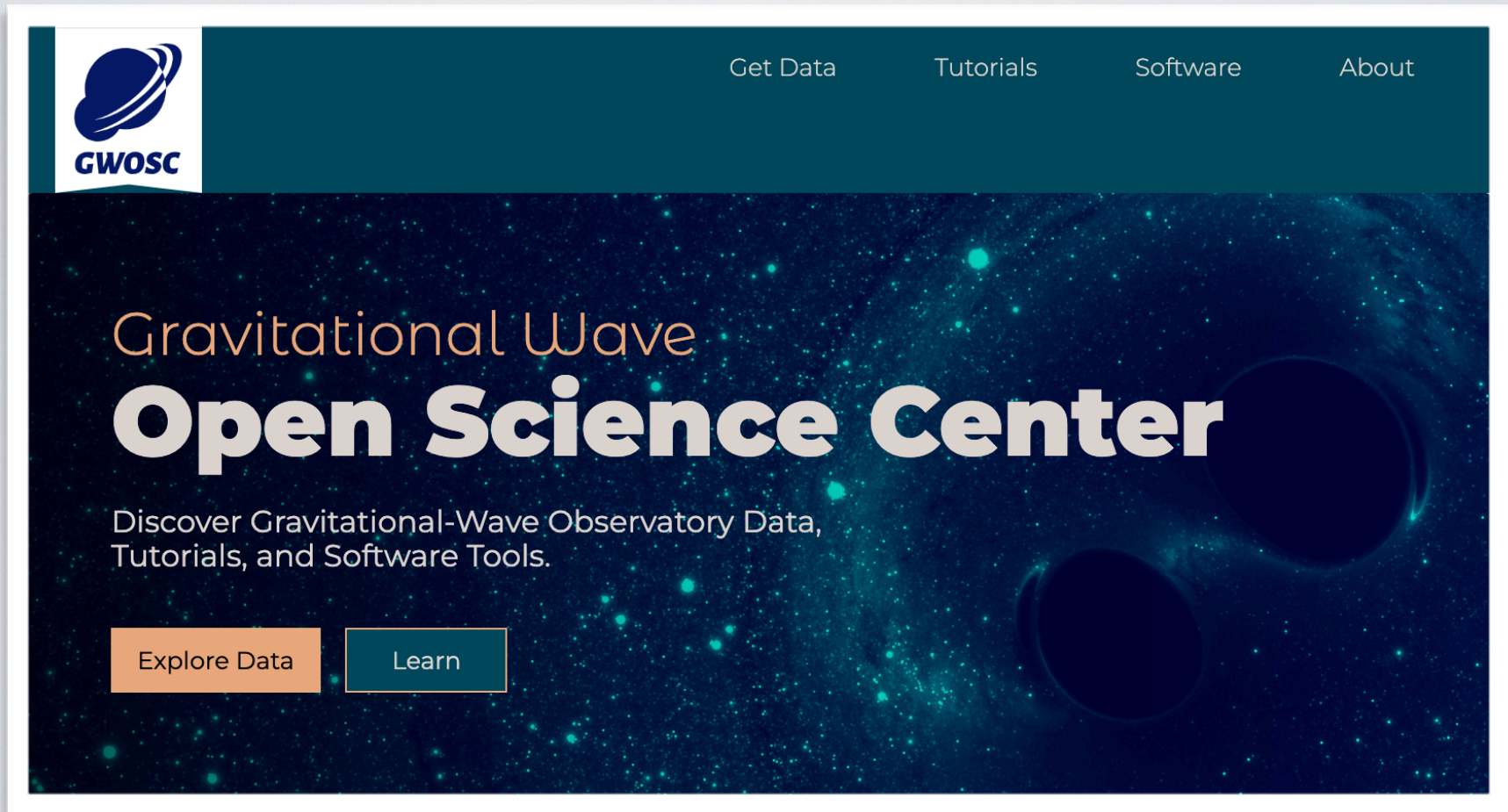


Public Portal for Gravitation Wave Data:

Introduction to the Gravitational Wave Open Science Center (GWOSC)



Kent Blackburn
LIGO Laboratory
California Institute Of Technology

WHY OPEN DATA?

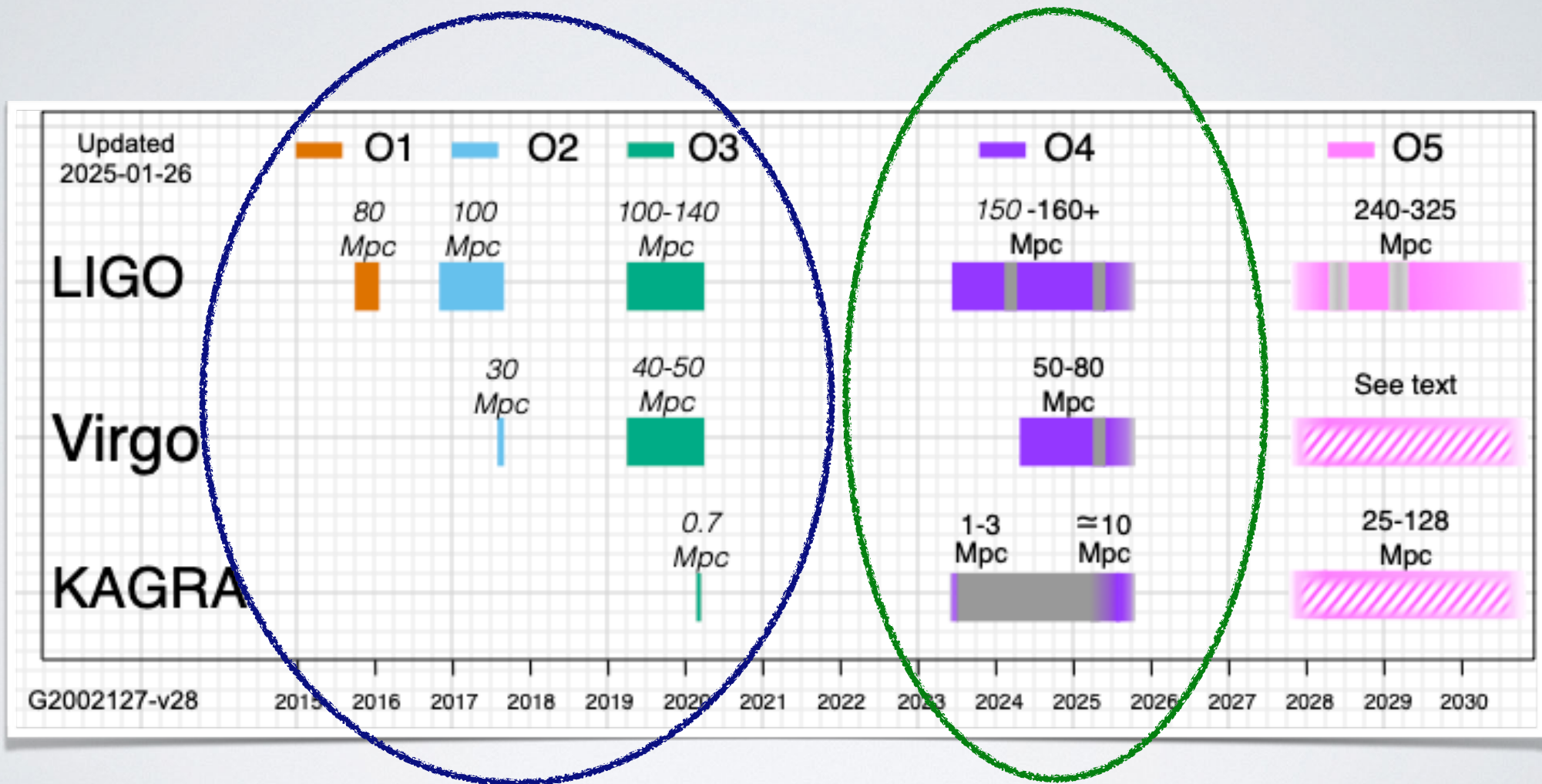
- **GWOSC** (*definition*): The Gravitational Wave Open Science Center (GWOSC) is a public data repository that provides free access to gravitational wave data from LIGO, Virgo, and KAGRA. (**Data released under a [CC BY 4.0 License](#)**)
- **Goals:**
 - Promote accessibility, transparency (and reproducibility).
 - Foster collaboration and interdisciplinary programs crucial for solving complex problems in astrophysics.
 - Enable new discoveries from existing data.
- **Who Contributes:**
 - LIGO Scientific Collaboration (LSC), Virgo Collaboration, KAGRA Collaboration. (LVK).
 - Broader Community (Publications, Community Catalogs)

TYPES OF DATA++ ON GWOSC?

- Strain, Segment Lists (Timelines) / Data Quality
- Events and Catalogs:
 - Search & Parameter Estimation Results for Events
- Documentation
- References to Publications and Additional Data
- Tutorials / Workshops
- Software / Web Apps / GWOSC API / Libraries
- Data Formats:
 - GWF (frames) - custom data format developed by LIGO and Virgo to share data.
 - HDF5 - format developed by the HDF Group for storing and organizing large amounts of data, including metadata, efficiently.
 - An assortment of other formats for smaller files - JSON, CSV, ASCII

GETTING OBSERVATIONAL DATA

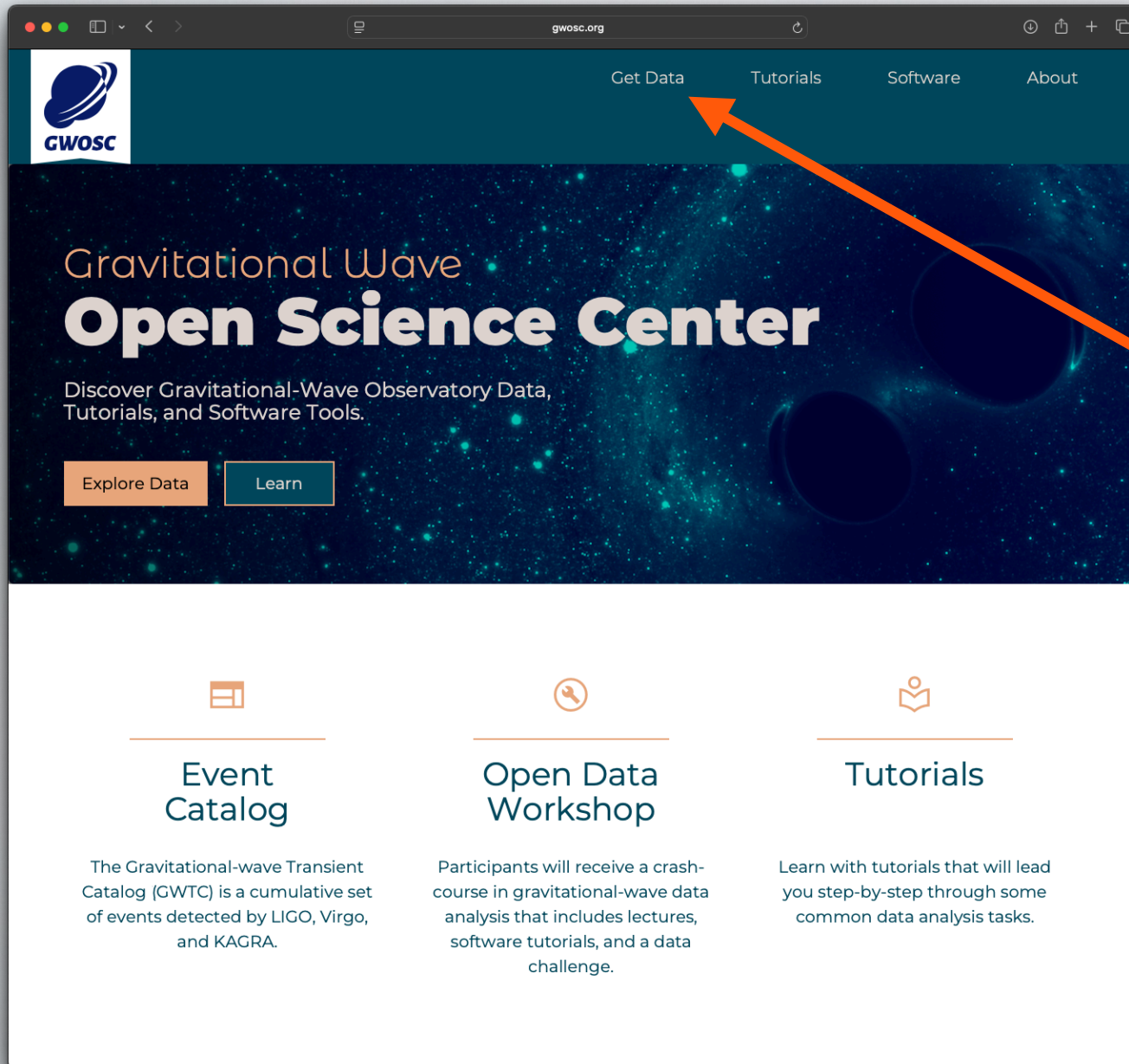
OBSERVATIONS



O1, O2, O3 Runs Available now!

