LIGO Laboratory / LIGO Scientific Collaboration

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aLIGO HEPI L1 ITMY (BSC1) Assembly Validation Report

E1300930

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Distribution of this document:
Advanced LIGO Project

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Introduction

This document summarizes the tests done to validate the HEPI L1 ITMY (BSC1) assembly. As all L1 HEPI BSC, it had been installed since 2004 at Livingston. However, it had been grounded for the 2 to 3 years of aLIGO install. All electronics has been updated since, and more importantly, the position of the ITMY support tubes (i.e. the position of the 4 HEPI ITMY boots), but not the one of the housings, were adjusted to accommodate the position needed for aLIGO alignment. Note that when HEPI was first released, we subsequently found out that there was some constant rubbing between the boot and the housing, due to some of the moves done for Initial Alignment. The boot assembly was adjusted to provide clearanceThose adjustments were completed in July 2013.

Sub-Components Testing

- Kaman Inductive Position Sensors: calibration, linearity, factory data, noise measurements

The IPS sensors on this chamber haven't been changed since their original installation in 2004. No specific individual testing had been done then or since.

- HEPI actuator linearity test (E1100338 – aLIGO HEPI Actuators Test Results)

   The HEPI actuators on this chamber haven't been changed since their original installation in 2004. No specific individual testing had been done then or since.

- L4C test

The L4C sensors on this chamber haven't been changed since their original installation in 2004. No specific individual testing had been done at the time or since on the "old units".

Assembly Validation

1.1 Load Cells assembly

- Spring attachment
   For the BSC HEPI springs, check the assembly per D030320-v4. See LLO aLOG 7162 for more details.

- Load cell values

BSC HEPI load cell capacity → 3000 lbs

	Spring	Left Spring (lbs)
Pier 1	1	
	2	
Pier 2	3	
	4	
Pier 3	5	

	6	
Pier 4	7	
	8	

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: ___**

1.2 Bellows

The bellows are hard to access and tests are hard to proceed. After several discussions and brainstorming sessions, it has been decided not to measure the gaps on HEPI-HAM and HEPI-BSC.

Test result: **Passed: ___   Failed: ___   Waived: _X_**

1.3 Boot Location

Test result: **Passed: ___   Failed: ___   Waived: _X_**

1.4 Check Stops Gaps

The stops must not touch the boot.

If the valve check test is a success, we are sure there is no touching against the boot.

Test result: **Passed: _X_**   **Failed:**

1.5 Gaps check

If the valve check test is a success, we are sure there is no touching against the boot.

Test result: **Passed: _X_**   **Failed: ___**

1.6   IPS Centering

Scripts files for processing and plotting in SVN at:
/SeiSVN/seismic/HEPI/Common/Testing_Functions_HEPI/Offset_STD_IPS_HEPI.m

All the loops must be turned off during this test.

	H1	H2	H3	H4	V1	V2	V3	V4
Mean (counts)								
Acceptance	+/- 15000	+/- 15000	+/- 15000	+/- 15000	+/- 15000	+/- 15000	+/- 15000	+/- 15000

