

Attachment A
to the
Memorandum of Agreement
Between
VIRGO,
KAGRA,
and the Laser Interferometer Gravitational Wave Observatory (LIGO)

October 2019

1 Scope of this attachment

This attachment details the organization of LIGO Scientific Collaboration (LSC), Virgo Collaboration, and KAGRA Collaboration gravitational wave analysis (astrophysics, cosmology, fundamental physics and development of the data analysis techniques needed), rules for dissemination and publication of analysis results, and coordination of participating scientists in the pursuit of supporting instrumentation and analysis research.

Section 2 governs the derivation and dissemination of gravitational wave observational results. We define an **Observational Result** as *any first statement of an astrophysical, cosmological, or fundamental physics nature derived from LIGO, GEO, VIRGO, or KAGRA 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.

Section 4 discusses joint work on instrument science.

We refer to the joint bodies of the LIGO Scientific Collaboration (LSC), the Virgo Collaboration, and KAGRA Collaboration as 'LVKC' in this document for brevity. The three Collaborations maintain their independent existence and may have differing (but not mutually incompatible) rules and procedures in some domains.

2 Gravitational Wave Analysis and Dissemination of Observational Results

2.1 Organization of observational analysis activities

- 2.1.1 Gravitational Wave Analysis activities will be organized into Analysis Groups, each comprising of members of the LSC, the Virgo Collaboration, and the KAGRA Collaboration. Any LVKC project concerned with gravitational wave analysis (astrophysics, cosmology, fundamental physics and the data analysis techniques needed) must be affiliated with at least one of the existing Analysis Groups.
- 2.1.2 Additional Analysis Groups may only come into existence by mutual agreement of all Collaborations.
- 2.1.3 Participation in the Analysis Groups is open to all LSC, Virgo Collaboration, and KAGRA Collaboration members.
- 2.1.4 Detector characterization, instrumentation and software experts will be included as active members of each Analysis Group to ensure appropriate use and interpretation of the data.
- 2.1.5 Analysis Groups carry the principal responsibility for writing scientific papers that report the results of their analyses.
- 2.1.6 Analysis Groups are also responsible for regularly presenting plans for upcoming analysis and publication of observational results to the Collaborations, following the prescription of Section 2.6.
- 2.1.7 It is expected that there will be several scientific topics being addressed under the umbrella of each Analysis Group, and teams focusing on these topics. All such focused teams will regularly report progress to the Analysis Group, in a spirit of transparency and openness; once an effort towards the goals of the Analysis Groups, as described in the White Papers and the LSC, Virgo Collaboration, and KAGRA Collaboration Programs (defined in Section 2.3 of this document), shows promise to lead to a useful result, it must be shared.

2.2 Analysis Group leadership

- 2.2.1 Each Analysis Group will have three Chairpersons: one from the Virgo Collaboration, one from the KAGRA Collaboration, and one from the LSC, each following their own Collaboration's internal procedures. Leaders of the Virgo Collaboration, the KAGRA Collaboration and of the LSC will be kept informed of progress in the selection of Chairpersons for either Collaboration.

- 2.2.2 A Deputy or Co-Chairperson may also be appointed from each Collaboration if necessary.
- 2.2.3 The Chairpersons are responsible for the overall guidance of the work of the Analysis Group, and they are given authority by their Collaboration to guide the activities of group members when necessary to achieve Collaboration goals, and to assist them in complying with Collaboration policies.
- 2.2.4
 - A. The 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.
 - B. The Chairpersons will monitor compliance of analysis efforts with Collaboration policies, and will ensure that analyses targeted at LVKC Observational publications are carried out by heterogeneous teams representing both Collaborations.
 - C. 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 gravitational wave signal interpretation. Normally this will require participation and concurrence of instrumentation and data quality experts familiar with each detector at the epoch when the observations were recorded.

2.3 Analysis research planning

- 2.3.1 Each Analysis Group will contribute to (and annually update) a **Gravitational Wave Analysis White Paper** describing the Collaborations' analysis research program. These White Papers will be input to the Virgo Collaboration Program, to the KAGRA Collaboration Program, and to the LSC Program, which will be formulated by the respective Program Committee to define the scope of efforts of that collaboration, and shall be approved by each Collaboration's governing bodies.
- 2.3.2 Software, computing hardware, data management, detector and data characterization are fundamental to the analysis activities. Thus, these activities must appear in the Gravitational Wave Analysis White Paper or companion documents properly referenced by the White Paper, with description of activities and plans in these areas that are consistent with the analysis needs. Specifically, the computing requirements and the optimization of each proposed analysis shall be assessed.

