

# LVK Rapid Response Team's Survey about Well-localized BBH Candidates

Keita Kawabe on behalf of LVK RRT

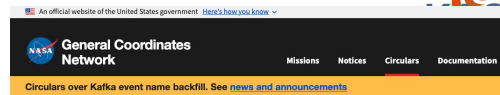
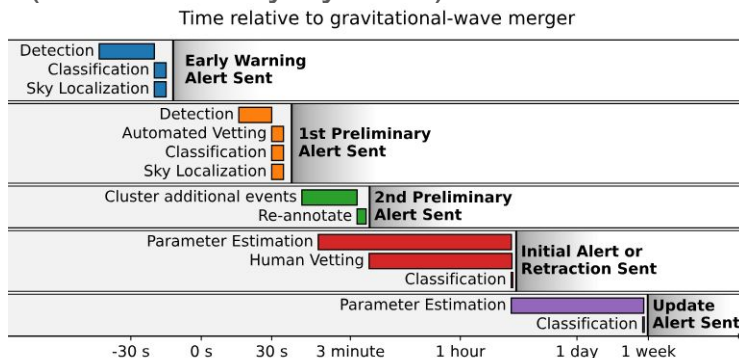
# TOC

1. How/why the RRT prioritizes certain types of candidates.
2. Survey about well-localized BBH candidates.

# What the RRT does from your point of view (in O4)



- The RRT provides manual processing/vetting of every significant GW candidate and issues the first GCN Circular (Initial or Retraction).
  - A pool of hundreds of non-expert shifters providing 24/7 coverage as well as small number of experts to achieve this goal.
- Timeline: Two automated Preliminary Notices (5 minutes apart) -> Human vetting -> Initial or Retraction Notice (triggered by RRT) -> Initial or Retraction Circular (sent manually by RRT)



← Back Text JSON Cite

## GCN Circular 39898

**Subject** LIGO/Virgo/KAGRA S250328ae: Identification of a GW compact binary merger candidate  
**Date** 2025-03-28T06:27:04Z (12 days ago)  
**From** Sayantan Ghosh at Indian Institute of Technology Bombay <stanghosh@iitb.ac.in>  
**Via** Web form

The LIGO Scientific Collaboration, the Virgo Collaboration, and the KAGRA Collaboration rep  
 We identified the compact binary merger candidate S250328ae during real-time processing of LIGO Hanford Observatory (H1), LIGO Livingston Observatory (L1), and Virgo Observatory (V1) 2025-03-28 05:48:27.419 UTC (GPS time: 1427175645.419). The candidate was found by the cwb [2], GstLAL [3], MBTA [4], MLY [5], PyCBC Live [6], and SPIIR [7] analysis pipelines.

S250328ae is an event of interest because its false alarm rate, as estimated by the online 3.2e-10 Hz, or about one in 1e2 years. The event's properties can be found at this URL:

<https://gracedb.ligo.org/superevents/S250328ae>



# What the RRT does from your point of view (in O4)



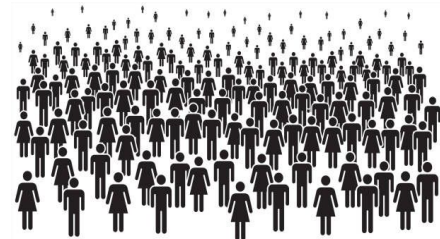
- Many BBH candidates are only handled by non-expert members, relying on automated tests.
- If automated tests don't pass, experts are pinged.
  - Even if there are issues, experts are not obliged to respond ASAP (e.g. in the middle of the night, though they often do so).

