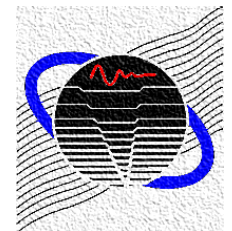


March 18, 2021

HVAC Duct Aspect Ratio Sensitivity Study

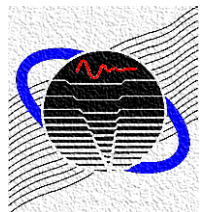
Caoyang Li
University of Kentucky

Vibro-Acoustics Consortium



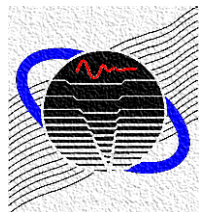
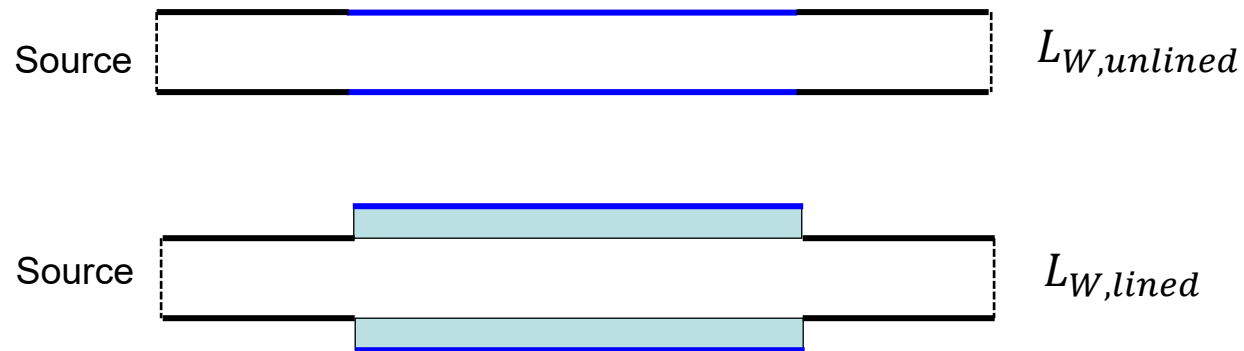
Overview

- Simulation Approach in Siemens Simcenter
- Aspect Ratio Sensitivity Study
- Improving the Attenuation with Large Aspect Ratios

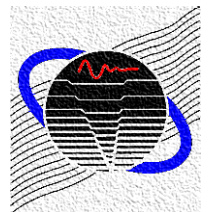
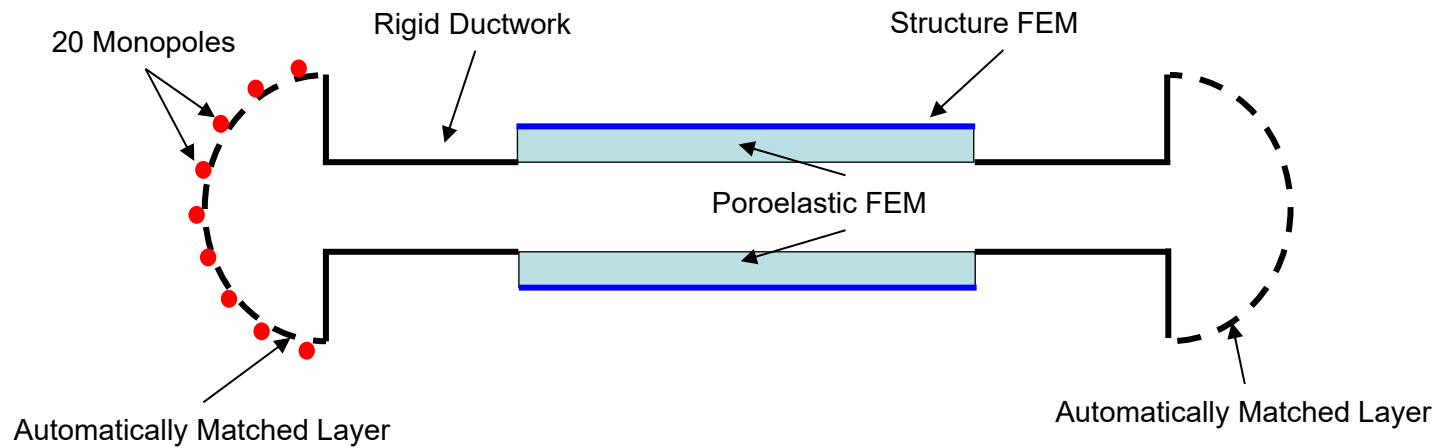
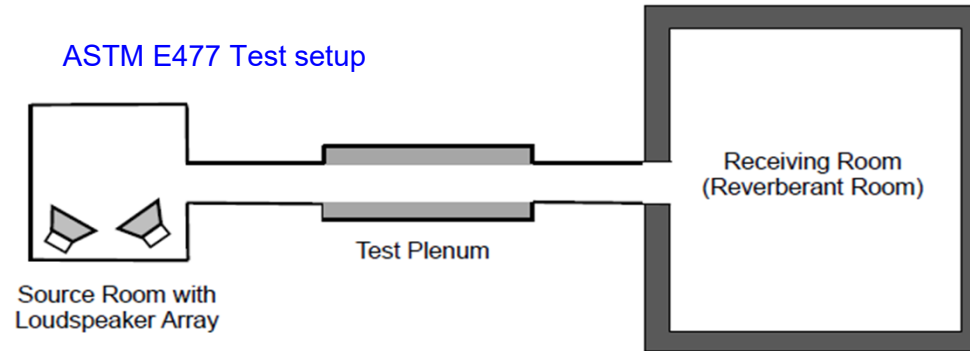


Insertion Loss

$$IL = L_{W,unlined} - L_{W,lined}$$

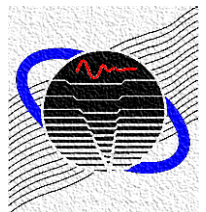
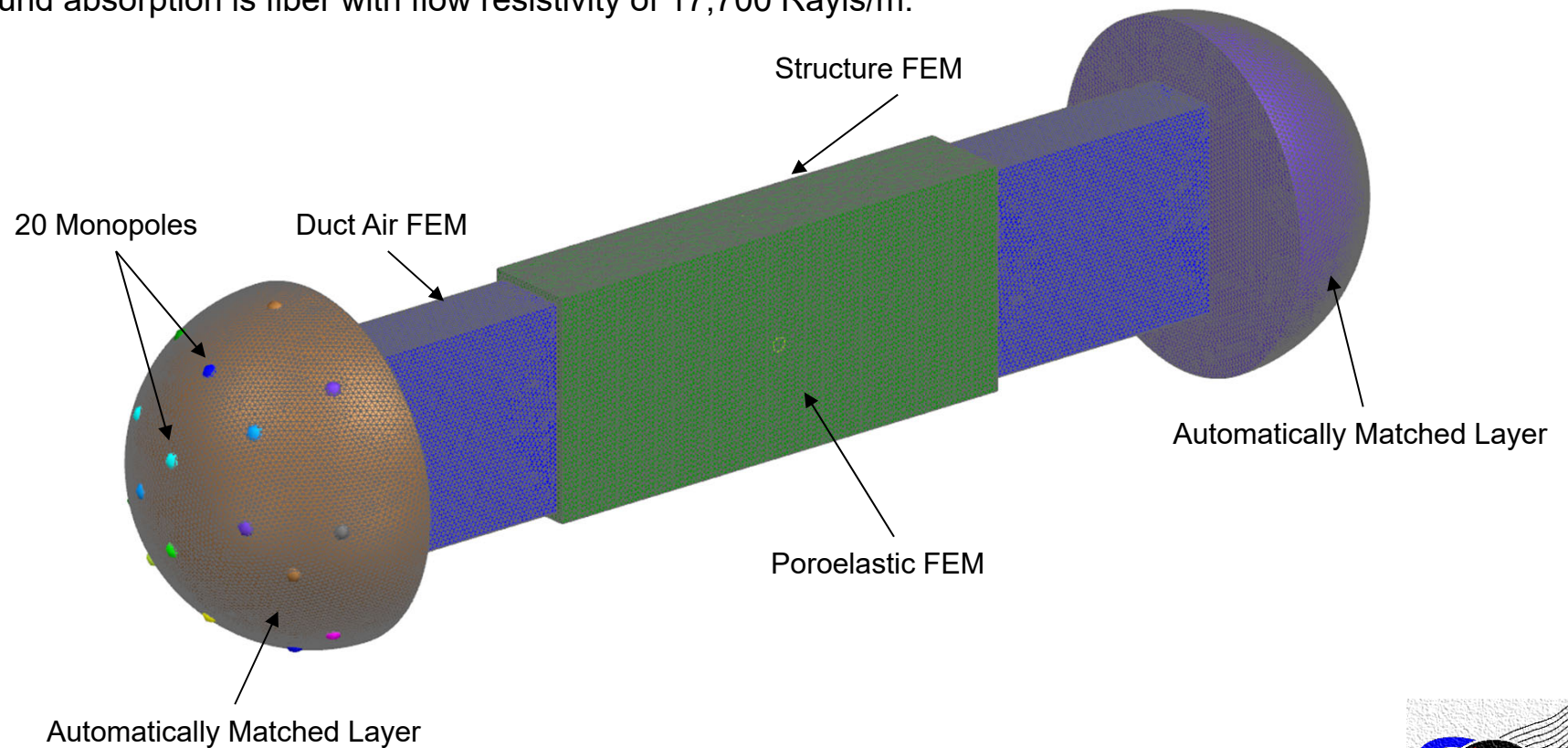