- 2.3.3 The research planning informs and is informed by the Publication Plan (see below).

2.4 Analysis Reviews

- 2.4.1 Each gravitational wave analysis will be critically reviewed before publication is considered. The review process will ensure:
- A. the accuracy and significance of reported results
 - B. the identification and resolution of errors
 - C. the reproducibility of results
 - D. a proper documentation of analysis methods and intermediate steps
 - E. adequate testing, vetting and documentation of software tools
 - F. appropriate response to comments from Collaboration members
- 2.4.2 Standing **Review Chairpersons** for each Analysis Group will be appointed by each Collaboration, in consultation with leaders of the other Collaboration. The Analysis Groups and the Review Chairpersons 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 (Defined in Section 2.5 below).
- 2.4.3 Review Chairpersons should not hold positions of leadership or other major responsibility in the corresponding Analysis Group.
- 2.4.4 Once an analysis is ready for review and result dissemination, according to procedures established within the Analysis Groups, a **Joint Review Committee (JRC)** will be established by the three Review Chairpersons. The JRC is responsible to review the validity of the analysis and the scientific results, encompassing the scope of a Journal reviewer for scientific content but not style. (The overall review for stylistic quality and clarity of the paper is in the scope of the Joint Editorial Board.) If a conflict of interest exists between the Review Chairpersons and an analysis to be reviewed, the DAC (see Section 2.5.1) co-chairs will appoint the JRC for that analysis, in consultation with the Analysis Group Chairs, and the JRC will report to them.
- 2.4.5 All Collaborations will be represented in the JRC membership; equal numbers are not required, but a critical mass of participating reviewers is required from each Collaboration.
- 2.4.6 JRC members will include people with expertise in instrument science (for each detector which supplied data for the analysis) as well as in gravitational wave analysis.

2.5 Coordination between Analysis Groups

- 2.5.1 Chairpersons of all Analysis Groups, Review Chairpersons, Chairpersons of the LIGO-Virgo-KAGRA Collaboration Computing and Software Committee, and Chairs of the Calibration and Detector Characterization Committees comprise the **Data Analysis Council (DAC)**. The Spokespersons are ex-officio members of this Council and represent the Collaborations' governing bodies.
- 2.5.2 Each Collaboration will appoint a **Data Analysis Coordinator** (also referred to as **DAC co-chair**) to jointly chair and oversee the DAC and report on its activities and findings.
- 2.5.3 The DAC 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 DAC will serve as a liaison between the Analysis Groups and the governing bodies alerting them of significant changes to search plans and/or of analysis progress or problems. The DAC has additional responsibilities and scope.
- 2.5.4 The DAC is charged with:
 - A. compiling and maintaining the Gravitational Wave Analysis White Paper (Sec. 2.4) and the LVKC Publication Plan (Sec 2.6),
 - B. discussing and resolving issues of common interest and concern across the search groups, which include harmonious utilization of human resources and computing resources and prioritization of the analysis objectives,
 - C. tracking of the progress towards such objectives and
 - D. maintaining this information in a form that is easily accessible and consumable by the Collaboration members.
- 2.5.5 In the event that disagreements cannot be resolved through consensus, the DAC co-chairs will have final authority in resolving differences, in consultation with the LSC, Virgo Collaboration, and KAGRA Collaboration governing bodies, where needed.

2.6 Publication of Observational Results

We refer in this section to the publication of gravitational wave Observational Results (see Section 1). For brevity we refer to papers which carry all of the qualified authors for Observational Results from the LVKC as 'LVKC Papers'.

