

O4 statistical predictions with PBD/GWTC-3 distribution with HL and HLVK

1. PREDICTIONS AND SCENARIOS

1. Here, we're running different scenarios for O4 such as:

- H : only one detector on duty (LHO), to answer Stuart's query on what happens if one detector is running.
- HL : only LHO and LLO are on duty
- HLVK : the 4 detectors are on duty (the perfect case)
- measured PSD is the result of what we measured during O4a
- ideal PSD is what we used in [Kiendrebeogo et al. 2023](#)

2. SNR : for HL we run the ideal PSD and the measured PSD with a threshold of 8 and 10 .

For H we only run it with the measured PSD and a threshold of 10.

Table 1. Annual Detection Rates for Compact binary coalescences that we expect for the run O4 using GWTC-3 distribution. These uncertainties do not incorporate the Monte Carlo method, but only combine both the *log-normal* distribution of the merger rate and the *Poisson counting statistics*

SNR	Network	BNS	NSBH	BBH
Annual number of detections				
10	H measured PSD	1 ⁺⁴ ₋₁	0 ⁺⁰ ₋₀	21 ⁺²⁹ ₋₁₄
	HL measured PSD	5 ⁺¹⁰ ₋₅	0 ⁺⁰ ₋₀	60 ⁺⁷⁸ ₋₃₆
8	HL measured PSD	12 ⁺¹⁷ ₋₉	1 ⁺⁴ ₋₂	115 ⁺¹⁴⁷ ₋₆₇
	HL ideal PSD	11 ⁺¹⁷ ₋₈	2 ⁺⁴ ₋₂	123 ⁺¹⁵⁷ ₋₇₁
	HLVK	36 ⁺⁴⁹ ₋₂₂	6 ⁺¹¹ ₋₅	260 ⁺³³⁰ ₋₁₅₀

In Table 2, we also provide statistics regarding the GW signal sky-localization area, luminosity distance, and comoving volume. Sky-localization area (volume) is given as the 90% credible region, defined as the smallest area (volume) enclosing 90% of the total posterior probability. This corresponds to the area (volume) of

Table 2. Summary Statistics for O4 .

These recorded values are given as 90% credible interval calculated with the 5% and 95% quantile. Those uncertainties have been described by Monte Carlo sampling.

SNR	Network	BNS	NSBH	BBH
Median 90% credible area (deg ²)				
10	H measured PSD	24708 ⁺³⁷ ₋₁₄	24970 ⁺¹⁹⁰ ₋₁₂₀	26553 ⁺⁶¹ ₋₇₈
	HL measured PSD	944 ⁺³⁷ ₋₈₂	1230 ⁺³⁴⁰ ₋₅₁₀	1551 ⁺⁵³ ₋₈₀
8	HL measured PSD	1570 ⁺¹⁴⁰ ₋₁₁₀	2210 ⁺³⁷⁰ ₋₅₂₀	2406 ⁺⁶⁵ ₋₆₅
	HL ideal PSD	1870 ⁺¹⁵⁰ ₋₁₁₀	2210 ⁺⁵⁵⁰ ₋₃₅₀	2561 ⁺⁷⁰ ₋₇₈
	HLV	1860 ⁺²⁵⁰ ₋₁₇₀	2140 ⁺⁴⁸⁰ ₋₅₃₀	1428 ⁺⁶⁰ ₋₅₅
Median 90% credible Comoving Volume (10 ⁶ Mpc ³)				
10	H measured PSD	25.5 ^{+7.0} _{-1.8}	95 ⁺¹⁴⁰ ₋₃₉	5210 ⁺⁶²⁰ ₋₅₉₀
	HL measured PSD	4.70 ^{+0.65} _{-0.63}	20.3 ⁺¹¹ _{-4.8}	1130 ⁺¹¹⁰ ₋₁₁₀
8	HL measured PSD	20 ^{+4.5} _{-4.0}	94 ⁺⁴⁴ ₋₂₉	3480 ⁺²⁴⁰ ₋₂₁₀
	HL ideal PSD	25.2 ^{+4.3} _{-5.6}	116 ⁺²⁷ ₋₄₀	3740 ⁺²⁵⁰ ₋₂₂₀
	HLVK	67.9 ^{+11.3} _{-9.9}	232 ⁺¹⁰¹ ₋₅₀	3400 ⁺³¹⁰ ₋₂₄₀
Median Luminosity Distance (Mpc)				
10	H measured PSD	163 ⁺²¹ ₋₁₉	240 ⁺¹⁵ ₋₁₅	1070 ⁺⁵⁰ ₋₂₅
	HL measured PSD	217 ⁺¹⁷ ₋₁₄	252 ⁺¹⁴⁶ ₋₂₁	1512 ⁺⁵³ ₋₃₄
8	HL measured PSD	278 ⁺¹⁴ ₋₁₃	462 ⁺²⁹ ₋₆₅	2024 ⁺³⁷ ₋₄₉
	HL ideal PSD	274 ⁺¹⁵ ₋₁₁	501 ⁺²⁷ ₋₄₆	2067 ⁺⁶² ₋₄₃
	HLVK	398 ⁺¹⁵ ₋₁₄	770 ⁺⁶⁷ ₋₇₀	2685 ⁺⁵³ ₋₄₀
Sensitive volume : detection rate / merger rate: (Gpc ³)				
10	H measured PSD	0.0091 ^{+0.0026} _{-0.0022}	0.063 ^{+0.037} _{-0.026}	1.253 ^{+0.102} _{-0.96}
	HL measured PSD	0.0275 ^{+0.0044} _{-0.0039}	0.122 ^{+0.048} _{-0.040}	3.53 ^{+0.17} _{-0.16}
8	HL measured PSD	0.0573 ^{+0.0062} _{-0.0057}	0.248 ^{+0.068} _{-0.057}	6.75 ^{+0.23} _{-0.23}
	HL ideal PSD	0.0553 ^{+0.0067} _{-0.0061}	0.305 ^{+0.081} _{-0.068}	7.22 ^{+0.26} _{-0.25}
	HLVK	0.172 ^{+0.013} _{-0.012}	0.78 ^{+0.14} _{-0.13}	15.15 ^{+0.42} _{-0.41}

