WSDG
WALTERS-STORYK DESIGN GROUP

Acoustic and Systems Considerations for Critical Listening & Interior Design

presented by

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Walters-Storyk Design Group

www.wsdg.com

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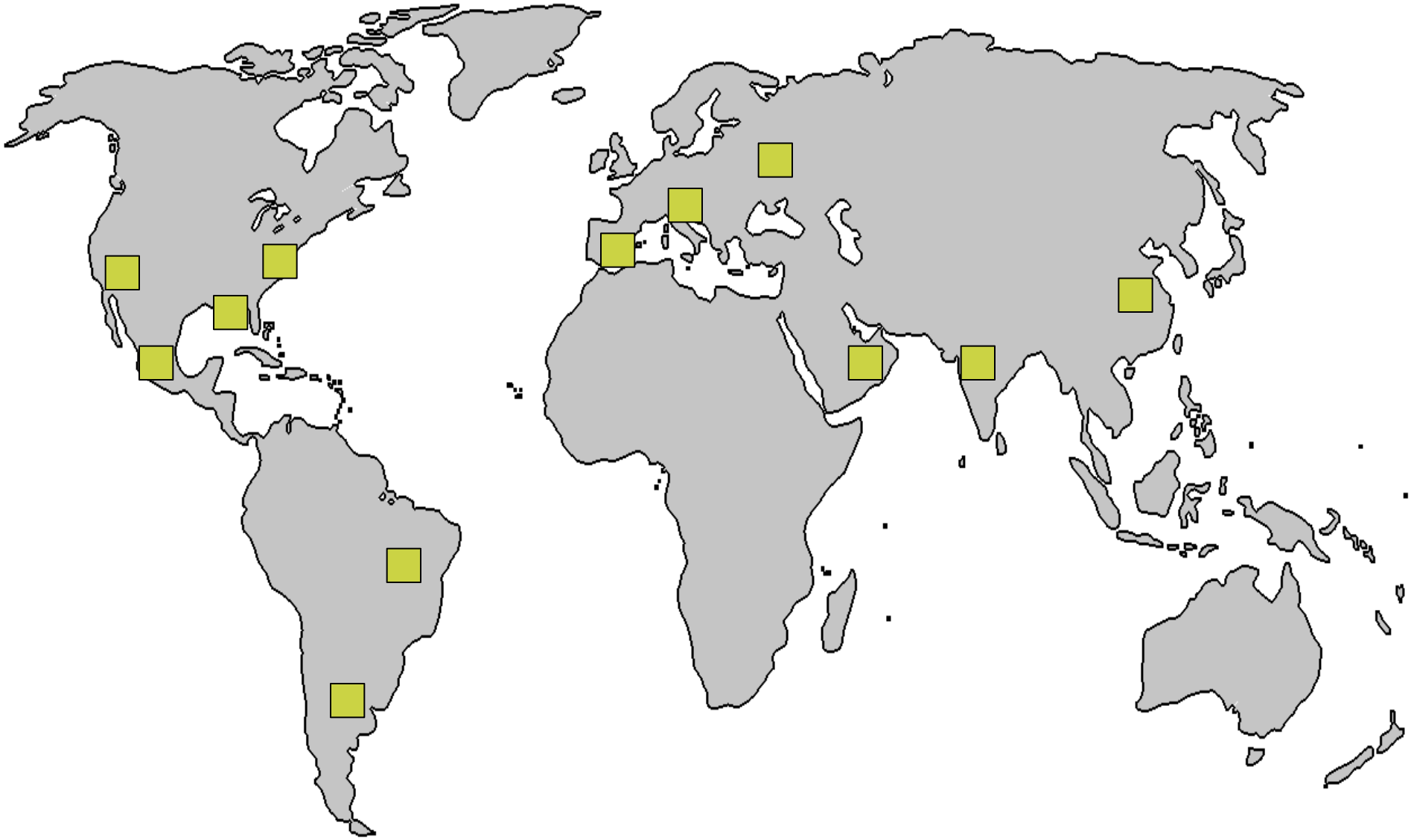
WSDG – Offices and Representatives



ARCHITECTURAL ACOUSTICS - AUDIO VISUAL - TECHNOLOGY INTEGRATION

Architectural Acoustics

- Recording Studio Design
- Media Facility Planning & Consulting
- Room Acoustics & Surface Treatments
- Structural Acoustics & Sound Isolation
- Acoustic Measurements & Simulations

ARCHITECTURAL ACOUSTICS - AUDIO VISUAL - TECHNOLOGY INTEGRATION

Audio Visual

- Electroacoustical Systems
- Systems Design & Integration
- Home Theater & Residential Systems Design

Technology Integration

- Media Distribution
- IT and Communication Systems
- Control Systems
- Theatrical Technology

- **Recording Studios – Post Production Facilities**
- **Broadcast Studios – Film, Radio, TV, Webcast.**
- **Corporate Offices, Hospitality, Museums, Casinos.**
- **Auditoriums, Theaters, Movie Cinemas, IMAX, Presentation Rooms**
- **Arenas, Stadiums, Large Venues**
- **Acoustic Restauration of Historic Spaces**
- **High End Dedicated Home Theaters**

45 years of worldwide experience

More than 70 profesionals as architects, acoustic engineers, designers, systems integrators

More than 3500 projects

Challenge

Unite the disciplines of

architecture - acoustics - technology integration

in order to create exciting spaces that are

acoustically accurate and *quiet* within the community.

