

Memorandum of Understanding among the Borexino Collaboration, the IceCube Collaboration, the LVD Collaboration, and the LIGO Scientific and VIRGO Collaborations

July 31, 2015

Participants and Mission

This Memorandum of Understanding (MoU) establishes collaboration among the Laser Interferometer Gravitational-wave Observatory (LIGO) and its associated scientific collaboration (LSC), the European Gravitational Observatory and Virgo Collaboration (EGO/Virgo), the Borexino detector operated by the Borexino Collaboration (Borexino), the High-Energy Neutrino telescope operated by the IceCube Collaboration (IceCube) and the Large Volume Detector operated by the LVD Collaboration (LVD) in order to (a) perform a joint research program using data from their experimental facilities for the coincident detection of gravitational waves (GW) and O(10) MeV neutrinos from core-collapse supernovae and (b) promote the overall experimental, phenomenology and theoretical work within the broader community around multi-messenger observations of core-collapse supernovae.

General terms and provisions

In entering into this MoU, the LIGO Laboratory will carry out its responsibilities following the requirements of the Cooperative Agreement with NSF. The LIGO Laboratory is also responsible for obtaining NSF approval of all collaborative Memoranda of Understanding with international partners, or involving NSF costs exceeding \$100,000. All Memoranda of Understanding will be provided to NSF for their information. Each party to this agreement continues to be responsible for all support of its staff including any expenses and travel costs associated with the activities described under this agreement. This MoU does not prevent the parties from establishing other agreements on data exchange or external collaborations. The existence and general terms of any other agreements that involve the combined use of GW and neutrino data will be shared among the parties of this MoU.

Data sharing, use and confidentiality

All parties agree that any information or data products shared as part of this research program shall be used only for the purpose of the collaborative work covered by this agreement and as detailed in proposal-like documents accompanying this MoU as attachments. All information or data exchange as part of this research program will be treated as confidential by all parties, unless it is otherwise stated. Any data analysis work will be coordinated by a joint analysis working group where all MoU parties will be represented. Membership in such working group will be open to all members of all collaborations participating in this MoU.

Period of validity and termination of this MoU

This MoU is valid initially for two years, following which participants may extend it by mutual agreement. Any participant in this MoU may withdraw from this agreement at any time. Data that may have already been exchanged under the terms of this agreement and prior to the withdrawal of any of its members or the MoU's expiration or termination, including on-going analyses of them and any publications and presentations using them will be governed by the terms of this MoU indefinitely unless all MoU parties agree to a change.

Publications and Presentations

All publications and presentations in any form (including peer-reviewed articles, conference presentations and proceedings, seminars and colloquia, press releases, theses and publicly-accessible electronic or not media) that involve exchanged data as part of this research program must be communicated in advance and approved unanimously by the signatories of this MoU. Such publications and presentations must be consistent with the corresponding policies of each collaboration that participates in the MoU. Publications that involve real data from the experiments will carry the full author list of the experiments, unless any given experiment chooses to treat differently how its authors should appear. Authors will appear grouped by Experiment/Collaboration according to their respective rules. Such groupings will be alphabetical in order by Experiment/Collaboration. The signatories of this MoU will resolve by consensus any conflicts arising in publication and presentation matters of this research program.

Signatures page

For the Borexino Collaboration:



Gioacchino Ranucci, co-Spokesperson



Cristiano Galbiati, co-Spokesperson

For the IceCube Collaboration:



Francis Halzen, Principal Investigator



Ty DeYoung, Deputy Spokesperson

For the LVD Collaboration:

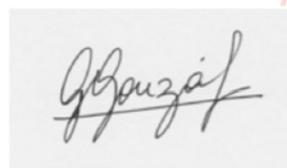


Walter Fulgione, Deputy Spokesperson

For the LIGO Scientific Collaboration:



David Reitze, LIGO Laboratory Executive Director



Digitally signed by Gabriela Gonzalez
DN: cn=Gabriela Gonzalez,
o=Louisiana State University,
ou=Physics and Astronomy
Department,
email=gonzalez@lsu.edu, c=US
Date: 2015.07.31 11:25:16 -06'00'

Gabriela Gonzalez, Spokesperson

For the VIRGO Collaboration:



Federico Ferrini, EGO Director



Digitally signed by Fulvio Ricci
DN: cn=Fulvio Ricci,
o=Università di Rome La
Sapienza, ou=Dipartimento di
Fisica,
email=fulvio.ricci@uniroma1.it,
c=IT
Date: 2015.08.05 18:39:39
+02'00'

Fulvio Ricci, Spokesperson

Attachment #1 Definition of MoU participants

Borexino is a low background unsegmented liquid scintillator detector collecting data at the Laboratori Nazionali del Gran Sasso since May 2007. The scintillator (278 tons) is contained into a spherical vessel of 4.25 m diameter and it is viewed by 2200 photomultipliers. The main goal is the detection of solar neutrinos with MeV and sub MeV energy. The hardware energy threshold is about 50-60 KeV. Borexino is equipped with electronic chains that allow it to detect supernova neutrinos (and antineutrinos). The detector is presently in data taking regime. The scientific collaboration is composed by about 70 people from different Institutions and Universities.

