



Small Room Acoustics

WAVES AND RAYS

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Product Design

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“If you want to find the secrets of the universe, think in terms of energy, frequency and vibration.”

Nikola Tesla

WAVES AND RAYS

WAVES

- Energy < 100 Hz.
- Longer in length
- W x H X L
- 30 Hz. = 37'
- Most problematic
- Movement like ocean waves

RAYs

- Energy > 100 Hz.
- Shorter in length
- $1,100$ Hz. = $1'$
- Sunshine

WAVES PRODUCE SOUND PRESSURE

- Room dimensions smaller
- Wavelengths too long
- Pressure build ups
- Sonic distortions
- Length largest issue

WAVELENGTH CALCULATION

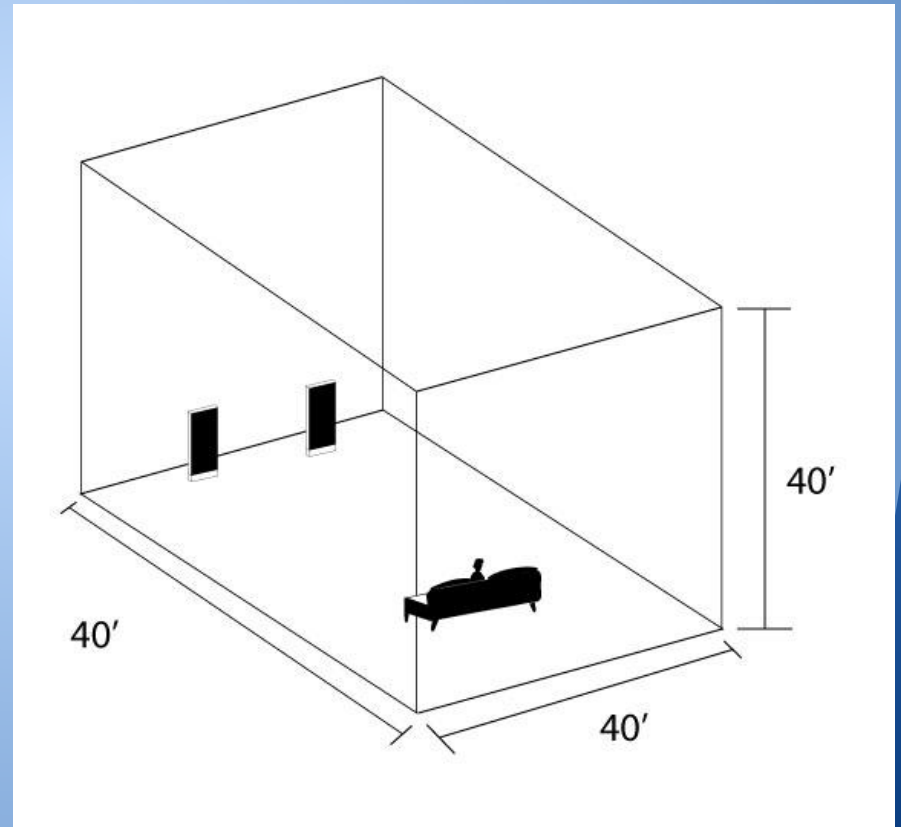
- Speed of sound divided by frequency
- 1,100 ft./sec. (rounded)/ Hz.
- Ex. $1,100 / 100 \text{ Hz.} = 1.1'$

WAVE CALCULATIONS

- 20 Hz. : $1,100 / 20 = 55.00'$
- 30 Hz. : $1,100 / 30 = 36.67'$
- 40 Hz. : $1,100 / 40 = 27.50'$
- 50 Hz. : $1,100 / 50 = 22.00'$
- 60 Hz. : $1,100 / 60 = 18.33'$
- 70 Hz. : $1,100 / 70 = 15.71'$
- 80 Hz. : $1,100 / 80 = 13.75'$
- 100 Hz. : $1,100 / 100 = 11.00'$