| H1 result           |     |        |            |                                             |
|---------------------|-----|--------|------------|---------------------------------------------|
| Overview            |     |        |            |                                             |
| Task                | IFO | Status | P-value    | Result                                      |
| bristol_H1          | H1  | Done   | 0.0        | <span style="color: red;">INFO Error</span> |
| gapmettree          | H1  | Done   | 0.07624    | <span style="color: green;">Pass</span>     |
| glitchfind          | H1  | Done   | 0.00000000 | <span style="color: green;">Pass</span>     |
| stationarity        | H1  | Done   | 1.0        | <span style="color: green;">Pass</span>     |
| lockcheck           | H1  | Done   | 1.0        | <span style="color: green;">Pass</span>     |
| ldg                 | H1  | Done   | 1.0        | <span style="color: green;">Pass</span>     |
| omcscanprint_H1     | H1  | Done   | -          | -                                           |
| spectro_template_H1 | H1  | Done   | -          | -                                           |
| omcscanheft_H1      | H1  | Done   | -          | -                                           |
| rangecheck          | H1  | Done   | -          | -                                           |
| omgscan             | H1  | Done   | -          | -                                           |

| L1 result           |     |        |            |                                         |
|---------------------|-----|--------|------------|-----------------------------------------|
| Overview            |     |        |            |                                         |
| Task                | IFO | Status | P-value    | Result                                  |
| bristol_L1          | L1  | Done   | 0.11976    | <span style="color: green;">Pass</span> |
| stationarity        | L1  | Done   | 0.275      | <span style="color: green;">Pass</span> |
| glitchfind          | L1  | Done   | 0.00000000 | <span style="color: green;">Pass</span> |
| gapmettree          | L1  | Done   | 0.00704    | <span style="color: green;">Pass</span> |
| lockcheck           | L1  | Done   | 1.0        | <span style="color: green;">Pass</span> |
| ldg                 | L1  | Done   | 1.0        | <span style="color: green;">Pass</span> |
| omcscanprint_L1     | L1  | Done   | -          | -                                       |
| spectro_template_L1 | L1  | Done   | -          | -                                       |
| omcscanheft_L1      | L1  | Done   | -          | -                                       |
| rangecheck          | L1  | Done   | -          | -                                       |
| omgscan             | L1  | Done   | -          | -                                       |

| V1 result  |     |        |         |                                         |
|------------|-----|--------|---------|-----------------------------------------|
| Overview   |     |        |         |                                         |
| Task       | IFO | Status | P-value | Result                                  |
| bristol_V1 | V1  | Done   | 0.07900 | <span style="color: green;">Pass</span> |

Automated tests



"Hey the test didn't pass, please have a look."

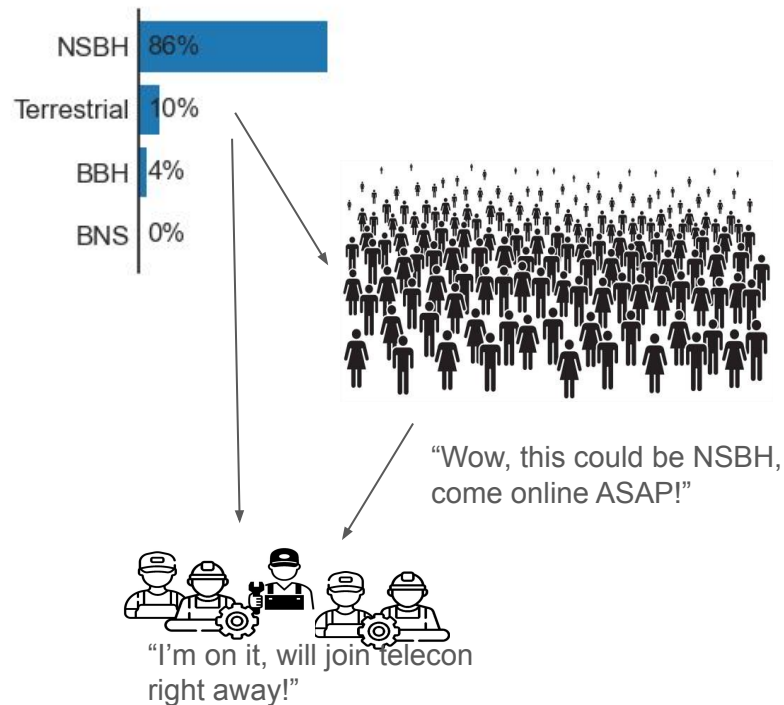


"Got it, will investigate!"

# What the RRT does from your point of view (in O4)



- Many BBH candidates are only handled by non-expert members, relying on automated tests.
- If automated tests don't pass, experts are pinged.
  - Even if there are issues, experts are not obliged to respond ASAP (e.g. in the middle of the night, though they often do so).
- However, some candidates are prioritized in that the experts are obliged to start manual vetting immediately (even before automated tests are complete) to provide elevated level of scrutiny upfront with the least human latency possible.



