LIGO Laboratory / LIGO Scientific Collaboration

LIGO- E1200107 *LIGO* September 19th, 2012

aLIGO HAM-ISI, Installation Test Report, Phase II, LLO HAM 6

E1200107-V1

Céline Ramet, Michael Vargas

Distribution of this document:
Advanced LIGO Project

This is an internal working note
of the LIGO Laboratory

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

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

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

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

Table of contents:

Introduction

This document presents the tests performed to characterize and validate the modifications made to the eLIGO HAM-ISI, previously installed in HAM 6 at LIGO Livingston. This unit was removed from the vacuum system in November 2010, kept in a shipping container with weekly dry Nitrogen purge until June 2012.

This was the 4th unit pulled out from storage for installation at Livingston, to be installed in HAM 6 chamber. All seismometers, Capacitive Positions Sensors, and in-vacuum cables were swapped for aLIGO ones. Also, the Capacitive Position Sensors cables were shielded.

There are 4 distinctive parts:

- Part I: side chamber testing results
- Part II: post insertion testing results
- Part III: Transfer functions taken during optics installation
  - 3.1 transfer functions after first triple install
  - 3.xx ....
- Part IV: Tests in final configuration

I. SIDE CHAMBER TESTING

Side chamber testing was conducted in the LLO LVEA with actual electronics and field cables from June 22nd until July 3rd 2012. Temporary extensions to those cables were used to reach the test stand located further away from the electronics than the HAM chamber is.
Steps 1 and 2 capture data from testing done previously, whereas all the following steps were done (or waived) during that side-chamber testing period.

- ***Step 1: GS13***

All the data related to GS-13 post podding testing can be found in the SVN at :
SeismicSVN\seismic\Common\Data\aLIGO_GS13_TestData\

E1000058 spreadsheet provides the status of each individual GS-13 at LLO site during aLIGO HAM assembly

Data files in SVN at:
seismic/Common/Data/aLIGO_GS13_TestData/PostMod_TestResults_RawASCII

Scripts files for processing and plotting in SVN at:
seismic/Common/MatlabTools
- gs13qatest.m

Figures in SVN at:
seismic/Common/Data/aLIGO_GS13_TestData/PostMod_TestResults_PDFs

- ***Step 1.1 – Horizontal GS-13s***

Huddle testing

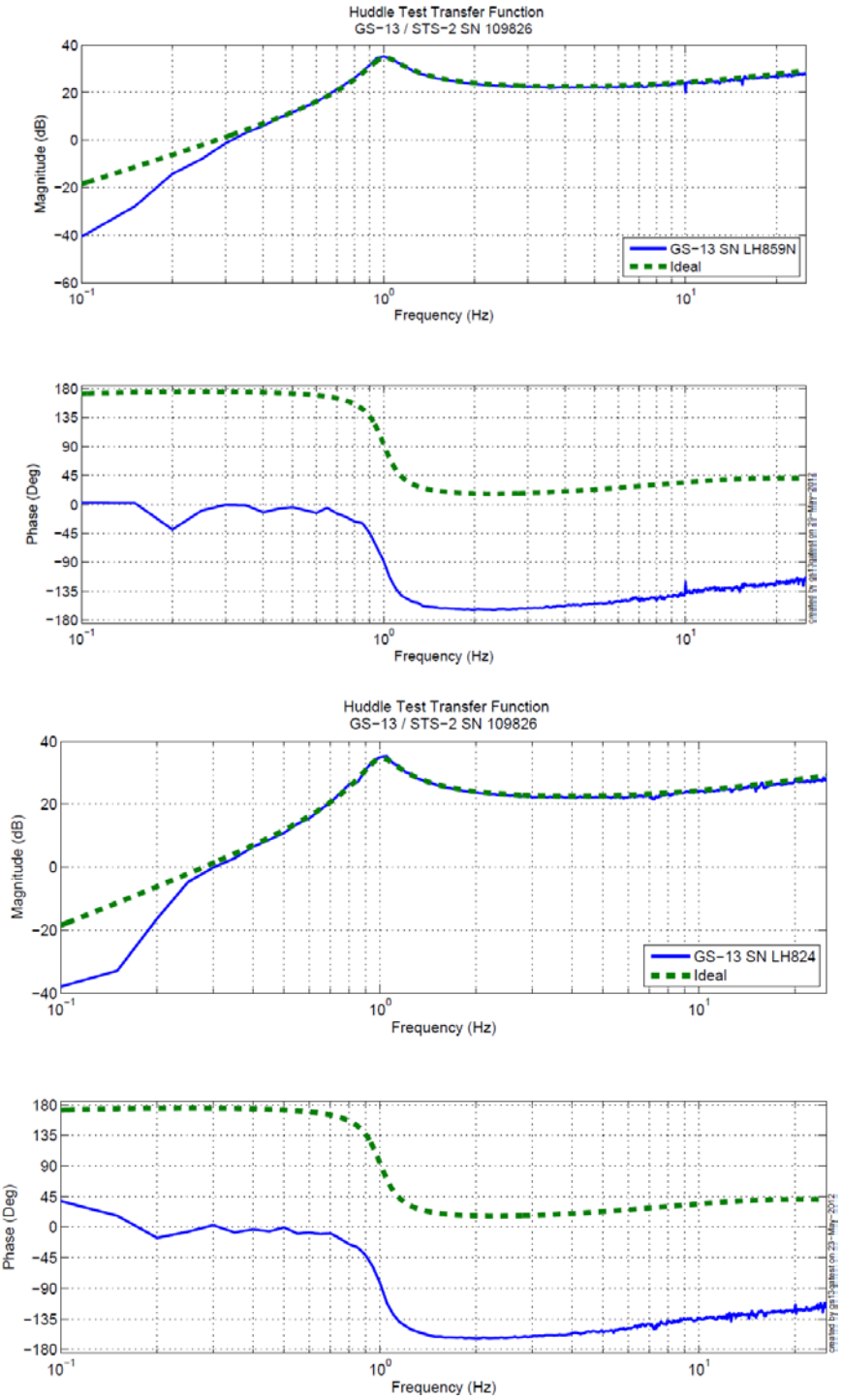
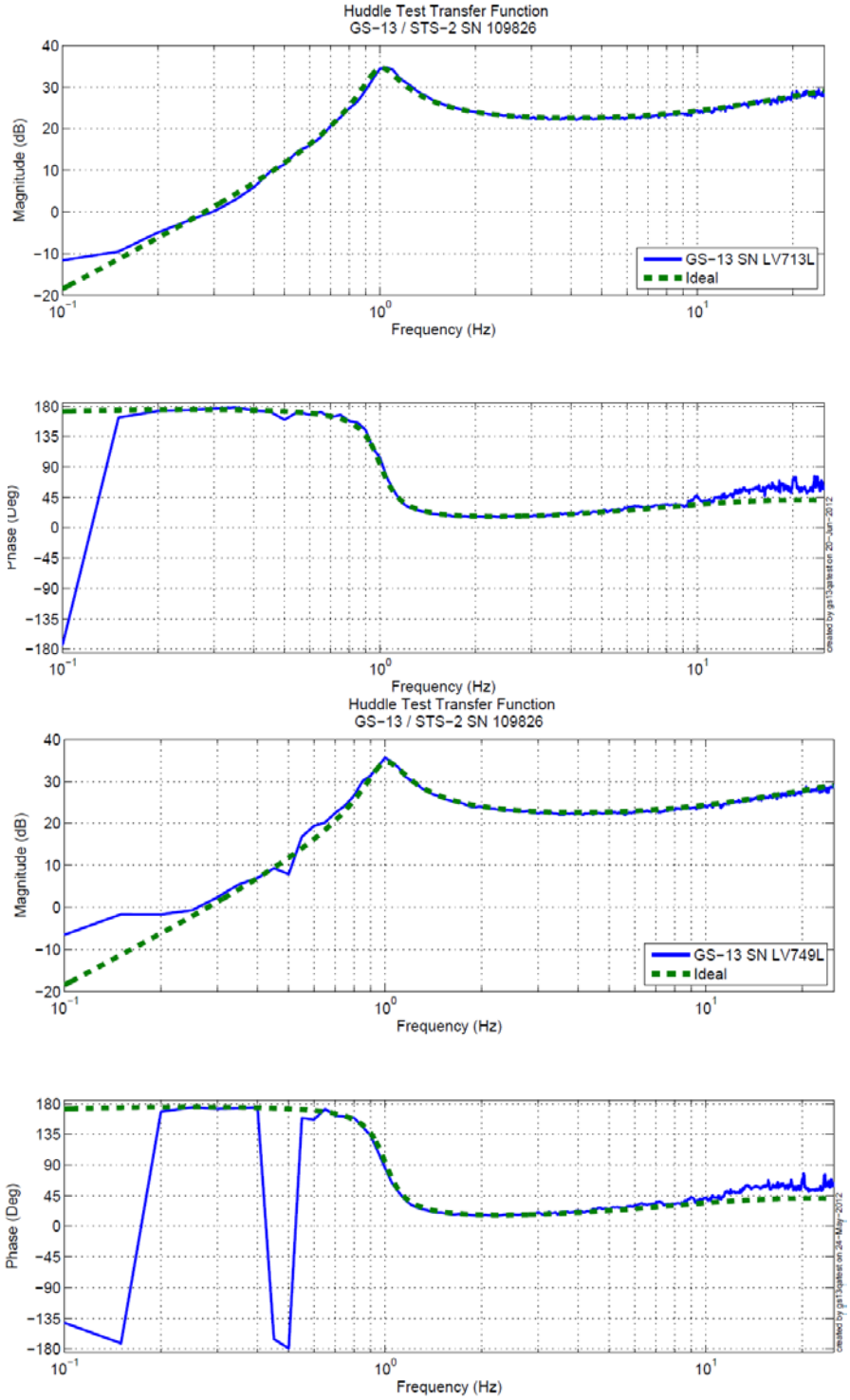


