

Attachment A

to the

Memorandum of Understanding

(LIGO-M060038-A-M, VIR-0092A-14)

between

VIRGO

and

LIGO

March 2014

1 Scope of this attachment

This attachment details the organization of LIGO Scientific Collaboration (LSC) and Virgo Collaboration data analysis activities, rules for dissemination and publication of data analysis results, and coordination of participating scientists in the pursuit of supporting research.

Section 2 governs the derivation and dissemination of gravitational wave observational results. We define an **Observational Result** as *any statement of an astrophysical or fundamental physics nature derived from LIGO, GEO or Virgo gravitational wave data*. The dissemination of results from common work and support activities done to derive an Observational Result is also covered by this section.

Section 3 establishes frameworks for coordination of the critical supporting activities underpinning such observational results. These include coordinated run planning, detector characterization and data quality assurance, calibration, editorial oversight of technical publications, and joint meetings of the Collaborations.

2 Data analysis and dissemination of results

2.1 Organization of observational data analysis activities

1. Data analysis activities will be organized into *Analysis Groups*, each comprising members of LSC and Virgo. Any Collaboration data analysis project directed at phenomena of an observational nature (astrophysical or fundamental physics) must be affiliated with at least one of the existing Analysis Groups.

2. Additional Analysis Groups may only come into existence by mutual agreement of both Collaborations.
3. Participation in these Analysis Groups is open to all LSC and Virgo members.
4. Instrumentation and software experts will be included as active members of each Analysis Group to ensure appropriate use and interpretation of data.
5. Analysis Groups are responsible for writing scientific papers that report the results of their analyses.
6. Analysis Groups are also responsible for regularly presenting plans for upcoming analysis and publication to the Collaborations.
7. It is expected that there will be several focal scientific topics being addressed under the umbrella of each Analysis Group. All focus teams will regularly report progress to the full Analysis Group, in a spirit of transparency and openness; once an effort shows promise to lead to a useful result, it must be shared.

2.2 Analysis group leadership

1. Each joint Analysis Group will have two Chairpersons: one chosen from Virgo and one chosen from the LSC. The two Chairpersons are responsible for overall guidance of the work of the joint Analysis Group.
2. Analysis Group Chairpersons representing each Collaboration will be chosen by that Collaboration's internal procedures. Leaders of both Virgo and the LSC will be kept informed of progress in selection of Chairpersons for either Collaboration.
3. A Deputy Chairperson may also be appointed from each Collaboration if necessary to appropriately support program activities.
4. Chairpersons are responsible for ensuring that the scientific potential of the data is exploited; that all results are correct, reproducible, and traceable; and that the analysis methods and techniques are reliably recorded and thoroughly documented.
5. Chairpersons will monitor compliance of analysis efforts with Collaboration policies, and will encourage that analyses are overall carried out by heterogeneous teams representing both Collaborations.
6. The Chairpersons are responsible for ensuring that environmental and instrumental vetoes, data quality, instrument idiosyncrasies, nonstationarity, calibration, timing, and digital artefacts are taken properly into account in any

astrophysical interpretation. Normally this will require participation and concurrence of instrumentation experts familiar with each detector at the epoch when the observations were recorded.

2.3 Analysis research planning

1. Each Analysis Group will contribute to (and annually update) a Data Analysis White Paper describing the Collaborations' astrophysical analysis research program.
2. Since software, computing hardware, data management, detector and data characterization are fundamental to the analysis activities the data analysis white paper will also include chapters describing activities and plans in these areas.
3. Each Analysis Group will maintain written plans for observational result papers, including the data to be used. These plans should also describe what work is necessary to achieve those goals and timelines for obtaining and publishing final results. Progress reports and/or updates on the scope of the search plans will be advertised within the Collaboration.

2.4 Analysis Reviews

Each astrophysical analysis will be critically reviewed before publication is considered. The review process will ensure:

- accuracy and significance of reported results
- early detection and resolution of errors
- reproducibility of results
- proper documentation of analysis methods and intermediate steps
- adequate testing and vetting of software tools and proper software documentation
- appropriate response to comments from Collaboration members.

