

*LIGO Laboratory / LIGO Scientific Collaboration*

LIGO- E1300837

**LIGO**

Date (fixed)

**aLIGO HEPI H1 ETMX  
Assembly Validation Report**

**E1300837**

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Distribution of this document:  
Advanced LIGO Project

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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—Need to Collect

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—**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**

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/ETMX/Data/Static\_Tests/  
H1\_HPI\_ETMX\_IPS\_Read\_Back\_Unlocked\_20141218\_08:16.mat

All the loops must be turned off during this test.

|               | H1           | H2           | H3           | H4           | V1           | V2           | V3           | V4           |
|---------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Mean (counts) | -14186       | 6453         | -3437        | -1255        | 9293         | -7126        | -949         | -7449        |
| Acceptance    | +/-<br>15000 | +/-<br>15000 | +/-<br>15000 | +/-<br>15000 | +/-<br>15000 | +/-<br>15000 | +/-<br>15000 | +/-<br>15000 |

Test result:

Passed: X

Failed: \_\_\_\_

## 8. Sensor ASD

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

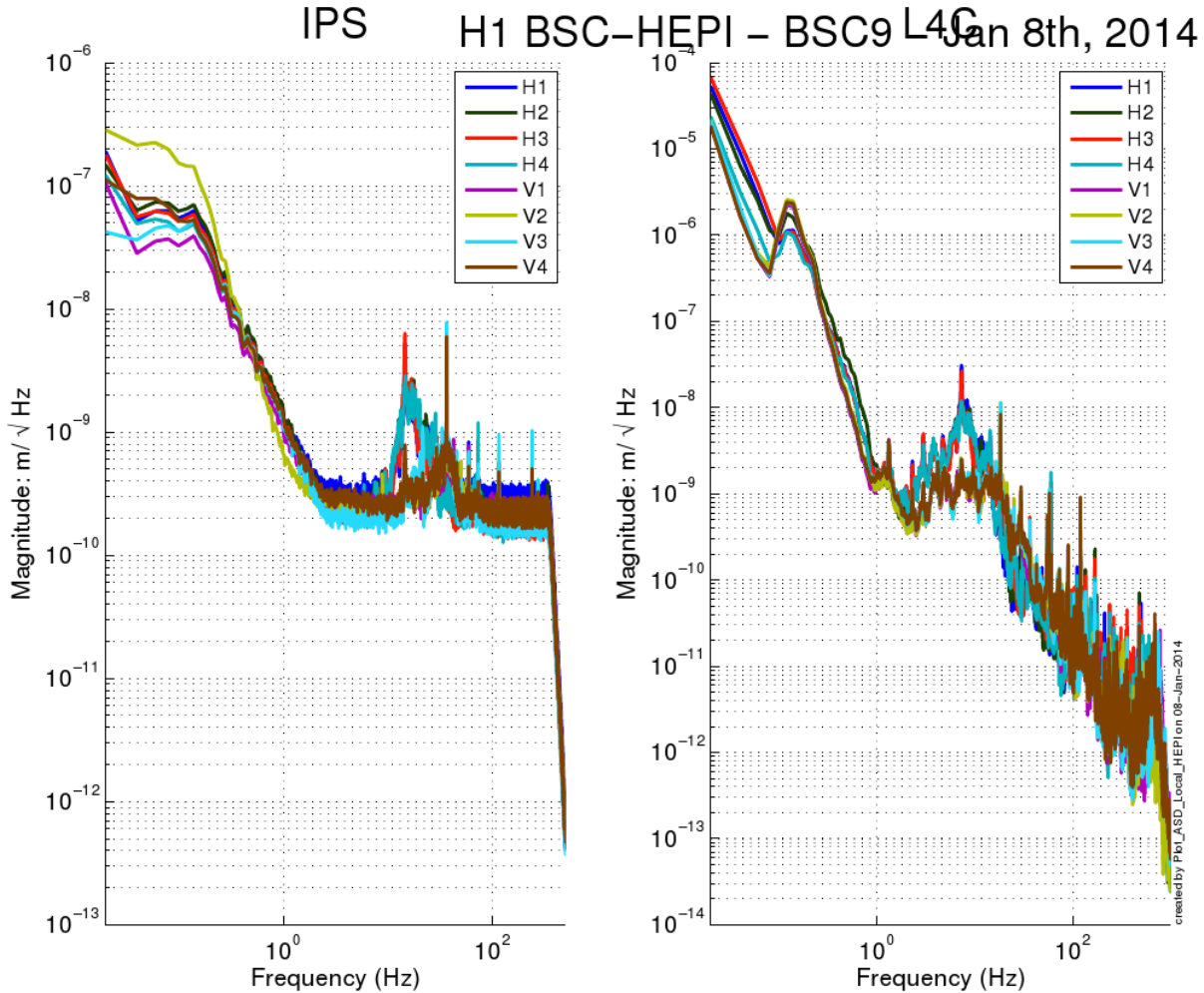
/SeiSVN/seismic/HEPI/Common/Testing\_Functions\_HEPI/ASD\_Measurements\_Local\_HEPI.m

