

Attachment SUS to the
Memorandum of Understanding (LIGO-M050297-00-M)
between the
Stanford Advanced Gravitational Wave Interferometry (SAGWI) Group
and the
Laser Interferometer Gravitational Wave Observatory (LIGO)
August 15, 2005

This Attachment SUS to the Memorandum of Understanding LIGO-M050297-00-M defines the role of the Stanford Advanced Gravitational Wave Interferometry Group (SAGWI) as a 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 August 15, 2005 to August 15, 2006.

1. 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 subsystems for the initial LIGO interferometers or in entirely new advanced interferometers. MOU Attachments define the roles and responsibilities of groups in this development group.
2. During the period August 15, 2005 to August 15, 2006, the members of SAGWI Group will participate in the SUS (Isolation/Suspensions/Thermal Noise Development Group) in the following areas:

Materials and Thermal Noise

(M. Fejer, R. Route, S Zappe)

- a) Investigations into the level of excess loss introduced by dielectric mirror coatings applied to test-mass substrates;

Reduction of the mechanical loss associated with coatings applied to substrates and associated thermal noise remains an important research area for Advanced LIGO and is vital for the success of any future detectors with sensitivities better than Advanced LIGO.

We will evaluate in collaboration with Glasgow the usefulness of silicon cantilevers with deposited dielectric thin films for the estimation of dielectric mirror coating mechanical losses.

In collaboration with Glasgow, MIT, Syracuse and Hobart and William Smith Colleges, we will continue our studies of coated substrate materials to investigate and reduce the mechanical losses of coatings.

- b) Participation as required in modeling efforts on the effects of inhomogeneous mechanical losses on the expected thermal noise from a finite sized test mass;

- c) Design and fabrication, using Stanford's extensive MEMS technology, of custom flexures from doped and non-doped single crystal silicon for evaluation as suspension elements for test masses;

This work will be carried out in collaboration with Glasgow.

- d) Continued optical and Q measurements on crystalline materials;

In collaboration with Glasgow we will continue our investigations of the optical and Q factors of samples of single crystal silicon with varying dopants and cut along different crystallographic axes.

Contingent on initial measurements by Glasgow, more cantilevers for the measurement of bulk-dominated loss effects will be fabricated. The quality of the silicon nitride masking layer and the cleanliness of surfaces in the case of silicon fusion bonding, respectively, will be improved.

Active Alignment, Isolation, Control and Suspension Design

(D. DeBra, M. DeGree, W. East, B. Lantz, N. Robertson, M. Thielvoldt)

Norna Robertson will continue to serve as Cognizant Scientist for the Suspensions subsystem (SUS) in Advanced LIGO, as chair of the LASTI Technical Advisory Committee, as chair of the LSC Nominating Committee, and as a member of the LSC restructuring committee. She will also serve on the MOU review panel in August 2005.

We will carry out further development of the design of suspension systems for controls and noise prototypes at LASTI and for Advanced LIGO, and we will carry out further design and development of the seismic isolation systems at the ETF, at LASTI, and for Advanced LIGO in general. We will:

- e) Work with other members of the SUS team on general design issues as they arise, and in particular on aspects of;
 - i) the testing and characterization of the ETM controls prototype at Caltech and subsequently at LASTI,
 - ii) the design of the noise prototype ETM/ITM, including implementing lessons learned from the controls prototype,
 - iii) the design of other BSC and HAM suspensions as required.
- f) Participate in upcoming SUS and SEI design reviews and planning meetings for BSC and HAM optics;
- g) Work with SUS and SEI colleagues on issues of integration of suspension and isolation systems, and on issues of integration with other subsystems. This will include collaborating on tests of the proposed SUS support structure attached to the ETF Technology Demonstrator at Stanford;
- h) Continue efforts to improve the isolation performance of the ETF Technology Demonstrator at 1 Hz and at 10 Hz;
- j) Improve the sensor performance of the GS-13 to improve the performance of the ETF Technology Demonstrator;
- k) Continue to develop methods and transfer knowledge to speed up the implementation of control techniques at LASTI and for Advanced LIGO;

- m) Work in collaboration with the LIGO Lab and LASTI to complete the ASI contract;
- n) Work with the LASTI lab to develop implementation and testing plans for the BSC prototype isolation and alignment system and support the installation and testing of this system at LASTI;
- o) Help develop requirements for the HAM isolation and alignment for Advanced LIGO;
- p) Work with the LIGO lab and outside vendors to develop a mechanical system for a HAM isolation and alignment system;
- q) Devise a control scheme to use with a HAM isolation and alignment system;
- r) Study the design for a coaxial double-pendulum, which uses the Initial LIGO optics, for possible use in an Interim Upgrade to Initial LIGO;
- s) Pursue, in consultation with the SWG, given sufficient time and additional manpower:
 - i) Temperature monitoring of the actuators in the ETF Technology Demonstrator,
 - ii) Control re-allocation and global control studies of the ETF technology demonstrator, using a capacitive displacement sensor located between the second stage and the support structure,
 - iii) Feed-forward isolation of the first stage of the ETF Technology Demonstrator to reduce the motion around 10 Hz from tip and tilt, using vertical seismometers.

All of the above will be carried out in collaboration with colleagues in the LSC.

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 SAGWI group members while on LIGO research assignment at any LIGO Laboratory site,
 - b) Access to LIGO data through established LSC channels in support of this work.
4. Coordination and Reporting – SAGWI Group will perform this 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 Isolation/Suspension/Thermal Noise Development Group of the LSC. Coordination will include 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 on-year period. These documents will be due one month before the close of the period of performance under this Attachment.

Approved:

Barry Barish
LIGO Laboratory Director

Robert L. Byer
SAGWI Principal Investigator

Peter Saulson
LSC Spokesperson

Joseph Giaime
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