- 2.6.1 LIGO, Virgo, and KAGRA Collaborations shall agree on an **LVKC Publication Plan** before the start of each observation run.
- 2.6.2 The Publication Plan lists the collaboration papers that the LVC commits to publishing as LVKC Papers. The Analysis Groups are the point of origin for LVKC papers. The collection of papers around an event or data segment is considered and potentially adjusted by DAC co-chairs and Spokespersons, in discussion with the Analysis Groups and in consultation with the Program Committees, and is adopted by the governing bodies of each Collaboration; if differences remain, the Spokespersons will resolve them. Periodic revisions are made (e.g., 6-month intervals, corresponding to 'chunks' on which analysis is performed and dates set for public release). The Collaborations will discuss the Publication Plan during joint meetings scheduled throughout the year and approve it or propose amendments.
- 2.6.3 The list of LVKC papers may be extended, after the start of the run, in response to an exceptional scientific discovery or finding, designated as such by the Spokespersons.
- 2.6.4 To the extent possible, lists of expected observational papers associated with various classes of possible discoveries will be determined in advance, with the option of ad-hoc adjustments by the DAC co-chairs.
- 2.6.5 Once an analysis activity is ready to be written into an observational paper, the Analysis Group shall propose a **Paper Writing Team** to cover both the technical and editorial basis for the paper. The composition of the team will be reviewed by the Spokespersons and adjusted and augmented as needed, to ensure that the right expertise in gravitational-wave science, data characterization, instruments, and writing are present in the team, and that the team is balanced e.g., in participation of junior and senior scientists.
- 2.6.6 The Publication Plan will be updated to list members of the Paper Writing Team and of the JRC (once appointed), and identify the human and material (e.g., computing) resources needed to bring the paper to fruition, including public bulk data release, data product release, and science summary preparation. The existence of the project, the team, and a means to follow progress will be communicated to the Collaborations.
- 2.6.7 The progress in realizing the Publication Plan will be tracked on a regular basis.
- 2.6.8 The LVKC aims to meet the following time targets for the dissemination of LVKC papers:
 - A. The LVKC aim to disseminate the transient catalogs within order of 6 months of the completion of each (part of a) run. Adjustments

can be made by mutual agreement of the Spokespersons for internal or external considerations.

- B. The LVKC aim to address new discoveries significant enough to warrant a stand-alone publication on a time scale of order 3 months. Adjustments can be made by mutual agreement of the Spokespersons for internal or external considerations. The objective will be to enable publication as fast as possible while maintaining quality and confidence in the results, and a manageable workload for collaboration members. Flexibility for each case is needed.
- C. The LVKC aim to have all observational papers released at the latest by the time the data become public.

- 2.6.9 A detailed timeline of the significant steps for each of the linked papers (including activities such as data cleaning, calibration, computing, paper writing, and internal reviews), consistent with the overall publication planning, shall be established jointly by the Paper Writing Team, the Analysis Group, and DAC. If milestones are significantly missed, a revised approach for the paper shall be established by the DAC Chairs and the causes addressed as needed to put the paper back on track though adjustments of scope, writing team, etc.
- 2.6.10 Each Analysis Group will provide progress updates to DAC once per month indicating progress against the Publication Plan. Any new proposals for publication of new results over the next six to 12 months will also be presented at that time. Each LVKC Paper Writing Team will announce its presentations during paper development to allow LVKC members to participate.
- 2.6.11 The dissemination plan should explain the scientific and programmatic rationale behind the proposed schedule and should be realistic about the resources necessary to carry it out, including associated review work. These plans will be collected in the LVKC Publication Plan.
- 2.6.12 Any dissemination of new results must be reviewed and approved by the appropriate Joint Review Committee.
- 2.6.13 After the Joint Review Committee has approved a result, the result will be presented to the LVKC.
- 2.6.14 Each new result must be approved by all Collaborations before it can be disseminated. Approval by each Collaboration shall be according to its own governing procedures. In case of a conflict about the nature or timing of the dissemination of results, the issue will be adjudicated by the Spokespersons.

- 2.6.15 LVKC papers which are linked (e.g., because of the data they use) shall be released simultaneously, to avoid time-critical competition with external teams that may pursue the same result on open data.
- 2.6.16 To release all relevant papers simultaneously, staggering of reviews, delays in submission of completed papers, and reallocation of efforts may be needed.
- 2.6.17 For all LVKC Observational Papers, appropriate associated data release products (e.g., 1 hour of gravitational strain data $h(t)$, data behind figures, posterior samples) must be defined, vetted, and ready when the paper is made public; and the paper's appearance in a science summary must be planned and prepared to be available when the paper is made public.