Figure - Huddle testing of Horiz GS-13 859, 824, and ??? after complete aLIGO modifications

- ***Step 1.2 – Vertical GS-13s***

Huddle testing



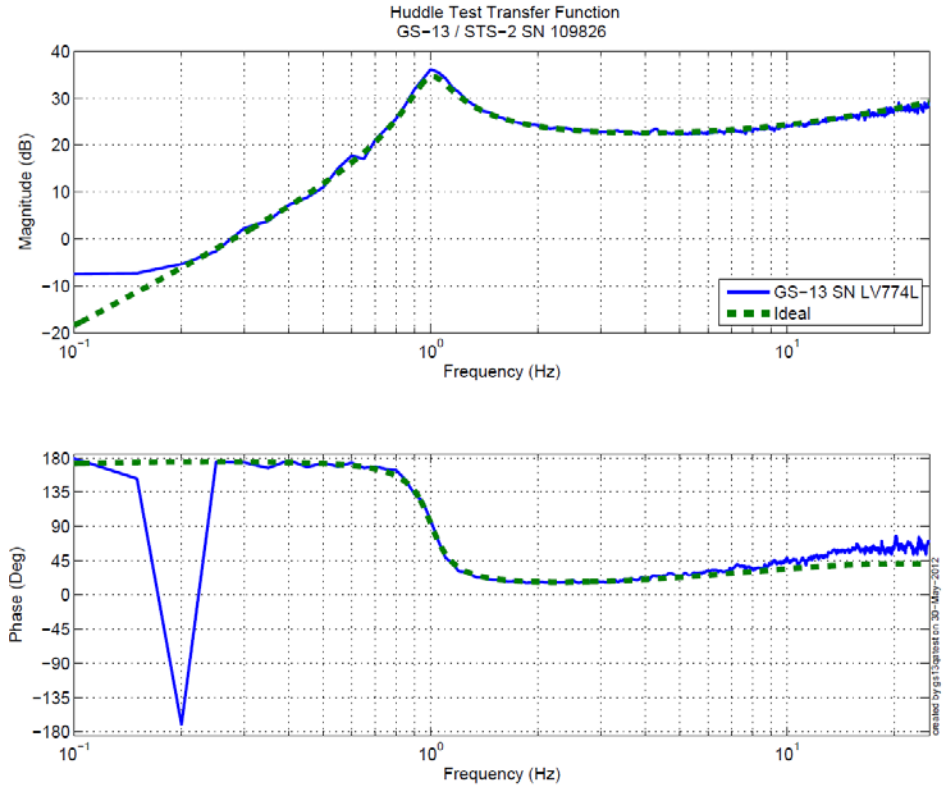
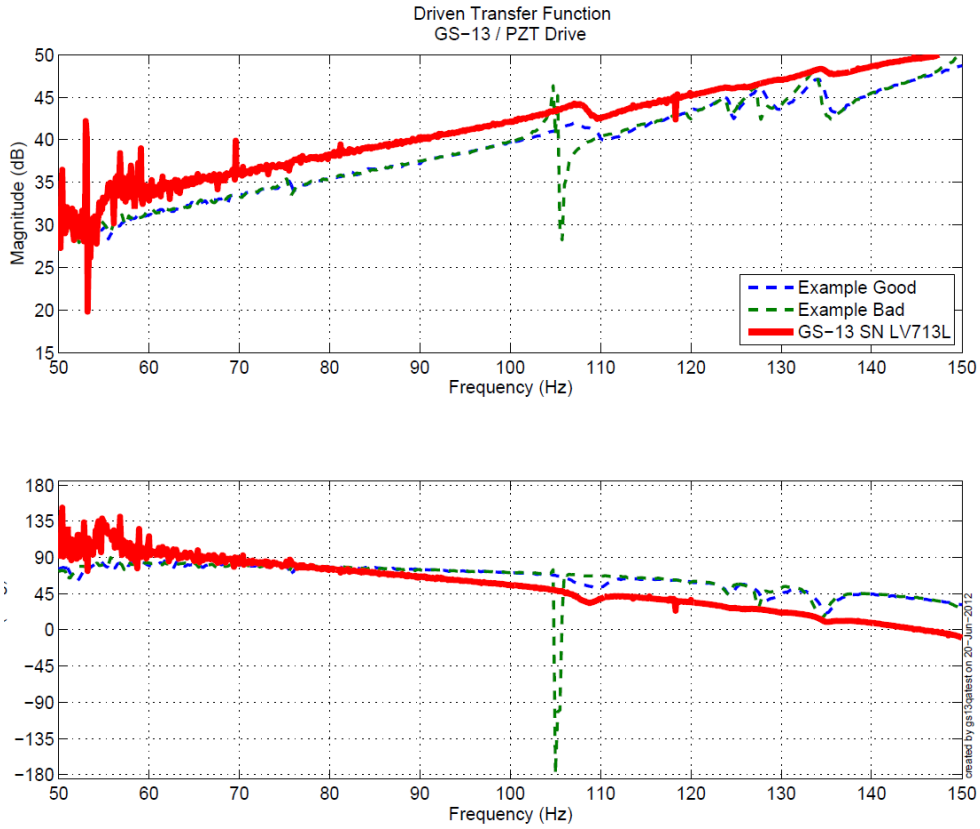


Figure - Huddle testing of Vert GS-13 679,683 and 699 after aLIGO modifications

Driven testing



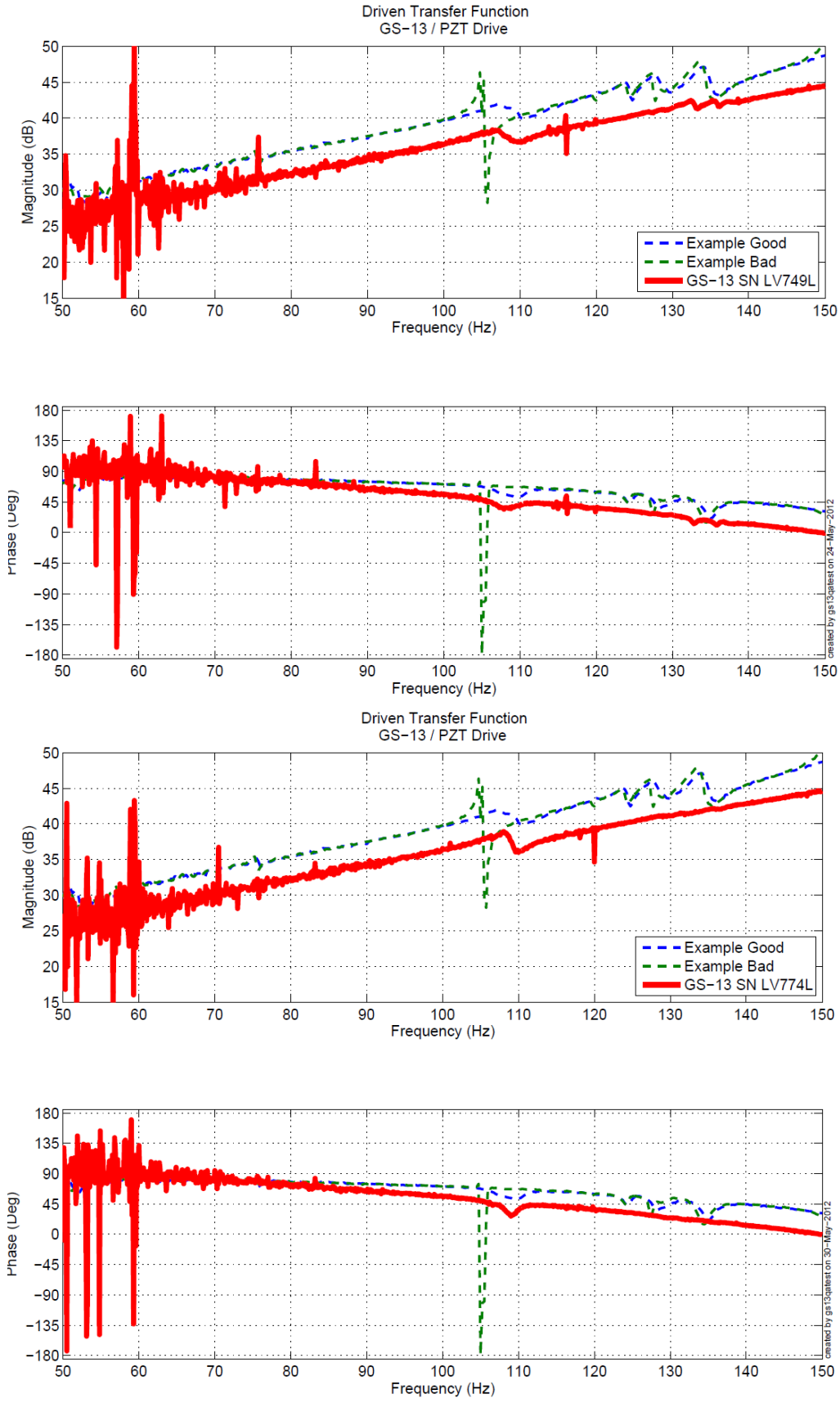


Figure - Driven Transfer Function of Vert GS-13 679,683 and 699 after aLIGO modifications

Issues/difficulties/comments regarding this test:
Not all GS-13s have exactly the same resonant frequency (cf huddle test results). This parameter was adjusted as well as manageable after modifications of the instruments. Instruments were passed as long as their resonant frequencies were within 0.95 and 1.2 Hz.

Some instruments appear out of phase compared to the model. This only means the instrument was placed at 180 deg compared to the expected position when the model was created . This was ignored in order to approve the instrument for use.

Acceptance Criteria

- All instruments match their expected response.

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

- ***Step 2: Inventory (E1000052)***

Data shown in red indicate changes made side-chamber, ** indicate parts older than 2009.

DCC/Vendor number	Part name	Configuration	S/N	S/N	S/N
D071001	Stage 0 base		**		
D071051	Stage 1 base		**		
D071050	Optical table		**		
D071002	Spring Post		**	**	**
D071100	Spring		**	**	**
D071102	Flexure		**	**	**
ADE	Position sensor	Horizontal	12044	11984	12072
		Vertical	12074	12065	12063
D047812	GS-13 pod	Horizontal	20	37	84
		Vertical	??	36	40
D047823	L4C pod	Horizontal	N/A	N/A	N/A
		Vertical	N/A	N/A	N/A
D0902749	Actuator	Horizontal	19**	09**	14**
		Vertical	20**	02**	10**

Acceptance Criteria

- Inventory is complete

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

- ***Step 3: Check level of Stage 1 Optical Table***

Due to past experience showing we had to adjust the shims both side chamber and in chamber we decided not to run this test.

Acceptance Criteria

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

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

- ***Step 4: Shim thickness***

Issues/difficulties/comments regarding this test: We adjusted shims under 2 lockers in order to improve the level of the table.

Lockers	Shim thickness (mil)
A	
B	
C	
D	

Table – Shims Thickness

Acceptance Criteria

- Inventory is complete

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

- ***Step 5: Blade spring profile***

Because we know we'll likely have to adjust the shims in chamber, we did not take this measurement.

Acceptance Criteria:

- Blades must be flat within 0.015" inches.

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

- ***Step 6: Gap checks on actuators-after installation on Stage 1***

Gaps were inspected on all vertical actuators and adjusted to be within requirements. No records were taken. Horizontal actuators will be inspected/adjusted in chambers.

Acceptance Criteria

- Gaps must be within 0.010" of design (i.e. 0.090" and .070" pass, but 0.095" and 0.065" doesn't).

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

- ***Step 7: Mass budget***

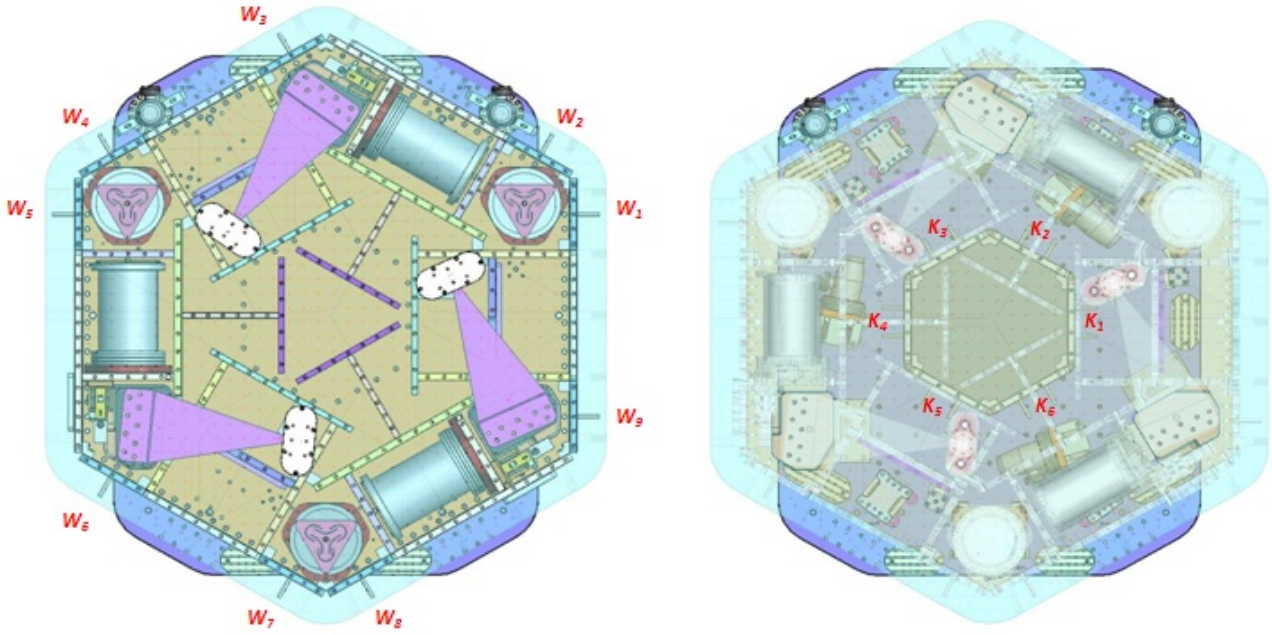


Figure – Keel Masses and Wall masses location

	0.1	00 0.6	01 1.1	02 2.2	03 4.5	04 7.9	05 15.6	06 27.2	lbs	kgs
w9	2			2			1	1	47.2	21.41
w1			1				1	1	43.9	19.91
w2	3				1		1	1	47.3	21.45
w3				1		0	1	1	45	20.41
w4			1	1	1		1	1	50.6	22.95
w5			1				1	1	43.9	19.91
w6	3		1				1	1	43.9	19.91
w7	4						1	1	42.8	19.41
w8							1	1	42.8	19.41
Side Masses Total	12	0	4	4	2	0	9	9	407.4	184.79

Table – Wall masses distribution

		00	01	02	03	04	05	06		
	0.1	0.6	1.1	2.2	4.5	7.9	15.6	27.2	lbs	kgs
k1									0.00	0.00
k2	1						1	1	42.80	21.23
k3									0.00	0.00
k4	1						1	1	42.80	21.23
k5									0.00	0.00
k6	1						1	1	42.80	21.23
	3	3	3	3	0	3	0	6	128.40	63.69

Table – Keel masses distribution

	D972213	D972214	D972215	D0901075				
				2.5 kg	5 kg	10 kg		
	610	375	230	5.5	11	22	lbs	kgs
A		2				2	794	360.15
B							0	0.00
C							0	0.00
D							0	0.00
E-1					1	2	55	24.95
E-2						2	44	19.96
E-3						2	44	19.96
Top Masses	0	2	0	0	1	8	937	425.02

Table - Optical Table Masses distribution

	Side	Keel	Top	Total
Weigh (kg)	184.79	63.69	425.02	673.50

Table - Masses distribution (computed using T1100261)

Acceptance Criteria

The Mass budget must be

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

Issues/difficulties/comments regarding this test:
This load is inexplicably high (fails by 20%) in comparison with the aLIGO ISIs. A difference between the springs because those were manufactured from a different batch several years before is possible, but still unlikely to explain such a disparity.

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

- ***Step 8: Lockers adjustment***

We used dial indicators for initial balancing, but fine balancing and locker adjustment was done using the CPSs. (See Step 12).