Test result: **Passed: __X__**   **Failed:**

1.7   Sensor ASD

Scripts files for processing and plotting in SVN at:
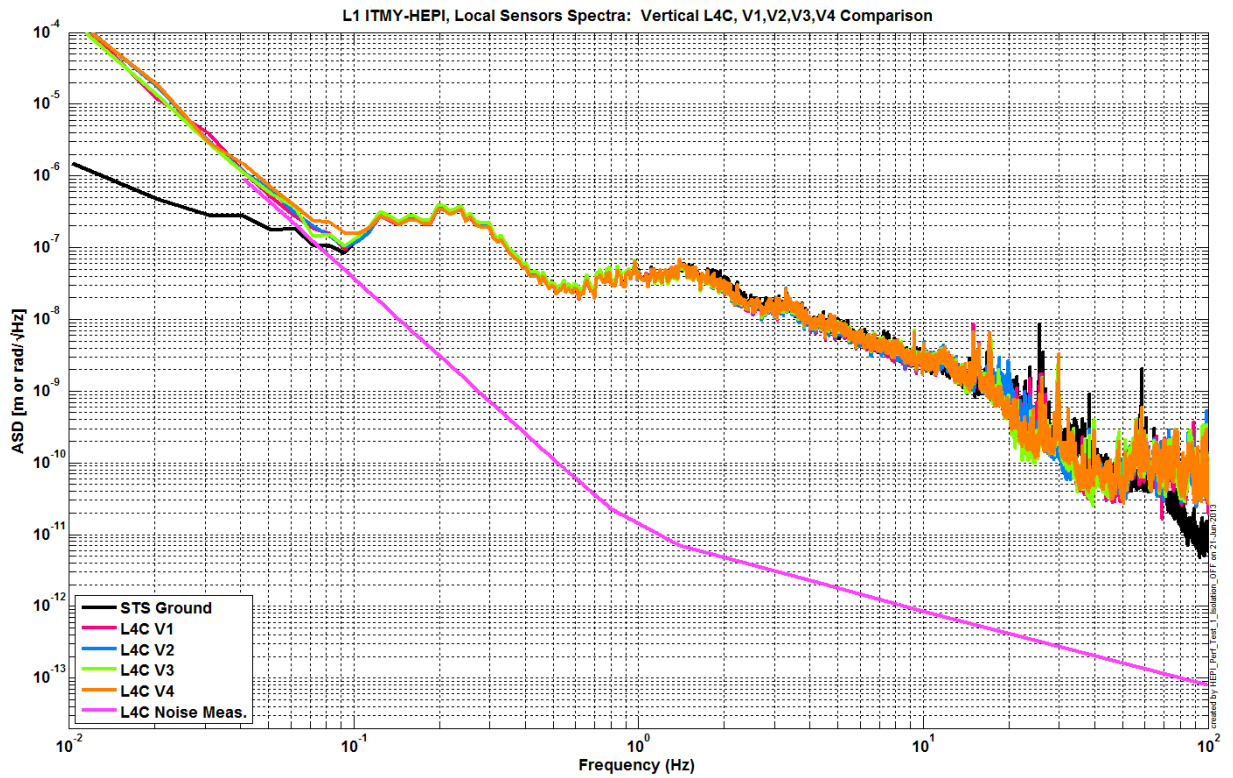