Missed astrophysical signal in the GW150914 event

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A common practice to deal with signals contained in complex noisy data is to apply the whitening filters. In figure 1 we presents graphs of the amplitude spectral density of the raw data from Hanford on the left, and on the right the strain after applying the whitening filter, which has been normalized in order to preserve the strain amplitude at the minimum of the amplitude spectral density of the detector.

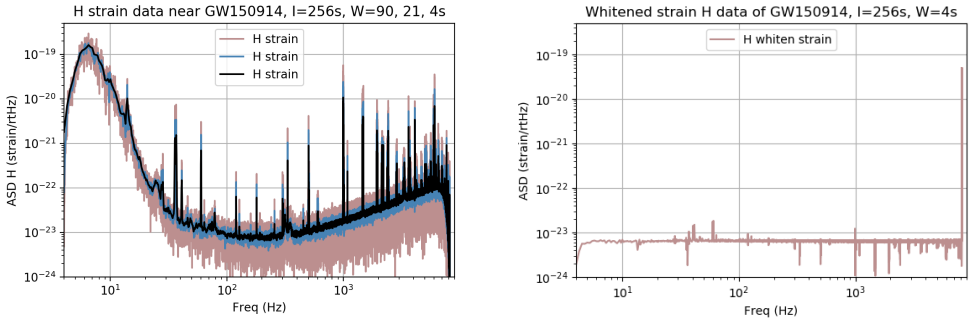

Figure 1: ASD of raw data from Hanford on the left, in the range from 4 to 9000Hz, for the interval of 256s around the time of the event with 90s windows. where one can observe the cutoff at the Nyquist frequency. On the right, the strain after applying the whitening filter, as explained in the public LIGO python scripts.

We present a new strategy for the pre-processing filtering techniques of the LIGO strain of the GW150914[1, 2] event that intends to extract as much physical information as possible, minimizing the use of prior assumptions, and avoiding transformations of the astrophysical signal. In figure 2 we show the graph of the amplitude spectral density of Hanford strain on the left and Livingston on the right, after applying our filters that include an initial bandpass from 22 to 1024Hz, and then a multiple stopband filter to exclude the intrinsic instrumental characteristic frequencies of each detector.

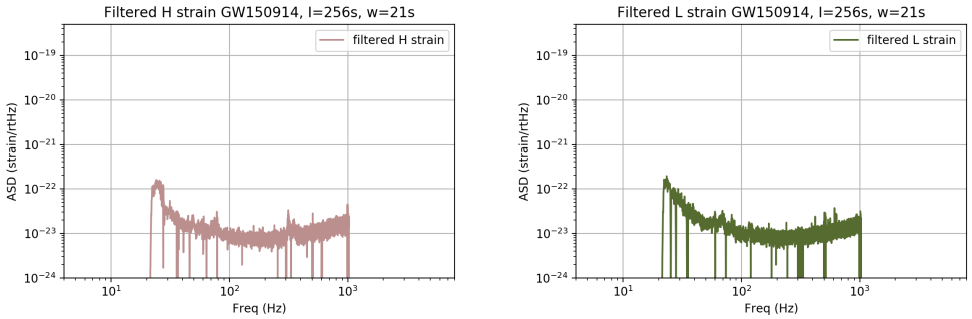

Figure 2: ASD of the strains after bandpass and stopband filter; Hanford on the left and Livingston on the right.

The idea behind the decision of not filtering the low frequencies at this stage is that we would like to allow for possible interesting physical signals at this initial portion of the spectrum. We do find such low frequency signals. By applying a different pre-processing filtering technique, we are able to notice that the astrophysical signal in the GW150914 event extends at least up to 0.5 seconds previous to the event time; instead of the published 0.1s.

References

[1] **Virgo, LIGO Scientific** Collaboration, B. P. Abbott *et al.*, "Observation of Gravitational Waves from a Binary Black Hole Merger," *Phys. Rev. Lett.* **116** no. 6, (2016) 061102, `arXiv:1602.03837 [gr-qc]`.

[2] **Virgo, LIGO Scientific** Collaboration, B. P. Abbott *et al.*, "Properties of the Binary Black Hole Merger GW150914," *Phys. Rev. Lett.* **116** no. 24, (2016) 241102, `arXiv:1602.03840 [gr-qc]`.