The Analysis Groups and the review committee together will agree on the most effective means to ensure that these goals are met in a timely manner, and report to the Data Analysis Council.

1. A *Joint Review Committee* associated with each Analysis Group will be established with two Review Chairpersons, one chosen from each Collaboration.

2. Review Chairpersons should not be active members of the corresponding Analysis Group.
3. Review Committee members will represent both Collaborations; equal numbers are not required, but a “critical mass” of participating reviewers is required from each Collaboration.
4. Review Committee Chairpersons will be appointed by each Collaboration or by procedures established within each Collaboration, in consultation with leaders of the other Collaboration.
5. Review Committee members will include people with expertise in instrument science (for each detector which supplied data for the analysis) as well as in data analysis.

2.5 Coordination between Analysis Groups:

1. Chairpersons of all Analysis Groups, chairpersons of the associated Review Committees, chairpersons of Joint Computing and Software Working Group, and Liaisons in Calibration and Detector Characterization and Data Quality comprise the **Data Analysis Council**. The Spokespersons are ex-officio members of this Council and represent the Collaborations’ governing bodies.
2. Each Collaboration will appoint a **Data Analysis Coordinator** to jointly oversee the Data Analysis Council and report on its activities and findings.
3. The Data Analysis Council is responsible for coordinating and overseeing the analysis activities across the different Analysis Groups and for ensuring uniform and appropriate review of results and procedures. The Data Analysis Council will serve as a liaison between the analysis groups and the governing bodies alerting them of significant changes to the search plans and/or of data analysis progress or problems. The LSC and Virgo Collaboration governing bodies may exercise final approval if there are any issues.
4. The Data Analysis Council is charged with discussing and resolving issues of common interest and concern across the search groups, including harmonious utilization of manpower and computing resources and prioritization of the analysis objectives, tracking of the progress towards such objectives and maintaining this information in a form that is easily accessible and consumable by the Collaboration members.

2.6 Publication of Observational Results and supporting activities

We refer in this section to dissemination outside of the Collaborations of gravitational wave Observational Results and of results from supporting activities. The definition of an Observational Result is given in Section 1 of this attachment.

Dissemination includes presentations at conferences, conference proceedings, papers or notes in any journal (peer-reviewed or otherwise), public archives, press releases or press interviews, and any web page accessible without authorized Collaboration credentials.

1. Each Analysis Group will present to the Collaborations and periodically update a plan for all dissemination of new results over the next six to 12 months.
2. The plan should explain the scientific rationale behind the proposed schedule and should be realistic about the resources necessary to carry it out, including associated review work. The Collaborations will discuss these plans during joint meetings scheduled throughout the year and approve them or propose amendments.
3. Any dissemination of new results must be reviewed and approved by the appropriate Analysis Review Committee.
4. After the Review Committee has approved a result, the result will be presented to the LSC and to the Virgo Collaboration.
5. Approval by each Collaboration shall be according to its own governing procedures.
6. Each new result must be approved by both Collaborations before it can be disseminated. In case of a conflict about the nature or timing of the dissemination of results, procedures in MOU clause 18 will be followed.

Regarding public presentation or discussion (e.g., at conferences open to non-Collaboration researchers):

7. To allow timely preparation and review, all planned talks or other verbal dissemination must be announced well in advance. Presentation slides will be made available to members of both Collaborations so that others can provide critical feedback. Implementation of the procedure will be worked out by the Joint Editorial Board
8. Talks presenting new results prior to formal publication must be approved by the corresponding analysis Review Committee and also by each Collaboration, according to their own governance.

9. After incorporating appropriate comments, finalized presentation materials must be authorized by the leader of each Collaboration or their respective designee(s).
10. Talks on behalf of the Collaborations reporting *previously approved* results must be reviewed and approved by the Virgo Editorial Board and the LSC Publications and Presentations Committee according to their usual procedures.