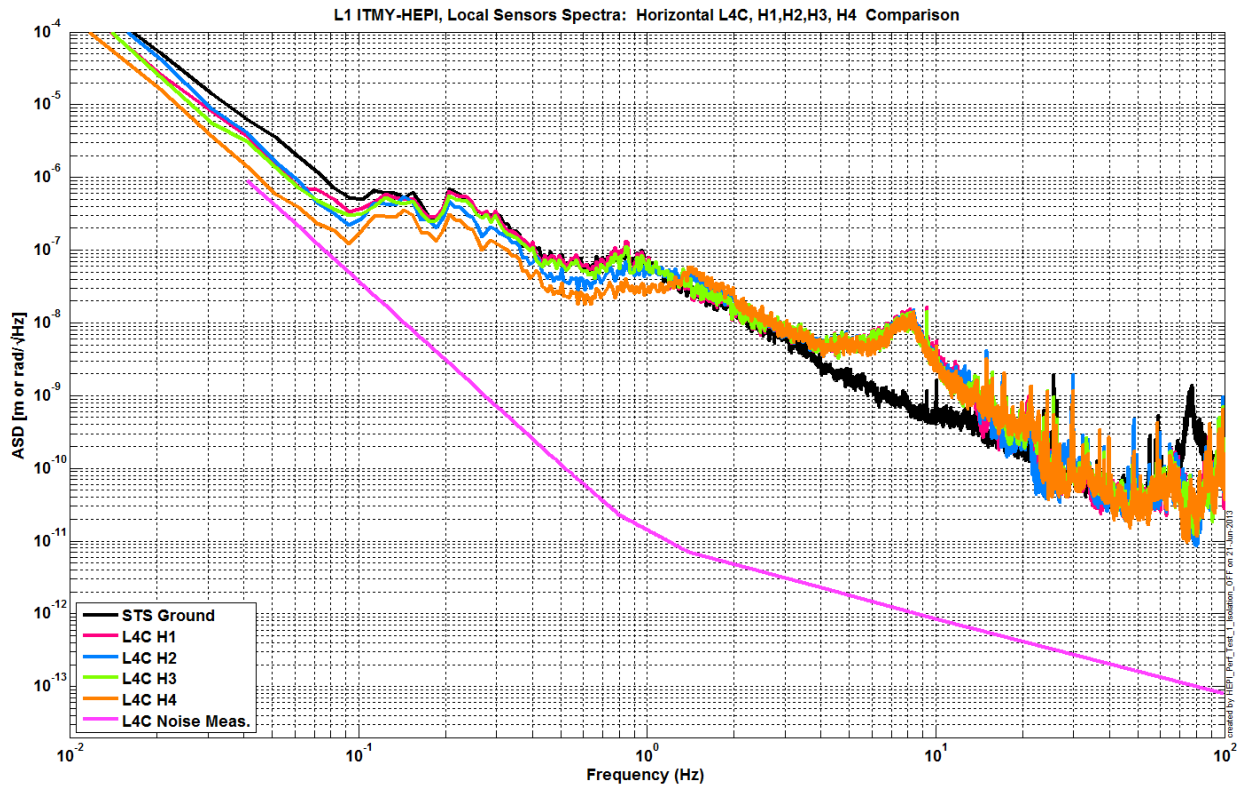/SeiSVN/seismic/HEPI/L1/ITMY/Scripts/Perf_Analysis/
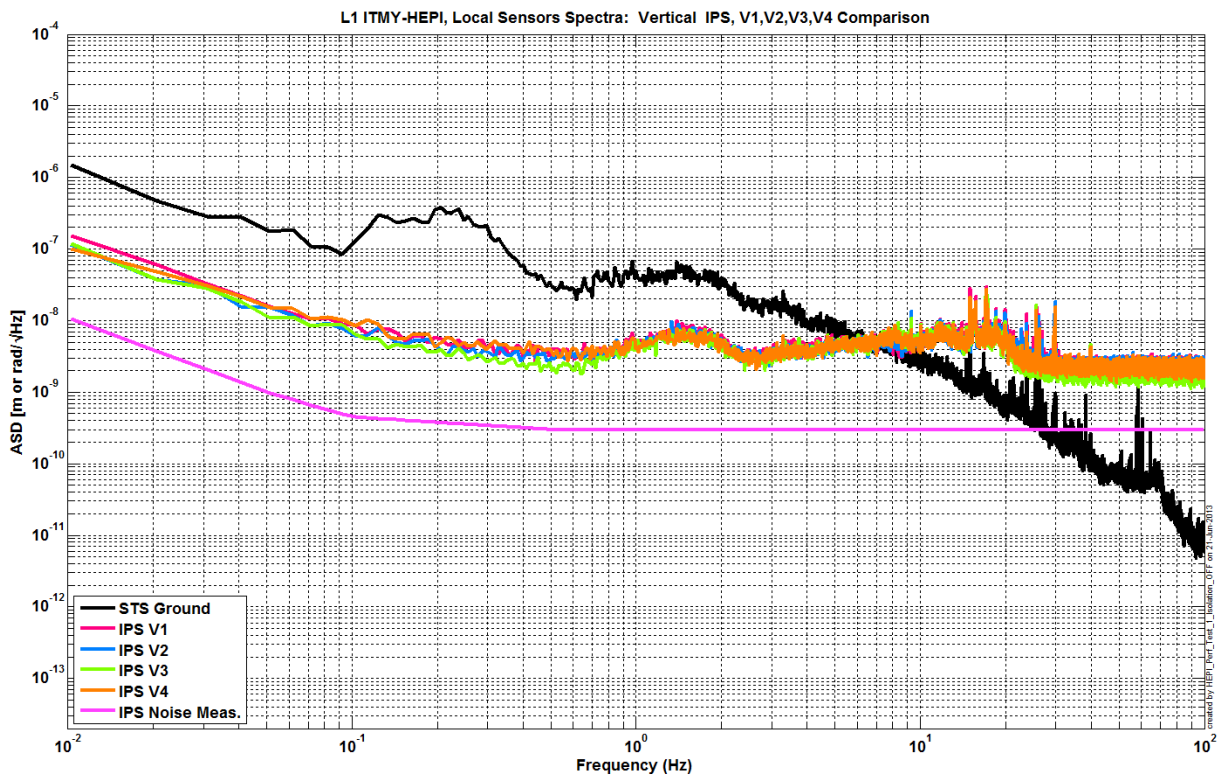

