LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

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Installation and testing of L1 PSL table legs

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LIGO Scientific Collaboration

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1 Introduction

During December of 2010, the 16' x 5' x 24" thick optical table for the Pre-stabilized laser for the LIGO Livingston interferometer was installed on six custom table legs. After installation, accelerometers were used to assess whether the installation had been completed successfully. The measurements indicated that it had.

2 Table legs and mounting

For aLIGO custom PSL table legs were designed by R. DeSalvo, R. Savage, and R. Schofield with the goal of improving on the performance of the off-the-shelf legs used for iLIGO. The principal drawbacks of the iLIGO legs were vertical resonances caused by flexure of the steel disks at the bases of the legs and large "card-table" horizontal sway motion allowed by the inherently low-compliance legs and their interfaces with the table and the ground.

The design of the aLIGO PSL table legs can be found in LIGO-D1001809. They are low-aspect-ratio, hexagonal, pyramidal steel weldments with parallel top and bottom flanges. They are grouted to the LVEA floor using Hydrostone contained in aluminum dams that are caulked in place. For the table to leg interface, the table is first "floated" on sections of Viton o-rings mounted in grooves in the leg top flanges to equalize the pressure on the six legs. Then an annular layer of epoxy was installed and held in place by dams created by the o-ring sections and backer rod and separated from the legs and table bottom by plastic wrap. When the table was lowered onto the legs, the epoxy oozed out though gaps in the dams and the table floated on the o-rings (and the added pressure arising from the surface tension and viscosity of the epoxy) until the epoxy hardened. The legs were filled with glass beads contained in plastic bags before the table eas set in place. The beads damped the leg resonances.

Figure 1 aLIGO PSL table leg test after lifting table off of legs. The leg is grouted to the LVEA floor using Hydrostone. The table "floats" on sections of Viton o-rings until an annular bead of epoxy hardens, thus equally loading the six legs and making a hard vertical connection.

A more detailed description of the mounting procedure and prototype performance testing can be found in LHO eLOG entries on Aug. 13, 2010

http://ilog.ligo-wa.caltech.edu/ilog/pub/ilog.cgi?group=detector&date_to_view=08/22/2010&anchor_to_scroll_to=2010:08:23:12:31:53-robert

and on Sept. 12, 2010

http://ilog.ligo-wa.caltech.edu/ilog/pub/ilog.cgi?group=detector&date_to_view=09/12/2010&anchor_to_scroll_to=2010:09:12:13:35:09-robert.

3 Livingston PSL table mounting performance assessment

The LLO PSL table performance assessment was reported in the aLOG by R. Schofield on Dec. 17, 2010,

https://alog.ligo-la.caltech.edu/aLOG/index.php?callRep=357

The log entry is reproduced here:

PSL table installation successful

SUMMARY: The aLIGO PSL table was successfully installed and the RMS motion in the aLIGO band is at least a factor of a few below the level for iLIGO. The table moves with the ground to its lowest resonances in the 100 Hz region (20 Hz for iLIGO).

The aLIGO PSL table was installed this week. Our design philosophy was to minimize RMS motion in the aLIGO band by raising the table sway resonances from iLIGO's 20 Hz to above 100 Hz, and the vertical bounce on the legs from the 40-60 Hz region to above 100 Hz. We chose not to float the table because the system we have experience with only controls 3 degrees of freedom and it increases low frequency motion in the 1 Hz region and below.

Figures 1 and 2 show that we reached our goal, moving the lowest sway resonance form around 20 Hz to the 120 to 150 Hz region (X and Y axes) and the bounce modes from 40 and 60 to above 200 Hz (Z axis). Figures 1 and 2 also show that the RMS motion of the table was reduced by at least a factor of a few. The actual improvement is probably better than the figure shows because the old data was taken when the table was inside an acoustic enclosure during S6 and the new data was taken with the table exposed to an environmentally noisy LVEA due to aLIGO activities. An example of this extra noise is the huge narrow 120 Hz peak.