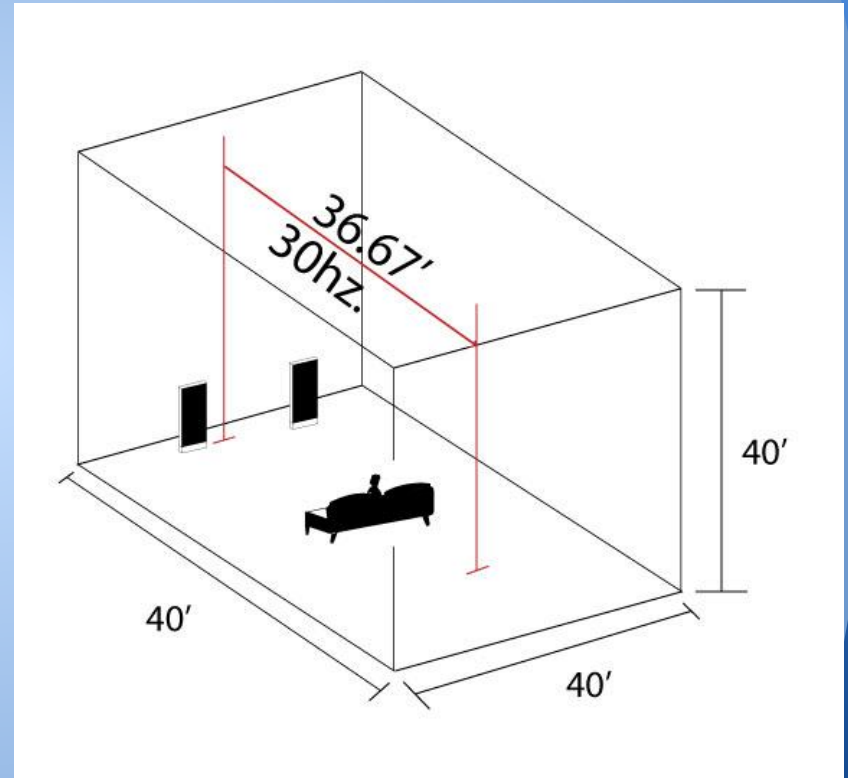
Ideal Room

- 40' x 40' x 40'
- 30 Hz. = 36.67'
- Full length to run
- Small rooms
- Always
compromise
- Low end issues



