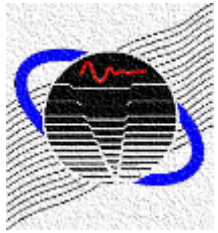
October 23, 2020

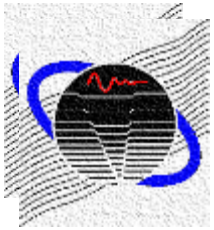
VAC Toolbox
Muffler Modeling Module

Caoyang LI
University of Kentucky



VAC Toolbox

- The VAC Toolbox muffler module has been thoroughly updated and is current with the latest MATLAB version. It runs with MATLAB Runtime 9.9 which can be accessed on the MathWorks website.
- The software does not require you to have MATLAB.
- Software is available to VAC members.



Transfer Matrix Method Based

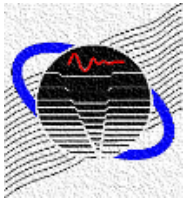
Assumes that all elements are in series with each other.

$$\begin{Bmatrix} p_1 \\ Q_1 \end{Bmatrix} = \begin{bmatrix} T_{11}^1 & T_{12}^1 \\ T_{21}^1 & T_{22}^1 \end{bmatrix} \begin{Bmatrix} p_2 \\ Q_2 \end{Bmatrix}$$

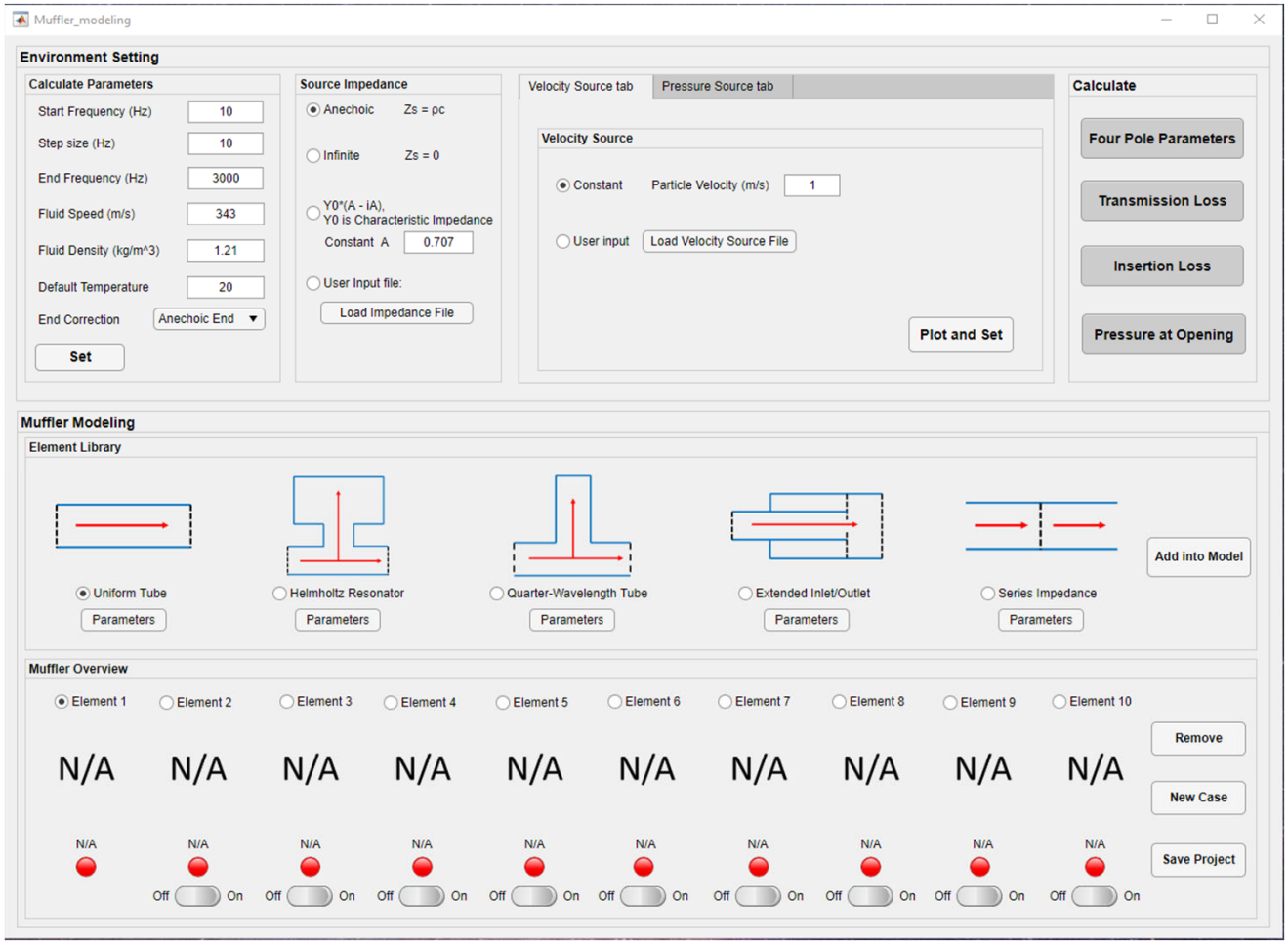
$$T_1 = \begin{bmatrix} T_{11}^1 & T_{12}^1 \\ T_{21}^1 & T_{22}^1 \end{bmatrix} \quad T_2 = \begin{bmatrix} T_{11}^2 & T_{12}^2 \\ T_{21}^2 & T_{22}^2 \end{bmatrix} \quad T_3 = \begin{bmatrix} T_{11}^3 & T_{12}^3 \\ T_{21}^3 & T_{22}^3 \end{bmatrix} \quad \cdots \cdots$$

