StarTrack predictions of the stochastic gravitational-wave background from compact binary coalescences

arXiv:[2008.00490]

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Stochastic background presentation

Definition

Signal composed by every non-resolved gravitational wave signals.

Stochastic background sources

- Astrophysical background : Gravitational waves from phenomena after the stellar activity like compact binaries coalescences.
- Cosmological background : Gravitational waves from phenomena from early universe.

Characterization

$$\Omega_{GW}(f) = \frac{f}{\rho_c}\frac{d\rho_{GW}}{df}$$

Problematic of the study

Population III

fs1.b from arXiv:[1612.01524]

- Metallicity : Z=0
- Never been observed
- Begining of the stellar formation
- Implies DM Halos

Population I/II

M30.B from arXiv:[1706.07053]

- Metallicity : Z[0.001-0.02]
- Isolated binaries

Non-merging population

- Population I/II stars
- Far from merger

Theorical aspects

Ω_{GW} calculation

$$\Omega_{gw}(f) = \frac{f}{c\rho_c}\phi(f), \tag{1}$$

$$\phi(f) = T^{-1}\sum_{k=1}^{N}\frac{1}{4\pi r^2}\frac{dE_{gw}^k}{df}(f), \tag{2}$$

dE/df(f)

arXiv:[0909.2867]

$$\frac{dE_{gw}}{df} = \propto \begin{cases} f^{-1/3} & \text{si } f < f_{\text{merg}} \\ f^{2/3} & \text{si } f_{\text{merg}} \leq f < f_{\text{ring}} \\ L(f, f_{\text{ring}}, \sigma) & \text{si } f_{\text{ring}} \leq f < f_{\text{cut}} \end{cases} \tag{3}$$

