

Recent Acoustic Liner Research at NASA Langley

Brian M Howerton (for the Liner Physics Team)
NASA Langley Research Center
Hampton, VA, USA

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NASA LaRC Liner Physics Team



Aeroacoustics Branch:

Brown

Structural Acoustics Branch:

Galles, Howerton, Jones, Nark, Schiller

Computational Aerosciences Branch:

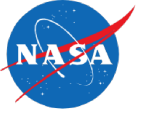
Watson (retired)

Fabrication Technology Development Branch:

Andrews

On-site contractor support:

Becker, Leath, Reid



Current Investigations

Liner Modeling and Concept Development

- Development of impedance education for multizone liners
- Development of improved perforate facesheet impedance model

Propagation Codes and Data Analysis

- Implementation of amplitude-compensated swept-sine measurements
- Investigation of flow direction effects on impedance education
- Updated CDTR data analysis routines for improved efficiency and accuracy
- Impedance education based on the Prony method controlled via a Python wrapper
- High Intensity Modal Impedance Tube (HIMIT) online within the next month

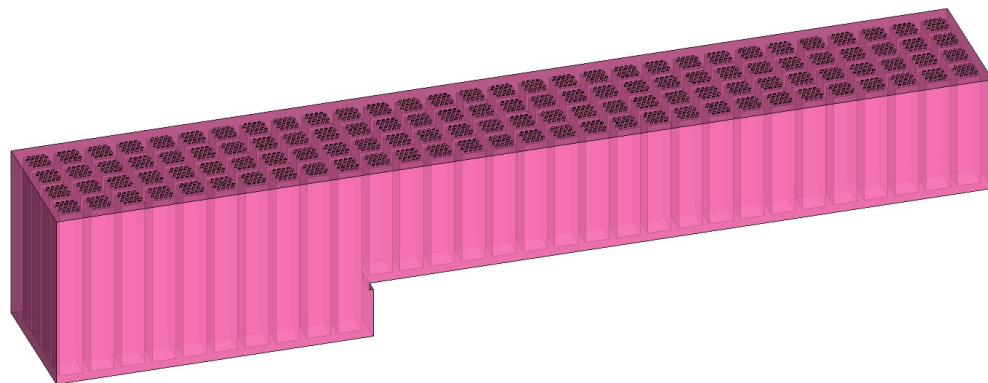
Current Investigations

Liner Drag

- Statistical methods to reduce liner drag measurement uncertainty (GFIT)
- Investigating commercial shear stress sensors (CDTR)

Novel Liner Concepts

- **Multizone**
- Multidegree of Freedom
- Shared port inlet
- Slotted core
- Variable-depth, bent chamber
- Metal foam with controllable variable density



