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HTS Vibration Experience – Sources & Mitigation

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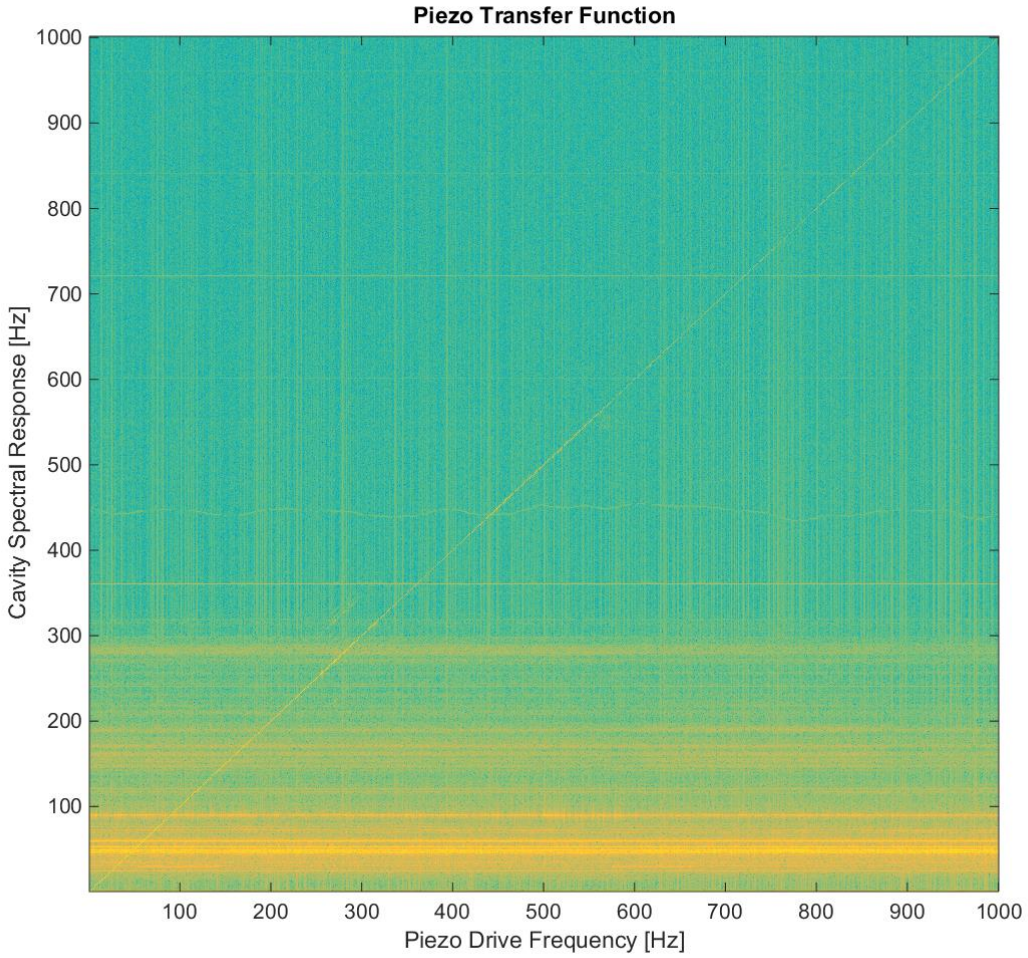
Synopsis

- Resonance Control Group has conducted several rounds of testing at HTS and discovered a quite sizable amount of microphonics disturbance
  - Notable sidebands at 30, 50 Hz and harmonics
- Larry D. and Brian C. attempted to control the cavity but were unable to because the detuning was so large
- Early attempts at diagnosis and mitigation revealed some obvious sources, and the environment was improved to the point testing was reasonable
- Further studies have proved relatively fruitful (Warren's Presentation)
- The results of this study and the resulting mitigation proposals will be presented here