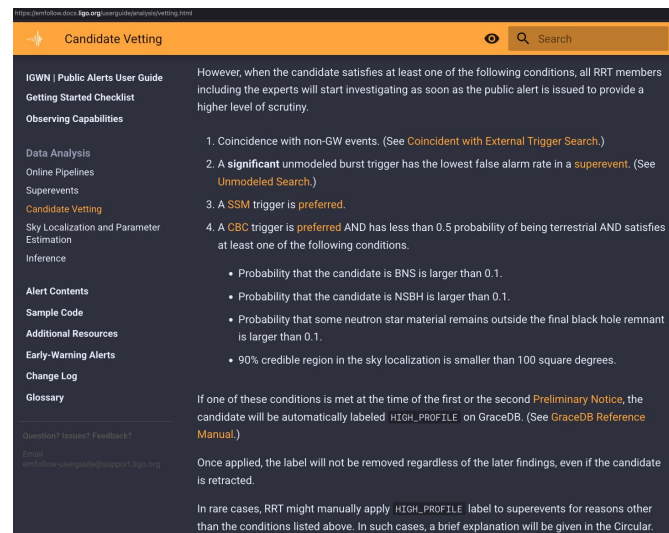
# “Prioritized” candidates receive ASAP manual vetting by experts.



Roughly speaking, these candidates are

- Coincidence with non-GW events
- Unmodeled burst
- Sub-Solar-Mass (SSM)
- Less than 0.5 probability of being terrestrial AND
  - Non-negligible probability of being BNS, NSBH, or that some neutron star material remains outside of the final black hole remnant, OR
  - 90% credible region in sky localization  $< 100 \text{ deg}^2$

This is a compromise between what we think might be of interest to wider community and what we can do with the person-power available.