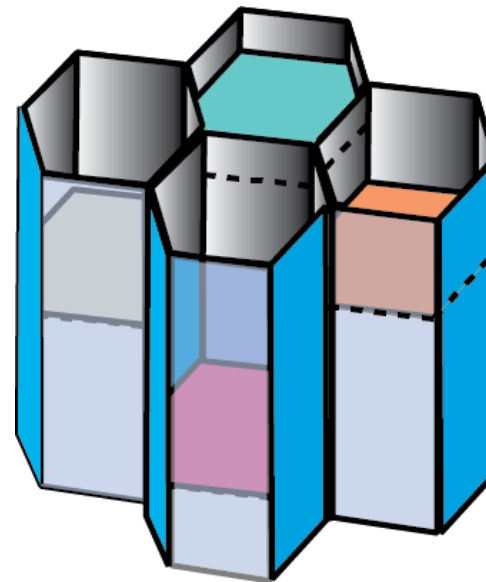
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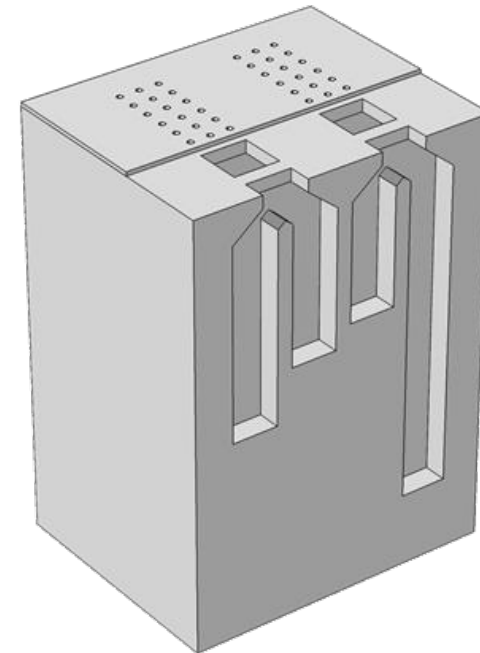
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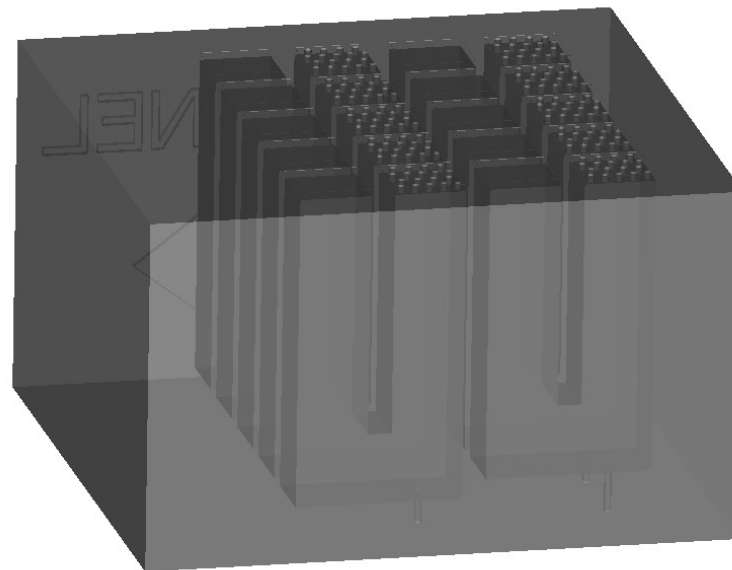
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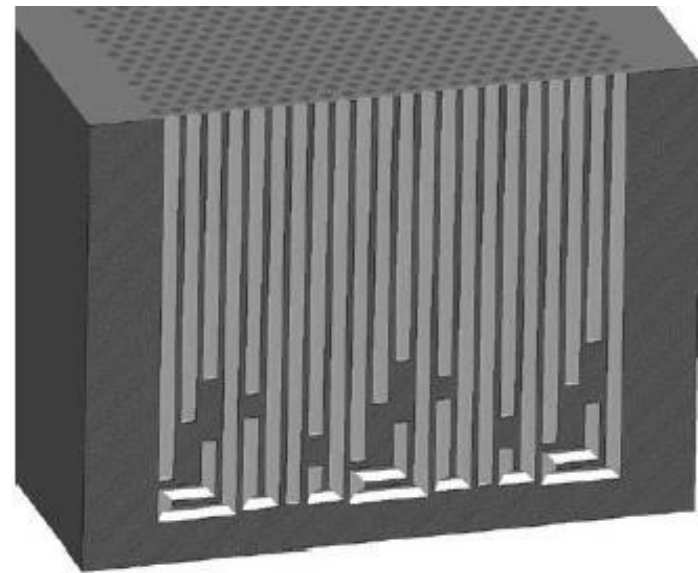
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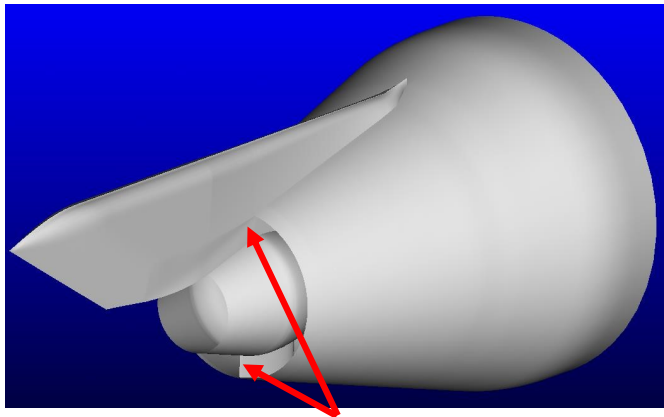
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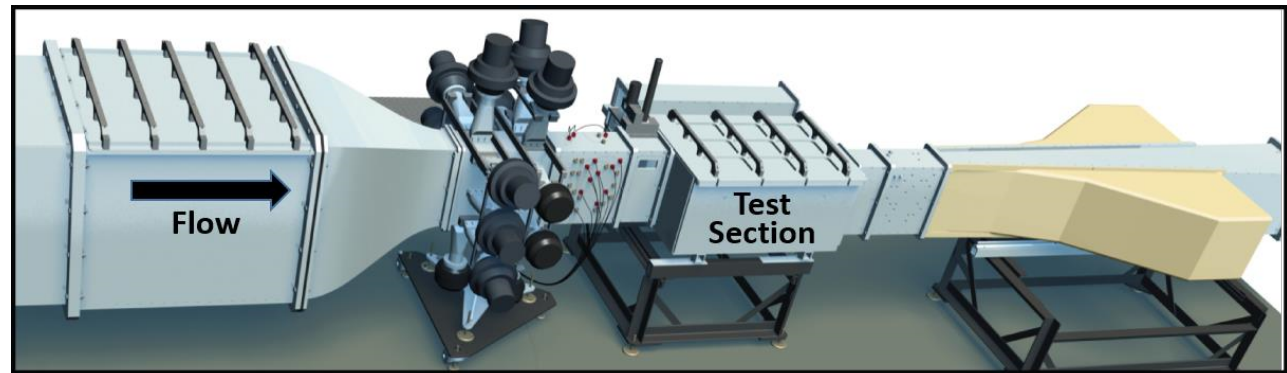
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Acoustically Treated Bifurcations

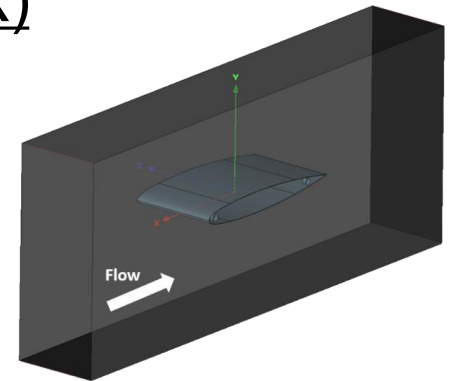


Bypass duct bifurcations



Curved Duct Test Rig (CDTR)