Regarding invited talks:

11. Invitations received by either a member of the LSC or the Virgo Collaboration for a talk dealing with either LIGO or Virgo or GEO results at a workshop or conference are regarded as invitations to both Collaborations.
12. Such invitations must be forwarded the **Joint Editorial Board** (defined below), who will decide whether to accept the invitation, and if so, which Collaboration member(s) should deliver the talk.

Regarding combined author lists:

13. The authorship of Observational results papers will be written as described in the section 'Review and publication of observational results' of the main MOU.
14. Each author's Collaboration affiliation will be designated appropriately in accord with target publication style requirements.
15. Detector and data characterization as well as some "method" papers may qualify for single Collaboration or short author list as described in the following section.

2.7 Single Collaboration or short author list publications

We define in this section the two classes of papers and presentations involving LIGO, GEO and Virgo data that are eligible for short author or single Collaboration author lists: instrument papers; and description and studies of data analysis methods as well as detector and data quality/characterization studies

Instrument papers, defined as *publications addressing the technical description and performance of the instruments*, as well as more general precision measurement and instrument science publications, are separately managed according to each Collaboration's internal publication policy.

To illustrate aspects of data analysis techniques which address imperfections found in

real data, and to support detector characterization and data quality studies, older data produced by the interferometers will be designated as ‘*collaboration open data*’. Members of the two collaborations are free to publish results of the above studies in accordance with the internal policies of their own Collaboration.

Each Collaboration may decide independently on declaring some of its own data as “open collaboration data”, or allow a fraction to be used in non-observational papers for detector characterization studies or data analysis method development.

Irrespective of *collaboration open data* status, any *Observational Result* (defined above) derived from such data will be considered a joint endeavor of both Collaborations and disseminated as described above in Section 2.6.

Planned papers on *collaboration open data* shall be announced to the Joint Editorial Board to verify that the scope of the paper is correct and that the choice of author list is appropriate.

2.8 Public data release

Once the first detections have been confirmed and sufficient confidence is attained in their interpretation, publishing alerts and data related to GW transient events will benefit the broader research community.

Both the LSC and Virgo recognize the interest of making their data public after detections become routine and initial scientific goals have been achieved. These data may, for example, comprise documented and calibrated strain time series. Each Collaboration can separately decide on releasing some or all of its data to the public, following policies that will be known sufficiently in advance to both Collaborations. Such public releases of either Virgo or LIGO data, whether voluntary or as required by their respective funding agencies, will not result in a termination of the MOU, nor do they imply any commitment by the other Collaboration to release the corresponding data set.

To encourage fairness to other collaboration members, and to discourage abuse of the privileges of collaboration membership, for at least one year after any public data release, current members of either Collaboration, as well as previous members who are still entitled to authorship rights on papers by the LIGO Scientific Collaboration or the Virgo Collaboration, must follow the publication rules of their respective Collaborations. In particular, dissemination of observational results needs to be reviewed by the two Collaborations, and will carry the authorship of both collaborations.

Both Collaborations will take all reasonable and feasible measures to ensure that users of any data made public by LSC or by Virgo will properly credit LSC, Virgo, and their respective funding agencies.

2.9 Announcement of discoveries

Joint claims of discoveries will follow these protocols for their announcement to the public:

1. Upon approval by the members of the Collaborations, final authorization of the public announcement must be given by the LIGO Directorate, the GEO Principal Investigator for Data Analysis, the EGO Director and the Virgo Spokesperson.
2. Any press release announcing a discovery, including the first detection of gravitational waves, will be issued jointly and simultaneously by the LIGO Scientific Collaboration (LIGO & GEO) and VIRGO.
3. Any press release pertaining to gravitational wave searches or to any other collaborative work will be issued jointly and simultaneously by the LIGO Scientific Collaboration (LIGO and GEO) and VIRGO.

