



Developing a Low Noise Seismometer in the Frequency Range of 0.3Hz to 20 Hz

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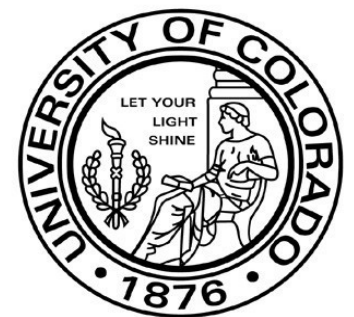
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Overview

- Introduction
- Limitations of Seismometers
- Improved Noise Models
- AutoCAD Design Analysis
- The Next Stage

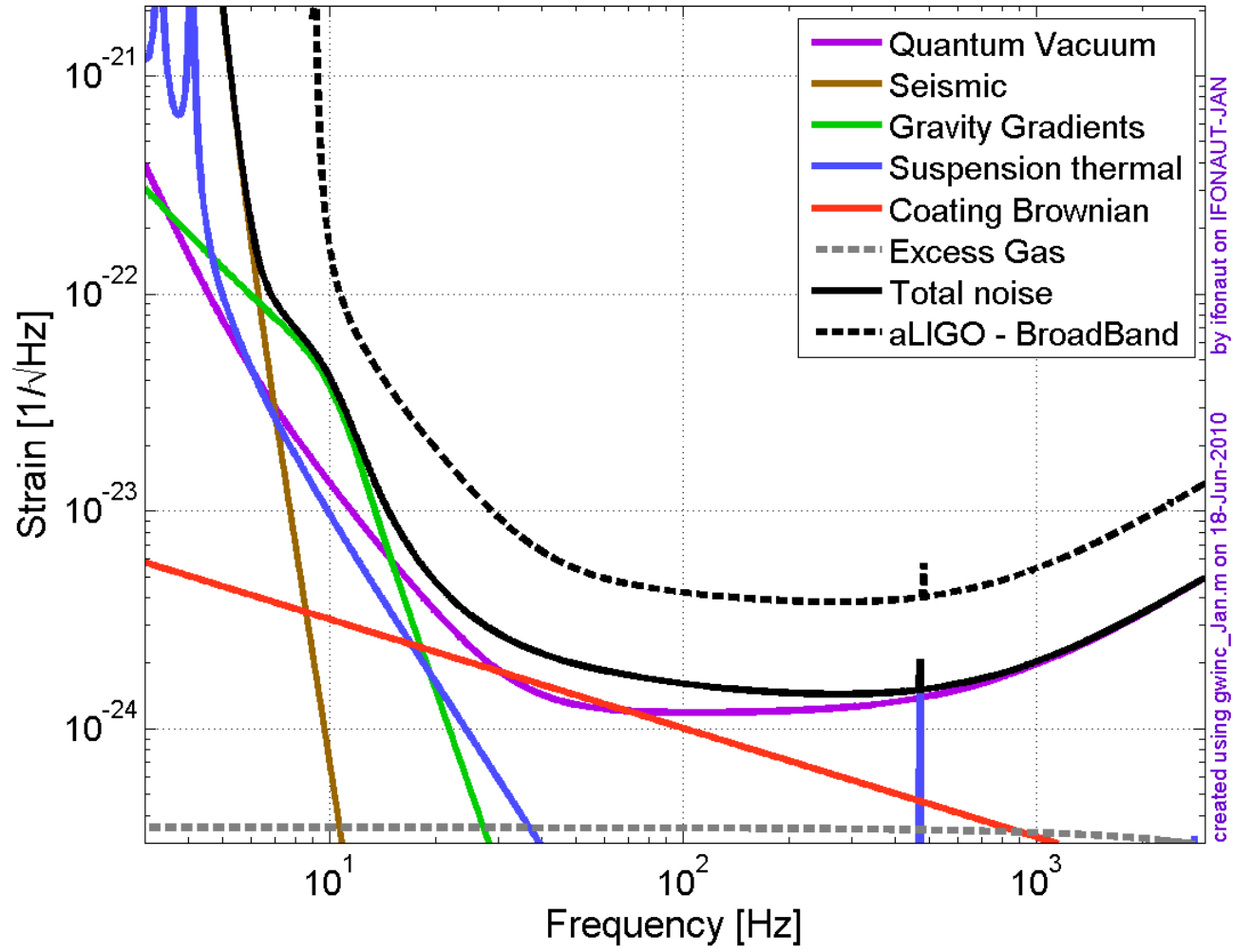


Introduction

Why?



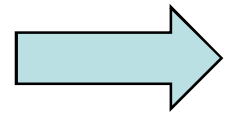
Graph of Noise in Future Detectors





“Seismically Induced” Newtonian Noise

Seismic fields create perturbations in the ground



causes the ground to displace ever so slightly



this changes the density around a test mass



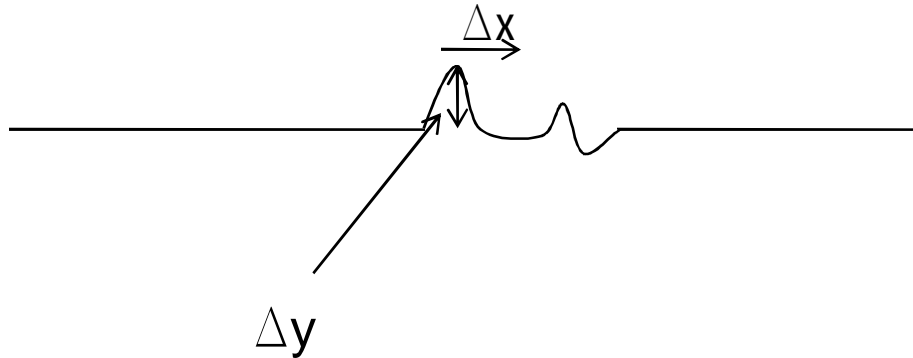
induces a force upon the mass which displaces it ever so slightly.

