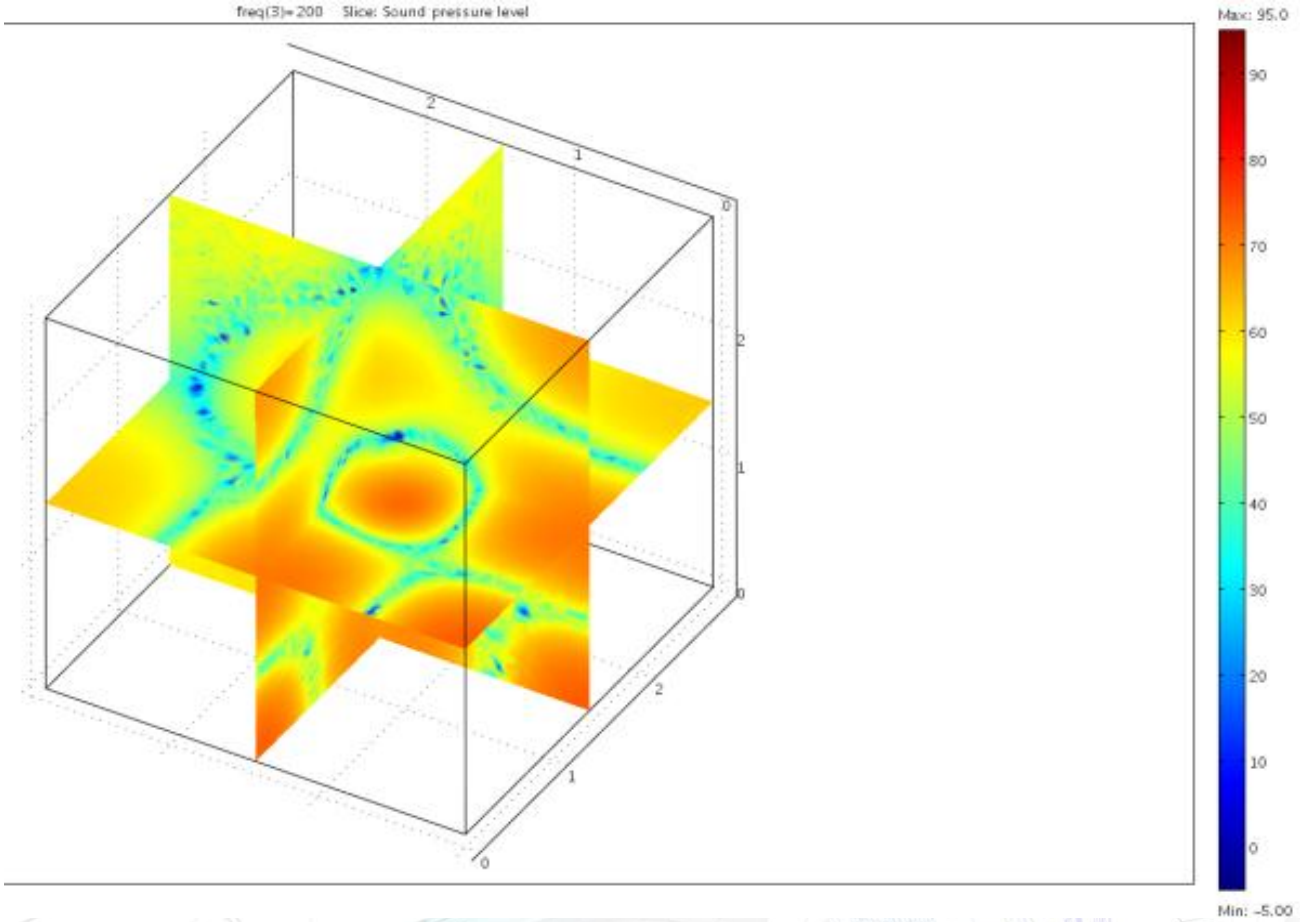
ALTASIM TECHNOLOGIES
REALIZING TOMORROW'S TECHNOLOGY