3 Joint collaboration in supporting activities

Derivation of publishable observational results is the endpoint of a broad supporting effort, comprising instrument science and detector design, construction and commissioning, background suppression, algorithm and computing development, and mentoring, education and public outreach. The quality of the Collaborations' joint astrophysics enterprise is directly dependent on coordination of their work on these foundations.

Joint Collaboration Committees, Liaisons and Working Groups are established to coordinate such activities, foster innovation, avoid unnecessary duplication, and efficiently and transparently share findings on these subjects.

3.1 Joint Run Planning Committee

A *Joint Run Planning Committee* will be formed comprising Virgo and LSC Data Analysis Coordinators; Cascina, Hannover, Hanford and Livingston observatory site representatives; Virgo, GEO and LIGO detector commissioning and software/computing representatives; and other relevant experts from Virgo, GEO, and LIGO.

1. The committee will have two Chairpersons, one an LSC member and one a Virgo member.

2. Each Collaboration will appoint its Chairperson and other representatives according to its internal policies.
3. The Joint Run Planning committee is charged with:
 - Strategic planning of detector upgrades, engineering runs, maintenance intervals, and observations
 - Prioritization and coordination of coincident operation and of complementary coverage as appropriate
 - Coordination of both coincident and individual-detector observing with concurrent external (non-gravitational wave) observations to optimize scientific opportunity
4. The Joint Run Planning committee will make a proactive and timely communication of detector status and plans for consideration by the full Collaborations.

3.2 Detector Characterization and Data Quality Liaisons

1. Each Collaboration will appoint a liaison for the Detector Characterization and Data Quality work.
2. Liaisons will meet regularly to make sure that the exchange of information between the two Collaborations is appropriate.
3. The liaisons will organize working meetings with scientists of both Collaborations as often as needed to assess and improve data quality in the detectors, and to evaluate whether data taken jointly for astrophysical purposes are supported by consistent and adequate standards for defining and reviewing data quality.
4. The liaisons will regularly report to the Data Analysis Council and the Joint Run Planning Committee.

3.3 Calibration Liaisons

1. Each Collaboration will appoint a liaison for Detector Calibration.
2. Liaisons will meet regularly to make sure that the exchange of information between the two Collaborations is appropriate.
3. The liaisons will organize working meetings with scientists of both Collaborations as often as needed to assess and improve calibration of the detectors, and to insure that data taken jointly for astrophysical purposes are supported by consistent and adequate standards for defining and reviewing calibration.

4. The liaisons will regularly report to the Data Analysis Council and the Joint Run Planning Committee.

3.4 Joint Computing and Software Working Group

1. A *Joint Computing and Software Working Group* will be formed, consisting of the leaders of computing and data analysis software, instrument control computing and software, and detector characterization computing and software efforts of Virgo and the LSC.
2. The mission of the Joint Computing and Software Group is to ensure proper communication between the LSC and Virgo Collaboration on computing and software development issues, to understand the constraints of each Collaboration's computing resources, and to optimally adapt the available resources to provide the appropriate degree of interoperability of computers and software and to aim at the broadest use of hardware and software. The objective shall be to provide straightforward access with usable bandwidth to all acquired data by all instruments in the two Collaborations.
3. The Working Group will have two Chairpersons, one an LSC member and one a Virgo member.
4. Each Collaboration will appoint its Chairperson and other representatives according to its internal policies.
5. Analysis software will be developed according to each Collaboration's internal rules and managed by the Joint Computing and Software Working Group. All software developed by members of either Collaboration for joint activities will remain accessible for use to members of the other Collaboration.

3.5 Joint Editorial Board

1. A *Joint Editorial Board* will be formed to establish and maintain consistent authorship and approval policies and procedures for dissemination of results by members of both Collaborations.-
2. Any paper which would require circulation by the rules of the authors' Collaboration, or originates from collaborative work or data covered under the terms of this agreement, or makes statements about either collaboration's results or capabilities, will be submitted to the Joint Editorial Board and circulated to both Collaborations prior to its public release. This includes collaboration-authored papers as well as short author list papers which meet the above criteria.

