

Development of a Weather Robust Microphone Configuration for Sonic Boom Measurements

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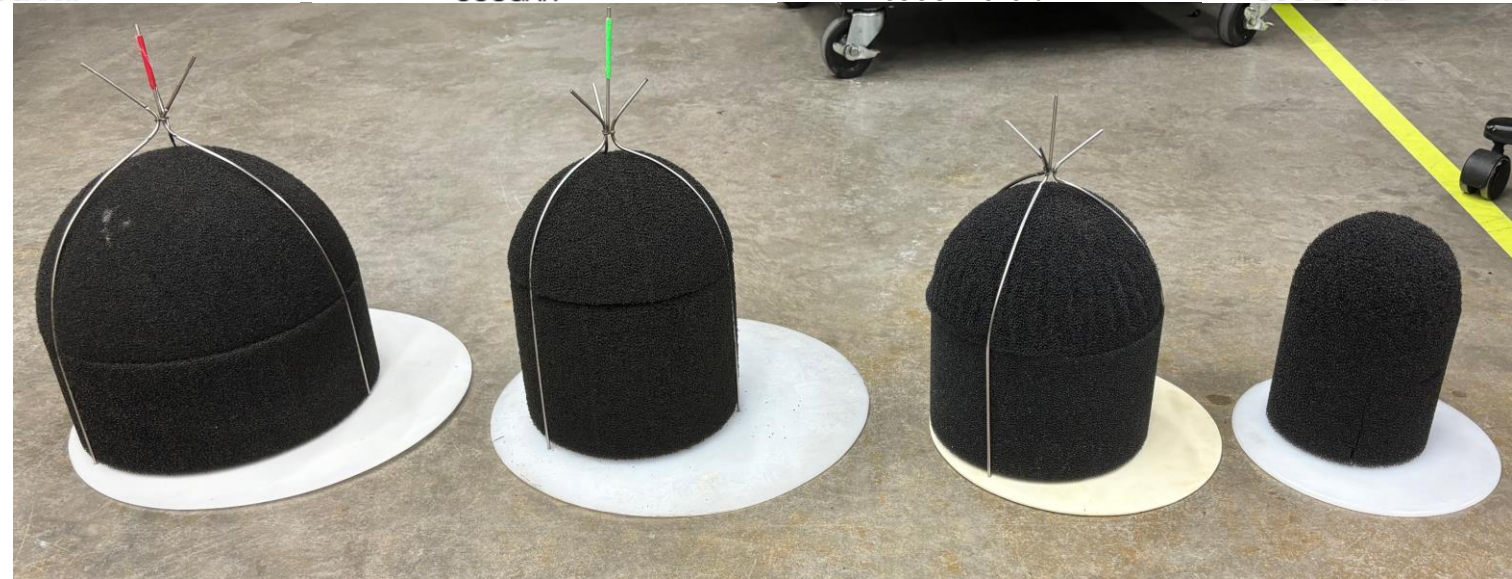
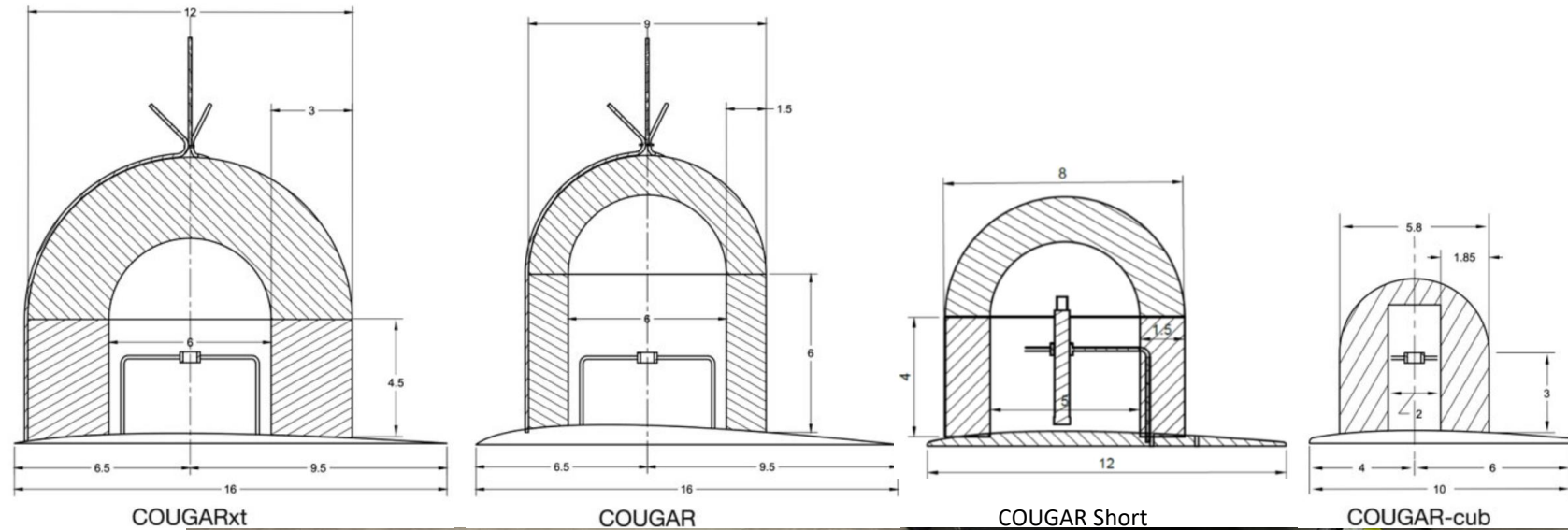
Relevance



- **NASA's Purpose: Quiet supersonic travel**
- **Our Objective: Aid in accurate sonic boom data collection and analysis**
- **Need a weather-robust system for outdoor measurements**

