Loud triggers in O3.

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Overview

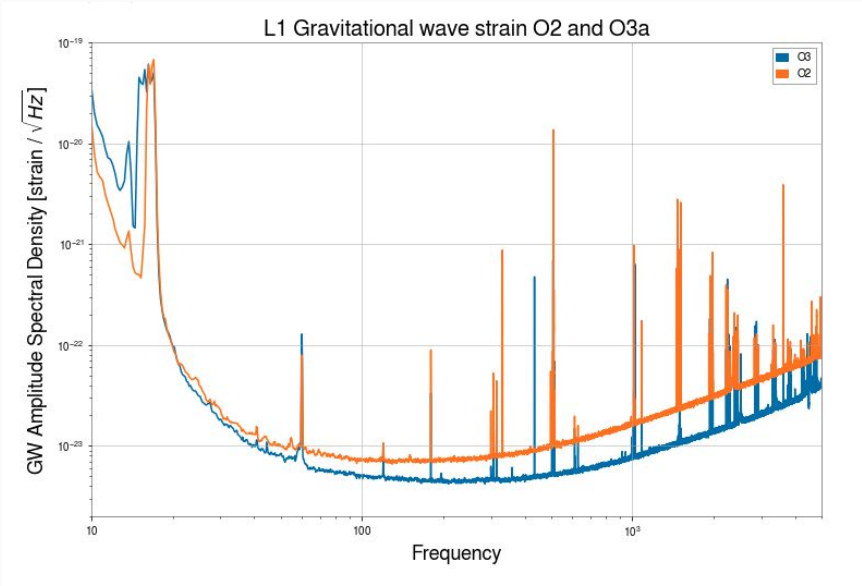
- Do we have more noise in O3 than in O2?
- How do we compare the rate of Loud Glitches in O2 and O3?
- What SNR is loud?
- Association with large range drops?
- Does Range always drop near Loud glitches?

Amplitude not SNR.

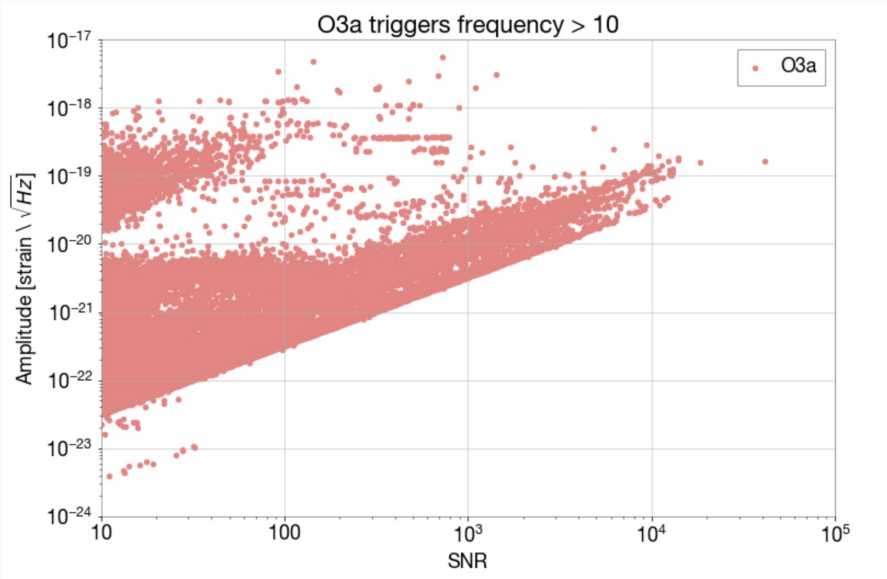
- How do we compare the loudness between O2 and O3?
- The same noise will appear louder since we have gotten better at ‘hearing’.
- Amplitude of a trigger is a more absolute measure of its energy compared to SNR.
- The two are related as

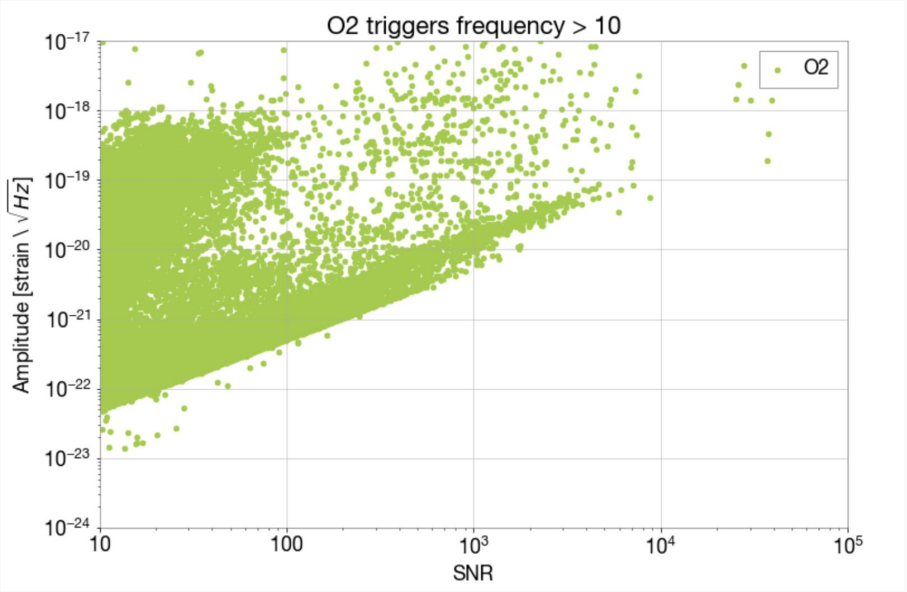
$$\rho = 2\left[\int_0^{+\infty} \frac{\tilde{h}^2(f)}{S(f)} df\right]^{1/2}$$

