Subtraction of loud CBC signals in the ET MDC

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2025

Our first paper on analyzing the ET MDC data

A weakly-modeled search for compact binary coalescences in Einstein Telescope

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(compiled December 20, 2024)

https://arxiv.org/abs/2408.13007

Phys. Rev. D 111, 022002 (2025)

The main problem: background estimation

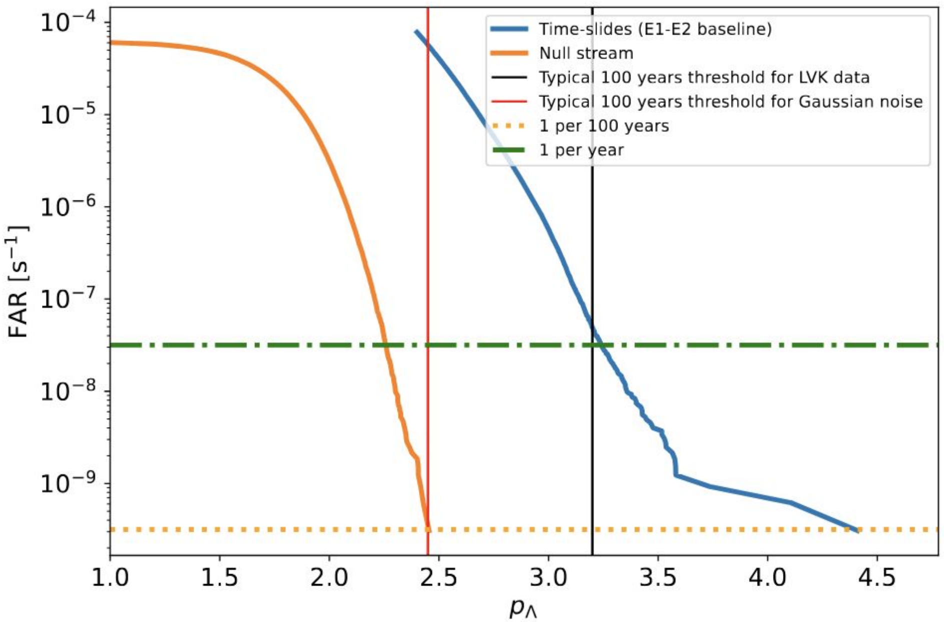

FIG. 1. Cumulative rate of noise triggers as a function of the detection statistic p_Λ for the two methods used to estimate the background.

