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The application of the edge-constraint effect to nearly-realistic noise control applications

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THE APPLICATION OF THE EDGE-CONSTRAINT EFFECT TO NEARLY-REALISTIC NOISE CONTROL APPLICATIONS

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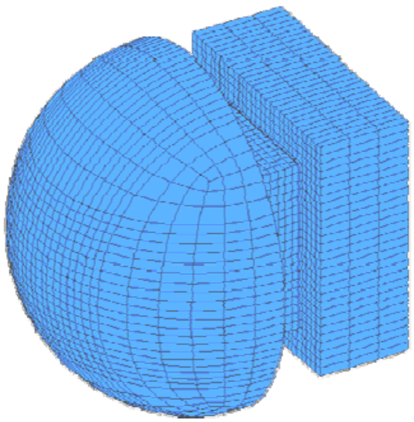


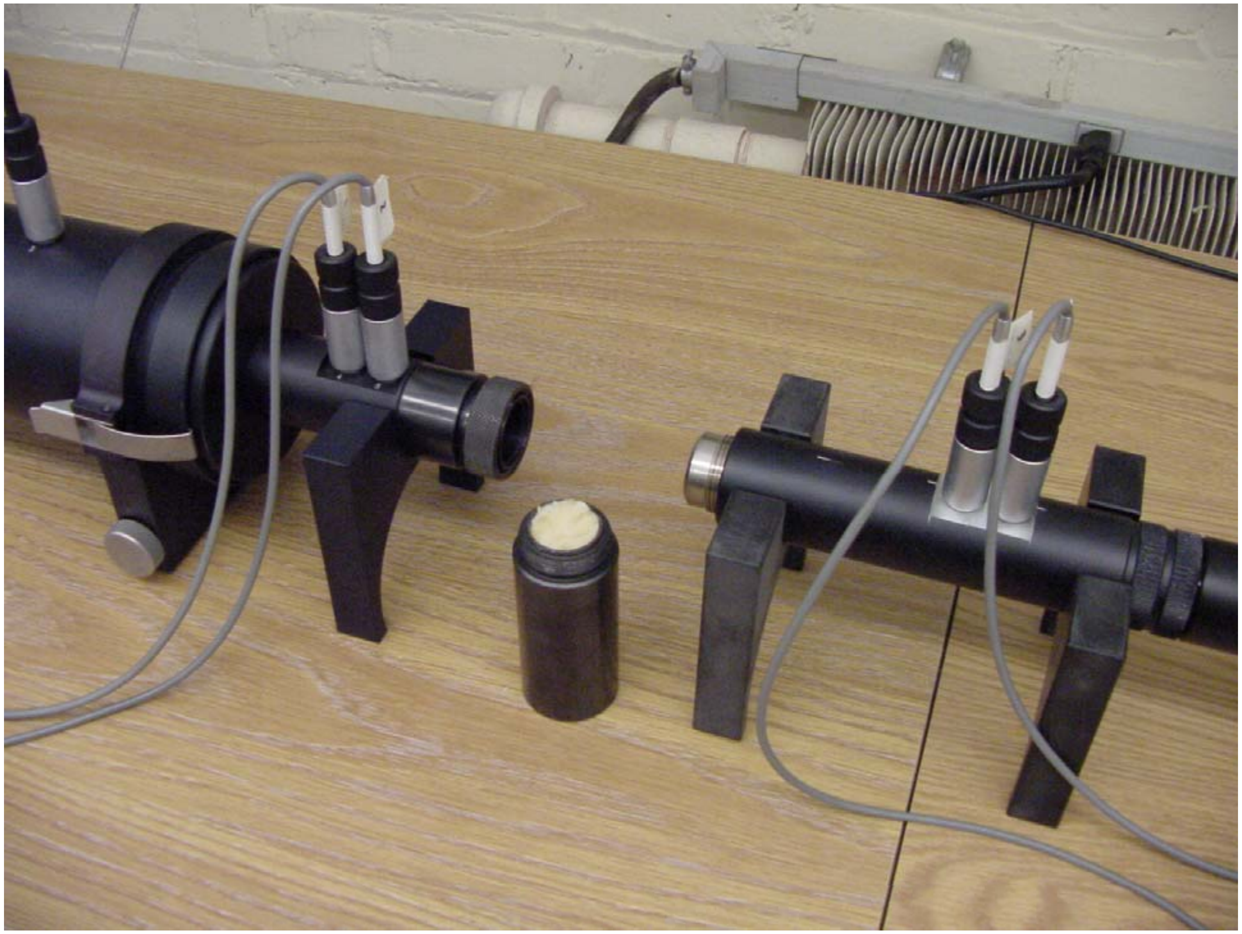
Background

- Investigation of edge constraint effect on samples placed in a modified standing wave tube (J. S. Bolton et al., *SAE* 1997; B. H. Song et al., *JASA* 1999).
- Internal constraints may be used to selectively enhance the transmission loss of lining materials at low frequencies (B. H. Song et al., *JASA* 2001).
- Enhancement of the barrier performance of porous linings by using internal constraints (B. H. Song et al., submitted for *NCEJ* 2001).

Introduction

- Comparison between measured and FE predicted random transmission loss.
- Enhancement of transmission loss of barrier system by exploiting the edge-constraint effect at low frequency
- Design of low frequency noise control barriers following from constraint of porous lining materials around their edges.

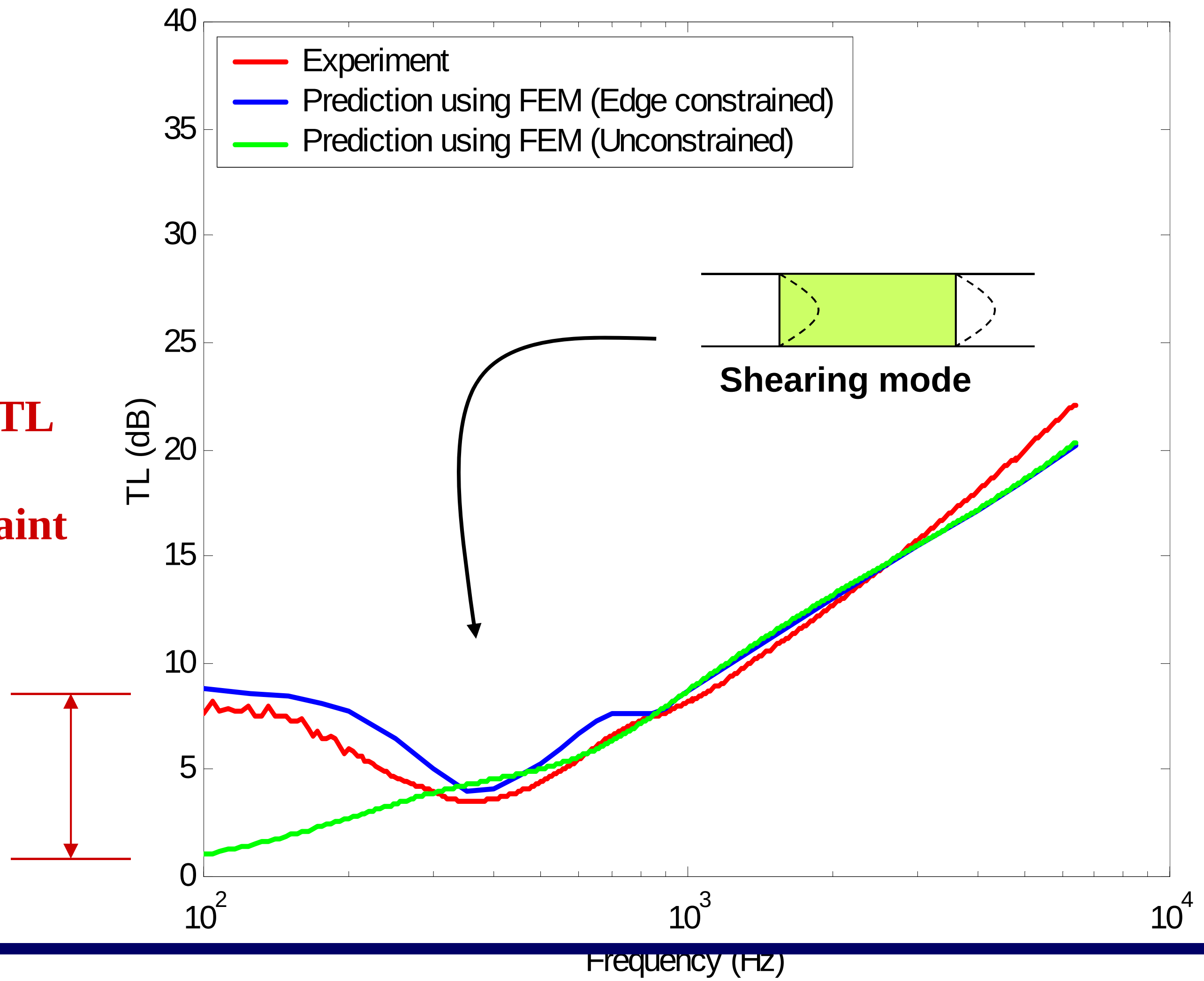
Glass Fiber Material inside of Sample Holder



