

Welcome!

Thank you for joining the Open Data Workshop!

Schedule is on workshop home page:

<https://www.gw-openscience.org/s/workshop3/>

A team of mentors have prepared the software tutorials and check questions (“Google Quiz”)
Work on these during hands-on sessions

You are assigned to 1 of 6 hands on sections

Each section will meet twice:

* Hands on sessions A1, A2, A3: May 26th and 27th, 19:30 - 22:00 UTC

* Hands on sessions B1, B2, B3: May 27th and 28th, 07:00 - 09:30 UTC

Mentors have volunteered their time to make this workshop happen.

Please remember to thank your mentors!!

Learning Objectives

Skills you will learn in this workshop:

- * Learn the measurement principles of GW detectors
- * Learn the basics of searches for compact object mergers
- * Find and download LIGO/Virgo data
- * Plot spectrograms to recognize signals and glitches (`gwpv`)
- * Apply matched filtering to find compact object mergers (`pyCBC`)
- * Use parameter estimation to find masses and locations (`bilby`)

Data Challenge

This year's data challenge is now open:

<https://github.com/gw-odw/odw-2020/tree/master/Challenge>

- * Test the skills you will learn
- * Work individually or in small teams (2 or 3 people)
- * Submit solutions by the close-out session on 3rd day (May 28)



Gravitational Wave Open Science Center

Jonah Kanner - LIGO Lab, Caltech
May 26, 2020

G2000805 v3



Gravitational Wave Open Science Center



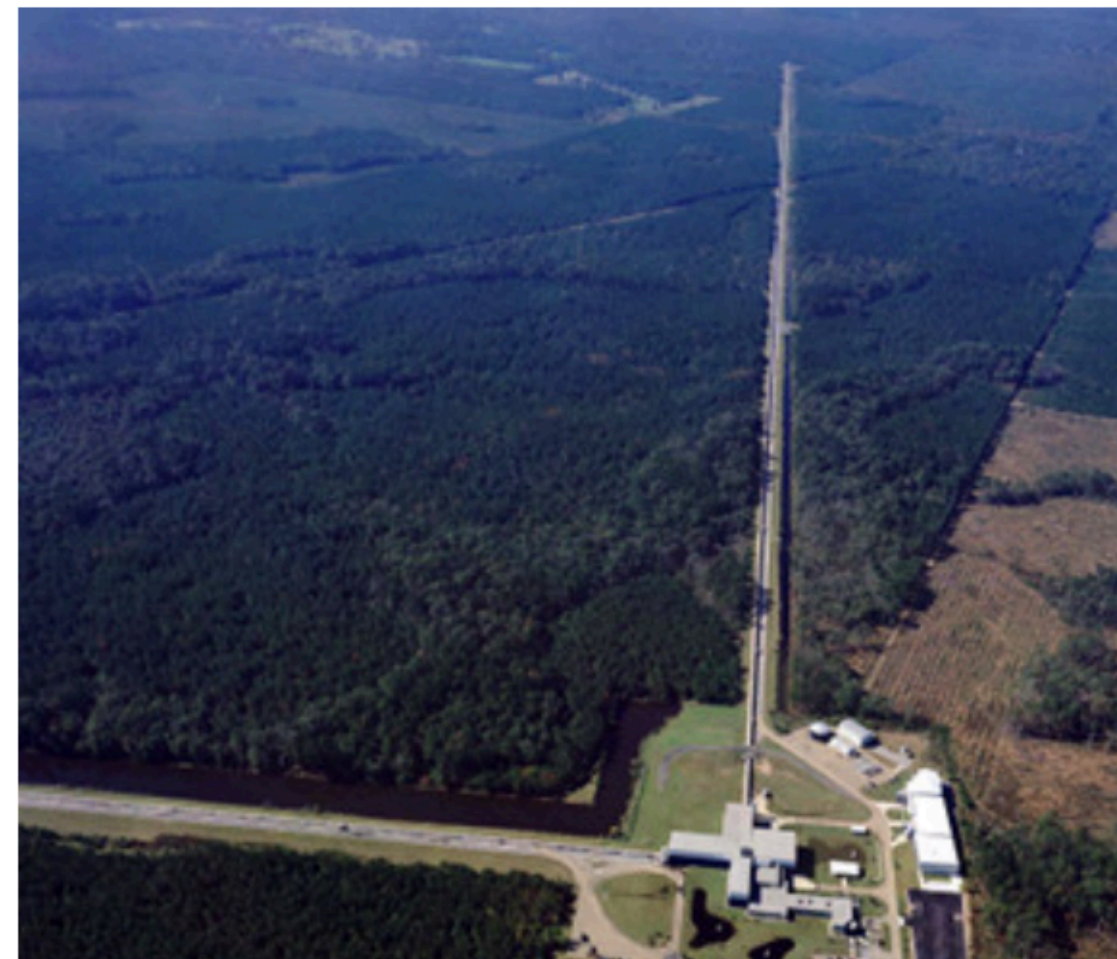
Data ▾

Software ▾

Online Status ▾

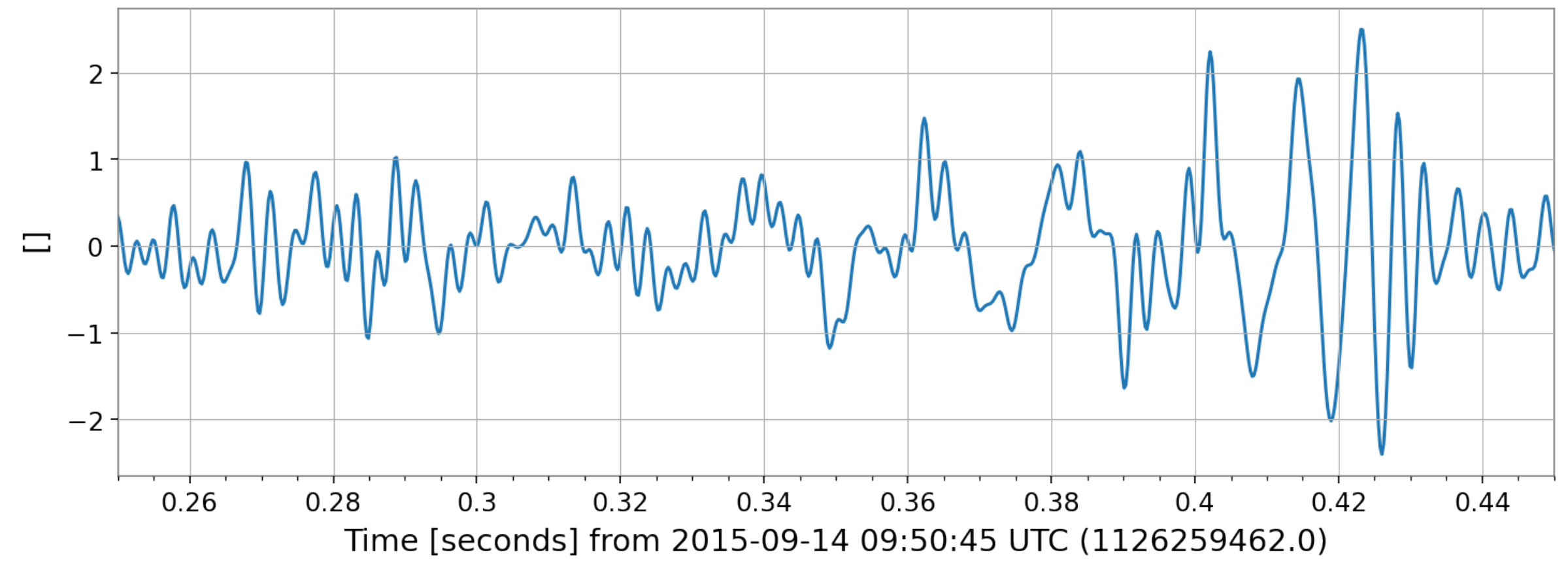
About GWOSC ▾

The Gravitational Wave Open Science Center provides **data from gravitational-wave observatories, along with access to **tutorials** and **software tools**.**



