

Example Application in Band Excitation Piezoresponse Force Microscopy Fitting

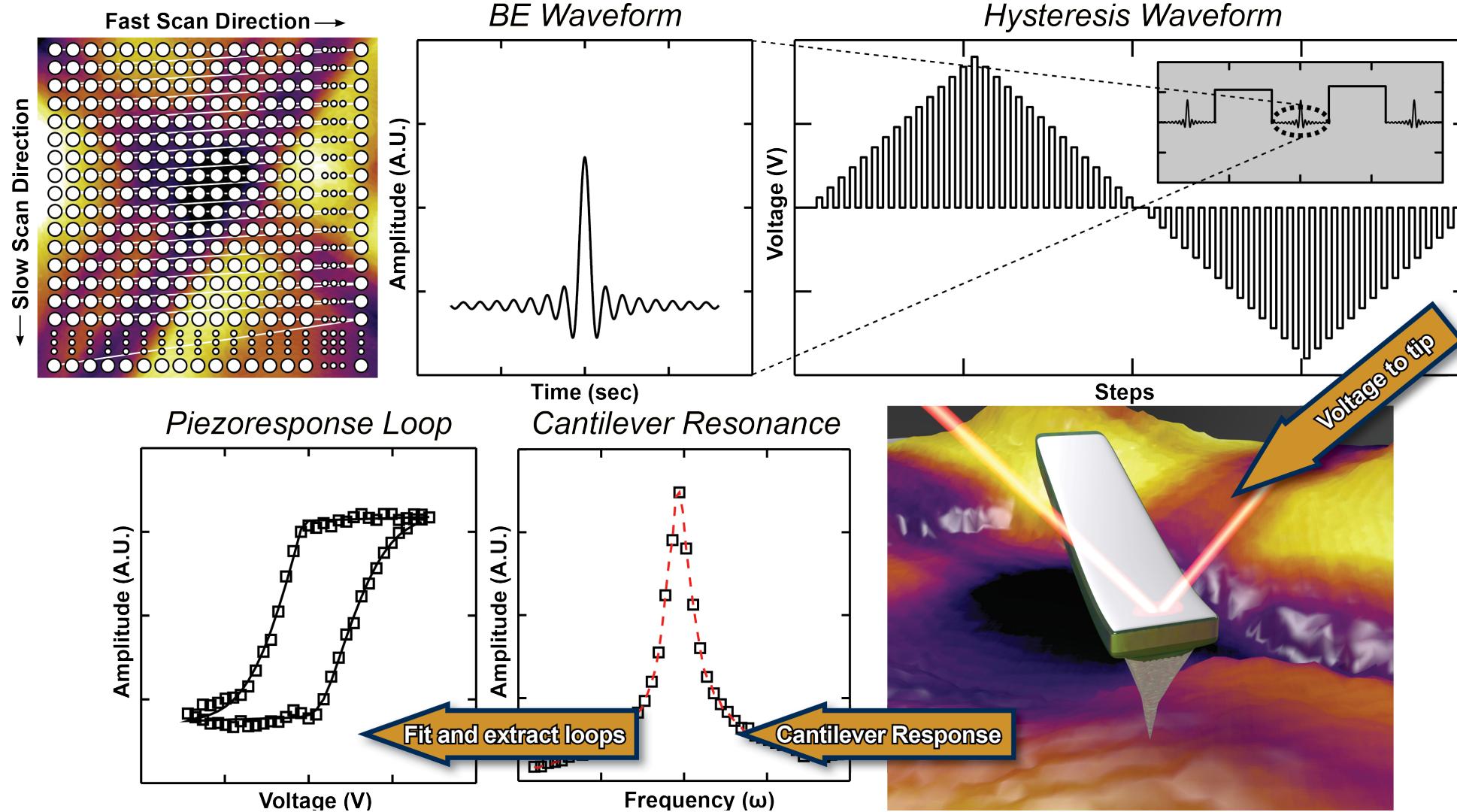
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Band Excitation Piezoresponse Force Microscopy



Band excitation (BE) PFM allows the spatially resolved measure of piezoresponse, modulus, and electromechanical dissipation

