

*LIGO Laboratory / LIGO Scientific Collaboration*

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**aLIGO HEPI H1 HAM2  
Assembly Validation Report**

**E1300828**

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Distribution of this document:  
Advanced LIGO Project

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**Contents**

1. Introduction.....	3
2. Sub-Components Testing.....	3
3. Load Cells assembly .....	3
4. Boot Location.....	4
5. Check Stops Gaps .....	4
6. Gaps check.....	5
7. IPS Centering.....	5
8. Sensor ASD.....	6
9. SUS-watchdogs interaction test .....	7
10. Static Test local drive.....	7
11. Linearity Test/Range of motion in the local basis .....	8
12. Actuator Plate to Shields gap.....	9
13. Valve Check.....	9
14. Local-to-local measurements.....	10
15. Alignment offsets:.....	12

## 1. Introduction

This document summarizes the steps to be done to validate HEPI assemblies. Corresponding reports must be posted in :

LIGO-E1300454: aLIGO HEPI Testing Reports

## 2. Sub-Components Testing

- Kaman Inductive Position Sensors: calibration, linearity, factory data, noise measurements (E0900426 – HEPI Kaman Sensor Receiving Analysis - Results posted in the SVN )
- HEPI actuator linearity test (E1100338 – aLIGO HEPI Actuators Test Results)
- L4C test (Q0900007)

## 3. Load Cells assembly

BSC HEPI load cell capacity → 3000 lbs

HAM HEPI load cell capacity → 2000 lbs

	<b>Left Spring (lbs)</b>	<b>Right Spring (lbs)</b>
<b>Pier 1</b>		
<b>Pier 2</b>		
<b>Pier 3</b>		
<b>Pier 4</b>		

### Acceptance criteria:

- The values must not exceed 80% of the load cell capacity (2400lbs for BSC and 1600lbs for HAM).

**Test result:**

**Passed:** \_\_\_\_

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

### 4. Boot Location

	Pier 1	Pier 2	Pier 3	Pier 4
Point 1a (Tangential)				
Point 1b (Tangential)				
Point 2a (Tangential)				
Point 2b (Tangential)				
Point 3 (Radial Back)				
Point 4 (Radial Front)				
Point 5 (Vertical)				

	Pier 1	Pier 2	Pier 3	Pier 4
Point 1a (Tangential)				
Point 1b (Tangential)				
Point 2a (Tangential)				
Point 2b (Tangential)				
Point 3 (Radial Back)				
Point 4 (Radial Front)				
Point 5 (Vertical)				

Acceptance criteria:

- 

Test result:

Passed: \_\_\_\_

Failed: \_\_\_\_

### 5. Check Stops Gaps

The stops must not touch the boot. There is 15 stops per boot, 5 per F bracket.

	Bracket 1					Bracket 2					Bracket 3							
	Gap 1	Gap 2	Gap 3	Gap4 above	Gap4 under	Gap 5	Gap 1	Gap 2	Gap 3	Gap4 above	Gap4 under	Gap 5	Gap 1	Gap 2	Gap 3	Gap4 above	Gap4 under	Gap 5
Pier 1																		
Pier 2																		
Pier 3																		
Pier 4																		

Test result:

Passed: \_\_\_\_

Failed: \_\_\_\_

## 6. Gaps check

Four particular gaps need to be check.

### Acceptance criteria:

- a 0.08” shim must fit in these two gaps

Issues/difficulties/comments regarding this test: Gap#1 is tricky to reach. At LASTI, the solution found was to tape the shim to an extension (rod, rigid ruler, etc.).

Gap#2 should be reachable by hand.

Gap#3 and 4 are tricky, but should also be doable (no picture)

	Gap#1	Gap#2	Gap#3	Gap#4
Pier 1				
Pier 2				
Pier 3				
Pier 4				

Test result:

Passed:     

Failed:     

## 7. IPS Centering

### Scripts files for processing and plotting in SVN at:

/SeiSVN/seismic/HEPI/Common/Testing\_Functions\_HEPI/Offset\_STD\_IPS\_HEPI.m

### Data in SVN at:

/ligo/svncommon/SeiSVN/seismic/HEPI/H1/HAM2/Data/Static\_Tests/  
\_IPS\_Read\_Back\_\_20131031\_15:23.mat

All the loops must be turned off during this test.

