

LIGO Laboratory / LIGO Scientific Collaboration

LIGO- E1200506

*LIGO*Jan 23rd, 2013

aLIGO HAM-ISI, Installation Test Report, Phase II
Chamber-Side Testing & Initial Chamber Testing
LHO HAM2-ISI (Unit #4)

E1200506-V4

Hugo Paris, Fabrice Matichard, Brian Lantz, Hugh Radkins, Jim Warner, Corey Gray

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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

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

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

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PHASE II Testing

The phase II of HAM-ISI testing corresponds to the tests performed after the *Assembly Validation*, and before the *Control and Commissioning* of the Units. It is divided in two parts. The present document is divided in two sections: One for each part of the Phase II testing:

- Part.1** Chamber-Side testing
- Part.2** Initial Chamber Testing
- Part.3** Final Chamber Testing

Chamber-Side Testing is a basic sensor check with a spectrum analyzer. Units can be inserted in their chamber of destination once they pass.

Initial Chamber Testing takes place in open chamber, with the optics off, and HEPI locked. The ISI is then connected to the electronic rack with the final in-field cables. Models are installed and running. Tests are performed with Matlab® scripts.

Optics and Suspensions can be installed right after the end of this phase of testing. No test is performed during their installation.

Final Chamber Testing starts once Optics and Suspensions are installed. The lockers and the CPSs usually need to be reset at this point.

Introduction

Chamber-Side Testing

HAM-ISI Unit #4 is intended to populate HAM2 chamber. The tests presented here were performed between May 11th and May 16th, in accordance to the second version of the *Pre-Integration Chamber-Side Testing* procedure (E1200513-v2).

Additional tests were performed on the CPSs on May 29th 2012. They revealed the need to ground the ADE boxes to the test stand (LHO aLog #2972).

At the beginning of the Chamber-Side Testing:

- Assembly validation testing has been performed on the ISI
- Phase I test report was validated (E1000314)
- The ISI was stored in a container, moved from the staging building to the LVEA, and installed under a clean room in the LVEA, on its container's base
- The container is sitting on lab-jacks to allow level adjustments without unlocking the ISI
- The Unit is equipped with production GS13s
- The optical table is not loaded with masses yet
- The ISI is locked

The goal of the Chamber-Side Testing is to ensure that the sensors and their electronics (ADE boxes of the CPSs) did not alter during storage/transportation.

At the end of the Chamber-Side Testing:

- All sensors have been checked
- Data related to the tests is available on the SVN
- The HAM-ISI is on the chamber-side, ready for the in-chamber insertion

▪ *Test 1 - CPS Check*

During this step, we want to make sure that the CPSs, their cables and their electronics are functional.

Corner	Direction	Voltage (No shim)	Sensor reacts to shim insertion
1	H	1.169	X
	V	0.359	X
2	H	-0.32	X
	V	3.159	X
3	H	-2.09	X
	V	3.934	X

Table – CPS Check

Issues/difficulties/comments regarding this test:

- ADE boxes were connected to the same power supply
- ADE boxes must share the same ground.
- ADE boxes must be grounded to the test stand
- Not having the ADE boxes grounded to the test stand causes the CPS readouts to vary with the number of probes that are connected to the ADE boxes (LHO aLog #2972).

Acceptance Criteria:

- All CPS were tested
- All CPS react to shim insertion
- The voltages recorded with no shim are within +/-5V.

Test result:

Passed: X **Failed:**

▪ *Test 2.1 – CPS noise spectra*

During this step, we want measure the noise spectra of the CPSs and make sure that it is not too high.

A spectrum analyzer is used. The maximum number of points available for the FFT (800) limits the frequency resolution. Measurements are performed in two sections that are combined afterwards to allow getting good resolution in low frequency. Sections overlap to allow checking for potential mismatch.

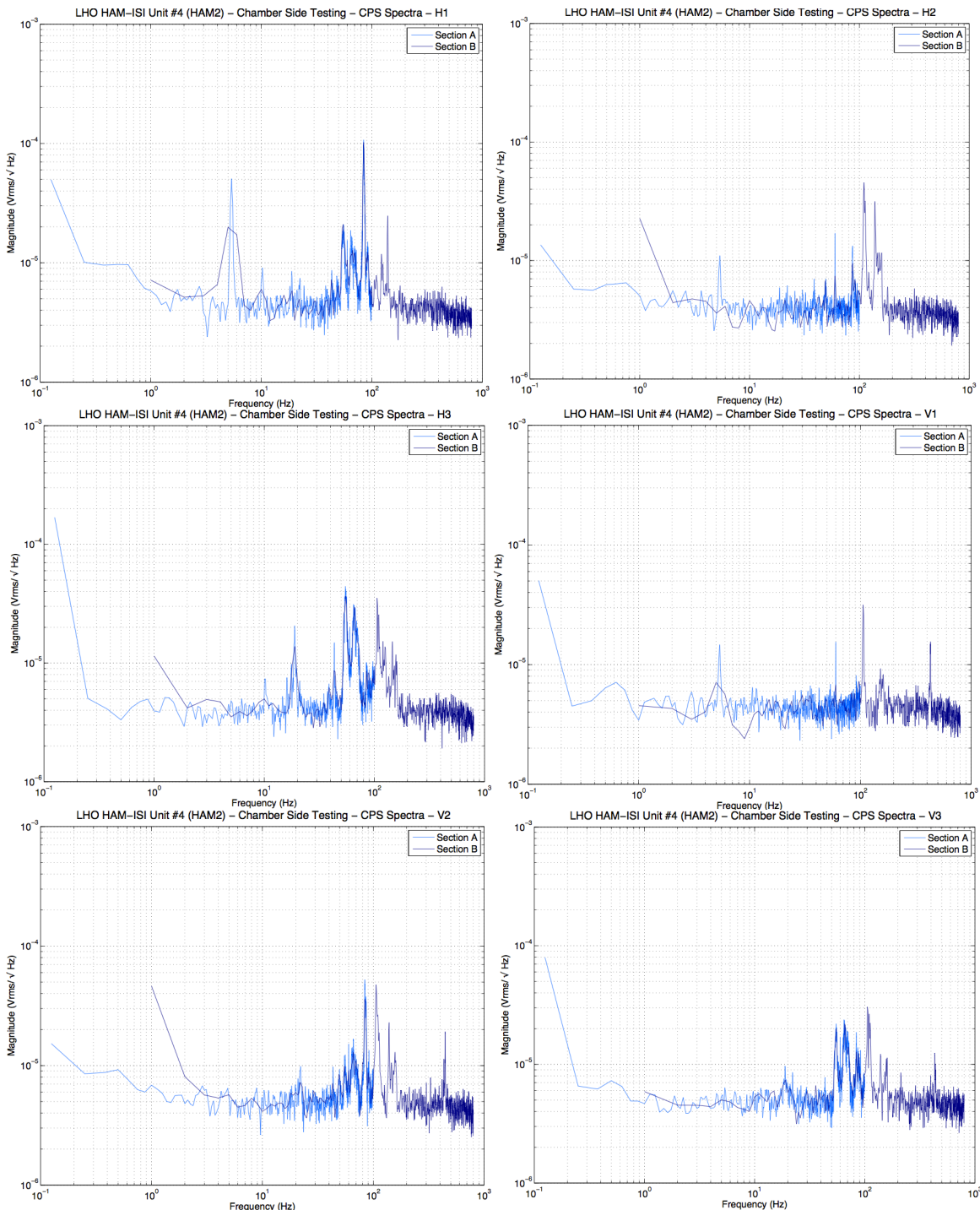


Figure – CPS Spectra - Section Check

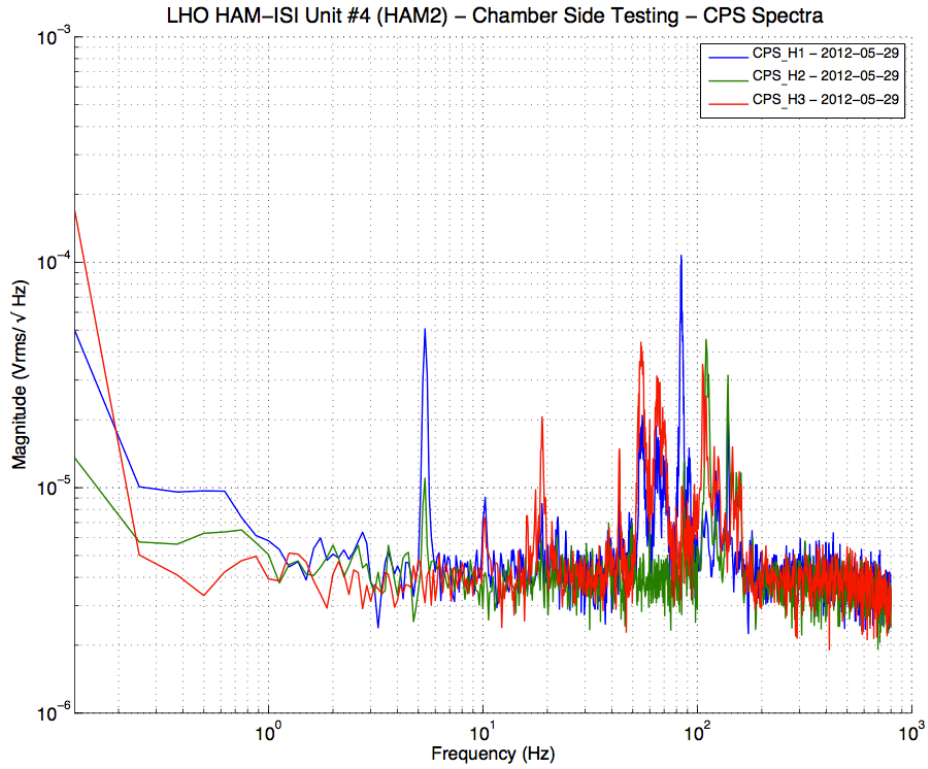


Figure – Horizontal CPSs spectra

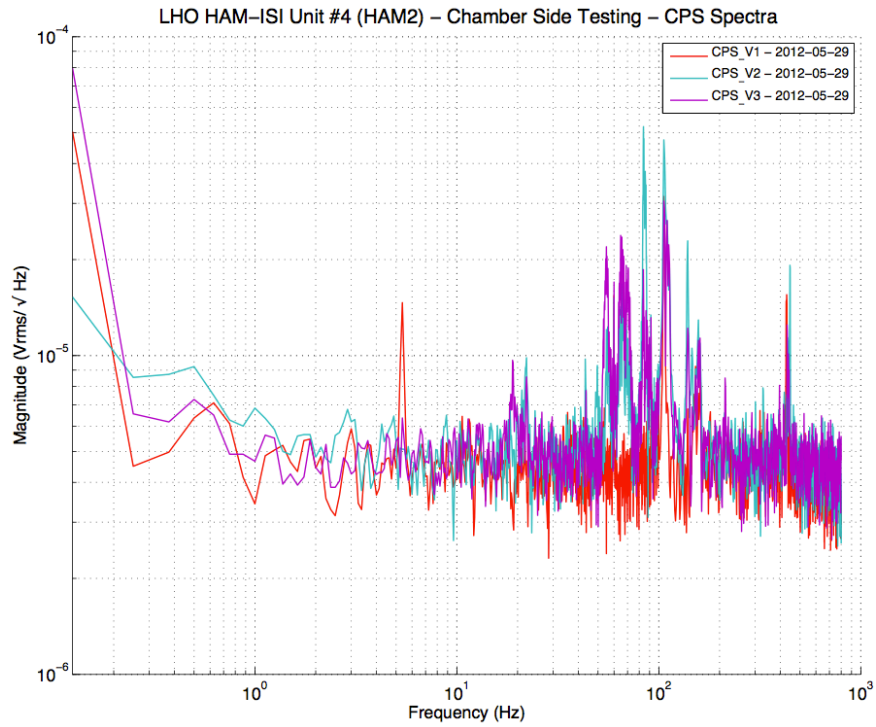
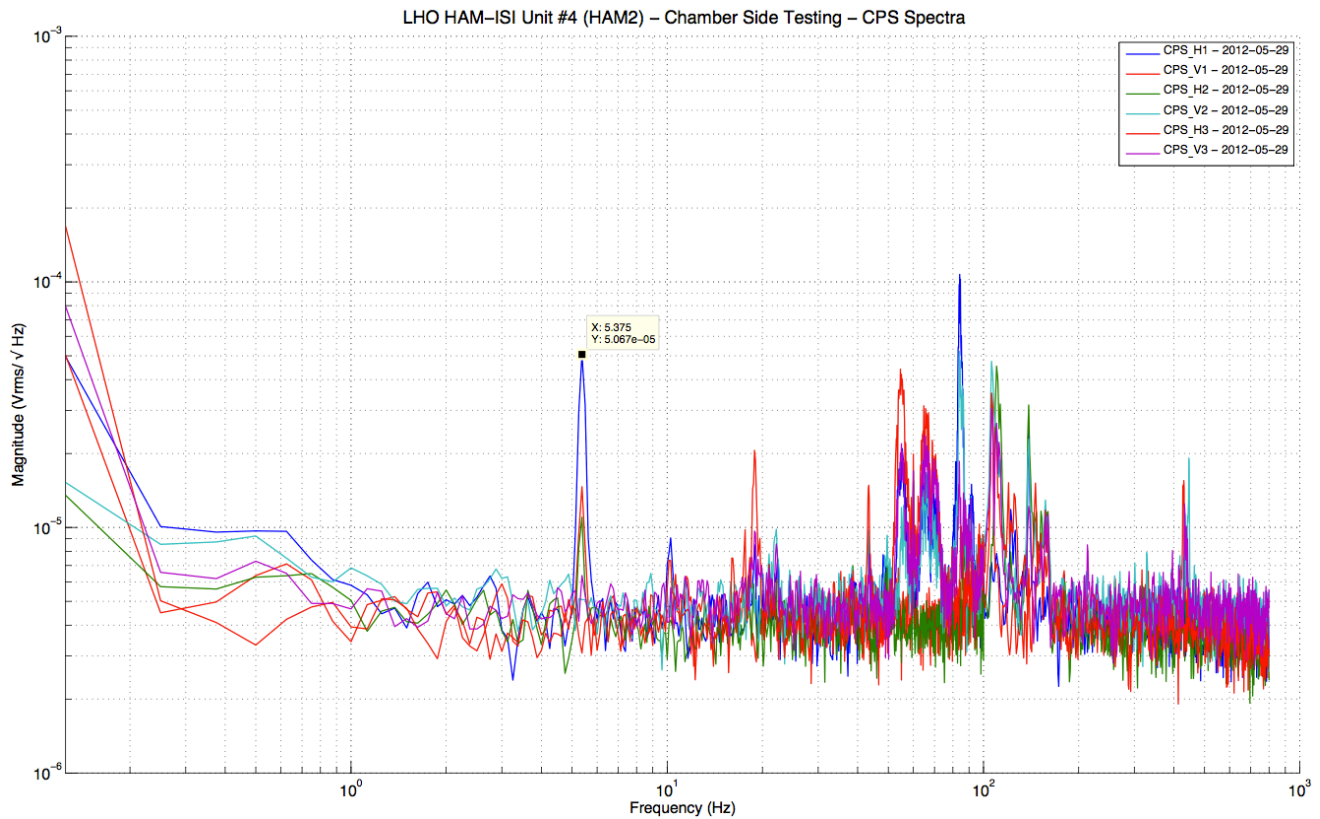


Figure – Vertical CPSs Spectra



Data in the SVN at:

[/SeiSVN/seismic/HAM-ISI/H1/HAM2/Data/Spectra/Chamber_Side/](#)

- SEI-HAM_ISI_Unit_4_Chamber_Side_Locked__CPS_Corner_1-Section_A-2012-05-29.214020.txt
- SEI-HAM_ISI_Unit_4_Chamber_Side_Locked__CPS_Corner_1-Section_B-2012-05-29.214344.txt
- SEI-HAM_ISI_Unit_4_Chamber_Side_Locked__CPS_Corner_2-Section_A-2012-05-29.215421.txt
- SEI-HAM_ISI_Unit_4_Chamber_Side_Locked__CPS_Corner_2-Section_B-2012-05-29.215154.txt
- SEI-HAM_ISI_Unit_4_Chamber_Side_Locked__CPS_Corner_3-Section_A-2012-05-29.220122.txt
- SEI-HAM_ISI_Unit_4_Chamber_Side_Locked__CPS_Corner_3-Section_B-2012-05-29.220623.txt

Sections Check plots in the SVN at

[/SeiSVN/seismic/HAM-ISI/H1/HAM2/Figures/Spectra/Chamber_Side/Sections_Check/](#)

- HAM_ISI_Unit_4_ASD_Volts_SECTION_CHECK_CPS_H1_ISI_Chamber_Side_Locked__2012_05_29.fig
- HAM_ISI_Unit_4_ASD_Volts_SECTION_CHECK_CPS_H2_ISI_Chamber_Side_Locked__2012_05_29.fig
- HAM_ISI_Unit_4_ASD_Volts_SECTION_CHECK_CPS_H3_ISI_Chamber_Side_Locked__2012_05_29.fig
- HAM_ISI_Unit_4_ASD_Volts_SECTION_CHECK_CPS_V1_ISI_Chamber_Side_Locked__2012_05_29.fig
- HAM_ISI_Unit_4_ASD_Volts_SECTION_CHECK_CPS_V2_ISI_Chamber_Side_Locked__2012_05_29.fig
- HAM_ISI_Unit_4_ASD_Volts_SECTION_CHECK_CPS_V3_ISI_Chamber_Side_Locked__2012_05_29.fig

Sections Combined plots in the SVN at:

[/SeiSVN/seismic/HAM-ISI/H1/HAM2/Figures/Spectra/Chamber_Side/Sections_Combined/](#)

- HAM_ISI_Unit_4_ASD_Volts_CPS_H_ISI_Chamber_Side_Locked__2012_05_29.fig
- HAM_ISI_Unit_4_ASD_Volts_CPS_ISI_Chamber_Side_Locked__2012_05_29.fig
- HAM_ISI_Unit_4_ASD_Volts_CPS_V_ISI_Chamber_Side_Locked__2012_05_29.fig

Programs to run the sr785 from a laptop under the SVN at:

/SeiSVN/seismic/HAM-ISI/H1/HAM2/Scripts/Chamber_Side/sr785_Programs/

Testing Scripts under the SVN at:

/SeiSVN/seismic/HAM-ISI/H1/HAM2/Scripts/Chamber_Side/Testing_Scripts /

Issues/difficulties/comments regarding this test:

- H1, V1 and H2 spectra feature a narrow peak at 5.375Hz.
- This peak is also noticeable on the spectra taken two weeks earlier, with the GS13s:
 - It is recorded at the same locations: H1, V1, and H2 (see below, and p.9)
 - It is recorded with very similar proportions: H1 is the most affected.
 - Even if the frequency it is observed at varied between the two measurements (5.25Hz vs 5.375Hz), it is very similar.
- Seeing this peak at the same locations, and at almost the same frequency, on two measurements taken 15 days apart from each other, with a different set of sensors/electronics, shows us that this peak is not caused by a malfunctioning of the sensor(s) and/or the electronics, and reveals that this peak is related to real motion.
- Measurements were performed in the LVEA, during the day, which is a noisy environment.

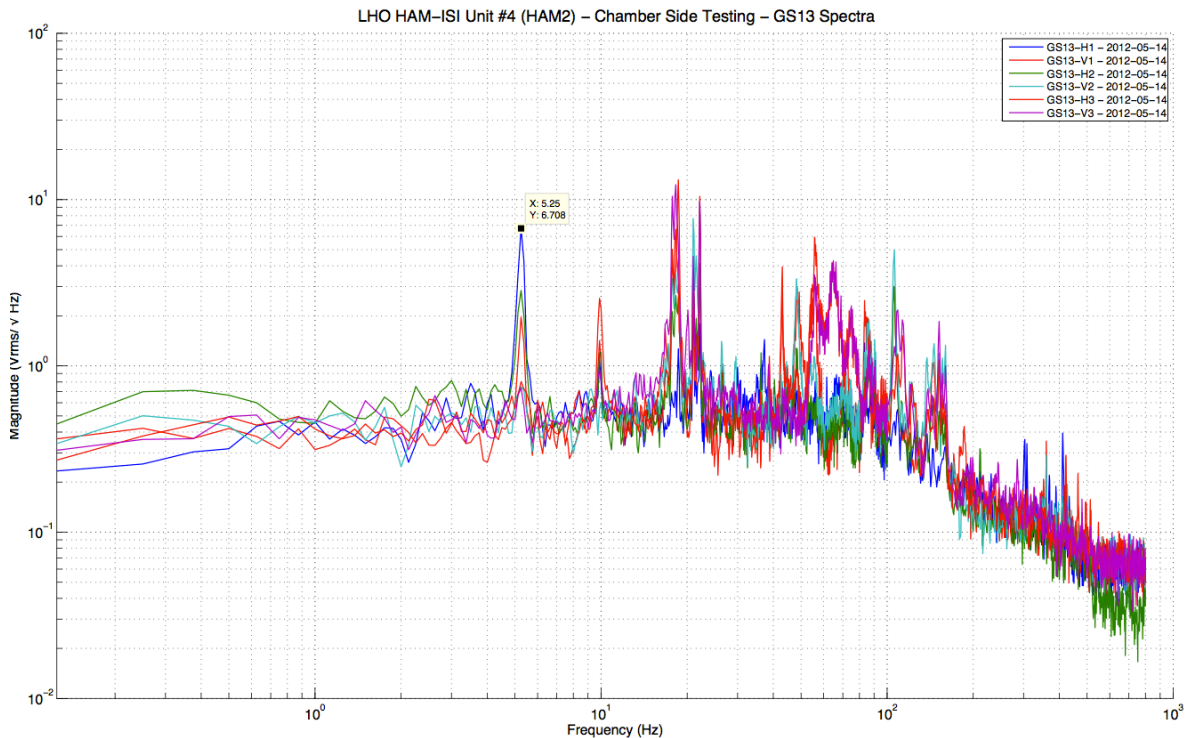


figure - GS13 spectra measured an May 14th 2012

Acceptance Criteria:

- Sections Match together
- CPS noise spectra must be below $10^{-4} V_{rms}/\sqrt{Hz}$
- Plots of Spectra are saved under the SVN

Test result:

Passed: X

Failed:

▪ *Test 2.2 – GS13 Spectra*

During this test we want to take spectra of the GS13s to make sure that they are still functional.

A spectrum analyzer is used. The maximum number of points available for the FFT (800) limits the frequency resolution. Measurements are performed in two sections that are combined afterwards to allow getting good resolution in low frequency. Sections overlap to allow checking for potential mismatch.

