LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

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Report from the Thermal Noise Interferometer Advisory Board Meeting of March 2008

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The Thermal Noise Interferometer Advisory Board met at the LSC/Virgo meeting at Caltech on March 18, 2004. Slides by Eric Black, Akira Villar, and Greg Ogin were reviewed. Items of particular interest in the presentations and related discussions include

- Tara Chelermsongsak is taking over the photothermal experiment, which had been moth-balled since Shanti Rao graduated. It is close to taking data again. A high priority is to measure the thermal expansion coefficient and thermal conductivity of an Advanced LIGO titania-doped tantala/silica coating.

- plans are in place to investigate the effects of the proposed gold barrel coating for Advanced LIGO on thermal noise as seen in the TNI

- moving the TNI spot across the face of an optic did not change the observed thermal noise to within 5 %

- the TNI may be close to directly measuring thermo-optic noise, however to be clear the shot noise may have to be reduced which may require new mirrors designed so the cavity has higher finesse

- the calibration of the TNI noise is accurate to 7 %, leading to a 14% uncertainty in coating loss angles

- the wrong polarization of light is currently entering the Pockels cell, which limits the sideband power. The modulation depth is currently about 5% while the optimal is about 40%. This can be fixed by rotating the Pockels cell or introducing a quarter-wave plate into the optical path.

- there was a suggestion made that the shot noise model used is not complete, it needs a correction term due to the non-stationarity of the light. This comes from work headed by Jordan Camp and is published.

- Greg Ogin has done impressive work interpreting the ellipsometry data from SOPRA which was collected to better determine dn/dT. The direct fits to the ellipsometry data are excellent, but the resulting graph of index versus temperature showed a lot of scatter. The value for the coefficient of thermal expansion is an order of magnitude different from the number currently used, and the dn/dT has the opposite sign from the value measured at ERAU.

Recommendations:

- contact members of the initial LIGO calibration team, possibly including Peter Fritschel, Keita Kawabe, Brian O'Reilly, and Mike Landry, to get input on the method and results of the TNI calibration. After doing this, a document describing the TNI calibration method and result would be very valuable.

- work on developing a noise model for the TNI, in the spirit of what Rana A and Stefan B did for initial LIGO (although it need not be as detailed as the resulting theses). Included in this is to investigate the shot noise formula for non-stationary light to see if a correction is warranted.

- as soon as feasible, make a measurement of the Advanced LIGO coating with the photothermal apparatus

- look into fixing the polarization problem in the Pockels cell

- work with the coating working group to continue investigations into thermo-optic noise

- write a proposal describing the planned work on gold barrel coatings, including what is expected to be learned and what limitations the TNI approach has.

- after there is more consensus in the coating working group on thermo-optic noise, write a proposal, as appropriate, on what hardware upgrades are necessary and useful to directly measure coating thermo-optic noise.

The Advisory Board recommends the following priorities for the TNI moving forward:

1. Understand all thermal noises in the Advanced LIGO optimized titania doped tantala/silica coating. This may include hardware upgrades to reduce shot noise.

2. Investigate whether a direct measurement of non-Gaussian noise is feasible and desirable with the TNI.

3. Investigate whether a direct measurement of thermal noise from a silicate bond is feasible and desirable with the TNI

4. Investigate whether a direct measurement of Gaussian noise from charging is feasible and desirable with the TNI

5. Investigate whether a direct measurement of suspension thermal noise is feasible and desirable with the TNI

6. Measure coating thermal noise from research coatings as developed in the coating research program. Currently the top priority would go to a silica-doped titania/silica coating, but this may shift depending on developments.

7. Directly measure the thermal noise effects of a change in spot size on the mirrors