LIGO Open Science Center

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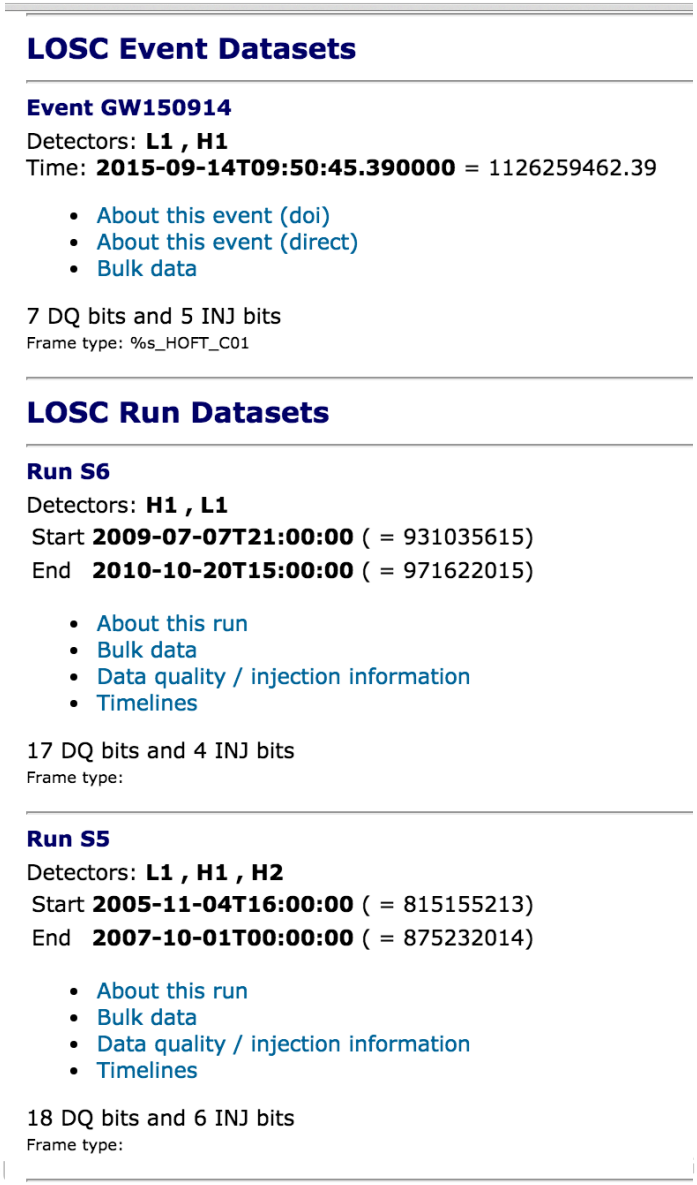
LIGO Laboratory
and many others

LIGO Open Science Center

- Data = Events + Runs

LIGO measures strain at 4 kHz with 2 detectors H1 and L1

LOSC serves 12 Tbytes from earlier Runs, as well as open data from confirmed Events



LOSC Event Datasets

Event GW150914

Detectors: **L1 , H1**
Time: **2015-09-14T09:50:45.390000** = 1126259462.39

- About this event (doi)
- About this event (direct)
- Bulk data

7 DQ bits and 5 INJ bits
Frame type: %s_HOFT_C01

LOSC Run Datasets

Run S6

Detectors: **H1 , L1**
Start **2009-07-07T21:00:00** (= 931035615)
End **2010-10-20T15:00:00** (= 971622015)

- About this run
- Bulk data
- Data quality / injection information
- Timelines

17 DQ bits and 4 INJ bits
Frame type:

Run S5

Detectors: **L1 , H1 , H2**
Start **2005-11-04T16:00:00** (= 815155213)
End **2007-10-01T00:00:00** (= 875232014)

- About this run
- Bulk data
- Data quality / injection information
- Timelines

18 DQ bits and 6 INJ bits
Frame type:

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- Data =
  - Strain at 4096 Hz
  - Data Quality and Injections at 1 Hz
- Formats =
  - hdf5 for longevity, broad use
  - gwf for the LIGO community
  - .txt.gz when you don't want metadata

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- Actors =
  - Human via html/forms/POST
  - Machine via json/POST
- Services
  - Bulk data tools
  - Timelines
  - MySources tool
  - Skymap Viewer