- Test Section: 6" x 15"
- $M = 0.0, 0.25, 0.45$
- Frequencies: [400:3000:200] Hz

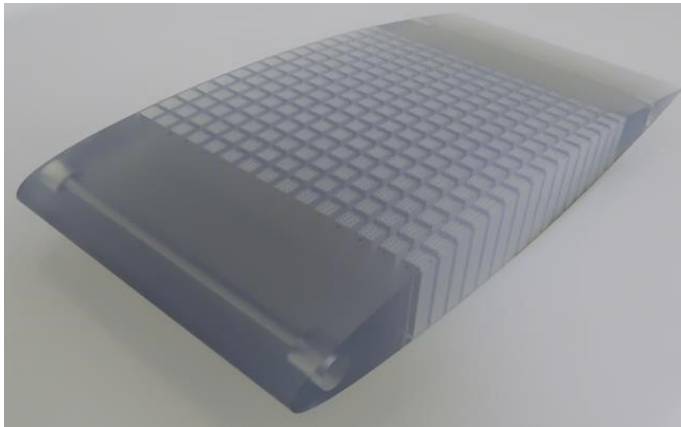


Fundamental study of the effects of bifurcation treatment on simulated aft fan noise

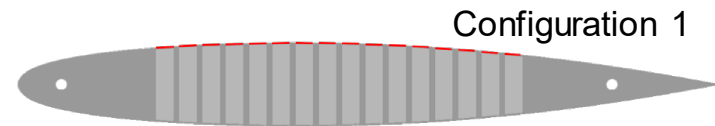
Acoustically Treated Bifurcations



CDTR test samples
Profile: NACA0012-64



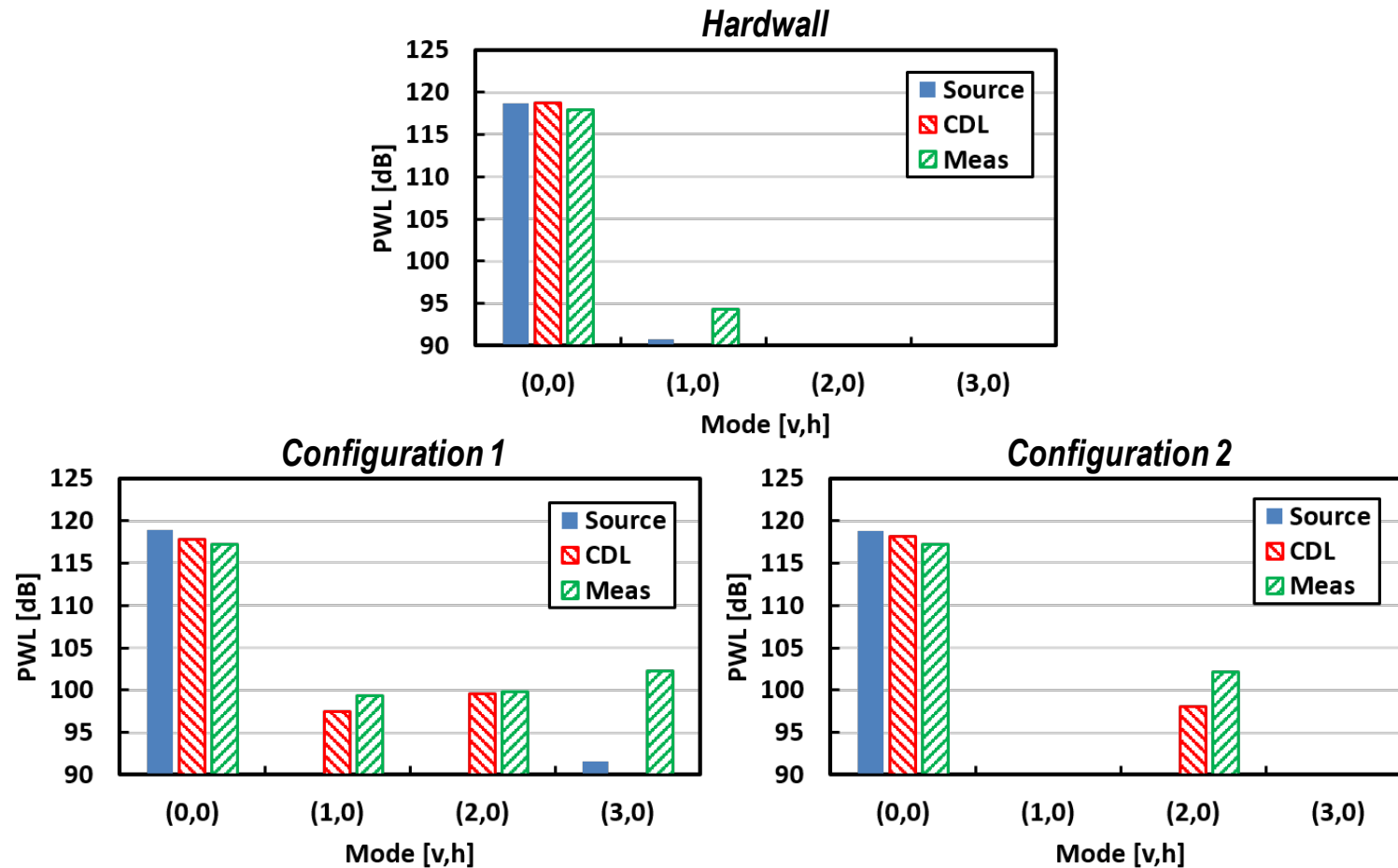
- 0.4" x 0.4" cells
- 15 Spanwise
 - 16 Chordwise



