*LIGO Laboratory / LIGO Scientific Collaboration*

LIGO- E1300840-v1 *LIGO* Date (fixed)

**aLIGO HEPI H1 ITMY**

**Assembly Validation Report**

**E1300840**

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 5](#__RefHeading__2636_85073724)

[2.Sub-Components Testing 5](#__RefHeading__2638_85073724)

[3.Load Cells assembly--BSC1 5](#__RefHeading__178_1185372569)

[4.Boot Location—Test Not Performed, HR 7](#__RefHeading__162_870708744)

[5.Check Stops Gaps—Test Not Performed, HR 8](#__RefHeading__836_1185372569)

[6.Gaps check—Test Not Performed, HR 8](#__RefHeading__170_870708744)

[7.IPS Centering-BSC10 9](#__RefHeading__840_1185372569)

[8.Sensor ASD 10](#__RefHeading__98_503471281)

[9.SUS-watchdogs interaction test—BSC10 Test not performed 11](#__RefHeading__196_1185372569)

[10.Static Test local drive-BSC10 11](#__RefHeading__23664_1262773321)

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

[12.Actuator Plate to Shields gap—Test Not Performed, HR 13](#__RefHeading__854_1185372569)

[13.Valve Check—BSC-10, Test Not Performed 14](#__RefHeading__208_1185372569)

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

[15. Alignment offsets: 18](#__RefHeading__2640_85073724)

# 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--BSC1

BSC HEPI load cell capacity → 3000 lbs

HAM HEPI load cell capacity → 2000 lbs

|  |  |  |
| --- | --- | --- |
|  | **Left Spring (lbs)** | **Right Spring (lbs)** |
| **Pier 1** | 2230 | 2070 |
| **Pier 2** | 1970 | 2020 |
| **Pier 3** | 2090 | 2220 |
| **Pier 4** | 1880 | 1960 |

**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-BSC10

**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/ITMY/Data/Static\_Tests/

H1\_HPI\_ITMY\_IPS\_Read\_Back\_Unlocked\_20130802.mat

All the loops must be turned off during this test.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | H1 | H2 | H3 | H4 | V1 | V2 | V3 | V4 |
| Mean (counts) | 1499 | -3135 | 918 | -3384 | -1973 | 1926 | -511 | -6243 |
| 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:**

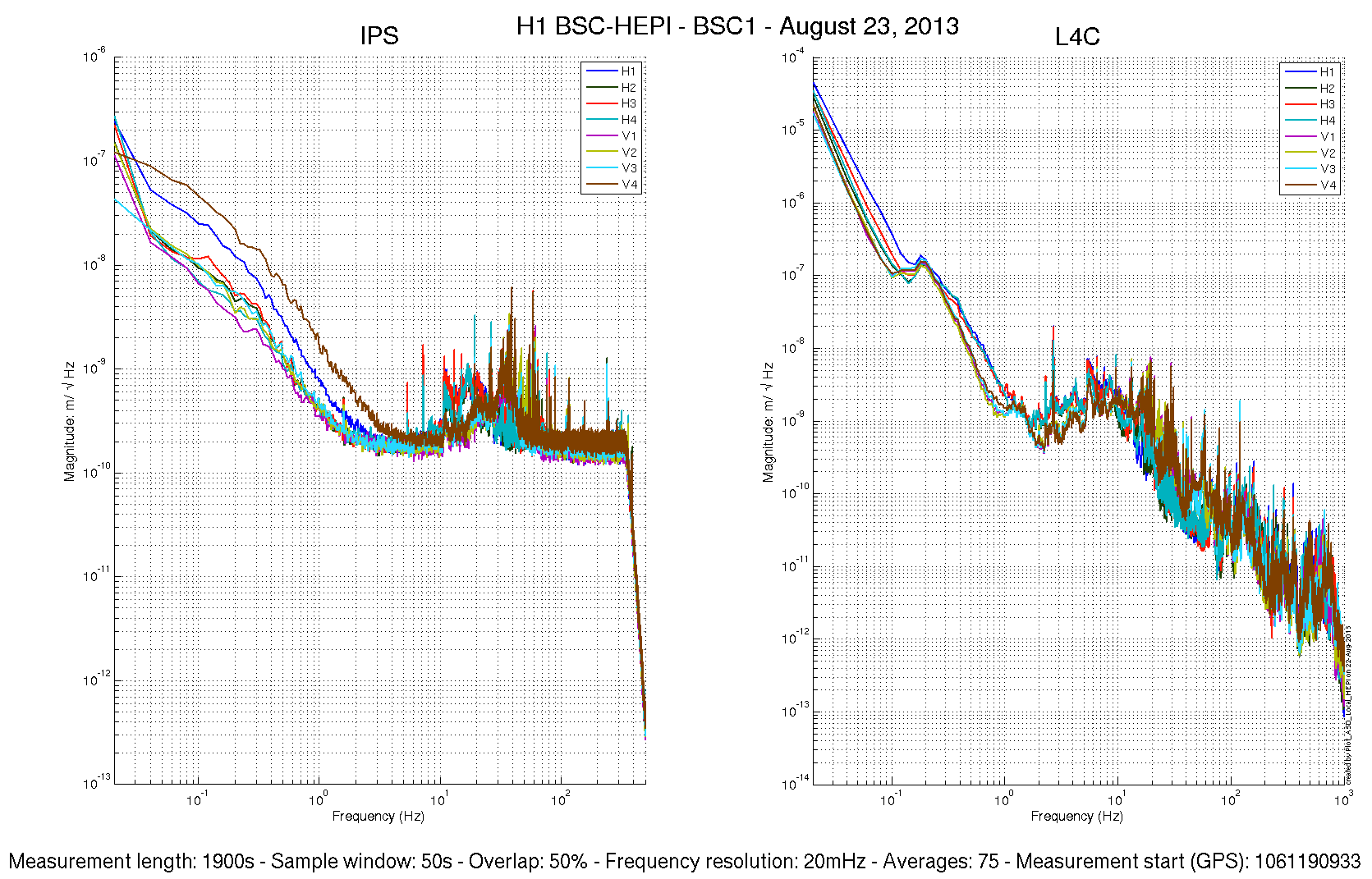
SeiSVN/seismic/HEPI/H1/ITMY/Data/Spectra/Undamped/

