Attachment OPT to the Memorandum of Understanding LIGO-M970077-00 between the German/British Collaboration (GEO 600) for the Detection of Gravitational Waves (GEO600) and the Laser Interferometer Gravitational Wave Observatory (LIGO)

For The Period August 15, 2008 - August 14, 2009

This Attachment OPT to the Memorandum of Understanding LIGO-M970077-00 defines the role of the German/British Collaboration (GEO 600) for the Detection of Gravitational Waves (GEO600) as a Member of the LIGO Scientific Collaboration (LSC), and a member of the Optics Development Group (LDG). The period of performance for the activities in this Attachment is from August 15, 2008 - August 14, 2009.

1. Collaboration

The Optics Development Group (ODG) is the scientific collaboration for defining and developing instruments in optics for use in advanced subsystems for the initial LIGO interferometers, or in entirely new advanced interferometers.
MOU Attachment OPT defines the roles and responsibilities of groups in this development group.

2. Participation

During the period August 15, 2008 - August 14, 2009, the members of GEO600 will participate in ODG in the following areas:

a. Optics Characterization

Coating Losses for Advanced LIGO and beyond

a.1.) Measurements of multi-layer coatings applied to fused silica substrates
(Bassiri, Murray, Rowan, Hough & I. MacLaren)
Reduction of the mechanical loss associated with the addition of coatings to substrates and associated thermal noise remains an important research area for Advanced LIGO and is vital for the success of any future detectors that aim to have sensitivities better than Advanced LIGO.
We propose to thus continue studies with our LSC colleagues at Stanford University, Syracuse University, MIT, Embry-Riddle Aeronautical University and Hobart and William Smith Colleges on the level of excess mechanical losses associated

with adding dielectric coatings to test mass substrates, as part on the ongoing LSC coating research program. We will investigate the suitability of multilayer coatings of silica-hafnia and silica-doped hafnia (doped with silica) from a thermal noise point-of-view. We also plan to study the material properties, e.g. Youngs modulus and refractive index, of multi-layer and single-layer coatings using Atomic Force microscopy and ellipsometry.

a.2.) Mechanical loss associated with coatings for diffractive optics

(Cumming, Heptonstall, Rowan & Hough)

We propose to investigate the mechanical loss of silicon substrates with diffractive coatings applied, in collaboration with colleagues in Hanover and Jena. We will contact appropriate vendors for the supply of diffractive components.

a.3.) Coating loss measurements using thin cantilever substrates

(Martin, Chalkley, Bassiri, Reid, Rowan, Hough & I. MacLaren)

We will continue to investigate the effects of heat treatment on the mechanical dissipation in thin-film tantala, with particular focus on possible alterations on the observed low temperature dissipation peak. Samples with tantala coatings have undergone annealing temperatures in the range of 300 to 800°C and will be studied. We plan to procure comparable thin-film silica coatings to also be studied as a function of annealing temperature. Studies of the microscopic structure of these coatings using electron microscopy may help identify any crystalline structure [using Selected Area Diffraction (SAD) and Convergent Beam Electron Diffraction (CBED)] and to identify short-range order using Reduced Density Function analysis to identify amorphous structure, and possibly help relate this to our macroscopic mechanical loss measurements.

b. Other Contributions

Studies of the use of non-Gaussian beams

(Miller, Strain & Robertson)

Experimental tests and theoretical development of the optics for mesa beam interferometery are carried out at Caltech. We will continue to provide input to this through the effort of John Miller (visiting Caltech). This work is supervised from Glasgow (Strain, Robertson) and Caltech (DeSalvo, Robertson).

3. Resource Sharing

The LIGO Laboratory will contribute resources including allocation of appropriate scientific and engineering personnel, research facilities, and funding in support of the effort in Item No. 2, as indicated below.

a. Research accommodations for GEO600 group members while on LIGO research assignment at any LIGO Laboratory site.

Not Applicable

b. Access to LIGO data through established LSC channels in support of this work.

Not Applicable

4. Coordination and Reporting

GEO600 will perform research within the structures established by the LIGO Laboratory and the LSC where appropriate. In particular, activities described in Item 2 will be carried out within the Optics Development Working Group of the LSC.
This includes keeping the Group leaders informed of activities and plans, reporting to the group at meetings and telecons, and through technical documents submitted to the LIGO Document Control Center.
In addition, an annual report will be submitted with the update to this Attachment, giving a summary status on research by topic as indicated in Item No. 2, including progress against the milestones if any, significant accomplishments such as new insights/discoveries or publications, issues of concern if any, and an indication of invested time.
This Attachment will be updated at least annually with a plan of activities for the succeeding one-year period. These documents will be due one month before the close of the period of performance under this Attachment.

5. Computer Code

All computer code delivered to the LSC under this Attachment must be developed in consultation with the LSC Data Analysis Software Working Group (DASWG) and archived, documented and reviewed as determined by that group.

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