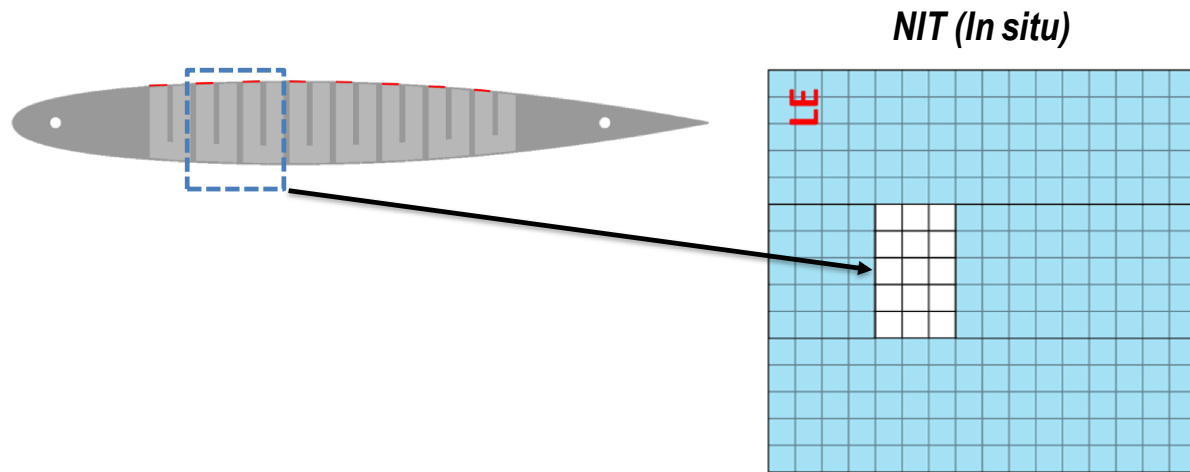


Acoustically Treated Bifurcations: CDTR Results

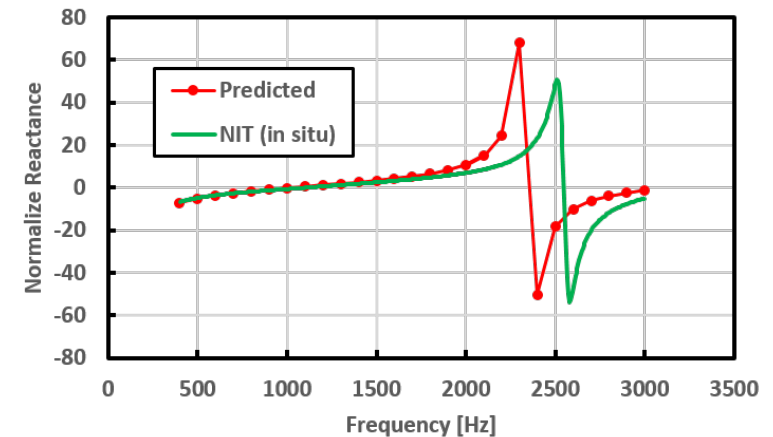
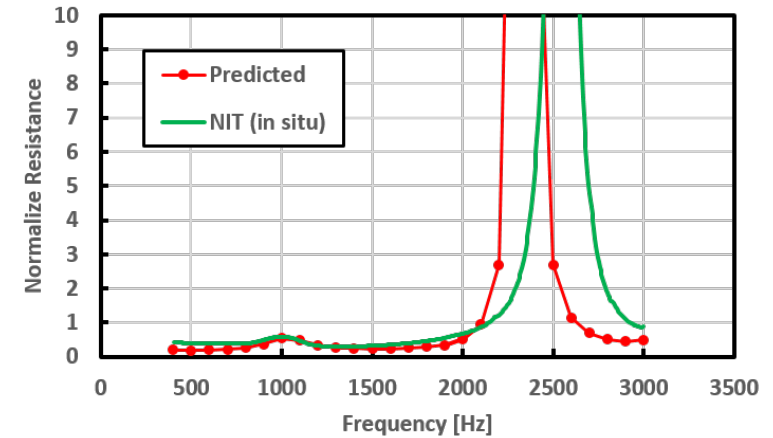
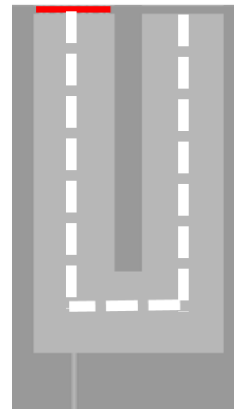
Plane Wave Source: $f = 1600$ Hz, $M = 0.25$



