*LIGO Laboratory / LIGO Scientific Collaboration*

LIGO- E1300832 *LIGO* Date (fixed)

**aLIGO HEPI H1 HAM6**

**Assembly Validation Report**

**E1300832**

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Distribution of this document:

Advanced LIGO Project

This is an internal working note

of the LIGO Laboratory

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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--HAM6

BSC HEPI load cell capacity → 3000 lbs

HAM HEPI load cell capacity → 2000 lbs

|  |  |  |
| --- | --- | --- |
|  | **Left Spring (lbs)** | **Right Spring (lbs)** |
| **Pier 1** | 1430 | 1510 |
| **Pier 2** | 1360 | 1480 |
| **Pier 3** | 1510 | 1500 |
| **Pier 4** | 1380 | 1440 |

**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/HAM6/Data/Static\_Tests/

LHO\_HPI\_HAM6\_IPS\_Read\_Back\_Unlocked\_20130917\_16:13.mat

All the loops must be turned off during this test.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | H1 | H2 | H3 | H4 | V1 | V2 | V3 | V4 |
| Mean (counts) | 1785 | 1011 | 928 | -3769 | -1842 | -2227 | -1967 | -1822 |
| 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.

# 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:**

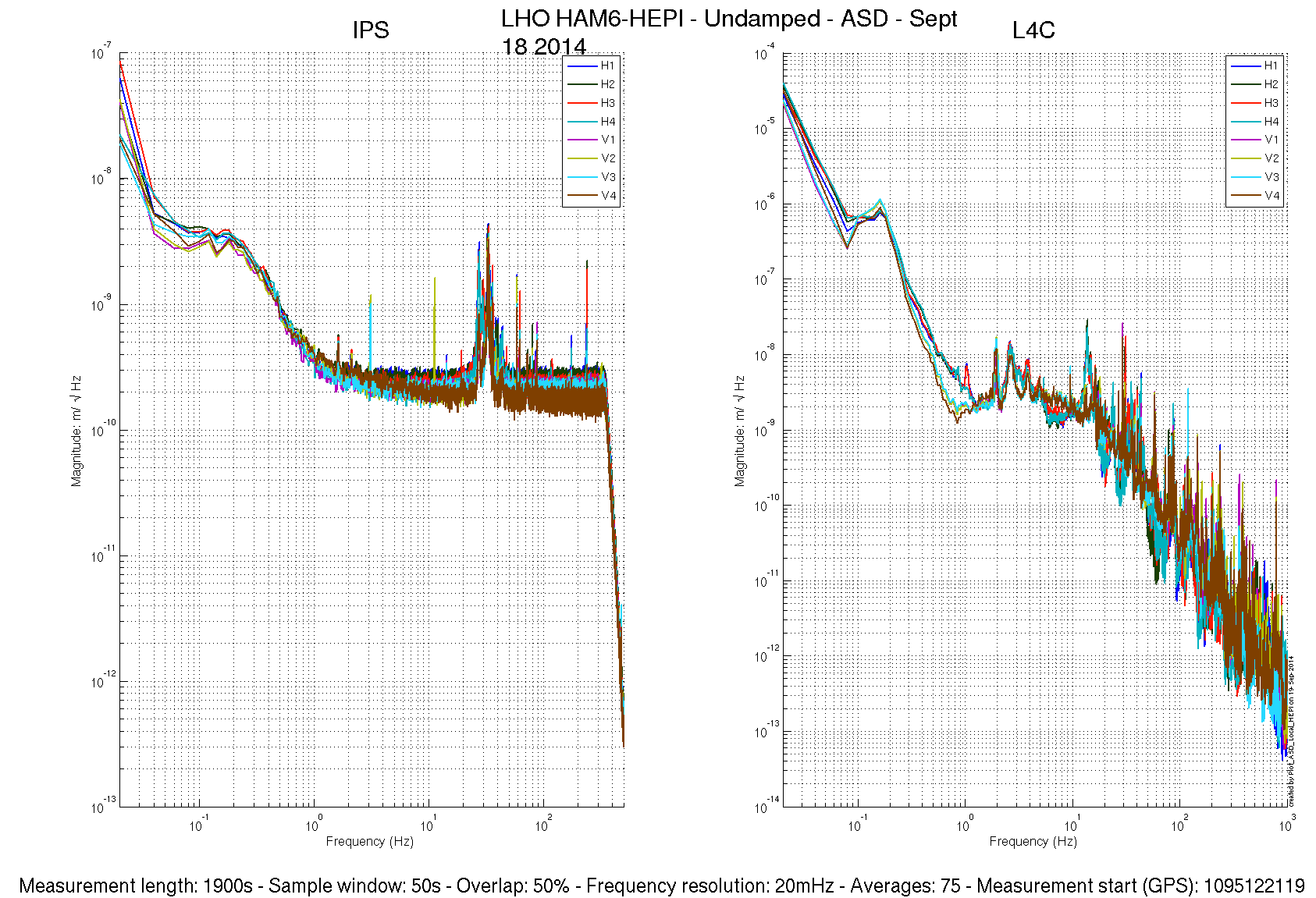
SeiSVN/seismic/HEPI/H1/HAM6/Data/Spectra/Undamped/