gw-openscience.org

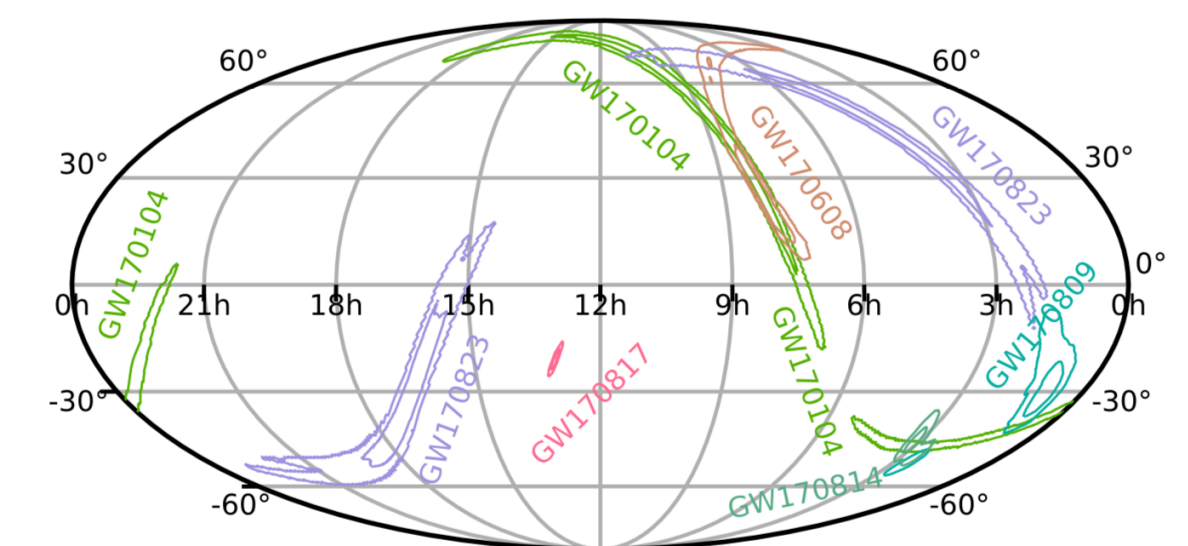
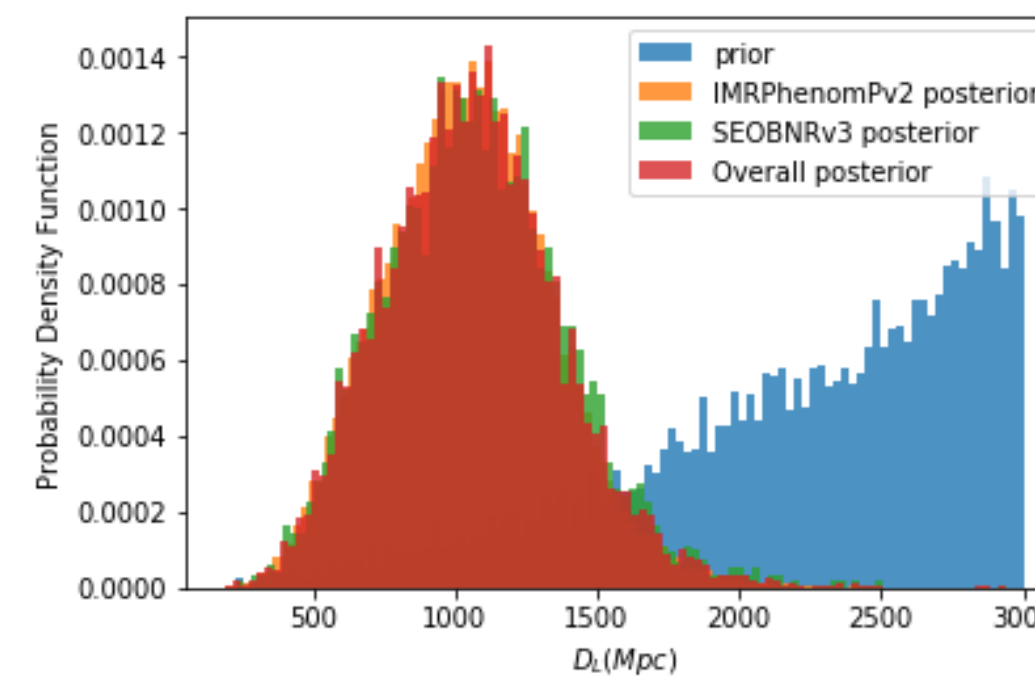
Strain Data



