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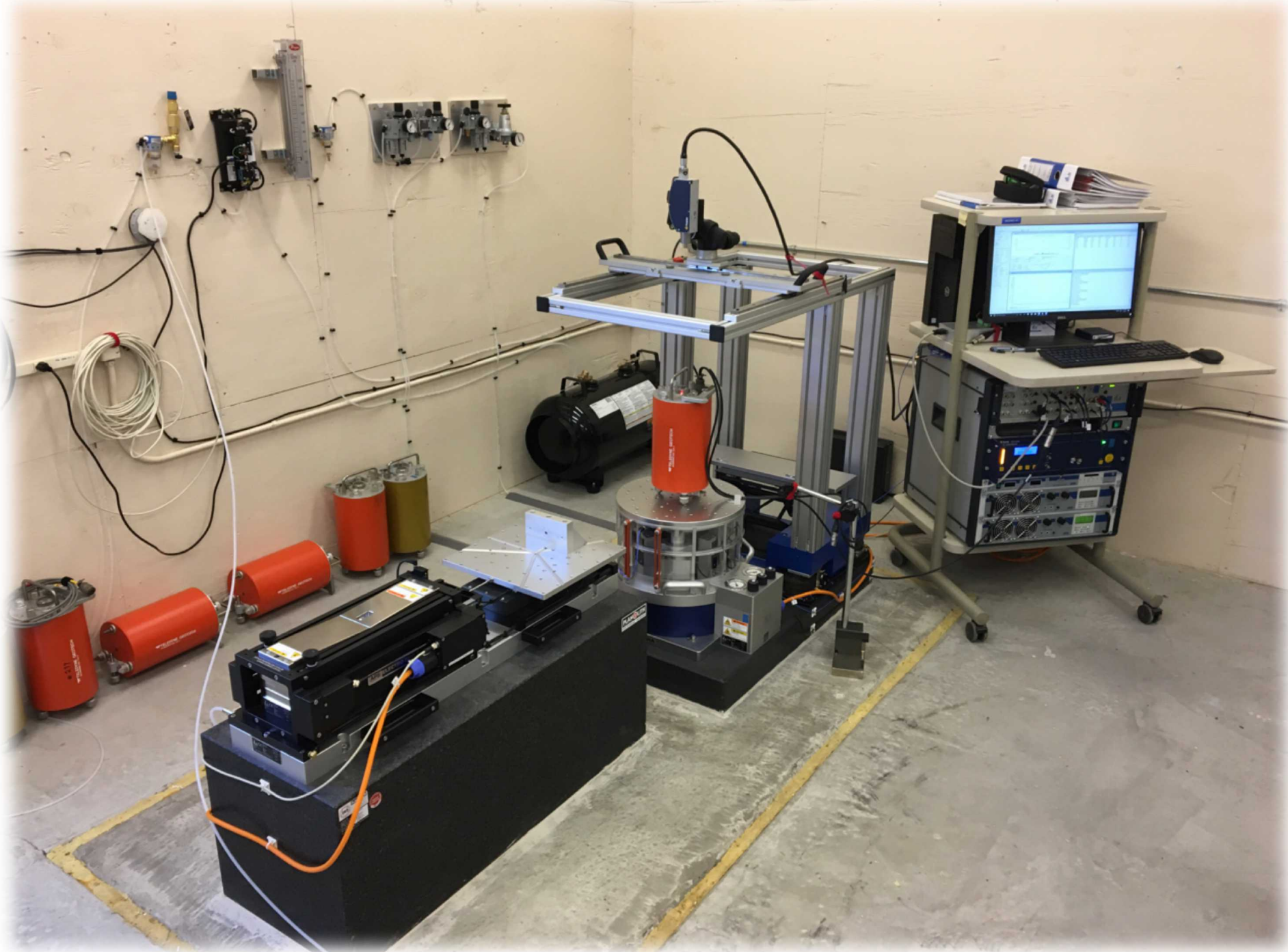
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## Introduction

The Facility for Acceptance, Calibration and Testing (FACT) at Sandia National Laboratories has been a valued resource for the U.S. monitoring community for decades. The FACT site hosts a number of capabilities focused on component evaluation including a recently added acoustic chamber, which provides superior isolation for sensors-under-test from the acoustic and pressure environment, and has the ability to be pressurized to sea-level conditions and evacuated to pressure levels found in the stratosphere. We also have recently installed a Spektra CS18 seismic calibration system, which we have leveraged for the purpose of determining seismic susceptibility of infrasound sensors.