LHO\_HPI\_HAM6\_ASD\_m\_IPS\_L4C\_20140918\_17:35:03.mat

**Figures in SVN at:**

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

LHO\_HPI\_HAM6\_ASD\_m\_IPS\_L4C\_20140918\_17:35:03.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 | 8814 | -1728 | -341 | -4170 | -122 | -285 | 200 | 140 |
| H2 | -2097 | 9439 | -4758 | -350 | -375 | -181 | 68 | 284 |
| H3 | -455 | -4265 | 8915 | -1868 | 227 | 117 | -82 | -368 |
| H4 | -5133 | -322 | -1865 | 8832 | 135 | 246 | -333 | -272 |
| V1 | -197 | -404 | 285 | 135 | 9172 | 1080 | -1972 | 1065 |
| V2 | -362 | -203 | 129 | 238 | 1606 | 7834 | 707 | -1786 |
| V3 | 196 | 42 | -18 | -263 | -830 | 1426 | 7368 | 845 |
| V4 | 94 | 233 | -256 | -192 | 1531 | -942 | 771 | 8013 |

*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 0.7mm

/SeiSVN/seismic/HEPI/H1/HAM6/Data/Static/Tests

LHO\_HPI\_HAM6\_Range\_Of\_Motion\_20140930.mat

**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:**

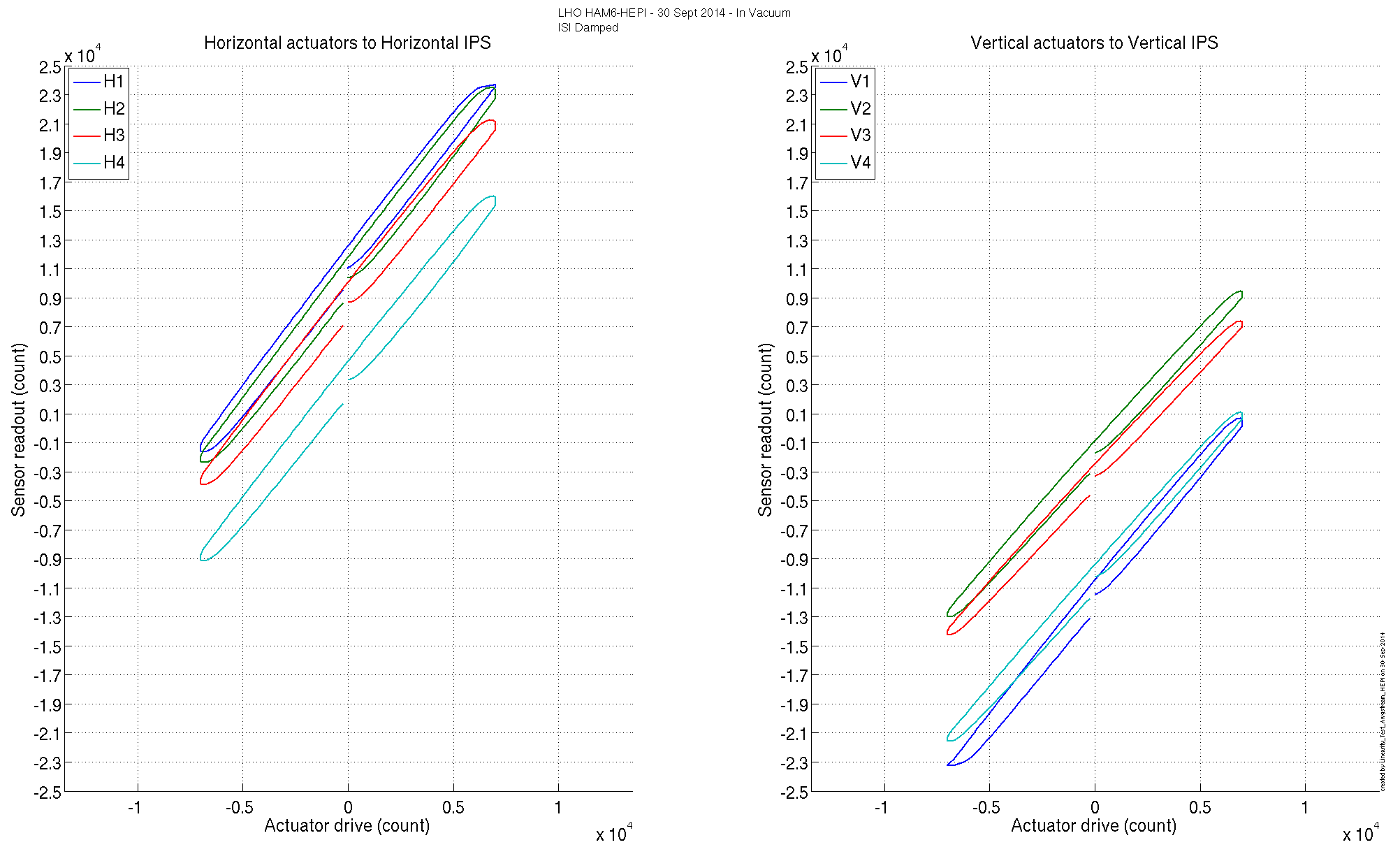
SeiSVN/seismic/HEPI/H1/HAM6/Data/Linearity\_Test/ LHO\_HPI\_HAM6\_Linearity\_test\_20140930T153703.mat