- ρ is SNR, S(f) is the power spectral density of noise and h(f) is the signal’s amplitude.
- We use amplitude of the trigger to compare the rate of loud glitches in O2 and O3.



Amplitude vs SNR

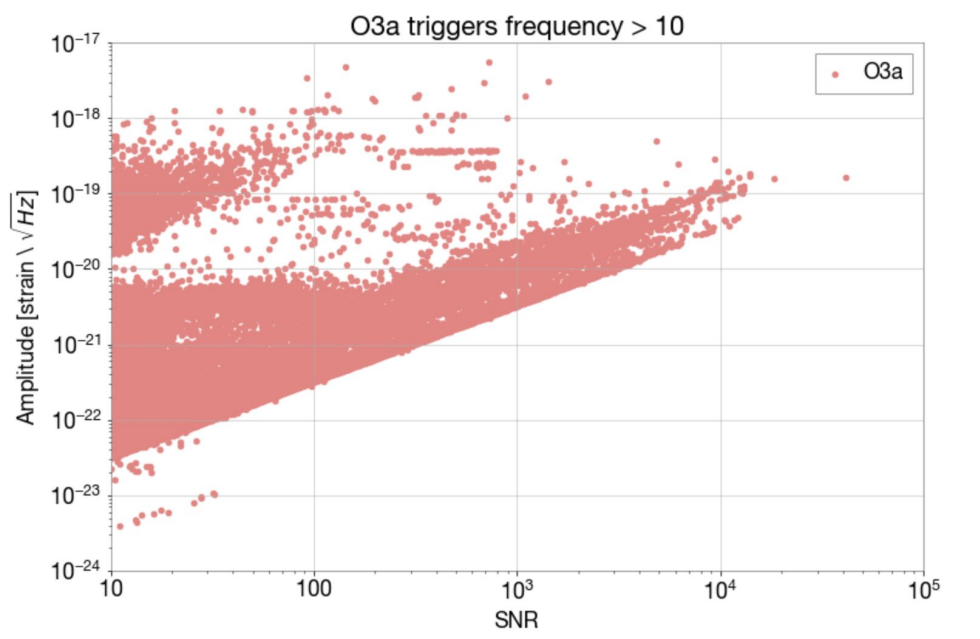




$$|h|_{tile} = \rho_{tile}\left[\sum_{f_{min}}^{f_{max}} P(f)\right]^{1/2}$$

P(f) is the weighted mean of the noise integrated over the frequency bounds of the tile.

Two blobs?

