

Memorandum of Understanding (LIGO-M050348-00-M)
between the
Goddard Gravitational Wave Astrophysics Group (GGWAG)
and the
Laser Interferometer Gravitational Wave Observatory (LIGO)
August 15, 2005

The purpose of this Memorandum of Understanding (MOU) is to establish and define a collaborative relationship between the Goddard Gravitational Wave Astrophysics Group (GGWAG) and the Laser Interferometer Gravitational-Wave Observatory (LIGO). Both parties to this agreement share the broad goals of developing the instruments and techniques for detecting and studying gravitational waves, and subsequently using them as an astrophysical probe. Under this MOU, the GGWAG Group will be a member group of the LIGO Scientific Collaboration.

1. The Goddard Gravitational Wave Astrophysics Group (GGWAG)) consists of Dr. Jordan Camp, who will serve as Principal Investigator for research in LIGO, and one astrophysicist, one postdoc, and one graduate student. The focus of the work done by the GGWAG Group under this agreement will be i) data analysis in the Burst group, including the development and application of a new burst search algorithm based on the Hilbert Transform, and ii) chairing the advisory committee of the Gingin High Power Test Facility in the Core Optics group.
2. LIGO comprises two parts: the LIGO Laboratory and the LIGO Scientific Collaboration. These two entities report to the LIGO Directorate, consisting of the LIGO Director, the LIGO Scientific Collaboration Spokesperson, and the LIGO Laboratory Deputy Director. The design and construction of the LIGO Observatories were carried out by California Institute of Technology (Caltech) and the Massachusetts Institute of Technology (MIT) under a Cooperative Agreement between the National Science Foundation (NSF) and Caltech. The LIGO Oversight Committee supervises the realization of LIGO.
 - A. The LIGO Laboratory is responsible for the operation of the LIGO Observatories, the development and implementation of future detector systems, and participates in all aspects of the research with the LIGO detectors. LIGO is a system of three interferometric Fabry-Perot antennas, two of them 4 kilometers long and the third one 2 kilometers long, aimed at the simultaneous detection of gravitational waves in the frequency range

40-6000 Hz. LIGO Observatories are located in Hanford, Washington and in Livingston Parish, Louisiana (USA) and began observations in the year 2002. The LIGO Laboratory is funded through a Cooperative Agreement between the National Science Foundation and Caltech, with the portion of the LIGO Laboratory at MIT funded through a subcontract from Caltech.

- B. The LIGO Scientific Collaboration (LSC) is organized as a separate entity from the LIGO Laboratory. It includes scientists from the LIGO Laboratory, and those from collaborating institutions, and has its own governance and leadership (which includes the LSC Spokesperson as a member of the LIGO Directorate). The Collaboration ensures equal scientific opportunity for individual participants and institutions. It organizes the research, publications, and all other scientific activities. The Collaboration reports to the LIGO 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 Program Advisory Committee. The organization of the LSC and its governance are defined in its Charter.
3. As a member group of the LSC, the GGWAG Group will participate in the governance of the LSC and in setting its policies and procedures, as defined in the LSC charter. Similarly, it agrees to abide by the policies and procedures adopted by the LSC and posted on its website (<http://www.ligo.org/policies.html>), concerning publication, data access, software standards, and so on.
 4. Membership in more than one collaboration active in the same area of research may present complications. Members of the LSC contemplating joining other gravitational wave collaborations or participating in data analysis efforts with collaborations outside a framework established by the LSC should inform and consult with LSC and the LIGO Laboratory to ensure that no conflicts of interest exist.
 5. The LSC is the primary advocate of interferometric gravitational wave research in the U.S. To function effectively in this role, it needs to be informed in advance about major new initiatives. The GGWAG Group agrees to inform the LSC of any major new proposals related to LIGO to be submitted to the NSF, and to consult with the LSC concerning the best approach to support the overall LIGO program. The final decision about the scope of any such proposal shall remain the prerogative of the GGWAG Group.
 6. LSC Service Functions - Participation in the LSC brings with it responsibility for service functions to support the overall effort in achieving high detector sensitivity and high data quality. In particular, each LSC group is expected to assist in the staffing of scientific monitoring shifts during organized data runs. The staffing of these shifts is notable for both its importance and the travel burden it places on scientists. This burden makes an equitable shift allocation mechanism necessary.

A nominal guideline is that each LSC group should staff a fraction of the shifts comparable to its FTE fraction devoted to LSC activities. Jordan Camp (GGWAG Group) will be responsible for interaction with the designated LSC Shift Organizer with respect to the GGWAG Group's Service Function commitments.