|  |  |  |
| --- | --- | --- |
|  | Slopes | Offsets |
| H1 | 1.86 | 11365 |
| H2 | 1.87 | 10554 |
| H3 | 1.82 | 8817 |
| H4 | 1.81 | 3472 |
| V1 | 1.76 | -11442 |
| V2 | 1.62 | -1699 |
| V3 | 1.56 | -3284 |
| V4 | 1.64 | -10215 |

**Figures in SVN at:**

/SeiSVN/seismic/HEPI/H1/HAM6/Data/Figures/Linearity\_Test/

LHO\_HPI\_HAM6\_Linearity\_test\_20140930T153703.fig \ .pdf



Issues/difficulties encountered during this test: No issues.

**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.

**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//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 | 125 | - | - | 1 |
| **100 - 500** | 0.5 | 1500 – 1500 | 125 | - | - | 0.6 |
| **10 - 100** | 0.25 | 1500 – 1500 | 100 | - | - | 1 |
| **0.7 - 10** | 0.05 | 0.75x1500 – 1500 | 50 | - | - | 2.3 |
| **0.1 - 0.7** | 0.025 | 0.75x1500 – 1500 | 15 | - | - | 1.5 |
| **0.01 - 0.1** | 0.01 | 0.5x1500 – 1500 | 5 | - | - | 1.25 |
| **0.002 - 0.01** | 0.002 | 0.5x1500 – 1500 | 3 | - | - | 4 |
|  |  |  |  |  |  | **16.1** |

\*: Values Need to be updated

**Data files in SVN at:**

/SeiSVN/seismic/HEPI/H1/HAM6/Data/Transfer\_Functions/Measurements/Undamped/

* LHO\_HPI\_BSC9\_Data\_L2L\_500Hz\_1000Hz\_20140923-231240.mat
* LHO\_HPI\_BSC9\_Data\_L2L\_100Hz\_500Hz\_20140924\_002234.mat
* LHO\_HPI\_BSC9\_Data\_L2L\_10Hz\_100Hz\_20140924-005825.mat
* LHO\_HPI\_BSC9\_Data\_L2L\_700mHz\_10Hz\_20140924-015449.mat
* LHO\_HPI\_BSC9\_Data\_L2L\_100mHz\_700mHz\_20140924-041536.mat
* LHO\_HPI\_BSC9\_Data\_L2L\_10mHz\_100mHz\_20140924-054822.mat
* LHO\_HPI\_BSC9\_Data\_L2L\_2mHz\_10mHz\_20140925-031007.mat

**Data is called by** **Case #3 of:**/SeiSVN/seismic/HEPI/H1/HAM6/Scripts/Control\_Scripts/Version\_5/

Measurements\_List\_H1\_HPI\_HAM6.m

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

/SeiSVN/seismic/HEPI/H1/HAM6/Scripts/Control\_Scripts/Version\_5/

* Step\_1\_TF\_Loc\_to\_Loc\_H1\_HEPI\_HAM6.m

**Figures in SVN at:**

/SeiSVN/seismic/HEPI/H1/HAM6/Data/ Figures/Transfer\_Functions/Measurements/Undamped/

