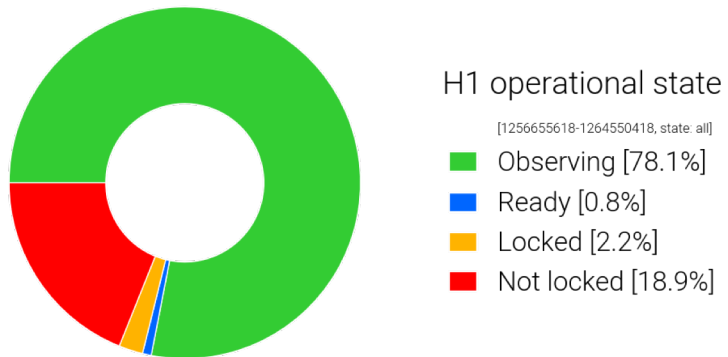
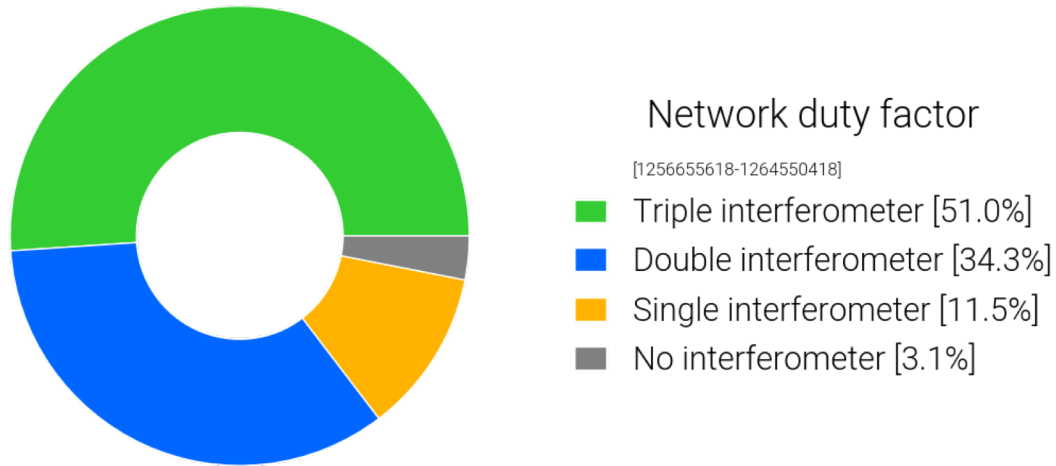


03 LIGO-Virgo-KAGRA update, January 2020

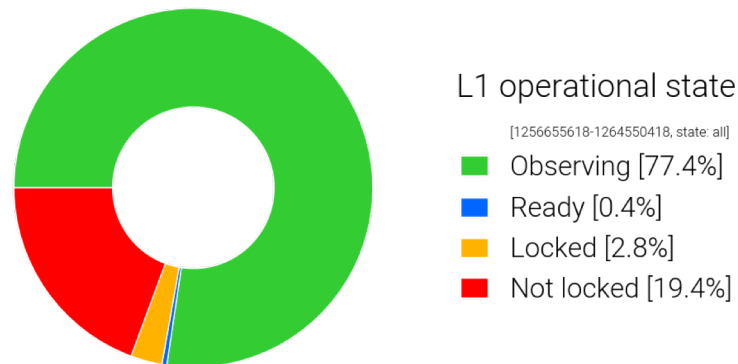
Nicolas Arnaud, Keita Kawabe, Nicolas Leroy, Shinji Miyoki,
Brian O'Reilly, Alessio Rocchi, David Shoemaker, Matteo Tacca

10th week into O3b: So far so good.