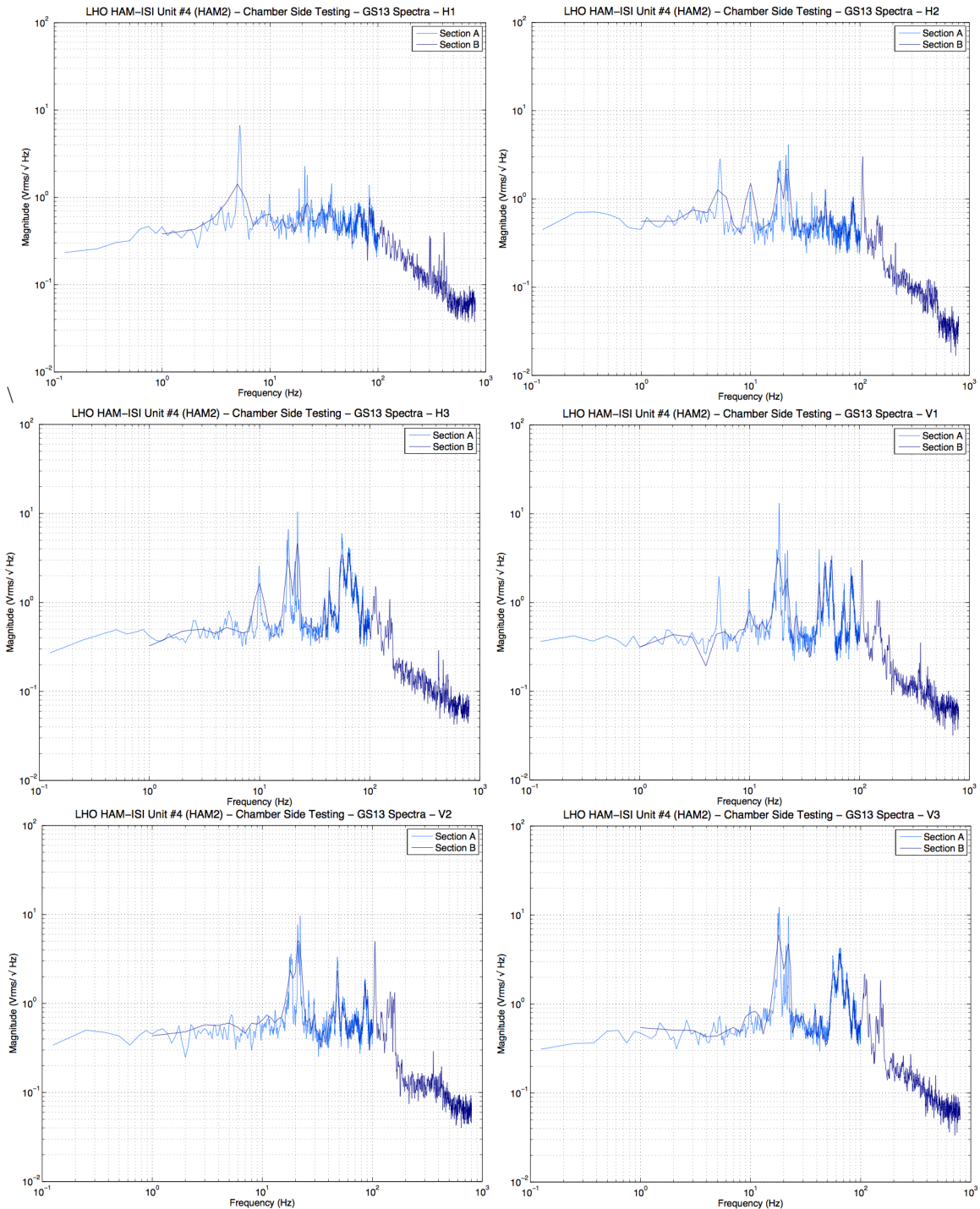


Figure – GS13 Spectra- Section Check

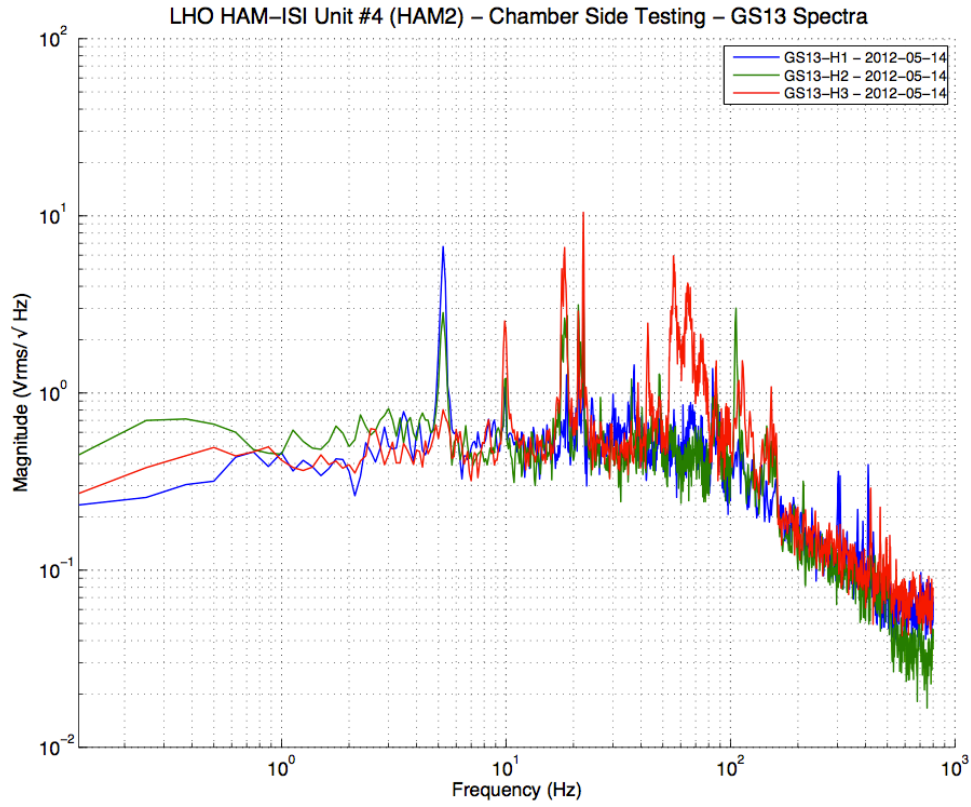


Figure – Horizontal GS13s Spectra

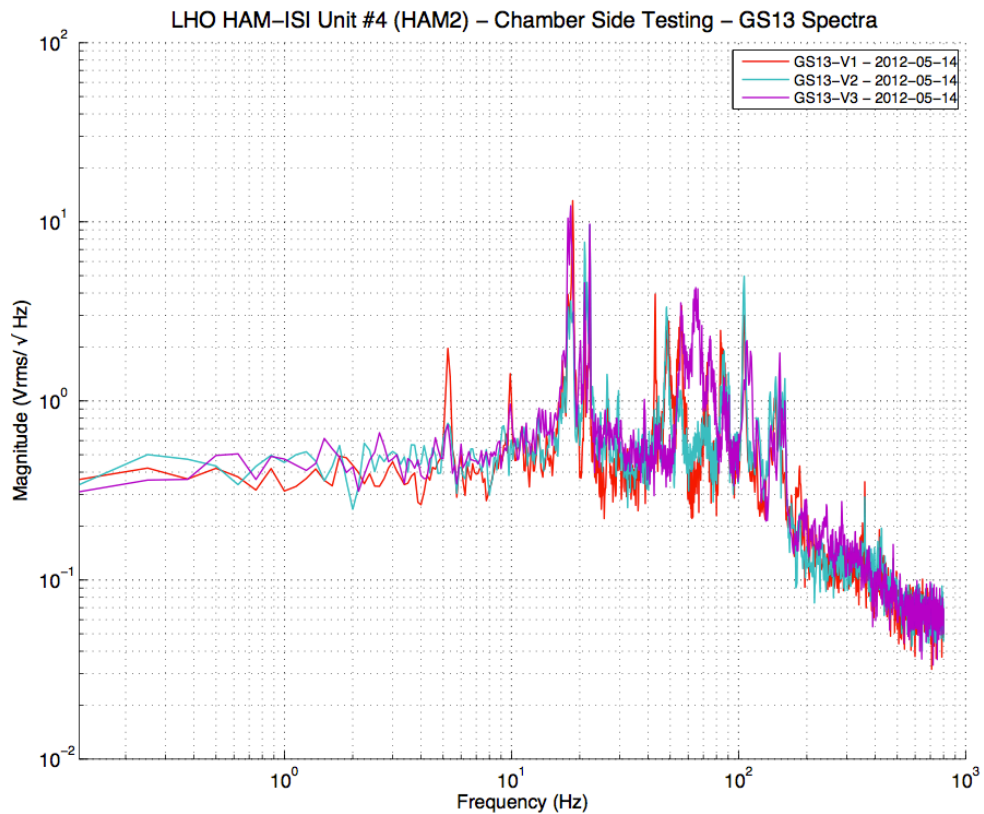


Figure – Vertical GS13s Spectra

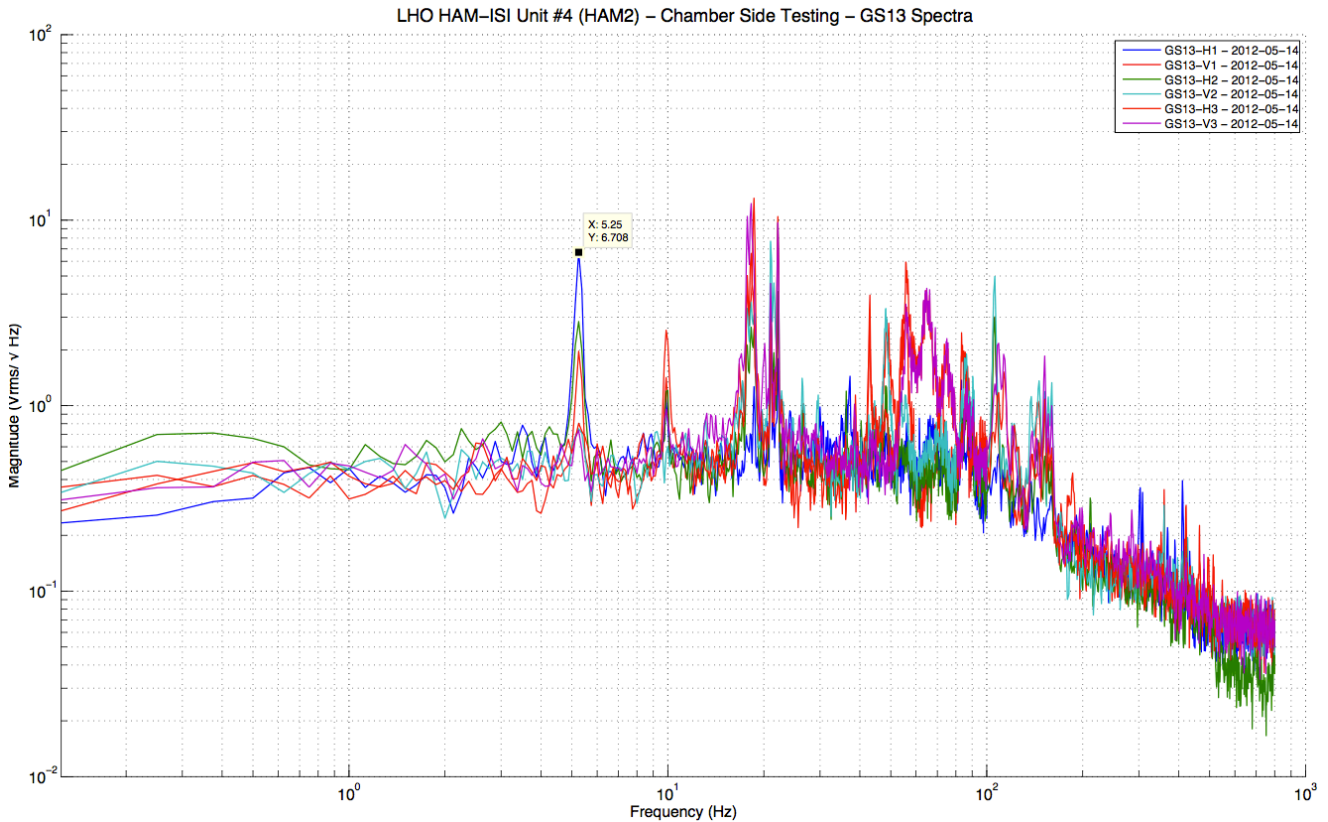


Figure – Horizontal and Vertical GS13s Spectra

Data in the SVN at:

[/SeiSVN/seismic/HAM-ISI/H1/HAM2/Data/Spectra/Chamber_Side/](#)

- SEI-HAM_ISI_Unit_4_Chamber_Side_Locked__GS13_Corner_1-Section_A-2012-05-14.224516.txt
- SEI-HAM_ISI_Unit_4_Chamber_Side_Locked__GS13_Corner_1-Section_B-2012-05-14.224342.txt
- SEI-HAM_ISI_Unit_4_Chamber_Side_Locked__GS13_Corner_2-Section_A-2012-05-14.225614.txt
- SEI-HAM_ISI_Unit_4_Chamber_Side_Locked__GS13_Corner_2-Section_B-2012-05-14.225910.txt
- SEI-HAM_ISI_Unit_4_Chamber_Side_Locked__GS13_Corner_3-Section_A-2012-05-14.230655.txt
- SEI-HAM_ISI_Unit_4_Chamber_Side_Locked__GS13_Corner_3-Section_B-2012-05-14.230957.txt

Sections Check plots in the SVN at

[/SeiSVN/seismic/HAM-ISI/H1/HAM2/Figures/Spectra/Chamber_Side/Sections_Check/](#)

- HAM_ISI_Unit_4_ASD_Volts_SECTION_CHECK_GS13_H1_ISI_Chamber_Side_Locked__2012_05_14.fig
- HAM_ISI_Unit_4_ASD_Volts_SECTION_CHECK_GS13_H2_ISI_Chamber_Side_Locked__2012_05_14.fig
- HAM_ISI_Unit_4_ASD_Volts_SECTION_CHECK_GS13_H3_ISI_Chamber_Side_Locked__2012_05_14.fig
- HAM_ISI_Unit_4_ASD_Volts_SECTION_CHECK_GS13_V1_ISI_Chamber_Side_Locked__2012_05_14.fig
- HAM_ISI_Unit_4_ASD_Volts_SECTION_CHECK_GS13_V2_ISI_Chamber_Side_Locked__2012_05_14.fig
- HAM_ISI_Unit_4_ASD_Volts_SECTION_CHECK_GS13_V3_ISI_Chamber_Side_Locked__2012_05_14.fig

Sections Combined plots in the SVN at:

[/SeiSVN/seismic/HAM-ISI/H1/HAM2/Figures/Spectra/Chamber_Side/Sections_Combined/](#)

- HAM_ISI_Unit_4_ASD_Volts_GS13_H_ISI_Chamber_Side_Locked__2012_05_14.fig
- HAM_ISI_Unit_4_ASD_Volts_GS13_ISI_Chamber_Side_Locked__2012_05_14.fig
- HAM_ISI_Unit_4_ASD_Volts_GS13_V_ISI_Chamber_Side_Locked__2012_05_14.fig

Programs to run the sr785 from a laptop under the SVN at:

/SeiSVN/seismic/HAM-ISI/H1/HAM2/Scripts/Chamber_Side/sr785_Programs/

Testing Scripts under the SVN at:

/SeiSVN/seismic/HAM-ISI/H1/HAM2/Scripts/Chamber_Side/Testing_Scripts /

Issues/difficulties/comments regarding this test:

- H1, V1 and H2 spectra feature a narrow peak at 5.25Hz.
- This peak was associated to real motion. See comments p.9 for more details.
- Measurements were performed in the LVEA, during the day, which is a noisy environment.

Acceptance Criteria:

- Sections Match together
- GS13s responses must not drop in low frequency
- Plots of powerspectra are saved under the SVN

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

Conclusion

Chamber-Side Testing

HAM-ISI Unit #4 is intended to populate HAM2 chamber. The tests presented here were performed between May 11th and May 16th, in accordance to the second version of the *Pre-Integration Chamber-Side Testing* procedure (E1200513-v2).

Additional tests were performed on the CPS on May 29th 2012. They revealed the need to ground the ADE boxes to the test stand (LHO aLog #2972).

All sensors appeared to be functional.

Introduction

Initial Chamber Testing

This part of the Phase II testing was performed during the last 2 weeks of August 2012. It took place in open chamber, with the optics off, and HEPI locked. The ISI was then connected to the electronic rack with the final in-field cables. Models were installed. Tests were performed with the seismic Matlab® scripts.

Optics and Suspensions can be installed right after the end of this phase of testing. No test is performed during their installation.

Final Chamber Testing starts once Optics and Suspensions are installed. The lockers and the CPSs usually need to be reset at this point.

▪ **Step 1: Cables Inventory**

Cable Connects		Cable S/N		
Part Name	Configuration	Corner 1	Corner 2	Corner 3
GS13	Horizontal	S1104678–36”	S1106657	S1104775
	Vertical			
L4C	Horizontal	NA	NA	NA
	Vertical	NA	NA	NA
Actuator	Horizontal	S1104758 – 95”	S1104757 - 95”	S1104770- 95”
	Vertical	S1104102 – 70”	S1104764 – 95”	S1104759 – 95”

Table – Cables inventory

NA: Not applicable

Issues/difficulties/comments regarding this test:
Some cables were changed since *Assembly Validation*.

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

▪ **Step 2: Level of Stage 1**

NE	SE	SW	NW	Notes
-2	-5	+5	+2	Stage-0: 0.001”

See LHO aLog #4478

The biggest difference measured between two corners was 7mils.

$$\text{Max angle} = 0.007'' / 76'' = 92 \mu\text{rad}$$

Issues/difficulties/comments regarding this test:
Measurement should be performed again once payload changes.

Acceptance Criteria

- The maximum angle of the table with the horizontal mustn't exceed ~100μrad

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

▪ *Step 3: Mass Budget*

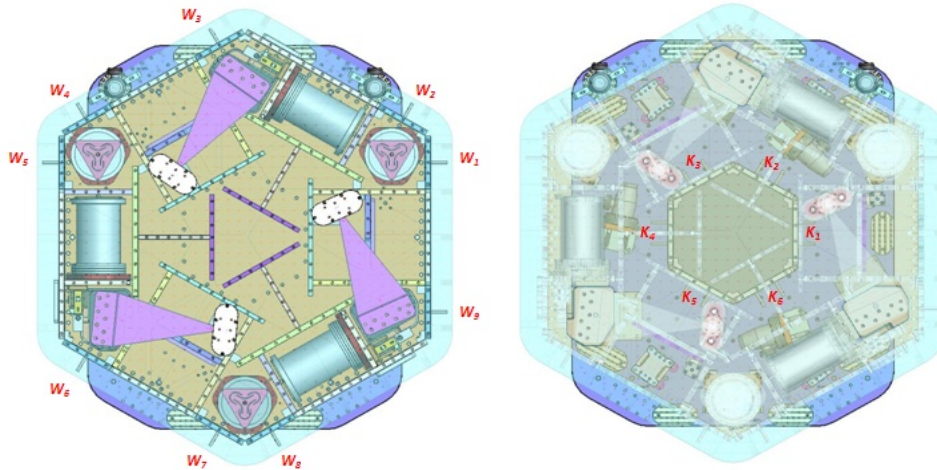


Figure – Wall Masses (W) and Keel masses (K) location. *South of picture = corner 1*

Issues/difficulties/comments regarding this test:

The payload will change a lot with the installation of suspensions. Mass budget was postponed to final in-chamber testing.

Acceptance Criteria

The Mass budget must be

- 579.1 Kg (cf. E1100427) +/- 25Kg (5%)

Test result:

Passed:

Postponed:

▪ *Step 4: Shim Thickness*

Issues/difficulties/comments regarding this test:

Unchanged from assembly validation.

Test result:

Passed:

Failed:

▪ *Step 5: Blade Spring Profile*

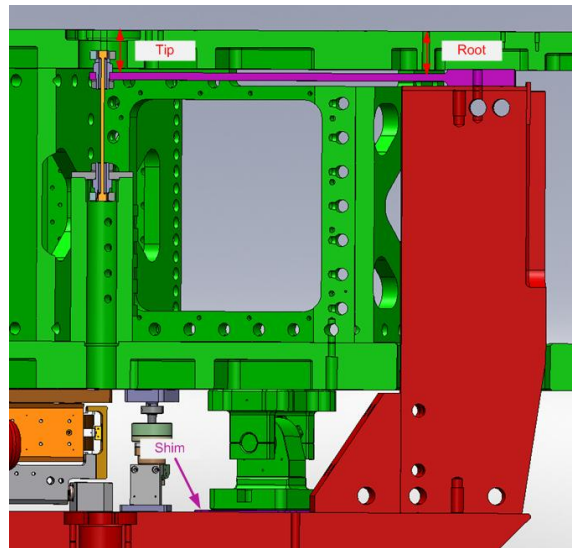


figure – Blade spring profile measurement points

Blade #	Root (Mils)	Tip(Mils)	Flatness (mils)
1			
2			
3			

Table – Blade Spring Profile

Issues/difficulties/comments regarding this test:

Postponed to final in chamber testing.

Acceptance Criteria:

- Recorded for traceability.
- Flatness preferred within 0.015" inches.

Test result:

Passed: _____

Postponed: X

▪ *Step 6: Lockers Adjustment*

The maximum difference recorded on the CPSs between the unlocked and the locked positions is out of the preferred ± 0.1600 cts range.

It is however good enough for this phase of testing. Lockers and CPS Gaps will be set up prior to the Final In-Chamber Testing.

Acceptance criteria:

- Recorded for traceability
- Preferred within ± 0.1600 cts

Test result:

Passed: _____

Postponed: X

▪ *Step 7: CPS Gap*

CPS mean readouts are out of the preferred ± 0.400 cts range.

It is however good enough for this phase of testing. Lockers and CPS Gaps will be set up prior to the Final In-Chamber Testing.