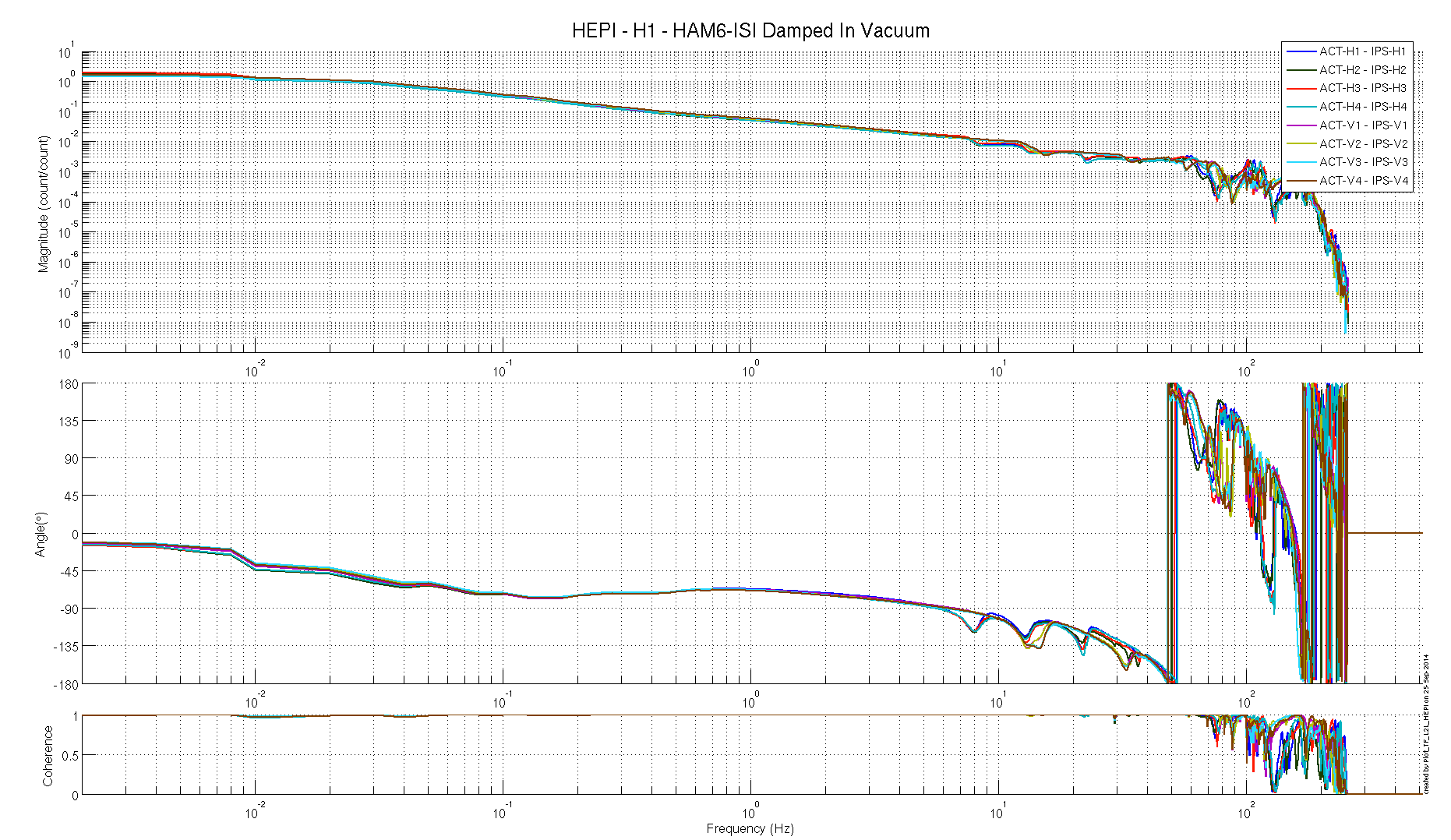
* H1\_HPI\_HAM6\_TF\_L2L\_Raw\_from\_ACT\_to\_IPS\_2014\_09\_23.fig
* H1\_HPI\_HAM6\_TF\_L2L\_Raw\_from\_ACT\_to\_L4C\_2014\_09\_23.fig