the sky that must be covered to have a 90% chance of including the source.

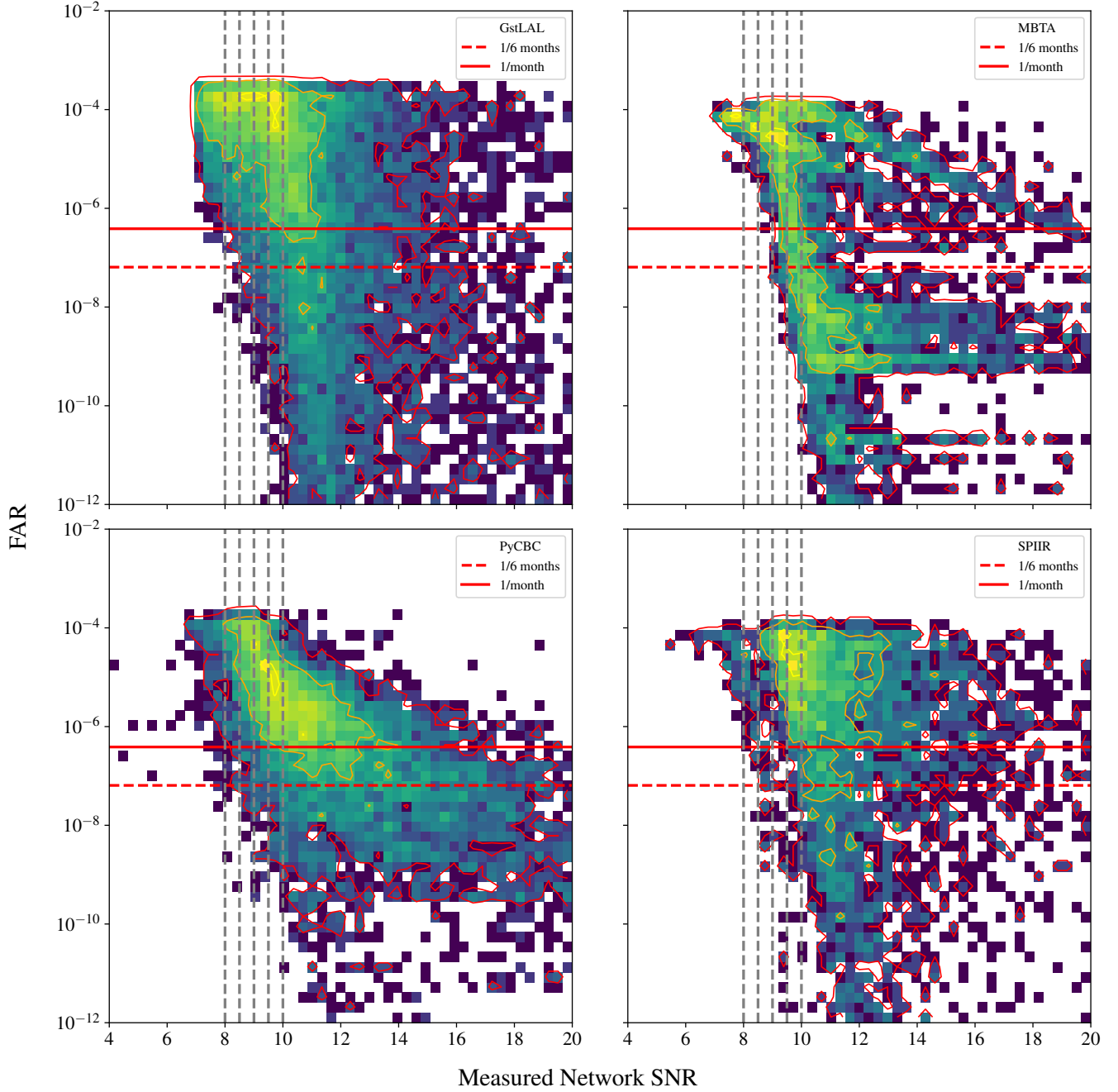


Figure 1. Log density plot of FAR compared to the measured network SNR individual CBC pipelines during an MDC cycle. The vertical lines are at SNRs of 8 to 10 by increments of .5. We see the highest density of events for an SNR just under 10, and a FAR close to 10^{-4} .