Acceptance criteria:

- Recorded for traceability
- Preferred within ± 0.400 cts

Test result:

Passed: _____

Postponed: X

▪ **Step 8: CPS and GS13 Spectra - ISI Unlocked**

Data files in SVN at:

/seismic/HAM-ISI/H1/HAM2/Data/Spectra/Undamped/
 - LHO_ISI_HAM2_ASD_m_CPS_T240_L4C_GS13_Locked_vs_Unlocked_2012_08_27.mat

Scripts files for taking and processing the data, and plotting it in SVN at:

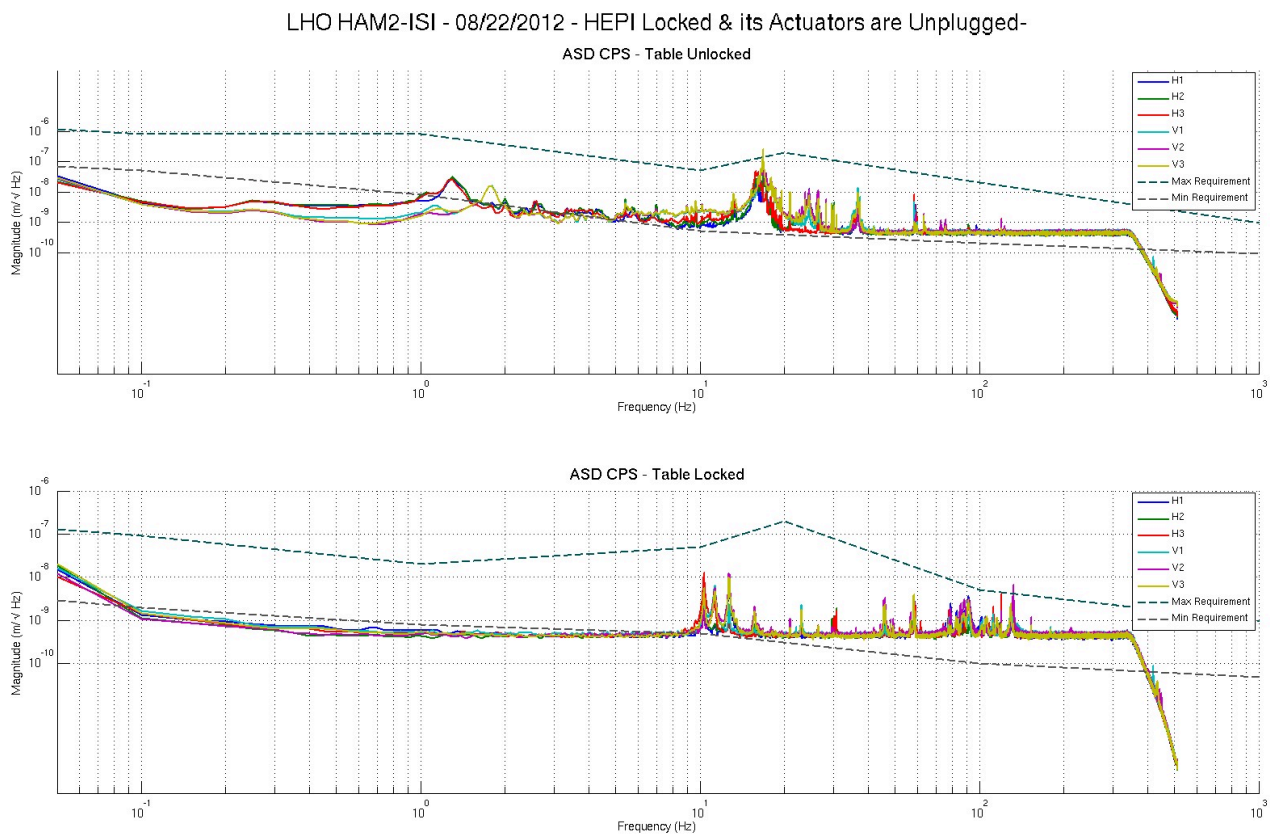
seismic/HAM-ISI/Common/Testing_Functions_HAM_ISI/
 - Plot_ASD_Unlocked_Locked_HAM_ISI.m
 - Plot_ASD_Unlocked_Locked_Group_HAM_ISI.m

Figures in SVN at:

seismic/HAM-ISI/H1/HAM2/Data/Figures/Spectra/Undamped/
 - LHO_ISI_HAM3_ASD_m_GS13_Requirements_Locked_vs_Unlocked_2012_08_27.fig
 - LHO_ISI_HAM3_ASD_m_CPS_Requirements_Locked_vs_Unlocked_2012_08_27.fig

CPS calibration:

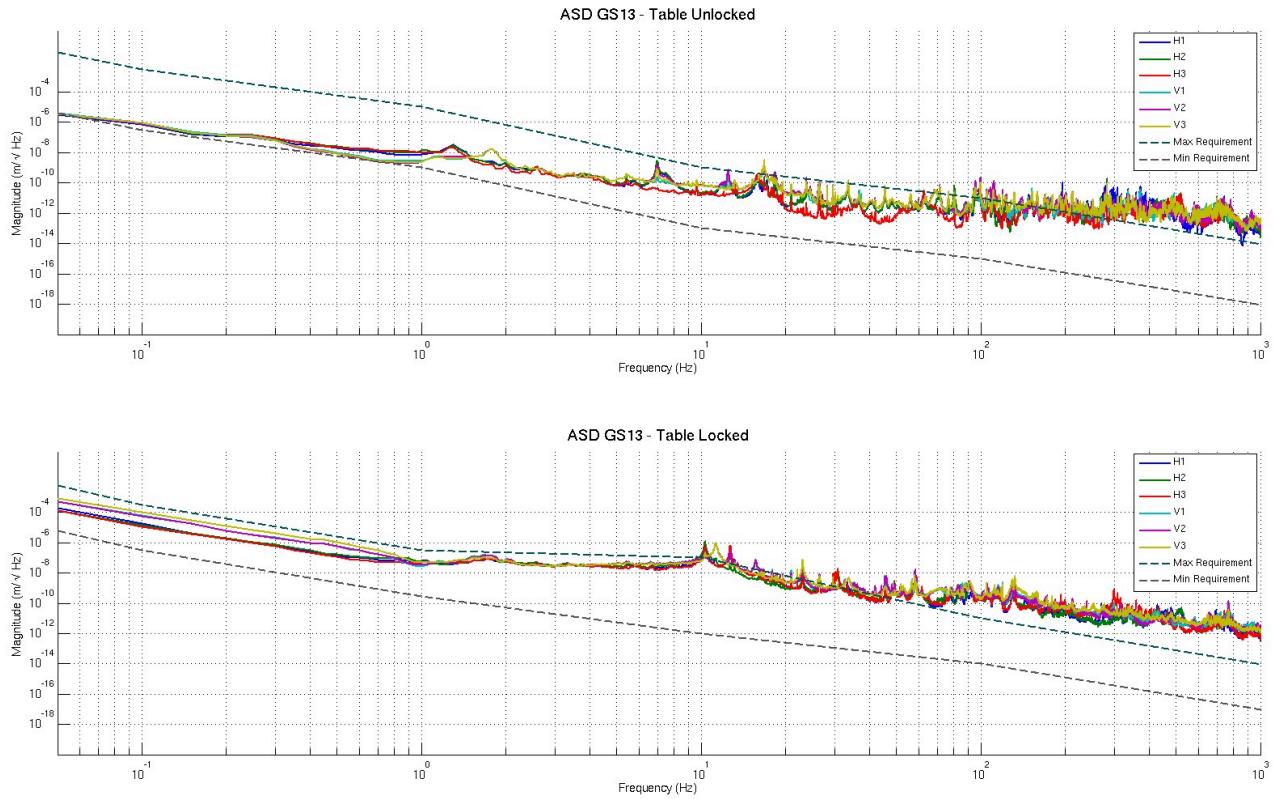
The CPS power spectrums are calibrated by using a sensitivity of 30.2 nm/count.



Measurement length: 1010s - Sample window: 20s - Overlap: 50% - Frequency resolution: 50mHz - Averages: 100 - Measurement start (GPS): 1030096020

Figure - Calibrated CPS power spectrum – ISI Unlocked/Locked

LHO HAM2-ISI - 08/22/2012 - HEPI Locked & its Actuators are Unplugged-



Measurement length: 1010s - Sample window: 20s - Overlap: 50% - Frequency resolution: 50mHz - Averages: 100 - Measurement start (GPS): 1030096020

Figure – Power spectrum Calibrated GS13 – ISI Unlocked/Locked

Acceptance criteria:

- No cross talk (peaks at low frequencies + harmonics on measurements)
- Magnitudes of power spectra must be between requirement curves

Test result:

Passed: X **Failed:**

Note:

- When a seismometer fails, its low frequency response is affected. Spectra are within requirements in low frequency. The GS13s installed on this unit are functional.
- GS13 requirement curves need to be updated.

▪ **Step 9: GS13 ASD - Tabled Tilted**

The figure below presents the GS13 power spectrum when the table is unlocked and loaded with a 10Kg mass at each of its corner.

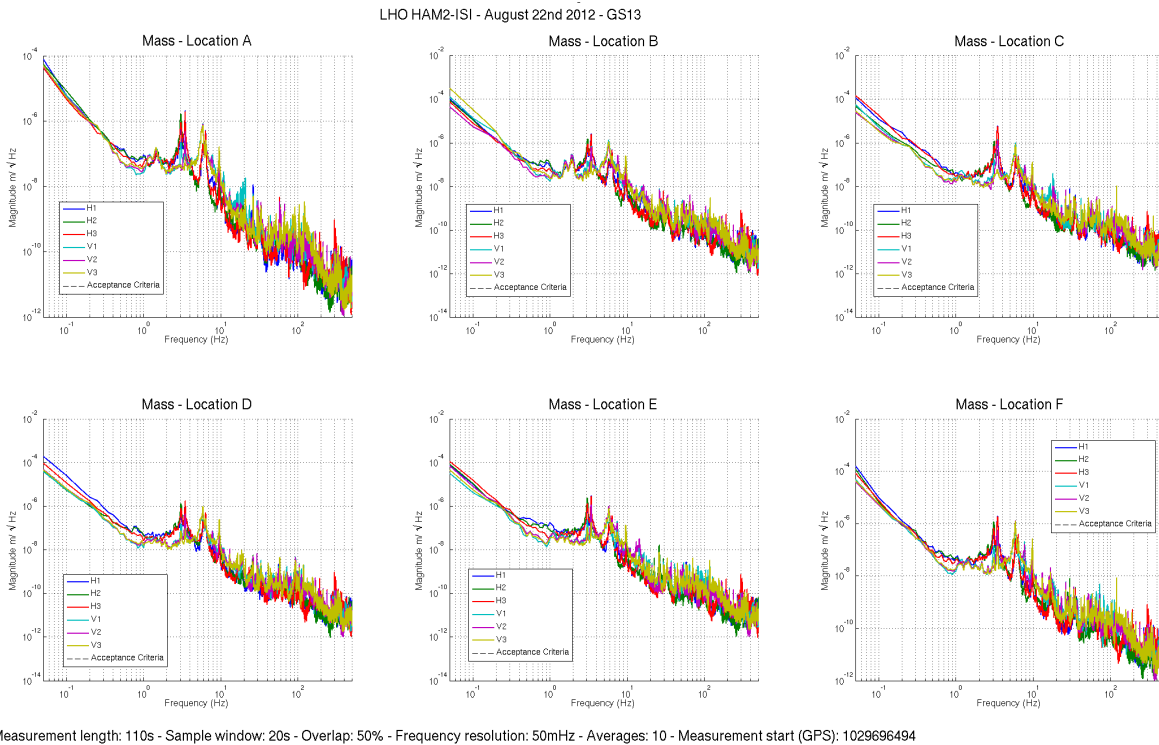


Figure – ASD Calibrated GS13 with mass at corner

Data files in SVN at:

/seismic/HAM-ISI/H1/HAM3/Data/Spectra/Undamped/
 - LHO_ISI_HAM2_ASD_m_GS13_Stage_Tilted_2012_08_22.mat

Scripts files for taking and processing the data, and plotting it in SVN at:

seismic/HAM-ISI/Common/Testing_Functions_HAM_ISI/
 - Plot_ASD_Tilted_Stage_HAM_ISI.m

Figures in SVN at:

seismic/HAM-ISI/H1/HAM3/Data/Figures/Spectra/Undamped/
 - LHO_ISI_HAM2_m_PSD_GS13_Tilted_2012_08_22.fig

Issues/difficulties/comments regarding this test:

- Good concordance between sensors of the same type and direction.
- No drop of response in low frequency

Test result:

Passed: X **Failed:**

▪ **Step 10: GS13 pressure readout**

Pods Pressure Sensors - HAM2

	Corner 1	Corner 2	Corner 3	
L4-C Direct Pressure	30	30	30	KPa
L4-C Differential Pressure	0	0	0	KPa
GS-13 Direct Pressure	99	99	100	KPa
GS-13 Differential Pressure	1	0	0	KPa

Figure – Pressure Readouts (07/16/2012)

Acceptance criteria:

- The pressure on *GS13_P* channels must be 102KPa +/-8 KPa (25000 counts +/- 3000 counts)
- *GS13_P* must vary the same way in each corner and *GS13_DIFF* must be constant (channels follow comparable trend)

Test result:

Passed: X **Failed:**

▪ **Step 11: Actuators Sign and range of motion (Local drive)**

	Negative drive	No Drive	Positive drive	ROM (Counts)
H1 readout (count)	-24247	-4141	23271	47518
H2 readout (count)	-23587	-2483	23341	46928
H3 readout (count)	-23968	-1076	24978	48946
V1 readout (count)	-18264	928	21177	39441
V2 readout (count)	-24047	-37	24667	48714
V3 readout (count)	-22779	-873	20038	42817

Table - Range of motion - Local drive

Acceptance criteria:

- Main couplings sensors readout must be at least 16000 counts (~0.02")
- A positive offset drive on one actuator must give positive sensor readout on the collocated sensor. Signs will also be tested when measuring local-to-local transfer functions.

Test result:

Passed: X **Failed:**

▪ *Step 12: Static Testing (Tests in the local basis)*

		Sensors (counts)					
		H1	H2	H3	V1	V2	V3
H1	1812	1138	1145	-9	0	-10	
H2	1124	1804	1136	-8	6	-8	
H3	1154	1148	1838	-9	8	-14	
V1	179	158	-340	1307	-47	-546	
V2	-335	175	178	-578	1318	-34	
V3	160	-341	164	-26	-562	1298	

Table - Main couplings and cross couplings

Issues/difficulties/comments regarding this test:

Acceptance criteria:

- **Vertical**

For a +1000 count offset drive on vertical actuators

- Collocated sensors must be 1400 counts +/- 10%

- **Horizontal**

For a +1000 count offset drive on horizontal actuators

- Collocated sensors must be 2000 counts +/- 10%
- Non-collocated horizontal sensors must be 1250 counts +/-10%

Test result:

Passed: X

Failed:

▪ *Step 13: Linearity test*

	Slope	Offset	Average slope	Variation from average(%)
H1	1.8281	-4151.4	1.83	-0.26
H2	1.8098	-2481.7		-1.26
H3	1.8606	-1082.4		1.51
V1	1.312	933.38	1.32	-0.33
V2	1.3159	-22.437		-0.03
V3	1.3211	-884.41		0.36

Table - Slopes and offset of the triplet Actuators - HAM-ISI - Sensors

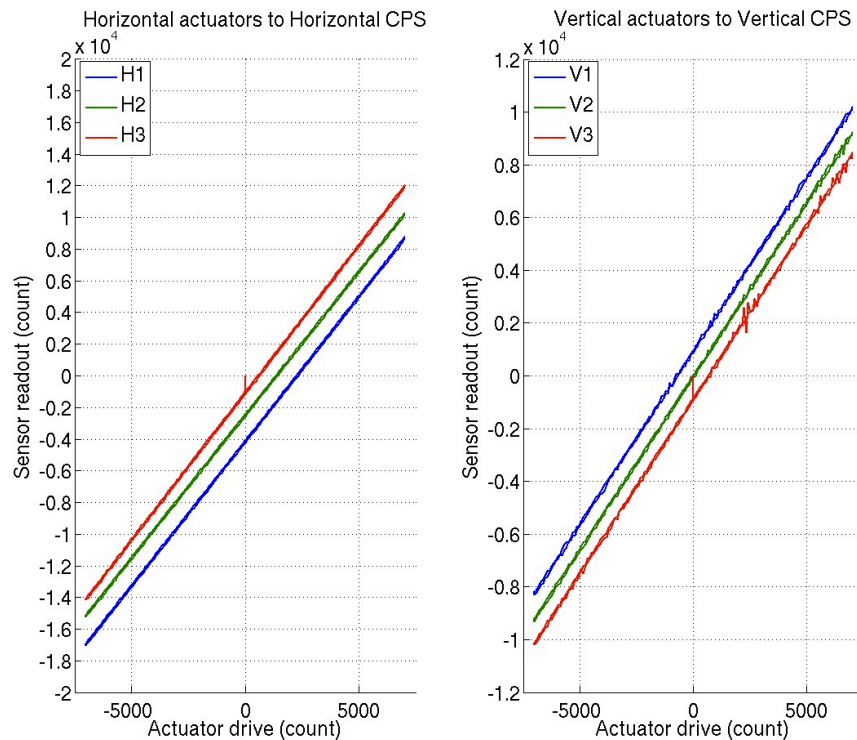


Figure - Horizontal and vertical actuators x HAM-ISI x sensors

Scripts files for taking data in SVN at:

seismic/HAM-ISI/Common/Testing_Functions_HAM_ISI/

- Linearity_Test_Awgstream_HAM_ISI.m
- Reprocess_Linearity_Test.m

Data files in SVN at: seismic/HAM-ISI/H1/HAM2/Data/Linearity_Test/

- LHO_ISI_HAM2_Linearity_test_20120827.mat

Figures in SVN at:

seismic/HAM-ISI/H1/HAM2/Data/Figures/Linearity_Test/

- LHO_ISI_HAM2_Linearity_test_Reprocessed_With_Right_Data_Rate_20120827.fig

Issues/difficulties/comments regarding this test:

Needed to write a script to reprocess test data. The original script did not account for the new data rate on the CPSs.

H3 is borderline but acceptable.

Acceptance criteria:

- Horizontal and vertical slopes of the triplet actuators x HAM-ISI x sensors = Average slope +/- 1.5%

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

- **Step 14: Frequency response**

All input/output filters are ON. HEPI is locked. The chamber is closed with sheets on.

- **Step 14.1: Local to local measurements**

Data files in SVN at:

seismic/HAM-ISI/H1/HAM2/Data/Transfer_Functions/Measurements/Undamped/
- LHO_ISI_HAM_Unit_2_Data_TF_L2L_10mHz_100mHz_20120825-023353.mat
- LHO_ISI_HAM_Unit_2_Data_TF_L2L_100mHz_500mHz_20120825-013201.mat
- LHO_ISI_HAM_Unit_2_Data_TF_L2L_500mHz_5Hz_20120824-192209.mat
- LHO_ISI_HAM_Unit_2_Data_TF_L2L_5Hz_200Hz_20120824-174819.mat
- LHO_ISI_HAM_Unit_2_Data_TF_L2L_200Hz_1000Hz_20120824-160521.mat

Data collection script files:

seismic/HAM-ISI/H1/HAM2/Scripts/Data_Collection/
- Run_Exc_Batch_H1_HAM2.m

Scripts files for processing and plotting in SVN at:

seismic/HAM-ISI/H1/HAM2/Scripts/Control_Scripts/Version_0/
- Step_1_TF_Loc_to_Loc_H1_ISI_HAM2.m

Figures in SVN at:

seismic/HAM-ISI/H1/HAM2/Data/Figures/Transfer_Functions/Measurements/Undamped/
- H1_ISI_HAM2_TF_L2L_Raw_from_ACT_to_CPS_2012_08_24.fig
- H1_ISI_HAM2_TF_L2L_Raw_from_ACT_to_GS13_2012_08_24.fig

Storage of measured transfer functions in the SVN at:

seismic/HAM-ISI/H1/HAM2/Data/Transfer_Functions/Simulations/Undamped/
- H1_ISI_HAM2_TF_L2L_Raw_2012_08_24.mat

The local to local transfer functions and presented below.

LHO HAM2-ISI - August 25 2012 - HEPI locked - In Chamber - In Air

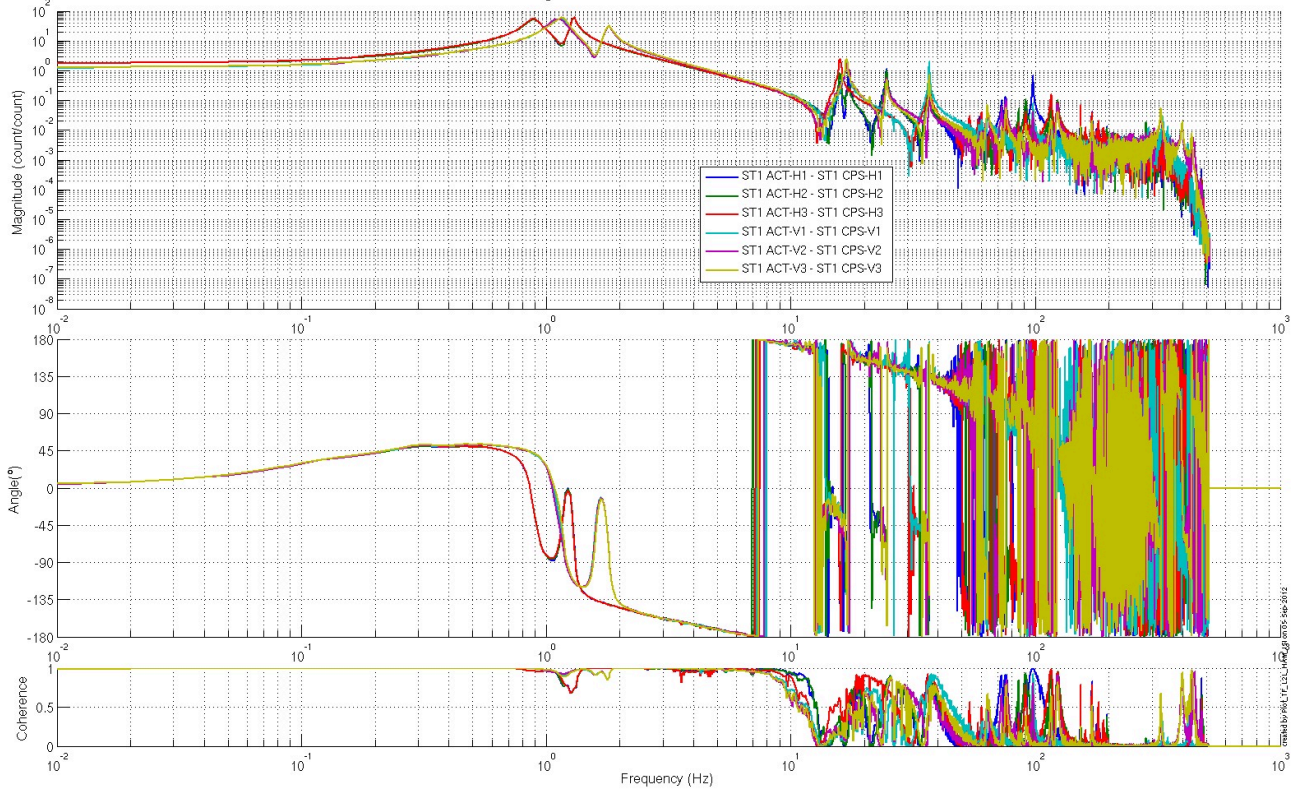


Figure - Local to Local Measurements –Capacitive Position Sensors

LHO HAM2-ISI - August 25 2012 - HEPI locked - In Chamber - In Air

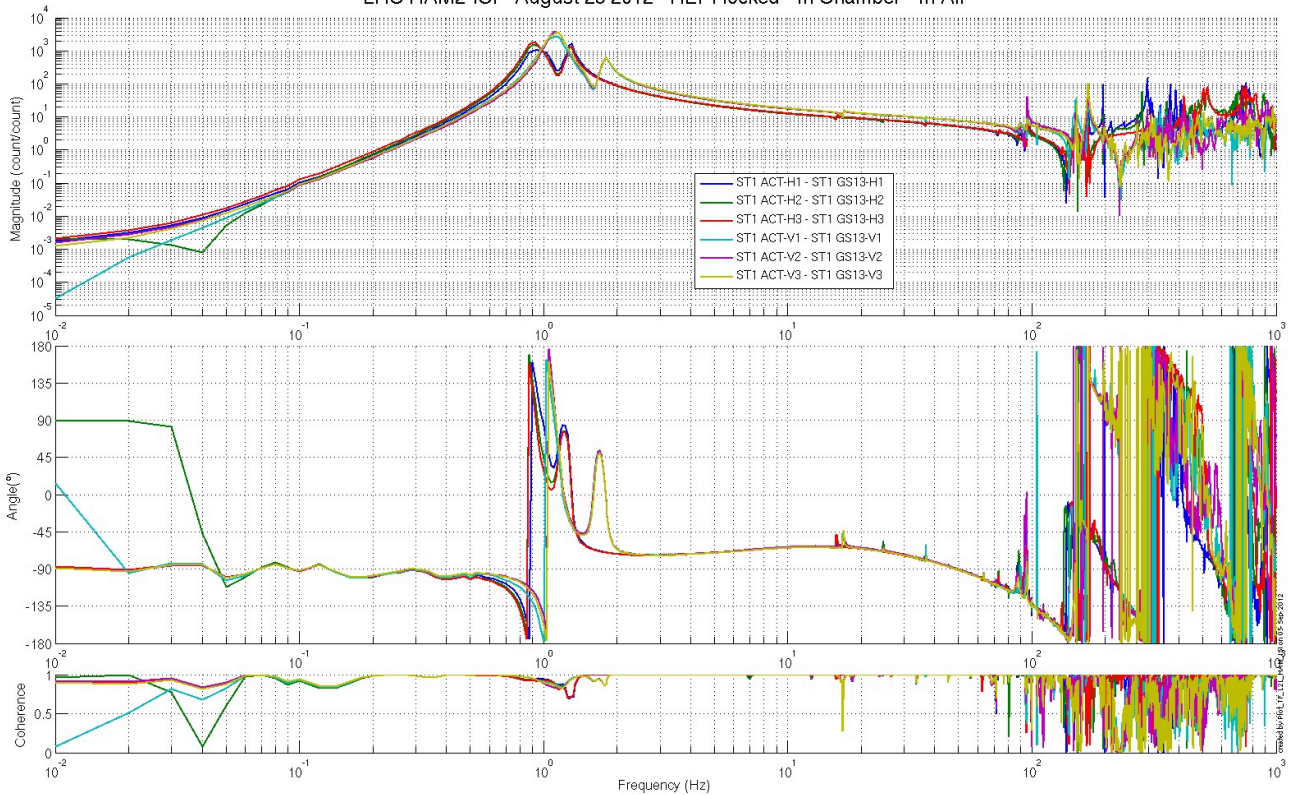


Figure - Local to Local Measurements – Inertial sensors

- ***Step 14.2: Local to local measurements V.S. LLO***

Data files in SVN at:**LHO:**

seismic/HAM-ISI/H1/HAM2/Data/Transfer_Functions/Measurements/Undamped/

- LHO_ISI_HAM_Unit_2_Data_TF_L2L_10mHz_100mHz_20120825-023353.mat
- LHO_ISI_HAM_Unit_2_Data_TF_L2L_100mHz_500mHz_20120825-013201.mat
- LHO_ISI_HAM_Unit_2_Data_TF_L2L_500mHz_5Hz_20120824-192209.mat
- LHO_ISI_HAM_Unit_2_Data_TF_L2L_5Hz_200Hz_20120824-174819.mat
- LHO_ISI_HAM_Unit_2_Data_TF_L2L_200Hz_1000Hz_20120824-160521.mat