H1\_HPI\_ITMY\_ASD\_m\_IPS\_L4C\_2020\_08\_22\_3 0:5:.mat

**Figures in SVN at:**

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

H1\_HPI\_ITMY\_ASD\_m\_IPS\_L4C\_2020\_08\_22\_3 0:5:.fig



Issues/difficulties/comments regarding this test:

**Acceptance criteria:**



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

# SUS-watchdogs interaction test—Test not performed

**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-BSC10

**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/ITMY/Data/Static\_tests/

H1\_HPI\_ITMY\_Offset\_Local\_Drive\_20130802.mat

. ***Drive of 5000 counts***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | H1 | H2 | H3 | H4 | V1 | V2 | V3 | V4 |
| H1 | 8916 | -3363 | -722 | -2792 | 214 | 204 | 50 | -238 |
| H2 | -3010 | 8134 | -2569 | -737 | 18 | -96 | -319 | 59 |
| H3 | -576 | -2164 | 7444 | -3043 | 39 | -186 | 51 | 171 |
| H4 | -2826 | -718 | -3351 | 9010 | -262 | 62 | 180 | -63 |
| V1 | 253 | 60 | 54 | -194 | 6734 | 1029 | -1755 | 1310 |
| V2 | 237 | -71 | -203 | 123 | 1062 | 6175 | 1218 | -1620 |
| V3 | 90 | -298 | 82 | 238 | -1675 | 1372 | 6468 | 999 |
| V4 | -206 | 124 | 236 | -26 | 1464 | -1679 | 1139 | 6668 |

*Table - Main couplings and cross couplings*

Issues/difficulties encountered during this test:

**Acceptance criteria:**



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

# Linearity Test/Range of motion in the local basis

0.7mm clear range of Motion: see ../HEPI/H1/Data/Static\_Tests/

H1\_HPI\_ITMY\_Range\_Of\_Motion\_20140723all.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:**