Analysis Pipeline

Simple Harmonic Oscillator Fitting

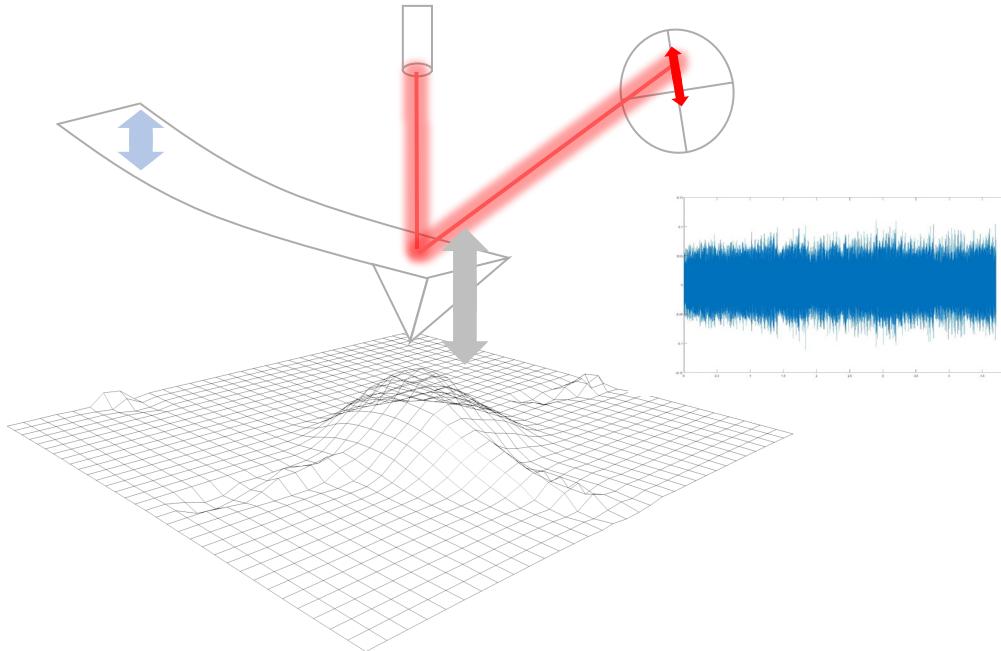
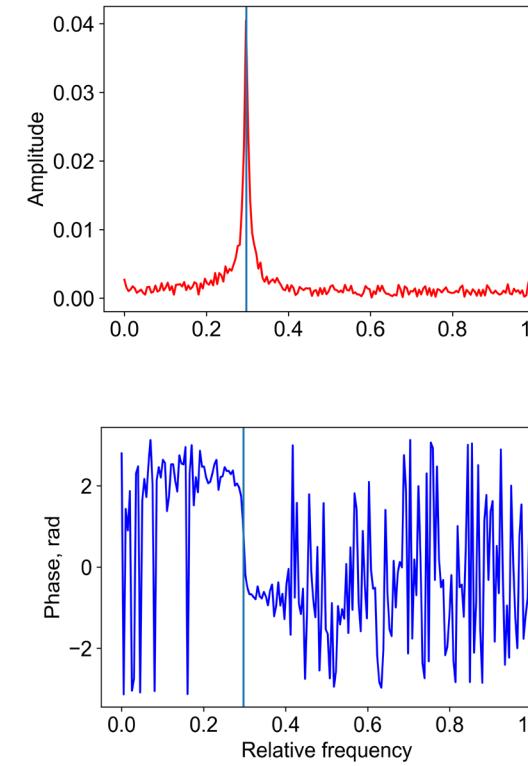