LLO:

seismic/HAM-ISI/L1/HAM2/Data/Transfer_Functions/Simulations/Undamped/

- LLO_ISI_HAM3_TF_L2L_Raw_2012_03_21.mat

Scripts files for processing and plotting in SVN at:

seismic/HAM-ISI/H1/HAM2/Scripts/Control_Scripts/Version_2/

- Step_1_TF_Loc_to_Loc_H1_ISI_HAM2.m
- Plot_TF_L2L_HAM_with_LLO.m

Figures in SVN at:

seismic/HAM-ISI/H1/HAM2/Data/Figures/Transfer_Functions/Comparisons/L2L/

- H1_ISI_HAM3_TF_L2L_Raw_from_ACT_H_to_CPS_H_vs_LLO_2012_03_21.fig
- H1_ISI_HAM3_TF_L2L_Raw_from_ACT_V_to_CPS_V_vs_LLO_2012_03_21.fig
- H1_ISI_HAM3_TF_L2L_Raw_from_ACT_H_to_GS13_H_vs_LLO_2012_03_21.fig
- H1_ISI_HAM3_TF_L2L_Raw_from_ACT_V_to_GS13_V_vs_LLO_2012_03_21.fig

LHO HAM2-ISI - Overnight - August 23nd 2012 - HEPI locked - In Closed Chamber - In Air

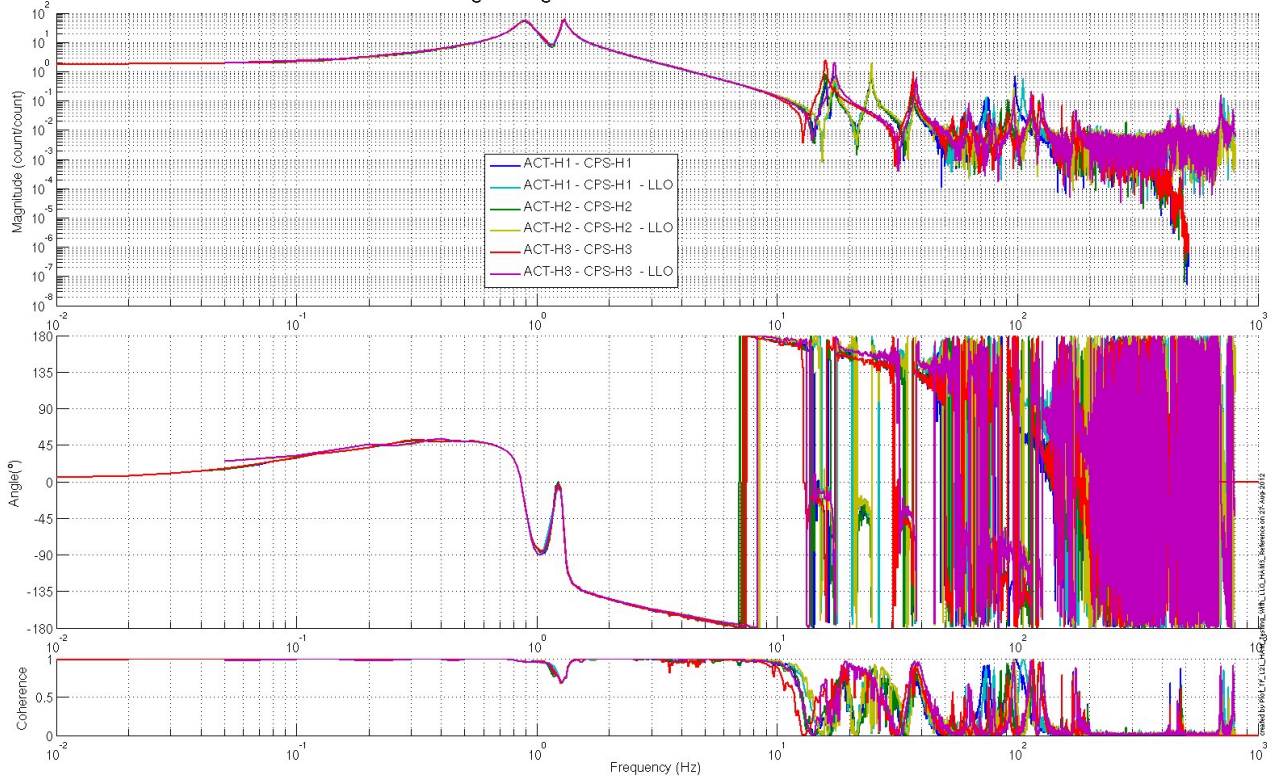


Figure – TF L2L – Horizontal CPS

LHO HAM2-ISI - Overnight - August 23nd 2012 - HEPI locked - In Closed Chamber - In Air

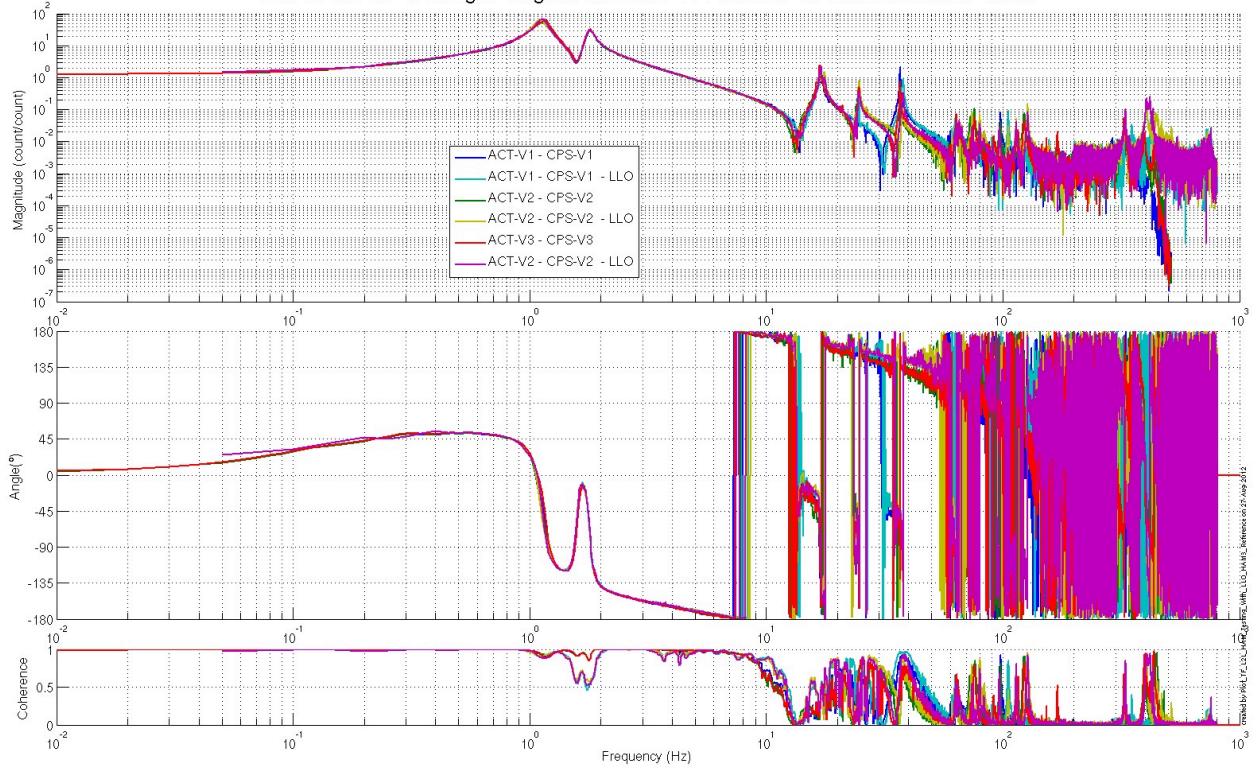


Figure – TF L2L – Vertical CPS

LHO HAM2-ISI - Overnight - August 23rd 2012 - HEPI locked - In Closed Chamber - In Air

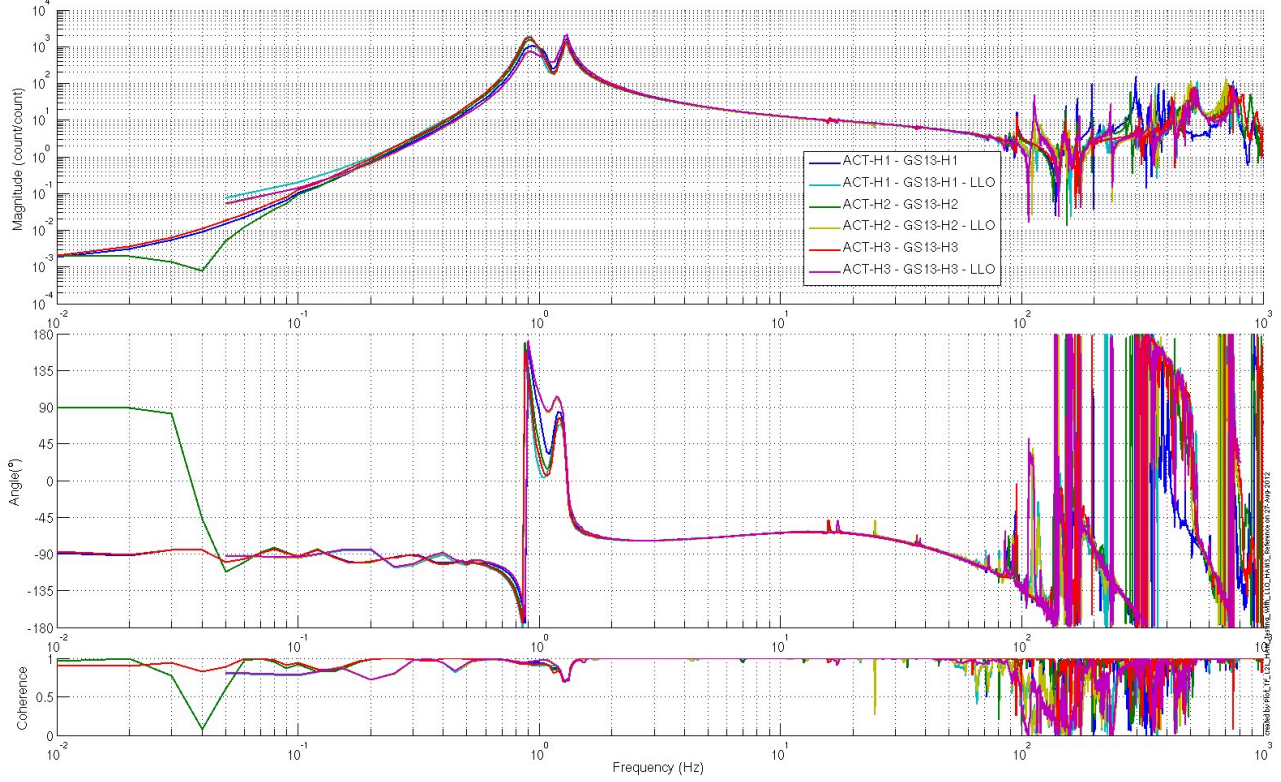


Figure – TF L2L – Horizontal GS13

LHO HAM2-ISI - Overnight - August 23rd 2012 - HEPI locked - In Closed Chamber - In Air

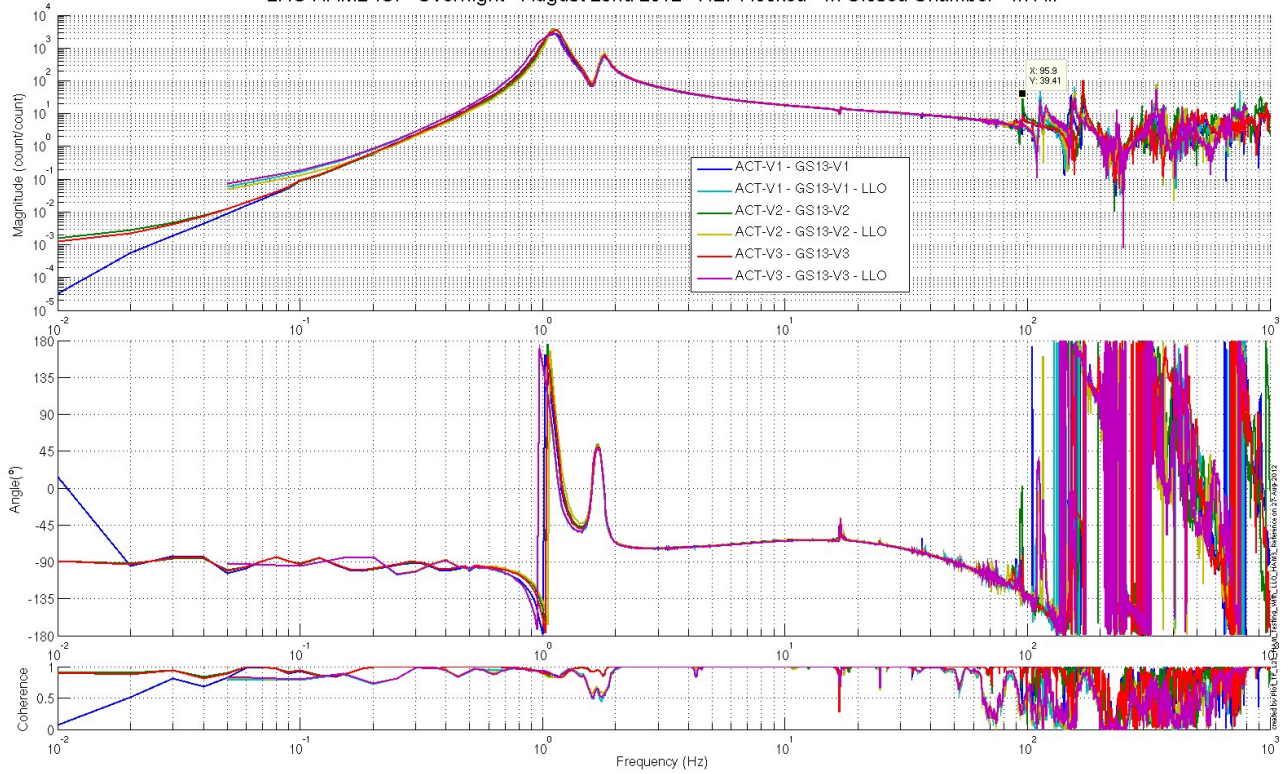


Figure – TF L2L – Vertical GS13

Issues/difficulties/comments regarding this test:

Good concordance with TF measured under the same conditions at LLO.

The big dummy mass used on top of the ISI to compensate for the absence of suspensions turned out to be perturbing the TF measurements. We put 2 small screwdriver tips under it to constrain it more. The results presented here are the ones taken after the *screwdriver tips fix*.

These results were posted in the LHO aLog, entry #4025. The initial chamber testing was validated on them.

Test result:

Passed: X **Failed:**

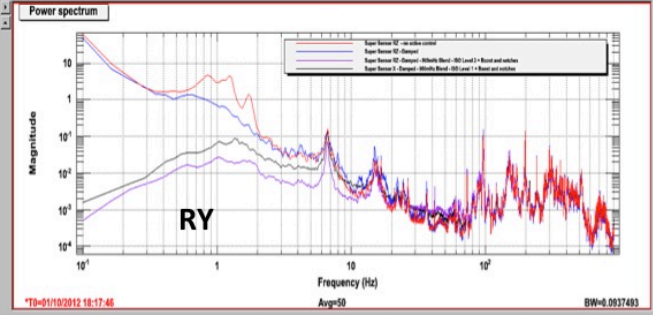
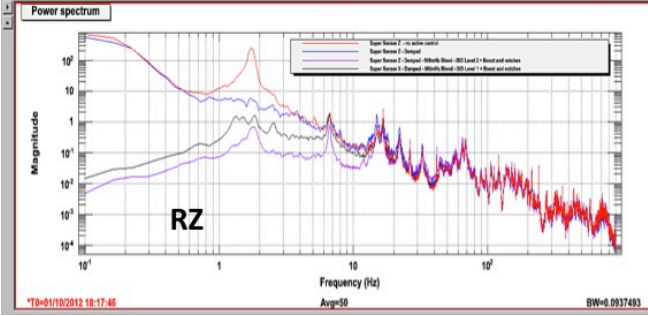
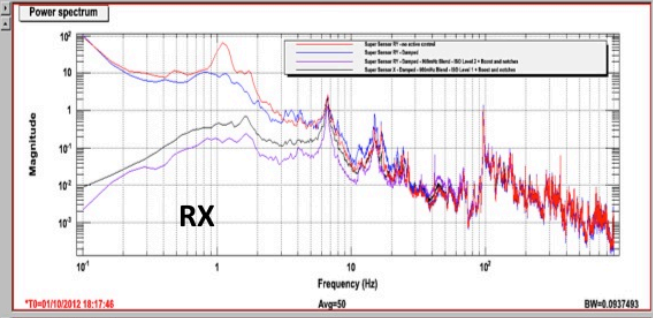
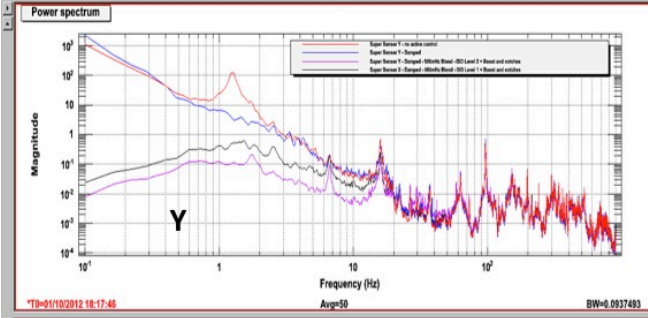
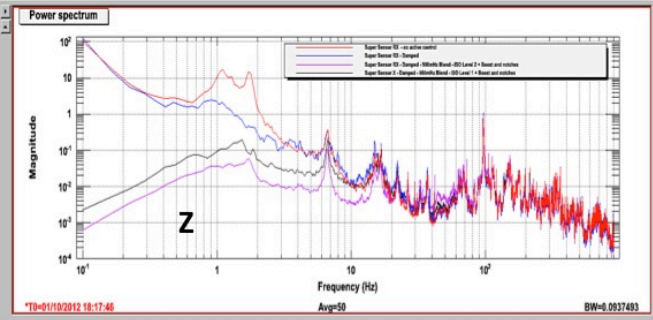
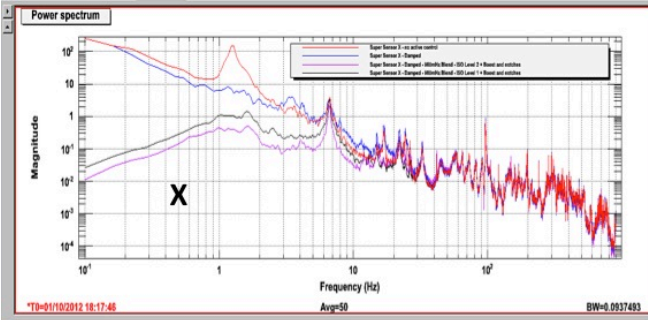
▪ ***Step 15: Pre-Commissioning***

Time was available at the end of the initial chamber testing. We used it to test the new commissioning scripts (Version 2), and see how much isolation we could get in this configuration.

We installed the HAM-ISI control loops level-1 and Level-2 on HAM2-ISI. Notches were needed to account for HEPI resonances. They were added in both levels of controllers. Details of the investigation that led to this conclusion can be found in LHO aLogs #4341 and #4345.

The MEDM commands allowed changing smoothly between states.

Results are presented below.



	Super Sensor	no active control
	Super Sensor	Damped
	Super Sensor	Damped - 900mHz Blend - ISO Level 2 + Boost and notches
	Super Sensor	Damped - 900mHz Blend - ISO Level 1 + Boost and notches

Conclusion

Initial In-Chamber testing

The Initial Chamber Testing of HAM2-ISI was performed during the last two weeks of August.

Other tasks were also performed then:

- Models were installed
- In-field cables were installed
- Electronic rack was troubleshooted:
 - o BIO-related cables missing fifth pin
 - o DAC/ADC card numbers in the IO chassis figured out
 - o BIO card used by the model figured out

Some Pre-Commissioning work was performed late September, in anticipation of *phase III testing*. It is presented in step 15. Results are encouraging for commissioning.

Very few issues were found during the *Initial In-Chamber Testing* of this unit. The known issues are summed up here:

- CPSs and lockers will need to be reset after SUS install, as expected
- Overnight Transfer Function often crashed due to incompatibility between Ubuntu OS and Mac computers.

Introduction

Final Chamber Testing

This part of the Phase II testing takes place in open chamber, with sheets on.