$$[T_{Global}] = [T_1][T_2] \ldots [T_{10}]$$

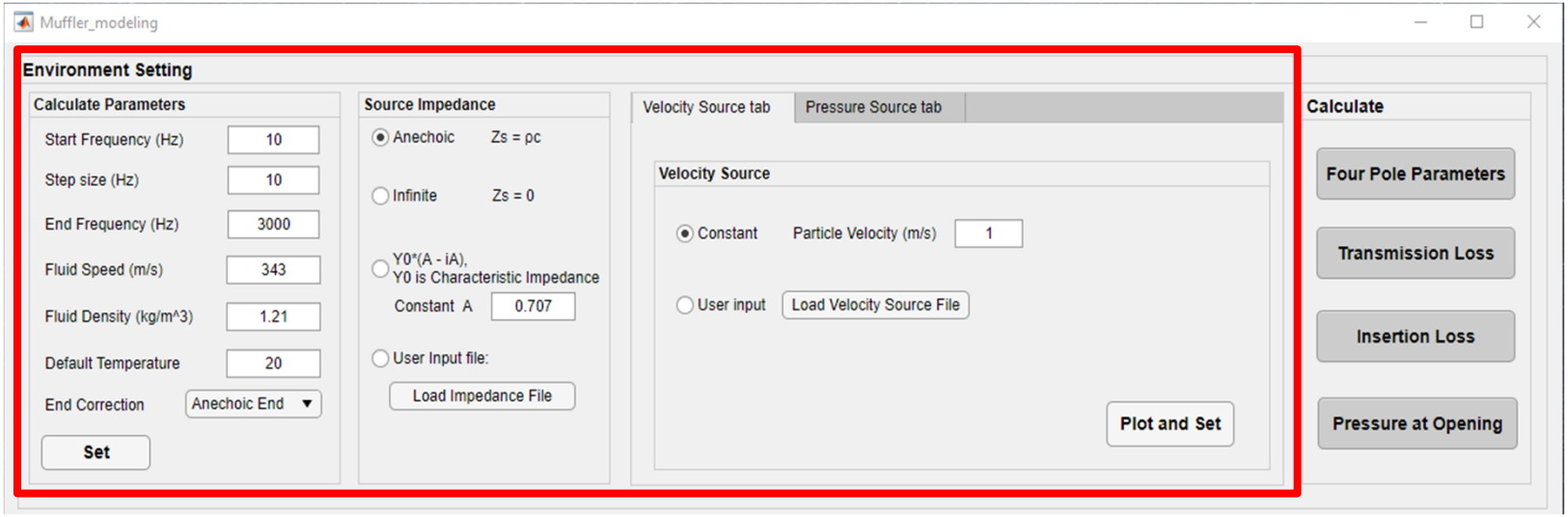
$$\begin{Bmatrix} p_1 \\ Q_1 \end{Bmatrix} = [T_{Global}] \begin{Bmatrix} p_{10} \\ Q_{10} \end{Bmatrix}$$