Figure: R. Vasudevan, ORNL



Simple Harmonic Oscillator

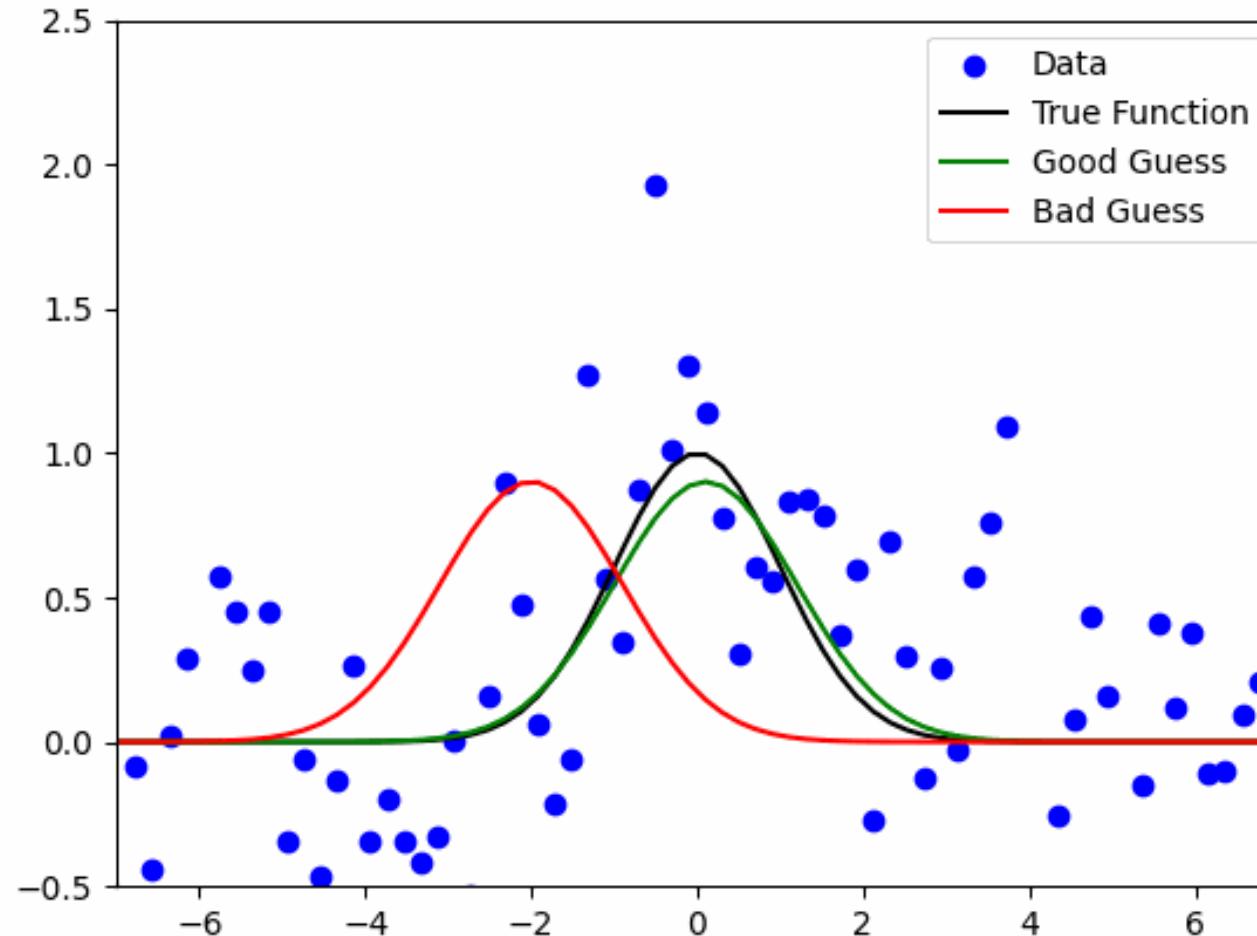
$$m\ddot{x}(t) + c\dot{x}(t) + kx(t) = \beta \cdot V(t)$$

$$f(\omega) = \frac{A_0 \omega_r^2 e^{i\varphi}}{\omega^2 - \frac{i\omega\omega_r}{Q} - \omega_r^2}$$

