

## **Memorandum of Understanding**

**between**

**VIRGO**

**on one side**

**and the**

**Laser Interferometer Gravitational Wave Observatory (LIGO)**

**on the other side**

### **Purpose of agreement:**

The purpose of this Memorandum of Understanding (MOU) is to establish and define a collaborative relationship between VIRGO on the one hand and the Laser Interferometer Gravitational Wave Observatory (LIGO) on the other hand in the use of the VIRGO, LIGO and GEO detectors based on laser interferometry to measure the distortions of the space between free masses induced by passing gravitational waves.

We enter into this agreement in order to lay the groundwork for decades of world-wide collaboration. We intend to carry out the search for gravitational waves in a spirit of teamwork, not competition. Furthermore, we remain open to participation of new partners, whenever additional data can add to the scientific value of the search for gravitational waves. All partners in the collaborative search should have a fair share in the scientific governance of the collaborative work.

Among the scientific benefits we hope to achieve from the collaborative search are: better confidence in detection of signals, better duty cycle and sky coverage for searches, and better source position localization and waveform reconstruction. In addition, we believe that the intensified sharing of ideas will also offer additional benefits.

This MOU supersedes the MOU LIGO-M970123-00-M between the VIRGO and LIGO Projects, established in November 1997, however all the agreements done under it or under Amendments No. 1 or 2 remain valid.

Details of and extensions to this MOU will be provided in Attachments agreed to by LIGO and VIRGO.

## Parties to the agreement

1. VIRGO denotes hereafter the Virgo Collaboration and the European Gravitational Observatory (EGO) consortium.

CNRS and INFN signed an agreement on 27 June 1994 concerning the realization of a three kilometer Fabry-Perot interferometric antenna aimed at the detection of gravitational waves in the frequency range 10-10 000 Hz, named Virgo, located at Cascina, Italy. This agreement was superseded by the Agreement between CNRS and INFN, founding the "European Gravitational Observatory "Consortium under Italian law (EGO), signed on 11 December 2000.

The main purpose of EGO is to ensure the end of the construction of the Virgo antenna, its commissioning, its operation and its upgrade, as well as to promote an open co-operation in R&D. The Consortium is supervised by the EGO Council. The implementation of the above is performed via the involvement of the Virgo collaboration in the framework of the Memorandum of Agreement between the Virgo Collaboration and EGO Consortium, signed on 20 November 2002.

The Virgo collaboration is composed of approximately 200 scientists and technicians coming mainly from CNRS and INFN laboratories and from EGO, which have signed an Agreement on 19 December 2001. Decisions are taken by its steering committee. The overall scientific exploitation of the Virgo antenna is under the responsibility of the Virgo Collaboration

In this MoU the Virgo collaboration is represented by the spokesman appointed by the Virgo steering committee and the EGO Consortium by the director of EGO appointed by the EGO council.

2. LIGO denotes hereafter the LIGO Laboratory and the LIGO Scientific Collaboration (LSC).

LIGO was built under a Cooperative Agreement between the National Science Foundation (NSF) and Caltech signed in May 1992 (No. PHY 9210038). 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 has been built in Hanford, Washington and in Livingston Parish, Louisiana (USA) and began observations in the year 2002. The design and construction of LIGO was carried out by California Institute of Technology (Caltech) and the Massachusetts Institute of Technology (MIT). Caltech operates LIGO for the NSF under a Cooperative Agreement and MIT participates in this effort under subcontract to Caltech. The LIGO Oversight Committee supervises the realization of LIGO.

The LSC is composed of approximately 520 individuals from about 35 institutions worldwide, including scientists and engineering personnel from the LIGO Laboratory. LSC membership includes all of the scientists and engineers in the GEO project. These scientists and engineers have the same rights and privileges as any other LSC members with regard to the provisions of this MOU.

The LSC Charter establishes the functions, organizational structure and responsibilities of the LSC as well as its role in the research of the LIGO Laboratory, and the release of scientific results. The LIGO leadership consists of a Directorate that includes the LIGO Executive Director, the LIGO Laboratory Deputy Director, and the LSC Spokesperson.

The German/British Collaboration for the Detection of Gravitational Waves (GEO) has built a detector of arm length 600m (GEO600) near Hannover in Germany, with the purposes of joining in a worldwide search for gravitational radiation from astronomical sources and of developing advanced interferometric and suspension technologies for later gravitational wave detectors. The design, construction and operation of the GEO600 system is being carried out by scientists and technologists at the University of Hannover, the University of Glasgow, and the Max Planck Institute for Gravitational Physics (Albert Einstein Institute) in Hannover and Golm. Data acquisition and analysis are managed by the Albert Einstein Institute (AEI), Cardiff University, and Birmingham University. The project is funded in Germany by the State Government of Niedersachsen, the Max Planck Gesellschaft (MPG), and the Bundesministerium fuer Bildung und Forschung (BMBF) in Germany, and by the Particle Physics and Astronomy Research Council (PPARC) in the UK.