2.7 Dissemination of Observational Results

We refer in this section to dissemination outside of the LVKC of gravitational wave Observational Results (see Section 1) and of results from supporting activities. In this context, 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.

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

- 2.7.1 To allow timely preparation and review, all planned talks or other verbal dissemination where a new result is first presented must be announced sufficiently in advance to allow Joint Editorial Board approval, coordination, and review of presentations. Presentation slides will be made available to members of the three Collaborations so that others can provide critical feedback. Implementation of the procedure will be worked out by the **Joint Editorial Board** (defined in Section 3.5 of this document).
- 2.7.2 Talks presenting new results prior to formal publication must be approved by the corresponding Joint Review Committee and also by each Collaboration, according to their own governance.
- 2.7.3 After incorporating appropriate comments, finalized presentation materials must be authorized by the Spokespersons of each Collaboration or their respective designee(s).
- 2.7.4 Talks on behalf of the Collaborations reporting previously approved results must be reviewed and approved by the Virgo Editorial Board, the KAGRA Committee of Publication Control, and/or the LSC Publications and

Presentations Committee, according to the procedures appropriate for LSC, Virgo, or KAGRA membership.

Regarding invited talks:

- 2.7.5 The LVKC will strive to select individuals for presentations to give appropriate credit to less visible, but critical efforts in the three Collaborations. To enable this, invitations received by either a member of the LSC, the Virgo Collaboration, or the KAGRA Collaboration for a talk dealing with LVKC results at a workshop or conference are regarded as invitations to all Collaborations.
- 2.7.6 Such invitations must be forwarded to the Joint Editorial Board, that will decide with the invitee whether to accept the invitation, and if so, which Collaboration member(s) should deliver the talk. While preference will be given to the invitee, effort will be made to give opportunities to others.

Regarding combined author lists:

- 2.7.7 The authorship of Observational Results papers will be written as described in the section 'Review and publication of observational results' of the main MOA.
- 2.7.8 Each author's Collaboration affiliation will be designated appropriately in accord with target publication style requirements.
- 2.7.9 Detector and data characterization as well as some methodological papers may qualify for single Collaboration or short author list publications as described in the following section.

2.8 Single Collaboration or short author list publications

This section addresses the classes of papers and presentations involving LVKC data that are eligible for short authorlist or single-Collaboration authorlists: instrument papers, and description and studies of gravitational wave analysis methods as well as detector and data quality/characterization studies. Short authorlist papers may be authored by a fraction of the LVKC and by any non-LVKC members.

- 2.8.1 The LVKC will strive to reward individuals and teams who have made significant contributions to observational publications, giving appropriate credit to less visible, but critical efforts in the three Collaborations. This will be achieved via the Publication Plan and the Joint Editorial Boards of the Collaborations. Specifically, short authorlist methods papers which enabled LVKC papers are best planned for advance, or simultaneous, release with

the relevant LVKC papers to highlight those critical contributions to new results, and key contributors to LVKC papers should have priority in giving timely talks relevant to their contributions.

- 2.8.2 All data that have been made available to the public, including detector strain data, may be used by members of the LVKC in short-author-list publications as soon as they are public, provided that this does not conflict with and/or pre-empt the LVKC Publication Plan.
- 2.8.3 Data released via low-latency Open Public Alerts (see below) also are considered to be public data, and may be used similarly for short-author-list publications provided that this does not conflict with and/or pre-empt the LVKC Publication Plan.
- 2.8.4 To illustrate aspects of analysis techniques which address imperfections found in real data, and to support detector characterization and data quality studies, publications may be proposed which use some not-yet otherwise public data produced by the interferometers after it is assured that no signals of gravitational wave interest are found in those data.
- 2.8.5 Waivers for the publications on normally proprietary data as described in 2.8.4 will be approved by a unanimous consent of the DAC Co-Chairs and Chairs of the JEB.
- 2.8.6 The Joint Editorial Board will verify that the scope of the papers is correct and that the choice of author lists is appropriate. When possible, they should be included in the Publication Plan. The paper will be circulated and reviewed per publication rules of the LVKC.
- 2.8.7 Irrespective of any waiver, any *Observational Result* (defined above) derived from proprietary data will be considered a joint endeavor of three Collaborations and disseminated as described above in Section 2.6.