O4 In Progress!

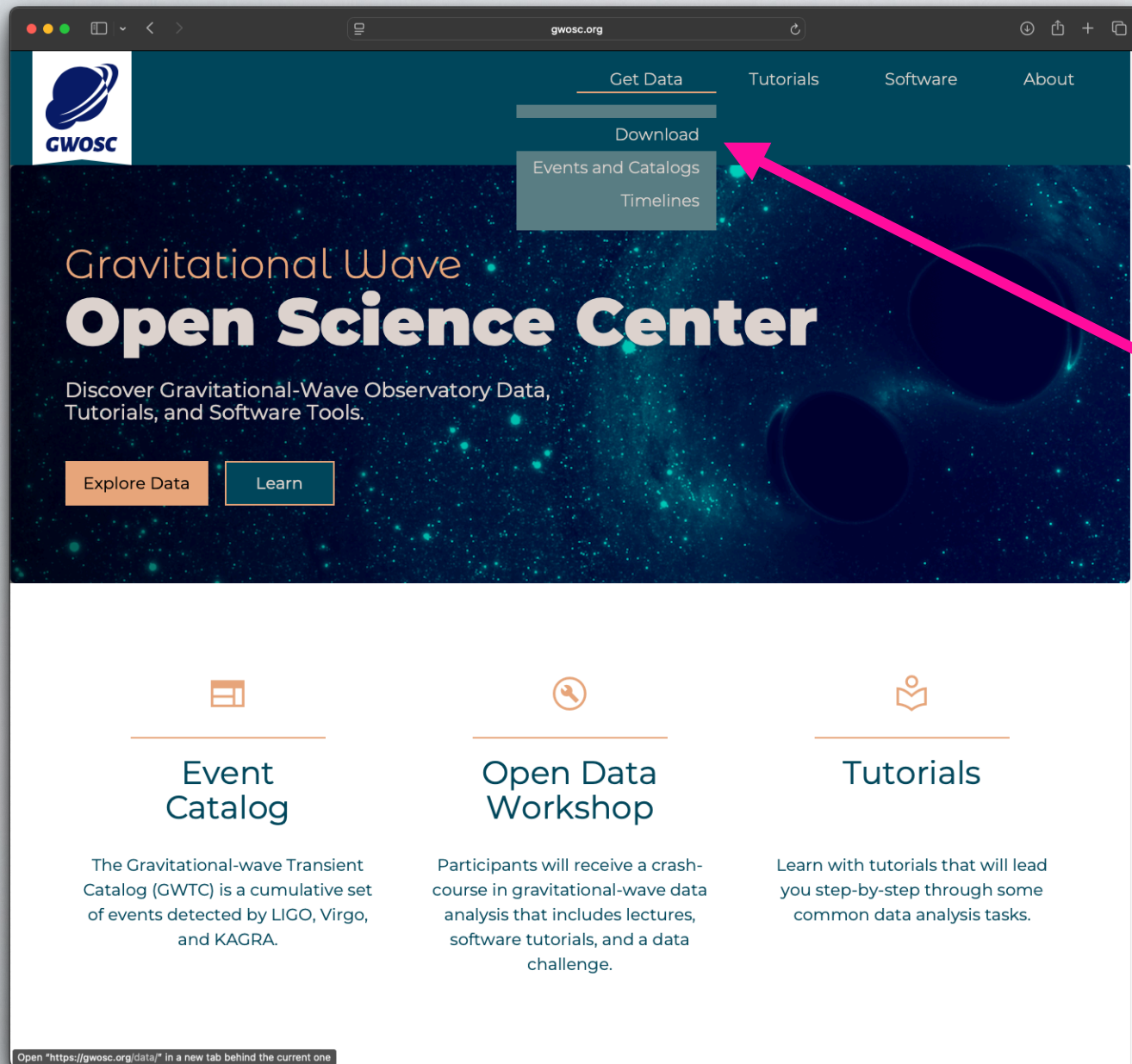
WEB BASED DATA DOWNLOAD



“Get Data” Pulldown Menu
Gateway to getting all types of
data products on GWOSC.

Click Here!

GETTING OBSERVING RUN DATA



Lets **download** an HDF5 file containing Hanford data from the O3b observing run.

Click Here!

FIND THE “O3B DATA RELEASE”

Important!

If you need to use large amounts of data follow the set of instruction under the **OSDF Docs**.

1) Scroll down on the Observatory Data Sets page until you find the **O3b Data Release**.

The screenshot shows the gwosc.org website with the 'Observatory Data Sets' section. A red arrow points from the 'Important!' box to the 'OSDF Docs' link in the 'Large Data Sets' section. A green arrow points from the 'O3b Data Release' section to the 'O3b Data Release' text in the 'O3b Data Release' section. Two blue arrows point from the '4 kHz Data' and '16 kHz Data' links in the 'O3b Data Release' section to the 'We'll demonstrate with 4kHz Data!' box.

gwosc.org

Get Data Tutorials Software About

Observatory Data Sets

Please Read This First!
[Click for data usage notes](#)

The [LIGO Laboratory's Data Management Plan](#) describes the scope and timing of LIGO data releases.

Events and Catalogs

[Event Portal](#)

Large Data Sets

For users of computing clusters or if accessing large amounts of data, OSDF is the preferred method to access public data.

[CVMS Docs](#) deprecated: usage will be dismissed starting from August 2025 and replaced by OSDF

[OSDF Docs](#)

GEO Data around FRBs

[Documents](#)

Time Range: April 28, 2020 through Dec 2, 2022
Detectors: GEO600 (Select times only)

O3 Auxiliary Data Release

[Data Quality and Cleaning](#) [Trend Data](#)

Time Range: April 1, 2019 through March 27, 2020
Detectors: Multiple channels from H1 and L1

O3GK Data Release

[4 kHz Data](#) [16 kHz Data](#)
[Documents](#) [Timeline](#)
[MICH/PRCL Data](#)

O3GK Time Range: April 7, 2020 through April 21, 2020
Detectors: G1 and K1

O3b Data Release

[4 kHz Data](#) [16 kHz Data](#)
[Documents](#) [Timeline](#)

O3b Time Range: November 1, 2019 through March 27, 2020
Detectors: H1, L1 and V1

2) Click on the sample rate you desire - 4kHz for a faster download, 16kHz if you want the most “samples per second.”

We'll demonstrate with 4kHz Data!

SELECT DOWNLOAD DETAILS

We said we wanted the Hanford detector, so be sure H1 radio button is selected.

Select the output format for the presentation of the data to be downloaded.

I've selected the second radio button to allow me to visualize the quality of the data along side the download links.

When ready, select the **Continue** button to generate the download links to your data.

gwsoc.org

Get Data Tutorials Software About

Archive for O3b_4KHZ_R1 dataset

[Details](#)

Each data file corresponds to 4096 seconds of GPS time, and may contain up to half a GB. The file may be downloaded in either HDF5 or Frame format.

For documentation, see the [tutorials](#).

O3b_4KHZ_R1 start GPS: 1256655618, UTC: 2019-11-01T15:00:00

O3b_4KHZ_R1 end GPS: 1269363618, UTC: 2020-03-27T17:00:00

Choose your gravitational wave detector:

☒ H1 ☐ L1 ☐ V1

Choose the start and end time of the data that you want.

Start Time

UTC 2019-11-01T15:00:00 GPS 1256655618 OK

Choose either [Universal time \(ISO8601\)](#) or GPS. Change either side and the other responds immediately.

End Time

UTC 2019-11-02T15:00:00 GPS 1256742018 OK

Choose either [Universal time \(ISO8601\)](#) or GPS. Change either side and the other responds immediately.

Choose your output format:

☐ Time series data in HDF5 and Frame files

☒ Time series data in HDF5 and Frame files, with data quality guide

☐ Includes statistics of each file: min/max, band-limited RMS, etc.

☐ JSON formatted table of files and data quality

[Continue](#)

Other Related Sites

These are the start and end times for the O3b observing run, and the automatically selected as defaults in the user chosen start/end time section below.

Here is where the user is able to select a subset of start/end times to generate download links to choose from in the next step. I've down-selected to one day at the beginning of O3b.

RESULT: TABLE OF LINKS

Timeline UTC Mbytes HDF5 Frame Seconds (of 4096) where flag is true

Click on any of the **HDF5** or **Frame** links will download the strain data, with data quality as well, locally on your computer.

					DATA	CBC_CAT1	CBC_CAT2	CBC_CAT3	BURST_CAT1	BURST_CAT2	BURST_CAT3	NO_CBC_HW_IND	NO_BURST_HW_IND	NO_DETCHAR_HW_IND	NO_CW_HW_IND	NO_STOCH_HW_IND
1256660992	2019-11-01T16:29:34	50.4 MB	HDF5	Frame	40.2	40.2	40.2	40.2	40.2	39.6	39.6	100.0	100.0	100.0	0.0	100.0
1256665088	2019-11-01T17:37:50	124.3 MB	HDF5	Frame	100.0	100.0	100.0	100.0	100.0	99.3	99.3	100.0	100.0	100.0	0.0	100.0
1256669184	2019-11-01T18:46:06	124.3 MB	HDF5	Frame	100.0	100.0	100.0	100.0	100.0	99.7	99.7	100.0	100.0	100.0	0.0	100.0
1256673280	2019-11-01T19:54:22	124.3 MB	HDF5	Frame	100.0	100.0	100.0	100.0	100.0	99.7	99.7	100.0	100.0	100.0	0.0	100.0
1256677376	2019-11-01T21:02:38	62.4 MB	HDF5	Frame	49.9	49.9	49.9	49.9	49.9	49.7	49.7	100.0	100.0	100.0	0.0	100.0
1256681472	2019-11-01T22:10:54	84.4 MB	HDF5	Frame	67.7	67.7	67.7	67.7	67.7	67.5	67.5	100.0	100.0	100.0	0.0	100.0
1256685568	2019-11-01T23:19:10	65.0 MB	HDF5	Frame	52.0	52.0	52.0	52.0	52.0	52.0	52.0	100.0	100.0	100.0	0.0	100.0
1256689664	2019-11-	124.3 MB	HDF5	Frame	100.0	100.0	100.0	100.0	100.0	99.9	99.9	100.0	100.0	100.0	0.0	100.0

