*LIGO Laboratory / LIGO Scientific Collaboration*

LIGO- E1300823-v4 *LIGO* Date (fixed)

**aLIGO HEPI H1 HAM1**

**Assembly Validation Report**

**E1300823-v4**

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

|  |  |
| --- | --- |
| **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 |

Contents

[1.Introduction 4](#__RefHeading__2502_1633653387)

[2.Sub-Components Testing 4](#__RefHeading__2504_1633653387)

[3.Load Cells assembly 4](#__RefHeading__178_1185372569)

[4.Boot Location—Measurements not taken-HR 6](#__RefHeading__162_870708744)

[5.Check Stops Gaps--Measurements not taken-HR 7](#__RefHeading__836_1185372569)

[6.Gaps check--Measurements not taken-HR 7](#__RefHeading__170_870708744)

[7.IPS Centering 8](#__RefHeading__840_1185372569)

[8.Sensor ASD 10](#__RefHeading__98_503471281)

[9.SUS-watchdogs interaction test 11](#__RefHeading__196_1185372569)

[10.Static Test local drive 11](#__RefHeading__23664_1262773321)

[11.Linearity Test/Range of motion in the local basis 12](#__RefHeading__444_1185372569)

[12.Actuator Plate to Shields gap--Measurements not taken-HR 13](#__RefHeading__854_1185372569)

[13.Valve Check--Measurements not taken-HR 14](#__RefHeading__208_1185372569)

[14.Local-to-local measurements 14](#__RefHeading__126_1080062798)

[15. Alignment offsets: 17](#__RefHeading__2506_1633653387)

# 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

BSC HEPI load cell capacity → 3000 lbs

HAM HEPI load cell capacity → 2000 lbs

|  |  |  |
| --- | --- | --- |
|  | **Left Spring (lbs)** | **Right Spring (lbs)** |
| **Pier 1** | 1050 | 690 |
| **Pier 2** | 930 | 1290 |
| **Pier 3** | 880 | 1070 |
| **Pier 4** | 970 | 920 |

**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—Measurements not taken-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--Measurements not taken-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--Measurements not taken-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\_HEPI.m

**Data in SVN at:**

/ligo/svncommon/SeiSVN/seismic/HEPI/H1/HAM2/Data/Static\_Tests/

\_IPS\_Read\_Back\_\_20131031\_15:23.mat

All the loops must be turned off during this test.

The test was performed on October 31st 2013, with HEPI Locked.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | H1 | H2 | H3 | H4 | V1 | V2 | V3 | V4 |
| Mean (counts) | 8076 | -2953 | -8150 | -1312 | 170 | 4531 | -1669 | -1583 |
| Acceptance | +/- 15000 | +/- 15000 | +/- 15000 | +/- 15000 | +/- 15000 | +/- 15000 | +/- 15000 | +/- 15000 |