Analysis of Acoustic Response of Rooms

COMSOL Conference

October 7-9, 2010

Background



Room acoustic resonance
< 1 kHz

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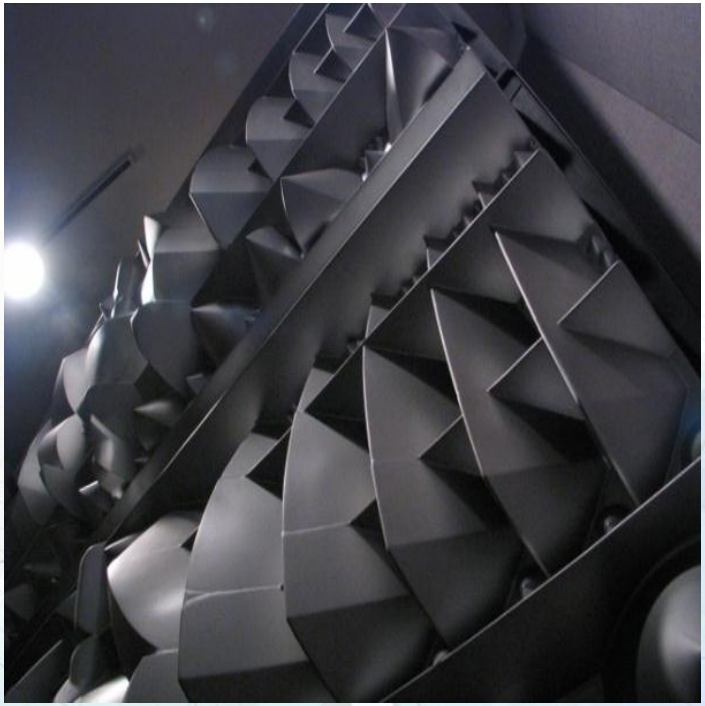
Solutions

- **Traditional**
  - **Reverberation time < 1s**
  - **Sound absorbing panels**
  - **Experience based**
  - **Non optimized**
- **Alternative**
  - **Acoustic distributor panels**
  - **Complex surface**



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Objective

- Acoustic analysis
- Analyze room acoustic resonance
- Optimize acoustic energy distribution