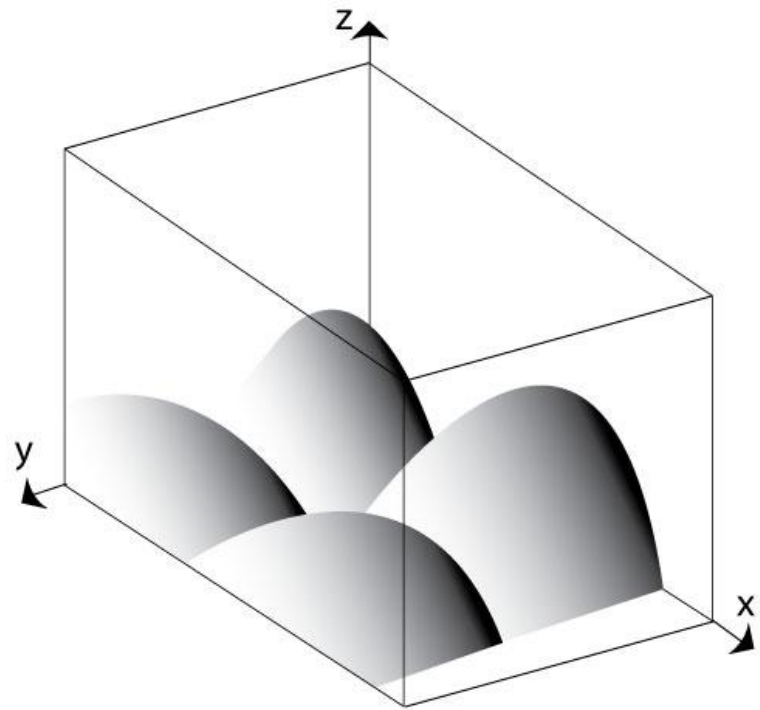
30 Hz. Room

- 30 Hz. wave
- 36.67'
- Full length run
- No pressure
- Every room dimension



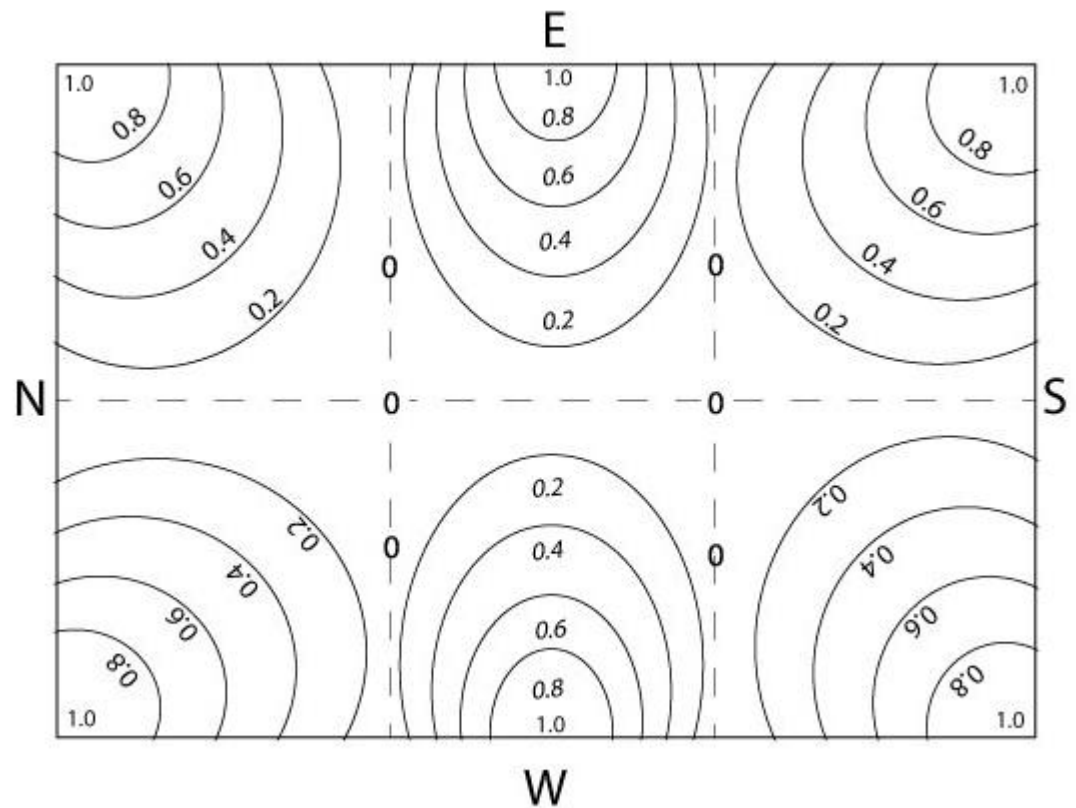
Pressure Modes

- Pressure areas within room
- Locations
- Have own bandwidth
- Cover
- Boost
- Room response made up of modes



