

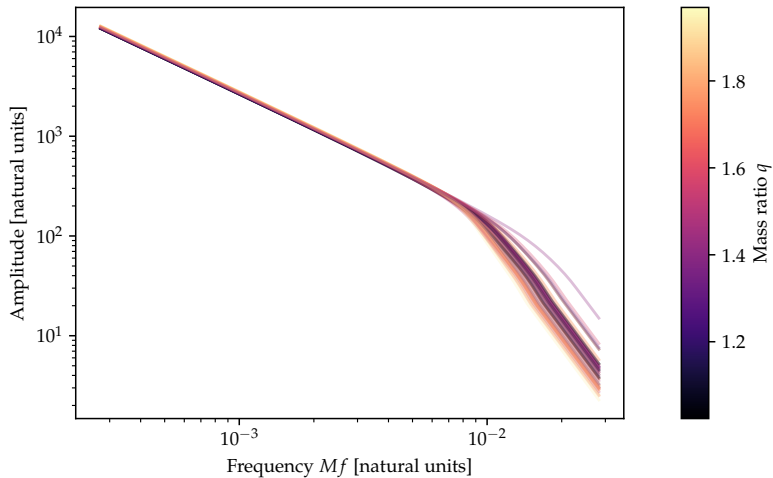
Machine Learning Gravitational Waveforms for Binary Neutron Star mergers

Jacopo Tissino

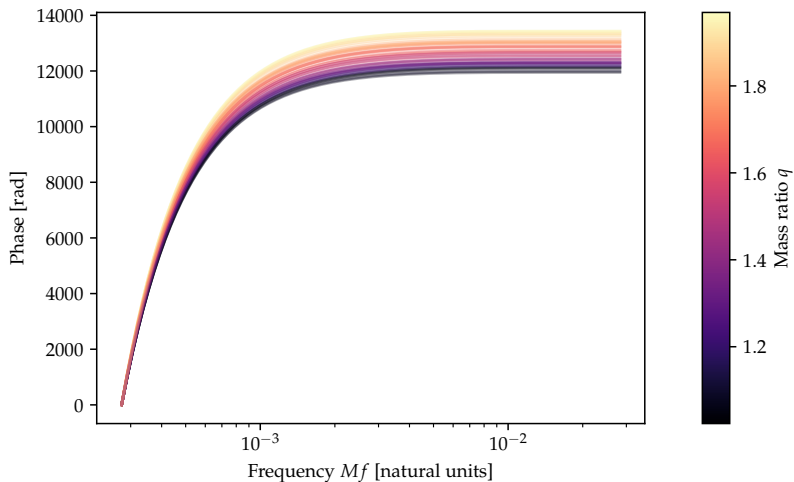
Advisors: Dr. Sebastiano Bernuzzi, Dr. Michela Mapelli

