



Micro Cantilevers as Mass Sensors

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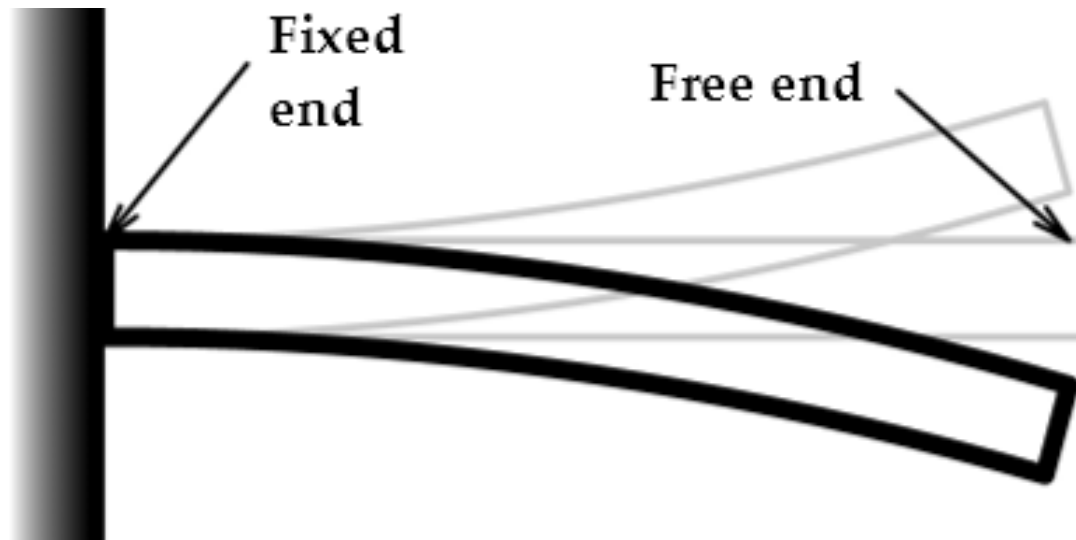
Faculty Advisor: Kimberly Turner

Real World Applications



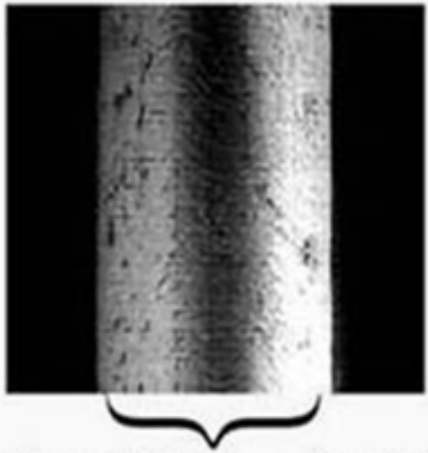
<http://sustainableashland.files.wordpress.com/2009/05/food-image.jpg>

What is a Cantilever?



http://www.understandingcalculus.com/chapters/11/integ_geometric_files/CantileverBeam.png

Macro vs. Micro



Human Hair (70 μm diameter)