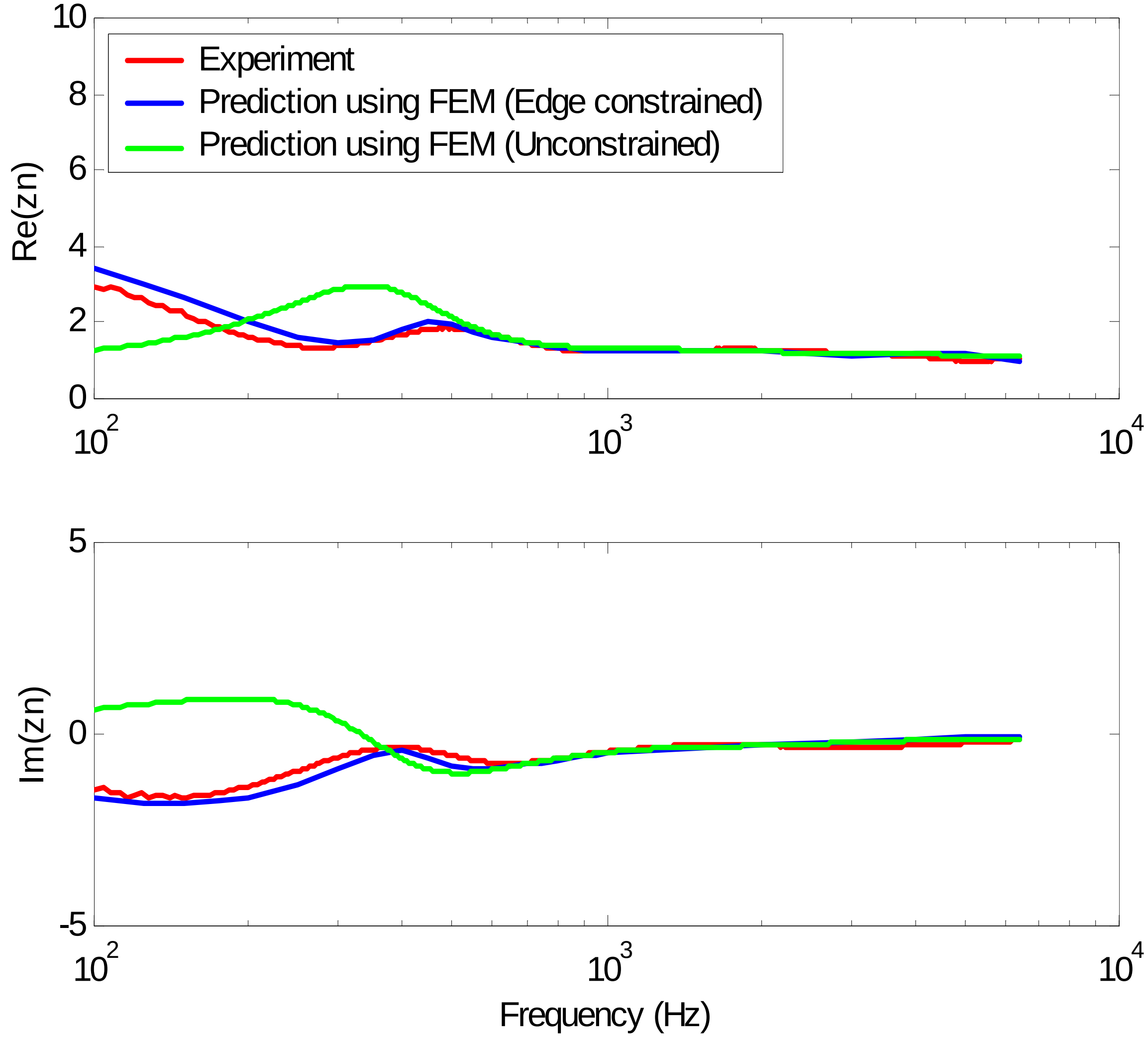
Four Microphone Measurement

Anechoic Transmission Loss
(3" Sample A in a Small Tube)

Increase in TL due to edge constraint

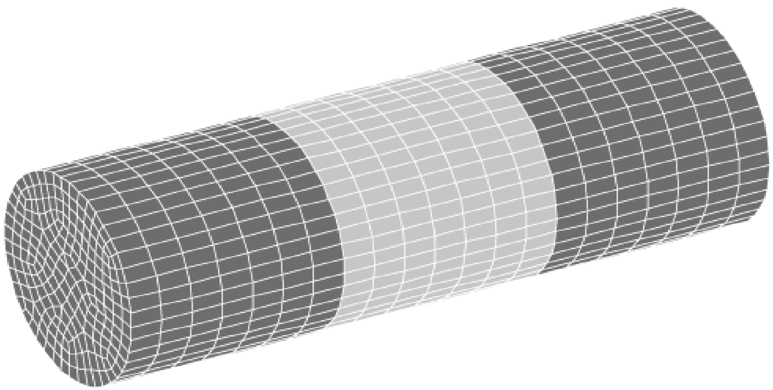


Surface Normal Impedance
(3" Sample A in a Small Tube)



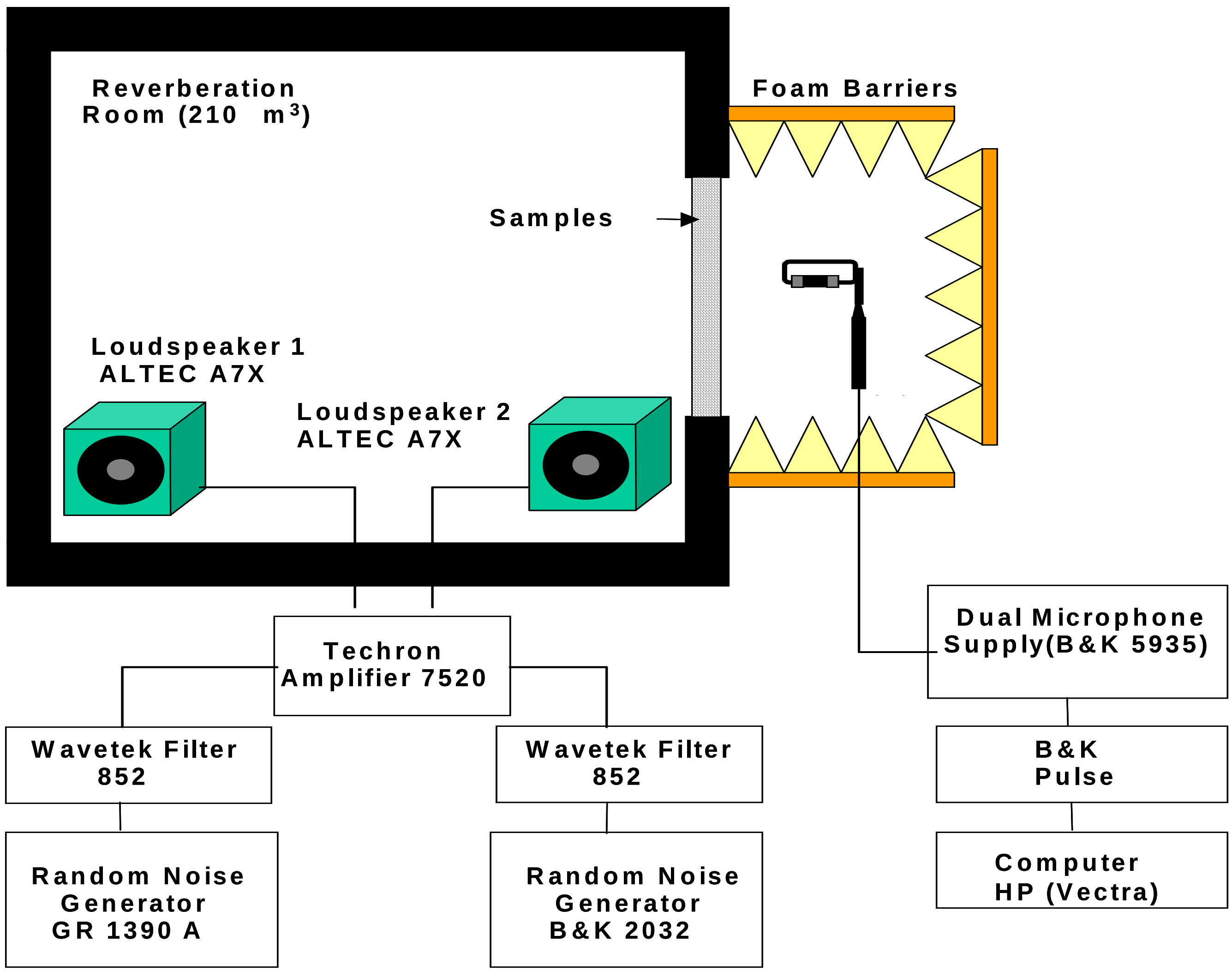
Poroelastic Material Properties used in Calculations

