



Efficiently Enclosing the Signal Manifold: SVD Approximations of Compact Binary Coalescence Gravitational-Wave Signals

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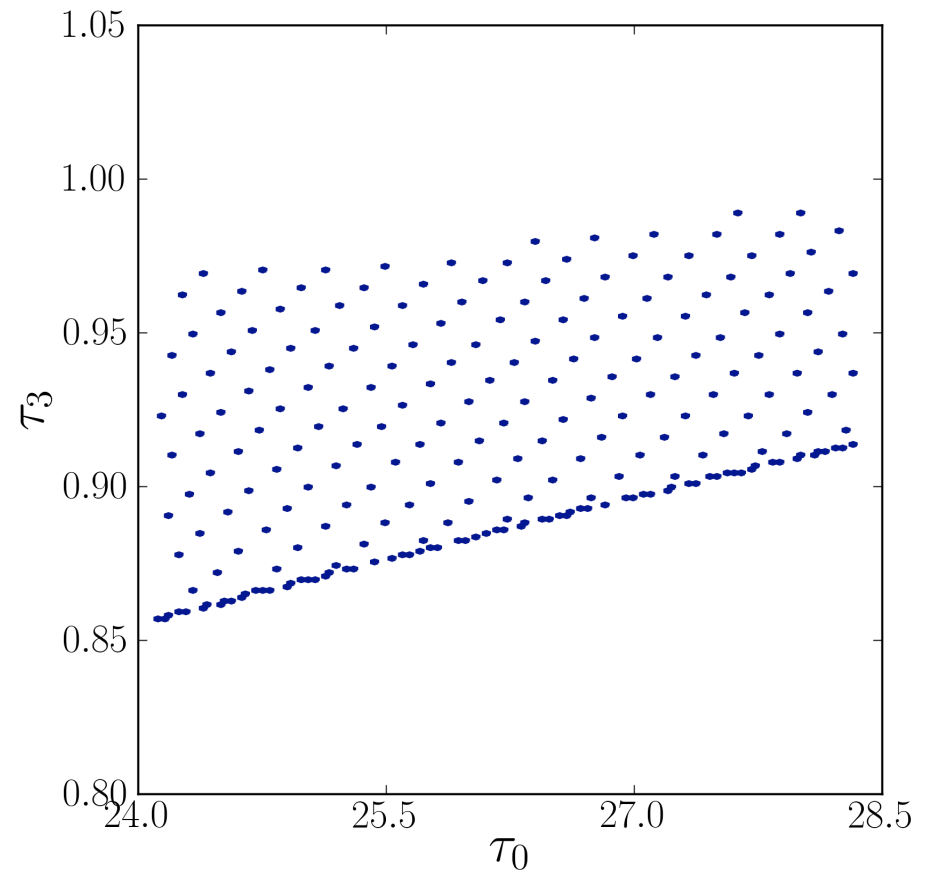
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Template Banks

- A set of template waveforms used in matched-filtering
- Lose amount of SNR given by minimal match of template bank
- Typically filter data using banks with 0.97 minimal match
- Neighboring templates highly overlap





Singular Value Decomposition

$$S_{ij} = \sum_k \sigma_k v_{ik} u_{kj}$$

- Decomposes a matrix into an orthonormal set of basis vectors and reconstruction coefficients