2.9 Public data release

- 2.9.1 Both the LSC, the Virgo Collaboration, and the KAGRA Collaboration recognize the interest of making their data public, with the objective to enable reproduction of LVKC results and further exploitation of the data by the greater scientific public. These data comprise of documented and calibrated strain time series, as well as data products associated with analysis results and publications. The Collaborations follow agreements with funding agencies for release of data and data products; for the LSC, the LIGO Data Management Plan (LIGO-M1000066), an agreement between the LIGO Laboratory and the National Science Foundation, is the defining document.

- 2.9.2 The Collaborations will determine a cadence for release of the full strain h(t) data set from a section of an observation run. This cadence will be consistent with agreements with the funding agencies. The objective will be to establish a cadence which permits the data to be rapidly released and the core science, as defined by the Programs of the Collaborations and the LVKC publication plan, to be published, before the release of the full data set.
- 2.9.3 The LVKC will release, simultaneous with publications analyzing these data, strain data around the times of transient events. These data will feature the full bandwidth that is used within the Collaborations.
- 2.9.4 LIGO, Virgo Collaborations, and the KAGRA Collaboration will release Open Public Alerts, with low latency, for all interesting signal triggers, and follow-up information sufficient for non-GW observers to find hosts.
- 2.9.5 The three Collaborations will take all reasonable and feasible measures to ensure that users of any data made public by LSC, by the Virgo Collaboration, or by the KAGRA Collaboration will properly credit LSC, the Virgo Collaboration, the KAGRA Collaboration and their respective funding agencies.

2.10 Announcement of discoveries

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

- 2.10.1 Upon approval by the members of the Collaborations, final authorization of the public announcement must be given by the LIGO Directorate, the GEO Lead Scientist, the EGO Director, the Virgo Collaboration Spokesperson, and the KAGRA Collaboration Spokesperson.
- 2.10.2 Any press releases announcing a discovery will be issued simultaneously by the LIGO Scientific Collaboration, VIRGO, and KAGRA. Each Collaboration release will make mention of other Collaboration releases, and official posting at each Collaboration web page will carry a pointer to the other Collaboration release.
- 2.10.3 Major discoveries will be announced jointly by VIRGO, KAGRA and LIGO in press conferences.
- 2.10.4 Any other press releases pertaining to gravitational wave searches or to any other collaborative work will be shared in advance with the LVKC leadership, with coordination as needed.

3 Joint collaboration in supporting activities

Publishable observational results are the endpoint of a broad supporting effort, comprising of 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 enterprise is directly dependent on coordination of their work on these foundations.

Joint Collaboration Committees and Working Groups as described below 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

- 3.1.1 The **Joint Run Planning Committee (JRPC)** consists of the Virgo Collaboration, the KAGRA Collaboration and LSC DAC co-chairs; Cascina, Kamioka, Hannover, Hanford and Livingston observatory site representatives; VIRGO, KAGRA, GEO and LIGO detector commissioning leaders; co-chairs of the LSC-Virgo-KAGRA Collaboration Computing and Software Committee or their delegates; and other relevant experts from VIRGO, KAGRA and LIGO.
- 3.1.2 The committee will have three Chairpersons, one an LSC member, one a Virgo Collaboration member, and one a KAGRA Collaboration member.
- 3.1.3 Each Collaboration will appoint its JRPC Chairperson, co-chairs, and other representatives according to its internal policies.
- 3.1.4 The Joint Run Planning Committee is charged with:
 - Coordination of 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
 - Proactive and timely communication of detector status and plans for consideration by the full Collaborations.

3.2 Detector Characterization and Data Quality Committee

- 3.2.1 Each Collaboration will appoint a Chair (and co-chair if desired) for Detector Characterization and Data Quality work.
- 3.2.2 Virgo Collaboration, KAGRA Collaboration and LSC Chairs will meet regularly to make sure that the exchange of information between the

three Collaborations is appropriate. Mutual attendance of LSC members, Virgo members and KAGRA members at another Collaboration's meetings will be facilitated.

- 3.2.3 The Chairs will organize working meetings with scientists of both Collaborations as often as needed to assess and improve data quality in the detectors. Joint teams will evaluate whether data taken jointly for observational purposes are supported by consistent and adequate standards for defining and reviewing data quality.
- 3.2.4 The Chairs will regularly report to the Data Analysis Council and the Joint Run Planning Committee.

