

Memorandum of Understanding (LIGO-M050233-00)
between the
Balearic Islands University Relativity and Gravitation Group (UIBRG)
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 Balearic Islands University Relativity and Gravitation Group (UIBRG) 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 UIBRG Group will be a member group of the LIGO Scientific Collaboration.

1. The Balearic Islands University Relativity and Gravitation Group (UIBRG) consists of Professor Alicia M. Sintes, who will serve as Principal Investigator for research in LIGO, and up to two undergraduate or graduate students. The focus of the work done by the UIBRG Group under this agreement will be data analysis activities in support of the initial LIGO interferometers, in particular the development of strategies and software to search for continuous gravitational signals. This research will be conducted by UIBRG in union with other LSC members, in particular with the German-British Collaboration for the Detection of Gravitational Waves (GEO 600).
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 UIBGR 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 UIBGR 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 ABC 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. Alicia M Sintes (UIBGR Group) will be responsible for interaction with the designated LSC Shift Organizer with respect to the UIBGR 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 UIBGR Group and to define any resources to be provided by the LIGO Laboratory to the UIBGR Group in support of those activities.
 9. UIBGR 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 UIBGR Group members will be updated at least every six months. UIBGR 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 UIBGR 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 UIBGR 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 UIBGR Group at LIGO facilities shall be owned by the Balearic Islands University, 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 UIBGR 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 UIBGR Group under this Attachment will be in accordance with the policies of Balearic Islands University.

14. This MOU supersedes the previous MOU between the LIGO Laboratory and the UIBGR group (LIGO- M020265-00-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

Alicia M Sintes
Principal Investigator
UIBRG Group

Peter Saulson
LSC Spokesperson

Attachment DAT to the
Memorandum of Understanding (LIGO-M050233-00-M)
between the
Balearic Islands University Relativity and Gravitation Group (UIBRG)
and the
Laser Interferometer Gravitational Wave Observatory (LIGO)
August 15, 2005

This Attachment DAT to the Memorandum of Understanding LIGO-M050233-00-M defines the role of the Balearic Islands University Relativity and Gravitation Group (UIBRG) 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 UIBGR group will participate in the analysis of initial LIGO data in the area of periodic GW.

Our next steps will focus on two broad areas: First, using still SFT data as input, and second combine the Hough and F statistic searches as another step forward to a multi-stage hierarchical search. This will continue being done in collaboration with GEO-AEI. In particular:

- We plan to investigate in detail the implications of using the adaptive peak selection criteria that would take into account possible non-stationarities of the detector noise and the amplitude modulation induced by the antenna pattern due to the motion of the detector. We plan to modify the search codes that were used for the S2 analysis and we hope to gain a factor ~15% in sensitivity while keeping a similar computational performance. The new codes would then be used to analyze S4 data.
- Data conditioning or line removal will be considered to be included in the pipeline in order to reduce the number of false candidates. We have codes able to do such conditioning, but so far they have only been used to clean the data that is searched using E@H.
- We will start working on a search code able to combine the Hough and F-statistic searches. Assuming the master equation is sufficiently accurate, the core routines for

performing this modified Hough search are already in place. These routines have to thus be interfaced with the other existing routines for calculating the F statistic, paying attention to the peak selection criteria. The possibility of doing this in the framework of Einstein@Home will also be seriously considered. If no major roadblocks appear, we would like to use Hough on F-statistic to analyze S5 data.

- Another issue that requires our attention is the possibility of developing a coincidence veto and optimize the candidate selection.
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 UIBGR 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 – UIBGR 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 LSC Pulsar 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.

Approved:

Barry Barish
LIGO Laboratory Director

Alicia M Sintes
UIBGR Principal Investigator

Peter Saulson
LSC Spokesperson

Mike Landry
LSC Pulsar Search Group Leader

Albert Lazzarini
LIGO Laboratory Data and Computing
Group Leader

**Attachment Number Z to the
Memorandum of Understanding (LIGO-M050233-00-M)
between the
Balearic Islands University Relativity Group (UIBRG)
and the
Laser Interferometer Gravitational-Wave Observatory (LIGO) Laboratory
Draft-February 15, 2005**

This Attachment to the Memorandum of Understanding LIGO-M050233-00-M lists the coordinates of members of the Balearic Islands University Relativity Group (UIBRG) 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
Sintes, Alicia M. 80% LIGO I 80% AdLIGO 0 Faculty	Department of Physics, Balearic Islands University E-07122 Palma de Mallorca, Spain	sintes@aei.mpg.de alicia.sintes@uib.es	+34-971-171380 Fax: +34-971-173426	Aug. 15, 2005	Aug. 15, 2006

Scientific Collaboration Council Delegate: Alicia M. Sintes.

Approved:

Barry Barish
LIGO Laboratory Director

Alicia Sintes Olives
Principal Investigator, Relativity Group
Balearic Islands University

Peter Saulson
LSC Spokesperson