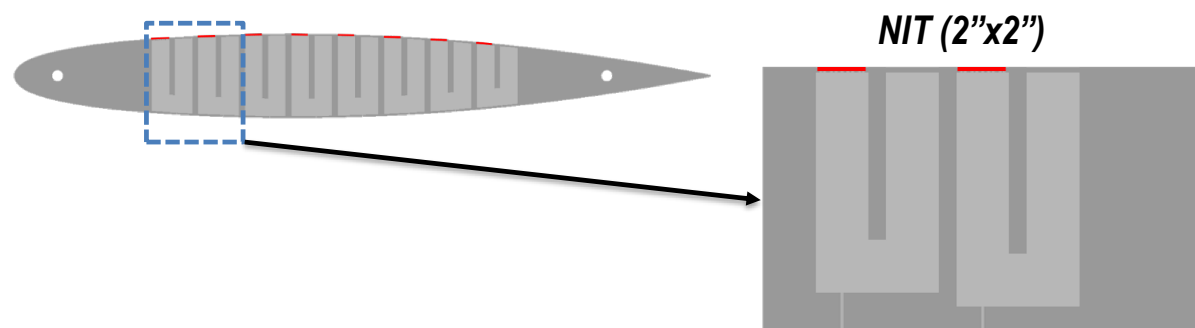
Configuration 3: Slotted Core (NIT)



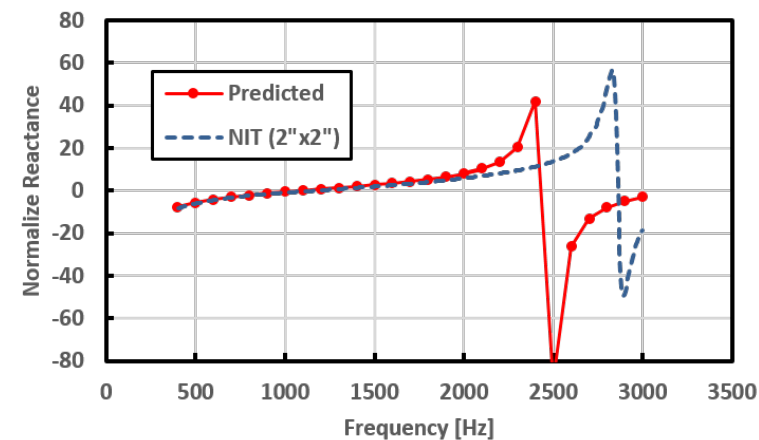
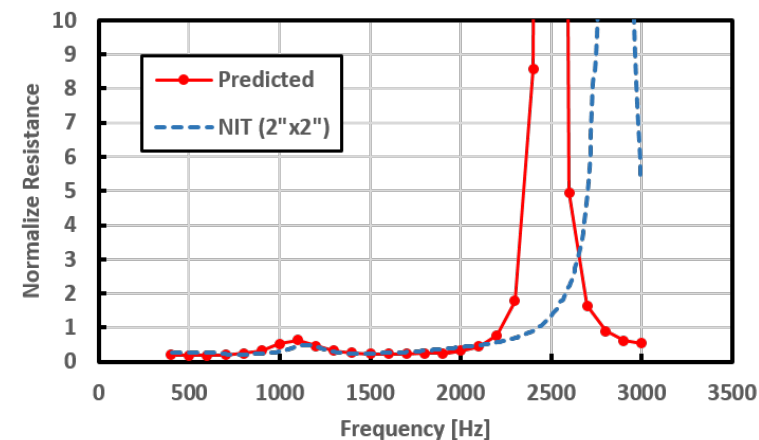
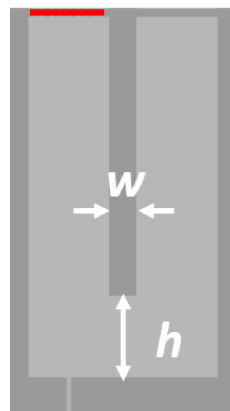
- Centerline length of slotted core used to define 'depth'
- Frequency of antiresonance under-predicted
- Possibly effect of sample curvature



