*LIGO Laboratory / LIGO Scientific Collaboration*

LIGO- E1300831-v1 *LIGO* Date (fixed)

**aLIGO HEPI H1 HAM5**

**Assembly Validation Report**

**E1300831**

Hugh Radkins, Hugo Paris, Fabrice Matichard for the SEI Team

Distribution of this document:

Advanced LIGO Project

This is an internal working note

of the LIGO Laboratory

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| **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 |

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# 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

# 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)

# Load Cells assembly--HAM4

BSC HEPI load cell capacity → 3000 lbs

HAM HEPI load cell capacity → 2000 lbs

|  |  |  |
| --- | --- | --- |
|  | **Left Spring (lbs)** | **Right Spring (lbs)** |
| **Pier 1** | 1290 | 1400 |
| **Pier 2** | 1430 | 1460 |
| **Pier 3** | 1325 | 1320 |
| **Pier 4** | 1245 | 1265 |

**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: .**

# 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: .**

# 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** | | | | | | | | | | | | | | | |
|  | **Gap1** | **Gap2** | **Gap3** | **Gap4 above** | **Gap4 under** | **Gap5** | **Gap1** | **Gap2** | **Gap3** | **Gap4 above** | **Gap4 under** | **Gap5** | **Gap1** | **Gap2** | **Gap3** | **Gap4 above** | **Gap4 under** | **Gap5** |
| **Pier 1** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Pier 2** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Pier 3** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Pier 4** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Test result: Passed: Failed:**

# 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: .**

# 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/HAM5/Data/Static\_Tests/

LHO\_HPI\_HAM5\_IPS\_Read\_Back\_Unlocked\_date.mat

All the loops must be turned off during this test.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | H1 | H2 | H3 | H4 | V1 | V2 | V3 | V4 |
| Mean (counts) |  |  |  |  |  |  |  |  |
| Acceptance | +/- 15000 | +/- 15000 | +/- 15000 | +/- 15000 | +/- 15000 | +/- 15000 | +/- 15000 | +/- 15000 |

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

This data not in svn. Will attempt to collect. Data in section 10, Offset Local Drive and even more obvious, the Linearity Data in Section 11, will give a good indication of the unlocked free hanging position.

# 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:**

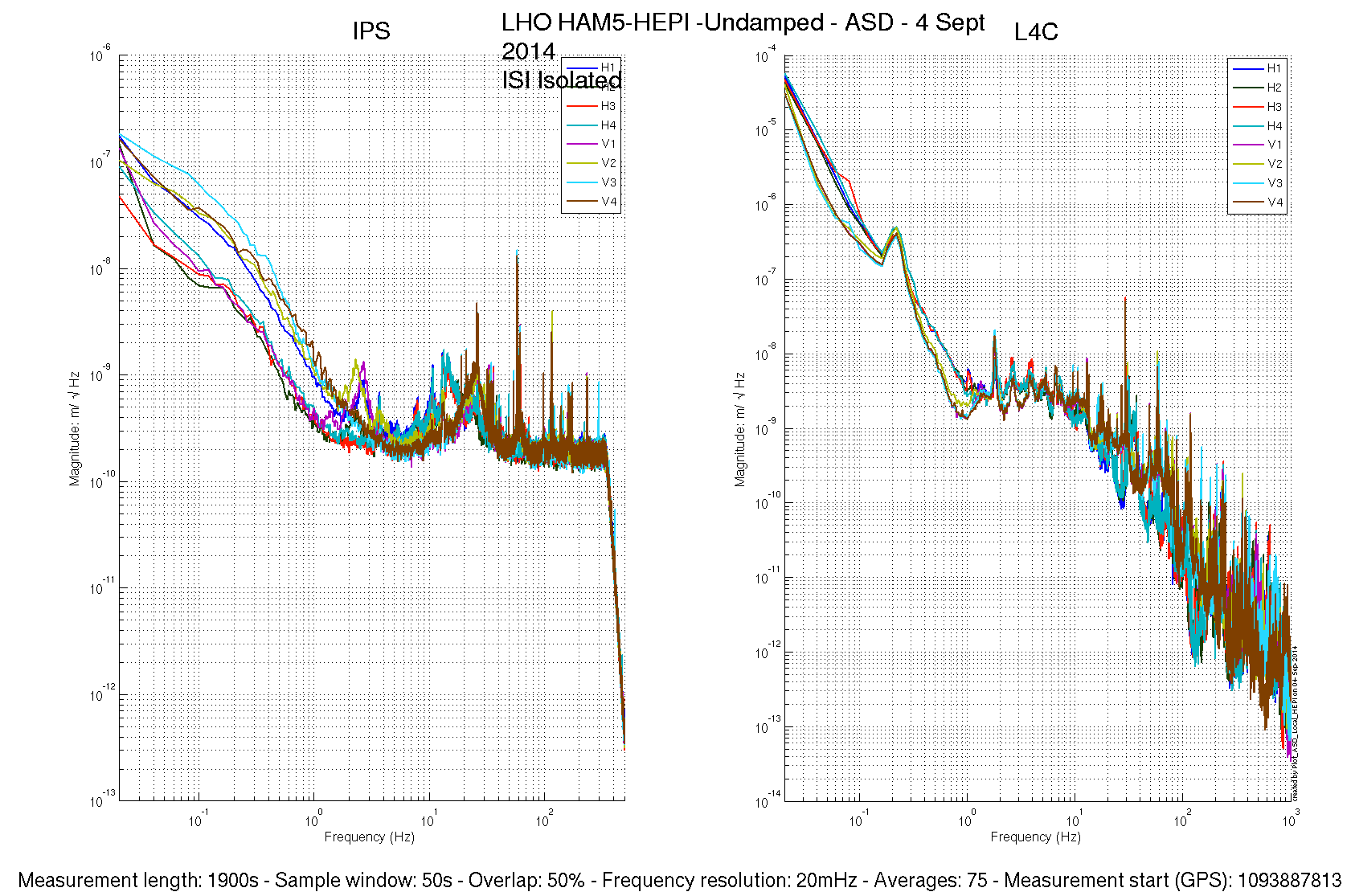
SeiSVN/seismic/HEPI/H1/HAM5/Data/Spectra/Undamped/