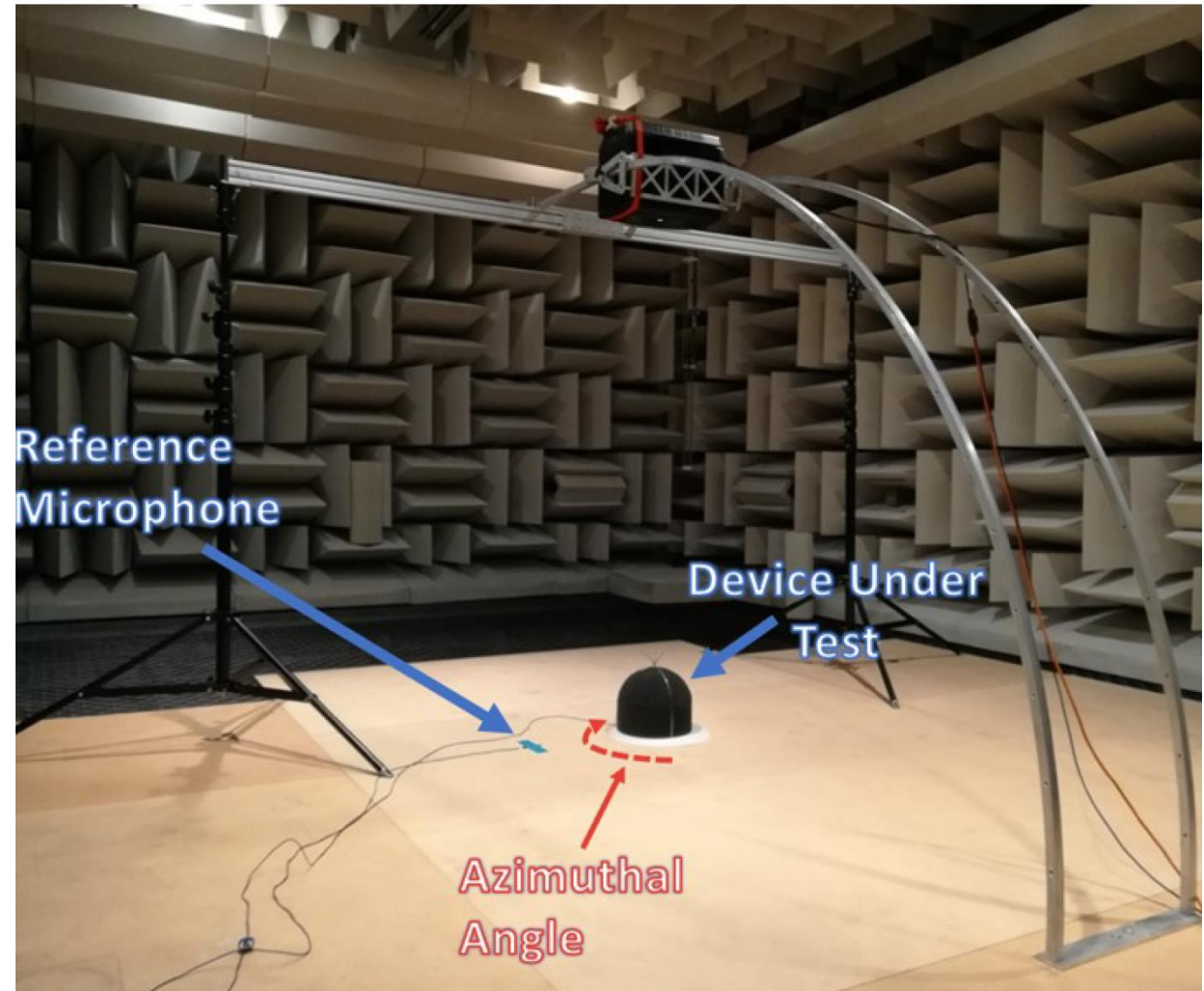
Our Solution

- Compact Outdoor Unit for Ground-based Acoustical Recordings (COUGAR)
- Compact, robust, and functional for NASA
- COUGAR XT, COUGAR, COUGAR Short, and COUGARcub



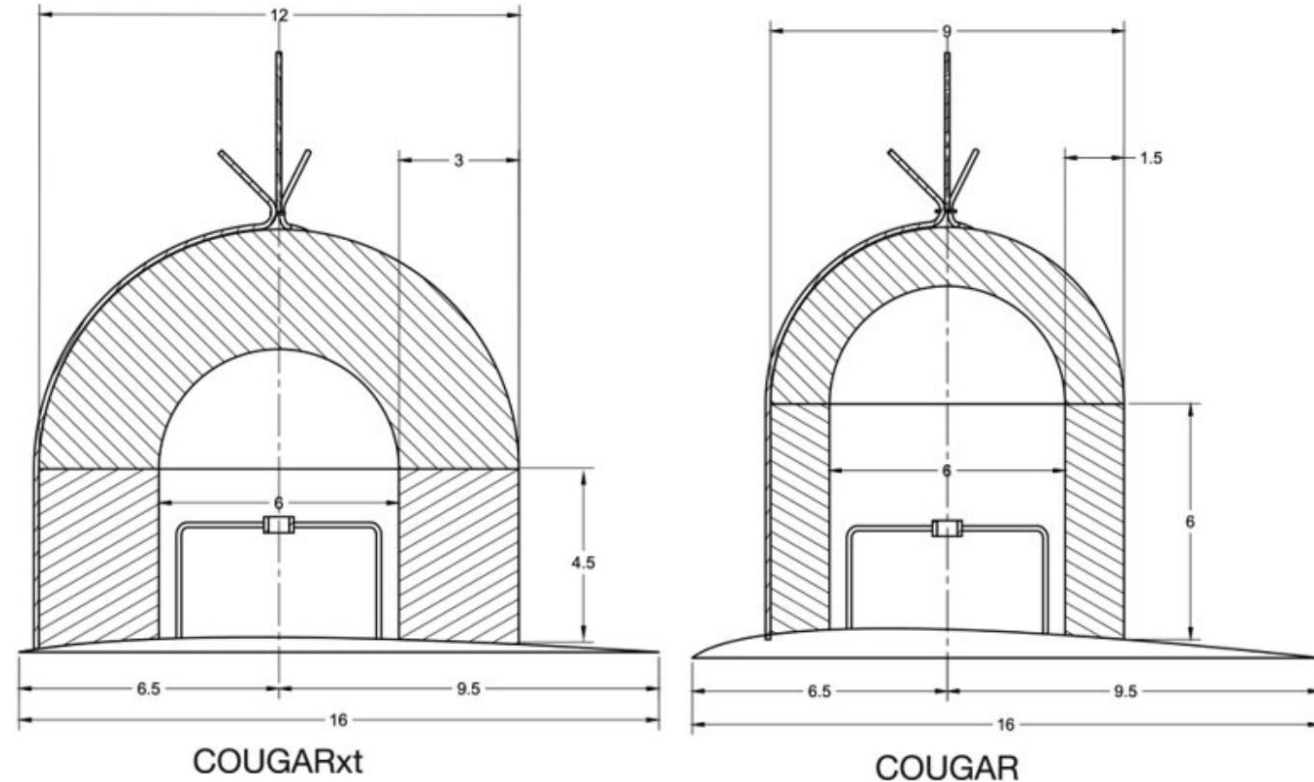
Previous Research and Methods

- COUGAR was tested in BYU's anechoic chamber
- The ARC was designed to alter the elevation angle of incoming sound signal to the COUGAR
- The effects of the plate, windscreen, elevation angle, and azimuthal angle have all been tested, and the COUGAR has compared favorably to a baseline (1/4" microphone) measurement



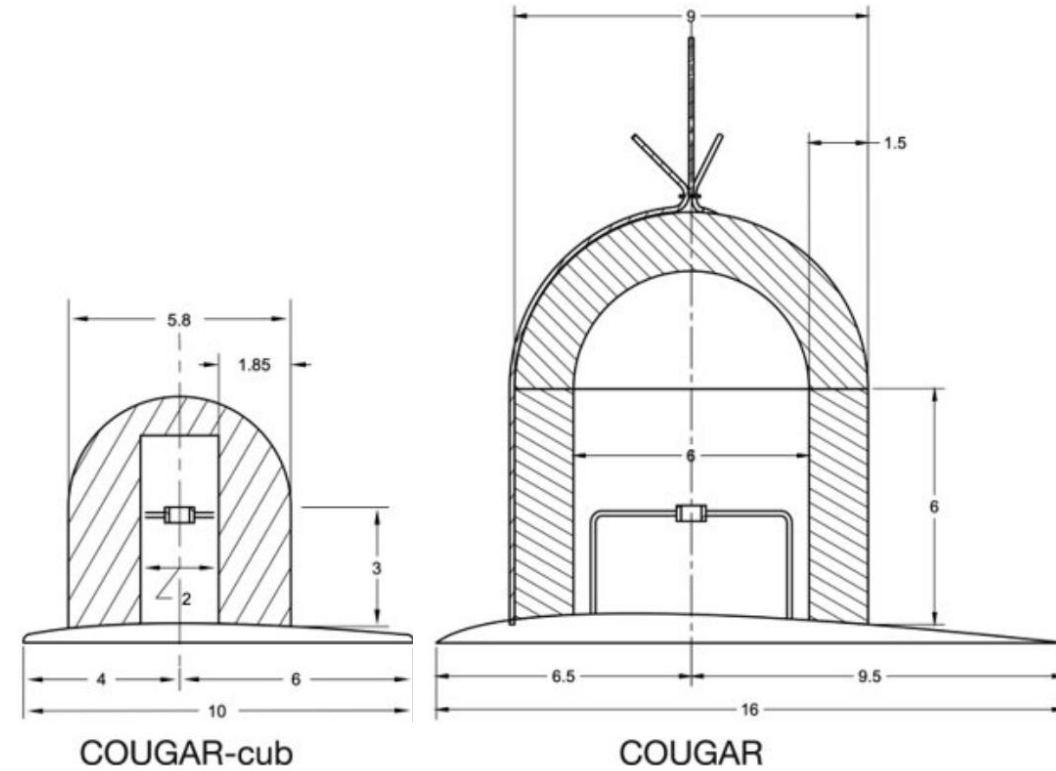
Evolution of the COUGAR: COUGARxt

- Our team has always worked towards improving the COUGAR. First with the COUGARxt:
 - 3" Windscreen (twice as thick)
 - Better wind noise rejection
 - Plate half as thick
 - Reduce Plate Effects
 - Shortcomings:
 - Plate breaks after sun exposure
 - Very large