This is the last phase of testing before the chamber is closed for the IMC test. All the suspensions and optics needed for the IMC test are on. PRM and PR3 are not.

At this time, HEPI pipes are not flushed yet. Hence, HEPI is locked.

IO was done with installing optics on December 17th 2012.

Tests presented here were performed between December 17th and December 19th 2012. Chamber started to be closed on Dec. 20th 2012.

I. Final In-Chamber Testing

▪ *Step 1: Parts Inventory (E1000052)*

DCC Number	Part name	Configuration	Corner 1 S/N	Corner 2 S/N	Corner 3 S/N
D071001	Stage 0 base	NA	11		
D071051	Stage 1 base	NA	11		
D071050	Optical table	NA	12		
D071002	Spring Post	NA	18	19	16
D071100	Spring	NA	12	8	47
D071102	Flexure	NA	10	17	9
ADE	Position sensor	Horizontal	12046 Master 0	12034 slave 180	12070 Slave 0
		Vertical	12018 slave 180	12042 slave 0	12081 Slave 180
D047812	GS-13 pod	Horizontal	44	93	07
		Vertical	88	14	30
D047823	L4C pod	Horizontal	NA	NA	NA
		Vertical	NA	NA	NA
D0902749	Actuator	Horizontal	124	99	107
		Vertical	108	51	64

Table – Parts inventory

NA: Not applicable

TMD	Corner	S/N
	1	16
	2	17
	3	18

Table – Tuned Mass Dampers

Issues/difficulties/comments regarding this test:

Same parts as during the Assembly Validation testing. Serial numbers were retrieved from report E1000313-v2.

Corner 1 and 3 CPSs are now connected to the same ADE box for in-air cable to reach feedthroughs.

TMDs were added since (LHO aLog # 4902).

Acceptance Criteria:

Inventory is complete

Test result:

Passed: X **Failed:**

▪ **Step 2: Cables inventory:**

Issues/difficulties/comments regarding this test:

No cables were changed since the *Initial In-Chamber testing*. Please refer to the *Initial In-Chamber testing - Step I* section of this report for details.

Acceptance Criteria:

Inventory is complete

Test result:

Passed: X

Failed:

▪ **Step 3: Electronics inventory**

Hardware	LIGO reference	S/N
Coil driver	D0902744	S1103344
		S1103363
Anti Image filter	D1100202	S1202069
Anti aliasing filter	D1000269	S1202072
		S1202073
Interface chassis	D1000067	S1201754
		S1201755

Table – Electronics Inventory, December 19th 2012

Issues/difficulties/comments regarding this test:

This same rack of electronics was used for the *initial in-chamber testing*.

Acceptance Criteria:

Inventory is complete

Test result:

Passed: X

Failed:

▪ *Step 4: Payload Survey*

During this step, the ISI is payloaded with suspensions and optics. PRM and PR3 will be installed after the IMC test (as it was done at LLO). The masses added to finish loading and balancing the ISI were recorded. See tables and figure below.

	00	01	02	03	04	05	06		
	0.6	1.1	2.2	4.5	7.9	15.6	27.2	lbs	kgs
w9	0	0	0	0	0	0	0	0	0.00
w1	1			1	1			13	5.90
w2		1		1		1		21.2	9.62
w3			1					2.2	1.00
w4				2	1			16.9	7.67
w5			1			1		17.8	8.07
w6	0	0	0	0	0	0	0	0	0.00
w7	1	2	1					5	2.27
w8	0	0	0	0	0	0	0	0	0.00
Side Masses Total	2	3	3	4	2	2	0	76.1	34.52

Table – Wall Mass Distribution

	00	01	02	03	04	05	06		
	0.6	1.1	2.2	4.5	7.9	15.6	27.2	lbs	kgs
k1						2		31.2	14.15
k2					1		1	35.1	15.92
k3						2		31.2	14.15
k4					1		1	35.1	15.92
k5						2		31.2	14.15
k6					1		1	35.1	15.92
Keel Masses Total	0	0	0	0	3	6	3	198.9	90.22

Table – Keel Mass Distribution

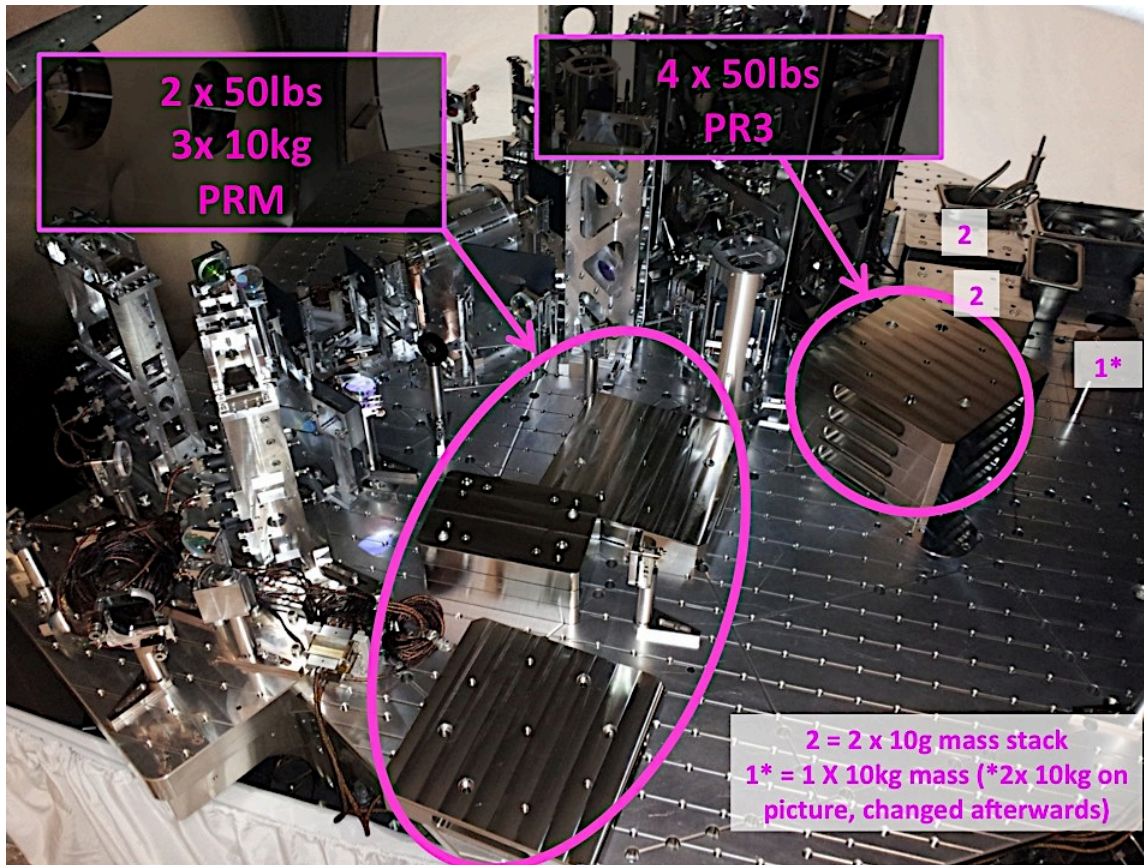


Figure – Optical Table Mass Distribution (60kg added with 10kg masses)

	Side	Keel	Top	Total
Weight (kg)	34.52	90.22	216.08	340.82

Table – Mass Budget Sum Up

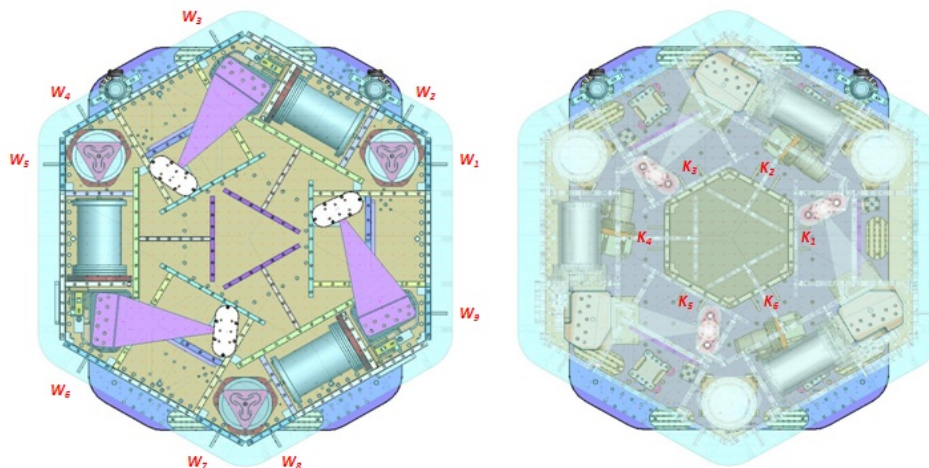


Figure – Wall Masses (W) and Keel masses (K) location. *South of picture = corner 1*

Issues/difficulties/comments regarding this test:

- Only wall masses and optical table masses were changed since the *Initial In-Chamber testing*. Keel masses were retrieved from this phase. Please refer to the related section for details.
- 50lbs and 10kg masses were used to account for the absence of PR3 and PRM. Please refer to the picture of the optical table on the previous page, and to the LHO alog# 4921, for more details.

Acceptance Criteria:

- Amount and position of wall masses is recorded
- Amount and position of keel masses is recorded
- Amount and position of optical table masses is recorded

Test result:Passed: X Failed: **▪ Step 5: Locked/Unlocked Spectra****Data files in SVN at:**

/seismic/HAM-ISI/H1/HAM2/Data/Spectra/Undamped/
- LHO_ISI_HAM2_ASD_m_CPS_T240_L4C_GS13_Locked_vs_Unlocked_2012_12_17.mat

Scripts files for taking and processing the data, and plotting it in SVN at:

seismic/HAM-ISI/Common/Testing_Functions_HAM_ISI/
- ASD_Measurements_Locked_Unlocked_HAM_ISI.m
- Plot_ASD_Unlocked_Locked_HAM_ISI.m
- Plot_ASD_Unlocked_Locked_Group_HAM_ISI.m
seismic/HAM-ISI/H1/HAM2/Data/Spectra/
- Measurements_List_Spectra_Locked_H1_ISI_HAM2.m

Figures in SVN at:

seismic/HAM-ISI/H1/HAM2/Data/Figures/Spectra/Undamped/
- LHO_ISI_HAM2_ASD_m_GS13_Requirements_Locked_vs_Unlocked_2012_12_17.fig
- LHO_ISI_HAM2_ASD_m_CPS_Requirements_Locked_vs_Unlocked_2012_12_17.fig

LHO HAM2-ISI - In Chamber - In Air - Sheets on

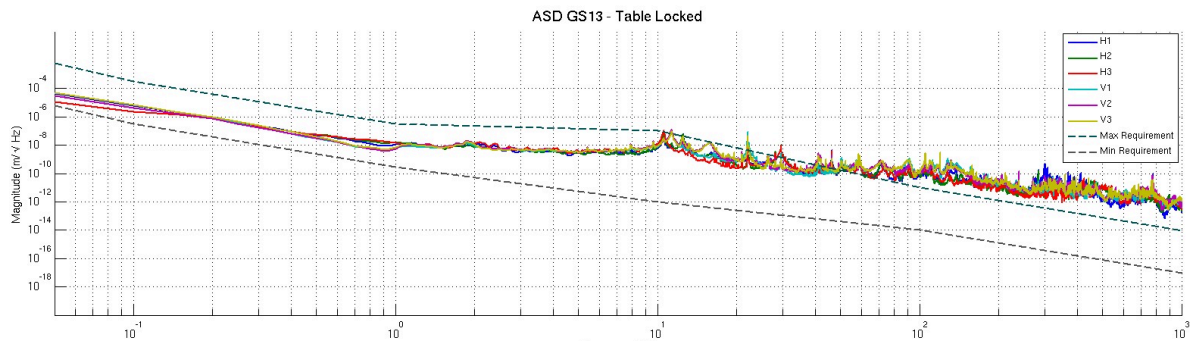
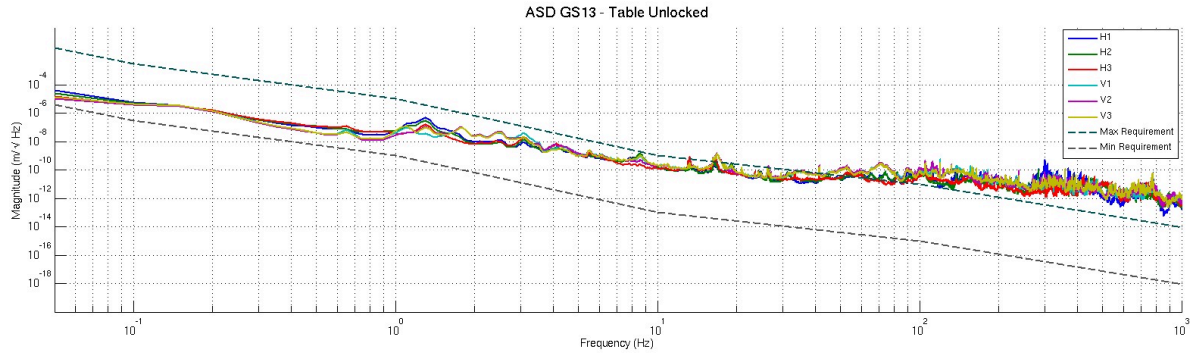


Figure - Calibrated CPS power spectrum – ISI Unlocked/Locked

LHO HAM2-ISI - In Chamber - In Air - Sheets on

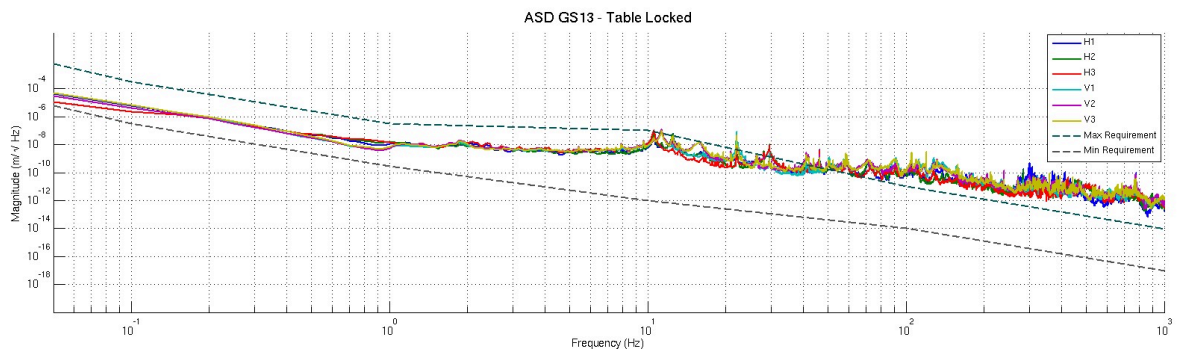
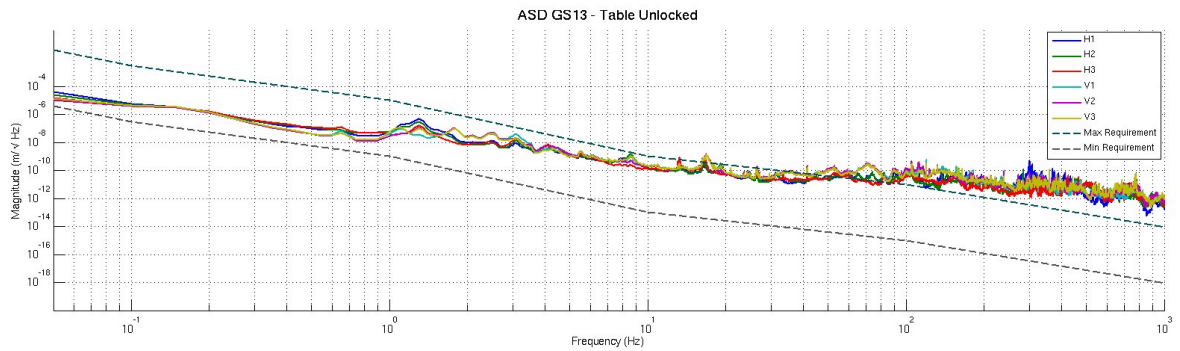


Figure – Power spectrum Calibrated GS13 – ISI Unlocked/Locked

Issues/difficulties/comments regarding this test:

- The testing functions used here need to load the calibration filters. The way we save these filters recently changed. The functions were updated to reflect these changes. Please, refer to SEI aLog #147 for more details.
- The CPS power spectra are calibrated by using a sensitivity of 30.2 nm/count.
- Even though *asd2.m* is now available, the functions used here still called *pwelch*.

Acceptance criteria:

- No cross talk (peaks at low frequencies + harmonics on measurements)
- Magnitudes of power spectra must be between requirement curves such as in the following figures (dashed lines)

Test result:

Passed: X **Failed:**

Comment:

GS13 requirement curves need to be updated.

▪ ***Step 6: Tilted Spectra***

Spectra with the ISI tilted were already taken during the initial in-chamber testing.. The GS13s were not changed, neither were they moved since. Locked and unlocked spectra are fine We are confident that the GS13s are fully functional.

Please, refer to the *Initial In-Chamber Testing section, step 9*, for details.

Test result:

Passed: X **Failed:**

▪ ***Step 7: Pressure Readouts***

Pods Pressure Sensors - HAM2			
	Corner 1	Corner 2	Corner 3
L4-C Direct Pressure	30	30	30
L4-C Differential Pressure	0	0	0
GS-13 Direct Pressure	100	99	99
GS-13 Differential Pressure	0	1	0

Figure – Pressure Readouts December 19th 2012

Pods Pressure Sensors - HAM2			
	Corner 1	Corner 2	Corner 3
L4-C Direct Pressure	30	30	30
L4-C Differential Pressure	0	0	0
GS-13 Direct Pressure	100	99	100
GS-13 Differential Pressure	0	1	0

Figure – Pressure Readouts, Jan 22nd 2013, after pumpdown

Issues/difficulties/comments regarding this test:

- The ISI is in air, with sheet covers on the chamber
- No relevant variation of in-pod pressure over time, and after pumpdown.

Acceptance criteria:

- The pressure on GS13_P channels must be 102KPa +/-8 KPa (25000 counts +/- 3000 counts)
- GS13_P must vary the same way in each corner and GS13_DIFF must be constant (channels follow comparable trend)

Test result:

Passed: X **Failed:**

▪ *Step 8: Lockers/CPS Adjustment*

Lockers’ adjustments were performed on December 15th after IO finalized the installation of the main elements of payload for HAM2-ISI. Details about this operation can be found in LHO aLog #4942.

CPS Offsets were off-requirements, but small enough to avoid sensors contacting targets, and good enough for the upcoming IMC test. The zero of the CPS was NOT reset after working on the lockers to save time and allow testing, and then pumpdown, by Christmas break. **CPSs will be reset once the chamber is re-opened, after the IMC test.**

The goal of this step is to make sure that the locked/unlocked shift read with the CPSs is within requirement.

Shift	Unlocked (Counts)	Locked (Counts)	Shift
H1	-3860	-3613.00	467.98
H2	-2136	-2109.00	334.36
H3	-286	-101.00	199.12
V1	828	561.00	25.64
V2	-147	-376.00	168.82
V3	-303	-285.00	141.63

Table – Locker’s Adjustments, December 15th 2012

Issues/difficulties/comments regarding this test:

- Locked-Unlocked shift is way below requirements. Same comment applies to the readouts.
- No shim was changed. Lockers were just adjusted horizontally.
- The zero of the CPSs will be reset after the IMC test.

Acceptance criteria (per E1000309-v12):

- Shift < 1600 cts
- Readouts < 2000 cts

Test result:

Passed: X **Failed:**

▪ **Step 9: Shim Thickness**

Lockers	Shim thickness (mil)
A	126
B	126
C	122
D	122

Table – Shim Thicknesses, December 15th 2012

Issues/difficulties/comments regarding this test:

- No shim was changed. Lockers were only adjusted horizontally.

Acceptance Criteria

- The shim thickness should be 125 mils +/-5

Test result:

Passed: X

Failed:

▪ **Step 10: Blade Spring Profile**

Blade #	Flatness (mils)
1	8
2	X
3	2

Table – Blade Spring Profile, December 15th 2012

Issues/difficulties/comments regarding this test:

- Access to the optical table holes used for this measurement is very limited once suspensions are installed. The profile of the blade of corner 2 could not be measured in this configuration.
- Transfer functions and Pre-commissioning tests show that the flatness of the blade of corner 2 will not be an issue for the IMC test.

Acceptance Criteria:

- Blades must be flat within 0.015" inches.

Test result:

Passed: X

Failed:

▪ **Step 11: Level of Stage 1**

The level of the Optical Table with the optical Level: ± 0.1 mm. See LHO aLog #4942 for more details.

$$\text{Max angle} = 0.004'' / 79'' \sim 50 \mu\text{rad}$$

Issues/difficulties/comments regarding this test:

- This measurement was performed after locker’s adjustments (see step 8)

Acceptance Criteria

- The maximum angle of the table with the horizontal mustn’t exceed $\sim 100 \mu\text{rad}$

Test result:

Passed: X

Failed:

▪ **Step 12: Range of Motion**

	Negative drive	No Drive	Positive drive	ROM (Counts)
H1 readout (count)	-27780	-3800	20480	48260
H2 readout (count)	-24800	-1900	21300	46100
H3 readout (count)	-23500	-400	24800	48300
V1 readout (count)	-18500	1100	20600	39100
V2 readout (count)	-21200	150	22900	44100
V3 readout (count)	-21800	-800	19600	41400

Table – Range of Motion, December 19th 2012

ROM: Range Of Motion

Issues/difficulties/comments regarding this test:

- Compensation filters are ON.
- Symmetrization filters are OFF

Acceptance criteria:

- Main couplings sensors readout must be at least 16000 counts ($\sim 0.02''$)
- A positive offset drive on one actuator must give positive sensor readout on the collocated sensor. Signs will also be tested when measuring local-to-local transfer functions.

Test result:

Passed: X

Failed:

▪ **Step 13: Static Testing**

Local to Cartesian transform matrices were already proofed during assembly-validation and Pre-commissioning. Hence, static testing is only performed in the local basis.

		Sensor Readouts (counts)					
		H1	H2	H3	V1	V2	V3
Drive (Counts)	H1	1761	1138	1136	10	16	-13
	H2	1069	1806	1133	2	13	-10
	H3	1093	1156	1861	7	19	-12
	V1	133	176	-339	1350	-46	-579
	V2	-400	184	185	-591	1348	-40
	V3	103	-355	173	-24	-579	1346

Table – Local Static Testing, December 19th 2012

Issues/difficulties/comments regarding this test:

- H1 response to H1 drive is very slightly below requirement.
- Some non-collocated horizontal sensors response are very slightly out of requirement.
- Transfer functions and Pre-commissioning tests show that this is not an issue for the IMC test.

