

**Attachment Number B to the
Memorandum of Understanding (LIGO-M970077-00-M)
between the
German/British Collaboration for the Detection of Gravitational Waves
(GEO600)
and the
Laser Interferometer Gravitational Wave Observatory (LIGO) Laboratory
February 15, 2003**

This Attachment to the Memorandum of Understanding LIGO-M970077-00-M covers the role of GEO600 as a Charter Member of the LIGO Scientific Collaboration (LSC) and a member of the Isolation/Suspension/Thermal Noise Development Group (ISTNDG). The period of performance for the activities in this Attachment is from February 15, 2003 to **August 15, 2003**. This period may be modified by agreement to a revision of this Attachment.

1. LIGO Scientific Collaboration - The LIGO Scientific Collaboration is organized as a separate organization from the LIGO Laboratory. It includes scientists from the LIGO Laboratory, and those from collaborating institutions, and has its own leadership and governance. The Collaboration will ensure equal scientific opportunity for individual participants and institutions. It will organize the research, publications, and all other scientific activities. The Collaboration will report to the Laboratory Directorate for final approval of its research program, technical work, observational physics publications, and talks announcing new observations and physics results. This will be done through regular reports to the Directorate and its PAC.
2. Charter Membership - An initial period for formation of the Charter group of institutions in the LIGO Scientific Collaboration commenced on March 1, 1997 and ended following the first full meeting of the Collaboration at which the Collaboration Council assumed its role.

Following the charter period proposals will be evaluated through the Collaboration Council. With Collaboration approval, an MOU with the LIGO Laboratory, including Attachments defining specific work, will be required for any participating institutions.

3. This document is an agreement between the German/British Collaboration for the Detection of Gravitational Waves (GEO600) and the LIGO Laboratory concerning the activities of GEO600 as a Collaborating Institution in the LIGO Scientific Collaboration (LSC) and in the Isolation/Suspension/Thermal Noise Development Group (ISTNDG), and as indicated in Item No. 8.

4. Isolation/Suspension/Thermal Noise Development Group - The Isolation/Suspension/Thermal Noise Development Group (ISTNDG) is the scientific collaboration for defining and developing future isolation and suspension improvements for use in advanced sub-systems for the initial LIGO interferometers or in entirely new advanced interferometers. A specific Attachment will define the roles and responsibilities of groups in this development group. Members of this group will normally be authors on publications reporting the work of the group and will normally be eligible to participate in data runs and science beyond the LIGO I data run.
5. Report of Progress - GEO600 will provide a status report on its activities in support of LIGO every six months. The report will consist of: a) a summary status on research by topic as indicated Item No. 8 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, b) updated List of Collaborators, and c) a plan of activities for the succeeding six-monthly period. The report will be due one month before the close of the period of performance under the Attachment in question.
6. Term of Membership - The Membership will be renewed every six months upon evidence of satisfactory performance of agreed upon duties.
7. For the coordinates of GEO600 personnel who will participate in the ISTNDG activities in Item No. 8 below, see Attachment Z to Memorandum of Understanding LIGO-M970077-00-M, and the attached GEO LSC Contribution for LSC Period February 15, 2003 to August 15, 2003.
8. During the period February 15, 2003 to August 15, 2003 the GEO600 team will work on suspension developments relevant to the Enhanced/Advanced LIGO as follows:
 - a) Suspension Developments by the GEO600 team relevant to Advanced LIGO
 - 1) Continued work on the suitability of silica ribbons for suspension of 40Kg test masses, including loading tests, violin and pendulum Q measurements and investigation of welding and bonding issues (Heptonstall and Cagnoli).
 - 2) Continued work on cantilever blade development including clamp design (Jones, Plissi, Perreur-Lloyd, Cagnoli, Cantley, Elliffe + Torrie (Caltech) + Rutherford Appleton Laboratory).
 - 3) Continued work on design and fabrication of electronic and associated parts for local control for prototypes at Caltech and LASTI, including investigation of development of lower noise sensors (Ward, D. Robertson, Jones, with Caltech and Lockerbie, (Strathclyde University) (to be confirmed)).
 - 4) Completion of the investigation of eddy current damping for potential use in Advanced LIGO suspensions including comparison with alternative low noise damping techniques e.g. smart control systems (Plissi, Cantley, Jones, Grant with Torrie (Caltech) and N. Robertson (Stanford)).