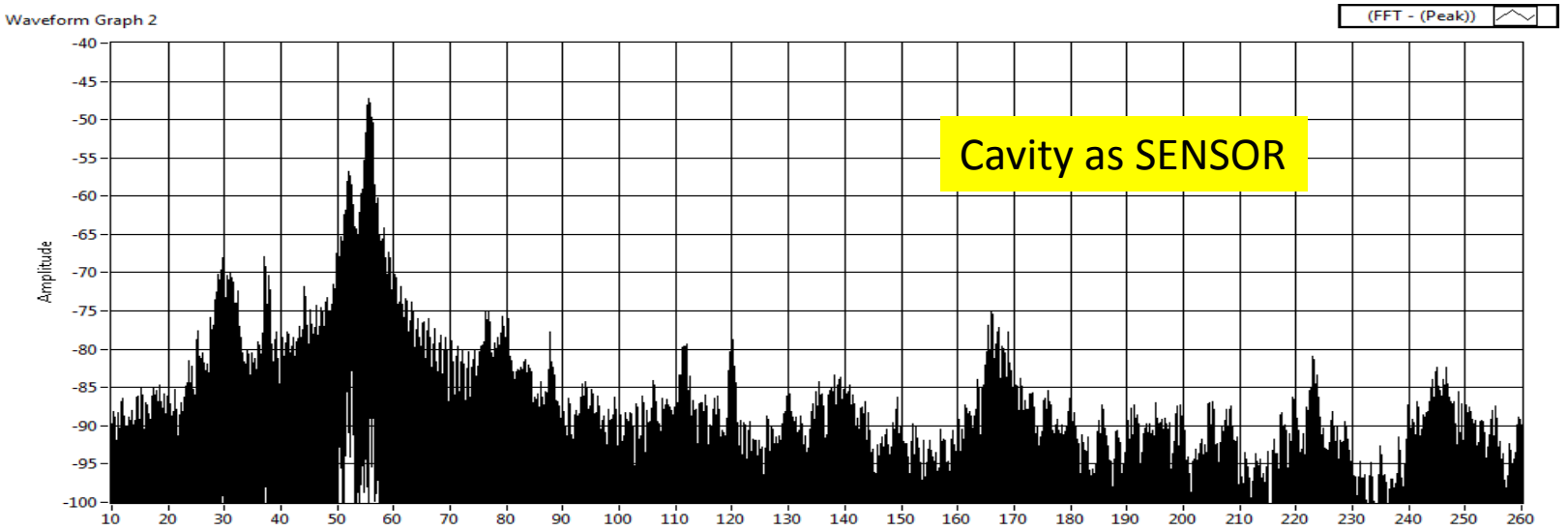
Testing Setup

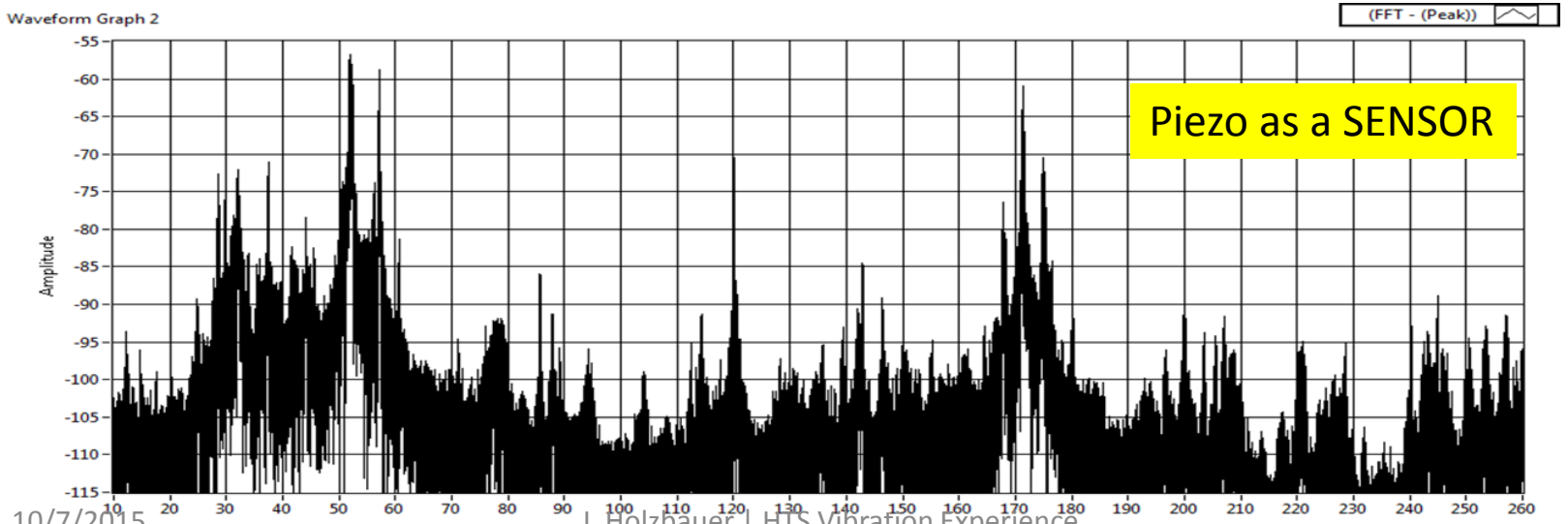
- Measuring voltage driven across the cavity piezoelectric tuners gives a measurement of the cavity mechanical vibration
- Because the cavity it warm, it cannot easily be correlated with absolute frequency detuning, but the spectral information is still quite useful for diagnosis of vibrational sources
- A pair of geophones was used in the cave at large to measure surface vibrations
- Data was taken for 1 second periods, and the spectral powers were averaged over a number of data sets, usually close to 10
- Caveat: 120 Hz line is almost certainly electrical noise

Cold HTS Transfer Function Data



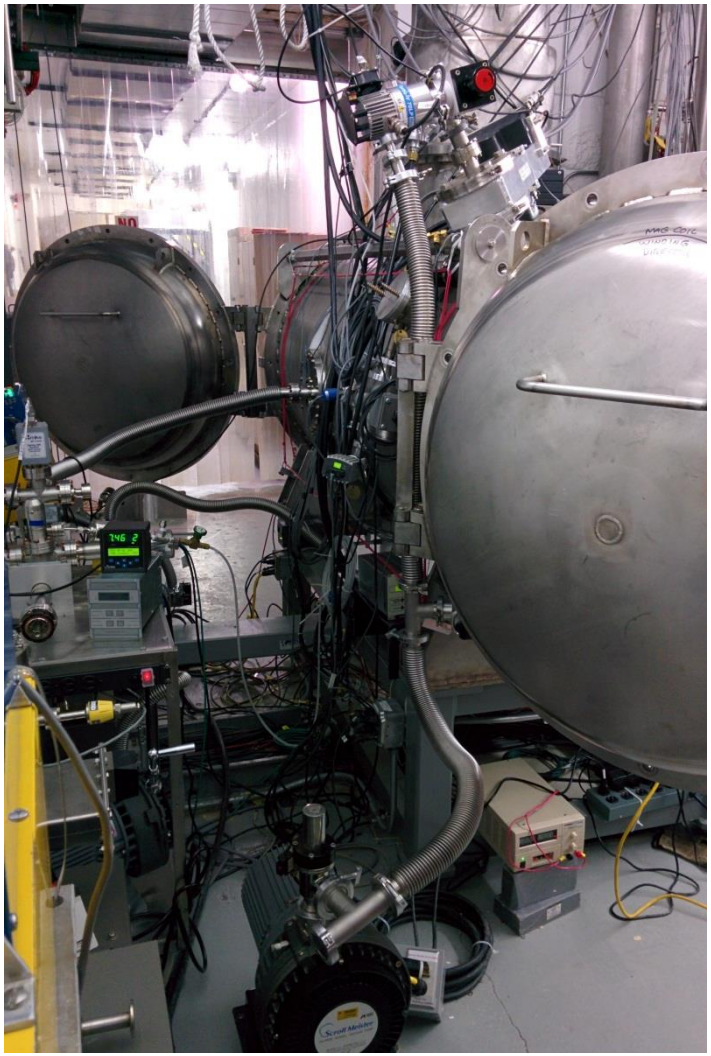
Measurements of cavity vibration (microphonics) using (1) RF signal from cavity & (2) piezo signal/piezo as a sensor