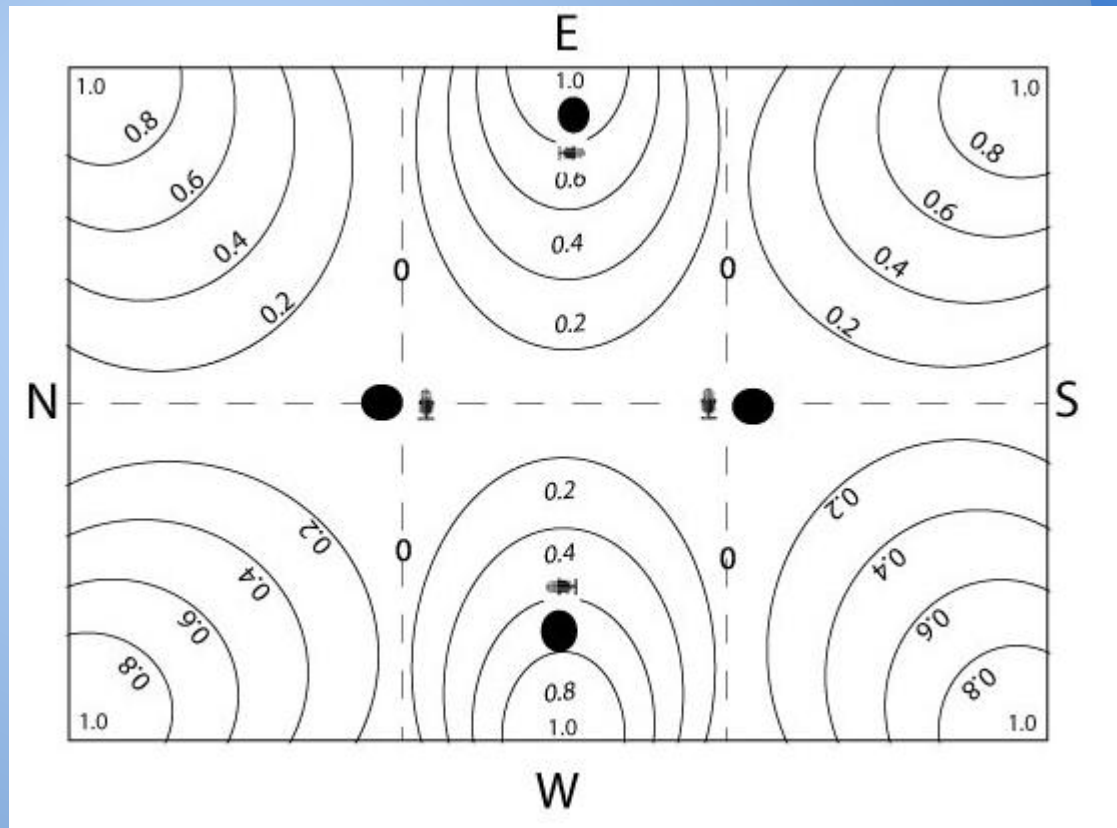
Pressure Zones

- Pressure
- Amplitude
- Location
- Frequency



Transducer Location

- Head / mic.
- Smother
- Exaggerate
- Frequency dependent
- Nulls
- Bass Boom
- Rays



Rays

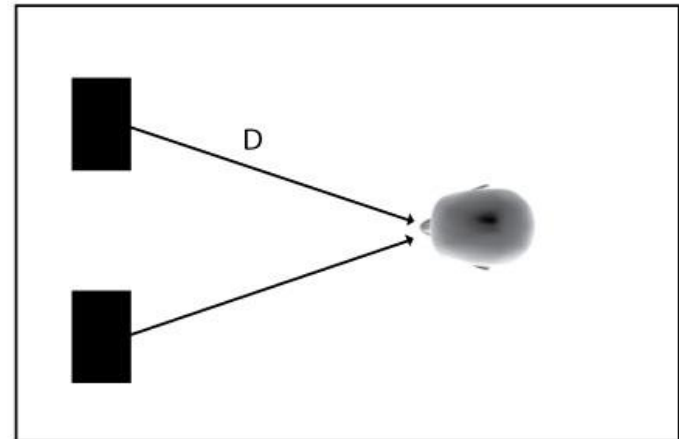
- Energy > 100 Hz.
- Shorter wavelengths
- Reflections everywhere
- Room boundary surfaces
- Room objects

Three Reflection Points

- Many reflections from surfaces that are important.
- Look at the three - side wall.
- Most translation critical.
- Have 85% of soundstage data in mix.
- Lots of sonic data in these three.
- Image , timbre , spaciousness
- **Direct sound**