LHO\_HPI\_HAM5\_ASD\_m\_IPS\_L4C\_20140904\_10:43:17.mat

**Figures in SVN at:**

/SeiSVN/seismic/HEPI/H1/HAM5/Data/Figures/Spectra/Undamped/

LHO\_HPI\_HAM5\_ASD\_m\_IPS\_L4C\_20140904\_10:43:17.fig



Issues/difficulties/comments regarding this test:

Measurements were performed with all PreFilters ON.

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



**Test result: Passed: ? Failed: .**

# 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 watchogs.

. 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).

# 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/HAM5/Data/Static\_tests/

LHO\_HPI\_HAM5\_Offset\_Local\_Drive\_20140422.mat

. ***Drive of 5000 counts***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | H1 | H2 | H3 | H4 | V1 | V2 | V3 | V4 |
| H1 | 10897 | -2440 | -600 | -5290 | -311 | -402 | 288 | 46 |
| H2 | -2108 | 11625 | -5897 | -836 | -546 | -483 | 243 | 237 |
| H3 | -335 | -4970 | 10365 | -2434 | 240 | 400 | -425 | -527 |
| H4 | -5156 | -545 | -2203 | 10792 | 376 | 295 | -346 | -45 |
| V1 | -317 | -396 | 220 | 575 | 8305 | 969 | -1753 | 768 |
| V2 | -339 | -351 | 345 | 423 | 933 | 8127 | 802 | -1708 |
| V3 | 343 | 310 | -412 | -115 | -1484 | 1072 | 7974 | 757 |
| V4 | 134 | 328 | -456 | -167 | 744 | -1233 | 1022 | 7513 |

*Table - Main couplings and cross couplings*

Issues/difficulties encountered during this test: No issues.

**Acceptance criteria:**

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

# Linearity Test/Range of motion in the local basis

Range of Motion: All dofs good at 1mm except neg V1 & V4. These two dofs were good at 0.8mm but not at 0.9mm.

