



The Talaske Group, inc.

## The Room Acoustics of Large Spaces

*Presented by:*

Rick Talaske

The Talaske Group, inc.

Oak Park, IL – U.S.A.

ASA Tutorial

Cancun, Mexico



*The photos of all projects are designed  
by The Talaske Group, inc.*





## Acoustically speaking: What is a “Large” Room



It is my pleasure to present this discussion in Cancun regarding the acoustics of large rooms. Generally, this topic is what the public thinks of when they hear the word “acoustics”. This is because of their experiences in churches, theatres and music halls. I hope to better your understanding about this interesting topic.

*Es un placer de estar aqui en Cancun y al al vez hacer un presentacion sobre la acustica en grandes espacios. Generalmente, la gente cada vez que se menciona la palabra “acusticaq”, la relacionan con iglesias, teatros ysalas musicales. Espero de que en esta presentacion, ustedes se lleven un mejor entendimiento del concepto de acustica.*





## Acoustically speaking: What is a “Large” Room



### In this paper, a large room:

- Schroeder's Frequency is less than 50 Hz
- $f_c = 2000 * SR (T_{60}/V)$
- $f_c$  is below the voice and music bandwidth.
- Comb filtering is a lesser consideration.
- *Un espacio grande es un cuarto con muchas resonancias normales. Hay tantas resonancias que finalmente no son tan importantes. Con espacios grandes, tenemos que pensar en “dominio del tiempo”.*





## Large Rooms Include:



- Greater than 300 m<sup>3</sup>
- Large Studios
- Rehearsal Rooms

### *Espacios grandes incluyen:*

- *Espacios 300 m<sup>3</sup> y mas grande*
- *Studios grandes*
- *Salas de ensayo*
- *Iglesias*
- *Salas de Musica*
- *Teatros*
- *Coliseos (no vamos a discutir coliseos)*





## Large Rooms Include:



- Greater than 300 m<sup>3</sup>
- Large Studios
- Rehearsal Rooms
- Worship Spaces





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- **Recital and Concert Halls**





## Large Rooms Include:



- Greater than 300 m<sup>3</sup>
- Large Studios
- Rehearsal Rooms
- Worship Spaces
- Recital and Concert Halls
- **Theatres**
- **(not Arenas, in this discussion)**





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## Goal: Quality experience for the listeners.

### Clarity

(articulation, intelligibility, definition)

- Clarity

The quality of sound which supports the comprehension of detail and the distinct separation of individual musical notes and articulations.

*Claridad nos provee el detalle de la musica o del orador.*





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## Goal: Quality experience for the listeners.

### Loudness

(volume, strength)

The overall quantity of sound, as heard by a listener.

*Ruido es necesario para escuchar el sonido con suficiente fuerza.*

- Clarity
- Loudness





## Goal: Quality experience for the listeners.

The ability to determine the exact or approximate location of the sound source.

*La habilidad para localizar el origen del sonido depende en la claridad y el sonido.*

- Clarity
- Loudness
- **Localization**





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## Goal: Quality experience for the listeners.

- Clarity
- Loudness
- Localization
- **Reverberance**





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## Goal: Quality experience for the listeners.

### Liveliness

(running liveliness)

The perception of reverberance is heard in two forms:

- The sense of a persistence of sound as heard during ongoing speech or music.

- Clarity
- Loudness
- Localization
- Reverberance

– **Running Liveliness**





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## Goal: Quality experience for the listeners.

### Reverberation

(decay, lingering)

•The perceived lingering of sound following the cessation of music.

*Reverbacion es escuchado en dos formas:*

- Escuchando musica y oratoria,*
- Al momento que la musica y oratoria se desvanese*

- Clarity
- Loudness
- Localization
- Reverberance
  - Running Liveliness
  - **Reverberation**





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## Goal: Quality experience for the listeners.

### Envelopment

- Envelopment

(immersion)

The sense of being surrounded by sound.

*Envoltura es el sentido de estar envuelto por sonido.*





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## Goal: Quality experience for the listeners.

### Warmth

(bass response)

The tonal quality resulting from an abundance of low-pitched sound (bass sound) within a room.

*El timbre del sonido se relaciona con la cantidad del tono bajo, medio y tono alto del sonido.*

- Envelopment
- Proper timbre
  - Warmth
  - Or, lack of “boominess”
  - Proper mid/high pitch





Goal: Quality experience for the users.



- **Communication**
  - Musicians on Stage
  - Musicians in Pit
- **Feedback**





## Goal: Quality experience for the users.



- Communication
  - Musicians on Stage
  - Musicians in pit
- Feedback
- **Freedom from abnormalities**