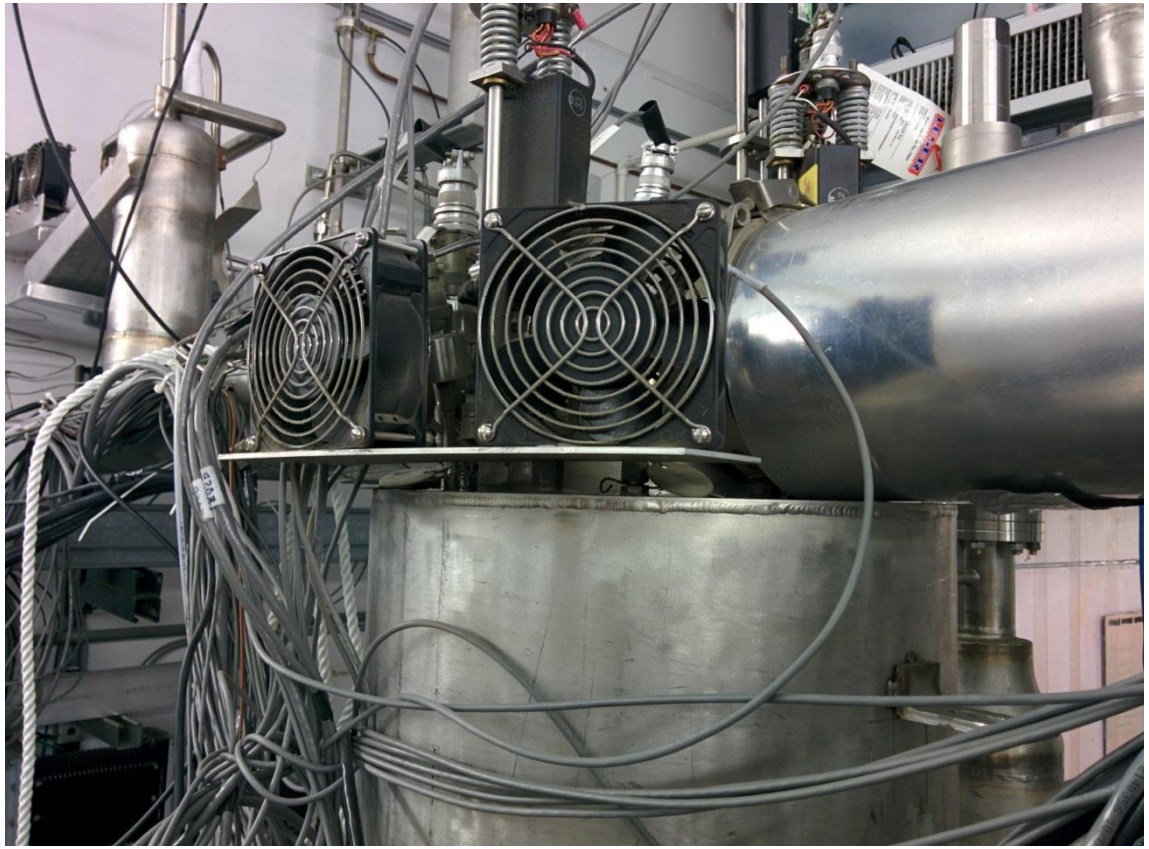
Credit to Yuriy for the Slide

Insulating Pump Stack

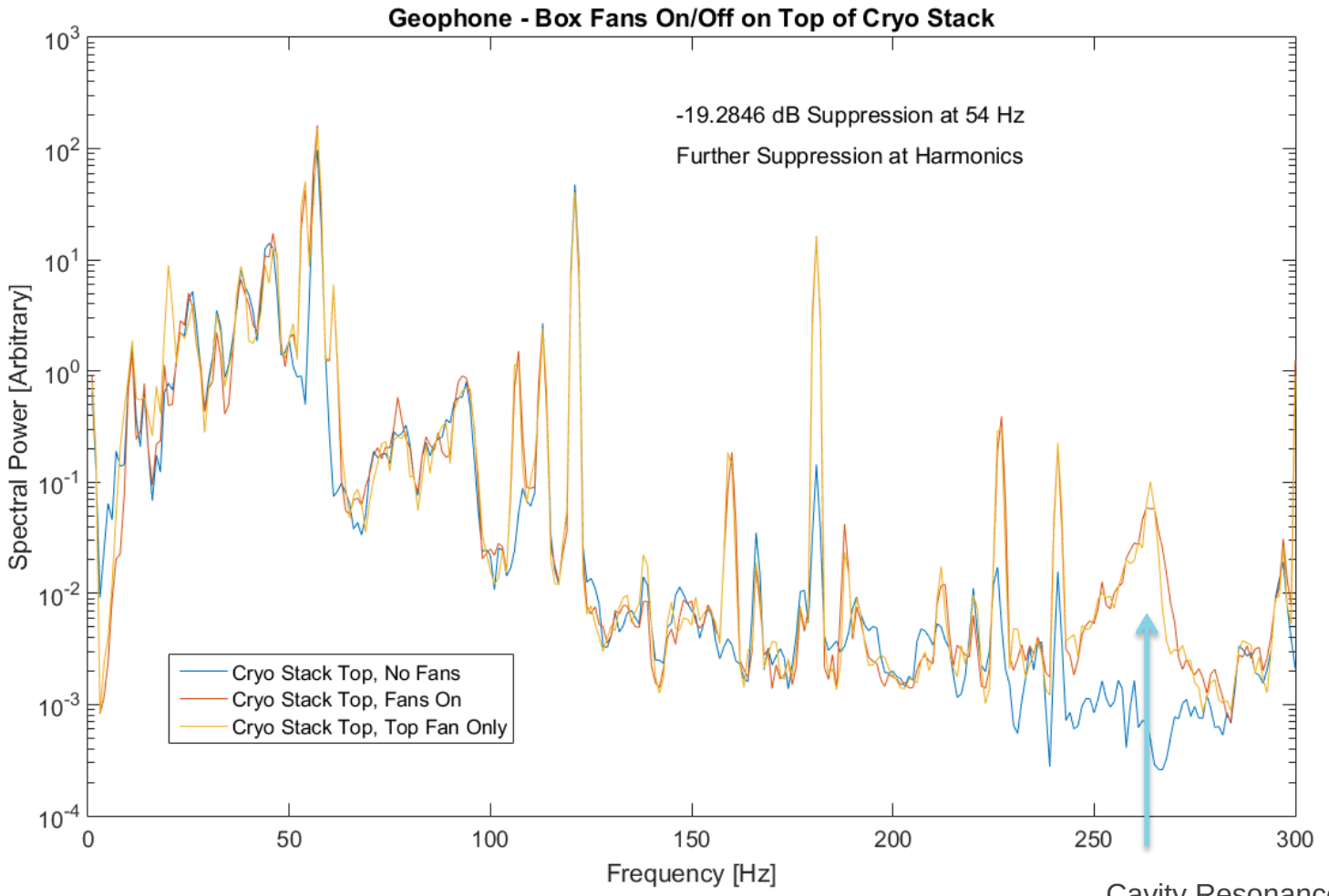


AD Cryo Box Fans

- Two box fans on a plate to mitigate valve heat leak, large vibration source
- Initially hard mounted, now soft mounted through grommets
- Heat leak is too large to have them off for more than a couple hours without significant icing
- AD cryo should be able to modify/replace with a non-vibrational heat source

