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Evaluation of Experimental Hyperion Infrasound Shrouds as an Improved Means of Wind Noise Attenuation

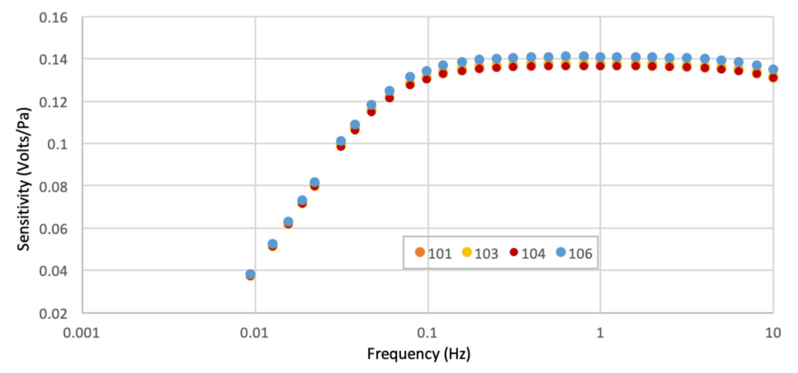
George W. Slad, B. John Merchant, Sandia National Laboratories, Albuquerque, New Mexico, U.S.A.

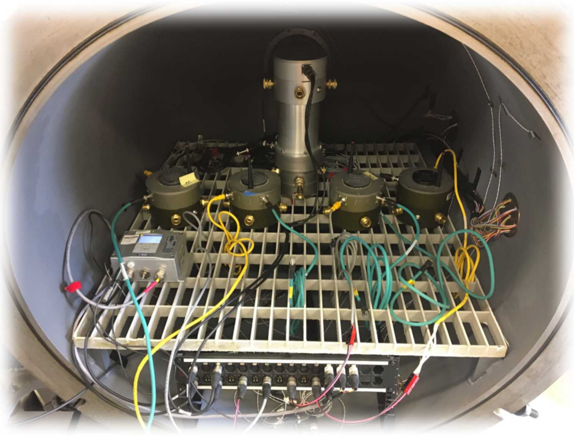
Introduction

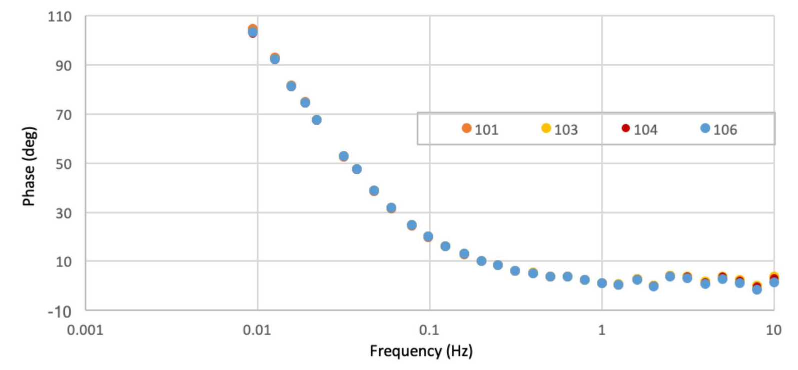
We evaluate experimental shrouds mounted on Hyperion IFS-5201W digital infrasound sensors. The experimental shrouds were designed by Doug Seastrand and Gary Walker of MSTS Inc., contractor to the National Nuclear Security Administration in Las Vegas, Nevada, as a means to further reduce wind noise. The shrouds inter-mix air pressure sampled, around the axially-symmetrical sensor body, through specially-machined plates integral to the shroud. Our evaluations take place at Sandia National Laboratories' Facility for Acceptance, Calibration and Testing (FACT) site, in Albuquerque, New Mexico, USA. Our evaluations include both laboratory acoustic isolation chamber tests and field tests. The acoustic isolation chamber tests utilize a MB2005 infrasound sensor as a reference throughout the evaluation process while ambient conditions, such as temperature, pressure and relative humidity are held nearly constant. These tests sample frequencies over the International Monitoring System (IMS) infrasound passband (0.02 Hz to 4 Hz) as a means to compare the instrument response of the sensors utilizing the experimental shrouds to that of a sensor with the standard open-port shroud. The field tests compare in-situ data collected from sensors utilizing the experimental shrouds with data collected from a sensor mounted with a standard open-port Hyperion shroud. We present preliminary results of these evaluations.