3. The Board will determine appropriate authorship type – short author list or full author list – for all presentations and publications which fall under the rules of this Attachment. This will determine the path for the subsequent review process,
4. The Committee will have two Chairpersons, one an LSC member and one a Virgo member.
5. Each Collaboration will appoint its Chairperson and other representatives according to its internal policies.
6. The Joint Editorial Board is also charged with:
 - a. Establishing and executing a method to identify speakers for conferences that can be used to communicate proposed speakers to Scientific Organizing Committees of relevant conferences. The recommendations will represent an diverse, adequate and fair distribution of speakers for both Collaborations.
 - b. Reviewing talks on behalf of the Collaborations, or talks given by Collaboration members that can affect the image of the Collaborations.
 - c. Maintaining records of assignments of speakers to establish statistics and to help refine the methods of assignment.

3.6 Joint Collaboration Meeting Committee

The Collaborations will schedule a sufficient number of joint Collaboration meetings to allow frequent and timely discussion of new observational results and to facilitate joint research in all other areas of gravitational wave detection.

The sites of the meetings will be geographically distributed, so as to fairly share the burden of travel. Remote participation will be made available, so that members unable to travel will be able to participate in key discussions and decisions.

1. A Joint Collaboration Meeting Committee will be formed to identify venues for future meetings and to perform coordinated planning of the oversight the organization of the joint Collaboration meetings.
2. The Committee will have two chairpersons, one from the LSC and one from Virgo.
3. Each Collaboration will appoint its Chairperson and other representatives according to its internal policies.

3.7 Joint Detection Committee

A Joint Detection Committee will be formed comprising LIGO and VIRGO members with a wide range of expertise, to participate in the detection procedure described in [LIGO-M080010](#) and VIR-096A-08.

When an analysis group and the Data Analysis Council have recommended a claim for a detection of gravitational waves, the case will be handed to the spokespersons who in turn will charge the Detection Committee to review the detection claim. The committee findings will be made public to both collaborations.

The committee will have two Chairpersons (one LIGO member and one Virgo member). The size of the committee will be jointly decided by both collaborations. Each Collaboration will appoint its Chairperson and other representatives according to its internal policies.

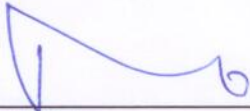
3.8 Additional Committees

Additional temporary ad hoc committees may be set up jointly by the leadership of both collaborations to investigate issues of common importance. In general, these committees will have one co-chair from each Collaboration.

4 Term of this agreement

This Attachment covers collaborative work beginning on April 1, 2014 (or after signed if later) and lasting for three years from that date. It may be extended by mutual agreement between LIGO and VIRGO.

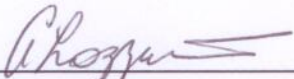
Approved:



David Reitze
LIGO Executive Director and LIGO Principal Investigator

20 MARCH 2014

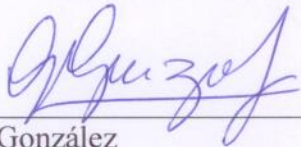
Date



Albert Lazzarini
LIGO Laboratory Deputy Director

20 March 2014

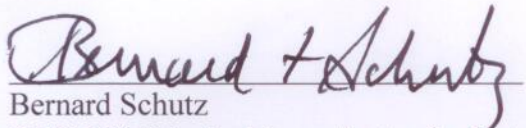
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Gabriela González
LSC Spokesperson

3/20/14

Date



Bernard Schutz
GEO 600 Principal Investigator for Data Analysis

20 March 2014

Date

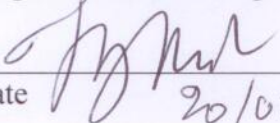


Federico Ferrini
Director of EGO

20 March 2014

Date

Jean-Yves Vinet
Virgo Collaboration Spokesperson



Date 20/03/2014