STADIUM
80000 SEATS

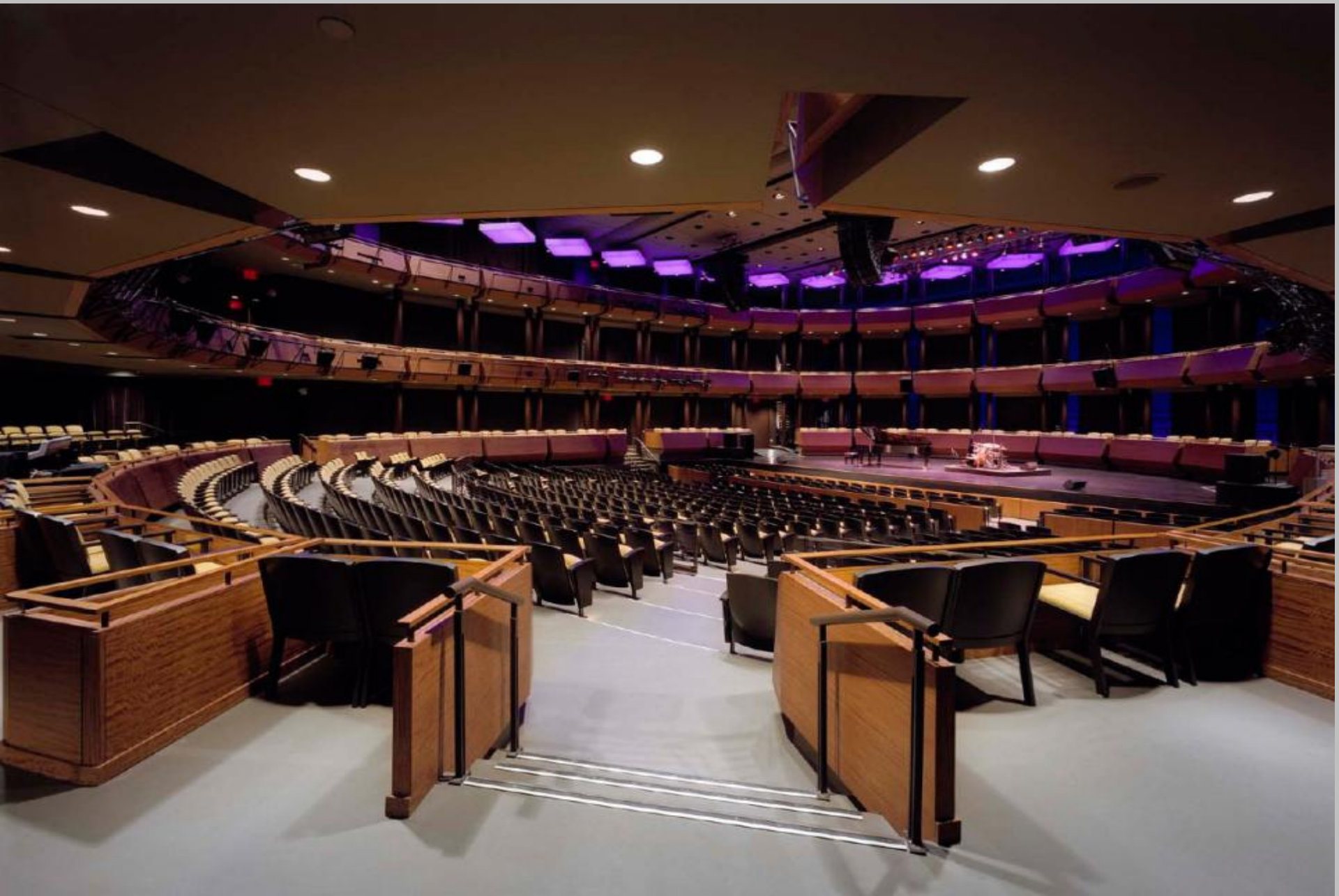
FIFA WORLD CUP
Brasil

STADIUM
20000 SEATS

ARENA
15000 SEATS

ARENA
5000 SEATS

AUDITORIUM – THEATER
3000 Seats



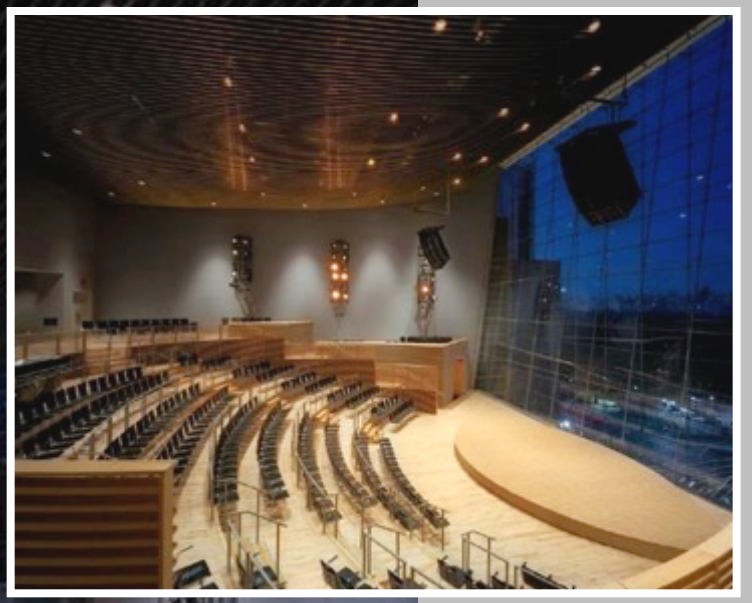
AUDITORIUM – THEATER
3000 Seats

AUDITORIUM – THEATER
1500 Seats

AUDITORIUM – THEATER
600 Seats

AUDITORIUM – THEATER
600 Seats

AUDITORIUM – THEATER
400 Seats

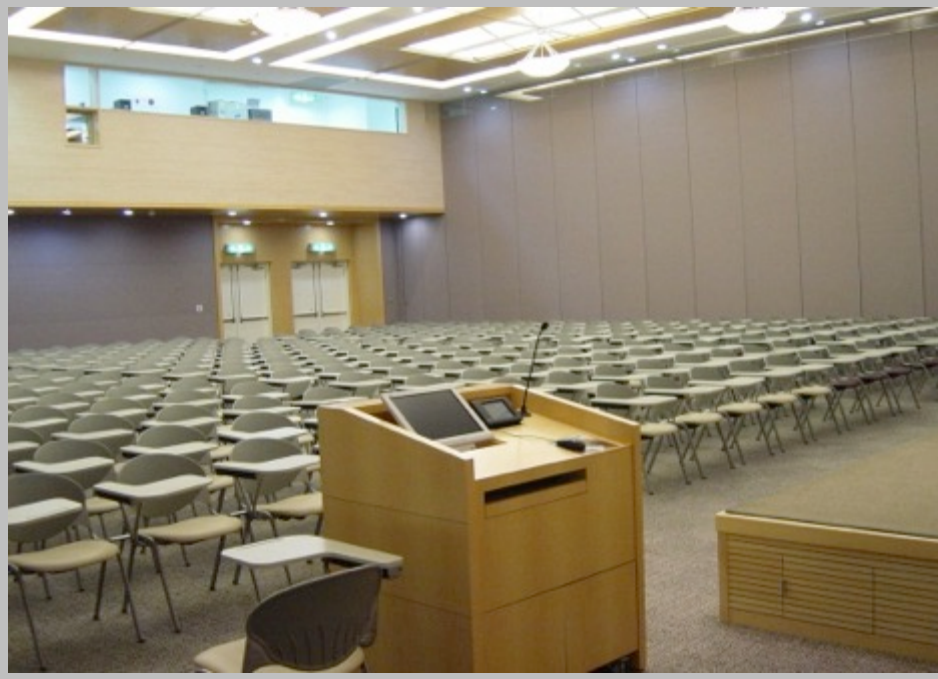


