LSC Six-Month Progress Report

Organization Stanford Advanced Gravitational Wave Interferometry Group
Report Date February 15, 2003

Attachment D - Advanced Detector Configurations Development Group
For the period August 2002 to February 2003

Advanced Configurations (R. Byer, M. Fejer, S. Rowan, E. Gustafson, R. Beausoleil, A. Bullington, and S. Sinha,)

a) In the area of improved modeling of distortions in all-reflective design of LIGO interferometers, the following manuscript describing our previous work has been under revision prior to submission.

> S. Traeger, P. Beyersdorf, Patrick Lu, J. Mansell, R. Beausoleil, E. Gustafson, R.L. Byer and M.M. Fejer, "Wavefront distortion produced by thermoelastic deformation of a diffraction grating"

b) MELODY has been upgraded to simulate LIGO gravity-wave sensitivity for signal-recycled configurations, and Melody 2.0 will be distributed early in 2003 after full-blown regression-testing that has become standard operating procedure over the last year. Development of the MELODY thermal modeling package has included code to the LASER_FIELD class of computational analyses to provide transverse mode intensity/phase plots of the total electric field anywhere in an arbitrary optical system. In addition, MELODY enables extraction of highly distorted interferometer eigenmodes for mode-matching simulations. Utility routines have been provided which allow MELODY users to change bases in simulations where the distortions have become so large that the curvature of the wavefront has changed sign relative to that of the corresponding unperturbed basis state at a given position. A GINGIN class has been added with an upgrade to allow modeling of power-independent optical distortions due to substrate index inhomogeneities.

MELODY will be an integral part of the modeling effort supporting the sapphire down-select decision process, so the code incorporating the results of the FEMLAB numerical computations of perturbation matrices into MELODY has been automated and streamlined significantly to allow routine changes in test mass parameters without significant user intervention. The 1000x speed advantage of MELODY over FFT and other numerical tools has been maintained.

c) Approximately 24 W has been obtained at the output of the Lightwave commercial optical amplifier which follows the LIGO 10 W master laser. Efforts have been made by Graduate Student, Amber Bullington, to make extremely accurate measurements of the amplifier's beam radius as it propagates so that the astigmatic output of the optical amplifier can be efficiently mode-matched to the mode cleaner. Due to the higher available incident powers, experiments are no longer being performed with chrome-

coated mirrors, but with low-loss dielectric mirrors whose behavior is more similar to that of the LIGO pre-mode cleaner. Eventually, when the 100 W demonstration is complete for the Lasers group, this beam will be made incident on the mode-cleaner.