

*LIGO Laboratory / LIGO Scientific Collaboration*

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*LIGO*

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**aLIGO HEPI H1 HAM4  
Assembly Validation Report**

**E1300830**

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Distribution of this document:  
Advanced LIGO Project

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of the LIGO Laboratory

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## 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--HAM4

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>	1400	1280
<b>Pier 2</b>	1290	1500
<b>Pier 3</b>	1170	1390
<b>Pier 4</b>	1450	1320

### Acceptance criteria:

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

**Test result:**

**Passed: X**

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

**4. Boot Location—Test Not Performed, HR**

	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—Test Not Performed, HR**

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

Test result:

Passed: \_\_\_\_

Failed: \_\_\_\_

**6. Gaps check—Test Not Performed, HR**

## E1300830

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\_Readback\_HEPI.m

### Data in SVN at:

/ligo/svncommon/SeiSVN/seismic/HEPI/H1/HAM4/Data/Static\_Tests/  
LHO\_HPI\_HAM4\_IPS\_Read\_Back\_Unlocked\_20140409\_17:53.mat

All the loops must be turned off during this test.

	H1	H2	H3	H4	V1	V2	V3	V4
Mean (counts)	-5022	6204	5480	9327	-1718	-696	-2306	-1684
Acceptance	+/- 15000	+/- 15000	+/- 15000	+/- 15000	+/- 15000	+/- 15000	+/- 15000	+/- 15000

Test result:

Passed: X

Failed: \_\_\_\_

As soon as any driven test is performed, system relaxes and appears to spread out. Near 10k counts on some IPS. Cartesian offsets <5000nm/urads. Maybe Actuators should be examined for clearance, possibly rezero'd (keep track of IAS position) and some of these tests reran.

## 8. Sensor ASD

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

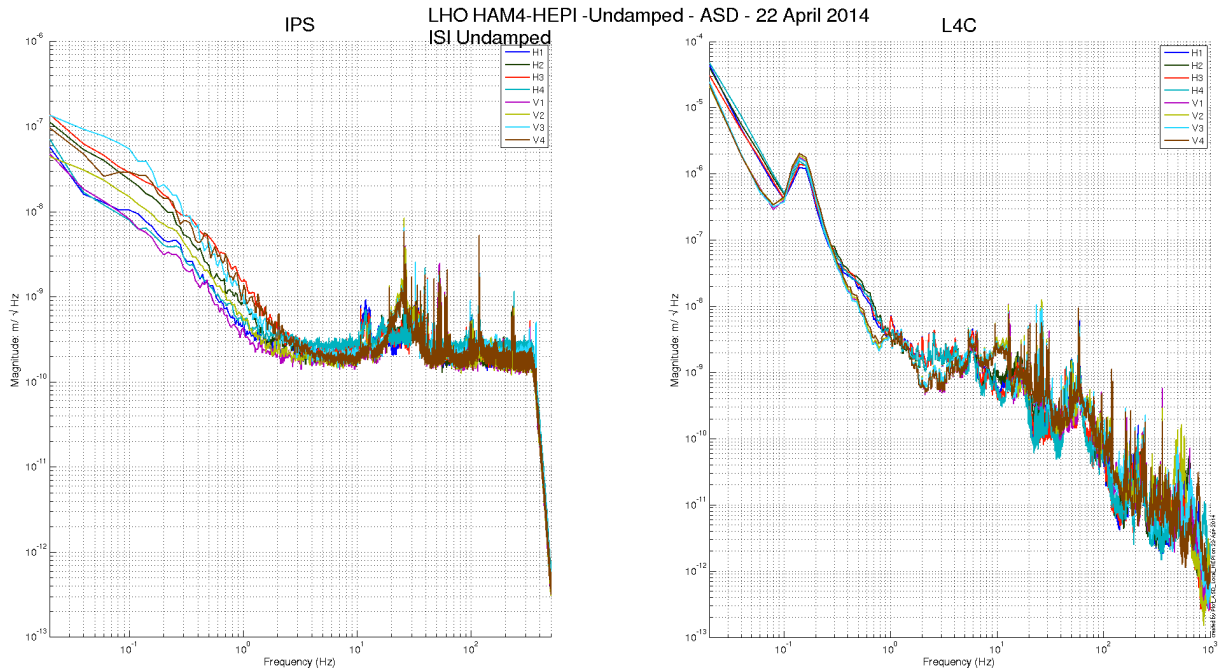
/SeiSVN/seismic/HEPI/Common/Testing\_Functions\_HEPI/ASD\_Measurements\_Local\_HEPI.m