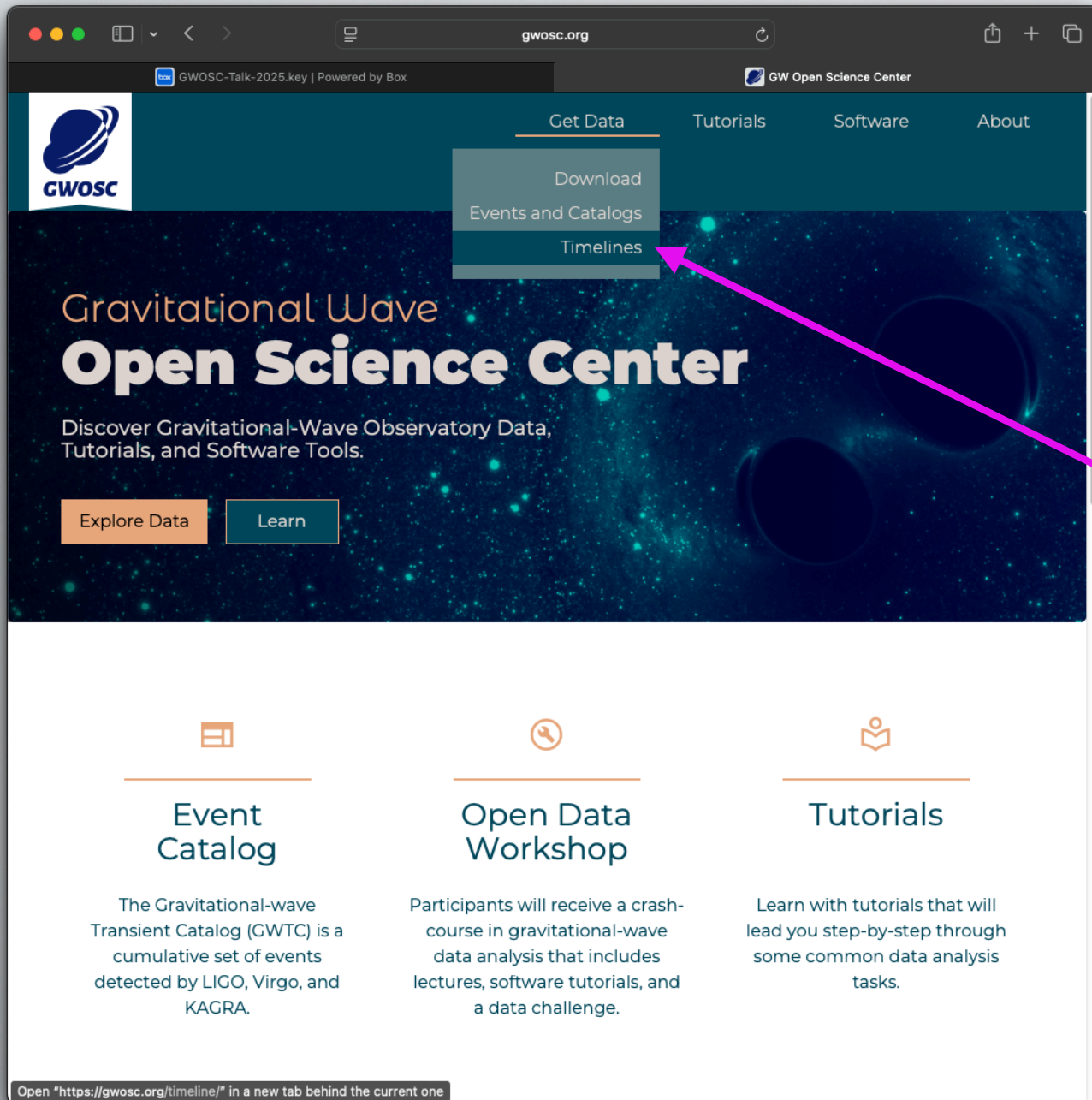
SEGMENTS, TIMELINES, AND DATA QUALITY

SEGMENT BASICS

Segments are simply lists of start and end time that characterize the state of the detectors and any irregularities that might have implications for astrophysical searches.

- During any time interval the detectors may be or may not be in observing “mode” (DATA flag).
- There may be irregularities in the detectors during observing mode that are detected using additional instrumentation on the environment and state (CAT1, CAT2 and CAT3 flags) that may interfere with searches for astrophysical searches (CBC & BURST) providing a measure of data quality.
- Man-made signals (**injections**) based on astrophysical models and detector noise signatures (sine-gaussians) may be added to the strain data for the purposes of calibration, search sensitivity, and in raw cases to challenge scientists. These are called injections and the times when these are added (or not added) are also available in the segments.
- Segment information (flags are also stored along side the strain data in GWF and HDF5 files.
- Segment lists can be visually displayed as timelines, or can be downloaded as JSON or ASCII.

GETTING SEGMENTS



Select the **Timelines** to get segment info.

SELECTING SEGMENT DATA

Select desired
Observing Run

Select Start and End
times, UTC or GPS

When ready,
click **Display**

The screenshot shows the 'Timeline Queries' page on gwosc.org. The interface includes a header with the site name and a 'Help' link. Below the header, there is an introductory text and a 'Show examples' button. The main form contains a 'Select a run' dropdown menu, 'GPS Start' and 'GPS End' input fields with calendar icons, and a 'Duration' field. Below these are 'Strain Files' buttons for H1, L1, and V1. The 'Segments' section has a 'Choose the output format below' label and three radio buttons: 'Plot', 'JSON', and 'ASCII'. A green arrow points to the 'Display' button. A blue box highlights a grid of checkboxes for selecting specific data segments, organized by detector (H1, L1, V1) and category (BURST_CAT, CBC_CAT) and time (1, 2, 3).

Timeline Queries

The Timeline App shows times when data are available, as well as data quality and injection segments.
Use the [Event Portal](#) to access individual Events and request any of the Event Timeline or Segment Lists.
[Show examples](#)

Select a run
O3b

GPS Start
1256655618
2019-11-01T15:00:00

GPS End
1256742018
2019-11-02T15:00:00

Duration
86400

Dates shown are in UTC time

Strain Files

Strain Data for H1 Strain Data for L1 Strain Data for V1

Segments

Choose the output format below

Plot JSON ASCII

Display

<input type="checkbox"/> H1_BURST_CAT1	<input type="checkbox"/> L1_BURST_CAT1	<input type="checkbox"/> V1_BURST_CAT1
<input type="checkbox"/> H1_BURST_CAT2	<input type="checkbox"/> L1_BURST_CAT2	<input type="checkbox"/> V1_BURST_CAT2
<input type="checkbox"/> H1_BURST_CAT3	<input type="checkbox"/> L1_BURST_CAT3	<input type="checkbox"/> V1_BURST_CAT3
<input type="checkbox"/> H1_CBC_CAT1	<input type="checkbox"/> L1_CBC_CAT1	<input type="checkbox"/> V1_CBC_CAT1
<input type="checkbox"/> H1_CBC_CAT2	<input type="checkbox"/> L1_CBC_CAT2	<input type="checkbox"/> V1_CBC_CAT2
<input type="checkbox"/> H1_CBC_CAT3	<input type="checkbox"/> L1_CBC_CAT3	<input type="checkbox"/> V1_CBC_CAT3

Portals to Strain Data
for each individual
detector

Options for
output format

Assortment of Data
Quality Flags for each
detector

DATA QUALITY OPTIONS

Select the **Display** button to visualize the selected data quality flags

The screenshot shows the 'Segments' page on gwosc.org. At the top, there are tabs for 'Plot', 'JSON', and 'ASCII'. Below these is a 'Display' button with an external link icon. The main content area is a grid of checkboxes organized into three columns and four rows. The first row contains burst categories (H1, L1, V1_BURST_CAT1-3). The second row contains CBC categories (H1, L1, V1_CBC_CAT1-3). The third row contains data categories (H1, L1, V1_DATA), which are highlighted with a green dashed border. The fourth row contains hardware injection categories (H1, L1, V1_NO_BURST_HW_INJ, H1, L1, V1_NO_CBC_HW_INJ, H1, L1, V1_NO_CW_HW_INJ, H1, L1, V1_NO_DETCHAR_HW_INJ, H1, L1, V1_NO_STOCH_HW_INJ). The 'H1_NO_DETCHAR_HW_INJ' checkbox is checked. A yellow dashed border highlights the first three rows, and a red dashed border highlights the fourth row.

gwosc.org

GWOSC-Talk-2025 key | Powered by Box

Timeline Queries

Timeline

Segments

Choose the output format below

Plot JSON ASCII

Display

<input type="checkbox"/> H1_BURST_CAT1	<input type="checkbox"/> L1_BURST_CAT1	<input type="checkbox"/> V1_BURST_CAT1
<input type="checkbox"/> H1_BURST_CAT2	<input type="checkbox"/> L1_BURST_CAT2	<input type="checkbox"/> V1_BURST_CAT2
<input type="checkbox"/> H1_BURST_CAT3	<input checked="" type="checkbox"/> L1_BURST_CAT3	<input type="checkbox"/> V1_BURST_CAT3
<input type="checkbox"/> H1_CBC_CAT1	<input type="checkbox"/> L1_CBC_CAT1	<input checked="" type="checkbox"/> V1_CBC_CAT1
<input type="checkbox"/> H1_CBC_CAT2	<input type="checkbox"/> L1_CBC_CAT2	<input type="checkbox"/> V1_CBC_CAT2
<input type="checkbox"/> H1_CBC_CAT3	<input type="checkbox"/> L1_CBC_CAT3	<input type="checkbox"/> V1_CBC_CAT3
<input checked="" type="checkbox"/> H1_DATA	<input checked="" type="checkbox"/> L1_DATA	<input checked="" type="checkbox"/> V1_DATA
<input type="checkbox"/> H1_NO_BURST_HW_INJ	<input type="checkbox"/> L1_NO_BURST_HW_INJ	<input type="checkbox"/> V1_NO_BURST_HW_INJ
<input type="checkbox"/> H1_NO_CBC_HW_INJ	<input type="checkbox"/> L1_NO_CBC_HW_INJ	<input type="checkbox"/> V1_NO_CBC_HW_INJ
<input type="checkbox"/> H1_NO_CW_HW_INJ	<input type="checkbox"/> L1_NO_CW_HW_INJ	<input type="checkbox"/> V1_NO_CW_HW_INJ
<input checked="" type="checkbox"/> H1_NO_DETCHAR_HW_INJ	<input type="checkbox"/> L1_NO_DETCHAR_HW_INJ	<input type="checkbox"/> V1_NO_DETCHAR_HW_INJ
<input type="checkbox"/> H1_NO_STOCH_HW_INJ	<input type="checkbox"/> L1_NO_STOCH_HW_INJ	<input type="checkbox"/> V1_NO_STOCH_HW_INJ

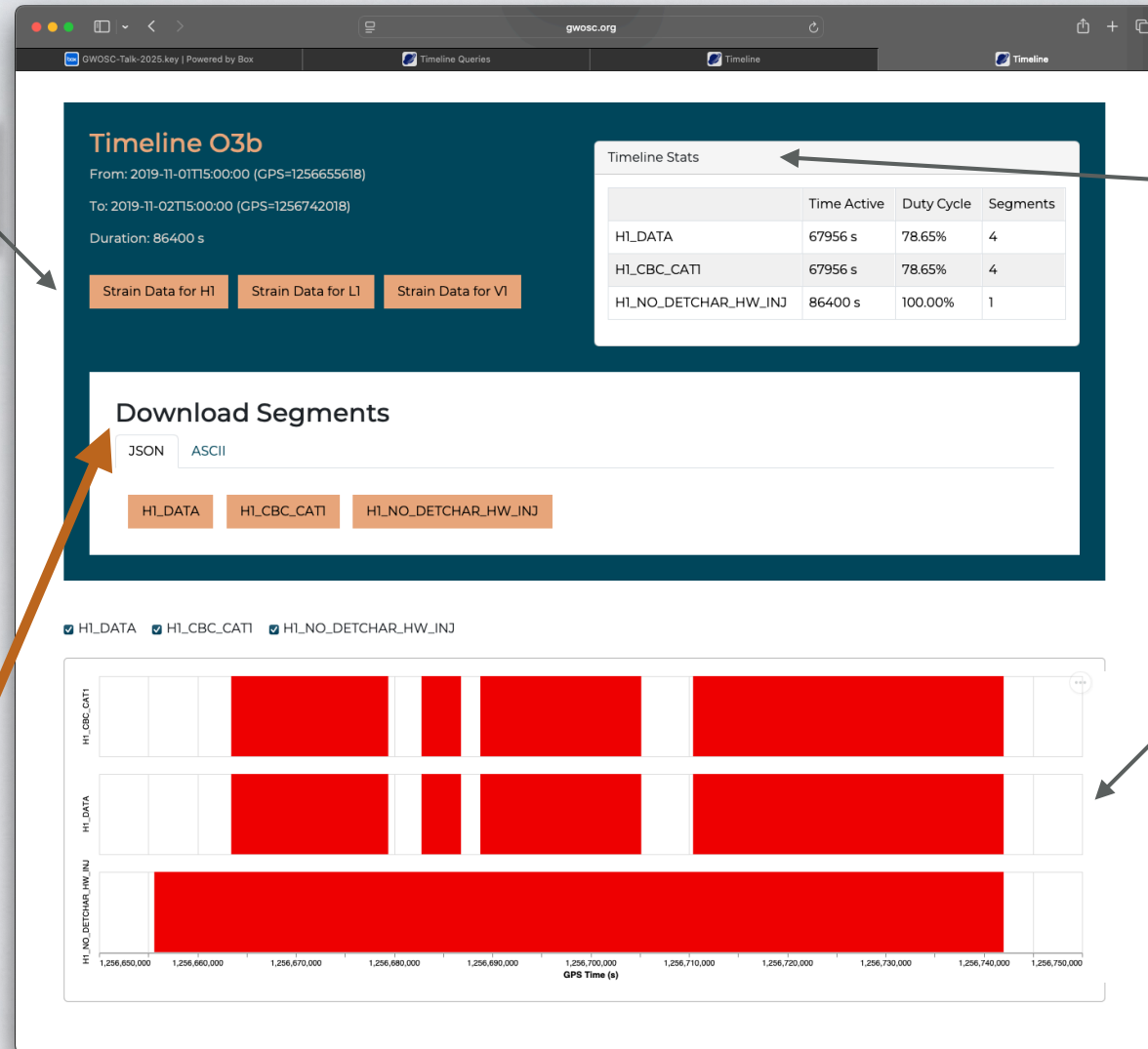
These are search sensitive data quality options that may have additional data cuts