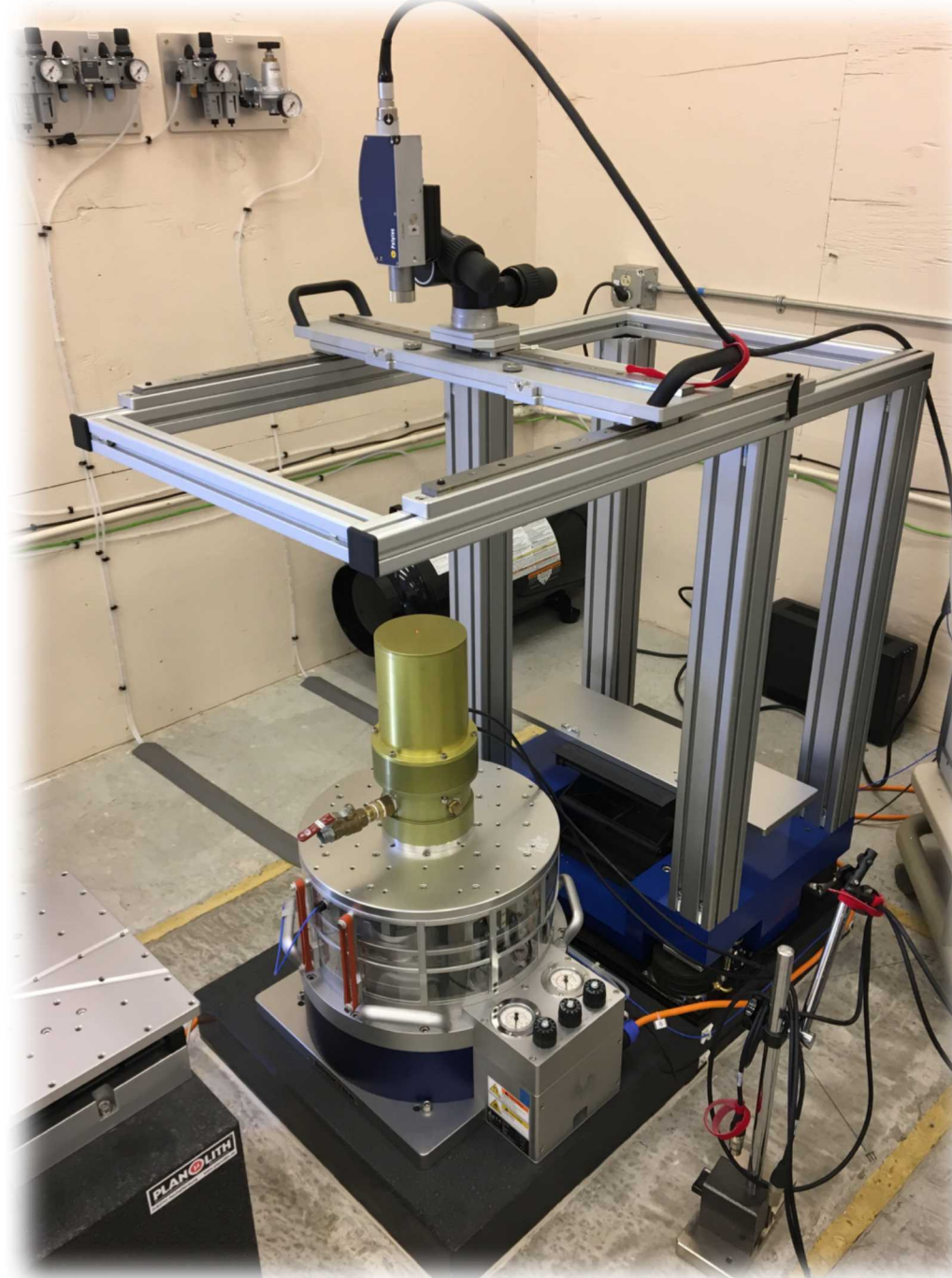
We have operated this chamber and seismic calibration system, conducting infrasound sensor evaluations and seismic susceptibility evaluations, for nearly one year. This work has included repeated calibrations, approximately once every three months for the past year, of ten infrasound sensors (two sets of five sensors), which are installed in the FACT site array as part of a separate sensor field evaluation effort. We have also utilized our seismic calibration system for evaluating the seismic susceptibility of an infrasound sensor. Here we present the preliminary results, of these quarterly calibrations and the stability and variability of the sensors-under-test, and the seismic susceptibility results of infrasound sensor under test.

## Spektra CS-18 Seismic Calibration System



- Horizontal and vertical shake tables
  - Frequency range: 0.1 Hz to 160 Hz.
  - Weight capacity: vertical table 50 kg, horizontal table 30 kg.
  - Motion configurable and may be limited by displacement, velocity or peak acceleration.
  - Supported by air-bearings, driven by Spektra amplifiers and software.
- Laser vibrometer
  - Provides independent measurement of motion induced by system.
  - Measurement used to calculate sensor amplitude and phase response.
  - Supported by a separate air-cushioned isolation platform
- Tables and isolation platform secured to granite blocks which are grouted onto a 0.9 m deep seismic pier.