$$\sum_i u_{ji} u_{ki} = \delta_{jk}, \quad \sum_i v_{ij} v_{ik} = \delta_{jk}$$

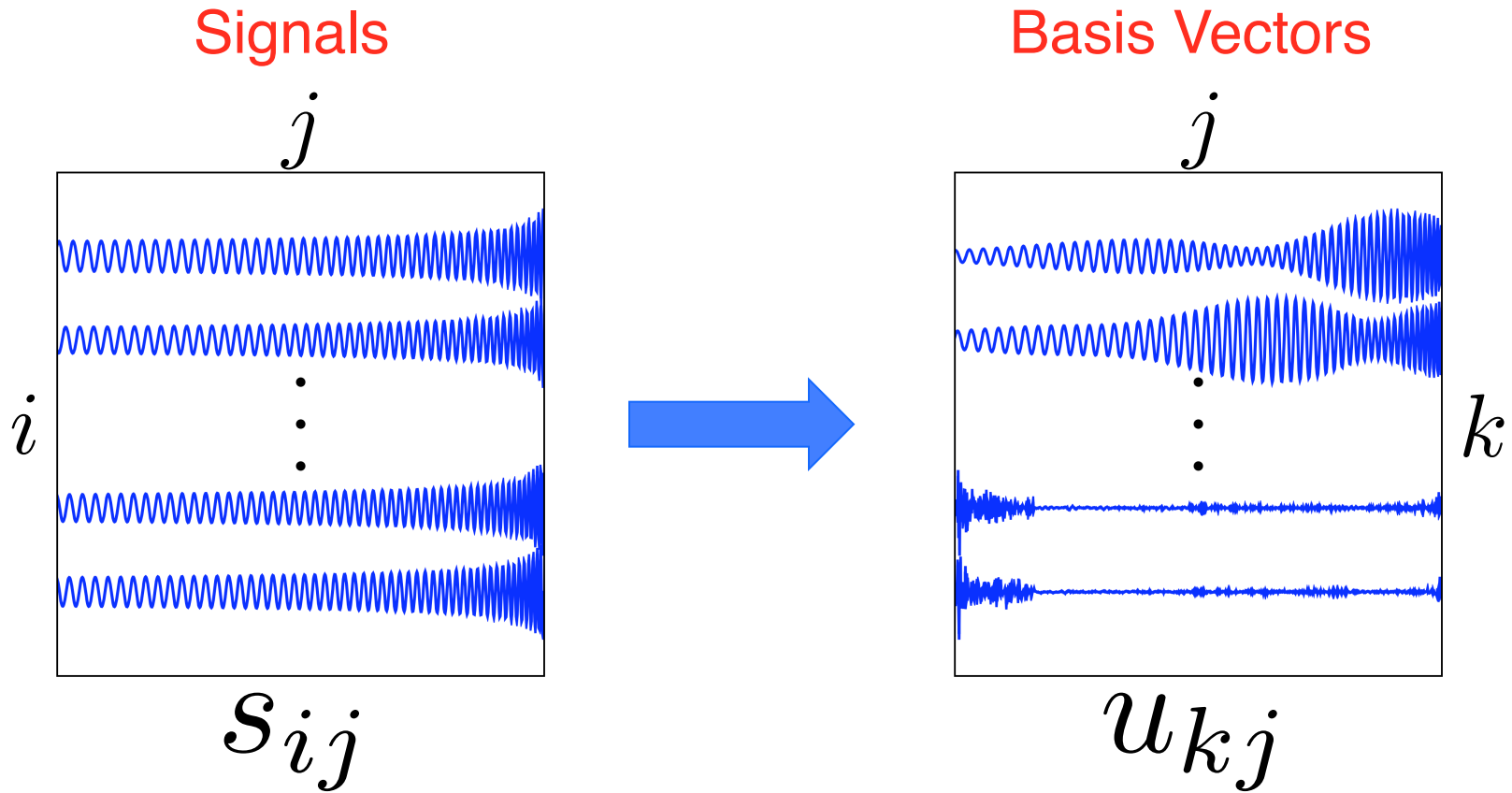
- Ranks basis vectors by their singular values

$$\tilde{S}_{ij} = \sum_{k=0}^r \sigma_k v_{ik} u_{kj}$$

- Identifies low singular-valued basis vectors, which can be discarded without losing much reconstruction accuracy