2021-09-10

Amplitudes



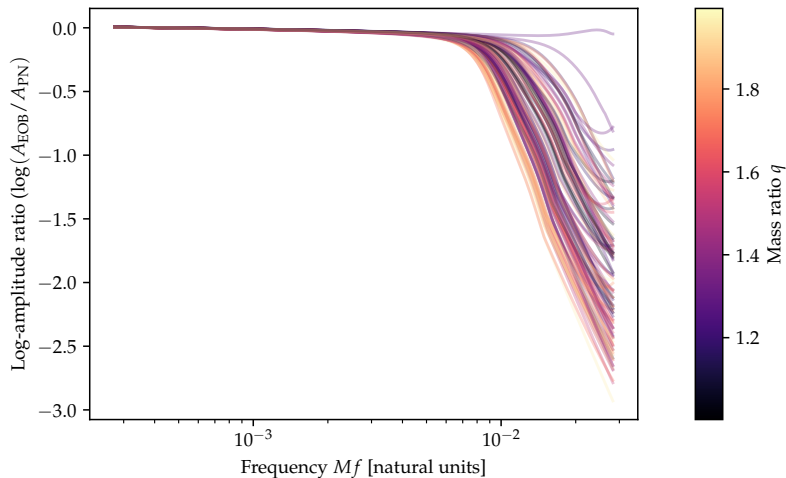
Phases



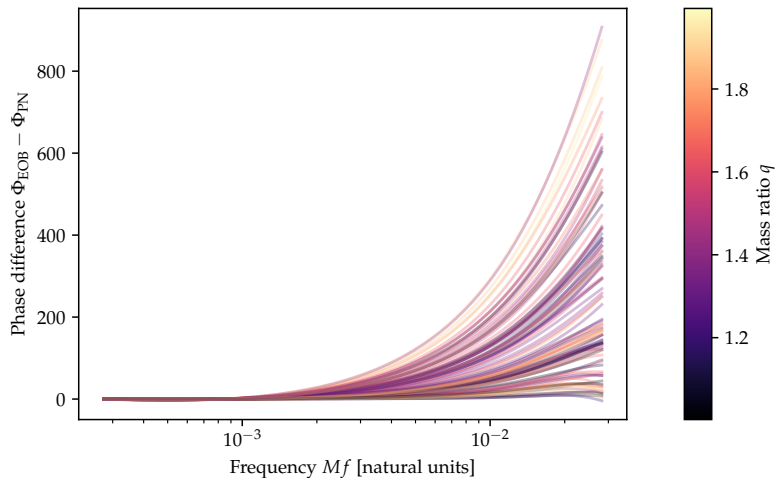
MLGW_BNS structure: training dataset generation

- Greedy adaptive downsampling fit;
- EOB waveform generation and downsampling;
- residuals from PN waveforms: $\Delta A = \log(A_{\text{EOB}}/A_{\text{PN}})$ and $\Delta\Phi = \Phi_{\text{EOB}} - \Phi_{\text{PN}}$;
- PCA on the combined, downsampled, rescaled residuals;
- a NN learns the map $\theta \rightarrow PC_i \lambda_i^\alpha$;
- the hyperparameters of the NN and α are optimized case-by-case.

