*LIGO Laboratory / LIGO Scientific Collaboration*

LIGO- E1300830-v1 *LIGO* Date (fixed)

**aLIGO HEPI H1 HAM4**

**Assembly Validation Report**

**E1300830**

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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--HAM4

BSC HEPI load cell capacity → 3000 lbs

HAM HEPI load cell capacity → 2000 lbs

|  |  |  |
| --- | --- | --- |
|  | **Left Spring (lbs)** | **Right Spring (lbs)** |
| **Pier 1** | 1400 | 1280 |
| **Pier 2** | 1290 | 1500 |
| **Pier 3** | 1170 | 1390 |
| **Pier 4** | 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: .**

# 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/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.

# 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:**

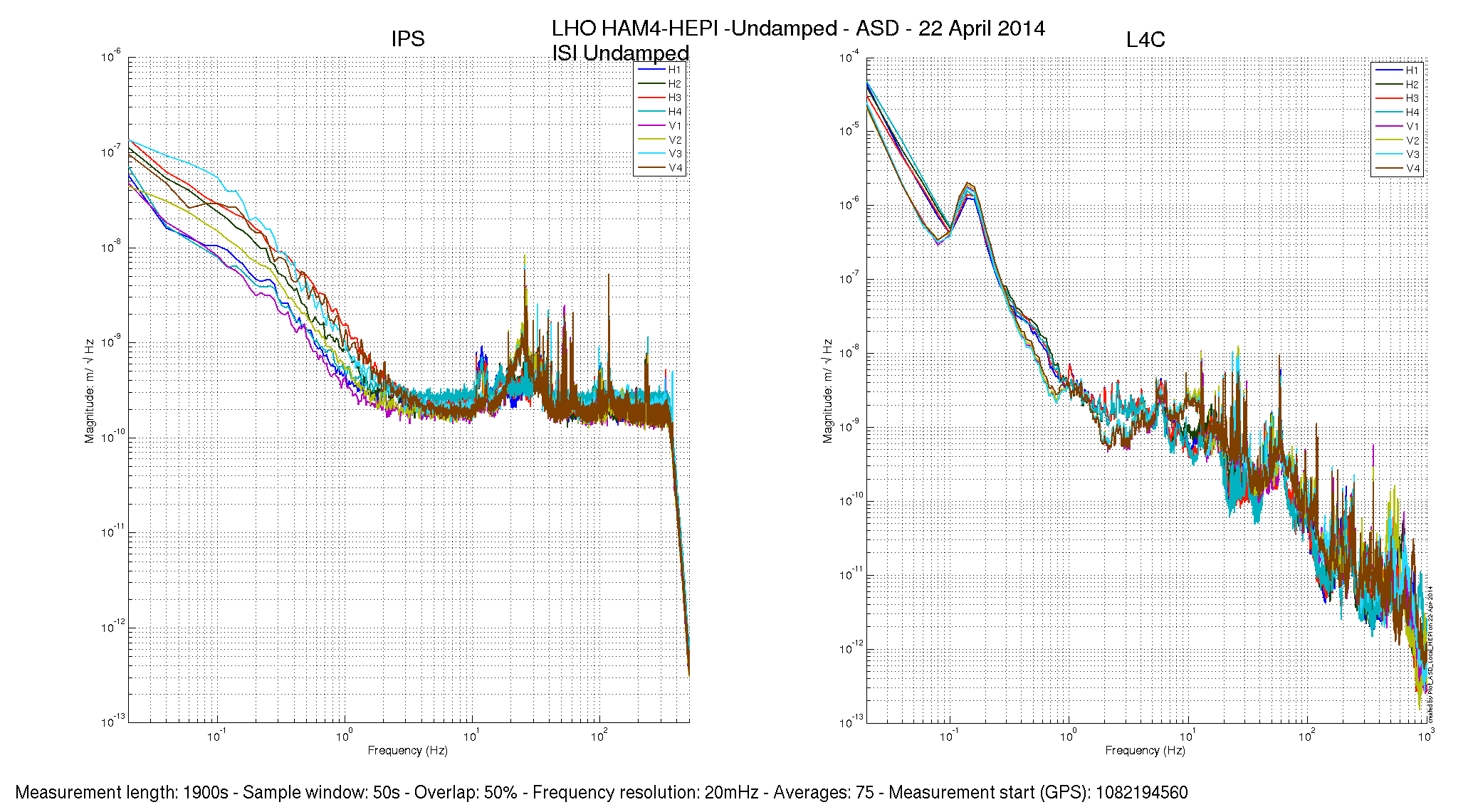
SeiSVN/seismic/HEPI/H1/HAM4/Data/Spectra/Undamped/