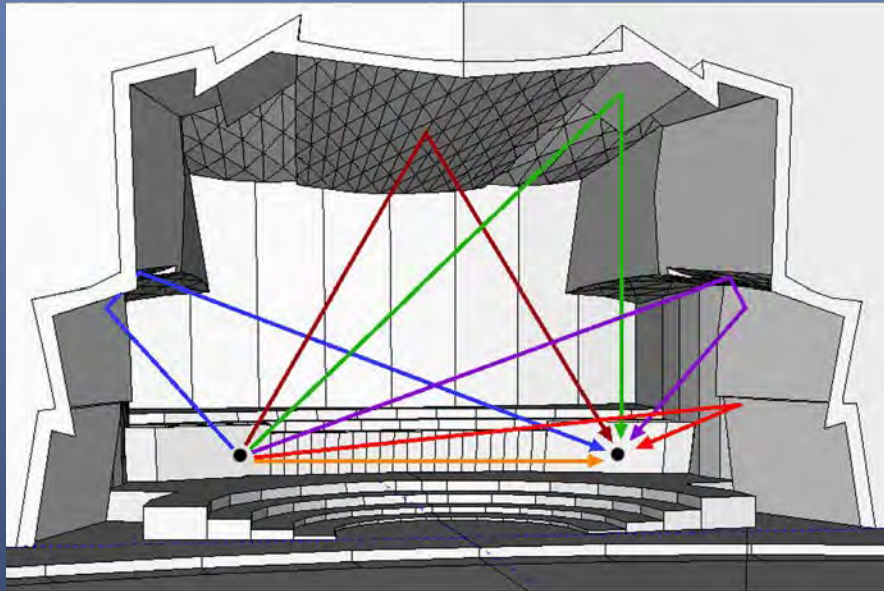
Source **PATH** Receiver

- **Size**





Source **PATH** Receiver

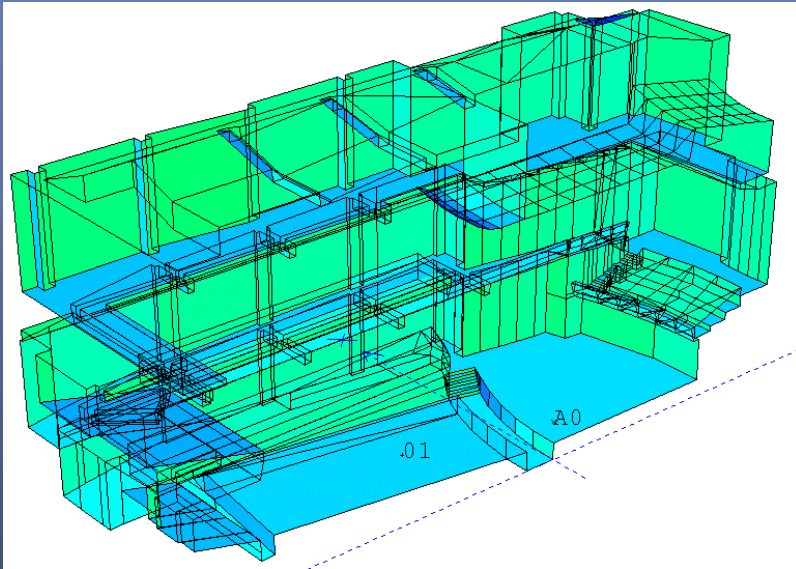


- Size
- Shape





## Source PATH Receiver

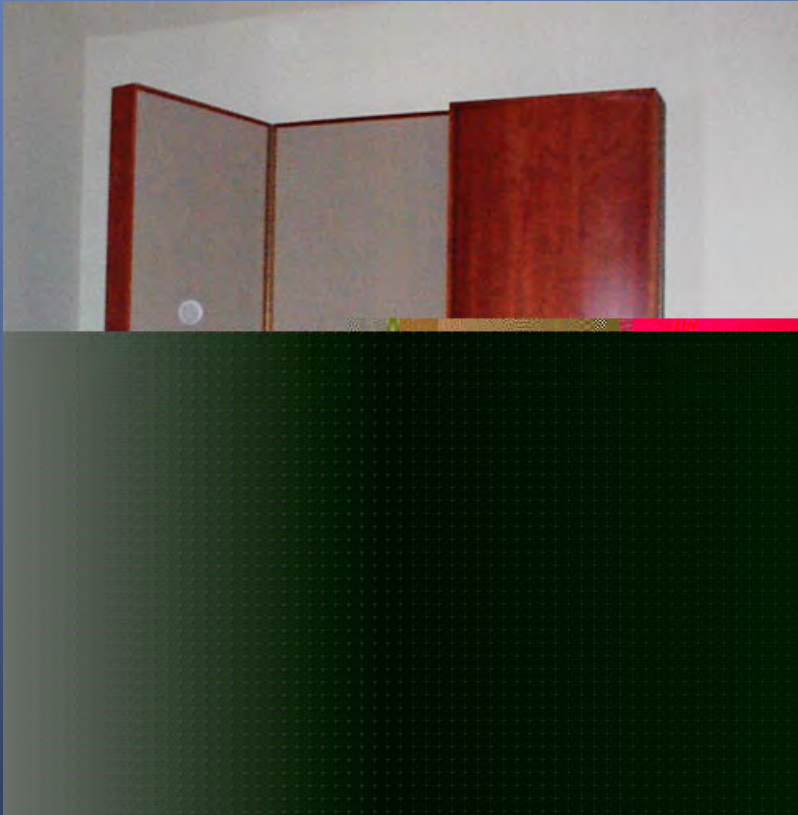


- Size
- Shape





## Source PATH Receiver



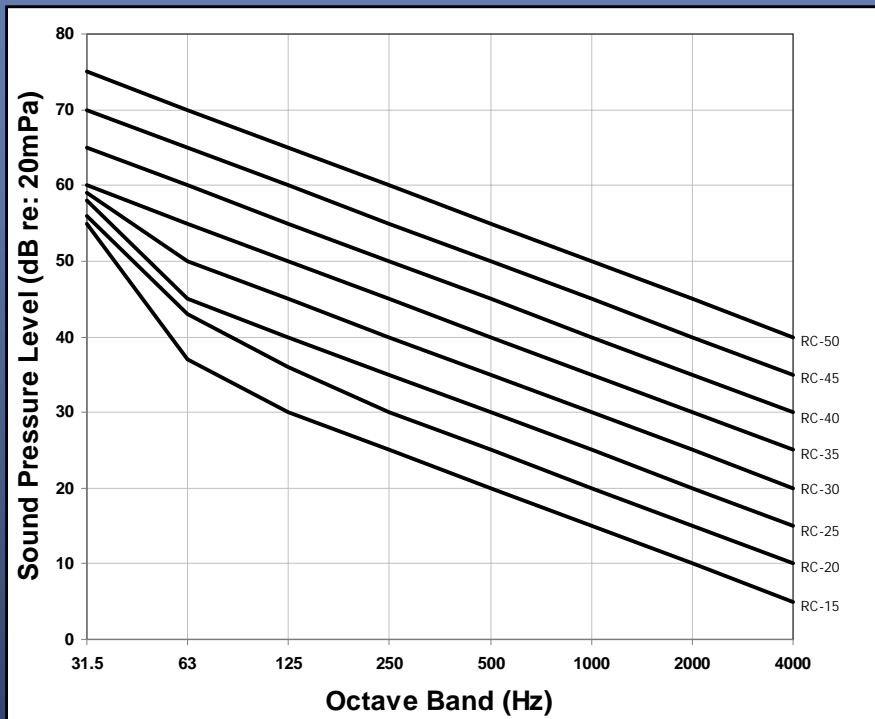
- Size
- Shape
- Materials

*El tamaño, forma y materiales determinan casi totalmente las características acústicas del espacio.*