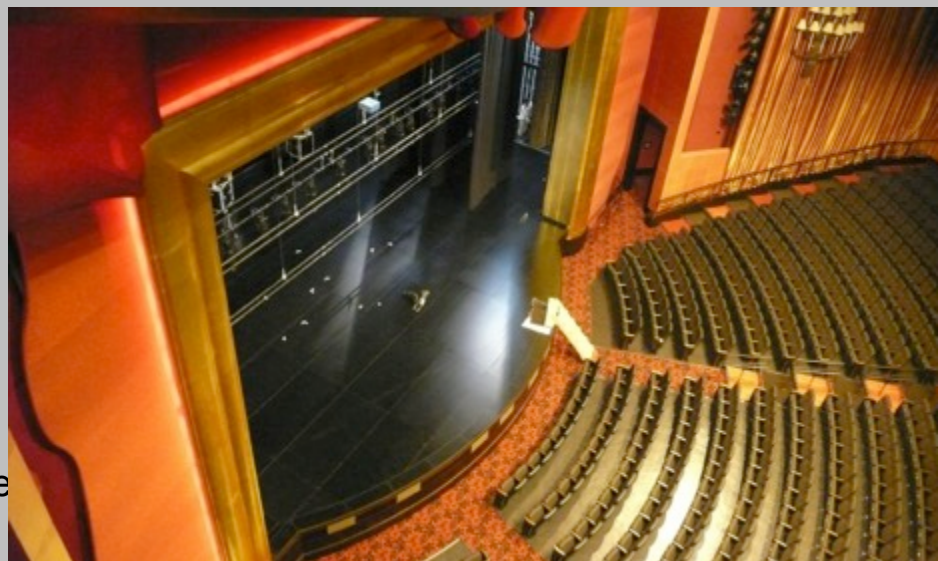
LECTURE HALL
150 SEATS

PRESENTATION – CONFERENCE ROOM
30 Seats

NIGHT CLUB

MULTIPURPOUSE HALL





Inte

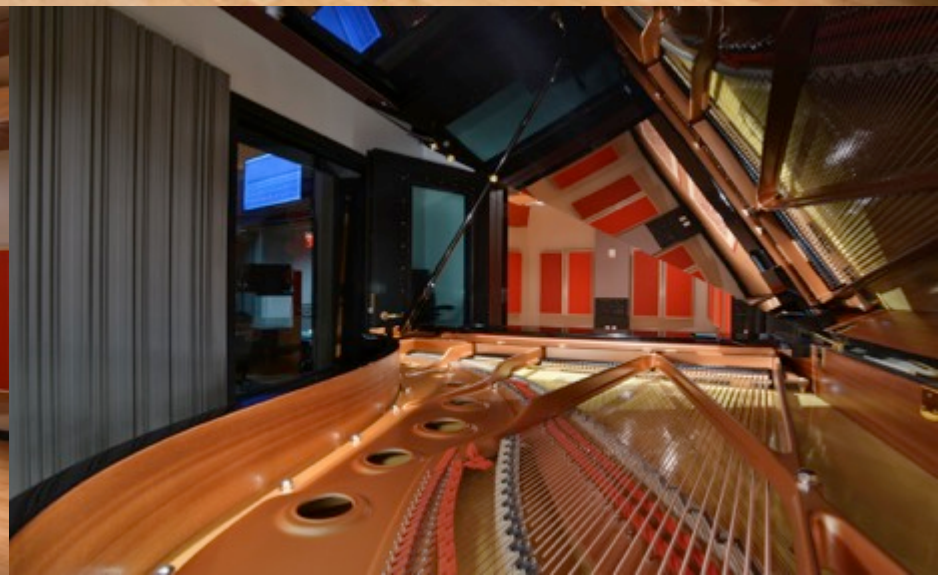
MULTIPURPOUSE HALL

MULTIPURPOUSE HALL


CHANEL

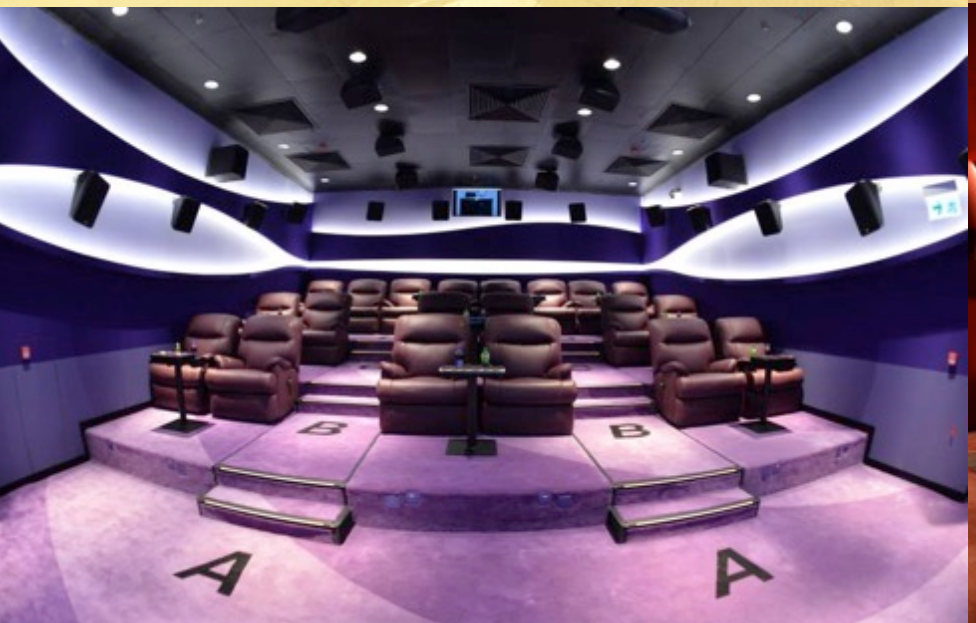
RECORDING STUDIO

RECORDING STUDIOS



RECORDING STUDIOS

MULTIPLEX
MOVIE CINEMA COMPLEX



IMAX MOVIE CINEMA