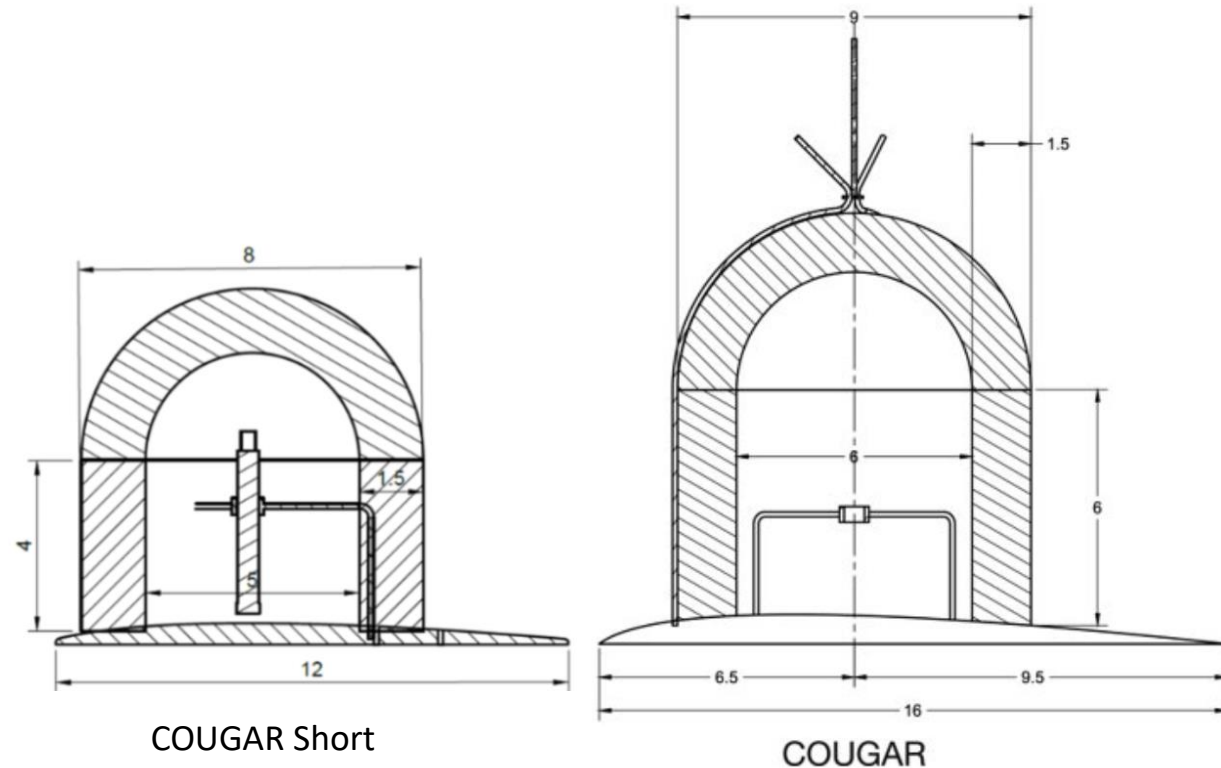
Evolution of the COUGAR: COUGARcub

- COUGARcub was made to see how small the COUGAR could be made, while remaining functional
 - Slightly thicker windscreen (1.85")
 - Much smaller ground plate (10")
 - Shortcomings:
 - Significant plate effects
 - Windscreen does not stay flush with ground plate



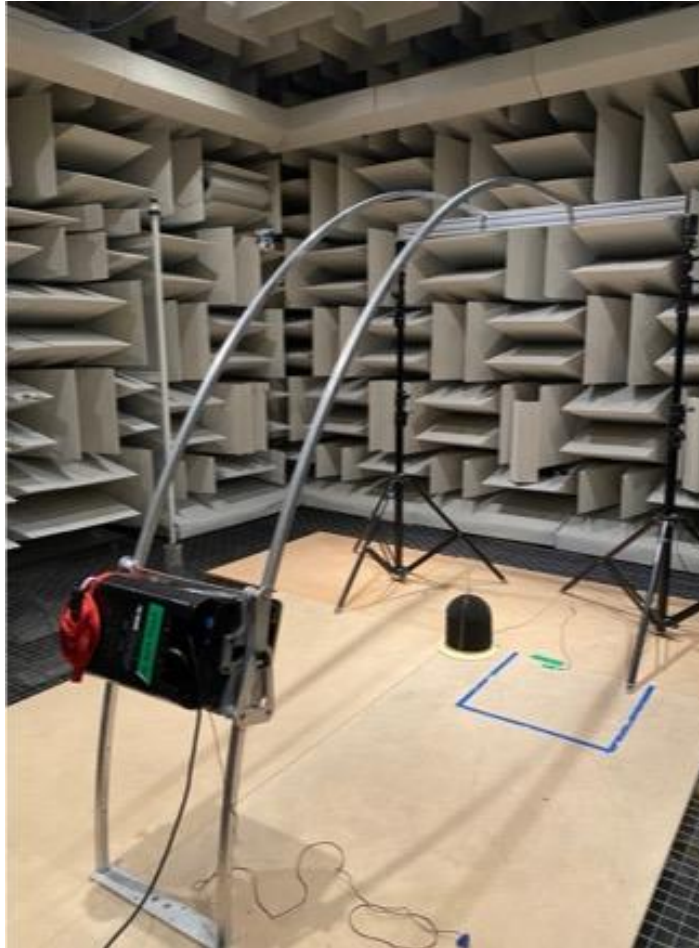
Evolution of the COUGAR: COUGAR Short

- An attempt at ideal height, and finding a new ground plate material
 - More compact
 - Plate smaller by 6"
 - Windscreen shorter by 1"
 - New plate material does not warp in the sun
 - Cheaper and quicker to manufacture (casting)
- Leading to the COUGAR Gold(locks)