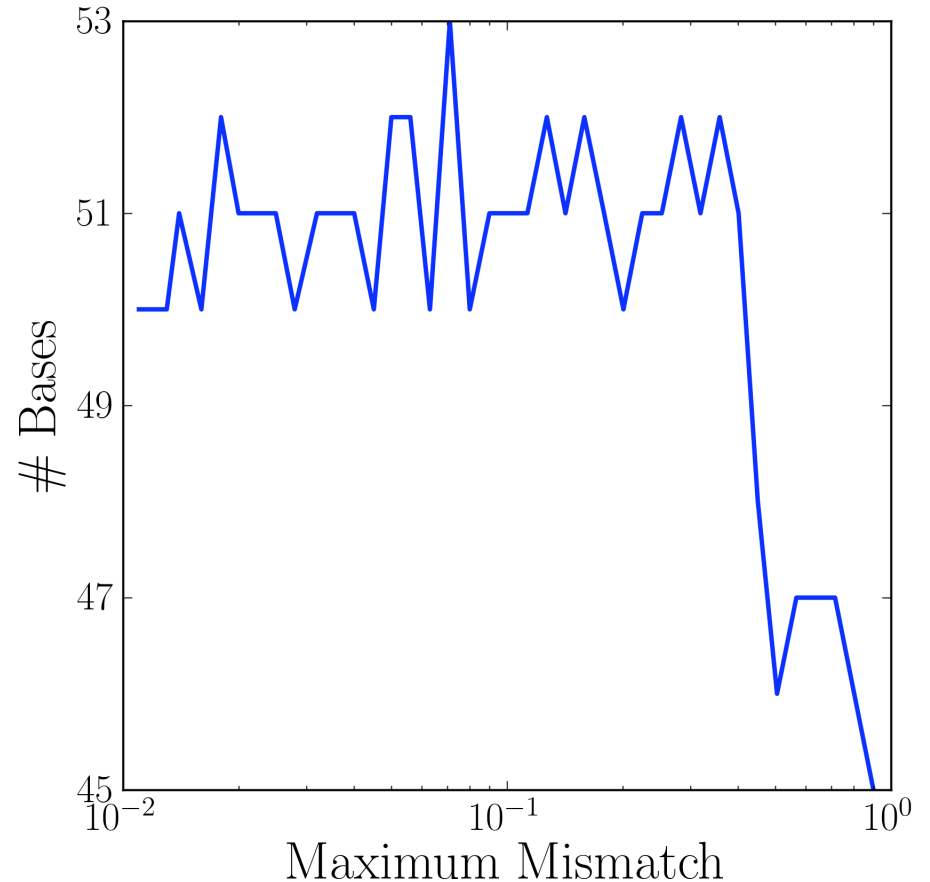
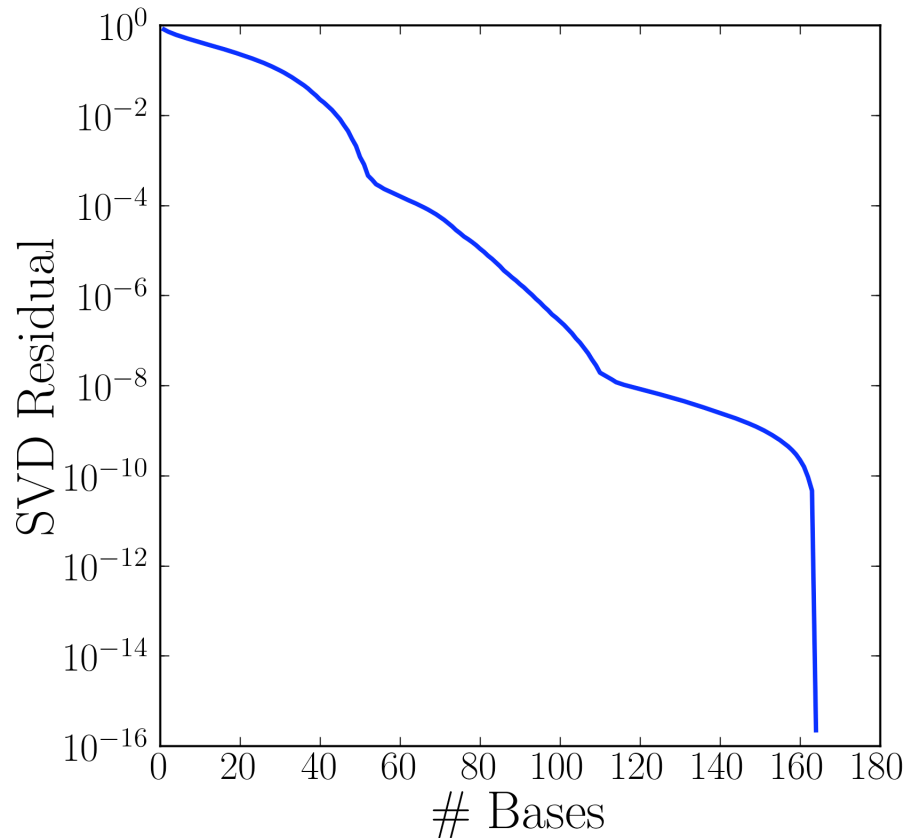
Singular Value Decomposition: CBC Waveforms