Solution: fit and subtract the loudest CBC signals found

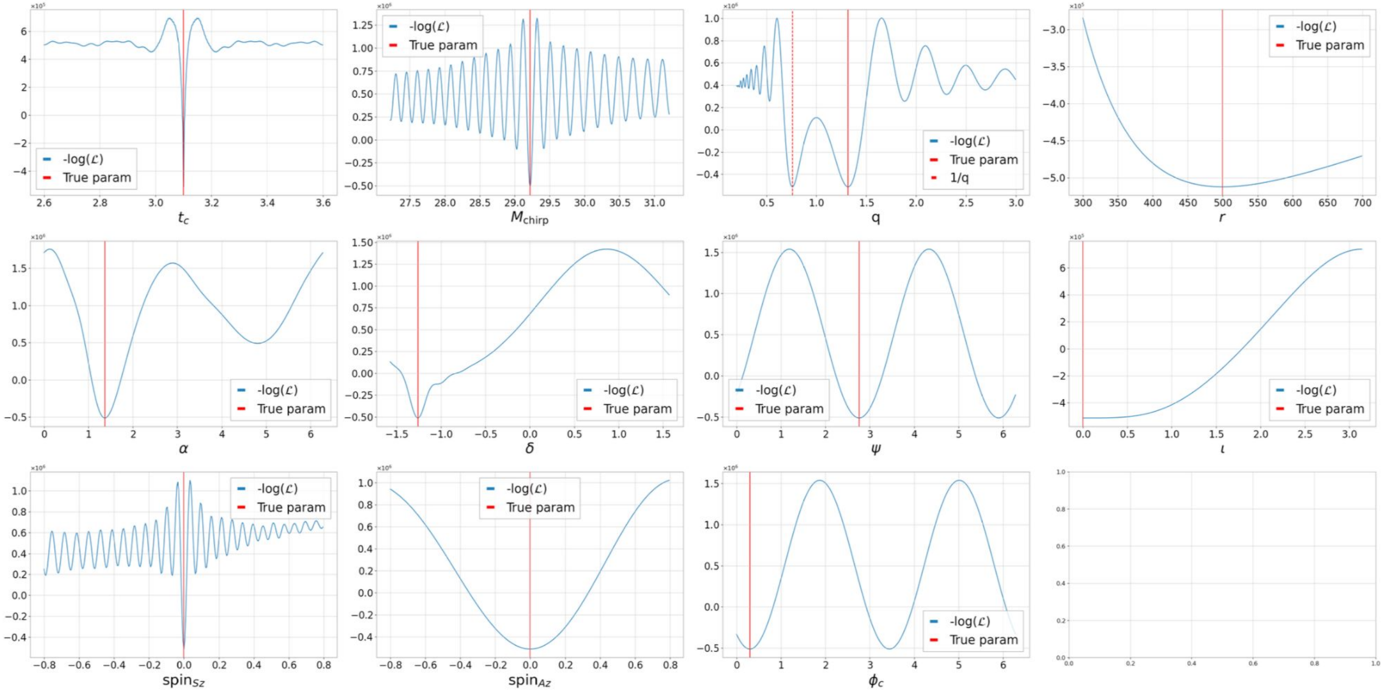

Figure 8 – Calculation of -log($\mathcal{L}_R$) for all the 11 parameters used in the MLE to generate GW signals from CBCs. The figure shows the different behaviour of -log($\mathcal{L}_R$) depending on the parameter considered. For instance, values close to the true value of the distance will give approximately the same value of -log($\mathcal{L}_R$). This is different for spin$_{Sz}$ or t_c which have a strong minimum at the true value.

Dimensionality and degeneracies: not a trivial fit

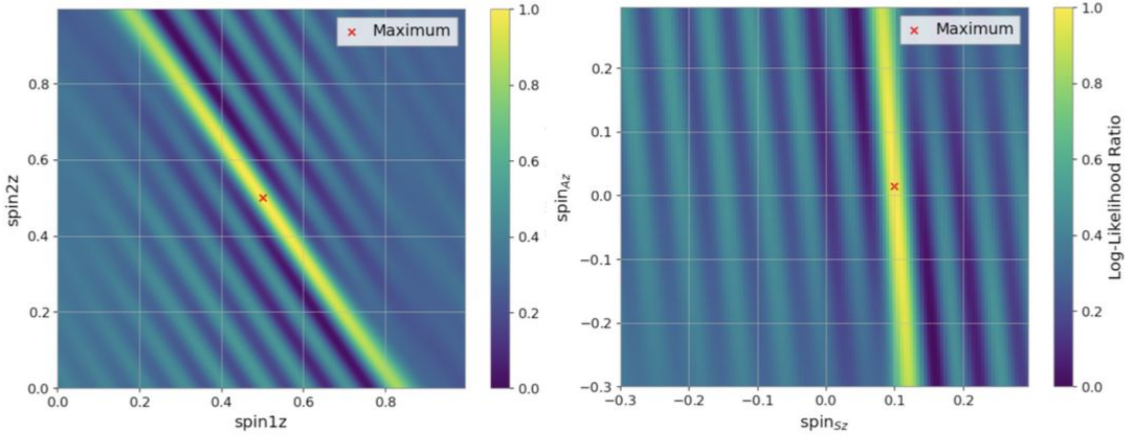

Figure 11 – Comparison of the correlation between two sets of parameters by calculating $\log(\mathcal{L}_R)$. The sub-figure of the left hand side shows correlations between the two spins along the z axis of the two objects of the CBC. On the right hand side, a similar figure is presented using spin_{Sz} and spin_{Az}.

