

**Attachment Number B to the
Memorandum of Understanding (LIGO-M950025-00-M)
between the
Australian Consortium for Interferometric Gravitational Astronomy (ACIGA)
and the
Laser Interferometer Gravitational Wave Observatory (LIGO) Laboratory
February 15, 1999**

This Attachment to the Memorandum of Understanding LIGO-M950025-00-M covers the role of the Australian Consortium for Interferometric Gravitational Astronomy (ACIGA) 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, 1999 to August 15, 1999. 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 Australian Consortium for Interferometric Gravitational Astronomy (ACIGA) and the LIGO Laboratory concerning the activities noted below, under provision 8, of ACIGA 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 - ACIGA 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. Intellectual Property Rights - The rights to intellectual property developed under this Attachment will be subject to the National Science Foundation Grant Policy as indicated in Section 730, Intellectual Property.
8. Australian National University: Within the ACIGA thermal noise project, the Australian National University is responsible for:
 - a. determining the optimum optical readout topology for a thermal noise measurement from 10Hz to 500Hz,
 - b. stabilisation of the free running frequency of the laser to a degree which will allow detection of thermal mirror motion down to a level of $1.5 \times 10^{-19} \text{ m}/\sqrt{\text{Hz}}$,
 - c. stabilisation of intensity within the test cavity to a level such that radiation pressure noise, due to intensity fluctuations, does not mask the thermal noise of the mirrors.

Currently, the preferred topology is a single cavity formed with two independently suspended test masses. This cavity is interrogated with a pre-stabilised laser using a Pound-Drever-Hall readout system.

Pre-stabilisation of the laser frequency will be achieved by locking the laser to a rigid, suspended, moderate finesse reference/mode cleaner cavity. Presently we have demonstrated frequency noise suppression sufficient to reach our target sensitivity over the region 10Hz to 100Hz. By adding a broad band electro-optic modulator, we plan to increase the servo bandwidth and gain to reach the target sensitivity across the entire thermal noise measurement band.

We have developed a new technique [Buchler et. al., Opt. Lett. 24, 258 19899] for intensity stabilisation which is capable of suppressing all classical radiation pressure noise and reducing quantum radiation pressure noise by up to a factor of two. Moreover this technique does so without reducing the available power for the optical readout system.

During the next six months we plan to add an electro-optic modulator to expand the frequency servo bandwidth and gain to meet the final sensitivity target. Once this task is complete, we will integrate the frequency servo, the intensity servo and the final test cavity readout system into one benchtop experiment and demonstrate the complete measurement system.

The University of Adelaide. The plan for the thermal noise experiment includes:

- a.) Finish reference cavity and lock it to the laser;
- b.) Lock laser to test Cavity;
- c.) Extract error signal;
- d.) Design and build suspension system for vacuum vessel;
- e.) Complete refurbishment of vacuum tank;
- f.) Test optical system in vacuum tank by Oct. 1999.

University of Western Australia (UWA).

- a.) Complete and test 3-D pre-isolation;
- b.) Develop self damping for the isolation;
- c.) Investigation of flexure attachment to sapphire test mass--active alloy bonding and silicate bonding;
- d.) Test the Q-factor of metallic glass flexure for high Q suspension.

Approved:

Barry Barish

Barry Barish
LIGO Laboratory Director

5/5/99

Date

John Sandeman

John Sandeman
ACIGA Principal Investigator

12/6/99

Date