## Source PATH Receiver

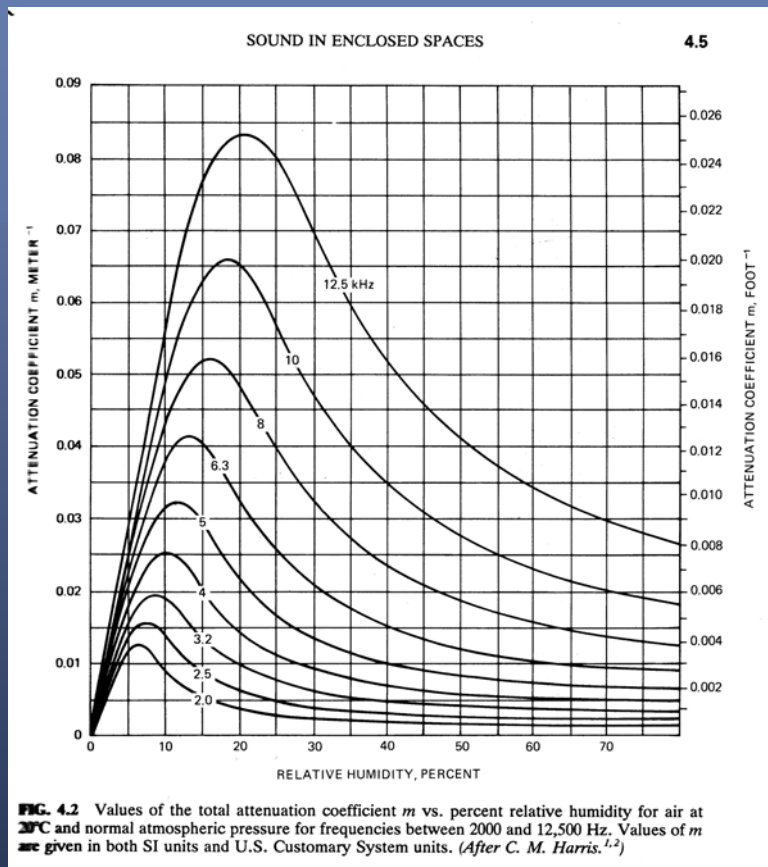


- Size
- Shape
- Materials
- **Also**
  - **Background noise**





## Source PATH Receiver



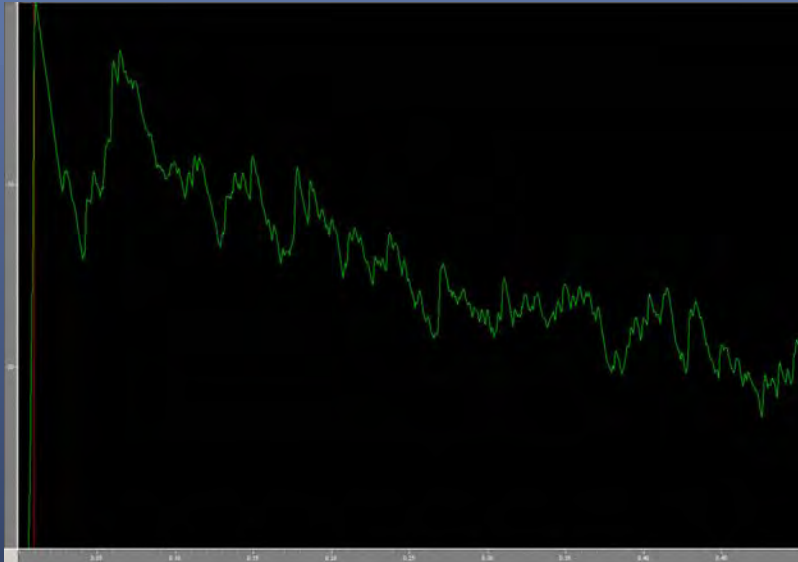
- Size
- Shape
- Materials
- Also
  - Background noise
  - Sound absorption in air