- Testing at macro scale
- Methods and techniques used at micro scale

Mass Detection

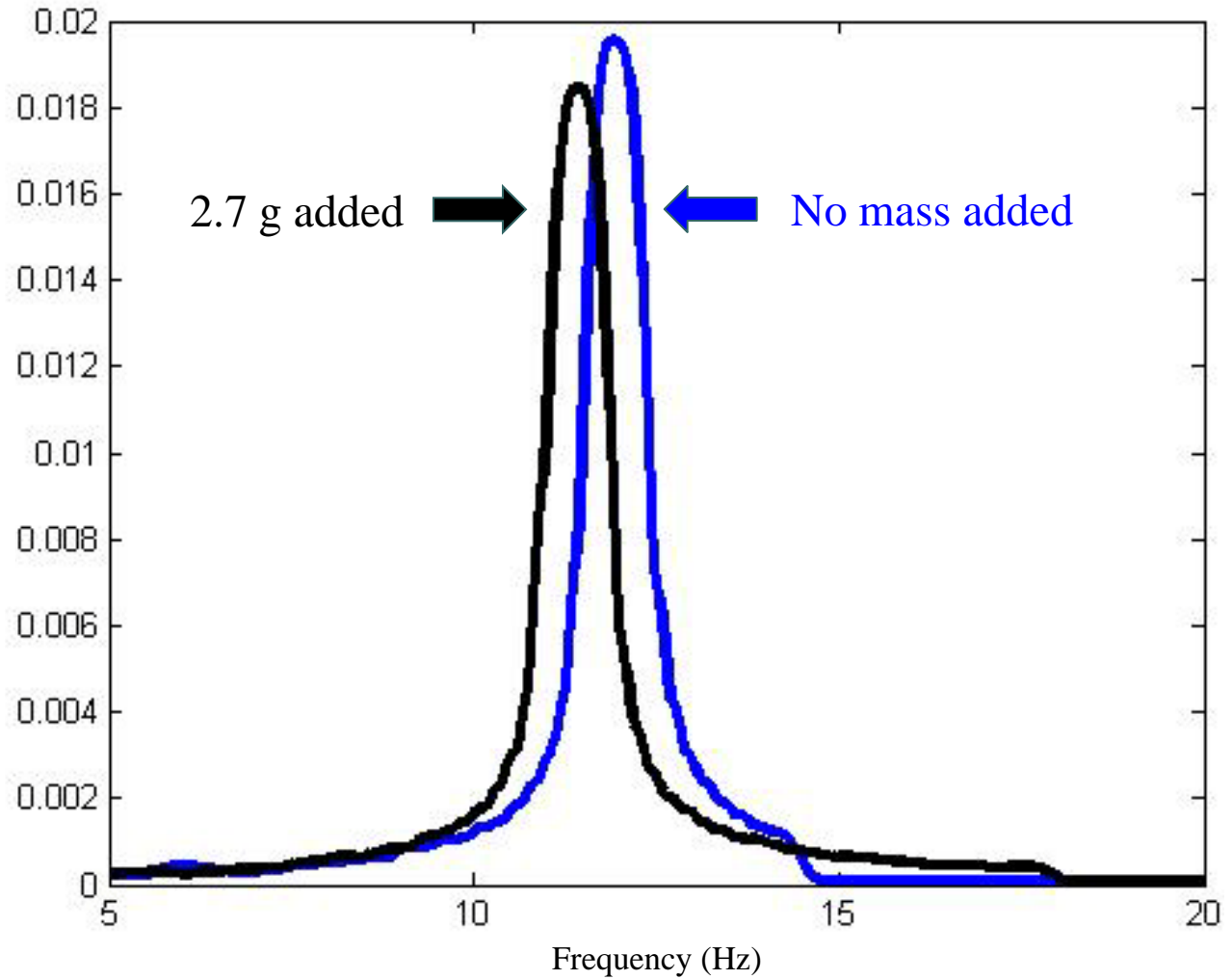
Macro Scale

Length: 0.22 m