Data in SVN at:
SeiSVN/seismic/HEPI/L1/ITMY/Data/Figures/Perf_Analysis/2013-06-21-Level2/
L1_HPI_ITMY_Test_1_2013-06-21-Level2.mat

Figures in SVN at:
/SeiSVN/seismic/HEPI/L1/ITMY/Data/Figures/Perf_Analysis/2013-06-21-Level2/
- HEPI_L1_ITMY_Test_1_Fig_a_HPI_L4C_Hor_2013-06-21-Level2.fig
- HEPI_L1_ITMY_Test_1_Fig_b_HPI_L4C_Vert_2013-06-21-Level2.fig
- HEPI_L1_ITMY_Test_1_Fig_c_HPI_IPS_Hor_2013-06-21-Level2.fig
- HEPI_L1_ITMY_Test_1_Fig_d_HPI_IPS_Vert_2013-06-21-Level2.fig

L1 ITMY-HEPI, Local Sensors Spectra: Horizontal L4C, H1,H2,H3, H4 Comparison

L1 ITMY-HEPI, Local Sensors Spectra: Vertical L4C, V1,V2,V3,V4 Comparison

L1 ITMY-HEPI, Local Sensors Spectra: Horizontal IPS, H1,H2,H3,H4 Comparison

L1 ITMY-HEPI, Local Sensors Spectra: Vertical IPS, V1,V2,V3,V4 Comparison
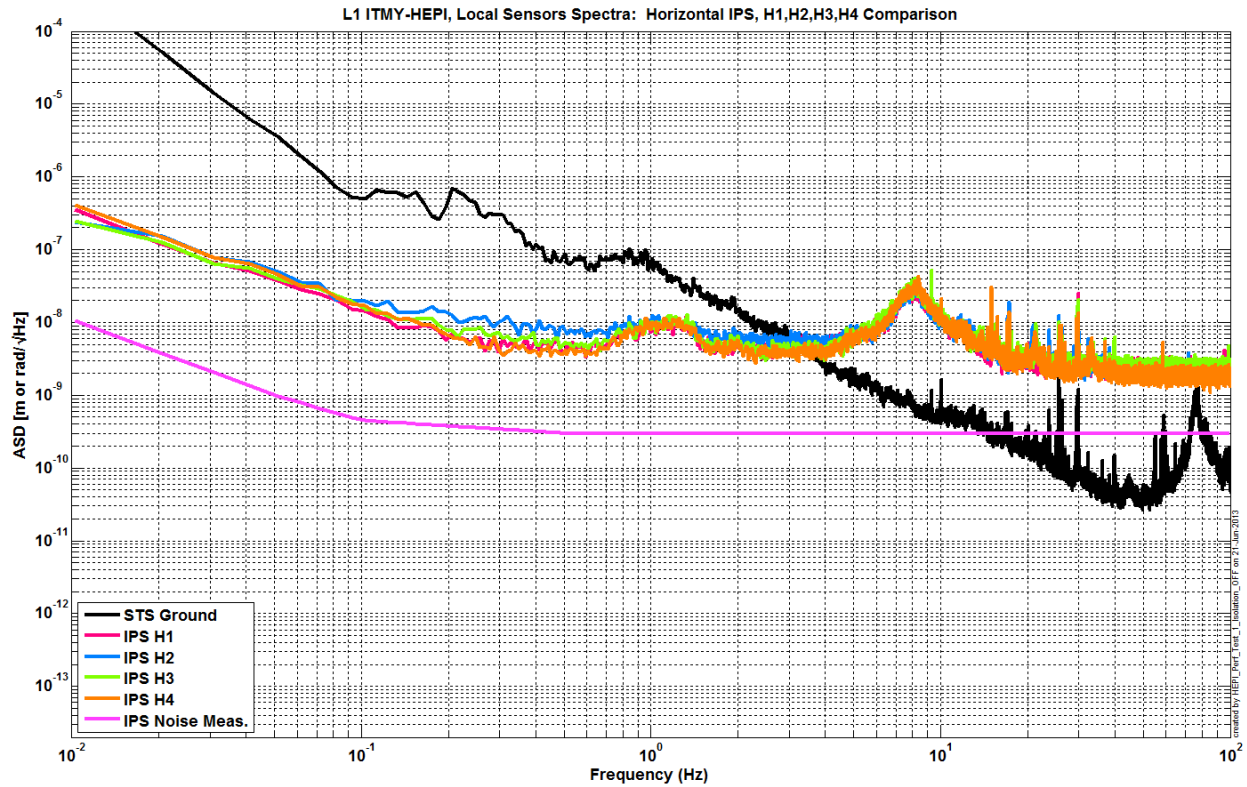
Issues/difficulties/comments regarding this test:

Calibration of IPS on those plots is slightly off I believe. However, those are enough to ensure proper functioning of all sensors.

Acceptance criteria:

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

1.8 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: **X** Failed: ___

When this test is done, reset everything (OVERRIDE button OFF, put back the value on the payload watchdog).

1.9 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 files in SVN at:
/SeiSVN/seismic/HEPI/L1/ITMY/Data/Static_Tests/

Drive of 5000 counts (Nominal value handled by testing script)

	H1	H2	H3	H4	V1	V2	V3	V4
H1	-10347.8	4054.0	1032.3	3696.3	-14.1	-52.3	-86.2	235.3
H2	2213.6	-8271.2	2921.5	864.8	-150.3	56.7	227.5	-90.3
H3	410.9	3475.1	-10313.7	3685.4	-122.6	282.6	-73.4	-228.5
H4	2333.9	1018.0	2954.0	-8909.2	108.2	-3.9	-205.5	-55.9
V1	-377.7	141.2	-221.0	230.6	-5924.4	-863.5	1601.3	-1299.0
V2	-493.0	259.9	-10.4	30.5	-913.1	-5415.2	-1149.8	1344.2
V3	-462.6	524.7	-214.3	-69.6	1342.6	-2132.2	-6899.4	-793.5
V4	-188.1	220.0	-324.8	105.5	-1461.9	777.0	-1571.8	-6540.9

. Drive of 100 counts (in progress)