**Data in SVN at:**

SeiSVN/seismic/HEPI/H1/HAM4/Data/Spectra/Undamped/  
LHO\_HPI\_HAM4\_ASD\_m\_IPS\_L4C\_20140422\_17:53.mat

**Figures in SVN at:**

/SeiSVN/seismic/HEPI/H1/HAM4/Data/Figures/Spectra/Undamped/  
LHO\_HPI\_HAM4\_ASD\_m\_IPS\_L4C\_20140422\_02:35:44.fig



Measurement length: 1900s - Sample window: 50s - Overlap: 50% - Frequency resolution: 20mHz - Averages: 75 - Measurement start (GPS): 1082194560

Issues/difficulties/comments regarding this test:

Measurements were performed with all PreFilters ON.

**Acceptance criteria: ??????**

■

**Test result:**

**Passed:   ?**

**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

Data File: /SeiSVN/seismic/HEPI/H1/HAM4/Data/Static\_tests/

LHO\_HPI\_HAM4\_Offset\_Local\_Drive\_20140410.mat

### . Drive of 5000 counts

	H1	H2	H3	H4	V1	V2	V3	V4
H1	8195	-1998	-614	-4299	-380	-343	247	192
H2	-2046	9485	-4987	-599	-473	-323	159	179
H3	-650	-4947	9284	-2108	279	297	-340	-544
H4	-4382	-583	-1919	8298	357	226	-250	-168
V1	-359	-406	204	377	7237	808	-1409	589
V2	-385	-351	274	262	980	7829	716	-1582
V3	333	173	-357	-207	-1748	832	7925	814
V4	250	215	-510	-86	745	-1454	800	7213

*Table - Main couplings and cross couplings*

### Issues/difficulties encountered during this test:

Changed H1 Parker Valve twice before acceptable results achieved.

### Acceptance criteria:

- 

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

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

Range of Motion results good at 0.8mm, above that IPS signals on H4 exceeds 32k. Needs rezeroing.

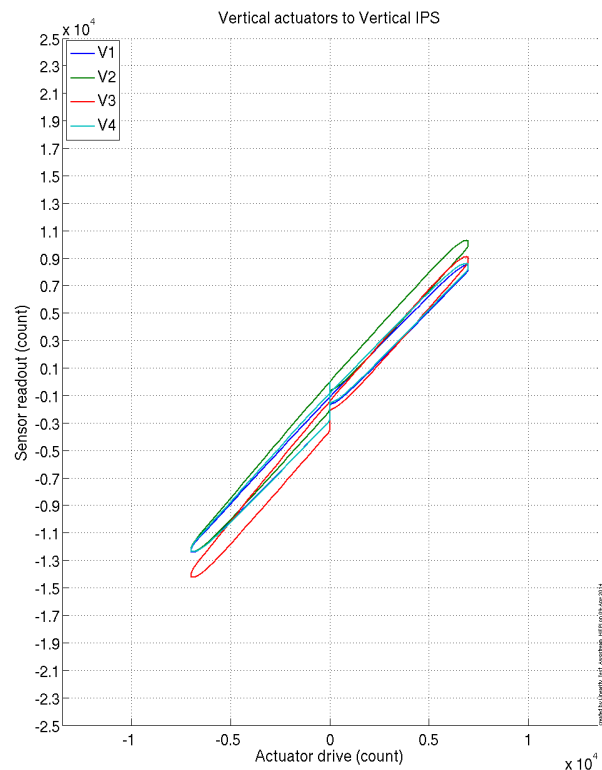
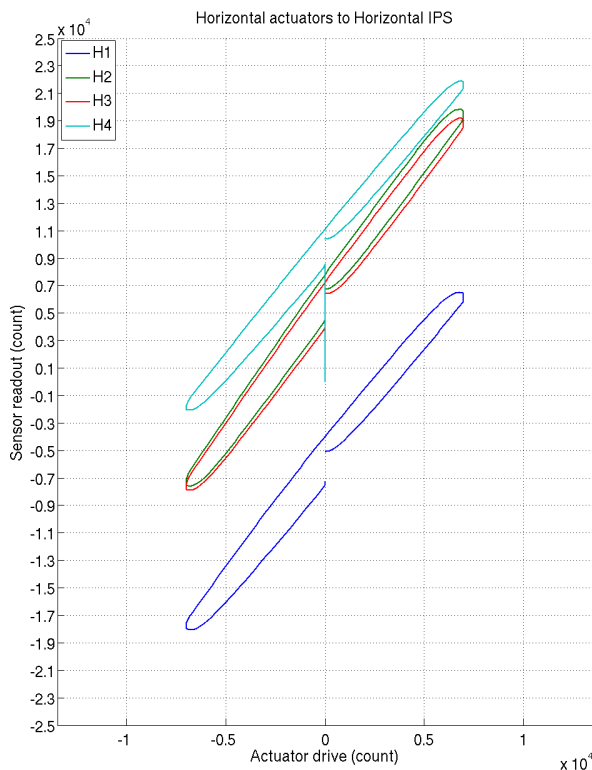
**Scripts files for processing and plotting in SVN at:**