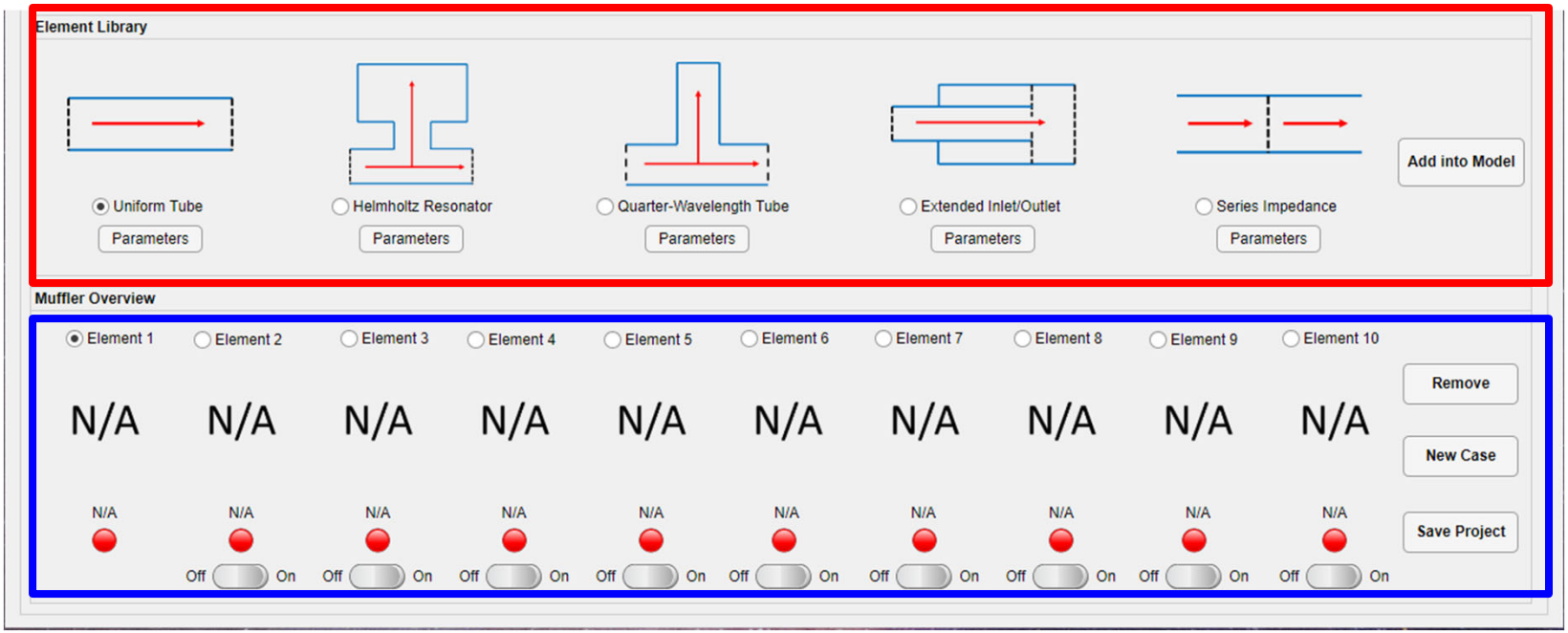
User Interface



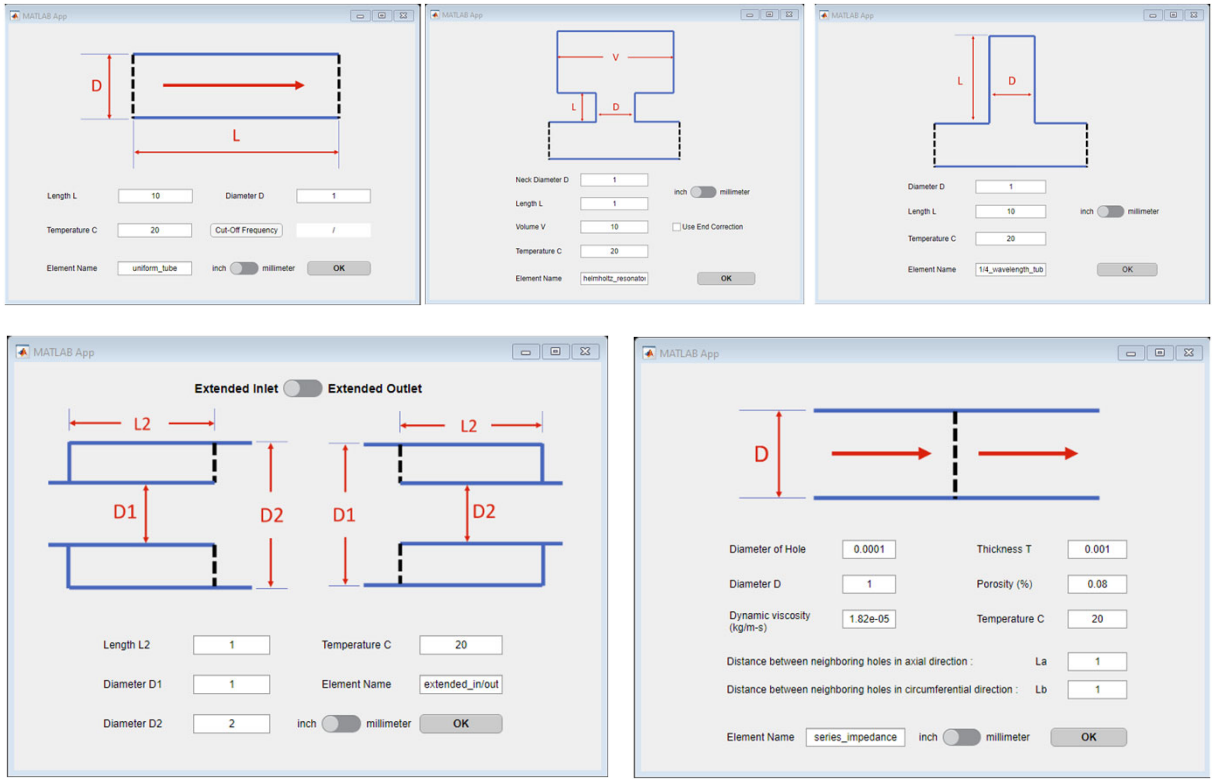
Environment Settings



Muffler Modeling