	H1	H2	H3	H4	V1	V2	V3	V4
H1	8350.9418	-5056.1049	-327.0384	-1879.51872	-178.9088	209.3388	192.18836	-370.0864
H2	-4104.049	8306.5349	-1822.531974	-448.11792	134.8916	-100.465	-301.80668	139.7868
H3	-233.5984	-2065.5751	8170.4572	-4615.56692	178.7694	-183.7838	-239.1095	118.1154
H4	-1807.7793	-701.3897	-4558.2268	9000.50088	-488.2914	367.591	-1.00976	-441.0128
V1	-87.0864	1.56718	302.0506	-174.51156	7490.8344	918.82254	-1656.35338	784.3534
V2	182.2748	-404.56522	-128.0876	486.57564	833.8752	7402.042	675.00182	-1629.1482
V3	309.8688	-477.33554	-80.087	272.82164	-1436.731	1099.12212	7236.42762	695.124
V4	-177.839	74.78868	291.7698	-126.46464	955.694	-1414.8926	824.44686	7487.4108

. Drive of 1000 counts (in progress)

	H1	H2	H3	H4	V1	V2	V3	V4
H1	8350.9418	-5056.1049	-327.0384	-1879.51872	-178.9088	209.3388	192.18836	-370.0864
H2	-4104.049	8306.5349	-1822.531974	-448.11792	134.8916	-100.465	-301.80668	139.7868
H3	-233.5984	-2065.5751	8170.4572	-4615.56692	178.7694	-183.7838	-239.1095	118.1154
H4	-1807.7793	-701.3897	-4558.2268	9000.50088	-488.2914	367.591	-1.00976	-441.0128
V1	-87.0864	1.56718	302.0506	-174.51156	7490.8344	918.82254	-1656.35338	784.3534
V2	182.2748	-404.56522	-128.0876	486.57564	833.8752	7402.042	675.00182	-1629.1482
V3	309.8688	-477.33554	-80.087	272.82164	-1436.731	1099.12212	7236.42762	695.124
V4	-177.839	74.78868	291.7698	-126.46464	955.694	-1414.8926	824.44686	7487.4108

Table - Main couplings and cross couplings

Issues/difficulties encountered during this test:

Acceptance criteria:
- The results in these three tables must be the same (within xxx%)

Test result: **Passed: ___** **Failed: ___**

1.10 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/L1/ITMY/Data/Spectra/Undamped/
L1_ISI_ITMY_ASD_m_CPS_T240_L4C_GS13_Locked_vs_Unlocked_2012_02_07.mat

Figures in SVN at:
/SeiSVN/seismic/HEPI/L1/ITMY/Data/Figures/Spectra/Undamped

	Slopes	Offsets
H1	1.63	1800.40
H2	1.88	-522.55
H3	1.63	1959.94
H4	1.76	-177.98
V1	1.54	-4082.29
V2	1.54	-1558.79
V3	1.42	-516.54
V4	1.56	-5144.56

Issues/difficulties encountered during this test:

Acceptance criteria:
-

Test result: **Passed: ___**   **Failed: ___**

1.11 Actuator Plate to Shields gap

Perform this test ONLY if the range of motion test failed.