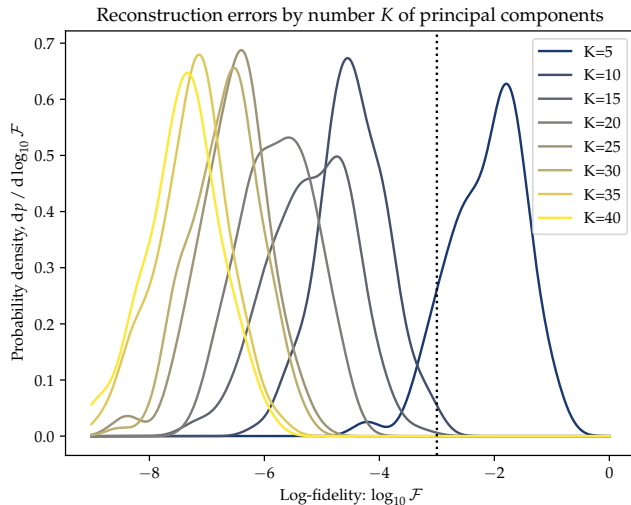
Residuals: amplitude



Residuals: phase

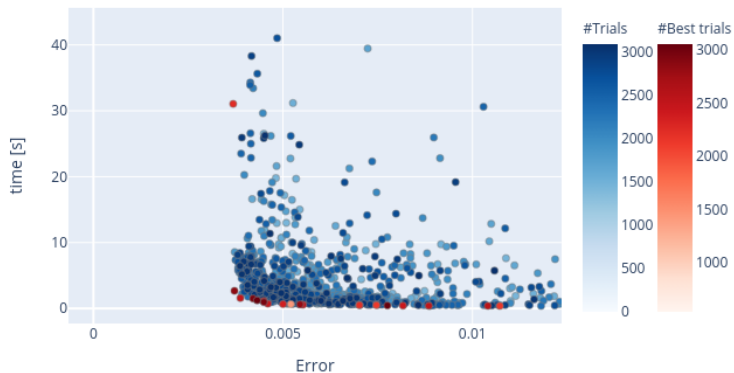


PCA mismatches

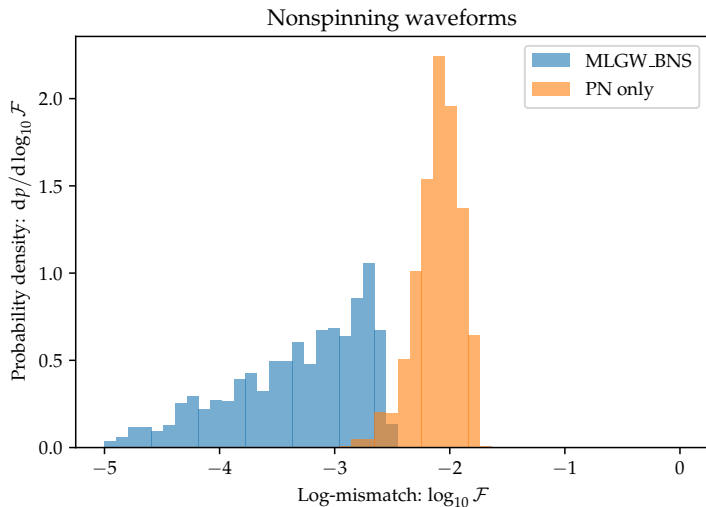


Hyperparameter optimization

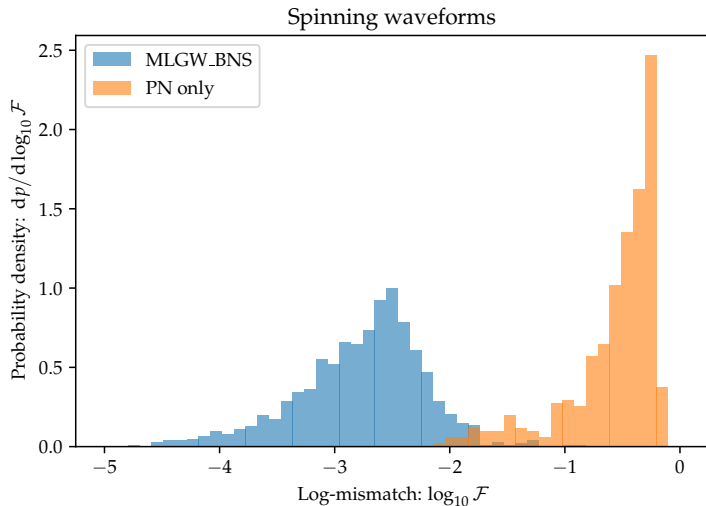
Pareto-front Plot



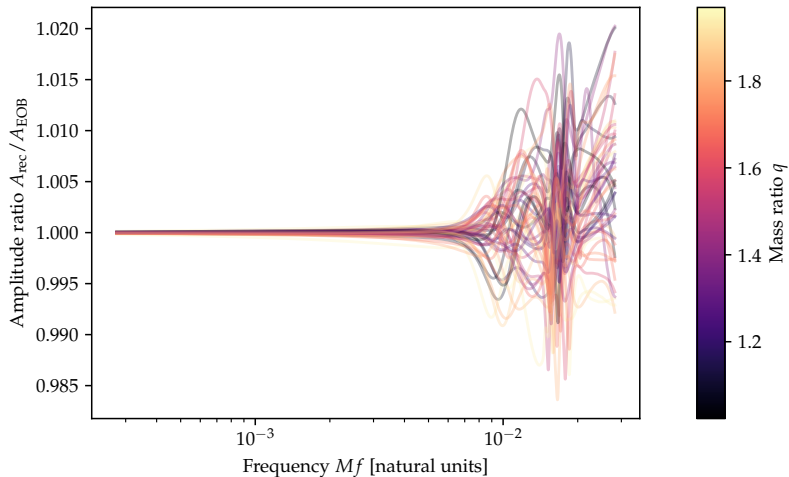
