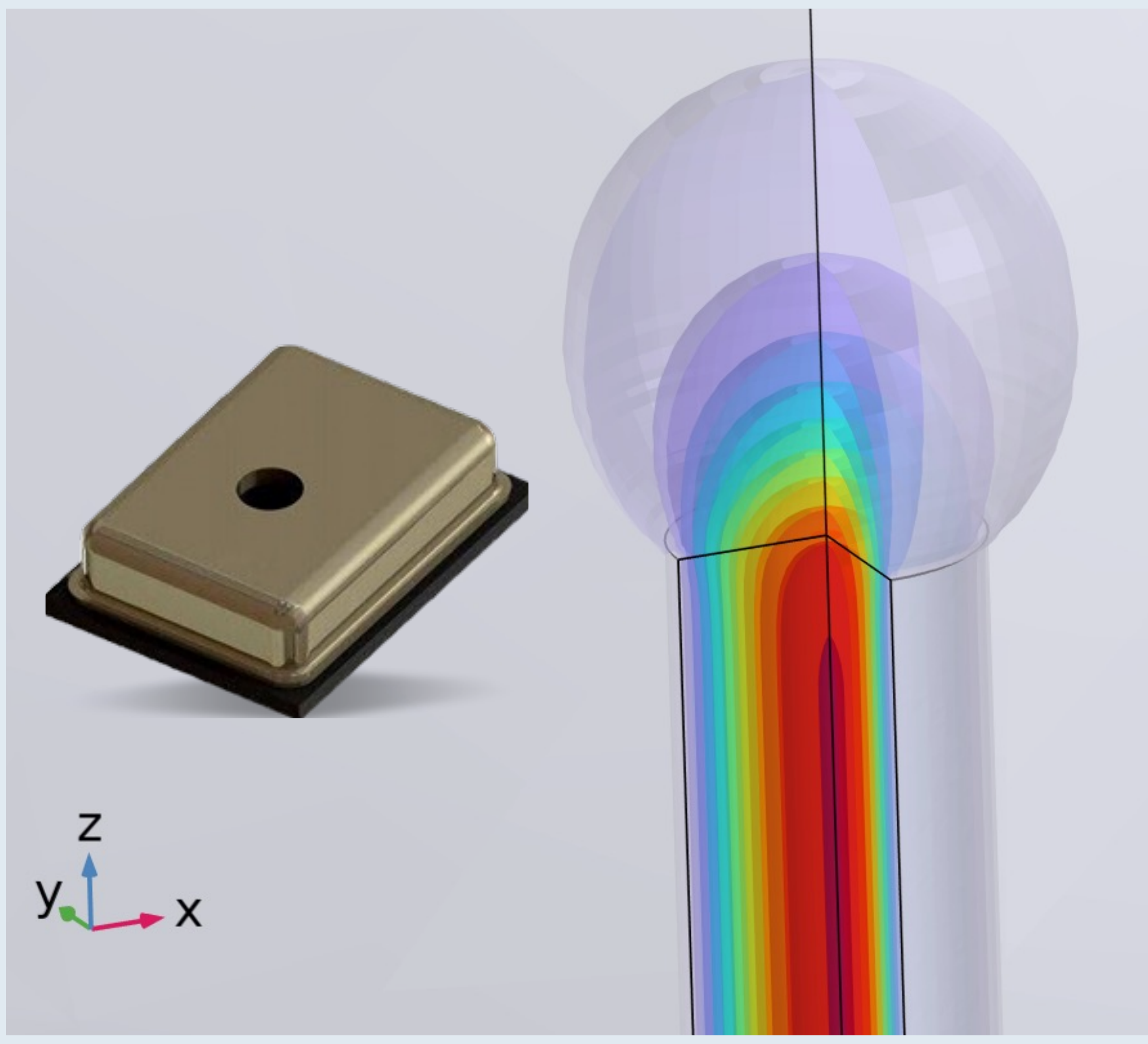


# End Corrections to Acoustic Mass and Acoustic Resistance of a MEMS Microphone Inlet

Prediction of end corrections to both acoustic mass and acoustic resistance of an acoustic channel, due to open or baffled channel termination, based on COMSOL® FEA and comparison to common practices.