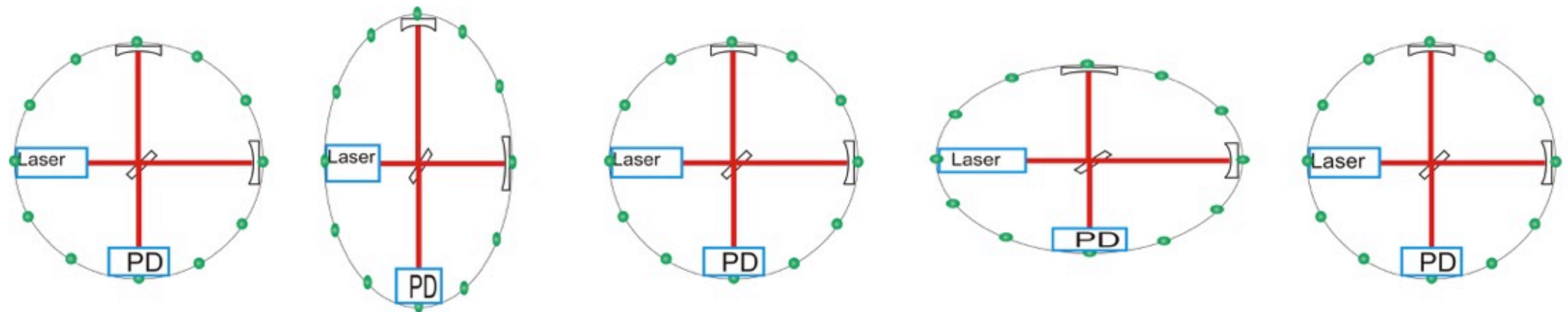
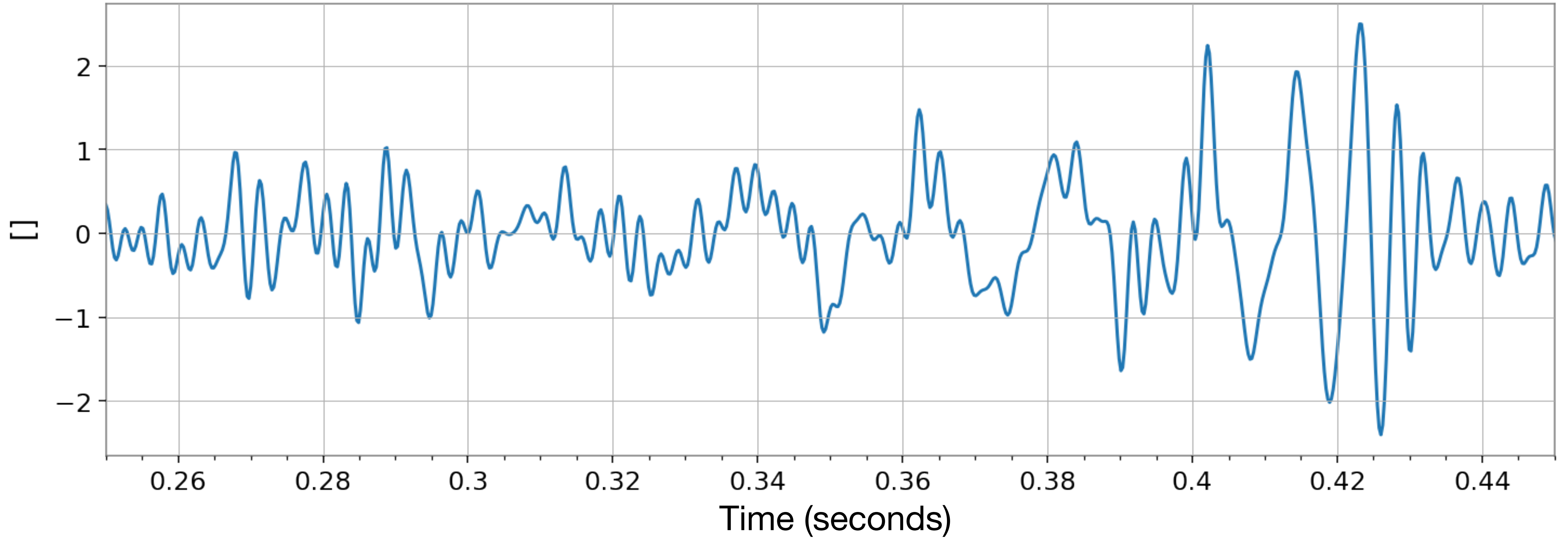
Segments (Timelines)

Start	Stop	Duration
1164559440	1164559654	214
1164560599	1164561392	793
1164562093	1164569775	7682

Analysis Results

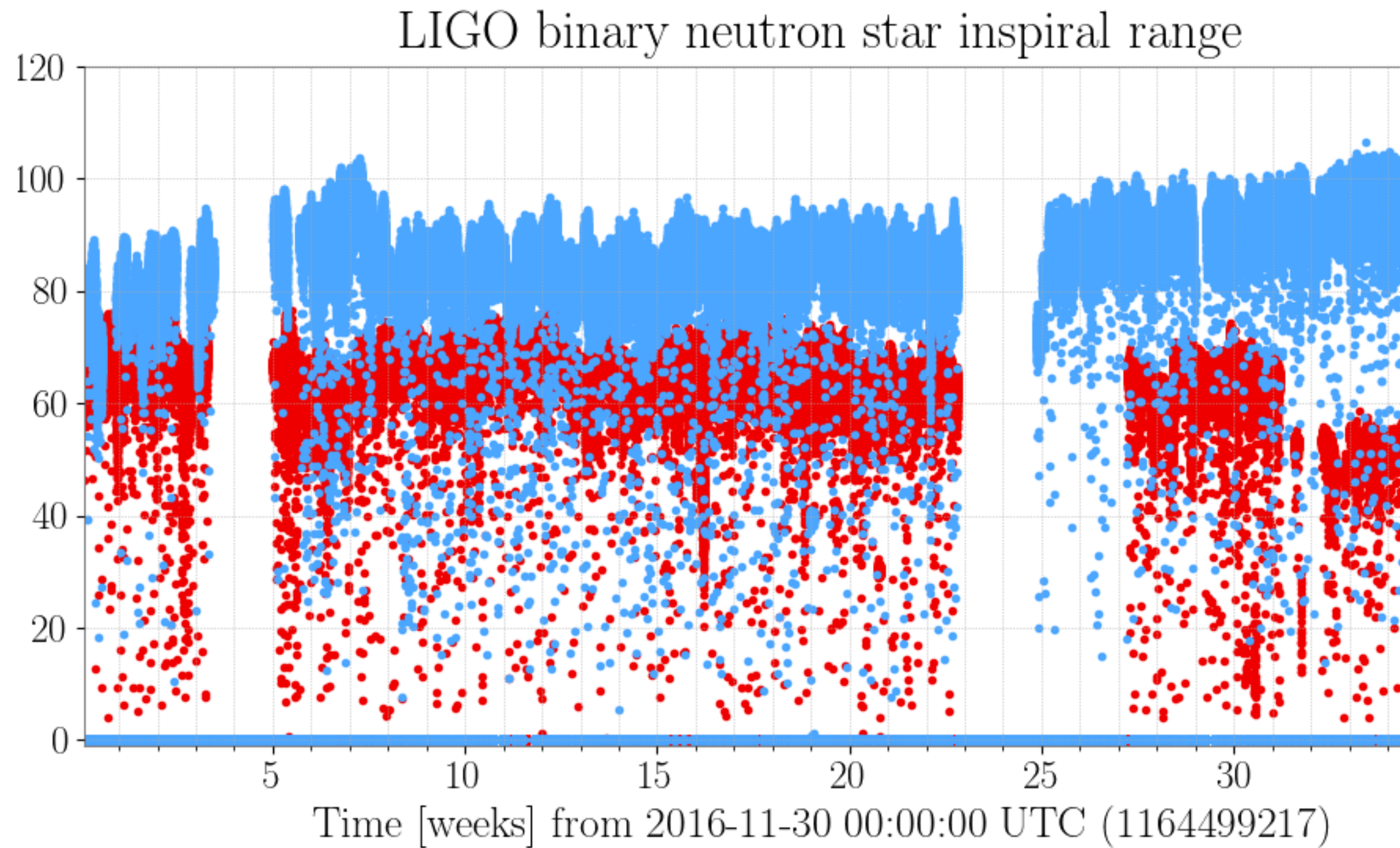


Time domain strain data



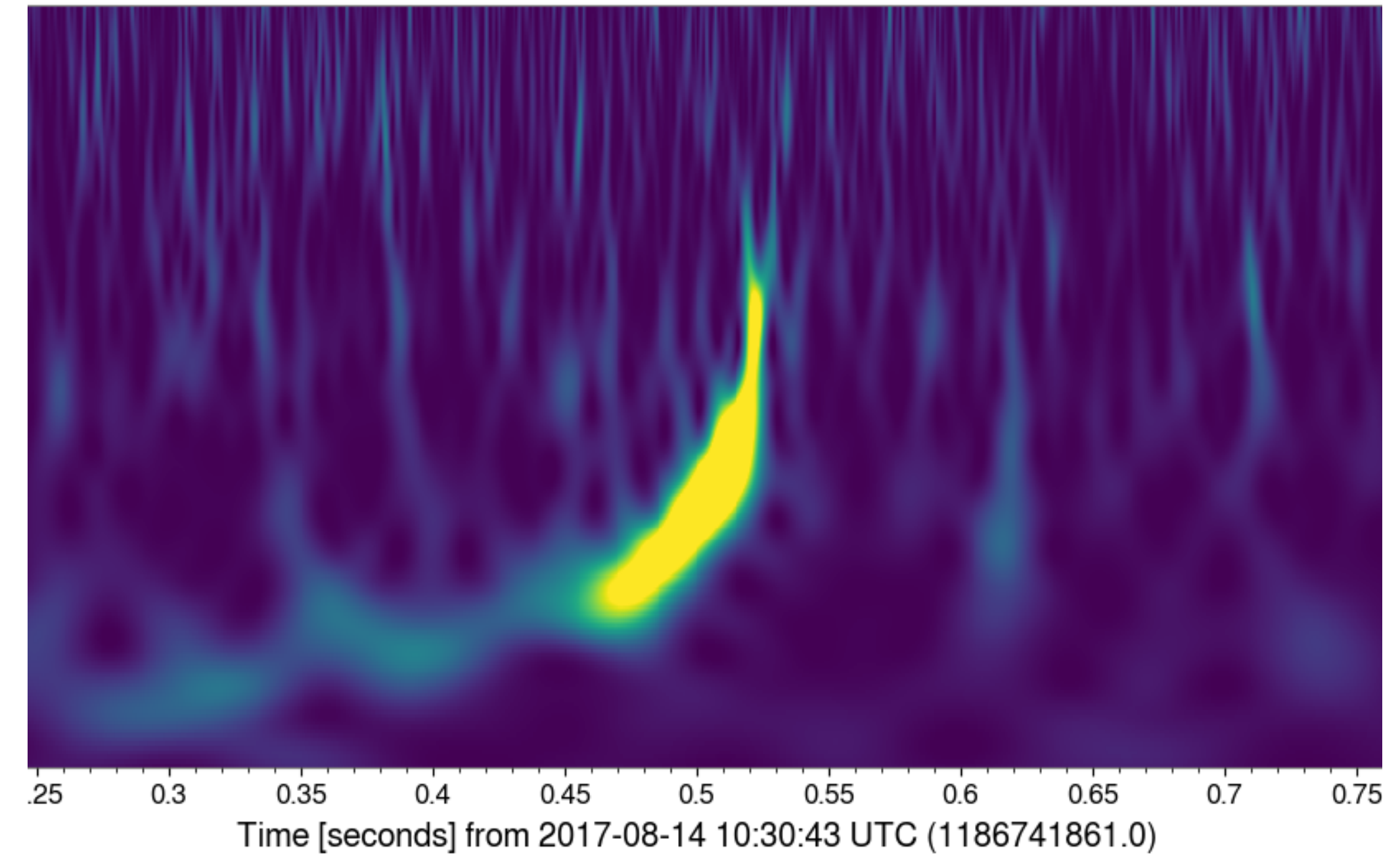
Runs

S5, S6, O1, and O2



Events

Transient Events



Access data through web interface, scriptable API, or CVMFS

Sponsored i



Adult Deluxe Chewbacca...

\$139.99

HalloweenCostum...

★★★★★ (20)



Adult Chewbacca Costume

\$343.90

Wholesale Hallow...



Boy's Deluxe Star Wars Chewbacca...

\$89.49

Oriental Trading C...



Adult's Deluxe Star Wars 2-Piece...

\$54.09

Oriental Trading C...



STAR WARS Chewbacca Do

\$10.00

📍 Petco.com

★★★★★ (70)



Event Portal

Find data from gravitational wave events.

[Browse catalogs](#)

[Browse events](#)

[Query by name](#)

Documentation

Version: v1

GPS: 1187529256.5

UTC Time: 2017-08-23 13:13

Catalog: [GWTC-1-confident](#)

Timeline: [Query for segments](#)