Detector is in Observing Mode, select any detector you would like to plot

These are times when NO specific hardware injection has been added

PLOTS OF SELECTED DATA QUALITY

Portals to Strain Data



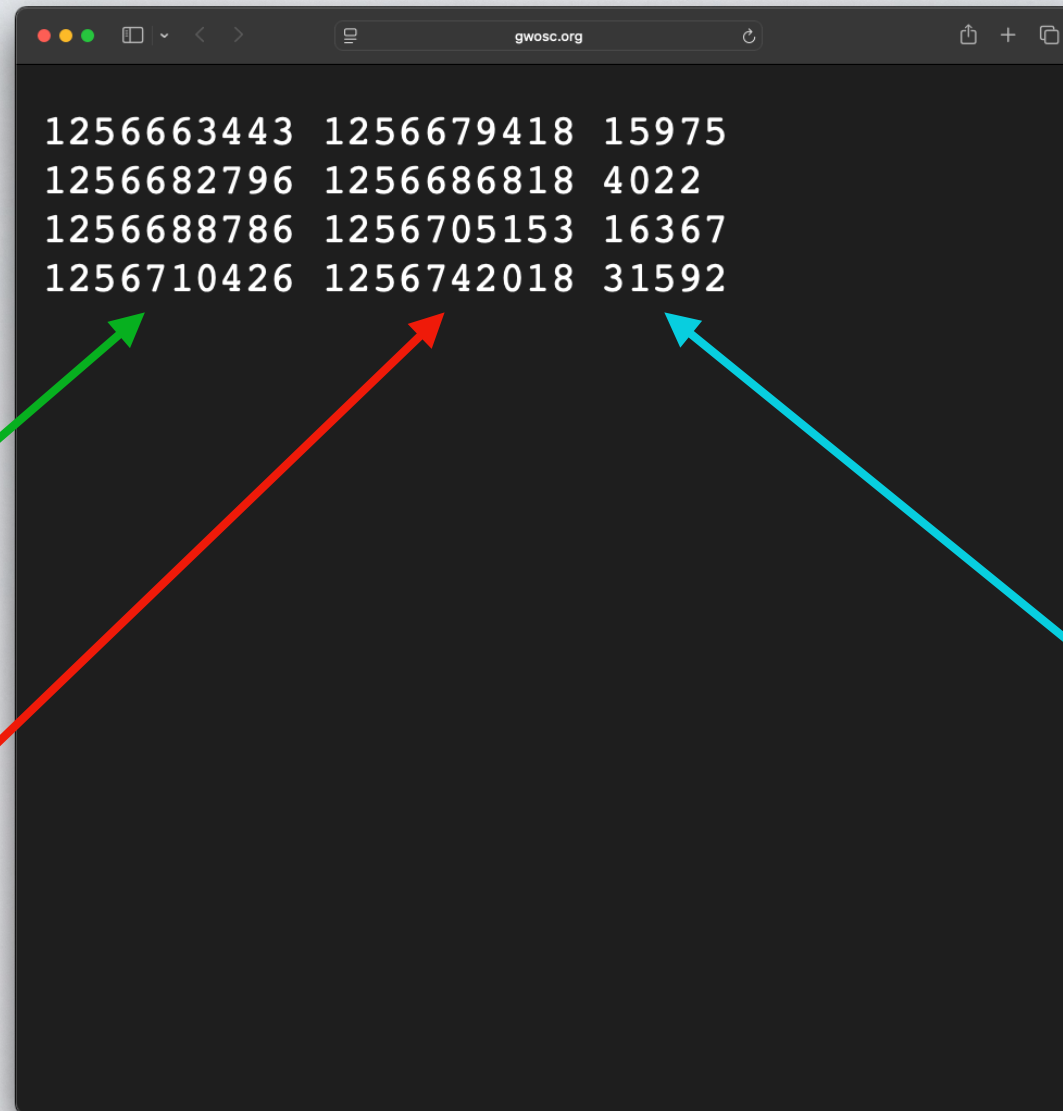
Statistics for timelines:
No DETCHAR and
No CBC_CATI cuts!

Select individual
data quality flag
to view list of
start/end times
for all segments
in this interval;

Lets look at the
ASCII output for
HI_DATA.

Graphs of selected
data quality flags

EXAMPLE SEGMENT LIST (HI_DATA)



A screenshot of a terminal window with a dark background and white text. The window title bar shows standard macOS window controls and the URL 'gwosc.org'. The terminal displays a list of four rows, each containing three numbers separated by spaces. Three arrows originate from labels outside the terminal: a green arrow points to the first column, a red arrow points to the second column, and a cyan arrow points to the third column.

1256663443	1256679418	15975
1256682796	1256686818	4022
1256688786	1256705153	16367
1256710426	1256742018	31592

GPS Start Time

GPS End Time

Duration in seconds

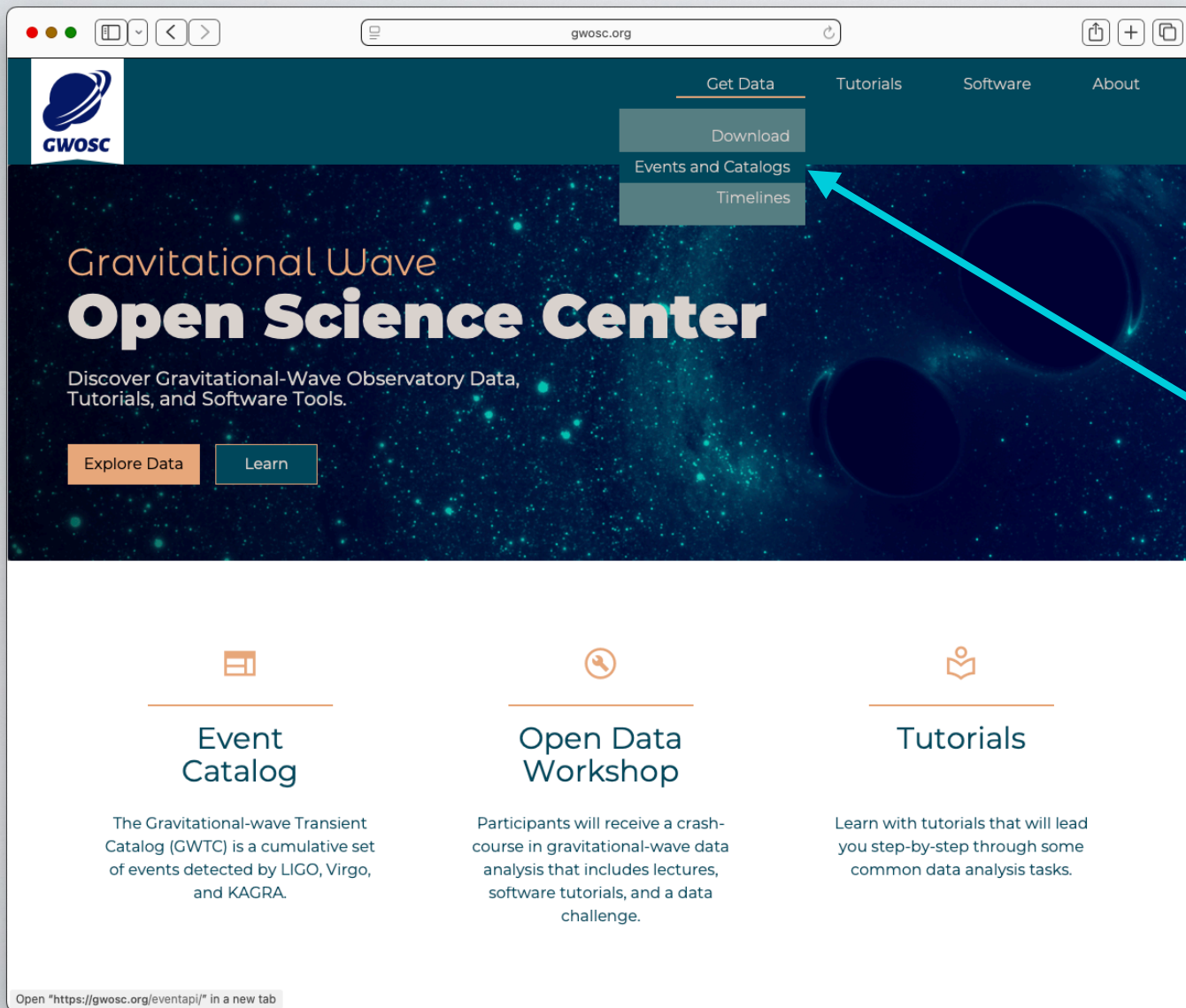
EVENTS AND CATALOGS

THE EVENT PORTAL

EVENT PORTAL

- The Event Portal is the gateway to events and catalogs
- Catalogs are groupings of events typically related by the observational run they were found in. They are also referred to as releases.
- Some catalogs have marginal events where not all criteria for confidence were met by searches.
- The GWTC Transient Catalog captures all confident events found by the LIGO/Virgo/KAGRA collaborations.
- We have started a program for including catalogs from the broader community (Community Catalogs).

NAVIGATING THE EVENT PORTAL



The screenshot shows the GWOSC website in a web browser. The browser's address bar displays "gwosc.org". The website's header features the GWOSC logo on the left and a navigation menu on the right with links for "Get Data", "Tutorials", "Software", and "About". A dropdown menu is open under "Get Data", showing options for "Download", "Events and Catalogs", and "Timelines". A red arrow points from the "Events and Catalogs" option to a callout box on the right. The main banner area has a dark blue background with a starry space pattern and the text "Gravitational Wave Open Science Center". Below this, it says "Discover Gravitational-Wave Observatory Data, Tutorials, and Software Tools." and includes two buttons: "Explore Data" and "Learn". The footer section contains three columns: "Event Catalog" with a calendar icon, "Open Data Workshop" with a magnifying glass icon, and "Tutorials" with a book icon. Each column has a brief description of its content.

GWOSC

Get Data Tutorials Software About

Download

Events and Catalogs

Timelines

Gravitational Wave
Open Science Center

Discover Gravitational-Wave Observatory Data,
Tutorials, and Software Tools.

Explore Data Learn

Event Catalog

The Gravitational-wave Transient Catalog (GWTC) is a cumulative set of events detected by LIGO, Virgo, and KAGRA.

Open Data Workshop

Participants will receive a crash-course in gravitational-wave data analysis that includes lectures, software tutorials, and a data challenge.