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

**Data in SVN at:** SeiSVN/seismic/HEPI/H1/HAM4/Data/Linearity\_Test/  
H1\_HPI\_HAM4\_Linearity\_test\_20140409T133012.mat

	Slopes	Offsets
H1	1.79	-5562
H2	2.00	6264
H3	1.97	5763
H4	1.75	9923
V1	1.51	-1855
V2	1.64	-910
V3	1.69	-2379
V4	1.52	-1730

**Figures in SVN at:** /SeiSVN/seismic/HEPI/H1/HAM4/Data/Figures/Linearity\_Test/  
LHO\_HPI\_HAM4\_Linearity\_test\_20140409T133012.fig & .pdf



Issues/difficulties encountered during this test: H1 Parker Valve replaced twice. See svn directory or LHO aLOG 11252 for bad valve plots.

**Acceptance criteria:** Looks good enough

- ???????



Test result:

Passed:  X

Failed:     

**12. Actuator Plate to Shields gap—Test Not Performed, HR**

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

	Horizo	Vertical				
	ntal	Gap #2	Gap #3	Gap #1	Gap #2	Gap #3
	Gap #1					
Pier 1						
Pier 2						
Pier 3						
Pier 4						

Test result:

Passed:     

Failed:     

**13. Valve Check—Test Not performed yet.**

Scripts files for processing and plotting in SVN at:

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

Data in SVN at:

SeiSVN/seismic/HEPI/H1//Data/Spectra/Undamped/

/SeiSVN/seismic/HEPI/H1//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>	0.25	0.5x1500 - 1500	250	4176*	69.6	1*
<b>100 - 500</b>	0.5	1500 - 1500	250	4176*	69.6	1.2*
<b>10 - 100</b>	0.25	1500 - 1500	200	6592*	109.9	1.8*
<b>0.7 - 10</b>	0.05	0.75x1500 - 1500	75	12320*	205.3	3.4*
<b>0.1 - 0.7</b>	0.025	0.75x1500 - 1500	30	10080*	168.0	2.8*
<b>0.01 - 0.1</b>	0.01	0.5x1500 - 1500	10	8960*	149.3	2.5*
<b>0.002 - 0.01</b>	0.002	0.5x1500 - 1500	2	12160*	202.7	3.4*
						<b>16.1*</b>

\*: Values Need to be updated

### Data files in SVN at:

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

- LHO\_HPI\_HAM4\_Data\_L2L\_500Hz\_1000Hz\_20140411-201249.mat
- LHO\_HPI\_HAM4\_Data\_L2L\_100Hz\_500Hz\_20140411-222915.mat
- LHO\_HPI\_HAM4\_Data\_L2L\_10Hz\_100Hz\_20140411-233829.mat
- LHO\_HPI\_HAM4\_Data\_L2L\_700mHz\_10Hz\_20140412-012815.mat
- LHO\_HPI\_HAM4\_Data\_L2L\_100mHz\_700mHz\_20140412-045541.mat
- LHO\_HPI\_HAM4\_Data\_L2L\_10mHz\_100mHz\_20140412-074825.mat
- LHO\_HPI\_HAM4\_Data\_L2L\_2mHz\_10mHz\_20140412-103032.mat