Bulk data tools

Timeline	UTC	Mbytes	HDF5	Frame	Seconds (of 4096) where flag is true																			
					DATA	CBC_HIGH_CAT1	CBC_HIGH_CAT2	CBC_HIGH_CAT3	CBC_HIGH_CAT4	CBC_LOW_CAT1	CBC_LOW_CAT2	CBC_LOW_CAT3	CBC_LOW_CAT4	BURST_CAT1	BURST_CAT2	BURST_CAT3	BURST_CAT4	BURST_CAT3H	BURST_CAT4H	CW_CAT1	STOCH_CAT1	HW_CBC	HW_BURST	HW_STOCH
962568192	2010-07-07T20:02:57	111 MB	HDF5	Frame	86	86	86	65	65	86	86	66	66	86	86	79	79	73	73	86	86	0	0	0	0
962572288	2010-07-07T21:11:13	77 MB	HDF5	Frame	59	59	59	52	52	59	59	54	54	59	58	52	52	50	50	55	59	0	0	0	0
962576384	2010-07-07T22:19:29	35 MB	HDF5	Frame	26	26	26	22	22	26	26	25	25	26	26	22	22	21	21	26	26	0	0	0	0
962580480	2010-07-07T23:27:45	42 MB	HDF5	Frame	32	32	32	31	31	32	32	31	31	32	31	30	30	29	29	29	32	0	0	0	0
962600960	2010-07-08T05:09:05	23 MB	HDF5	Frame	17	17	17	16	16	17	17	17	17	17	17	17	17	17	17	17	17	0	0	0	0
962605056	2010-07-08T06:17:21	129 MB	HDF5	Frame	100	100	100	99	99	100	100	99	99	100	100	99	99	98	98	100	100	0	0	0	0
962609152	2010-07-08T07:25:37	129 MB	HDF5	Frame	100	100	100	97	97	100	100	98	98	100	100	98	98	97	97	100	100	3	3	0	0
962613248	2010-07-08T08:33:53	129 MB	HDF5	Frame	100	100	100	99	99	100	100	99	99	100	100	99	99	98	98	100	100	2	0	2	0
962617344	2010-07-08T09:42:09	129 MB	HDF5	Frame	100	100	100	98	98	100	100	98	98	100	100	98	98	98	98	100	100	0	0	0	0
962621440	2010-07-08T10:50:25	80 MB	HDF5	Frame	61	61	61	58	58	61	61	59	59	61	60	56	56	55	55	56	61	0	0	0	0
962625536	2010-07-08T11:58:41	102 MB	HDF5	Frame	78	78	78	46	46	78	78	46	46	78	78	62	62	61	61	76	78	0	0	0	0
962629632	2010-07-08T13:06:57	45 MB	HDF5	Frame	34	34	34	22	22	34	34	22	22	34	34	30	30	28	28	34	34	0	0	0	0
962633728	2010-07-08T14:15:13	48 MB	HDF5	Frame	36	36	36	19	19	36	36	19	19	36	36	28	28	26	26	31	36	2	0	2	0
962637824	2010-07-08T15:23:29	129 MB	HDF5	Frame	100	100	100	80	80	100	100	81	81	100	100	93	93	92	92	100	100	3	3	0	0
962641920	2010-07-08T16:31:45	87 MB	HDF5	Frame	67	67	67	34	34	67	67	34	34	67	66	47	47	47	47	62	67	0	0	0	0
962646016	2010-07-08T17:40:01	129 MB	HDF5	Frame	100	100	100	71	71	100	100	71	71	100	100	96	96	95	95	100	100	0	0	0	0

JSONLint

The JSON Validator


```
{
    "dataset": "S6",
    "GPSstart": 962571615,
    "GPSend": 966351615,
    "strain": [{
        "GPSstart": 962568192,
        "UTCstart": "2010-07-07T20:02:57",
        "detector": "L1",
        "sampling_rate": 4096,
        "duration": 4096,
        "format": "hdf5",
        "url": "https://losc.ligo.org/archive/data/S6/
        "min_strain": -1.4990449180 9e-16,
        "max_strain": 1.3957843069 7e-16,
        "mean_strain": -1.0750702232 7e-20,
        "stdev_strain": 2.8107085234 9e-17,
        "duty_cycle": 86.1572265625,
        "BLRMS200": 4.0991408513e-23,
        "BLRMS1000": 4.4539109274e-22,
        "BNS": 13.0657611268
    }, {
        "GPSstart": 962568192,
```