Subtraction seen in the time domain

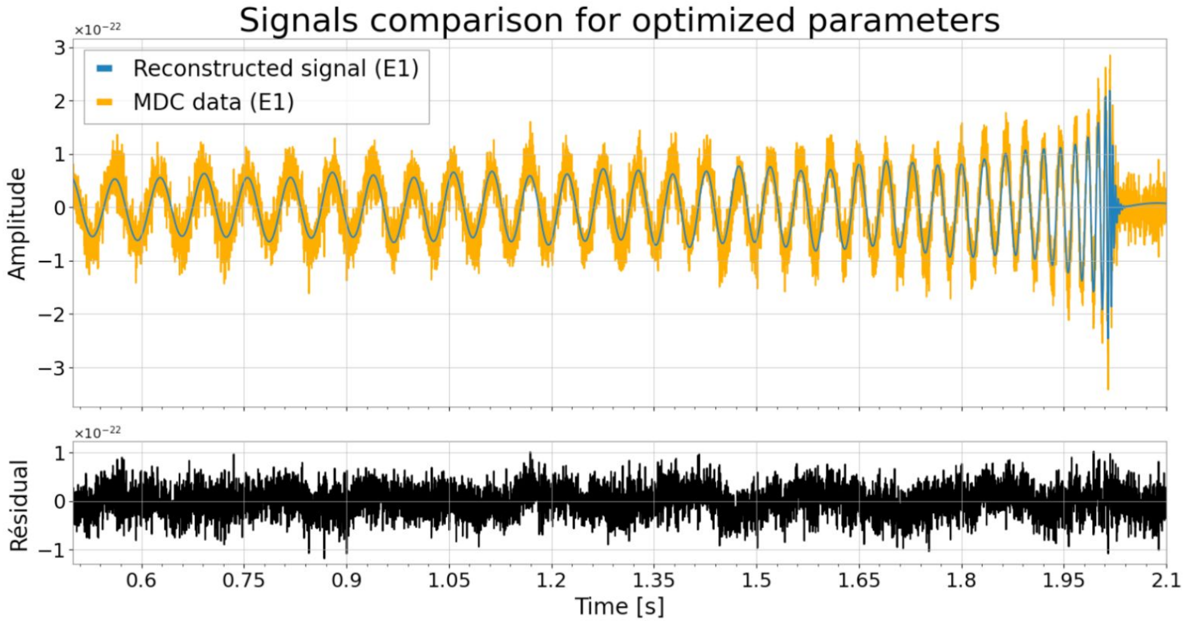

Figure 15 – Comparison in time domain between the MDC data (in orange) and the reconstructed signal (in blue) of a GW signal from a loud (SNR = 343.8) BBH in the ET-MDC. The signal is from E1. The reconstructed signal matches the data well in terms of both frequency and amplitude. The residual between the two signals is shown in black at the bottom. It appears that there is no remaining signal and that the residual resembles Gaussian noise.

Subtraction seen in the frequency domain

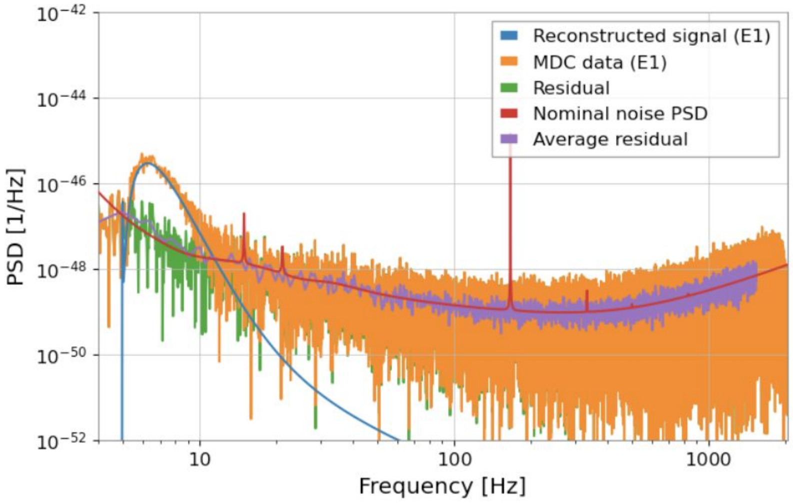

Figure 16 – Comparison in frequency domain between the MDC data (in orange) and the reconstructed signal (in blue) of the same GW signal introduced in figure 15. The average residual (in purple) fits well the nominal noise PSD (in red) used in the ET-MDC to simulate the noise of ET.