Figures 3 and 4 compare the top of the periscope to the table top and floor. We wanted to increases the table support resonances into the hundred Hz region but not clear up into the region of periscope resonances above 200 Hz. The figures show that we were mostly successful, though the peak at 200 Hz is a little higher in frequency than we wanted and may overlap with part of the periscope resonances. Much of the broad band difference between the table top and the periscope top is probably due to greater acoustic coupling, the taller peaks that are tens of Hz wide likely indicate the actual periscope resonances. We note that, between about 100 Hz and a couple of hundred Hz, the signals from accelerometers huddled on the floor were coherent only at about 0.5 rather than 1, indicating that, because of the electronic noise floor, ground motion in this band is somewhat less than indicated by the plots.

Robert Schofield, Anamaria Effler, Rick Savage, Michael Rodruck, Mike Fyffe, Keith Thorne, Harry Overmier, Gary Traylor, David Kinzel

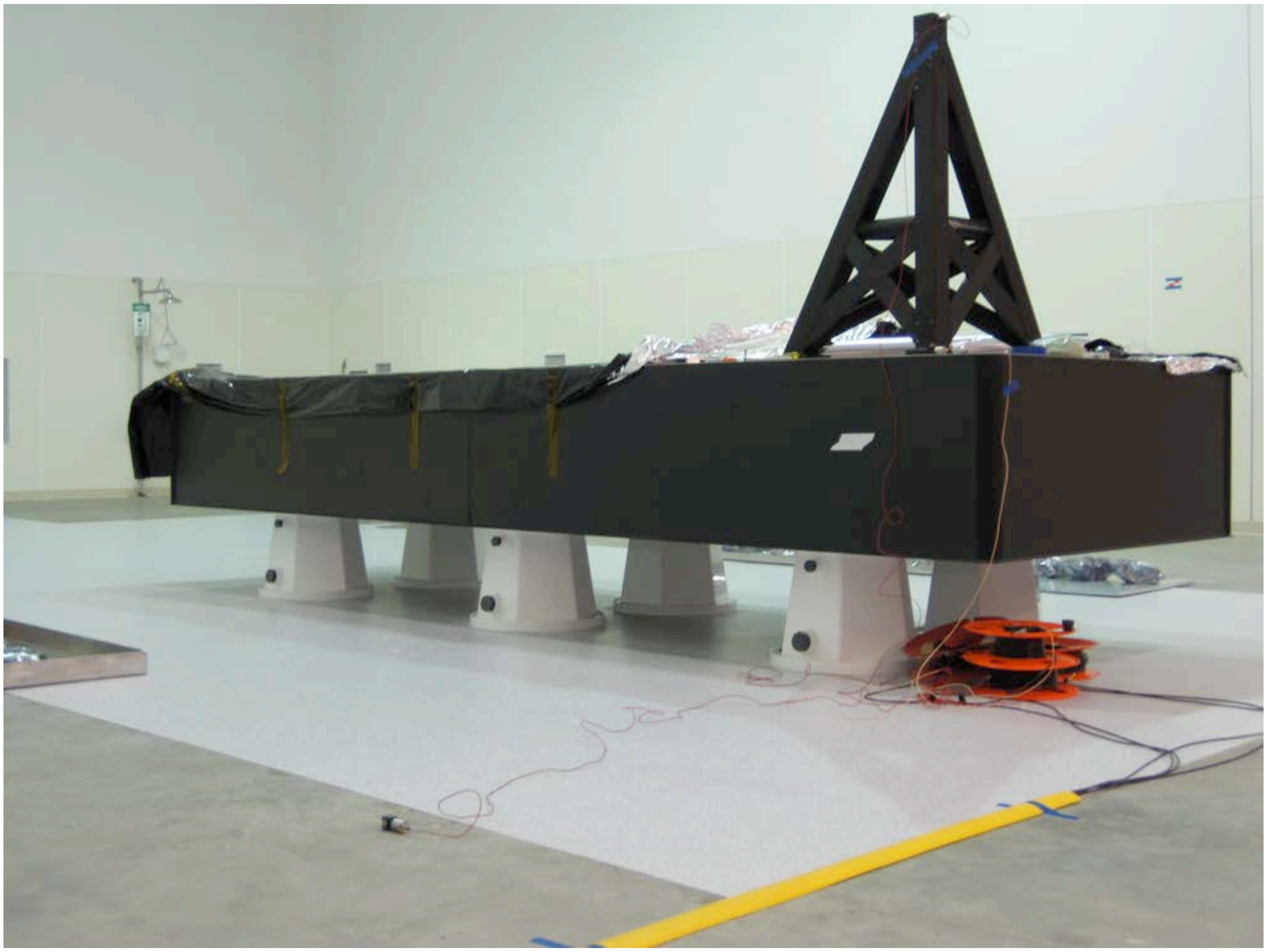

Figure 2 LLO PSL table after installation and during performance testing.

