
- L1_ISI_ETMX_TF_L2L_Raw_from_ST1_ACT_to_ST1_CPS_2013_11_22.fig
- L1_ISI_ETMX_TF_L2L_Raw_from_ST1_ACT_to_ST1_L4C_2013_11_22.fig
- L1_ISI_ETMX_TF_L2L_Raw_from_ST1_ACT_to_ST1_T240_2013_11_22.fig
- L1_ISI_ETMX_TF_L2L_Raw_from_ST2_ACT_to_ST2_CPS_2013_11_22.fig
- L1_ISI_ETMX_TF_L2L_Raw_from_ST2_ACT_to_ST2_GS13_2013_11_22.fig

**Note 1:** The transfer functions are measured from the Output filters bank excitation point to the input (IN1) of the input filters bank. The transfer functions presented below are raw transfer functions without any electronic compensation.

**Note 2:** The L4Cs are out of phase (should be -90 before 1Hz). A minus sign is added in the calibration filters that convert count to nm/s.
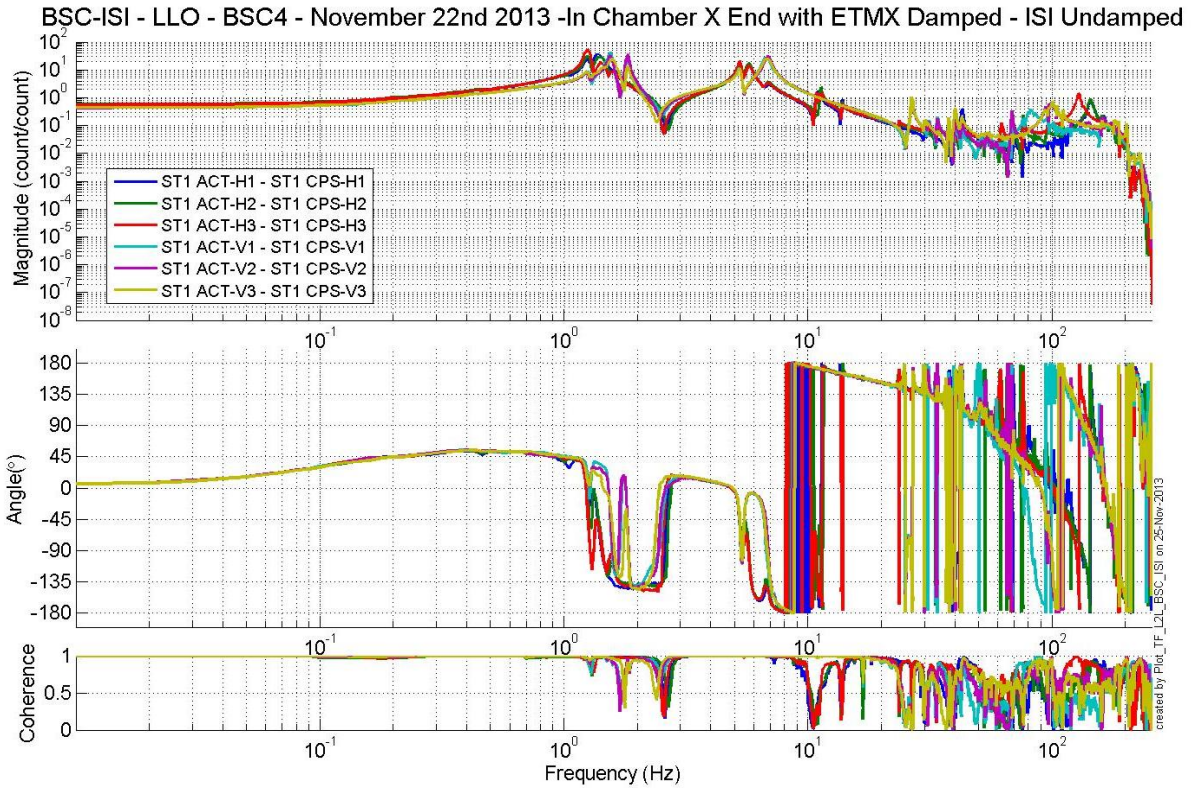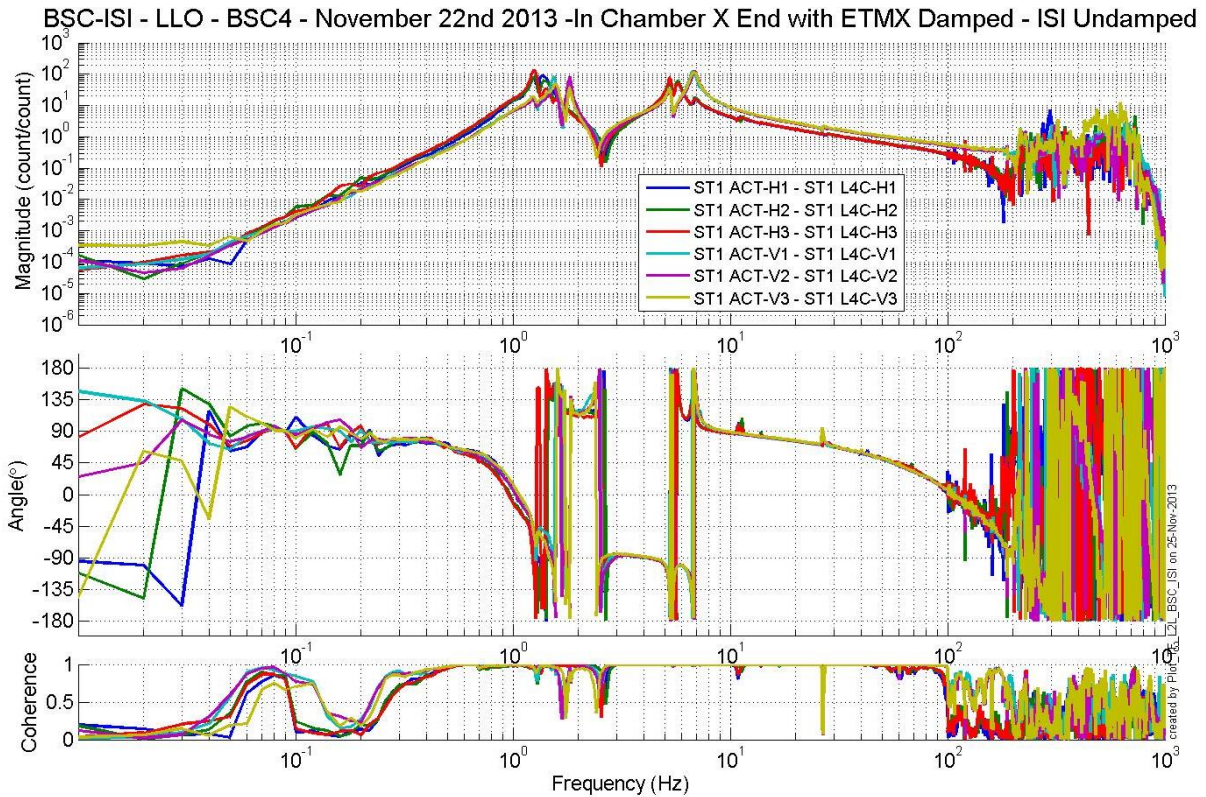
Figure 24 - TF ST1 ACT to ST1 CPS
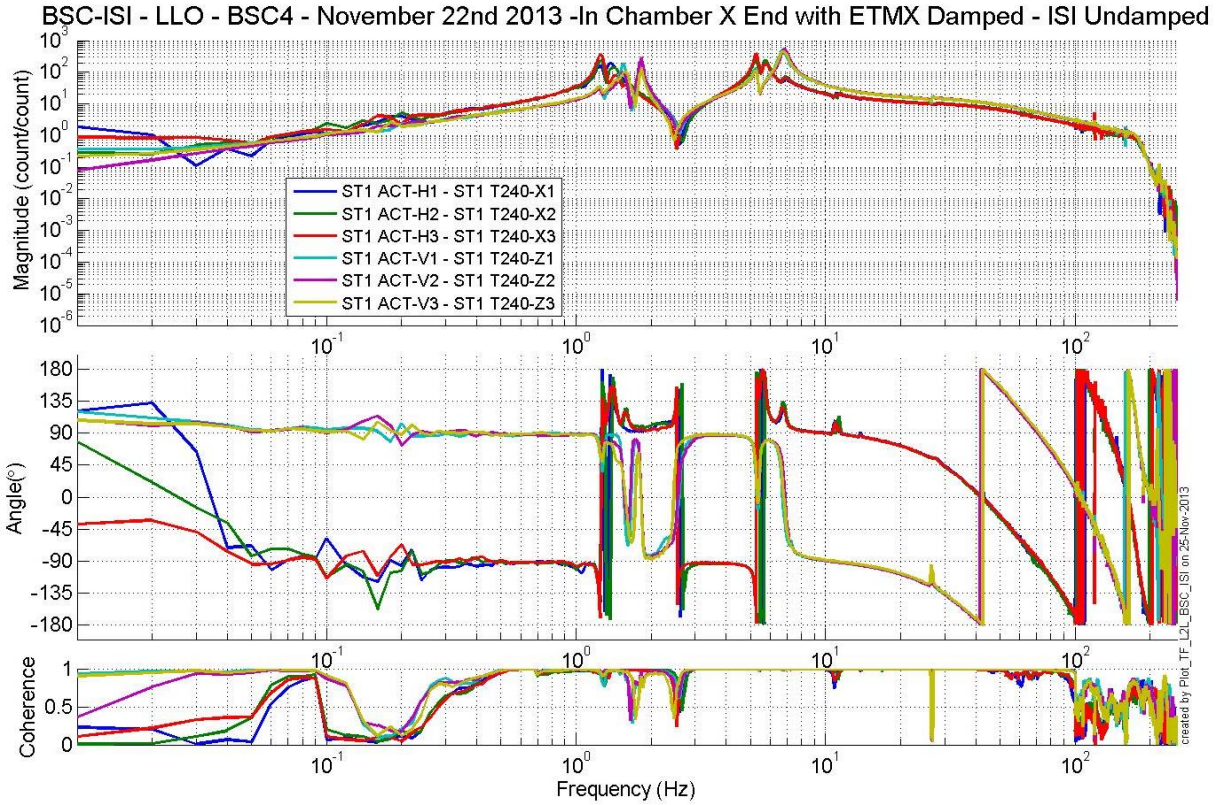