Test Setup



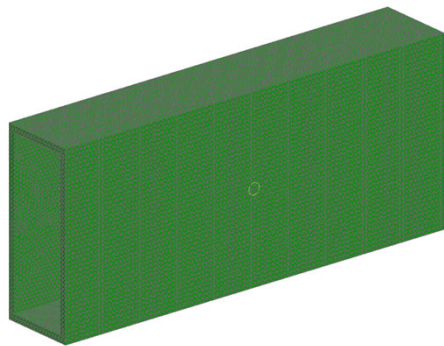
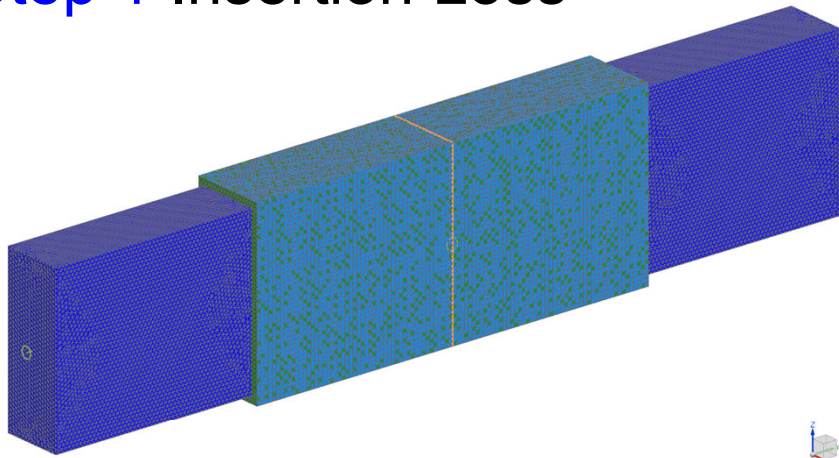
Siemens Simcenter FEM Model

10 ft test section (total length 20 ft).
Duct wall thickness is 0.034 in (21 gage).
Sound absorption is fiber with flow resistivity of 17,700 Rayls/m.

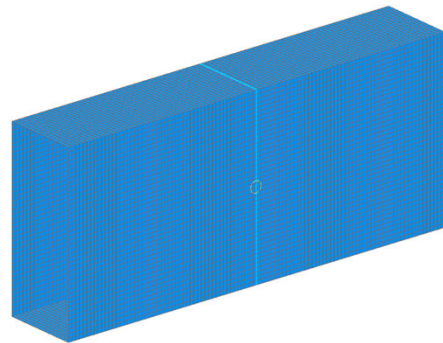


Siemens Simcenter FEM Model

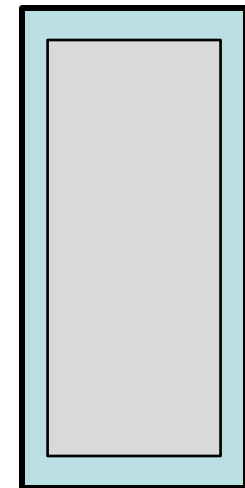
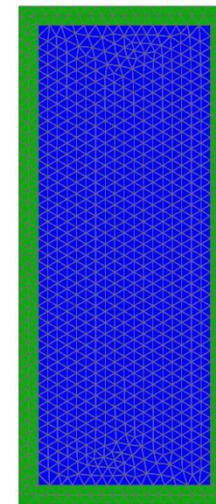
Step 1 Insertion Loss



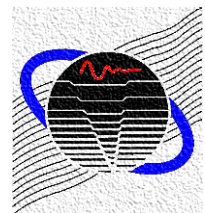
Poroelastic Mesh



Structural Mesh
(with beam brace support)

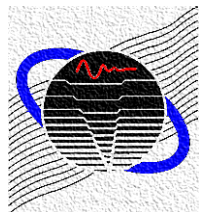
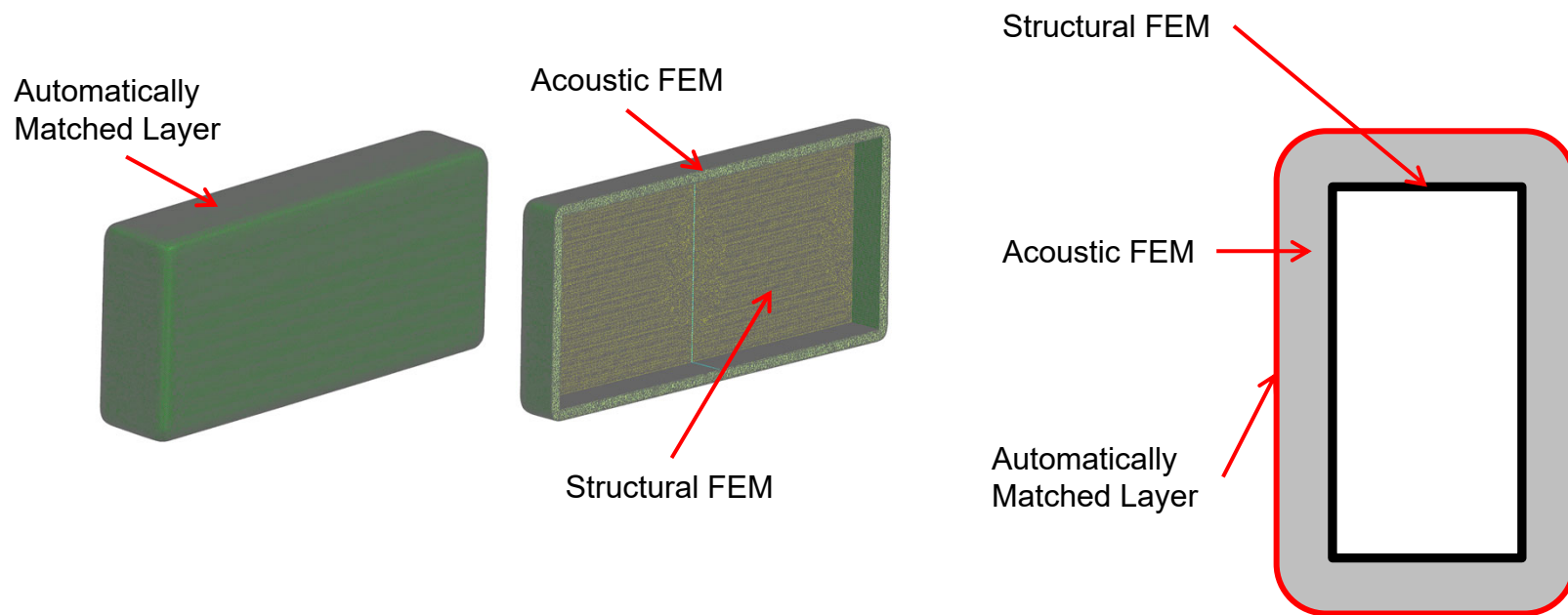


Cross-section view of mesh (left) and schematic (right).