Challenges

Acoustic panel geometries are complex with hundreds of surfaces

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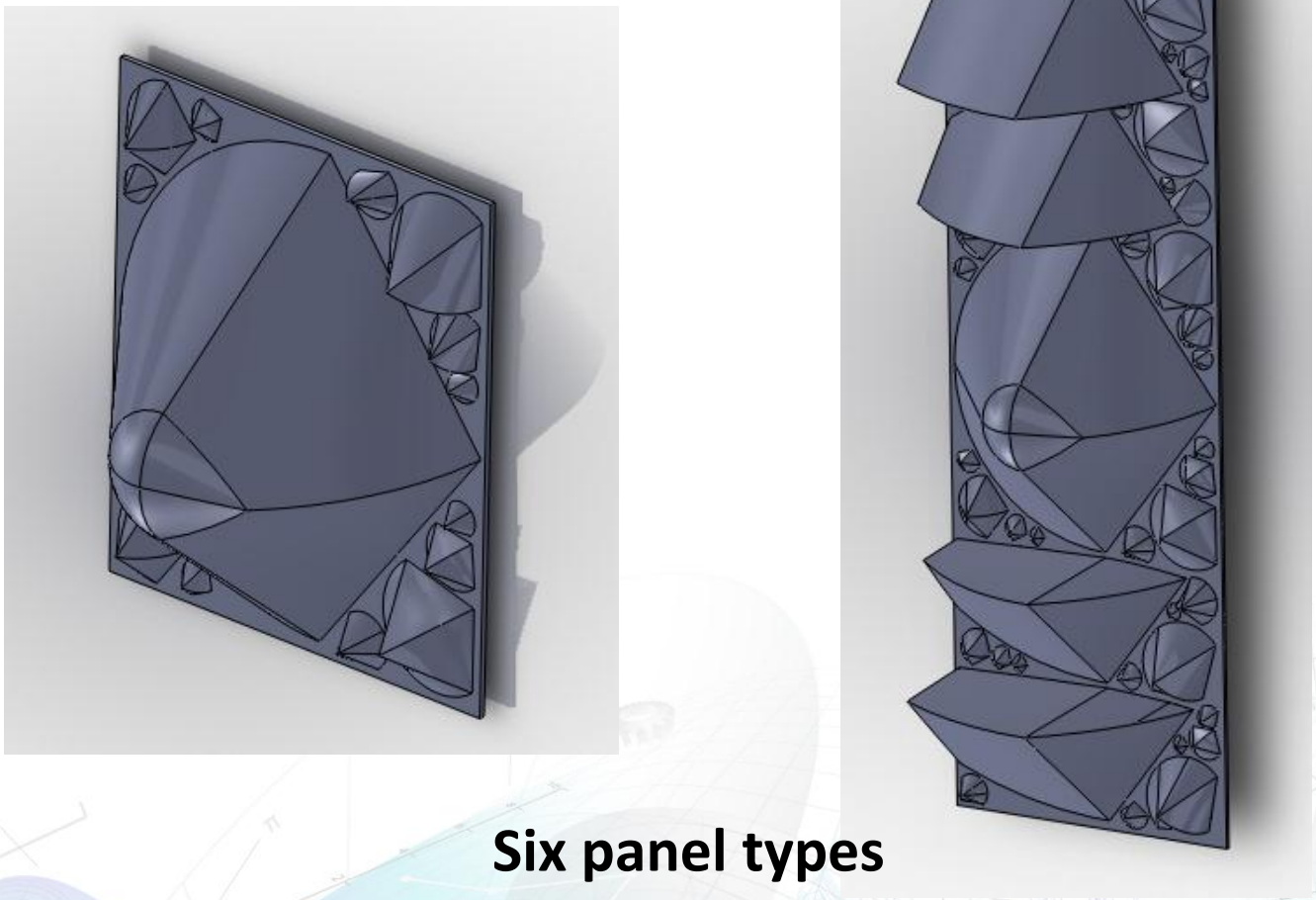
Challenges

- **CAD work in SolidWorks prior to use in COMSOL**
  - **Repairing surface contours**
  - **Building solid panels from the surfaces**
  - **Removing features smaller than the shortest wavelengths of interest**

Acoustic panels



Six panel types

Model set up

- **Time-harmonic acoustic field in a lossless medium**

$$\nabla \cdot \left(-\frac{1}{\rho_0} \nabla p \right) - \frac{\omega^2}{\rho_0 c_s{}^2} p = 0$$