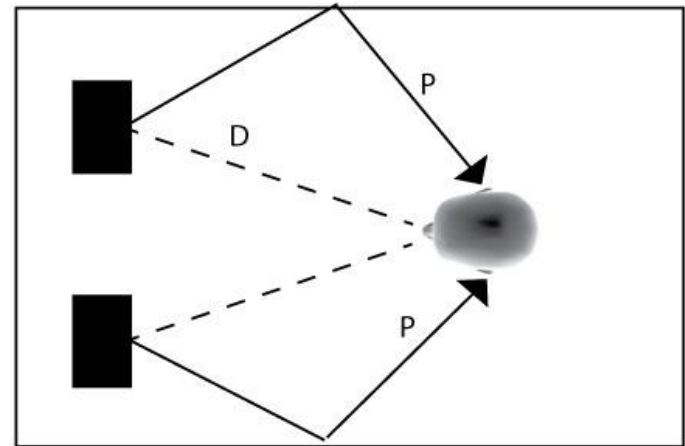
Direct Energy

- Straight line
- Short path
- No room sound
- Near field
- 3 reflections



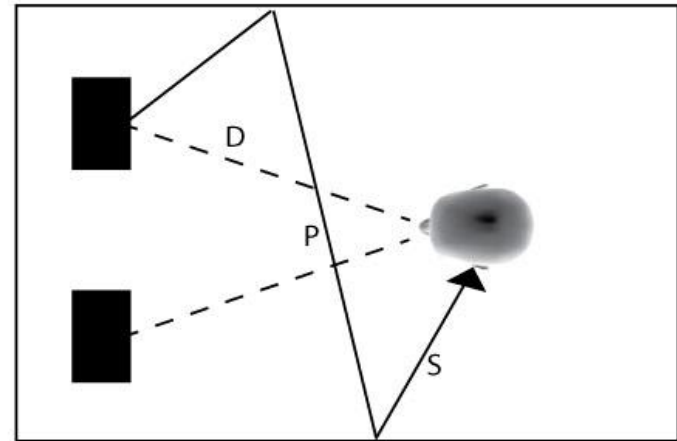
Primary Reflection

- Side walls
- Direct sound
- Arrival times
- Room Sound
- *Time Delay*



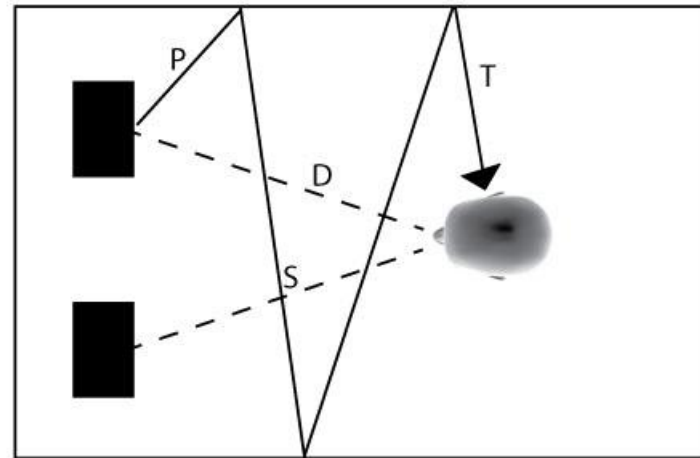
Secondary Reflection

- Side to side
- Right side to left side-ears
- Direct sound
- Room sound
- *Time Delay*



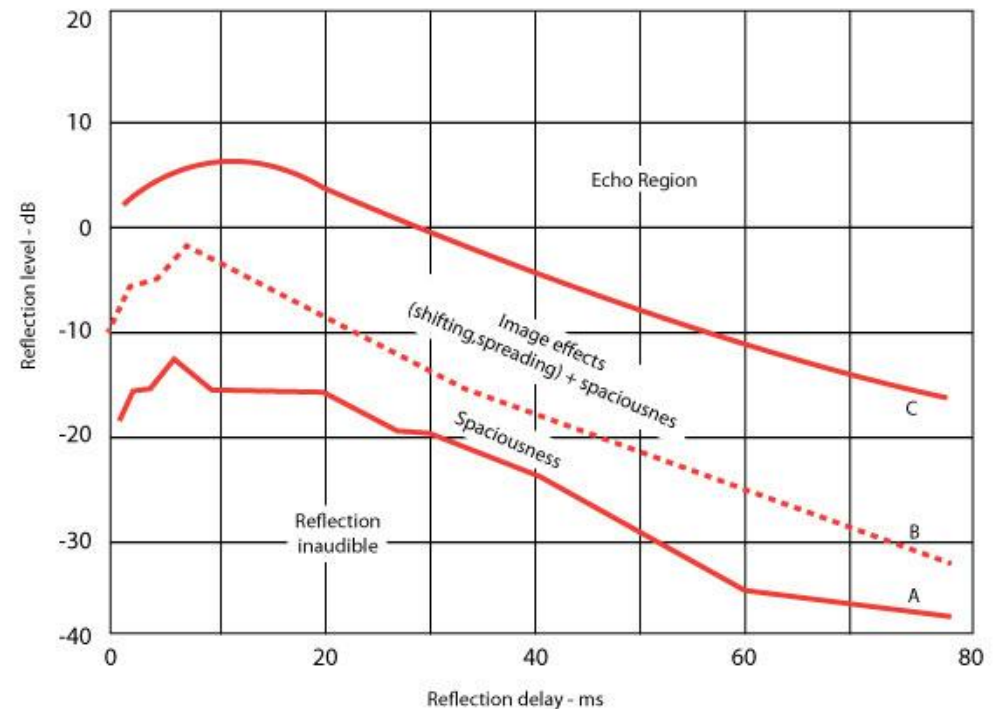
Tertiary Reflection

- Side,side,side
- Amplitude loss
- Room sound
- Virtual image
- *Time Delay*



Reflection Content

- Image effects
- A = reflection
- B = shifting
- Shifting
- Spreading
- Spaciousness
- Air