Material	Bulk density (Kg/m^3)	Porosity	Tortuosity	Flow resistivity (MKS Rayls/m)	Shear modulus (Pa)	Loss factor
Sample A	6.73	0.99	1.1	21000	1200	0.35



Random Incidence Transmission Loss
(27 cm X 27 cm)

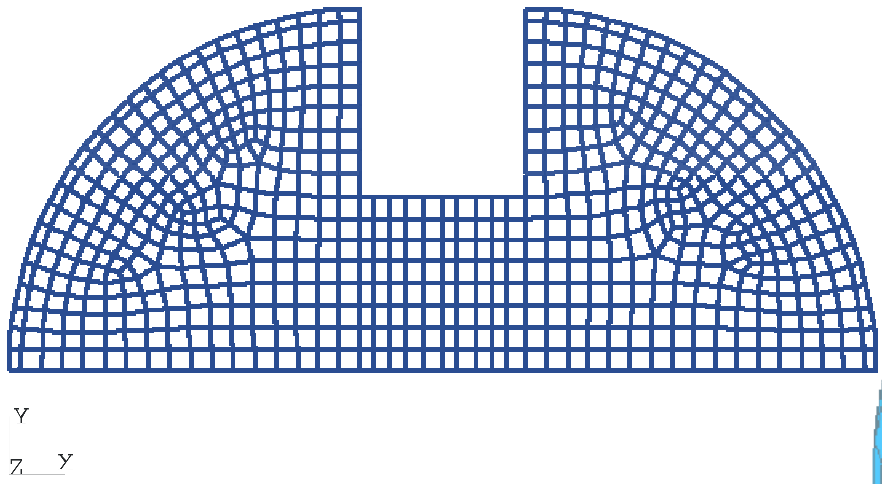
Schematic of Experimental Setup for the Random Transmission Loss

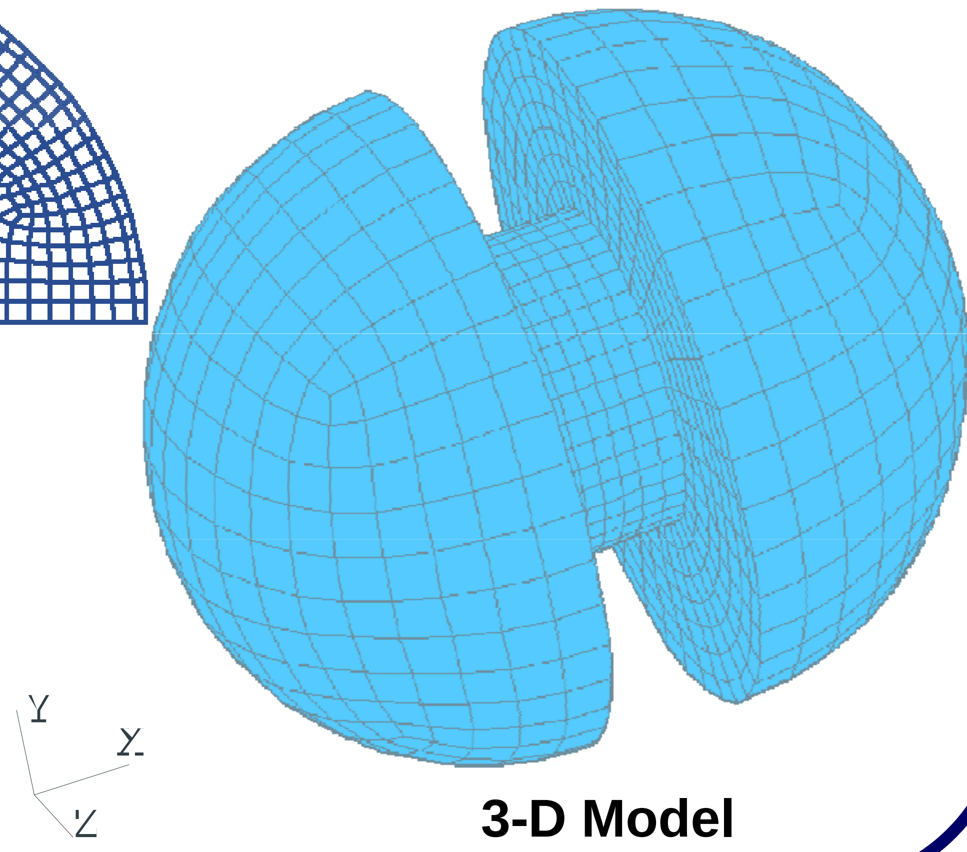


The Circular Aperture for Random Incidence Transmission Loss (30 cm Diameter)

Axisymmetric and 3-D FE Models
(30 cm Diameter Circular Aperture)