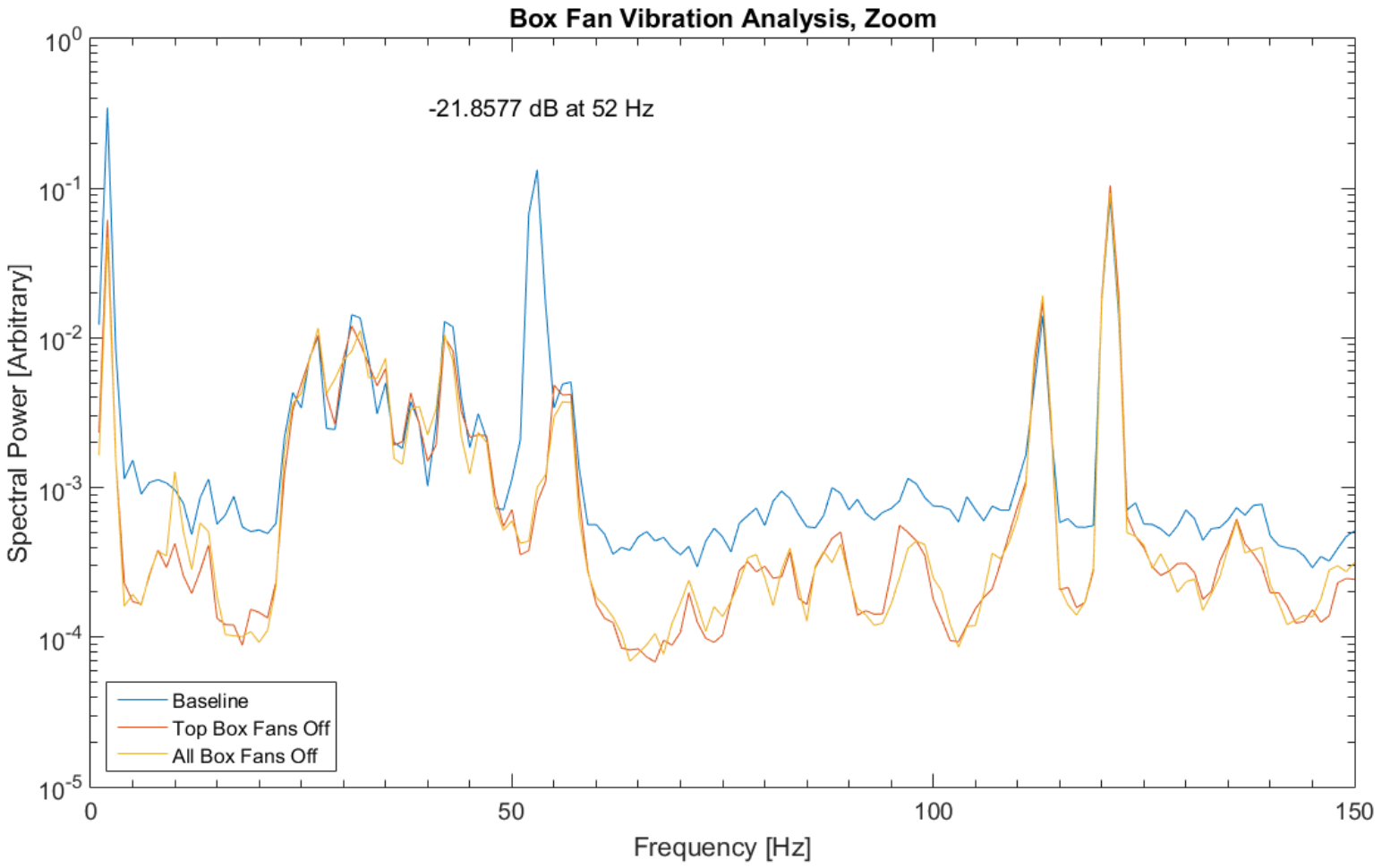


AD Cryo Box Fans – Geophones Next to Source

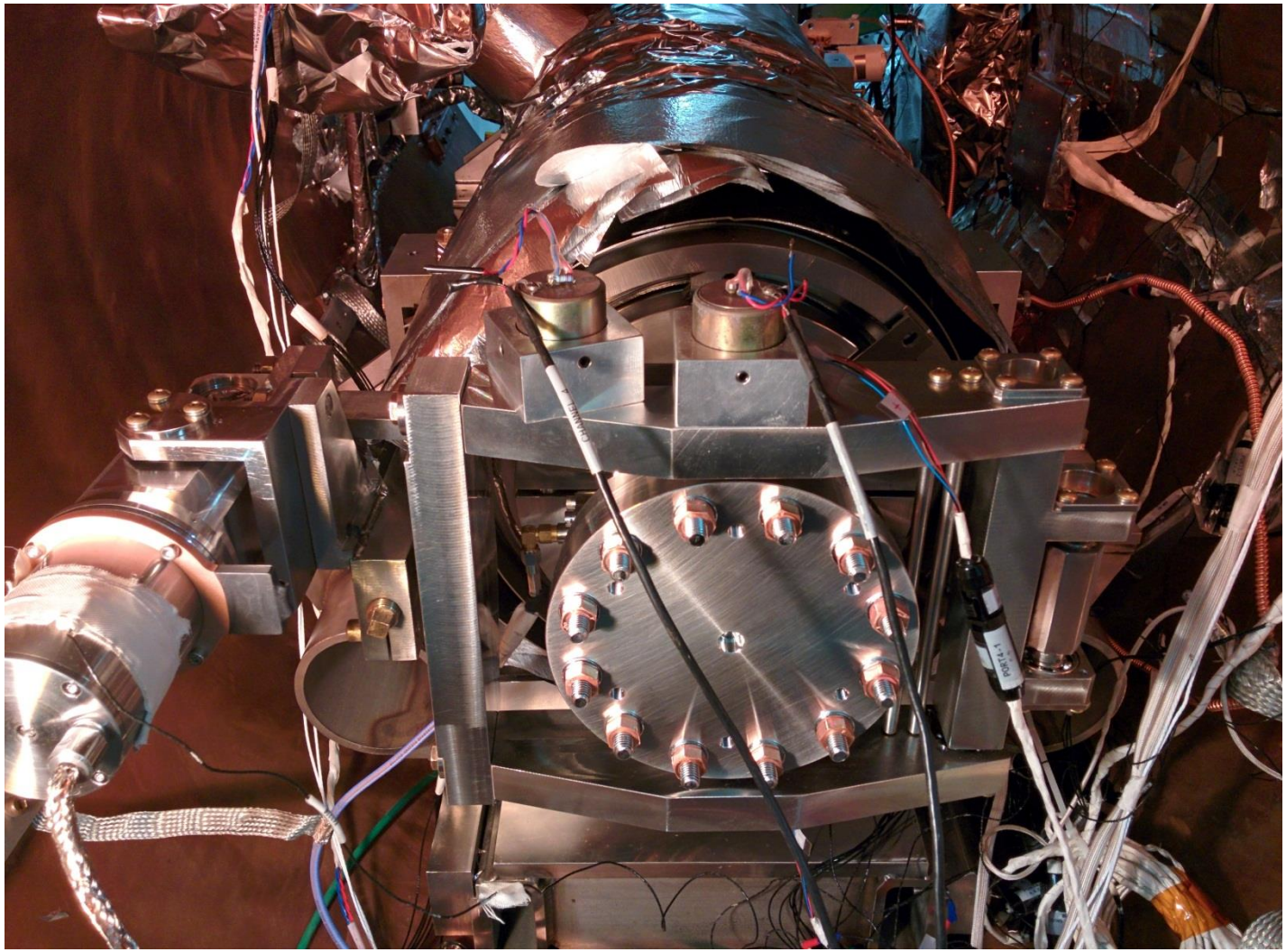


*Again, be wary of 120 Hz peak/harmonics

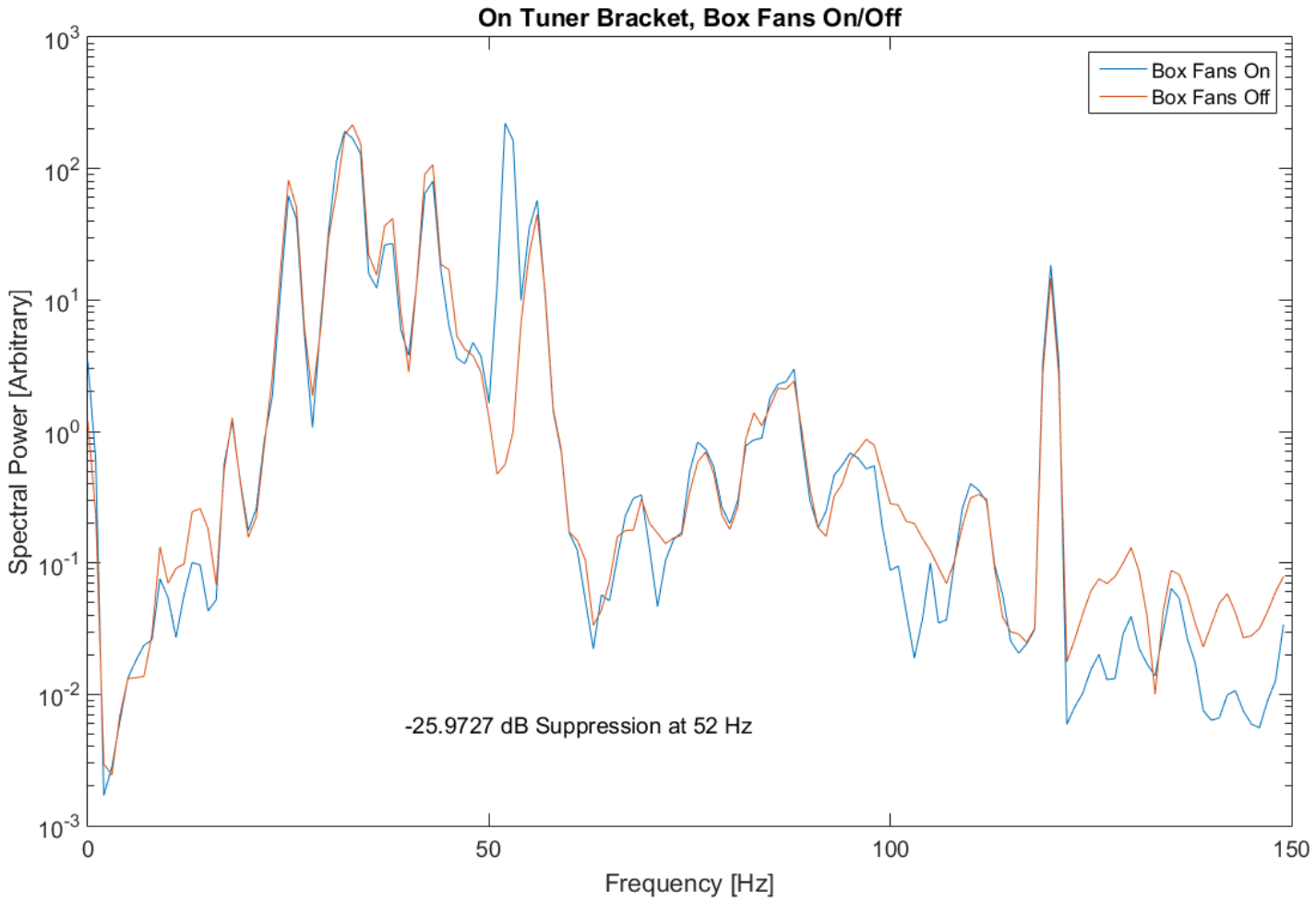
AD Cryo Box Fans – Piezo Data