**Data in SVN at:**

SeiSVN/seismic/HEPI/H1/ETMX/Data/Spectra/Undamped/  
H1\_HPI\_ETMX\_ASD\_m\_IPS\_L4C\_2020\_01\_08\_4 1:6:.mat

**Figures in SVN at:**

/SeiSVN/seismic/HEPI/H1/ETMX/Data/Figures/Spectra/Undamped/  
H1\_HPI\_ETMX\_ASD\_m\_IPS\_L4C\_2020\_01\_08\_4 1\_1\_.fig



Measurement length: 1900s – Sample window: 50s – Overlap: 50% – Frequency resolution

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

**. Drive of 5000 counts**

|    | H1      | H2      | H3      | H4      | V1      | V2      | V3      | V4      |
|----|---------|---------|---------|---------|---------|---------|---------|---------|
| H1 | 9443.6  | -3704.3 | -812.1  | -2989.5 | -328.7  | 293.1   | -218.0  | -468.6  |
| H2 | -2981.2 | 9903.0  | -3205.7 | -921.8  | 106.1   | -161.8  | -575.6  | -145.9  |
| H3 | -526.6  | -2998.7 | 9828.0  | -4102.2 | -43.0   | -287.2  | -138.5  | 2.9     |
| H4 | -2319.4 | -572.1  | -2982.5 | 8676.0  | -383.4  | 67.9    | -159.9  | -211.4  |
| V1 | 54.5    | 373.8   | 166.3   | -163.2  | 6172.4  | 1016.5  | -1880.9 | 1083.6  |
| V2 | 484.4   | -46.4   | -159.1  | 149.5   | 1025.5  | 6503.6  | 957.2   | -1859.2 |
| V3 | 269.5   | -169.3  | 238.2   | 172.2   | -1655.0 | 1559.3  | 6279.6  | 868.6   |
| V4 | -14.9   | 214.0   | 293.1   | 41.4    | 1243.5  | -1438.4 | 772.2   | 6025.7  |

***Table - Main couplings and cross couplings***

Issues/difficulties encountered during this test: None

### Acceptance criteria:

- The results in these three tables must be the same (within ???%)**If you drive different amounts, why would you expect the results to be the same? HR**