- **Sound-hard boundaries for acoustic panel surfaces**

$$\frac{\partial p}{\partial n} = 0$$

Model set up

- **Impedance BC for sound absorbing walls**

$$\mathbf{n}\cdot\left(\frac{1}{\rho_0}\nabla p\right)+\frac{i\omega}{Z}p=0$$

- **Normal acceleration BC for acoustic source**

$$\mathbf{n}\cdot\left(\frac{1}{\rho_0}\nabla p\right)=a_n$$

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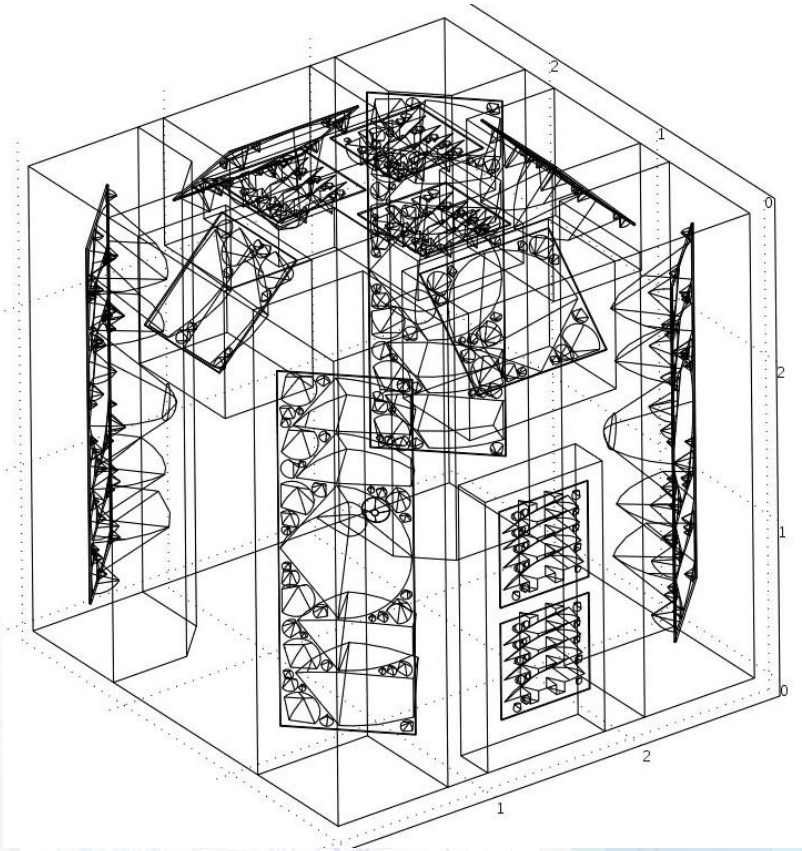
Model set up

- Acoustic panels as individual domains, mesh sequentially
- Min 6 elements per wavelength to resolve the acoustic field
- Mesh > 10^6 elements depending on the frequency, room size, and panels