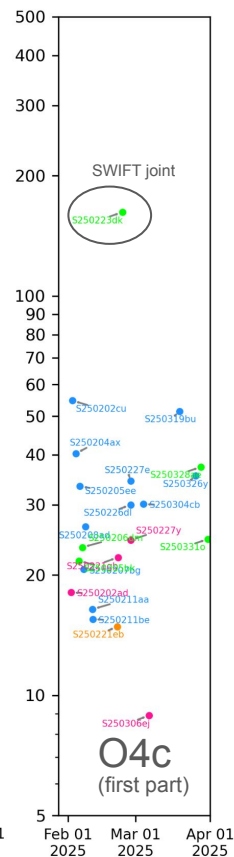
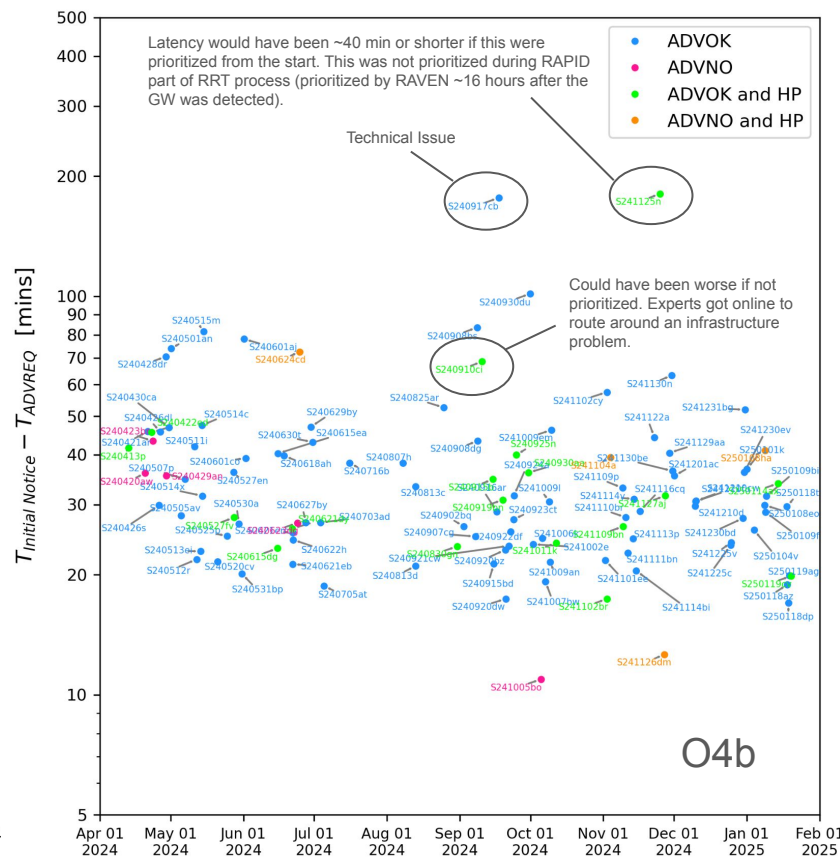
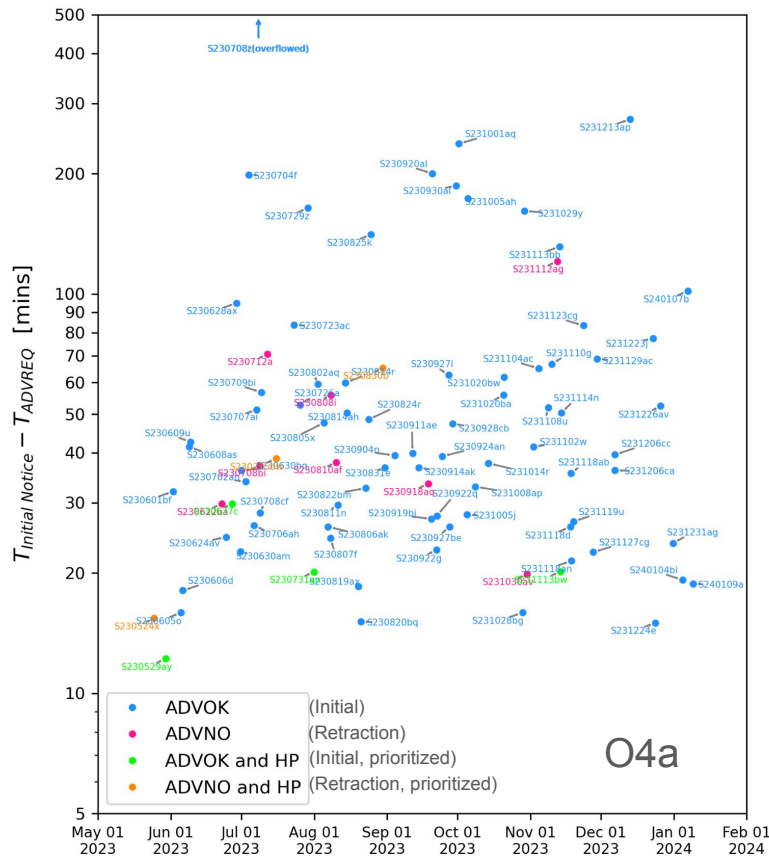


See <https://emfollow.docs.ligo.org/userguide/analysis/vetting.html> for details.