Axisymmetric Model

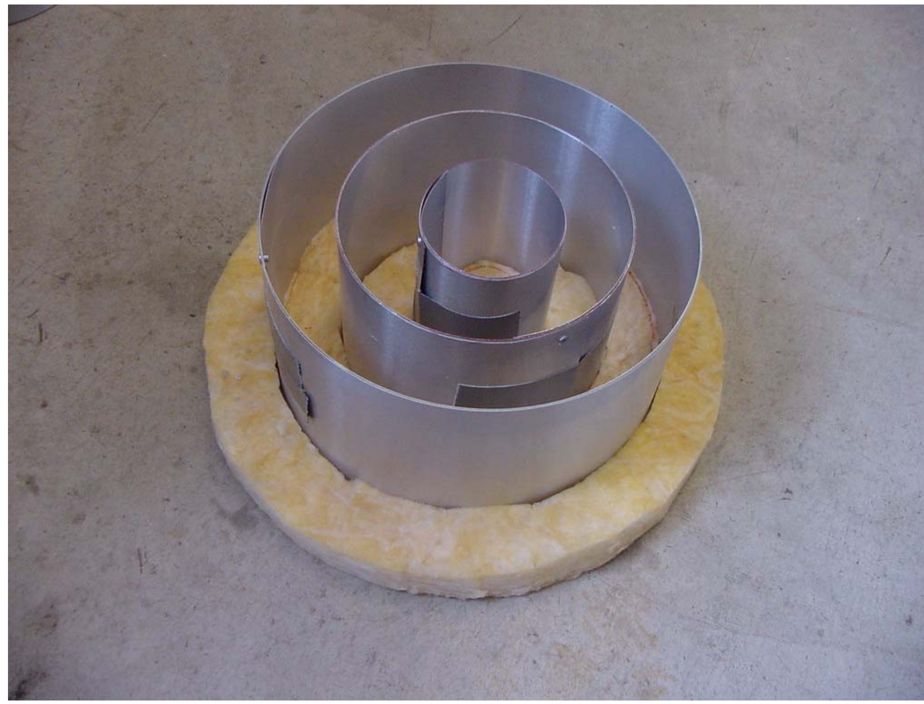


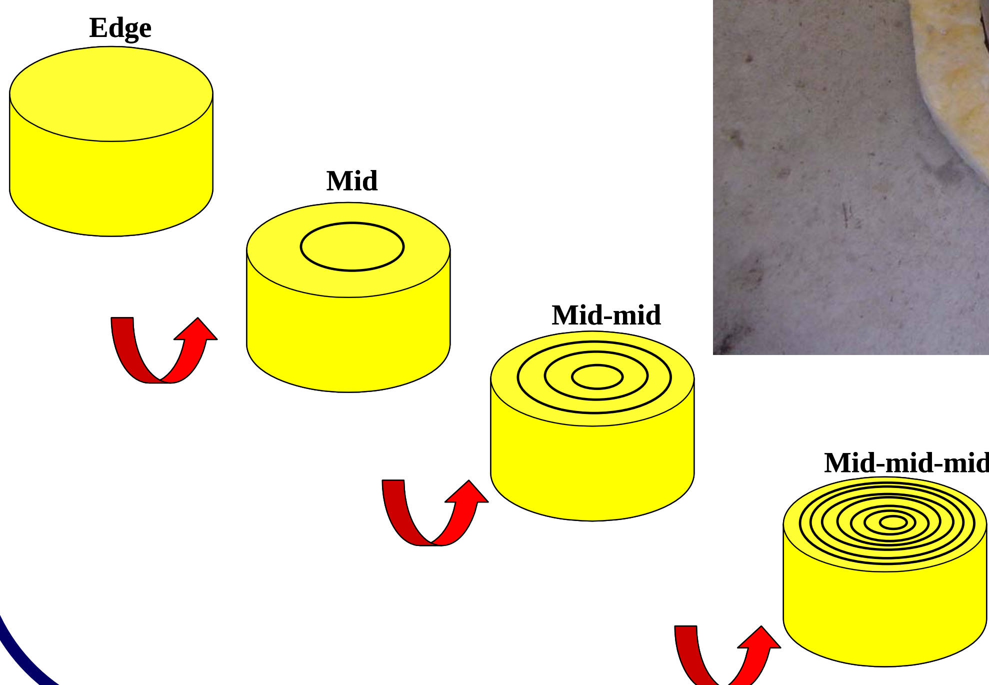


3-D Model

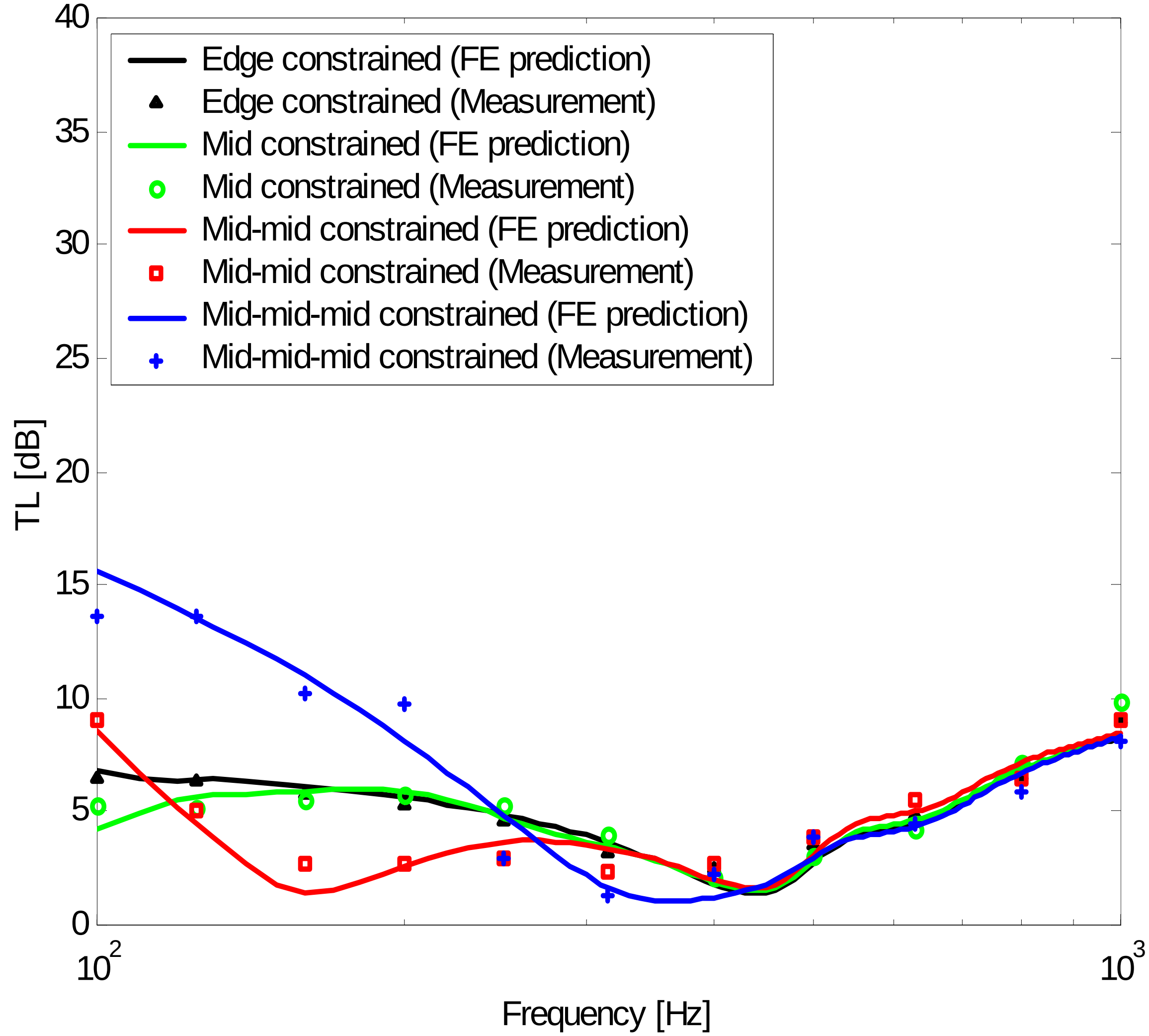
Internally-Constrained, 30 cm Diameter Sample