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

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

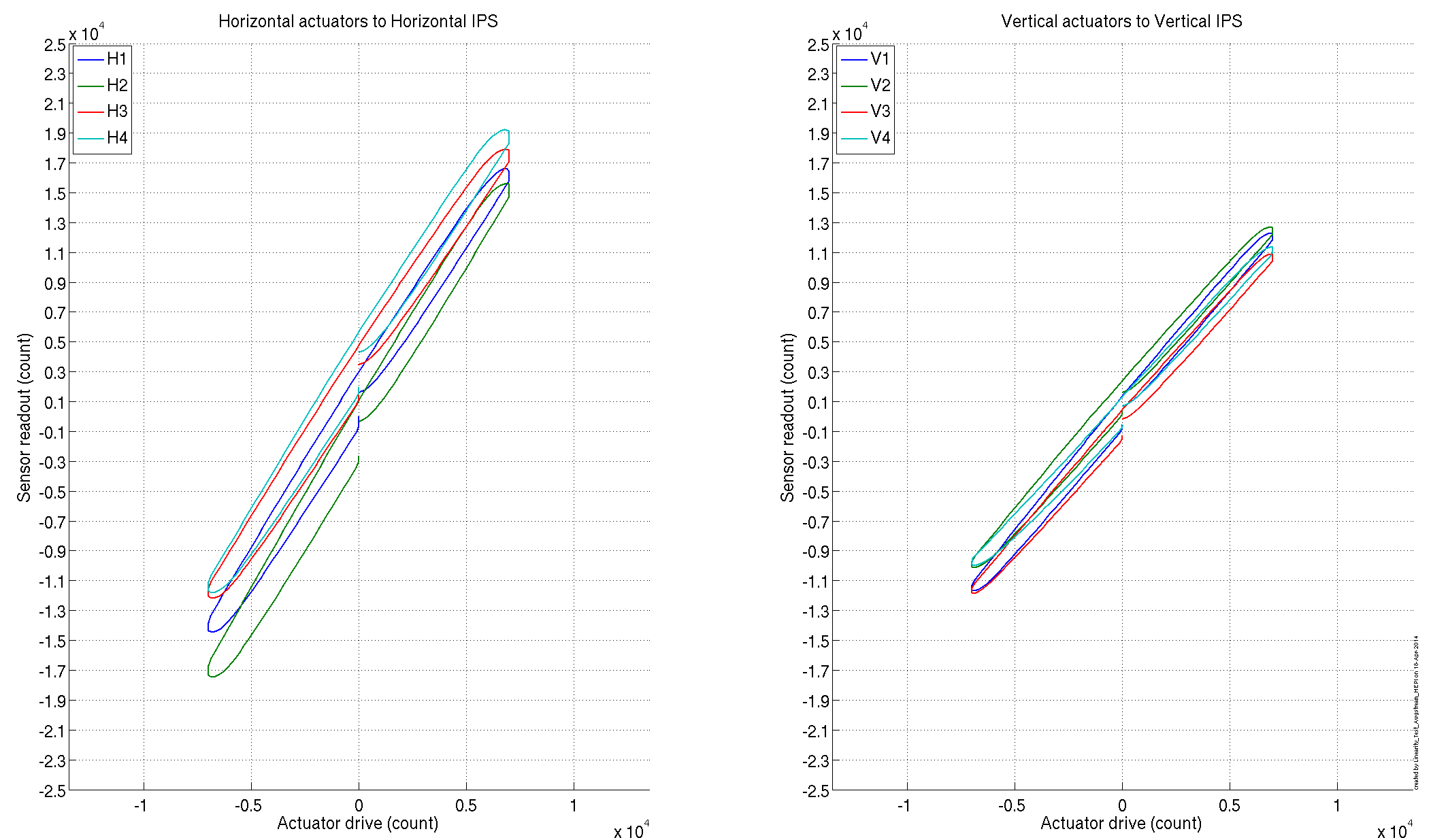
**Data in SVN at:**

SeiSVN/seismic/HEPI/H1/HAM5/Data/Linearity\_Test/ H1\_HPI\_HAM5\_Linearity\_test\_20140418T153926.mat

|  |  |  |
| --- | --- | --- |
|  | Slopes | Offsets |
| H1 | 2.26 | 1270 |
| H2 | 2.41 | -769 |
| H3 | 2.19 | 3073 |
| H4 | 2.26 | 3845 |
| V1 | 1.74 | 398 |
| V2 | 1.65 | 1392 |
| V3 | 1.64 | -419 |
| V4 | 1.56 | 558 |

**Figures in SVN at:**

/SeiSVN/seismic/HEPI/H1/HAM5/Data/Figures/Linearity\_Test/



Issues/difficulties encountered during this test: No issues, first try results.