The agreement LIGO-M040357-00-M (dated November 5, 2004) between LIGO and GEO states, «All such agreements to share data with external projects will be made jointly by LIGO/LSC and GEO leadership, with the goal that, wherever it makes scientific sense, provisions for sharing data will treat data from LIGO and GEO equivalently.» Thus, this agreement applies equally to data from any of the three LIGO interferometers and to data from the GEO 600 interferometer. The signature of the GEO600 Principal Investigator for Data Analysis on this MOU is in accord with LIGO-M040357-00-M and constitutes their endorsement of this collaboration.

By virtue of this agreement, the term LIGO as used in this MOU includes GEO as well.

### *Scope of the agreement*

3. This agreement governs cooperative scientific work between VIRGO and LIGO. The terms governing work on data analysis are exclusive; that is, the parties agree that all of the data analysis work that they do will be carried out under the framework of this agreement. The terms governing other forms of collaborative work are not exclusive; they may, in addition, make agreements with other parties that are not governed by this agreement, as long as such agreements do not involve sharing of data.
4. The agreement described herein represents a scientific collaboration between independent projects, not a merger. Each project will maintain its own separate governance. Decisions on issues that bear on collaborative work will be made in discussion among the leadership of the projects, each representing their Collaborations' position as determined according to their own governing structures.

5. Goals for joint data analysis will be proposed by LSC/Virgo collaboration Joint Data Analysis Groups, will be discussed jointly by both Collaborations and will be approved by each Collaboration according to their own governing structures. The specific mechanisms for the coordination of the data analysis activities are described in an Attachment to this MOU.

Proposals for joint work on commissioning and advanced R&D may be proposed by the technical working groups; these, too, will be approved by the leadership of both projects.

6. After the data sharing provisions of this agreement go into effect, all subsequent observational data will be open to both collaborations, to be used in the framework of Joint Data Analysis Groups on all gravitational wave analysis topics. All gravitational wave data analysis will be carried out under the umbrella of this agreement between LIGO and VIRGO; there will be no LSC-only or Virgo-only gravitational wave data analyses while this agreement remains in force. (However, each collaboration may use its own environmental data freely, outside the framework of this agreement.)

Nevertheless, the LSC and the Virgo collaboration each reserve the right to maintain independent pipelines to carry out any data analysis problem.

After the data sharing provisions of this agreement go into effect, all subsequent collaborative data analysis work with projects other than LIGO or VIRGO will be negotiated by and carried out by the LSC and VIRGO together; prior agreements will remain in force automatically only for data collected earlier.

7. The functioning of this Memorandum of Understanding (including any addenda or attachments) shall be monitored by a Liaison Group, made up of two advisors one appointed by the LIGO Executive Director and the other by the EGO Council (CNRS-INFN), to which they report and from whom they convey advice. The Liaison Group will keep informed of the status of implementation of the MOU and provide its advice to the leadership of the Collaborations.

**Procedure for bringing this agreement into effect:**

8. Upon signing this MOU, the parties will immediately begin a transition period to implement the joint data analyses. This will include formation of joint data analysis groups and studies of data analysis pipelines using simulated or real data, as described in the Attachment. LSC and Virgo Collaboration meetings will be opened to members of both collaborations, and joint meetings will be planned. The full data sharing provisions of this agreement will go into effect when the sensitivity and duty cycle of the interferometers will allow a significant contribution to joint searches for gravitational waves. This date will be jointly determined by VIRGO and LIGO.

**Coordination between VIRGO and LIGO**

9. The scientific representatives of LIGO and VIRGO will meet regularly to exchange

information on detector status and the progress of joint data analysis, and to share plans for future data collection, instrument repairs, and detector enhancement. The leaders of the projects will work to coordinate those plans, with the goal of optimizing the science done with the network of instruments. These plans will have to be approved by the LIGO Directorate and the EGO consortium whenever they involve financial and human resources.

10. The LSC and the Virgo collaboration will each appoint (according to their governing structures) representatives to joint committees to coordinate data analysis planning, run planning, and computing. The makeup of these committees will be decided by mutual agreement between the projects.

**Organization of joint data analysis:**

11. All data analysis activities will be open to all members of the LSC and Virgo Collaborations, in a spirit of cooperation, open access, full disclosure and full transparency with the goal of best exploiting the full scientific potential of the data.

Data analysis projects and activities will be organized in joint Analysis Groups, comprising members of the LSC and Virgo. Every data analysis project must be affiliated with at least one of the Analysis Groups.

Participation in the Analysis Groups will be open. Instrument experts will be active members of all Analysis Groups and Review Committees, to ensure appropriate use and interpretation of the data.

The organization and operation of the Analysis Groups are detailed in Attachment A to this MOU.