Mid-mid-Constrained Case

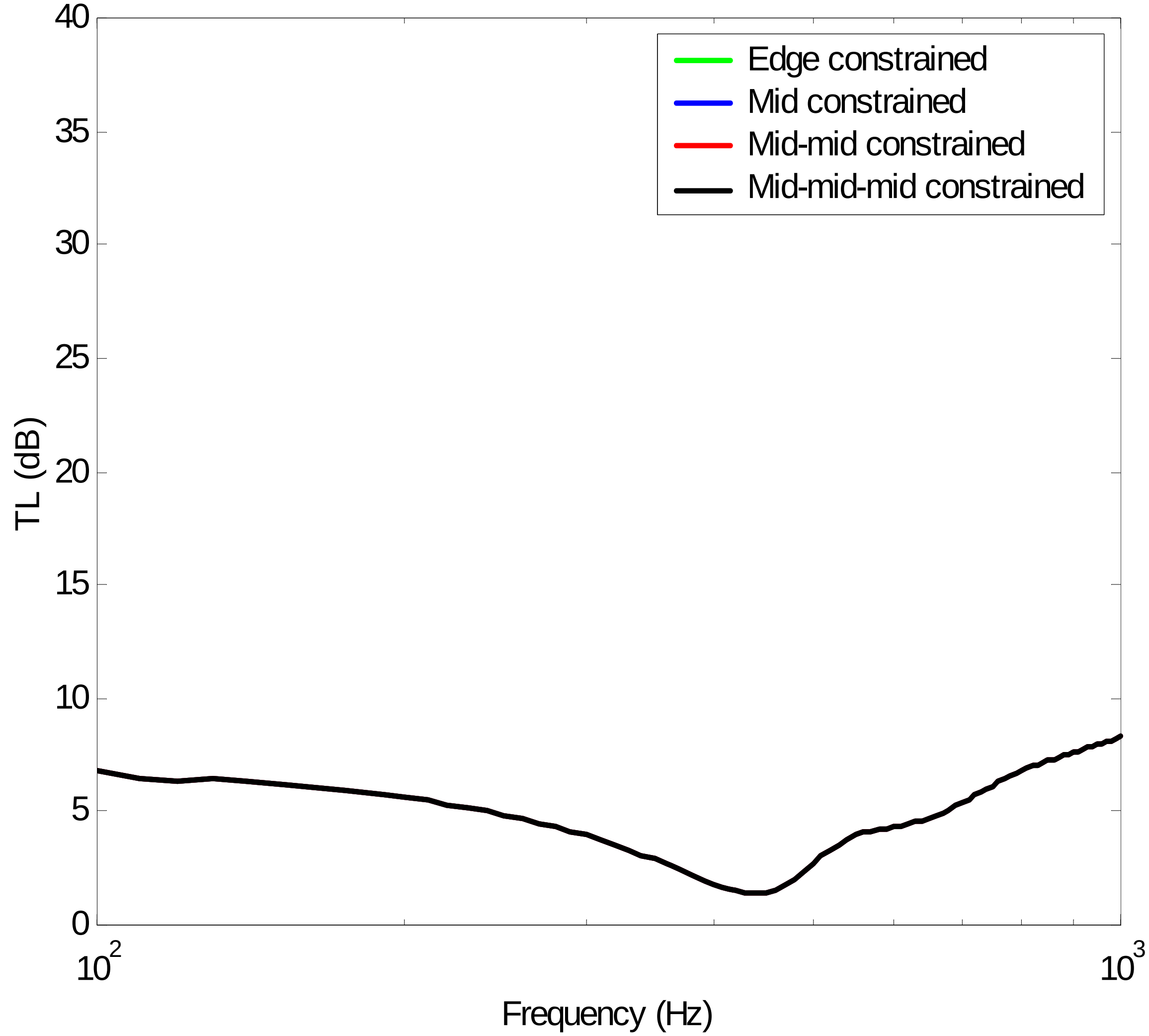




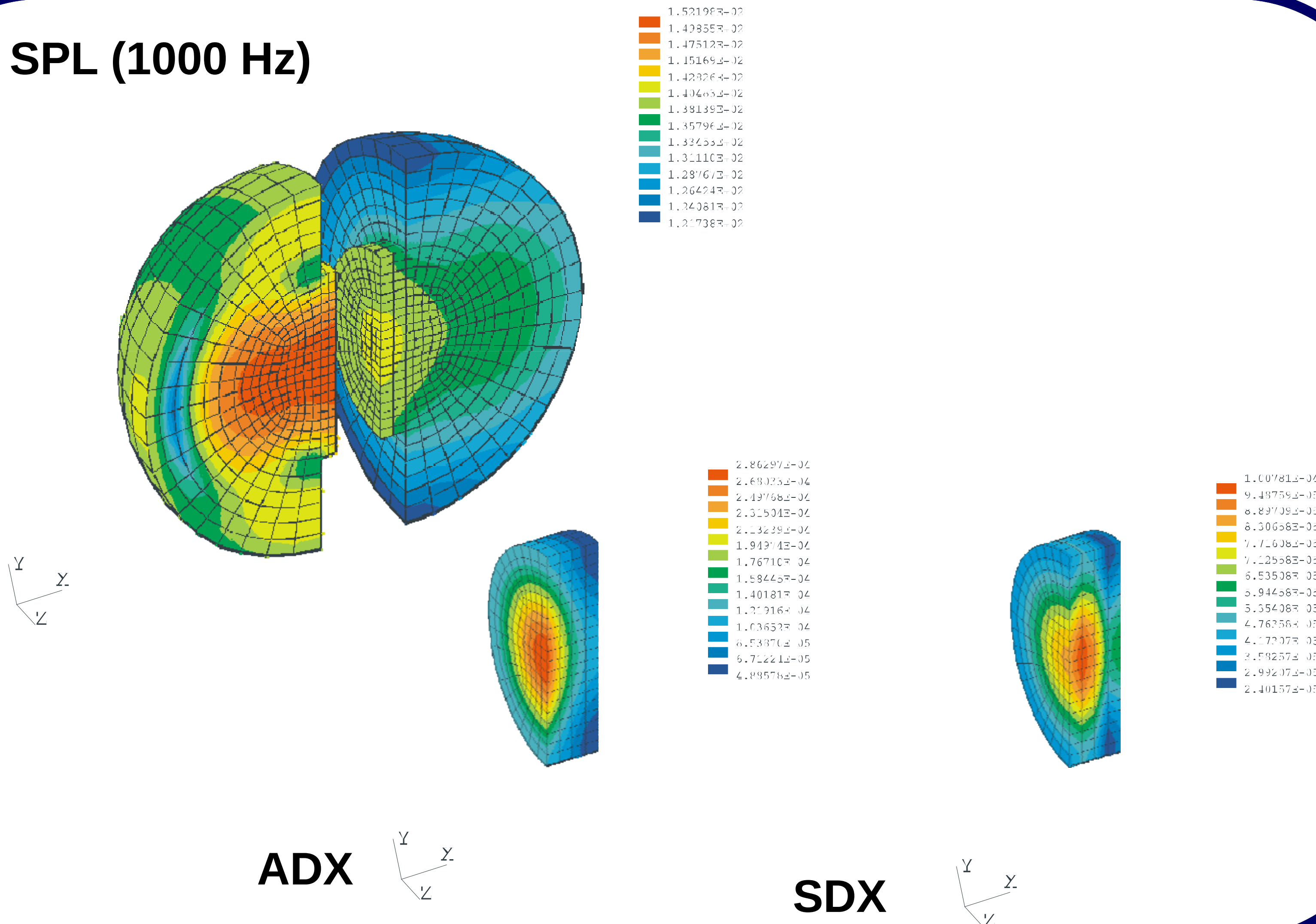
TL for the Various Constraint Cases



TL for the Unconstrained FE Predictions

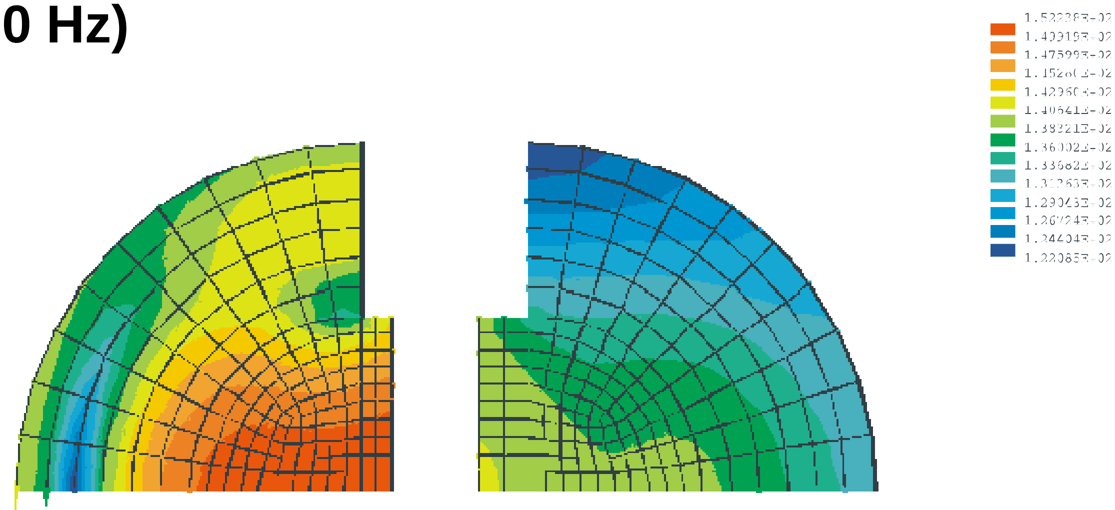


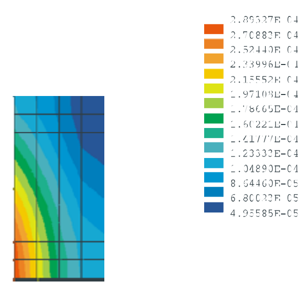
FE Prediction of Random Incidence Transmission Loss (3-D Model)