# Prioritization VS human vetting latency

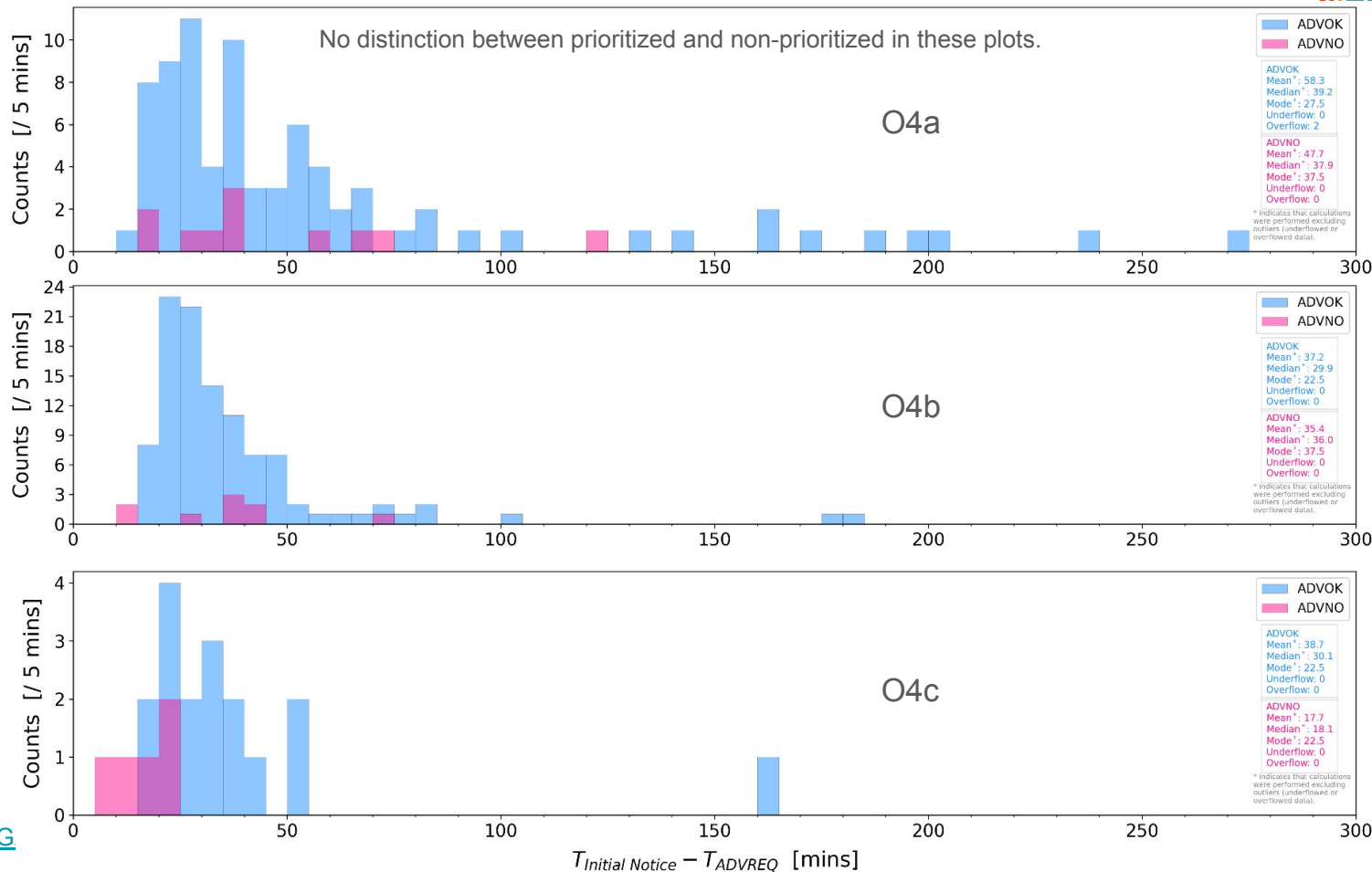
- Prioritization eliminates the possibility that an interesting candidate is left unattended by relevant experts, potentially for hours.
  - However, even for “vanilla” BBH candidates, experts tend to respond in low latency.
- Prioritization doesn't necessarily move things much faster than non-prioritized ones. After all, we're providing elevated level of scrutiny upfront.
  - Despite that, there's no evidence that prioritized events move slower, either.
- As the run progresses and kinks in software/hardware/procedures are ironed out, the latency slowly becomes smaller in general, prioritized or not.

# Human vetting latency for 228 O4 candidates (~ Preliminary to Initial Notice)





# Human vetting latency (~ Preliminary to Initial Notice latency)



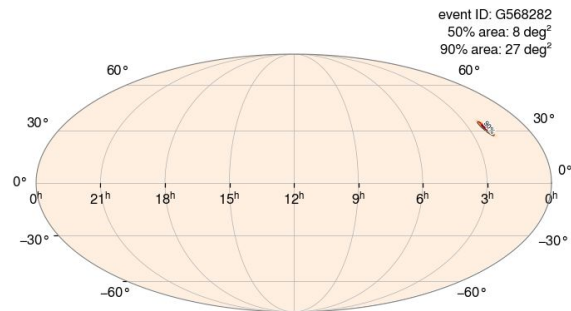
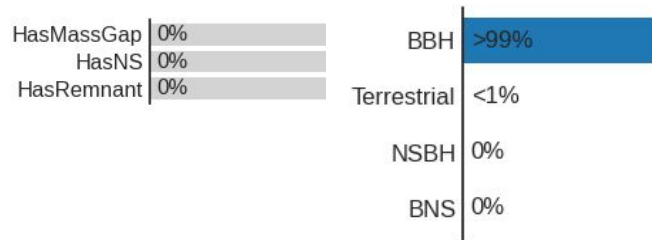
# “Tightly localized” CBC candidates are prioritized. Is it worth it even if it’s BBH?