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



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/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: .**

# 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:**

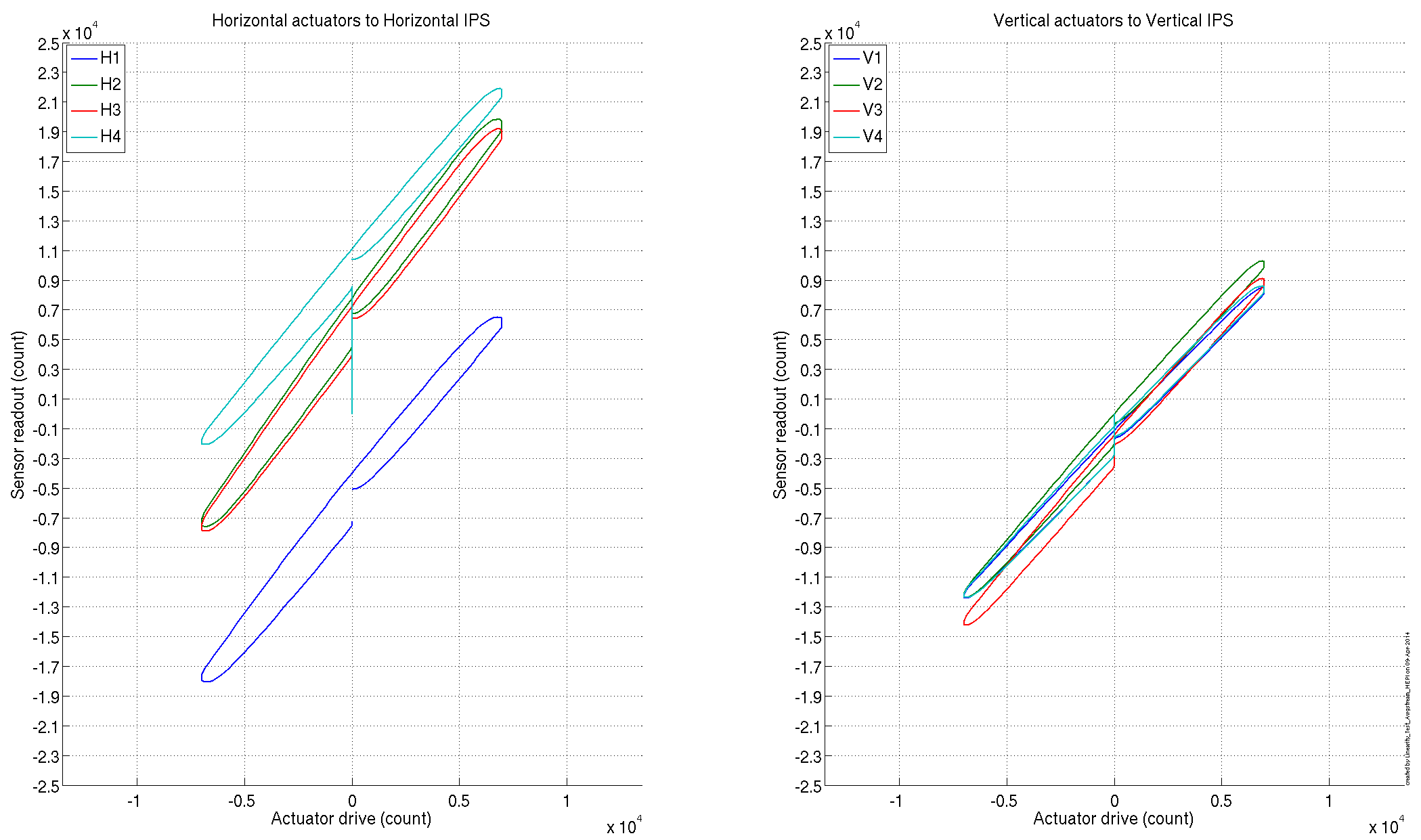
/SeiSVN/seismic/HEPI/Common/Testing\_Functions\_HEPI/Linearity\_Test\_Awgstream\_HEPI.m