### Data is called by Case #1 of:

/ligo/svncommon/SeiSVN/seismic/HEPI/H1/HAM4/Data/Transfer\_Functions/Measurements/Measurements\_List\_H1\_HPI\_HAM4.m

### Data collection script files:

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

- Run\_TF\_L2L\_500Hz\_1000Hz.m
- Run\_TF\_L2L\_100Hz\_500Hz.m
- Run\_TF\_L2L\_10Hz\_100Hz.m
- Run\_TF\_L2L\_700mHz\_10Hz.m
- Run\_TF\_L2L\_100mHz\_700mHz.m
- Run\_TF\_L2L\_10mHz\_100mHz.m
- Run\_TF\_L2L\_2mHz\_10mHz.m

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

/SeiSVN/seismic/HEPI/H1/HAM4/Scripts/Control\_Scripts/Version\_5/

- Step\_1\_TF\_Loc\_to\_Loc\_H1\_HEPI\_HAM4.m

**Figures in SVN at:**

/SeiSVN/seismic/HEPI/H1/HAM4/Data/ Figures/Transfer\_Functions/Measurements/Undamped/

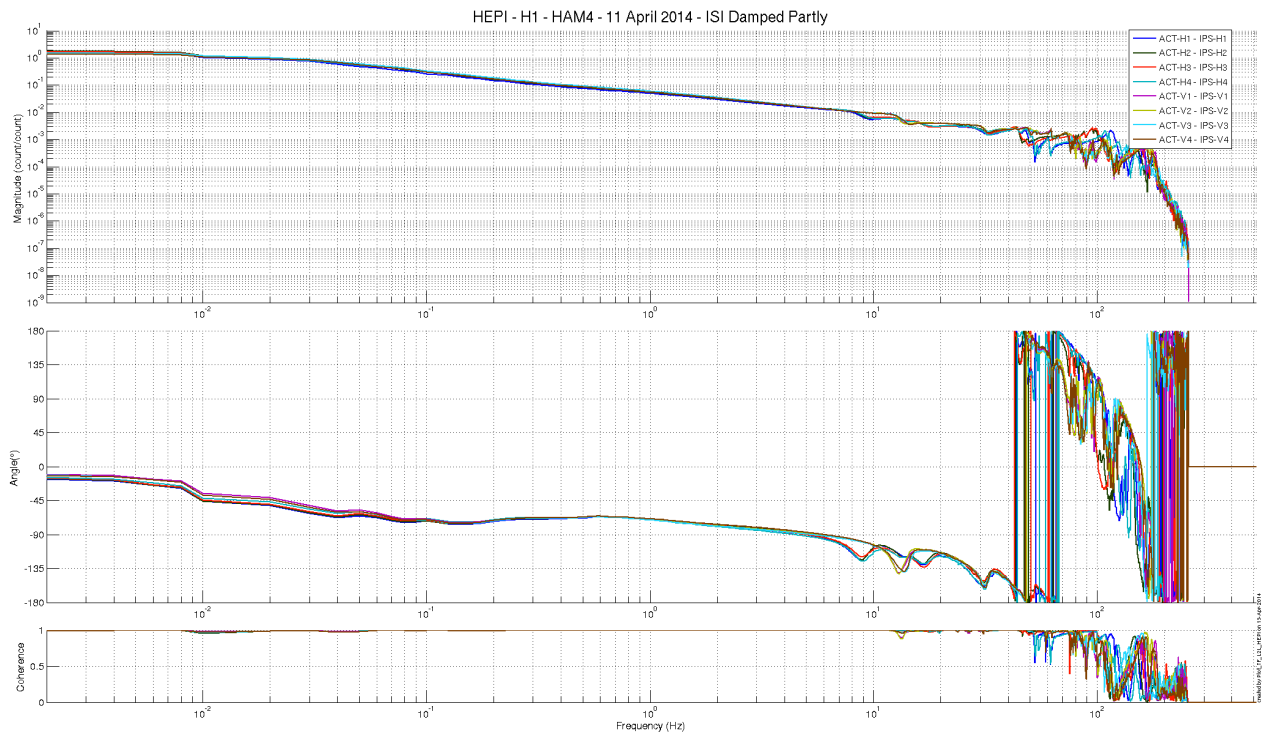
- H1\_HPI\_HAM4\_TF\_L2L\_Raw\_from\_ACT\_to\_IPS\_2014\_04\_14.fig
- H1\_HPI\_HAM4\_TF\_L2L\_Raw\_from\_ACT\_to\_L4C\_2014\_04\_14.fig