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

# 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:**

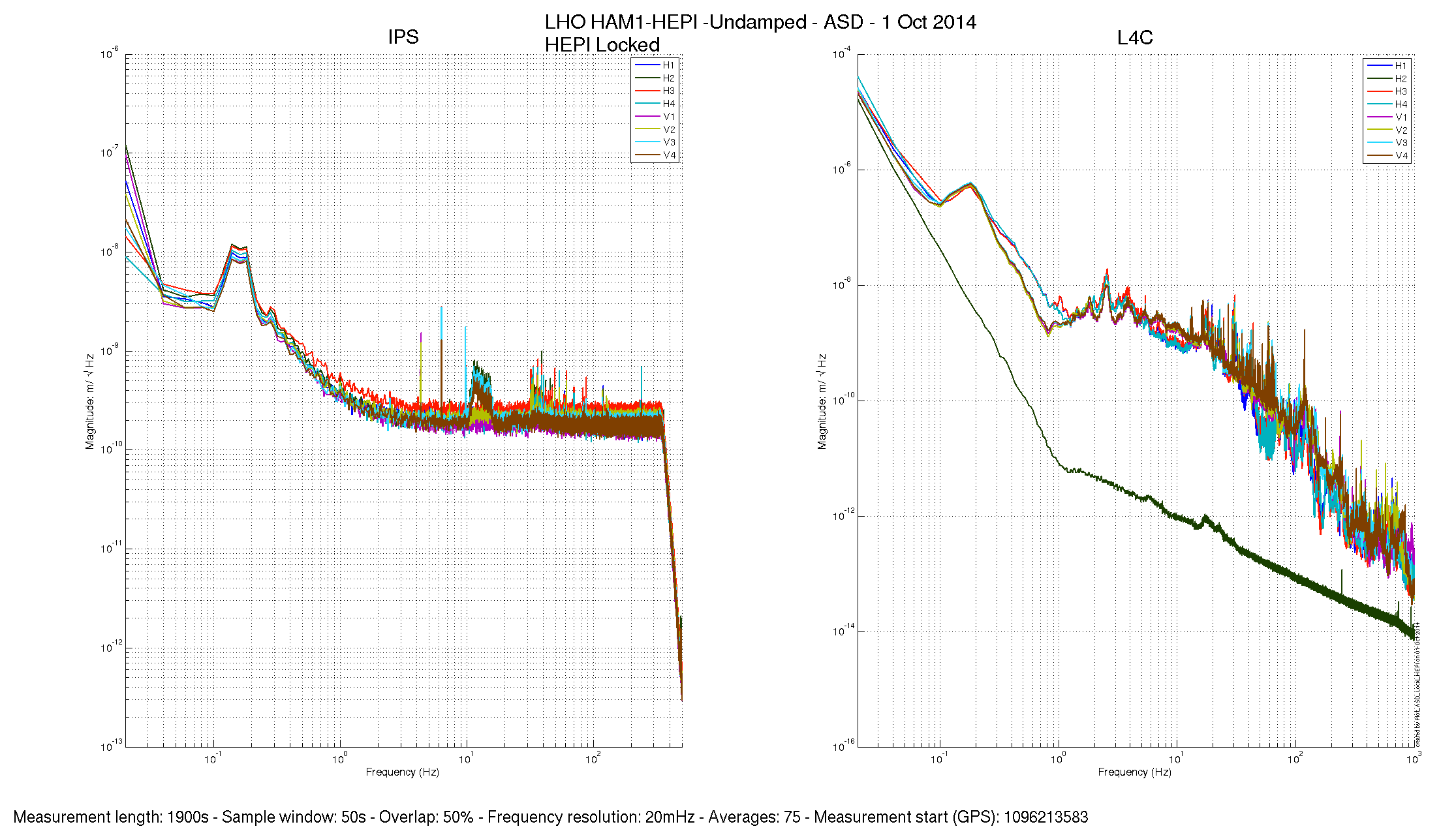
SeiSVN/seismic/HEPI/H1/HAM1/Data/Spectra/Undamped/

LHO\_HPI\_HAM1\_ASD\_m\_IPS\_L4C\_20141001\_08:46:07.mat

**Figures in SVN at:**

/SeiSVN/seismic/HEPI/H1/HAM2/Data/Figures/Spectra/Undamped/

LHO\_HPI\_HAM1\_ASD\_m\_IPS\_L4C\_20141001\_08:46:07.fig



Issues/difficulties/comments regarding this test:

Measurements were performed with all PreFilters ON. Spectrum of H2 L4C indicates a bad L4C. Invasive to replace.

**Acceptance criteria:**



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

# 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 in SVN at:**

SeiSVN/seismic/HEPI/H1/HAM1/Data/Static\_Tests/

LHO\_HPI\_HAM1\_Offset\_Local\_Drive\_20130606.mat

. ***Drive of 5000 counts***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | H1 | H2 | H3 | H4 | V1 | V2 | V3 | V4 |
| H1 | 7736 | -3730 | -399 | -1530 | -122 | 188 | 229 | -194 |
| H2 | -3631 | 7710 | -1769 | -470 | 180 | -214 | -255 | 210 |
| H3 | -294 | -1903 | 8472 | -4076 | 238 | -340 | -102 | 102 |
| H4 | -1696 | -527 | -4210 | 7843 | -390 | 238 | 89 | -261 |
| V1 | 47 | 178 | 174 | -394 | 7616 | 464 | -1300 | 554 |
| V2 | 409 | -304 | -414 | 200 | 492 | 7386 | 586 | -1178 |
| V3 | 468 | -339 | -161 | 51 | -1340 | 685 | 7936 | 473 |
| V4 | -17 | 196 | 22 | -252 | 522 | -976 | 449 | 6017 |