DOI: <https://doi.org/10.7935/82H3-HH23>

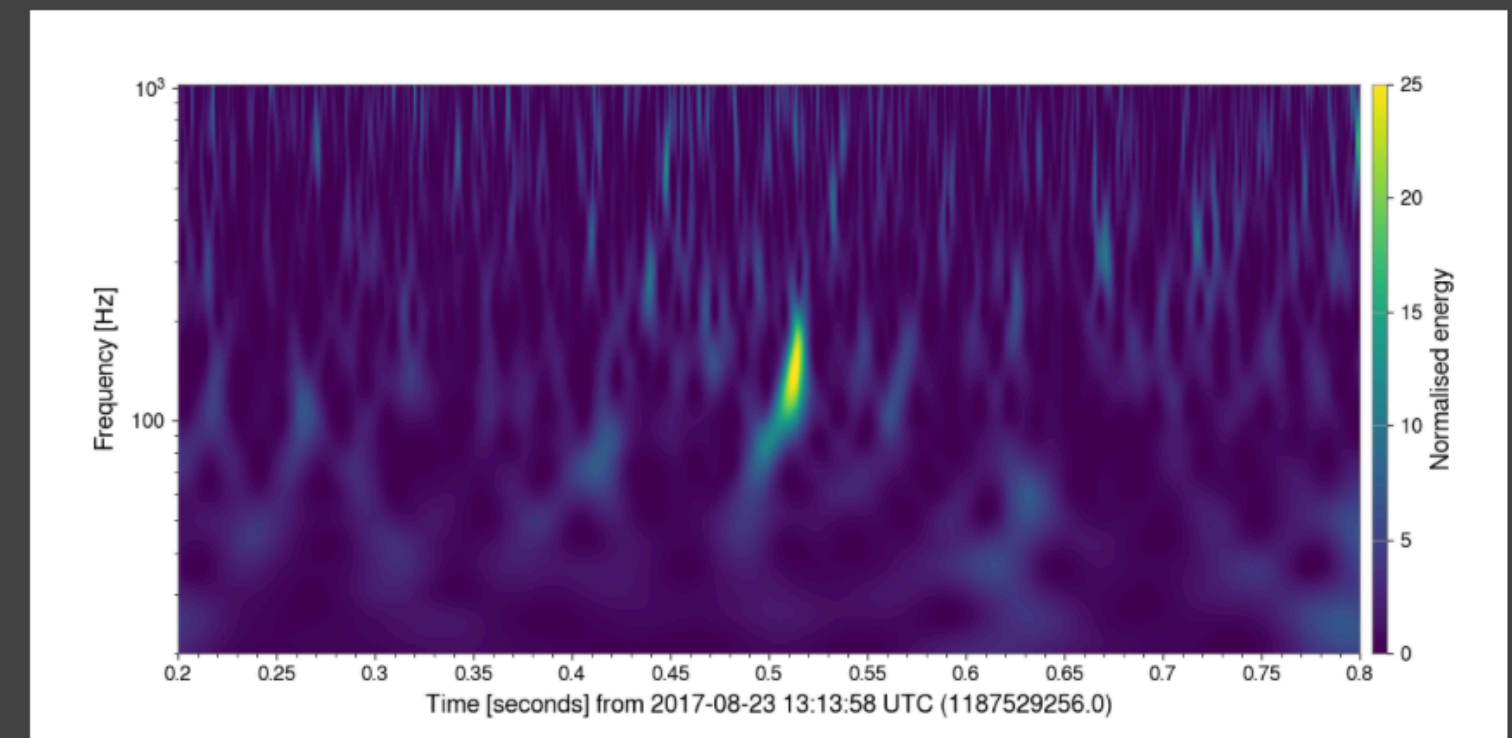
SORT: GPS ↓

Event List

Name	Version	Catalog	GPS ↓	Mass 1 (M _⊙)	Mass 2 (M _⊙)	Network SNR	Distance (Mpc)	X _{eff}	Chirp (M _⊙)
GW170823	v1	GWTC-1-confident	1187529256.5	^{+11.2} 39.5 _{-6.7}	^{+6.7} 29.0 _{-7.8}	11.5	⁺⁹⁷⁰ 1940 ₋₉₀₀	^{+0.22} 0.09 _{-0.26}	⁺ 29.2 ₋₃
GW170818	v1	GWTC-1-confident	1187058327.1	^{+7.5} 35.4 _{-4.7}	^{+4.3} 26.7 _{-5.2}	11.3	⁺⁴²⁰ 1060 ₋₃₈₀	^{+0.18} -0.09 _{-0.21}	⁺ 26.5 ₋₁
GW170817	v3	GWTC-1-confident	1187008882.4	^{+0.12} 1.46 _{-0.10}	^{+0.09} 1.27 _{-0.09}	33.0	⁺⁷ 40 ₋₁₅	^{+0.02} 0.00 _{-0.01}	1.186

Download table as: [JSON](#) - [ASCII](#) - [CSV](#)

H1 strain



32sec • 16KHz: [GWF](#) [HDF](#) [TXT](#)

32sec • 4KHz: [GWF](#) [HDF](#) [TXT](#)

4096sec • 16KHz: [GWF](#) [HDF](#) [TXT](#)

4096sec • 4KHz: [GWF](#) [HDF](#) [TXT](#)



Hulk Hogan & Randy Savage join forces: Saturday Night's

1,472,607 views • May 8, 2012

11K likes, 264 comments, SHARE, SAVE, ...

WWE logo and channel name with 60.4M subscribers

SUBSCRIBE button

Hulkamania and Macho Madness come together when Hulk Hogan & Randy Savage join forces on

Up next

AUTOPLAY toggle

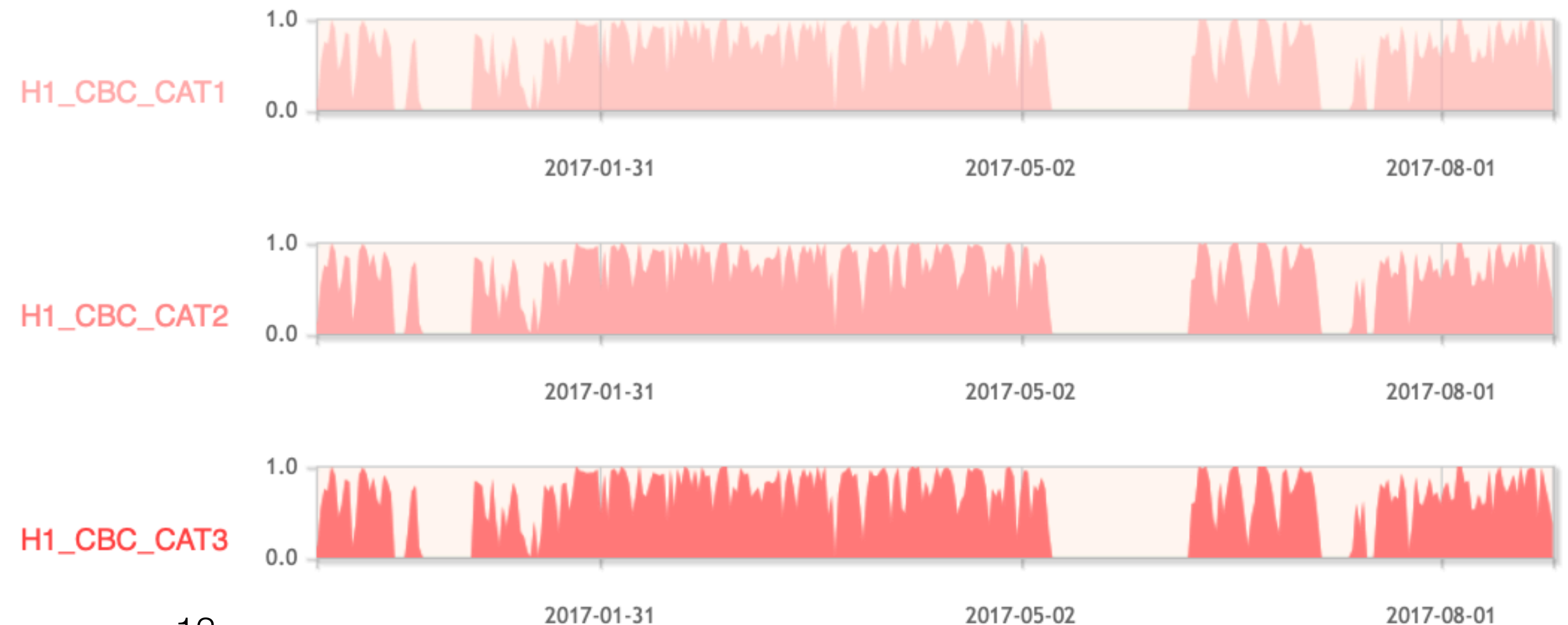
- The Untold Truth Of 'Macho Man' Randy Savage**
Grunge ✓
1.5M views • 11 months ago
11:42
- Corrections of errors taught by all churches**
Brady Hess
9.9K views
Ad
- 10 Wrestling Comebacks That Should Have Never Happened**
Cultaholic Wrestling
665K views • 2 weeks ago
1992 20 18:59
- Carson Can't Keep Up with Rodney Dangerfield's Non-Sto...**
Rodney Dangerfield ✓
9.9M views • 2 years ago
11:51
- An Inspiring must see interview with the Ultimate Warrior**
Slow Clap
1.1M views • 6 years ago
RIP V 8:15
- Coronavirus VII: Sports: Last Week Tonight with John Oliver...**
LastWeekTonight ✓
Recommended for you
New
21:46

Data quality segments

For all strain data, GWOSC provides segments lists for:

- * when DATA are available
 - * data quality category 1,2,3 for CBC searches
 - * data quality category 1,2,3 for burst searches
 - * all hardware injections
- * Same segment lists used by LVC working groups
- * Sufficient to reproduce search results

