# COMSOL® Analysis for Duct Acoustic

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## Abstract

COMSOL analysis of the acoustic modes of two different Combustion Wind Tunnel Facility's test sections was conducted in this project. The test sections are rectangular ducts, therefore the mathematical expressions to predict the longitudinal and transverse modes inside a tube were used and compared with COMSOL simulations. Three different cases with different boundary conditions were simulated and they included: open-open, close-close, and close-open boundaries. The Pressure Acoustic, Frequency Domain Model was used for simulation. On the first duct, COSMOL results showed a great agreement with both the theoretical and experimental results such as showing the fundamental longitudinal mode of the open-open and close-close cases is a half-wavelength, and a quarter wavelength for the close-open case, with pressure node at open boundaries and antinode at hard or closed boundaries. The close-close case's results were the closest to the theoretical values. Boundary conditions not only effected the longitudinal modes, but also effected the transvers modes as well. For example, the (1, 0) transverse mode was around 844 Hz in the close-close case, and increased to 875 Hz in the open-open case. The open-open and close-open cases had similar pressure acoustic phenomena such as the coupling of the (1, 0) and (0, 1) transverse modes along the duct (x-axis), and interference of transvers modes on the longitudinal direction. Another phenomena was observed in both open-open and close-open cases that was the transverse modes had the same wavelength pattern of the longitudinal mode along the duct. Among the four modes were generated in COMSOL the fundamental transverse mode (1, 1) was the dominant mode in all cases.

On the other geometry that was the rig in the famous paper "A Mechanism for High-frequency oscillation in ramjet combustors and afterburners" two boundary conditions were applied that included: open-open, and close-close boundaries. Again COMSOL results are in good agreement with the theoretical and experimental results presented in the paper. For instance, they detected two type of instabilities: low-frequency "rumble" around 280 cps, and high-frequency "screech" around 3800 cps. COMSOL simulations also found two similar frequencies and they were around 279 Hz and 3687 Hz respectively, in the close-close case.

# Figures used in the abstract

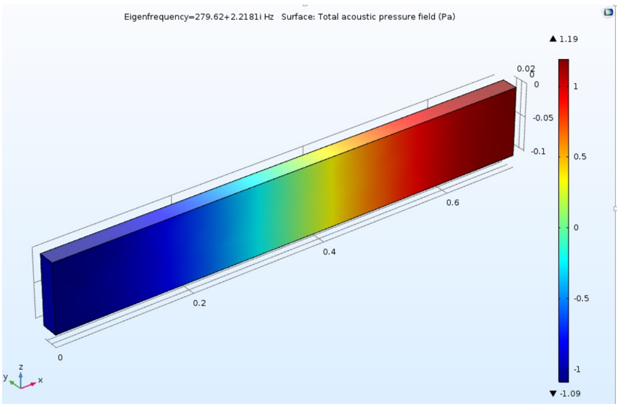


**Figure 1**: Figure 1: the pressure field pattern of the fundamental longitudinal mode (279 Hz in COMSOL) “rumble”, which was around 280 Hz experimentally.