LSC Six-Month Progress Report

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Elementary Particles and Relativity Group (EPRG-CSUDH)

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Attachment A / LIGO I

Task-1 (from our MOU for 2-15-04-8-15-04): (Ganezer, Wiley, and Jennings)
The CSUDH group will undertake computation and documentation of results for imperfect optics simulations of Advanced LIGO, LIGO I, and the upgraded 40m using the LIGO-FFT program and other software including a finite element model of phase deformations due to thermal effects. The LIGO-I computations will involve comparison of simulations based on as-built configurations and phase maps of H1, H2, and L2, when available, with the actual performance of the LIGO-I IFOs. Results of these simulations will also be applied to design questions for Advanced LIGO.

We performed LIGO-I FFT simulations on the effects of thermal lensing on modulation sidebands in H1 and set up similar simulations for H2 and L1, although we did not perform simulations for H2 or L1 during this period. Thermal lensing was simulated directly using phasemaps for the ITMs from the FEMLAB model of Willems, and indirectly through the use of mismatches between the physical ROC of the SRM and the ROC of the modulation sideband at the SRM. In brief, the physical curvature of the SRM was varied from 8 km -16 km for the SRM, which has an as-built ROC of 14.4 km, in order to take into account the effects of thermal lensing. Our results were compared with those of perfect optics. We found maximum power in the modulation sidebands was obtained at an SRM ROC of about 9.8 km, in agreement with other LIGO-I simulations including those of Bill Kells and independent simulations of Ericka D' Ambrosio. Intensity plots and intensity profiles were also obtained for modulation sidebands in H1 and a modal decomposition for 256 modes was obtained for perfect optics, ITM FEMLAB thermal phases, and for SRM- modulation sideband mismatches of 1, 2, 5, and 10%, and for the perfect optics cases. There was a large contribution for higher than TEM_{00} modes for the thermal phases and for 5 and 10 % curvature mismatches.

FFT based simulations were also undertaken for Advanced LIGO using phasemaps to represent the effects of thermal lensing in Sapphire ITMs. Close attention was paid to Gravitational Wave Sidebands in the SRC. As in the case of modulation sidebands, we used curvature mismatches, this time at the SRC, in order to simulate in a crude way the effects of thermal lensing on GW-sbs. It was found that thermal maps for the ITMs yielded significant shifts to lower frequencies of the peak of the GW-sb Amplitude frequency spectrum, increasing the width of the spectrum and gradually washing out the peak. We found that curvature mismatches has similar effects on the GW-sb spectrum, as thermal phase-maps. A simple modal analysis and intensity maps and profiles revealed that large proportions of higher order modes were present in cases with thermal phase maps or significant curvature mismatches. There seemed to be a good analogy between our LIGO-I and Advanced LIGO studies of modulation and GW sidebands, both undergoing similar degradations due to either thermal phasemaps or curvature mismatches at the PRM or SRM respectively.

Task-2 (From MOU): (Ganezer and Keig) Efforts on burst source analysis. The CSUDH group will work with the burst source analysis group on burst source S2 and S3 data. CSUDH will help to improve methods for correlating cosmological neutrino measurements with LIGO I gravity wave data for a galactic supernova and other burst sources. The CSUDH group will work along with members of the burst source group on establishing upper limits on gravity waves from the S2 and S3 data runs and on formulating manuscripts on these analyses.

Ganezer contributed to the S2 and S3 burst source analysis by participating in weekly burst group teleconferences. MDC Version-2 (sine Gaussian) frames, for software determination of the ETG efficiencies, to a CSUDH host and setup the LIGOTOOLS MATLAB software package (including the framedatadump and framedataextract functions) to view and check the MDC frames. In July Ganezer gave a 15-minute update on SNEWS to the burst group at a teleconference (that included posted slides) and was based on the SNEWS meeting at Neutrino 2004 (in June 2004).

Task-3 (from MOU): (Ganezer and Keig) The CSUDH group will undertake the required number of scientific monitoring shifts for the S4 data run if it occurs during the MOU period and will maintain and upgrade when needed the seismic-BLRMS anthropogenic noise monitor software.

S4 did not take place during this MOU period. Tests of the blrms software were setup on the Caltech Sun cluster using archived DMT data. It was found that upon restarts of the seismic software filter ringdown of the blrms filters at LHO and LLO could cause spurious peaks that might be incorrectly interpreted as due to seismic peaks. Efforts were begun to mark data-loss episodes in the seismic data (that were completed in the following MOU period). Ganezer was a regular participant in Detector Characterization teleconferences.

Task-4: (from MOU): (Ganezer). The CSUDH group will participate in the final preparations of the 40m for data taking and in initial tuning of the 40m for data taking Ganezer visited the 40m on occasion to obtain updates on the 40m upgrade. At the end of the MOU period the mode cleaner and individual arms had been locked but data taking had not yet begun.

Grant Writing Activities (Ganezer and Wiley):

In early November 2004 Ganezer submitted a grant application to the NSF, on behalf of the CSUDH LIGO subgroup that focused on Optical Simulations for active thermal compensation in Advanced LIGO and included some work on the seis_blrms software. Ganezer presented this proposal at the LIGO PAC meeting at MIT in December 2004.