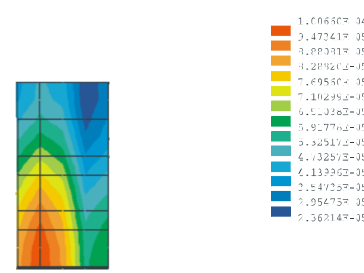


FE Prediction of Random Incidence Transmission Loss (Axisymmetric FE Model)

SPL (1000 Hz)





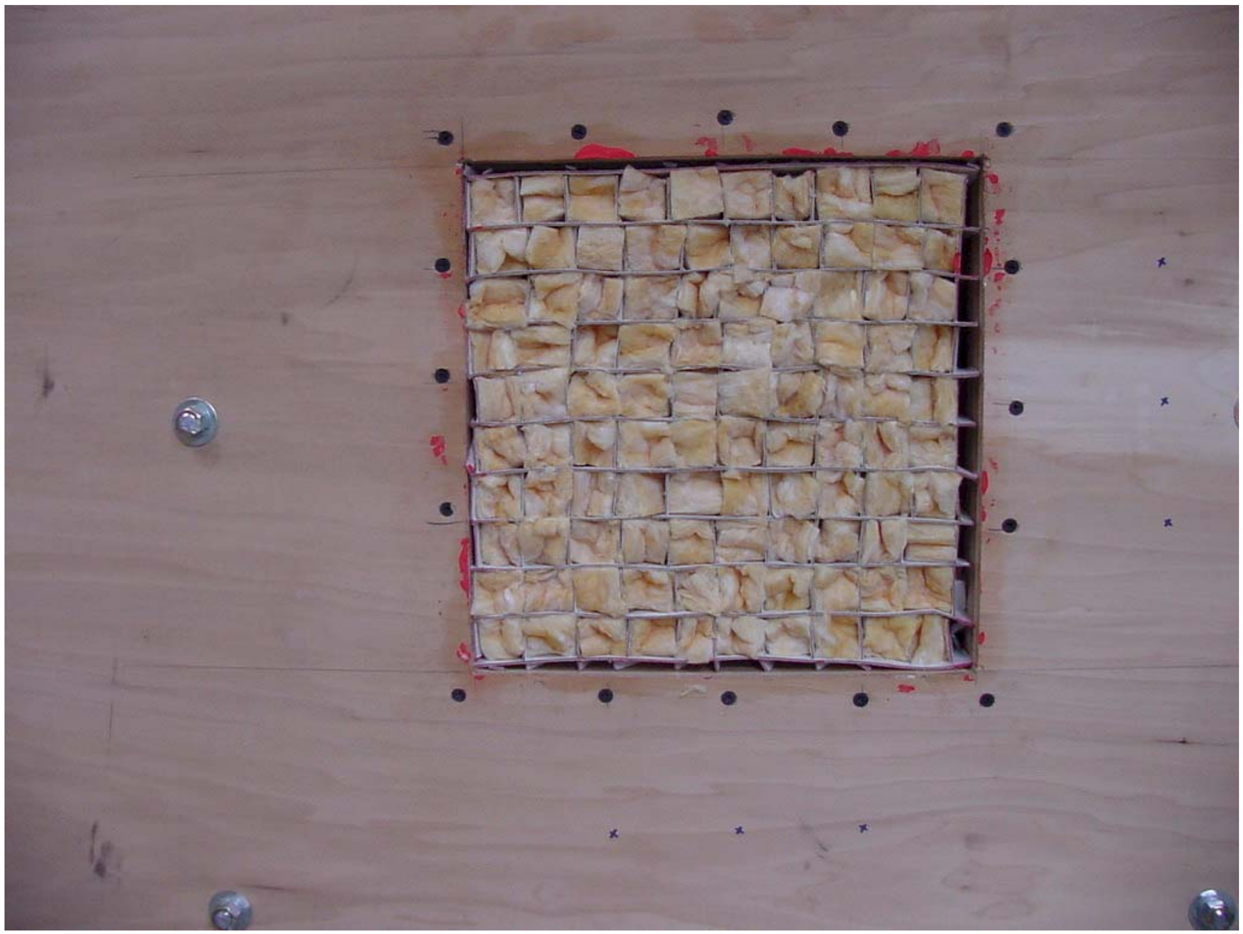


ADX

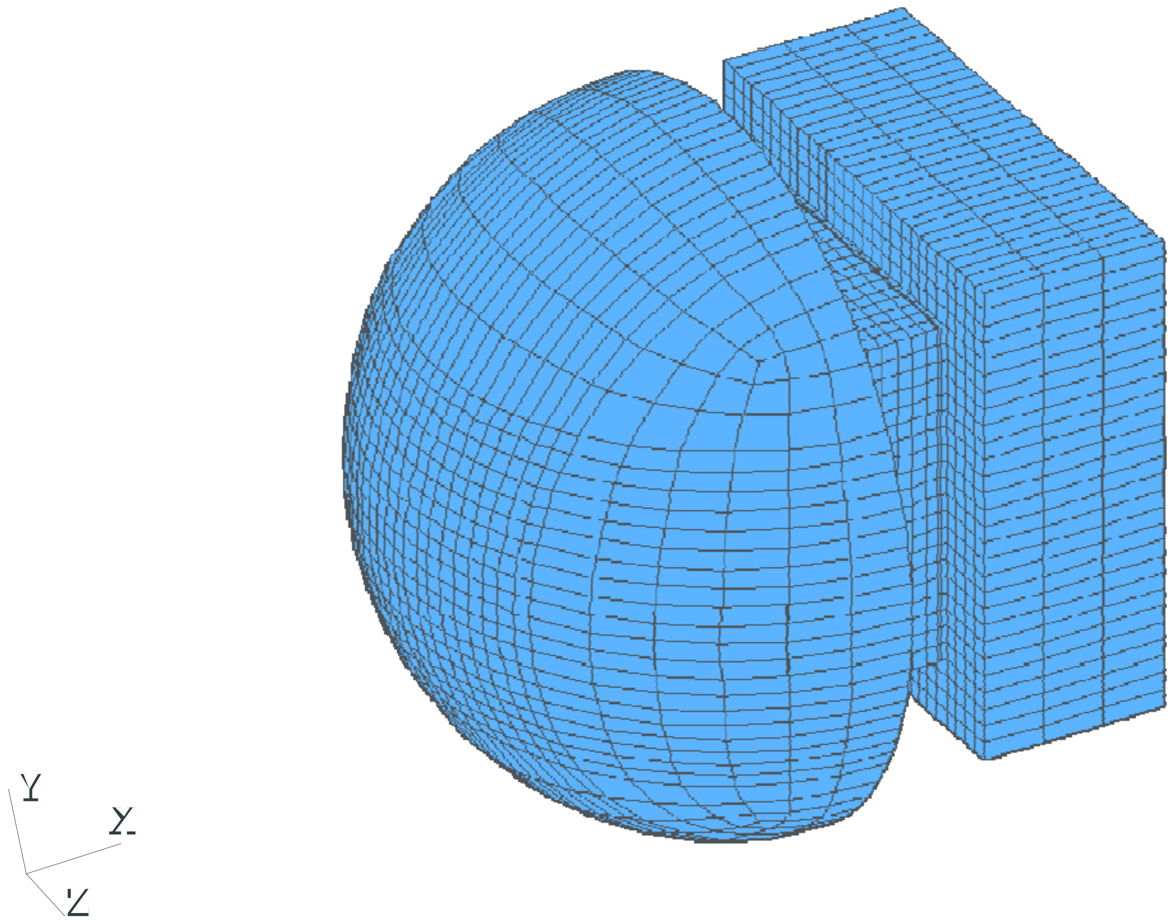
SDX

The Square Aperture for Random Incidence Transmission Loss (27 cm by 27 cm)