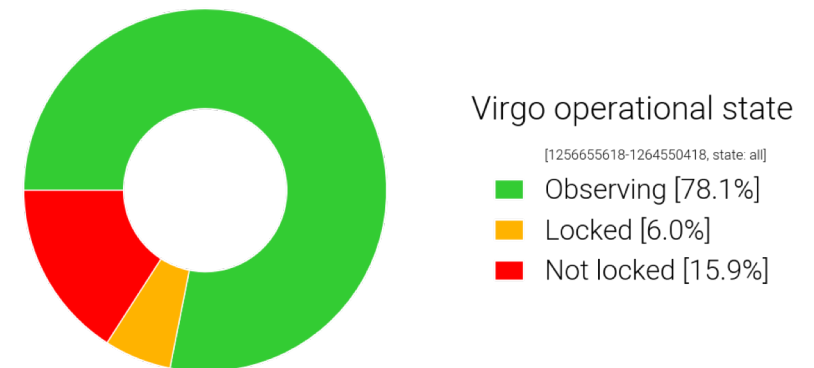
- 51% Triple IFOs (VS 44.5% in O3a)
- 85.3% Double or Triple (VS 81.9%)
- 3.1% zero IFO (VS 3.2%)
- (Downtime includes everything including but not limited to maintenance)



78.1% VS 71.2 in O3a

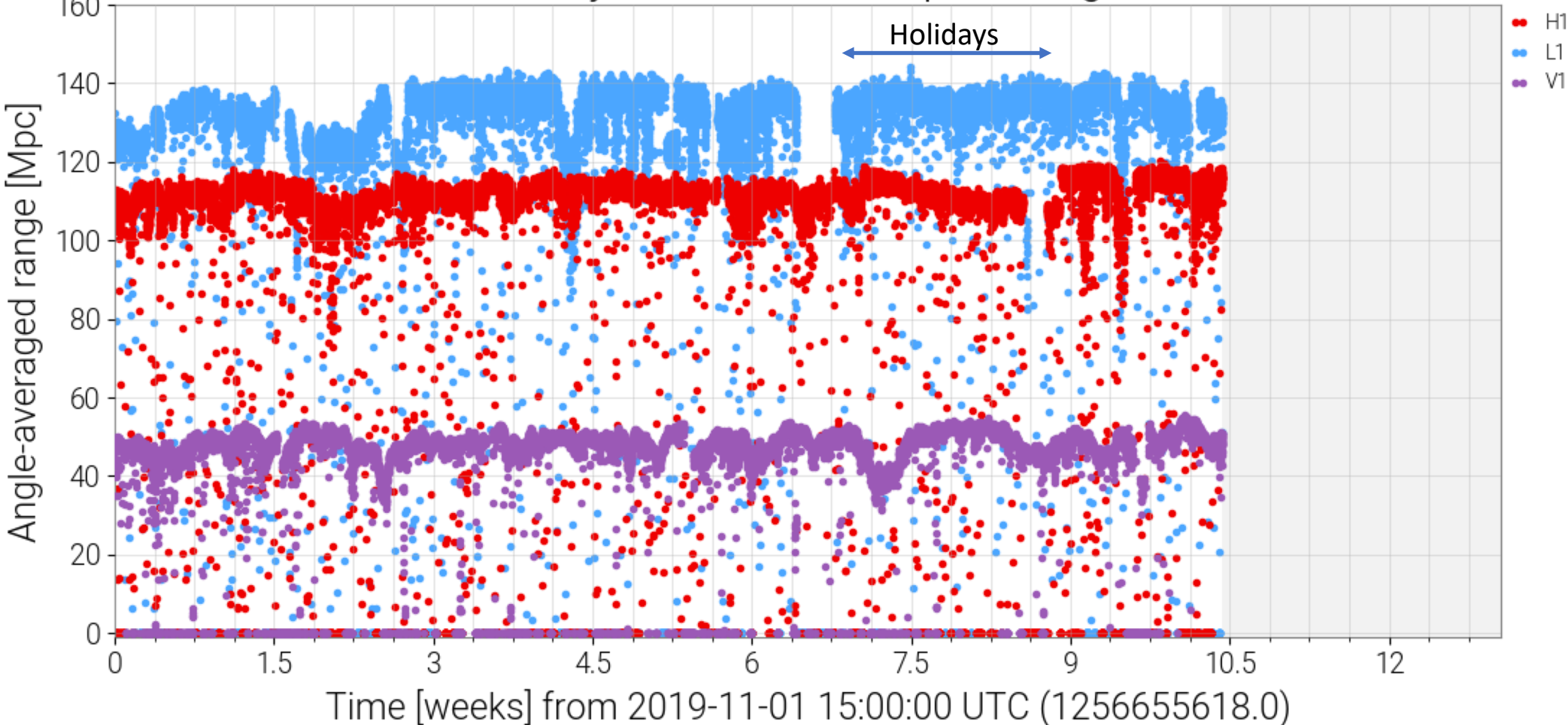


77.4% VS 75.8

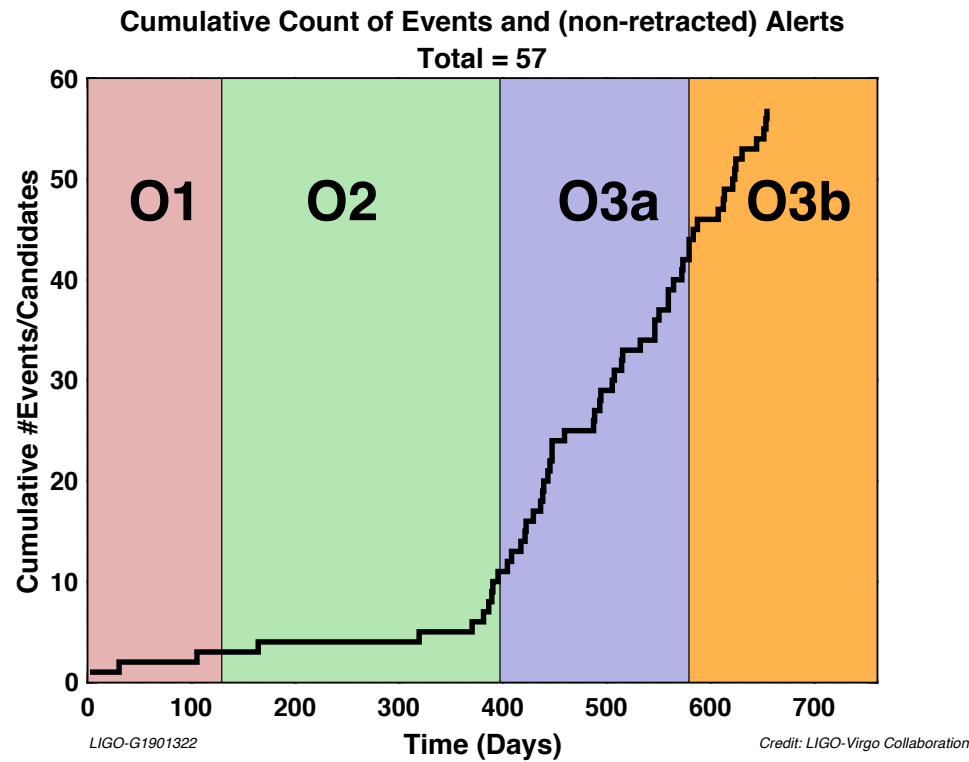


78.1% VS 76.3

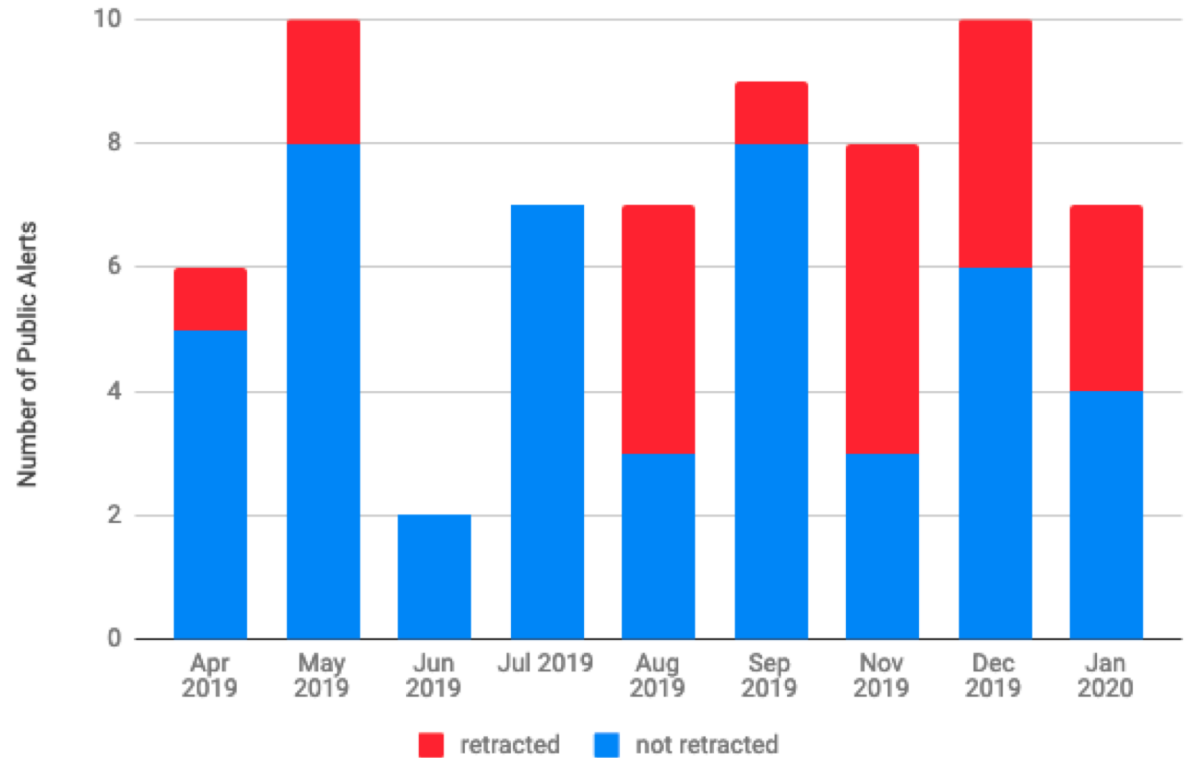
Binary neutron star inspiral range



Some stats. 19 alerts including 8 retractions since the last OpenLVEM telecon on Nov/21/2019.