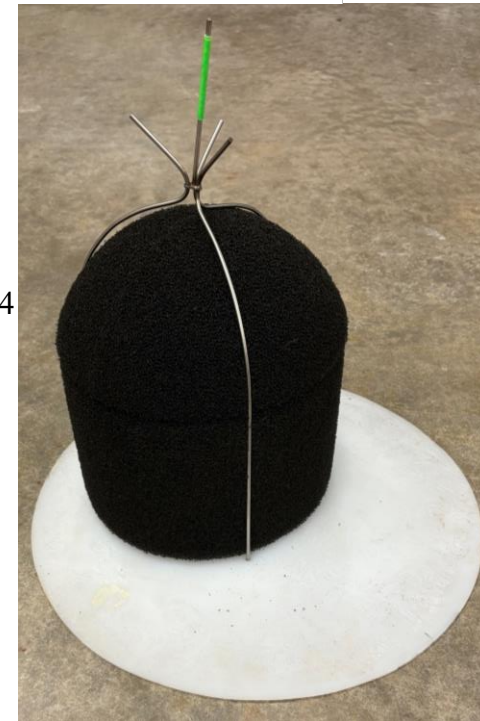
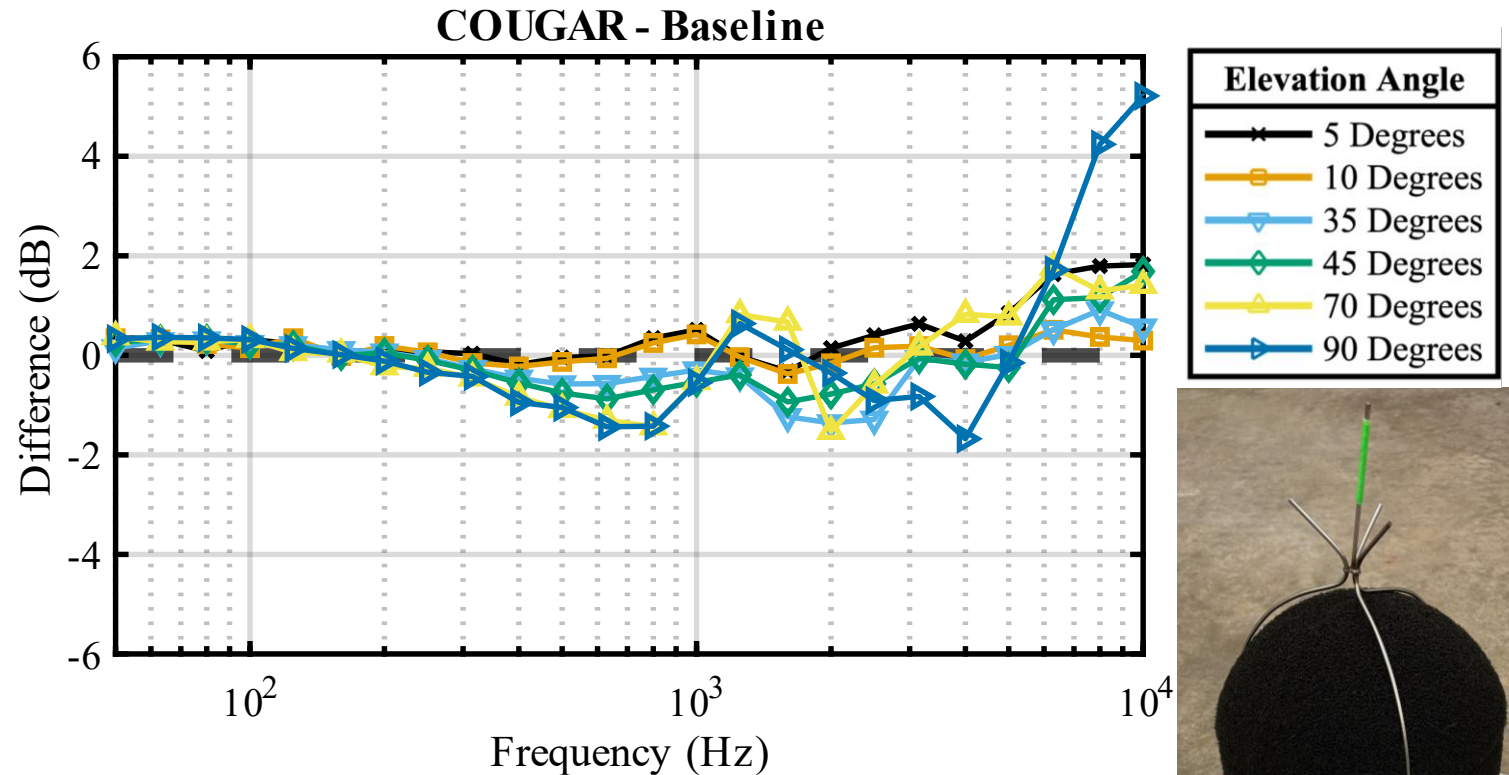
Latest Research

- For the first time, we began performing ARC measurements outdoors over grass and concrete
- Baseline is a 1/4" pressure microphone taped to the ground perpendicular to the source



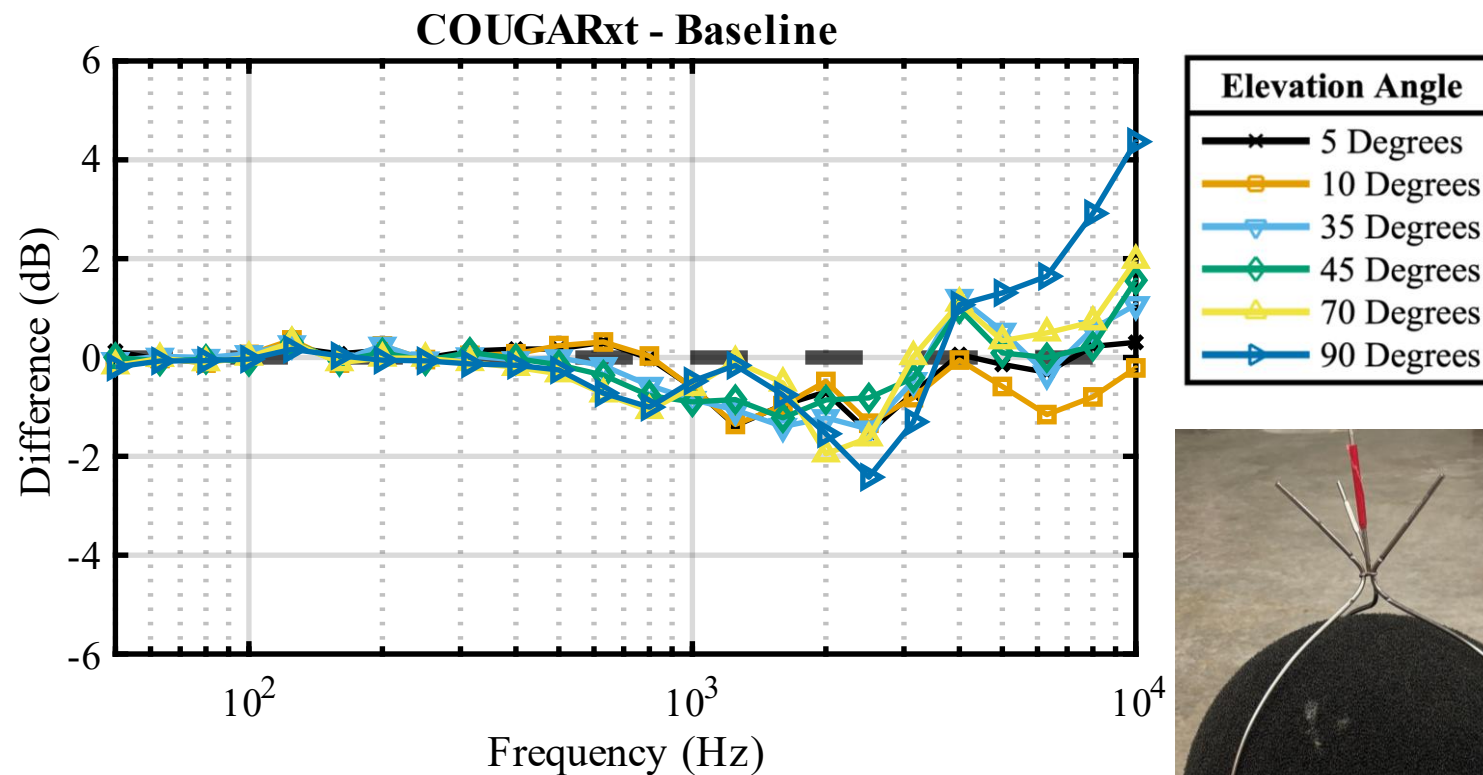
Anechoic Comparison: COUGAR re Baseline

- These graphs are anechoic chamber results, spectra from a baseline taken and subtracted from the spectra of each measurement
- We need the COUGARs to be functional within ± 2 dB up to 10 kHz