HOSPITALITY – F&B

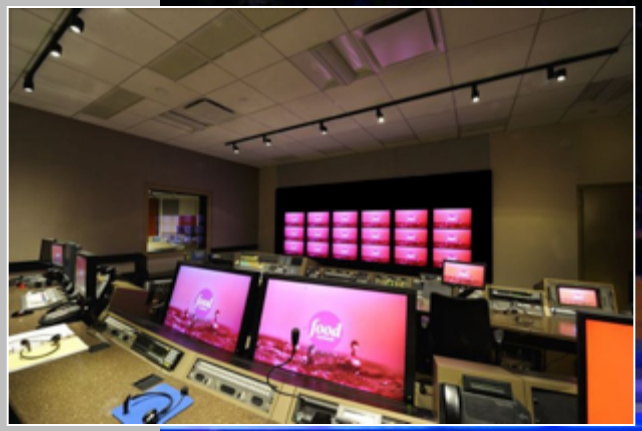
HOSPITALITY – F&B

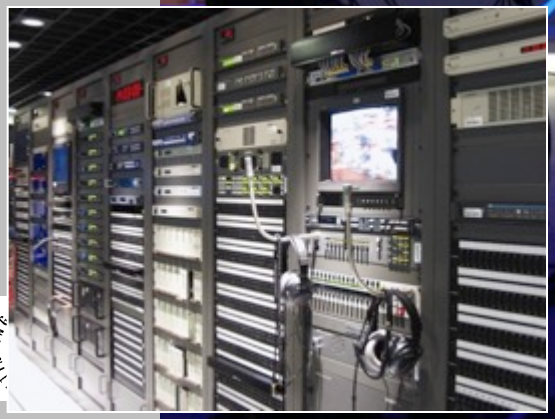
SHOPPING MALLS

FACADE LIGHTING

TRANSPORTATION HUBS

BROADCAST – TV STATION





BROADCAST – MOBILE TV STUDIOS

DISTRIBUTED AUDIO AND VIDEO
DIGITAL SIGNAGE

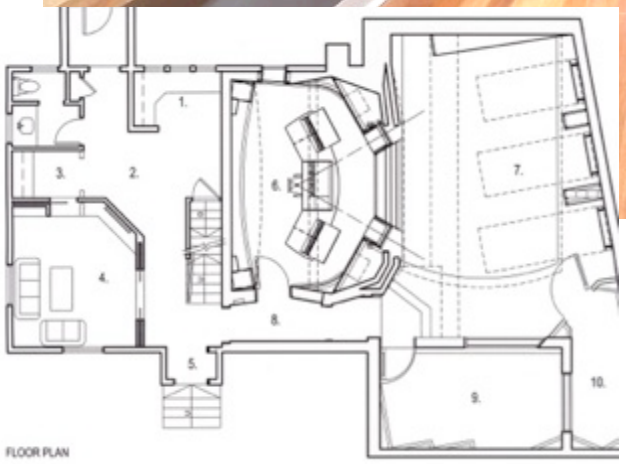
MASTER CONTROL ROOM

RESIDENTIAL MEDIA ROOMS

RESIDENTIAL MEDIA ROOMS

1. NORTH ISO BOOTH
2. NORTH CONTROL ROOM