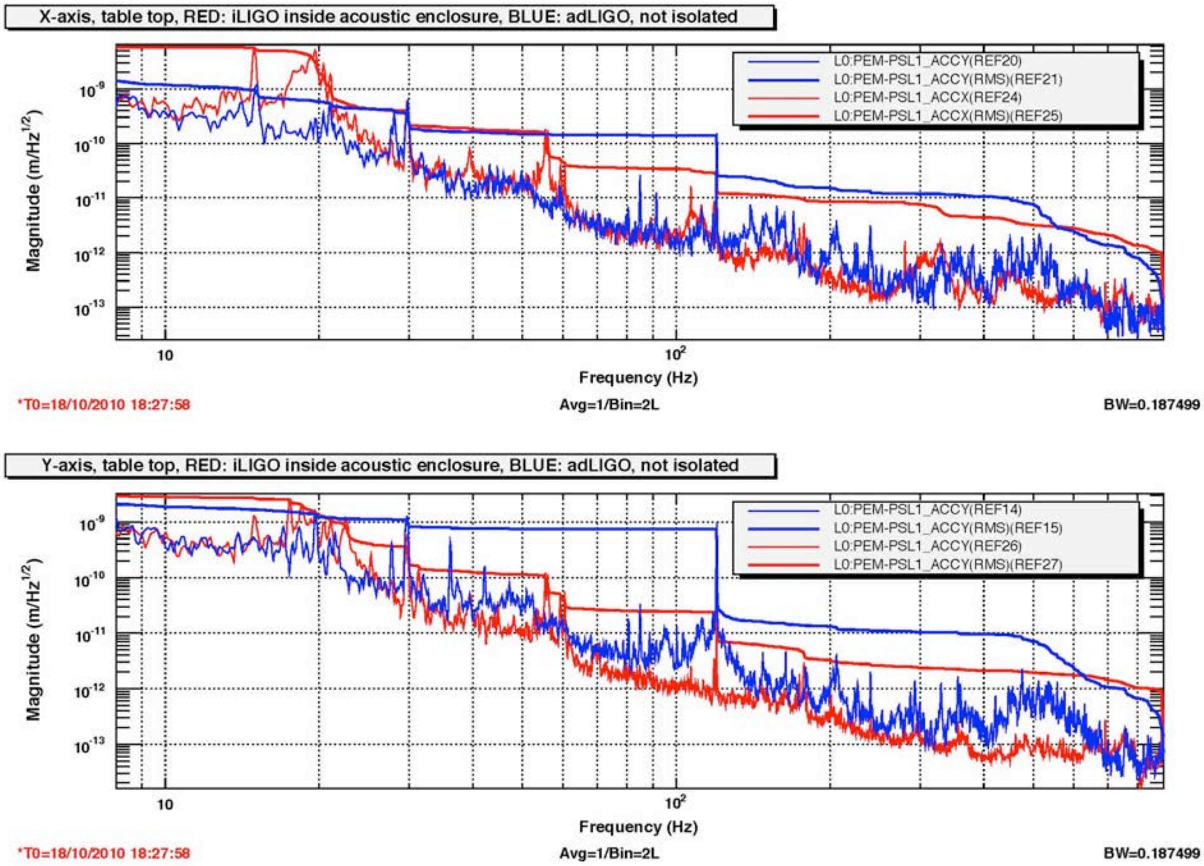

Figure 3 Figure 1 from aLOG entry.