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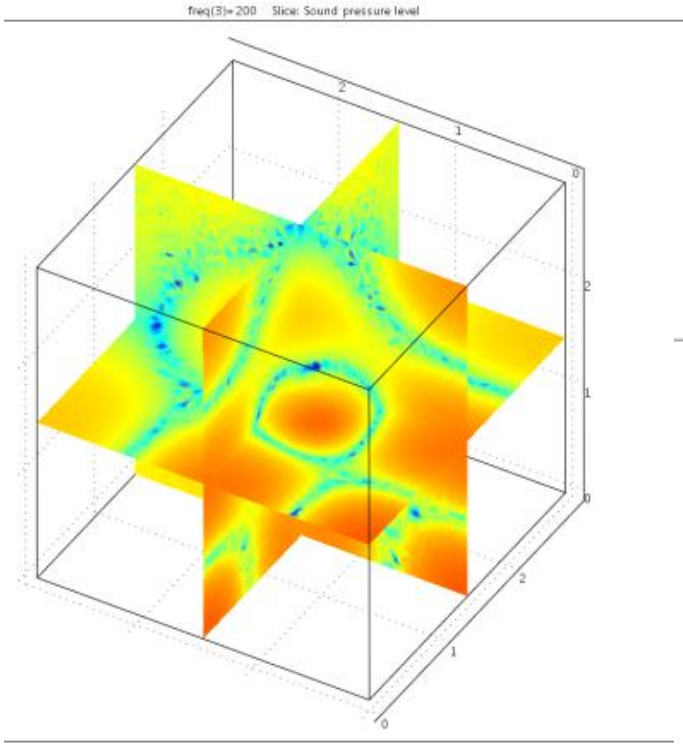
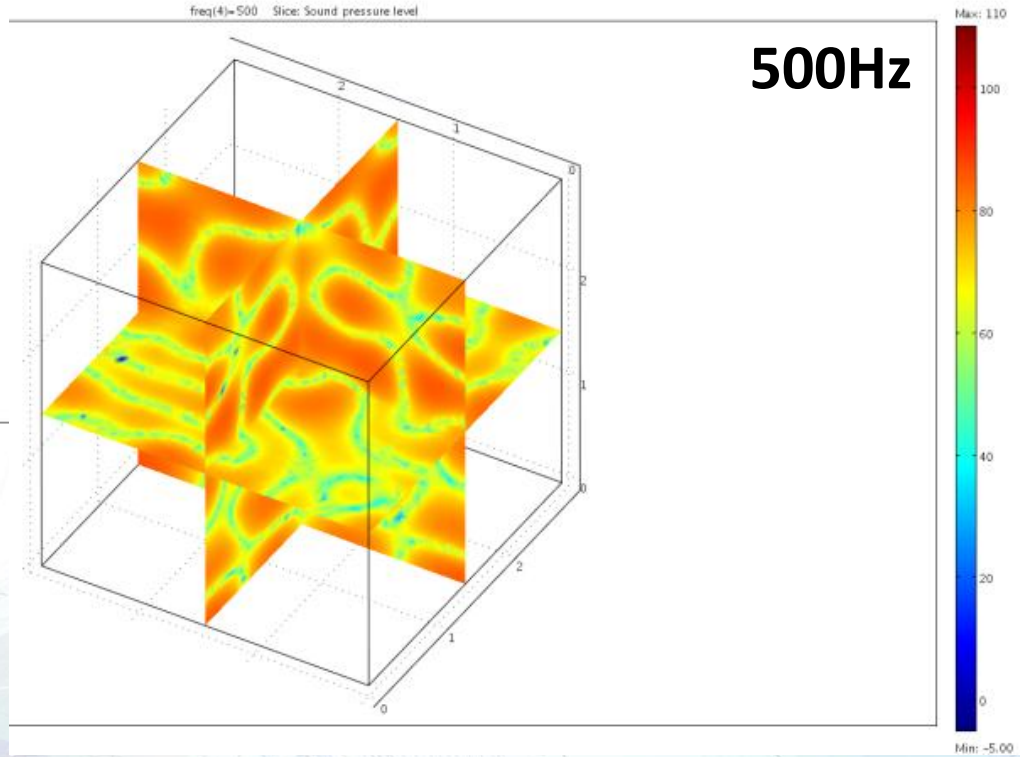
Analysis





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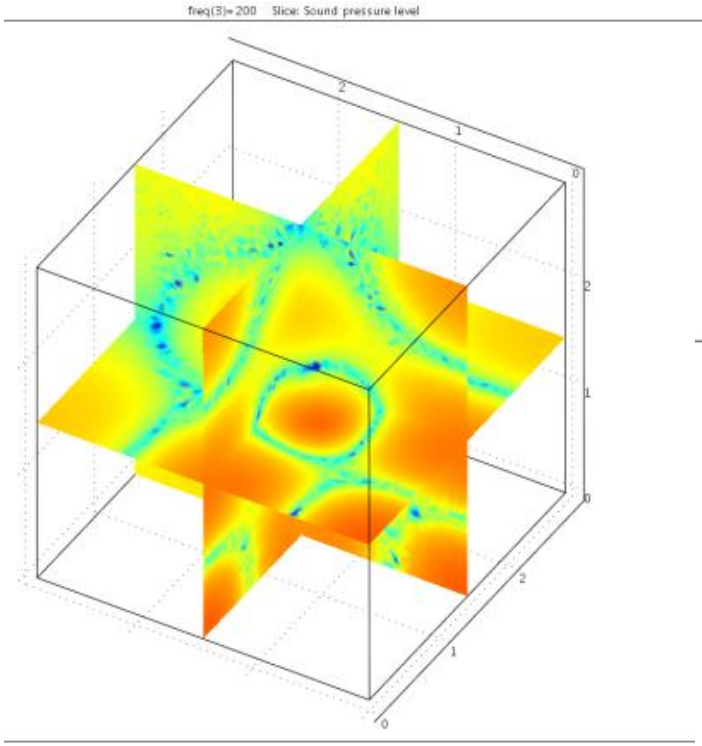