Hyperion IFS-5201W - Establishing a Base Line Response

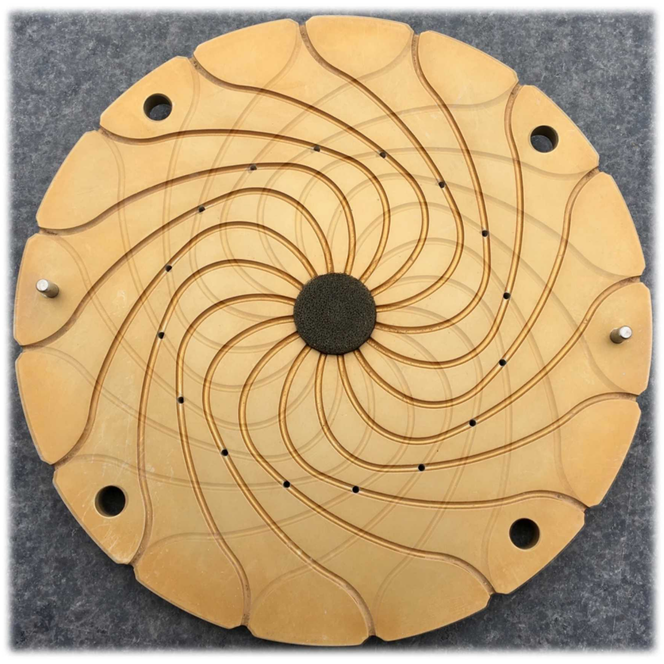
- Individual sensitivities for each sensor are measured with an open-port shroud configuration as a baseline against which other shroud responses are compared.
- Integrated sensor and datalogger configured with a 250 Hz sampling rate.
- Base line amplitude and phase calibrations, at 1 Hz, conducted with standard, open-port shroud.
- Reference signal: 5 Pa, 1/3 octave frequency intervals from 100 s to 10 Hz.





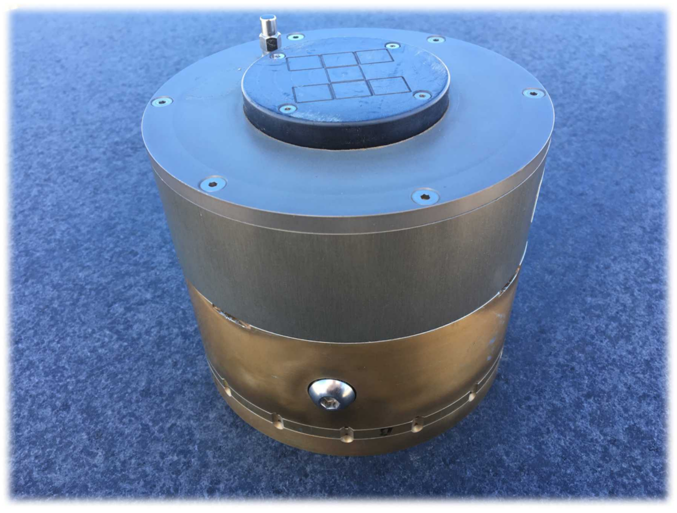


Experimental Shrouds – the Concept



Transparent image of the bottom surface superimposed on the photo to illustrate the tubule geometry of the bottom surface and inter-connected tubules.