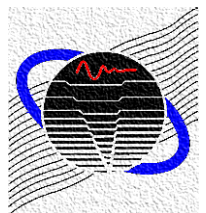
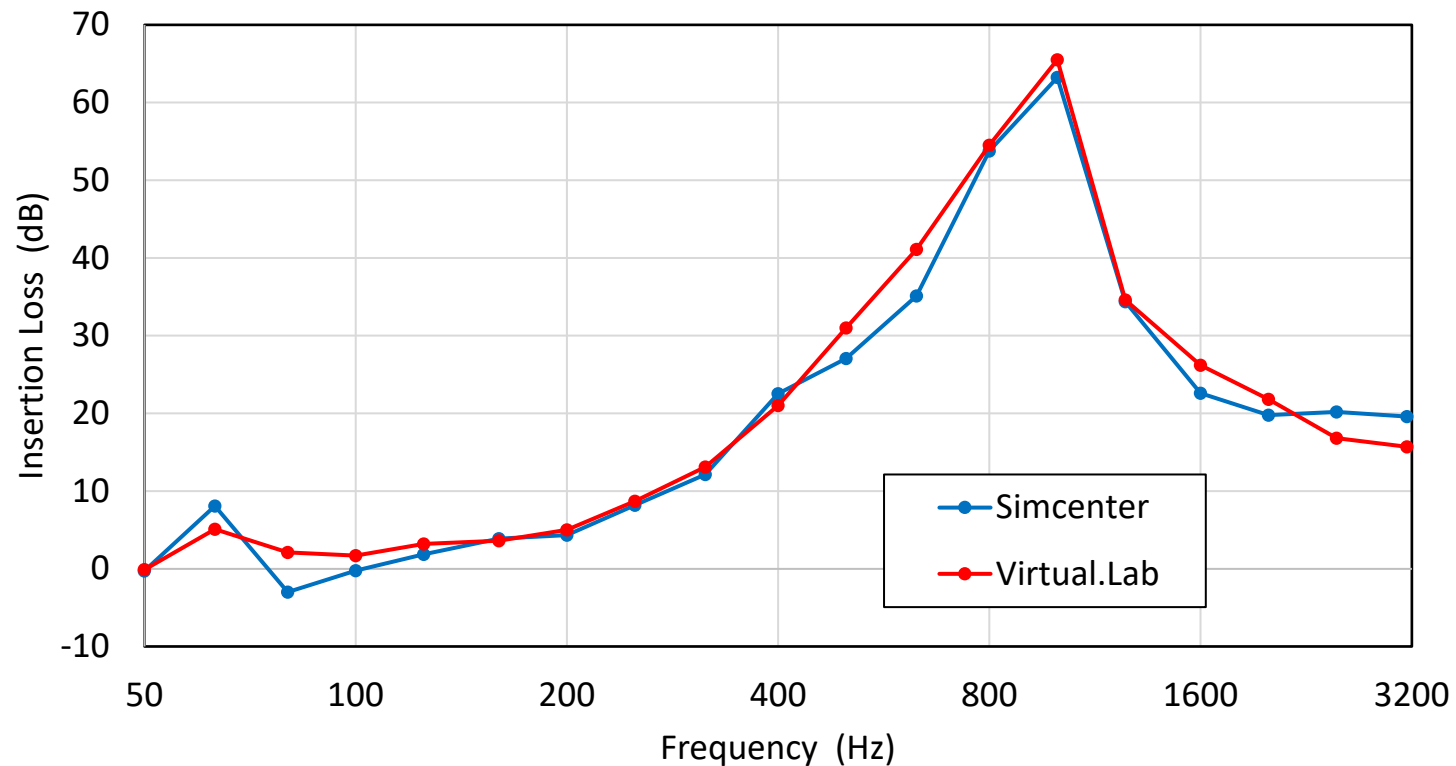
Siemens Simcenter FEM Model

Step 2 Breakout Transmission Loss



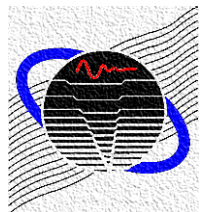
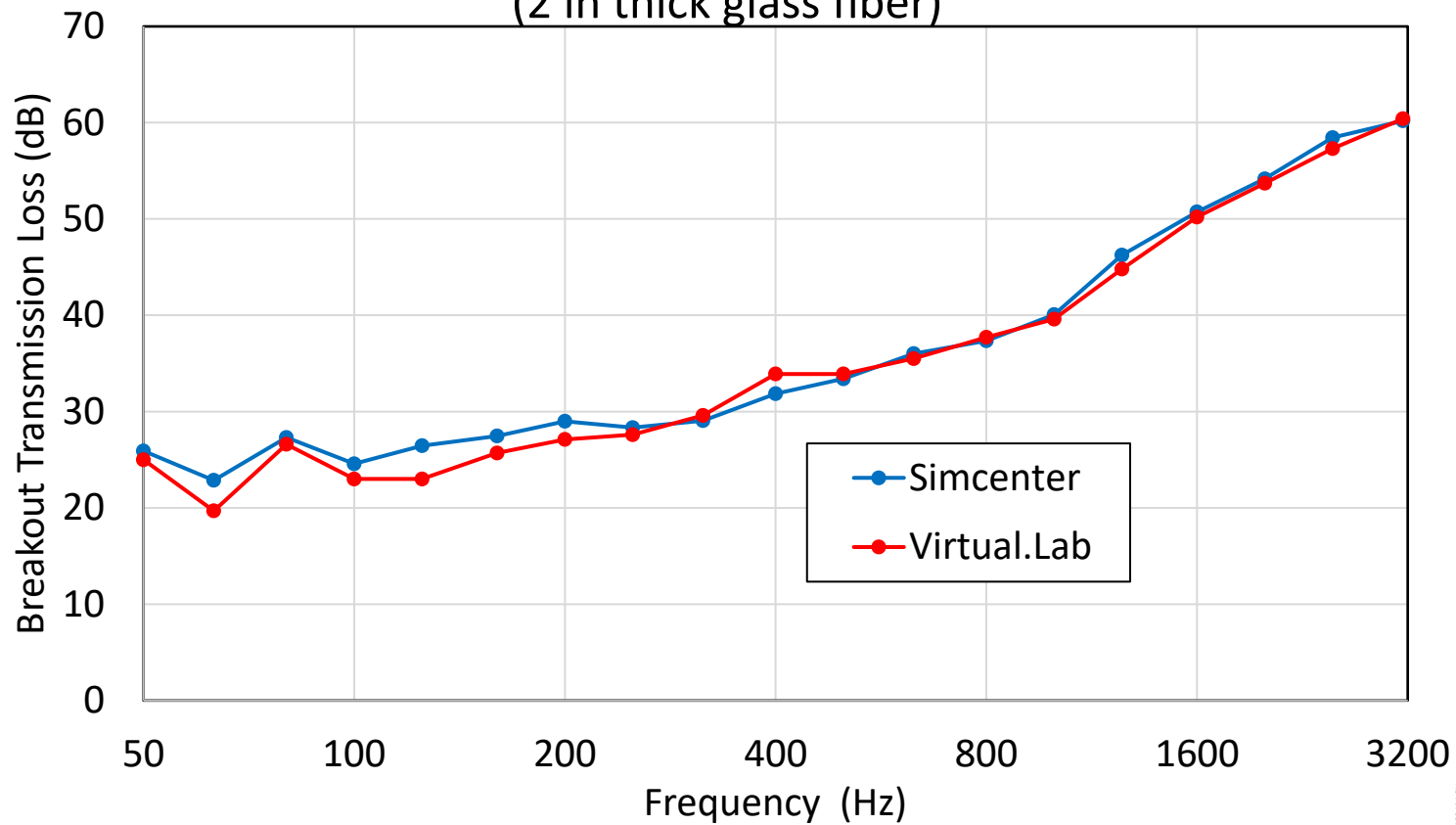
Insertion Loss

16 in x 48 in Duct of 20 ft long with 10 ft lining
(2 in glass fiber at all sides)



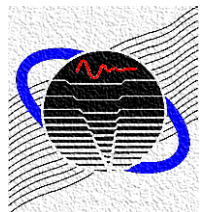
Breakout Transmission Loss

16 in x 48 in Duct with 10 ft lining
(2 in thick glass fiber)