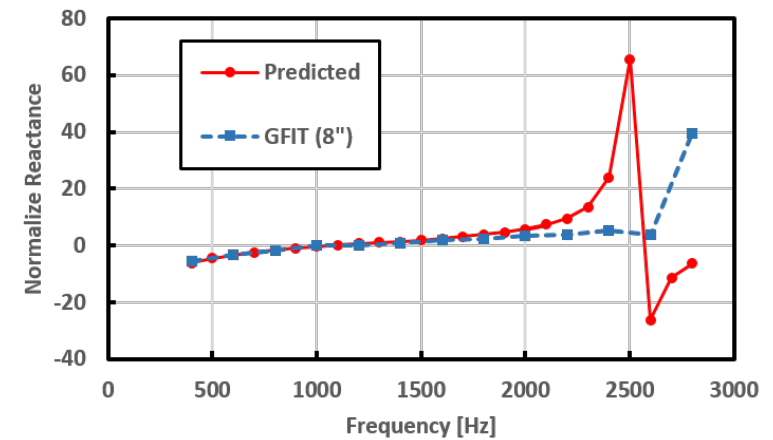
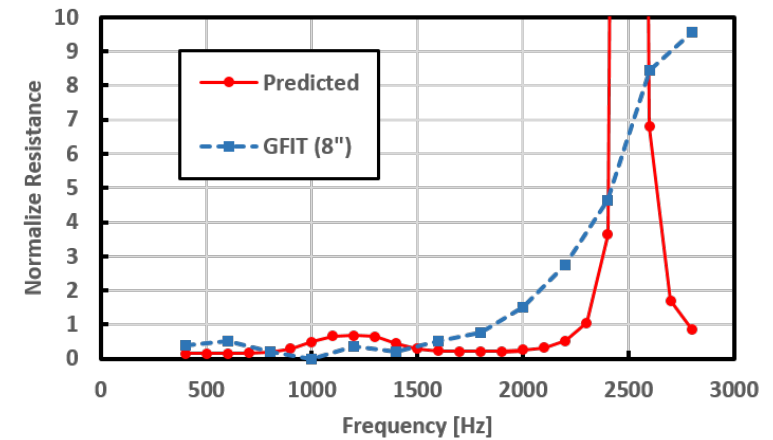
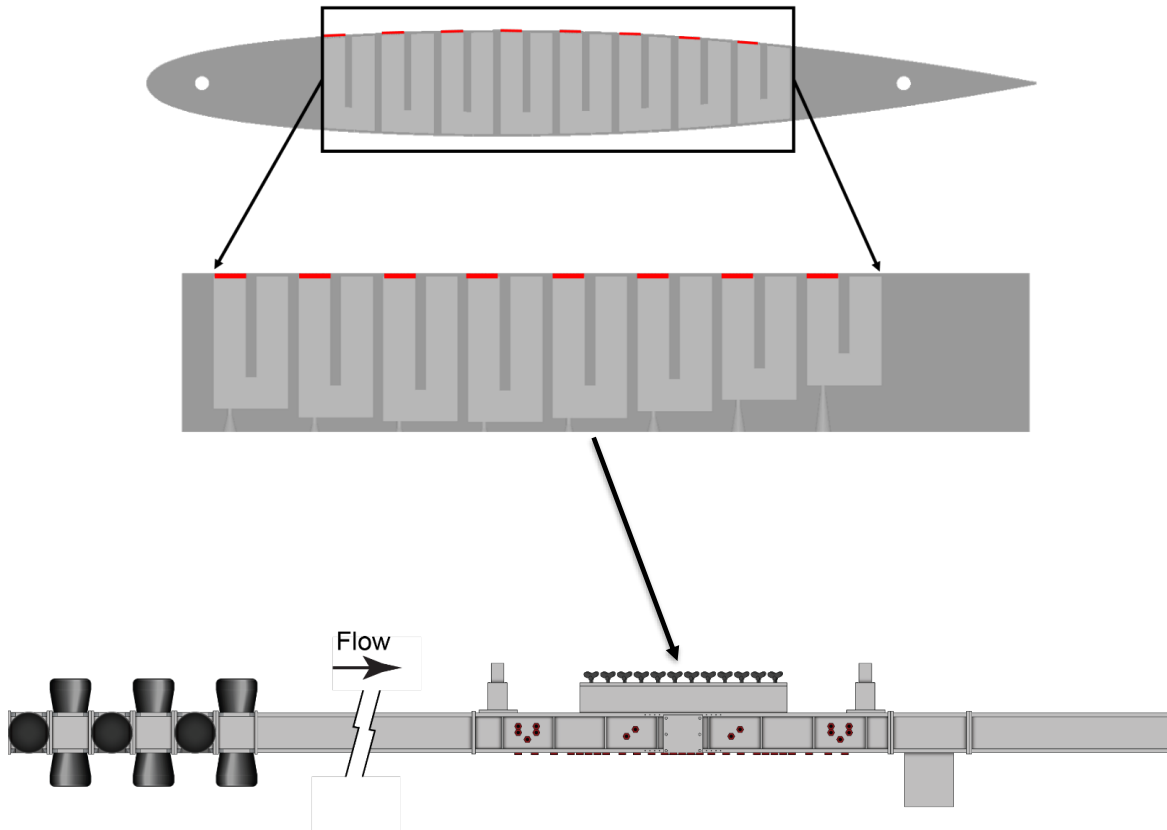
Configuration 3: Slotted Core (NIT)



- Flat sample upper surface
- Frequency of antiresonance again under-predicted
- Seek updated estimate for “effective” cell depth



Acoustically Treated Bifurcations: Slotted Core (GFIT)