$$S_{ij} = \sum_k \sigma_k v_{ik} u_{kj}$$



SVD Residual

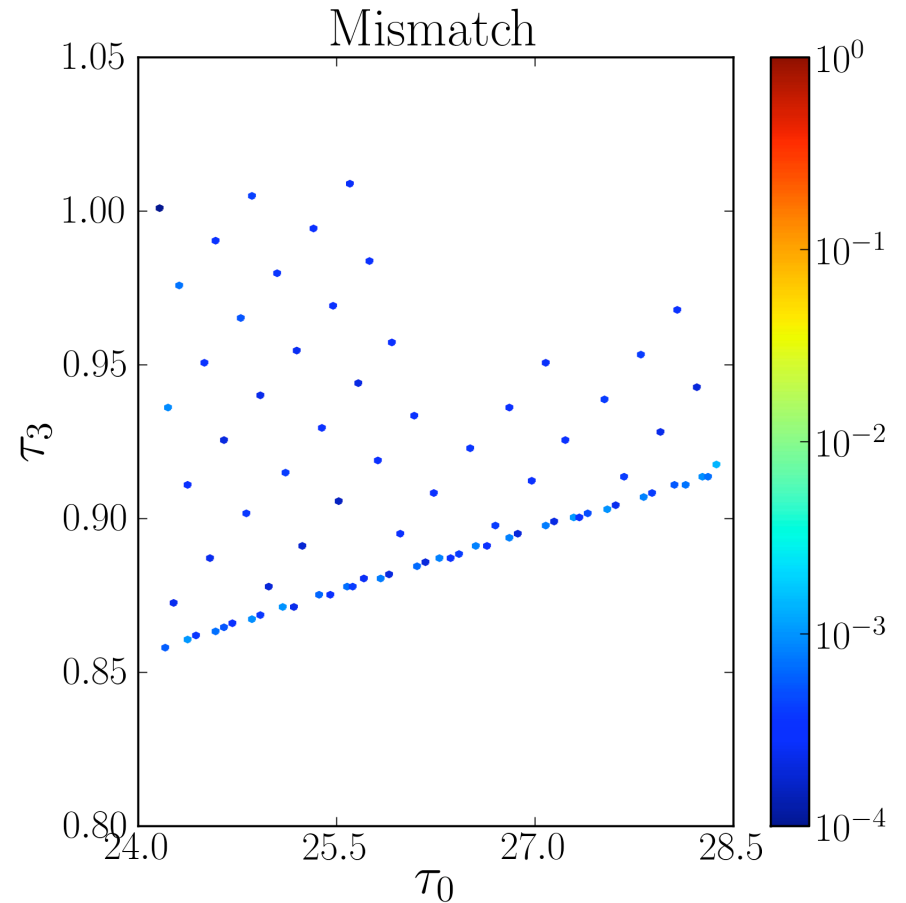
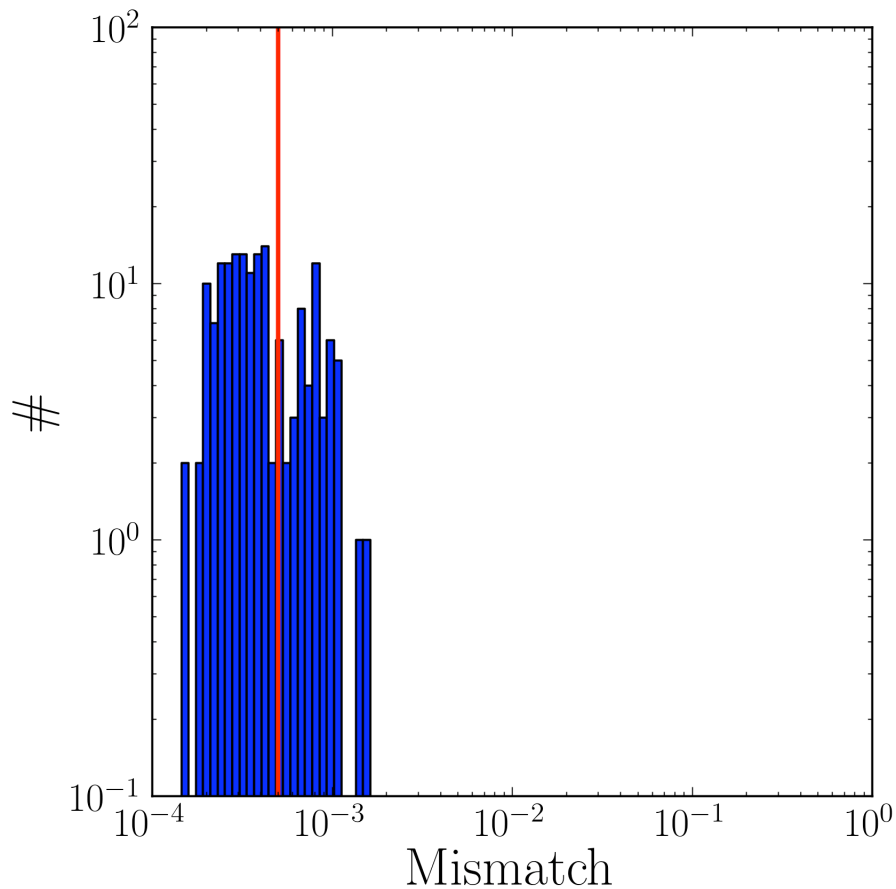


- Fraction of singular values discarded gives the residual

- For a given residual and parameter space, the number of basis vectors is independent of template bank density