- Continuously flowing wind creates a slight increase in pressure on the windward side of sensor.
- Wind flowing by the sensor, at a 90° position relative to the wind direction, creates a slight decrease in pressure (Bernoulli's Principle)
- The foam filled central port allows air pressure changes, due to wind flow, to intermix, effectively reducing the amplitudes of pressure changes due to steady state wind.
- The machined grooves in the plate (left), known as tubules, direct airflow into the central chamber, allowing intermixing of air.
- In a second set of shrouds, tubules on the bottom surface of the plate are inter-connected to tubules on the top of the plate which are azimuthally separated by 90 deg.



Shrouds Evaluated

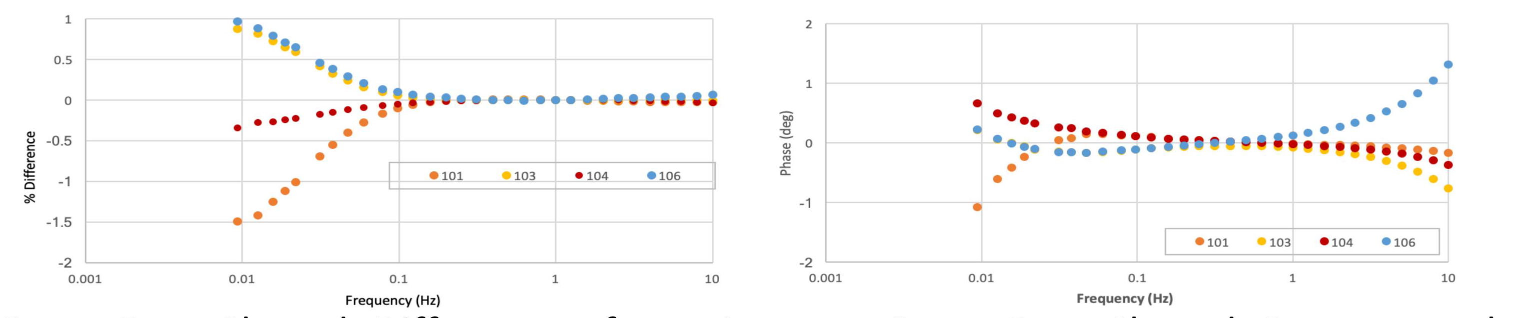
Small sensor port isolated tubules

Large sensor port isolated tubules

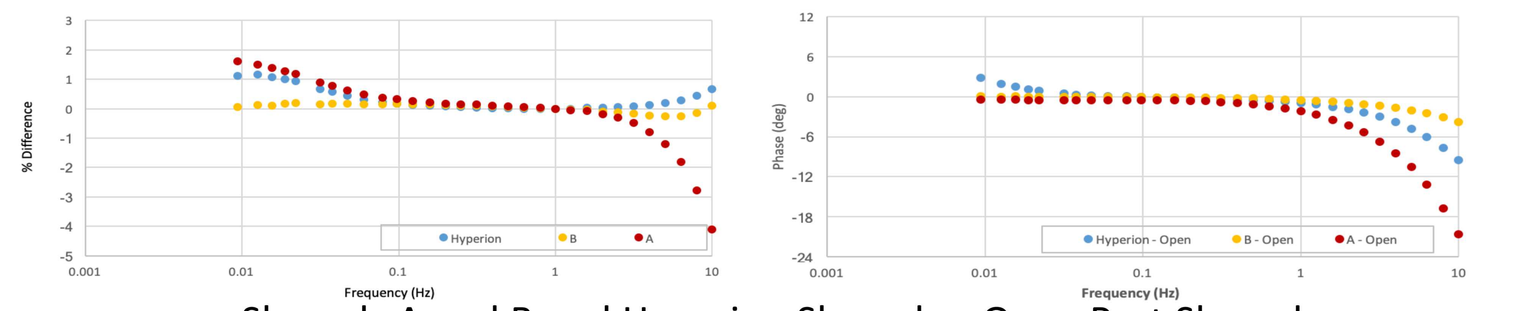
Small sensor port inter-connected tubules