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

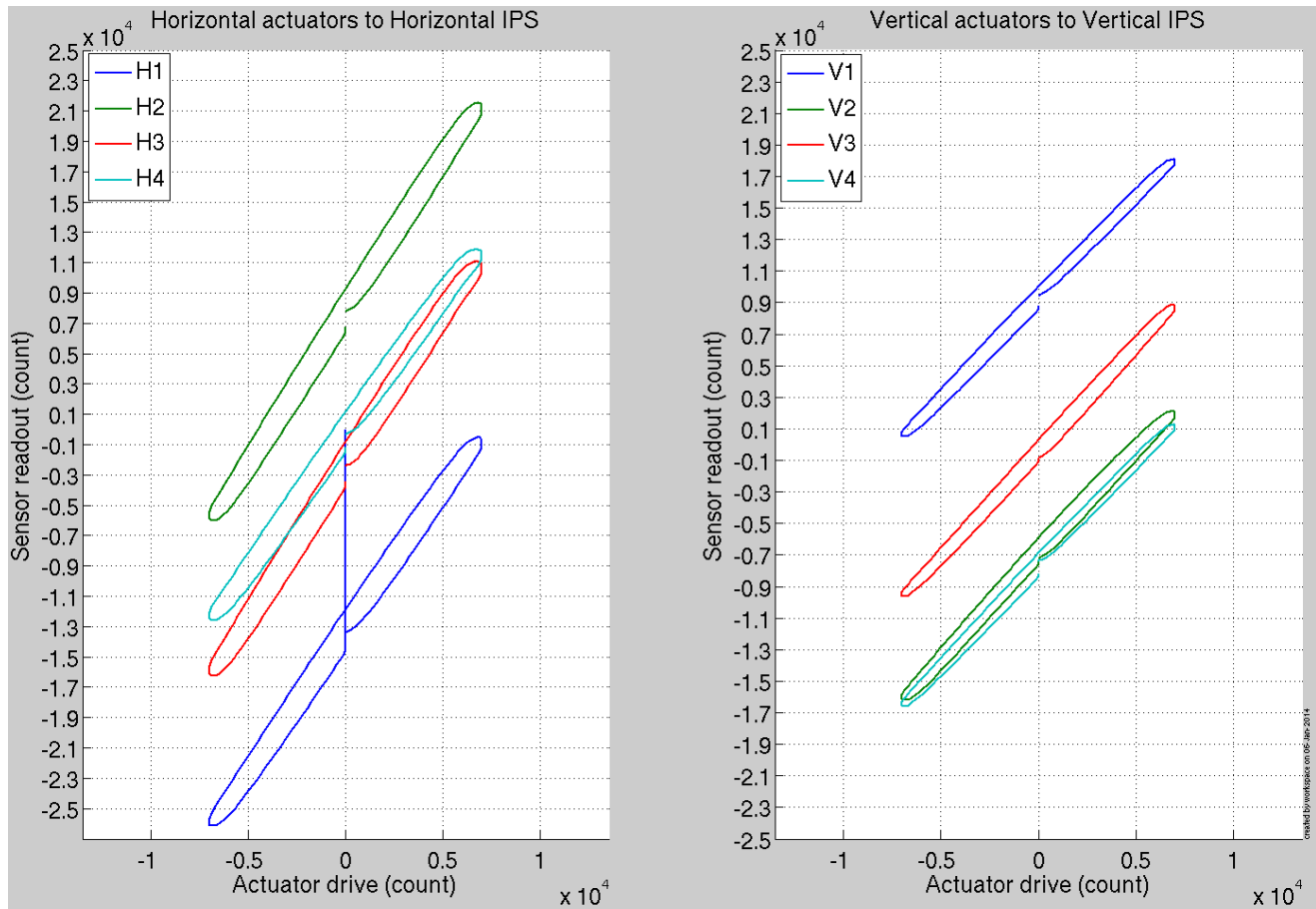
Data in SVN at:

SeiSVN/seismic/HEPI/H1/ETMX/Data/Linearity\_Test/  
H1\_HPI\_ETMX\_Linearity\_test\_20140103T152206.mat

Figures in SVN at:

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

|    | Slopes | Offsets |
|----|--------|---------|
| H1 | 1.855  | -13170  |
| H2 | 1.996  | 7857    |
| H3 | 1.985  | -2348   |
| H4 | 1.781  | -190    |
| V1 | 1.272  | 9361    |
| V2 | 1.318  | -6892   |
| V3 | 1.330  | -422    |
| V4 | 1.293  | -7570   |





Issues/difficulties encountered during this test:

Acceptance criteria:

- ???????

Test result:

Passed: ?

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

|        | Horizontal | Vertical |        |        |        |        |
|--------|------------|----------|--------|--------|--------|--------|
|        | Gap #1     | Gap #2   | Gap #3 | Gap #1 | Gap #2 | Gap #3 |
| Pier 1 |            |          |        |        |        |        |
| Pier 2 |            |          |        |        |        |        |
| Pier 3 |            |          |        |        |        |        |
| Pier 4 |            |          |        |        |        |        |

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>     | 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\_BSC9\_Data\_L2L\_500Hz\_1000Hz\_20140102-162618.mat
- LHO\_HPI\_BSC9\_Data\_L2L\_100Hz\_500Hz\_20140102-184241.mat
- LHO\_HPI\_BSC9\_Data\_L2L\_10Hz\_100Hz\_20140102-195153.mat
- LHO\_HPI\_BSC9\_Data\_L2L\_700mHz\_10Hz\_20140103-031632.mat
- LHO\_HPI\_BSC9\_Data\_L2L\_100mHz\_700mHz\_20140102-214141.mat
- LHO\_HPI\_BSC9\_Data\_L2L\_10mHz\_100mHz\_20140103-003426.mat
- LHO\_HPI\_BSC9\_Data\_L2L\_2mHz\_10mHz\_20140103-064355.mat

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

/ligo/svncommon/SeiSVN/seismic/HEPI/H1/ETMX/Data/Transfer\_Functions/Measurements/Measurements\_List\_H1\_HPI\_ETMX.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/ETMX/Scripts/Control\_Scripts/Version\_5/  
 - Step\_1\_TF\_Loc\_to\_Loc\_H1\_HEPI\_ETMX.m