3. S.L.
4. NORTH LOUNGE
5. MIDI PRODUCTION
6. ISO BOOTH
7. KITCHENETTE
8. CENTRAL LOUNGE
9. RECEPTION
10. ENTRY VESTIBULE
11. WC
12. OFFICE
13. CMR
14. STORAGE / MECH.
15. CLOSET
16. ELECTRICAL CLOSET
17. SOUTH CONTROL ROOM
18. SOUTH ISO BOOTH
19. SOUTH LOUNGE
20. ELEVATOR

0 5 10 FEET



FLOOR PLAN

Acoustics Fundamentals

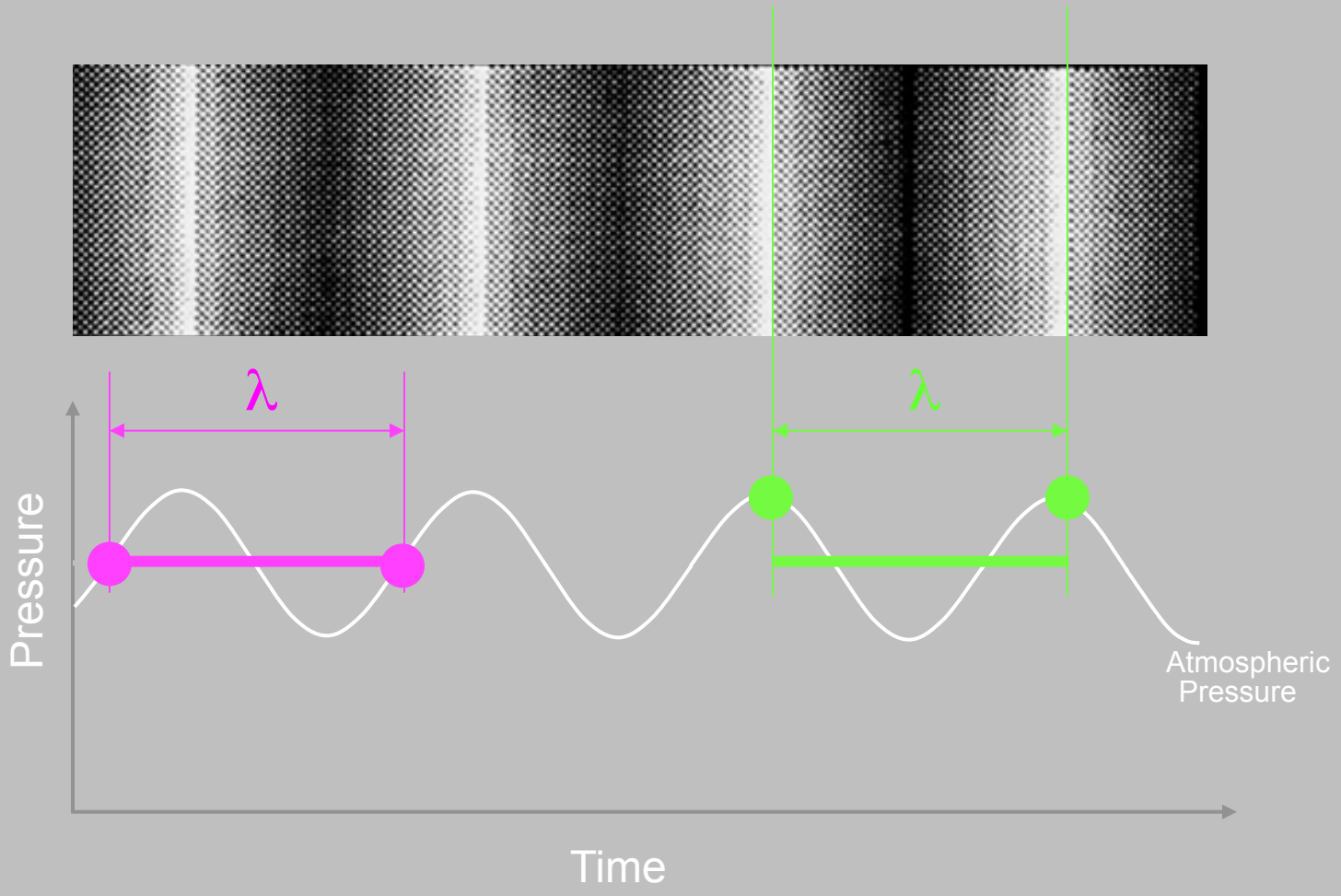
Acoustics
is the study of sound.