Tight localization scenario:  $p_{\text{terr}} < 0.5$  AND 90% confidence level localization area  $< 100 \text{ deg}^2$ , even when it’s BBH for RRT purposes.

As of April/01/2025, 14 (incl. 2 retracted) tightly localized BBH candidates out of 34 total prioritized candidates.

It’s hard at times for RRT experts involved.



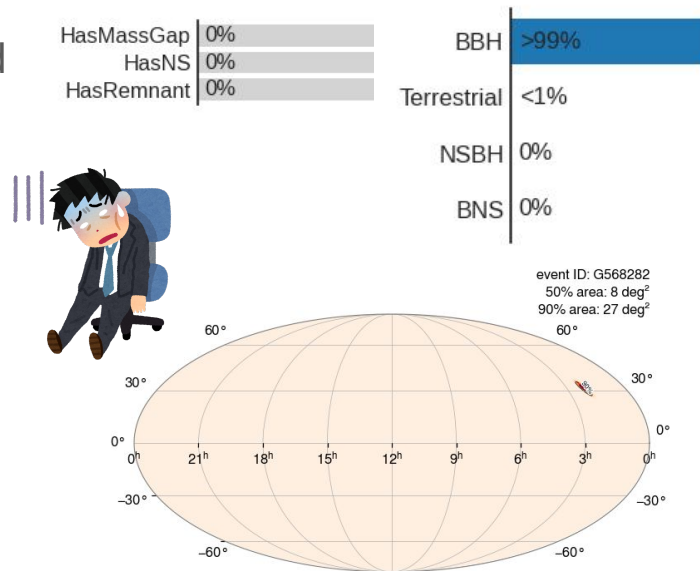
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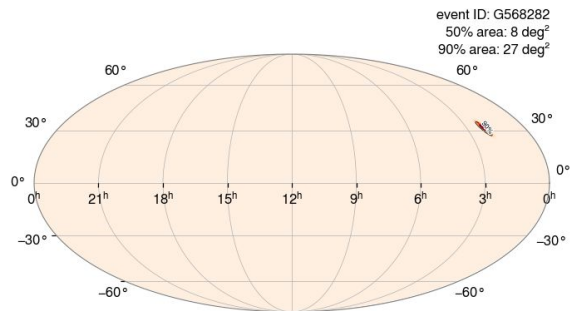
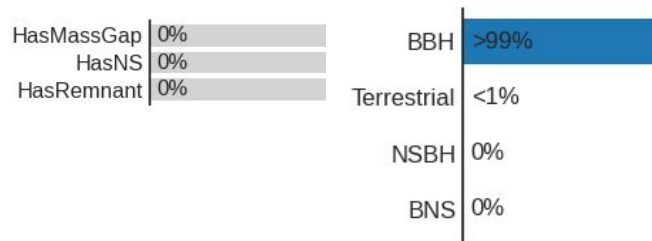
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It’s hard at times for RRT experts involved.

Is it worth waking people up for BBH just because the localization is good? Is such a candidate exciting enough for astronomers? If not, why the effort?

Instead of second-guessing...



# We asked you. It was the first time we asked for your help about RRT.



An email to OpenMMA mailing list on Jan/01/2025. The questions were, in essence, these:

1. Would you prefer the RRT to keep prioritizing human vetting of well localized BBH?
2. Would you mind if we lower the area threshold to e.g.  $30 \text{ deg}^2$  instead of 100? Do you have a suggestion for a different threshold?
3. Independent of 2. above, would you mind if we add a 300 Mpc mean distance threshold (e.g. 90% credible region smaller than XX  $\text{deg}^2$  and mean distance smaller than 300 Mpc)? Do you have a suggestion for a different threshold? Or is adding this criterion inadvisable?