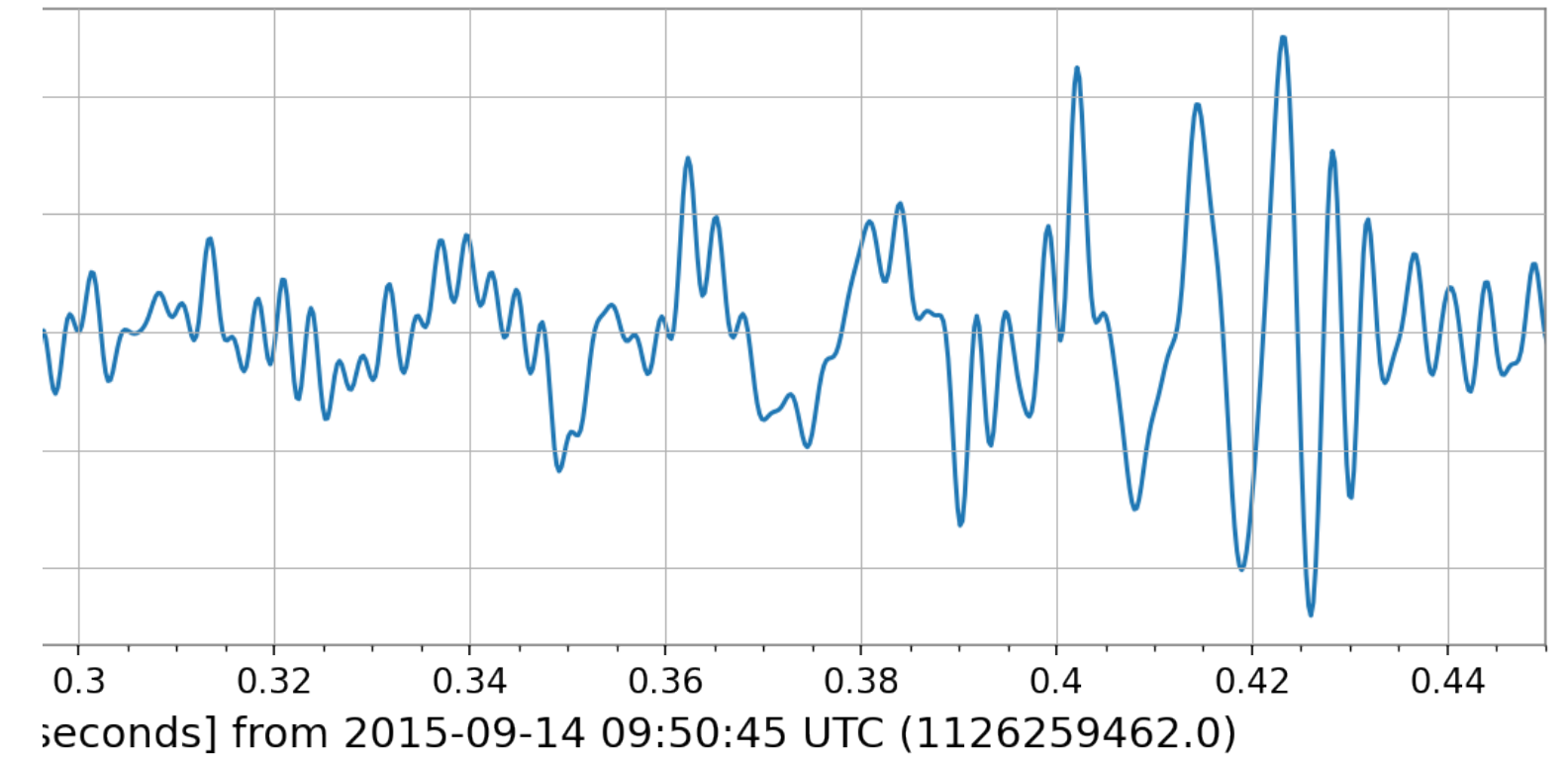
Start	Stop	Duration
1164559440	1164559654	214
1164560599	1164561392	793
1164562093	1164569775	7682
1164569814	1164574892	5078
1164596667	1164603464	6797
1164603474	1164603521	47
1164664648	1164665292	644
1164667198	1164669773	2575



What's in a data file?

Strain Vector

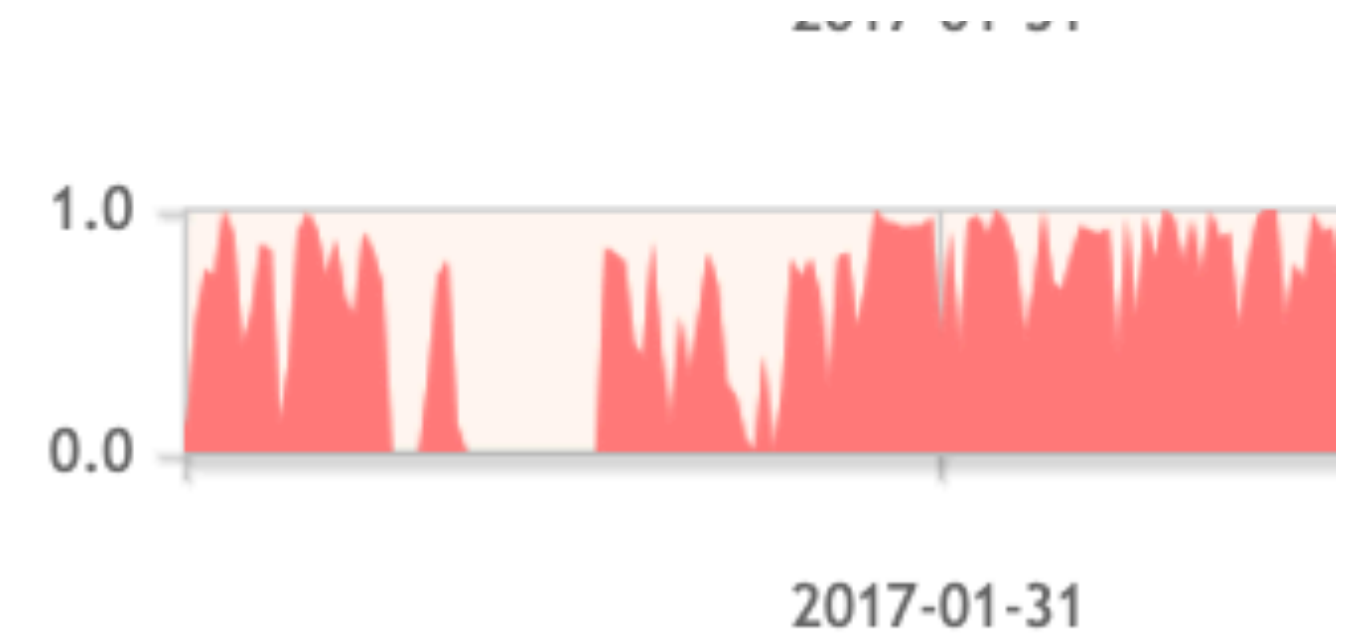
```
[2.17704028e-19,  
2.08763900e-19,  
2.39681183e-19,  
.../  
]
```