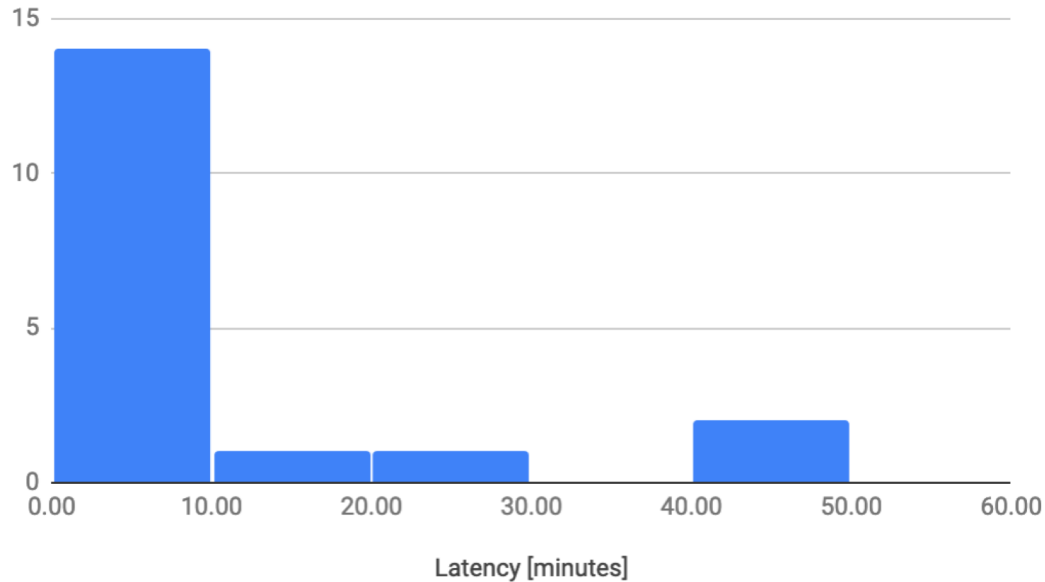
O3 Public Alerts by Month



<https://dcc.ligo.org/LIGO-G1901322/public>

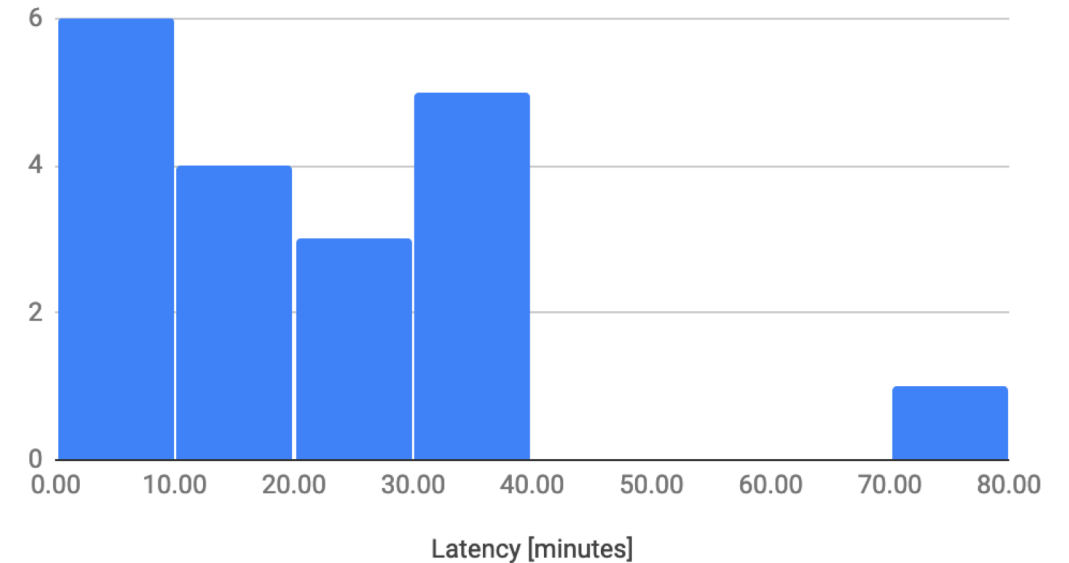
Event-prelim latency Nov 21 2019 - Jan 16 2020

(except for S200105ae, a huge outlier)



Prelim-initial and prelim-retraction latency Nov 21 2019 - Jan 16 2020

(all events)



- Preliminary alerts got faster with lesser outliers, thanks to the efforts of low latency software developers at multiple fronts.
 - We plan to implement incremental improvements like these till the end of O3.
- Initial alert (and Retraction) latency after the Preliminary is sent is human-dependent, ~20min on average for both Initial and Retraction.
- Retractions cannot be entirely eliminated. However, 2 out of 8 retractions in this period could have been programmatically caught before sending Preliminary. Fix is in place.

Event to explain: S200105ae, a subthreshold LV event candidate.

GraceDB – Gravitational-Wave Candidate Event Database

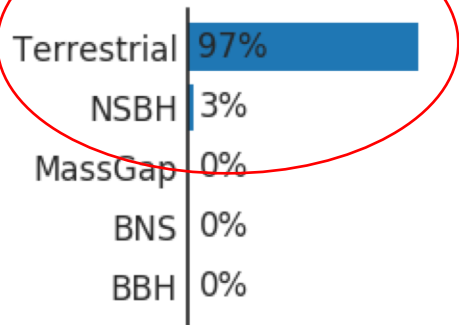
HOME PUBLIC ALERTS SEARCH LATEST DOCUMENTATION LOGIN

Superevent Info

Superevent ID	Category	Labels	FAR (Hz)	FAR (yr ⁻¹)	t_start	t_0	t_end	Submission time	Links
S200105ae	Production	EM_READY PE_READY ADVOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY DQOK GCN_PRELIM_SENT	7.672e-07	24.21 per year	1262276683.057208	1262276684.057208	1262276685.059117	2020-01-05 16:24:53 UTC	Data