The test was performed on October 31<sup>st</sup> 2013, with HEPI Locked.

	H1	H2	H3	H4	V1	V2	V3	V4
Mean (counts)	5801.1	771.1	-1873.1	-1737.9	-3931	-3650.1	-1845.9	-4244.2
Acceptance	+/- 15000	+/- 15000	+/- 15000	+/- 15000	+/- 15000	+/- 15000	+/- 15000	+/- 15000

Test result:

Passed:   X  

Failed:

### 8. Sensor ASD

Scripts files for processing and plotting in SVN at:

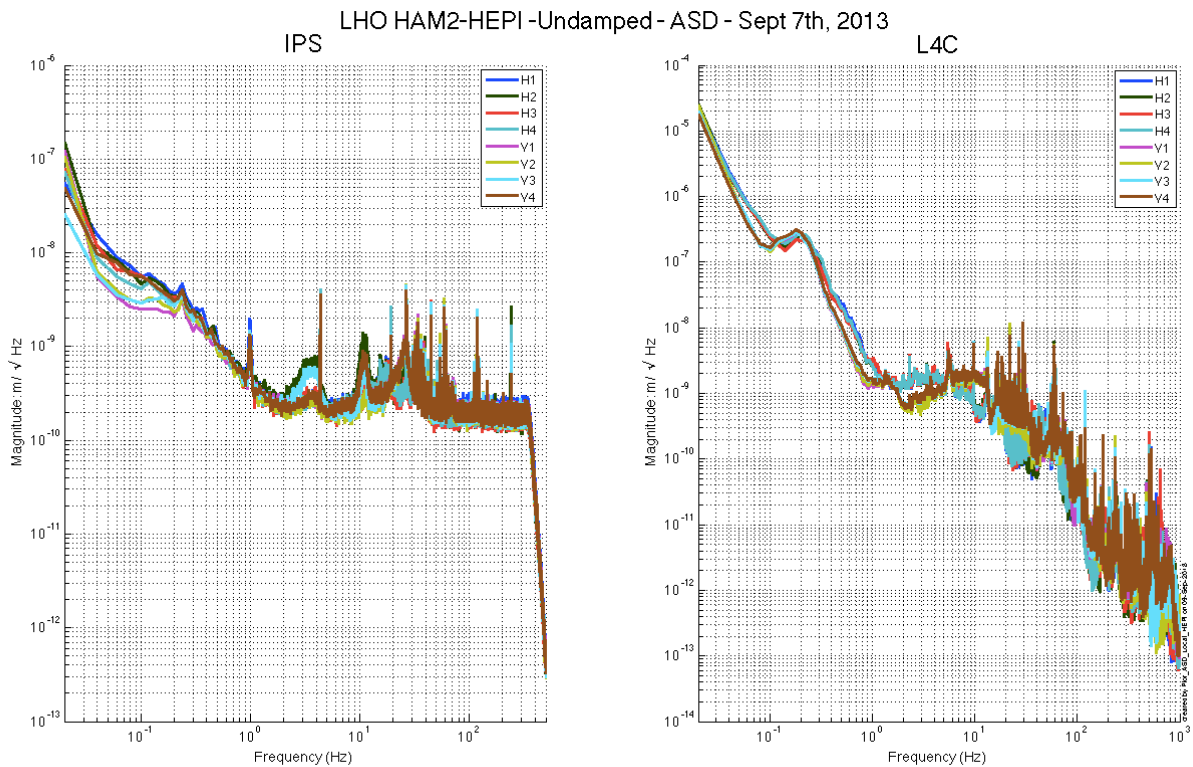
/SeiSVN/seismic/HEPI/Common/Testing\_Functions\_HEPI/ASD\_Measurements\_Local\_HEPI.m

Data in SVN at:

SeiSVN/seismic/HEPI/H1/HAM2/Data/Spectra/Undamped/  
LHO\_HPI\_HAM2\_ASD\_m\_IPS\_L4C\_2020\_09\_07\_3 6:1:.mat

Figures in SVN at:

/SeiSVN/seismic/HEPI/H1/HAM2/Data/Figures/Spectra/Undamped/  
LHO\_HPI\_HAM2\_ASD\_m\_IPS\_L4C\_2020\_09\_07\_3\_6\_1\_.fig



Measurement length: 1900s - Sample window: 50s - Overlap: 50% - Frequency resolution: 20mHz - Averages: 75 - Measurement start (GPS): 1062630103

Issues/difficulties/comments regarding this test:

Measurements were performed with all PreFilters ON.