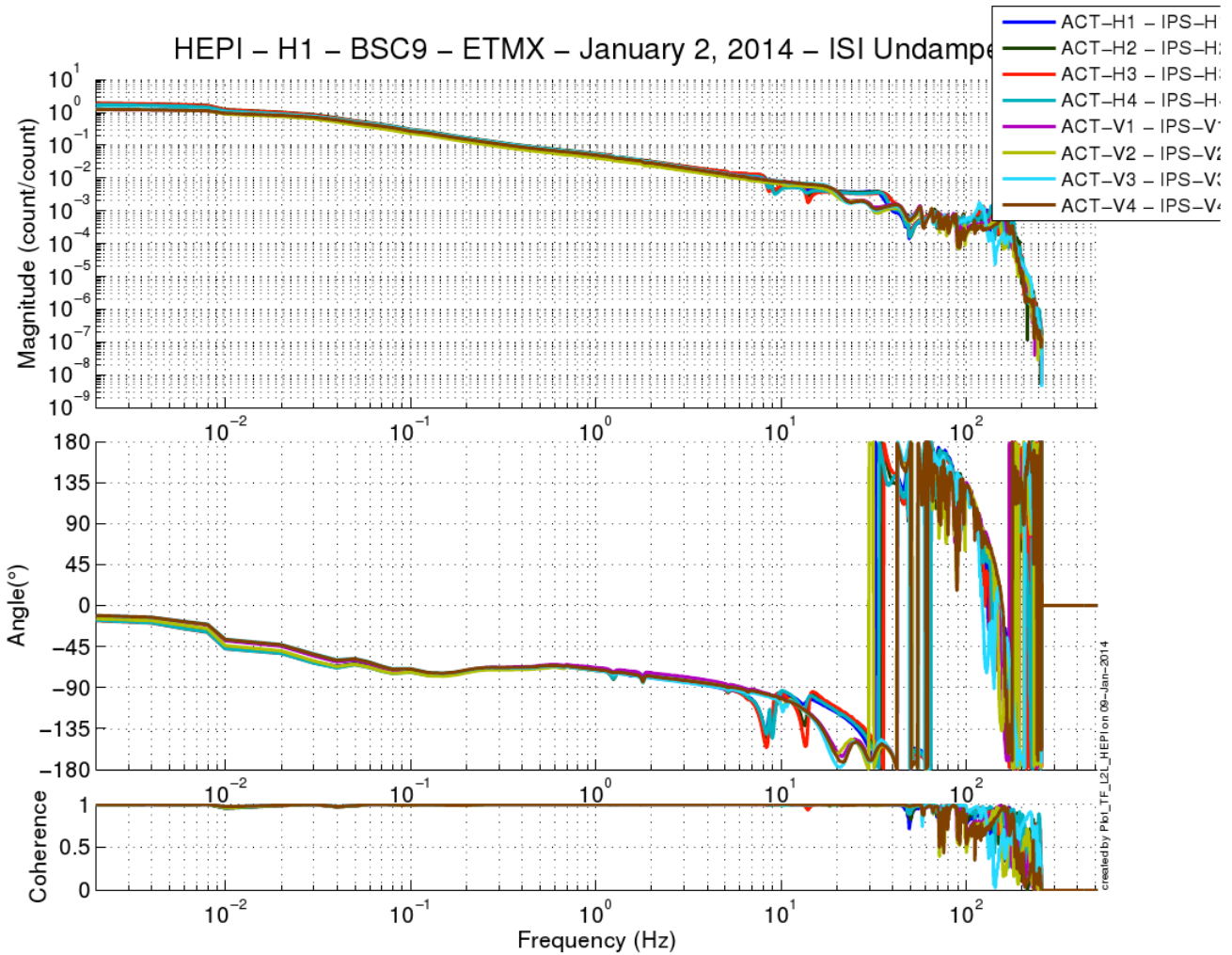
**Figures in SVN at:**

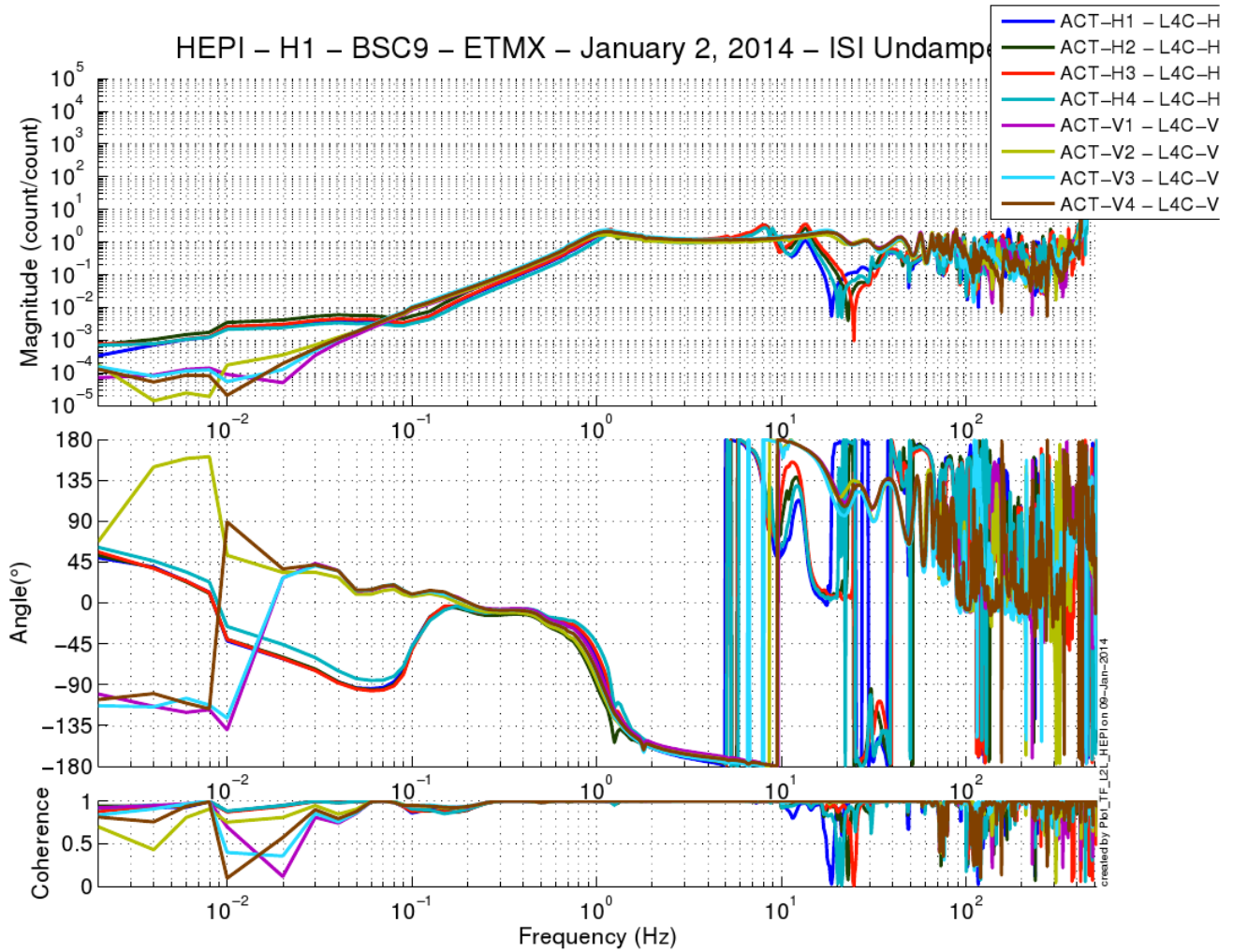
- /SeiSVN/seismic/HEPI/H1/ETMX/Data/ Figures/Transfer\_Functions/Measurements/Undamped/  
 - H1\_HPI\_ETMX\_TF\_L2L\_Raw\_from\_ACT\_to\_IPS\_2014\_01\_02.fig  
 - H1\_HPI\_ETMX\_TF\_L2L\_Raw\_from\_ACT\_to\_L4C\_2014\_01\_02.fig

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

- /SeiSVN/seismic/HEPI/H1/ETMX/Data/Transfer\_Functions/Simulations/Undamped/  
 - H1\_HPI\_ETMX\_TF\_L2L\_Raw\_2014\_01\_02.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—**Not sure if this is true, HR**
- 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[**NOT**] 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.

**This text should be rewritten in respect of the now Bias Position alignment, HR**

|    | IPS<br>Read-<br>outs<br>HEPI<br>Locked | Offset<br>Value |
|----|--|-----------------|
| H1 | -11500                                 | -<br>1331.1     |
| H2 | 7500                                   | -<br>957.72     |
| H3 | 1200                                   | -<br>2157.4     |
| H4 | 2200                                   | 1303.6          |
| V1 | 6900                                   | 2742.7          |
| V2 | -6900                                  | 511.83          |
| V3 | 1560                                   | -1034           |
| V4 | -7760                                  | 2882.9          |

Offsets not really worth the typing.

Issues/difficulties encountered during this test:

Readings were retrieved from LHO aLog # 8504

**Acceptance criteria:**

Offsets were recorded.

**Test result:**

**Passed:**   X  

**Failed:**