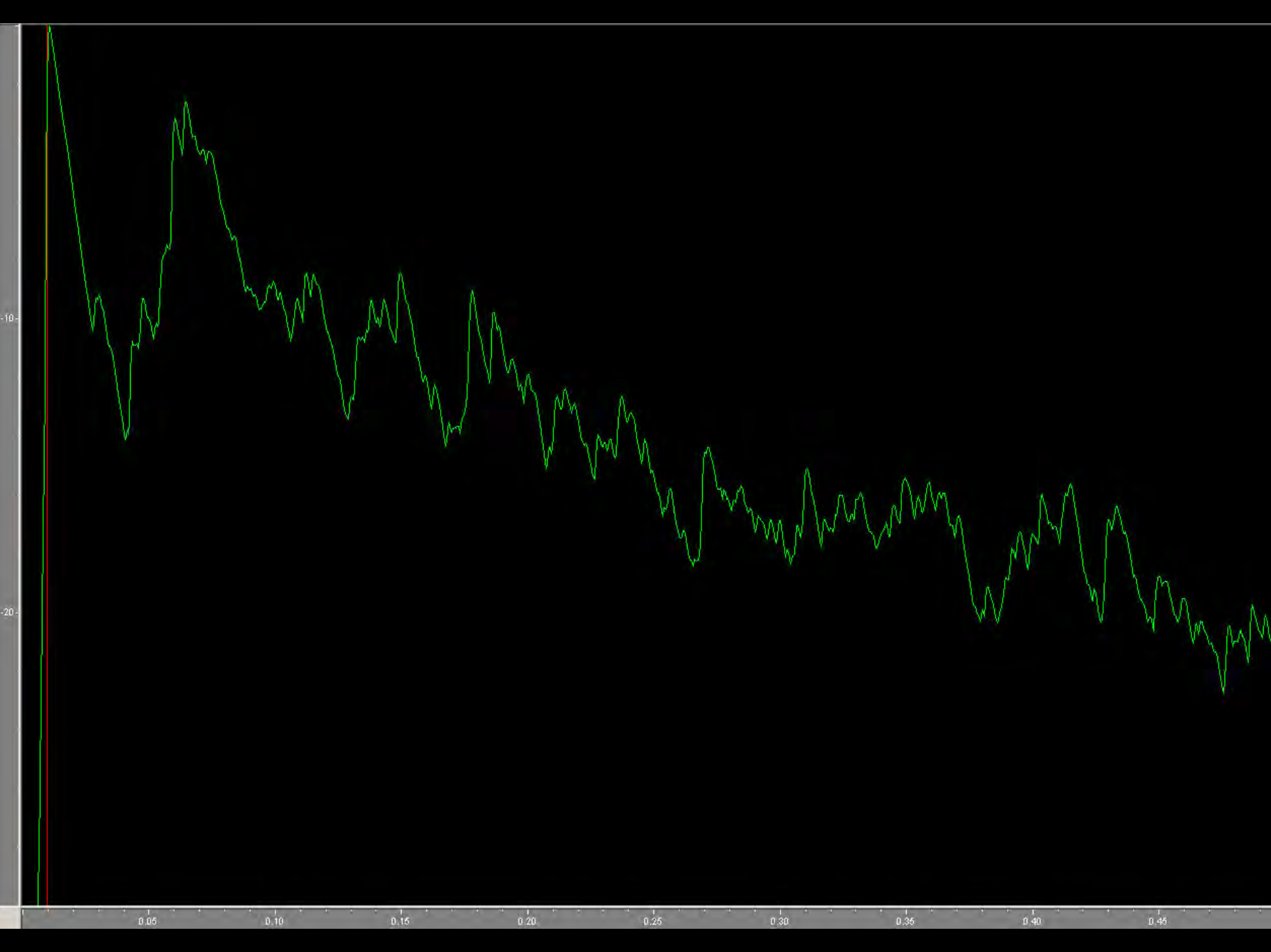
## First: Need to think in the *Time* Domain

- The direct sound offers Clarity, Loudness and establishes position.
- Very Early Reflections (0 to 10 msec) create comb filtering
- First Early Reflections (10 to 40 msec) promote Clarity, Loudness and aid localization.