SUMMARY

- Waves cause 75% room acoustic issues.
- Longer wavelengths < 100 Hz. do not fit.
- Powerful like ocean waves.
- Produce unwanted pressure areas
- Reflections mix with direct sound
- Reflections contain sonic info.
- Image shifting, spaciousness, timbre
- Waves + rays = **Room Distortions**

WAVES AND RAYS

FOUR AUDIBLE

ROOM DISTORTIONS

ROOM DISTORTIONS

- Room Modes
- Speaker-boundary interference
- Comb filtering
- Poor diffusion

ROOM MODES

- Two parallel surfaces-axial
- Four surfaces - tangential
- Six surfaces - oblique
- Resonance and fundamentals
- High pressure / low pressure regions
- Opposite polarity - pressure on one side wave increasing, other decreasing
- Room response all modes
- Each mode own bandwidth

SPEAKER BOUNDARY INTERFERENCE

- Direct sound / reflections mixing
- Occurs across entire frequency response
- Room boundaries form virtual images of sound coming from speakers
- Virtual image combines with direct
- They can enhance or cancel direct depending on amplitude and phase

COMB FILTERING

- Direct vs. reflected
- Reflections cause time delays
- Reflected path longer than direct looks like teeth of comb
- Continual reflection over time
- Image and timbre distortion
- Speaker / wall