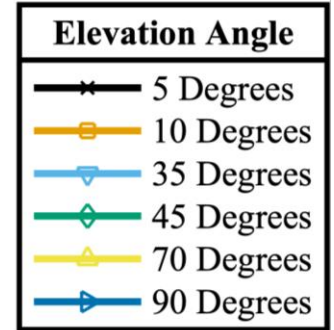
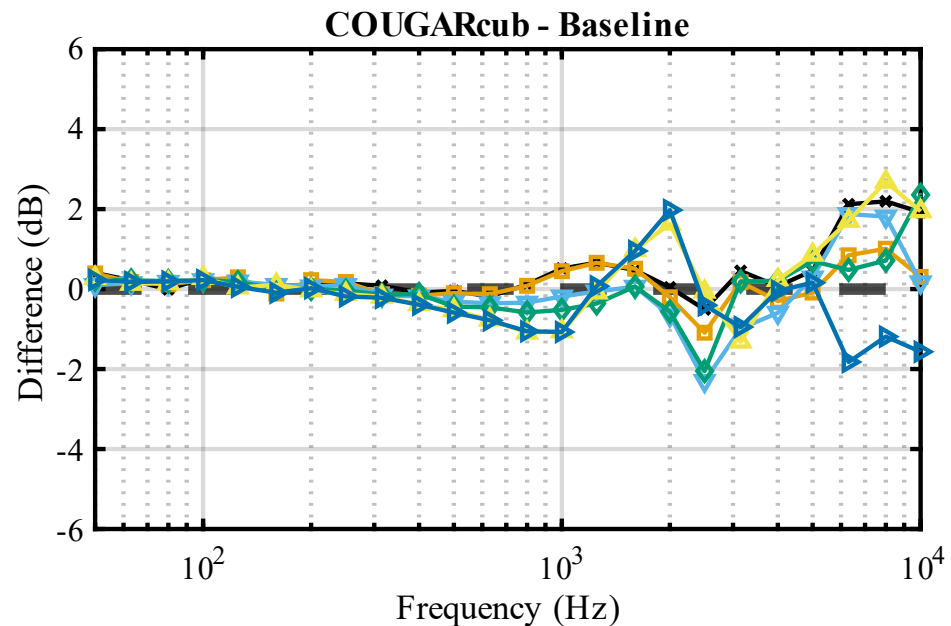
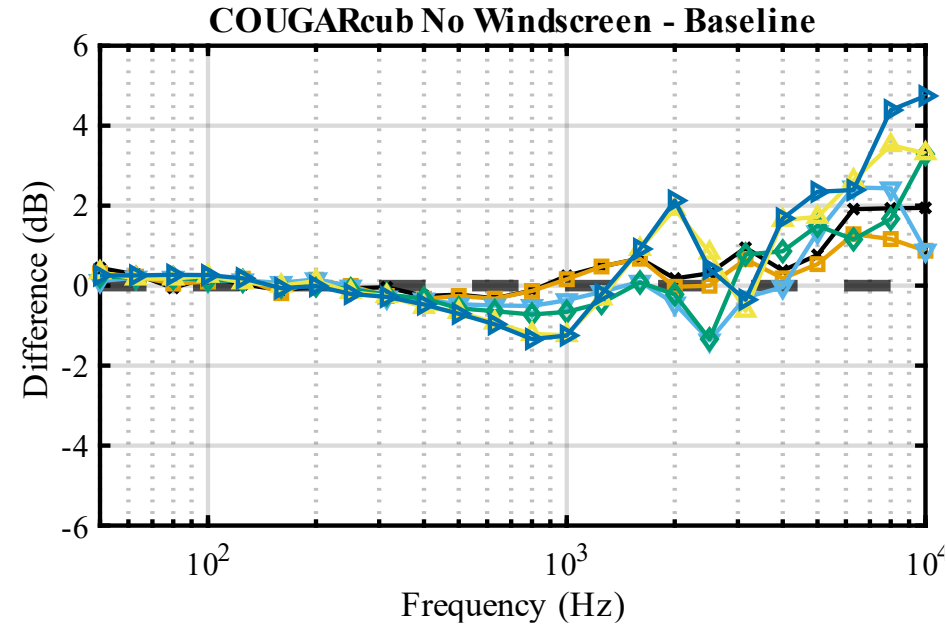
Results Indoors: COUGARxt re Baseline

- Ground plate half as thick
- Windscreen twice as thick
- Performs just as well as COUGAR



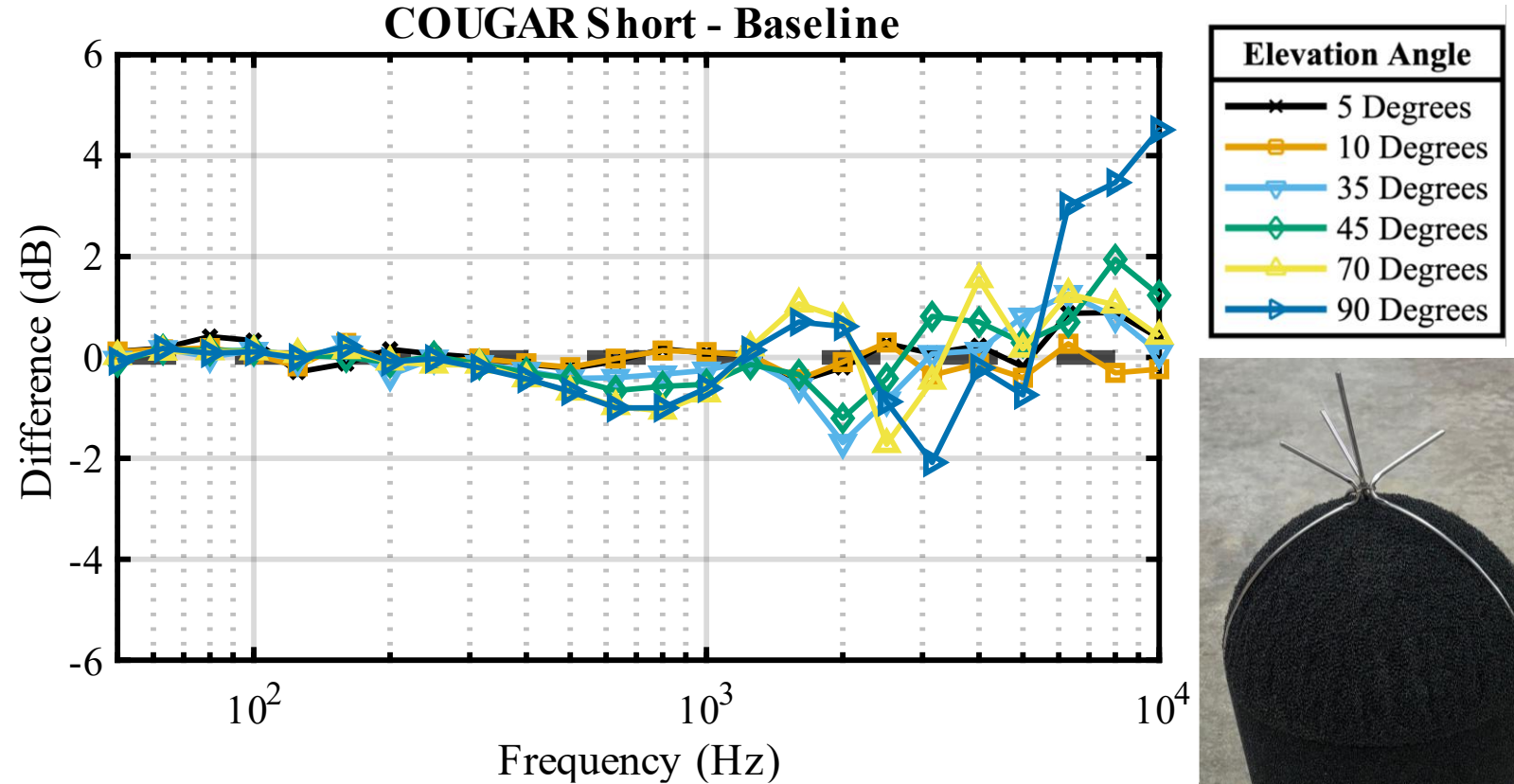
Results Indoors: COUGARcub re Baseline

- The COUGARcub works well at lower frequencies, however at higher frequencies there appears to be some noise that is not present in the baseline