## Use Case: Seismic Susceptibility Testing



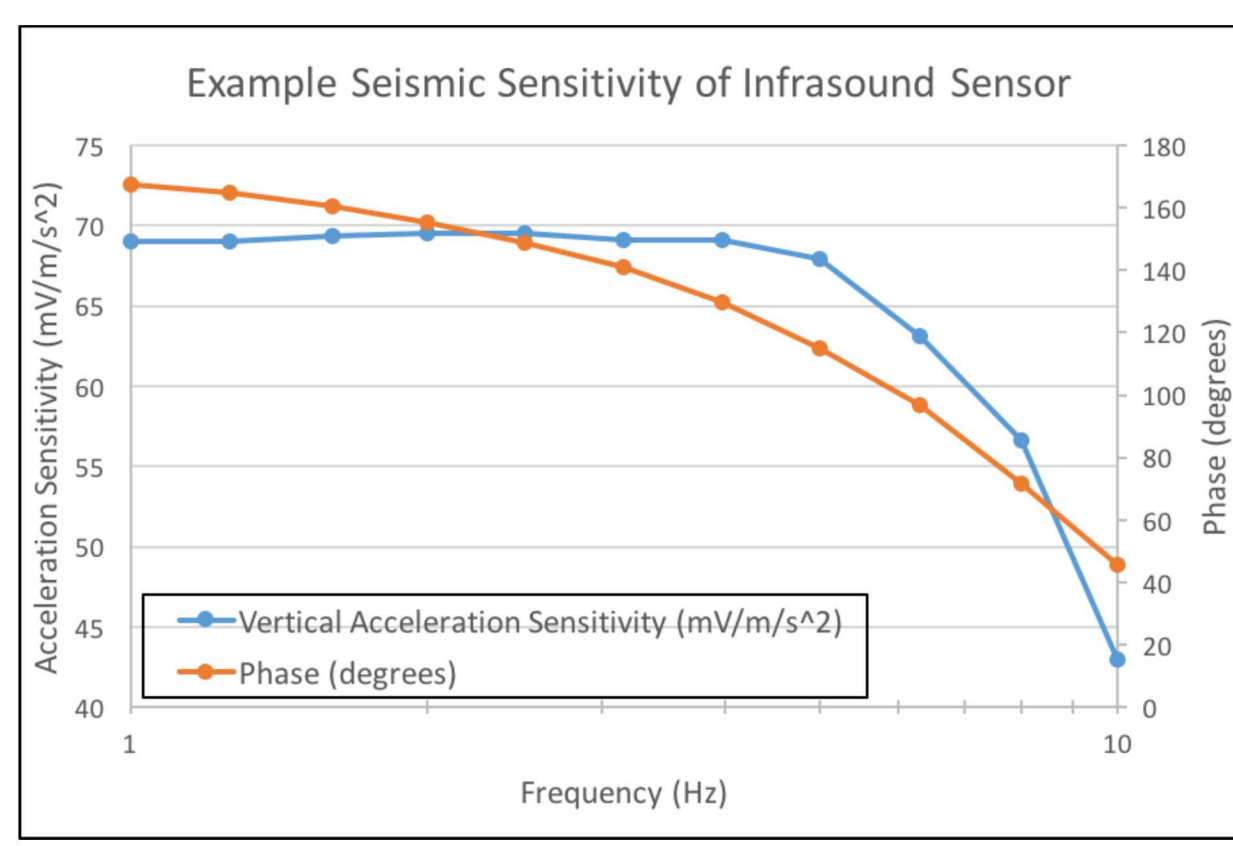
The Spektra system allows for convenient and objective evaluation of an infrasound sensor's sensitivity to vertically-induced acceleration.

System configured as follows:

- Uniform 10%g acceleration (may be displacement-limited at low frequencies)
- Sinusoidal motion
- Discrete frequencies; 1 Hz to 10 Hz, 1/3 octave spacing.

### An Infrasound Sensor's Response to Vertical Acceleration

- Sensor has a relatively flat response to acceleration between 1 Hz and 5 Hz.
- Note the plot is an example and does not represent results from the sensor in the photo.



## Infrasound Chamber

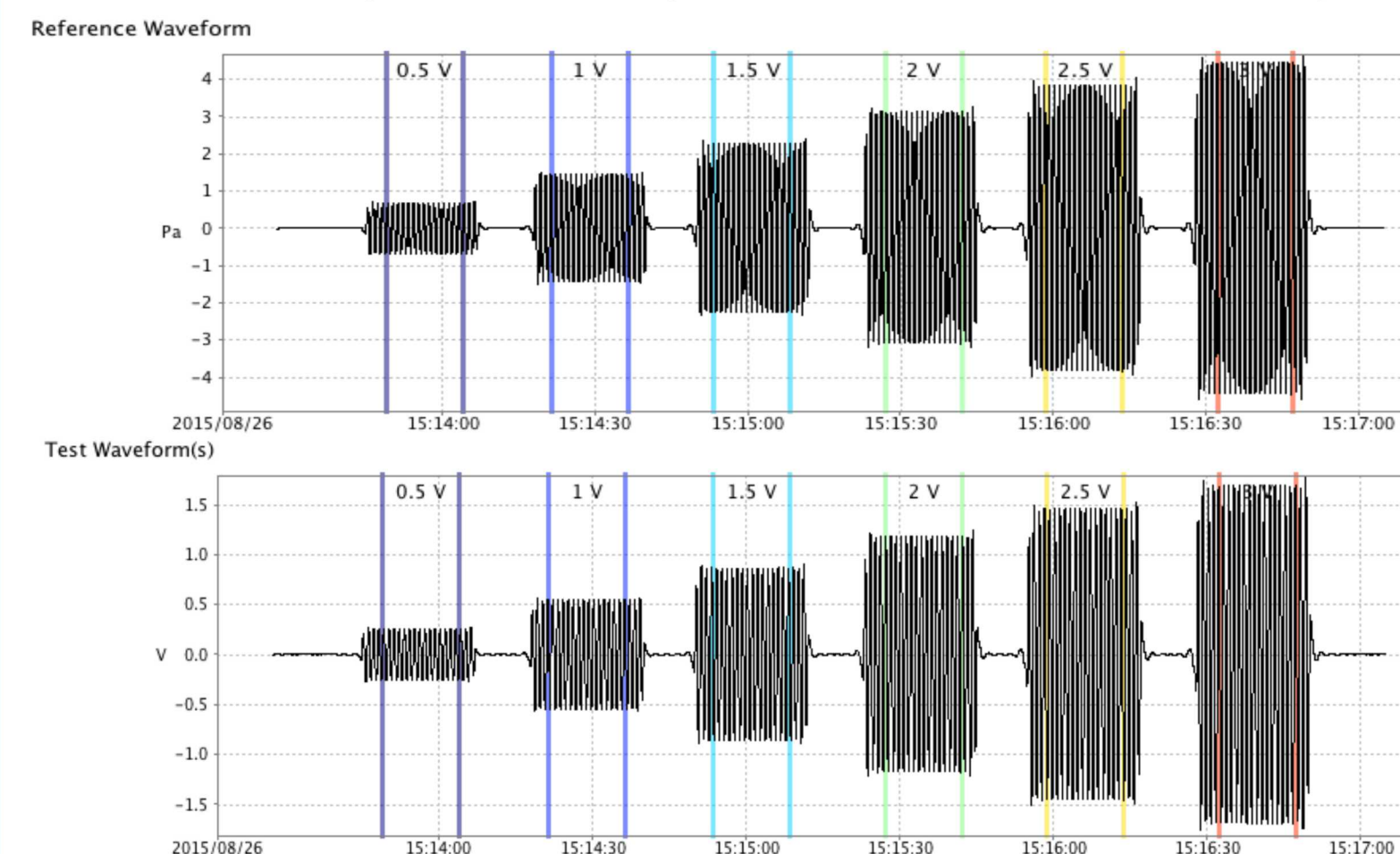
- Approximately 2 m length x 1 m diameter; interior volume ~1400 L; 2.5 cm thick steel and weighs over 1800 kg.
- Thermally stable: utilizes thermostatically-controlled heating pads to maintain 23°C.
- Ability to pressurize to sea-level conditions and evacuate to upper-atmosphere conditions.
- Two 750W, 10 inch subwoofers driven by 1000 W amplifiers and DS-360 signal generators.
- Demonstrated evaluation frequency range of 0.01 Hz – 10 Hz.
- Amplitude measurement uncertainty 4%.



