

# The LSC White Paper on Communications, Education and Public Outreach

Goals, Status and Plans, Priorities (2020-2021)

Communications and Education Division of the LSC<sup>1</sup>

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# 1 Executive Summary and List of Priorities

This document presents an Executive Summary of the priorities and objectives for 2020-21 of the Communications and Education Division of the LIGO Scientific Collaboration; they are also set out in Section 2.10 of the [LSC 2020-21 Program](#). Broader context for these priorities is provided in the subsequent chapters. LSC Groups are encouraged to consult this Executive Summary, and the associated table of activities and tasks<sup>1</sup>, when formulating their 2020-21 MoU plans. Groups are also welcome to contact the C&E Division Chair or relevant member(s) of the EPO Committee to discuss their plans. (See 1.4 for names and contact details.)

## 1.1 Communications and Education Division: Mission and Goals

A core mission of the LSC is to harness the excitement and enthusiasm generated by gravitational wave research to inspire and educate students and the general public in astronomy and fundamental science; the LSC believes that the opportunity to discover the beauty of the cosmos should not be limited by age, culture or abode.

The LSC EPO working group was established in 2008 and aims to lead the LSC efforts to carry out this mission. In 2020, following a comprehensive review of LSC structures and organisation, the EPO working group was re-designated and re-organised as the Communications and Education (C&E) Division of the LSC.

By combining and synthesising a range of ideas and approaches across participating institutions, and promoting collaboration and sharing of best practise, the LSC C&E Division seeks to communicate LSC science and to create education and outreach programs which are far more effective than they would be if LSC member institutions worked independently.

The C&E Division's program of activities and priorities is shaped by the following general goals:

- To communicate LSC results in an accessible way to the world - to other physicists, students, and the general public.
- To develop educational resources that will inspire and train the next generation of scientists and build overall scientific literacy.
- To advocate for future development and growth in our field, in partnership with LSC/Lab leadership and the broader GW and EM astronomy communities.

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<sup>1</sup>available on google sheets [here](#). Note, ligo.org login credentials required.

## **1.2 EPO Priorities for 2020-21**

### **1.2.1 Priorities for the LIGO Laboratory**

The current priority areas for LIGO Laboratory Outreach are as follows:

1. We will expand the LIGO Livingston Observatory (LLO) Science Education Center (SEC) capability for evaluating the impact it has on students participating in field trips, continuing to serve the local teacher community through summer workshops and collaborative teacher exchanges. The 2020 summer teacher workshops will be held virtually.
2. We will continue work to develop the LIGO Exploration Center (LExC) at the LIGO Hanford Observatory (LHO), for which \$7.7M was approved by Washington State for design and construction planned for 2021.
3. We will continue to organize a yearly International Physics and Astronomy Educator Program at LHO. This Program will be held remotely in 2020.
4. We will continue to work with collaborators from across astronomy to produce a multi-messenger astronomy masterclass.
5. We will change our virtual offerings, primarily targeting local schools with virtual tours and classroom oriented experiences in order to help deal with the current pandemic.

### **1.2.2 Priorities in Formal and Higher Education**

The current priority areas for Formal and Higher Education are as follows:

1. We will develop new classroom units for high schools aligned with Next Generation Science Standards (NGSS) and other appropriate international school standards, including updates and revisions of existing classroom activities.
2. We will develop high-school teacher training materials that can be tested and evaluated prior to use.
3. We will conduct professional development with high school teachers at local, regional, national, and international venues.
4. We will develop new classroom and laboratory activities on LIGO-related data analysis, astrophysics, and experimental topics, suitable for use in high school and undergraduate introductory astronomy and physics classes.
5. We will help to promote the Gravitational-Wave Open Science Center, in order to encourage and facilitate the use of the public strain data and other analysis data products that are curated there by the public, in educational settings, and by professional scientists.