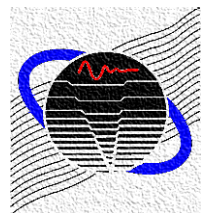
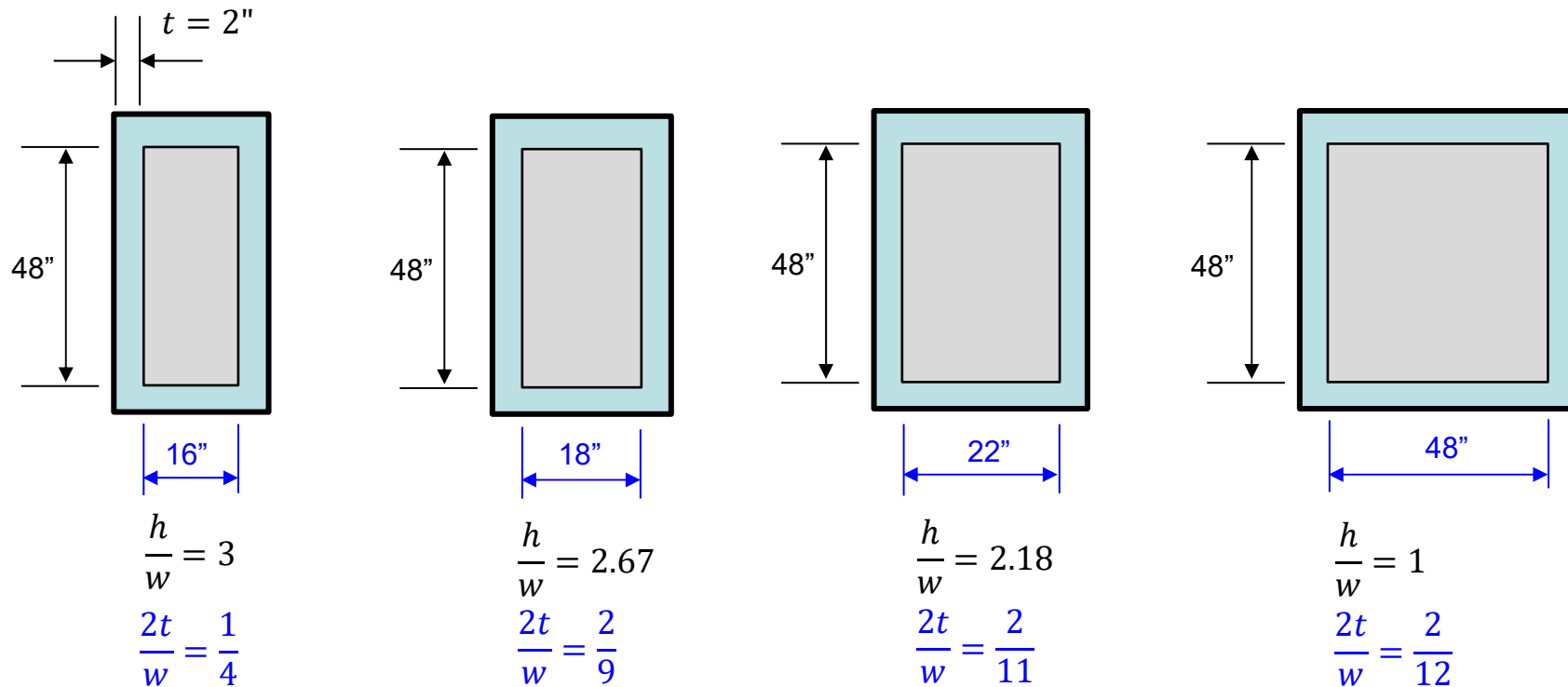


Overview

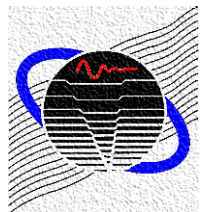
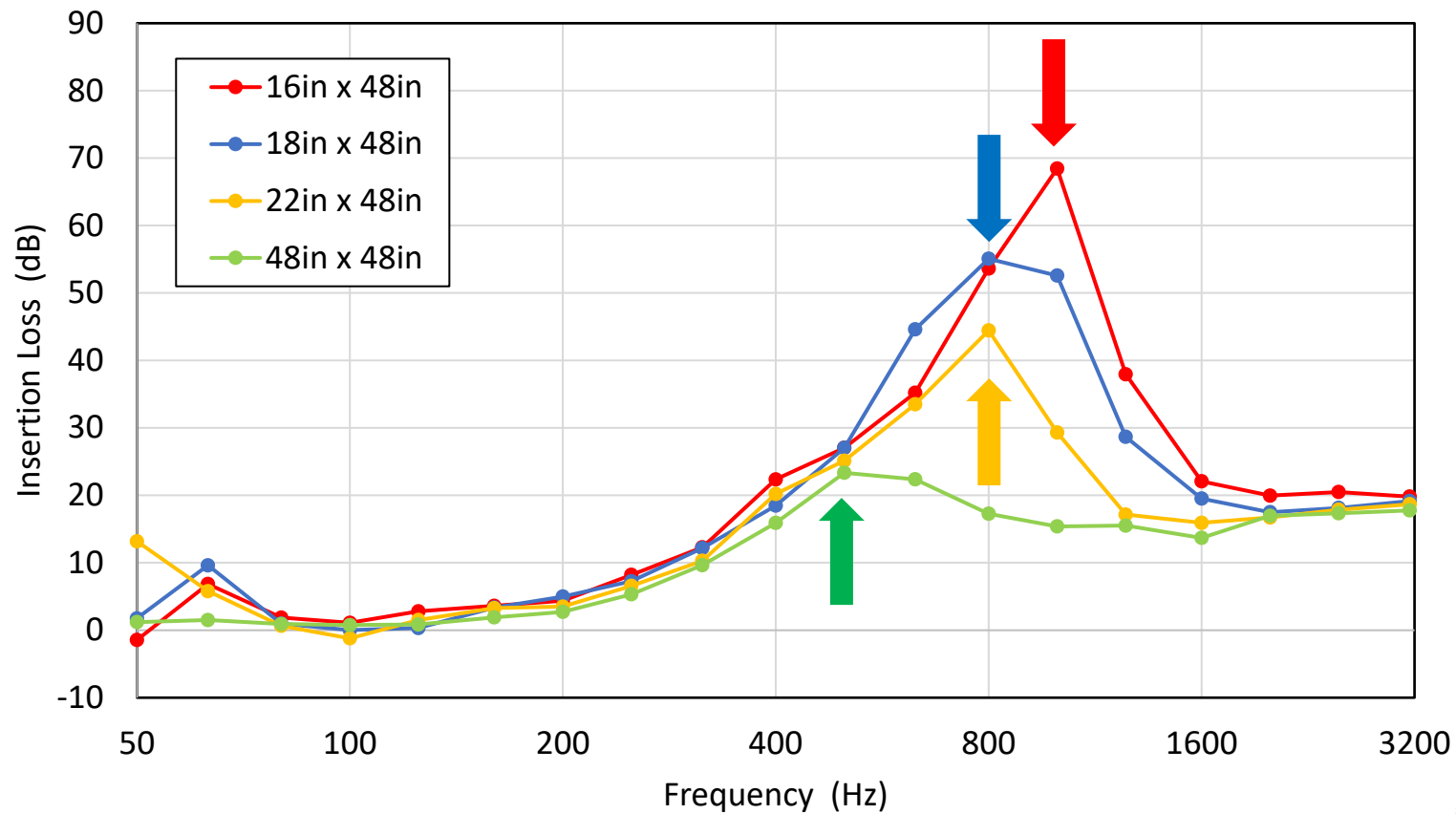
- Simulation Approach in Siemens Simcenter
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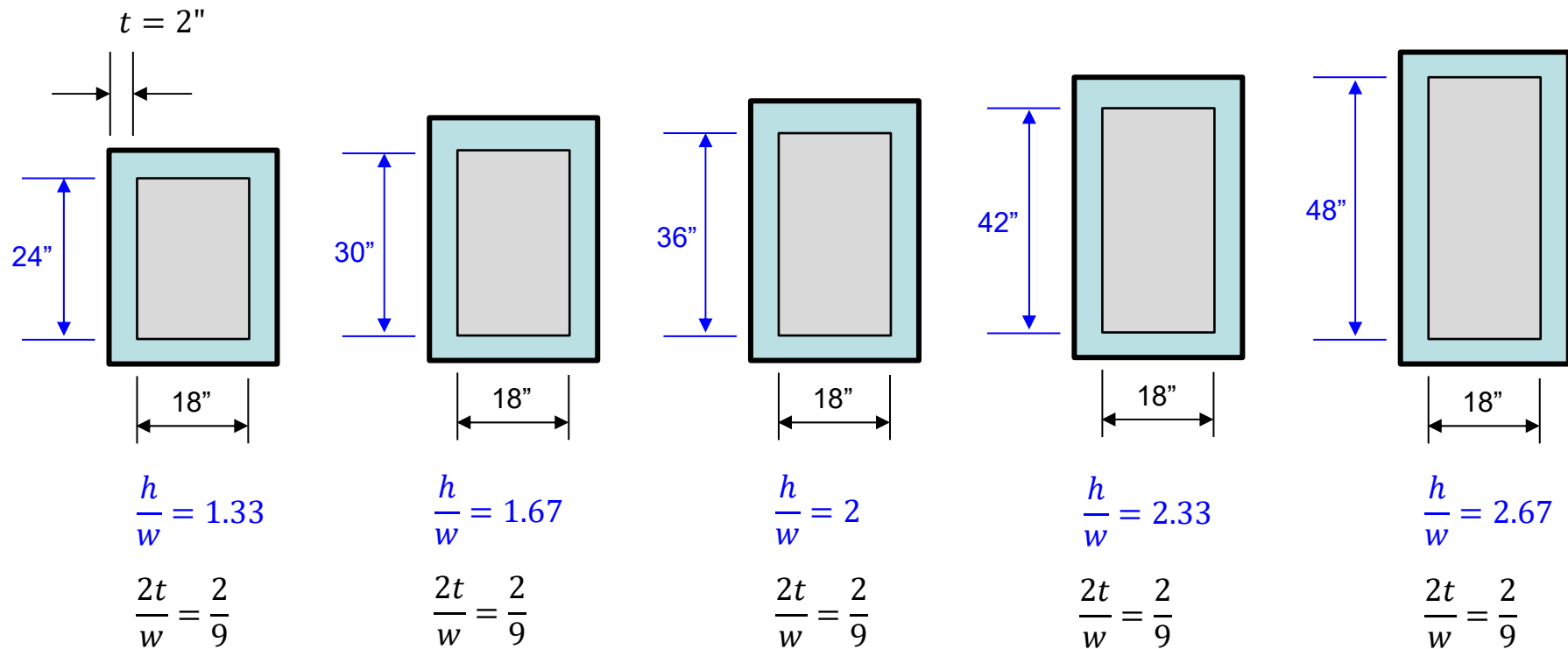
Sensitivity Study Constant Height