This is Newtonian Noise



Simple Look and Possible Solution

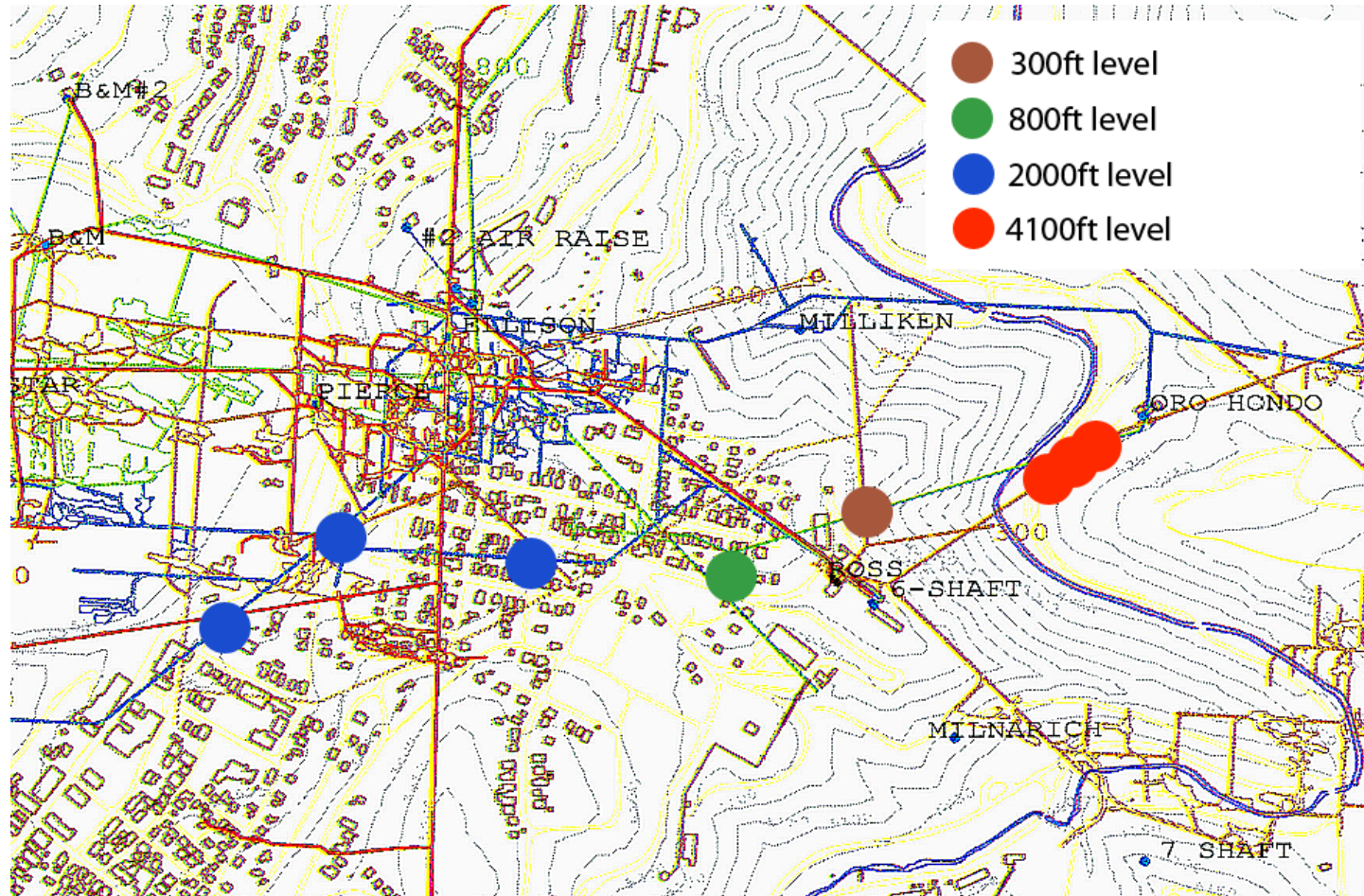
2-D Model of NN:



Learn about Newtonian Noise at Homestake

-Develop methods to subtract it

Homestake





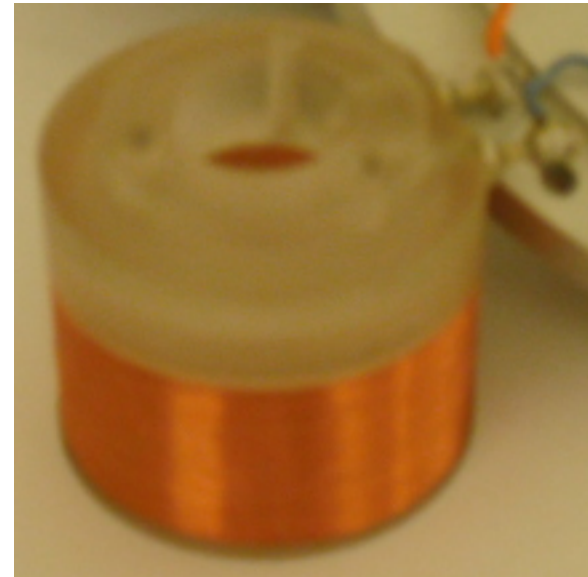
Limitations of Seismometers



Capacitor Readout vs. Coil Readout

-Coil Readout

-too high sensor
impedance = more noise

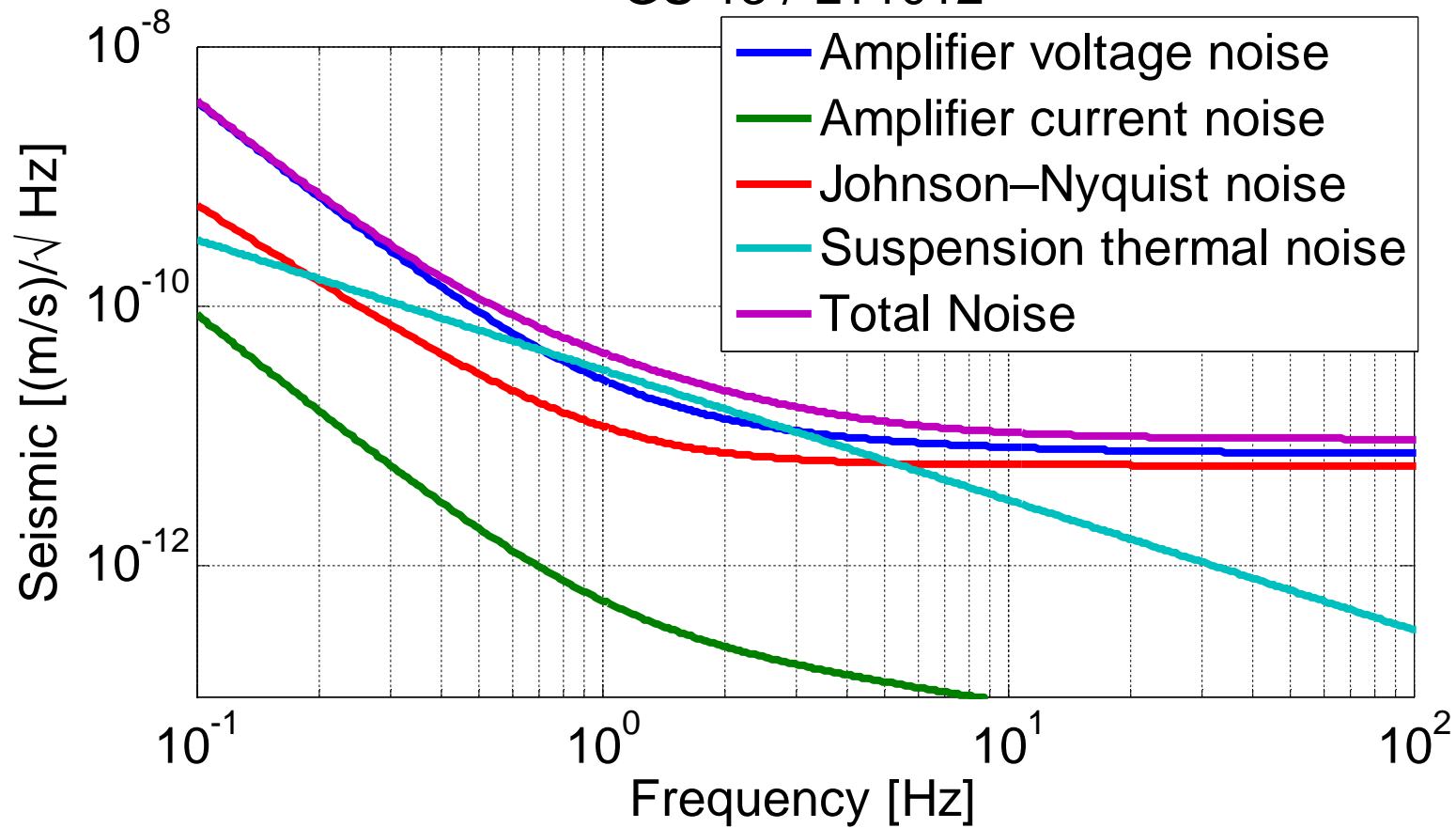


-A capacitor has as little resistance as