Acceptance criteria:

- **Vertical axis**
For a +1000 count offset drive on vertical actuators
 - o Collocated sensors must be 1400 counts +/- 10%
- **Horizontal axis**
For a +1000 count offset drive on horizontal actuators
 - o Collocated sensors must be 2000 counts +/- 10%
 - o Non-collocated horizontal sensors must be 1250 counts +/-10%

Test result:

Passed: X Failed:

▪ **Step 14: Linearity Test**

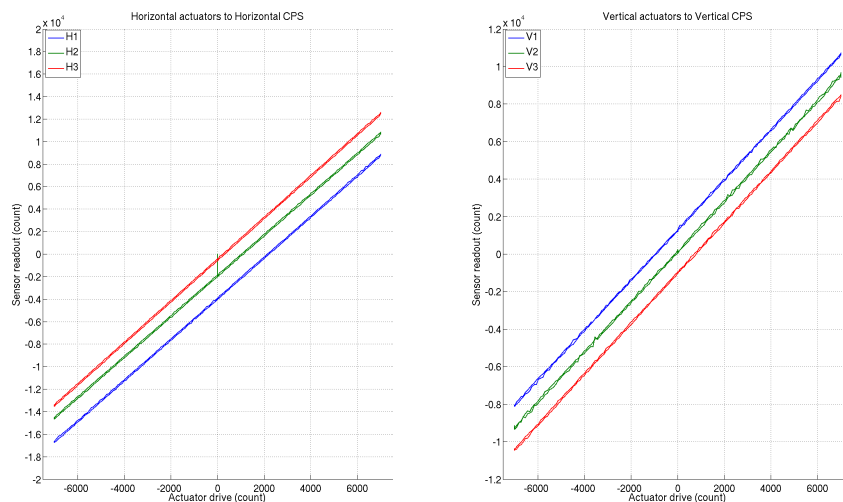


Table – Linearity test, December 17th 2012

	Slope	Offset	Average slope	Variation from average(%)
H1	1.82	-3939.89	1.83	-0.37
H2	1.81	-1903.29		-1.05
H3	1.85	-474.80		1.43
V1	1.34	1291.50	1.34	-0.39
V2	1.34	139.11		-0.16
V3	1.35	-993.25		0.55

Table – Linearity test, slopes and offsets

Issues/difficulties/comments regarding this test:

- *Linearity_Test_Awgstream_HAM_ISI_Updated_Data_Rate.m* is used instead of the regular script to account for the new data rate of the CPSs (1024, instead of 2048)

Scripts files for taking data in SVN at:

seismic/HAM-ISI/Common/Testing_Functions_HAM_ISI/

- *Linearity_Test_Awgstream_HAM_ISI_Updated_Data_Rate.m*

Data files in SVN at:

seismic/HAM-ISI/L1/HAM2/Data/Linearity_Test/

- *LHO_ISI_HAM2_Linearity_test_20121217.mat*

Figures in SVN at:

seismic/HAM-ISI/H1/HAM2/Data/Figures/Linearity_Test/

- *LHO_ISI_HAM2_Linearity_test_20121217.fig*

Acceptance criteria:

- Horizontal and vertical slopes of the triplet actuators x HAM-ISI x sensors = Average slope +/- 1.5%

Test result:

Passed: X **Failed:**

- ***Step 15: Local to Local Transfer Function Measurements***

All input/output filters, but *Symmetrization*, are ON. HEPI is locked. The chamber is closed with sheets on.

- ***Step 15.1: Local to local measurements***

Data files in SVN at:

seismic/HAM-ISI/H1/HAM2/Data/Transfer_Functions/Measurements/Undamped/

- LHO_ISI_HAM_Unit_2_Data_TF_L2L_200Hz_1000Hz_20121219-035007.mat
- LHO_ISI_HAM_Unit_2_Data_TF_L2L_5Hz_200Hz_20121219-050745.mat
- LHO_ISI_HAM_Unit_2_Data_TF_L2L_500mHz_5Hz_20121218-214032.mat
- LHO_ISI_HAM_Unit_2_Data_TF_L2L_100mHz_500mHz_20121219-064124.mat
- LHO_ISI_HAM_Unit_2_Data_TF_L2L_10mHz_100mHz_20121219-074303.mat

Data collection script files:

seismic/HAM-ISI/H1/HAM2/Scripts/Data_Collection/

- Run_Exc_Batch_H1_HAM2.m

Scripts files for processing and plotting in SVN at:

seismic/HAM-ISI/H1/HAM2/Scripts/Control_Scripts/Version_2/

- Step_1_TF_Loc_to_Loc_H1_ISI_HAM2.m

seismic/HAM-ISI/H1/HAM2/Data/Transfer_Functions/Simulations/Undamped/

- Measurements_List_H1_ISI_HAM2.m (Measurement # 10)

Figures in SVN at:

seismic/HAM-ISI/H1/HAM2/Data/Figures/Transfer_Functions/Measurements/Undamped/

- H1_ISI_HAM2_TF_L2L_Raw_from_ACT_to_CPS_2012_12_19.fig
- H1_ISI_HAM2_TF_L2L_Raw_from_ACT_to_GS13_2012_12_19.fig

Storage of measured transfer functions in the SVN at:

seismic/HAM-ISI/H1/HAM2/Data/Transfer_Functions/Simulations/Undamped/

- H1_ISI_HAM2_TF_L2L_Raw_2012_12_19.mat

The local to local transfer functions are presented below.

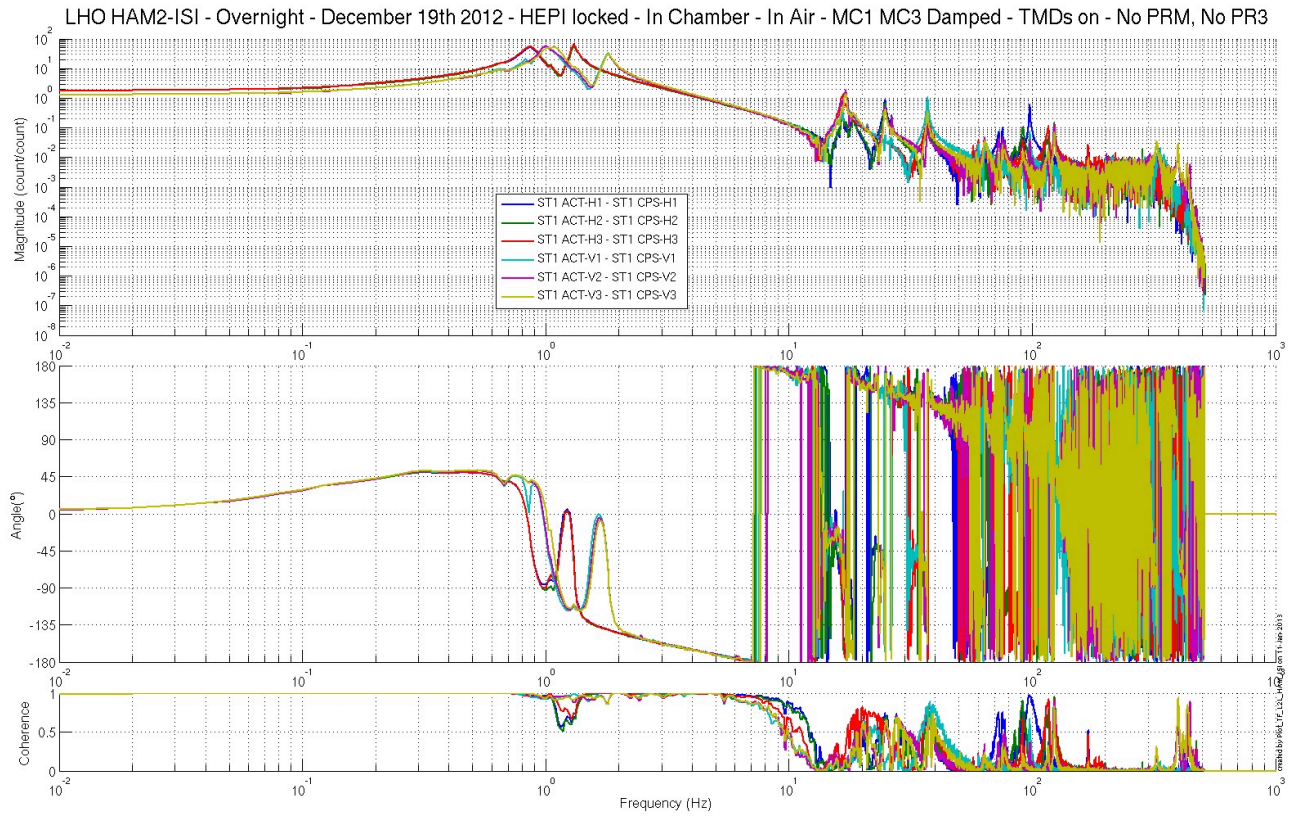
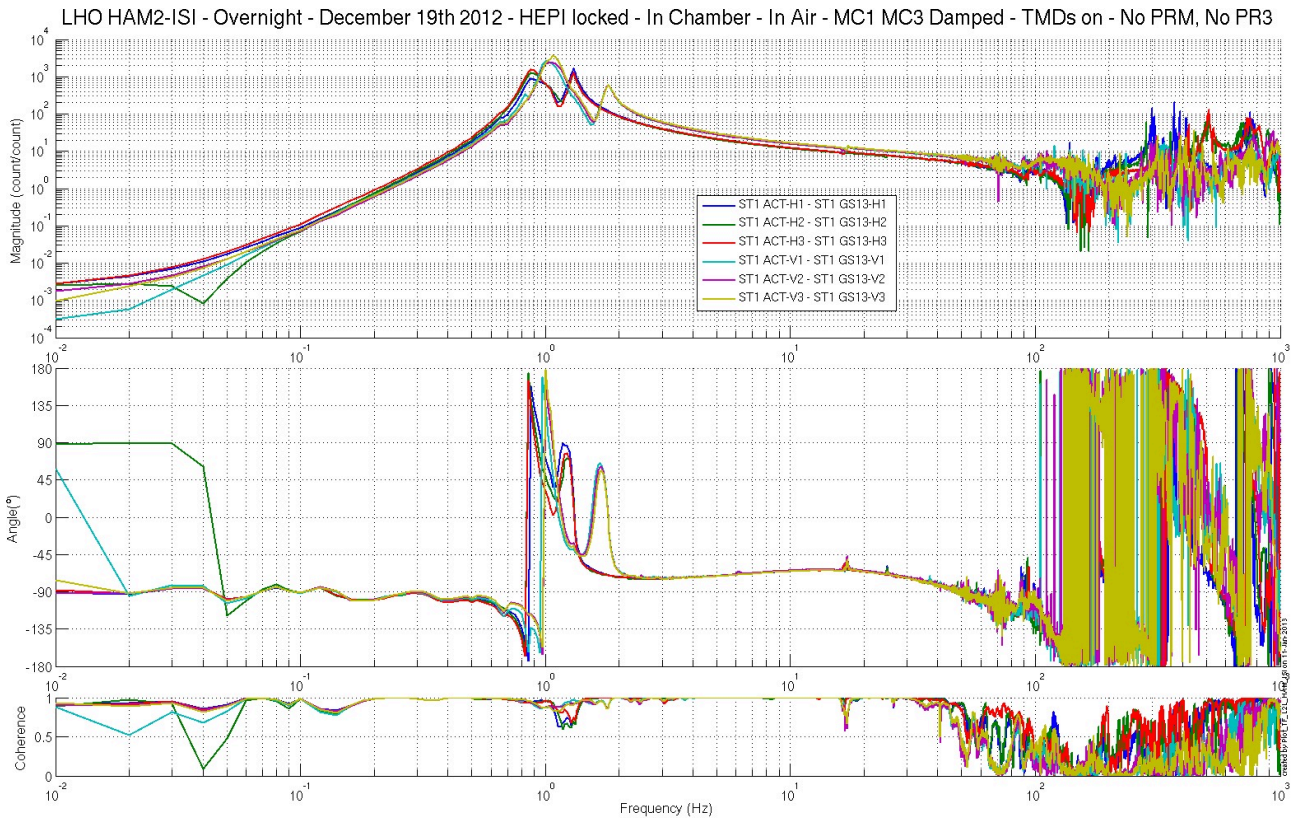


Figure – Local-to-Local Transfer Function – Capacitive Position Sensors



Figure– Local-to-Local Transfer Function – Inertial Sensors

- *Step 15.2: Local to local measurements V.S. LLO*

Data files in SVN at:**LHO:**

- seismic/HAM-ISI/H1/HAM2/Data/Transfer_Functions/Measurements/Undamped/
- LHO_ISI_HAM_Unit_2_Data_TF_L2L_200Hz_1000Hz_20121219-035007.mat
 - LHO_ISI_HAM_Unit_2_Data_TF_L2L_5Hz_200Hz_20121219-050745.mat
 - LHO_ISI_HAM_Unit_2_Data_TF_L2L_500mHz_5Hz_20121218-214032.mat
 - LHO_ISI_HAM_Unit_2_Data_TF_L2L_100mHz_500mHz_20121219-064124.mat
 - LHO_ISI_HAM_Unit_2_Data_TF_L2L_10mHz_100mHz_20121219-074303.mat

LLO:

- seismic/HAM-ISI/L1/HAM2/Data/Transfer_Functions/Simulations/Undamped/
- L1_ISI_HAM2_TF_L2L_Raw_2012_09_27.mat

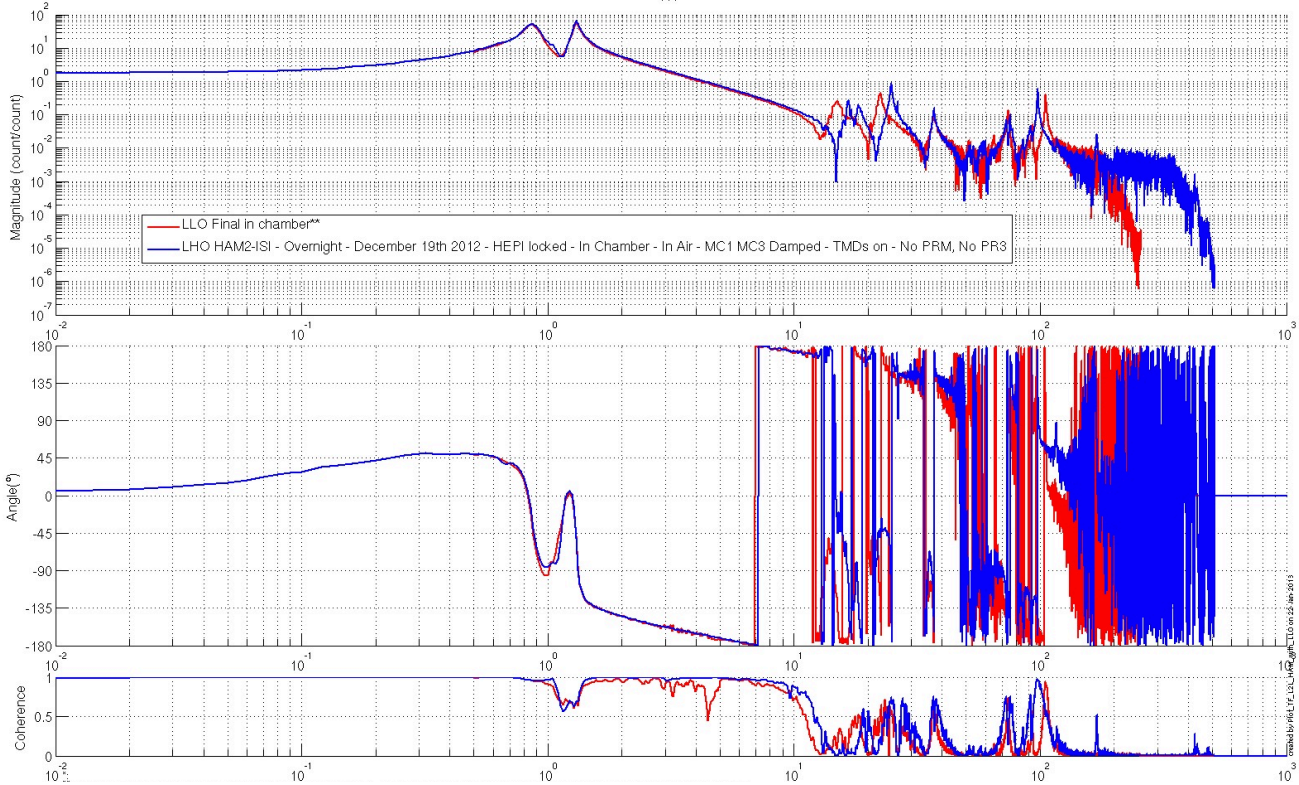
Scripts files for processing and plotting in SVN at:

- seismic/HAM-ISI/H1/HAM2/Scripts/Control_Scripts/Version_2/
- Step_1_TF_Loc_to_Loc_H1_ISI_HAM2.m
- seismic/HAM-ISI/H1/HAM2/Scripts/Control_Scripts/Version_2/New_Functions/
- Plot_TF_L2L_HAM_with_LLO.m

Figures in SVN at:

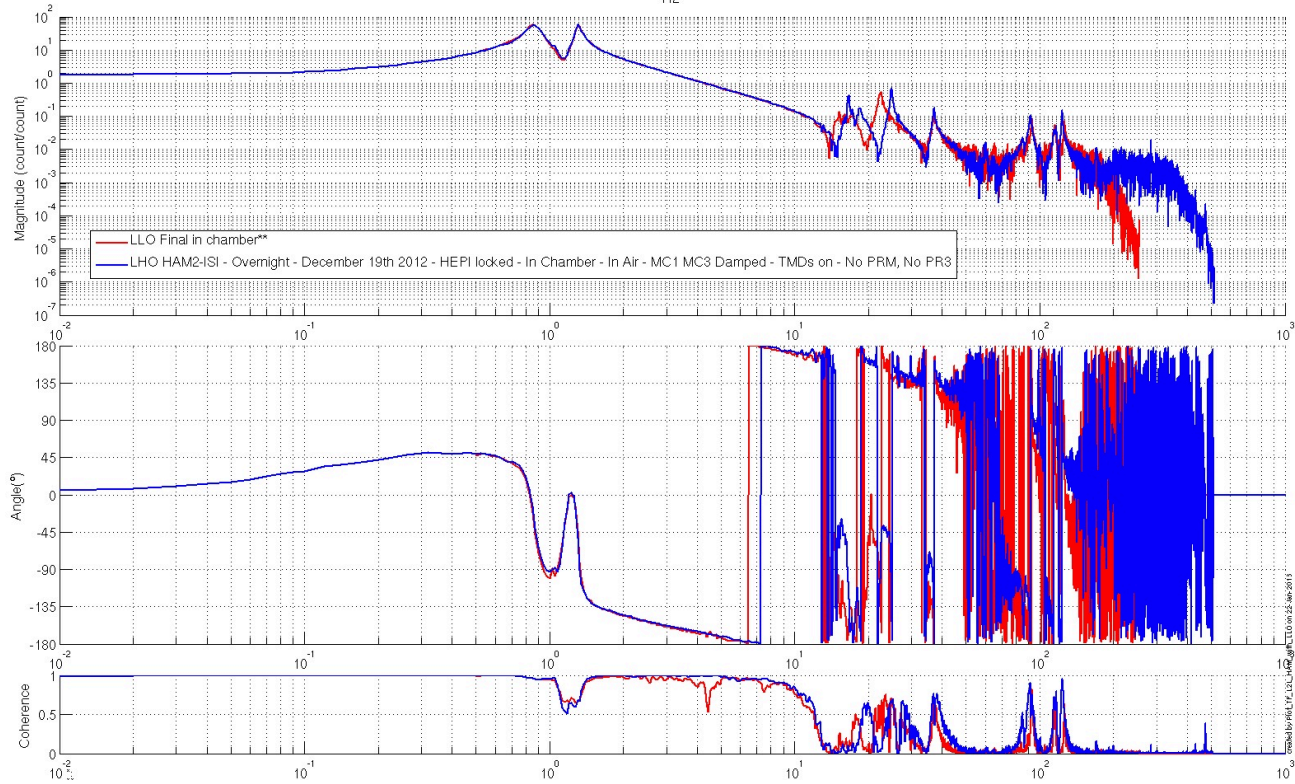
- seismic/HAM-ISI/H1/HAM3/Data/Figures/Transfer_Functions/Comparisons/L2L/
- H1_ISI_HAM2_TF_L2L_Raw_from_ACT_H1_to_CPS_H1_vs_LLO_2012_12_19.fig
 - H1_ISI_HAM2_TF_L2L_Raw_from_ACT_H1_to_GS13_H1_vs_LLO_2012_12_19.fig
 - H1_ISI_HAM2_TF_L2L_Raw_from_ACT_H2_to_CPS_H2_vs_LLO_2012_12_19.fig
 - H1_ISI_HAM2_TF_L2L_Raw_from_ACT_H2_to_GS13_H2_vs_LLO_2012_12_19.fig
 - H1_ISI_HAM2_TF_L2L_Raw_from_ACT_H3_to_CPS_H3_vs_LLO_2012_12_19.fig
 - H1_ISI_HAM2_TF_L2L_Raw_from_ACT_H3_to_GS13_H3_vs_LLO_2012_12_19.fig
 - H1_ISI_HAM2_TF_L2L_Raw_from_ACT_V1_to_CPS_V1_vs_LLO_2012_12_19.fig
 - H1_ISI_HAM2_TF_L2L_Raw_from_ACT_V1_to_GS13_V1_vs_LLO_2012_12_19.fig
 - H1_ISI_HAM2_TF_L2L_Raw_from_ACT_V2_to_CPS_V2_vs_LLO_2012_12_19.fig
 - H1_ISI_HAM2_TF_L2L_Raw_from_ACT_V2_to_GS13_V2_vs_LLO_2012_12_19.fig
 - H1_ISI_HAM2_TF_L2L_Raw_from_ACT_V3_to_CPS_V3_vs_LLO_2012_12_19.fig
 - H1_ISI_HAM2_TF_L2L_Raw_from_ACT_V3_to_GS13_V3_vs_LLO_2012_12_19.fig

LHO HAM2-ISI - Overnight - December 19th 2012 - HEPI locked - In Chamber - In Air - MC1 MC3 Damped - TMDs on - No PRM, No PR3
 CPS
 H1