### 1.2.3 Priorities in Informal Education and Public Outreach

The current priority areas for Informal Education and Public Outreach are as follows:

1. We will maintain, update and renovate the [ligo.org](http://ligo.org) website for informal users.
2. We will continue worldwide outreach and communication through social media (Twitter, Facebook, Instagram, Reddit) and other informal educational materials that showcase our observational and instrument science and the importance of multi-messenger astronomy.
3. We will provide educational materials and social media support for exceptional event announcements.
4. We will continue answering [question@ligo.org](mailto:question@ligo.org) queries, developing efficient approaches to curate and organize them.
5. Together with Virgo and KAGRA, we will develop printed material and multilingual resources including science summaries for collaboration papers.
6. We will promote development of innovative approaches that communicate LIGO science, such as audio, video, virtual reality, web and phone apps, video games and planetarium shows.
7. We will develop and maintain tools to share, in low latency, public alerts of detection candidates and resources to explain the content of these alerts.
8. We will explore innovative approaches to generating and disseminating this content that will be scalable to the candidate event rates expected for O4.
9. We will support the Humans of LIGO blog, Gravity Spy and other relevant citizen science initiatives.
10. We will support our LSC members communicating our science through public talks, writing popular articles, and communications on social media such as Twitter, Reddit or blogs.
11. We will develop and curate a bank of approved graphics and multimedia on all aspects of gravitational wave science, suitable for LSC, Virgo, and KAGRA colleagues to use in public lectures.
12. We will support LSC presence at major science festivals, exhibitions, and other high-profile public events that attract large audiences both online and face-to-face.
13. We will develop flexible and easily portable resources that can be used at exhibitions as well as other informal education and outreach events.

### 1.2.4 Priorities for Professional Outreach

The current priority areas for Professional Outreach are as follows:

1. We will maintain, update and renovate the [ligo.org](http://ligo.org) website for professional scientists.
2. We will support the provision of information and materials for professional astronomers, including public alerts during observing time, organization and promotion of LVK webinars, and communication with the astronomy community as described in the Operations Analysis white paper.
3. We will promote outreach to scientists and policy makers at professional conferences and meetings, both online and face-to-face, working in collaboration with other gravitational wave communities where appropriate.
4. We will develop flexible and easily portable resources that can be used at professional conferences and exhibitions as well as other informal education and outreach events.
5. We will aim to enable our collaboration members to present the science of our latest results at conferences in talks and panel discussions, through online presentations, and at seminars and colloquiums at individual institutions.
6. We will help to promote the Gravitational-Wave Open Science Center, in order to encourage and facilitate the use of the public strain data and other analysis data products that are curated there by the public, in educational settings, and by professional scientists.

### 1.2.5 Priorities for Public Relations and Communications

The current priority areas for Public Relations and Communications are as follows:

1. We will continue to support communication with media contacts and to provide media guidance and training for collaboration members.
2. We will coordinate regular communication liaison for LVK public announcement of scientific results, particularly (but not only) O3 exceptional event papers and webinars.
3. We will develop a framework (appropriate both for O3b and for the event rates anticipated in O4) for deciding when LSC papers are worthy of public announcement, as e.g. exceptional events and/or webinars, and for effective and efficient management of these public announcements.
4. We will maintain and produce public materials such as the LIGO Magazine.

### 1.3 EPO Committee: Present and Future

The EPO Committee is defined in the Bylaws of the LSC as:

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7.13 Education and Public Outreach Committee

7.13.1 The Education and Public Outreach (EPO) Committee is responsible for overseeing and documenting the Collaboration’s activities in education and public outreach. The EPO committee is also responsible for formulating the Collaboration’s strategic plans to harness the excitement and enthusiasm generated by gravitational wave research in order to inspire and educate students and the general public in astronomy and fundamental science, and thus to help improve science literacy and education among the citizenry.

7.13.2 The EPO Committee consists of a chair appointed by the LSC Spokesperson, and at least four additional members from the LSC (including members from LIGO Observatories) with a spread of interests and expertise in formal and informal education, media relations, and in public and professional outreach.

7.13.3 The chair of the EPO Committee is appointed by the LSC Spokesperson for a term of two years. Other members of the EPO committee are appointed by the EPO Chair for the term of the Chair’s tenure, in consultation with the LSC Spokesperson.

7.13.4 The EPO Committee is also responsible for preparing and maintaining a White Paper relevant to the Collaboration’s plans and activities for education and public outreach, with an up-to-date version to be available before the beginning of the annual LSC MOU review cycle.”