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## Introduction

In professional audio and hearing aid industries often lumped element (LE) models [1] are used as a quick and convenient tool to predict the behavior of audio transducers, such as MEMS microphones. To increase the accuracy, end corrections to the acoustic channel length [2], for example, a spout or sound inlet, need to be included in the LE models. End corrections describe how an acoustic channel is open to the outside environment, for instance a channel with an open end or a channel that ends with an opening in the infinite plane, called baffle.

Present finite element study using COMSOL® reveals that the end correction for acoustic mass can be different than the one for the acoustic resistance. This is in contradiction to a widespread assumption.

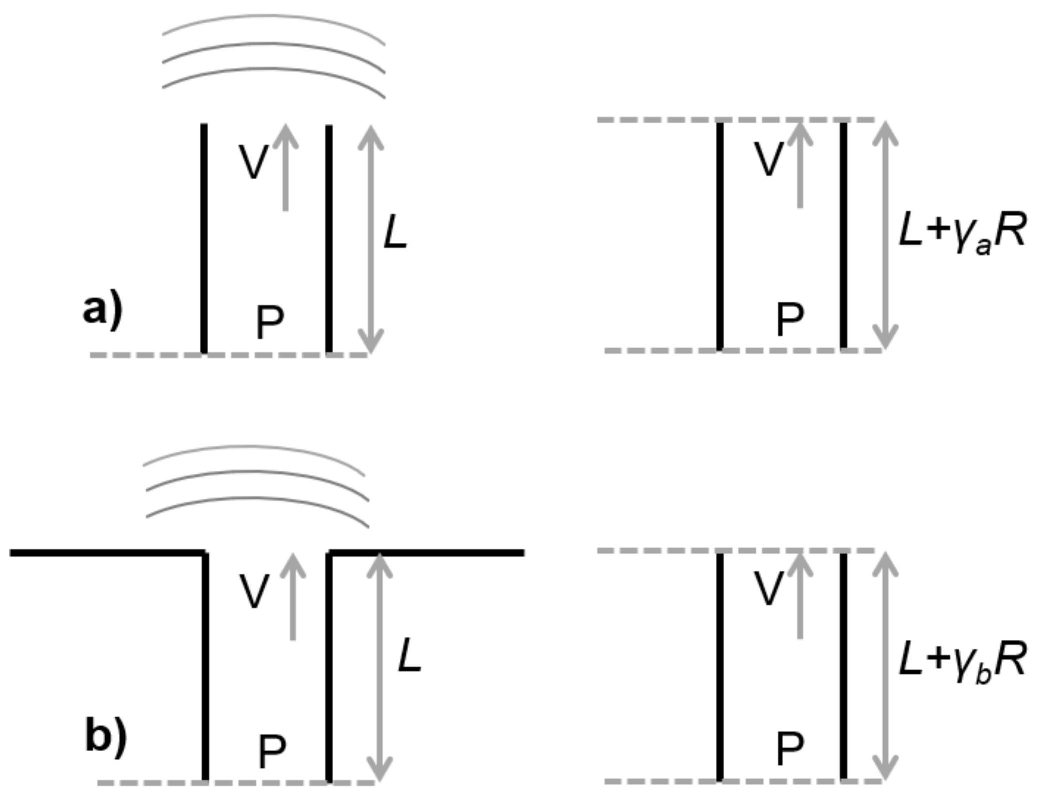


FIGURE 1. Pipe terminated into an open space and an equivalent ideal pipe (a). Pipe terminated into a baffled space and an equivalent ideal pipe (b).

## Methodology

The difference between the complex impedances of the open cylindrical pipe and ideal pipe both driven by the pressure source is calculated with COMSOL FEA:

$$\left|Z_{open\ space} - Z_{ideal}\right|$$

Then this frequency dependent value is fitted with the end correction impedance equation including different end correction coefficients ($\gamma_1$ and $\gamma_2$) for real and imaginary parts:

$$\left|\frac{8\eta_{air}\gamma_1 R}{\pi R^4} + j\omega\gamma_2 R\frac{\rho_{air}}{\pi\ R^2}\right|$$

## Results

In both cases of the pipe terminated to the open space and the pipe terminated to the baffled space the end correction coefficients for the acoustic mass, $\gamma_{2a}$ and $\gamma_{2b}$, calculated based on COMSOL result, have been found in agreement with the literature.

On the other hand, COMSOL result reveals a 24% difference between the end correction coefficients for acoustic mass $\gamma_{2b}$ and acoustic resistance $\gamma_{1b}$ in case of the pipe terminated to the baffled space. This disagrees with a widespread assumption that $\gamma_{1b}$ = $\gamma_{2b}$.