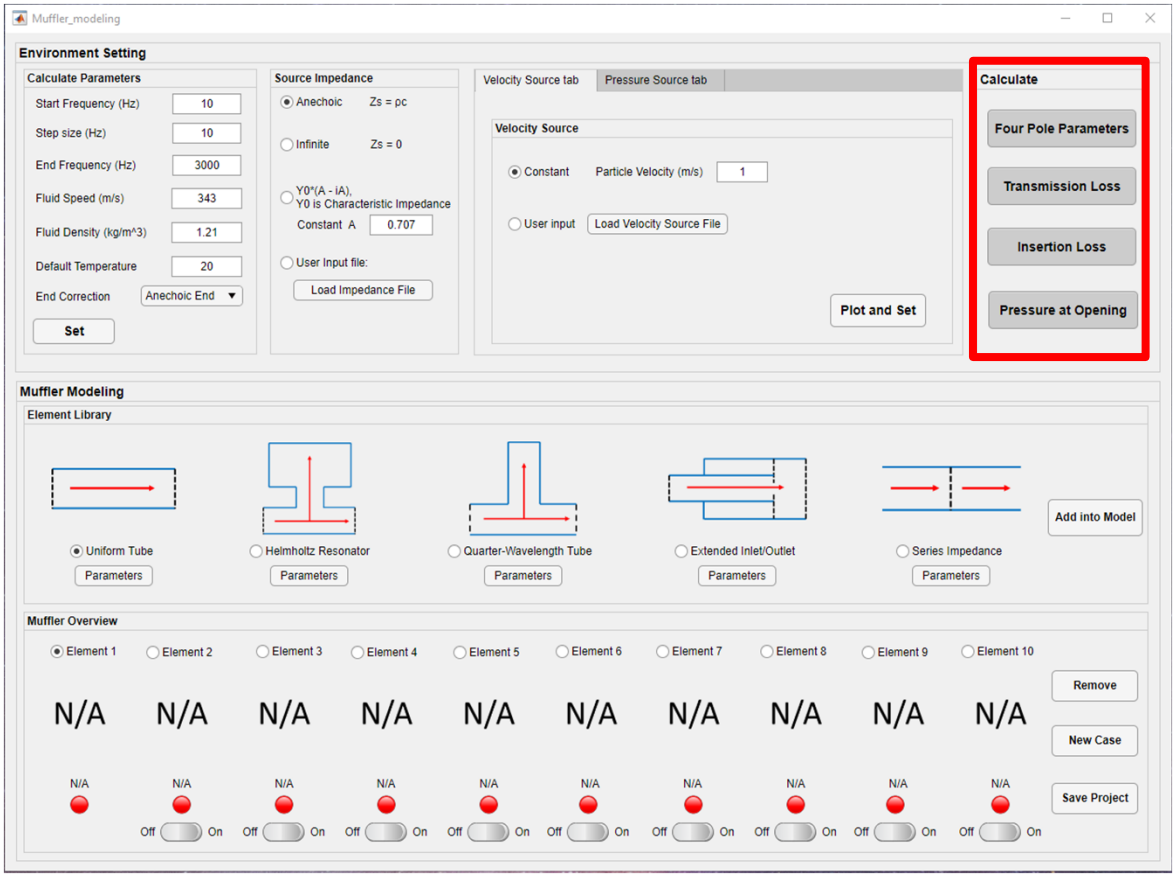


Define Element Parameters

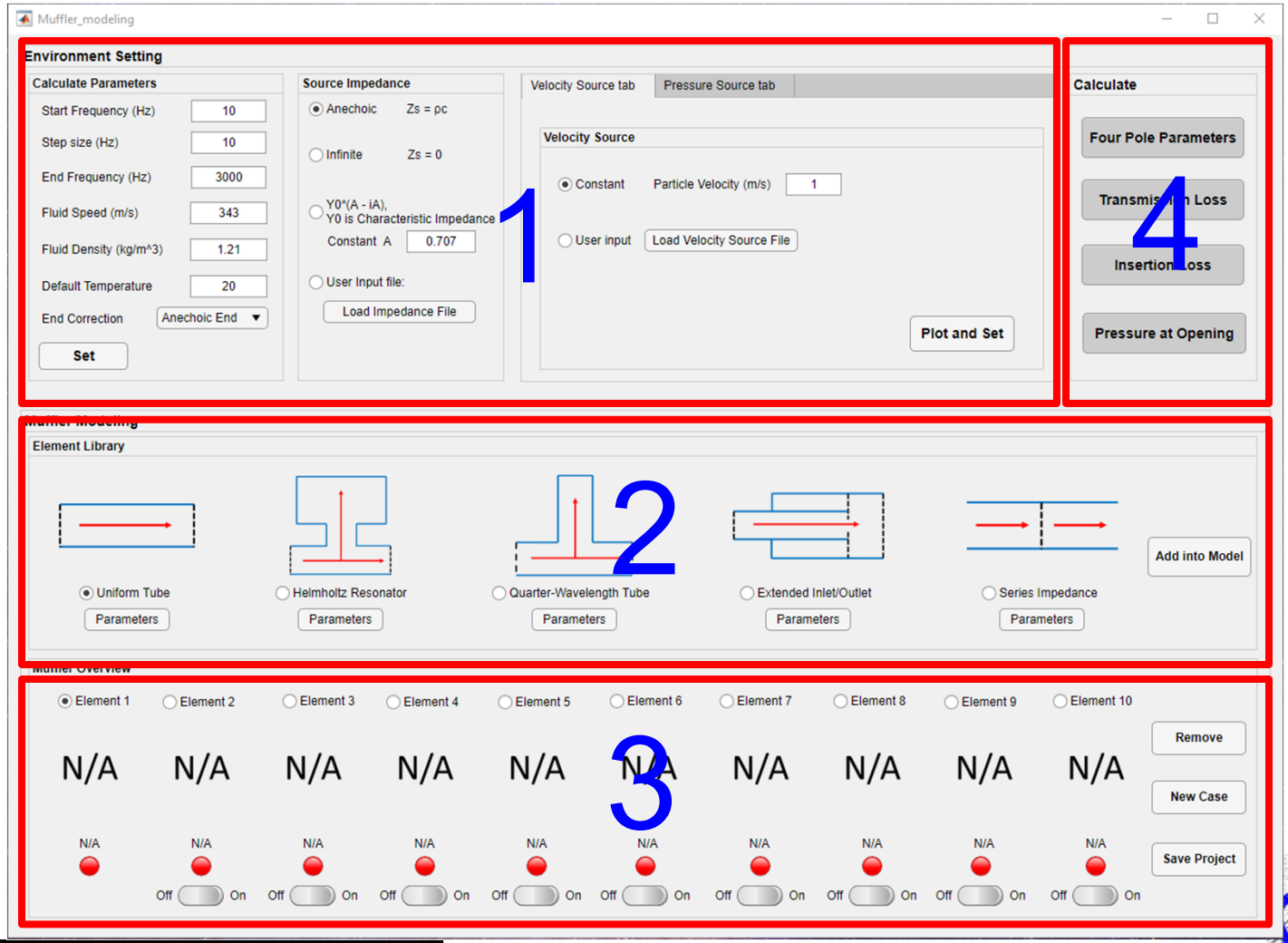


Temperature for each element may be considered.