Acceptance criteria:

■

Test result:

Passed:  X

Failed:

## 9. SUS-watchdogs interaction test

**This test will be obsolete very soon, as the payload-HEPI WD connection is planned for removal.**

- . Set up a zero value on the payload watchdogs.
- . Check that the payload watchdog screen of HEPI tripped.
- . In the payload watchdog screen, click on the OVERRIDE button and reset the watchdog.
- . Do the same process for all the payloads

### Acceptance criteria:

- The HEPI must trip when the payload watchdogs are tripped
- The HEPI watchdogs could be reset when the OVERRIDE button is ON

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

When this test is done, reset everything (OVERRIDE button OFF, put back the value on the payload watchdog).

## 10.Static Test local drive

### Scripts files for processing in SVN at:

/SeiSVN/seismic/HEPI/Common/Testing\_Functions\_HEPI/Static\_Test\_Local\_Basis\_HEPI.m

### . Drive of 5000 counts

	H1	H2	H3	H4	V1	V2	V3	V4
H1	8350.9418	-5056.1049	-327.0384	-1879.51872	-178.9088	209.3388	192.18836	-370.0864
H2	-4104.049	8306.5349	-1822.531974	-448.11792	134.8916	-100.465	-301.80668	139.7868
H3	-233.5984	-2065.5751	8170.4572	-4615.56692	178.7694	-183.7838	-239.1095	118.1154
H4	-1807.7793	-701.3897	-4558.2268	9000.50088	-488.2914	367.591	-1.00976	-441.0128
V1	-87.0864	1.56718	302.0506	-174.51156	7490.8344	918.82254	-1656.35338	784.3534
V2	182.2748	-404.56522	-128.0876	486.57564	833.8752	7402.042	675.00182	-1629.1482
V3	309.8688	-477.33554	-80.087	272.82164	-1436.731	1099.12212	7236.42762	695.124
V4	-177.839	74.78868	291.7698	-126.46464	955.694	-1414.8926	824.44686	7487.4108

Table - Main couplings and cross couplings

### . Drive of 1000 counts

Table - Main couplings and cross couplings

### . Drive of 2500 counts

Table - Main couplings and cross couplings

Issues/difficulties encountered during this test:

**Drive of 1000 and 2500 counts were skipped. Static\_Test\_Local\_Basis\_HEPI.m drives at 5000 counts only.**

Acceptance criteria:

- The results in these three tables must be the same (within xxx%)

Test result:

Passed:  X

Failed:    

### 11. Linearity Test/Range of motion in the local basis

Scripts files for processing and plotting in SVN at:

/SeiSVN/seismic/HEPI/Common/Testing\_Functions\_HEPI/Linearity\_Test\_Awgstream\_HEPI.m

Data in SVN at:

SeiSVN/seismic/HEPI/H1/HAM2/Data/Linearity\_Test/

LHO\_HPI\_HAM2\_Linearity\_test\_20130903T135532.mat

Figures in SVN at:

/SeiSVN/seismic/HEPI/H1/HAM2/Data/Figures/Linearity\_Test/

	Slopes	Offsets
H1	1.63	1800.40
H2	1.88	-522.55
H3	1.63	1959.94
H4	1.76	-177.98
V1	1.54	-4082.29
V2	1.54	-1558.79
V3	1.42	-516.54
V4	1.56	-5144.56

Issues/difficulties encountered during this test:

**The autosave failed and the plots saved under the SVN are empty.**

Acceptance criteria:

- 

Test result:

Passed:  ?

Failed:



## 12. Actuator Plate to Shields gap

Perform this test **ONLY** if the range of motion test failed.

Three gaps per actuator need to be checked.