Fidelity: nonspinning case



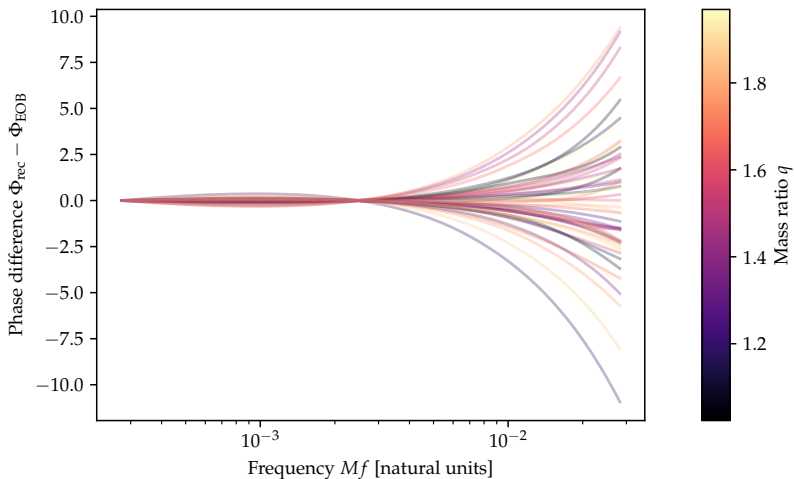
Fidelity: spinning case



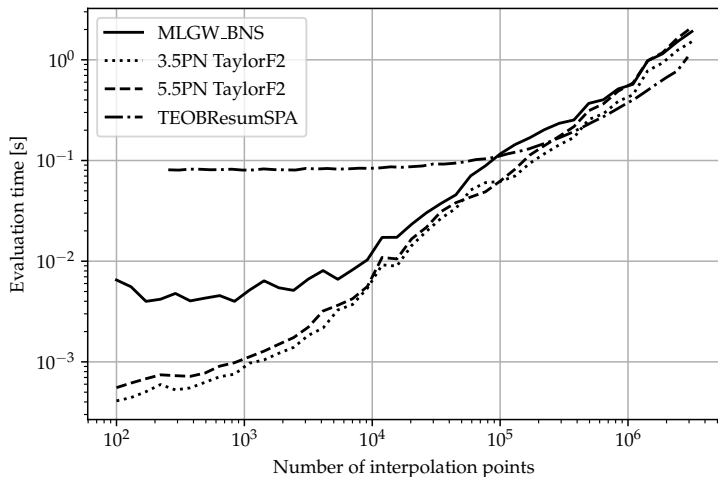
Amplitude reconstruction residuals



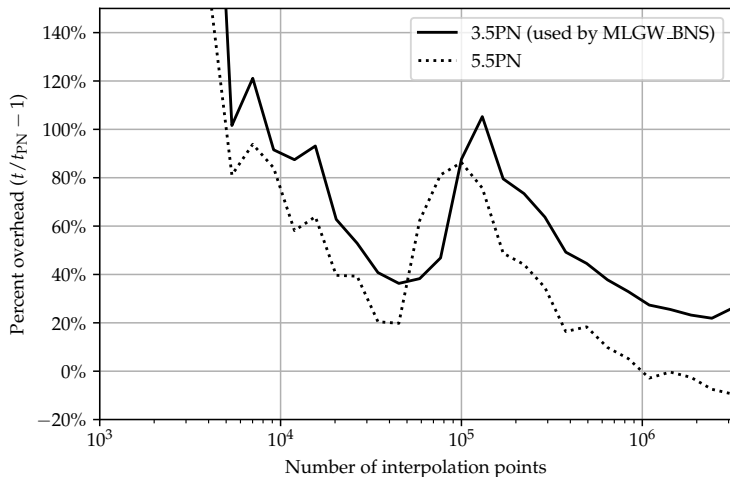
Phase reconstruction residuals



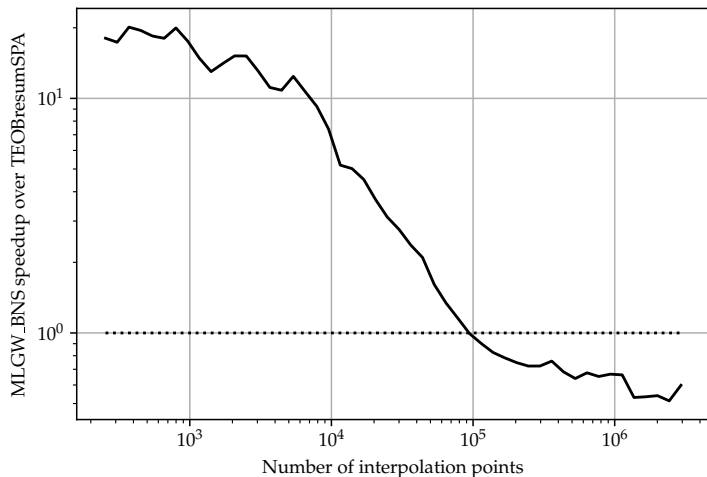
Evaluation time: $f_0 = 20$ Hz