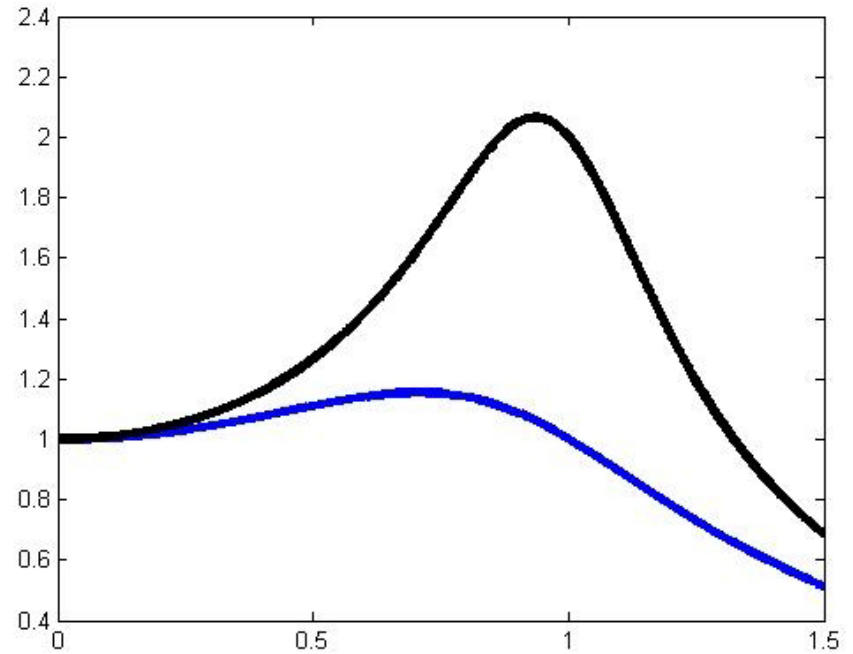
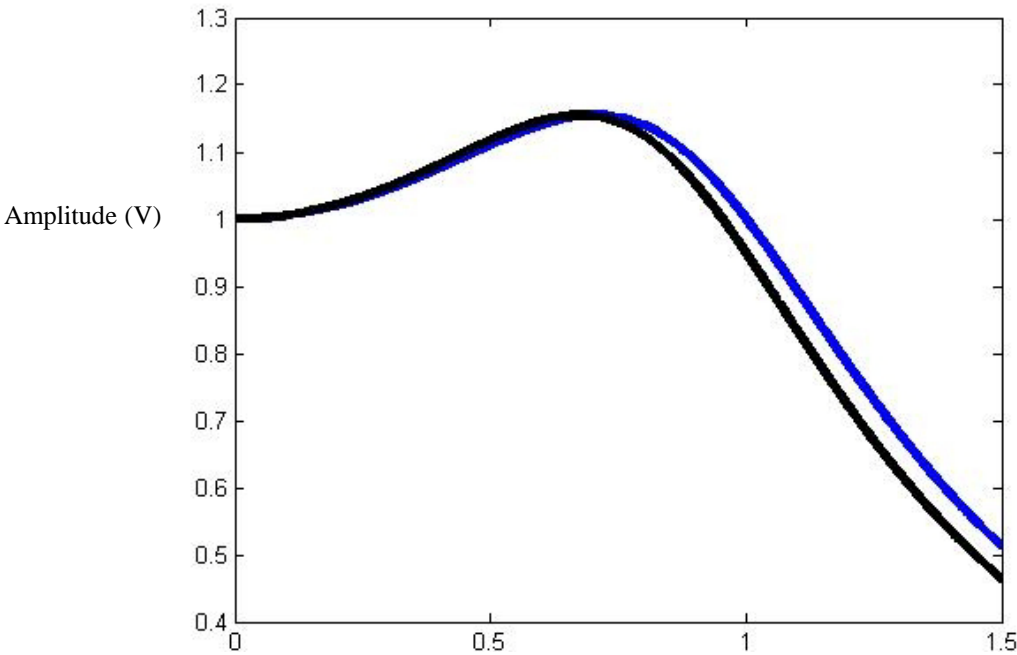
Width: 2.18×10^{-2} m

Thickness: 1.77×10^{-3} m

Amplitude (V)



Amplification Techniques



Frequency (Hz)