*Con espacios grandes, necesitamos pensar en el “dominio del tiempo”.*

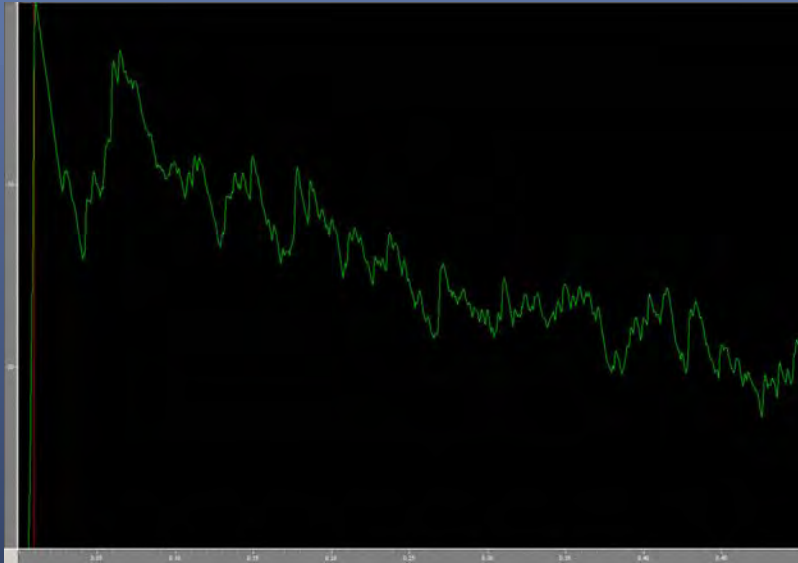


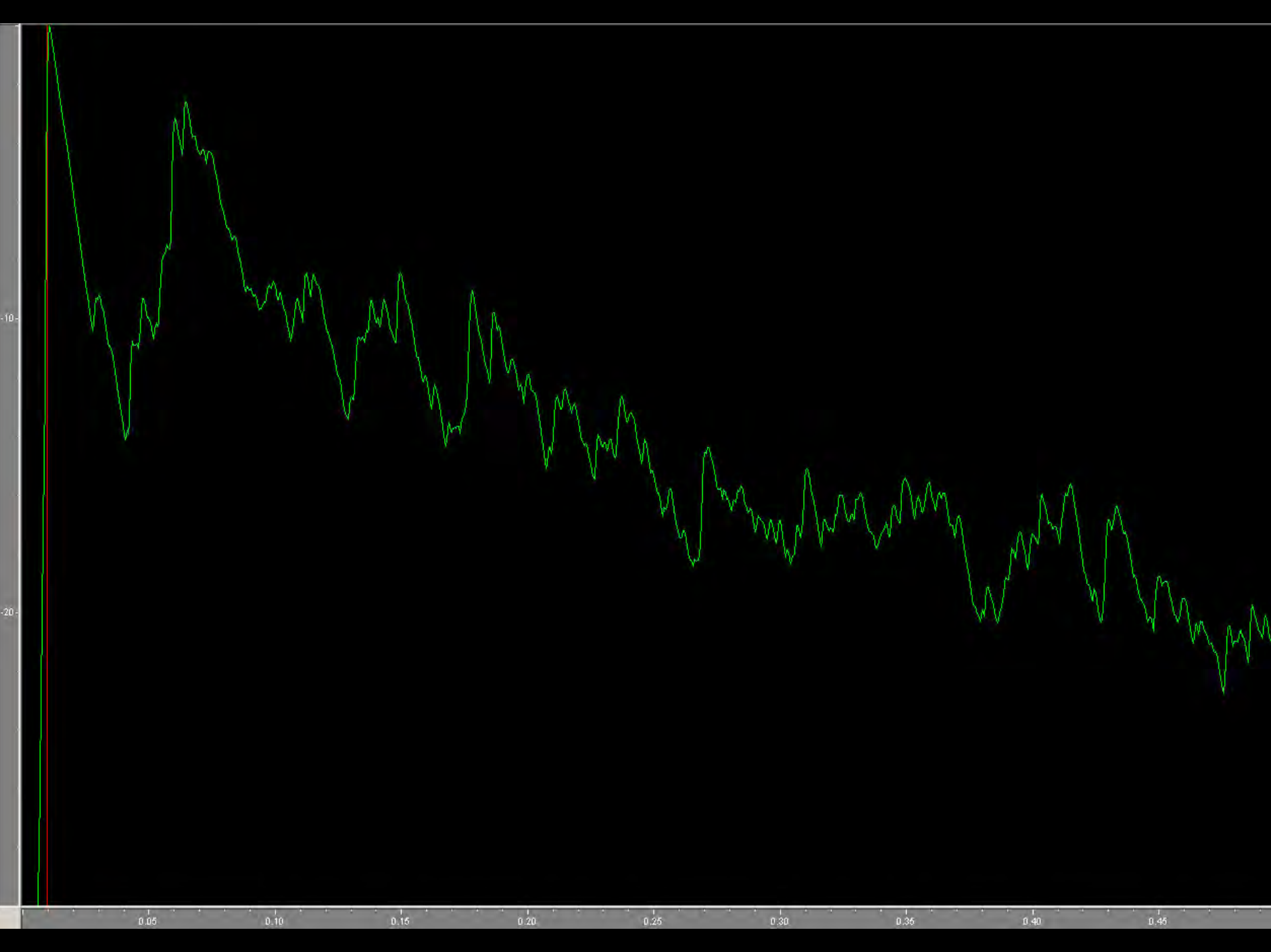




## First: Need to think in the *Time* Domain

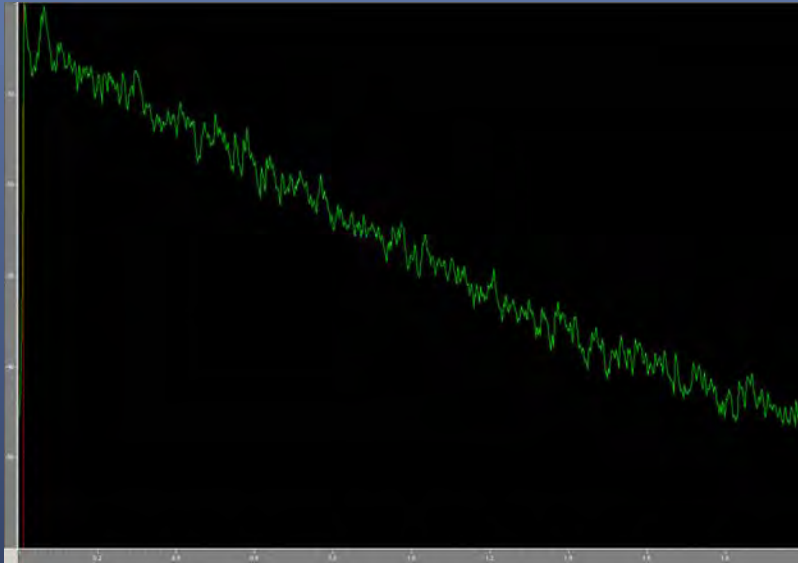
- Additional Early Reflections (10 to 80 msec) promote Clarity and Loudness.
- Later sound reflections (40 to 250 msec) promote Running Liveliness and Envelopment.