Large sensor port inter-connected tubules

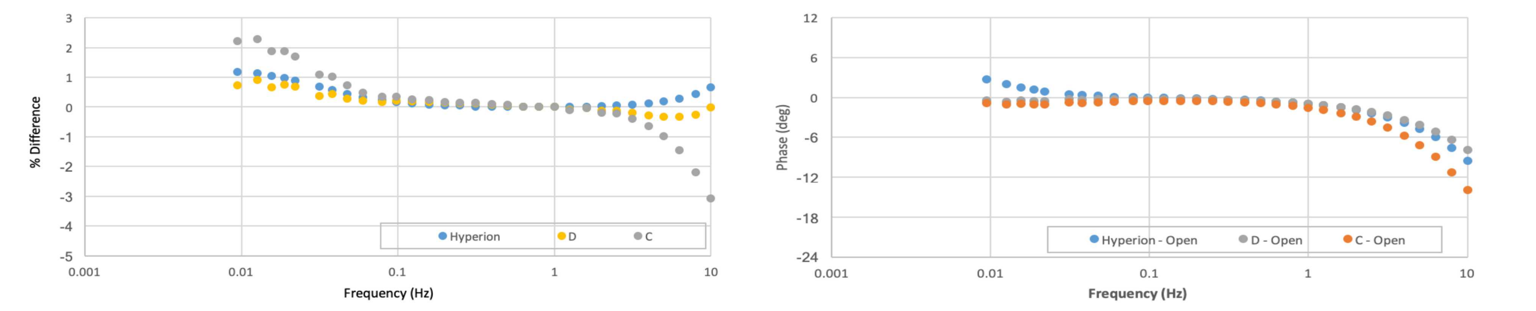
Chamber Testing (all amplitude responses normalized at 1 Hz)



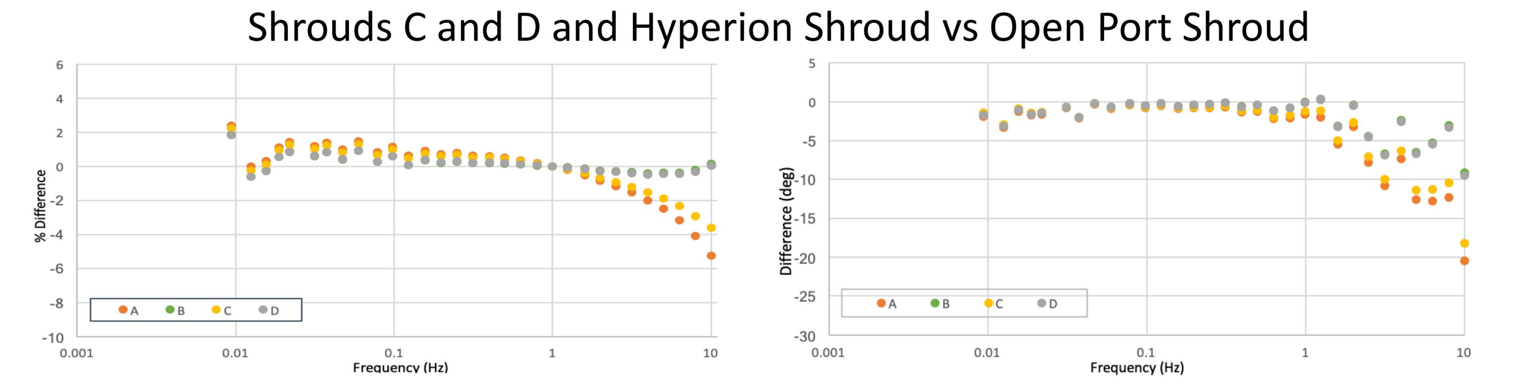
Open Port Shroud Differences from Average Open Port Shroud Response: the aforementioned base-line testing illustrates the subtle differences in individual sensors from the average base-line response (almost within 1% the uncertainty of these amplitude measurements).



