Gstlal Online Search in O1

Kipp Cannon, Chad Hanna, Kent Blackburn, Patrick Brady, Sarah Caudill, Jolien Creighton, Ryan Everett, Tjonnie Li, Duncan Meacher, Cody Messick, Steve Privitera, Surabhi Sachdev, Laleh Sadeghian, B.S. Sathyaprakash, Gareth Thomas, Les Wade, Alan Weinstein, et al.
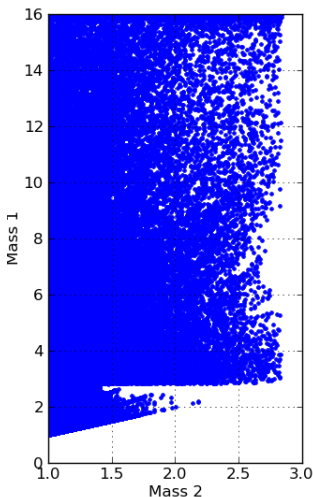
CBC Call, Sept 29 2015

Parameter space

This covers an EM bright region created with pycbc geometric bank placement

- ▶ Component masses 1-2.83, 1-16
- ▶ BH maximal spin
- ▶ NS up to 0.05
- ▶ 25 Hz Flow
- ▶ 171,277 templates per ifo

You can find more details here:
`https://www.lsc-group.phys.uwm.edu/ligovirgo/cbcnote/O1/gstlal/low_latency`
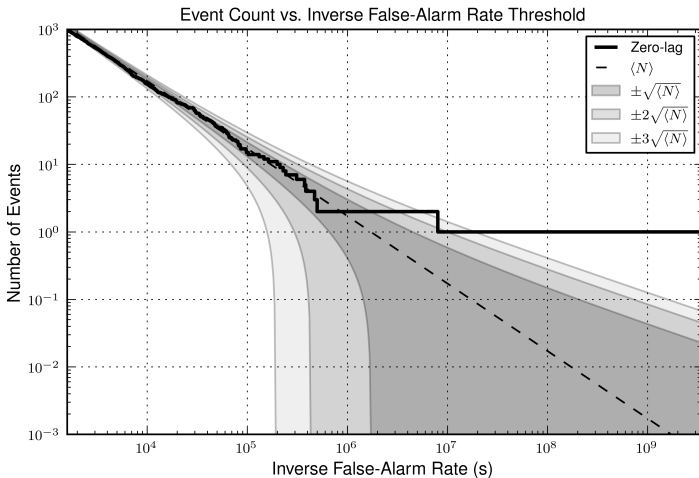
The search uses gstlal based code

- ▶ Time domain matched filtering with orthonormal basis made by SVD
  - ▶ Phys. Rev. D 82, 044025 (2010)
  - ▶ Phys. Rev. D 83, 084053 (2011)
  - ▶ ApJ 748 136 (2012)
- ▶ Likelihood ratio based ranking statistic and slideless FAR estimation
  - ▶ Phys. Rev. D 88, 024025
  - ▶ arXiv:1504.04632
- ▶ It applies exact match coincidence and can decompose and filter spin-aligned waveforms
  - ▶ Phys. Rev. D 89, 024003 (2014)
- ▶ It has been tested on Gaussian and recolored MDC data in conjuction with BAYESTAR and lalinference
  - ▶ ApJ 795 105 (2014)
  - ▶ ApJ 804 114 (2015)