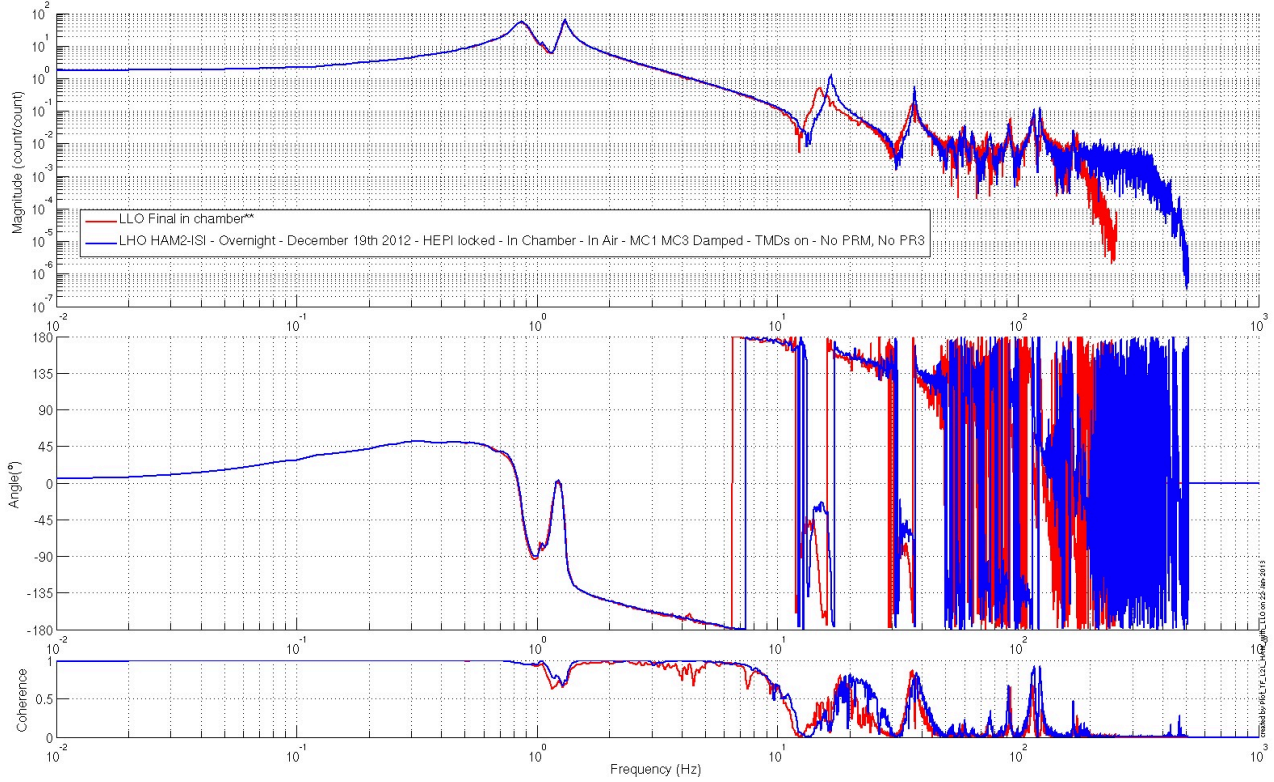
Figure– Local-to-Local Transfer Function – CPS H1 – Comparison with LLO

LHO HAM2-ISI - Overnight - December 19th 2012 - HEPI locked - In Chamber - In Air - MC1 MC3 Damped - TMDs on - No PRM, No PR3
 CPS
 H2



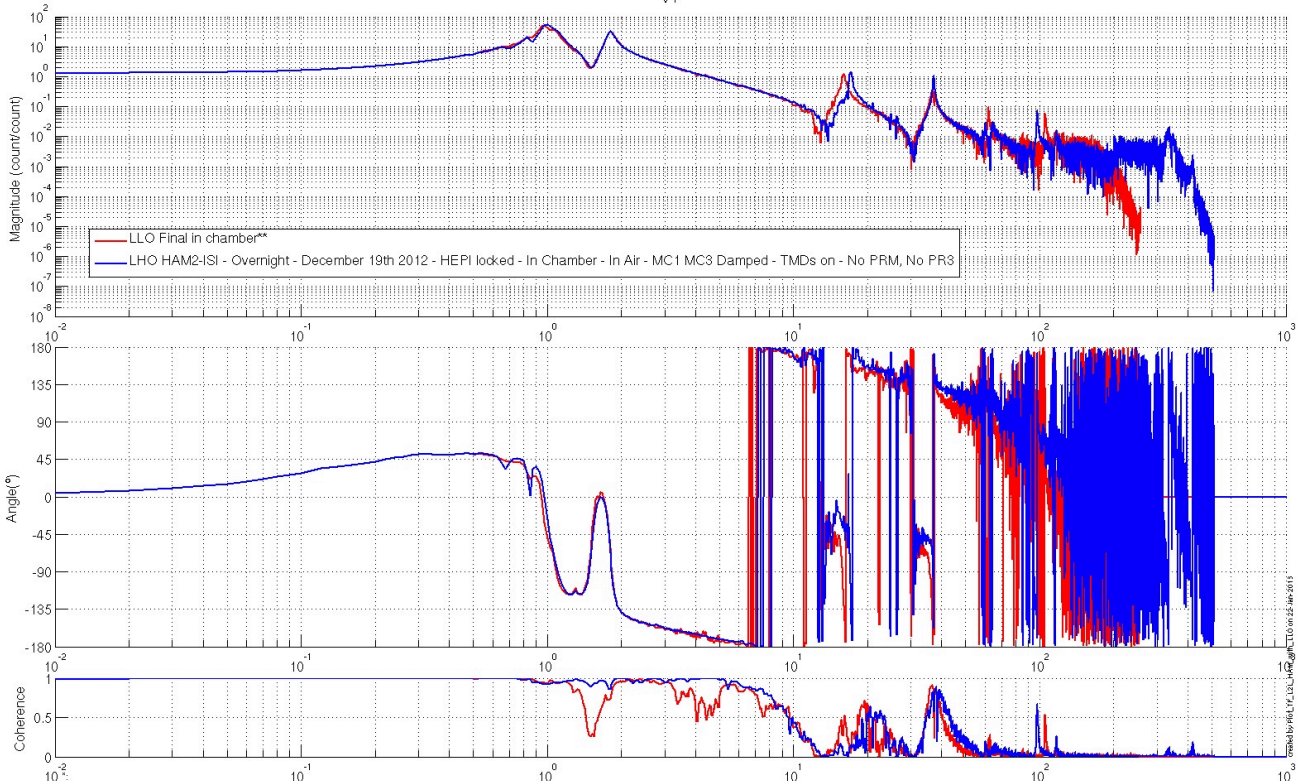
Figure– Local-to-Local Transfer Function – CPS H2 – Comparison with LLO

LHO HAM2-ISI - Overnight - December 19th 2012 - HEPI locked - In Chamber - In Air - MC1 MC3 Damped - TMDs on - No PRM, No PR3
 CPS
 H3



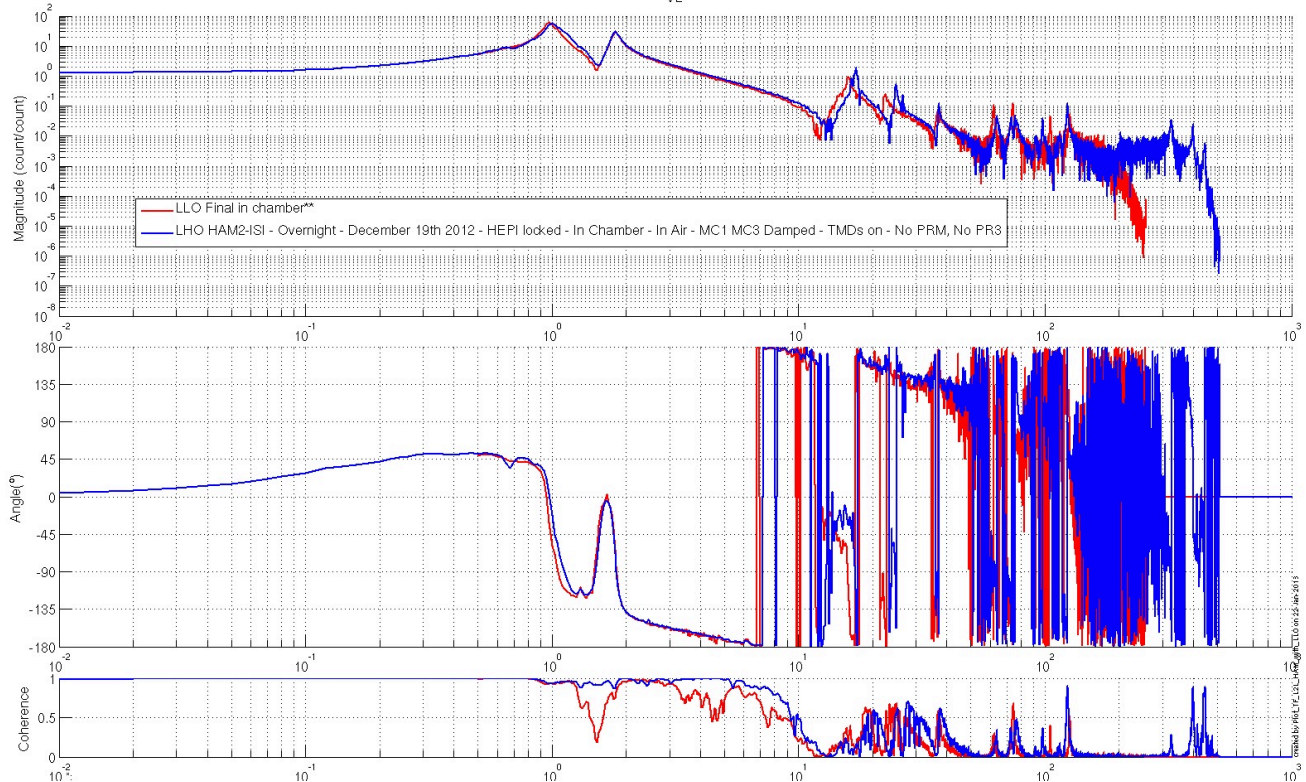
Figure– Local-to-Local Transfer Function – CPS H3 – Comparison with LLO

LHO HAM2-ISI - Overnight - December 19th 2012 - HEPI locked - In Chamber - In Air - MC1 MC3 Damped - TMDs on - No PRM, No PR3
 CPS
 V1



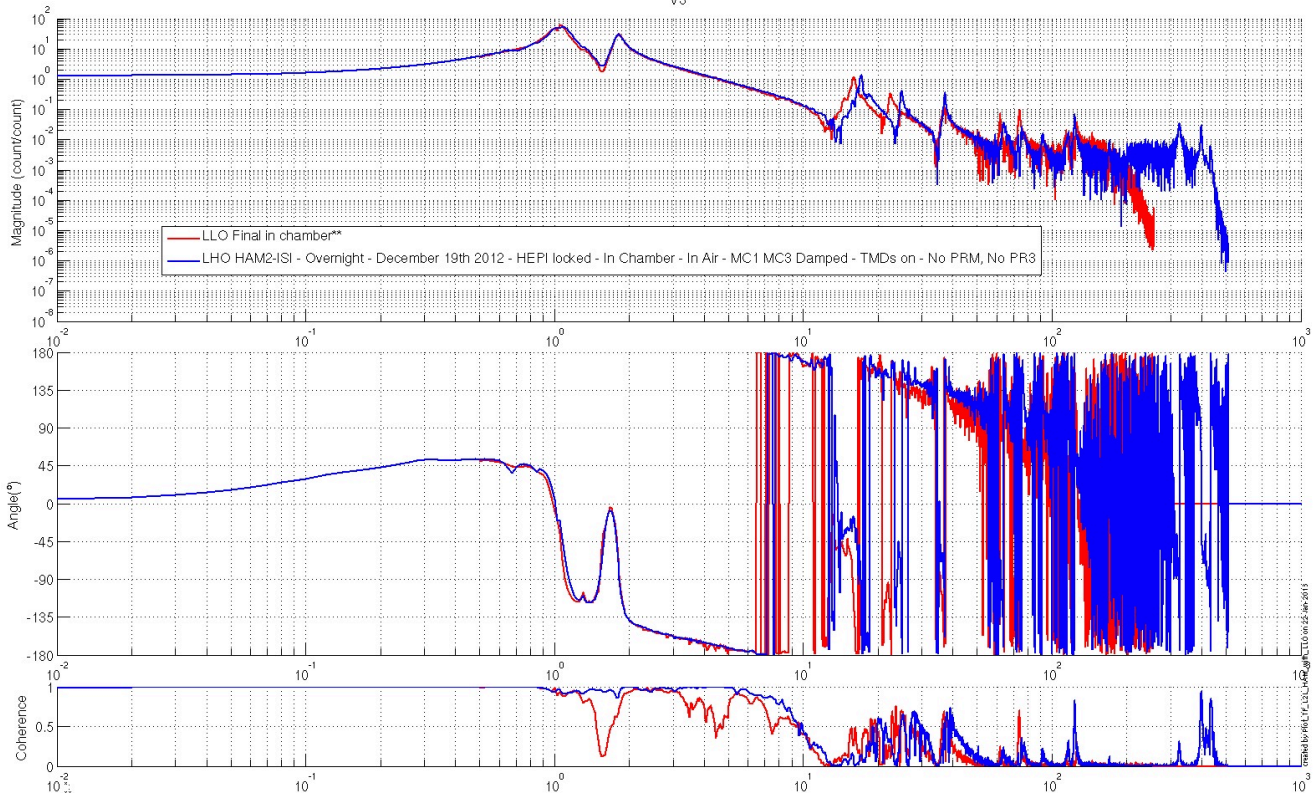
Figure– Local-to-Local Transfer Function – CPS V1 – Comparison with LLO

LHO HAM2-ISI - Overnight - December 19th 2012 - HEPI locked - In Chamber - In Air - MC1 MC3 Damped - TMDs on - No PRM, No PR3
CPS
V2



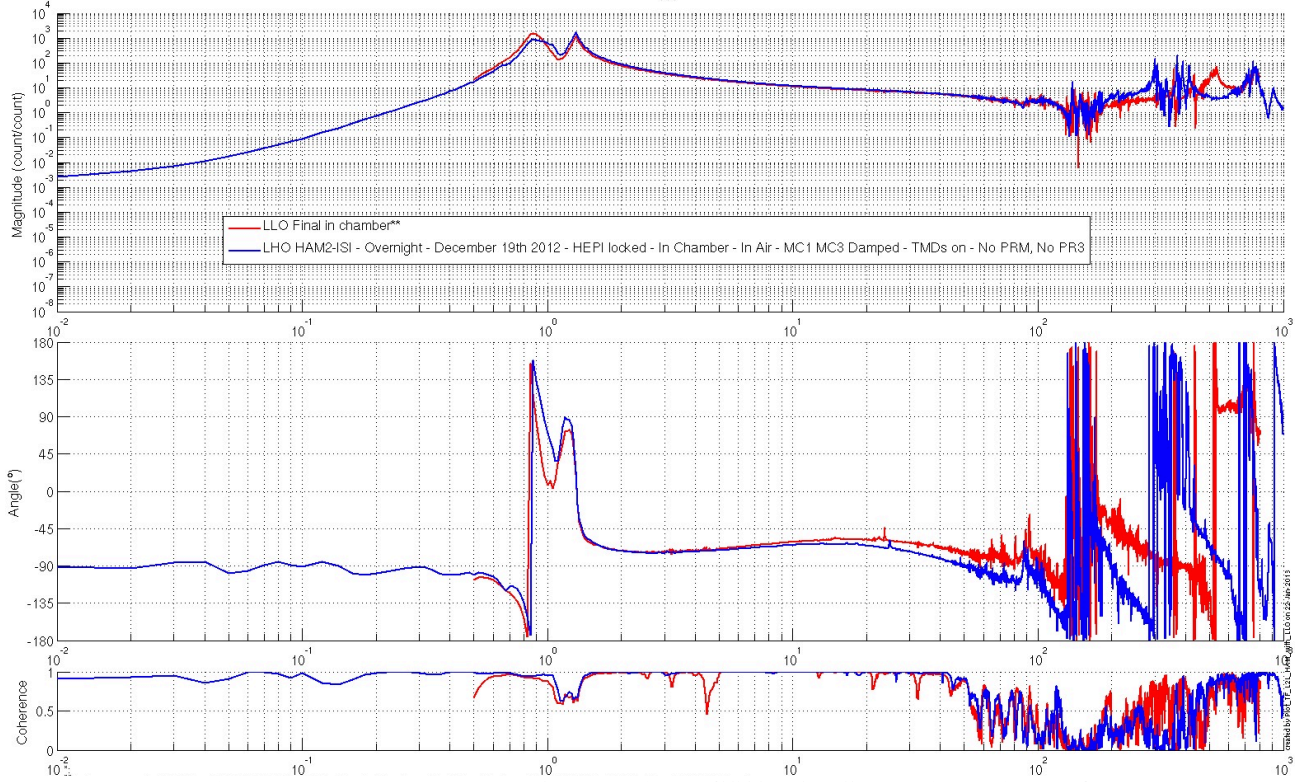
Figure– Local-to-Local Transfer Function – CPS V2 – Comparison with LLO

LHO HAM2-ISI - Overnight - December 19th 2012 - HEPI locked - In Chamber - In Air - MC1 MC3 Damped - TMDs on - No PRM, No PR3
CPS
V3



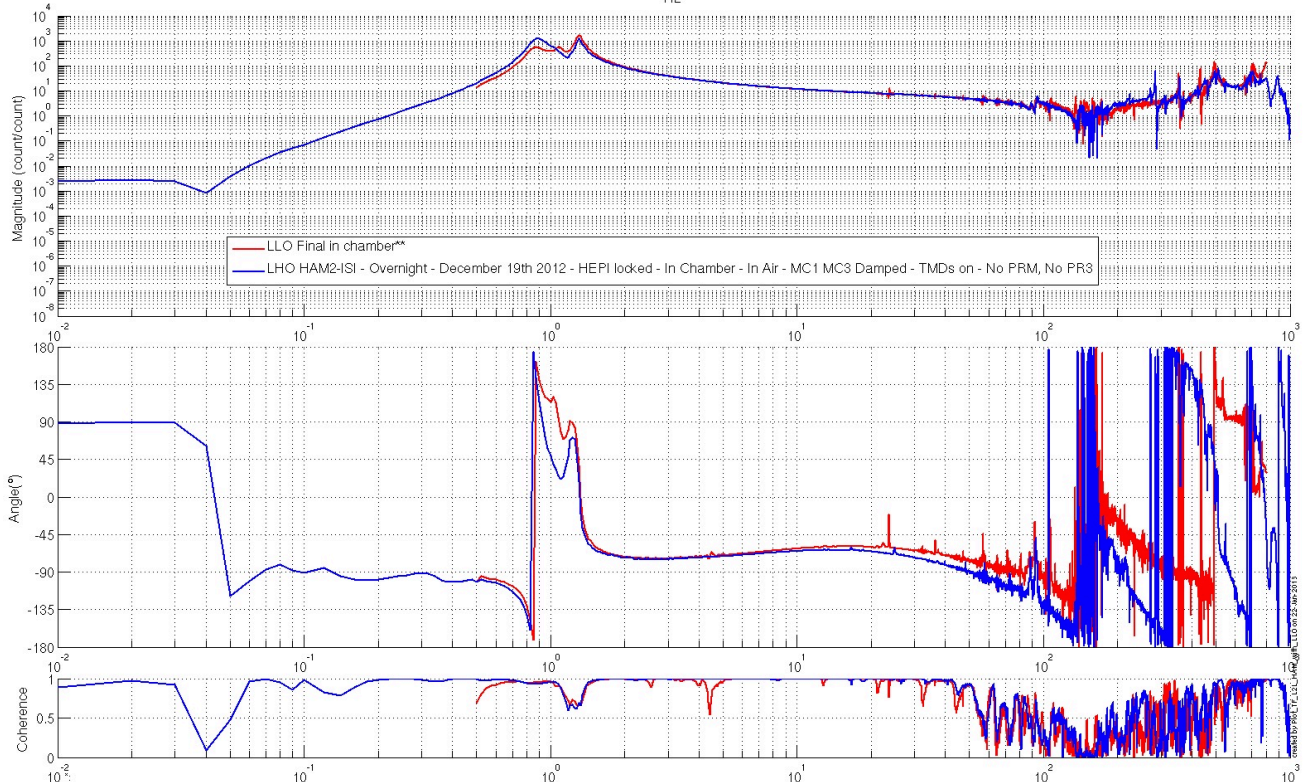
Figure– Local-to-Local Transfer Function – CPS V3 – Comparison with LLO

LHO HAM2-ISI - Overnight - December 19th 2012 - HEPI locked - In Chamber - In Air - MC1 MC3 Damped - TMDs on - No PRM, No PR3
 GS13
 H1



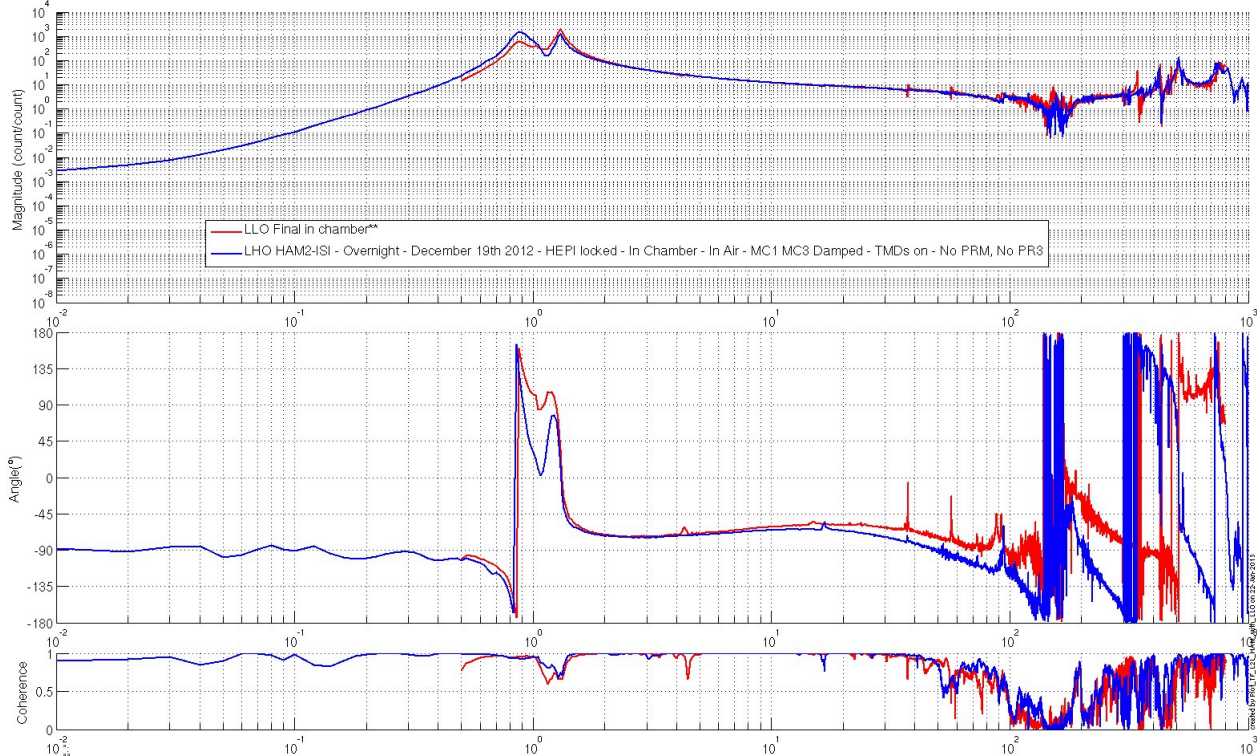
Figure– Local-to-Local Transfer Function – GS13 H1 – Comparison with LLO

LHO HAM2-ISI - Overnight - December 19th 2012 - HEPI locked - In Chamber - In Air - MC1 MC3 Damped - TMDs on - No PRM, No PR3
 GS13
 H2



