

Attachment DAT to the
Memorandum of Understanding (LIGO-M 050348 -00-M)
between the
Goddard Gravitational Wave Astrophysics Group (GGWAG)
and the
Laser Interferometer Gravitational Wave Observatory (LIGO)
August 15, 2006

This Attachment DAT to the Memorandum of Understanding LIGO-M 050348 -00-M defines the role of the **Goddard Gravitational Wave Astrophysics Group** 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, 2006 to August 15, 2007.

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. 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, 2006 to August 15, 2007, the members of **GGWAG** will participate in the analysis of initial LIGO data in the following areas:

b) Bursts

Development of New Time Domain Search Algorithm for Identification of Gravitational Wave Signals, and Search for BH-BH Merger and Ringdown Signals

Camp, Cannizzo and Numata are continuing the development of a new time domain search algorithm (Hilbert-Huang Transform, or HHT) for gravitational wave detection, which involves the use of the Hilbert Transform. This algorithm is adaptive and does not assume an a priori basis waveform for the signal, but does result in a time-frequency decomposition of the data, and offers the possibility of high resolution in the time-frequency plane. It appears to offer the greatest advantage for short, very non-linear signals, of the kind generated by the merger/ringdown of BH-BH (or BH-NS) binaries. We intend to build an analysis pipeline to search for BH-BH (and BH-NS) mergers with the HHT. This work will be done in consultation with the Burst Analysis group.

e) Other Contributions

Not Applicable

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 through established LSC channels in support of this work.
- c) Not Applicable

4. Coordination and Reporting -

GGWAG will perform this research within the structures established by the LIGO Laboratory and the LSC where appropriate. In particular activities described in Item 2a) will be carried out within the LSC Inspiral Search Group, Item 2b) will be carried out within the LSC Burst Search Group, Item 2c) will be carried out within the LSC Stochastic Search Group and Item 2d) will be carried out within the LSC Continuous Waves search Group. This includes 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:

Jay Marx
LIGO Laboratory Director



Peter Saulson
LSC Spokesperson

Jordan
Camp

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Jordan Camp

Principal Investigator

Goddard Gravitational Wave Astrophysics Group

Attachment OPS to the
Memorandum of Understanding (LIGO-M 060247 -00-M)
between the
Goddard Gravitational Wave Astrophysics Group (GGWAG)
and the
Laser Interferometer Gravitational Wave Observatory (LIGO)
August 15, 2006

This Attachment OPS to the Memorandum of Understanding LIGO-M 060247 -00-M defines the role of the **Goddard Gravitational Wave Astrophysics Group** as a Member of the LIGO Scientific Collaboration (LSC) in the areas of detector commissioning, detector characterization, and operations support in the initial LIGO interferometers. The period of performance for the activities in this Attachment is from August 15, 2006 to August 15, 2007.

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, 2006 to August 15, 2007, the members of **GGWAG** will participate in the initial LIGO detector research program in the following areas:

a) Detector Commissioning

Not applicable

b) Detector Characterization

The work of the GGWAG in 2006-2007 will focus on the application of the Hilbert-Huang Transform (HHT) to the characterization of the LIGO detectors. The HHT is designed to provide a high resolution time-frequency decomposition of non-linear and non-stationary time-series data, and for many transient signals provides better resolution than Fourier or Wavelet analysis. Thus it should have a number of useful applications in characterizing non-linear noise effects in LIGO. In particular we will focus on the critical problem of upconversion of low frequency noise to in-band noise, to characterize the time structure of the noise, and to help identify its cause. We will also use the HHT to examine short glitches in LIGO data. Finally, this year we will publish an article on the application of the HHT to gravitational wave data analysis.

c) Detector Operations

Not Applicable

d) Other Contributions

Not Applicable

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 through established LSC channels in support of this work.
 - c) Not Applicable