Validation on S6 replay with big dog: closed box offline

Event Count vs. Inverse False-Alarm Rate Threshold (Closed Box)
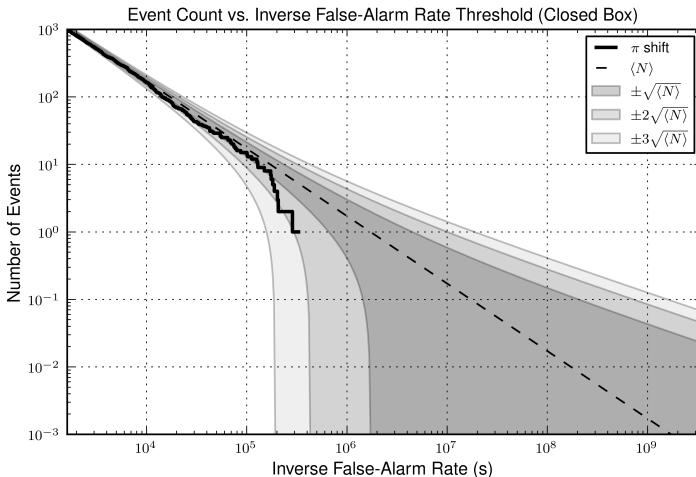
Validation on S6 replay with big dog: open box offline

Event Count vs. Inverse False-Alarm Rate Threshold

Validation on S6 replay with big dog: Comparison of online vs offline parameters

Offline

FAR	FAP	SNR	M_{total}	M_{chirp}
$2. \times 10^{-25}$ Hz	4×10^{-19}	17.45	10.87	4.72

Online

FAR	FAP	SNR	M_{total}	M_{chirp}
$9. \times 10^{-25}$ Hz	1×10^{-19}	17.48	10.87	4.72

Remarkably similar parameters were found between the online and offline runs altough we have not yet completed the full S6 replay **online** run over the 1 month period.

Validation on S6 replay with second loudest: Comparison of online vs offline parameters

Offline

FAR	FAP	SNR	M_{total}	M_{chirp}
$1. \times 10^{-7}$ Hz	2×10^{-1}	9.19	3.17	1.29

Online

FAR	FAP	SNR	M_{total}	M_{chirp}
$2. \times 10^{-7}$ Hz	1×10^{-1}	9.21	3.17	1.29

Remarkably similar parameters were found between the online and offline runs although we have not yet completed the full S6 replay **online** run over the 1 month period.

Including zero lag in the background estimate.

As requested we have tools to rank events leaving zero lag into the background (normal behavior is to remove)

```
gstlal_inspiral_recompute_online_far_from_gracedb
--with-zerolag T185258
```

```
FAR of T185258 before: 8.86624e-25
likelihood ratio of T185258 after: 20.185222
FAR of T185258 after: 2.00153e-11
```

Cody is working on automating this for offline, but the above tool exists for online analysis.
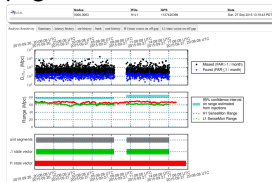
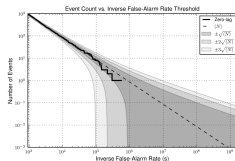# Results on various timescales

Seconds:

gracedb
simdb

Minutes:

summary monitoring page

Hours:

Full "offline style" summary pages

We will be working hard throughout O1 to increase the quality and quantity of information available at each timescale.

Seconds: Keep up to date with gracedb latest

GraceDB — Gravitational Wave Candidate Event Database

Latest — as of 27 September 2015 20:32 CDT

Query:
Get neighbors:

UID	Labels	Group	Pipeline	Search	Instruments	Event Time	FAR (Hz)	Latency (sec)	Created
G187896		Burst	CWB	AllSky	H1,L1	1127436420.14	2.123e-06	285.864400	2015-09-28 00:51:29 UTC
G187895		CBC	MBTAOnline		H1,L1	1127436429.77	5.148e-05	170.231090	2015-09-28 00:49:43 UTC
G187894		CBC	gstlal	LowMass	H1,L1	1127436436.02	8.512e-05	69.975852	2015-09-28 00:48:09 UTC
G187884		CBC	gstlal	LowMass	H1,L1	1127433073.68	5.898e-05	68.318940	2015-09-27 23:52:05 UTC
G187862		CBC	gstlal	LowMass	H1,L1	1127426223.56	2.384e-05	67.437312	2015-09-27 21:57:54 UTC
G187858		CBC	gstlal	LowMass	H1,L1	1127425550.86	1.586e-05	66.135091	2015-09-27 21:46:40 UTC
G187809		CBC	gstlal	LowMass	H1,L1	1127407877.13	4.072e-05	78.873317	2015-09-27 16:52:19 UTC
G187808		CBC	gstlal	LowMass	H1,L1	1127407877.11	3.478e-05	65.894382	2015-09-27 16:52:06 UTC
G187800		CBC	gstlal	LowMass	H1,L1	1127405893.43	4.651e-05	65.571987	2015-09-27 16:19:02 UTC
G187799		CBC	gstlal	LowMass	H1,L1	1127405770.58	5.512e-05	64.416044	2015-09-27 16:16:58 UTC
G187785		CBC	gstlal	LowMass	H1,L1	1127400885.33	9.173e-05	64.674878	2015-09-27 14:55:33 UTC
G187783		Burst	CWB	AllSky	H1,L1	1127400415.47	3.715e-06	145.528900	2015-09-27 14:49:04 UTC
G187778		CBC	gstlal	LowMass	H1,L1	1127399013.22	9.503e-05	63.776314	2015-09-27 14:24:20 UTC
G187777		CBC	gstlal	LowMass	H1,L1	1127399006.66	3.356e-06	65.344062	2015-09-27 14:24:15 UTC
G187775		CBC	gstlal	LowMass	H1,L1	1127398970.03	9.143e-05	69.972126	2015-09-27 14:23:43 UTC
G187766		CBC	MBTAOnline		H1,L1	1127395443.98	1.113e-05	99.015389	2015-09-27 13:25:26 UTC
G187751		CBC	MBTAOnline		H1,L1	1127391620.57	9.665e-05	58.426461	2015-09-27 12:21:02 UTC
G187746		CBC	gstlal	LowMass	H1,L1	1127390077.49	6.846e-05	70.510114	2015-09-27 11:55:31 UTC
G187740		CBC	gstlal	LowMass	H1,L1	1127388490.46	1.257e-05	65.539433	2015-09-27 11:28:59 UTC

Whether it is CWB, MBTA or gstlal, you can keep up with the excitement in realtime by leaving `gracedb.ligo.org/latest` open in your browser.

Seconds: See event parameters as they come in

Basic Info

UID	Labels	Group	Pipeline	Search	Instruments	GPS Time ▾ Event Time	FAR (Hz)	Links	UTC ▾ Submitted
G187894		CBC	gstlal	LowMass	H1,L1	1127436436.0241	8.512e-05	Data	2015-09-28 00:48:09 UTC

Coinc Tables

End Time (GPS)	1127436436.0241 s
Total Mass	4.8836 $M_\odot$
Chirp Mass	1.6805 $M_\odot$
SNR	9.8794
False Alarm Probability	1.000e+00

Single Inspiral Tables

| IFO	L1	H1
Channel	GDS-CALIB_STRAIN	GDS-CALIB_STRAIN
End Time (GPS)	1127436436.033419061 s	1127436436.024147402 s
Template Duration	53.9506306604 s	53.9506306604 s
Effective Distance	232.52345 Mpc	195.14787 Mpc
COA Phase	-0.2201813 rad	-2.9525366 rad
Mass 1	3.8318219 $M_\odot$	3.8318219 $M_\odot$
Mass 2	1.051777 $M_\odot$	1.051777 $M_\odot$
η	0.16898534	0.16898534
F Final	1024.0 Hz	1024.0 Hz
SNR	5.75316	8.0313959
χ^2	0.82651901	1.9612914
χ^2 DOF	1	1
spin1z	-0.075058058	-0.075058058
spin2z	-0.02389881	-0.02389881

Neighbors   [-5,+5]

No neighbors in range.

Basic parameters, mass, spin, FAR, SNR, . . . are available at the top of each event page.