Geophones on Tuner Bracket

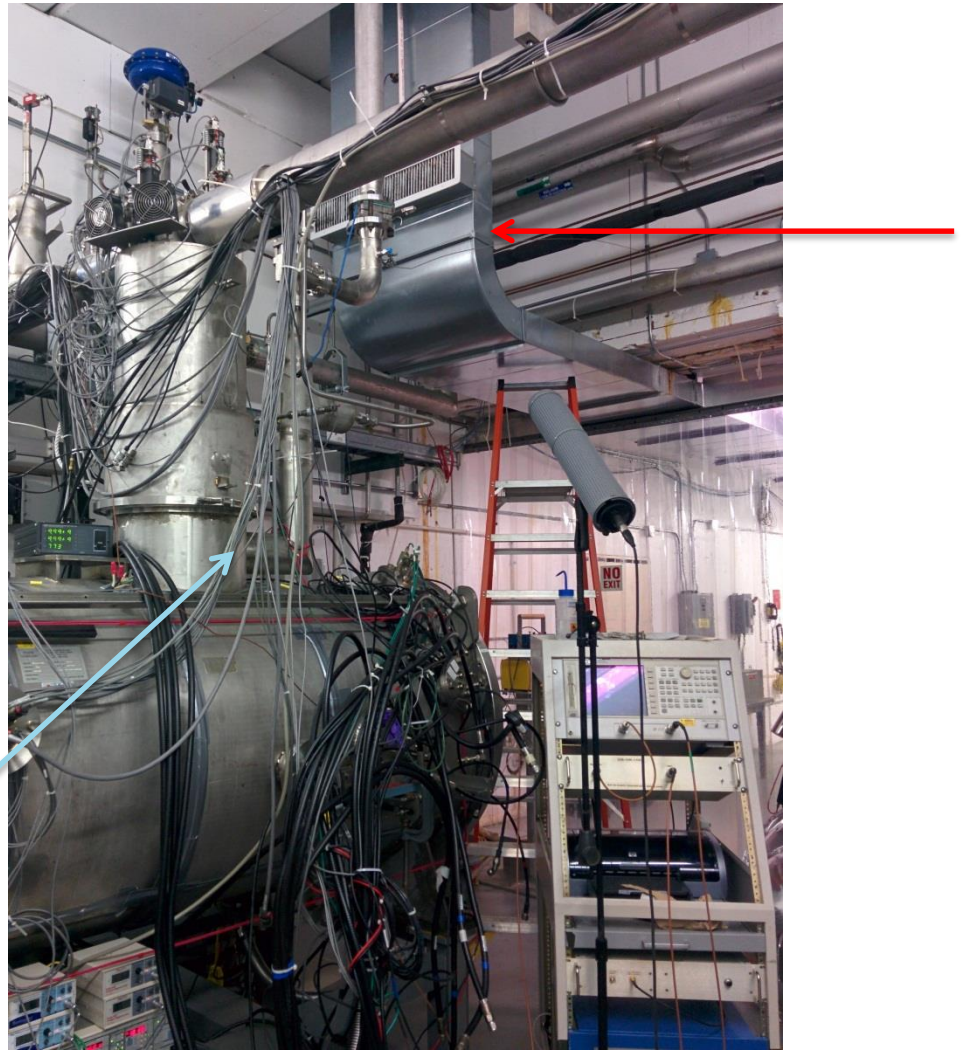


AD Cryo Box Fans – Geophone Data



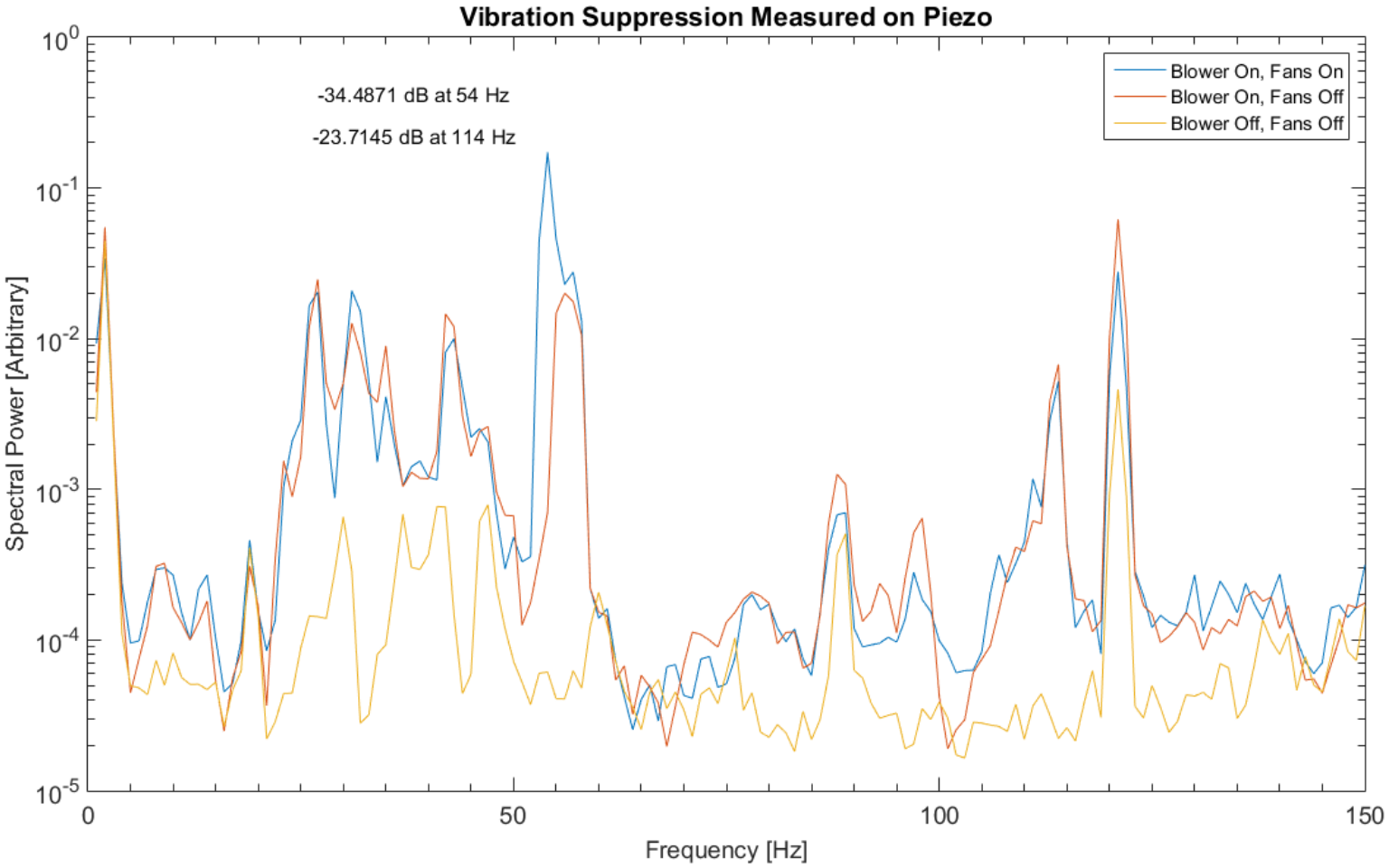
ODH Blowers/HVAC Duct

- Ventilation in the HTS cave is run by two systems in parallel
- HVAC is (theoretically) controlled by a thermostat outside the cave
- ODH ventilation blowers run 24/7 when the cave is unsecured
- ODH blowers should be off when cave is secured
- Primary vent blows directly onto a cryo relief stack which hard-connects to the HTS stack