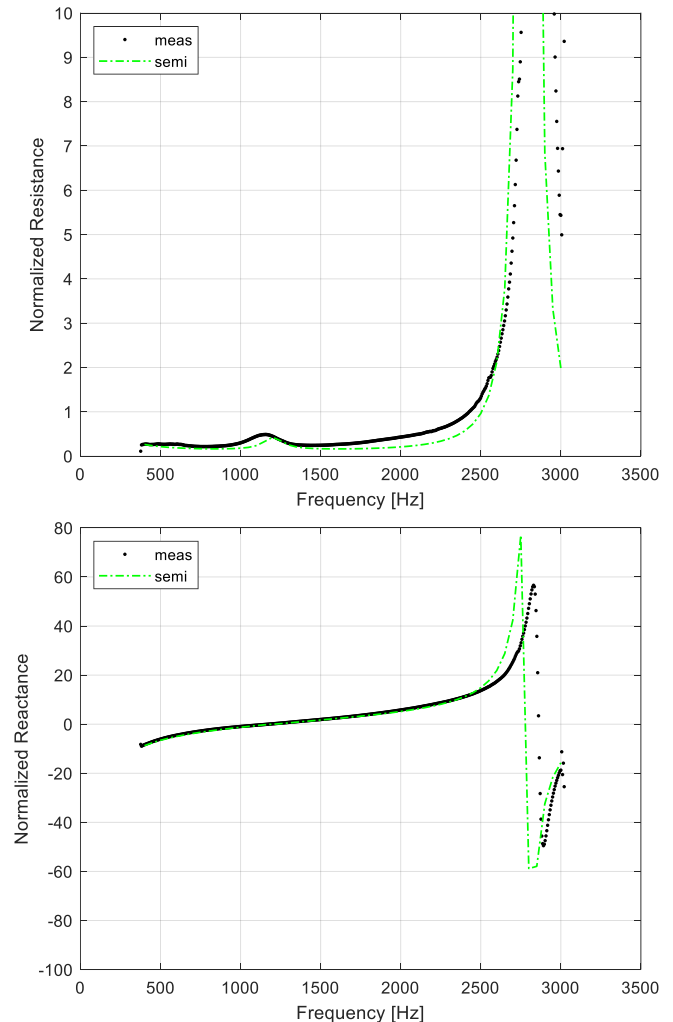
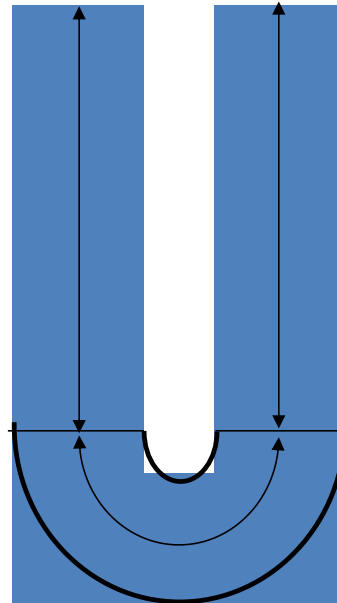


Acoustically Treated Bifurcations: Slotted Core (Model)



Updated Liner Model

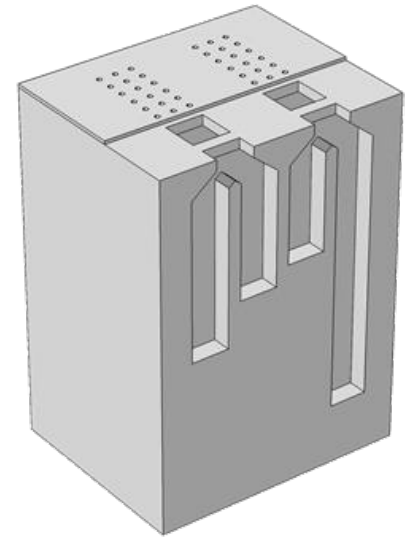
- Seek semiempirical model for use in liner optimization
- Model with equivalent curved resonator (ref: Cummings)
- “Effective” cell depth based on mean radius of curved portion (shorter than previous estimate)
- Slotted core NIT results provide insights to antiresonance behavior



Additional Liner Concept Development



- Low-drag concepts
 - Alternative facesheet designs (slotted facesheet: B737 MAX flight test)
 - Reduced POA (shared port)
- Investigating statistical methods to reduce liner drag measurement uncertainty in GFIT
- Shear stress sensor testing in CDTR