Calculation

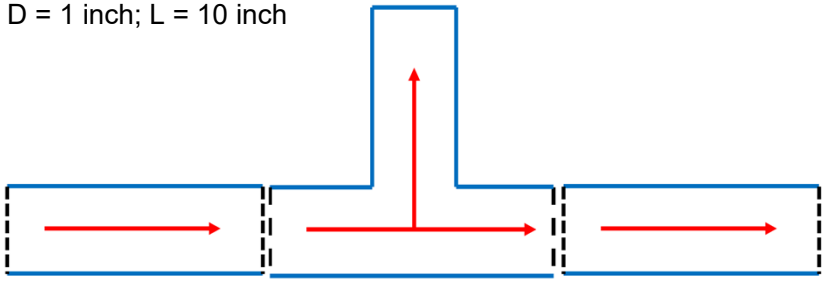


Muffler Modeling Workflow

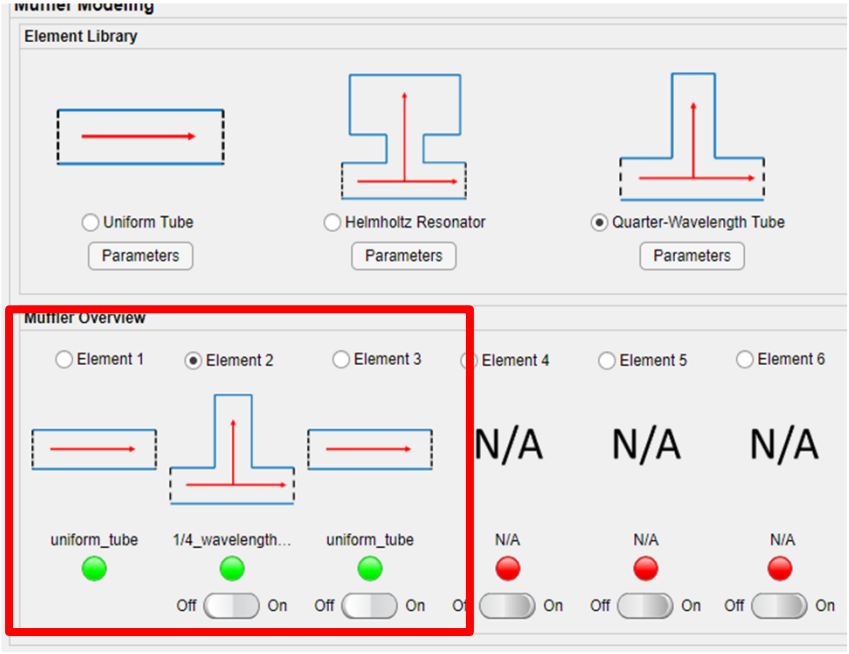


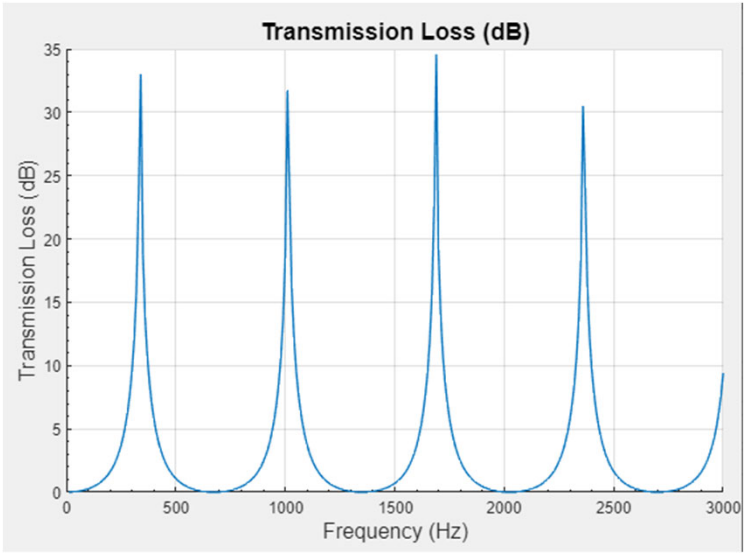
Transmission Loss Quarter Wavelength Tube

Uniform Tubes:
D = 1 inch; L = 10 inch



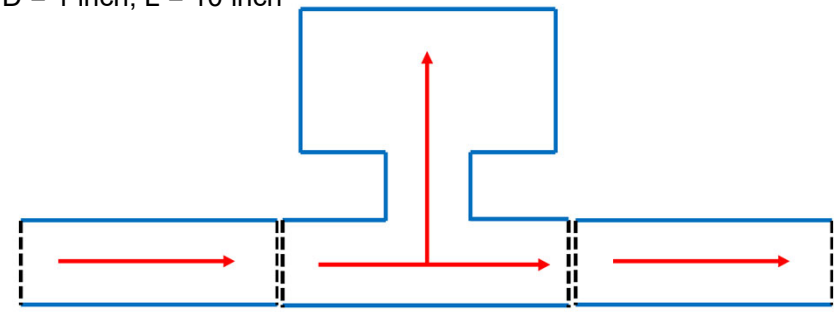
Quarter Wavelength Tubes:
Branch Diameter = 1 inch
Branch Length = 10 inch