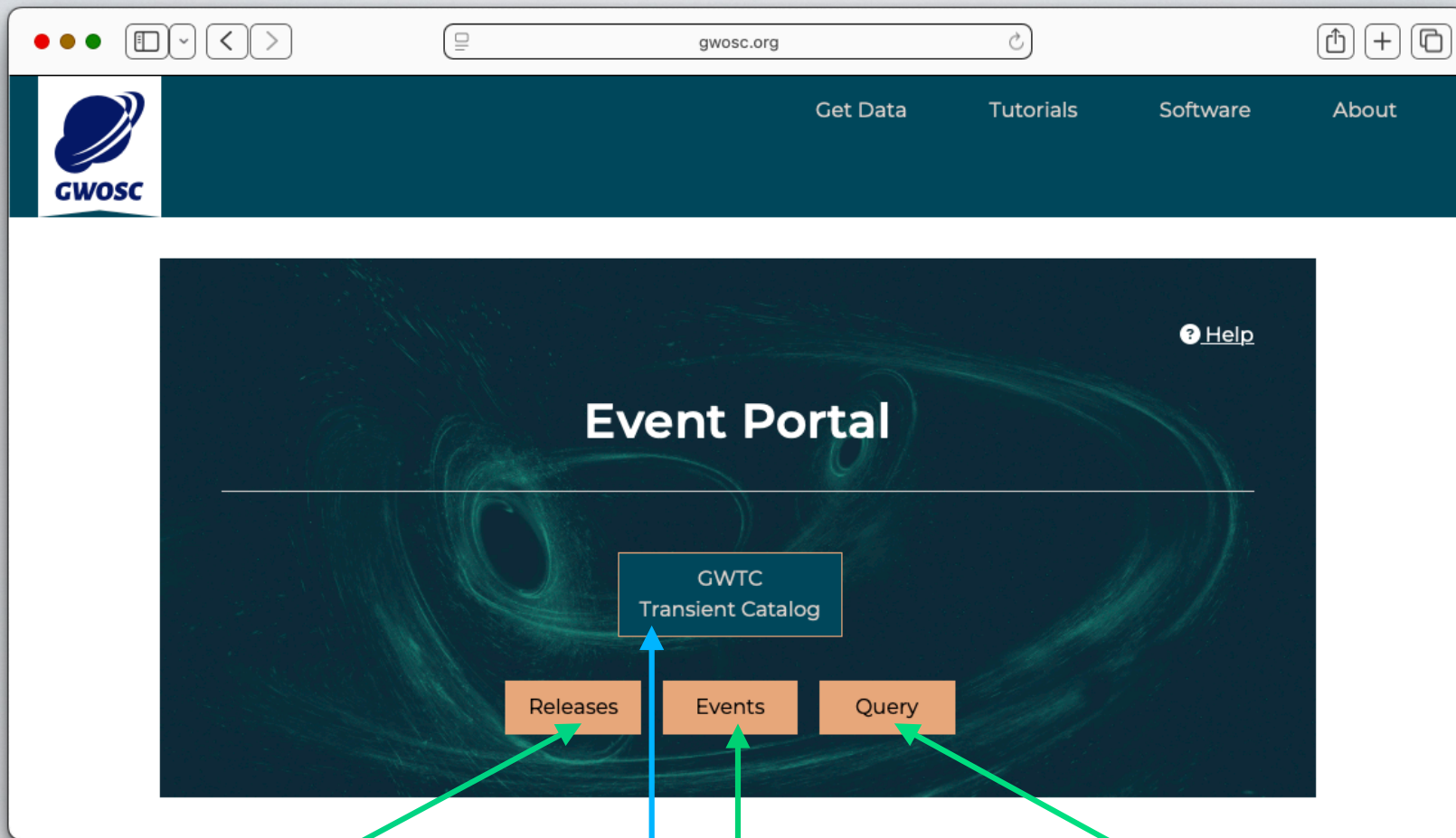
Tutorials

Learn with tutorials that will lead you step-by-step through some common data analysis tasks.

Open "https://gwosc.org/eventapi/" in a new tab

To access the Event Portal, click **Events and Catalogs** menu option under Get Data

EVENT PORTAL FEATURES



[Click for Catalogs/Releases](#)

[Click for ALL Events](#)

[Click for Query Form](#)

Click for LVK confident detection Events

GWTC TRANSIENT CATALOG

[New Search](#) [Help](#)

GWTC

Click on any event to see SINGLE EVENT details!

i The Gravitational-wave Transient Catalog (GWTC) is a cumulative set of gravitational wave transients maintained by the LIGO/Virgo/KAGRA collaboration. The online GWTC contains confidently-detected events from multiple data releases. For further information, see documentation for individual releases: [GWTC-1](#), [GWTC-2](#), [GWTC-2.1](#), and [GWTC-3](#).

Note, this catalog is only updated periodically, and may not contain recently published events. For the most recent events, you can browse [all available events](#).

Previous versions of this catalog are archived in [zenodo](#).

- Toggle columns on/off with Display button at right.
- Click an event name for all versions and more information.
- Values in the table below are from the **Default SEARCH** and **Default PE** cases found in the individual event's page.
- See [Event Portal Usage Notes](#) for more details.

List contains 93 events.

93 confident events!

[Focus](#)

[Display all](#) [Display](#)

Name	Version	Release	GPS	Mass 1 (M_{\odot})	Mass 2 (M_{\odot})	Network SNR	Distance (Mpc)	χ_{eff}	Total Mass (M_{\odot})
GW200322_091133	v1	GWTC-3-confident	1268903511.3	+130 38 -22	+24.3 11.3 -6.0	+2.7 4.5 -3.0	+12500 3500 -2200	+0.54 0.27 -0.58	+132 50 -22
GW200316_215756	v1	GWTC-3-confident	1268431094.1	+10.2 13.1 -2.9	+2.0 7.8 -2.9	+0.4 10.3 -0.7	+480 1120 -440	+0.27 0.13 -0.10	+7.2 21.2 -2.0
GW200311_115853	v1	GWTC-3-confident	1267963151.3	+6.4 34.2 -3.8	+4.1 27.7 -5.9	+0.2 17.8 -0.2	+280 1170 -400	+0.16 -0.02 -0.20	+5.3 61.9 -4.2
GW200308_173609	v1	GWTC-3-confident	1267724187.7	+166 60 -29	+36 24 -13	+2.5 4.7 -2.9	+13900 7100 -4400	+0.58 0.16 -0.49	+169.0 92.0 -48.0
GW200306_093714	v1	GWTC-3-confident	1267522652.1	+17.1 28.3 -7.7	+6.5 14.8 -6.4	+0.4 7.8 -0.6	+1700 2100 -1100	+0.28 0.32 -0.46	+11.8 43.9 -7.5
GW200302_015811	v1	GWTC-3-confident	1267149509.5	+8.7 37.8 -8.5	+8.1 20.0 -5.7	+0.3 10.8 -0.4	+1020 1480 -700	+0.25 0.01 -0.26	+9.6 57.8 -6.9
GW200225_060421	v1	GWTC-3-confident	1266645879.3	+5.0 19.3 -3.0	+2.8 14.0 -3.5	+0.3 12.5 -0.4	+510 1150 -530	+0.17 -0.12 -0.28	+3.6 33.5 -3.0
GW200224_222234	v1	GWTC-3-confident	1266618172.4	+6.7 40.0 -4.5	+4.8 32.7 -7.2	+0.2 20.0 -0.2	+500 1710 -650	+0.15 0.10 -0.16	+7.2 72.3 -5.3

RELEASES

Release List

Click on any Release Name to see Table of Events in Catalog

Release Name	Description
<u>GWTC</u>	The Gravitational-wave Transient Catalog (GWTC) is a cumulative set of gravitational wave transients maintained by the LIGO/Virgo/KAGRA collaboration. The online GWTC contains confidently-detected events from multiple data releases.
<u>GWTC-1-confident</u>	Confident detections from "GWTC-1: A Gravitational-Wave Transient Catalog of Compact Binary Mergers Observed by LIGO and Virgo during the First and Second Observing Runs." Additional data products, including PE samples and skymaps, are linked from the documentation at https://doi.org/10.7935/82H3-HH23
<u>GWTC-1-marginal</u>	Marginal candidates from "GWTC-1: A Gravitational-Wave Transient Catalog of Compact Binary Mergers Observed by LIGO and Virgo during the First and Second Observing Runs." Additional data products are linked from the documentation at https://doi.org/10.7935/82H3-HH23
<u>GWTC-2</u>	Events from the O3A observation run of LIGO and Virgo, as described in the GWTC-2 catalog paper. These events are also included in a cumulative list of all GWTC events published to date. Details and additional data products are linked from the documentation page .
<u>GWTC-2.1-auxiliary</u>	This release/list/table contains candidates from GWTC-2 which, based on the [updated] analysis presented in the GWTC-2.1 catalog paper [https://arxiv.org/abs/2108.01045], do not satisfy the requirements/criteria for inclusion in the GWTC-2.1-confident or GWTC-2.1-marginal releases.
<u>GWTC-2.1-confident</u>	Confident events from the O3A observation run for LIGO and Virgo, as described in the GWTC-2.1 catalog paper. These events are also included in a cumulative list of all GWTC events published to date. Details and additional data products are linked from the documentation page .
<u>GWTC-2.1-marginal</u>	Marginal candidates from the O3A observation run for LIGO and Virgo, as described in the GWTC-2.1 catalog paper. Details and additional data products are linked from the documentation page .
<u>GWTC-3-confident</u>	Confident events from the O3b observing run for LIGO and Virgo, as described in the GWTC-3 catalog paper. These candidate events have a probability of astrophysical origin (probability of being a gravitational-wave signal versus being instrumental noise) assuming a compact binary (such as a binary black hole, neutron star-black hole binary or binary neutron star) coalescence source of greater than 0.5 based upon results of at least one of the search pipelines. These events are also included in a cumulative list of all GWTC events published to date. Details and additional data products are linked from the documentation page .

EVENTS

[New Search](#) [Help](#)

Event List

Click on any event to see SINGLE EVENT details!

i All the events and all versions.

- Toggle columns on/off with Display button at right.
- Click an event name for all versions and more information.
- Values in the table below are from the **Default SEARCH** and **Default PE** cases found in the individual event's page.
- See [Event Portal Usage Notes](#) for more details.

List contains 182 events.

All 182 reported events!

[Focus](#)

[Display all](#) [Display](#) ▼

Name	Version	Release	GPS	Mass 1 (M _o)	Mass 2 (M _o)	Network SNR	Distance (Mpc)	X _{eff}	Total Mass (M _o)
GW230529_181500	v1	O4_Discovery_Papers	1369419318.7	+0.8 3.6 -1.2	+0.6 1.4 -0.2	11.6	+102 201 -96	+0.12 -0.10 -0.17	+0.6 5.1 -0.6
GW200322_091133	v1	GWTC-3-confident	1268903511.3	+130 38 -22	+24.3 11.3 -6.0	+2.7 4.5 -3.0	+12500 3500 -2200	+0.54 0.27 -0.58	+132 50 -22
GW200316_215756	v1	GWTC-3-confident	1268431094.1	+10.2 13.1 -2.9	+2.0 7.8 -2.9	+0.4 10.3 -0.7	+480 1120 -440	+0.27 0.13 -0.10	+7.2 21.2 -2.0
GW200311_115853	v1	GWTC-3-confident	1267963151.3	+6.4 34.2 -3.8	+4.1 27.7 -5.9	+0.2 17.8 -0.2	+280 1170 -400	+0.16 -0.02 -0.20	+5.3 61.9 -4.2
GW200311_103121	v1	GWTC-3-marginal	1267957899.7	--	--	9.2	--	--	--
GW200308_173609	v1	GWTC-3-confident	1267724187.7	+166 60 -29	+36 24 -13	+2.5 4.7 -2.9	+13900 7100 -4400	+0.58 0.16 -0.49	+169.0 92.0 -48.0
GW200306_093714	v1	GWTC-3-confident	1267522652.1	+17.1 28.3 -7.7	+6.5 14.8 -6.4	+0.4 7.8 -0.6	+1700 2100 -1100	+0.28 0.32 -0.46	+11.8 43.9 -7.5
GW200302_015811	v1	GWTC-3-confident	1267149509.5	+8.7 37.8 -8.5	+8.1 20.0 -5.7	+0.3 10.8 -0.4	+1020 1480 -700	+0.25 0.01 -0.26	+9.6 57.8 -6.9
GW200225_060421	v1	GWTC-3-confident	1266645879.3	+5.0 19.3 -3.0	+2.8 14.0 -3.5	+0.3 12.5 -0.4	+510 1150 -530	+0.17 -0.12 -0.28	+3.6 33.5 -3.0
GW200224_222234	v1	GWTC-3-confident	1266618172.4	+6.7 40.0 -4.5	+4.8 32.7 -7.2	+0.2 20.0 -0.2	+500 1710 -650	+0.15 0.10 -0.16	+7.2 72.3 -5.3
GW200220_124850	v1	GWTC-3-confident	1266238148.1	+14.1 38.9 -8.6	+9.2 27.9 -9.0	+0.3 8.5 -0.5	+2800 4000 -2200	+0.27 -0.07 -0.33	+17 67 -12
GW200220_061928	v1	GWTC-3-confident	1266214786.7	+40 87 -23	+26 61 -25	+0.4 7.2 -0.7	+4800 6000 -3100	+0.40 0.06 -0.38	+55 148 -33

QUERY FORM

Query Events

Event Name:

The (partial) name of the event, e.g. GW150914

Release:

Initial_LIGO_Virgo
GWTC-1-confident
GWTC-1-marginal
O1_O2-Preliminary

Restrict search to a Catalog Release

Mass 1 Range:

0

∞

Mass 2 Range:

0

∞

Total Mass Range:

0

∞

Final Mass Range:

0

∞

Chirp Mass Range:

0

∞

Detector Frame Chirp Mass Range:

0

∞

Distance (Mpc) Range:

0

∞

Redshift Range:

0

∞

Network SNR Range:

0

∞

χ_{eff} Range:

-1

1

False Alarm Rate Range:

0

∞

P_{astro} Range:

0

1

UTC Time Range:

GPS Time Range:

Show only last version

Output Format:

☒ HTML

☐ JSON

☐ CSV

☐ ASCII

Submit Query

Click the **Submit Query** button after filling out form

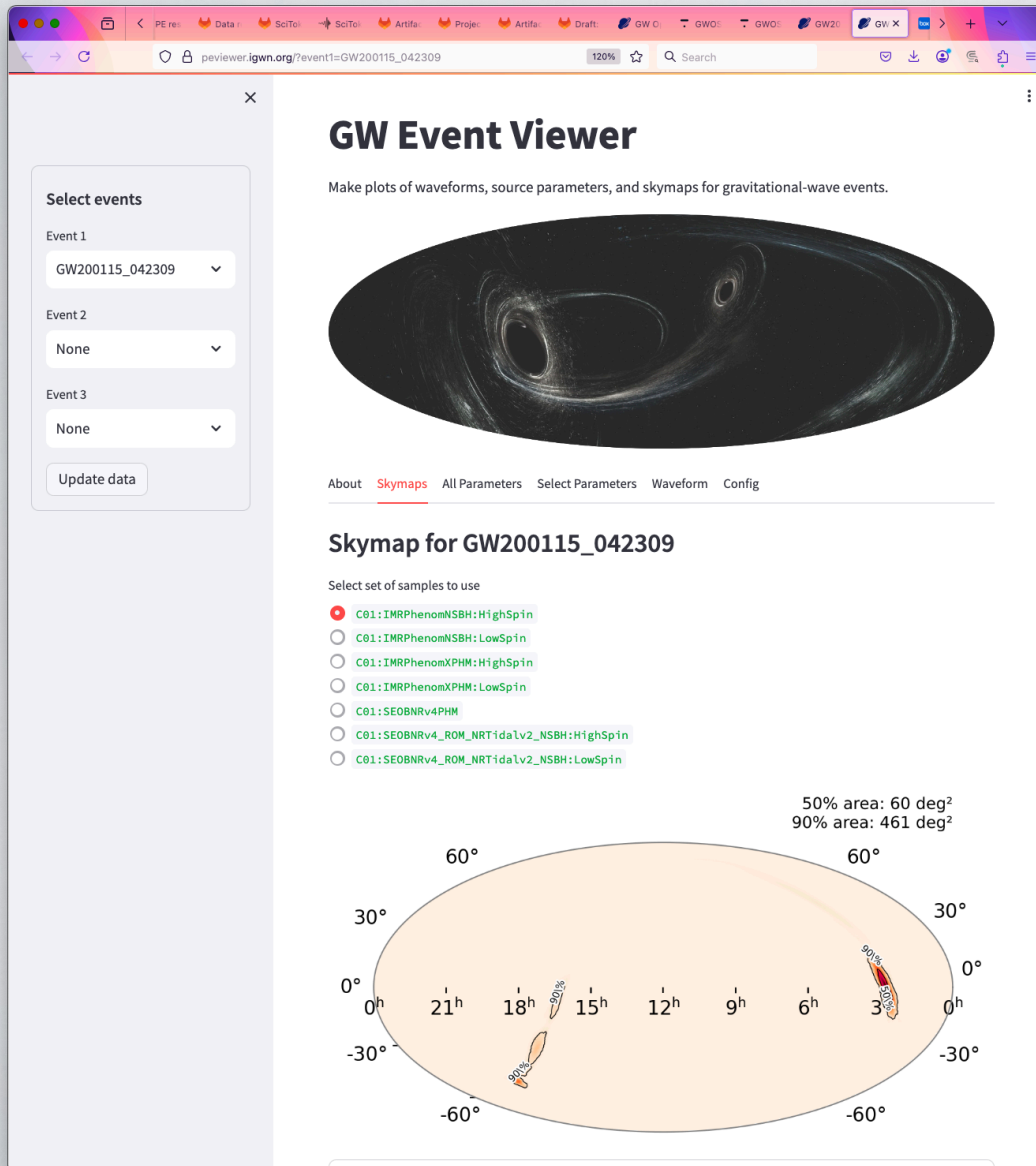
SINGLE EVENT PAGE



Lots of information in one place

- Metadata about event
- All search results
- All parameter estimation results
- Links to PE samples and skymaps
- Q-Transform plots centered on event
- Strain data downloads
- Interactive Plotting via **Event Viewer**

GRAVITATIONAL WAVE EVENT VIEWER



Visualize Various Aspects of Events

- Select Events
- Skymaps
- Parameters (all or subset)
- Waveforms

<https://peviewer.igwn.org/>

COMMUNITY CATALOGS

Community Catalog Information

The GWOSC [Event Portal](#) provides access to a database of known gravitational-wave events. Before 2025, the database only included events published by the LIGO/Virgo/KAGRA (LVK) collaboration. Here, we set out guidelines for how catalogs from authors outside the LVK collaboration can be added to the [Event Portal](#) database. By taking this step, we hope to better reflect the current state of knowledge about gravitational-wave transients, and so better serve the scientific community.

Publishing Community Catalogs on GWOSC

You can learn more about the possibility to add your community catalogs to the [Event Portal](#) in the [GWOSC Community Catalogs Guidelines](#) document.

Community Catalogs development details are provided on [GitHub](#) where the JSON schema is specified, as well as test codes and notebooks for validation of the JSON file format. This provides the standardization for sharing a new community catalog with GWOSC for injection, when the criteria outlined in the guidelines are satisfied.

Current List of Community Catalogs

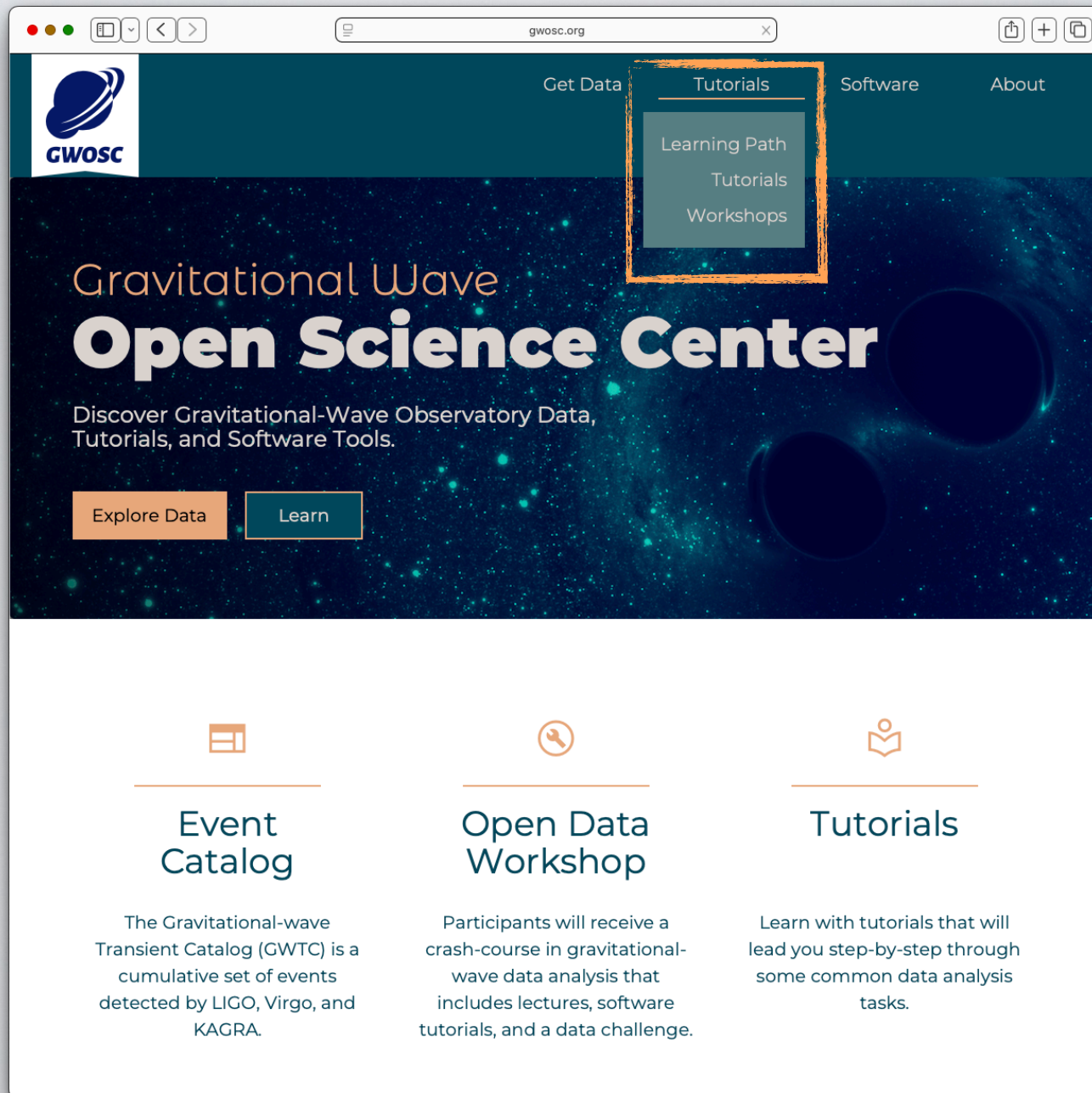
Release Name	Description
IAS-O3a	The IAS-O3a catalog contains 42 binary black hole mergers in the public data from the first half of the third observing run (O3a) of advanced LIGO and advanced Virgo. Of these, 10 were reported there for the first time. Details and additional data products are linked from the documentation page .