**Acceptance criteria:** Looks good enough

* ???????

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

# 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:**

# Valve Check—Test Not performed yet.

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

/SeiSVN/seismic/HEPI/H1/HAM5/Scripts/Valve\_Check/plot\_valve\_check.m

**Data in SVN at:**

SeiSVN/seismic/HEPI/H1/HAM5/Data/Spectra/Undamped/

/SeiSVN/seismic/HEPI/H1/HAM5/Scripts/Valve\_Check

**Figures in SVN at:**

/SeiSVN/seismic/HEPI/H1/HAM5/Scripts/Valve\_Check

**Acceptance criteria: ????**

**Test result: Passed: Failed: .**

# Local-to-local measurements

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Band (Hz)** | **Resolution** | **Amplitude** | **Nreps** | **Time (s)** | **Time (min)** | **Time (h)** |
| **500-1000** | 0.25 | 0.5x1500 – 1500 | 250 | 4176\* | 69.6 | 1\* |
| **100 - 500** | 0.5 | 1500 – 1500 | 250 | 4176\* | 69.6 | 1.2\* |
| **10 - 100** | 0.25 | 1500 – 1500 | 200 | 6592\* | 109.9 | 1.8\* |
| **0.7 - 10** | 0.05 | 0.75x1500 – 1500 | 75 | 12320\* | 205.3 | 3.4\* |
| **0.1 - 0.7** | 0.025 | 0.75x1500 – 1500 | 30 | 10080\* | 168.0 | 2.8\* |
| **0.01 - 0.1** | 0.01 | 0.5x1500 – 1500 | 10 | 8960\* | 149.3 | 2.5\* |
| **0.002 - 0.01** | 0.002 | 0.5x1500 – 1500 | 2 | 12160\* | 202.7 | 3.4\* |
|  |  |  |  |  |  | **16.1\*** |

\*: Values Need to be updated

**Data files in SVN at:**

/SeiSVN/seismic/HEPI/H1/HAM5/Data/Transfer\_Functions/Measurements/Undamped/

* LHO\_HPI\_HAM5\_Data\_L2L\_500Hz\_1000Hz\_20140904-152405.mat
* LHO\_HPI\_HAM5\_Data\_L2L\_100Hz\_500Hz\_20140904-162031.mat
* LHO\_HPI\_HAM5\_Data\_L2L\_10Hz\_100Hz\_20140904-164947.mat
* LHO\_HPI\_HAM5\_Data\_L2L\_700mHz\_10Hz\_20140904-173253.mat
* LHO\_HPI\_HAM5\_Data\_L2L\_100mHz\_700mHz\_20140904-195337.mat
* LHO\_HPI\_HAM5\_Data\_L2L\_10mHz\_100mHz\_20140904-215302.mat
* LHO\_HPI\_HAM5\_Data\_L2L\_2mHz\_10mHz\_20140905-000831.mat

**Data is called by** **Case #2 of:**/ligo/svncommon/SeiSVN/seismic/HEPI/H1/HAM5/Data/Transfer\_Functions/Measurements/

Measurements\_List\_H1\_HPI\_HAM5.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/HAM5/Scripts/Control\_Scripts/Version\_5/

* Step\_1\_TF\_Loc\_to\_Loc\_H1\_HEPI\_HAM5.m

**Figures in SVN at:**

/SeiSVN/seismic/HEPI/H1/HAM5/Data/ Figures/Transfer\_Functions/Measurements/Undamped/