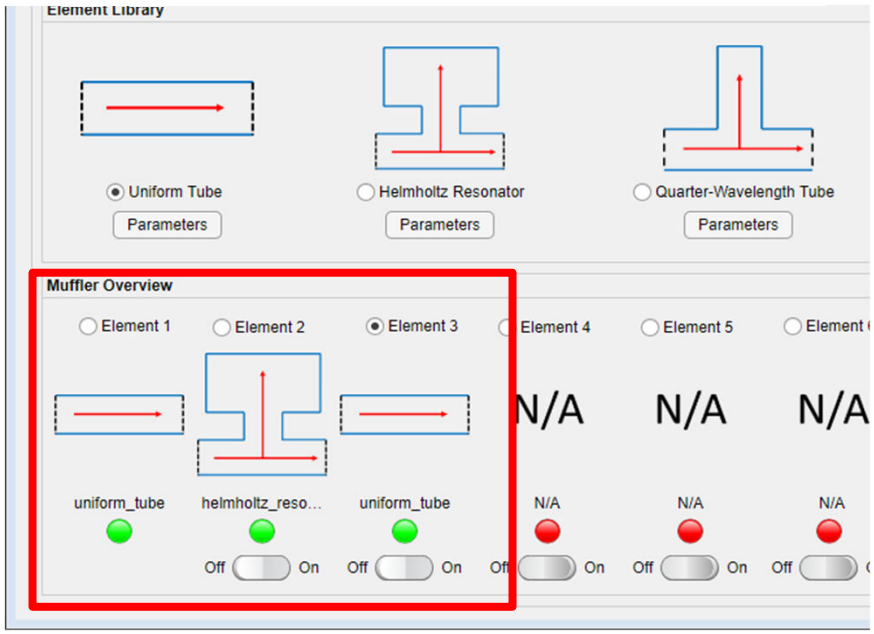


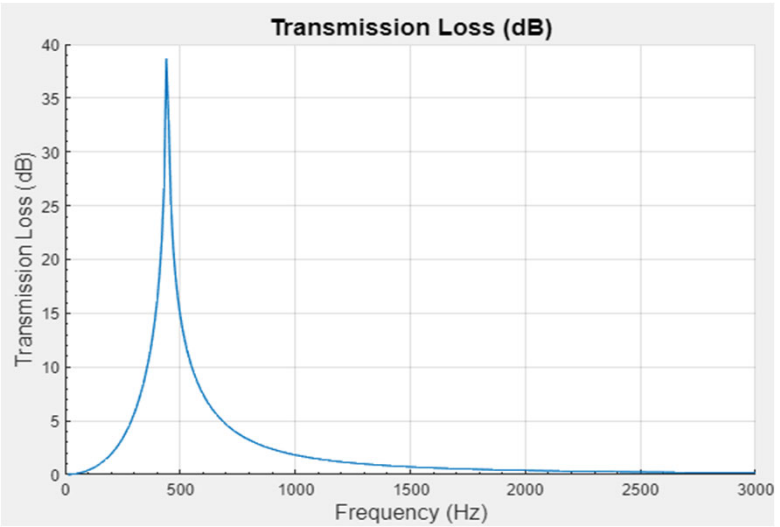
Transmission Loss Helmholtz Resonator

Uniform Tubes:
D = 1 inch; L = 10 inch



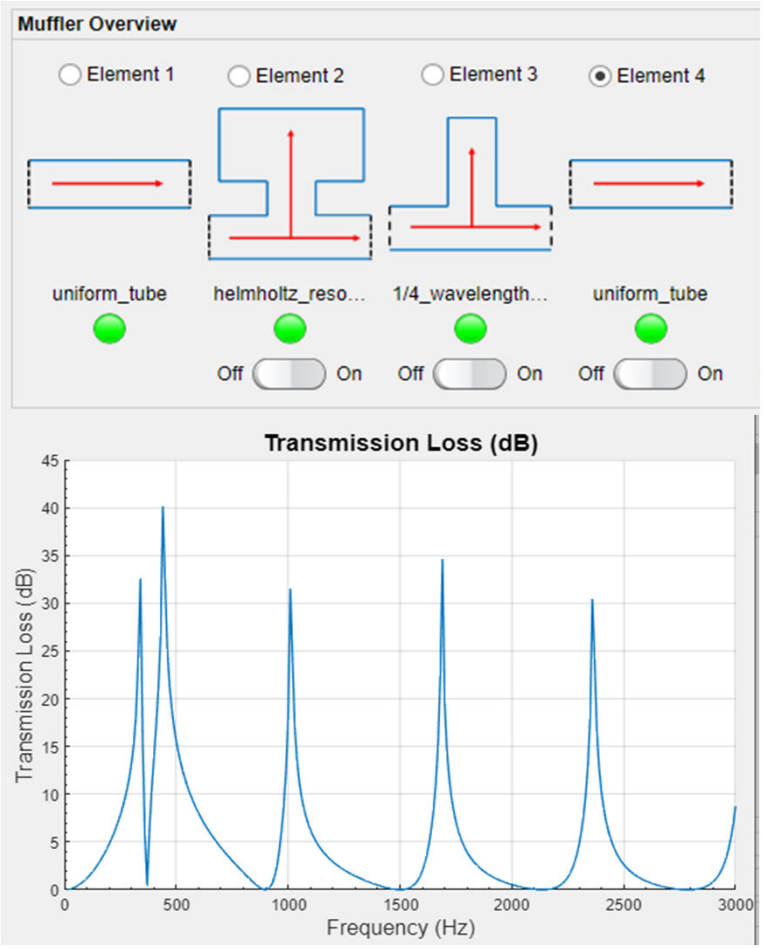
Helmholtz Resonator:
Neck Diameter = 1 inch
Neck Length = 10 inch
Volume = 10 cubic inch
(neck end correction used)