Reconstruction Accuracy of Template Bank

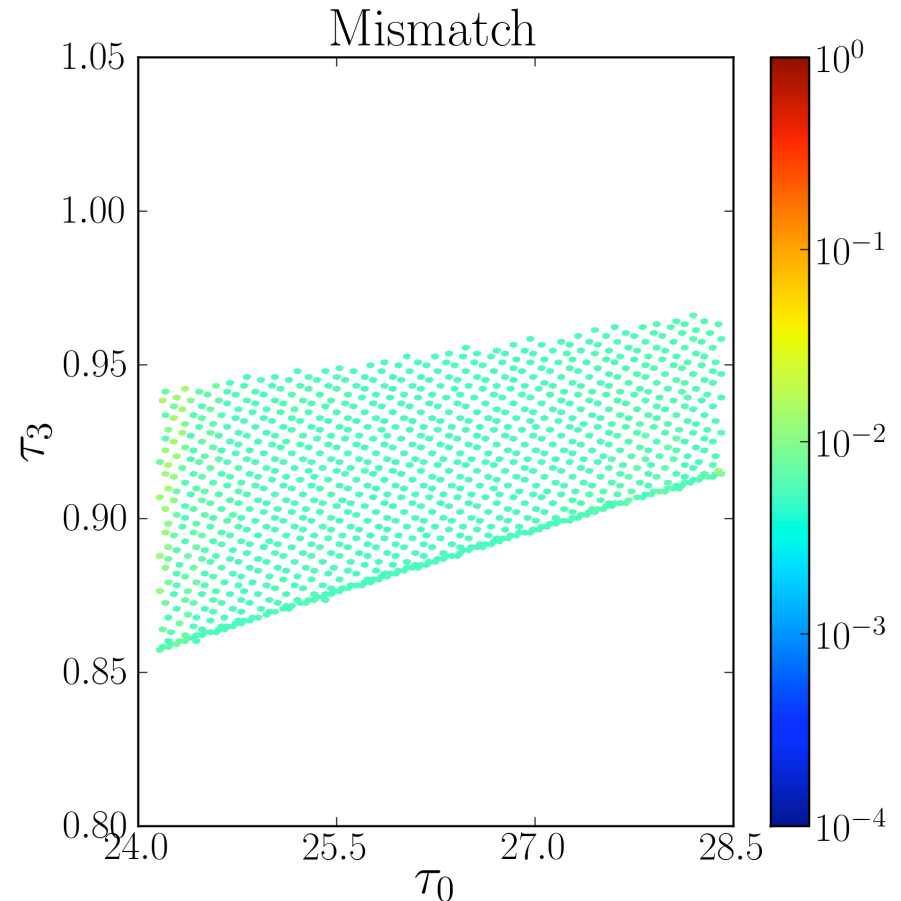
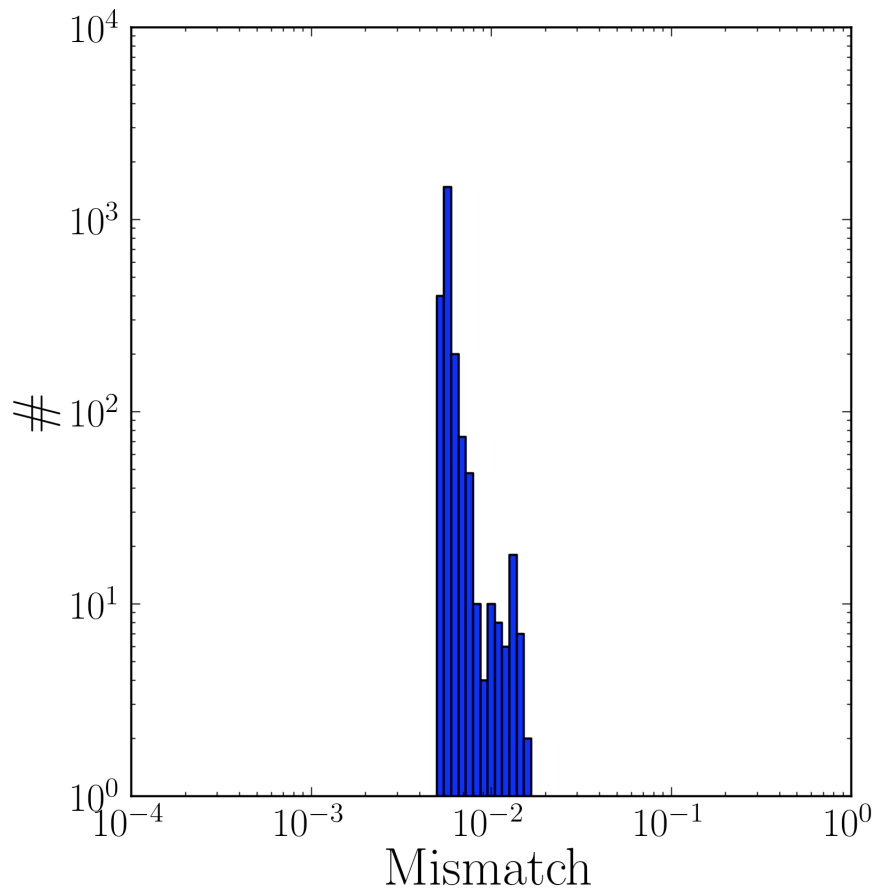