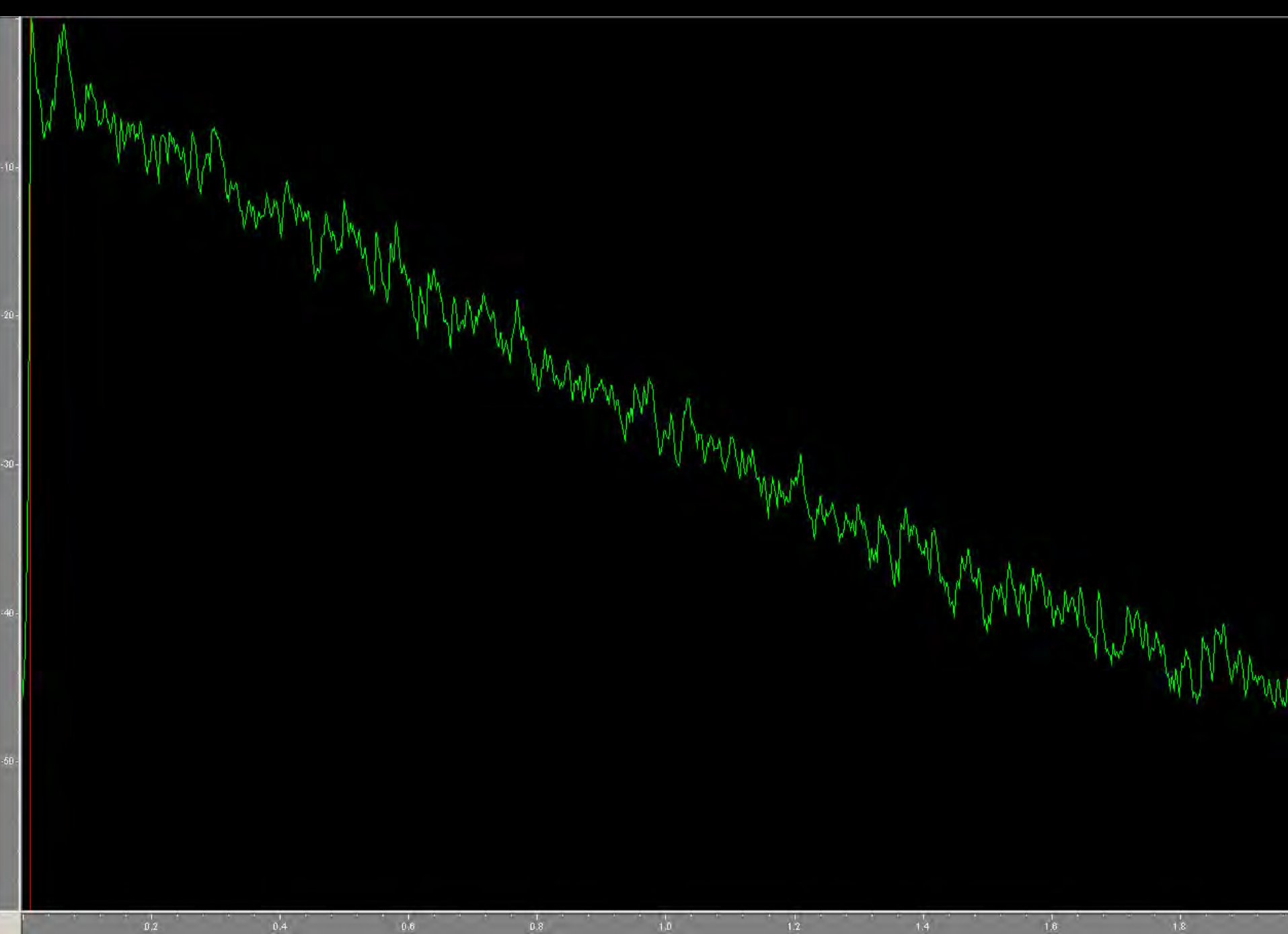


## First: Need to think in the *Time* Domain



- Mid time period (250 to 750 msec) is masked.
- Reverberant sound (750 to 1000, 2000 or more msec)
- *La abundancia de reflexiones de sonido entre 40 a 250 milisegundos determinan la percepcion o resonancia mas que la reverbacion del tiempo en el espacio o sala.*







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## Achieving Clarity Loudness and Proper Localization

### Clarity

- Strong direct sound to listeners
- Quickly-arriving sound reflections
- Size, shape, and materials
- Absence of noise





## Achieving Clarity Loudness and Proper Localization



### Loudness

- Early and mid-arriving sound reflections from sidewalls (0.01 to 0.25 seconds)
- Room shape that supports multiple lateral sound reflections
- Near-parallel side walls w/balconies support loudness





## Achieving/Controlling Running Liveliness



- **Running Liveliness** influences the perception of reverberance more than **Reverberation Time**.
- **True**, especially during ongoing music or speech





## Achieving/Controlling Running Liveliness

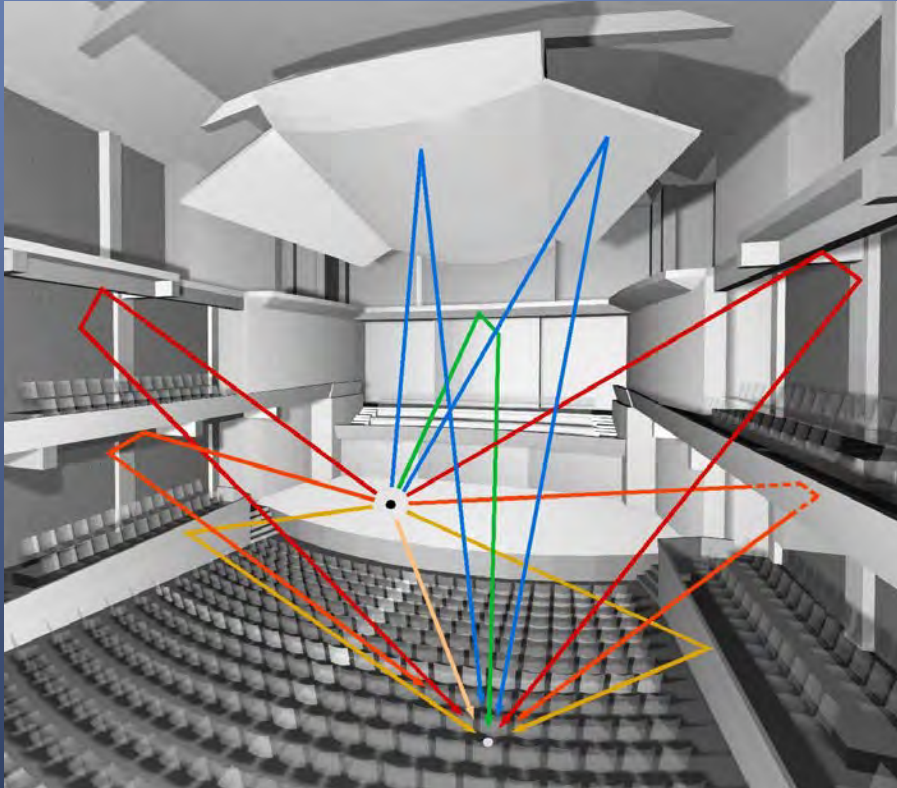


- Running Liveliness influences the perception of reverberance more than Reverberation Time.
- True, especially during ongoing music or speech
- **True, even during the audible decay of reverberation.**





