*LIGO Laboratory / LIGO Scientific Collaboration*

LIGO- E1300837 *LIGO* Date (fixed)

**aLIGO HEPI H1 ETMX**

**Assembly Validation Report**

**E1300837**

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) 395-2129Fax (626) 304-9834E-mail: info@ligo.caltech.edu | **Massachusetts Institute of Technology****LIGO Project – NW22-295****185 Albany St****Cambridge, MA 02139**Phone (617) 253-4824Fax (617) 253-7014E-mail: info@ligo.mit.edu |
| **LIGO Hanford Observatory****P.O. Box 1970****Mail Stop S9-02****Richland WA 99352**Phone 509-372-8106Fax 509-372-8137 | **LIGO Livingston Observatory****P.O. Box 940****Livingston, LA 70754**Phone 225-686-3100Fax 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—Need to Collect

BSC HEPI load cell capacity → 3000 lbs

HAM HEPI load cell capacity → 2000 lbs

|  |  |  |
| --- | --- | --- |
|  | **Left Spring (lbs)** | **Right Spring (lbs)** |
| **Pier 1** |  |  |
| **Pier 2** |  |  |
| **Pier 3** |  |  |
| **Pier 4** |  |  |

**Acceptance criteria:**

* The values must not exceed 80% of the load cell capacity (2400lbs for BSC and 1600lbs for HAM).

**Test result: Passed: 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\_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 | +/- 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/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



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

. ***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: .**

# 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: .**

# 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

**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: .**

# 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\_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.



![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—Not sure if this is true, HR
* 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[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 Readouts HEPI Locked | Offset Value |
| H1 | -11500 | -1331.1 |
| H2 | 7500 | -957.72 |
| H3 | 1200 | -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: .**