5) Further development of aspects of detailed design of recycling mirror and test mass suspensions for controls and noise prototypes for LASTI. This will include work on blade design and adjustment, blade wire clamps and design of catcher support for silica fiber assembly, and general assistance using SOLIDWORKS for drawings and assemblies of parts (Plissi, Cantley, Jones, Perreur-Lloyd, Cagnoli, + N Robertson (Stanford) + Torrie et al (Caltech)).

6) Investigation of the potential application of penultimate mass silica blades for vertical isolation of test masses (Cagnoli, Heptonstall, Cantley, Plissi).

7) Investigation and development of smart control systems for potential application to damping of Advanced LIGO suspensions in consultation with Virgo Pisa (Cantley, Plissi with Torrie (Caltech) and N. Robertson (Stanford)).

b) Materials research relevant to Advanced LIGO and beyond

1) Continuation of investigation of losses associated with dielectric coatings on silica and sapphire test masses in collaboration with Stanford, Syracuse and MIT (Rowan, Sneddon, Crooks, Cagnoli and Hough).

2) Ongoing investigation of ribbon strengths and quality factors and effects of welding to silicate bonded attachments, in collaboration with Stanford and Caltech, (Heptonstall, Cagnoli, Hough, Rowan with Willems).

3) Ongoing investigation of hydroxy-catalysis bonding of silica to crystalline materials, in collaboration with Stanford and Caltech. Also further investigation of bonding of silica to heavy glasses which could be used for penultimate mass in multiple pendulum. (Rowan, Elliffe, Hough with Armandula).

4) Continued evaluation of design of silica ears of suitable design to allow the jointing of ribbons in collaboration with Stanford and Caltech (Cagnoli, Cantley, Hough, Rowan with Willems).

5) The construction of a fabricated heavy glass mass of 25 cm diameter suitable as an intermediate mass for LIGO (Elliffe, Hough, Cagnoli, Heptonstall and Rowan).

6) The preliminary testing of large sapphire mass, 25 cm diameter by 10 cm deep (Sneddon, Crooks, Hough, Rowan and Cagnoli).

7) The hanging of the sapphire mass from the heavy glass mass by silica ribbons connected to the sapphire and heavy glass by means of bonded ears (Heptonstall, Cagnoli and Hough).

8) The preliminary testing of the bonded configuration (Heptonstall, Cagnoli, Hough, Elliffe etc).

c) Other relevant research

The experiment for measuring the off-resonant thermal noise of the pendulum mode of a suspended mirror has been redesigned to achieve higher moments of inertia for the masses of the different pendulum stages. The changes especially reduced the resonance frequencies of the three rotation modes of the masses, which significantly reduces the seismic coupling at higher frequencies. Another vertical isolation stage has also been included. However the locking process of these new pendulums causes problems, as these new masses have a number of internal resonances in the control band. Future development depends on the success of the current experiments and might lead to another redesign of the different pendulum stages. (Leonhardt et al.).

9. During the period February 15, 2003 to August 15, 2003, the LIGO Laboratory will share, as requested and appropriate, LIGO data of relevance to the planned research in Item No. 8.
10. The research effort pursuant to this Attachment B will be coordinated by Caroline Cantley and Gary Sanders on behalf of GEO600 and the LIGO Laboratory, respectively.
11. 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. 8, as indicated below.
 - a) Accommodations for GEO600 investigators while on LIGO research assignment at Caltech, and/or at LIGO sites.

Approved:

Barry Barish
Barry Barish
LIGO Laboratory Director
12-Feb-04
Date

Karsten Danzmann
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12.5.04
Date

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