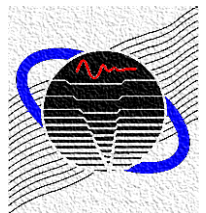
Insertion Loss Constant Height



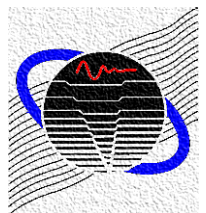
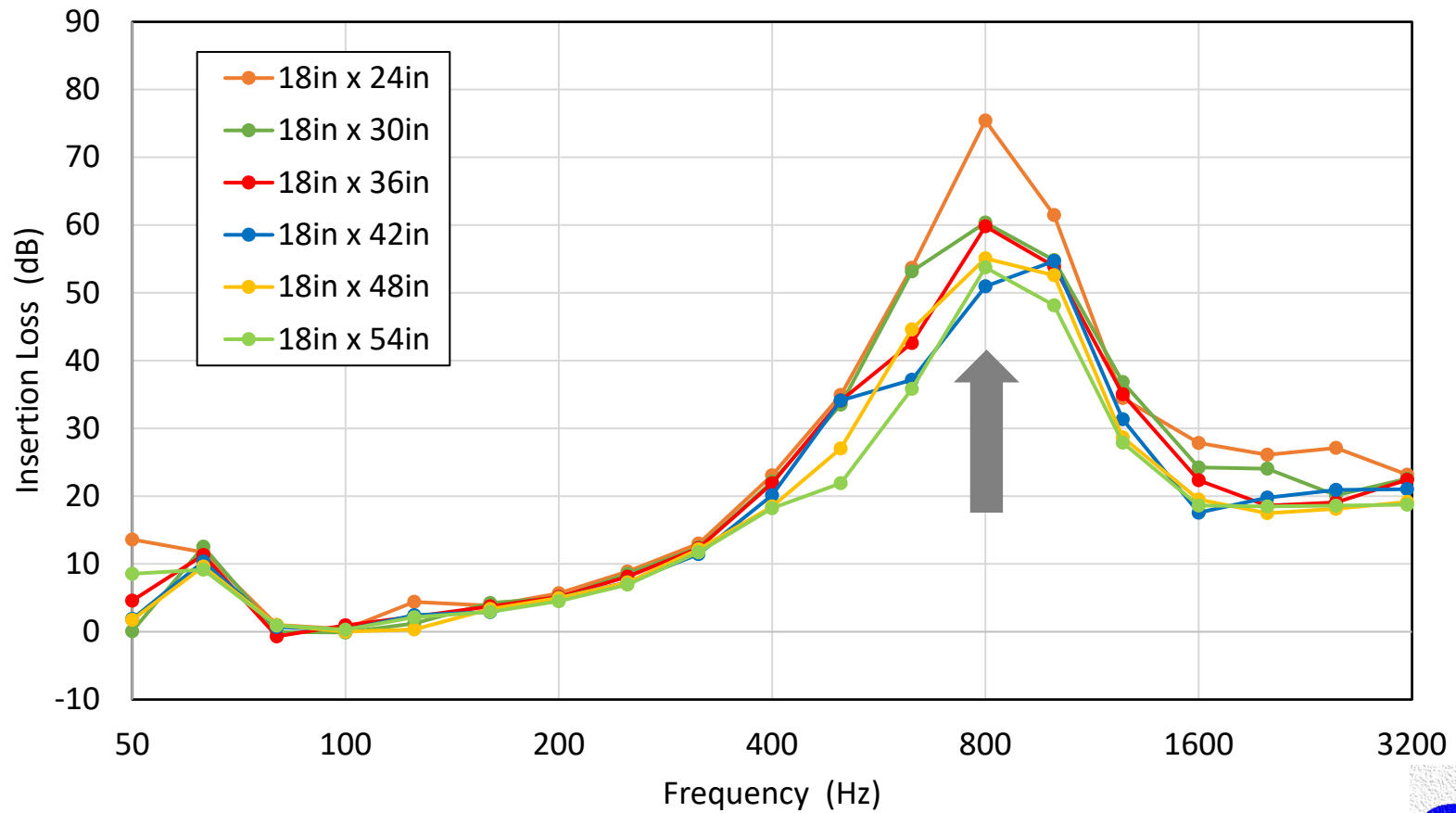
Sensitivity Study Constant Width



Note: 2 inch fiber on sides.

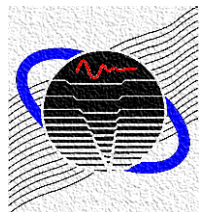


Insertion Loss Constant Width



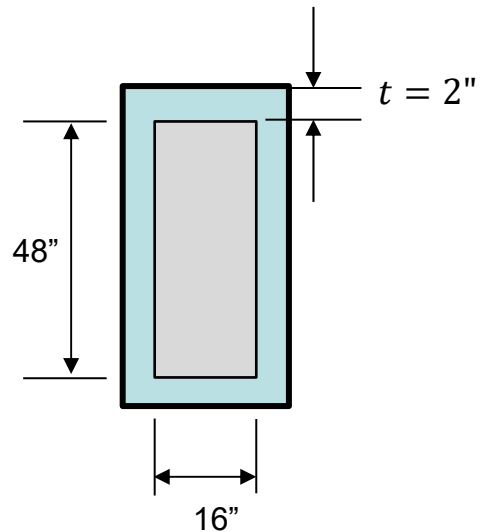
Overview

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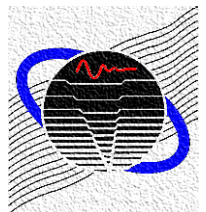
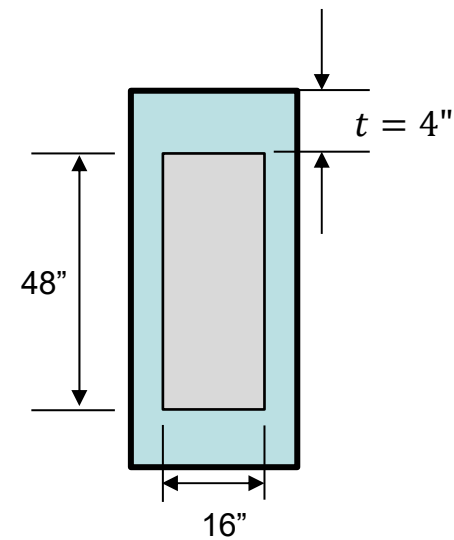