Groups making extensive contributions to the LSC in other service efforts that involve a substantial travel burden may request a reduction in their nominal share of shift staffing. Those efforts can include:

- Commissioning and instrument improvement
 - Participation in on-site detector characterization investigations
 - Development/operation of analysis software/hardware infrastructure and validation of analysis software that requires travel away from the home institution.
7. Each party to this agreement continues to be responsible for all support of its staff including travel costs associated with the activities under this agreement. Exceptional support of travel by the other institution may be allowed for travel requested by that institution.
 8. Attachments to this MOU will be prepared annually to define the specific activities and responsibilities of the GGWAG Group and to define any resources to be provided by the LIGO Laboratory to the GGWAG Group in support of those activities.
 9. GGWAG Group will provide an annual status report on its activities in support of LIGO. The report will consist of a summary status on research by topic as indicated in the Attachments for that period 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 by each member of the group. The report will be due one month before the close of the period of performance under the Attachments in question.
 10. The LSC will review the progress report against the Attachments from the previous year and assess the Attachments for the up-coming year annually, under its established procedure, and recommend acceptance or rejection of each Attachment by the LIGO Director and the LSC Spokesperson.
 11. A list of GGWAG Group members will be updated at least every six months. GGWAG Group members and appropriate contact information will be provided in electronic form as Attachment Z to this Memorandum of Understanding. In cases where individuals who leave the group have had access to LIGO data and this access should be terminated, the GGWAG Group Principal Investigator is responsible for timely notification to the Directorate and to the computing committee so access may be revoked.
 12. The LIGO Laboratory is responsible for obtaining NSF approval of collaborative Memoranda of Understanding where required. All Memoranda of Understanding will be provided to NSF for their information.

13. The rights to intellectual property developed under this Attachment using LIGO Laboratory resources will be subject to the National Science Foundation Grant Policy as indicated in Section 730, Intellectual Property.
- A. In the event a patentable invention is conceived or first actually reduced to practice during the work of a member(s) of the GGWAG Group at LIGO Laboratory facilities, he/she will:
 - i) make prompt disclosure of the invention to the Director of the LIGO Laboratory; and
 - ii) cooperate with LIGO Laboratory and supply all information and execute all papers including invention reports, records of invention, patent applications and powers of attorney, necessary and proper to fulfill the obligations of the LIGO Laboratory to the U.S. Government sponsor.
 - B. The ownership of inventions conceived solely by members of the GGWAG Group at LIGO facilities shall be owned by NASA/GSFC, although the LIGO Laboratory shall be granted a license to use such invention for noncommercial research purposes at LIGO facilities. Inventions that are conceived by both members of the GGWAG Group and LIGO Laboratory staff as part of the LIGO project shall be jointly owned and any income from commercial licensing shall be shared in proportion to the number of joint inventors from each institution.

In all other regards, the rights to intellectual property developed by members of the GGWAG Group under this Attachment will be in accordance with the policies of NASA/GSFC.

14. This MOU supersedes the previous MOU between the LIGO Laboratory and the GGWAG group (LIGO-M010217-00-M) and its amendments and attachments. This MOU will remain in force until the parties mutually agree to terminate it, or until it is terminated in accordance with LSC procedures.

Approved:

Barry Barish
LIGO Director

Jordan Camp
Principal Investigator
GGWAG Group

Peter Saulson
LSC Spokesperson

Attachment DAT to the
Memorandum of Understanding (LIGO- M050348-00-M)
between the
Goddard Gravitational Wave Astrophysics Group (GGWAG)
and the
Laser Interferometer Gravitational Wave Observatory (LIGO)
August 15, 2005

This Attachment DAT to the Memorandum of Understanding LIGO-M050348-00-M defines the role of the Goddard Gravitational Wave Astrophysics Group (GGWAG) as a Member of the LIGO Scientific Collaboration (LSC), in particular, its activities in data analysis 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 are responsible for implementing and exploiting the initial LIGO detector through its science data runs. The LSC has organized the data analysis effort into search groups which coordinate the analyses, perform detailed reviews, and prepare publications on behalf of the collaboration. LSC groups are encouraged to participate in one or more of these groups. MOU Attachments define the contributions of each participating group to the data analysis groups.
2. During the period August 15, 2005 to August 15, 2006, the members of GGWAG Group will participate in the analysis of initial LIGO data in the following areas:
 - b) *Bursts* – The development and application of a new burst search algorithm based on the Hilbert Transform will continue to be the focus of the GGWAG data analysis effort during this period. This new algorithm is adaptive, rather than derived from a specific basis set, and thus offers high time frequency resolution. It has applications to unmodeled burst waveform searches as well as detector characterization. Both will be pursued with LIGO data.
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 GGWAG group members while on LIGO research assignment at any LIGO Laboratory site,
 - b) Access to LIGO data in support through established LSC channels in support of this work.
 - c) ...others...
4. Coordination and Reporting – GGWAG Group will perform this research within the structures established by the LIGO Laboratory and the LSC where appropriate. In particular activities described in Item 2b) will be carried out within the LSC Burst Search Group.