WHAT ARE COMMUNITY CATALOGS

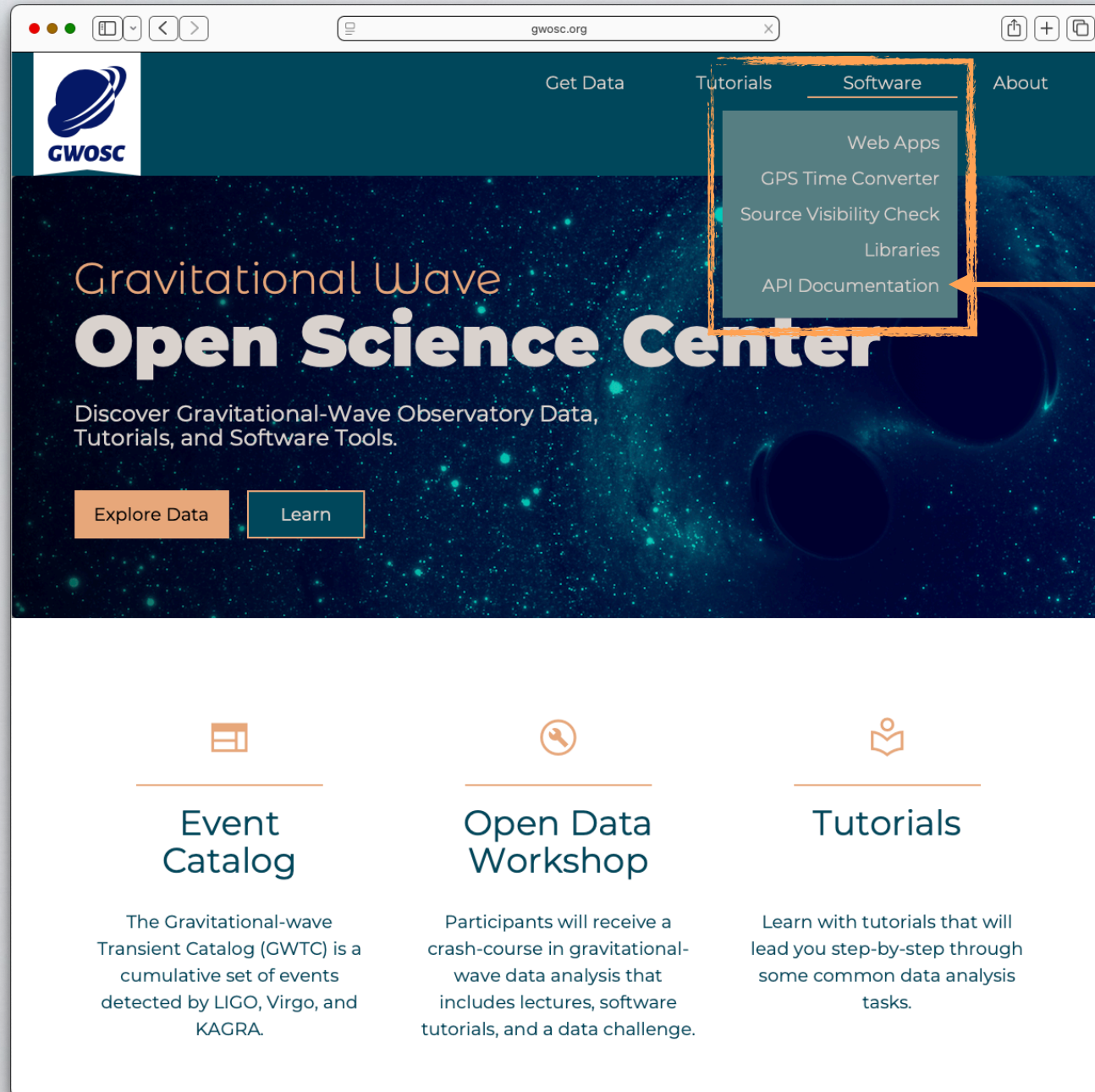
- Catalogs by authors outside of the LVK collaboration that are included on GWOSC
 - (see <https://gwosc.org/CommCatalogs/CommCatInfo/>)
- Community Catalogs are carefully vetted using the criteria listed in the *Community Catalog Guidelines* document:
 - Goal is to include the full set of GW discoveries available in the scientific literature.
 - It is not meant to include every re-analysis; instead to focus on work that discovers previously unknown astrophysical transients.
 - In general, catalogs that are added to the Event Portal should be published in a respected peer-reviewed, scientific journal.
 - (see <https://dcc.ligo.org/LIGO-M2500012/public> for guideline details)
- Currently one (IAS-O3a) community catalog, but have plans for more in the future.

TUTORIALS, SOFTWARE & MORE

TUTORIALS MENU



SOFTWARE



The screenshot shows the GWOSC website in a web browser. The browser's address bar displays 'gwosc.org'. The website's header features the GWOSC logo on the left and navigation links for 'Get Data', 'Tutorials', 'Software', and 'About' on the right. The 'Software' link is highlighted with an orange box, and a dropdown menu is visible, listing 'Web Apps', 'GPS Time Converter', 'Source Visibility Check', 'Libraries', and 'API Documentation'. An orange arrow points from a text box on the right to the 'API Documentation' option. The main content area has a dark blue background with a starry pattern and features the text 'Gravitational Wave Open Science Center' and 'Discover Gravitational-Wave Observatory Data, Tutorials, and Software Tools.' Below this are two buttons: 'Explore Data' and 'Learn'. At the bottom, there are three sections: 'Event Catalog' with a calendar icon, 'Open Data Workshop' with a wrench icon, and 'Tutorials' with a book icon. Each section has a brief description of its content.

GWOSC


Get Data Tutorials **Software** About

Web Apps
GPS Time Converter
Source Visibility Check
Libraries
API Documentation


Gravitational Wave
Open Science Center

Discover Gravitational-Wave Observatory Data,
Tutorials, and Software Tools.


Explore Data Learn

 **Event Catalog**

The Gravitational-wave Transient Catalog (GWTC) is a cumulative set of events detected by LIGO, Virgo, and KAGRA.

 **Open Data Workshop**

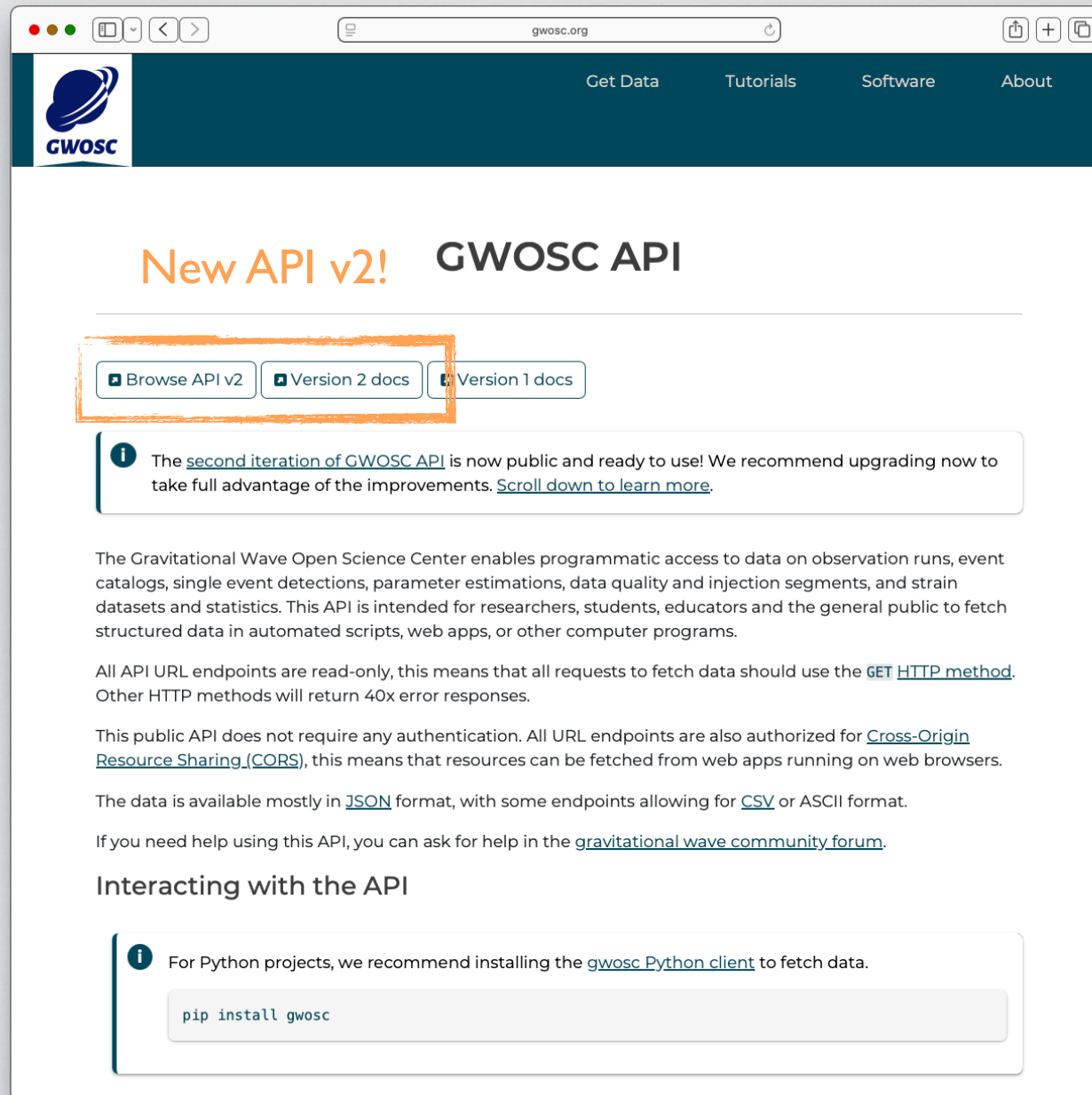
Participants will receive a crash-course in gravitational-wave data analysis that includes lectures, software tutorials, and a data challenge.

 **Tutorials**

Learn with tutorials that will lead you step-by-step through some common data analysis tasks.

Programmatic
interface to
the data!

PROGRAMMATIC ACCESS TO DATA



The screenshot shows the GWOSC API website in a web browser. The browser's address bar displays 'gwosc.org'. The website's header features the GWOSC logo on the left and navigation links for 'Get Data', 'Tutorials', 'Software', and 'About' on the right. The main content area has a large heading 'New API v2! GWOSC API'. Below this heading, there are three buttons: 'Browse API v2', 'Version 2 docs', and 'Version 1 docs'. The 'Browse API v2' button is highlighted with an orange rectangular border. Below the buttons, an information box with an 'i' icon states: 'The [second iteration of GWOSC API](#) is now public and ready to use! We recommend upgrading now to take full advantage of the improvements. [Scroll down to learn more.](#)'. The main text block explains that the GWOSC API provides programmatic access to data on observation runs, event catalogs, single event detections, parameter estimations, data quality and injection segments, and strain datasets and statistics. It notes that the API is read-only and uses the GET HTTP method. It also mentions that the API is public and does not require authentication, supporting Cross-Origin Resource Sharing (CORS). The data is available in JSON format, with some endpoints supporting CSV or ASCII. A link to the gravitational wave community forum is provided for help. The section 'Interacting with the API' follows, with an information box recommending the installation of the 'gwosc Python client' for Python projects. A code block shows the command 'pip install gwosc'.

GWOSC

Get Data Tutorials Software About

New API v2! GWOSC API

[Browse API v2](#) [Version 2 docs](#) [Version 1 docs](#)

i The [second iteration of GWOSC API](#) is now public and ready to use! We recommend upgrading now to take full advantage of the improvements. [Scroll down to learn more.](#)

The Gravitational Wave Open Science Center enables programmatic access to data on observation runs, event catalogs, single event detections, parameter estimations, data quality and injection segments, and strain datasets and statistics. This API is intended for researchers, students, educators and the general public to fetch structured data in automated scripts, web apps, or other computer programs.

All API URL endpoints are read-only, this means that all requests to fetch data should use the [GET HTTP method](#). Other HTTP methods will return 40x error responses.

This public API does not require any authentication. All URL endpoints are also authorized for [Cross-Origin Resource Sharing \(CORS\)](#), this means that resources can be fetched from web apps running on web browsers.

The data is available mostly in [JSON](#) format, with some endpoints allowing for [CSV](#) or ASCII format.

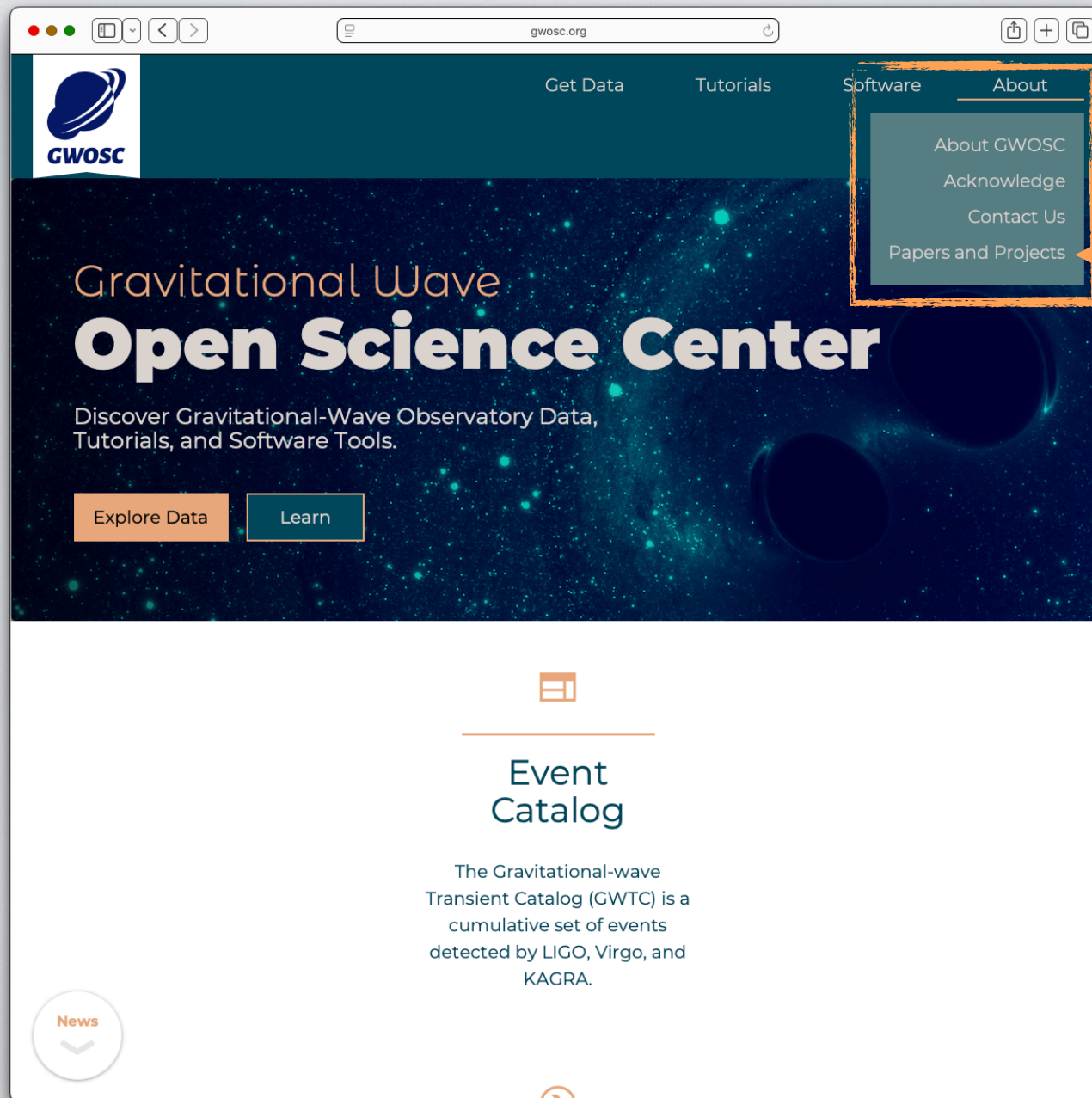
If you need help using this API, you can ask for help in the [gravitational wave community forum](#).