Improvements Increase Absorption

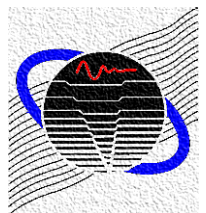
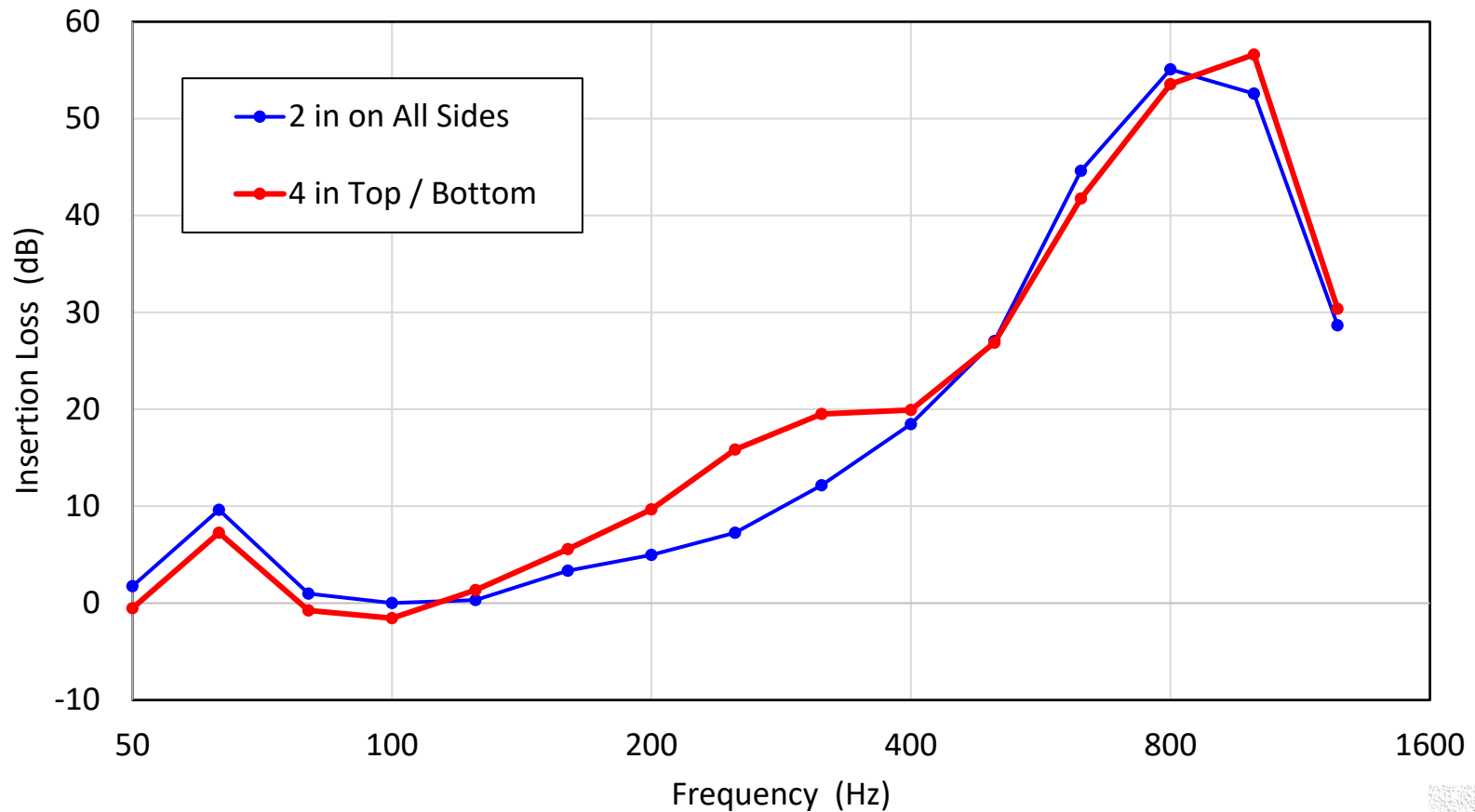
2 in lining on all sides



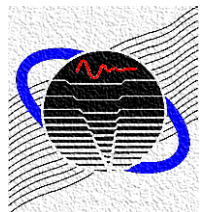
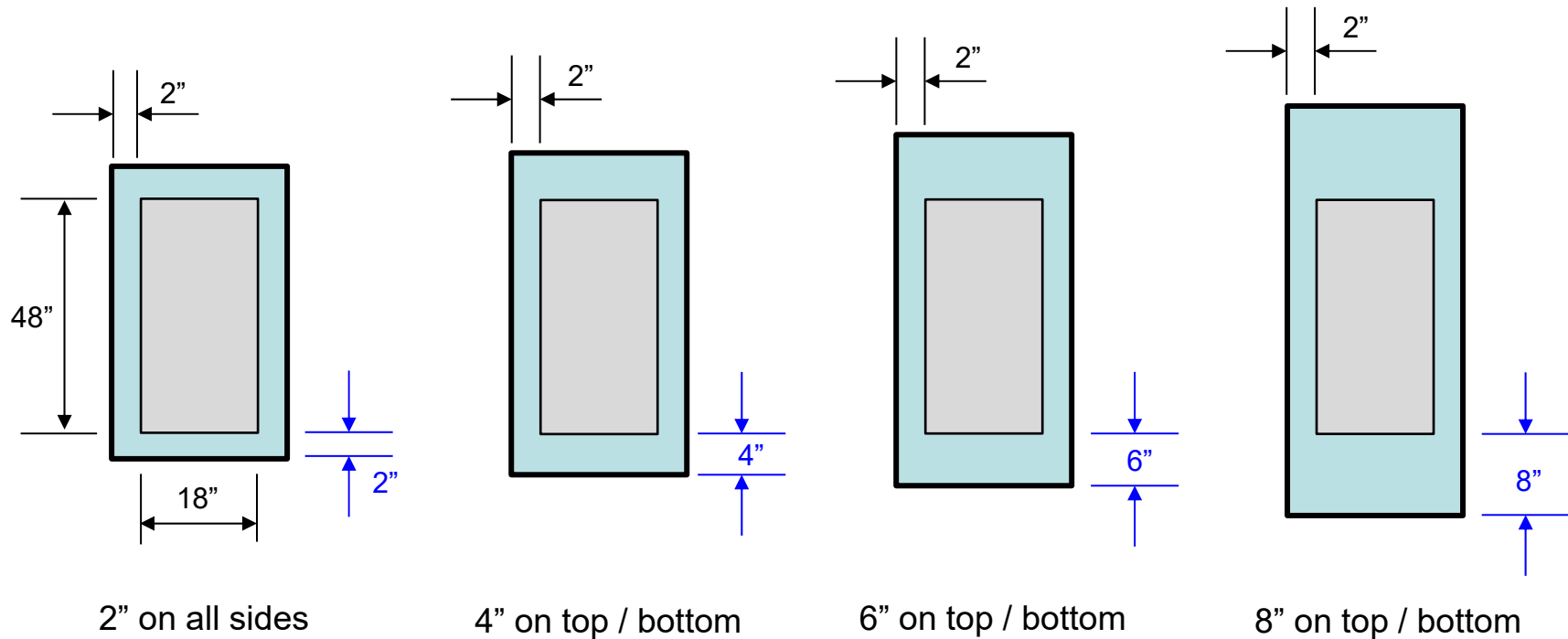
4 in lining on top / bottom