## Achieving/Controlling Running Liveliness



- Running Liveliness influences the perception of reverberance more than Reverberation Time.
- True, especially during ongoing music or speech
- True, even during the audible decay of reverberation.
- **Hence, controlling running liveliness is more important than controlling reverberation time.**





## Creating Envelopment



- Sound reflections from side walls.
- Sound reflections from rear walls
- Proper rake/arrangement of audience seating areas
- Begins with proper theatre planning (not “applied” acoustics)





## Creating proper *timbre*



- **LOW PITCH SOUND**
  - Add Warmth by conserving and reflecting low-pitched sound
    - Massive walls
    - Large surface areas





## Creating proper *timbre*

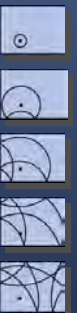
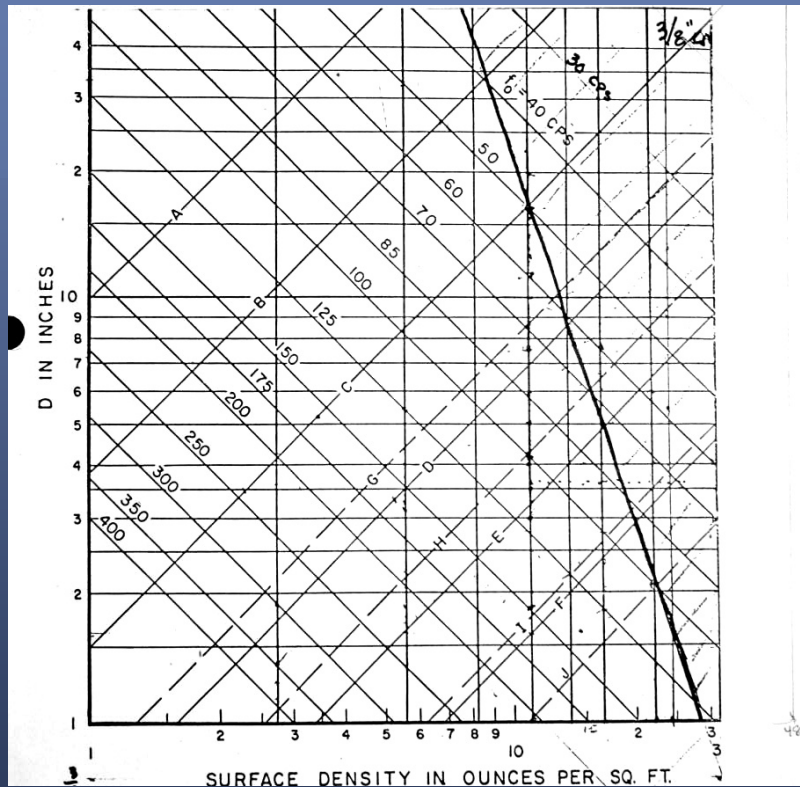
- LOW PITCH SOUND

- Add Warmth by conserving and reflecting low-pitched sound

- Massive walls
- Large surface areas

- **Control “boominess”** by absorbing low-pitched sound

- Absorption by resistance

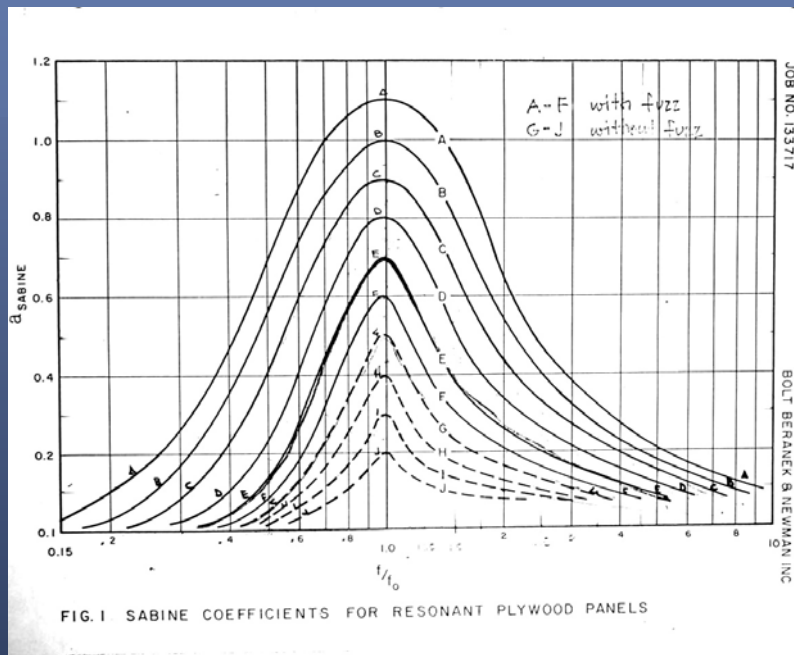




## Creating proper *timbre*

- LOW PITCH SOUND

- Remember relationship to (long) wavelength
  - Absorption by reactance
- Calculate the resonance and Q of reactive sound absorbers. (need *some* resistance)
- *Materiales de peso liviano en frente de cavidades de aire absorben sonidos de tono bajo.*





