INTRODUCTION: Acoustic metamaterials are commonly created with an array of Helmholtz resonators that are attached to a waveguide. The computational time of a simulation for such a metamaterial can be substantially affected by the complexity of the resonator’s design. We believe any Helmholtz resonator that has a complex design and complies with a certain set of assumptions can be replaced in the simulation with an equivalent cylindrical resonator, in order to reduce the computational time. However, our experiment was to test whether this method would work for one resonator attached to a waveguide.

The physical model is a waveguide made of PVC pipe and a plastic chemical flask representing the Helmholtz resonator with a complex design.

RESULTS: For the physical experiment, the resonance frequency was varied ten times by adding 10% of the cavity’s original volume each time. This is seen in the figure below, where \( \text{AdjCon} \) represents the percentage of the original cavity’s volume that does not contain water.

CONCLUSIONS: The simulated resonance frequencies had an error of less than 13% in comparison to the measured resonance frequencies. This method should not be used when there is a need for precise simulation data. However, this method could be useful in the preliminary design of an acoustic metamaterial where speed of results is more important than precise results. In addition, the equation for the Helmholtz resonance was used to determine the dimensions for the equivalent cylindrical resonator, but the equation for the Helmholtz resonance is an approximation of a transcended equation.

REFERENCES: