Attachment Number C to the Memorandum of Understanding (LIGO-M950060-A-M) between the Stanford Advanced Gravitational Wave Interferometry Group and the Laser Interferometer Gravitational Wave Observatory (LIGO) Laboratory

August 15, 1999

This Attachment to the Memorandum of Understanding LIGO-M950060-A-M covers the role of the Stanford Advanced Gravitational Wave Interferometry Group (Stanford Group) as a Charter Member of the LIGO Scientific Collaboration (LSC) and a member of the Lasers/Optics Development Group (LODG). The period of performance for the activities in this Attachment is from August 15, 1999 to February 15, 2000. 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 Stanford Group and the LIGO Laboratory concerning the activities of the Stanford Group as a Collaborating Institution in the LIGO Scientific Collaboration (LSC) and in the Lasers/Optics Development Group (LODG), and as indicated in Item No. 8 below

4. Lasers/Optics Development Group - The Lasers/Optics Development Group (LODG) is the scientific collaboration for defining and developing future high power lasers and required improvements in optics 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 in 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 - The Stanford Group 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 below 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.

   The Galileo group coordinates are included in Attachment Z to the Memorandum of Understanding LIGO-M950060-A-M.

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. During the period August 15, 1999 through February 15, 2000, Professors Robert Byer and Martin Fejer; Senior Research Associate Eric Gustafson; Post Doctoral Research Affiliates Sheila Rowan; Graduate students Bill Tulloch, Todd Rutherford, and Justin Mansell will work on high power optical amplifiers and their noise when saturated, on adaptive optics for spatial mode control and the use of a gaussian to super gaussian beam converter to improve efficiency of the optical amplifier. The Stanford Group will:

   a) Measure the noise power as a function of gain in a multi-pass, saturated, diode-laser-pumped Nd:YAG slab amplifier using a low noise master oscillator and a 10 watt Lightwave laser to partially saturate the amplifier and compare with theory.

   b) Continue testing and development of the edge pumped conduction cooled slab optical amplifier. This effort will include the design of the next generation amplifier, emphasizing improved power extraction and beam quality.

   c) Begin construction of a 100 watt laser system, consisting of two power amplifiers and a 10 watt master oscillator. Begin assembly of the diode laser current supplies and temperature controllers. This work includes fabrication and testing of a fiber coupled, 400 watt, 808 nm, diode laser pump module, testing each diode laser pump module and testing each diode laser bar including determining the optimum temperature of each of the diode laser bars for operation at 808 nm.

   d) Continue the collaboration with the Florida group on thermal distortions in phase modula-

tors and optical isolators induced by high power 1064 nm beams.

e) Collaborate with LIGO personnel on the development of high power optical amplifiers. This collaboration will include regular visits by Peter King of LIGO to Stanford who will work with Bill Tulloch and Todd Rutherford on the assembly and testing of a 100 watt amplifier. This will include the operation of this high power source with a pre-mode cleaner similar to the one used in the LIGO I PSL. It will also include regular visits by Eric Gustafson to the LIGO sites to investigate those thermal loading problems which may effect the performance of the LIGO II interferometer, and in particular those problems related to how beam heating induced distortions interact with the control system of the interferometer.

f) Continue to improve the sensitivity of Shack-Hartmann wavefront sensors by reducing cross-talk using apodized lenslet arrays. Evaluate sensitivity limits and behavior for Shack-Hartmann wavefront sensing for Gaussian apodization

g) Use a silicon deformable mirror to actively compensate the distortions introduced in the spatial mode of a low power diode pumped solid state laser when it passes through an absorbing glass plate.

h) Build a new generation of silicon deformable mirror using an intermediate silicon layer to reduce crosstalk, increase the resonant frequency and possibly lower the required drive voltage.

i) Build and test a CMOS-based Shack-Hartmann wavefront sensor as a potential low cost way of making core optic distortion measurements.

j) Build and test a refractive optic intensity profile converter pair to reduce the wavefront distortions before the pre mode cleaner.

9. As part of the research collaboration under this agreement the LIGO Laboratory will share, as requested and appropriate, the LIGO data of relevance to the research focus in Item No. 8 above.

10. The research effort pursuant to this Attachment C will be coordinated by Eric Gustafson and Syd Meshkov on behalf of the Stanford Group and 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. These resources will be in addition to the coordination effort and data to be made available per Item No. 9 above.

a) Provide accommodations for investigators in Item No. 8 above while on research assignment at LIGO facilities.

b) Provide on loan a 10W Laser to be used in conjunction with the Stanford edge pumped

slab laser for testing optical components at high power.

Approved:

Barry Barish
LIGO Laboratory Director

2/15/00
Date

Robert L. Byer
Principal Investigator

2/20/00
Date