Test result: **Passed: ___**   **Failed: ___**   **Waived: _X_**

1.12 Valve Check

Scripts files for processing and plotting in SVN at:
/SeiSVN/seismic//HEPI/L1/ITMY/Scripts/Valve_Check/plot_valve_check.m
/SeiSVN/seismic/HEPI/L1/ITMY/Scripts/Valve_Check/dtt2mlab_Valve_Check.m
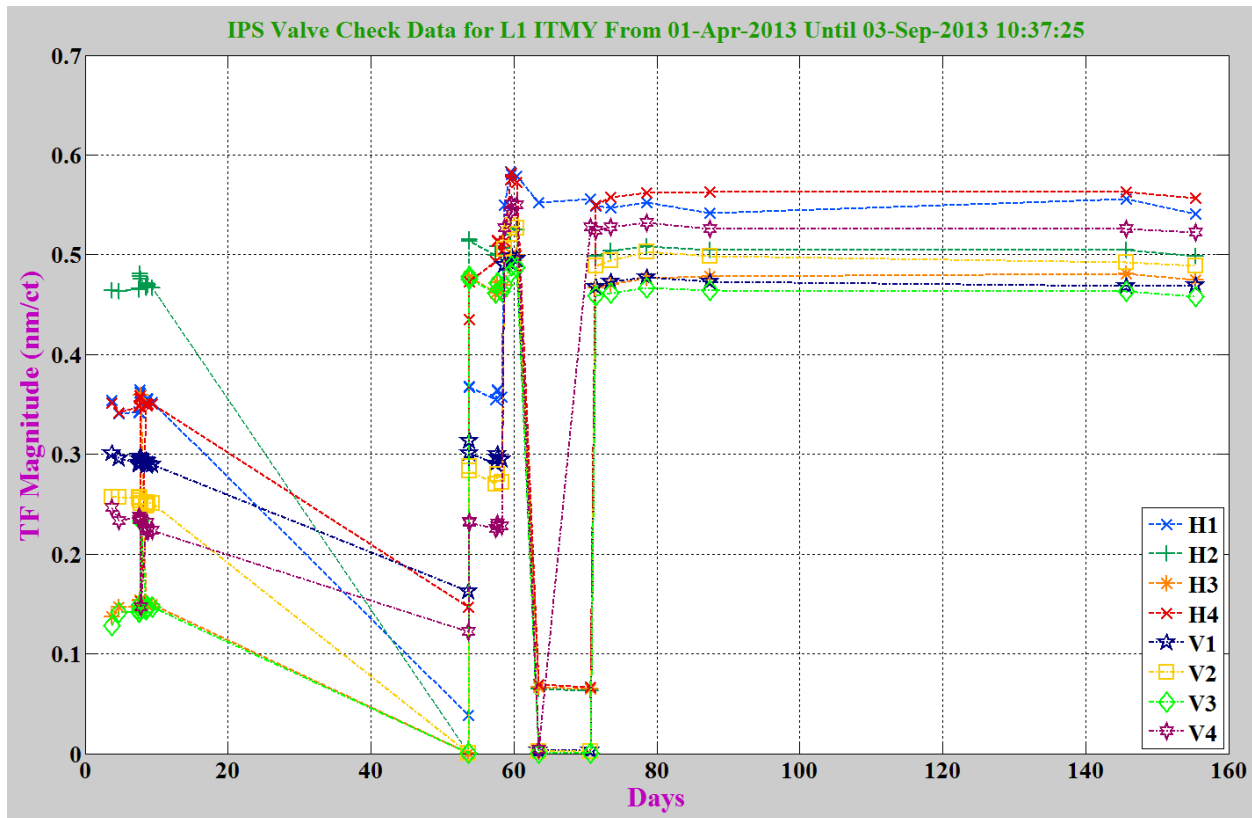
Data in SVN at:
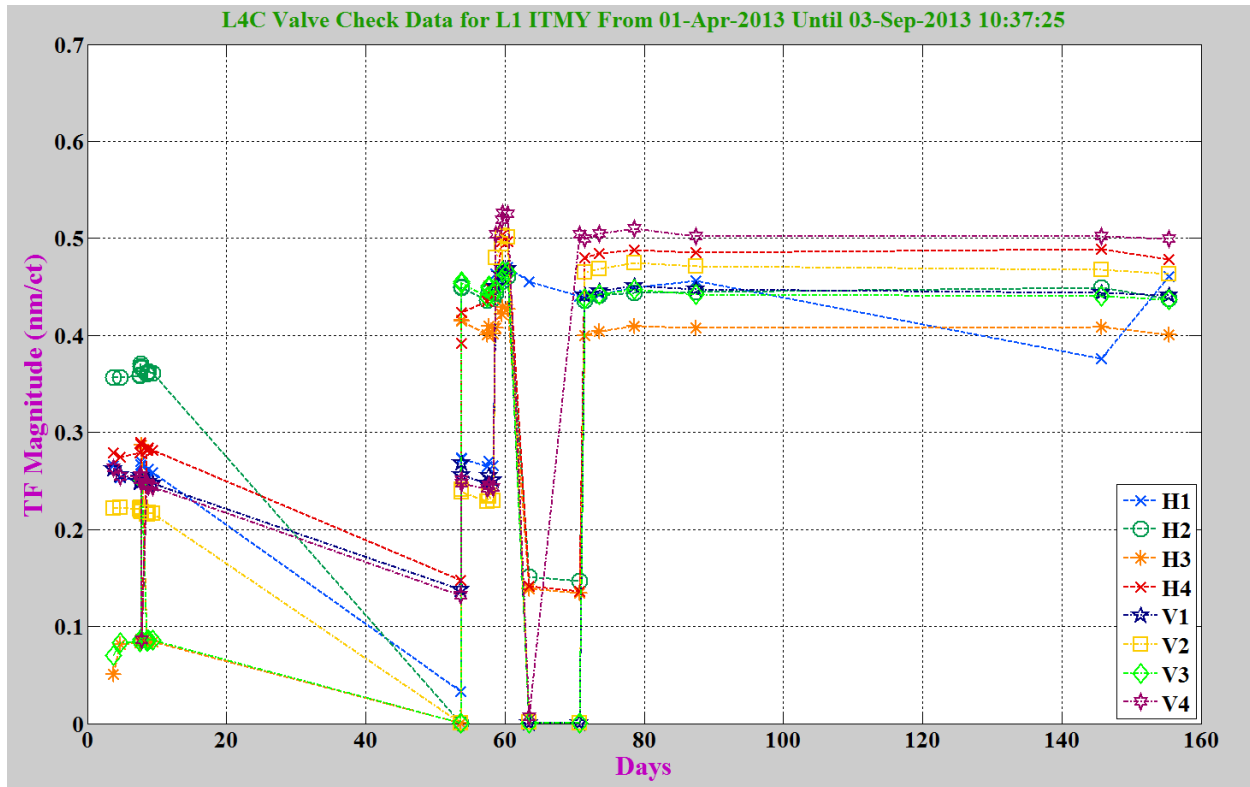/SeiSVN/seismic/HEPI/L1/ITMY/Data/Spectra/Undamped/
/SeiSVN/seismic/HEPI/L1/ITMY/Scripts/Valve_Check/