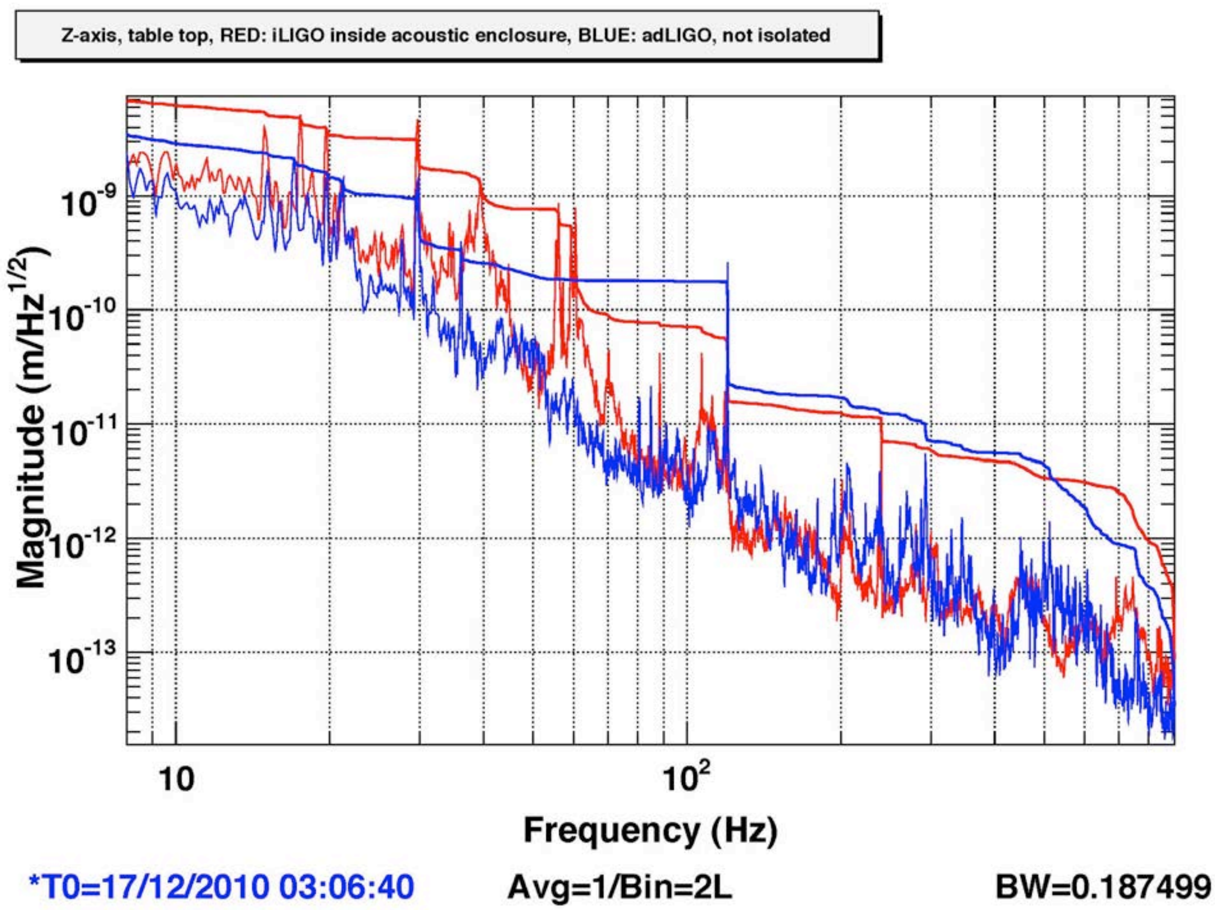

Figure 4 Figure 2 from aLOG entry.