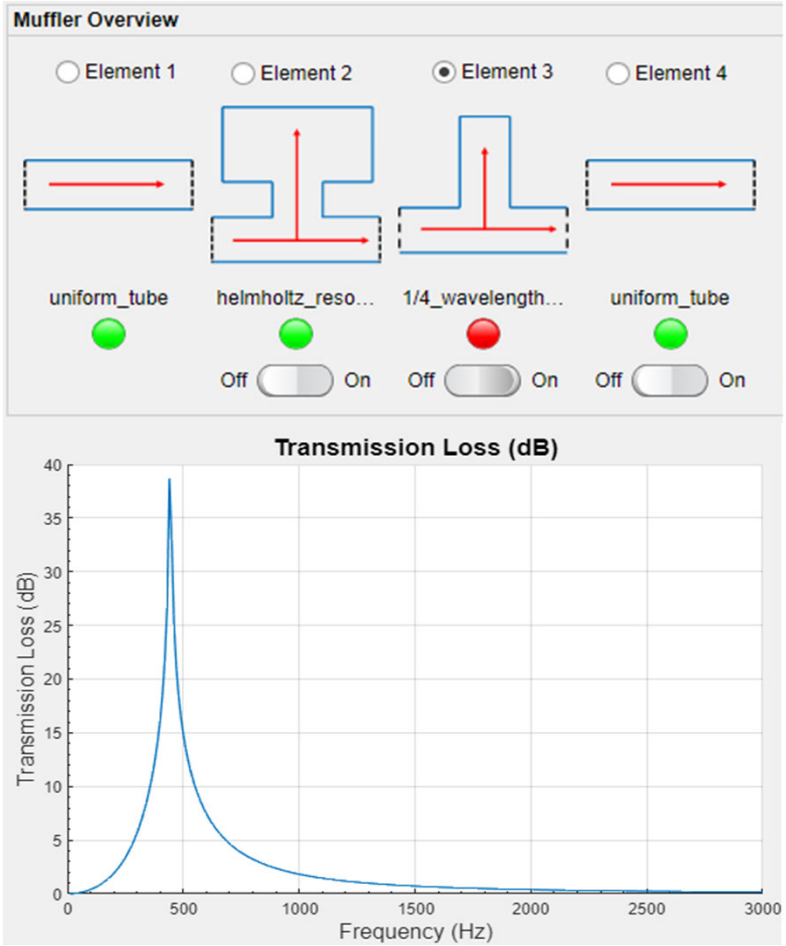


Transmission Loss Simple Muffler

With quarter wavelength tube



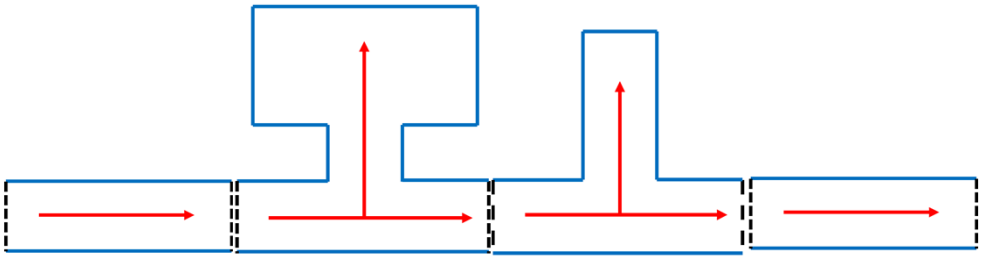
Without quarter wavelength tube

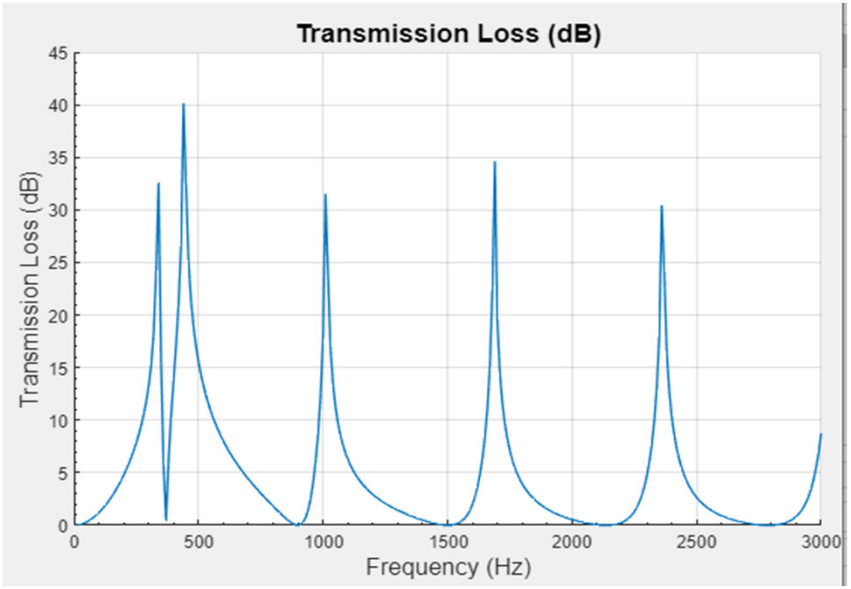


Compare with SIDLAB

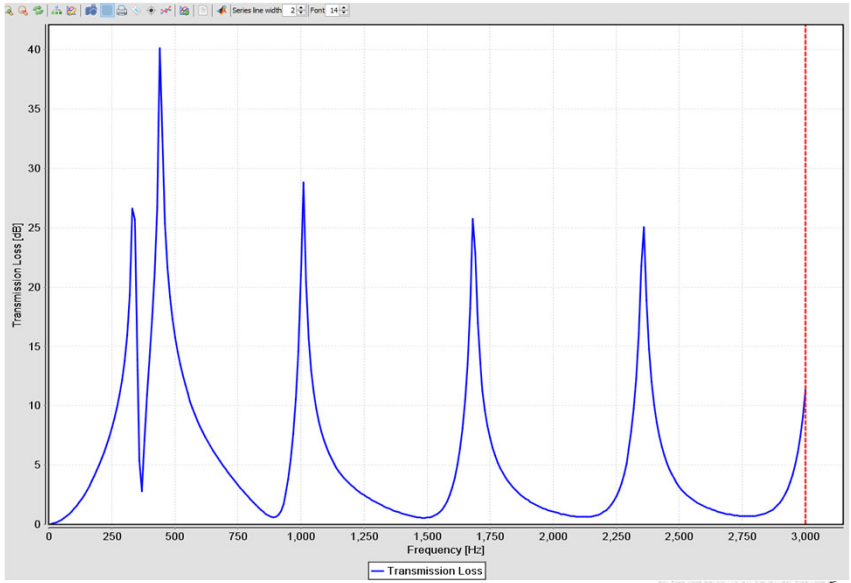
Helmholtz Resonator:
Neck Diameter = 1 inch
Neck Length = 10 inch
Volume = 10 cubic inch
(neck end correction used)