Deadline Fri. Jan/17/2025, responses collected via Google Forms.

A screenshot of a Google Form titled "Feedback Request on LVK's Rapid Response for Well Localized BBH Candidates". The form has a header with "Questions", "Responses" (13), and "Settings". The main text of the form reads: "In the hope of refining our understanding of GW candidate events the observers may wish to follow up, LVK would like your feedback on our internal procedure to handle well localized BBH candidates. It would be greatly appreciated if you respond by January 17, 2025. Your response may be shared in an aggregate form inside LVK, but your identity information (email, name, facility/observatory) will not be shared outside of the RRT management. If you have any questions regarding this questionnaire, please contact Keita Kawabe (keita.kawabe@ligo.org)." Below this text are three input fields: "Email \*" with a "Valid email" error message, "Your name and the facility/observatory you are representing. \*" with a "Short answer text" error message, and a checkbox "Is it OK to share your response in an aggregate form in OpenMMA, not just inside LVK? Regardless of your answer, we will keep your identity (email, name, facility/observatory) as confidential information inside the RRT management." with an asterisk.

# You spoke. Thank you, that was greatly appreciated!

13 responses from 12 individuals covering at least 10 instruments/collaborations. One responded on behalf of an instrument/collaboration. Many listed multiple instruments, some people overlapping with others. Great to know that some really do care.

Overwhelming majority (12/13) would like us to keep prioritizing tightly localized BBH.

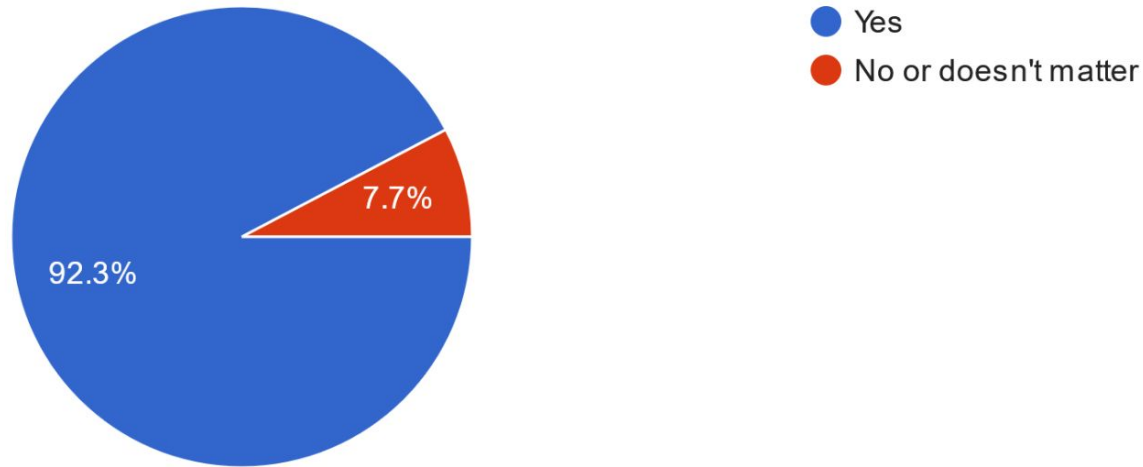
Majority didn't want us to tighten the condition at all.

- 7/13 wanted to keep 100 deg<sup>2</sup> threshold, 3/13 wanted 200 deg<sup>2</sup>, and 3/13 wrote that 30 deg<sup>2</sup> is fine.
- 9/13 didn't want us to add the mean distance threshold, 4/13 wrote that 300 Mpc is fine.

As a result, we decided to keep status-quo. Tightly localized BBH is still prioritized without changing anything for the moment.