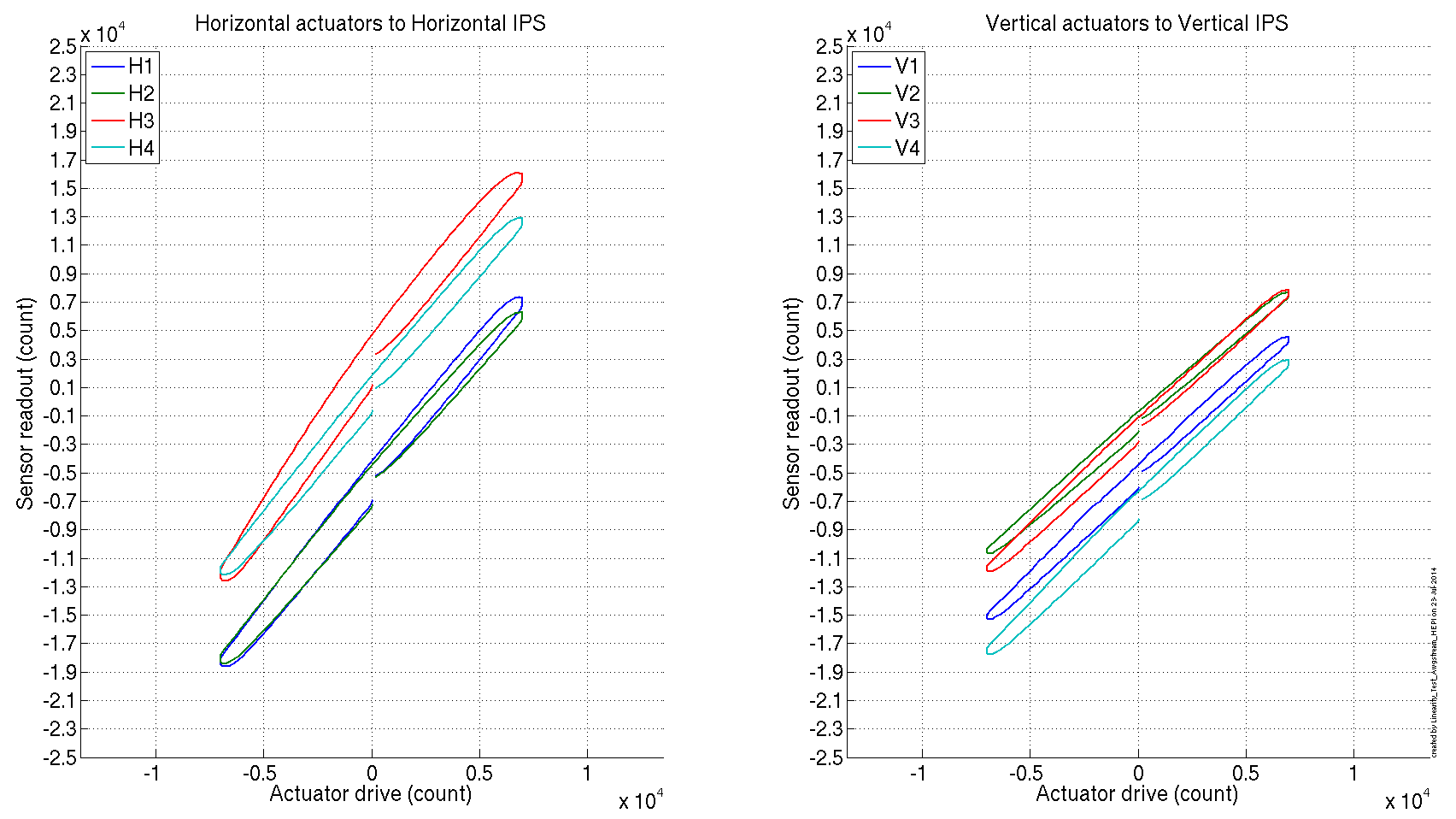
SeiSVN/seismic/HEPI/H1/ITMY/Data/Linearity\_Test/

H1\_HPI\_ITMY\_Linearity\_test\_20140723T133926.mat

**Figures in SVN at:**

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

H1\_HPI\_ITMY\_Linearity\_test\_20140723T133926.fig



|  |  |  |
| --- | --- | --- |
|  | Slopes | Offsets |
| H1 | 1.89 | -5528 |
| H2 | 1.80 | -5825 |
| H3 | 2.09 | 2569 |
| H4 | 1.82 | 559 |
| V1 | 1.44 | -5207 |
| V2 | 1.33 | 1389 |
| V3 | 1.43 | -1935 |
| V4 | 1.50 | 7253 |

Issues/difficulties encountered during this test:

**Acceptance criteria:**

* ???????