4. Coordination and Reporting -

GGWAG will perform this research within the structures established by the LIGO Laboratory and the LSC where appropriate. In particular activities described in Item 2a) will be carried out in coordination with the LIGO Laboratory Commissioning Leader, Item 2b) will be carried out within the Detector Characterization Working Group of the LSC, and Item 2c) will be carried out in coordination with the LHO {or LLO} Site Head. 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:

Jay Marx
LIGO Laboratory Director



Peter Saulson
LSC Spokesperson

**Jordan
Camp**

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Jordan Camp

Principal Investigator

Goddard Gravitational Wave Astrophysics Group

**Attachment Number Z to the
Memorandum of Understanding (LIGO-M **060246** -00-M)
between the
Goddard Gravitational Wave Astrophysics Group (**GGWAG**)
and the
Laser Interferometer Gravitational Wave Observatory (LIGO) Laboratory**

This Attachment to the Memorandum of Understanding LIGO-M **060246** -00-M lists the coordinates of members of the **Goddard Gravitational Wave Astrophysics Group** 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, 2006 to August 15, 2007. This period may be modified by agreement to a revision of this Attachment. This list may be extended by agreement to a revision of this Attachment.

Principal InvestigatorFirst Name: **Jordan**Last Name: **Camp**Affiliation: **NASA / Goddard Space Flight Center**Address: **Code 663**City: **Greenbelt**State: **Md**Zip Code: **20771**Country: **United States**Primary Email: **Jordan.B.Camp@nasa.gov**Job Title: **Astrophysicist**

Secondary Email:

Phone Number: **301 286-3528**

Fax Number:

Begin Date: **Aug 15, 2006**End Date: **Aug 15, 2007**Research FTE: **50 %**LIGO FTE: **50 %**

AdvLIGO FTE: %

Author on LSC papers: LSC Council Delegate?

Member #2

Select this box if the contact information of this member is the same as that of the Principal Investigator.

First Name: **John**

Last Name: **Cannizzo**

Affiliation: **NASA / Goddard Space Flight Center**

Address: **Code 663**

City: **Greenbelt**

State: **Md**

Zip Code: **20771**

Country: **United States**

Primary Email: **cannizzo@milkyway.gsfc.nasa.gov**

Job Title: **Astrophysicist**

Secondary Email:

Phone Number: **301 286-9820**

Fax Number:

Begin Date:

End Date:

Research FTE **50** %

LIGO FTE **50** %

AdvLIGO FTE %

Author on LSC papers:

LSC Council Delegate?

Member #3

Select this box if the contact information of this member is the same as that of the Principal Investigator.

First Name: **Kenji**

Last Name: **Numata**

Affiliation: **University of Maryland, Astronomy Department**

Address: **Code 663**

City: **College Park**

State: **Md**

Zip Code: **20742**

Country: **United States**

Primary Email: **numata@milkyway.gsfc.nasa.gov**

Job Title: **Assistant Research Scientist**

Secondary Email:

Phone Number:

Fax Number:

Begin Date:

End Date:

Research FTE **50** %

LIGO FTE **50** %

AdvLIGO FTE %

Author on LSC papers:

LSC Council Delegate?

Member #10

Select this box if the contact information of this member is the same as that of the Principal Investigator.

First Name:

Last Name:

Affiliation:

Address: **Code 663**

City:

State:

Zip Code:

Country:

Primary Email:

Job Title:

Secondary Email:

Phone Number:

Fax Number:

Begin Date:

End Date:

Research FTE %

LIGO FTE %

AdvLIGO FTE %

Author on LSC papers:

LSC Council Delegate?

Authorship:

Camp

Cannizzo

Numata

Scientific Collaboration Council Delegate(s):

Camp

Approved:

Jay Marx

LIGO Laboratory Director

Peter Saulson

LSC Spokesperson

**Jordan
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l=Greenbelt, o=NASA, ou=EUD
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Jordan Camp

Principal Investigator(s)

Goddard Gravitational Wave Astrophysics Group