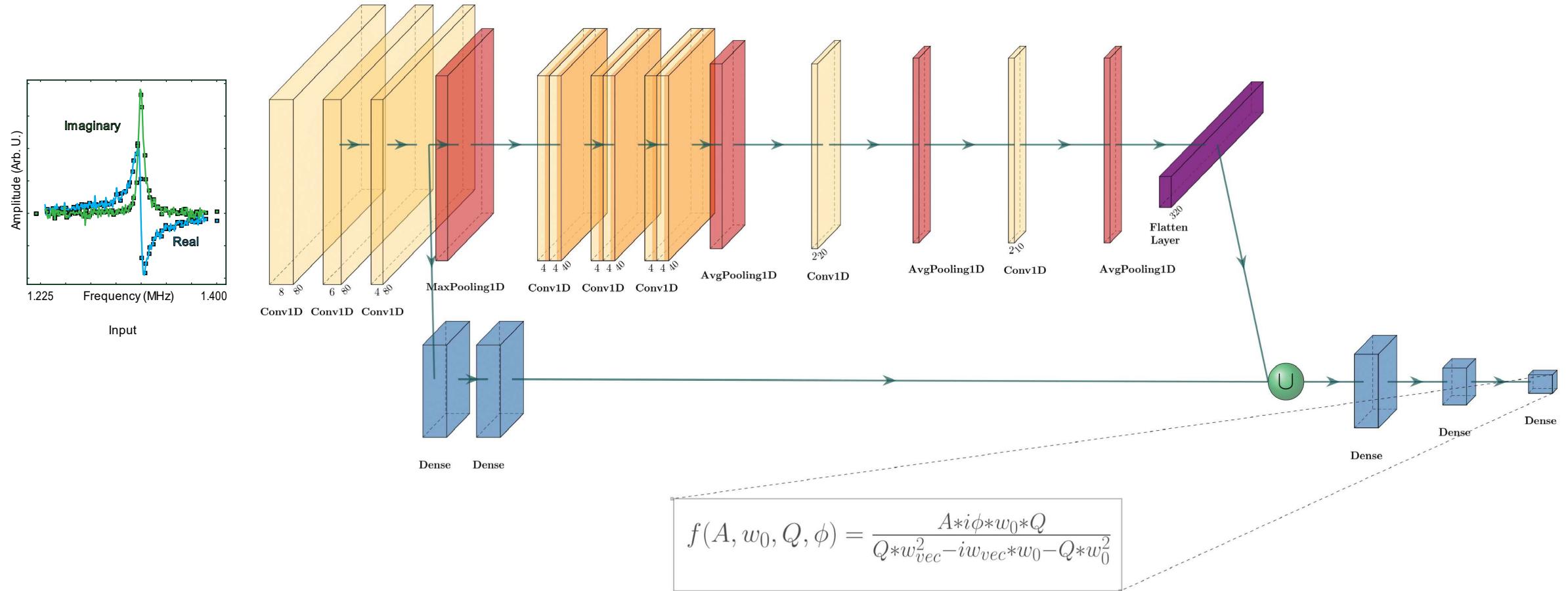
Can we use a neural network to improve and accelerate this analysis?