O3a results

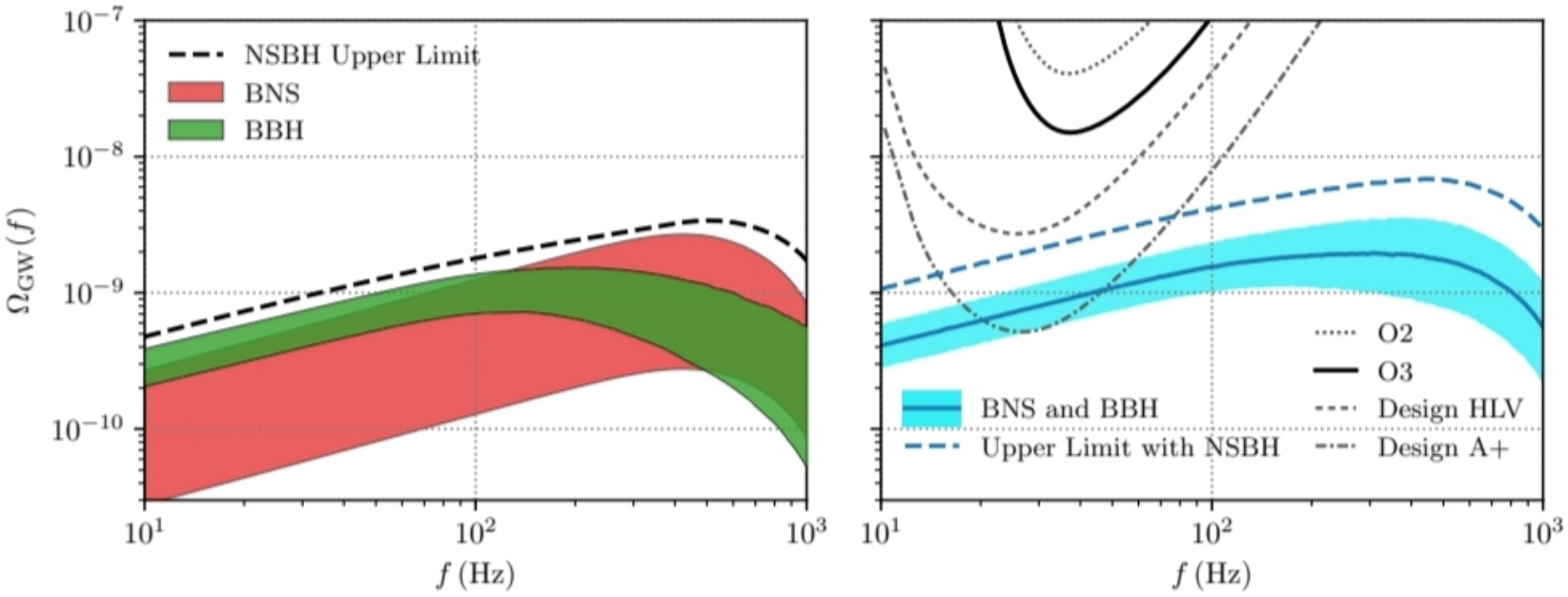


Figure: *Fiducial model prediction for the energy density background from BNS, BBH and NSBH. arXiv:[2101.12130]*

- $\Omega_{gw}^{BNS}(25\mathrm{Hz}) = 2.1^{+2.9}_{-1.6} \times 10^{-10}$
- $\Omega_{gw}^{BBH}(25\mathrm{Hz}) = 5.0^{+1.7}_{-1.4} \times 10^{-10}$

arXiv:[2101.12130]