3.3 Calibration Committee

- 3.3.1 Each Collaboration will appoint a Chair (and a co-chair if desired) for Detector Calibration.
- 3.3.2 Chairs will meet regularly to make sure that the exchange of information between the three Collaborations is appropriate. Mutual attendance of LSC members, Virgo members and KAGRA members at another Collaboration's meetings will be facilitated.
- 3.3.3 The chairs will organize working meetings with scientists of the three Collaborations as often as needed to assess and improve calibration of the detectors. Joint teams will evaluate whether data taken jointly for observational purposes are supported by consistent and adequate standards for defining and reviewing data quality.
- 3.3.4 The chairs will regularly report to the Data Analysis Council and the Joint Run Planning Committee.

3.4 Joint Computing and Software Committee

- 3.4.1 An LSC-Virgo-KAGRA Collaboration Computing and Software Committee is established, consisting of the chairs of the Virgo Collaboration and LSC Computing groups, and coordinating with key users and developers of computing and analysis software, instrument control computing and software, and detector characterization computing and software efforts of the Virgo Collaboration, the KAGRA Collaboration and the LSC.
- 3.4.2 The mission of the Joint Computing and Software Committee is to ensure proper communication and technical coordination between the LSC, Virgo Collaboration, and KAGRA 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 three Collaborations.

- 3.4.3 The LSC-Virgo-KAGRA Collaboration Computing and Software Committee will have three Chairpersons, one an LSC member, one a Virgo Collaboration member, and one a KAGRA Collaboration member. Each Collaboration may add a co-chair or deputy as needed.
- 3.4.4 Each Collaboration will appoint its Chairperson and other representatives according to its internal policies.
- 3.4.5 Analysis software will be developed according to each Collaboration's internal rules and managed by the Joint Computing and Software Working Group. Software developed in the Collaborations is to be stored during development and after deployment in repositories open to the Collaborations.
- 3.4.6 All software developed by members of either Collaboration for joint activities will use LVKC-accessible code repositories. The code shall remain continuously accessible for use by all members of three Collaborations through development and implementation. All software shall remain available to the Collaborations to use and modify after departure of groups that were involved in code development.
- 3.4.7 A comparable (per author) amount of computing resources must be made available by each Collaboration to joint gravitational wave analysis. This includes not only the number of computing cycles required for analysis, but also the effort in computing support, pipeline adaptation to accommodate the use of various resources, identity and access management, security, and uniform utilization accounting of computing resources of the Collaborations.
- 3.4.8 The Joint Computing and Software Committee will develop a strategy for the evolution of computing needs and solutions, seeking to optimize the LVKC's ability to exploit resources worldwide on short and long timescales.
- 3.4.9 The responsibility for hosting infrastructure and services (e.g., the Gravitational Wave Open Science Center GWOSC) will be distributed between the collaborations (and names adopted designating their bilateral role).

3.5 Joint Editorial Board

- 3.5.1 A Joint Editorial Board will be formed to establish and maintain quality of exposition, consistent authorship, and approval policies and procedures for dissemination of results by members of the three Collaborations.

- 3.5.2 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 the three Collaborations prior to its public release. This includes collaboration-authored papers as well as short author list papers which meet the above criteria.
- 3.5.3 The Board will determine if the appropriate authorship type – short author list or full author list – is proposed for all presentations and publications which fall under the rules of this Attachment. This will determine the path for the subsequent review process,
- 3.5.4 The Joint Editorial Board will assign reviewers to assess and improve the quality and clarity of writing, and to flag any science issues the JEB reviewer identifies. (The Joint *Review* Committee is responsible to review the validity of the analysis and the scientific results, encompassing the scope of a Journal reviewer for scientific content.) The JEB may appoint standing reviewers to establish uniform style and quality of LVKC papers.
- 3.5.5 The Board will have three Chairpersons, one an LSC member, one a Virgo Collaboration member, and one a KAGRA Collaboration member. Additional co-chairs or deputies may be named.
- 3.5.6 Each Collaboration will appoint its Chairperson and other representatives according to its internal policies.
- 3.5.7 Means to synchronize the databases used for storing publication documents for the LSC, the Virgo Collaboration, and the KAGRA Collaboration ensures that processes and distribution in the Collaborations are timely and reliable. This synchronization should be implemented regardless of the instantiation of the Joint Editorial Board.
- 3.5.8 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, taking into account the varying scale and importance of conferences. The recommendations will represent a diverse, adequate and fair distribution of speakers for the three Collaborations and a means to give exposure to contributors to the core Collaborations activities. Meetings of more restricted geographical reach will be addressed by the appropriate local JEB members.
 - 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 Meeting Committee

