Open Public Alerts

LIGO-Virgo Low-latency Analysis Group

All you need to know

- LIGO/Virgo will immediately release alerts for transient event candidates
  - These alerts will be publicly available through the Gamma-ray Coordinates Network (GCN)
  - Event candidates will be publicly available in https://gracedb.ligo.org (not live yet)
  - There will be no human vetting for the **Preliminary** alert

- LIGO/Virgo Public Alerts User Guide & Support
  - https://emfollow.docs.ligo.org/userguide/quickstart.html (thanks to Leo Singer, Sarah Antier, Shaon Ghosh, Shasvath Kapadia, Geoffrey Mo, Karelle Siellez, Om Salafia, Deep Chatterjee and Duncan Meacher)
 - contact+emfollow/userguide@support.ligo.org

Detection rates in O3

- Binary neutron stars (BNS)
  - 1/month to 1/year
  - Median 90% credible localization 120-180 deg^2; 12-21% localized < 20 deg^2
- Binary black holes (BBH)
  - few/week to few/month
- Neutron-star black-hole binaries (NSBH)
  - Uncertain, estimates include zero
- Other transients
  - Unknown
- **LIGO-Virgo target contamination of public alerts**
  - **Contamination ~10% of public alerts across all categories together**
  - **BNS, NSBH & other transients may individually have higher contamination**

LIGO
Scientific
Collaboration

((O)))VIRGO

Superevents

- Multiple pipelines running over data
  - CBC: gstlal, mbta, pycbc, spiir carry out matched filter searches for compact binaries
  - Burst: cwb, olib carry out searches for unmodeled transients
- Superevents
  - A new abstraction to unify gravitational-wave candidate events from multiple pipelines
  - One superevent per physical transient
  - One candidate event within a superevent is identified as the preferred event from which significance, localization, classification, ... are inherited by the superevent
- Preferred event selection
  - multiple interferometer candidates are preferred over single interferometer candidates
  - CBC candidates are preferred over Burst candidates
  - The highest signal to noise ratio (SNR) CBC candidate is preferred.
  - The lowest false alarm rate (FAR) Burst candidate is preferred in a Burst-only superevent

GCN Notice times after a gravitational-wave signal
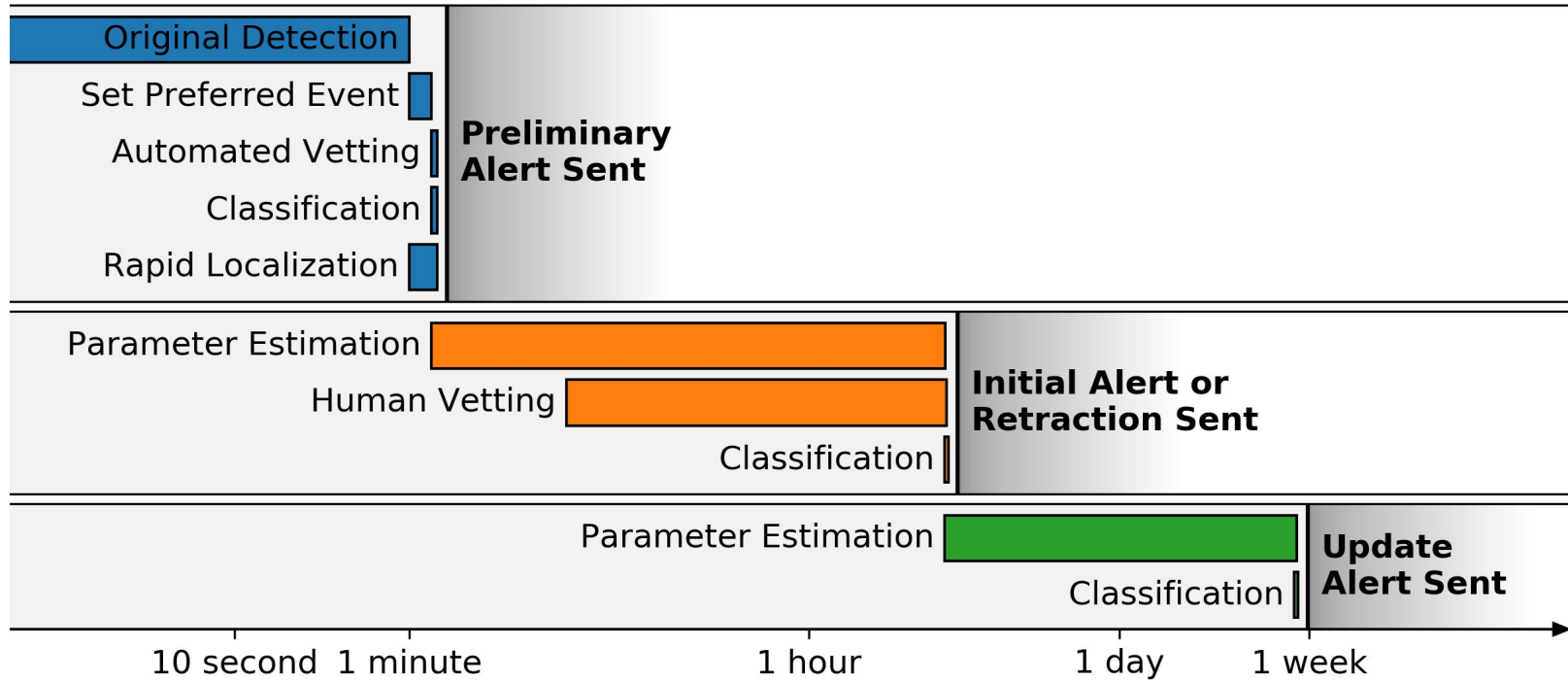
Time-coincidence with external triggers

- RAVEN search pipeline continuously monitors for time (and spatial) coincidence between all gravitational-wave triggers submitted to gracedb and external triggers (e.g. neutrinos, gamma-ray bursts,..)
    - Alerts will be issued if the combined false-alarm-rate meets standard criteria
    - Single detector gravitational-wave triggers may lead to such alerts

- At any time, we may promote an extraordinary candidate that does not pass the automated analysis criteria
    - **Note:** Initial notices and circulars will be distributed, but a preliminary alert may not!

Localization and Inference

- Rapid 3D localization is ready in seconds
  - Distributed in FITS file as a HEALPix all-sky image
- Classification of CBC alerts
  - The classification consists of four numbers, summing to unity, that give the probability that the source is a BNS, NSBH, BBH merger, or terrestrial (i.e. a background fluctuation or a glitch).
  - **Question:** can refine to include a Gap classification for binaries with a component mass in range 3-5 Msun. Is this desireable?
- Properties
  - A set of numbers, each between zero and unity, that give the probabilities that the source
    - HasNS: At least one of the compact objects in the binary has a mass that is consistent with a neutron star (i.e. $m2 \leq 3M\odot$).
    - HasRemnant: Source ejected a nonzero mass outside the final remnant compact object.

Alert contents

https://emfollow.docs.ligo.org/userguide/content.html

Bringing things online

- Regular update e-mails from now until infrastructure is stable

- Rough estimate of timeline
  a. Mock public alerts ~23 Nov 2018 through O3
  b. Public access to gracedb.ligo.org ~1 Dec 2018
  c. End-to-end test events ~14 Dec 2018
  d. Engineering operations mode 14 Dec 2018 to ~30 Jan 2019
  e. O3 production operations and APIs frozen ~1 Feb 2019