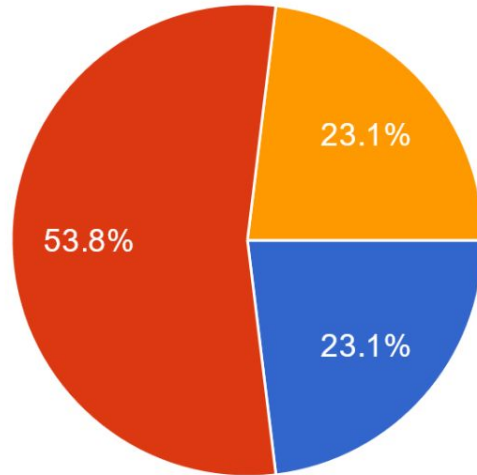
Would you prefer the LVK RRT to maintain prioritization of BBH candidates that are well localized?

13 responses



If yes, should we lower the threshold for the 90% credible region to, for instance, 30 deg<sup>2</sup> instead of 100 deg<sup>2</sup>? Do you have a specific suggestion for t...NS > 10%, \* pNSBH > 10%, or \* HasRemnant > 10%.

13 responses



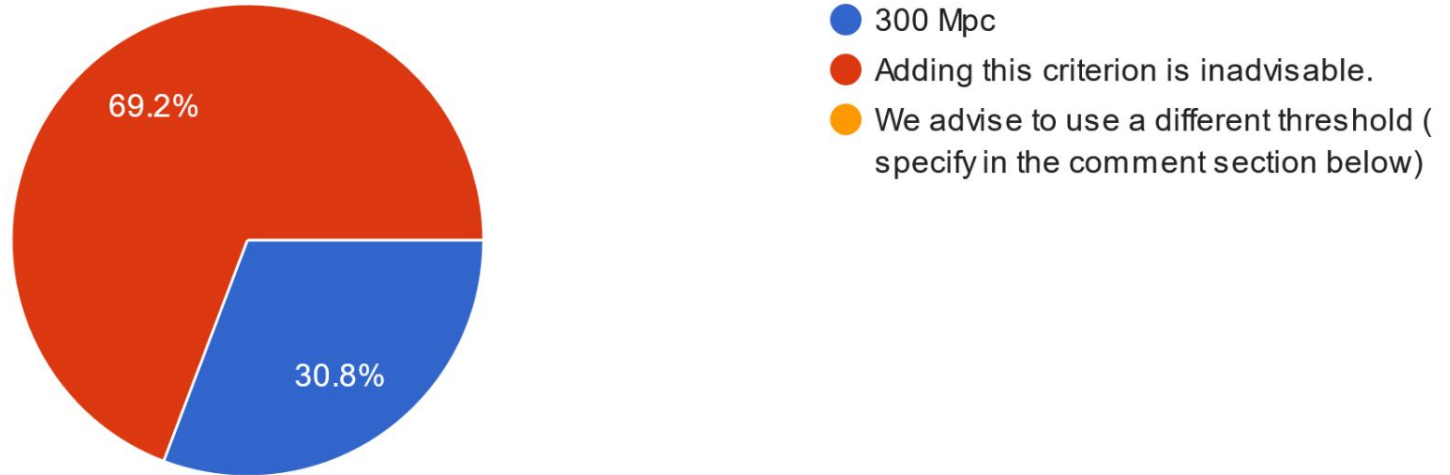
- 30 deg<sup>2</sup> is fine.
- Keep 100 deg<sup>2</sup> threshold.
- We advise to use a different threshold (specify in the comment section below)

(3/13 wanted us to use 200 deg<sup>2</sup> threshold)



Independently of the above, we are also considering adding a mean distance criterion to the localization threshold (e.g., 90% credible region ...BNS > 10%, \* pNSBH > 10%, or \* HasRemnant > 10%.

13 responses



# We won't change the prioritization criteria for now.

- No expert group feels that that's untenable for the rest of O4. Given the event rate (14 tightly localized BBH candidates out of 34 prioritized events total for the entire O4 so far), it's still manageable though hard at times.
- If there's a sudden change in the event rate, we WILL revisit.
  - We might ask you more questions, like the latency of YOUR response to our tightly localized BBH alerts, if you wait for our Initial Notice before doing anything, that kind of stuff.
  - If we change anything we'll tell you via OpenMMA mailing list and update IGWN Public Alert User Guide (<https://emfollow.docs.ligo.org/userguide/>).
- We sincerely thank you, the MMA community, for useful feedback.
  - More events in O5 -> RRT must change. More announcements and questions might come, not just about BBH.