Total background from population I/II

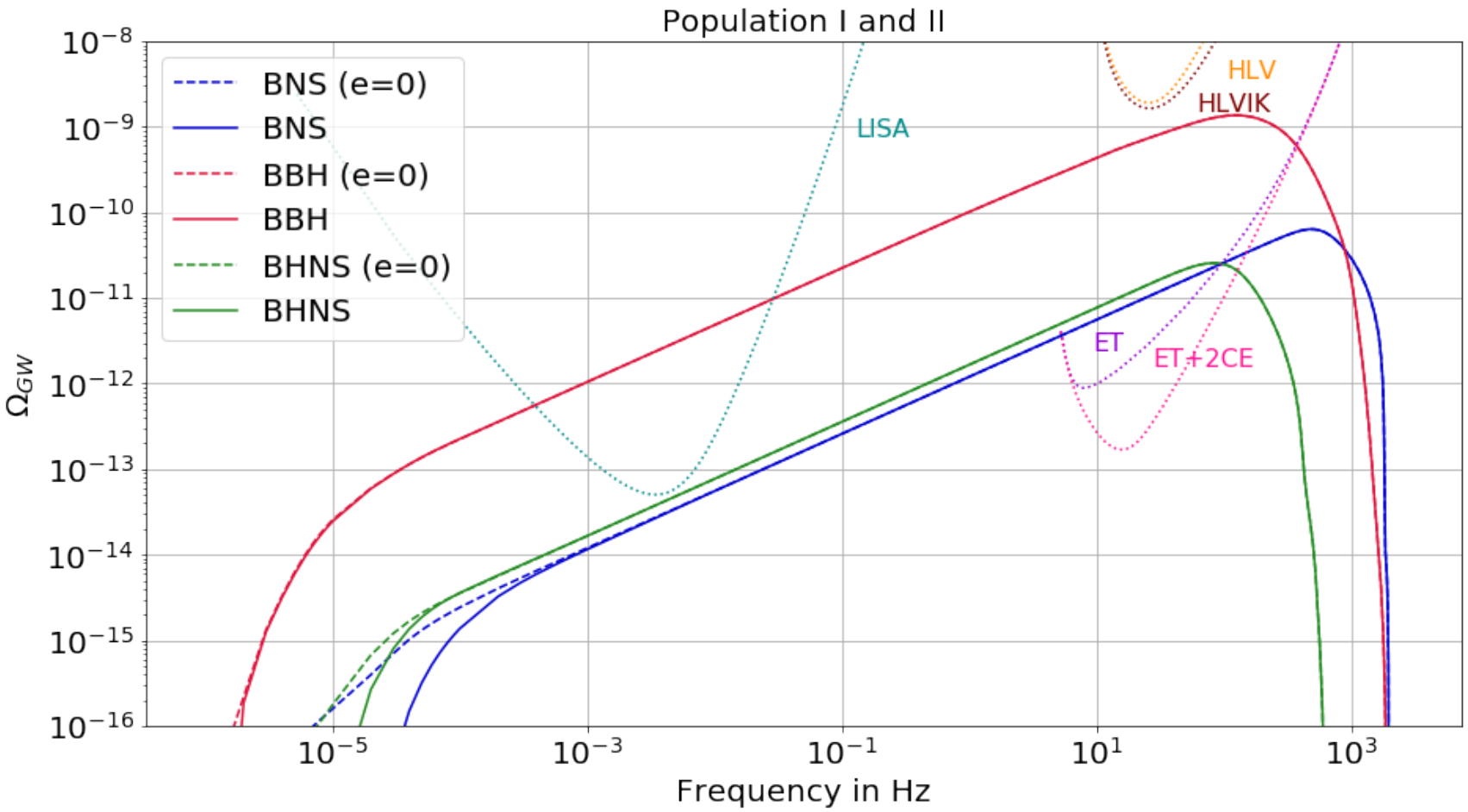


Figure: *Total background of population I/II from StarTrack predictions.arXiv:[2008.00490]*