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

- ***Step 9- Electronics Inventory***

Hardware	LIGO reference	S/N
Coil driver	D0902744	S1103331
		S1103318
Anti Image filter	D1100202	S1200954
Anti aliasing filter	D1000269	S1200950
		S1200949
Interface chassis	D1000067	S1200667
		S1107437

Table - Inventory electronics

Acceptance Criteria

- Inventory is complete

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

- ***Step 10– Cables inventory – E1100822***

The location of all cables must be reported in the spreadsheet E1100822.

Cable Connects		Cable S/N		
Part Name	**Configuration**	**Corner 1**	**Corner 2**	**Corner 3**
GS13	Horizontal	S1104642-S1104609	S1104647-S1104596	S1104641-S1104470
GS13	Vertical			
Actuator	Horizontal	S1104752	S1104475	S1107757
	Vertical	S1104473	S1104716	S1104750

Table – Cables inventory

Acceptance Criteria

- Cable inventory completed
- E110082 spreadsheet updated

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

- ***Step 11 - Set up sensors gap***

	No mass	
Table locked	ADE boxes on	
Sensors	Offset (Mean)	Std deviation
H1	125.72	26.371
H2	-331.76	13.788
H3	54.683	18.929
V1	-219.05	19.088
V2	-229.87	17.625
V3	-85.35	20.183

Table – Capacitive position sensor readout after gap set-up

Issues/difficulties/comments regarding this test: HAM-ISI – LLO HAM 6 uses synchronized boxes, with power boards installed on their back.

Acceptance criteria:

- All mean values must be lower than 400 cts (a bit less than .0005").
- All standard deviations below 5 counts.
- No cross talk

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

- ***Step 12- Measure the Sensor gap***

This test was not done any more due to risk of damage to sensor targets.

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

- ***Step 13 - Check Sensor gaps after the platform release***

	Table locked		Table unlocked	
Sensors	**Offset (Mean)**	**Std deviation**	**Offset (Mean)**	**Difference**
H1	125.72	26.371	-660.85	-786.57
H2	-331.76	13.788	-586.56	-254.8
H3	54.683	18.929	-1327.3	-1382
V1	-219.05	19.088	-253.35	-34.3
V2	-229.87	17.625	-734.46	504.58
`V3	-85.35	20.183	-1216.4	-1131.1

Table – Sensor gaps after platform release

Acceptance criteria:

- Absolute values of the difference between the unlocked and the locked table must be below:
  - 1600 cts for horizontal sensors (~0.002")
  - 1600 cts for vertical sensors (~0.002")
- Considering the acceptance criteria of step 4, all mean values must be lower than
  - 2000 cts for horizontal sensors (~0.0025")
  - 2000 cts for vertical sensors (~0.0025")

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

- ***Step 14– Performance of the limiter***
- ***Step 14.1 - Test Nº1 - Push "in the general coordinates"***

Issues/difficulties/comments regarding this test:
It is to be noted in this test and in all the following ones involving the actuators, than despite having everything supposedly similar to all the aLIGO ISIs, the actuators from this ISI were always driving in the opposite direction as the others. This will be solved after installation by a modification on the field cables.

	CPS read out		Calculated after calibration	
Sensors	**UP (Counts)**	**Down (Counts)**	**UP (mil)**	**Down (mil)**
V1	20300	-20000		
V2	20400	-19500		
V3	20300	-20600		
	CPS read out		**Calculated after calibration**	
Sensors	**CW(-RZ)**	**CCW (+RZ)**	**CW (mil)**	**CCW (mil)**
H1	20100	-22000		
H2	21900	-22700		
H3	22800	-19600		

Table - Optic table range of motion

Acceptance criteria:

- The vertical sensor readout be positive when the optic table is pushed in the +Z direction
- The horizontal sensor readout be negative when the optic table is pushed in the +RZ direction

Step 15.1

- Absolutes value of all estimated motions must be higher than 16000counts (~0.020")

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

- ***Step 15- Position Sensors unlocked/locked Amplitude Spectral Densities***

Data files in SVN at:
/seismic/HAM-ISI/L1/HAM6/Data/Spectra/Undamped/
- LLO_ISI_HAM6_ASD_m_CPS_T240_L4C_GS13_Locked_vs_Unlocked_2012_07_03.pdf

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/L1/HAM6/Data/Figures/Spectra/Undamped/
- LLO_ISI_HAM6_ASD_m_CPS_Requirements_Locked_vs_Unlocked_2012_07_03.pdf
- LLO_ISI_HAM6_ASD_m_GS13_Requirements_Locked_vs_Unlocked_2012_07_03.pdf

