LSC Six-Month Progress Report

Organization University of Michigan Gravity Wave Group (MGWG)

Report Date 08/15/1999

Attachment A - LIGO I

Item - Task 8 - a)

We have identified and fixed two noise sources in the 40 Meter PSL system. Two sources of 60 Hz and its harmonics have been found and addressed in the demodulation read out chain. Noise in the 40 Meter is considerably less embarrassing than it once was. A 'lock box' scheme (gadget) has been devised for lock acquisition; this is based on transmitted light in the last arm to lock; this has not yet been tested.

Item - Task 8 - b)

The 40 Meter has been locked, sometimes with ease, and others times with difficulty. Lock periods of 10 to 100 minutes are achieved with attention. Locking and maintaining lock requires a substantial misalignment of the arms.

We believe the optical parameters of the 40 Meter have come in very close to critical coupling. While in principle very efficient, this is operationally a disaster. We depend on some carrier to be reflected from the interferometer beating with the PRM resonant sidebands to yield a beam splitter and recycling mirror error signal. The coupling and hence the amplitude and even the sign of these signals will vary dynamically with small fluctuations in light power, alignment, etc., especially operating near critical coupling, and especially during lock acquisition. This would explain the difficulty in aligning the arms, i.e., the necessity to detune the IFO, thus moving the IFO away from critical coupling. We are thus motivated to invent new carrier-independent error signal schemes for the beam splitter and recycling mirror (I-, I+) servos (see below).

A further reality seems to be that undamped degrees of freedom on driven test masses (e.g., the vertical & roll modes of the recycling mirror and beam splitter) tend to be excited, and challenge the dynamic range of the beam splitter and recyling mirror servos; this is worst during lock acquisition. We have not found a simple way around this problem.

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Item - Task 8 - c)

As chair of the LSC Detector Characterization Working Group, Riles has organized (together with Lab Liaison Daniel Sigg and subgroup leaders Fred Raab, Jim Brau and Sam Finn) the effort to monitor the LIGO interferometers offline (but onsite).

Working group organization has involved:

* Chairing working group sessions at the LSC meetings in March at Gainesville and in July at Stanford, along with occasional teleconferences.
* Setting up and maintaining a web site for the working group.
* Defining tasks and finding volunteers to carry them out. Detailed task tables have been assembled with priorities assigned and volunteers recruited. These tables can be found at http://www-mhp.physics.lsa.umich.edu/~keithr/lscdc/tasktables.html.
* Helping write the LSC White Paper on Data Analysis to be submitted to NSF in fall 1999. Riles hosted the initial organizational meeting for the paper in Ann Arbor.

Much of the detector characterization will be carried out in the environment of the Data Monitor Tool (DMT) running on a workstation at each site (developed by John Zweizig of Caltech). Riles has installed the DMT package at Michigan and begun writing algorithms for performance characterization and transient analysis. Initial versions of the algorithms will be completed in the next 6-month period to help in commissioning the 2-km interferometer at Hanford.

Item - Task 8 - d)

A new I+ servo error signal scheme has been invented, tested and commissioned. This is based on AM sidebands substituting for the carrier in the detection-demodulation process at the symmetric photodiode and yields a recycling mirror signal independent of the arm modified carrier (rather than our unfavorable 100:1 mix of arm and recycling cavity signals in the standard 40 Meter and LIGO I+ scheme).

A similar I- (beam spltter) scheme has just worked for the first time (8/99). This promises to allow full alignment of the test masses after lock, giving us a system much more robust against perturbation with no possibility of servo sign reversal.

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Report Date 08/15/1999

Item - Task 8 - e)

In developing the diagnostics and servo schemes described above, electronics have been cobbled together, as needed. If LIGO I adopts these ideas, the electronics will require more rigorous engineering. We have not yet begun this work.

Item - Task 8 - f)

Gustafson and undergraduate Justin Dombrowski have spent much of the summer shaking down the 40 Meter in order to improve its lock acquisition and stability, as described above. Preparations are underway to collect data in September in a fully recycled, LIGO-like configuration with more than a hundred data acquisition channels recorded.

Item - Task 8 - Overview

The Michigan group has continued work at Caltech's 40 Meter prototype instrument (Gustafson & Dombrowski). New servo schemes for controlling the Michelson cavity degrees of freedom have been developed and tested at the 40 Meter. Various sources of noise have been identified and mitigated, and new diagnostics have been developed. We are now preparing to collect and record data in a fully recycled, LIGO-like configuration.

Riles chairs the LSC Detector Characterization Working Group and has worked on organization of group efforts and on particular detector characterization algorithms. He also helped write the LSC White Paper on Data Analysis.

Note 1, Linda Turner, 02/08/00 03:59:04 PM
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