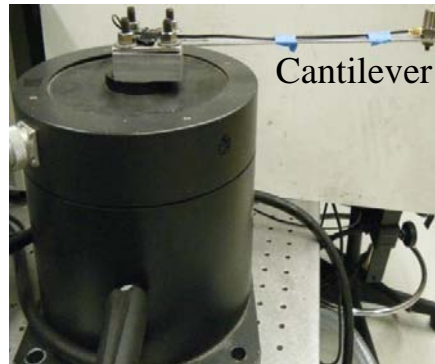
Laboratory Testing



Computer



Function Generator



Shaker

Accelerometer

Cantilever



Spectrum Analyzer

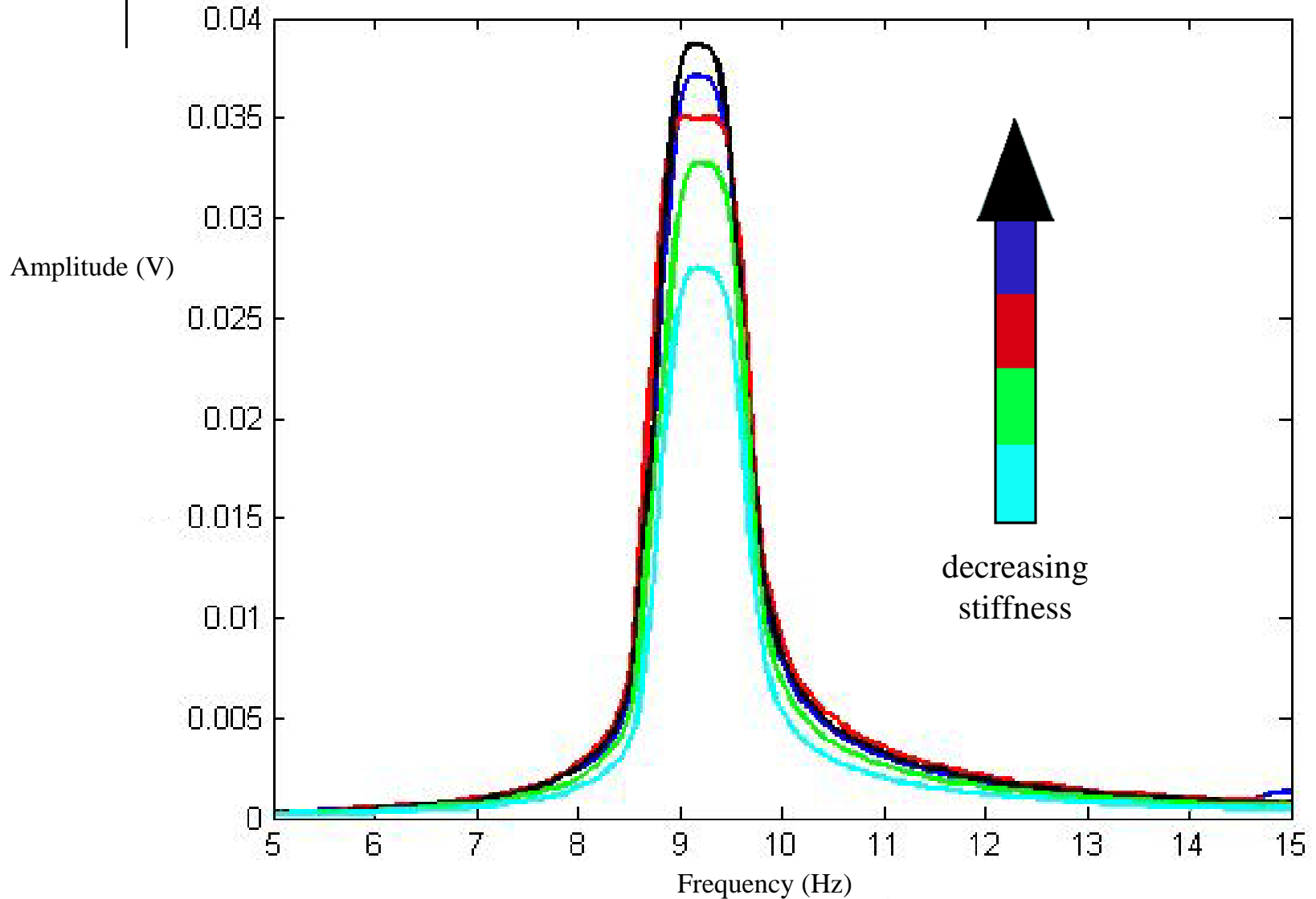
Parametric Amplification

- Someone on the swings
- Parameter as a function of time
- Effective Stiffness

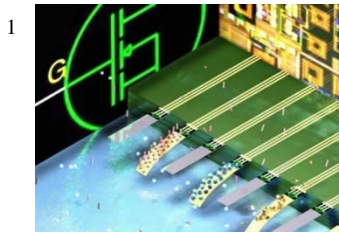


http://comps.fotosearch.com/comp/UNN/UNN457/boy-cute-child_-u12751976.jpg

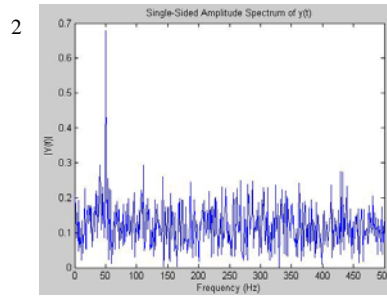
Parametric Amplification Results