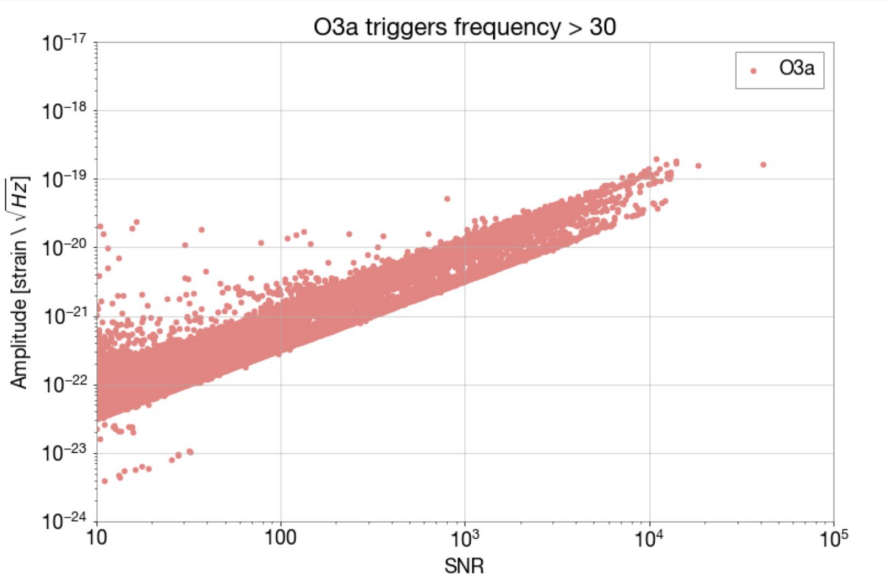


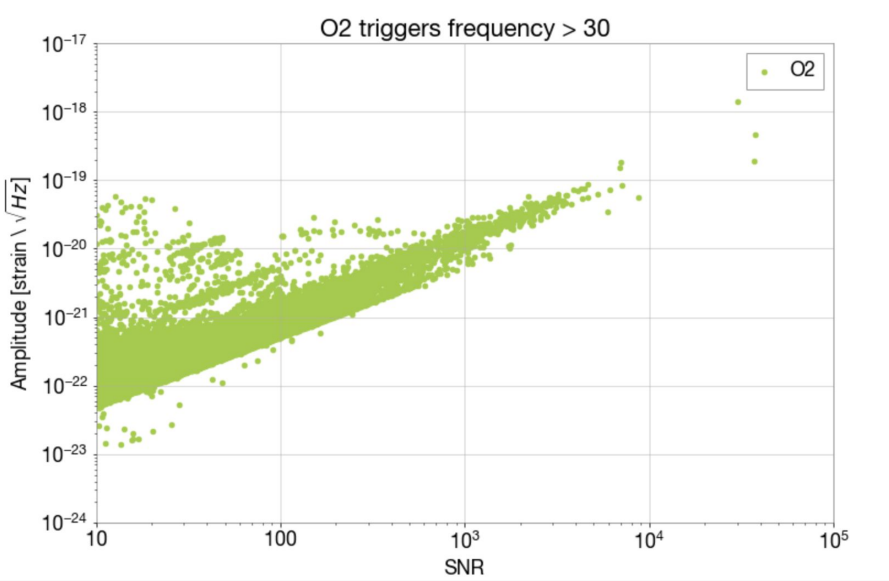
Why are there two blobs?

1) What do the triggers with high amp but low snr look like?
2) What is their frequency content?

So it looks like the SNR and amplitude indeed are correlated within each blobs, when in fact we should have seen just one population.
What these plots are essentially saying is that there are quite a few triggers with very high amplitude and low snr (in the top blob) and that does not sound good, lets see what do we get if we only look at triggers with frequency above 30 Hz.

Amp vs SNR (frequency > 30 Hz)



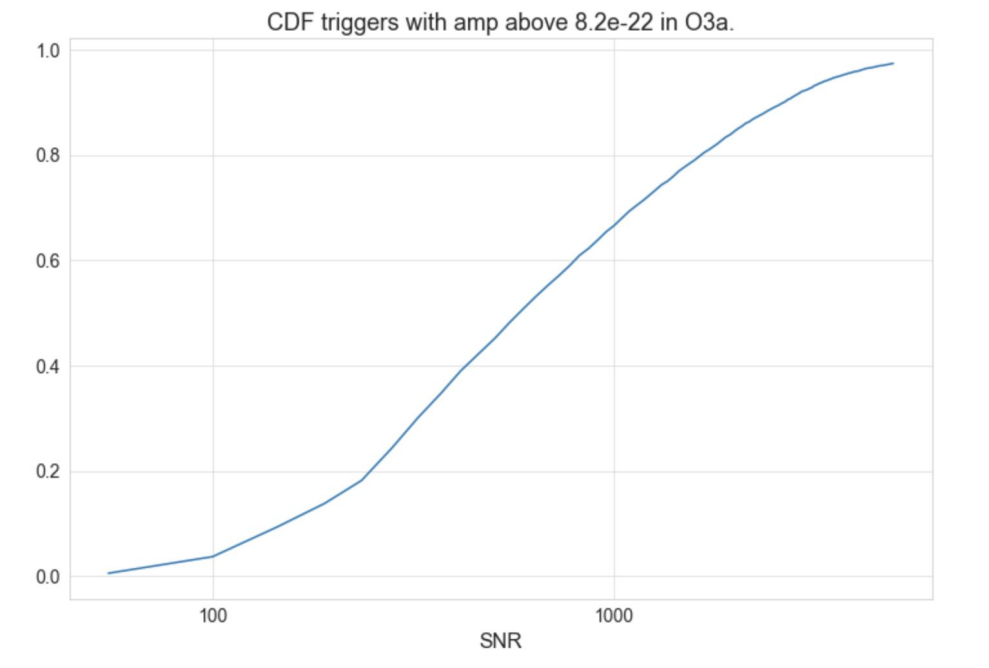


This looks a lot cleaner. The spectra plot in the slide 3 shows that we have quite a bit of noise below 30 Hz (bad sensitivity), which also explains the high amplitude low snr nature of the triggers below 30 Hz. In this analysis we focus on noise events with frequency above 30 Hz.