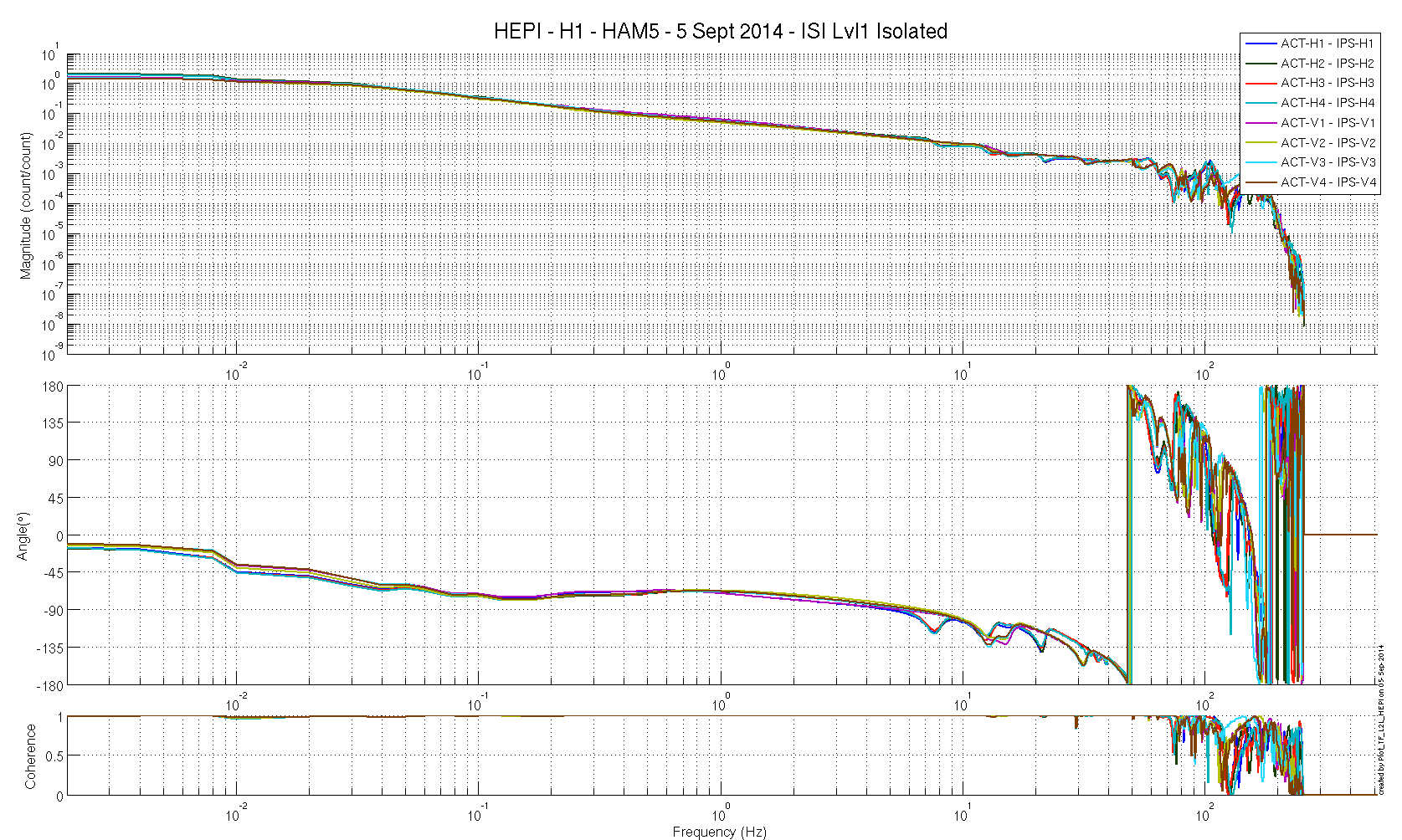
* H1\_HPI\_HAM5\_TF\_L2L\_Raw\_from\_ACT\_to\_IPS\_2014\_09\_05.fig
* H1\_HPI\_HAM5\_TF\_L2L\_Raw\_from\_ACT\_to\_L4C\_2014\_09\_05.fig