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

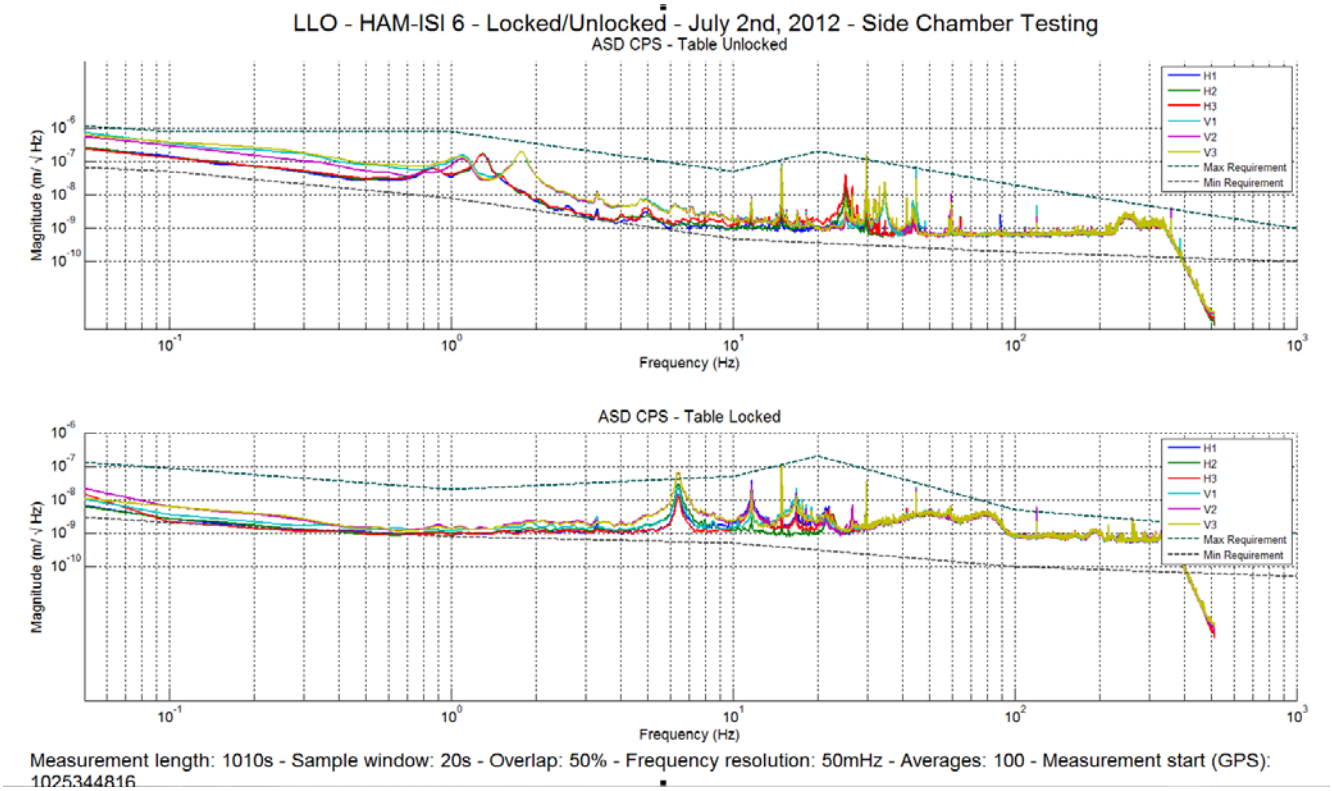


Figure - Calibrated CPS power spectrum

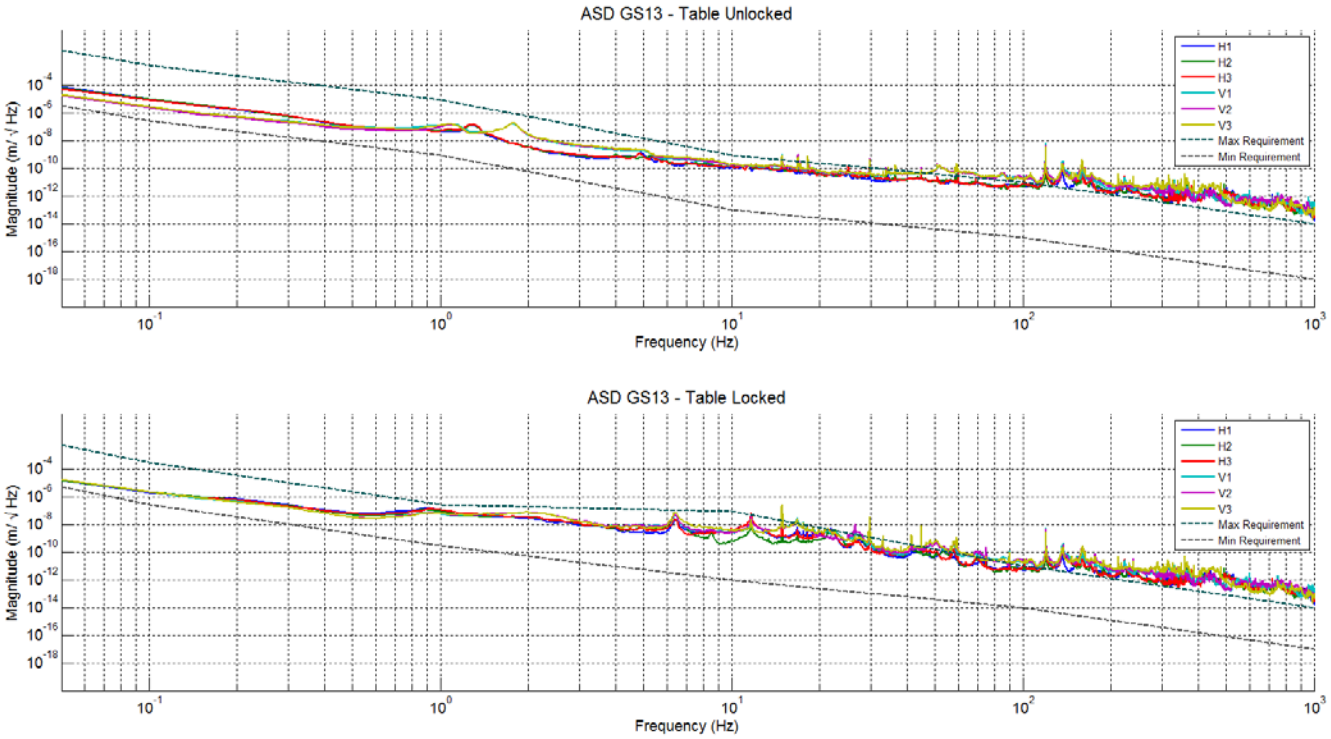


Figure – Power spectrum Calibrated GS13s

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)

Issues/difficulties/comments regarding this test:

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

- ***Step 16 - GS13 ASD -tabled tilted***

The figure below presents the GS13 power spectrum when the table is unlocked and loaded with a 20Kg mass at one of its corner.

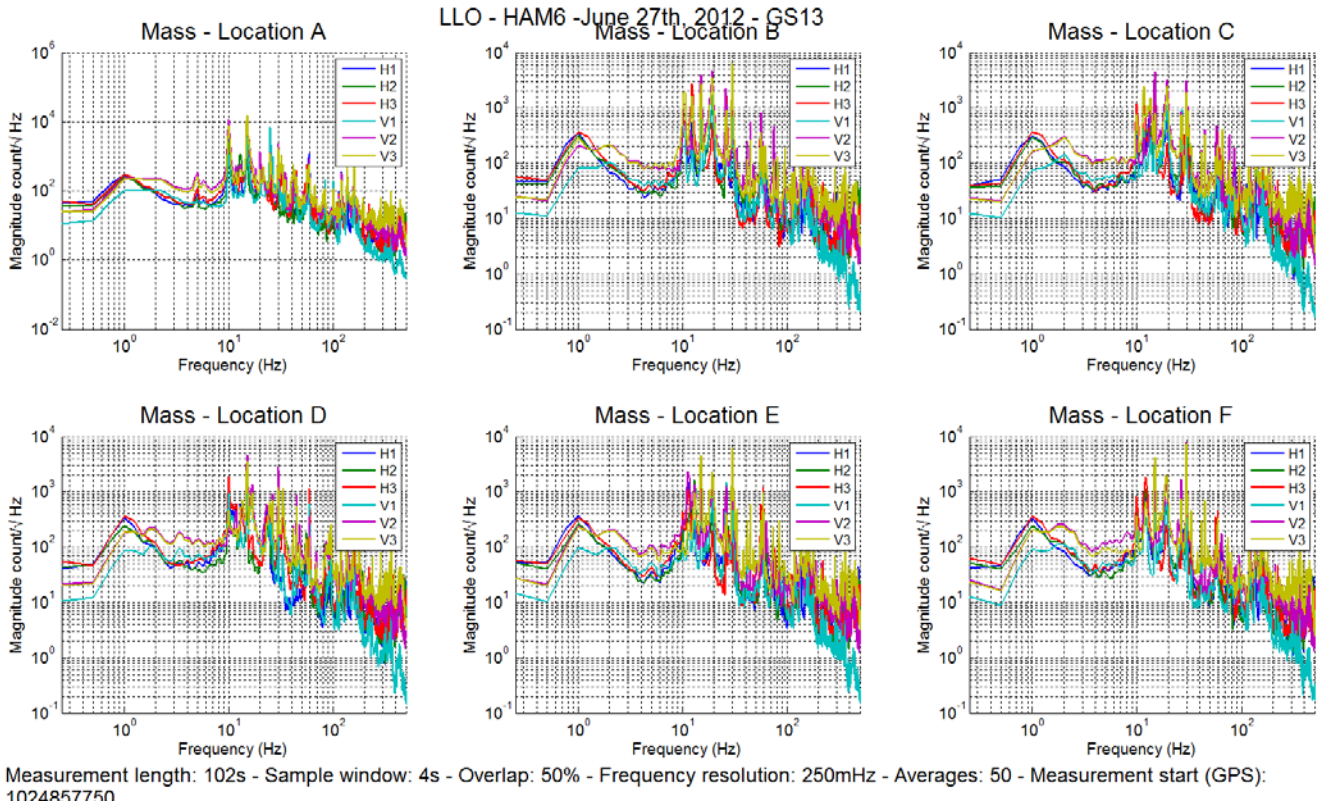


Figure – ASD Calibrated GS13 with mass at corner

Data files in SVN at:
/seismic/HAM-ISI/L1/HAM6/Data/Spectra/Undamped/
- LLO_HAM_ISI_Unit_3_Calibrated_PSD_GS13_Table_Tilted_2012-06-27.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_Tilted_Stage_HAM_ISI.m

Figures in SVN at:
seismic/HAM-ISI/L1/HAM6/Data/Figures/Spectra/Undamped/
- LLO_ISI_HAM6_ASD_CT_GS13_Tilted_2012_06_27.pdf

Acceptance criteria:
- With table unlocked and tilted, magnitudes of power spectra must be fully included within:

Issues/difficulties/comments regarding this test:
One can notice that V1 seismometer, even though displaying similar behavior than the other vertical seismometers, has an amplitude about half as those. This was due to a connection issue between the field cable and the HAM-ISI interface. Those tests were not taken again after the find.

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

- ***Step 17- GS13 pressure readout***

As of 07/02/12, readout was as follow:

	Corner 1	Corner 2	Corner 3
GS-13 Direct Pressure	99	100	78
GS-13 Diff Pressure	0	0	0

Acceptance criteria:
- The pressure on direct channels must be 102KPa +/-8 KPa
- The pressure on differential channels must be 0KPa +/-8 KPa

Issues/difficulties/comments regarding this test:
The channels in orange do not pass because of a gain difference in the GS-13 channels of the HAM-ISI interfaces. Those out of vacuum electronics will be corrected later on.

