

**Attachment Number B to the  
Memorandum of Understanding (LIGO-M970077-00-M)  
between the  
German/British Collaboration for the Detection of Gravitational Waves  
(GEO 600)  
and the  
Laser Interferometer Gravitational Wave Observatory (LIGO) Laboratory  
February 15, 1998**

This Attachment to the Memorandum of Understanding LIGO-M970077-00-M covers the role of GEO 600 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, 1998 to August 15, 1998. This period may be modified by agreement to a revision of this Attachment.

1. LIGO Scientific Collaboration - The LIGO Scientific Collaboration will be organized as a separate organization from the LIGO Laboratory. It will include scientists from the LIGO Laboratory, and those from collaborating institutions, and will have 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 will commence on March 1, 1997 and will end following the first full meeting of the Collaboration at which the Collaboration Council will assume its role. We expect that this transition will occur within six months. Membership in the Collaboration during this charter period will be initiated by proposal to the LIGO Laboratory Directorate.

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 (GEO 600) and the LIGO Laboratory concerning the activities noted below, under provision 7, of GEO 600 as a Collaborating Institution in the LIGO Scientific Collaboration (LSC) and in the Isolation/Suspension/Thermal Noise Development Group

(ISTNDG).

4. Isolation/Suspension/Thermal Noise Development Group - The Isolation/Suspension/Thermal Noise Development Group (ISTNDG) will be the scientific collaboration for defining and developing future isolation and suspension improvements for use in advanced subsystems 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 - GEO 600 will provide a summary report of progress, monthly, by e-mail to the Collaboration Council and to the LIGO Laboratory Director. GEO 600 will submit a complete report on its activities every six months, supply an updated List of Collaborators, and a plan of activities for the next six months. This report should be submitted one month before the updated attachment will take effect.
6. Term of Membership - Membership will be renewed every six months upon evidence of satisfactory performance of agreed upon duties.
7. During the period February 15, 1998 to August 15, 1998, the following GEO 600 personnel will participate in ISTNDG activities:

University of Glasgow, Department of Physics and Astronomy

Faculty: Hough ( 50%), N. Robertson (30%), Ward (10%)  
 Postdocs: Plissi (100%), Rowan (100%), Strain (40%)  
 Grad. Students: Torrie (100%), McIntosh (100%)  
 Engineers: Craig (80%), Hutchins (30%)

Universitat Hannover, Institut fur Atom und Molekulphysik

Faculty: Danzmann (5%), Aufmuth (20%)  
 Grad. Students: Jennrich (100%), Traeger (100%)  
 Engineer: Weidner (10%)

Max Planck Institute fur Quantenoptik, Garching

Equivalent Faculty: Ruediger (100%)

8. Suspension Developments by the GEO 600 team, relevant to Enhanced/Advanced LIGO.
  - a. System Under Development
    1. Double/triple pendulum system with reaction masses, the assembly being suspended from two passive stacks on top of one active stage.
    2. Two extra stages of vertical isolation are provided by cantilever springs in the suspensions of the top and intermediate pendulum masses.
    3. The active stage at the base of the system is provided to reduce seismic noise in order to

ease acquisition of lock of the servo systems in the interferometry and to allow low frequency movements to be reduced to a level where non-linear coupling of various noise sources will not be a problem.

4. The possibility of using active isolation on the supporting mass for the double pendulum is a future development area.
5. The last stage of the pendulum will use fused silica fibres (or ribbons) bonded in a low loss, high vacuum compatible way to the bottom and intermediate masses.
6. In particular the technique of silicate bonding of fused silica to fused silica and of fused silica to sapphire will be studied, with particular reference to evaluation of losses associated with the bonding. This work will be carried out in collaboration with the Department of Applied Physics, Ginzton Laboratory, Stanford University.

b. Required Performance of System

1. Isolation at 50 Hz of  $6 \times 10^6$  in the vertical and  $6 \times 10^9$  in the horizontal.
2. Reduction of rms microseismic noise around 0.3 Hz by a factor of  $\sim 10$ .

c. Further relevant research

1. An experiment to measure the off resonance thermal noise spectrum in a small suspended sample of fused silica is currently being carried out in Hannover; this will allow the frequency dependence of the damping factor of the material (+ jointing) to be investigated.

Approved:

Barry Barish  
Barry Barish  
LIGO Principal Investigator

March 12, 1998  
Date

Karsten Danzmann  
Karsten Danzmann  
GEO 600 Principal Investigator

12.3.98  
Date

James Hough  
James Hough  
GEO 600 Principal Investigator

March 13, 1998  
Date

Bernard Schutz  
Bernard Schutz  
GEO 600 Principal Investigator

13. March 1998  
Date