Preferred Event Info

Group	Pipeline	Search	Instruments	GPS Time Event time	Submission time
CBC	gstlal	AllSky	L1,V1	1262276684.0572	2020-01-05 16:24:52 UTC



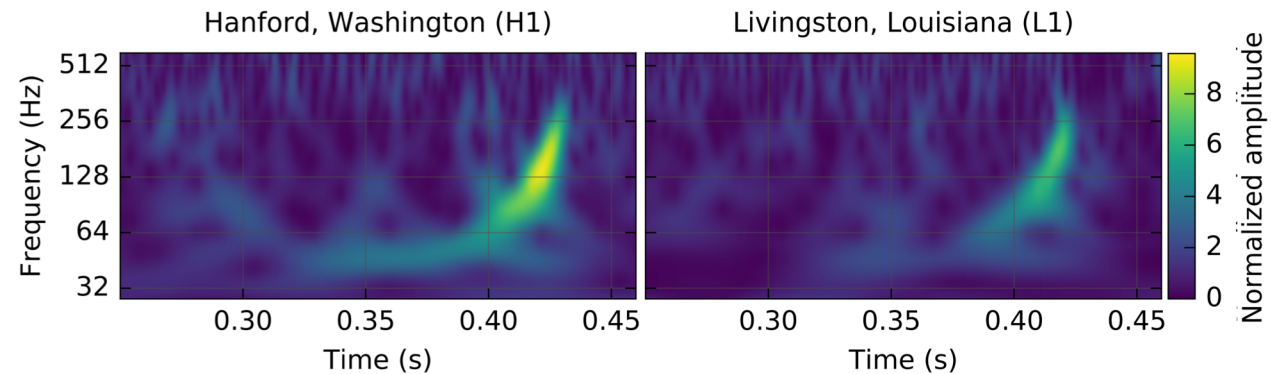
Subthreshold FAR (24 per year), large $p_{\text{terrestrial}}$ (97%), why did we bother?

S200105ae: What we said in GCNs

- GCN 26657: “Preliminary human vetting of this candidate indicates a chirp structure in the L1 time-frequency plane with no indication of contamination by instrumental artifacts.”
- GCN 26688: “our examination of the data indicates that the signal has greater significance than what was calculated in real-time processing (and is still contained in the GCN Notice), sufficient to warrant a public alert.”
- What do these mean?

“Preliminary human vetting” (= all sorts of things, but anyway...)

- One of them is manual inspection of the “omega scan”, a tool for time-frequency analysis.
- **Example** of the omega scan of IFO strain for GW150914 (**note that this is NOT for S200105ae!!**)



- We do this systematically for all useful channels, not just strain, for all candidates.
- In S200105ae, clear chirp in L1 omega scan but not in any of L1 witness channels. Thus a suspicion that this is more real than $\text{FAR} \sim 24/\text{year}$.

Why low significance?

- Basically L1-only as far as online FAR is concerned though V1 was running at the time.
- Single-detector events are heavily penalized in the production code, estimating FAR larger than we believe in this case.
- Better code is being developed.
- We don't have a revised significance, but we sent PE-based update for localization as well as classification assuming that this is of astrophysical origin. HasNS~98%, HasRemnant<1%.

Future of O3

- Planned end date of O3: Still April 30 2020.
- As always, incremental improvements are to be made for instruments as we go, reducing noise as well as increasing stability.
 - We'd like to see the excellent duty factor of O3b continue till the end.
- KAGRA will join.

Future: KAGRA

- Finally successfully locked in Power Recycled FPMI (PRFPMI) configuration though only for a short time!
- Output Mode Cleaner (OMC), which we believe is necessary for noise and sensitivity improvement in PRFPMI configuration, was installed.
- Optimization and noise hunting continues.
- For now we're planning to start observing some time in mid-February.
 - Infrastructure to fold KAGRA members into event-vetting RRT is in place.



Example of vacuum leak spot found at LLO. Mitigation/patching continues.



It can happen that the risk of flood increases at the Virgo site (last November)



Wind also means overabundance of tumbleweed at LHO. Pitchforking etc. continues.



KAGRA boar



KAGRA OMC

G2000062-V4 Open LVEM, 16 January 2020