Total background

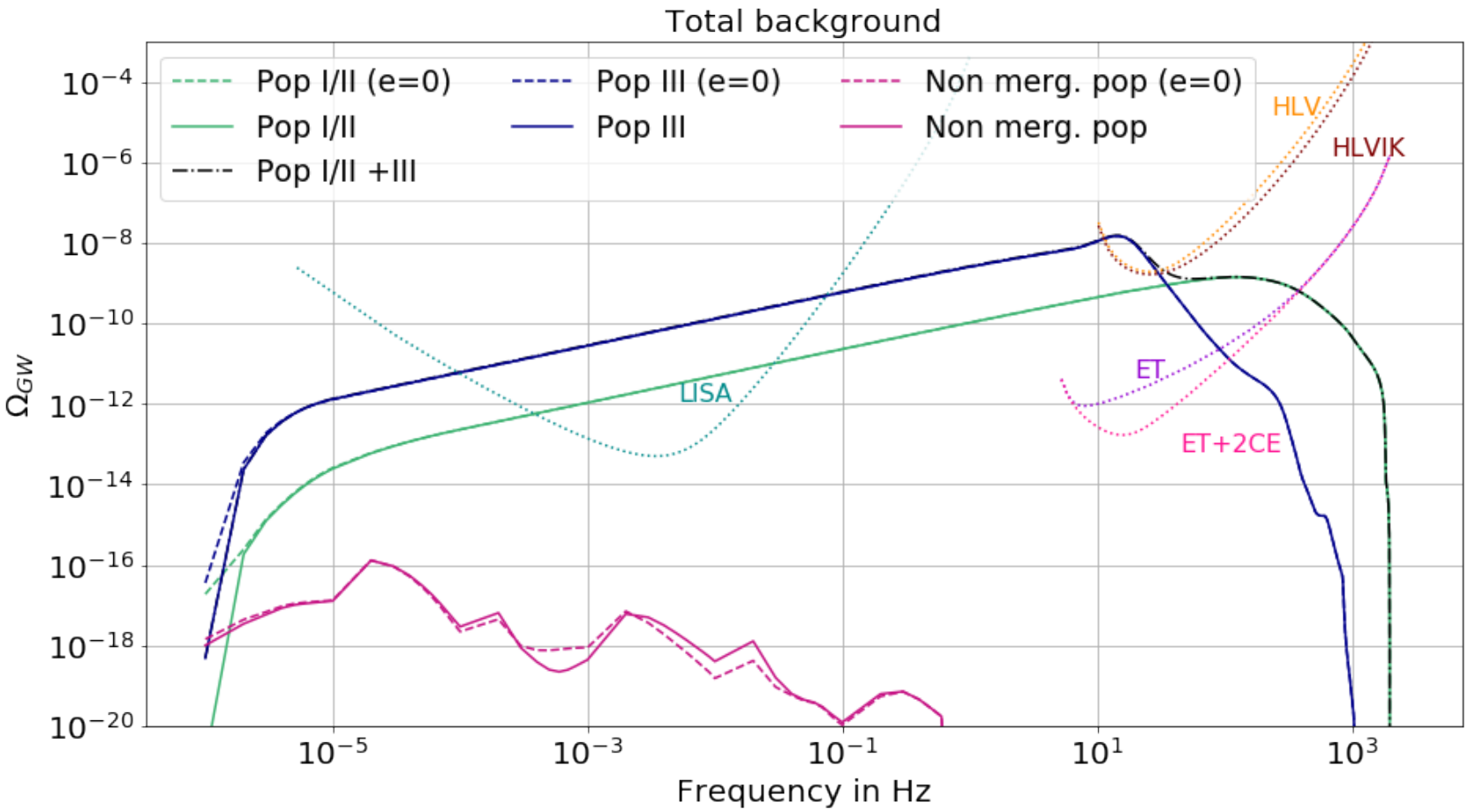


Figure: *Total background from population I/II, population III and non-merging population.arXiv:[2008.00490]*