**Acceptance criteria:**

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

# 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

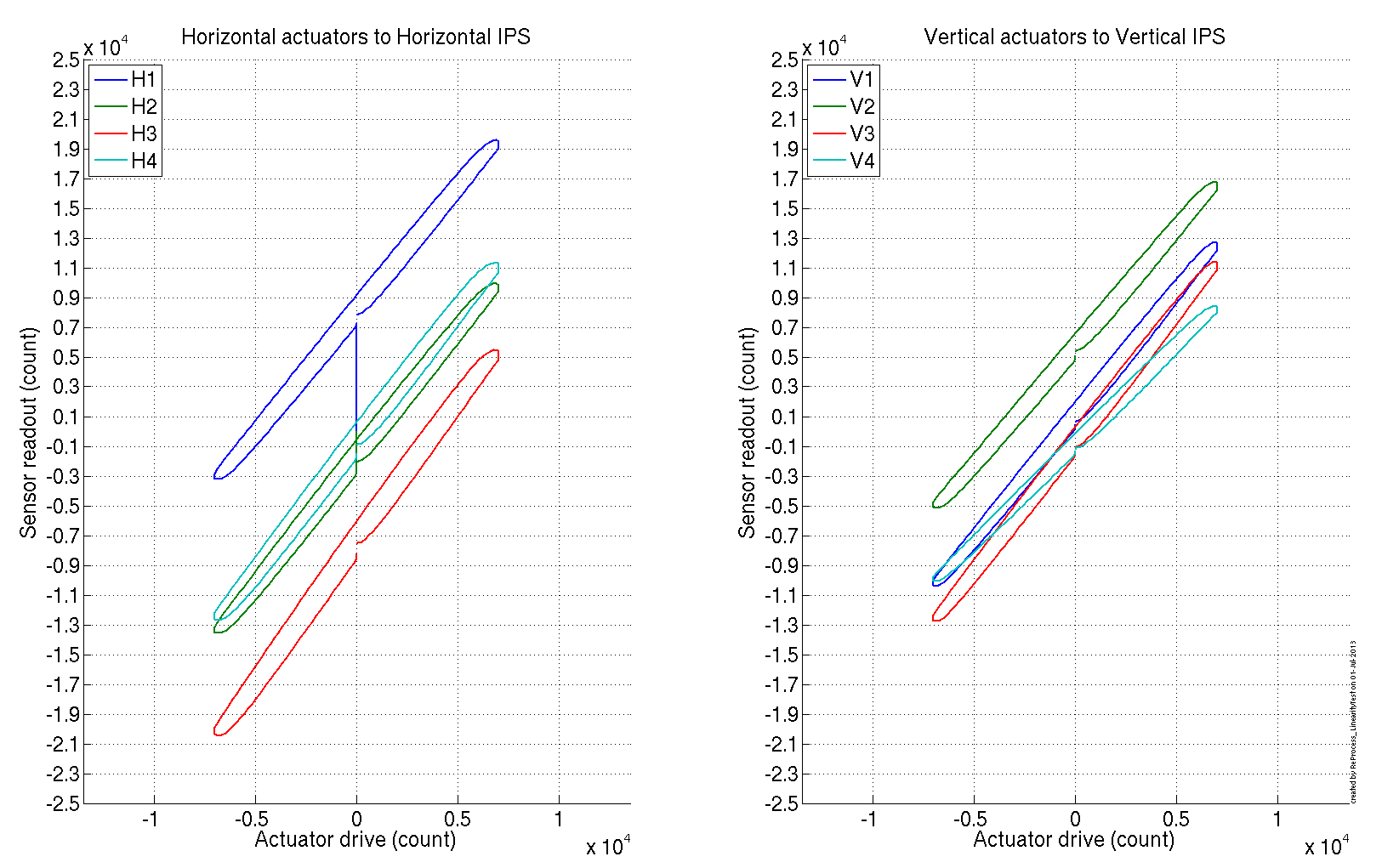
**Data in SVN at:**

SeiSVN/seismic/HEPI/H1/HAM1/Data/Linearity\_Test/ LHO\_HPI\_HAM1\_Linearity\_test\_20130701T135904.mat

**Figures in SVN at:**

/SeiSVN/seismic/HEPI/H1/HAM1/Data/Figures/Linearity\_Test/

LHO\_HPI\_HAM1\_Linearity\_test\_20130701T135904.fig



|  |  |  |
| --- | --- | --- |
|  | Slopes | Offsets |
| H1 | 1.64 | 8117 |
| H2 | 1.70 | -1725 |
| H3 | 1.88 | -7355 |
| H4 | 1.74 | -626 |
| V1 | 1.65 | 1095 |
| V2 | 1.58 | 5712 |
| V3 | 1.73 | -692 |
| V4 | 1.32 | -848 |