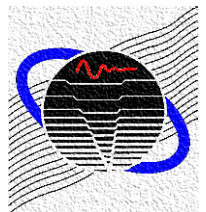
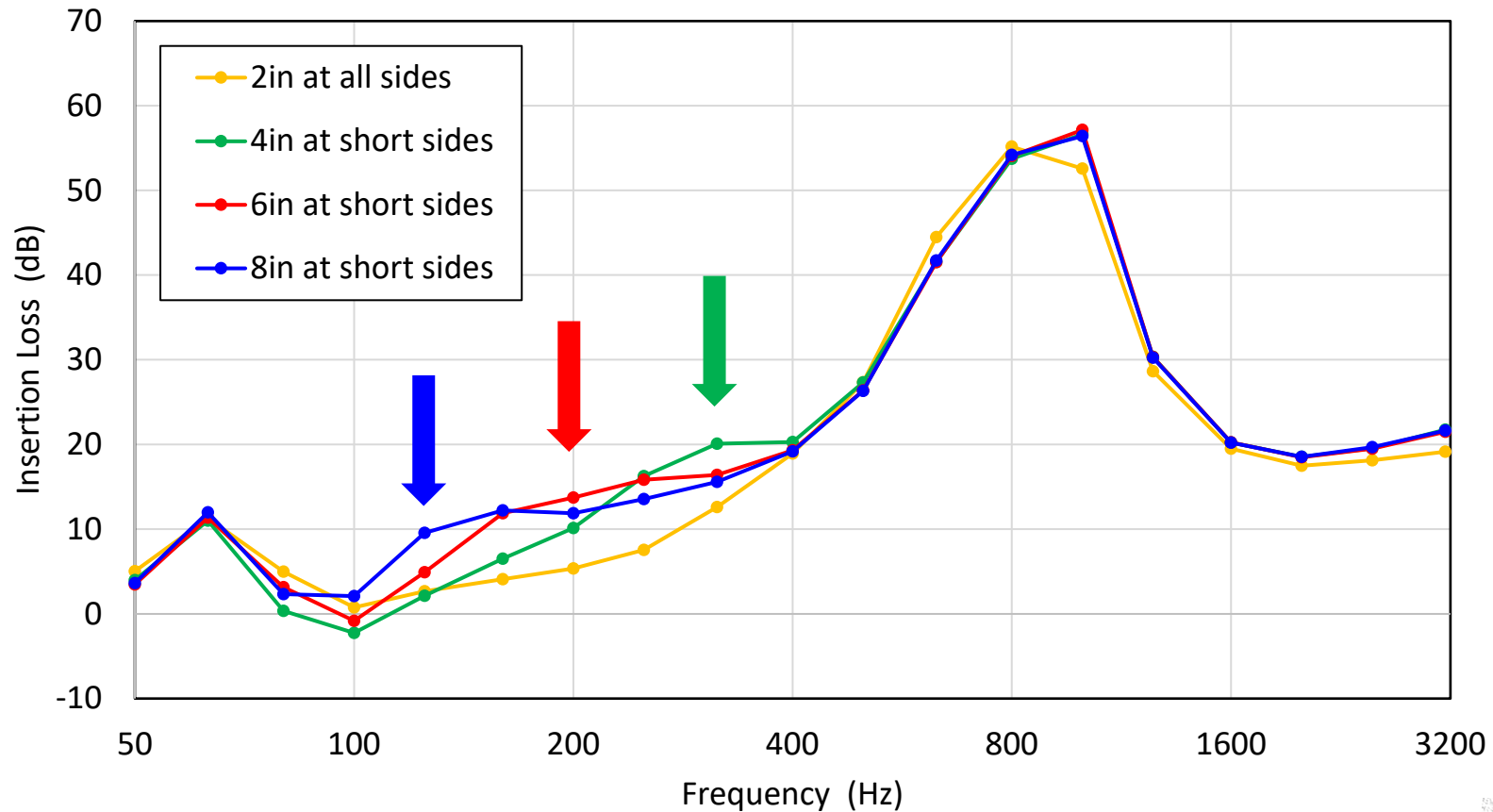
Insertion Loss Thicker Absorption



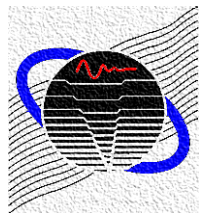
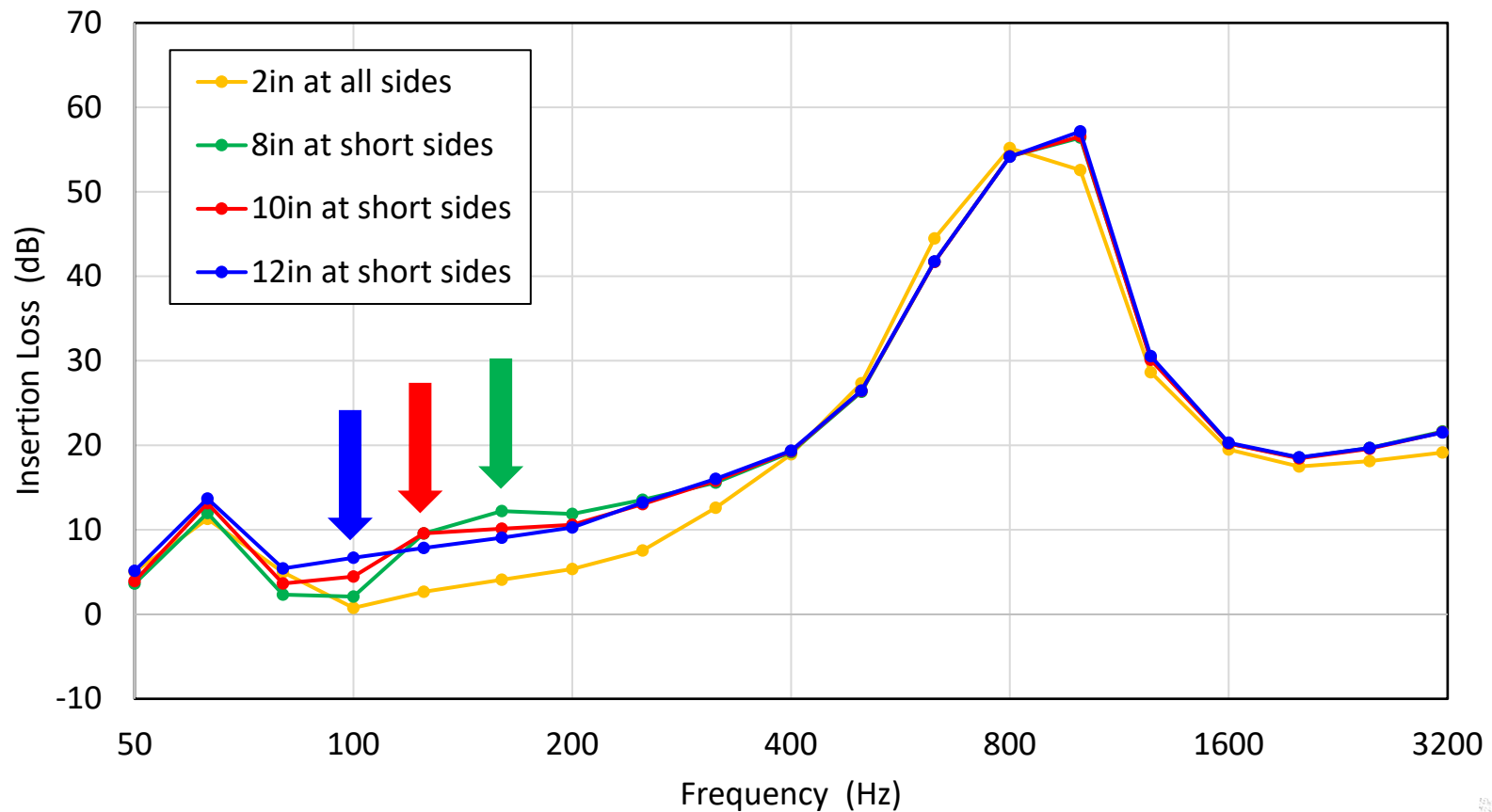
Improvements Increase Absorption