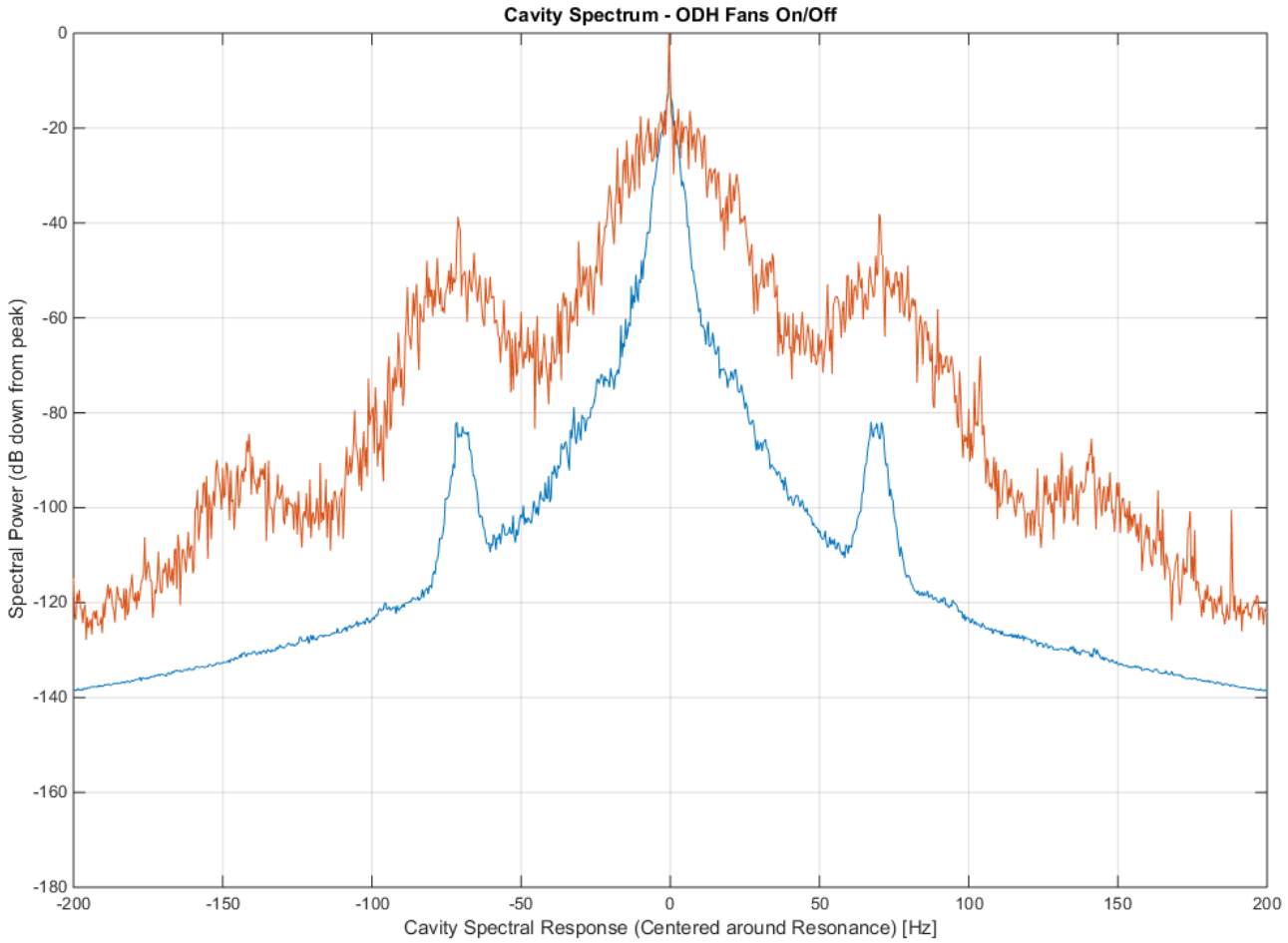


Cryo Relief Stack

HVAC/ODH Blower is a large noise source



Probe Spectrum Noise ON vs. OFF



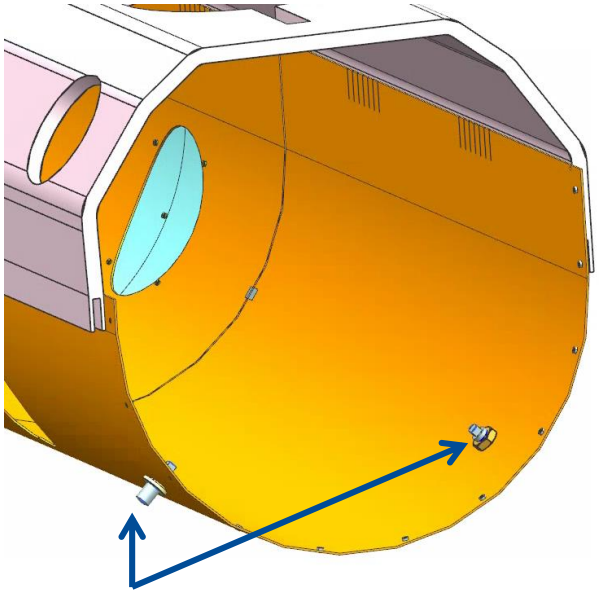
Mitigation Conclusions

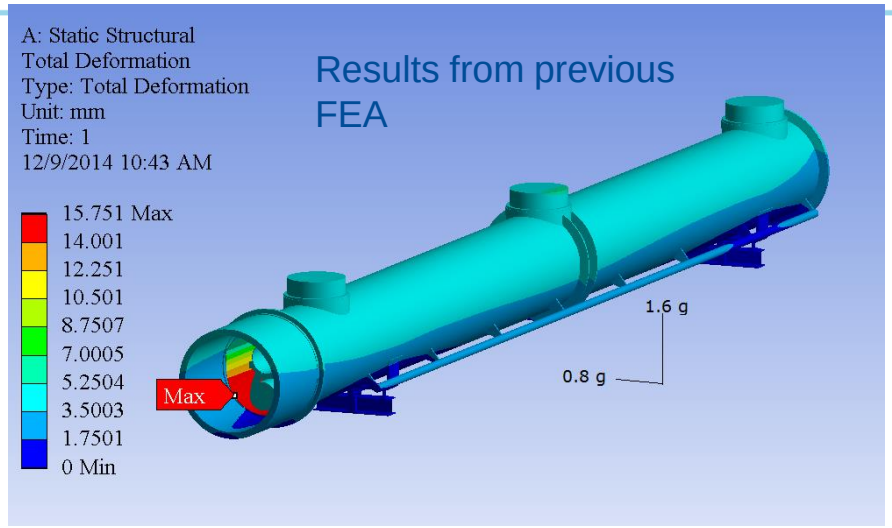
- ODH blower, HVAC, and AD cryo box fans seem to be the dominant sources of noise
- All spectral lines between 50 and 55 Hz (the dominant sources) seem to be suppressed or removed by these changes
- The ODH should no longer be a problem as it should shut off when the cave is interlocked (the original intention, and now restored)
- The HVAC can be turned off for periods of time when needed (summer is harder)
- The AD cryo box fans were just turned off, and the Cryo guys keep an eye on the valve icing

Future Work - Conclusions

- Passive mitigation is only one aspect of microphonics stability
  - Cavity/Tuner Design (excellent work done on df/dP for SSR1)
  - Cryogenics/Cryomodule Design (bath pressure environment, mechanical modes)
- My motto: “Passive mitigation first, last, and always.”
- Good news: Vibration sources/issues are often obvious in retrospect
- Bad news: That retrospect part
- A centralized effort must be made to think about these issues ahead of time (my opinion)

Changes to FEA thermal shield model





- G10 support rods (newly added in 3D model), two on each end of lower shield
- To restrict the motion, in case of seismic event the lower shield cannot move further due to the G10 rods getting in contact with the inside of the vacuum vessel
- Plan to leave a gap between the inside of the vacuum vessel and the tip of these G10 rods, for thermal leak & shrinkage

Material properties of thermal shield:

- EN AW-1050A, Al 99.5%
- The extruded tube material: EB AW-6060 AlMgSi0.5

Table I. Mass Distribution of Finite Element Model (kg)

cold mass			
	cavity string	509.93	
	shield	2061.5	

Expected to be lower

Table II. Density and Modulus of model parts

Part	density (kg/m^3)	modulus (GPa)
shield	13815	207

Credit to Yun He for the Slide

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