Problems with Least-Squares Fitting

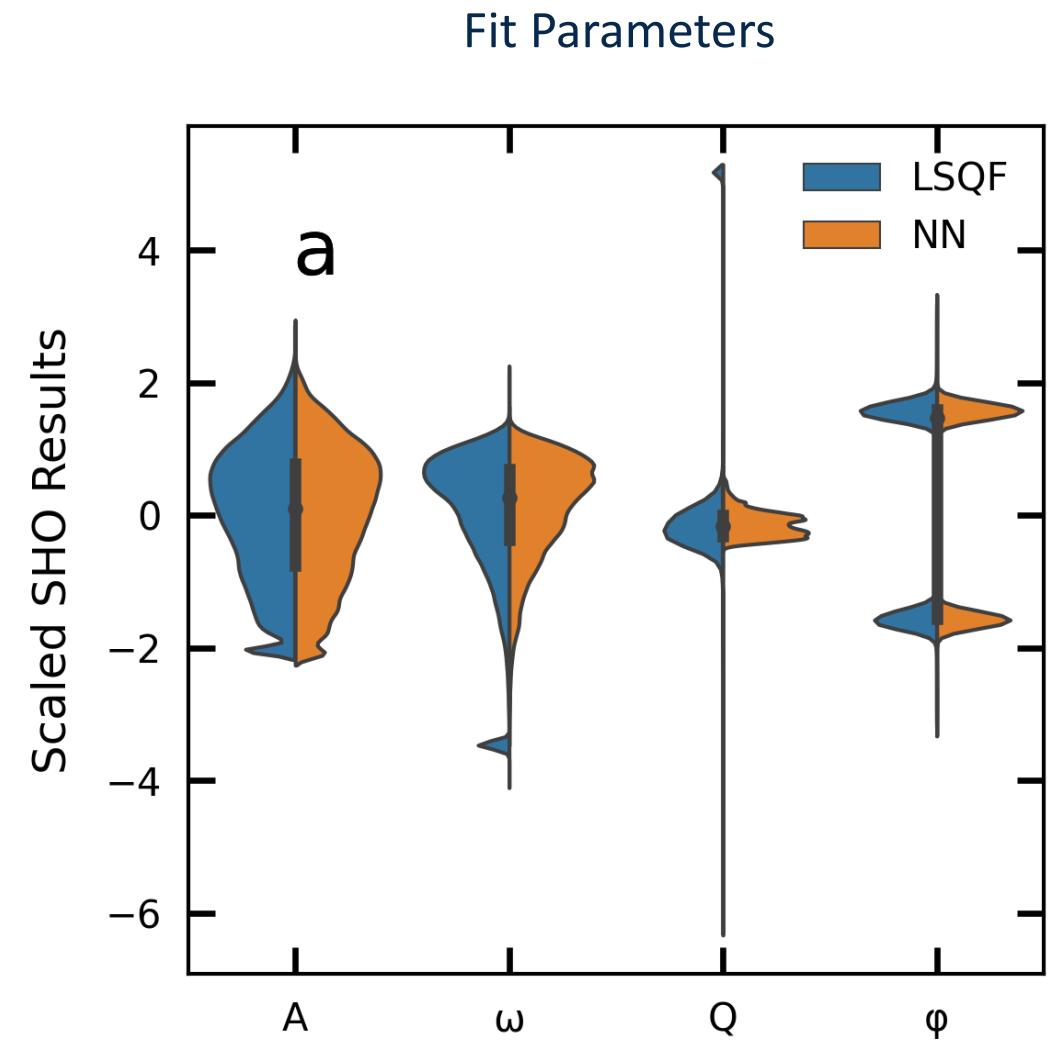
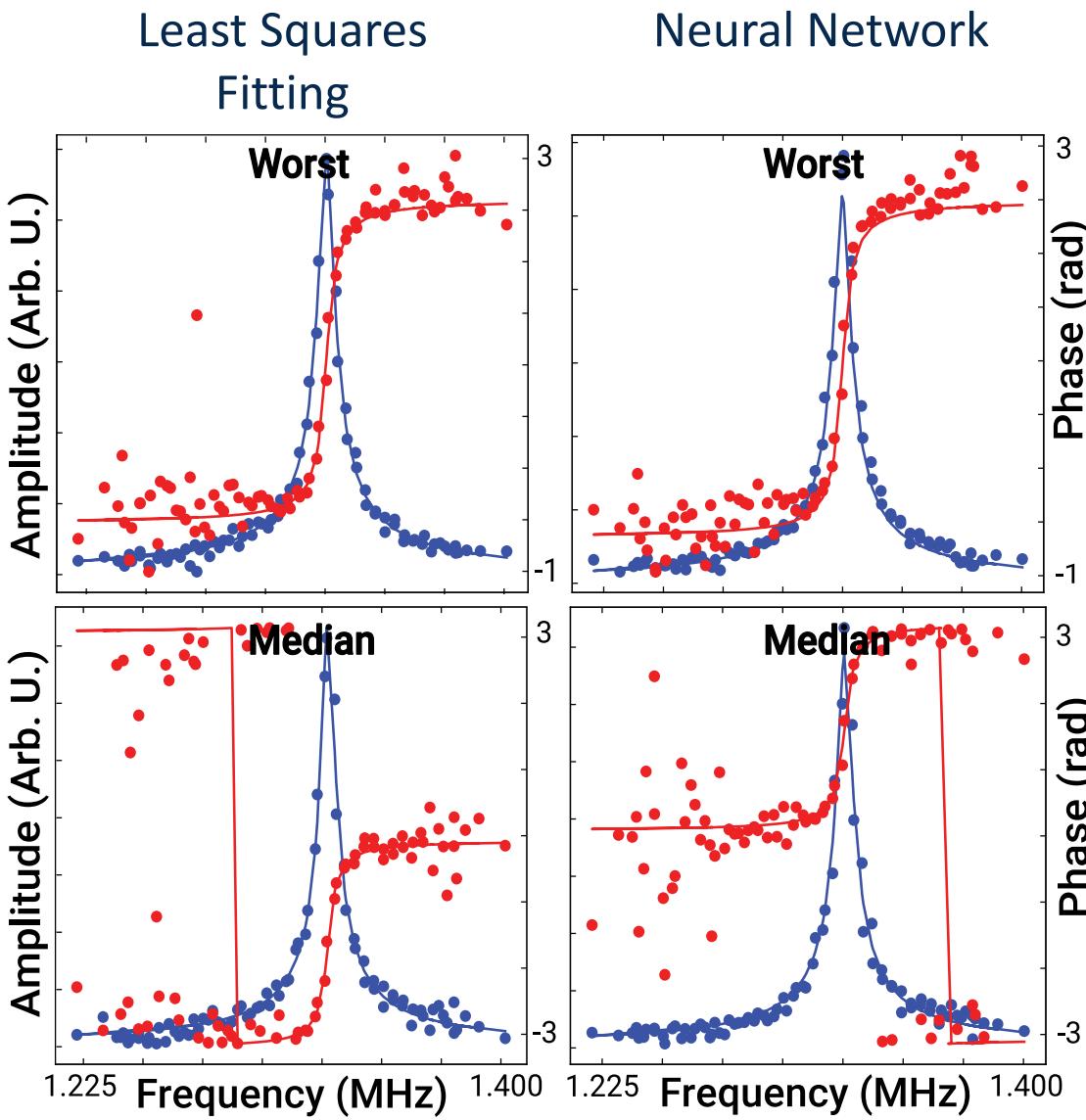
Sensitive to the noisy and the initial guess