**Review and publication of observational results:**

12. A Review Committee will be attached to each Analysis Group. It will be responsible for carrying out the detailed technical review of analysis results and to vet claims made in talks and papers.

The organization and operation of the Review Committee, as well as other aspects of the review process, are described in Attachment A to this MOU.

All data and their interpretation will be held strictly within the membership of the Collaborations until the review processes outlined below are complete and both Collaborations have given their permission for public release. This is to be interpreted that no discussion of results or pre-prints may take place with scientists who are not members of the Collaborations or with members of the media, until the leaderships of the Collaborations have approved the release of the information.

The Virgo collaboration, subject to the approval of the EGO Council, and the LSC will negotiate mutually consistent amendments to their Publication Policies to cover other aspects of talks and papers on joint work.

13. Author lists are to be separately established according to the rules of each collaboration, and maintained by them. When papers are published, the author lists will be combined in a manner established by mutual agreement between the collaborations.

#### **Organization of collaborative technical research**

14. We encourage all possible ways to share technical information, whether related to commissioning of present interferometers or R&D on future interferometers. We will encourage visits (both short-term and long-term) of scientists to the observatories and/or to the campus research facilities of the other project. We also encourage specific joint research and development projects whenever feasible. The leadership of LIGO and VIRGO need to be informed of all collaborative work; they may require an Attachment to the MOU be negotiated if significant commitments are required.

Meetings of technical working groups of one Collaboration will be open to members of the other Collaboration. In addition, periodic joint collaboration-wide meetings will be held, to facilitate the exchange of knowledge and ideas.

A joint review process will be established for technical papers that have joint authorship, to ensure both the quality of papers and timely publication. All publications and presentations which come about due to the work of the joint collaborative effort or from sharing of ideas in the context of the joint collaboration must be submitted to the joint review process, whether or not authorship includes members from both collaborations.

#### **Coordination with governing bodies and sponsors:**

15. Each party to this MOU continues to be responsible for obtaining all resources, and for all support of its staff including travel costs associated with the activities under this MOU. Exceptional support of travel by the other institution may be allowed for travel requested by that party.

16. In order to preserve the intellectual property rights of their respective institutions and sponsors, the Virgo Collaboration Spokesperson, the EGO Director and the LIGO Executive Director will promptly inform each other of any invention resulting from joint actions which might lead to intellectual property rights. Each of them will be responsible to further notify their respective governing bodies as well as relevant institutions and sponsors from their collaboration with any possible interest in those intellectual property rights.

17. In the framework of the action of internationalization by the participating funding agencies the possibility is foreseen to create joint post-doctoral fellowships to support the scientific goals of this MoU. Details will be provided in an Attachment to this MOU.

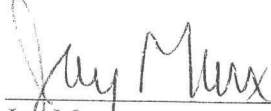
18. The LIGO Laboratory is responsible for obtaining NSF approval of collaborative Memoranda of Understanding where required. All attachments will be provided to NSF for their information.

19. The Virgo spokesperson and the EGO Director are responsible for obtaining the EGO council approval of collaborative Memoranda of Understanding and the CNRS, INFN endorsement, where required. All attachments will be provided to EGO council for its information.

**Term of agreement:**

20. This agreement will come into force after the endorsement by NSF, CNRS, and INFN. It covers collaborative work beginning on the signing date and lasting for three years from that date. It may be extended by mutual agreement between LIGO and VIRGO. Cessation of any data exchange may take place at the request of either LIGO or VIRGO. Data collected under the terms of this agreement (prior to its cessation), on-going analyses of them, and any publications and presentations using them are governed by the terms of this MOU and its attachments indefinitely, unless both LIGO and VIRGO agree to a change.

Approved:

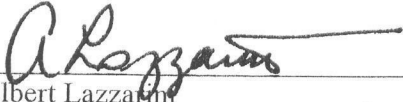


Jay Marx

LIGO Executive Director and LIGO Principal Investigator

Jan 24, 2007

Date



Albert Lazzarini

LIGO Laboratory Deputy Director

24 Jan 2007

Date

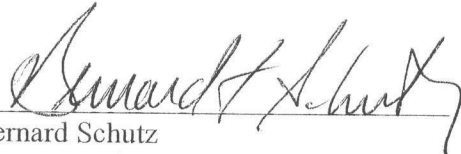


Peter Saulson

LSC Spokesperson

17 Jan 2007

Date

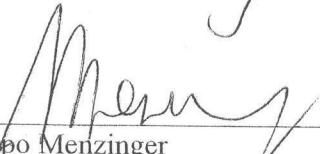


Bernard Schutz

GEO 600 Principal Investigator for Data Analysis

12 February 2007

Date



Filippo Menzinger

Director of EGO

5 March 2007

Date



Benoit Mours

Virgo Collaboration Spokesperson

15 February 2007

Date