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

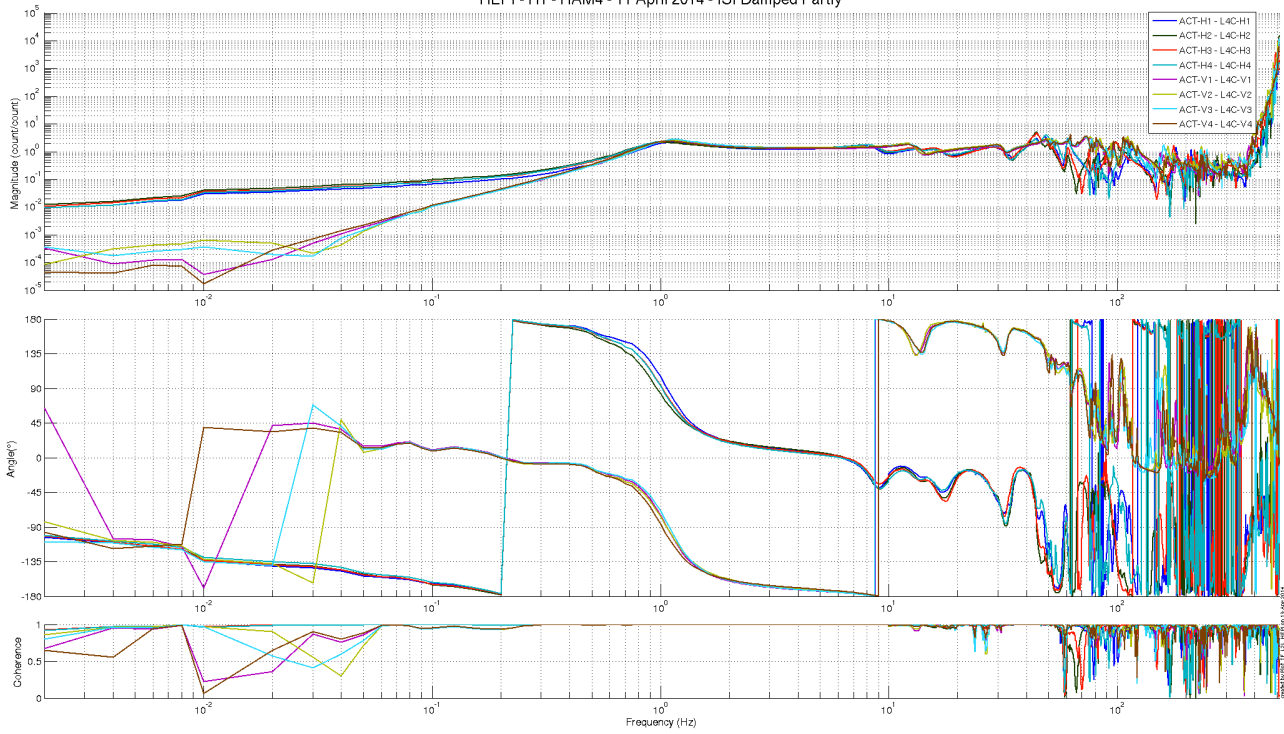
/SeiSVN/seismic/HEPI/H1/HAM4/Data/Transfer\_Functions/Simulations/Undamped/

- H1\_HPI\_HAM4\_TF\_L2L\_Raw\_2014\_04\_14.mat

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



HEPI - H1 - HAM4 - 11 April 2014 - ISI Damped Party



Issues/difficulties/comments regarding this test:

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**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:**

Values retrieved from H1:HPI\_CUST\_CHAMBER{HAM4}\_OVERVIEW and CART\_BIAS on 5 February 2015.

	IPS Readouts HEPI Isolated	Cartesian DOF	TARGET
H1	-5240	X	168500
H2	6080	Y	-142100
H3	5380	Z	-44600
H4	8280	RX	10800
V1	-1410	RY	3500
V2	-410	RZ	-77500
V3	-1610	HP	140600
V4	-1170	VP	-14000

Issues/difficulties encountered during this test:

**Acceptance criteria:**  
Offsets were recorded.

**Test result:**

**Passed:**  X

**Failed:**