

**Attachment OPS to the  
Memorandum of Understanding (LIGO-M050266-00-M)  
between the  
Michigan Gravitational Wave Group (MGWG)  
and the  
Laser Interferometer Gravitational Wave Observatory (LIGO)  
August 15, 2005**

This Attachment OPS to the Memorandum of Understanding LIGO-M050266-00-M defines the role of the University of Michigan (MGWG) as a Member of the LIGO Scientific Collaboration (LSC) in the areas of detector commissioning, detector characterization, and operations in support of the initial LIGO interferometers. The period of performance for the activities in this Attachment is from August 15, 2005 to August 15, 2006.

1. Together, the LIGO Laboratory and the LIGO Scientific Collaboration (LSC) are responsible for implementing and exploiting the initial LIGO detector through its science data runs. LSC groups are encouraged to contribute to the commissioning, characterization, and operation of the LIGO detectors, as members of working groups established by the LIGO Laboratory and the LSC.
2. During the period August 15, 2005 to August 15, 2006, the members of MGWG Group will participate in the initial LIGO detector research program in the following areas:
  - a) *Commissioning* –
    - 1) Gustafson will continue to investigate and reduce systemic noise in the LHO interferometers and strongly support commissioning work toward reaching the SRD sensitivity goals for the LHO 4K and 2K interferometers.
    - 2) Gustafson will further refine the Recycling Cavity Sideband Analyzer System (compact demodulation electronics) including its extension to the other ports and LIGO interferometers.
    - 3) Gustafson will study the Recycling Cavity, pursuing noise reduction issues vis-a-vis sideband dynamics and operation; correlation of SB variation and the infamous AS-I signal will be investigated. Consequences of a non-perfect match of the recycling cavity free spectral range frequency to the laser-modecleaner tuned choice will be explored.
    - 4) Gustafson, with Kawabe [LHO] and a student, will further pursue Output Mode Cleaner Issues; optical simulation; possible 6 meter configuration (folded to 1 meter) is contemplated; a prototype test unit is possible. The Side Band Analyzer system will be employed. Perfectly identical treatment of sidebands and carrier is (we believe) key to

success. (The small non-resonant SB OMC, while seemingly beautiful, was a noise failure.)

5) Goetz (graduate student) will begin a 2-year residence at LHO in summer 2006 (having spent the three previous summers at LHO as a SURF student or Michigan graduate student). He will work primarily on commissioning and detector characterization.

b) *Detector Characterization* –

1) Riles will continue to chair the LSC Detector Characterization Working Group. He will continue coordinating the Group's efforts, together with LIGO liaison Daniel Sigg and the leaders of the data run investigation teams. All of this work will be done in coordination with the astrophysical search groups.

Riles will continue working with LIGO Laboratory physicists, primarily John Zweizig, to facilitate efficient contributions to detector characterization by LSC members. He will also continue contributing directly to software algorithms for the on-site Data Monitor Tool (DMT)..

2) Riles will maintain the DMT operational state condition software package.

3) Riles will maintain the LockLoss DMT monitor.

4) Riles will write a DMT monitor class based on the LAL code of Xavier Siemens of UWM for producing  $h(t)$  for general use by DMT monitors.

5) Dergachev (graduate student) will continue maintaining the `ligo_viewer` program for viewing LIGO data trends at the observatory sites remotely from unix/linux and Windows computers.

6) Dergachev will maintain the SpectrumFold DMT monitor to track pervasive combs of harmonic lines in real time.

7) Dergachev and Riles will continue contributing to cataloguing known instrumental lines in the gravitational wave channel.

8) Subtle lines seen in the pulsar group data will be pursued by Gustafson in the backend electronics, e.g., the class of lines derived from various crystal oscillators in the Pentium processors of the control computers beating ( at various harmonic levels ) with the LIGO GPS driven DAQ clocks.

c) *LIGO Operations* –

1) Riles will organize LSC participation in upcoming engineering and science runs, including staffing of scientific monitoring shifts, in coordination with lab-designated engineering run leaders at the sites.

2) Riles will continue maintaining data quality segment repositories for engineering and

science data runs.

3) Gustafson will assist in LIGO Hanford operations during S5 by helping with repairs and other necessary tasks as required.

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 MGWG 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 – MGWG Group will perform this research within the structures established by the LIGO Laboratory and the LSC where appropriate. Activities described in Item 2) will be carried out in coordination with the LIGO Laboratory Commissioning Leader, the LHO Site Head, and the Detector Characterization Working Group of the LSC, as appropriate. 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.

5. All computer code delivered to the LSC under this Attachment must be developed in consultation with the LSC Data Analysis Software Working Group (DASWG) and archived, documented and reviewed as determined by that group.

Approved:

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Barry Barish  
LIGO Laboratory Director

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Keith Riles  
MGWG Principal Investigator

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Peter Saulson  
LSC Spokesperson

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Daniel Sigg  
LSC Detector Characterization Co-Leader

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Fred Raab  
LHO Site Head

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Peter Fritschel  
LIGO Lab Commissioning Leader