Interacting with the API

i For Python projects, we recommend installing the [gwosc Python client](#) to fetch data.


```
pip install gwosc
```



ABOUT



Papers about
GWOSC and
much more!

LATEST O3B OPEN DATA PAPER





A publishing partnership

OPEN ACCESS

Open Data from the Third Observing Run of LIGO, Virgo, KAGRA, and GEO


R. Abbott, H. Abe, F. Acernese, K. Ackley, S. Adhicary, N. Adhikari, R. X. Adhikari, V. K. Adkins, V. B. Adya, C. Affeldt [Show full author list](#)


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[The Astrophysical Journal Supplement Series, Volume 267, Number 2](#)

Citation R. Abbott *et al* 2023 *ApJS* 267 29

DOI 10.3847/1538-4365/acdc9f

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Article information ▾

Abstract


The global network of gravitational-wave observatories now includes five detectors, namely LIGO Hanford, LIGO Livingston, Virgo, KAGRA, and GEO 600. These detectors collected data during their third observing run, O3, composed of three phases: O3a starting in 2019 April and lasting six months, O3b starting in 2019 November and lasting five months, and O3GK starting in 2020 April and lasting two weeks. In this paper we describe these data and various other science products that can be freely accessed through the Gravitational Wave Open Science Center at <https://gwosc.org>. The main data set, consisting of the gravitational-wave strain time series that contains the astrophysical signals, is released together with supporting data useful for their analysis and documentation, tutorials, as well as analysis software packages.

Export citation and abstract




 

Article metrics

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Abstract

1. Introduction
2. Instruments
3. Strain Data
4. Online Event Catalogs
5. Technical Validation
6. Usage Notes
7. Summary

[Acknowledgments](#)

[Footnotes](#)

[References](#)

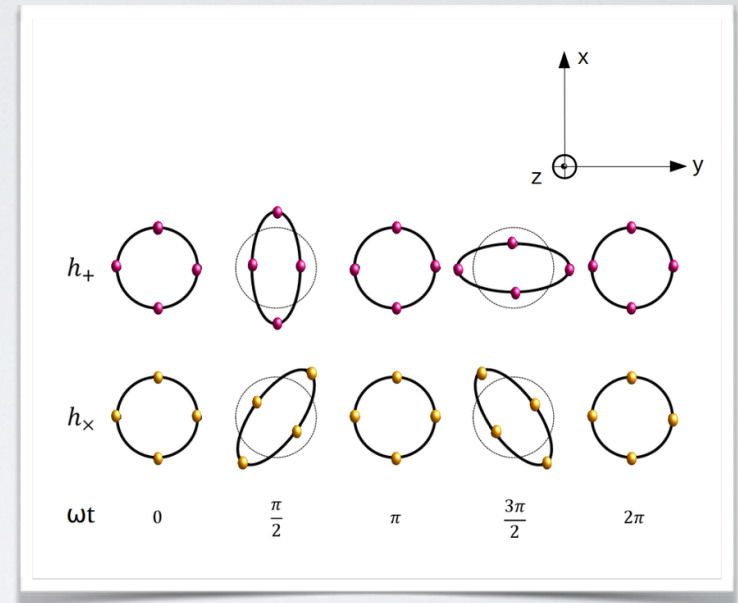
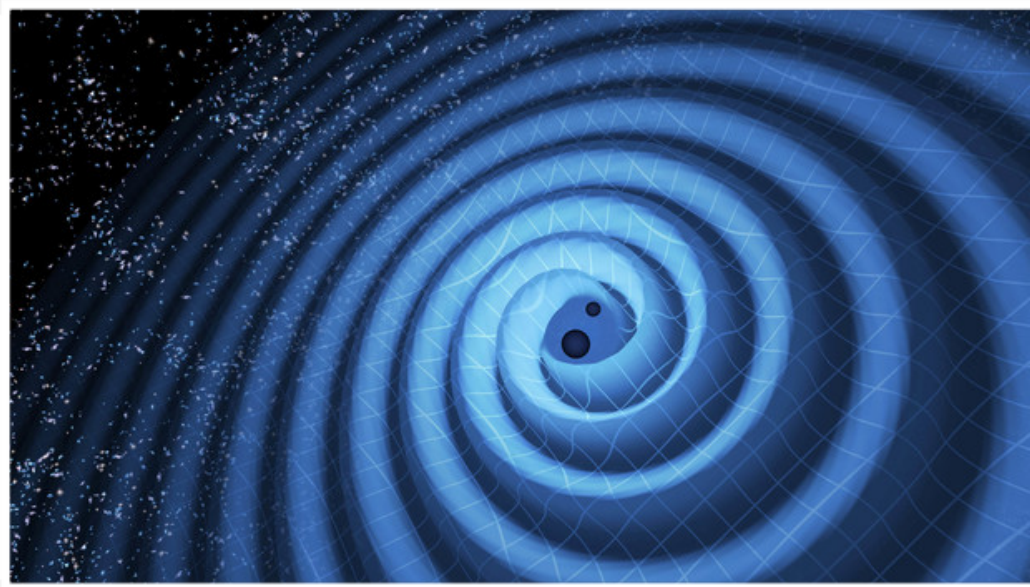
DOI 10.3847/1538-4365/acdc9f

“I was born not knowing and have had only a little time to change that here and there.”

– Richard P. Feynman

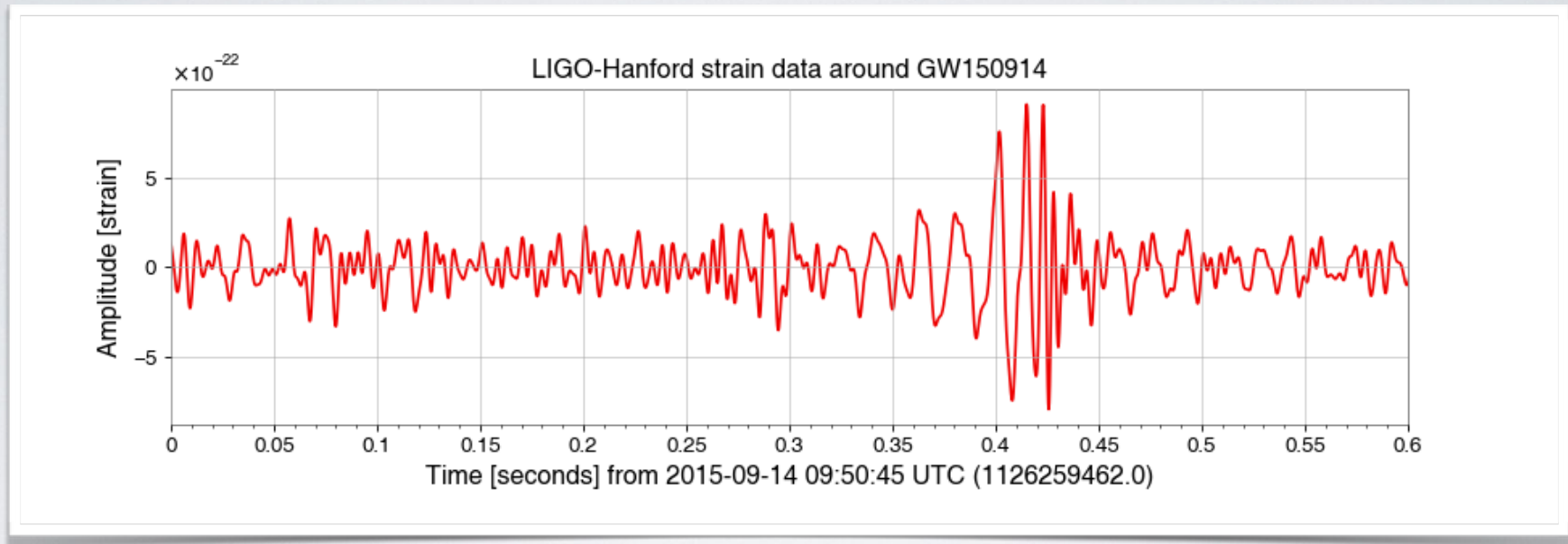
BONUS SLIDES
FOR YOUR SPARE TIME

WHAT ARE GRAVITATIONAL WAVES?



- Gravitational waves are **ripples in the fabric of spacetime**, illustrated in the left figure.
- Gravitational waves **travel at the speed of light** in a vacuum.
- Gravitational waves have **two fundamental polarizations** states called “plus” and “cross”, denoted by h_+ and h_\times in the right figure.
 - The plus (+) polarization, the circle stretches vertically and squeezes horizontally.
 - The cross (×) polarization, the stretching and squeezing happens at 45° angles relative to the plus.
 - If the detector arm are along the x and y directions and the wave travels in the z direction, only the h_+ polarization would be measured by the gravitational wave detector.

HOW GRAVITATIONAL WAVES ARE DETECTED



- Gravitational wave detectors experience the linear combination of these polarizations projected along the detector arms.
- The strain measured by the a gravitational wave detector is given by the change in length divided by the length of the detector's arms (*notice how small this is in the plot above - a few times 10^{-22}*).
- The gravitational signal measured by the LIGO-Hanford detector for the first detection (GW150914) is shown.
- The LIGO Livingston arms are sensitive to roughly the same polarization states but typically have a different time of arrival based on the position of the source on the sky.
 - NOTE: This detection resulted in the Nobel Prize in Physics (2017).
- This measured polarization state is the strain data provided on GWOSC.

WHY STUDY GRAVITATIONAL WAVES

Studying **gravitational waves** opens a **new way/window** to observe the **universe**, beyond light (electromagnetic waves), neutrinos, or cosmic rays:

- **New Information:** Gravitational waves carry information about events that **don't emit light** or whose light is hidden, like the collision of black holes. Traditional telescopes can't "see" these.
- **Testing Einstein's Theory:** They allow us to **test general relativity** in extreme conditions (like near black holes and neutron stars) where no other tests are possible.
- **Understanding Cosmic Events:** Gravitational waves reveal details about **cataclysmic events** — like black hole mergers, neutron star collisions, non-axisymmetric pulsars, supernovae, and even the Big Bang.
- **Probing the Early Universe:** Light-based telescopes can't look back earlier than about 380,000 years after the Big Bang (CMB), but gravitational waves could carry information from much **earlier times** — possibly just after the Big Bang.
- **Discovering the Unknown:** Just like radio waves led to discovering pulsars and X-rays led to finding black hole candidates, gravitational wave astronomy might **reveal phenomena we haven't imagined yet**.
- **Interdisciplinary Advances:** Multi-messenger astronomy / Developing the technology to detect gravitational waves (like LIGO and Virgo) pushes boundaries in **lasers, optics, quantum mechanics, data science, and materials science**.
- **Mature a User Community:** Researchers, Students, Citizen Scientists, Educators, and you.