**Acceptance criteria:**

- A 0.1” shim must fit into the gap #1
- A 0.05 shim must fit into gap #2 and #3

	Horizontal			Vertical		
	Gap #1	Gap #2	Gap #3	Gap #1	Gap #2	Gap #3
<b>Pier 1</b>						
<b>Pier 2</b>						
<b>Pier 3</b>						
<b>Pier 4</b>						

**Test result:**

**Passed:** \_\_\_\_

**Failed:**

## 13. Valve Check

**Scripts files for processing and plotting in SVN at:**

/SeiSVN/seismic/HEPI/H1/HAM2/Scripts/Valve\_Check/plot\_valve\_check.m

**Data in SVN at:**

SeiSVN/seismic/HEPI/H1/HAM2/Data/Spectra/Undamped/  
/SeiSVN/seismic/HEPI/H1/HAM2/Scripts/Valve\_Check

**Figures in SVN at:**

/SeiSVN/seismic/HEPI/H1/HAM2/Scripts/Valve\_Check

**Acceptance criteria:**

- 

**Test result:**

**Passed:** \_\_\_\_

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

## 14. Local-to-local measurements

Band (Hz)	Resolution	Amplitude	Nreps	Time (s)	Time (min)	Time (h)
<b>500-1000</b>		4000 – 4000*	250	4176*	4176	1*
<b>100 - 500</b>	0.5	4000 – 4000*	250	4176*	69.6	1.2*
<b>10 - 100</b>	0.25	4000 – 4000*	200	6592*	109.9	1.8*
<b>0.7 - 10</b>	0.05	4000 – 4000*	75	12320*	205.3	3.4*
<b>0.1 - 0.7</b>	0.025	4000 – 4000*	30	10080*	168.0	2.8*
<b>0.01 - 0.1</b>	0.01	4000 – 4000*	10	8960*	149.3	2.5*
<b>0.002 - 0.01</b>	0.002	4000 – 4000*	2	12160*	202.7	3.4*
						<b>16.1*</b>

\*: Values Need to be updated

### Data files in SVN at:

/SeiSVN/seismic/HEPI/H1/HAM2/Data/Transfer\_Functions/Measurements/Undamped/

- LHO\_HPI\_HAM2\_Data\_L2L\_500Hz\_1000Hz\_20130903-153845.mat
- LHO\_HPI\_HAM2\_Data\_L2L\_100Hz\_500Hz\_20130903-175509.mat
- LHO\_HPI\_HAM2\_Data\_L2L\_10Hz\_100Hz\_20130903-190426.mat
- LHO\_HPI\_HAM2\_Data\_L2L\_700mHz\_10Hz\_20130904-164150.mat
- LHO\_HPI\_HAM2\_Data\_L2L\_100mHz\_700mHz\_20130904-200912.mat
- LHO\_HPI\_HAM2\_Data\_L2L\_10mHz\_100mHz\_20130904-230152.mat
- LHO\_HPI\_HAM2\_Data\_L2L\_2mHz\_10mHz\_20130905-014352.mat'

### Data is called by Case #2 of:

/ligo/svncommon/SeiSVN/seismic/HEPI/H1/HAM2/Data/Figures/Transfer\_Functions/Measurements/Measurements\_List\_H1\_HPI\_HAM2.m

### Data collection script files:

/SeiSVN/seismic/HEPI/Common//Transfer\_Function\_Scripts/

- Run\_TF\_L2L\_10mHz\_100mHz.m
- Run\_TF\_L2L\_100mHz\_500mHz.m
- Run\_TF\_L2L\_500mHz\_5Hz.m
- Run\_TF\_L2L\_5Hz\_100Hz.m
- Run\_TF\_L2L\_100Hz\_1000Hz.m