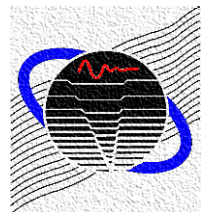
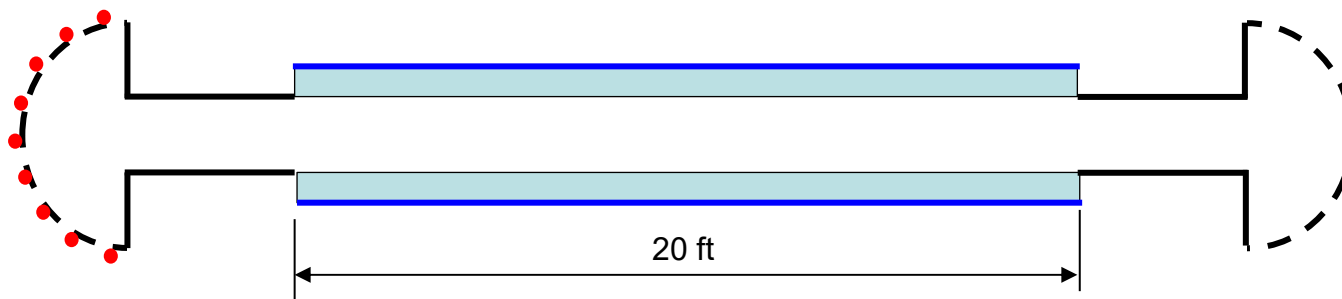
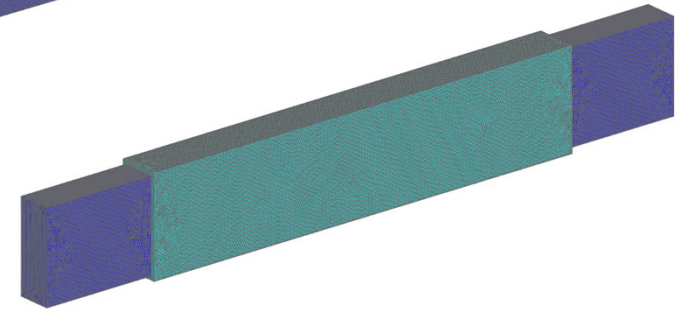
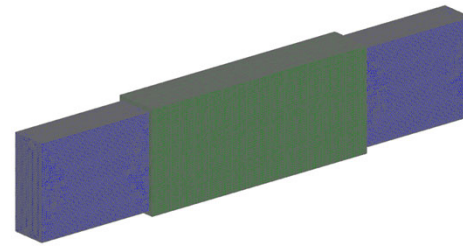
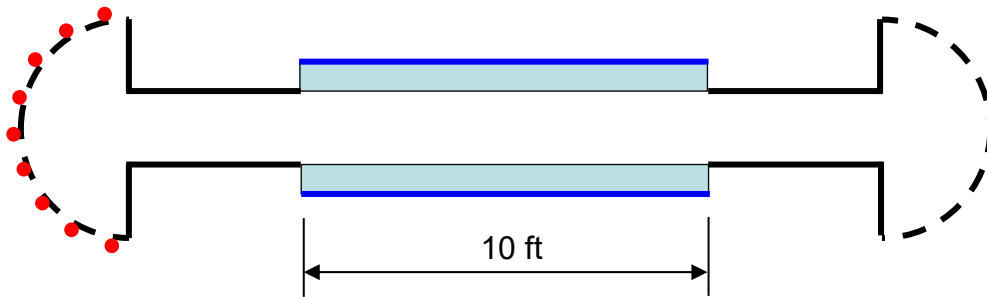
Insertion Loss Thicker Absorption



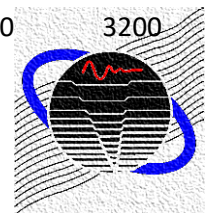
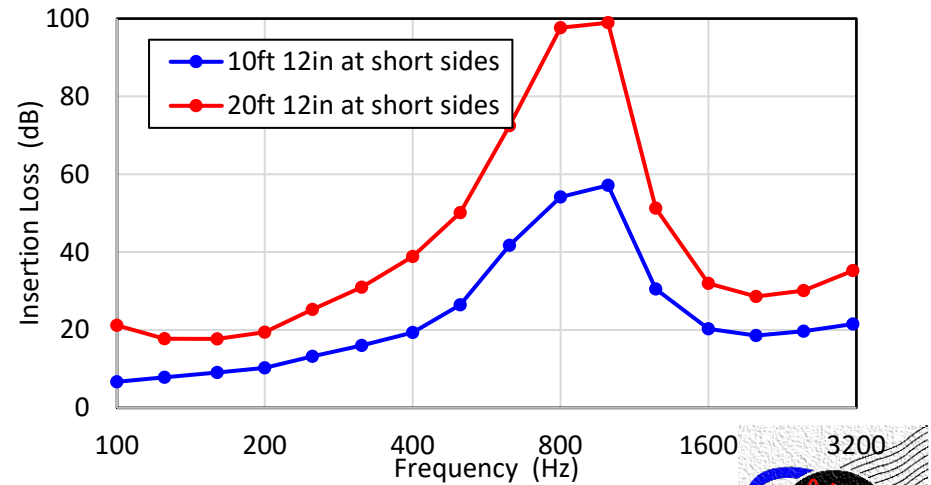
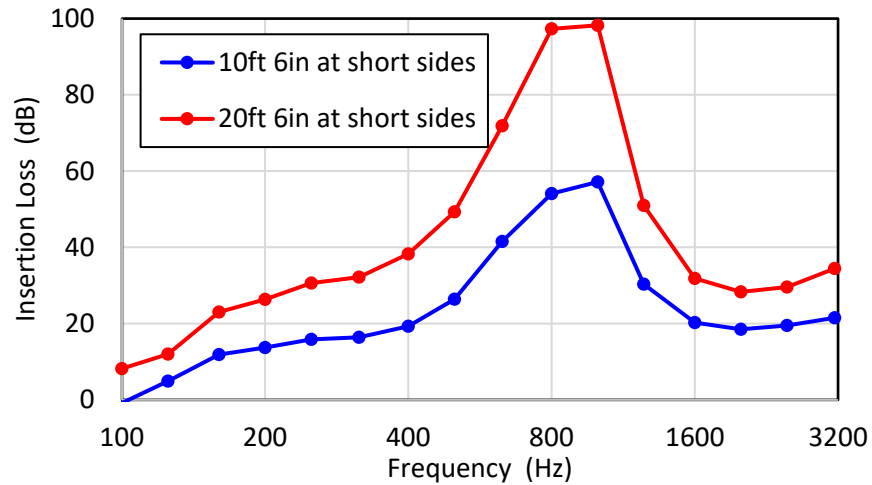
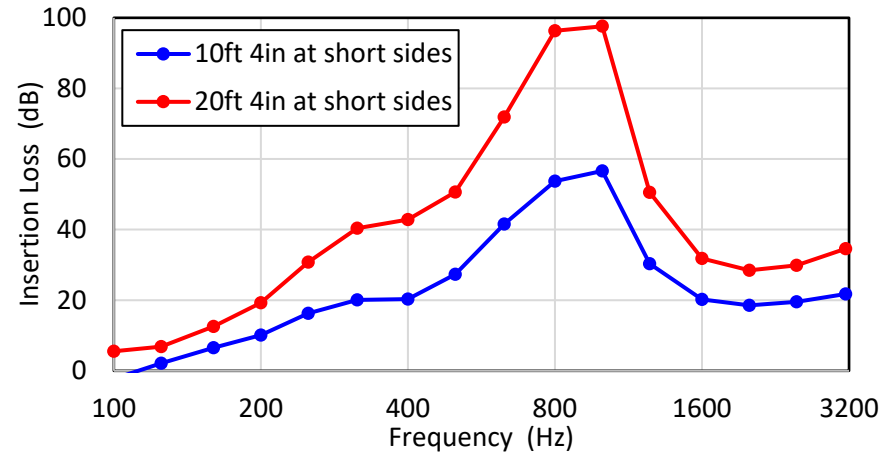
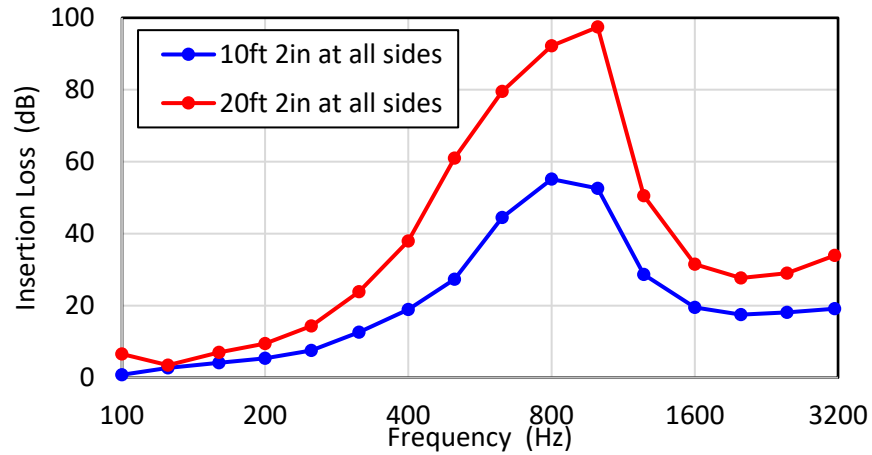
Insertion Loss Thicker Absorption



Improvements Add Length



Insertion Loss Add Length



Summary

- FEM Simcenter was used successfully to predict the insertion loss and breakout transmission loss.
- The smallest cross-sectional dimension drives the insertion loss performance.
- Performance can be improved by increasing the sound absorption thickness at the top / bottom of the duct assuming the height is the longest dimension.