Figure 25 - TF ST1 ACT to ST1 L4C

BSC-ISI - LLO - BSC4 - November 22nd 2013 -In Chamber X End with ETMX Damped - ISI Undamped

Figure 26 - TF ST1 ACT to ST1 T240

BSC-ISI - LLO - BSC4 - November 22nd 2013 -In Chamber X End with ETMX Damped - ISI Undamped
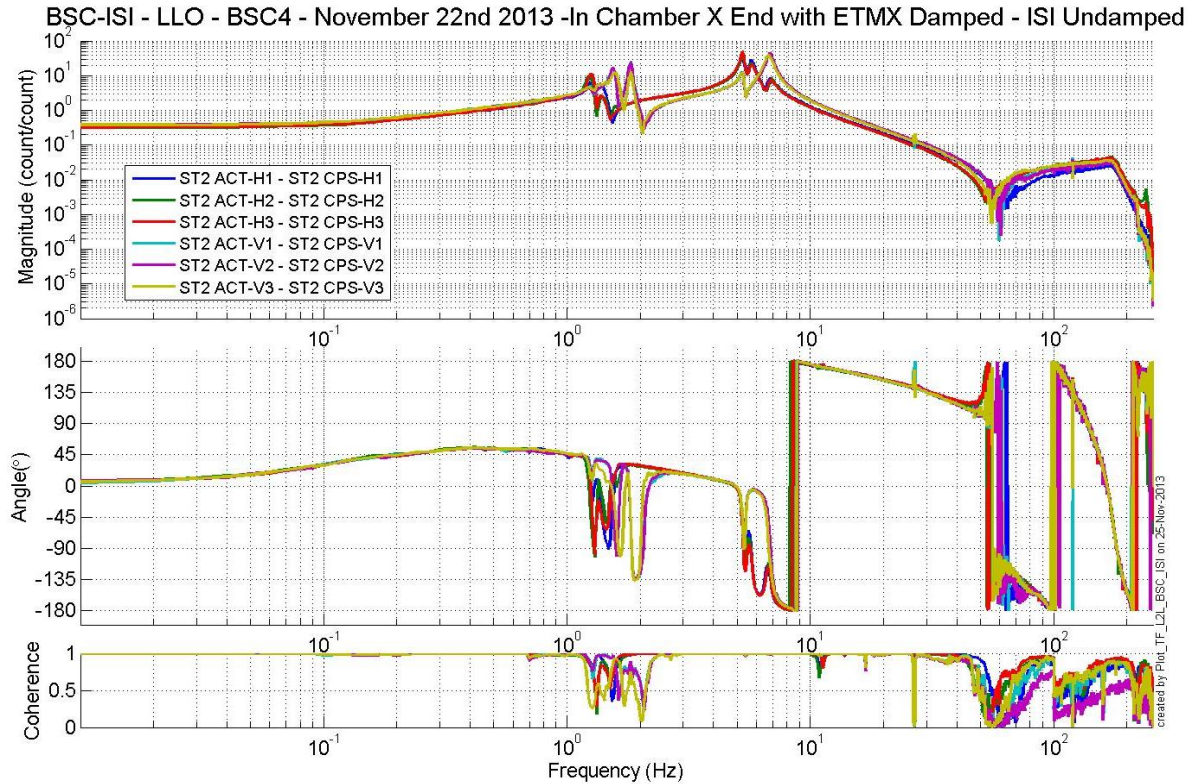