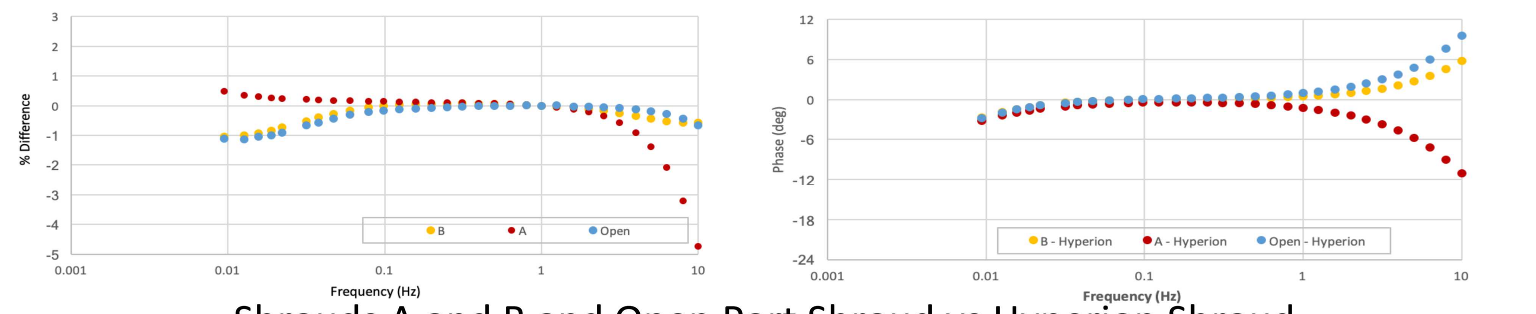
Shrouds A and B and Hyperion Shroud vs Open Port Shroud



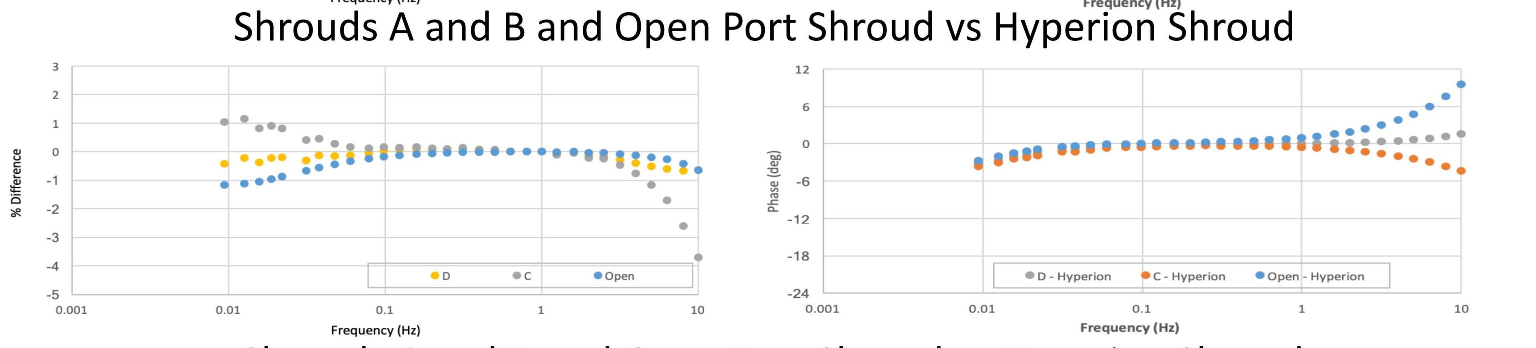
Shrouds C and D and Hyperion Shroud vs Open Port Shroud