Figures in SVN at:
/SeiSVN/seismic/HEPI/L1/ITMY/Scripts/Valve_Check/
/SeiSVN/seismic/HEPI/L1/ITMY/Scripts/Evolution/

Issues/difficulties/comments regarding this test:
The one before last H1 point was a measurement issue, valve and L4C are ok.

Acceptance criteria:

- All corners should behave consistently (usually displacement > 0.4 nm/ct)

Test result: Passed: __X__   Failed: ____

1.13 Local-to-local measurements

Data files in SVN at:
/SeiSVN/seismic/HEPI/L1/ITMY/Data/Transfer_Functions/Measurements/Undamped/
- L1_HEPI_BSC1_100_to_250Hz_20130531-040811.mat
- L1_HEPI_BSC1_20_to_100Hz_20130531-015132.mat
- L1_HEPI_BSC1_2_to_20Hz_20130530-230413.mat
- L1_HEPI_BSC1_0p5_to_2Hz_20130530-171533.mat
- L1_HEPI_BSC1_0p5_to_2Hz_20130530-171533.mat

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/L1/BS/Scripts/Control_Scripts/release/
- Step_1_TF_Loc_to_Loc_L1_HEPI_ITMY.m

Figures in SVN at:
/SeiSVN/seismic/HEPI/L1/ITMY/Data/Figures/Transfer_Functions/Measurements/Undamped/
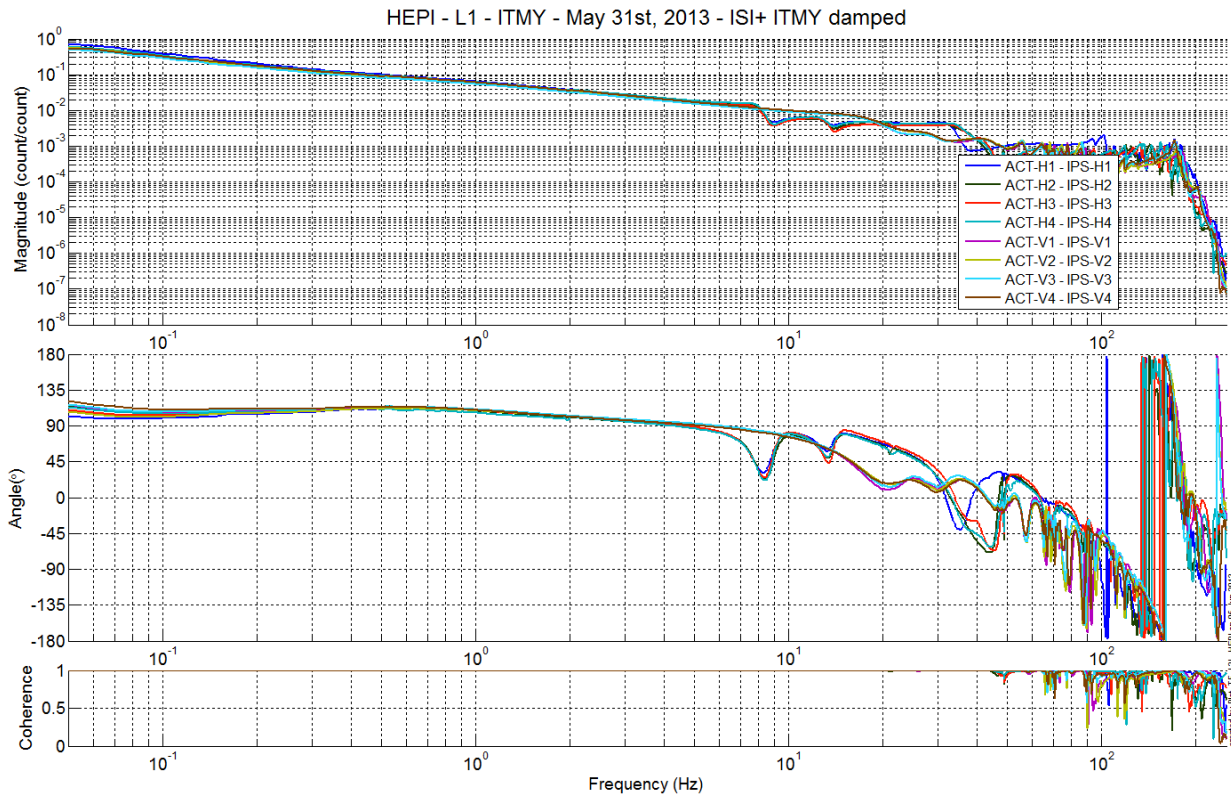- L1_HPI_ITMY_TF_L2L_Raw_from_ACT_to_IPS_2013_05_31.fig
- L1_HPI_ITMY_TF_L2L_Raw_from_ACT_to_L4C_2013_05_31.fig