As of July 2020, the EPO Committee comprises:

- Martin Hendry (EPO Chair: [martin.hendry@ligo.org](mailto:martin.hendry@ligo.org))
- Amber Stuver (Informal Education & Public Outreach Lead: [amber.stuver@ligo.org](mailto:amber.stuver@ligo.org))
- Amber Strunk (Formal & Higher Education Lead, and EPO Lead for LIGO Hanford: [amber.strunk@ligo-wa.caltech.edu](mailto:amber.strunk@ligo-wa.caltech.edu))
- William Katzman (EPO Lead for LIGO Livingston: [wkatzman@ligo-la.caltech.edu](mailto:wkatzman@ligo-la.caltech.edu))
- Marc Favata (WebComm Chair: [marc.favata@ligo.org](mailto:marc.favata@ligo.org))

Following re-organisation of the EPO working group and its re-designation as the Communications and Education Division, during 2020-21 the EPO Committee will similarly be re-designated and re-organised to include representation from the Chairs (to be appointed) of the C&E Division Committees. These Committees are:

- Formal Education Committee
- Informal Education and Public Outreach Committee
- Professional Outreach Committee
- LSC Web Committee
- Media Relations Committee
- LIGO Magazine Committee

# Contents

|          |   |          |
|----------|---|----------|
| <b>1</b> | <b>Executive Summary and List of Priorities</b>                             | <b>i</b> |
| 1.1      | Communications and Education Division: Mission and Goals . . . . .          | i        |
| 1.2      | EPO Priorities for 2020-21 . . . . .  | ii       |
| 1.2.1    | Priorities for the LIGO Laboratory . . . . .                                | ii       |
| 1.2.2    | Priorities in Formal and Higher Education . . . . .                         | ii       |
| 1.2.3    | Priorities in Informal Education and Public Outreach . . . . .              | iii      |
| 1.2.4    | Priorities for Professional Outreach . . . . .                              | iv       |
| 1.2.5    | Priorities for Public Relations and Communications . . . . .                | iv       |
| 1.3      | EPO Committee: Present and Future . . . . .                                 | v        |
| <b>2</b> | <b>Introduction</b>   | <b>1</b> |
| 2.1      | Our EPO Philosophy . . . . .  | 1        |
| 2.2      | EPO Aims and Objectives . . . . .   | 2        |
| 2.2.1    | EPO Aims . . . . .  | 2        |
| 2.2.2    | EPO Objectives . . . . .  | 2        |
| 2.3      | Scope of our EPO Activities and Programs . . . . .                          | 3        |
| <b>3</b> | <b>Education and Public Outreach of the LIGO Laboratory</b>                 | <b>5</b> |
| 3.1      | Overview . . . . .  | 5        |
| 3.2      | LIGO Livingston Observatory and the LIGO Science Education Center . . . . . | 6        |
| 3.2.1    | Past and Current Activities . . . . .                                       | 6        |
| 3.2.2    | Needs and Future Plans . . . . .  | 6        |
| 3.3      | LIGO Hanford Observatory . . . . .  | 7        |
| 3.3.1    | Past and Current Activities . . . . .                                       | 7        |
| 3.3.2    | Needs and Future Plans . . . . .  | 7        |
| <b>4</b> | <b>Formal Education</b>   | <b>9</b> |
| 4.1      | Formal Education Unit Inspired by LIGO . . . . .                            | 9        |
| 4.2      | Teacher Professional Development Related to LIGO . . . . .                  | 10       |
| 4.2.1    | On-line Teacher Professional Development . . . . .                          | 12       |
| 4.3      | Partnerships with Existing Classroom Networks . . . . .                     | 12       |
| 4.4      | Gravitational Wave ‘Master Class’ for High School Students . . . . .        | 13       |
| 4.5      | The Einstein First project . . . . .  | 14       |
| 4.6      | Dissemination of Formal Education Products . . . . .                        | 14       |
| 4.7      | Formal and Higher Education Priorities . . . . .                            | 14       |