LIGO-G1501229

Seconds – hours: See additional supporting information uploaded automatically to gracedb
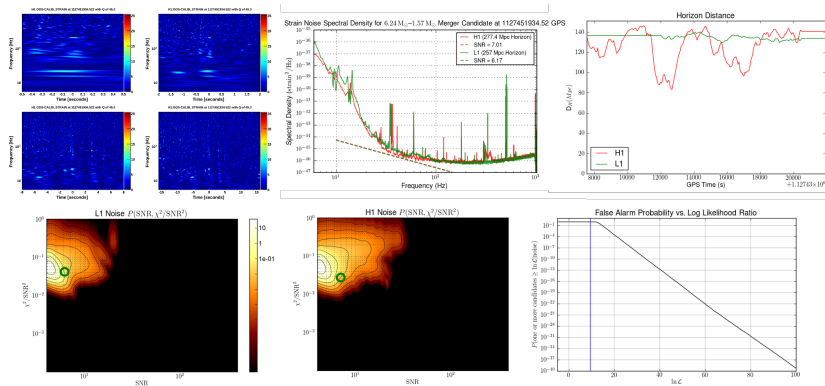
We will be continue to add more automated plots / information.

Minutes: See the current status
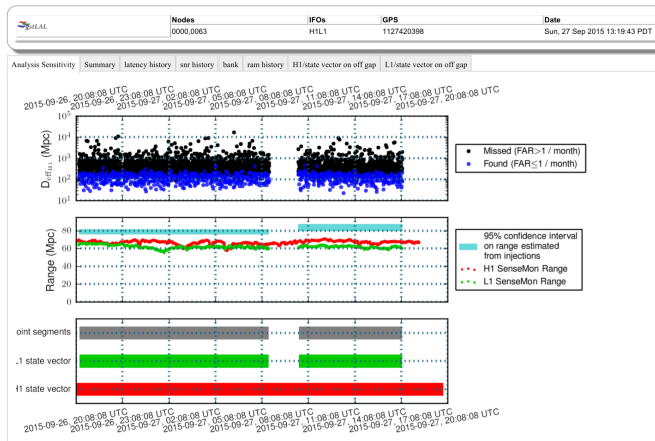
The simulataneous real-time injection run provides an up-to-date
sensitivity measurement at https://ldas-jobs.ligo.caltech.edu/
~gstlalcbc/cgi-bin/gstlalcbcsummary

Hours: Full offline style pages

We constantly process the output of the online data in a fashion similar to the offline analysis in order to make offline style summary pages. The pages are cumulative. As we add plots and other information to the offline analysis we should see most of them available to the online search too.

Hours: See the current IFAR plot
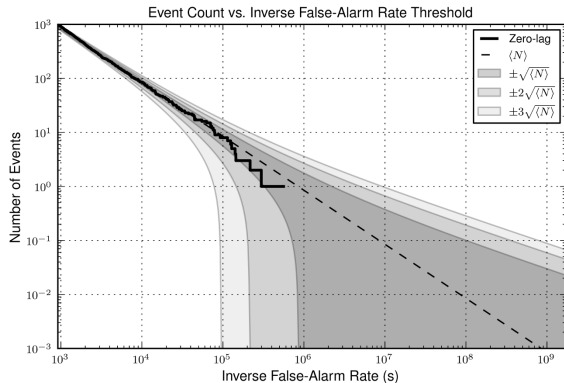
The IFAR plot for the search is updated every few hours and is *cumulative*. Currently there are no outliers.

Monitoring with nagios at monitor.ligo.org

Sun Sep 27 2015 **21:21:32**	LDAS **2 OK** Last updated at 21:21	ODC **2 / 2 WARNING** Last updated at 21:21	DMT **1 / 12 WARNING** Last updated at 21:21	Low-latency Data **18 OK** Last updated at 21:21
LIGO Data Replicator **3 OK** Last updated at 21:21	DetChar Summary **1 / 25 CRITICAL** Last updated at 21:21	GraCEDb **4 OK** Last updated at 21:21	LVAlert **2 OK** Last updated at 21:21	DQSegDB **14 OK** Last updated at 21:21
NDS **21 OK** Last updated at 21:21	ligoDV Web **5 OK** Last updated at 21:21	gstLAL Inspiral **3 OK** Last updated at 21:21	CIS **2 OK** Last updated at 21:21	EMFollow **6 OK** Last updated at 21:21

A team is automatically notified if the analysis experiences trouble.

Get involved

Don't like to sleep? You too can be awoken in the middle of the night!

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