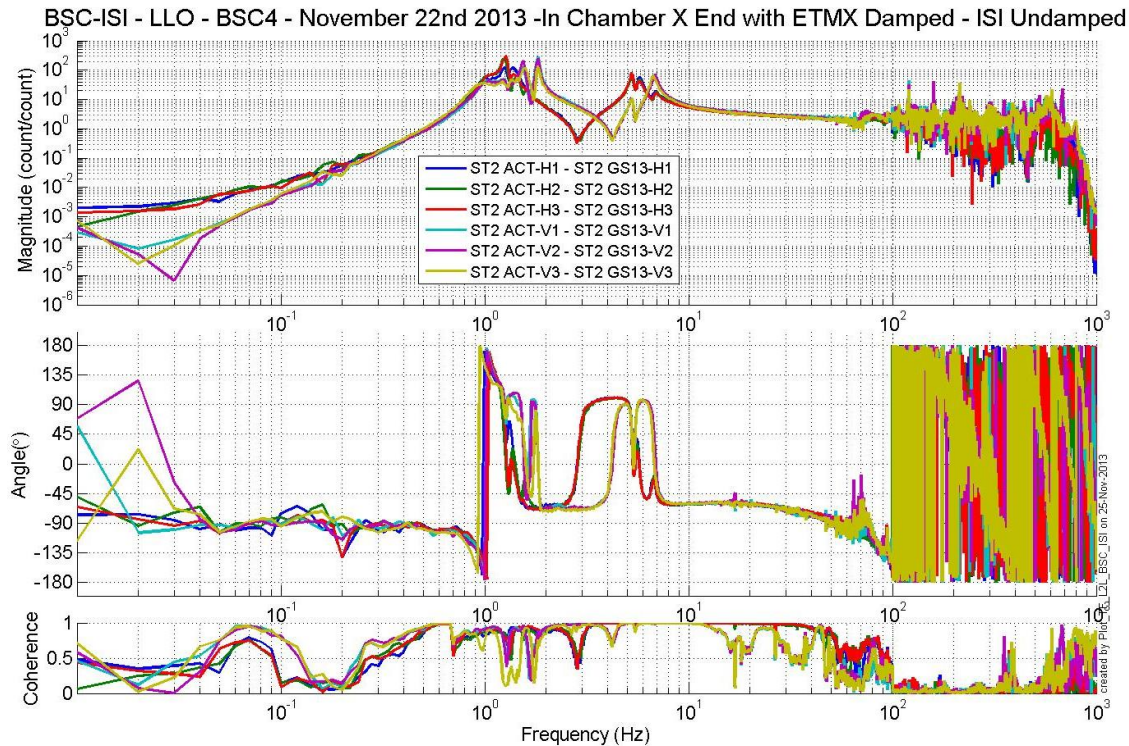**Figure 27 - TF ST2 ACT to ST2 CPS**

Figure 28 - TF ST2 ACT to ST2 GS13

Note: We can notice on this last Figure that the resonances that we had on the TFs with the Quad Locked around 20Hz are gone.

3. Comparisons with H1 BSC 9 ETMX

Note: the following transfer functions have been taken with the ISI in Chamber, with the dome off, the TMS Structure Unlocked but the **Quad unlocked**.

At this point, all the tuned mass dampers are on (on Stage 0-1 springs, the vibration absorbers on Stage 1 doors & Viton under the keel masses).

Measurements data can be found in the SVN at:
_https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Transfer_Functions/Measurements/Undamped:_
 - LLO_ISI_BSC4_Data_L2L_10mHz_100mHz_ST1_ST2_20131123-090401.mat
 - LLO_ISI_BSC4_Data_L2L_100mHz_700mHz_ST1_ST2_20131123-034107.mat
 - LLO_ISI_BSC4_Data_L2L_700mHz_10Hz_ST1_ST2_20131122-220223.mat
 - LLO_ISI_BSC4_Data_L2L_10Hz_100Hz_ST1_ST2_20131122-185521.mat
 - LLO_ISI_BSC4_Data_L2L_100Hz_500Hz_ST1_ST2_20131122-172030.mat
 - LLO_ISI_BSC4_Data_L2L_500Hz_1000Hz_ST1_ST2_20131122-160402.mat

Data after processing can be found in the SVN at:
_https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/L1/ETMX/Data/Transfer_Functions/Simulations/Undamped_

- L1_ISI_ETMX_TF_L2L_Raw_2013_11_22.mat

https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-ISI/H1/
ETMX/Data/Transfer_Functions/Simulations/Undamped
- H1_ISI_ETMX_TF_L2L_Raw_2013_09_21.mat

The transfer functions can be found in the SVN at:
https://svn.ligo.caltech.edu/svncommon/SeiSVN/seismic/BSC-
ISI/L1/ETMX/Data/Figures/Transfer_Functions/Comparisons/L2L/

- L1_ISI_BSC4_InChamber_X-End_with_H1-BSC4-
ETMX_Comparison_TF_L2L_ST1_ACT_H_to_ST1_CPS_H_20131122_vs_20130921.fig
- L1_ISI_BSC4_InChamber_X-End_with_H1-BSC4-
ETMX_Comparison_TF_L2L_ST1_ACT_H_to_ST1_L4C_H_20131122_vs_20130921.fig
- L1_ISI_BSC4_InChamber_X-End_with_H1-BSC4-
ETMX_Comparison_TF_L2L_ST1_ACT_V_to_ST1_CPS_V_20131122_vs_20130921.fig
- L1_ISI_BSC4_InChamber_X-End_with_H1-BSC4-
ETMX_Comparison_TF_L2L_ST1_ACT_V_to_ST1_L4C_V_20131122_vs_20130921.fig
- L1_ISI_BSC4_InChamber_X-End_with_H1-BSC4-
ETMX_Comparison_TF_L2L_ST2_ACT_H_to_ST2_CPS_H_20131122_vs_20130921.fig
- L1_ISI_BSC4_InChamber_X-End_with_H1-BSC4-
ETMX_Comparison_TF_L2L_ST2_ACT_H_to_ST2_GS13_H_20131122_vs_20130921.fig
- L1_ISI_BSC4_InChamber_X-End_with_H1-BSC4-
ETMX_Comparison_TF_L2L_ST2_ACT_V_to_ST2_CPS_V_20131122_vs_20130921.fig
- L1_ISI_BSC4_InChamber_X-End_with_H1-BSC4-
ETMX_Comparison_TF_L2L_ST2_ACT_V_to_ST2_GS13_V_20131122_vs_20130921.fig

___*Note 1:*___ The transfer functions are measured from the Output filters bank excitation point to the input (IN1) of the input filters bank. The transfer functions presented below are raw transfer functions without any electronic compensation.