- Residual identifies rough amount of SNR loss

- Worst reconstruction occurs at edges of parameter space



Reconstruction Accuracy of Signal Manifold



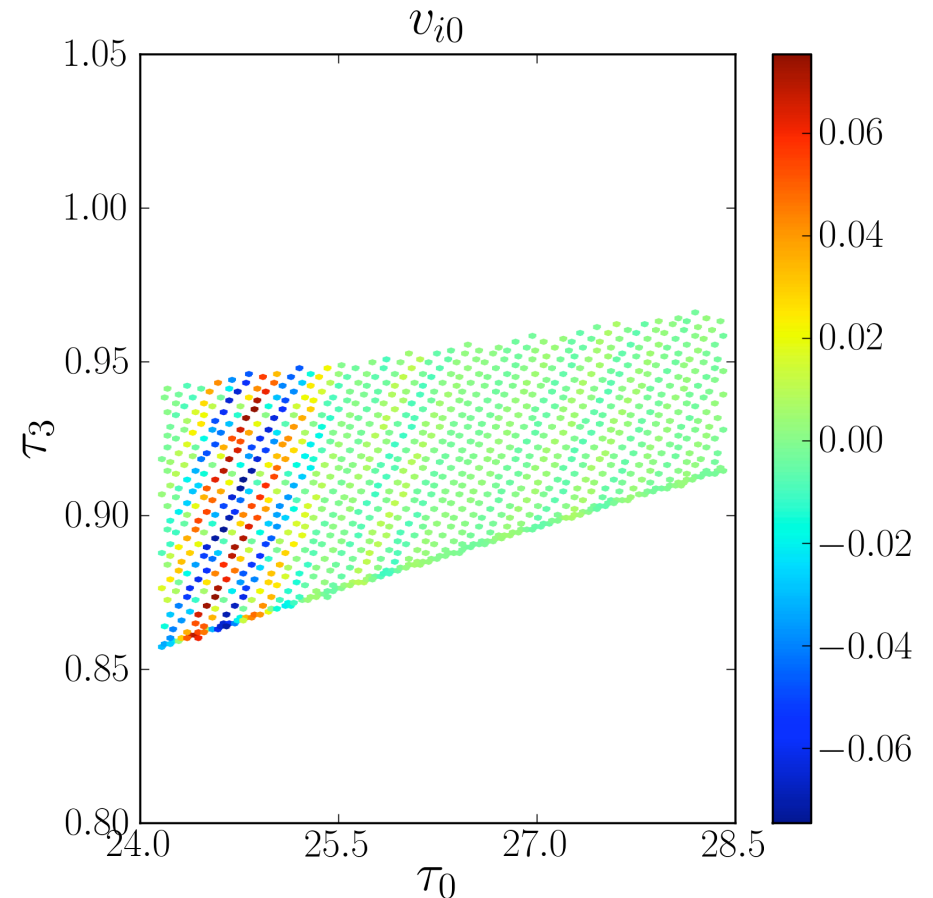
- Same basis vectors can be used to reconstruct other waveforms in within the parameter space

$$v'_{ik} = \sum_j s_{ij} u_{kj}$$



Future Work

- Quickly interpolate reconstruction coefficients
 - » could be used in the context of parameter estimation searches
- Apply technique to other classes of waveforms
 - » higher dimensional waveform families
 - » IMR waveforms





Singular Value Decomposition: CBC Waveforms