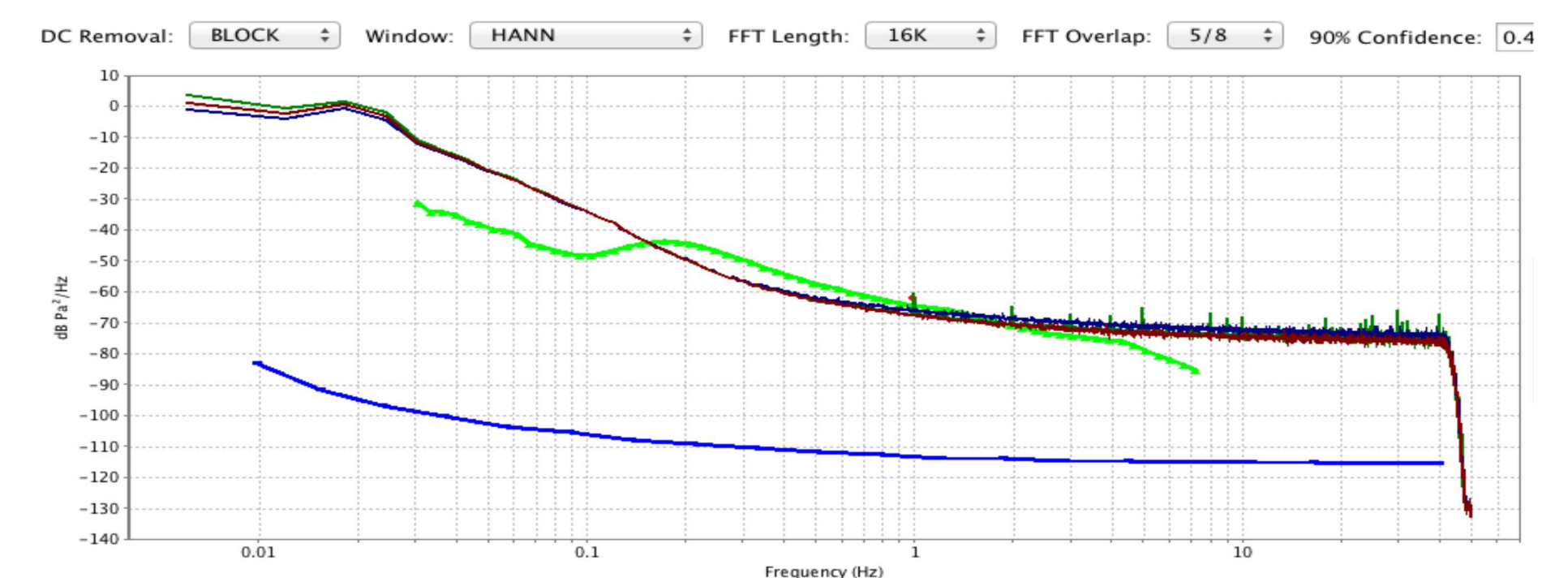
## Infrasound Characterization and Testing

- Power
- Isolation Noise
- Dynamic Range
- Amplitude Response Verification
- Phase Response Verification
- Dynamic Noise
- Seismic Sensitivity