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.
6. The research effort pursuant to this Attachment A will be coordinated by Jordan Camp (GGWAG Group), Albert Lazzarini (LIGO Laboratory), and Peter Shawhan (LSC Burst Search Group Leader).

Approved:

Barry Barish
LIGO Laboratory Director

Jordan Camp
GGWAG Principal Investigator

Peter Saulson
LSC Spokesperson

Peter Shawhan
LSC Burst Search Group Leader

Albert Lazzarini
LIGO Laboratory Data and Computing
Group Leader

**Attachment OPT to the
Memorandum of Understanding (LIGO-M050348-00-M)
between the
Goddard Gravitational Wave Astrophysics Group (GGWAG)
and the
Laser Interferometer Gravitational Wave Observatory (LIGO)
August 15, 2005**

This Attachment OPT to the Memorandum of Understanding LIGO-M050348-00-M defines the role of the Goddard Gravitational Wave Astrophysics Group (GGWAG) as a Member of the LIGO Scientific Collaboration (LSC) and a member of the Optics Development Group (ODG). The period of performance for the activities in this Attachment is from August 15, 2005 to August 15, 2006.

1. Optics Development Group – The Optics Development Group (ODG) is the scientific collaboration for defining and developing improvements in optics 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 GGWAG Group will participate in ODG in the following areas:
 - a) *Gingin High Power Test Facility* – Jordan Camp will serve as chairman of the advisory committee of the Gingin High Power Test Facility. The advisory committee advises the LIGO laboratory and the LSC on management and technical issues related to the Gingin research program.
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 GGWAG group members while on LIGO research assignment at any LIGO Laboratory site,
 - b) Access to LIGO data in support through established LSC channels in support of this work.
4. Coordination and Reporting – GGWAG 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 the Optics Development Working 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.

5. The research effort pursuant to this Attachment A will be coordinated by Jordan Camp (GGWAG Group) and the leader(s) of the ODG.

Approved:

Barry Barish
LIGO Laboratory Director

Jordan Camp
GGWAG Principal Investigator

Peter Saulson
LSC Spokesperson

David Reitze
ODG Leader

**Attachment Number Z to the
Memorandum of Understanding (LIGO-M010217-00-M)
between the
Goddard Gravitational Wave Astrophysics Group (GGWAG)
and the
Laser Interferometer Gravitational-Wave Observatory (LIGO) Laboratory
August 15, 2005**

This Attachment to the Memorandum of Understanding LIGO-M010217-00-M lists the coordinates of the GGWAG members who will participate in the LIGO Scientific Collaboration (LSC) as members of LIGO Development Groups. The period of performance for the activities in this Attachment is from August 15, 2005 to August 15, 2006. This period may be modified by agreement to a revision of this Attachment.

Name	Address	E-Mail	Phone Nos.	Begin Date	End Date
Camp, Jordan 60% LIGO I 50% AdLIGO 10% Scientist, LIGO author	Code 663 NASA/Goddard Space Flight Center Greenbelt, MD 20771	camp@ lheapop.gsfc. nasa.gov	301-286-3528 Fax:301-286-1682	Aug. 15, 2005	Aug. 15, 2006
Cannizzo, John 50% LIGO I 50% Scientist, LIGO author	Code 661 NASA/Goddard Space Flight Center Greenbelt, MD 20771	cannizzo@ milkyway.gsfc. nasa.gov	301-286-9820 Fax:301-286-1682	Aug. 15, 2005	Aug. 15, 2006
McWilliams, Sean 100% LIGO I 100% Graduate Student, U Maryland	Code 663 NASA/Goddard Space Flight Center Greenbelt, MD 20771	stmcwill@umd.edu	301-286-1256 Fax:301-286-1682	Feb. 15, 2005	Aug. 15, 2006

Numata, Kenji 20% LIGO I 20% Scientist	Code 663 NASA/Goddard Space Flight Center Greenbelt, MD 20771	numata@ milkyway.gsfc. nasa.gov	301-286-0799 Fax:301-286-1682	Feb. 15, 2005	Aug. 15, 2006
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Scientific Collaboration Council Delegate: Jordan Camp

Approved:

Barry Barish
LIGO Laboratory Director

Jordan Camp
GGWAG Principal Investigator

Peter Saulson
LSC Spokesperson