|          |  |           |
|----------|--|-----------|
| <b>5</b> | <b>Higher Education</b>  | <b>16</b> |
| 5.1      | In Person Faculty Professional Development Related to LIGO . . . . . | 16        |
| 5.2      | On-line Teacher Professional Development . . . . .                   | 16        |
| 5.3      | Resources for College Faculty . . . . .                              | 17        |
| 5.4      | Resources for College Students . . . . .                             | 18        |
| 5.5      | Talks and Lectures . . . . .   | 19        |
| 5.6      | Summer Research Programs . . . . .                                   | 19        |
| 5.7      | Formal and Higher Education Priorities . . . . .                     | 19        |
| <b>6</b> | <b>Informal Education and Public Outreach</b>                        | <b>21</b> |
| 6.1      | Visual Media . . . . .   | 21        |
| 6.2      | Web Media . . . . .  | 22        |
| 6.3      | Audio Media . . . . .  | 22        |
| 6.4      | Multimedia . . . . .   | 23        |
| 6.5      | Social Media . . . . .   | 23        |
| 6.6      | Apps and Software Tools, Computer and Board Games . . . . .          | 25        |
| 6.7      | Citizen Science . . . . .  | 26        |
| 6.8      | Exhibits . . . . .   | 26        |
| 6.9      | Printed Materials . . . . .  | 27        |
| 6.10     | Connections to Art, Theater, and Dance . . . . .                     | 28        |
| 6.11     | Multilingual Outreach . . . . .                                      | 29        |
| 6.12     | Outreach to Children . . . . .                                       | 29        |
| 6.13     | Public lectures . . . . .  | 30        |
| 6.14     | Priorities for Informal Education and Public Outreach . . . . .      | 30        |
| <b>7</b> | <b>Professional Outreach, Public Relations and Communications</b>    | <b>32</b> |
| 7.1      | Priorities for Professional Outreach . . . . .                       | 33        |
| 7.2      | Priorities for Public Relations and Communications . . . . .         | 33        |



# 2 Introduction

## 2.1 Our EPO Philosophy

This White Paper outlines the 2020-21 priorities for the (erstwhile) Education and Public Outreach (EPO) committee<sup>1</sup> of the LIGO Scientific Collaboration (LSC). It also provides a description and summary of current efforts and elaborates on the goals, philosophy, and plans of our international network of scientists. It is not meant to be a comprehensive list or to contain the history of all LSC EPO efforts. This is a living document that is updated regularly and is improved continuously.

More than half of the research groups in the LSC are actively involved in projects related to Education and Public Outreach (EPO). The main goal of the broader EPO team is to build on the excitement of LIGO's discoveries to engage the wider public beyond GW scientists, motivating students and increasing the scientific literacy of the general public.

The goal of the LSC is the detection of gravitational waves from cataclysmic astrophysical sources. The first direct measurements of gravitational waves has opened up a revolutionary new window on the Universe, which will probe some of the most violent and energetic phenomena in the cosmos - from black holes and supernovae to the Big Bang itself.

LSC outreach initiatives seek to inform the public not only about the exciting new science of gravitational waves and the activities of LIGO and other partner detectors, but also about science in general. LIGO outreach introduces non-scientists to multi-messenger astronomy, high-energy physics, cosmology, laser technology, materials science, computing facilities and data acquisition. The cornerstones of this program are the following principles:

- The scientific endeavor of the LSC is motivated by the same desire for exploration, curiosity about the unknown and awe of nature that have inspired and motivated humankind throughout millennia of history.
- A new view of the distant Universe is revealed by non-electromagnetic means through the detection of gravitational waves. Mapping the gravitational-wave sky provides an understanding of the Universe in a way that electromagnetic observations cannot.
- Giant, new non-conventional 'telescopes' are needed to detect the gravitational-wave spectrum. The cutting-edge technology of these telescopes, called interferometers, is pushing back the frontiers of many scientific fields. A remarkable combination of technological innovations in

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vacuum technology, precision lasers, measuring techniques, and advanced optical and mechanical systems is required to observe gravitational waves.