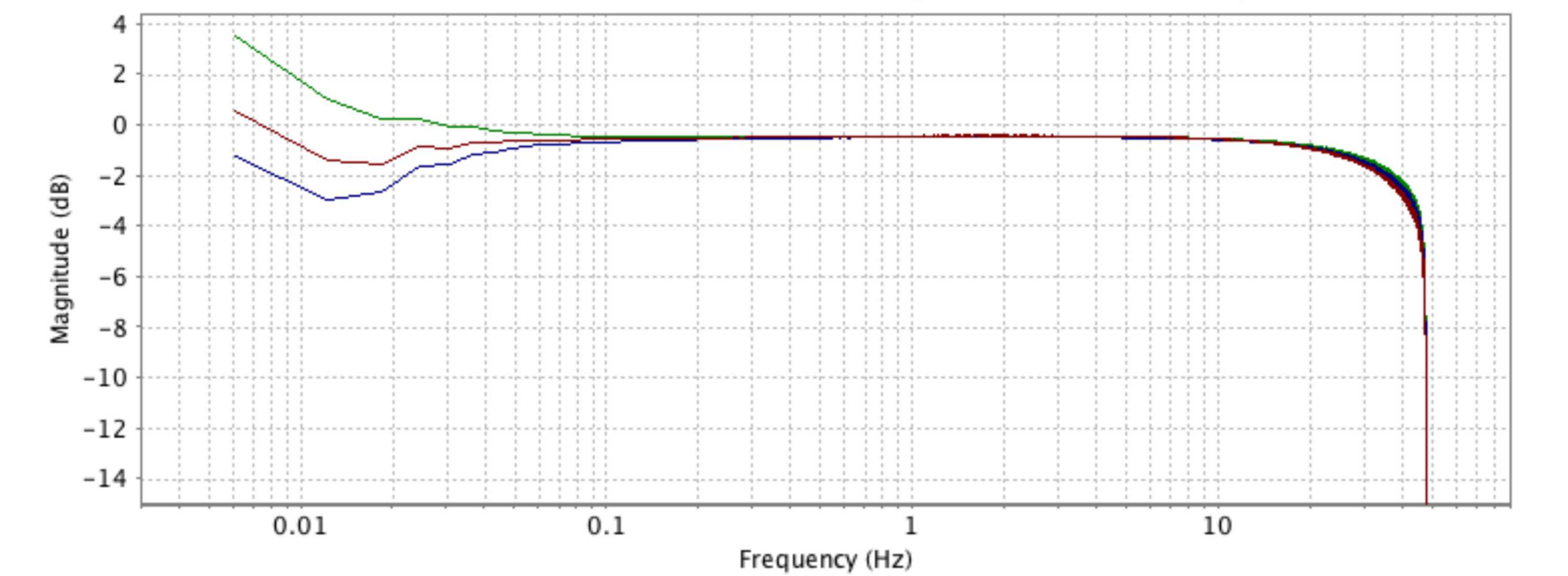
### Amplitude Response Verification Example