REFERENCES

- Kiendrebeogo, R. W., Farah, A. M., Foley, E. M., et al.
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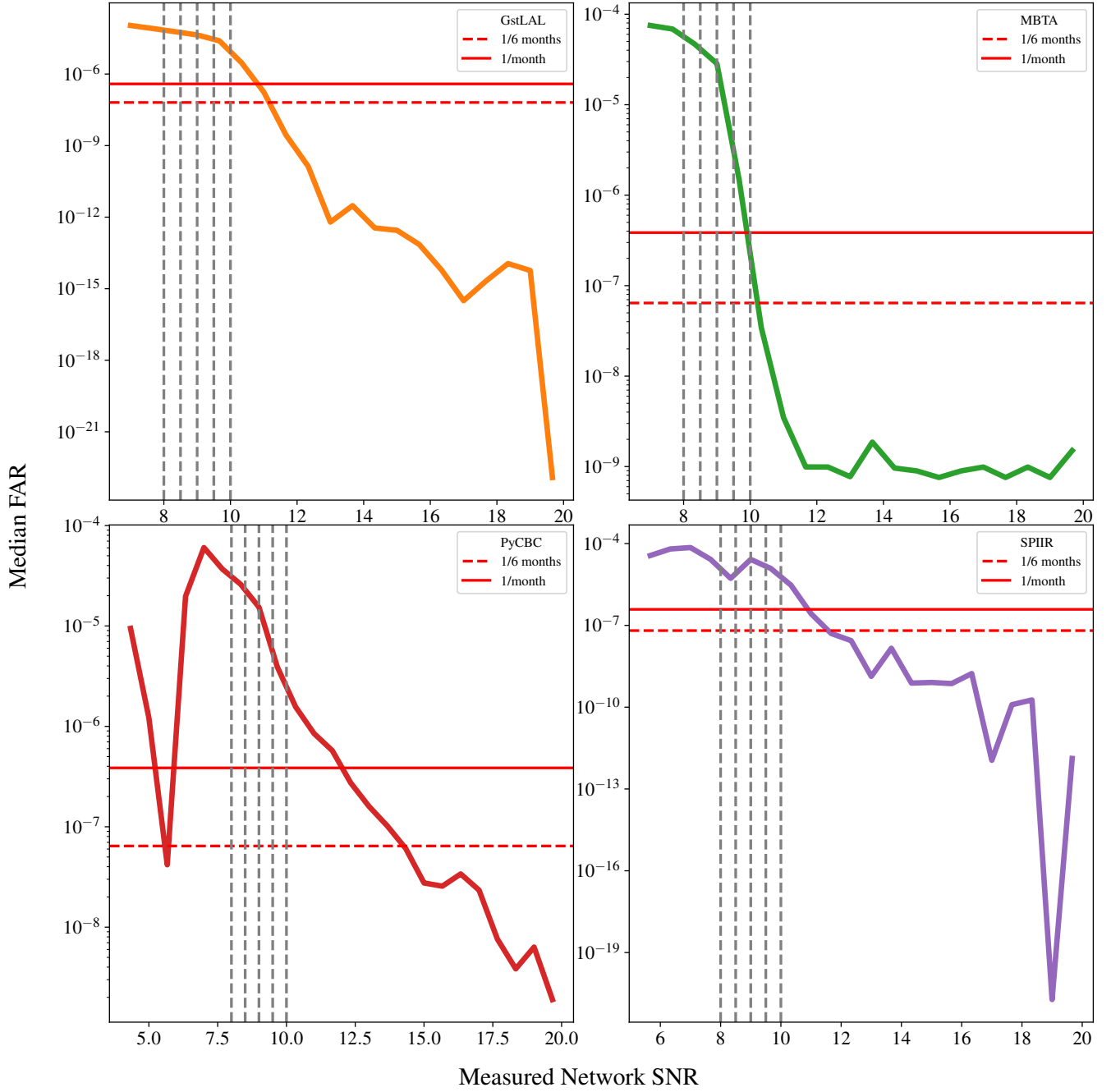


Figure 2. Comparison of the median FAR in a given SNR bin to the measured network SNR during an MDC cycle for individual CBC pipelines. The vertical lines are at SNRs of 8 to 10 by increments of .5. We find the measured network SNR to be approximately between 10-12, depending on the CBC pipeline, for a FAR threshold of 1/month, which is the significant public alert threshold before trials factor.