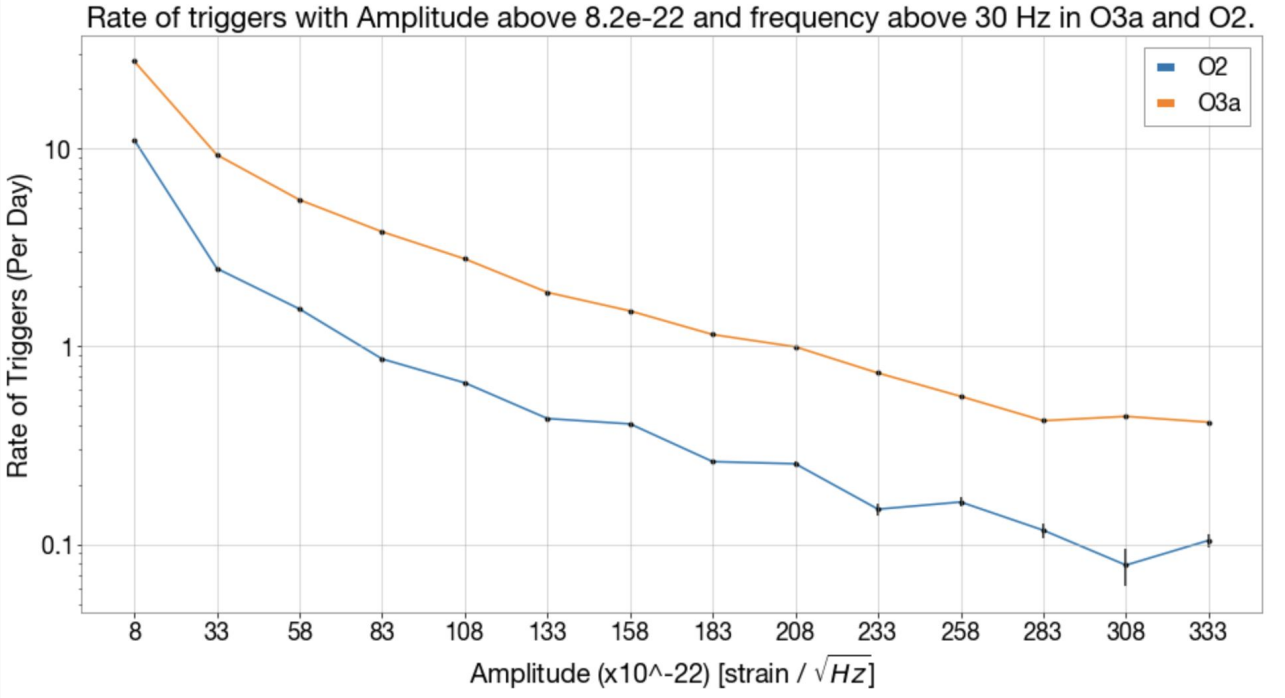
Now that we have preprocessed the data we will look at, next we decide an amplitude threshold for Loud triggers.

Threshold for Loud triggers.

- Approximate SNR range above which we observe large range drops (drops below 100 Mpc)?
- Triggers with SNR above 180 - 200, usually cause range large drops in O3a.
- This provided an equivalent threshold in amplitude of 8.2e-22 for loud triggers.
- Compare the rate of triggers above this threshold amplitude in O2 and O3a.

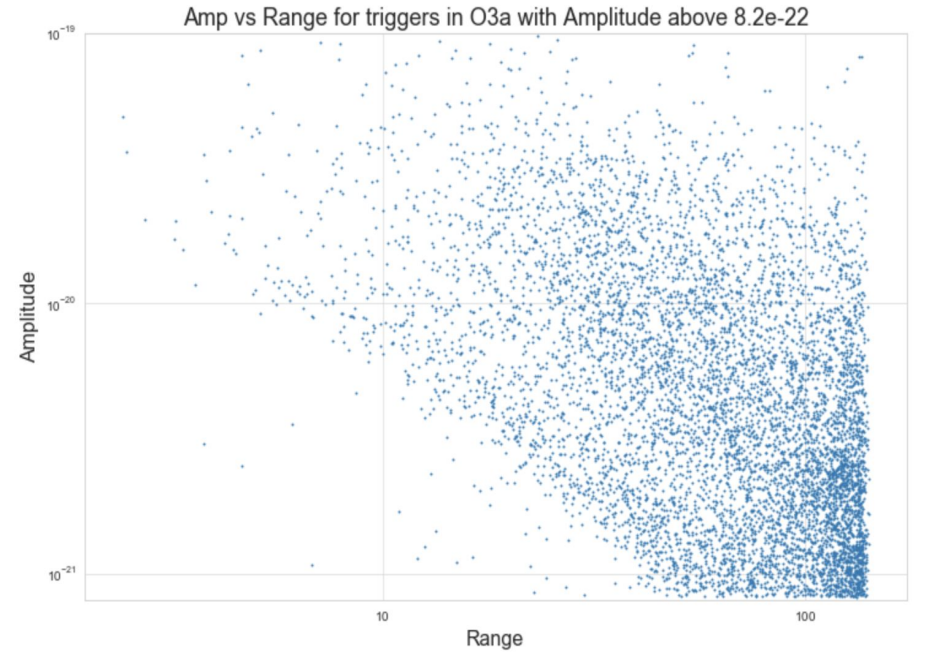


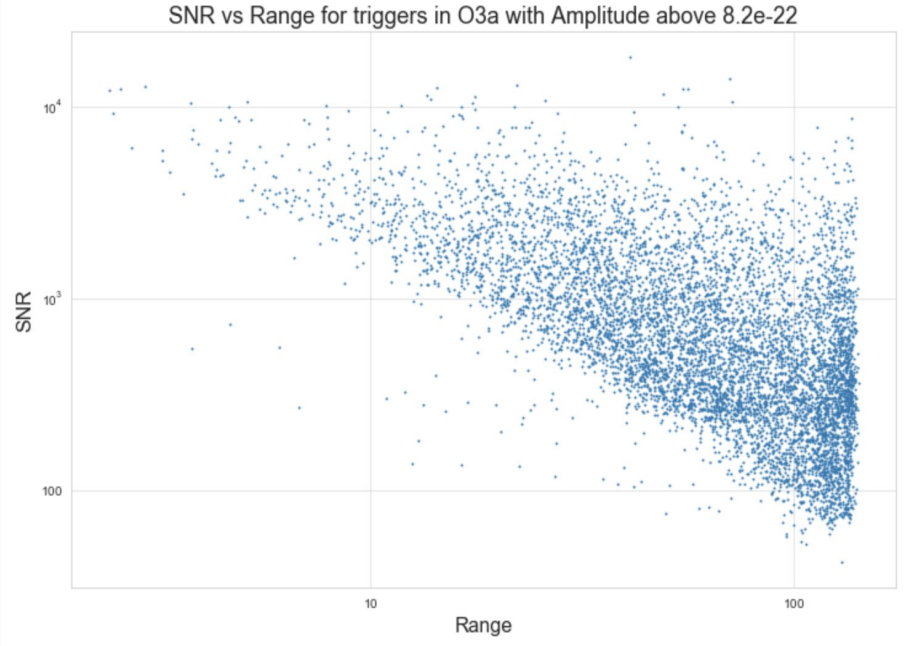
Rate of loud triggers



We can see from this plot that the rate of Loud triggers is higher in O3 than in O2.
Let's look at the impact on range next.

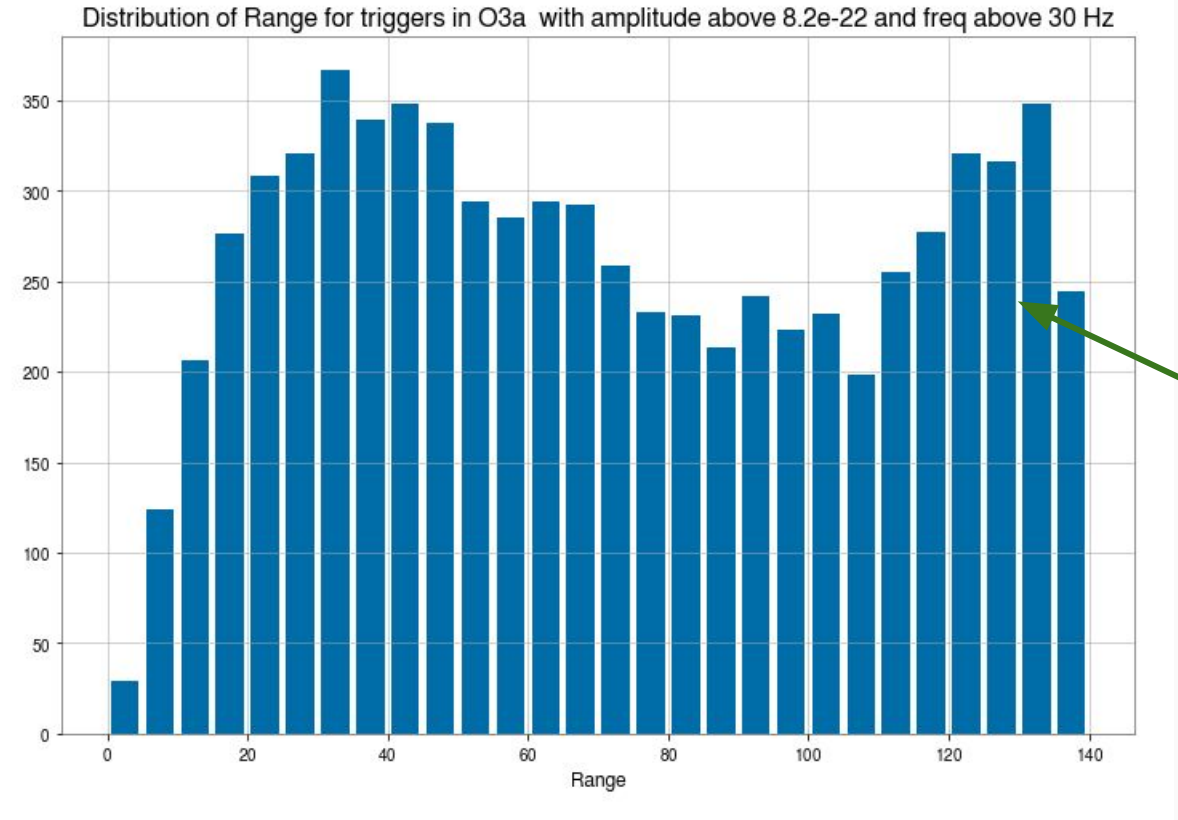
Amp and SNR vs Range for Loud triggers in O3a.





There are some triggers with high amplitude and/or SNR and high range as well.
That's surprising since we expect range to go down for all loud triggers

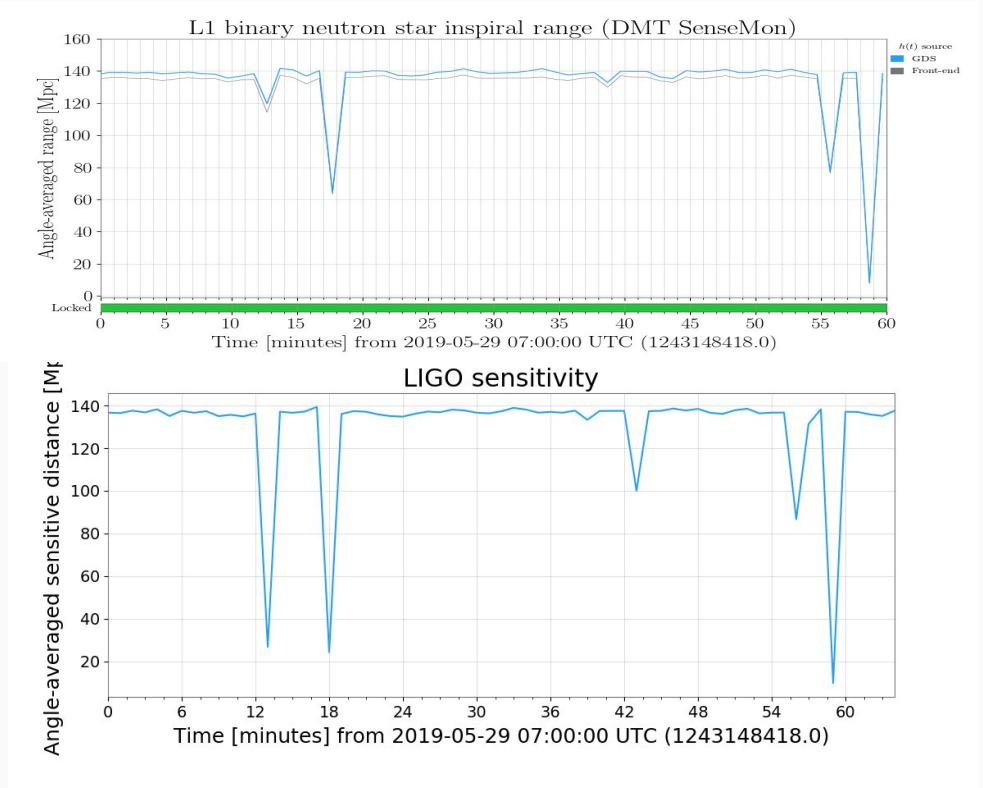
Range drops for Loud triggers.



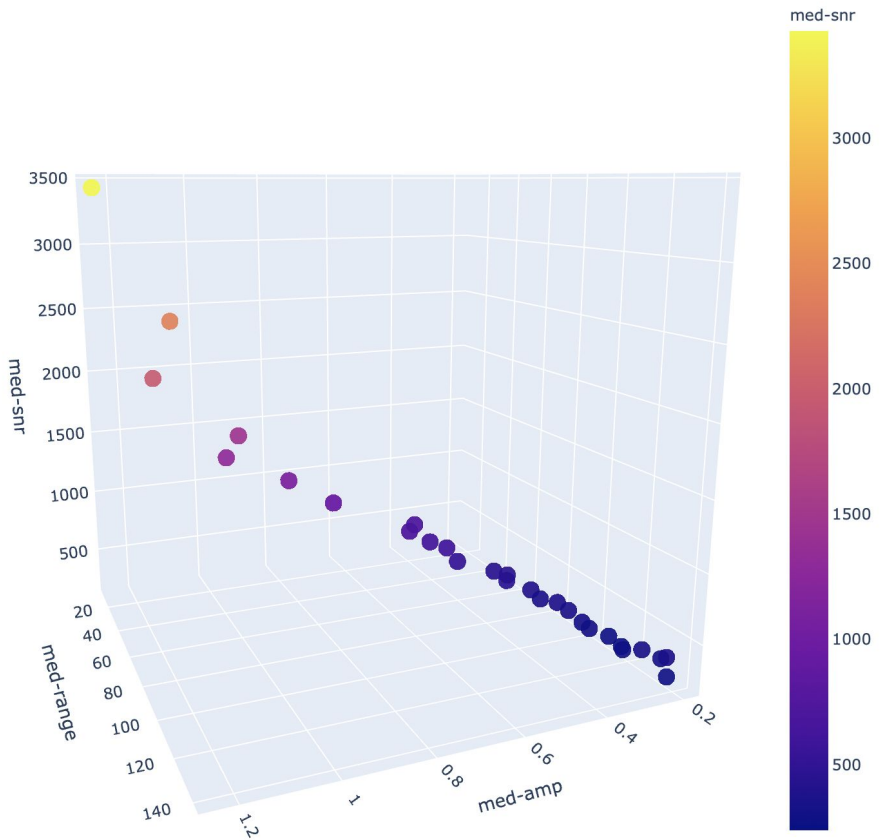
Why do we have this?