**Test result: Looks Good 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—BSC-10, 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)** | **Res** | **Amplitude** | **Nreps** | **Time (s)** | **Time (min)** | **Time (h)** |
| **500-1000** | 0.25 | 1.0x1500 – 1500 | 250 | 4176\* | 69.6 | 1\* |
| **100 - 500** | 0.5 | 1.0x4000 – 4000 | 250 | 4176\* | 69.6 | 1.2\* |
| **10 - 100** | 0.25 | 1.0x4000 – 4000 | 200 | 6592\* | 109.9 | 1.8\* |
| **0.7 - 10** | 0.05 | 1.0x4000 – 4000 | 75 | 12320\* | 205.3 | 3.4\* |
| **0.1 - 0.7** | 0.025 | 1.0x4000 – 4000 | 30 | 10080\* | 168.0 | 2.8\* |
| **0.01 - 0.1** | 0.01 | 1.0x4000 – 4000 | 10 | 8960\* | 149.3 | 2.5\* |
| **0.002 - 0.01** | 0.002 | 1.0x4000 – 4000 | 2 | 12160\* | 202.7 | 3.4\* |
|  |  |  |  |  |  | **16.1\*** |

\*: Values Need to be updated

**Data files in SVN at:**

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

LHO\_HPI\_BSC1\_Data\_L2L\_2mHz\_10mHz\_20130817-034652.mat

LHO\_HPI\_BSC1\_Data\_L2L\_10mHz\_100mHz\_20130816-213722.mat

LHO\_HPI\_BSC1\_Data\_L2L\_100mHz\_700mHz\_20130816-184438.mat

LHO\_HPI\_BSC1\_Data\_L2L\_700mHz\_10Hz\_20130817-001928.mat

LHO\_HPI\_BSC1\_Data\_L2L\_10Hz\_100Hz\_20130816-165455.mat

LHO\_HPI\_BSC1\_Data\_L2L\_100Hz\_500Hz\_20130816-154541.mat

LHO\_HPI\_BSC1\_Data\_L2L\_500Hz\_1000Hz\_20130816-132912.mat

**Data is called by** **Case #7 of:**/ligo/svncommon/SeiSVN/seismic/HEPI/H1/ITMY/Data/Transfer\_Functions/Measurements/

/Measurements\_List\_H1\_HPI\_ITMY.m

**Data collection script files:**

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

* Run\_TF\_L2L\_500Hz\_1000Hz\_HEPI.m
* Run\_TF\_L2L\_100Hz\_500Hz\_HEPI.m
* Run\_TF\_L2L\_10Hz\_100Hz\_HEPI.m
* Run\_TF\_L2L\_700mHz\_10Hz\_HEPI.m
* Run\_TF\_L2L\_100mHz\_700mHz\_HEPI.m
* Run\_TF\_L2L\_10mHz\_100mHz\_HEPI.m
* Run\_TF\_L2L\_2mHz\_10mHz\_HEPI.m

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

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

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

**Figures in SVN at:**

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

* H1\_HPI\_ITMY\_TF\_L2L\_Raw\_from\_ACT\_to\_IPS\_2013\_08\_16.fig
* H1\_HPI\_ITMY\_TF\_L2L\_Raw\_from\_ACT\_to\_L4C\_2013\_08\_16.fig

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

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

* H1\_HPI\_ITMY\_TF\_L2L\_Raw\_2013\_08\_16.mat

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

A description...

A description...

Issues/difficulties/comments regarding this test: – Under vacuum w/ ISI Damped

**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, after alignment work was performed—These numbers would nominally be all zero because after alignment and we attached the actuator and got a confirm that alignment was good, the IPS would be set to zero. However, once testing commences, the platforms will settle more, splay out if you will etc.

The numbers below are with the platform now in its nominal alignment and where the system operates. These values are good for the performance of the IPS. Much above 15000 would start to approach badness where the response loses linearity

|  |  |  |  |
| --- | --- | --- | --- |
|  | IPS Readouts HEPI Isolated | Cartesian DOF | TARGET |
| H1 | 10720 | X | 600000 |
| H2 | -12880 | Y | -63300 |
| H3 | -13470 | Z | -189000 |
| H4 | 6700 | RX | 15140 |
| V1 | -5860 | RY | 60130 |
| V2 | -2760 | RZ | -16200 |
| V3 | -2490 | HP | -87000 |
| V4 | -8380 | VP | 27000 |

Issues/difficulties encountered during this test:

Readings were retrieved from medms 11 Feb 2015.

**Acceptance criteria:**

Values near and certainly above 15000 should be reduced by centering or other action.

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