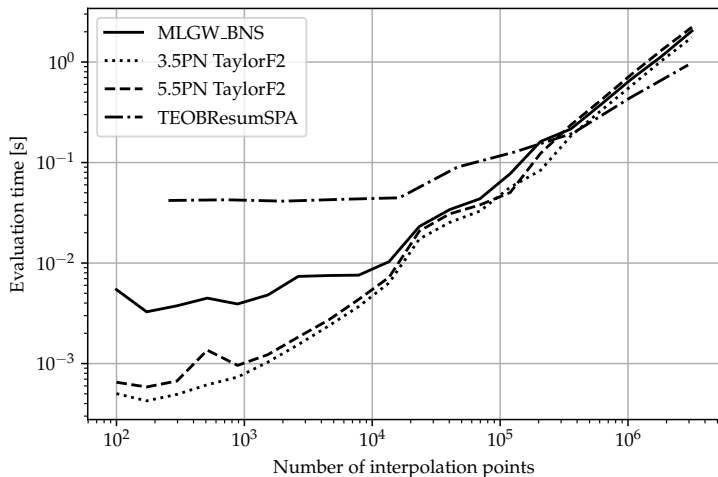
Evaluation time: $f_0 = 20$ Hz



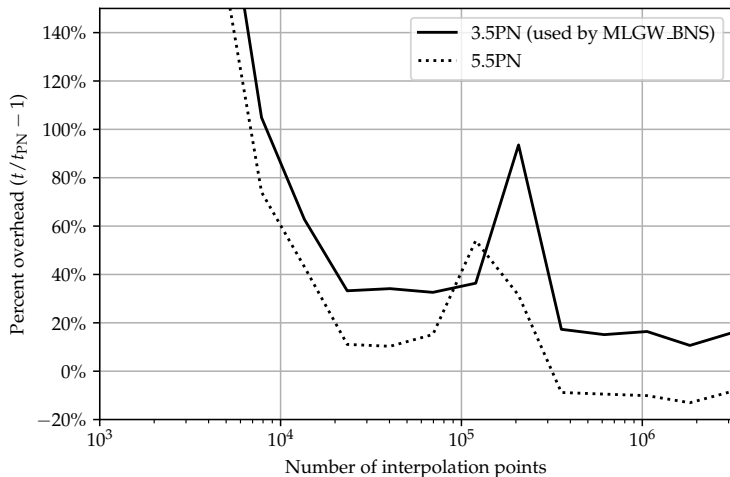
Evaluation time: $f_0 = 20$ Hz



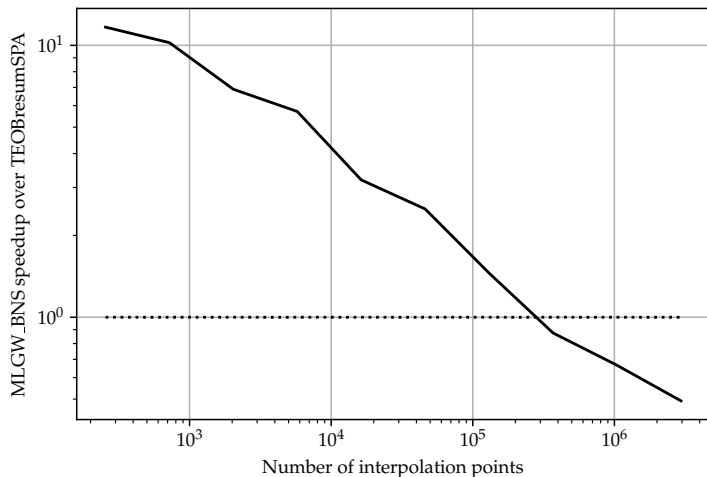
Evaluation time: $f_0 = 10$ Hz



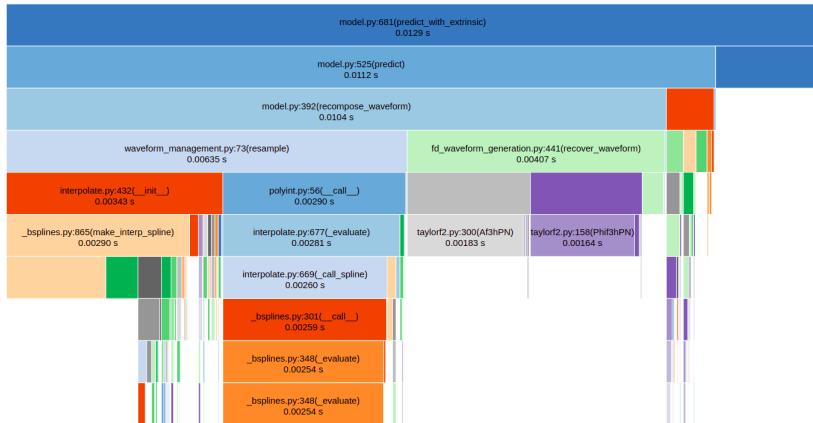
Evaluation time: $f_0 = 10$ Hz



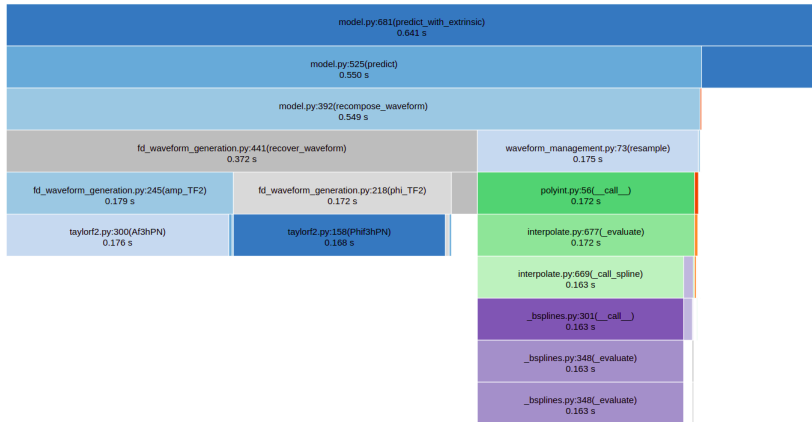