___*Note 2:*___ The L4Cs are out of phase (should be -90 before 1Hz). A minus sign is added in the calibration filters that convert count to nm/s.

Figure 29 – TF ST1 H ACT to ST1 H CPS comparisons between L1 BSC4 & H1 BSC9

Figure 30 - TF ST1 V ACT to ST1 V CPS comparisons between L1 BSC4 & H1 BSC9

Figure 31 - TF ST1 H ACT to ST1 H L4C comparisons between L1 BSC4 & H1 BSC9

Figure 32 - TF ST1 V ACT to ST1 V L4C comparisons between L1 BSC4 & H1 BSC9

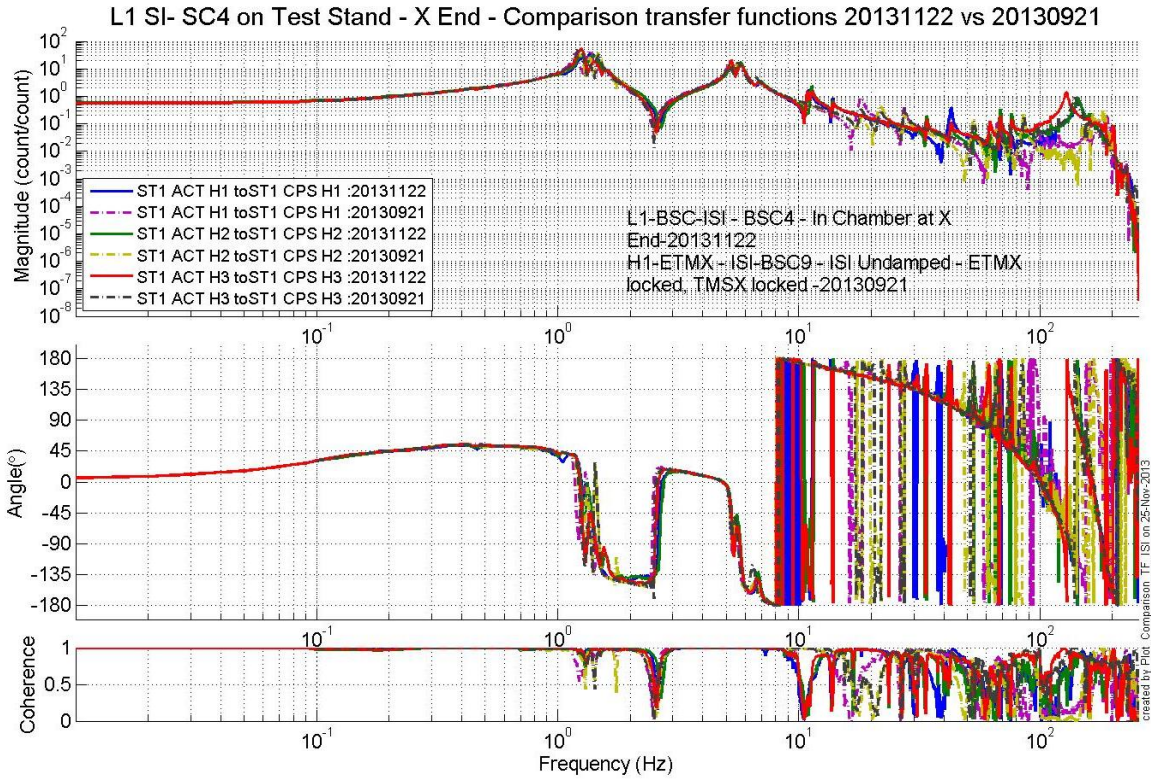**Figure 33 - TF ST2 H ACT to ST2 H CPS comparisons between L1 BSC4 & H1 BSC9**