one can make it with



Sensitivity

GS-13 / LT1012

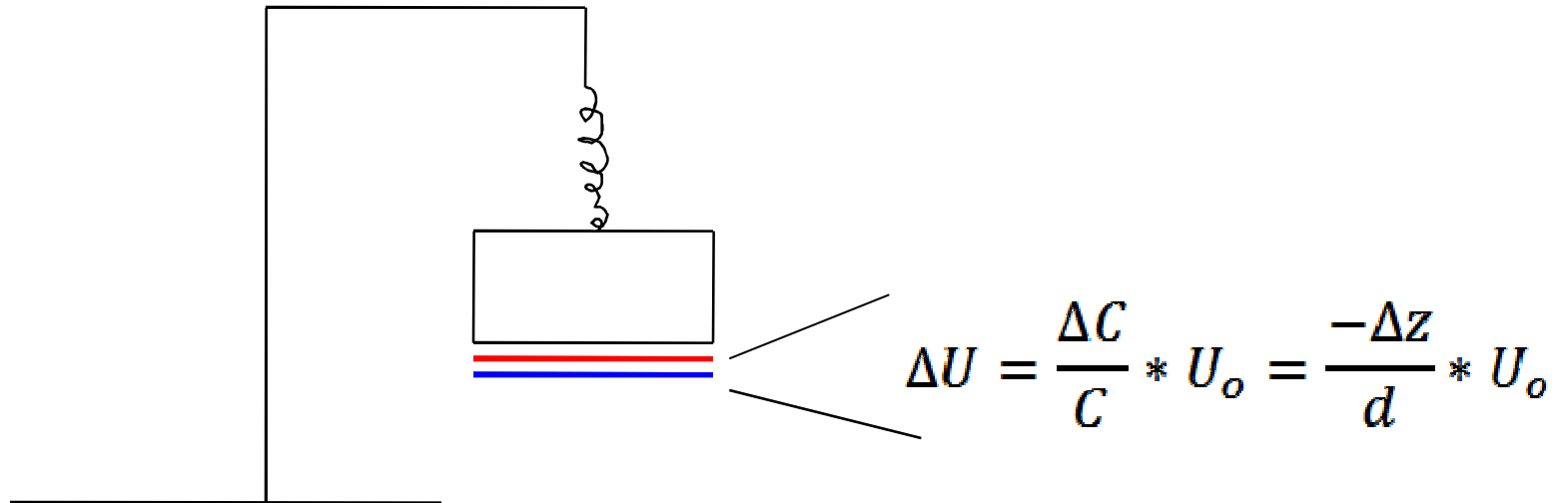




Improved Noise Models



Mathematics with the Capacitor Addition



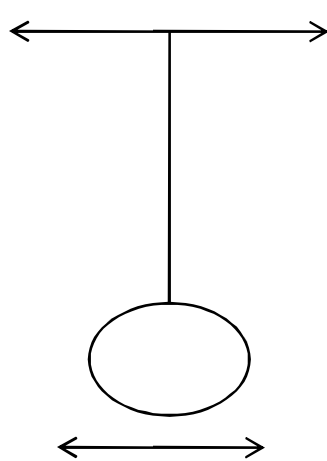
U = driving voltage

C = capacitance

d = distance between capacitor plates

Δz = change in plate distance

Transfer Function