### Scripts files for processing and plotting in SVN at:

/SeiSVN/seismic/HEPI/H1/HAM2/Scripts/Control\_Scripts/release/

- Step\_1\_TF\_Loc\_to\_Loc\_H1\_HEPI\_HAM2.m

### Figures in SVN at:

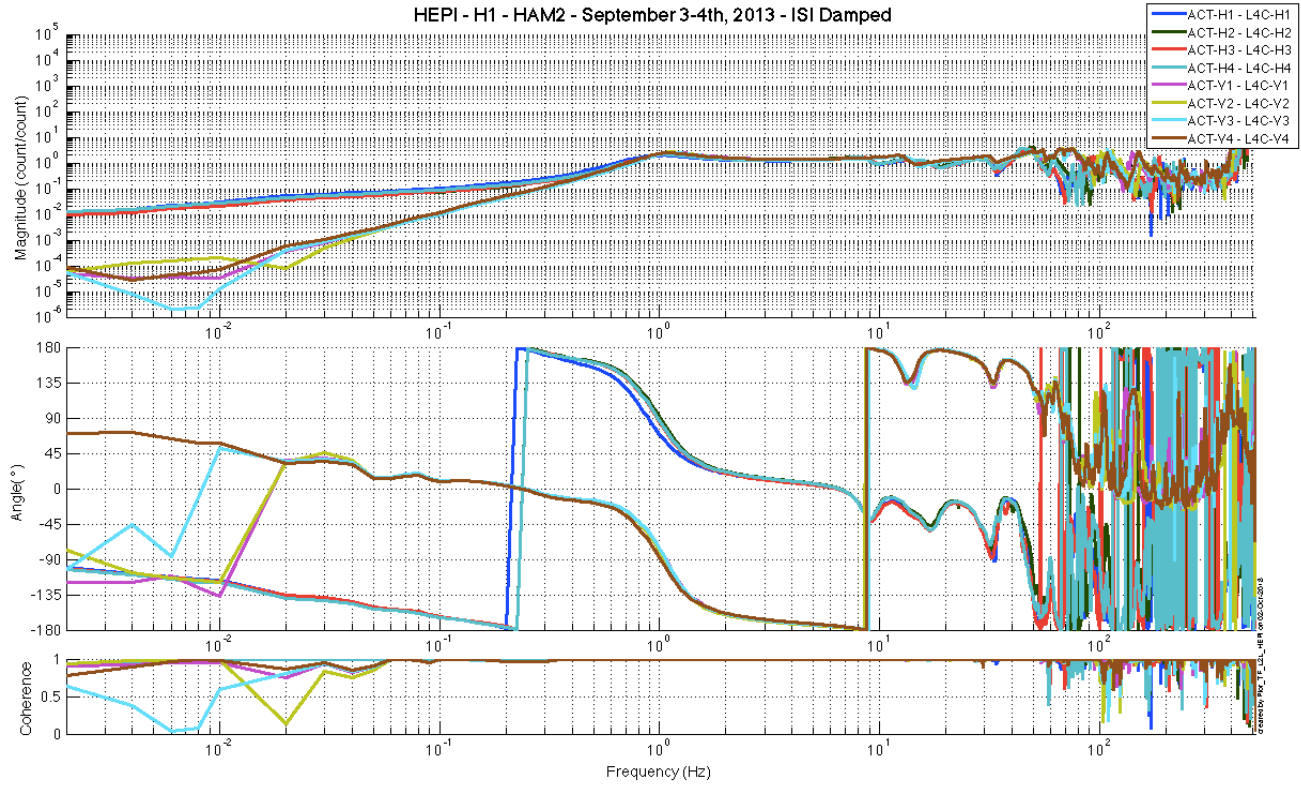
/SeiSVN/seismic/HEPI/H1/HAM2/Data/Figures/Transfer\_Functions/Measurements/Undamped/