The **IceCube** Collaboration is an organization of scientists pursuing a research program to study high-energy neutrinos from cosmic sources. The Collaboration uses the IceCube Observatory at the National Science Foundation (NSF) Amundsen-Scott South Pole Station for this research program. The IceCube Observatory consists of a surface array, IceTop, and a deep ice array IceCube, which includes an inner detector, DeepCore. The detector was built as a lattice of 5160 photomultiplier tubes monitoring one cubic kilometer of clear Antarctic ice for the Cherenkov light emitted by relativistic charged particles passing through the ice. The Host Institution for the IceCube project is the University of Wisconsin-Madison (UW), under the terms of Cooperative Agreements with the NSF¹. The IceCube Collaboration is composed of approximately 250 individuals from 41 institutions worldwide. In this MOU, the IceCube Collaboration is represented by the Principal Investigator, the Director of the Observatory, and the Spokesperson.

The **Large Volume Detector (LVD)** is a modular scintillator observatory operating, since 1992, at the INFN Gran Sasso National Laboratory. The detector consists of one thousand tons of liquid scintillator, contained in 840 counters, monitored by 2520 photomultiplier tubes. Main purpose of LVD is the detection of neutrinos with MeV energy from gravitational stellar collapse. The LVD Collaboration is composed by more than 30 individuals from different Institutions worldwide

LIGO denotes the Laser Interferometer Gravitational-wave Observatory (LIGO) 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. PHY9210038). LIGO is a system of interferometric Fabry-Perot antennas possessing 4km arm lengths, aimed at the simultaneous detection of gravitational waves in the frequency range of 10-6000 Hz. LIGO observatories have been built in Hanford, Washington and in Livingston Parish, Louisiana (USA) and began observations in 2002. The design and construction of LIGO was carried out by the California Institute of Technology (Caltech) and the Massachusetts Institute of Technology (MIT). Caltech and MIT jointly operate LIGO Laboratory for the NSF under a Cooperative Agreement between NSF and Caltech, with MIT participating through a subaward from Caltech. The LIGO Oversight Committee supervises the realization and scientific exploitation of LIGO. The LSC is composed of approximately 900 individuals from more than 70 institutions worldwide, including scientists and engineering personnel from the LIGO Laboratory. LSC membership includes all the scientists and engineers in the GEO project (defined in the next paragraph). 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 LSC Collaboration Council, with proportional representation from each group, votes on issues of importance to the collaboration and elects the Spokesperson.

GEO is the German/British Collaboration for the Detection of Gravitational Waves. GEO has built a detector with a 600m arm length (GEO600) near Hannover in Germany, with the purpose of joining the worldwide search for gravitational radiation from astronomical sources and also 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 carried out by the Albert Einstein Institute (AEI), Cardiff University, the University of Glasgow and Birmingham University. The project is funded in Germany by the State Government of Niedersachsen, the Max Planck Gesellschaft (MPG), and the Bundesministerium für Bildung und Forschung (BMBF) in Germany, and by the Science and Technologies Facilities Council (STFC) in the UK. The agreement LIGO-M040357-00-M (dated November 5, 2004) between LIGO and GEO states that "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 LIGO interferometers and to data from the GEO600 interferometer.

VIRGO denotes 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 3km Fabry-Perot interferometric antenna aimed at the detection of gravitational waves in the frequency range of 10-10000 Hz, named Virgo, located at Cascina, Italy. This agreement was superseded by the Agreement between CNRS and INFN, founding the "European Gravitational Observatory" (EGO) Consortium under Italian law and which was signed on 11 December 2000. Netherlands became an associate member following an agreement signed with the Nikhef group in July 2009. The main purpose of EGO is to ensure the completion 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, which have signed an Agreement on 19 December 2001, as well as from EGO, the Netherlands, Poland and Hungary. 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 spokesperson appointed by the Virgo steering committee and the EGO Consortium by the director of EGO appointed by the EGO council.

1 Cooperative Agreement Nos. ANT-0236449, dated August 2002, and ANT-0639286, dated April 2007, between the National Science Foundation, Washington D.C. 20550 and the University of Wisconsin-Madison, Madison, WI 53715