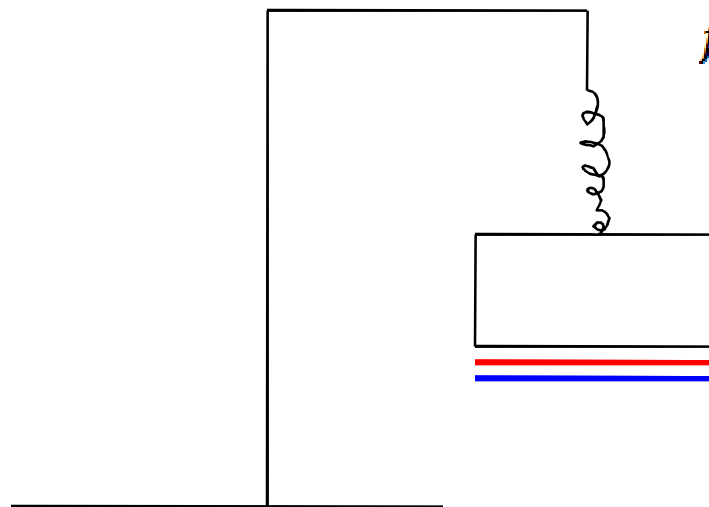


$$|H(f)|^2 = \frac{f^4}{(f_o^2 - f^2)^2 + \varphi^2 f_o^4}$$

φ = loss angle of spring

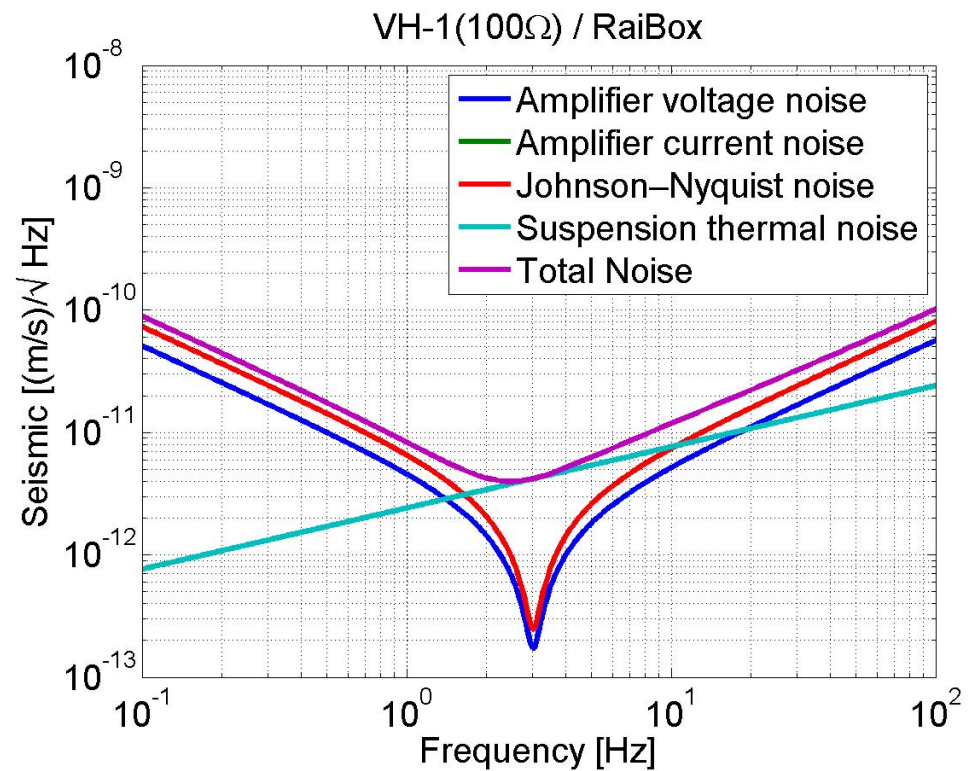
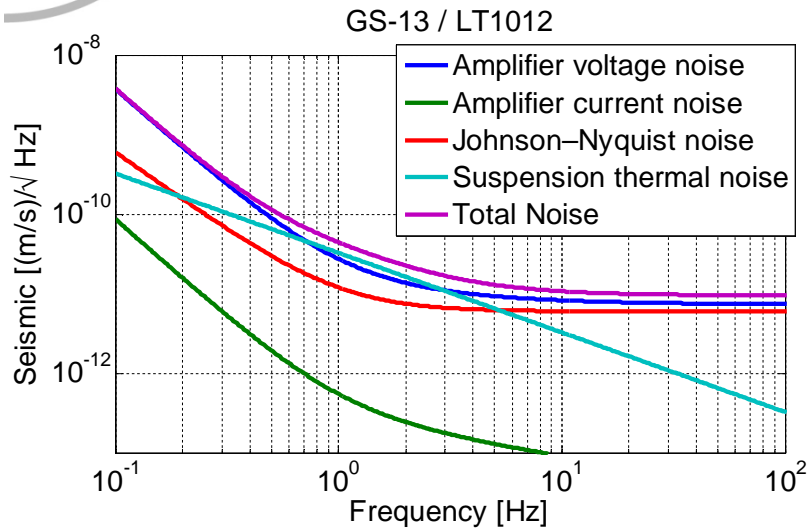
f = signal frequency

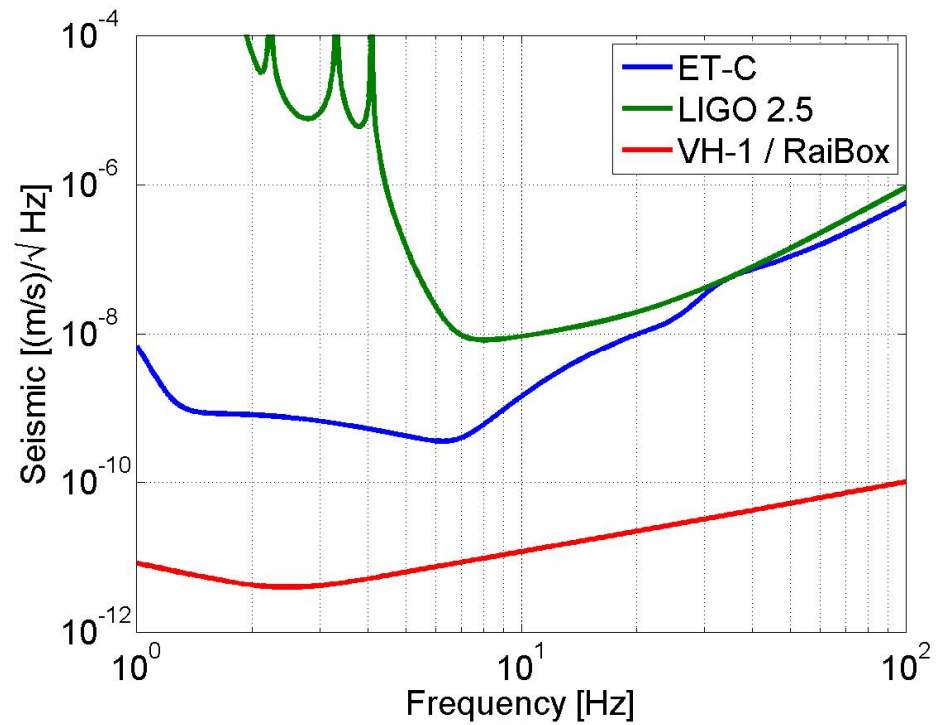
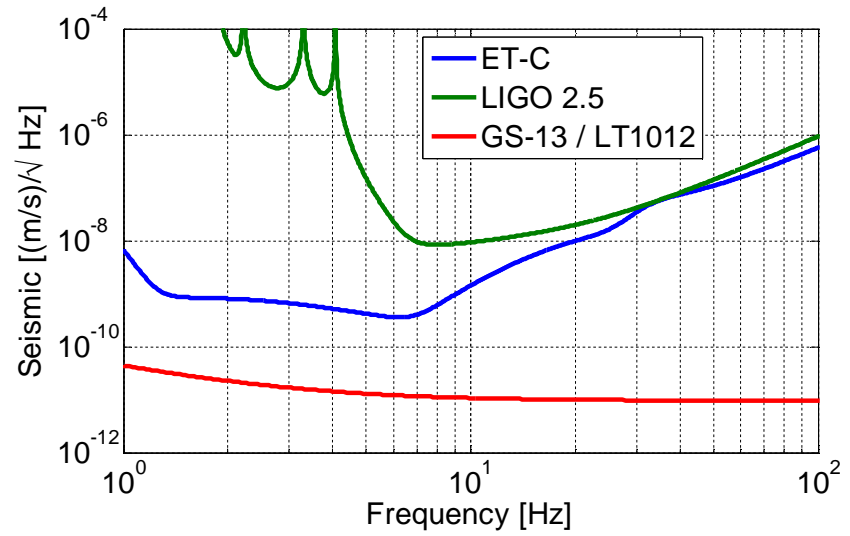
f_o = resonant frequency of spring