Results Indoors: COUGAR Short re Baseline

- COUGAR Short performs on par with COUGAR, which means the smaller plate size is not an issue like it is for COUGARcub
- COUGARcub has 10" plate
- COUGAR Short has 12" plate

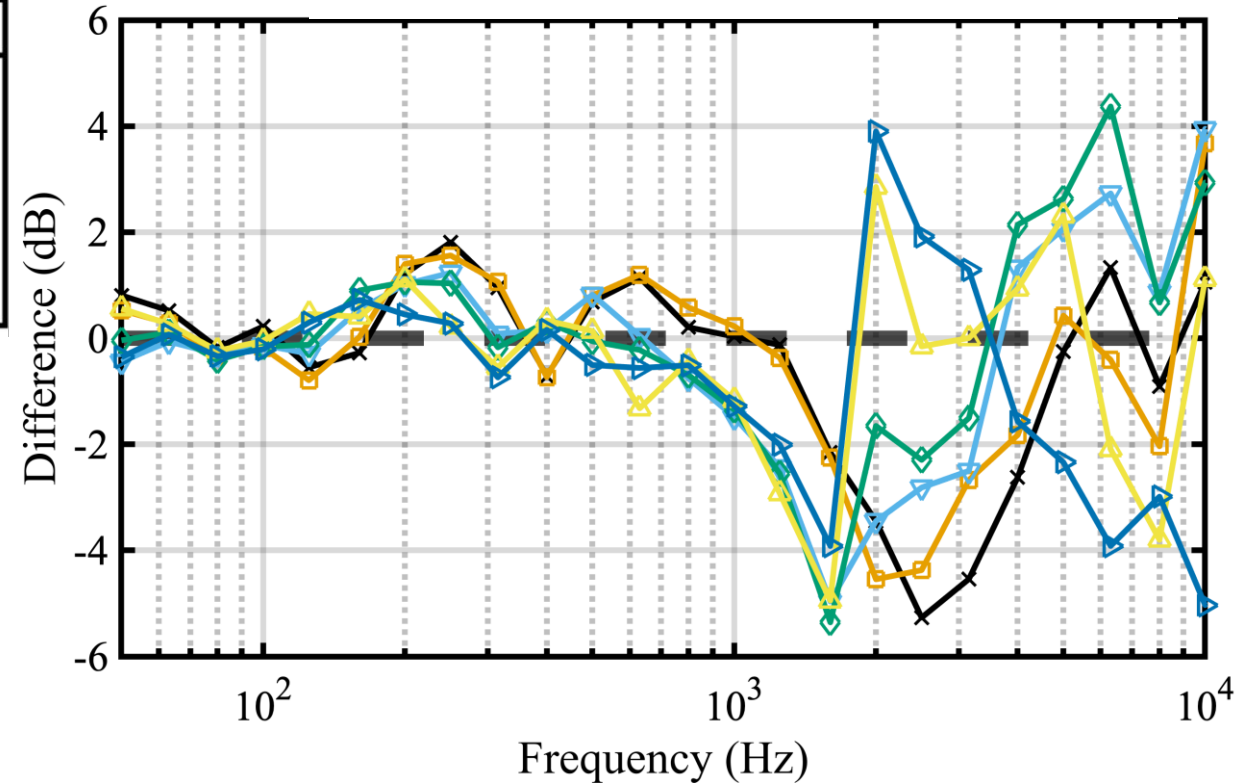
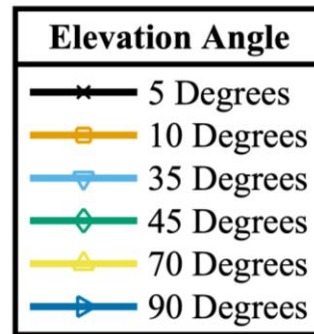


Results: Outdoor Terrains Baseline Issue

- When taking the baselines for outdoor measurements, the microphone was placed directly in grass, dirt, and concrete
- This figure shows a grass baseline re anechoic baseline
- This results in a lot of variability