Timelines


From: 2005-05-13T06:13:07
= GPS 800000000
Plot width: 11.10 years
= 350000000 s
Zoom out all the way
Zoom out
To: 2016-06-15T04:26:23
= GPS 1150000000
Sample time: 1.73 weeks
Coarser resolution
Finer resolution
URL for this view | Download this data
To zoom by factor 2, click in any panel.
G1_SCI
H1_SCI
H2_SCI
L1_SCI
V1_SCI
1.0
0.0
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
From: 2010-04-18T14:30:29
= GPS 955636244
Plot width: 3.12 hours
= 11230 s
Zoom out all the way
Zoom out
To: 2010-04-18T17:37:39
= GPS 955647474
Sample time: 32.00 secs
Coarser resolution
Finer resolution
URL for this view | Download this data
To zoom by factor 2, click in any panel.
H1_CBCLOW_CAT1
H1_CBCLOW_CAT2
H1_CBCLOW_CAT3
H1_CBCLOW_CAT4
L1_CBCLOW_CAT1
L1_CBCLOW_CAT2
L1_CBCLOW_CAT3
L1_CBCLOW_CAT4
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00

MySources

Replace these examples of input lines with your own in the format **Time [ID] [RA Dec]**, or copy/paste from the links above.

```
2009-07-20T17:02:56 090720B 13:31:59 -54:48
2009-08-02T05:39:03 090802A 05:37:19  34:05
2009-08-15T23:21:39 090815C 04:17:57 -65:57
2009-08-20T12:13:16 090820B 21:13:02 -18:35
2009-08-31T07:36:36 090831A 09:40:23  50:58
2009-09-27T10:07:16 090927  22:55:42 -70:58
2009-10-18T20:48:19 091018  02:08:46 -57:33
2009-11-26T07:59:24 091126A 05:33:00 -19:16
2009-11-27T23:25:45 091127  02:26:19 -18:57
```

(output as html) Run Query

The results show what proportion of the time the detector was in science mode during the window (duty
recorded by the Science Mode Timeline. If a source position is provided, the antenna response (F_{rss}) to t
also shown. $F_{rss} = \mathrm{sqrt}(F_+^2 + F_x^2)$ is a number between 0 and 1, where 1 means that the detector respc
maximum (See arXiv:1001.0165 for details). The color of each entry in the table is green for high duty c
taking data), or red for low duty cycle (detector was not taking data). The antenna pattern ($F_{+,x}$) is calc
function antenna.response(), with the polarization and inclination angles set to 0.

GPS	UTC	ID	G1 D.C. (F_{rss})	H1 D.C. (F_{rss})	L1 D.C. (F_{rss})	V1 D.C. (F_{rss})
932144591	2009-07-20T17:02:56	090720B	0.0 (0.42)	0.0 (0.85)	1.0 (0.56)	1.0 (0.42)
933226758	2009-08-02T05:39:03	090802A	1.0 (0.84)	1.0 (0.15)	1.0 (0.28)	1.0 (0.87)
934413714	2009-08-15T23:21:39	090815C	0.0 (0.78)	1.0 (0.85)	1.0 (0.80)	1.0 (0.68)
934805611	2009-08-20T12:13:16	090820B	0.0 (0.79)	1.0 (0.46)	0.0 (0.55)	1.0 (0.85)
935739411	2009-08-31T07:36:36	090831A	0.0 (0.90)	1.0 (0.15)	0.0 (0.09)	1.0 (0.88)
938081251	2009-09-27T10:07:16	090927	1.0 (0.94)	1.0 (0.57)	1.0 (0.46)	1.0 (0.89)
939934114	2009-10-18T20:48:19	091018	1.0 (0.59)	1.0 (0.98)	0.0 (0.82)	1.0 (0.30)
943257579	2009-11-26T07:59:24	091126A	1.0 (0.52)	1.0 (0.51)	0.0 (0.65)	1.0 (0.57)
943399560	2009-11-27T23:25:45	091127	0.0 (0.28)	0.0 (0.32)	1.0 (0.13)	1.0 (0.53)
944301012	2009-12-08T09:49:57	091208B	1.0 (0.31)	1.0 (0.39)	0.1 (0.11)	1.0 (0.58)
947218384	2010-01-11T04:12:49	100111A	0.0 (0.49)	1.0 (0.53)	1.0 (0.67)	0.0 (0.61)
949498220	2010-02-06T13:30:05	100206A	1.0 (0.49)	1.0 (0.54)	1.0 (0.67)	0.0 (0.64)
950135283	2010-02-13T22:27:48	100213A	0.0 (0.51)	1.0 (0.99)	1.0 (0.82)	0.0 (0.06)

LOSC and Jupyter

== iPython notebook

- Open Science =
  - Open Data + ← hdf5 files
  - Open Code + ← Jupyter notebook
  - Open Computing ← free cloud computing