Data Quality Segments

```
1 Hz array of  
"good" and "bad"  
times
```

H1_CBC_CAT3



Meta-data

```
Start time, sample rate, DQ definitions, ...
```

Strain File formats

GWF
or HDF5

4 kHz
or 16 kHz

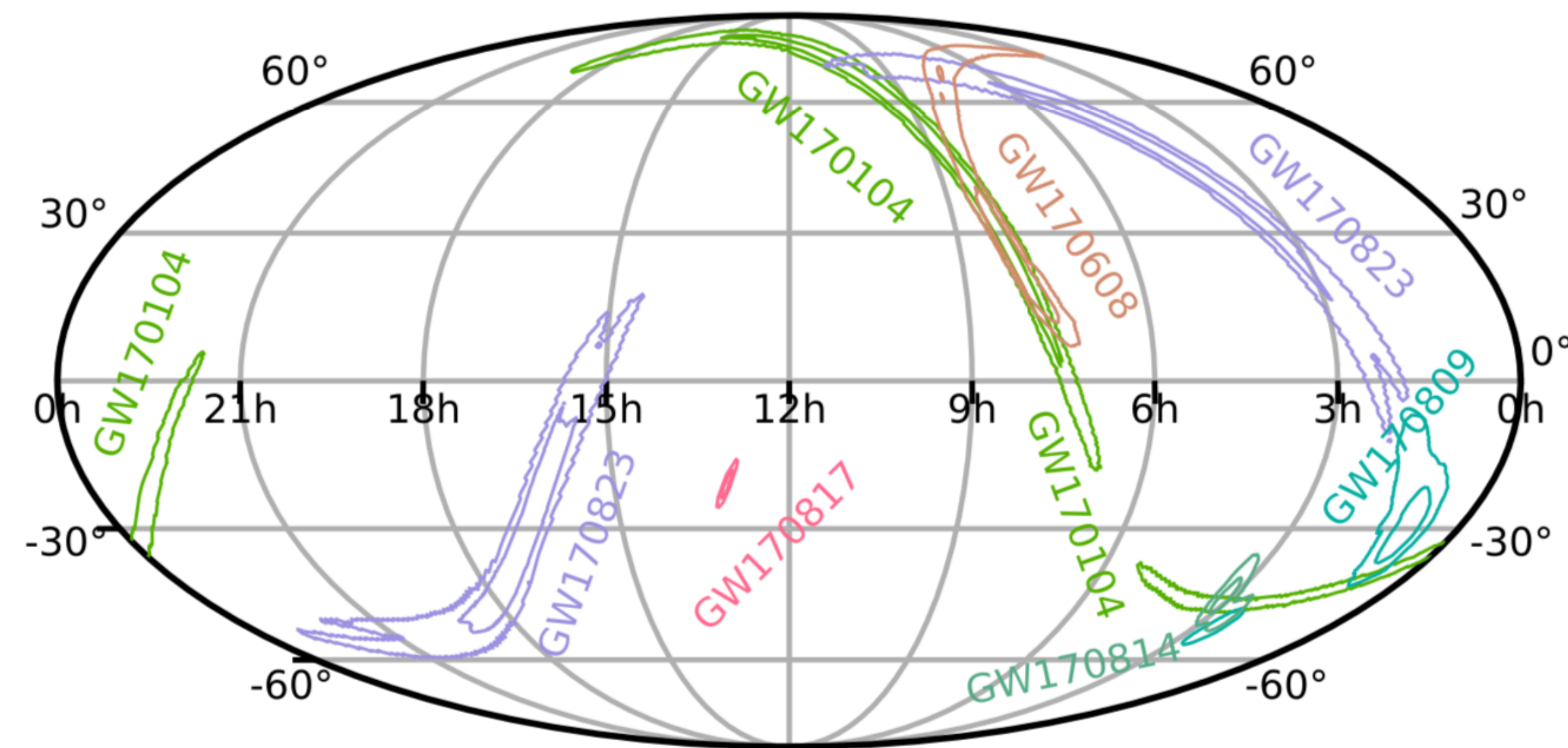
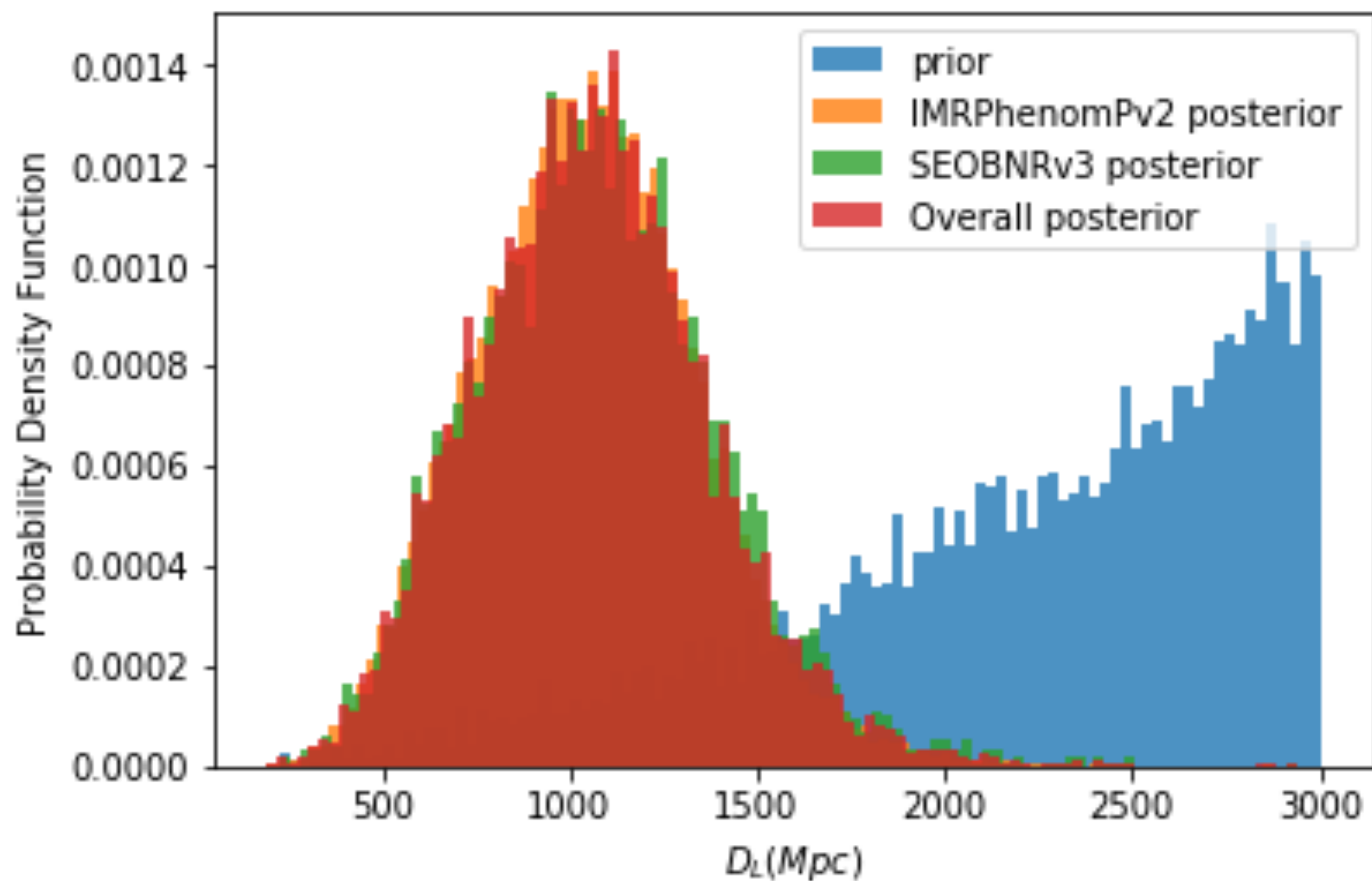
GWF format used internally:
gw-openscience.org/software