Sound
is the change of pressure in a medium (air) over time.

All acoustical parameters must be thought of as being

FREQUENCY DEPENDENT

Wavelength



Wavelength & Speed

$$c = \lambda f$$

c, the velocity of sound, is constant.

Imperial Units: $c \approx 1130\ ft/s = 1.13\ ft/ms \approx 1\ ft/ms$

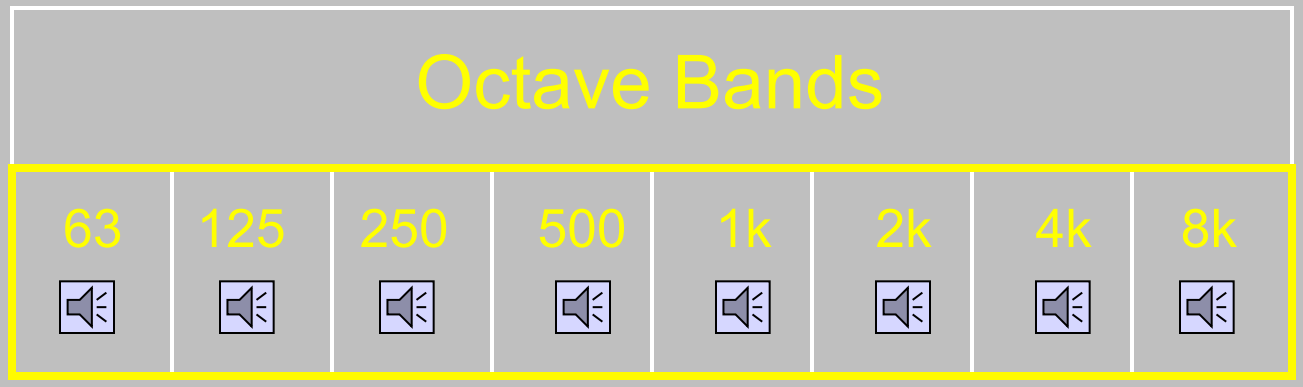
SI Units: $c \approx 344\ m/s = 34.4\ cm/ms \approx 30\ cm/ms$

Therefore, if λ gets small, *f* must get large.
If λ gets large, *f* must get small.