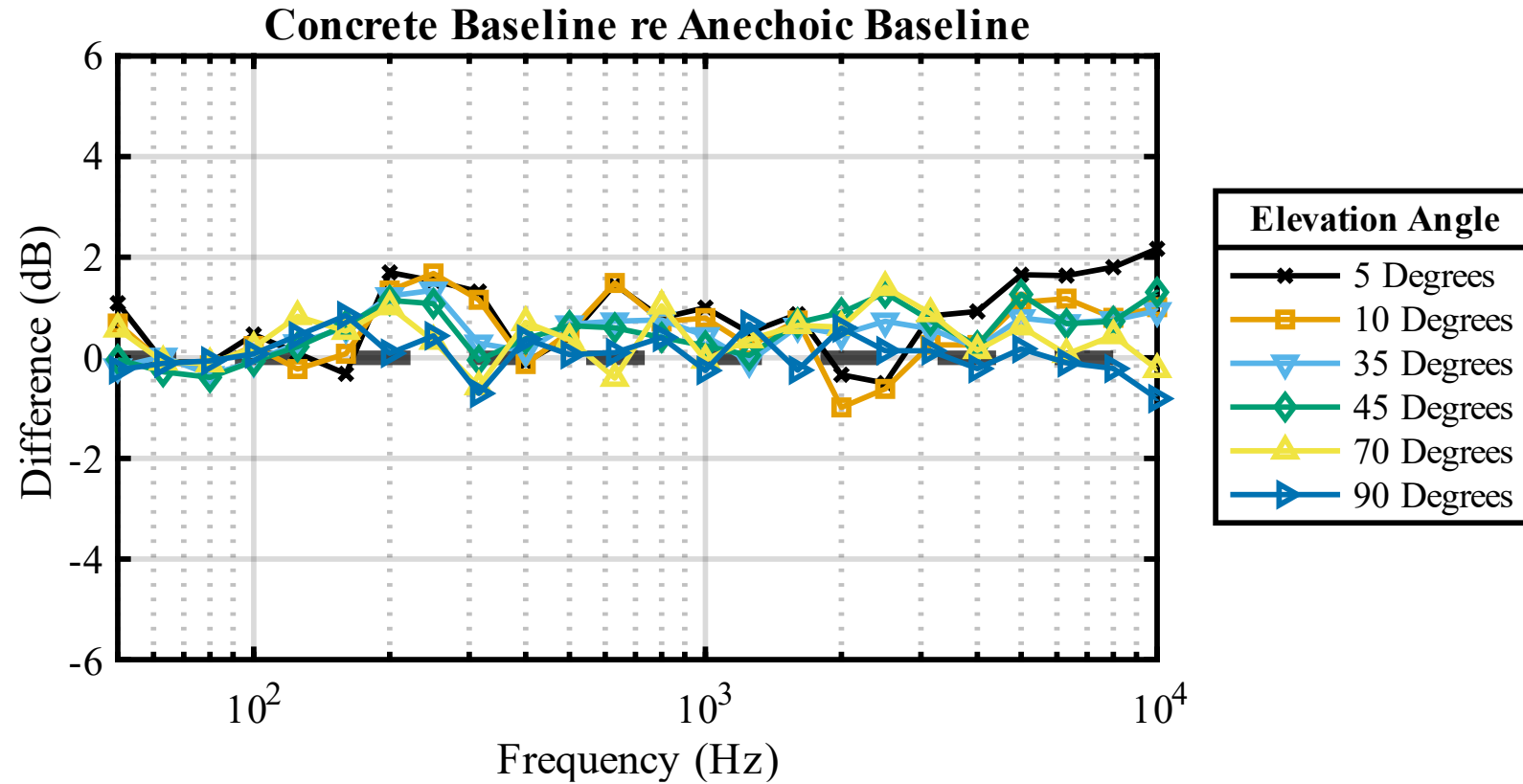


Grass Baseline re Anechoic Baseline



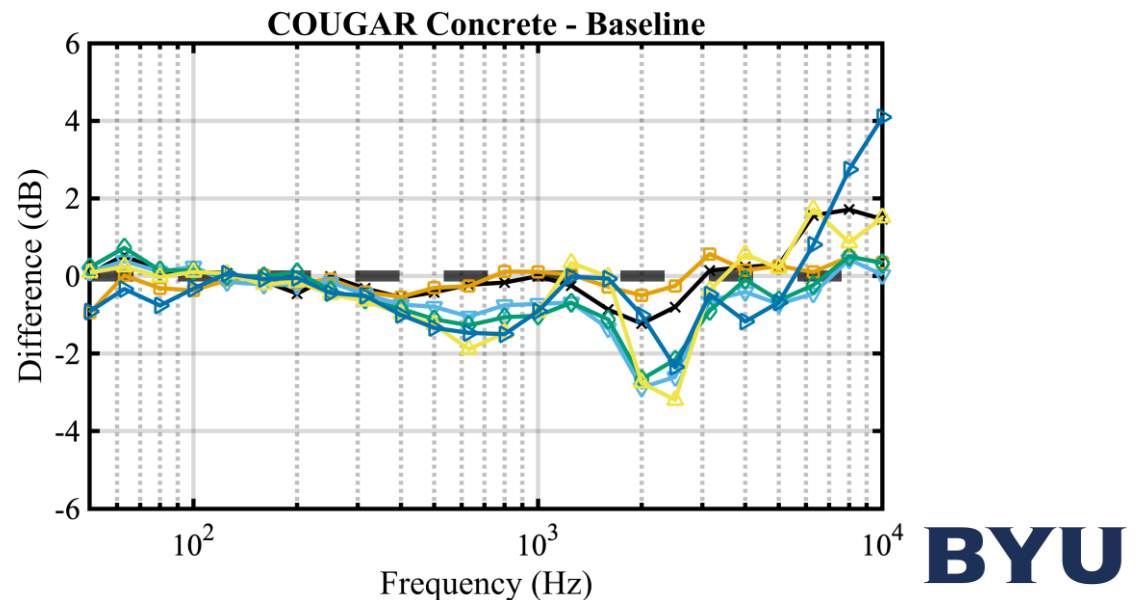
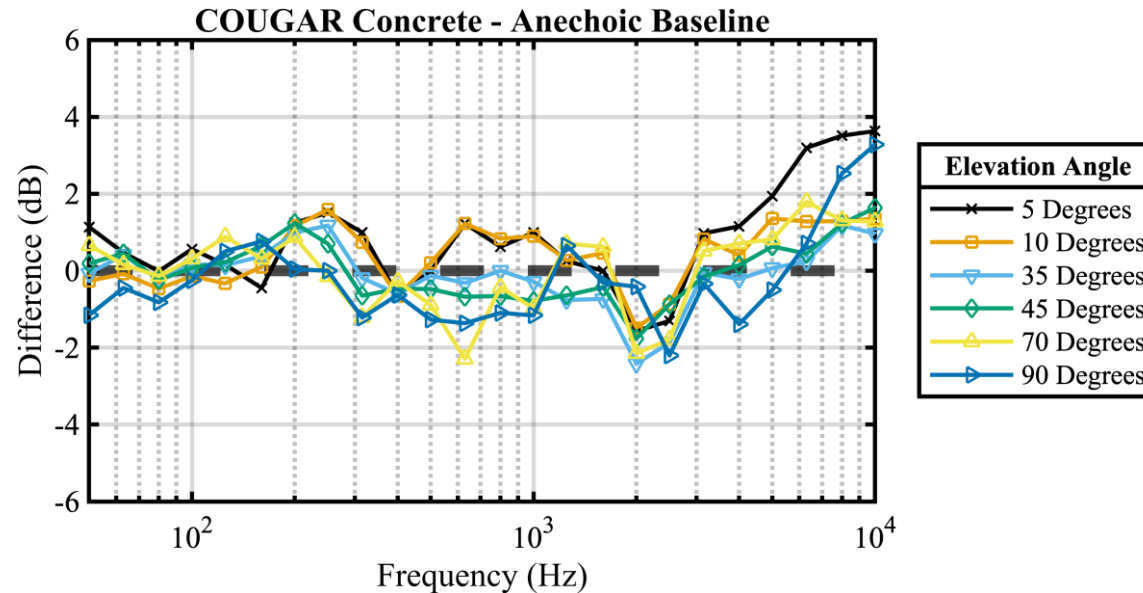
Results: Outdoor Terrains Baseline Issue

- We observe that our anechoic measurements over particle board are representative of measurements over concrete as there is little relative difference between the two baselines



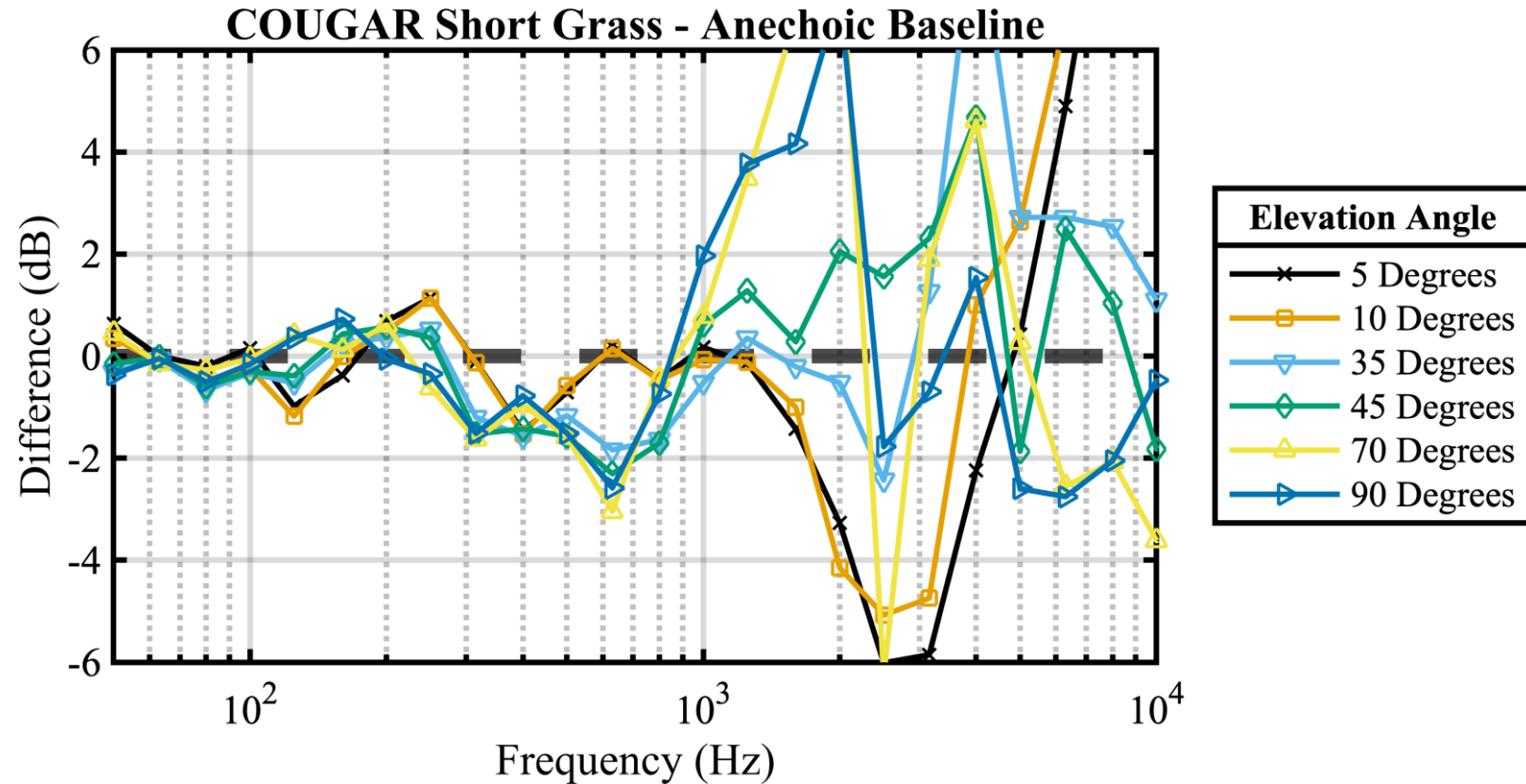
Results: Outdoor Terrains Baseline Issue