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

- ***Step 18- Actuators Sign and range of motion (Local drive)***

	Negative drive	Positive drive
H1 readout (count)	24356.63	-23581.5
H2 readout (count)	23436.76	-23902.2
H3 readout (count)	25256.95	-24624.4
V1 readout (count)	19121.5	-19818.9
V2 readout (count)	24979.59	-24208.1
V3 readout (count)	21160.23	-22650.5

Table - Range of motion - Local drive

Data files in SVN at:
/seismic/HAM-ISI/L1/HAM6/Data/Static_Tests/
- LLO_ISI_HAM6_Range_Of_Motion_20120703.mat

Scripts files for taking and processing the data, and plotting it in SVN at:
seismic/HAM-ISI/Common/Testing_Functions_HAM_ISI/
- Range_Motion_HAM_ISI.m

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 19 - Static Testing (Tests in the local basis)***

	H1	H2	H3	V1	V2	V3
H1	-1761.71	-1103.13	-1100.84	-15.9095	12.5823	2.6116
H2	-1094.45	-1743.49	-1097.05	17.8259	9.667	-14.0226
H3	-1119.06	-1125.8	-1788.9	12.42717	12.1842	-15.1616
V1	-165.306	-170.033	332.568	-1278.77	37.36716	559.6561
V2	317.665	-188.887	-171.338	550.6327	-1246.62	19.856
V3	-168.966	313.483	-168.426	30.41616	551.4492	-1256.83

Table - Main and cross coupling

Data files in SVN at:
/seismic/HAM-ISI/L1/HAM6/Data/Static_Tests/

- LLO_ISI_HAM6_Offset_Local_Drive_20120703.mat

Scripts files for taking data in SVN at:
seismic/HAM-ISI/Common/Testing_Functions_HAM_ISI/

- Static_Test_Local_Basis_HAM_ISI.m

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 20- Linearity test***

	Slope	Offset	Average slope	Variation from average(%)
H1	-1.7604	-1076.71	-1.76438	-0.22533
H2	-1.74814	-913.349		-0.92022
H3	-1.78459	-1632.13		1.145553
V1	-1.28621	84.82623	-1.26453	1.71472
V2	-1.2655	-758.596		0.076528
V3	-1.24188	-1326.95		-1.79125

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

Scripts files for taking data in SVN at:
/seismic/HAM-ISI/Common/ Common/Testing_Functions_HAM_ISI

- Linearity_Test_Awgstream_HAM_ISI.m

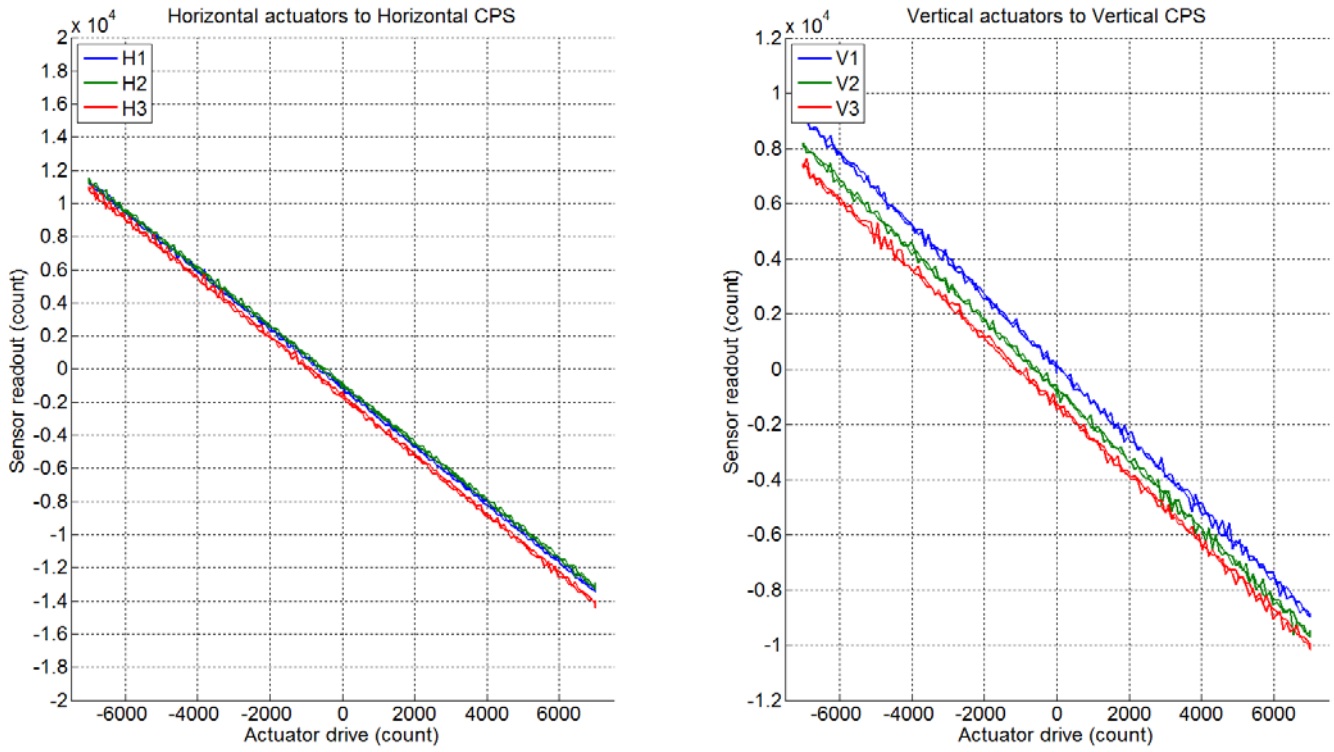


Figure - Horizontal and vertical actuators x HAM-ISI x sensors

Data files in SVN at:
seismic/HAM-ISI/L1/HAM6/Data/Linearity_Test/

- LLO_ISI_HAM6_Linearity_test_20120703.mat

Figures in SVN at:
seismic/HAM-ISI/L1/HAM6/Data/Figures/Linearity_Test/

- LLO_ISI_HAM6_Linearity_test_20120703.pdf

Issues/difficulties/comments regarding this test:
A few actuators display higher slopes difference than expected (i.e. 1% to average). But it was deemed close enough to be acceptable here (field and in-vacuum cables have different lengths).

It took us numerous attempts before passing this test. Indeed we would regularly have one or the other actuator which would display a much lower slope. This was blamed on the unprotected end of the actuator cables (actuator side) contacting any other part of the ISI, therefore reducing the current flowing through the actuator. This can be measured at the air-side of the feedthru (the resistance between the 2 pins would be much higher than intended). This issue was found hard to detect and/or improve, and at this point it is not yet clear why this issue has been repeated so many times on this ISI and not on the others.

Acceptance criteria:

- Horizontal and vertical slopes of the triplet actuators x HAM-ISI x sensors: Average slope +/- 1%

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

- ***Step 21 Cartesian Basis Static Testing***

1000 counts Drive	H1	H2	H3	V1	V2	V3
X Drive	-204.493	-204.728	461.3768	-36.2418	1.80454	7.4758
Y Drive	380.6837	-372.8	-3.459	-7.18695	3.55744	15.118
Z Drive	-10.2574	-4.40514	0.6114	-247.434	-217.85	-196.366
Rx Drive	393.2914	-409.009	3.7404	383.0866	-1452.24	1043.733
Ry Drive	231.4814	219.8392	-467.026	1474.289	-335.09	-1059.94
Rz Drive	1709.158	1704.476	1721.099	3.860908	8.25052	44.9336

Table - Tests in the local coordinate basis

1000 counts Drive	X	Y	Z	RX	RY	RZ
X Drive	-443.579	-5.88621	-15.1806	2.052502	-10.5316	-17.7086
Y Drive	-7.77595	-441.642	-18.2114	26.79738	-24.171	-6.9564
Z Drive	0.66663	-4.74997	-228.798	12.56017	-11.6906	13.0496
Rx Drive	-12.7533	-13.9779	-11.7751	-2236.12	-19.912	11.1894
Ry Drive	-0.97062	-9.49364	-16.3234	-3.48221	-2284.08	11.3914
Rz Drive	-2.26277	2166.048	-19593.2	4545.38	-35835.9	-20711.3

Table - Tests in the general coordinate basis

Acceptance criteria:

- For a positive drive in the Cartesian basis Local sensor readout must have the same sign that in the following table:

1000 counts Drive	H1	H2	H3	V1	V2	V3	Direction read out
X Drive	+	+	-				+
Y Drive	-	+	0				+
Z Drive				+	+	+	+
Rx Drive				-	+	-	+
Ry Drive				-	+	+	+
Rz Drive	-	-	-				+

Table – Reference table

For a positive drive in the Cartesian basis:

- Local sensor readout must have the same sign that the reference table (**CONT2ACT check**)
- Cartesian sensors read out must be positive (**DISP2CEN check**) in the drive direction

Issues/difficulties/comments regarding this test:
Apart from the known sign difference (see introduction), the local coordinate table abides by the reference perfectly. The general coordinate basis one seems more surprising, but at worse, this would be a matrix error, which would not interfere with the decision to install the HAM-ISI.

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

- ***Step 22- Frequency response***
- ***Step 22.1 - Local to local measurements***

Local to local transfer functions have been measured with 90 repetitions.