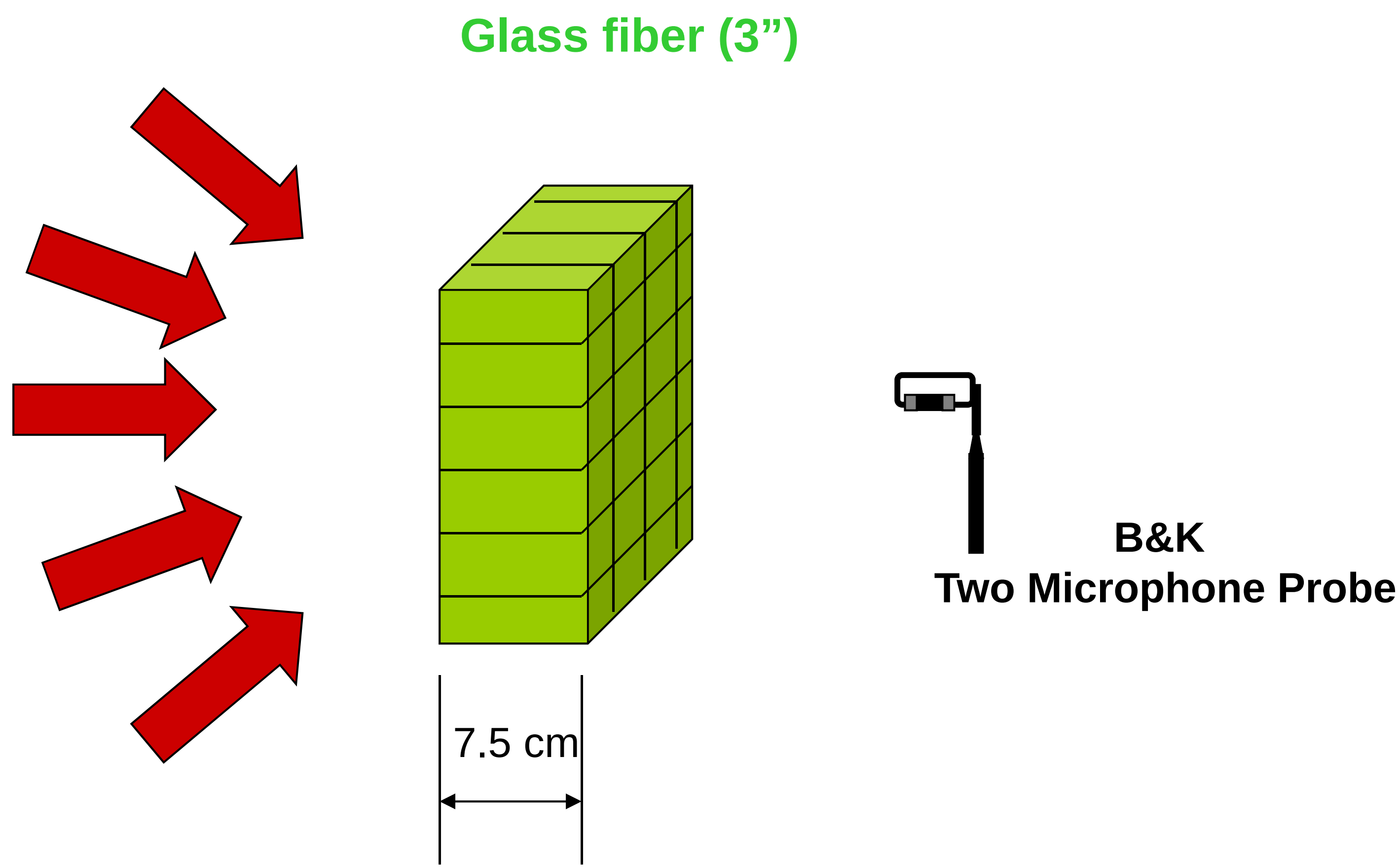
Internally-Constrained, 27 cm by 27 cm Sample



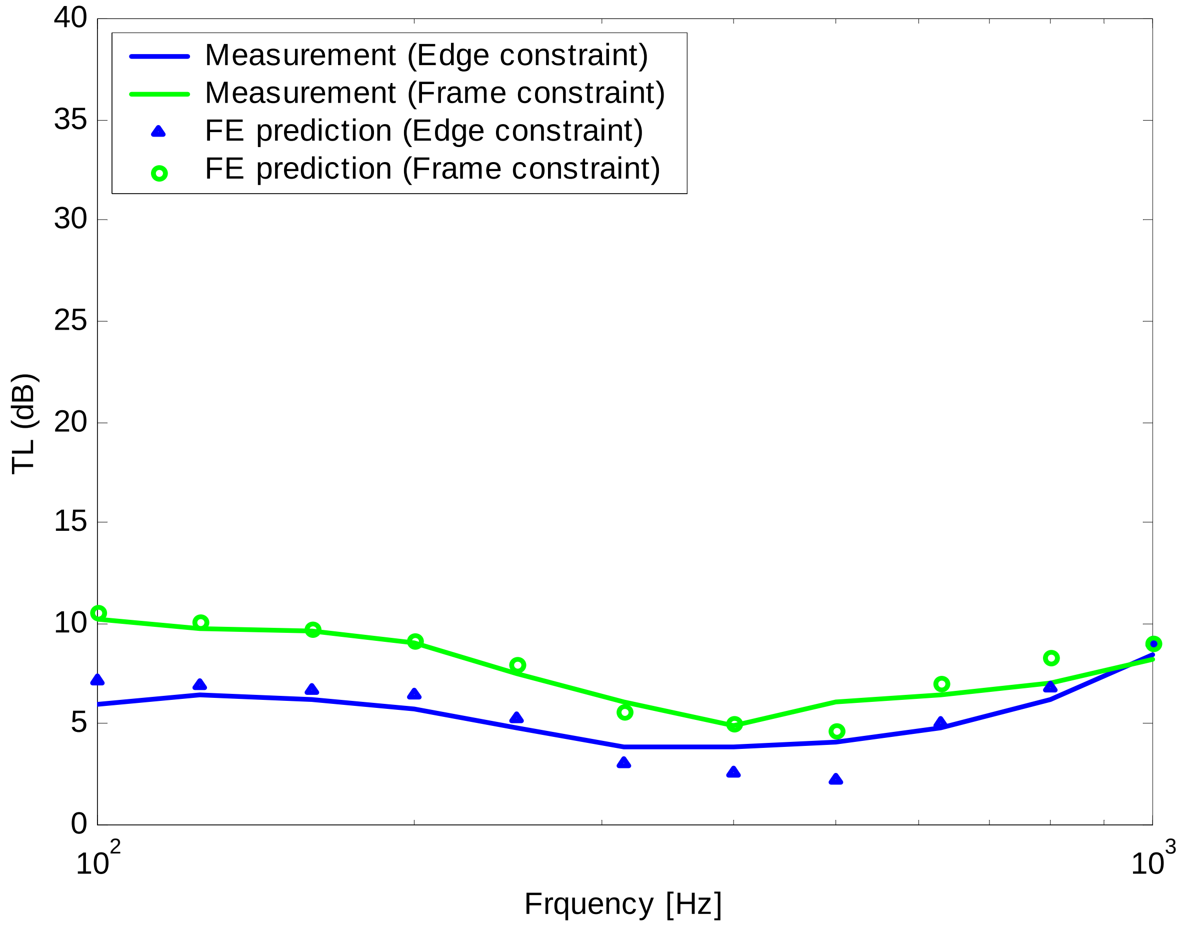
3-D FE Model
(27 cm by 27 cm, Square Aperture)



Internally-Constrained Green Sample (Frame Constraint)