Storage of measured transfer functions in the SVN at:
/SeiSVN/seismic/HEPI/L1/ITMY/Data/Transfer_functions/Simulations/Undamped/
    L1_HPI_ITMY_TF_L2L_Raw_2013_05_31.mat

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

HEPI - L1 - ITMY - May 31st, 2013 - ISI+ ITMY damped
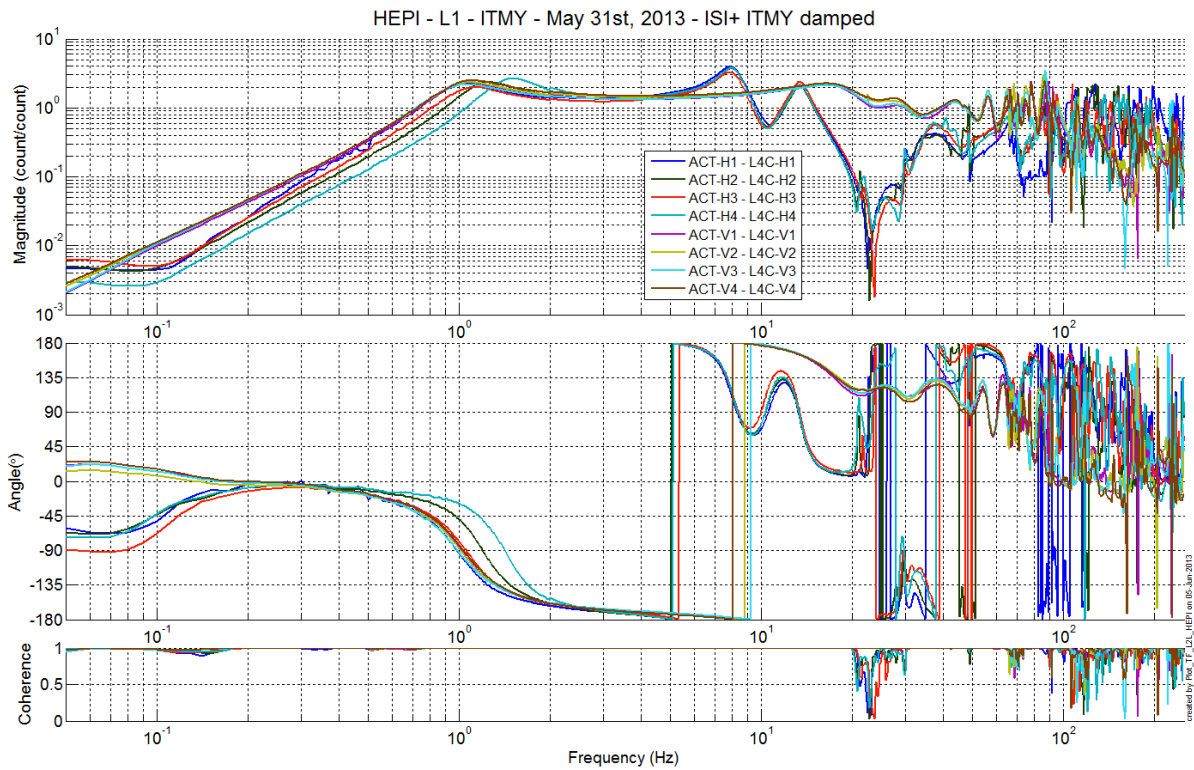
Issues/difficulties/comments regarding this test:
One can notice that and H4 L4C corner frequency is significantly higher than the other. This is likely due to that boot being tilted, but it is unclear how to solve the issue.
Note additionally that the L4C sign is opposed to expectations, this is due to the old L4C cables.

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: __**   **Waived: _X_**   **Failed: ___**

1.14 Alignment offsets:

The IPS readouts recorded below are for HEPI unlocked, when on 06/12/13, the commissioning crew made their first attempt at DRMI alignment check (cf LLO alog 7383)

	IPS Readouts
H1	14945
H2	7703

H3	12857
H4	-1459
V1	10952
V2	-11214
V3	-3438
V4	9980

Note at the moment, for this chamber, the offsets are re-computed every time HEPI loops are started.

Acceptance criteria:
Offsets were recorded.

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

Conclusion

The only tests run for initial approval of this systems were the valve checks, the sensors ASDs and the transfer functions. All have looked good since July 2013. Position loops have been used routinely on this chamber.