### Isolation Power Spectra Example

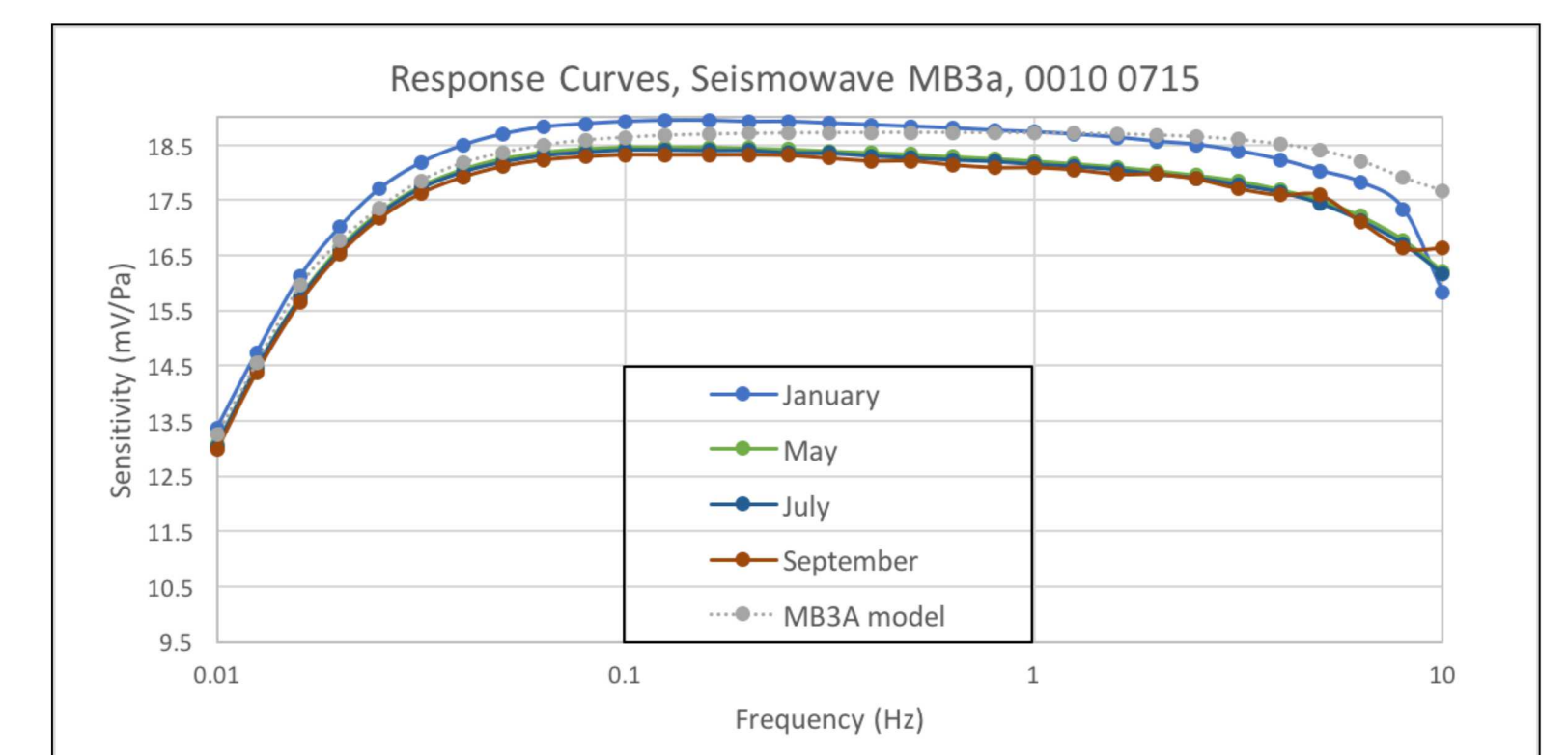
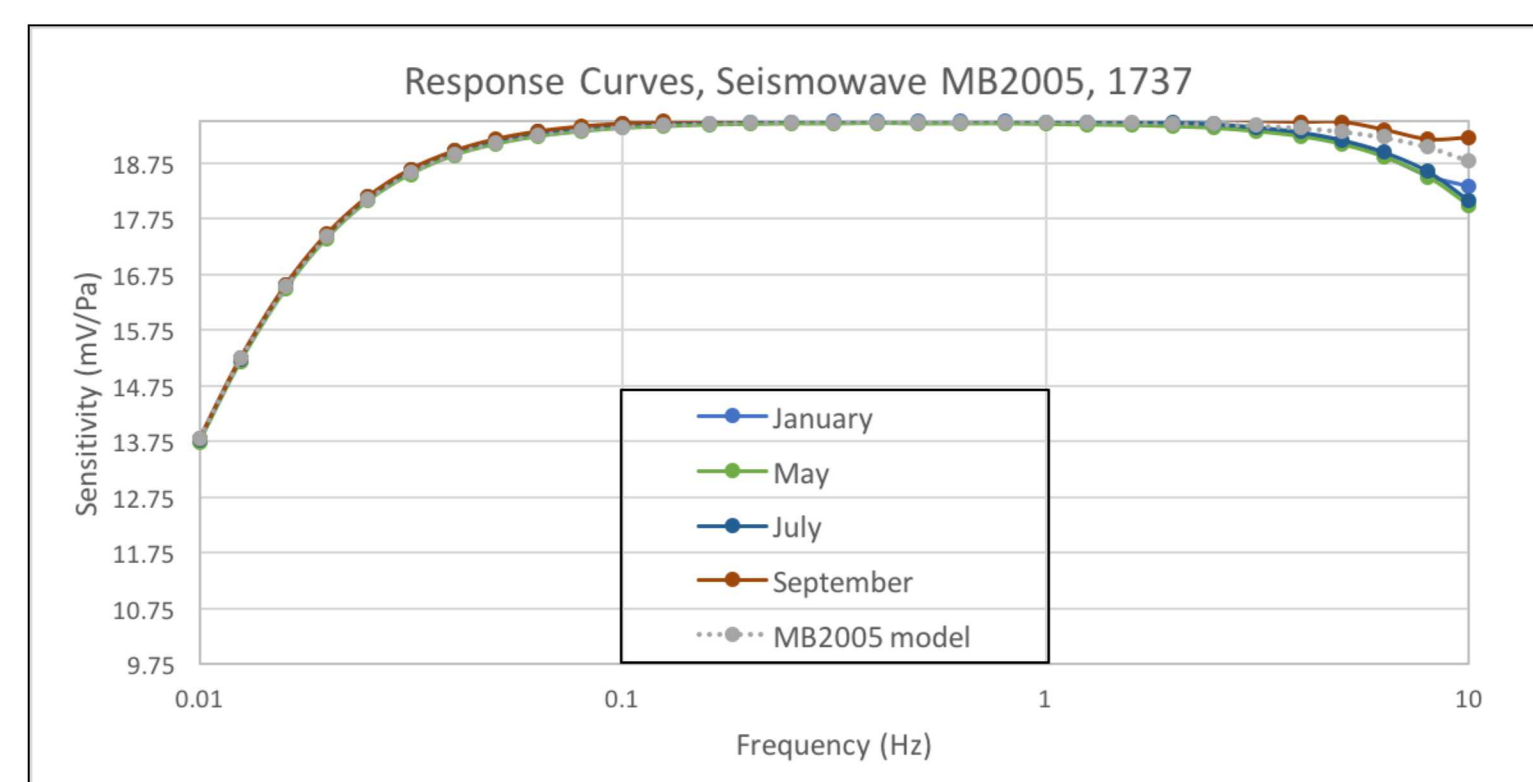
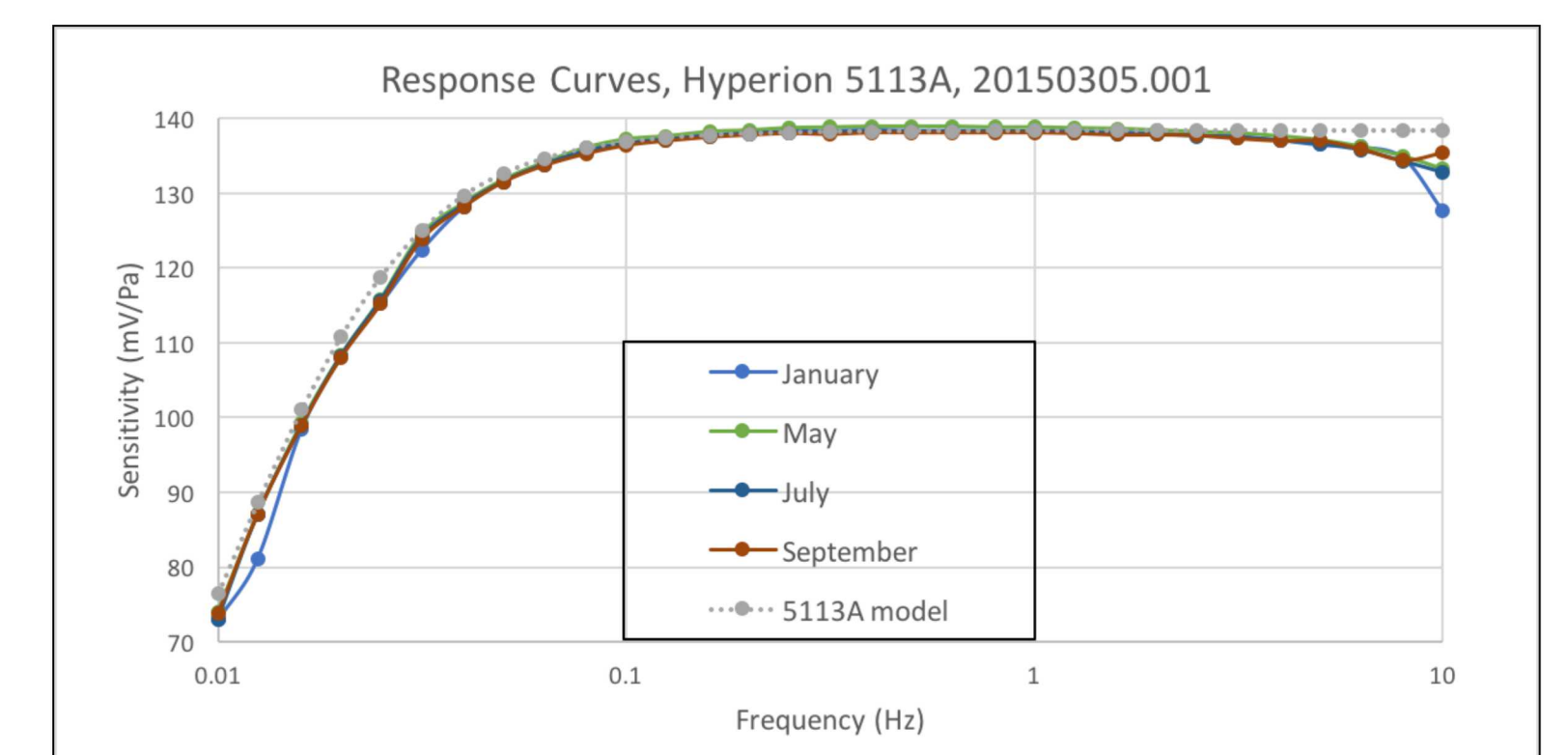
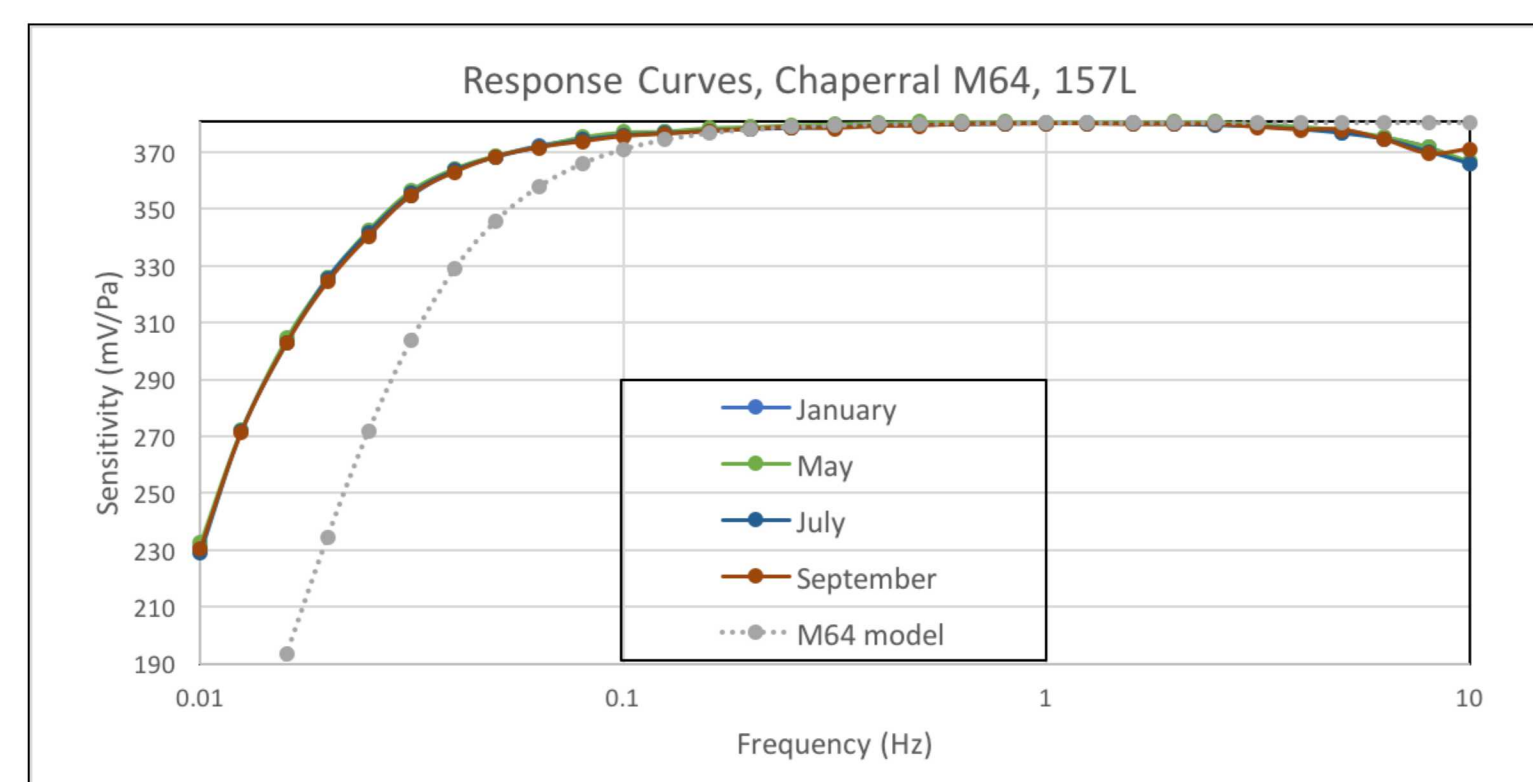
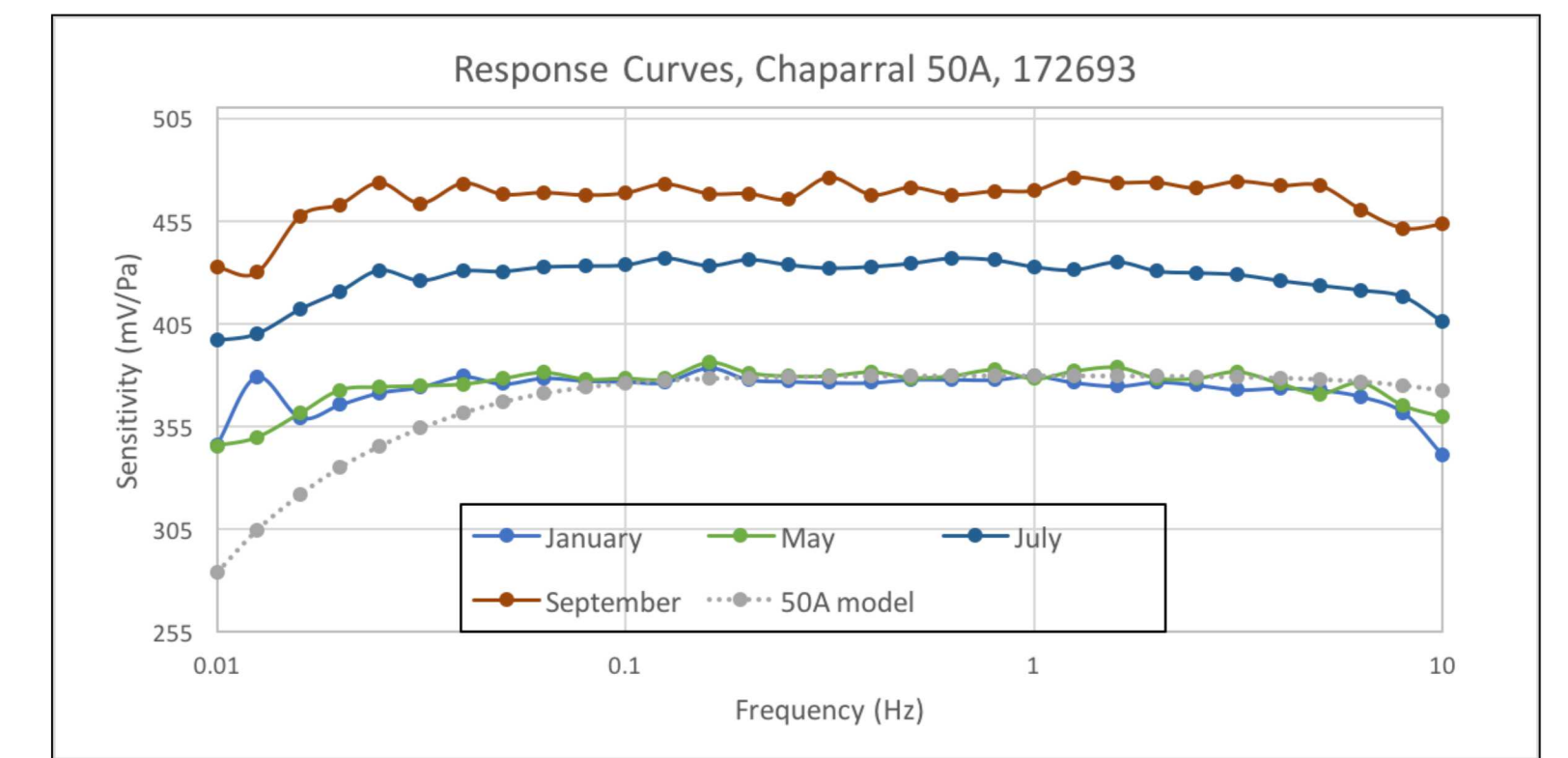


### White Noise Relative Magnitude Example



## Use Case: Preliminary Results of Sensor Calibrations over Time

- Ten infrasound sensors utilized in a long-term study have had four calibrations over the past year.
- Calibration signals: sine wave, 4 Pa - 5 Pa peak amplitude, 0.01 Hz to 10 Hz, 1/3 octave intervals.
- Sensors were sub-divided into two groups of five sensors and then calibrated simultaneously as a group. The sensors remained in the same group throughout the year.



## Future Work

- Increase amplitude of pressure signal. Goal: to attain clip level for typical sensors (~100 Pa).
- Install solenoids to allow for remotely controlled venting/sealing of the sensor back volumes while the chamber is pressurized or evacuated