Average Shroud Difference from Base-line Open Port Response; Shrouds Rotated Amongst all Sensors (No Open Port Sensor Included During Testing)

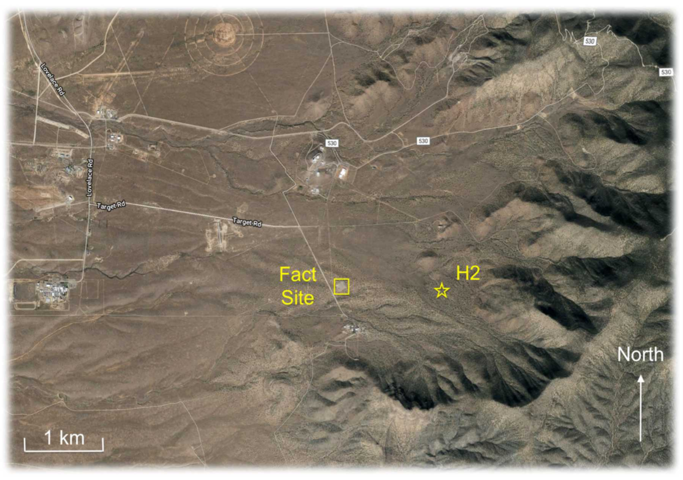


Shrouds A and B and Open Port Shroud vs Hyperion Shroud



Shrouds C and D and Open Port Shroud vs Hyperion Shroud

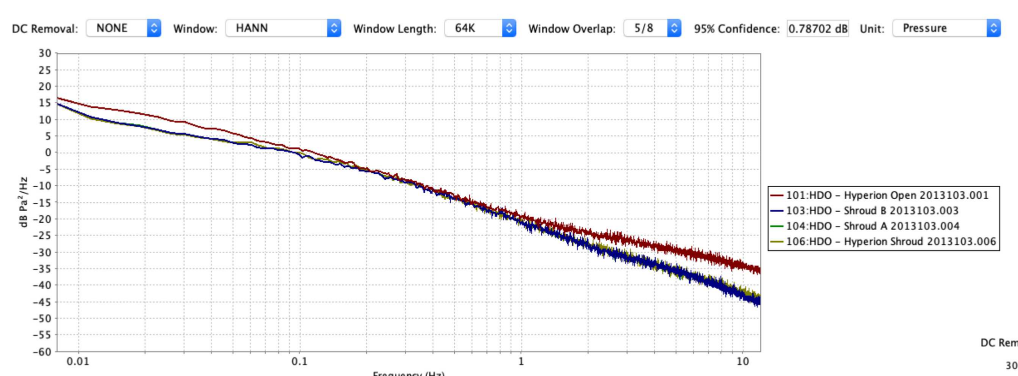
Field Testing



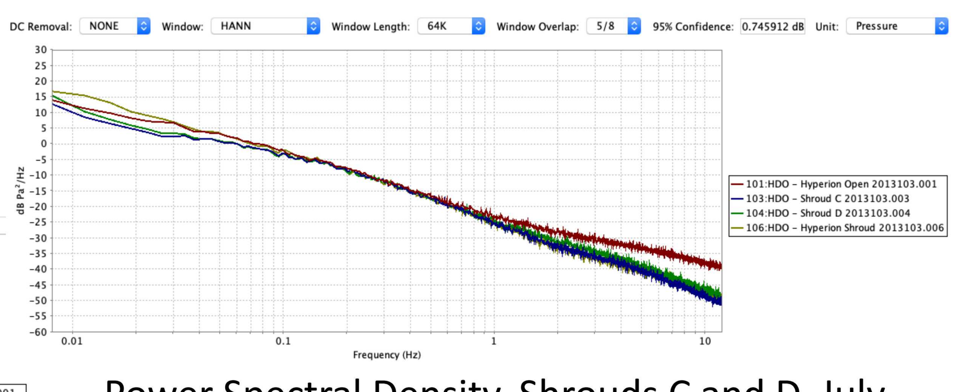
Site H2, of the Sandia/NACT Infrasound Testing Array, 1.5 km east of the FACT site, hosted the shroud field tests.