HDF5 popular file format:
h5py.org or hdgroup.org

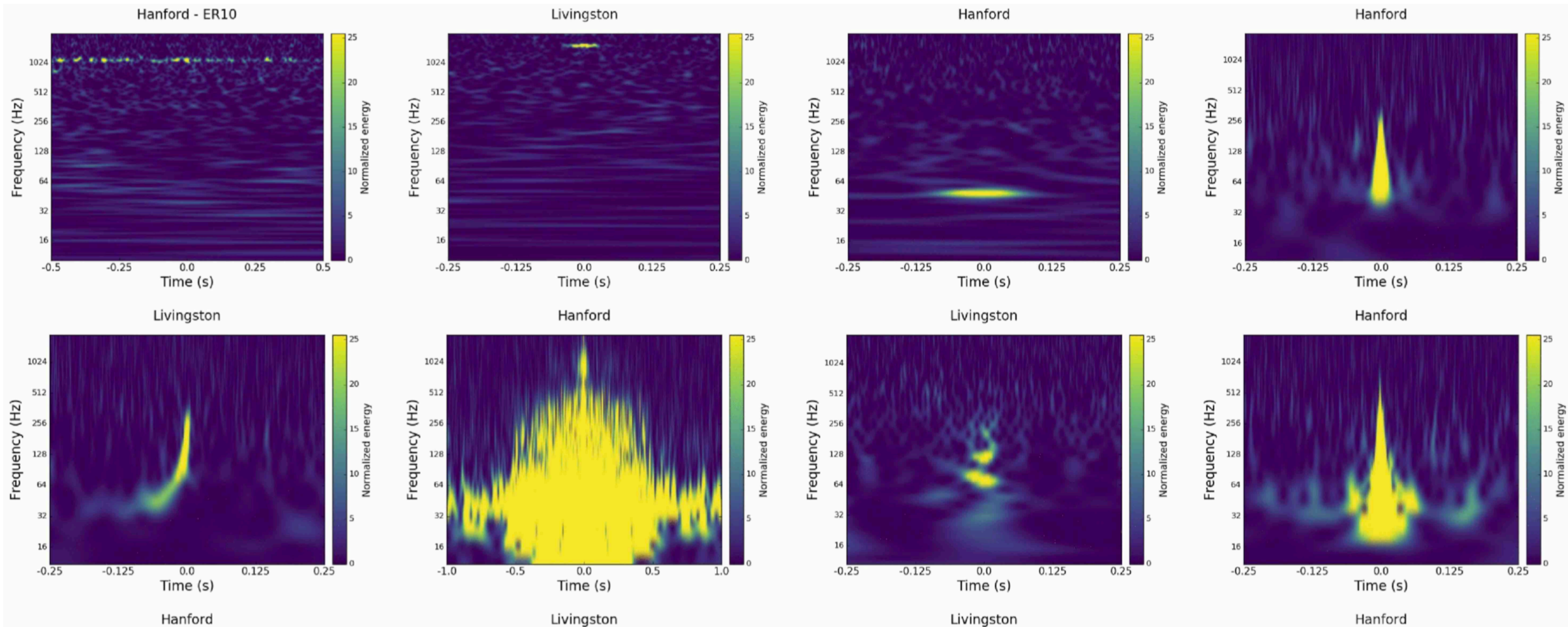
Choice of full sample rate 16384 Hz
or
Down-sampled 4096 Hz

Linked from Event Portal

- * Posterior samples
- * Confidence intervals
- * Source Localization



Machine Learning: Gravity Spy Data Set

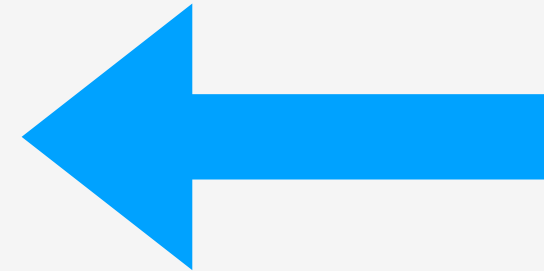


<https://doi.org/10.5281/zenodo.1486046>

Find & download data with `gwosc` client

<https://pypi.org/project/gwosc/>

```
[5] from gwosc import locate  
import requests
```

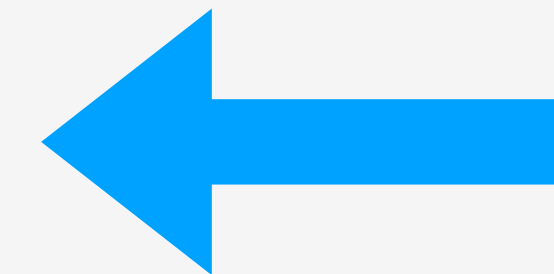


Find & download data with gwosc client

<https://pypi.org/project/gwosc/>

```
[5] from gwosc import locate
import requests

t0 = 1126259462.4
url = locate.get_urls('H1', t0, t0)[-1]
```



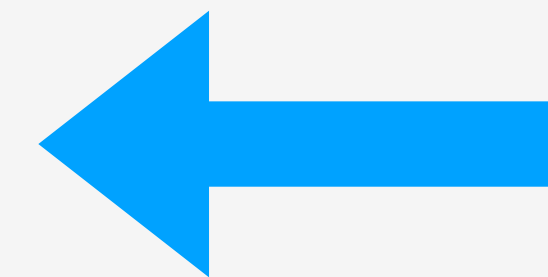
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```
[5] from gwosc import locate
import requests

t0 = 1126259462.4
url = locate.get_urls('H1', t0, t0)[-1]

with open(fn, 'wb') as strainfile:
    straindata = requests.get(url)
    strainfile.write(straindata.content)
```



“Quickview” at gw-openscience.org/tutorials

gw-openscience.org/software

Software for Gravitational Wave Data

Many of these packages can be installed through [LSCSoft Conda](#). See installation suggestions on the [software setup page](#).

GWpy

GWpy is a python package for gravitational-wave astrophysics.

- [GWpy Home Page](#)

PyCBC

PyCBC is a software package used to explore astrophysical sources of gravitational waves. It is a python package that provides functionality to analyze gravitational-wave data, detect the signatures of compact binary mergers, and estimate the parameters of a potential source.

- [Home Page](#)
- [Online Notebooks](#)
- [Docker container](#)

Bilby

The aim of bilby is to provide user friendly interface to perform parameter estimation. It is primarily designed and built for inference of compact binary coalescence events in interferometric data, but it can also be used for more general problems.

- [Documentation](#)
- [Source Code](#)
- [Python package in PyPI](#)

gw-openscience.org/software

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At this workshop!

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- [Python package in PyPI](#)



Data Release Timing



Data management plan at: <https://dcc.ligo.org/LIGO-M1000066/public>

O3 Policy

- * **Public Alerts:** 5 minutes latency
 - * EM Counterparts
 - * Sky position, false alarm rate, source classification

- * **Strain data around events:** With publication
 - * Catalogs: 6 months observing + 6 months analysis
 - * 4096 seconds of strain data per event

- * **“Bulk” strain data:** 6 months observing, released after 18 months
 - * All observing mode strain data
 - * First O3 bulk data release April of 2021

Summary

Everything you need to work with LIGO/Virgo data at
gw-openscience.org

Data downloads

Software

Tutorials

Event Catalogs

Data Analysis Results

Thank you

Impacts of open data

Professional research, student projects, classroom activities, text books, art projects, workshops, training

140 published papers that acknowledge use of GWOSC (INSPIRE-HEP)
<https://inspirehep.net/search?ln=en&p=refersto%3Arecid%3A1322875>

Around 3,000 visitors each month (unique IP) and thousands of strain file downloads