- When comparing the same measurement to the two different baselines, there are similar results
- Thus, the rest of the outdoor measurements will be shown relative to an anechoic baseline

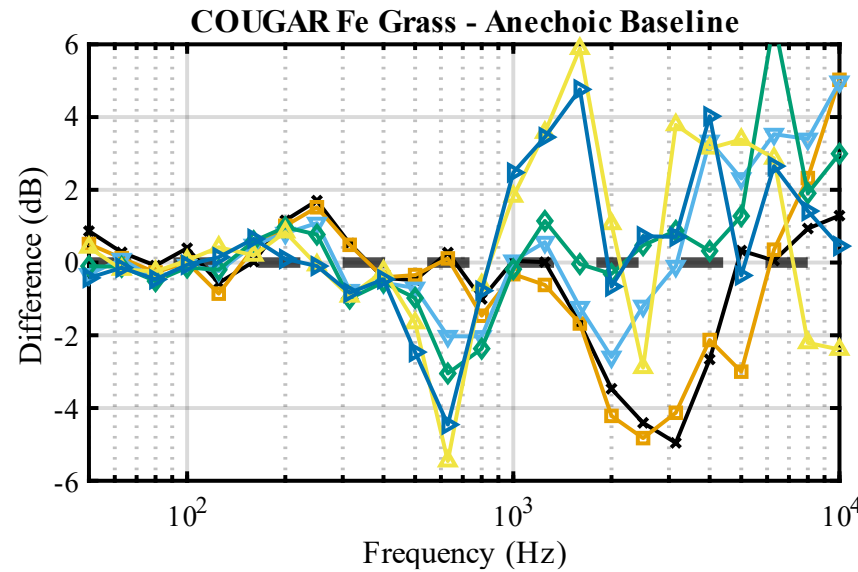
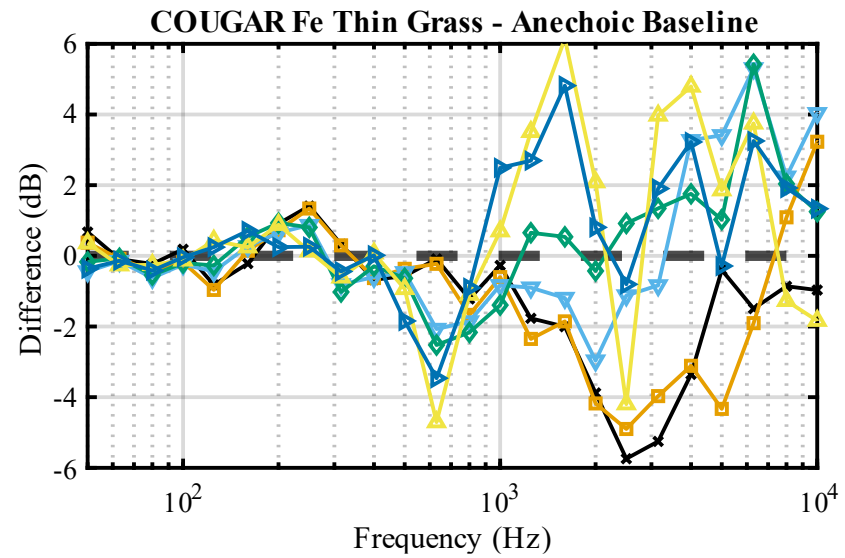
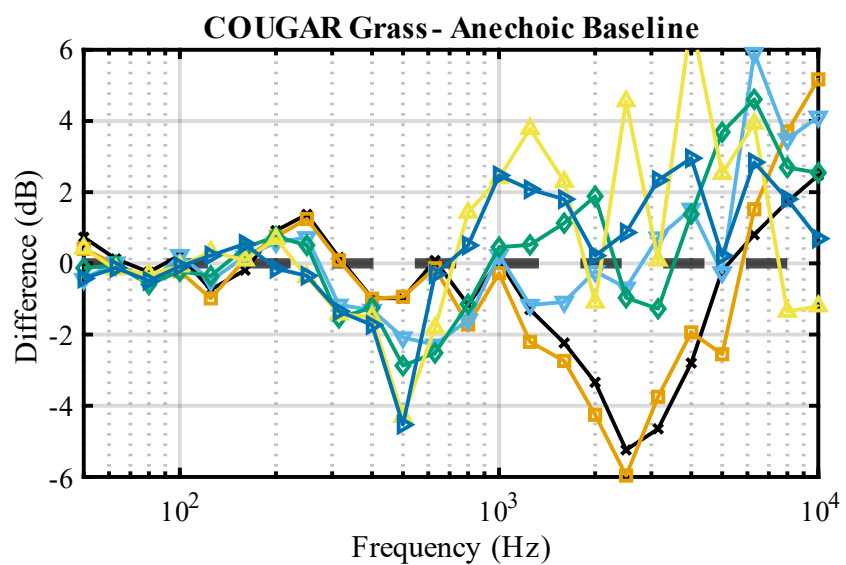
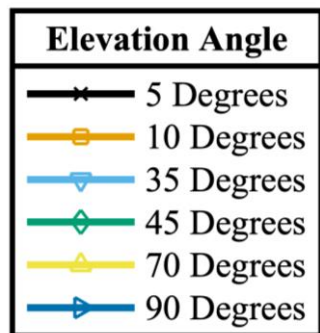
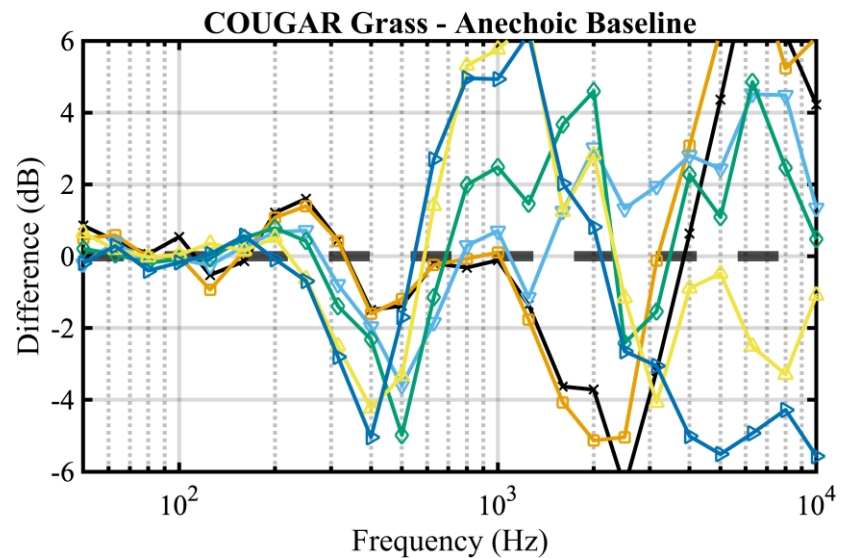


Results Outdoor Terrains: Grass

- The Grass measurements were the the worst. We suspect there was a lot of scattering at the higher frequencies, as well as a dip showing up, that might have been from the unit not being flush with the grass. The data, however, are too variable to make any good conclusions



Other Results Over Grass



Conclusion

- Outdoor measurements come with ambient noise and impedance variability. More testing required
- Particle board in an anechoic chamber is a good representation of a concrete surface
- Testing should be done again over different terrains in a more controlled environment
- The COUGAR Short is leading to the development of COUGAR Gold(ilocks), with the right balance between compactness, and functional wind noise rejection.





Questions?