The site surface is composed predominantly of alluvial sand and rock and covered with pinion and juniper vegetation, and more sparsely with desert grasses.

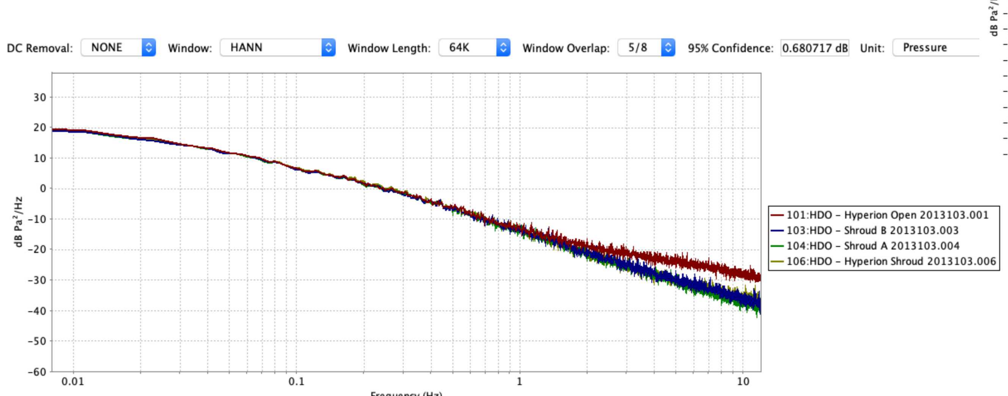
The sensors were placed upon concrete patio blocks rather than directly on the sand, to minimize the exposure of the orifices to possible contamination in the event rains splash surrounding sand, and finer soil particles, on to the shrouds, partially or completely blocking the orifices and potentially changing the shrouds' response.



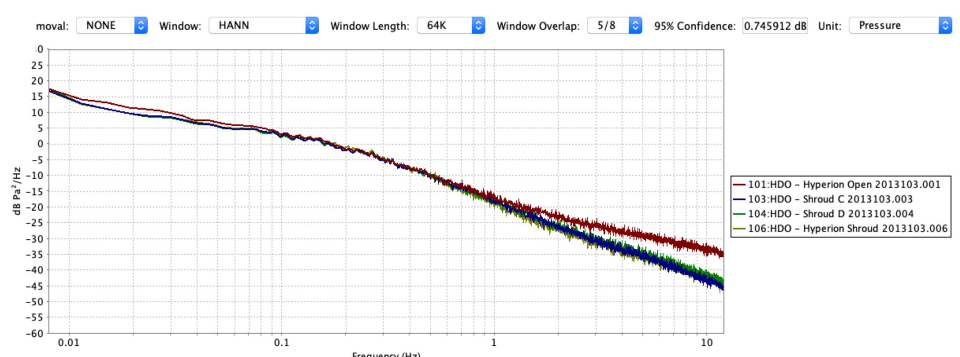
Power Spectral Density, Shrouds A and B, July 15, 2019



Power Spectral Density, Shrouds C and D, July 28, 2019



Power Spectral Density, Shrouds A and B, July 20, 2019



Power Spectral Density, Shrouds C and D, July 31, 2019

- Time periods of significant wind activity selected for PSD plots to focus on the potential wind reduction ability of the experimental shrouds
- While there are modest variations in power levels at low frequencies (< 0.1 Hz), all of the shrouds provide a reduction signal power above 1 Hz to 1.5 Hz.
- At 10 Hz the all shrouds provide approximately 7-8 dB of wind noise reduction over the open port shroud; over the Hyperion shroud, the experimental shrouds perhaps reduce noise 1 dB to 4 dB, though there is significant variation in the observations.

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