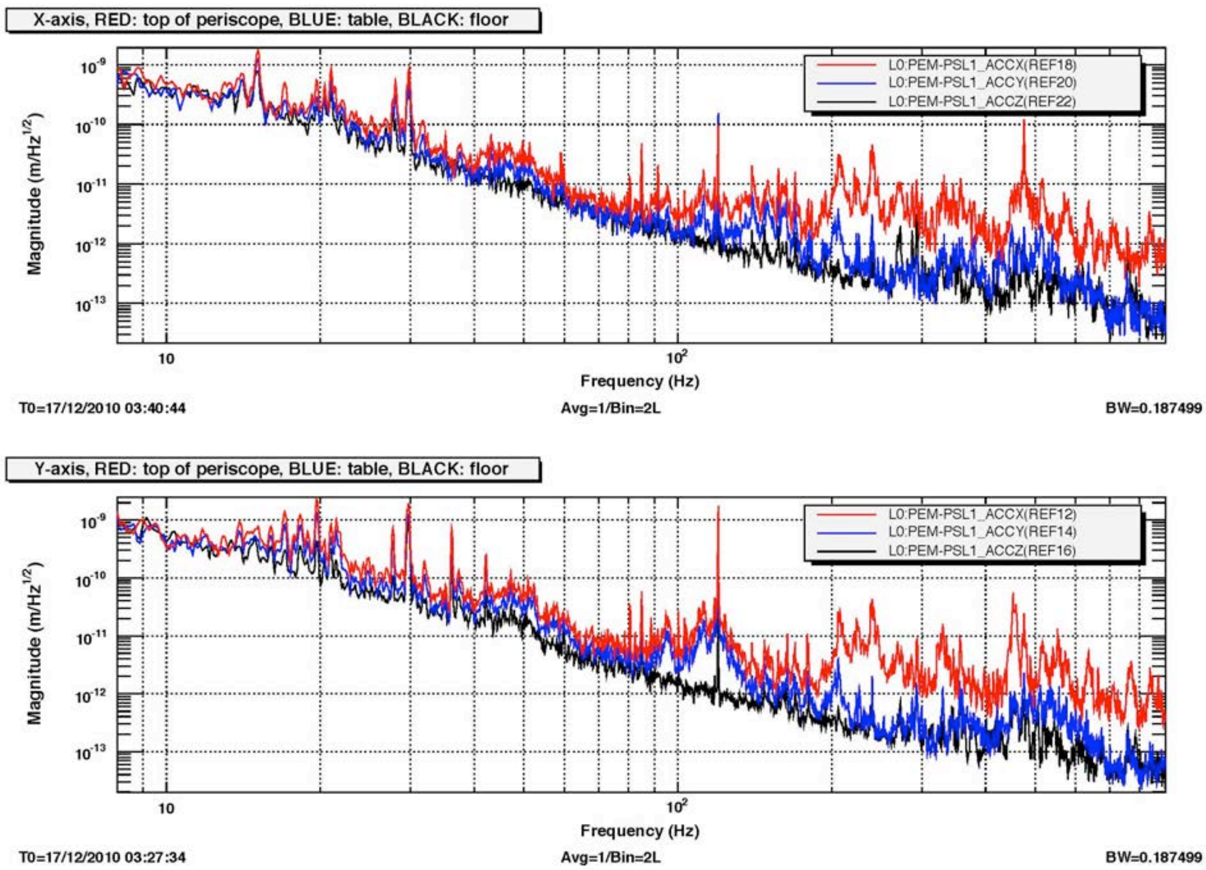

Figure 5 Figure 3 from aLOG entry.