Open Code

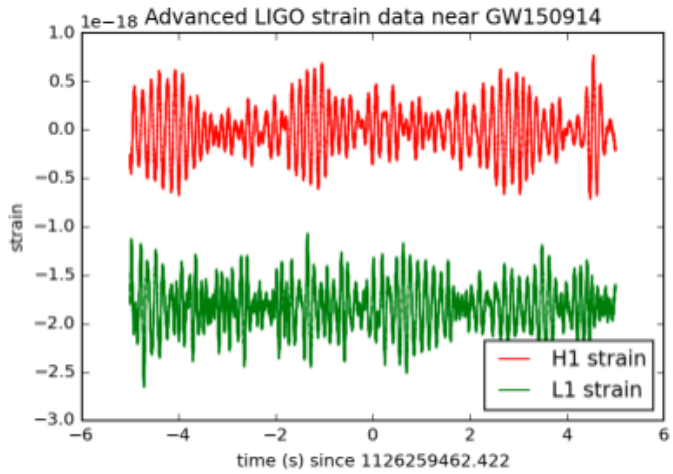
https://13.93.157.4:9999/notebooks/LOSC_Event_tutorial.ipynb

jupyter LOSC_Event_tutorial Last Checkpoint: a day ago (unsaved changes)

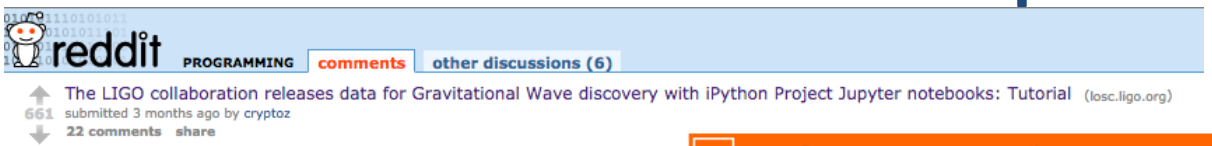
File Edit View Insert Cell Kernel Help

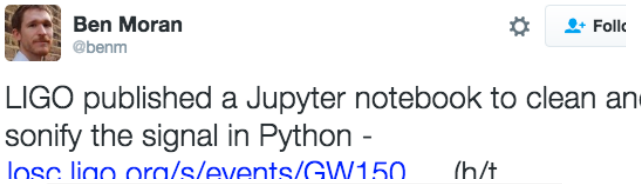
Code CellToolbar

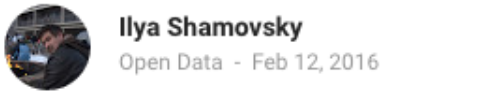
```
plt.figure()
plt.plot(time_H1[indxt]-tevent,strain_H1[indxt],'r',label='H1 strain')
plt.plot(time_L1[indxt]-tevent,strain_L1[indxt],'g',label='L1 strain')
plt.xlabel('time (s) since '+str(tevent))
plt.ylabel('strain')
plt.legend(loc='lower right')
plt.title('Advanced LIGO strain data near '+eventname)
plt.savefig(eventname+'_strain.png')
```

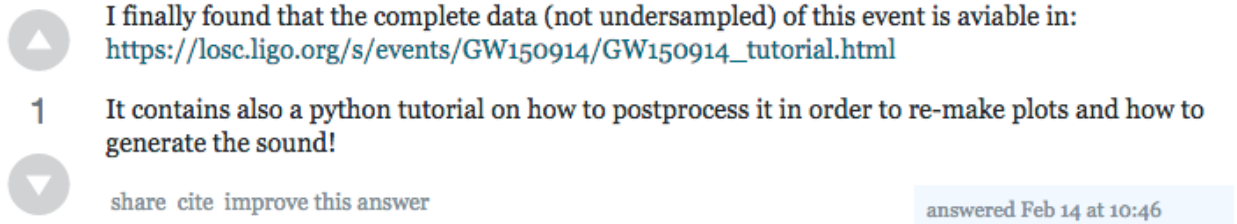


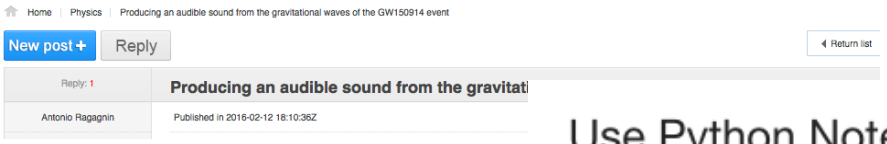
GW150914 open code

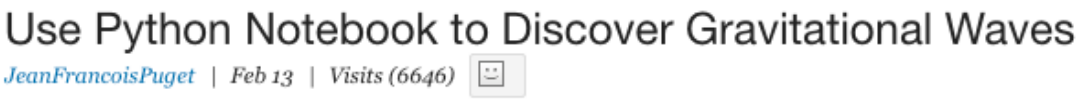












Open (free) computing

(coming soon)

from Google

from Microsoft