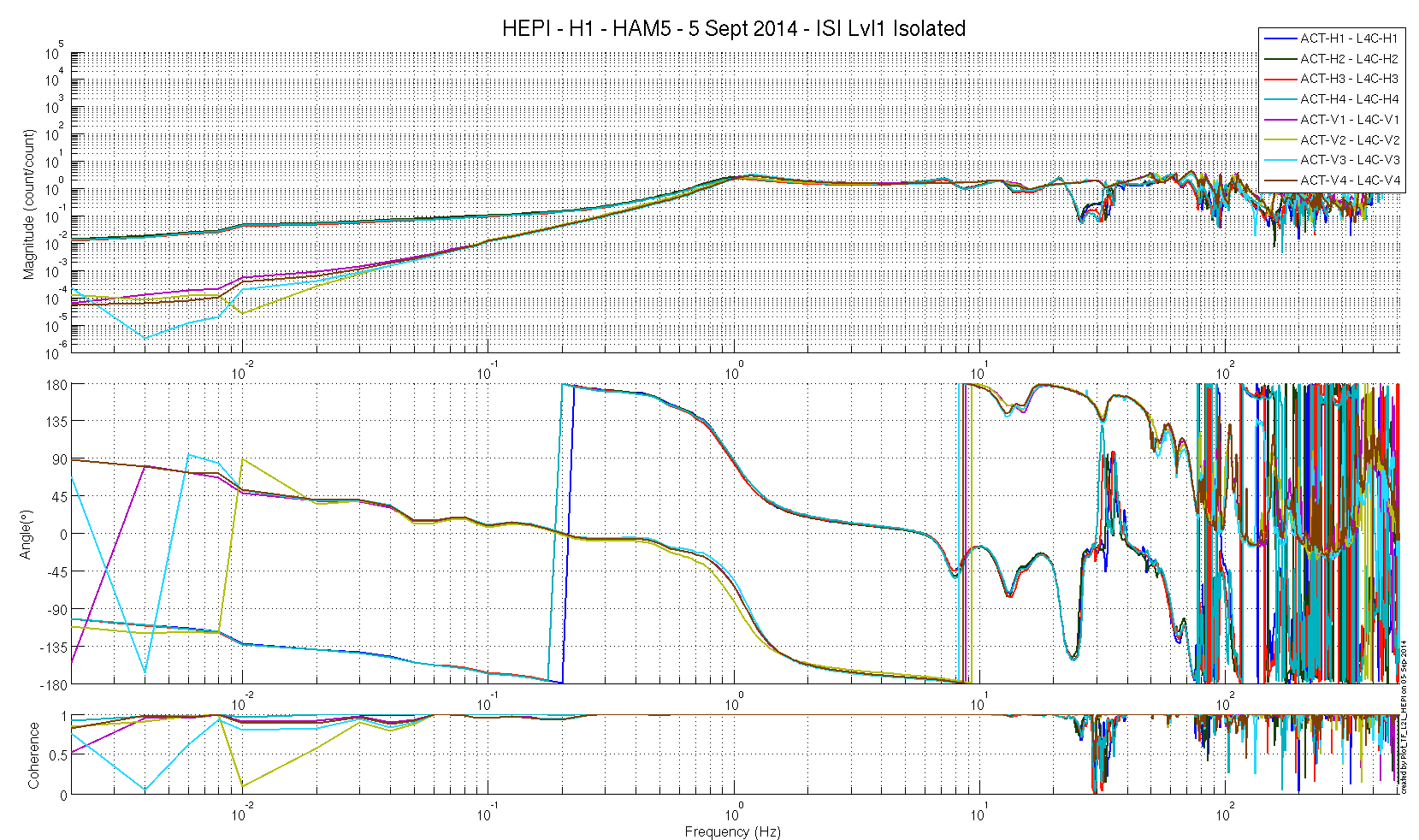
**Storage of measured transfer functions in the SVN at:**

/SeiSVN/seismic/HEPI/H1/HAM5/Data/Transfer\_Functions/Simulations/Undamped/

* H1\_HPI\_HAM5\_TF\_L2L\_Raw\_2014\_09\_05.mat

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



![A description...](data:None;base64,)

Issues/difficulties/comments regarding this test: Low coherence at lowest frequencies on the L4C. Look at phase above these frequencies.

**Acceptance criteria:**

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

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

# Alignment offsets:

Those are the IPS readouts that were recorded with HEPI isolated, after alignment work by commissioners.

|  |  |  |  |
| --- | --- | --- | --- |
|  | IPS Readouts HEPI Isolated | Cartesian DOF | TARGET |
| H1 | -500 | X | 47400 |
| H2 | -460 | Y | -10280 |
| H3 | 5320 | Z | -16600 |
| H4 | 2990 | RX | 96900 |
| V1 | 1760 | RY | -13100 |
| V2 | 1710 | RZ | 12500 |
| V3 | -3610 | HP | 71300 |
| V4 | -1560 | VP | -19000 |

Issues/difficulties encountered during this test:

Readings were retrieved from medm H1:HPI-HAM5\_Cart\_BIAS 4 Feb 2015.

**Acceptance criteria:**

Offsets were recorded.

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