## **2.2 EPO Aims and Objectives**

As a frontier physics effort, a core mission of the LSC is to harness the excitement and enthusiasm generated by gravitational wave research to inspire and educate students and the general public in astronomy and fundamental science, thus raising standards of science literacy and education. LSC researchers and students believe that the opportunity to discover the beauty of the cosmos should not be limited by age, culture or abode.

The LSC EPO working group aims to communicate the vision and benefits of gravitational wave detection to the public at large throughout the world. By combining different ideas and approaches across participating institutions, the LSC EPO network is able to create outreach programs which are far more effective than they would be if LSC member institutions worked independently.

### **2.2.1 EPO Aims**

The broad outreach aims of the LSC include:

- Communicating the scientific activities and discoveries of the collaboration through national and international news media, as the field of gravitational-wave astronomy becomes firmly established in the mainstream of astronomical research;
- Improving science literacy in the general population;
- Increasing participation in science, especially among under-represented and underserved groups;
- Helping to reduce existing disparities in the access to educational resources;
- Advocating the intellectual and social / socio-economic benefits of careers in science;
- Recruiting future generations of scientists and engineers, to our own collaboration and to the wider scientific community;
- Improving understanding by the citizenry of frontier science and large scientific projects.

### **2.2.2 EPO Objectives**

The EPO Group seeks to achieve these aims by focussing our efforts on the following objectives:

- To build upon the tremendous global coverage and excitement associated with the discovery announcements to date (building upon the extraordinary level of public interest in the GW150914 announcement) and the dawn of gravitational-wave astronomy
- To arouse interest, attention, and motivation for outreach activities across the collaboration;
- To ensure that collaboration skills are optimally used to enhance the collaboration's public visibility;

- To coordinate the EPO activities of the LSC and wherever possible to align them closely with those of our Virgo and Kgara colleagues;
- To streamline and optimize the development and use of EPO resources;
- To create, facilitate, and nourish synergies among teams within and outside of the LSC;
- To interface EPO needs, goals, and objectives to the practical realities (e.g., prioritization, resource management, external hooks, etc.).

## 2.3 Scope of our EPO Activities and Programs

LSC outreach programs use different ways to communicate these concepts to the public in formal and informal settings:

- Organisation of press and media events to announce gravitational-wave discoveries;
- Events at the observatory outreach centers, on-site and online tours and visits; Public events and lectures, projects in local communities;
- Development of printed materials, hand-outs;
- Development of internet-based activities, games, multimedia;
- Use of social media;
- Formal education projects, classroom lessons, curriculum development;
- After-school programs, classroom visits;
- Professional development of teachers, graduate students and post-docs;
- Interdisciplinary activities, science and art events;
- Diversity programs;
- Participation at conferences, science fairs, and exhibits.

Our EPO programs offer great potential for public education and outreach at all levels and external funding is continuously sought to realize them. Target audiences for these activities are school-age children and their families, college students, young adults, teachers and science professionals, and more generally informal learners, who may have some general awareness of astronomy and its long and rich cultural heritage. Increasing the awareness of current scientific research in the youngest segments of the citizenry is particularly important to achieve the four goals of the ‘[Rising Above the Gathering Storm](#)’ report:

- Increase the talent pool in all the participating nations by improving science education;
- Strengthen the participating nations’ commitment to fundamental research;
- Educate, recruit, and retain top students and scientists;

- Ensure the leading role of the participating nations in innovation and scientific research.

LSC outreach efforts should continuously explore new opportunities to promote science among adolescents and young people. LSC outreach programs also contribute to human resource development in science by providing opportunities for the mentoring of post-docs, graduate and undergraduate students in the field of gravitational physics and science in general. An important component of LSC outreach programs is training students to become the next generation of science educators. Through participation in outreach projects, junior researchers and students have the opportunity to engage with the public and improve their teaching and communication skills.

## 3 Education and Public Outreach of the LIGO Laboratory

LIGO Laboratory began implementing public outreach programs at Livingston and Hanford after the completion of construction in 1998. The sites provided tours of the facilities and summer teacher internships from the outset as the Observatory Heads built relationships with nearby institutions and outreach interests. After years of steady growth in the breadth of outreach activities and in the strength of regional partnerships, LIGO's site-based programs reached over 30,000 people in 2015. Each observatory aims to thoughtfully serve the large underrepresented populations that reside in the nearby counties/parishes.