Graphs from Transfer Function



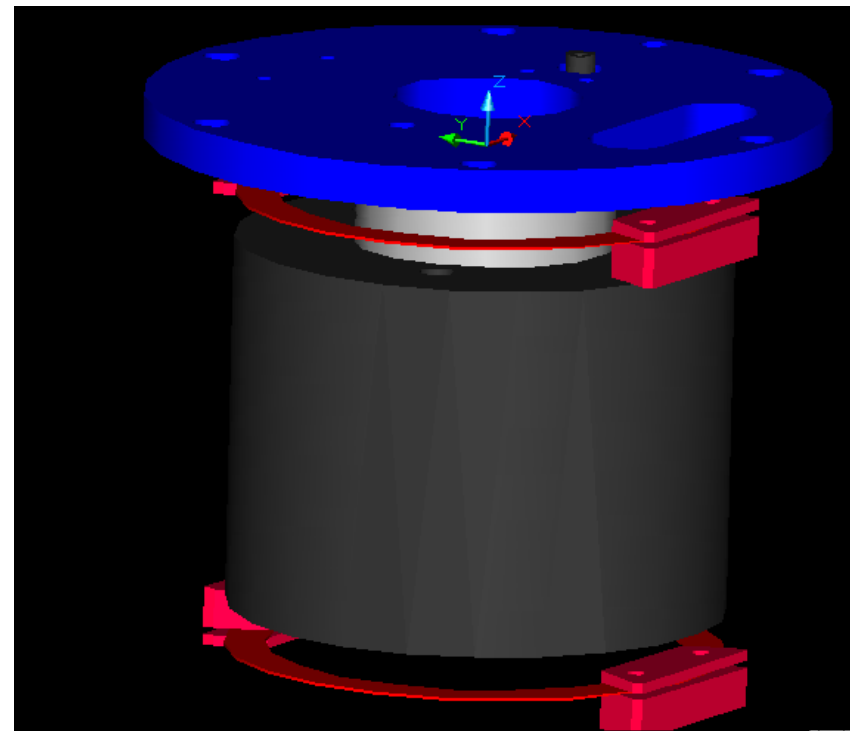
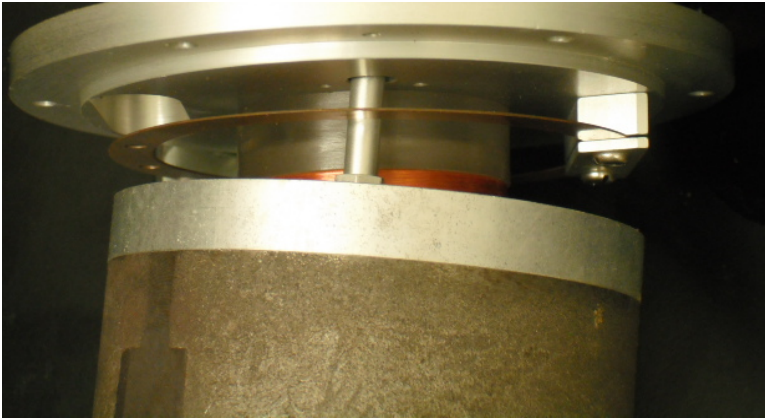