range_timeseries

- Why do we have extremely loud triggers with no range drops?
- Randomly selected 25 gpstimes with high amplitude and range above 100.
- Plotted range using range_timeseries, stride = 60, fft = 4, overlap =2, window ='hann' and Welch averaging.
- For 22 of 25 gpstimes, the Range drops below 60.
- The DMT Sensmon does not use overlap. Is that why the discrepancy?



Amplitude-SNR-Range



As amplitude and SNR increases, the range drops

Summary

1. Do we have more loud triggers in O3 or is it because we are more sensitive compared to O2? This is the same as asking, is there really more absolute noise or is it because our ability to “hear” noise has gotten better that we notice more noise.

2. Amplitude is a more absolute measure of noise than SNR.

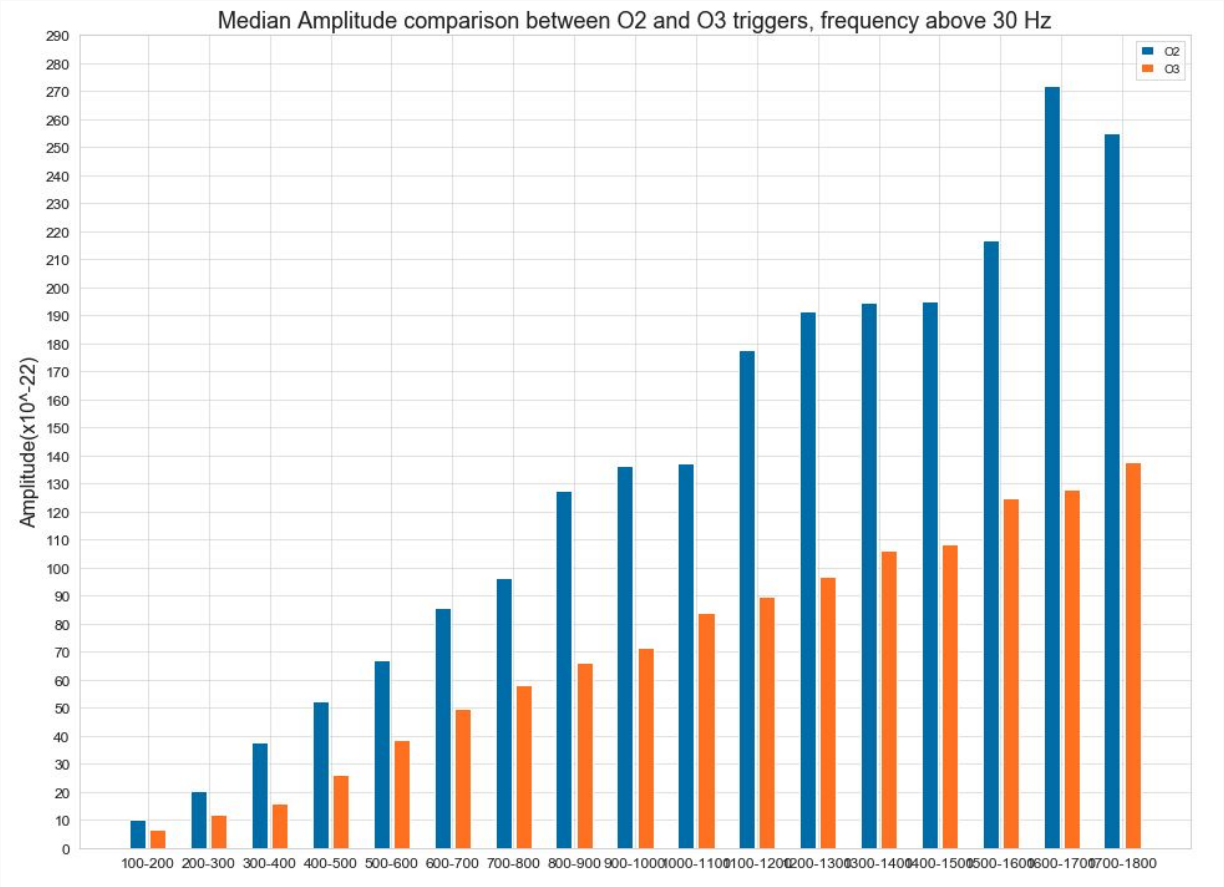
3. Amplitude comparison of loud triggers between O2 and O3 shows that there is indeed a higher rate of loud triggers in O3