- 3.6.1 The LVKC 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.
- 3.6.2 A Joint Meeting Committee identifies venues for future meetings and performs coordinated planning of the joint Collaboration meetings.
- 3.6.3 The Committee will have three chairpersons, one from the LSC, one from the Virgo Collaboration, and one from the KAGRA Collaboration. Each Collaboration will appoint its Chairperson and other representatives according to its internal policies.
- 3.6.4 The Committee will maintain a checklist of requirements and responsibilities for committees and working groups in the Collaborations to ensure an orderly and distributed effort.
- 3.6.5 The Committee will ensure that formats, schedules, and plans to enforce adherence to the LVKC Code of Conduct.

3.7 Joint Detection Committee

- 3.7.1 A Joint Detection Committee will be formed comprising of LIGO, VIRGO, and KAGRA members with a wide range of expertise.
- 3.7.2 The Detection Committee will be tasked with the verification of exceptional 'first' detections, whether due to a change in the network (e.g., adding a detector) or when a new type of gravitational wave source is observed. When an Analysis Group and the Data Analysis Council believe such an event has been observed, 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 the three collaborations.
- 3.7.3 The committee will have three chairpersons, one from the LSC, one from the Virgo Collaboration, and one from the KAGRA Collaboration. The size of the committee will be jointly decided by the Spokespersons, in consultation with the respective Collaborations. Each Collaboration will appoint its Chairperson and other representatives according to its internal policies.

3.8 Additional Committees

- 3.8.1 Additional ad hoc committees may be set up jointly by the leadership of the three collaborations to deal with arising issues of common concern not within the purview of existing committees. In general, these committees will have one co-chair from each Collaboration.

4 Instrument papers

- 4.1 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, and R&D papers on upgrades and future interferometers must abide by the following:
 - 4.1.1 Prior contributions in the domain by LVKC teams must be recognized in the text and via citations, as appropriate.
 - 4.1.2 Scientific or technical knowledge from experimental programs in the LVKC that is the unique product of LVKC members must be recognized. This can be accomplished, e.g. by inviting LVKC members originating the knowledge to join the author list.
 - 4.1.3 The Publication Plan should specify any collaboration items that are foreseen to result in joint publications. In this manner joint short author list papers on instrumentation and R&D can be planned in advance.
 - 4.1.4 Instrumental teams must propose to the LVKC if they believe that there are (limited) domains of their work that remain outside of the LVKC scope. This situation could arise when there are potential conflicts around commercial concerns. In these cases no unpublished collaboration results may be used in that private research. These proposed exclusive research areas are subject to the approval of the Joint Working Groups, with conflicts resolved by the Spokespersons of the Collaborations.
 - 4.1.5 All instrument papers authored by LSC, KAGRA Collaboration and/or Virgo Collaboration authors need to be circulated to the full LVKC.

5 Term of this agreement

This Attachment remains valid while the general LVKC MoA is valid. It can be updated independent of the MoA if needed, but must be reviewed and re-approved when the general LVKC MoA is renewed.

Approved:

David Reitze 4 Oct 2019
Date
LIGO Executive Director and LIGO Principal Investigator

Albert Lazzarini 27 September 2019
Date
LIGO Laboratory Deputy Director

Patrick Brady 27 September 2019
Date
LSC Spokesperson

James Hough 27 September 2019
Date
GEO Representative

Stavros Katsanevas 30-Sep-2019
Date
Director of EGO

Jo van den Brand Oct. 4, 2019
Date
Virgo Collaboration Spokesperson

Takaaki Kajita Oct. 4, 2019
Date
KAGRA Principal Investigator

H. Shinkai Oct 4, 2019
Date
KSC Board Chair