Issues/difficulties encountered during this test: **The V4 Actuator would appear to be weak. When the platform is unlocked, this test must be repeated. The Parker Valve may need replacing.**

**Acceptance criteria:**

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

# Actuator Plate to Shields gap--Measurements not taken-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--Measurements not taken-HR

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

/SeiSVN/seismic/HEPI/H1/HAM1/Scripts/Valve\_Check/plot\_valve\_check.m

**Data in SVN at:**

SeiSVN/seismic/HEPI/H1/HAM2/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** |  | 4000 – 4000\* | 250 | 4176\* | 4176 | 1\* |
| **100 - 500** | 0.5 | 4000 – 4000\* | 250 | 4176\* | 69.6 | 1.2\* |
| **10 - 100** | 0.25 | 4000 – 4000\* | 200 | 6592\* | 109.9 | 1.8\* |
| **0.7 - 10** | 0.05 | 4000 – 4000\* | 75 | 12320\* | 205.3 | 3.4\* |
| **0.1 - 0.7** | 0.025 | 4000 – 4000\* | 30 | 10080\* | 168.0 | 2.8\* |
| **0.01 - 0.1** | 0.01 | 4000 – 4000\* | 10 | 8960\* | 149.3 | 2.5\* |
| **0.002 - 0.01** | 0.002 | 4000 – 4000\* | 2 | 12160\* | 202.7 | 3.4\* |
|  |  |  |  |  |  | **16.1\*** |

\*: Values Need to be updated

**Data files in SVN at:**

/SeiSVN/seismic/HEPI/H1/HAM1/Data/ Figures/Transfer\_Functions/Measurements/Exc/

LHO\_HPI\_HAM1\_Data\_L2L\_500Hz\_1000Hz\_exc\_20130612-172146.mat

LHO\_HPI\_HAM1\_Data\_L2L\_100Hz\_500Hz\_exc\_20130613-200310.mat

LHO\_HPI\_HAM1\_Data\_L2L\_10Hz\_100Hz\_exc\_20130613-211226.mat

LHO\_HPI\_HAM1\_Data\_L2L\_700mHz\_10Hz\_exc\_20130613-230210.mat

LHO\_HPI\_HAM1\_Data\_L2L\_100mHz\_700mHz\_exc\_20130614-022932.mat

LHO\_HPI\_HAM1\_Data\_L2L\_10mHz\_100mHz\_exc\_20130614-052213.mat

LHO\_HPI\_HAM1\_Data\_L2L\_2mHz\_10mHz\_exc\_20130614-080413.mat

**Data is called by** **Case # of:**/ligo/svncommon/SeiSVN/seismic/HEPI/H1/HAM1/Data/Transfer\_Functions/Measurements/

Measurements\_List\_H1\_HPI\_HAM1.m

**Data collection script files:**

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

* Run\_TF\_L2L\_10mHz\_100mHz.m
* Run\_TF\_L2L\_100mHz\_500mHz.m
* Run\_TF\_L2L\_500mHz\_5Hz.m
* Run\_TF\_L2L\_5Hz\_100Hz.m
* Run\_TF\_L2L\_100Hz\_1000Hz.m

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

/SeiSVN/seismic/HEPI/H1/HAM2/Scripts/Control\_Scripts/release/

* Step\_1\_TF\_Loc\_to\_Loc\_H1\_HEPI\_HAM1.m

**Error in Routine when step runs...**

**Figures in SVN at:**

/SeiSVN/seismic/HEPI/H1/HAM2/Data/ Figures/Transfer\_Functions/Measurements/Undamped/

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

/SeiSVN/seismic/HEPI/H1/HAM2/Data/Transfer\_functions/ Simulations/Undamped/

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

A description...

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 locked, after aligment work was performed. The opposite 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.

|  |  |  |  |
| --- | --- | --- | --- |
|  | IPS Readouts HEPI Isolated | Cartesian DOF | TARGET |
| H1 | 8550 | X | 194300 |
| H2 | -1810 | Y | -318400 |
| H3 | -8210 | Z | -121900 |
| H4 | -1000 | RX | 7700 |
| V1 | -1430 | RY | -73200 |
| V2 | -4250 | RZ | -17100 |
| V3 | -5310 | HP | -26000 |
| V4 | -1600 | VP | -8400 |

Issues/difficulties encountered during this test:

**Acceptance criteria:**

Valves collected from medm 10 March 2015 with platform Isolated to nominal position.

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