Subtraction seen in the time-frequency domain

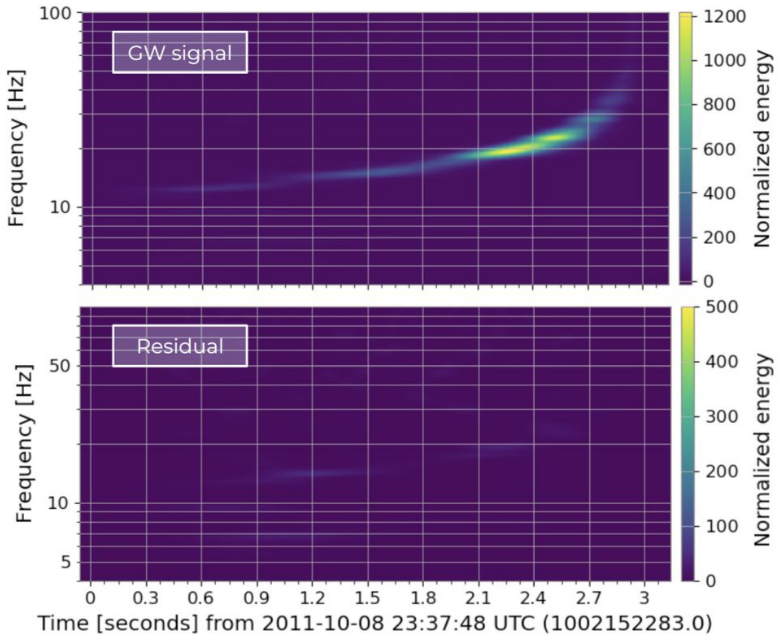

Figure 17 – The upper figure shows the q-transform of the GW signal introduced in figure 15. The bottom figure shows the q-transform of the residual obtained by subtracting the reconstructed signal.

Impact of the subtraction on the background estimation

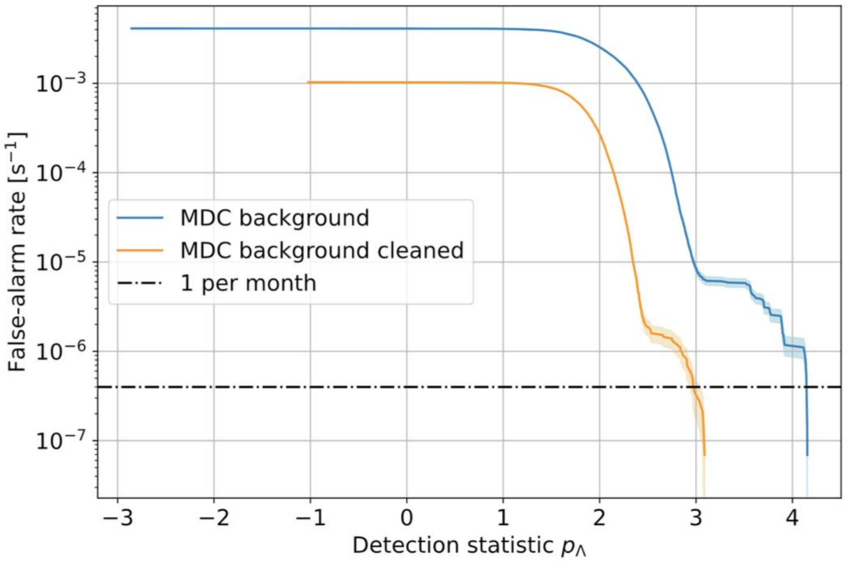

Figure 22 – Comparison of the background estimation for the ET-MDC (in blue) and the cleaned dataset where the loudest GW signals have been subtracted (in blue). The study has been made for 9000 seconds of the ET-MDC from 1001590000 to 1001599000 seconds.