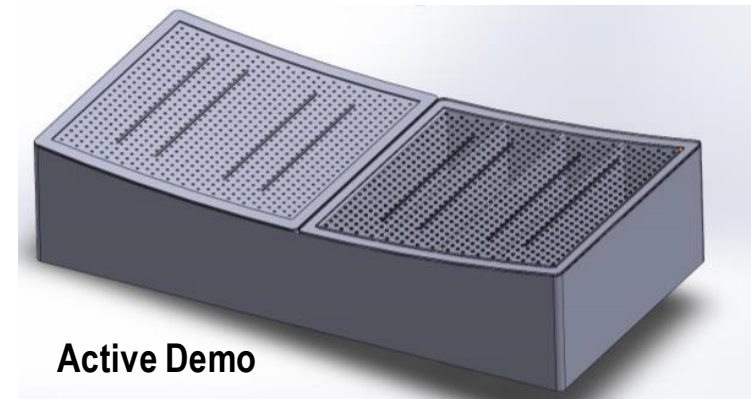


Additional Liner Concept Development

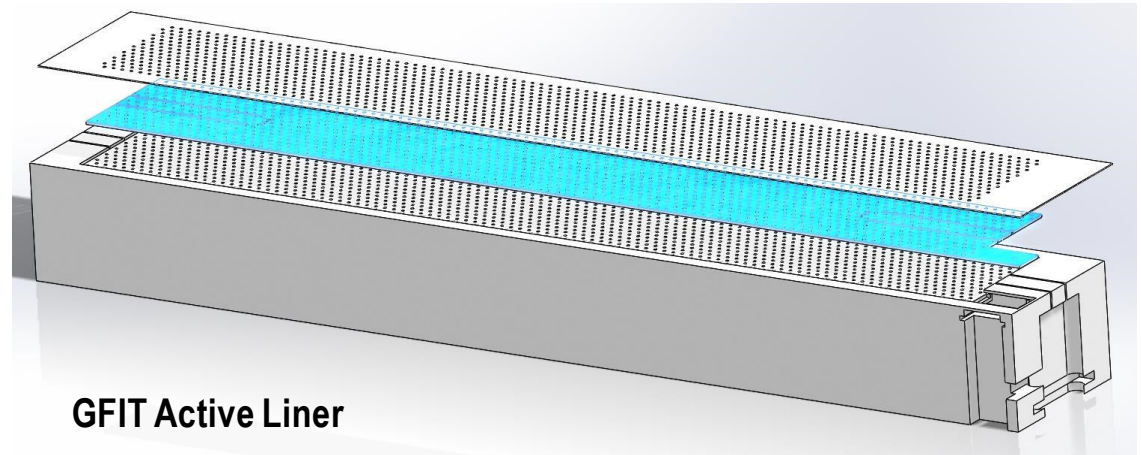


Active Liner (NRA: Boeing/FSU)

- Actively modulate impedance – variable hole size for drag reduction in cruise
- Active Demo: Incorporate curvature representative of aircraft system
- GFIT Active Liner: Acoustic test in representative environment (Mach 0.5, 140 to 150 dB)



Active Demo

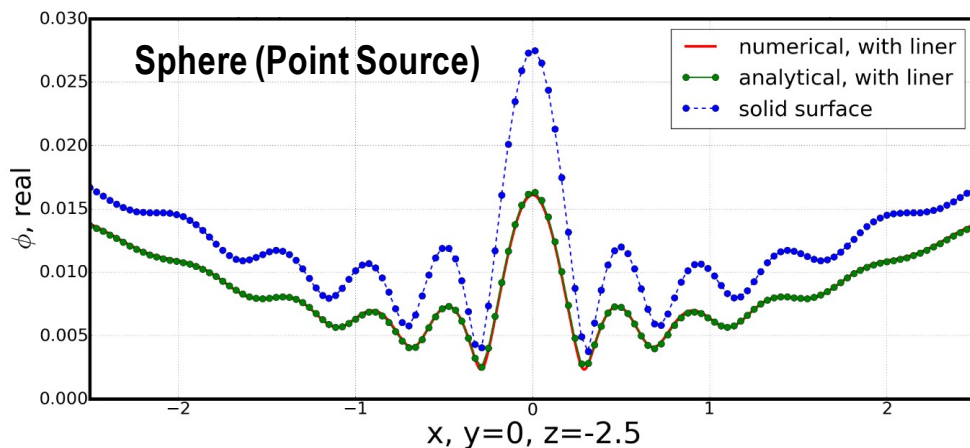


GFIT Active Liner

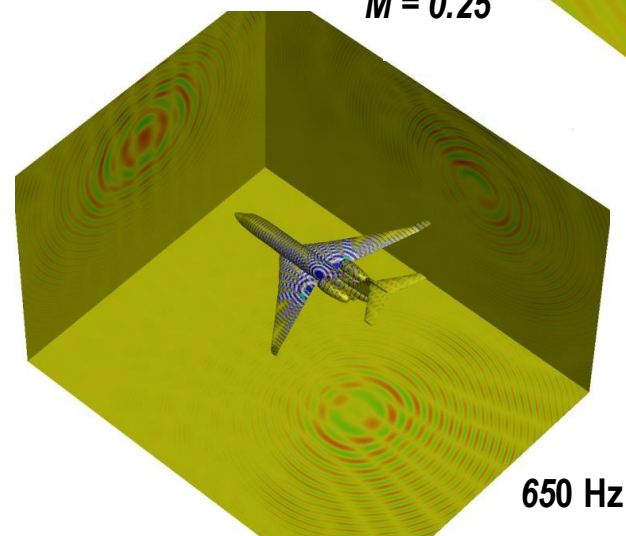
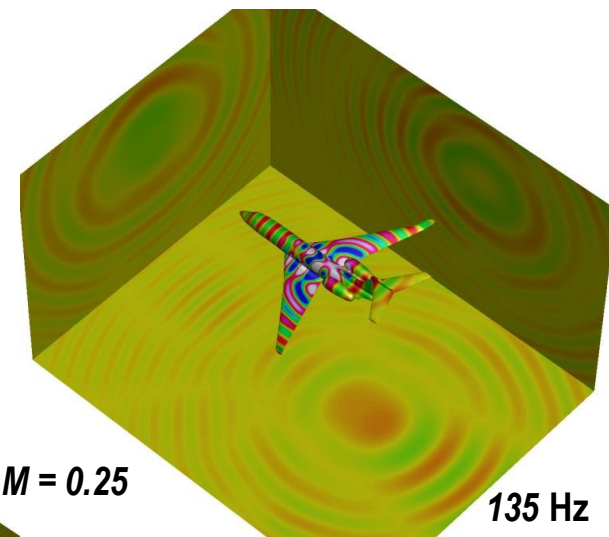
Additional Liner Concept Development

External liner evaluation

- Time-domain (Time Domain Fast Acoustic Scattering Toolkit: TDFAST) and frequency-domain (Fast Scattering Code: FSC)
- Validation via comparison with analytic solution and measured results (QFF, LSAWT)
- Full-scale predictions to assess external liner impact



National Aeronautics and Space Administration



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