Figure 34: TF ST2 V ACT to ST2 V CPS comparisons between L1 BSC4 & H1 BSC9

Figure 35: TF ST2 H ACT to ST2 H GS13 comparisons between L1 BSC4 & H1 BSC9

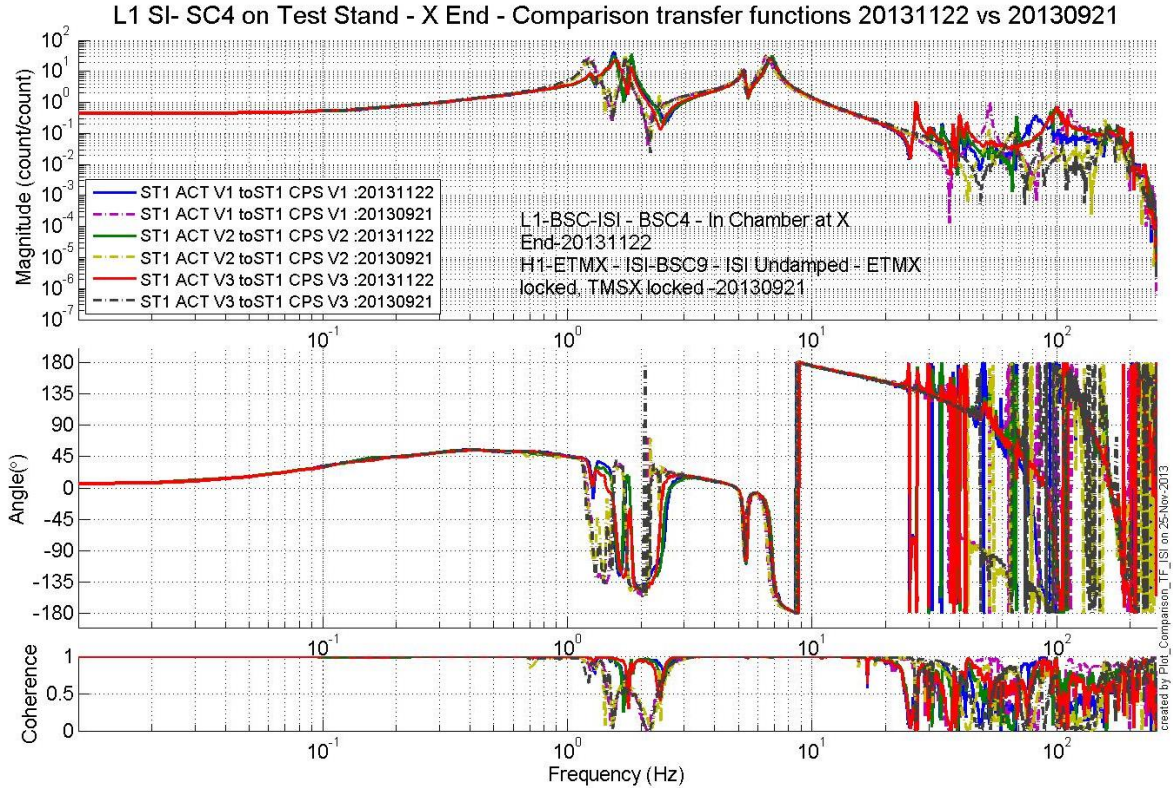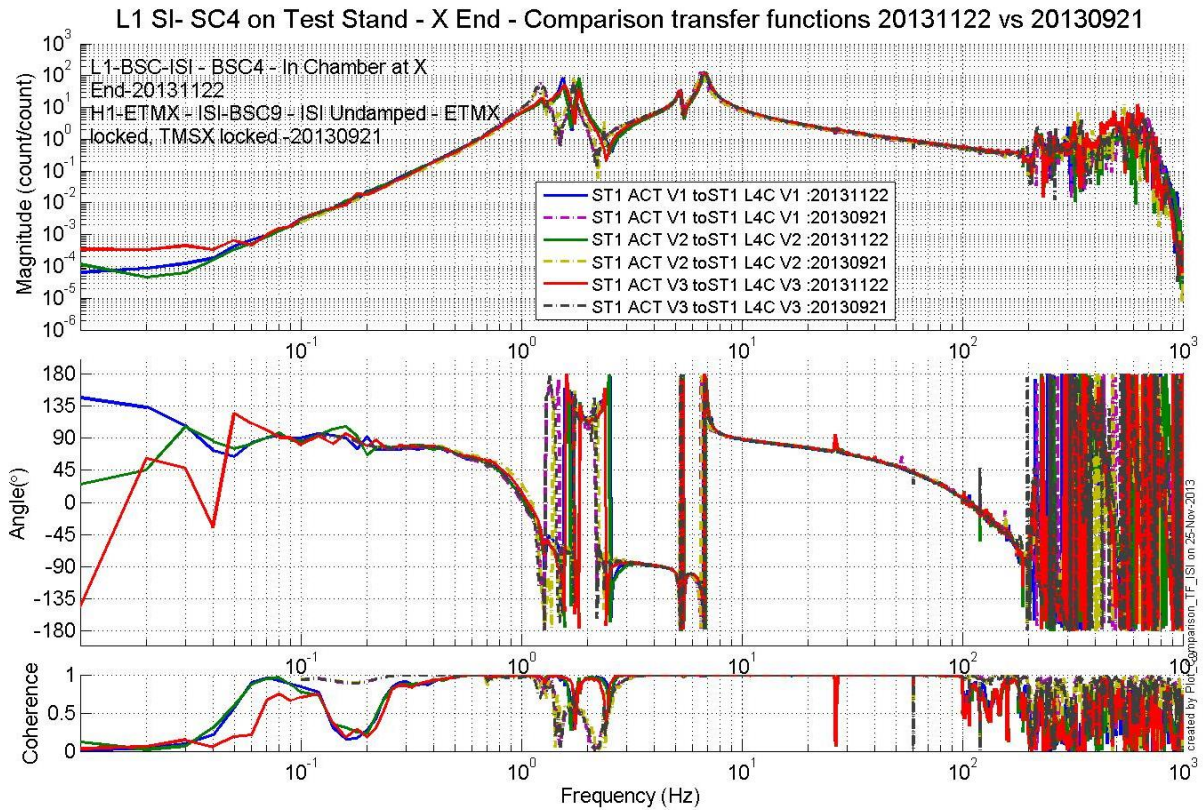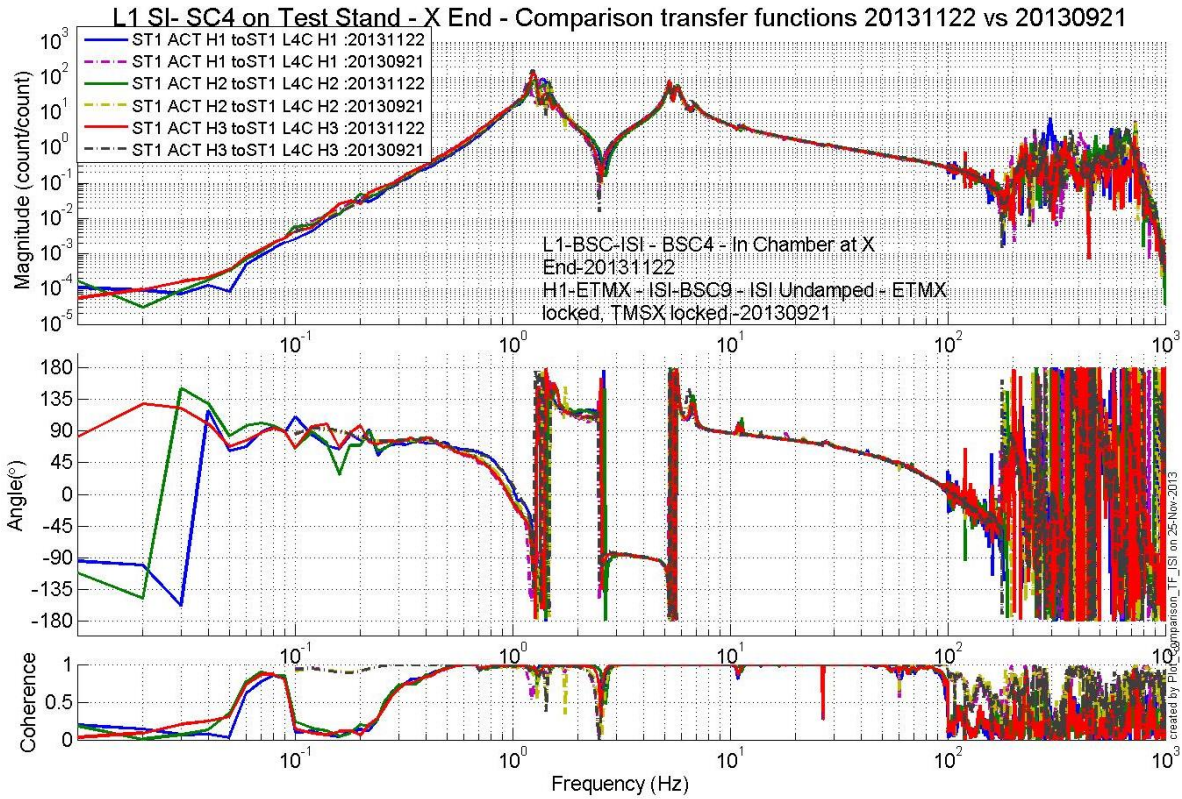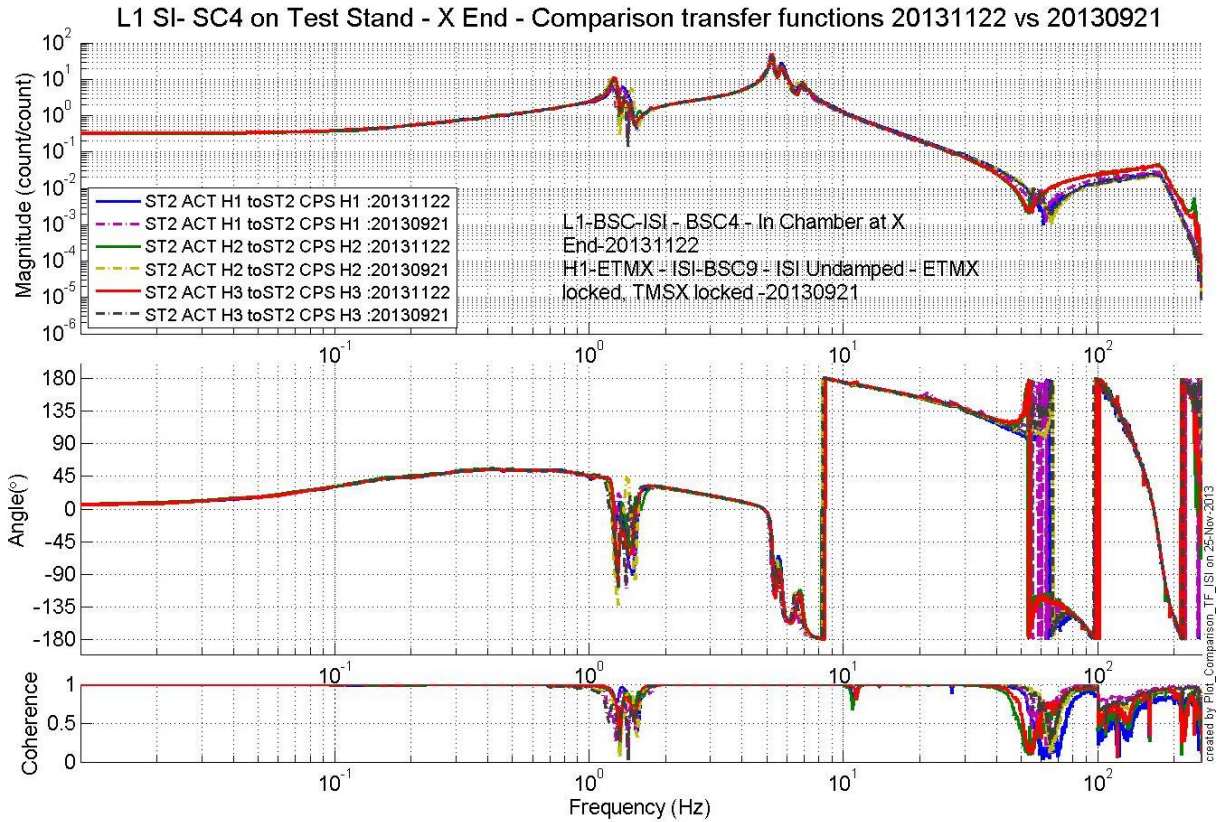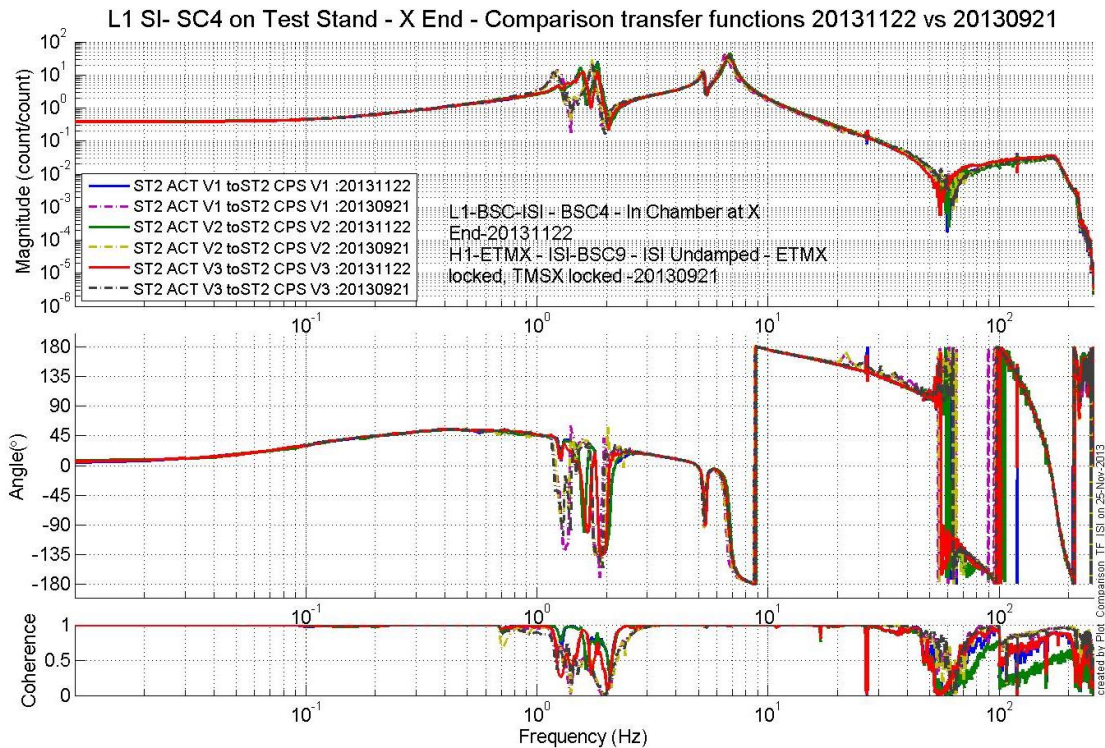**Figure 36: TF ST2 V ACT to ST2 V GS13 comparisons between L1 BSC4 & H1 BSC9**

Note: We can notice on this last Figure that the resonances that we had on the TFs with the Quad Locked around 20Hz are gone for the L1 BSC4 ETMX (Quad Unlocked) but are there for BSC9 (these TFs were taken at Handford with the Quad and TMS Locked)..

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

7. Conclusion Phase II-B – After Install

All results appear satisfying. The last set of Transfer Functions has been taken with the Quad UnLocked, and we have been able to confirm that the resonance at ~20Hz on **Figure 22 - TF ST2 ACT to ST2 GS13** (see **Figure 23: H1 BSC9 ETMX TF ST2 ACT to ST2 GS13 (Quad & TMS Locked)** were due to the Locked Quad.

We can also notice that at higher frequencies (above 100Hz) we lose coherence. This might be due to the fact that we lowered the excitation for the transfer functions or due to the extra noise coming from the clean room right above the BSC.

If this Unit can be approved before Tuesday, November 26th 2013, we would be able to put the dome back on BSC 4 before Thanksgiving, and we would retake some more data.

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