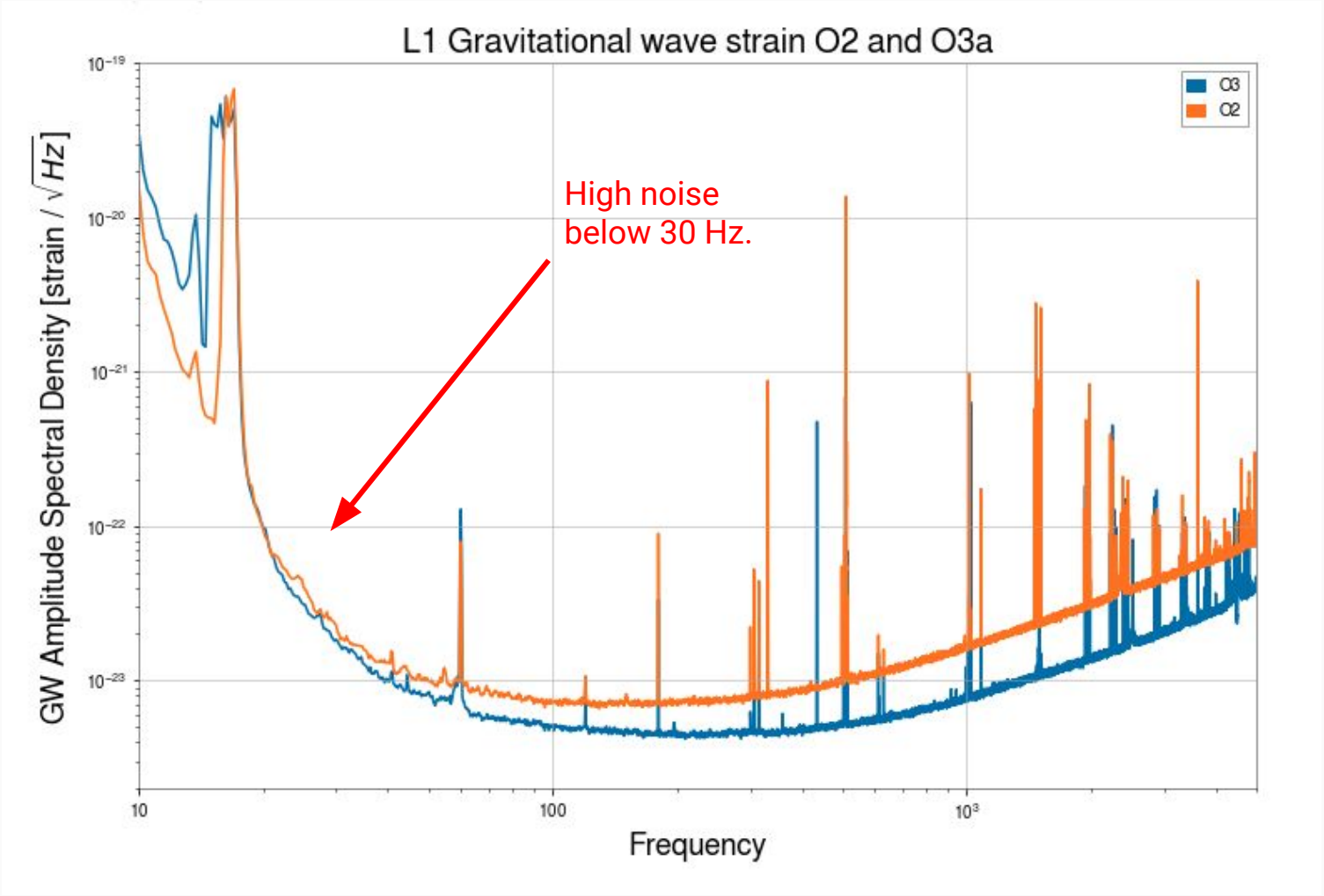
4. We noticed that for some of these high amplitude loud triggers, the DMT range (sensitivity) does not drop as we would expect it to.

5. We used another tool to calculate the range for these loud triggers and found that it is indeed dropping, so there is some fft overlap issue with the DMT range tool

Thank You
Comments and Questions

Amplitude comparison O2 and O3, for similar SNR range triggers.




L1 Gravitational wave strain O2 and O3a
High noise
below 30 Hz.
O3
O2
GW Amplitude Spectral Density [strain / √Hz]
10⁻¹⁹
10⁻²⁰
10⁻²¹
10⁻²²
10⁻²³
10
100
10³
Frequency