**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: .**

# 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//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: .**

# 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/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/

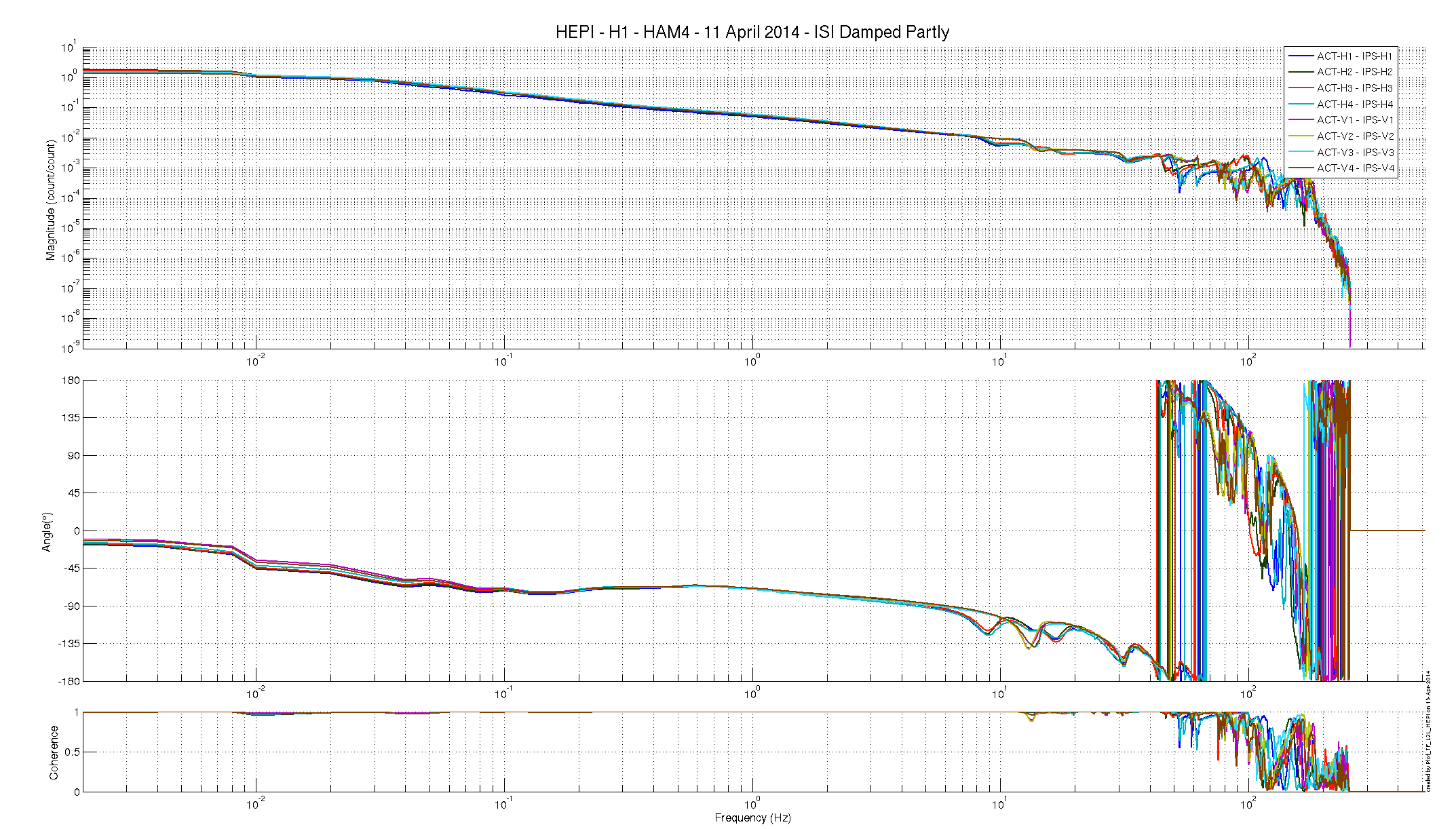
* H1\_HPI\_HAM4\_TF\_L2L\_Raw\_from\_ACT\_to\_IPS\_2014\_04\_14.fig
* H1\_HPI\_HAM4\_TF\_L2L\_Raw\_from\_ACT\_to\_L4C\_2014\_04\_14.fig