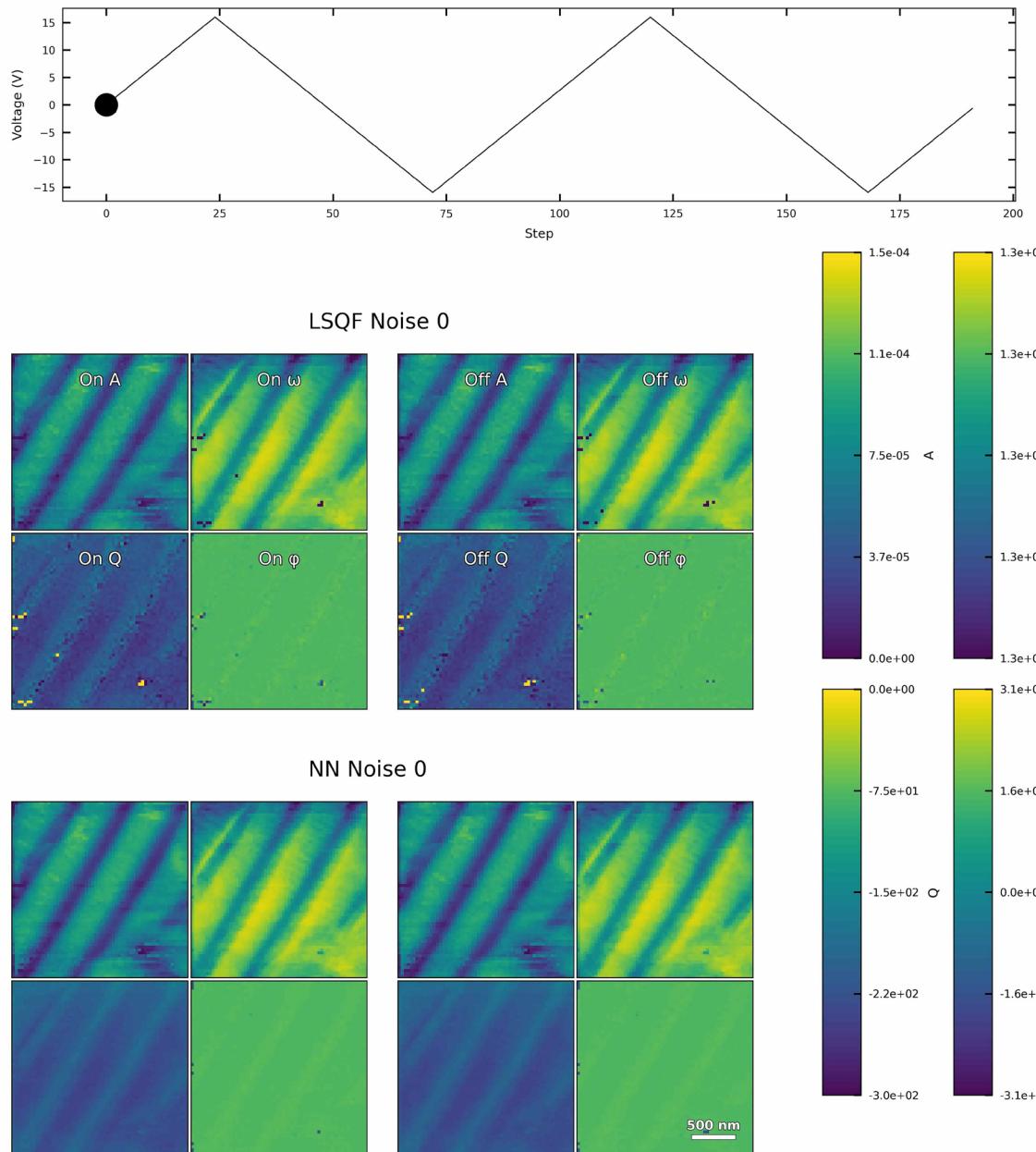
Recasting as a Physics Constrained Neural Network