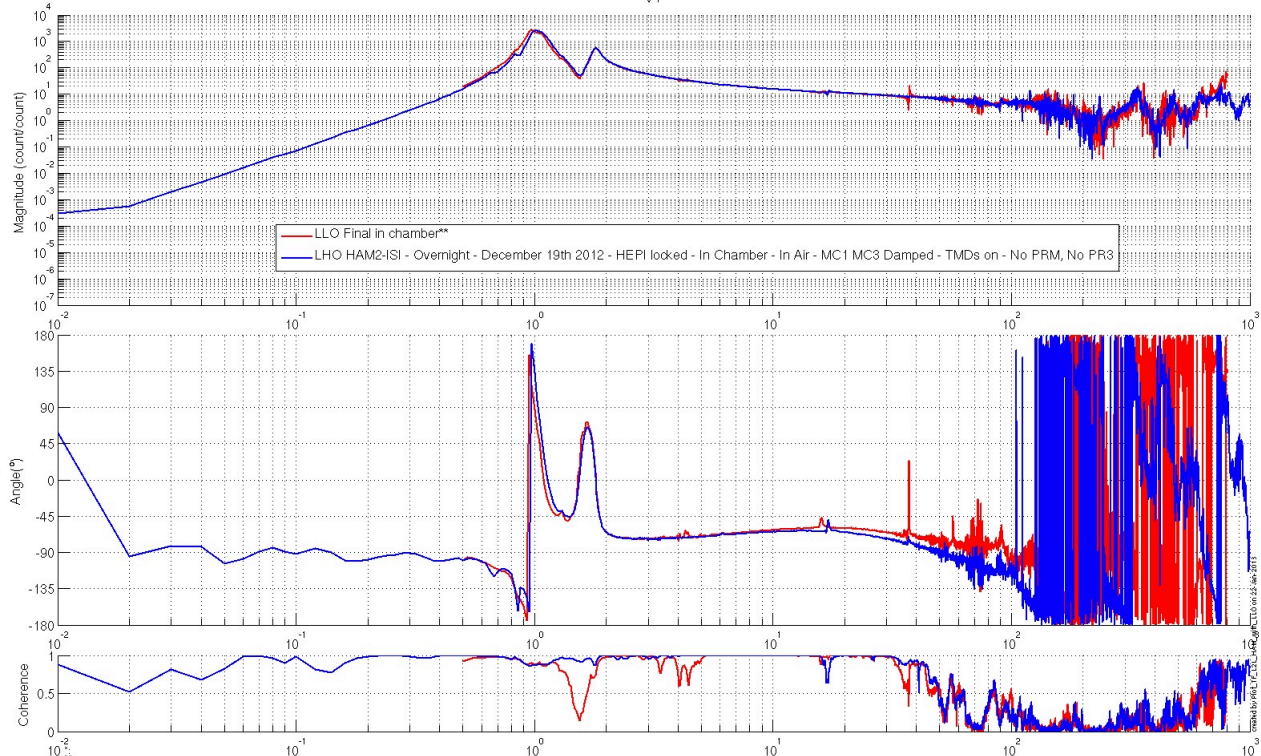
Figure– Local-to-Local Transfer Function – GS13 H2 – Comparison with LLO

LHO HAM2-ISI - Overnight - December 19th 2012 - HEPI locked - In Chamber - In Air - MC1 MC3 Damped - TMDs on - No PRM, No PR3
 GS13
 H3



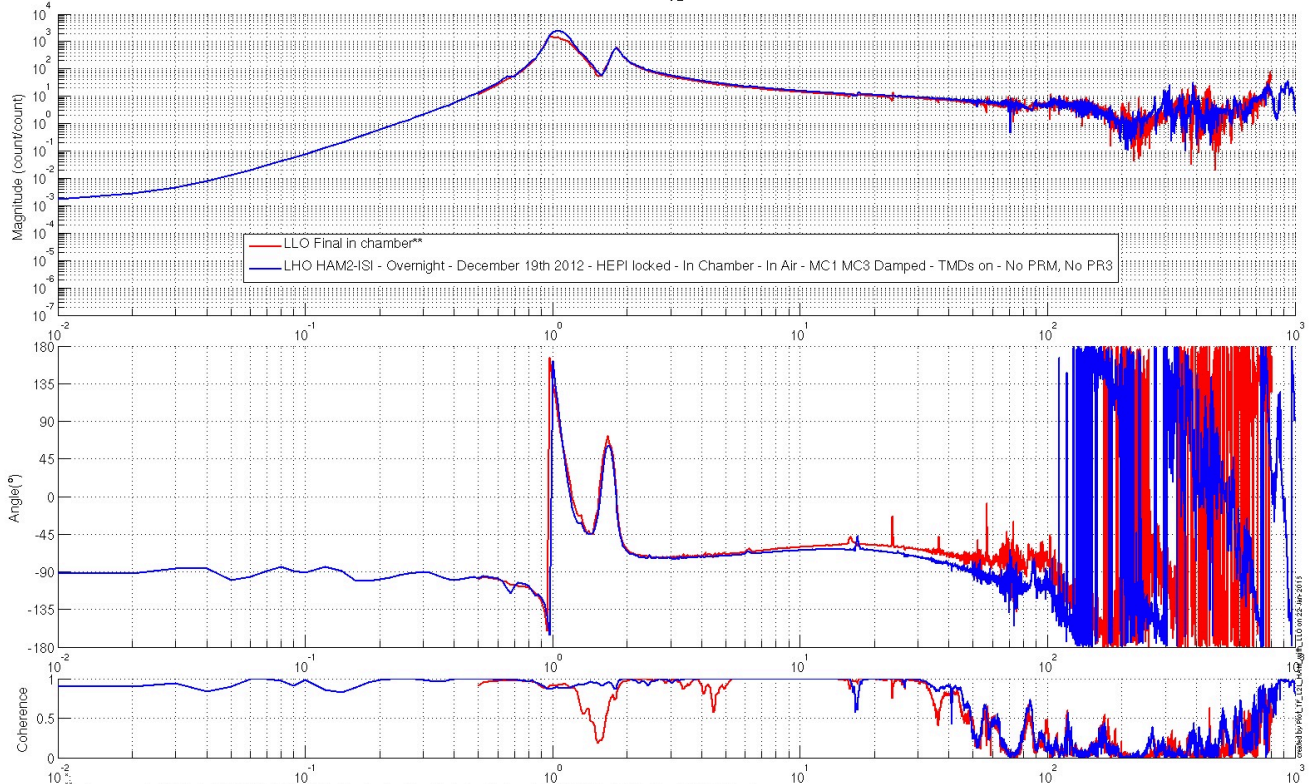
Figure– Local-to-Local Transfer Function – GS13 H3 – Comparison with LLO

LHO HAM2-ISI - Overnight - December 19th 2012 - HEPI locked - In Chamber - In Air - MC1 MC3 Damped - TMDs on - No PRM, No PR3
 GS13
 V1



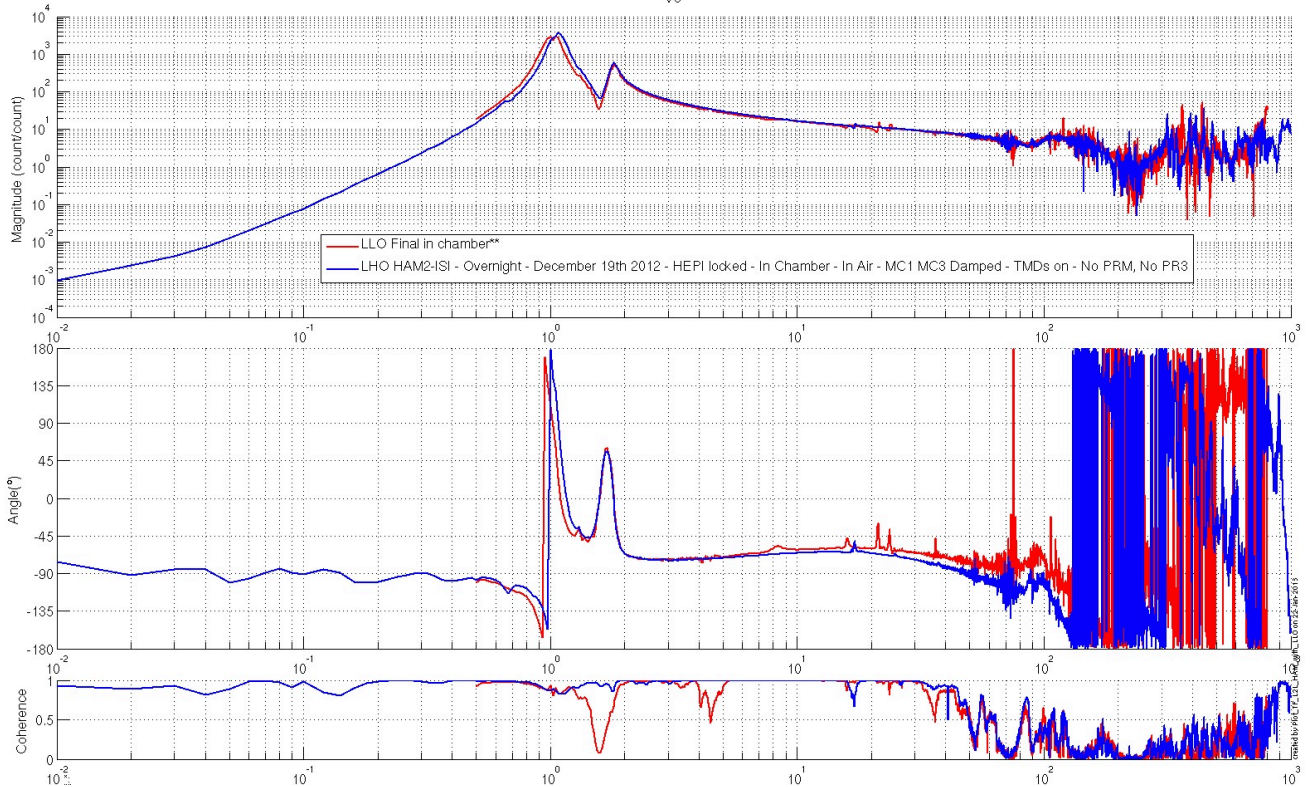
Figure– Local-to-Local Transfer Function – GS13 V1 – Comparison with LLO

LHO HAM2-ISI - Overnight - December 19th 2012 - HEPI locked - In Chamber - In Air - MC1 MC3 Damped - TMDs on - No PRM, No PR3
 GS13
 V2



Figure– Local-to-Local Transfer Function – GS13 V2 – Comparison with LLO

LHO HAM2-ISI - Overnight - December 19th 2012 - HEPI locked - In Chamber - In Air - MC1 MC3 Damped - TMDs on - No PRM, No PR3
 GS13
 V3



Figure– Local-to-Local Transfer Function – GS13 V3 – Comparison with LLO

Issues/difficulties/comments regarding this test:

- Transfer functions corresponding to the same phase of testing could not be found for LLO HAM2-ISI.
- The transfer functions used as reference were measured at LLO on December 18th. It is likely that HEPI was then unlocked.

Acceptance criteria:

- Good concordance with TF measured under the same conditions at LLO.
- Local to local measurements
 - o On CPS, the phase must be 0° at DC
 - o On Geophones, the phase must be -90° at DC
 - o Identical shape in each corner
- Cartesian to Cartesian measurements
 - o On CPS, the phase must be 0° at DC
 - o On Geophones, the phase must be -90° at DC
 - o Identical shape X/Y and RX/RX

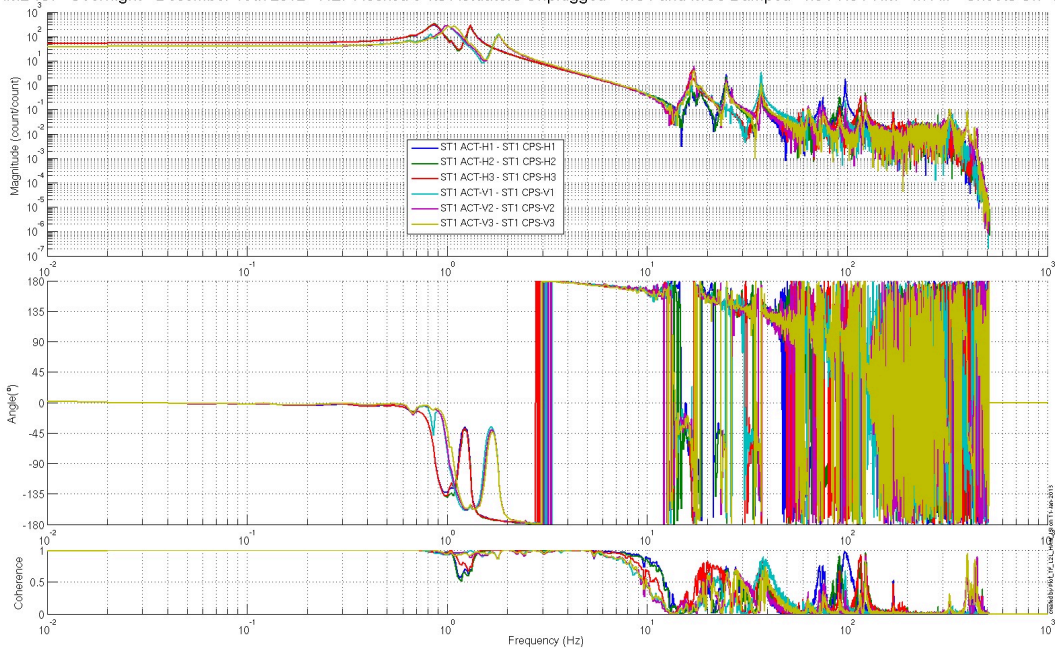
Test result:

Passed: X **Failed:**

▪ ***Step 16: Symmetrized Transfer functions***

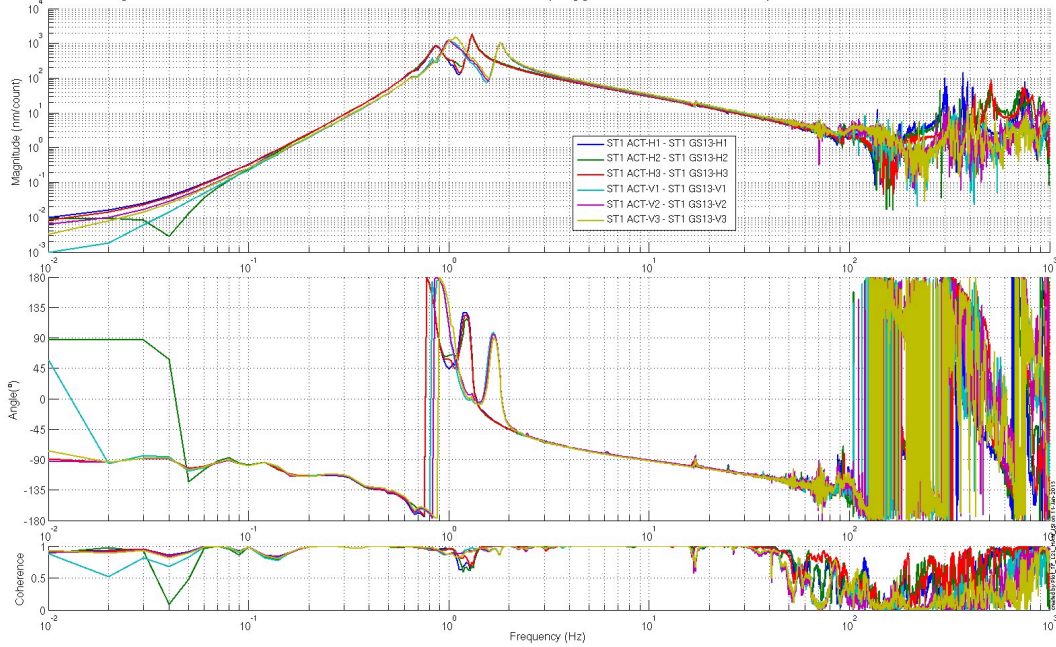
The following symmetrized transfer functions were calculated from the Local-to-Local transfer functions presented above, in step 15. They are provided as extra material. Hence, they are not subject to acceptance (fail/pass).

LHO HAM2-ISI - Overnight - December 19th 2012 - HEPI locked & its Actuators Unplugged - MC1 and MC3 Damped - no PR3 PRM - In Air - Sheets On - Symmetrized



Figure– Local-to-Local Transfer Function – Capacitive Position Sensors – Symmetrized

LHO HAM2-ISI - Overnight - December 19th 2012 - HEPI locked & its Actuators Unplugged - MC1 and MC3 Damped - no PR3 PRM - In Air - Sheets On - Symmetrized

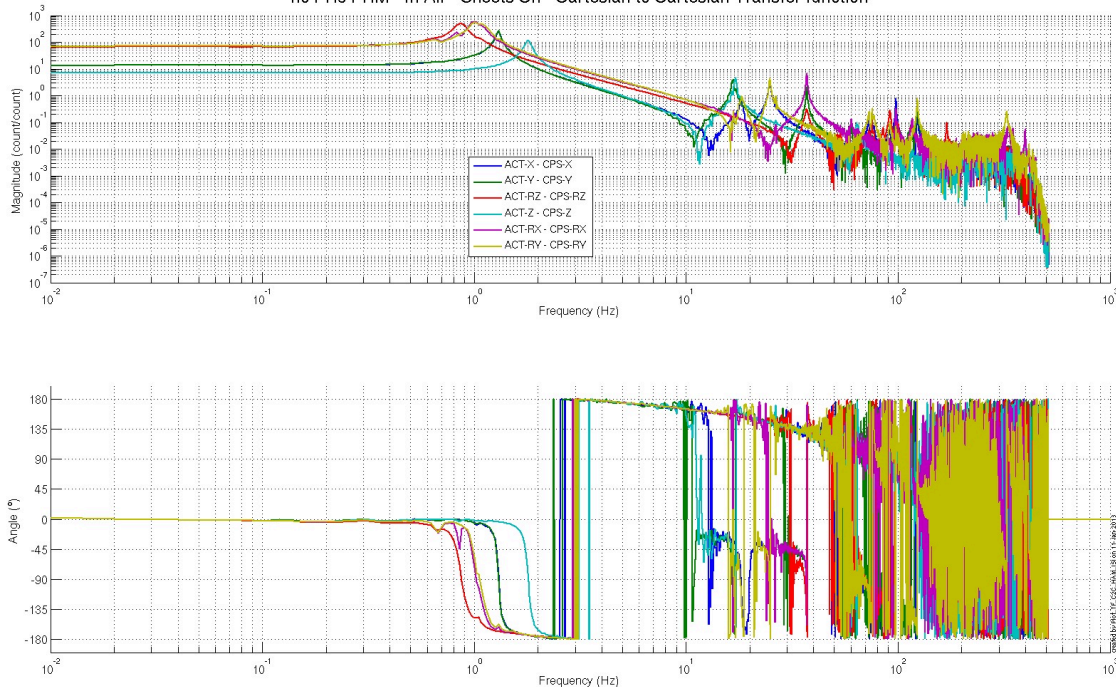


Figure– Local-to-Local Transfer Function – GS13s – Symmetrized

▪ **Step 17: Cartesian-to-Cartesian Transfer functions.**

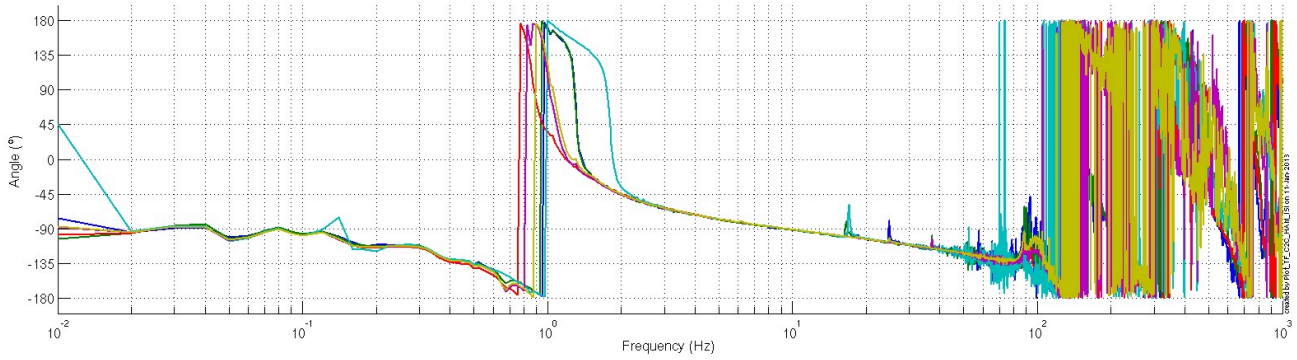
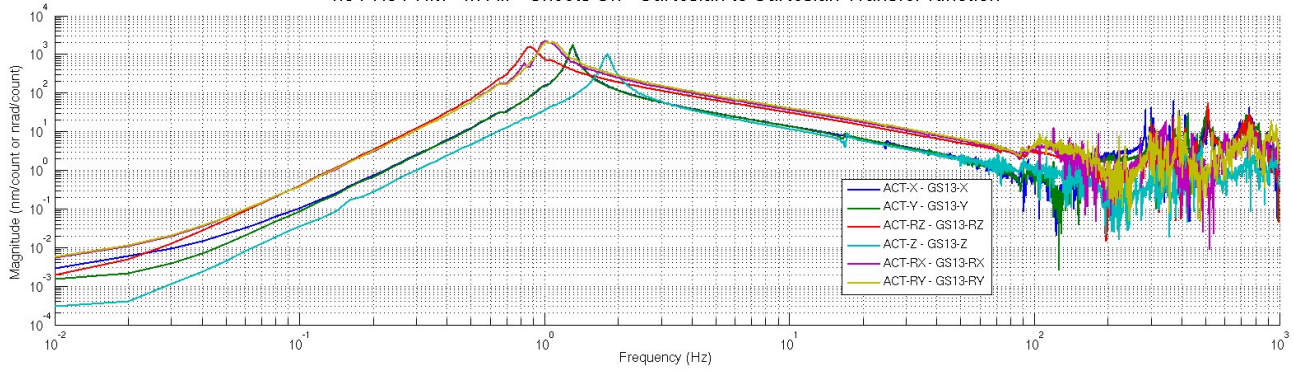
The following Cartesian-to-Cartesian symmetrized transfer functions were calculated from the Local-to-Local transfer functions presented above, in step 15. They are provided as extra material. Hence, they are not subject to acceptance (fail/pass).

LHO HAM2-ISI - Overnight - December 19th 2012 - HEPI locked & its Actuators Unplugged - MC1 and MC3 Damped
no PR3 PRM - In Air - Sheets On - Cartesian to Cartesian Transfer function



Figure– Cartesian-to-Cartesian Transfer Function – CPSs – Symmetrized

LHO HAM2-ISI - Overnight - December 19th 2012 - HEPI locked & its Actuators Unplugged - MC1 and MC3 Damped
no PR3 PRM - In Air - Sheets On - Cartesian to Cartesian Transfer function



Figure– Cartesian-to-Cartesian Transfer Function – GS13s – Symmetrized

Conclusion

Final Chamber Testing

This part of the Phase II testing took place in open chamber, with sheets on. All the suspensions, and optics, needed for the IMC test were on. PRM and PR3 will be installed after the IMC test.

At this time, HEPI pipes are not flushed yet. Hence, HEPI is locked.

This was the last phase of testing before the chamber was closed for the IMC test.

The chamber was closed on Dec 20th, after SEI approval of the latest set of transfer functions (12/19/2013)

Waved Tests:

- Step 6 – Tilted Spectra: Locked/Unlocked spectra look fine and this test was already validated during the *Initial In-Chamber Testing section (step 9)*
- Step 10 - The profile of the blade of corner 2 could not be measured. Pre-commissioning tests and transfer function indicate that it will not be an issue for the IMC test.
- LZMP: It is a lengthy measurement that needs tweaking before being run with suspensions on. Indeed, suspensions trip when the test is run.

Particularities to be kept in mind:

- **CPS gaps need to be reset after IMC test.**