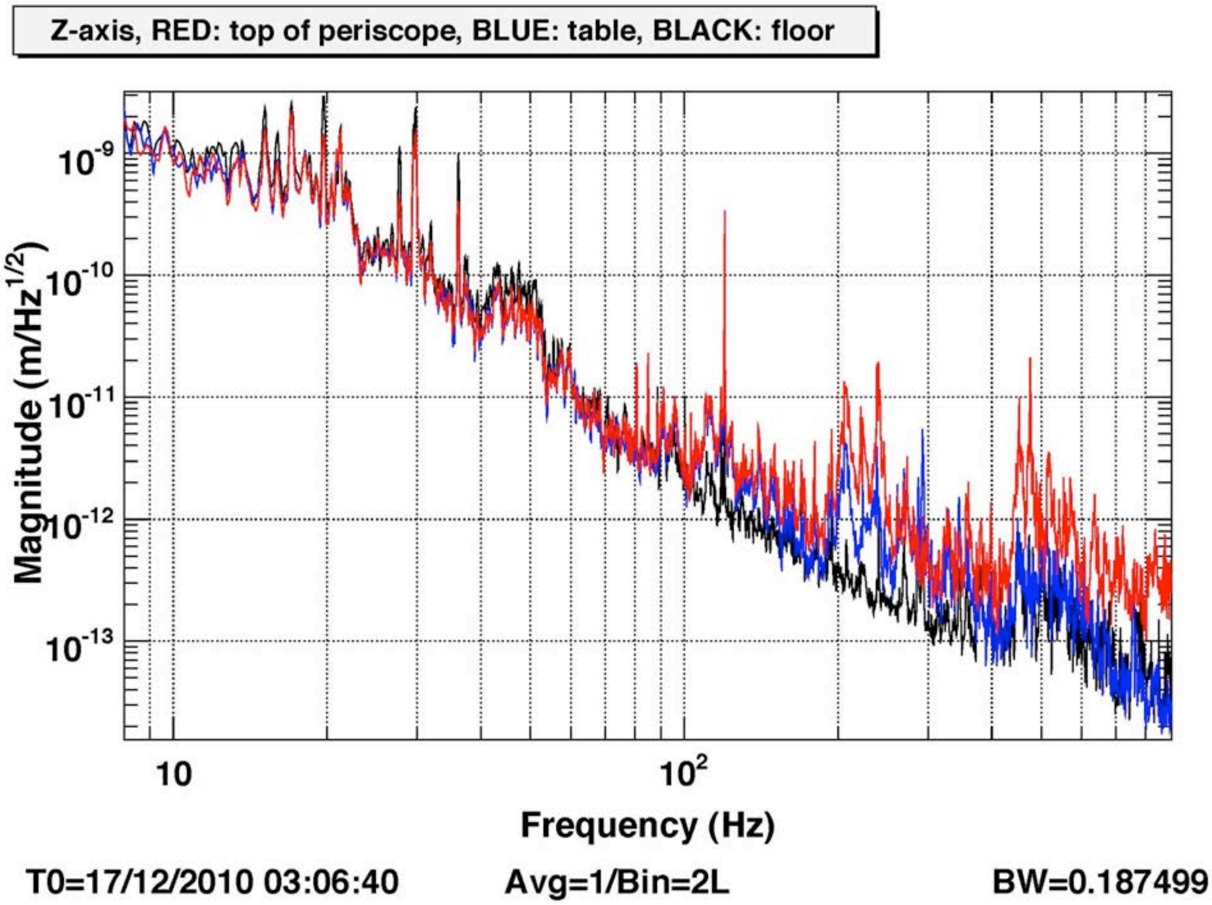

Figure 6 Figure 4 from aLOG entry.