## Creating proper *timbre*



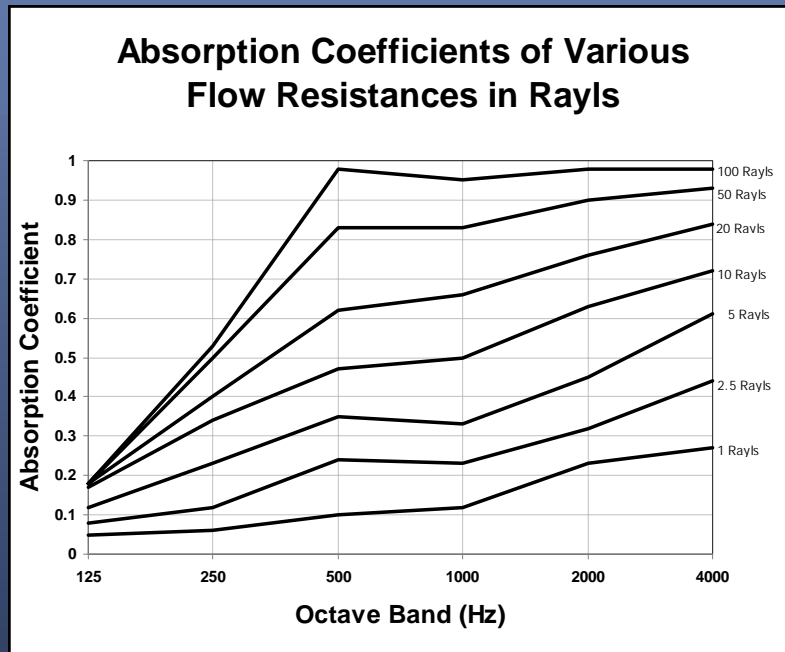
- MID/HIGH PITCH SOUND
  - Porosity of materials





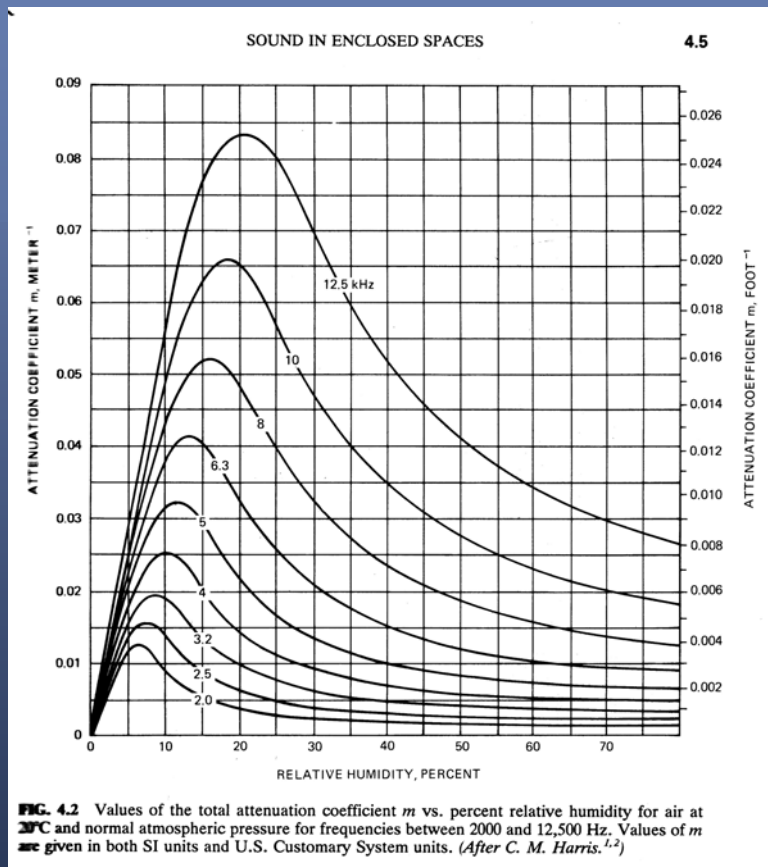
## Creating proper *timbre*

- MID/HIGH PITCH SOUND
  - Porosity of materials
    - Flow resistance
    - Thickness





## Creating proper *timbre*



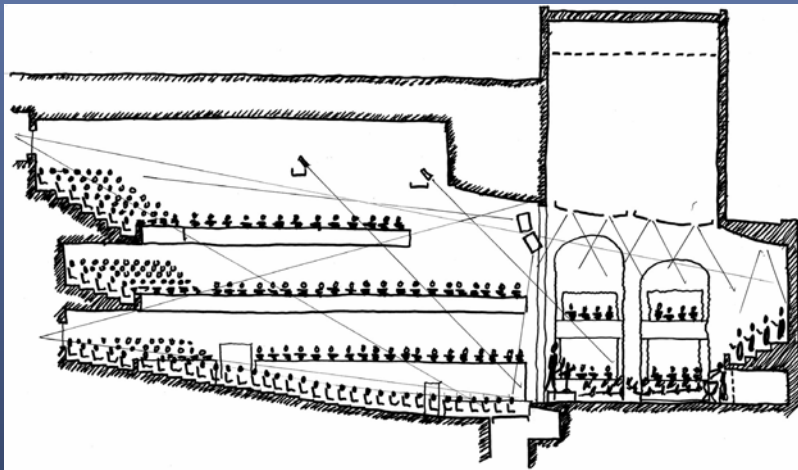
- MID/HIGH PITCH SOUND
  - Porosity of materials
    - Flow resistance
    - Thickness
  - Room Volume, relative humidity of air





## Other considerations

- Few spaces are “single use”
- Acoustic design begins at the concept stage and is integral to the theatre planning.



- *La acustica de una sala o espacio debe de ser desarrollada como una pieza integral en el proceso de planeamiento del teatro. La acustica del espacio no puede ser aplicada a las paredes.*





## Other considerations

- Few spaces are “single use”
- Acoustic design begins at the concept stage and is integral to the theatre planning.
- **Best achieved with acoustical consultant hired directly by the client**





## Other considerations

- Few spaces are “single use”
- Acoustic design begins at the concept stage and is integral to the theatre planning.
- Best achieved with acoustical consultant hired directly by the client
- **Need to be mindful of source directivity**
- **Low noise is imperative**
- *La ausencia de sonido es muy importante.*





## Other considerations

We must all aspire to the highest level of acoustic design appropriate for a given space.

*Todos debemos de aspirar a los mas altos niveles en el diseno de acusticas.*





## Closing



- Reading List
  - Room Acoustics by Kuttruff
  - ASA publications
  - Sabine Centennial Symposium Proceedings

Presented by:

Rick Talaske

The Talaske Group, inc.

Oak Park, IL 60301 USA

(located adjacent to Chicago)