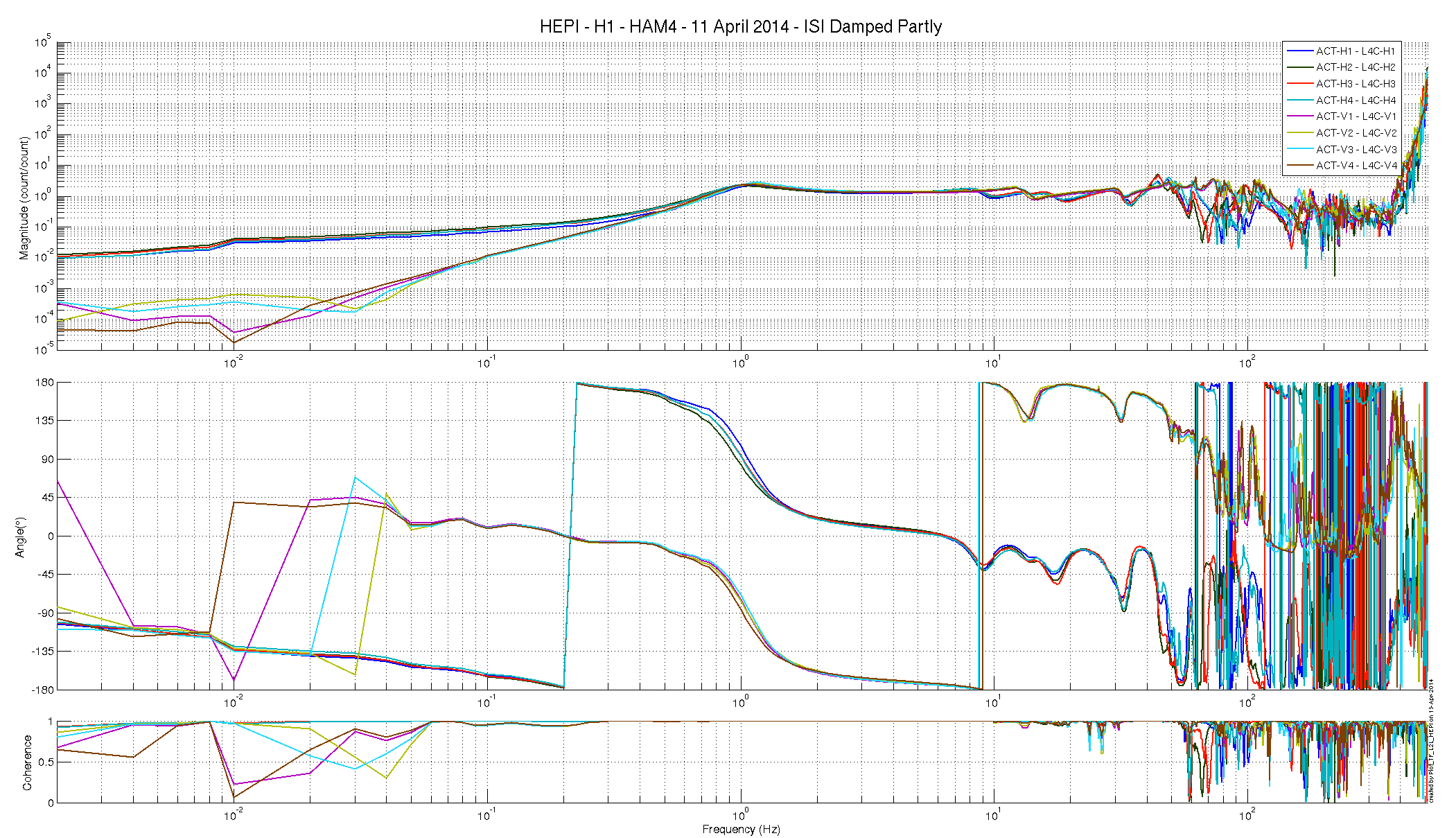
**Storage of measured transfer functions in the SVN at:**

/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.





![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:

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: .**