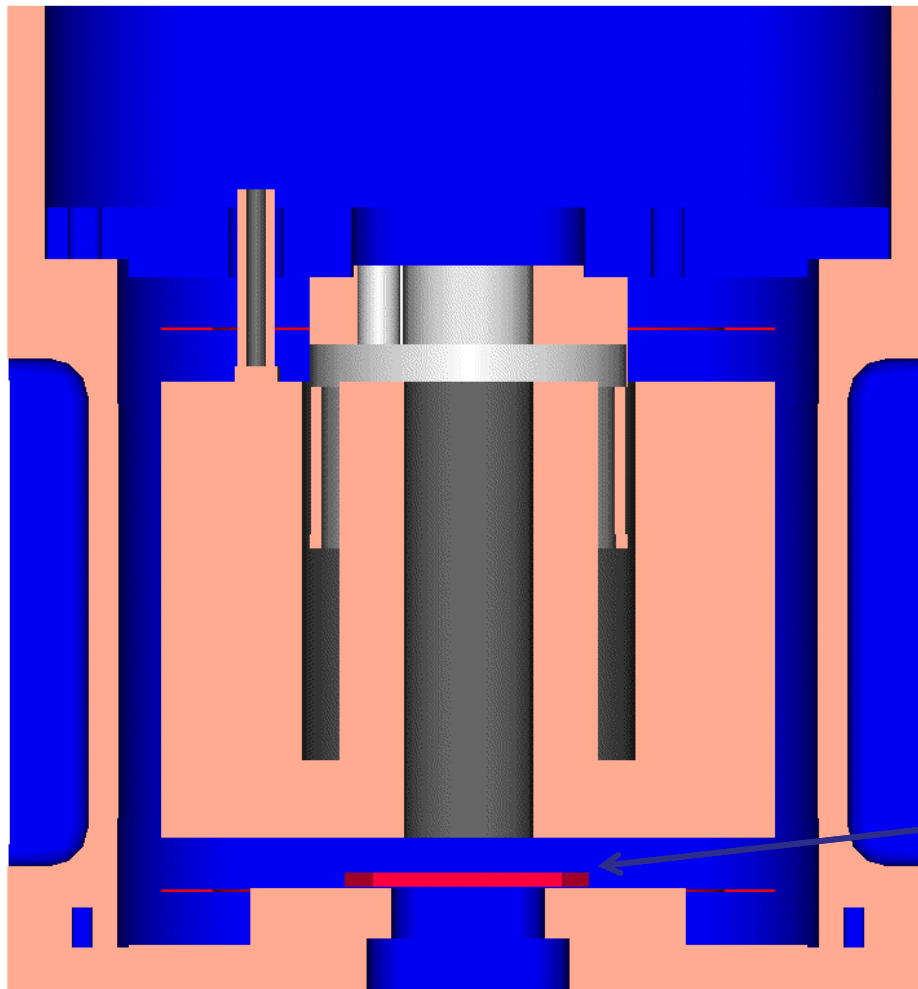
AutoCAD Design and Analysis



Dimensions to 3-D Models

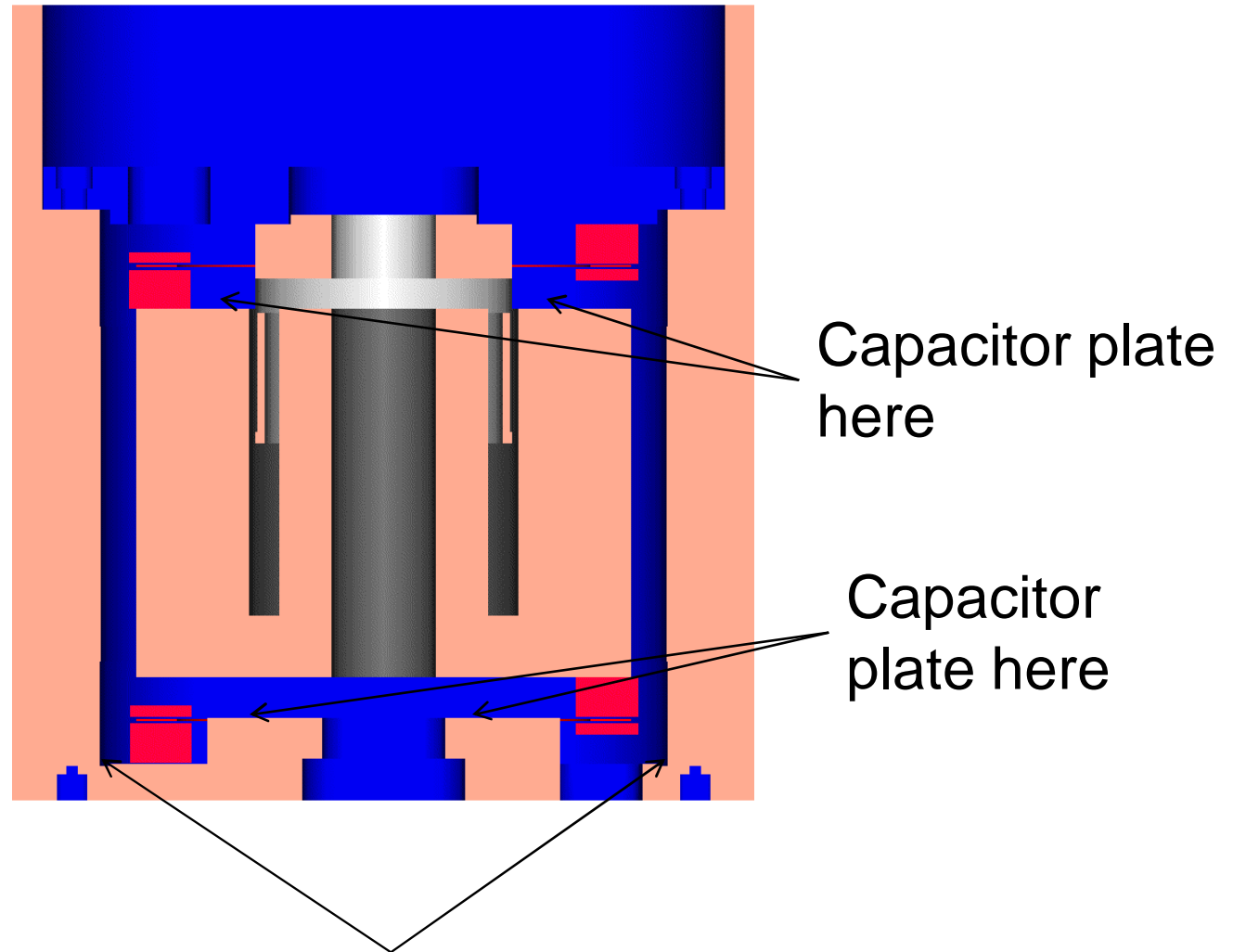


Cross Section



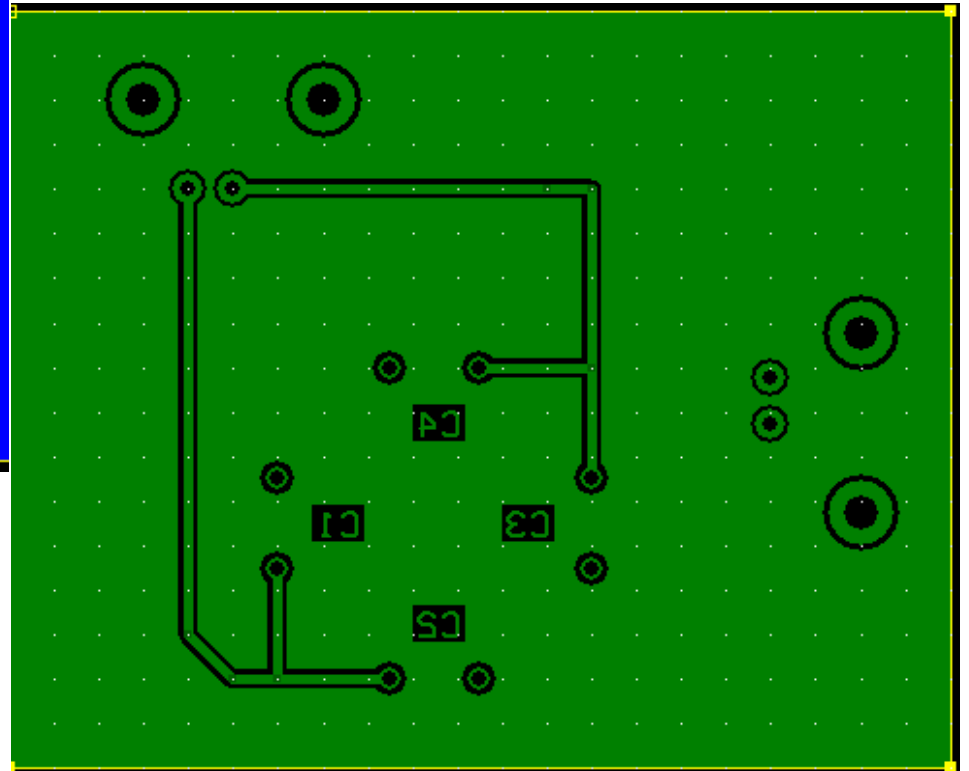
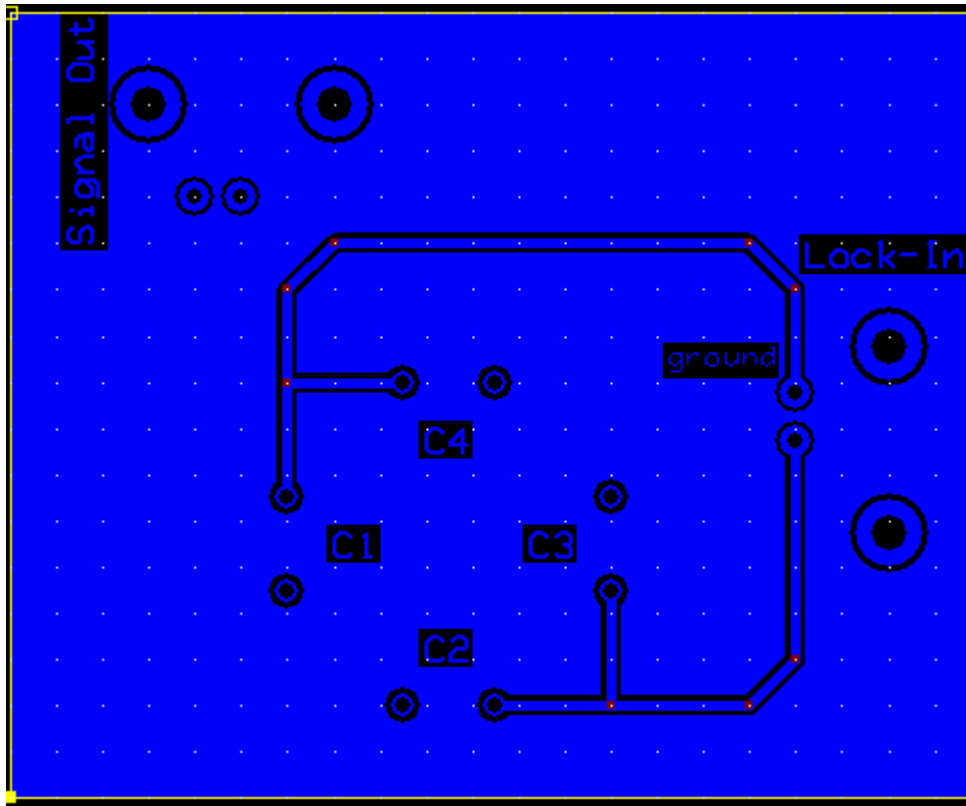
-Possibly no room for capacitor at bottom due to the calibration coil taking up too much space.

Calibration coil



Add on to the outside cylinder to make room?

PCB





What is Next?



Short Term

- Complete the setup of newly arrived seismometers
- Noise measurements with the seismometers
- Find out the major limitations and determine how to lower these limits



Long Term

- In the next year get into Homestake and begin more seismic measurements for modeling NN
- Over the next few years keep modifying seismometers for less limitations and better seismic study



Acknowledgements

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References

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