Evaluation time: $f_0 = 10$ Hz



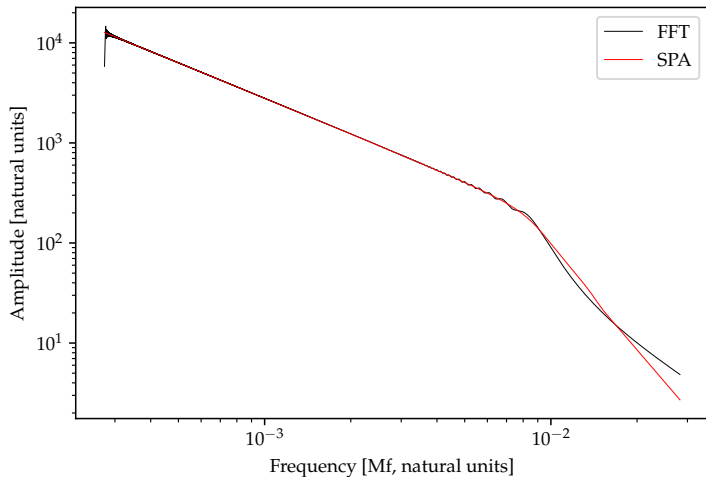
Profiling the evaluation: 10^4 interpolation points



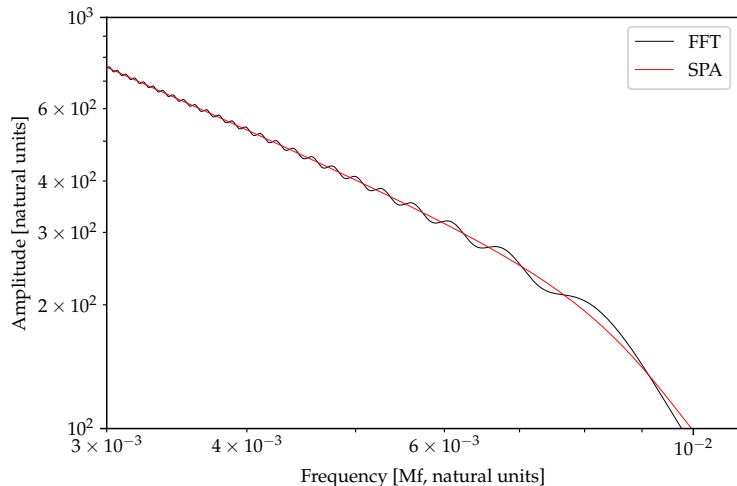
Profiling the evaluation: 10^6 interpolation points



Fourier transform issues



Fourier transform issues



Fourier transform issues