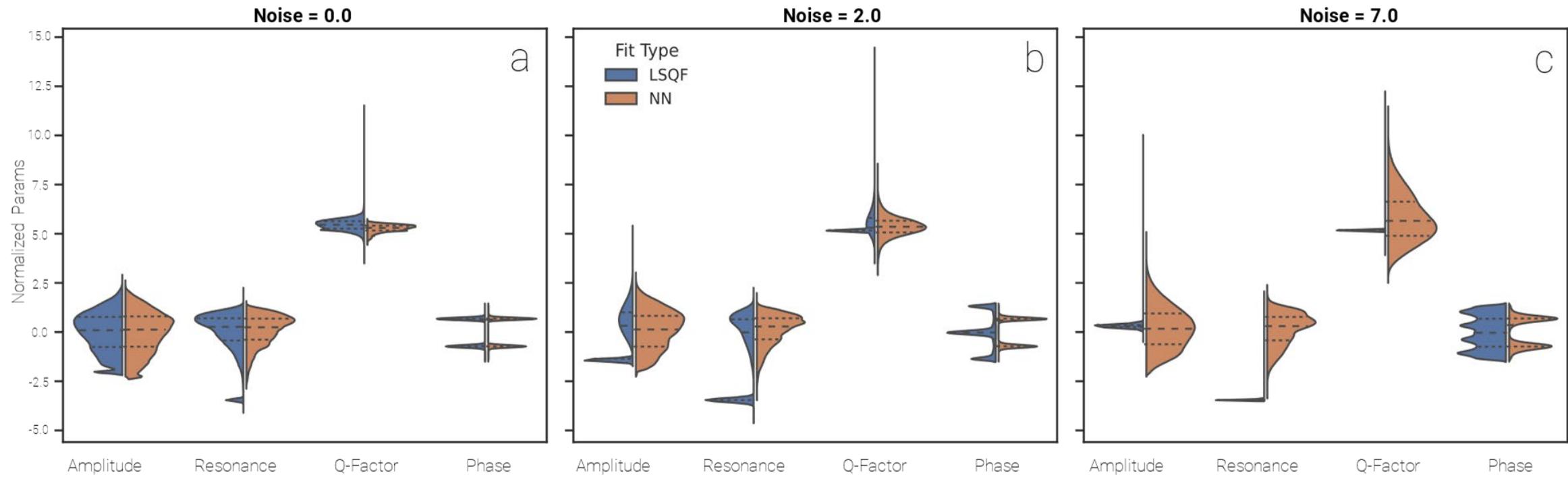
Fit Results



Switching Results



Robustness to Noise



Stochastic averaging (batching) in neural networks improves robustness to noise