LIGO Livingston's Science Education Center (SEC) now represents a premier science education destination in the Louisiana region, offering dozens of compelling hands-on physics exhibits and hosting a growing variety of innovative science programs for students, teachers and the general public. LIGO Hanford's, soon to be constructed, LIGO Exploration Center (LExC) is poised to follow suit in Washington State region.

### 3.1 Overview

Staff (5.25 FTE) are responsible for operating the outreach programs at the observatories. Numerous members of the site technical staffs and LSC technical visitors also participate in site-based outreach activities. The Hanford and Livingston outreach teams coordinate the outreach involvement of these individuals. Normally, the vast majority of Hanford and Livingston outreach contacts are face-to-face – although the COVID-19 pandemic has drastically changed this pattern in spring summer 2020. Additional site-based interactions occur with visitors who connect to the observatories via Zoom and similar virtual platforms.

The LSC EPO Working Group provides a mechanism for Lab personnel to participate in national and international gravitational wave outreach projects. The Lab outreach team brings resources from the observatories to bear on these projects as needed. Technical and outreach staff in the Lab collaborate with members of the LSC EPO group in promoting LIGO to the public and to diverse student groups through participation in conferences and exhibitions. Activity also flows into the Lab through the LSC EPO group as personnel at LSC locations are able to connect their local constituents with education resources that are available through the observatories.

## 3.2 LIGO Livingston Observatory and the LIGO Science Education Center

### 3.2.1 Past and Current Activities

In 2004, a successful proposal to the NSF authored by a partnership of LIGO, Southern University at Baton Rouge (SUBR), the Exploratorium, and the Louisiana Systemic Initiative Program and Louisiana GEAR UP resulted in the construction of the 10,000 sq. ft. Science Education Center (SEC) at the Livingston site. The SEC currently houses over 50 Exploratorium-style exhibits that focus on the science themes of LIGO. Auditorium and classroom space near the exhibit hall amplify the educational value of the facility, allowing the staff to delve into topics in more depth. Three LLO outreach staff members operate the SEC with assistance from undergraduate SUBR docents and LLO staff. The Exploratorium continues to partner with the SEC on exhibit training and teacher professional development.

The SEC has become a key destination for school field trips and K-12 teacher professional development activities in central Louisiana and beyond. This year the SEC served 2787 on-site K-12 visitors and trained 200 K-12 teachers and pre-service teachers through teacher workshops. Since its inception, the SEC has seen an increase in LLO's on-site outreach attendance from 1100 on-site visitors in 2004 to around 12,000 on-site visitors in 2015. In this past year, in spite of the pandemic, LIGO-SEC was able to reach out to approximately 7843 individuals.

### 3.2.2 Needs and Future Plans

The Science Education Center (SEC) at the LIGO Livingston Observatory has transitioned to a regional collaboration headed by the Baton Rouge Area Foundation (BRAAF). BRAAF provides an institutional umbrella under which the collaboration can continue to grow and mature.

Future plans include growth in the scope and depth of the SEC's programming with an eye towards innovation as the SEC staff continues to expand the reach of the facility, reaches out to the general public more effectively and leverages the facility's potential as a unique tool for enhancing the public's science literacy and the level of interest in LIGO's pioneering research.

One aspect of this mission includes the LIGO/SUBR (Southern University of Baton Rouge) docent program. This program involves SUBR STEEM (Science, Technology, Engineering, Education, Mathematics) students who are trained in interacting with the school children and the general public around LIGO-based themes. This program is intended to provide effective role modeling for visitors, while at the same time instill a passion for science outreach in the undergraduates.

Another aspect of this mission involves prioritizing local partnerships that will yield more teacher professional development opportunities targeted at local teachers. Teachers then spend time at LIGO's Science Education Center, where physical science concepts are explored as they relate to the overall LIGO project.

In the future the SEC will need to retain the ability to involve LIGO in new and innovative outreach work as such opportunities arise, while at the same time serving its core audiences.

- We will expand the Science Education Center (SEC) capability for evaluating the impact it has on students participating in field trips, continuing to serve the local teacher community through