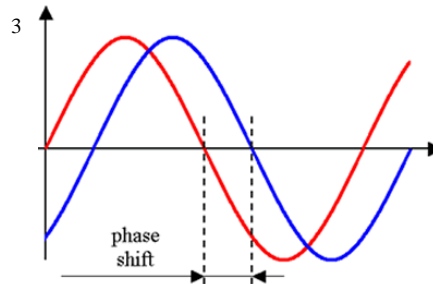
Q-Control



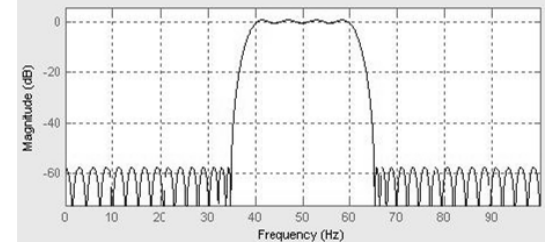
★ Cantilever



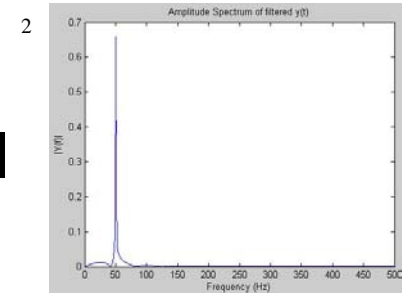
Response Signal



Amplified and Phase Shifted

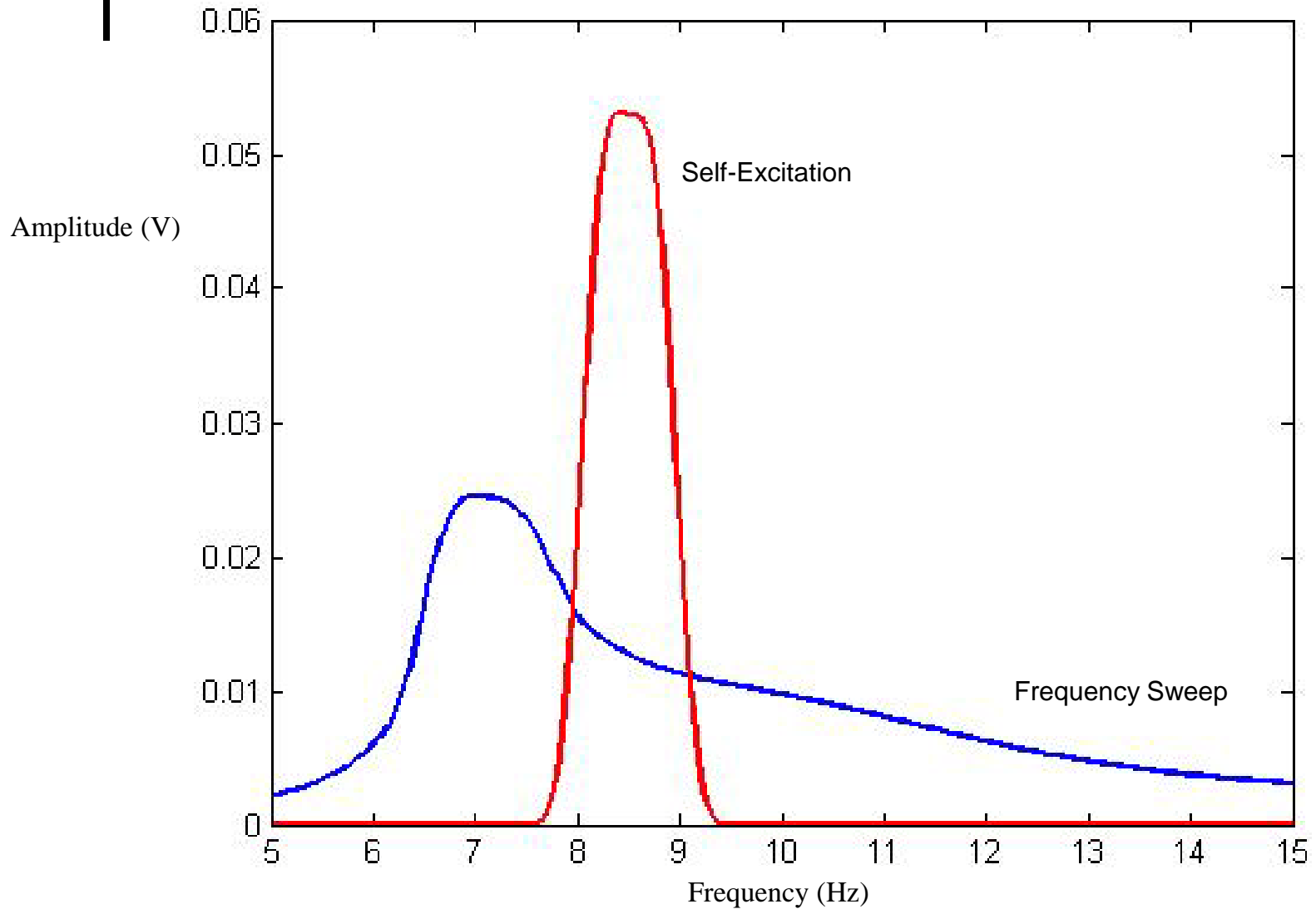


Filter



1. <http://biosingularity.wordpress.com/2006/03/06/transistor-cantilever-combo-detects-biomolecules-with-high-sensitivity/>
2. <http://basic-signalprocessing.com/spsounddenoising.htm>
3. http://www.bom.gov.au/weather/radar/about/phase_changes.shtml