Residual background in 2G detectors

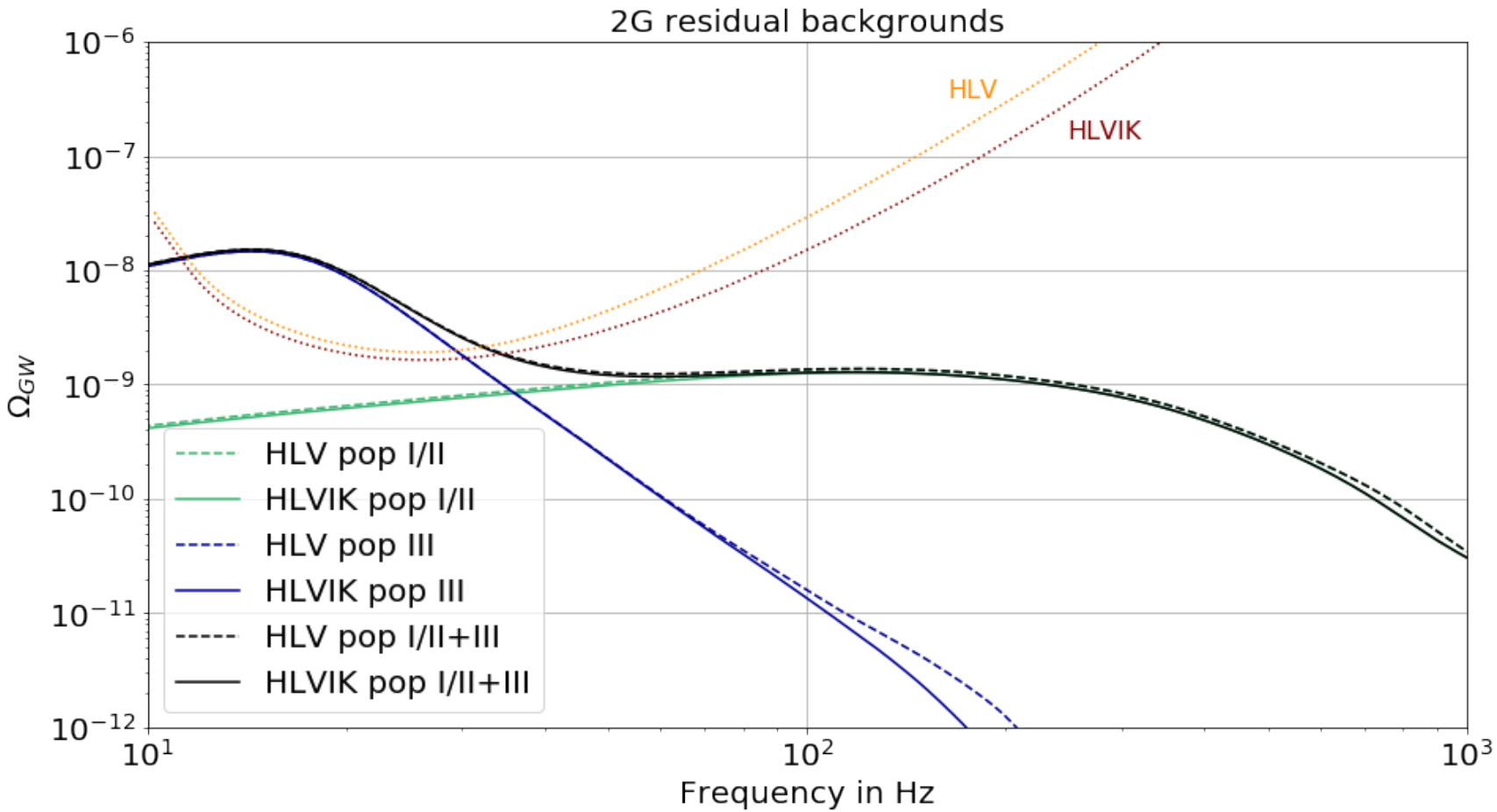


Figure: *Residual background in 2G detector networks from StarTrack predictions arXiv:[2008.00490]*

Residual background in 3G detectors

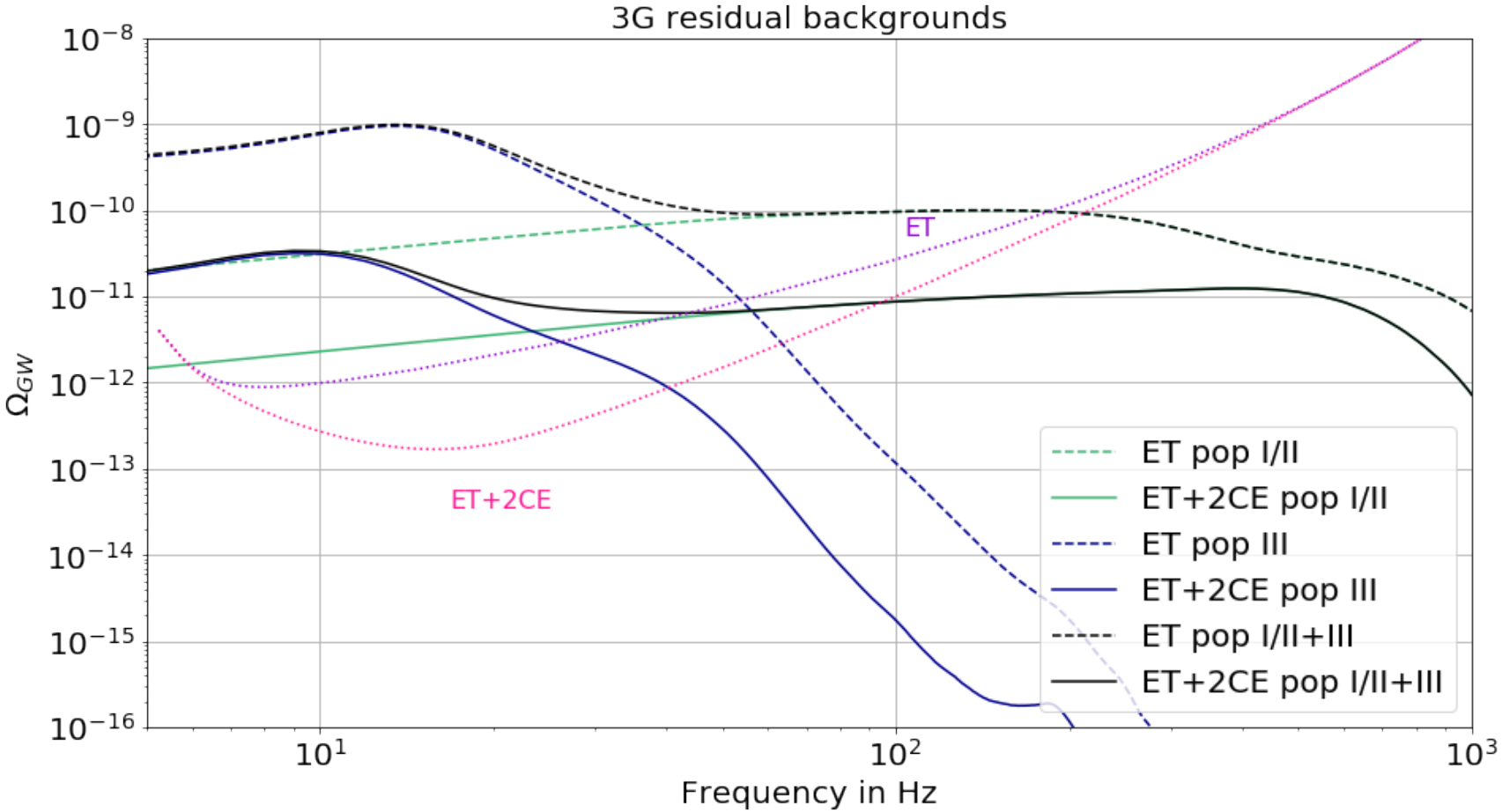
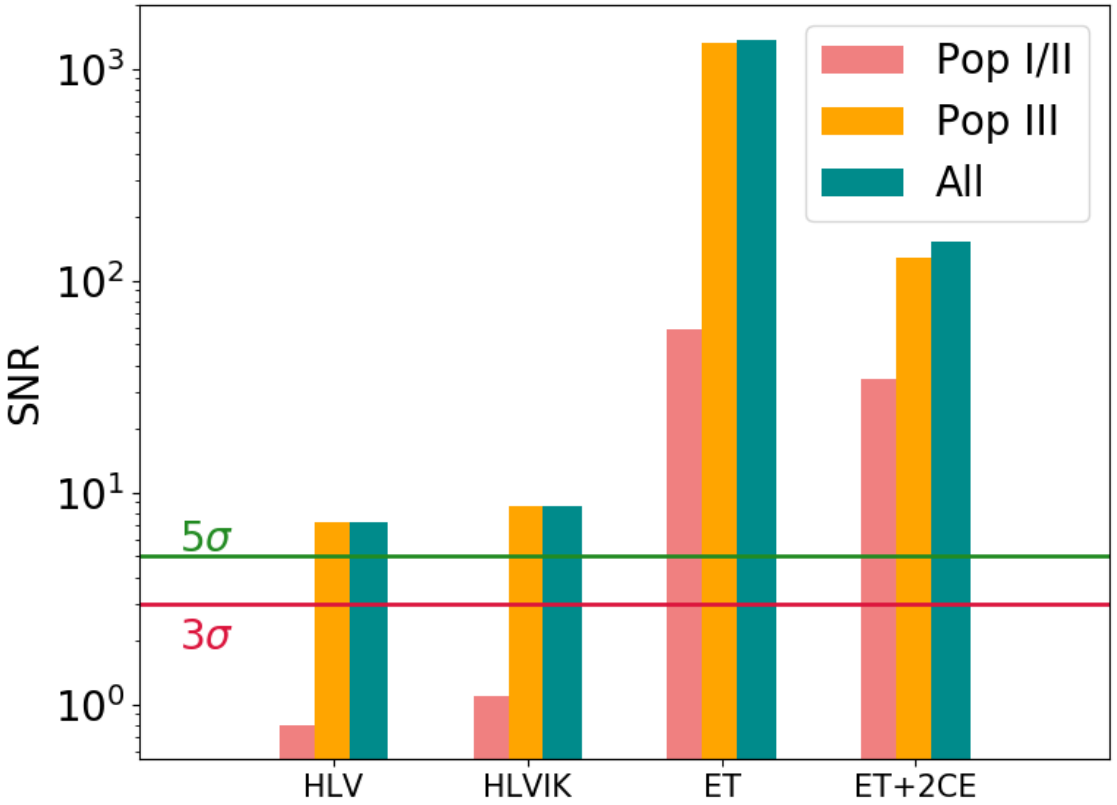


Figure: *Residual background in 3G detector networks from StarTrack predictions arXiv:[2008.00490]*

Detectability summary

$$\mathrm{SNR} = \frac{3H_0^2}{10\pi^2}\sqrt{2T}\left[\int_0^\infty df \sum_{i=1}^{n}\sum_{j>i}\frac{\gamma_{ij}^2(f)\Omega_{gw}^2(f)}{f^6 P_i(f)P_j(f)}\right]^{1/2} \quad (4)$$

arXiv:[gr-qc/9710117]



- Pop I/II : detectable with 3G
- Pop III : detectable now ?!

Figure: *SNR calculation for residual backgrounds*

To be continued...

- Detecting Pop III with an appropriate analysis ==> In progress
- Impact of formation channels on the CBC background.
- IMBH signature? Background shape and the derived detectability...