Data files in SVN at:
seismic/HAM-ISI/L1/HAM6/Data/Transfer_Functions/Measurements/Undamped/
- LLO_ISI_HAM6_Data_TF_L2L_50mHz_500mHz_20120705-174022.mat
- LLO_ISI_HAM6_Data_TF_L2L_500mHz_5Hz_20120705-204555.mat
- LLO_ISI_HAM6_Data_TF_L2L_5Hz_200Hz_20120705-085134.mat
- LLO_ISI_HAM6_Data_TF_L2L_200Hz_800Hz_20120703-172903.mat

Data collection script files:
seismic/HAM-ISI/L1/HAM6/Scripts/Data_Collection/
- Run_Exc_Batch_L1ISIHAM6.m

Scripts files for processing and plotting in SVN at:
seismic/HAM-ISI/L1/HAM6/Scripts/Control_Scripts/release/
- Step_1_TF_Loc_2_Loc_L1_ISI_HAM6.m

(note that here release was soft linked to Version_1)

Figures in SVN at:
/seismic/HAM-ISI/L1/HAM6/Data/Figures/Transfer_Functions/Measurements/Undamped/
- LLO_ISI_HAM6_TF_L2L_Raw_from_ACT_to_CPS_2012_07_05.fig
- LLO_ISI_HAM6_TF_L2L_Raw_from_ACT_to_GS13_2012_07_05.fig

Storage of measured transfer functions in the SVN at:
seismic/ HAM-ISI/L1/HAM6/Data/Transfer_Functions/Simulations/Undamped
- L1_ISI_HAM6_TF_L2L_Raw_2012_07_05.mat
-

The local to local transfer functions are presented below.

