LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

- LIGO -

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M. Landry, R. McCarthy, D. Sigg		

Distribution of this draft:

Commissioning mailing list

California Institute of Technology
LIGO Project - MS 51-33
Pasadena CA 91125
Phone (626) 395-2129
Fax (626) 304-9834
E-mail: info@ligo.caltech.edu

Massachusetts Institute of Technology
LIGO Project - MS 20B-145
Cambridge, MA 01239
Phone (617) 253-4824
Fax (617) 253-7014
E-mail: info@ligo.mit.edu

WWW: http://www.ligo.caltech.edu/

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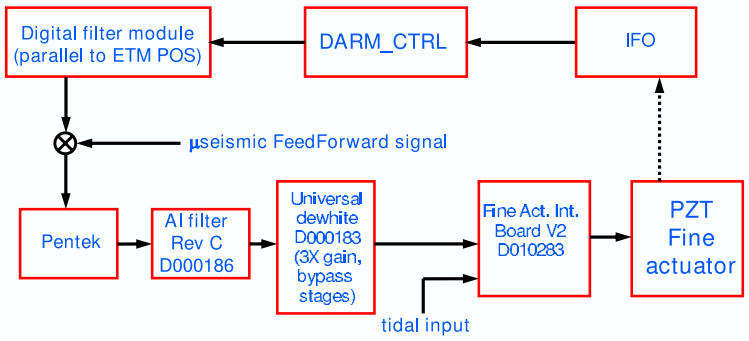

Figure 1: Feedback schematic. A copy of the ETM control signal in and end station will be filtered and sent to the PZT fine actuators.

1 Introduction

There is not universal agreement that microseism mitigation is strictly necessary at LIGO Hanford [1]. Both correlations and anticorrelations are observed with high microseism and robust locking of the 4k IFO. Seeing as multiple noise sources are present (e.g. cultural noise), we will add microseismic mitigation to the Hanford instruments in order to reduce that noise component. In the process we hope to, at least most of the time, help stabilize the instruments and reduce the mean-time-to-lock when low frequency noise is high. Our approach is a staged one, to add the simplest mitigation scheme on the 4k first, and then move on to more complicated arrangements and the shorter IFO (less impacted by microseism) later.

Two flavours of microseimic mitigation are proposed, feedback and feedforward. The former relies on an error signal generated by the locked interferometer (we will use ETM{X,Y}_CTRL), which is filtered and fed back to the PZT fine actuation system. The latter feedforward method has already been successfully employed (but superceded by HEPI) at LLO and we will largely copy this subsystem.

2 Feedback

Feedback may be a sufficient form of useism mitigation and may obviate the need for more complicated feedforward methods. DARM_CTRL can be used as an error signal, sent (with appropriate filtering) to the PZT fine actuators in the end station [2]. Fig. 1 is a schematic of the feedback loop. LSC front end code changes would be required for the end stations, adding a filter bank parallel to the ETM POS filter to condition the ETM control signal (differing only from DARM_CTRL by an output matrix element) and form the control signal to be sent to the PZT fine actuators. Care must be taken when designing the filters so as to have gain at 0.1Hz but not add noise above the pendulum resonance.

Initially, an existing version of the PZT driver box built by J. Myers of LHO will be used. Later, a V2 version may be added to make the 4k and 2k boxes identical (currently the time-constant of the 4k tidal input is longer than that of the 2k).

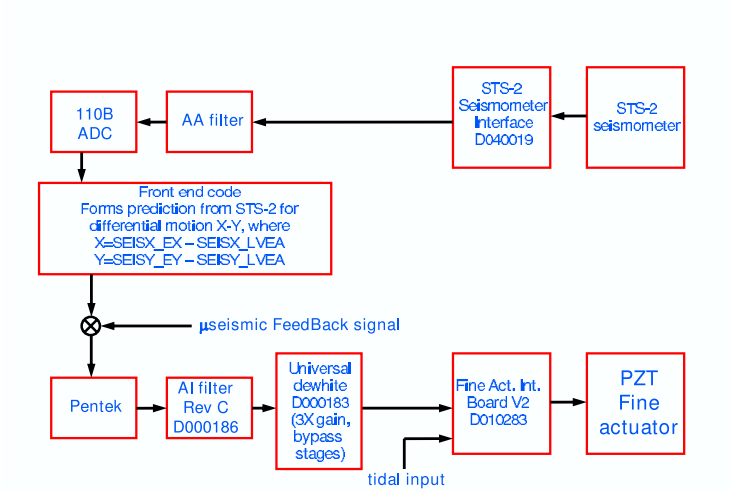

Figure 2: Feedforward schematic. For clarity only one seismometer is shown. The microseism feedforward and feedback signals are summed digitally before being sent out to the PZT fine actuators. The STS-2 interface box was designed by R. Abbot and conforms to the RFI standards adopted at LLO.

3 Feedforward

A feedforward subsystem was used at LLO to mitigate microseismic noise [3].

Fig. 2 is a schematic of the system we would build at LHO. Only one STS-2 seismometer is shown in the figure; three per IFO are required (in effort prevent intermingling of 2k and 4k hardware, 2 STS-2 seismometers are required for the cornerstation). Currently, only 5 STS-2 seismometers are available at LHO. A sixth would be required if the 2k was to be instrumented with a feedforward system.

The feedforward design will follow the LLO pre-HEPI installation. In-beam Seismometer output is integrated to form displacement signals for the corner and end stations. The signals will be bandpassed to remove noise below 0.1Hz, and supress action at the first stack frequency of 1.2Hz. The signals are differenced to form predictions for x and y arm motion. Differential displacement is sent to end station DAC units and on to the PZT fine actuators.

R. Adhikari notes that the STS-2 seismometers must be insulated such that noise from thermal air currents is smaller than ambient tilt below 0.1Hz, and that it may be desirable to balance actuators to remove any POS to YAW coupling.

4 Timeline

We will begin by implementing and testing microseismic feedback on the 4k IFO. Assuming this is successful, we will copy it to the 2k IFO. If necessary, we will next implement feedforward on the 4k, followed by the 2k.

Feedback is to be implemented on the 4k and 2k, provided R. Bork and/or A. Ivanov have sufficient time to modify LSC front-end software, in time for the E11 engineering run beginning Nov 16, 2005.

We would implement feedforward on the 4k, followed by the 2k, by the beginning of the S4 run.

References

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