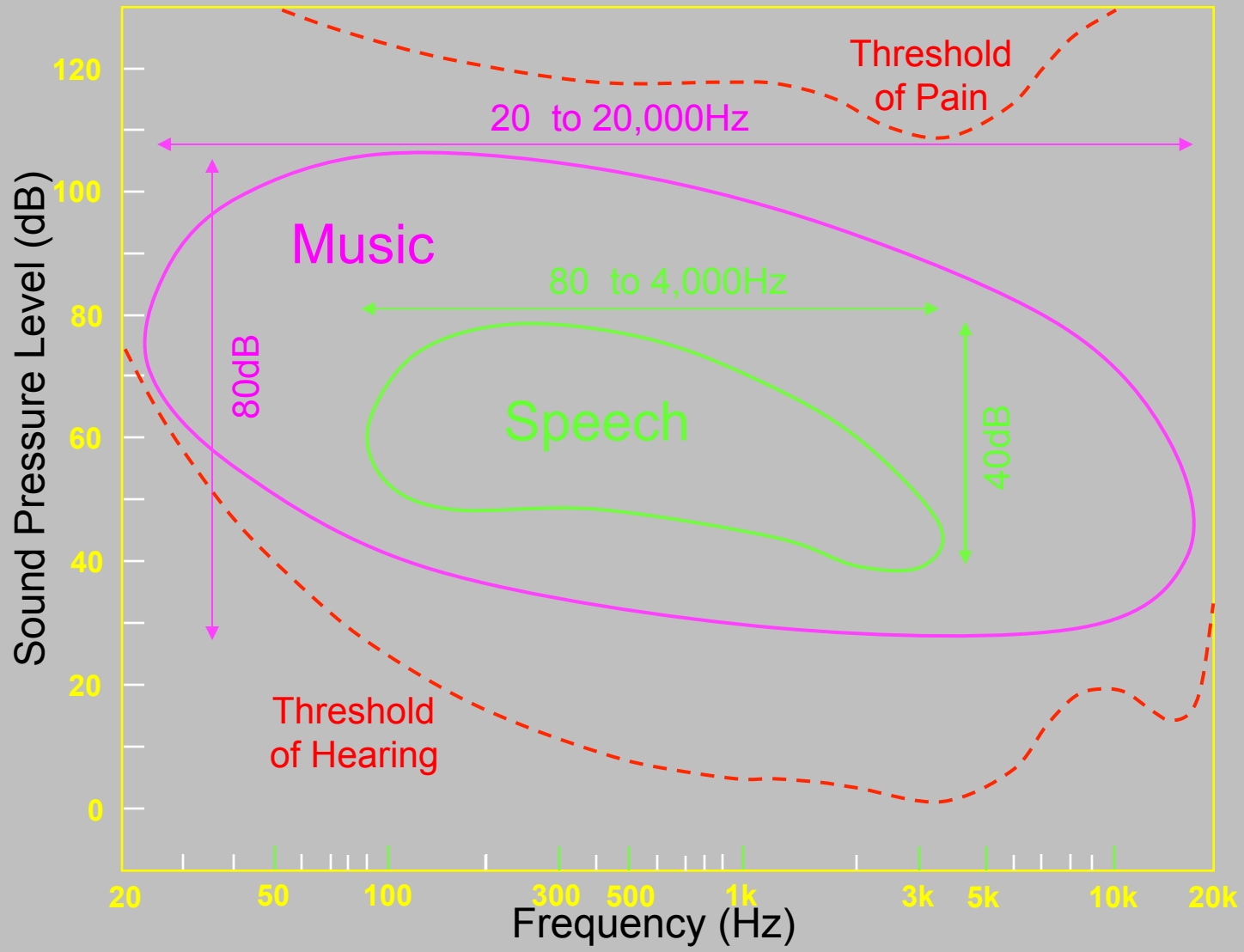
Low frequencies have long wavelengths.
High frequencies have short wavelengths.

Frequency Range in Bands

The most common frequency bands have their centers at octave or 1/3 octave intervals.