Quarter Wavelength Tubes:
Branch Diameter = 1 inch
Branch Length = 10 inch



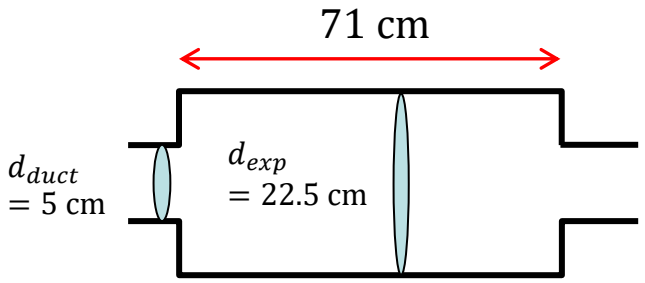


VAC Toolbox



SIDLAB

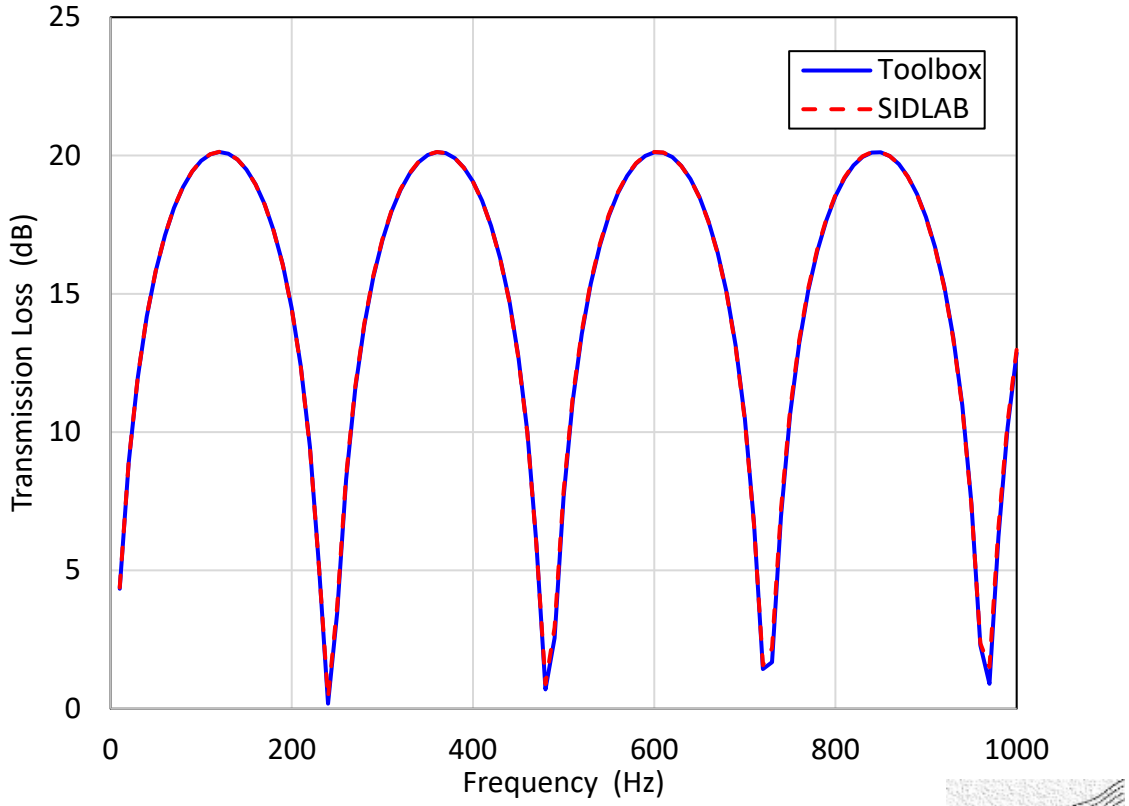
Transmission Loss SEC



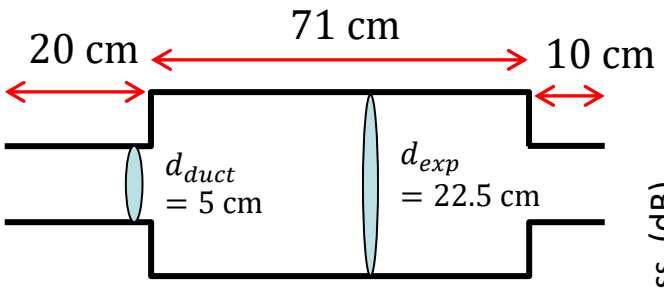
$d_{duct} = 5$ cm

$d_{exp} = 22.5$ cm

$L = 71$ cm



Insertion Loss SEC



$d_{duct} = 5$ cm

$d_{exp} = 22.5$ cm

$L = 71$ cm