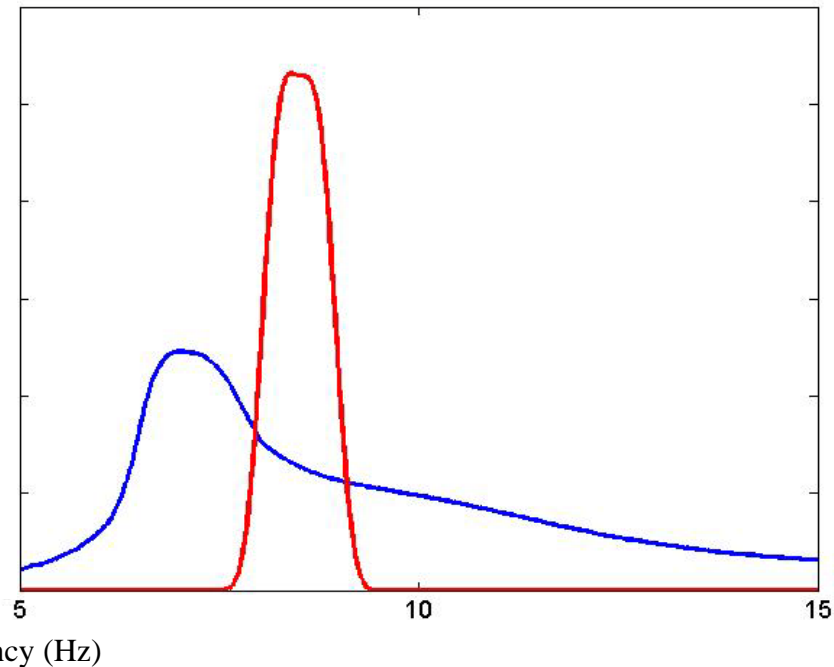
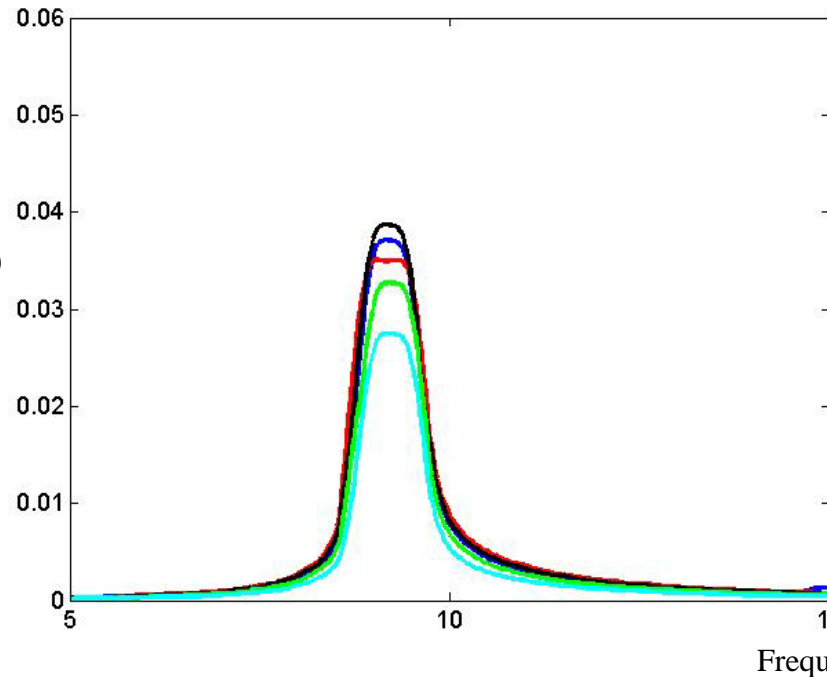
Q-Control Results



And the winner is...

Parametric Amplification

Q-Control



40% Gain

115% Gain

Acknowledgements

Kari Moran

Kimberly Turner

Arica Lubin

Matt Crossley