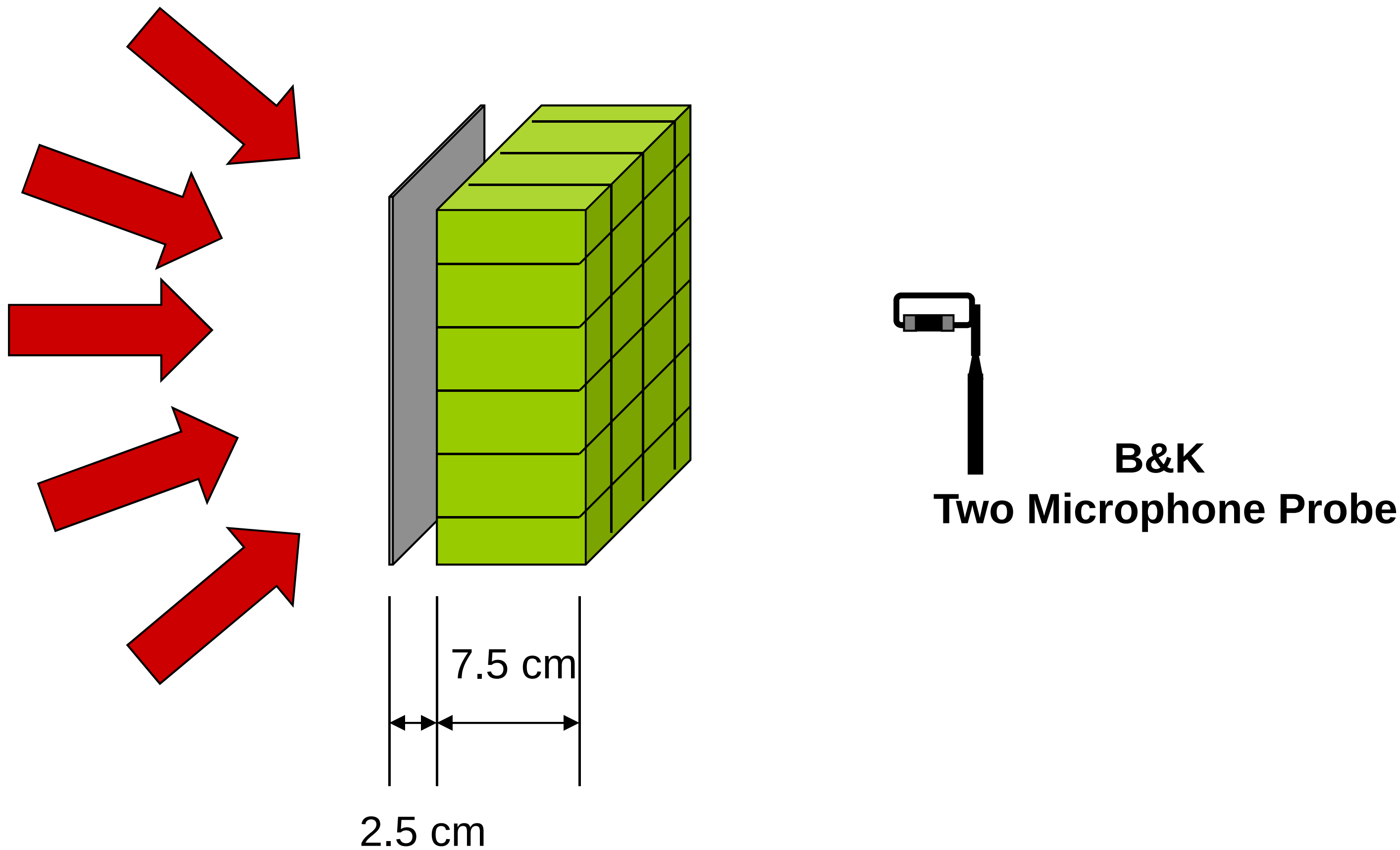


TL Increase for the Internally-Constrained Sample A (Frame Constraint)

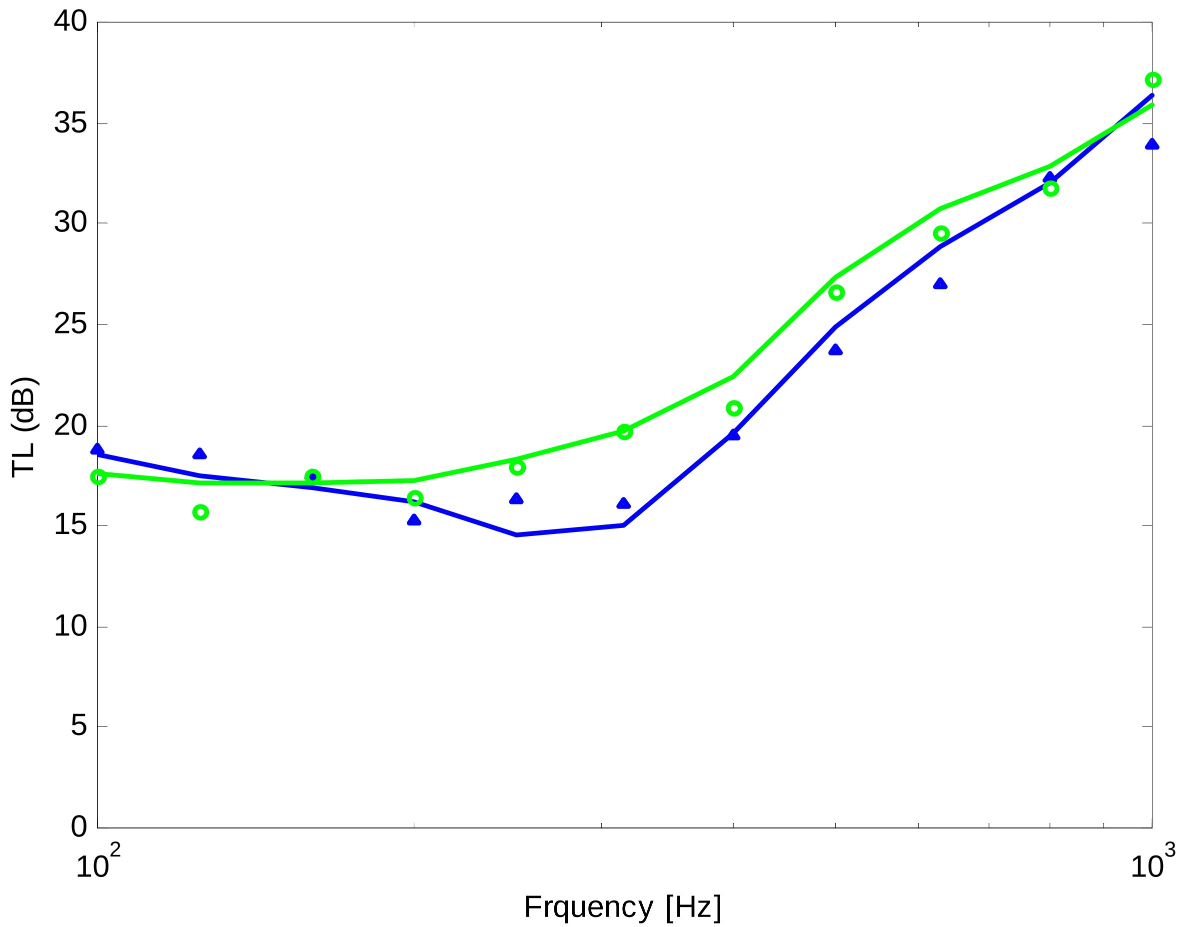


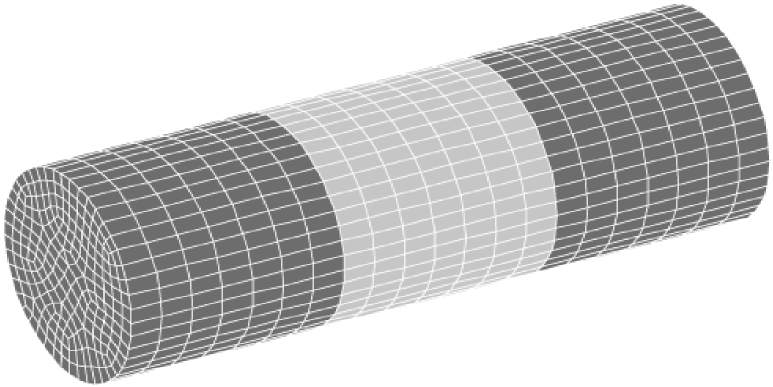
TL for the Single Panel System Lined with Glass Fiber Material

Limp Panel (0.078”)+Air (1”)+Glass fiber (3”)



TL Increase for the Internally-Constrained Sample A (Frame Constraint)





Conclusions

- Good agreement between measured and FE predicted random transmission losses.
- Random transmission losses through segmented lining materials were enhanced at low frequencies by the edge constraint effect.
- Light and stiff fibrous materials combined with edge and internal constraint mechanisms can be used to design, light, high performance low frequency noise control barriers.