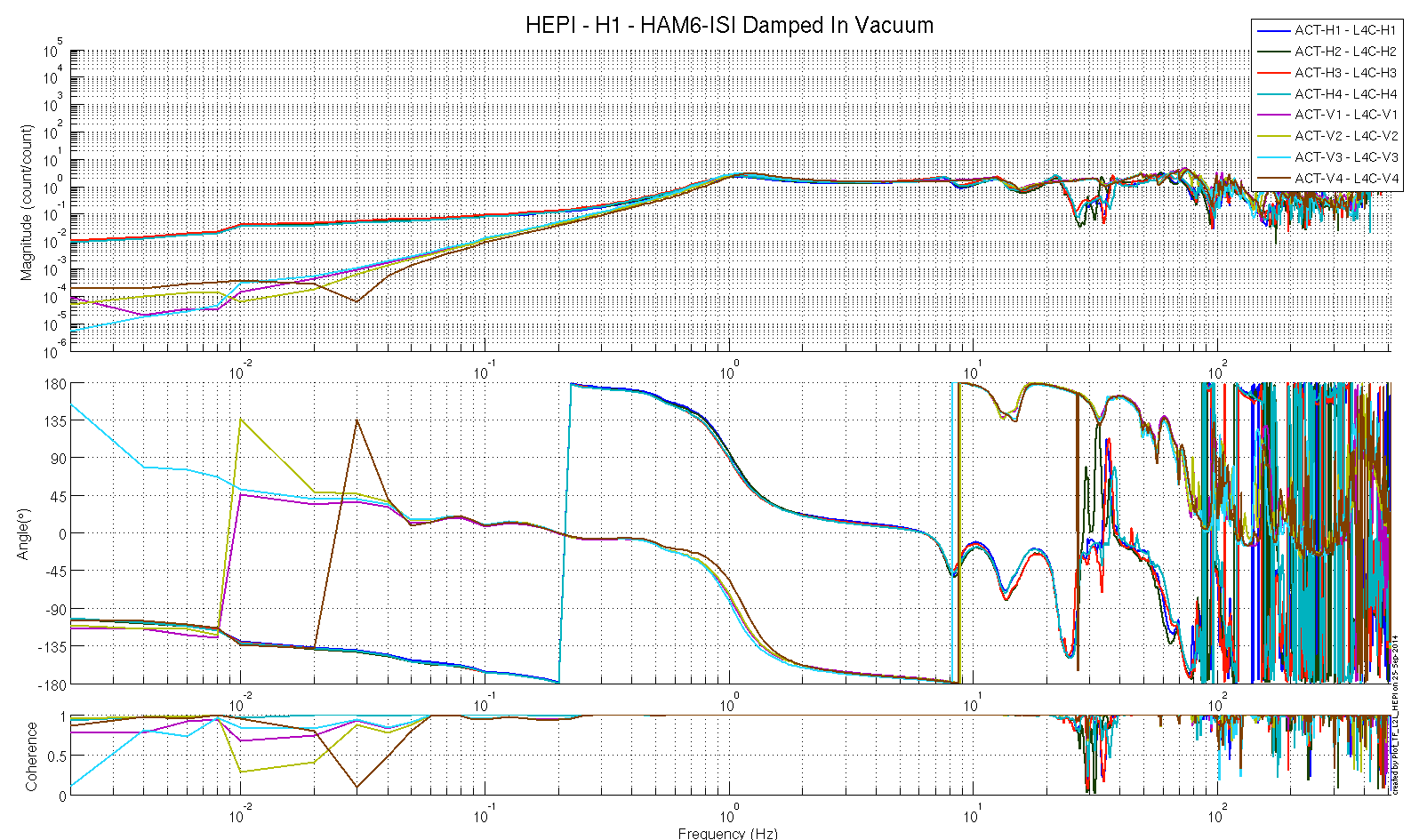
**Storage of measured transfer functions in the SVN at:**

/SeiSVN/seismic/HEPI/H1/HAM6/Data/Transfer\_Functions/Simulations/Undamped/

* H1\_HPI\_HAM6\_TF\_L2L\_Raw\_2014\_09\_23.mat

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





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

Issues/difficulties/comments regarding this test:

**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 Locked | Cartesian DOF | TARGET |
| H1 | 9370 | X | 111300 |
| H2 | 12065 | Y | 107800 |
| H3 | 7290 | Z | -282500 |
| H4 | 4420 | RX | 500 |
| V1 | -12555 | RY | 114500 |
| V2 | -1992 | RZ | 950 |
| V3 | -3401 | HP | 320000 |
| V4 | -11192 | VP | -28000 |

Issues/difficulties encountered during this test:

Readings were retrieved from medm H1:HPI-HAM6\_Cart\_BIAS 3 Feb 2015.

**Acceptance criteria:**

Offsets were recorded.

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