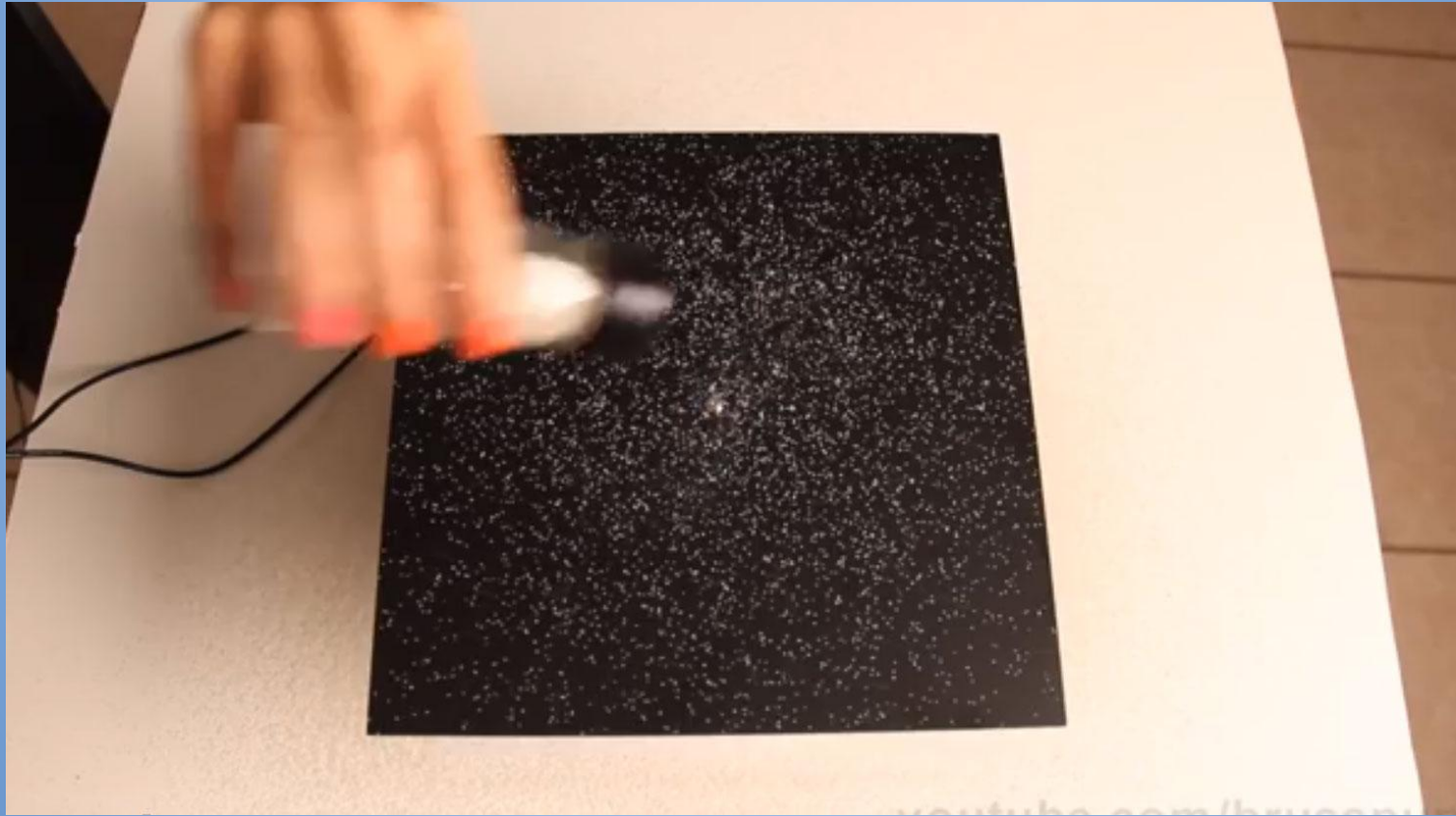
POOR DIFFUSION

- Specular reflections needed
- Localization
- Dimensional determination
- Add to sonic realism
- Rooms too dead
- Larger rooms vs. smaller
- Vertical / horizontal

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Salt On Plate



345 Hz.

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1033 Hz.

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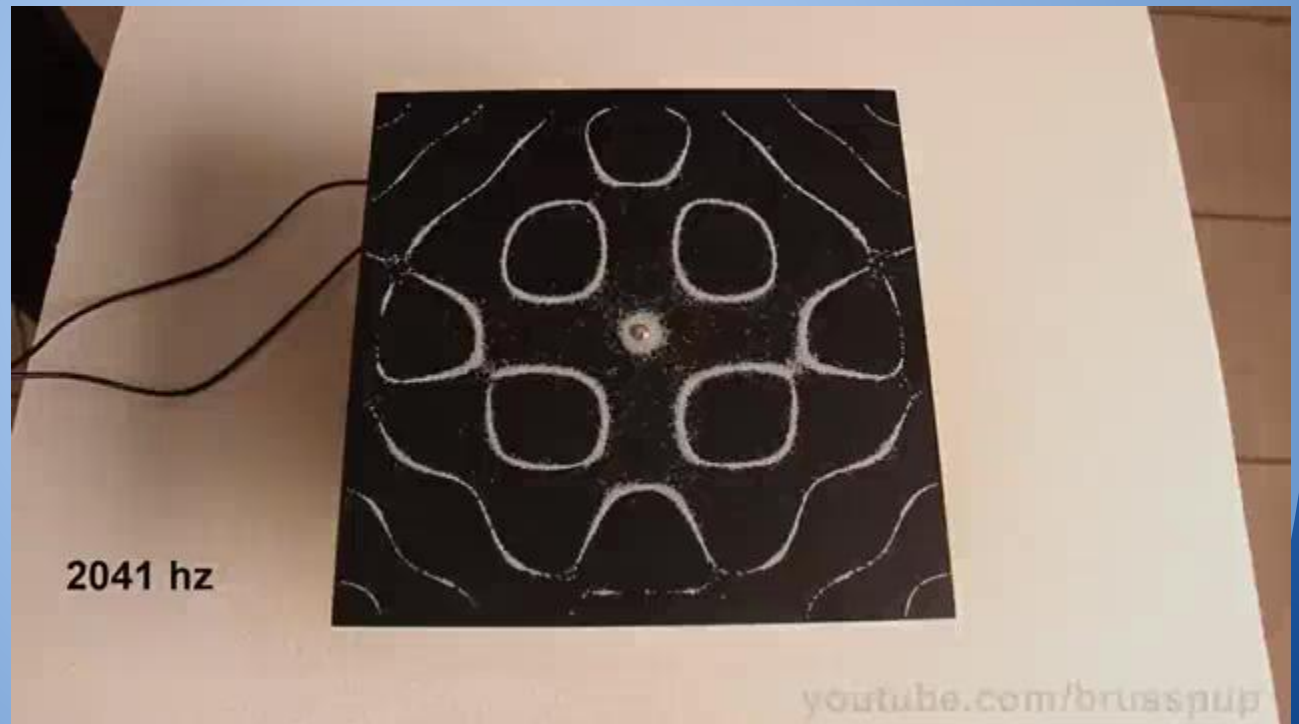
1820 Hz.

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2041 Hz.

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3240 Hz.

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3855 Hz.

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3975 Hz.

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4049 Hz.

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Absorption And Diffusion: Small Room Applications

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