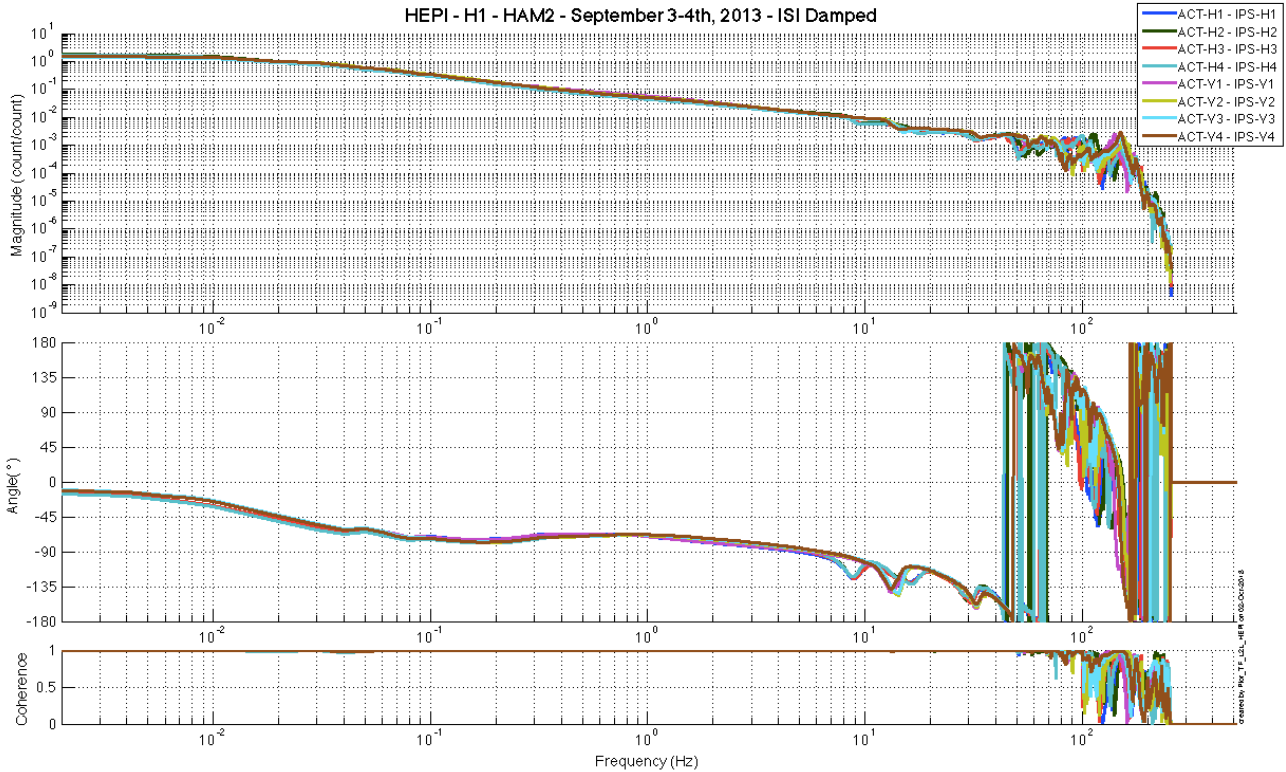
- H1\_HPI\_HAM2\_TF\_L2L\_Raw\_from\_ACT\_to\_IPS\_2013\_09\_04.fig
- H1\_HPI\_HAM2\_TF\_L2L\_Raw\_from\_ACT\_to\_IPS\_2013\_09\_04.fig

### Storage of measured transfer functions in the SVN at:

/SeiSVN/seismic/HEPI/H1/HAM2/Data/Transfer\_functions/ Simulations/Undamped/  
- H1\_HPI\_HAM2\_TF\_L2L\_Sym\_2013\_09\_04.mat

The local-to-local transfer functions are presented below.





Issues/difficulties/comments regarding this test:

**Acceptance criteria:**

- On IPS, the phase must be 0° at DC
- On geophones, the phase must be 90° at DC
- Identical shape in each corner

**Test result:**

**Passed:**  X

**Failed:**    

**15. Alignment offsets:**

Those are the IPS readouts that were recorded with HEPI locked, after alignment work was performed. The opposite of those values is to be installed as offset of the IPS filter banks when the Isolation loops are turned on. This way, HEPI will be operating in its *preferred alignment* state.

	IPS Readouts HEPI Locked	Offset Value
H1	1331.1	-1331.1
H2	957.72	-957.72
H3	2157.4	-2157.4
H4	-1303.6	1303.6
V1	-2742.7	2742.7
V2	-511.83	511.83
V3	1034	-1034
V4	-2882.9	2882.9

Issues/difficulties encountered during this test:

Offsets were retrieved from LHO aLog # 7180

**Acceptance criteria:**

Offsets were recorded.

**Test result:**

**Passed:**  X

**Failed:**