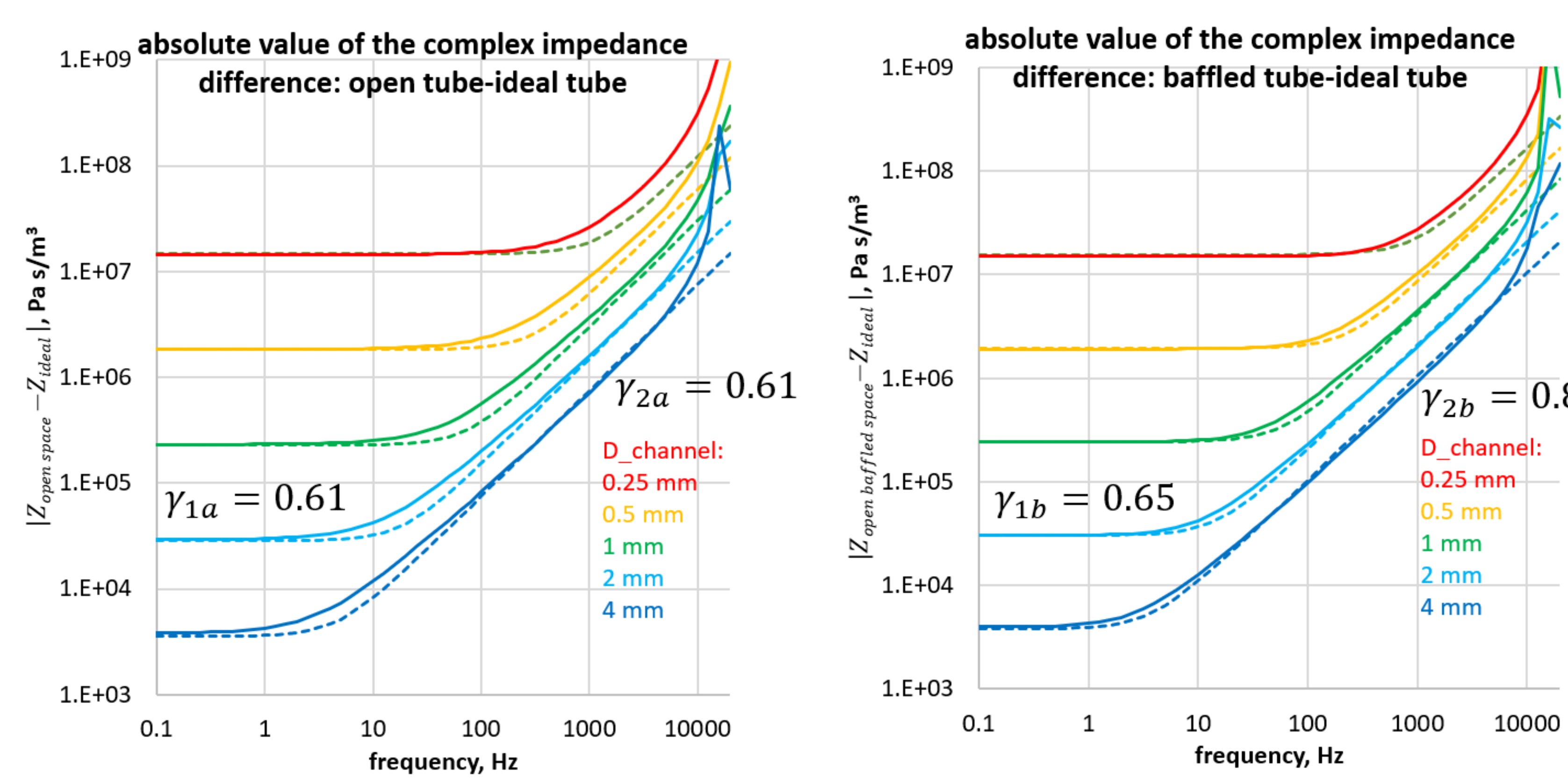


FIGURE 2. Fitting the end correction equation (dashed) to COMSOL impedance difference (solid) allows determination of end correction coefficients $\gamma_1$ and $\gamma_2$.

## REFERENCES


1. J. Merhaut, Theory of Electroacoustics, 1981, McGraw-Hill
2. J. M. Eargle, End Correction for Pipes, 1994. In: Electroacoustical Reference Data, Springer, Boston, MA.


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