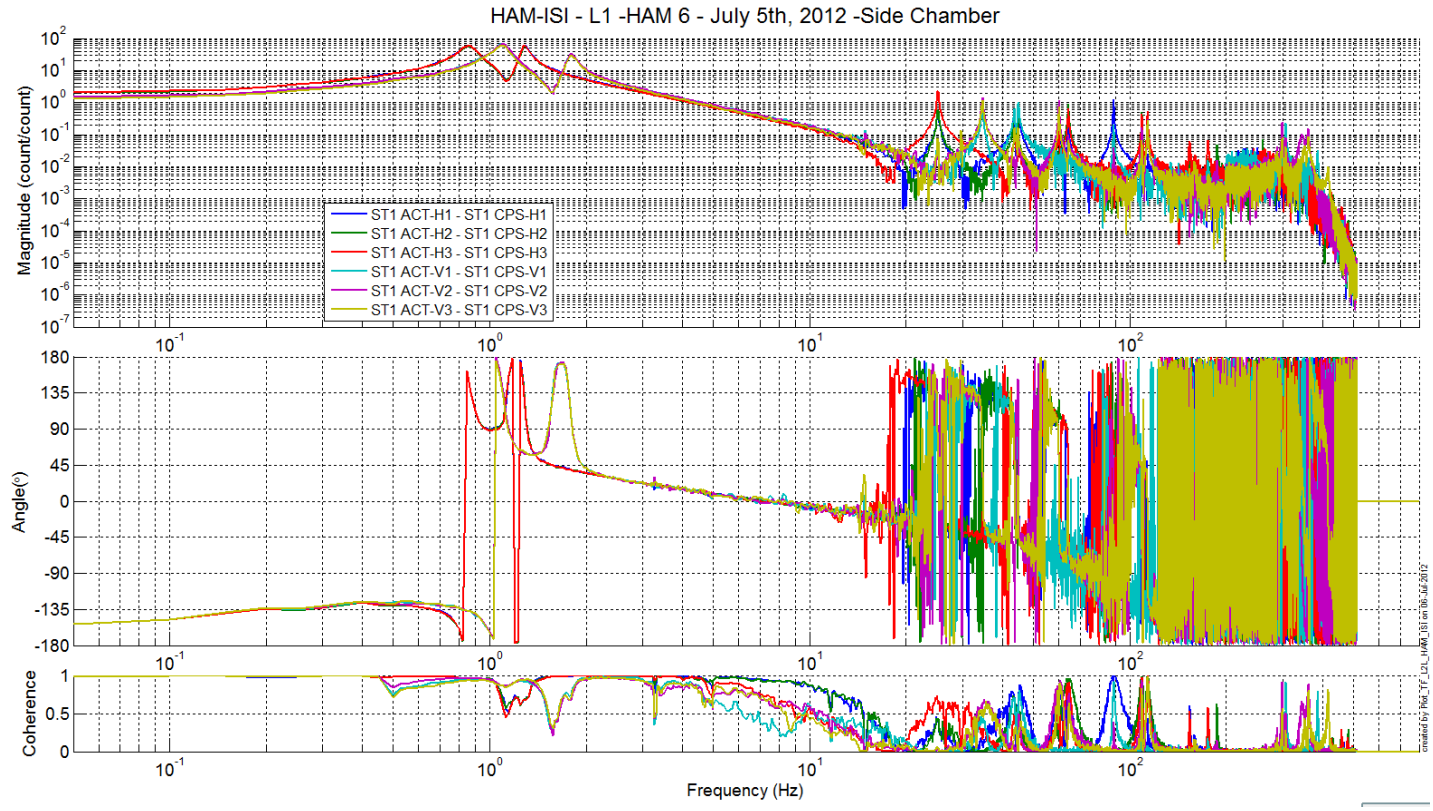


Figure - Local to Local Measurements –Capacitive Position Sensors

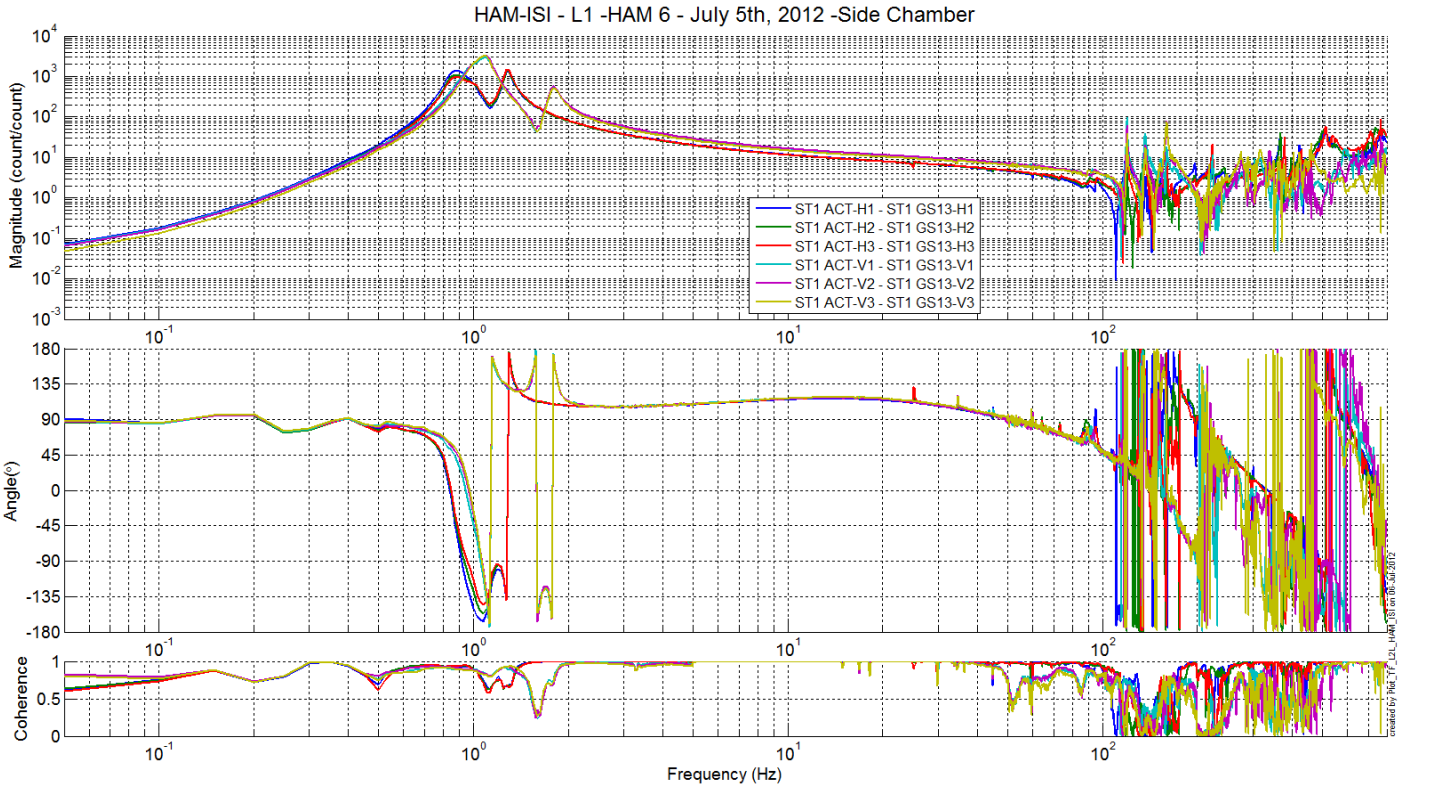


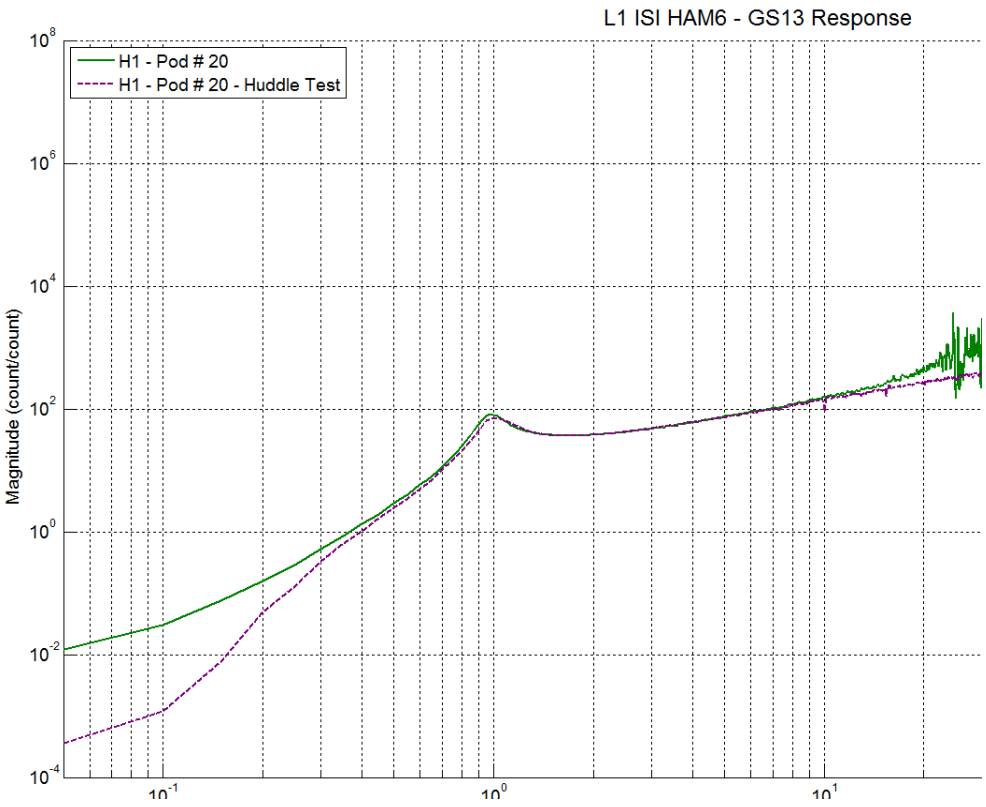
Figure - Local to Local Measurements – Inertial sensors

Issues/difficulties/comments regarding this test:
We can see that horizontal sensors in corner 1 and 3 seem to see a slightly different behavior around 1 Hz. We tried to assess whether this could be due to the GS-13 characteristics themselves by extracting the sensor response from the transfer function and comparing this to the huddle test results.

Data collection script files:
seismic/HAM-ISI/L1/HAM6/Scripts/Data_Collection/
- L1_HAM6_GS13_Resp_Extraction_Fitting.m

Figures in SVN at:
/seismic/HAM-ISI/L1/HAM6/Data/Figures /Instrument_Responses/GS13/
- L1_ISI_HAM6_GS13_H1_Pod_20_Extracted_Response_VS_Huddle.fig
- L1_ISI_HAM6_GS13_H2_Pod_37_Extracted_Response_VS_Huddle.fig
- L1_ISI_HAM6_GS13_H3_Pod_84_Extracted_Response_VS_Huddle.fig
- L1_ISI_HAM6_GS13_V1_Pod_80_Extracted_Response_VS_Huddle.fig
- L1_ISI_HAM6_GS13_V2_Pod_64_Extracted_Response_VS_Huddle.fig
- L1_ISI_HAM6_GS13_V3_Pod_15_Extracted_Response_VS_Huddle.fig

Here are the plots for the 3 horizontal sensors:



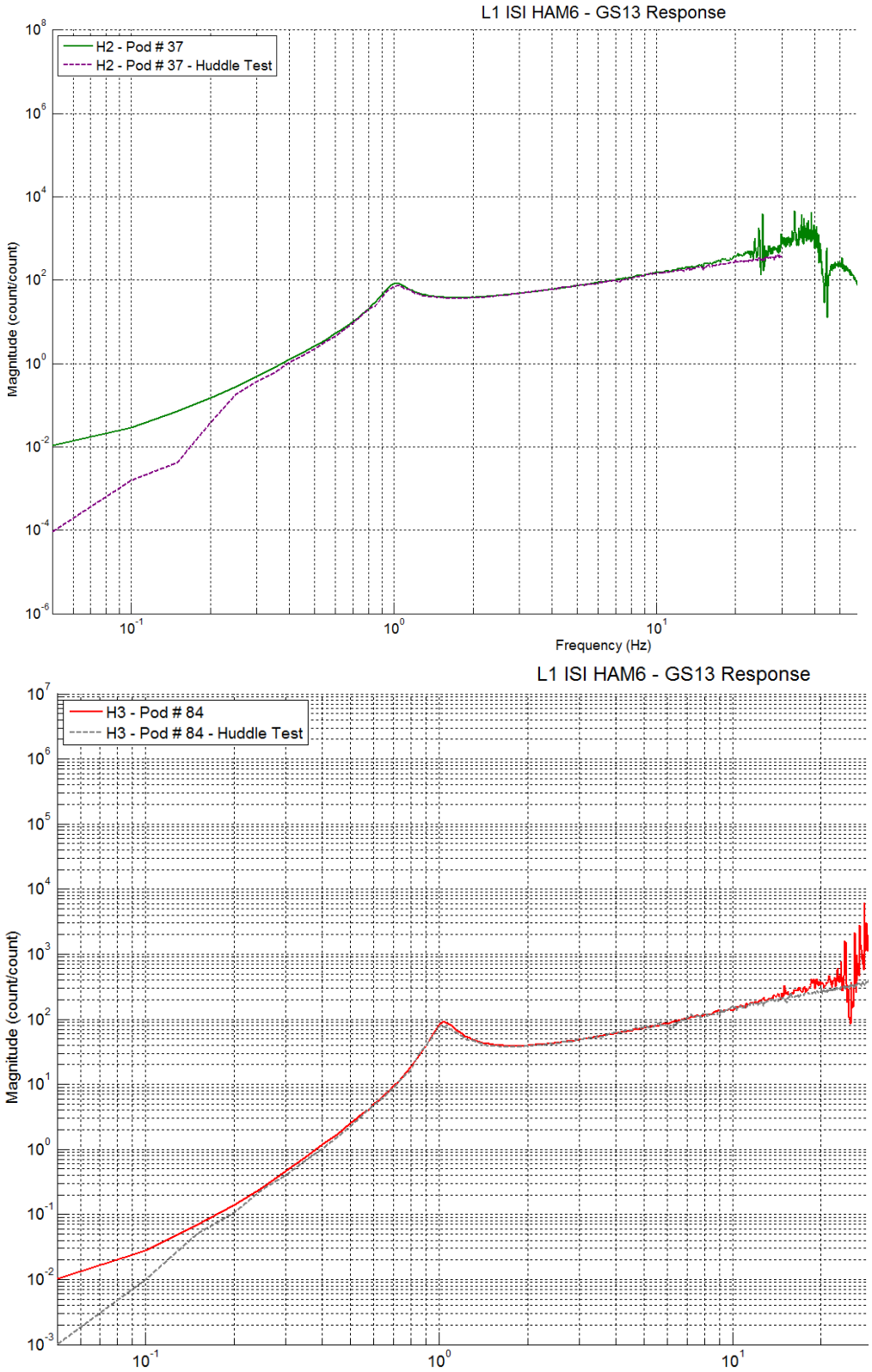


Figure – Comparison between the responses of the horizontal GS-13s installed on HAM-ISI 6 and their respective huddle test results.

From those last 3 plots, we can notice that H1 and H3 resonant frequencies appear to be slightly under and over 1 Hz respectively, which may partly explain the slight difference between the horizontal corners. However, those slight differences were not visible on huddle test data. This may be due to a lower resolution on huddle test data

Conclusion of Side Chamber testing

When the actuator cables were properly isolated from the actuators (cf Step 20 linearity test comment), only a few minor issues were found during testing of this ISI:

- Slightly different actuator slope on H3 (in comparison to the other horizontal actuators)
- Slightly different response of the H1 and H3 GS-13s (in comparison to H2) between 0.8 and 1.1 Hz. This appears to be explained by the different sensors responses.
- The ISI mass load is inexplicably high compared to the other ISIs. We haven't been able to find any mistakes in the weights recorded. (cf Step 7-Mass budget)

A number of mechanical tests (and adjustments) were waived at the time of side-chamber testing, leaving this for in-chamber initial testing:

- Level of the optical table
- Spring flatness measurements
- Horizontal actuator gaps