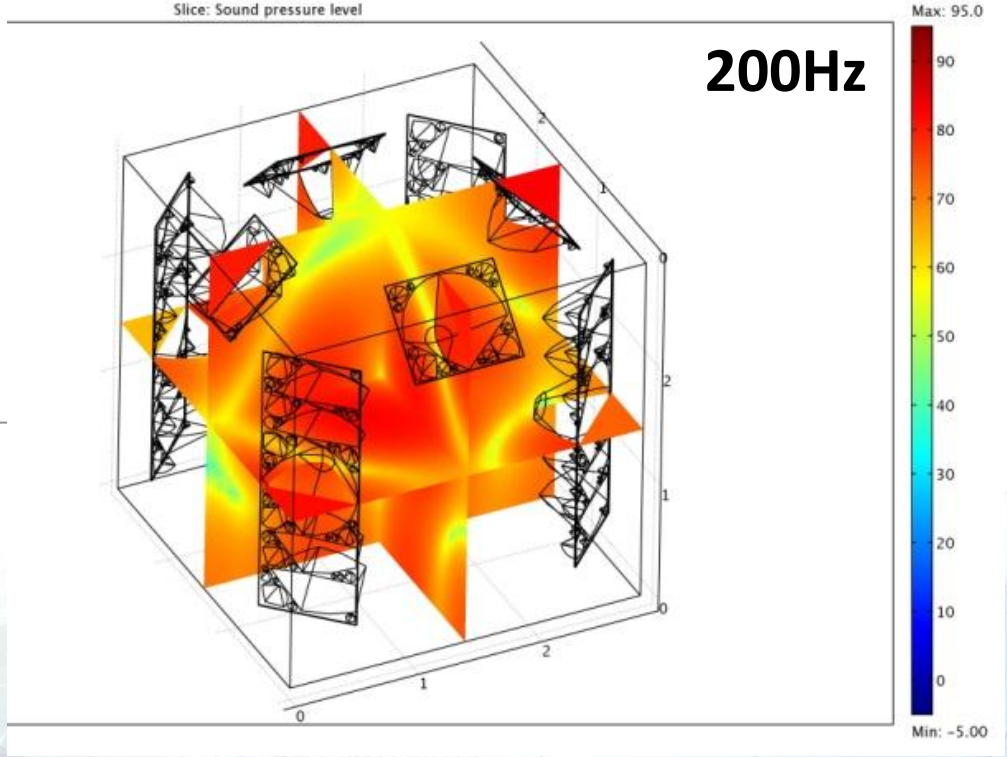

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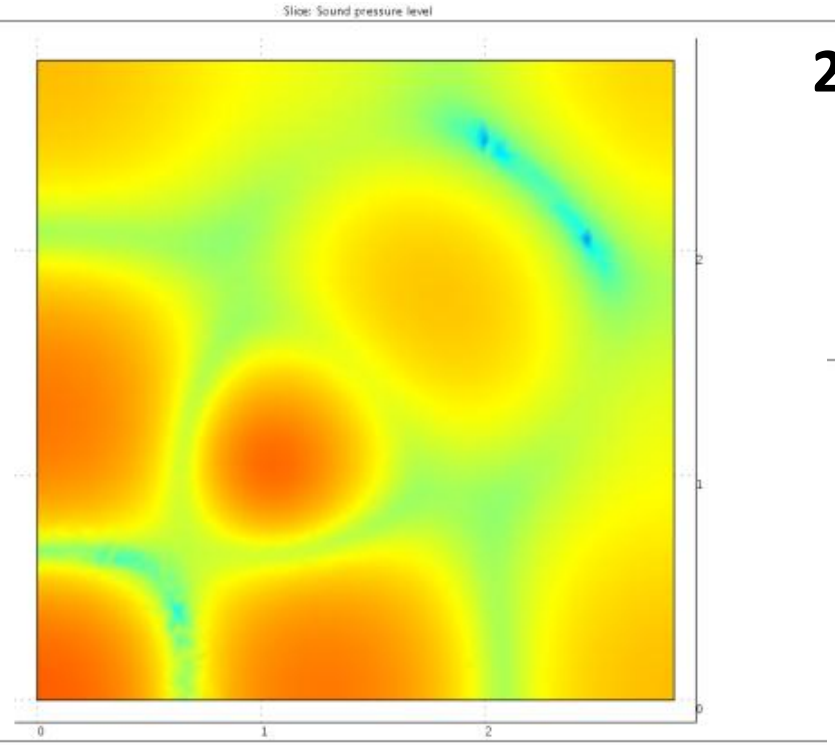
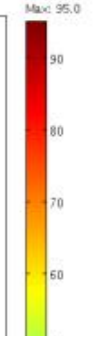
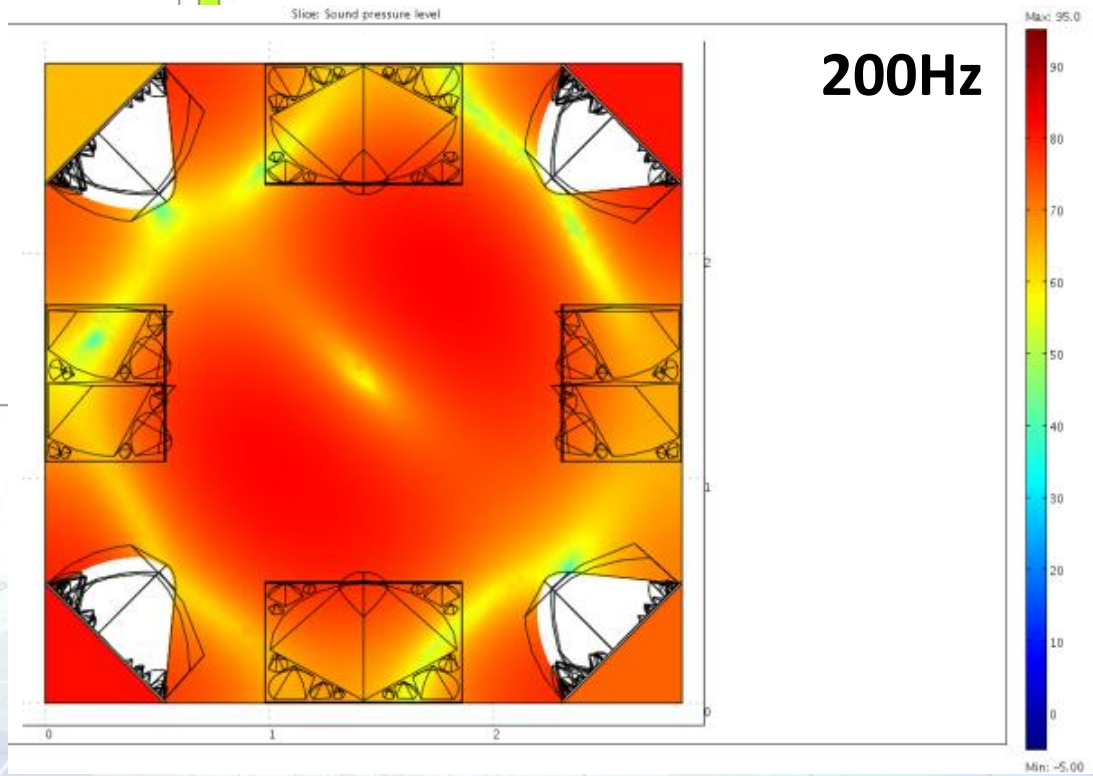


200Hz





200Hz

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Summary

- Predictive analysis of room acoustic response
- Predict distribution of acoustic energy
- Analyze influence of distribution panels
- Analyze effect of acoustic materials
- Identify room design for optimum acoustic response