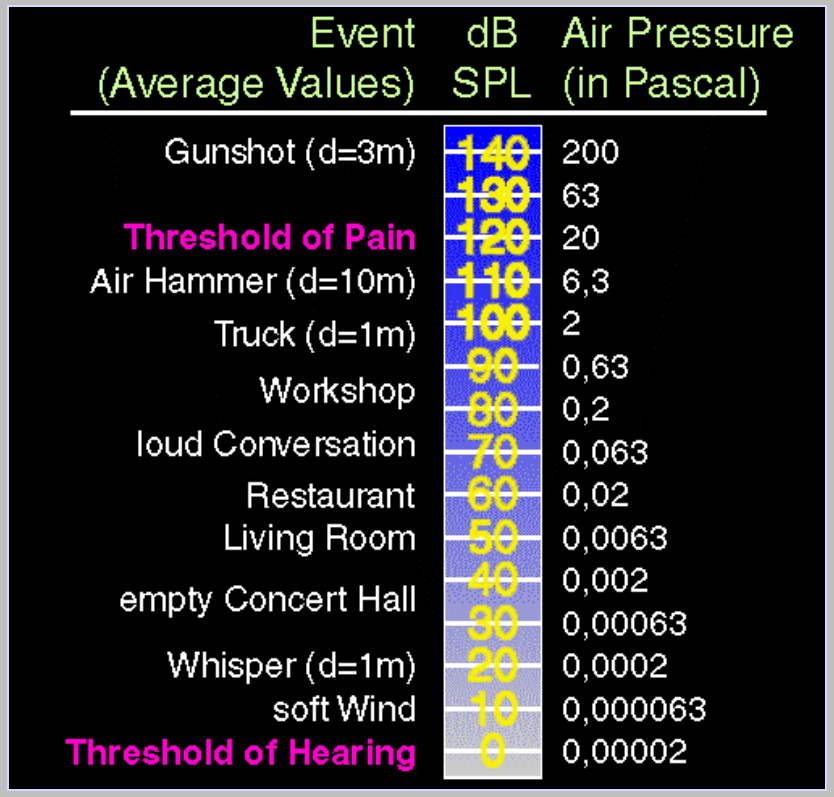


Speech and Music



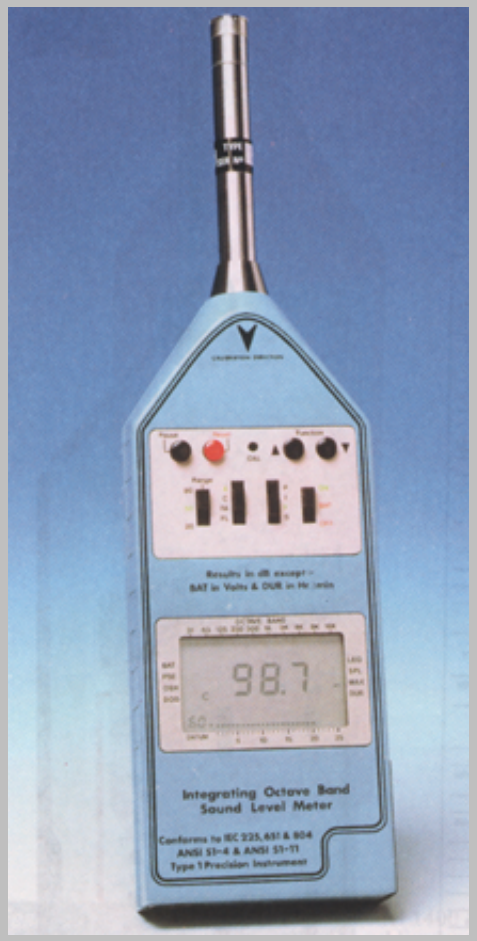
Acoustic Sound Levels
dB SPL Chart

Our ear's sensitivity for loudness and frequency is logarithmic – measured in decibel (dB)



Measuring Sound Levels

Handheld SPL Meter
by Radio Shack
under $100



Handheld SPL Meter
with octave band filters
approx. $4000

SPL Meter APP
on Smartphones
approx. $20

Applied acoustics in design

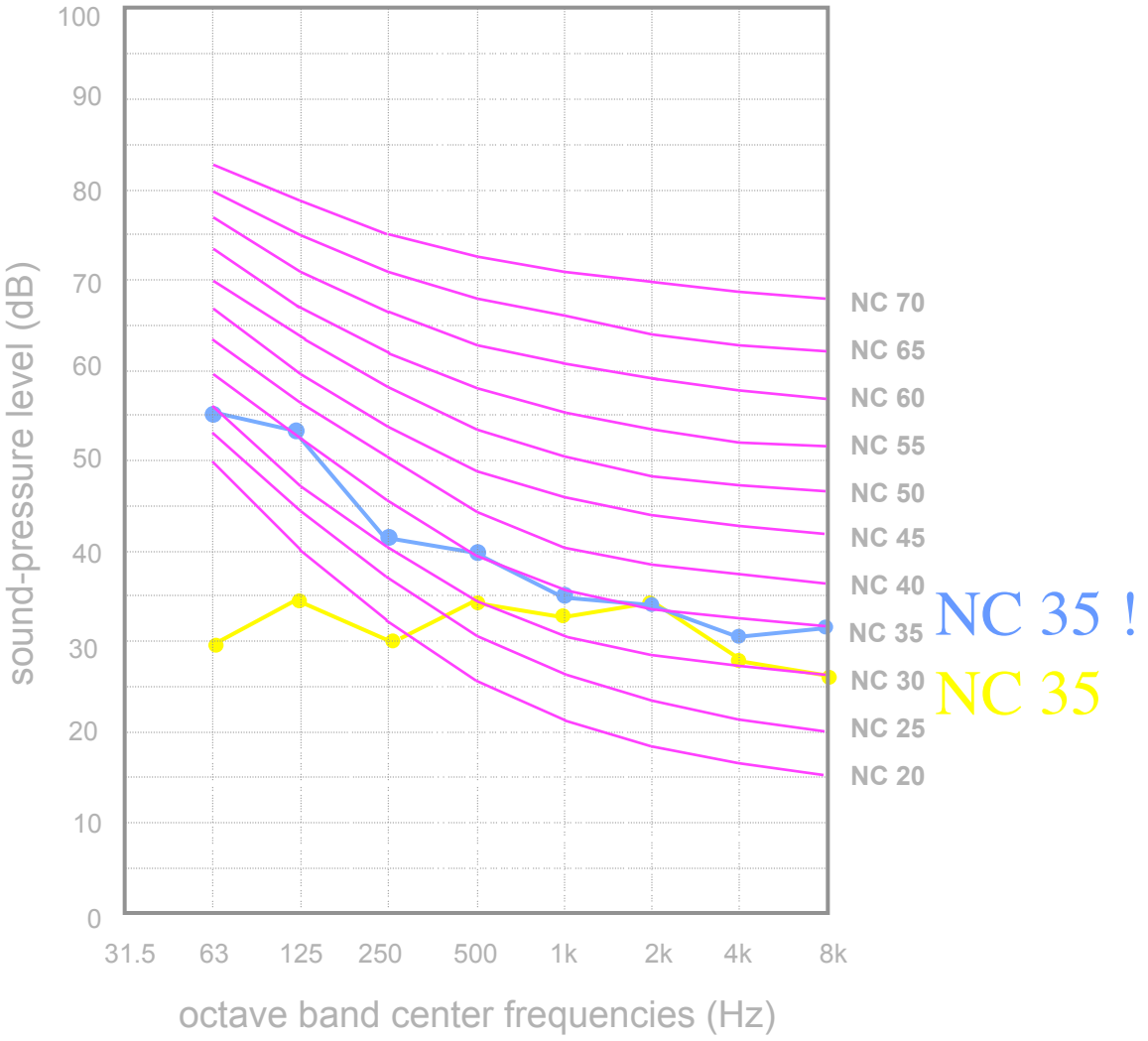
- transfer and isolation (NC, STC)
- internal room (rt60, a, NRC)

transfer and isolation acoustics

Noise Criteria Curves (NC)

One of the most commonly used single-number readings for quietness is the Noise Criteria (NC).

NC curves are convenient but can be deceiving in accuracy for individual frequency values

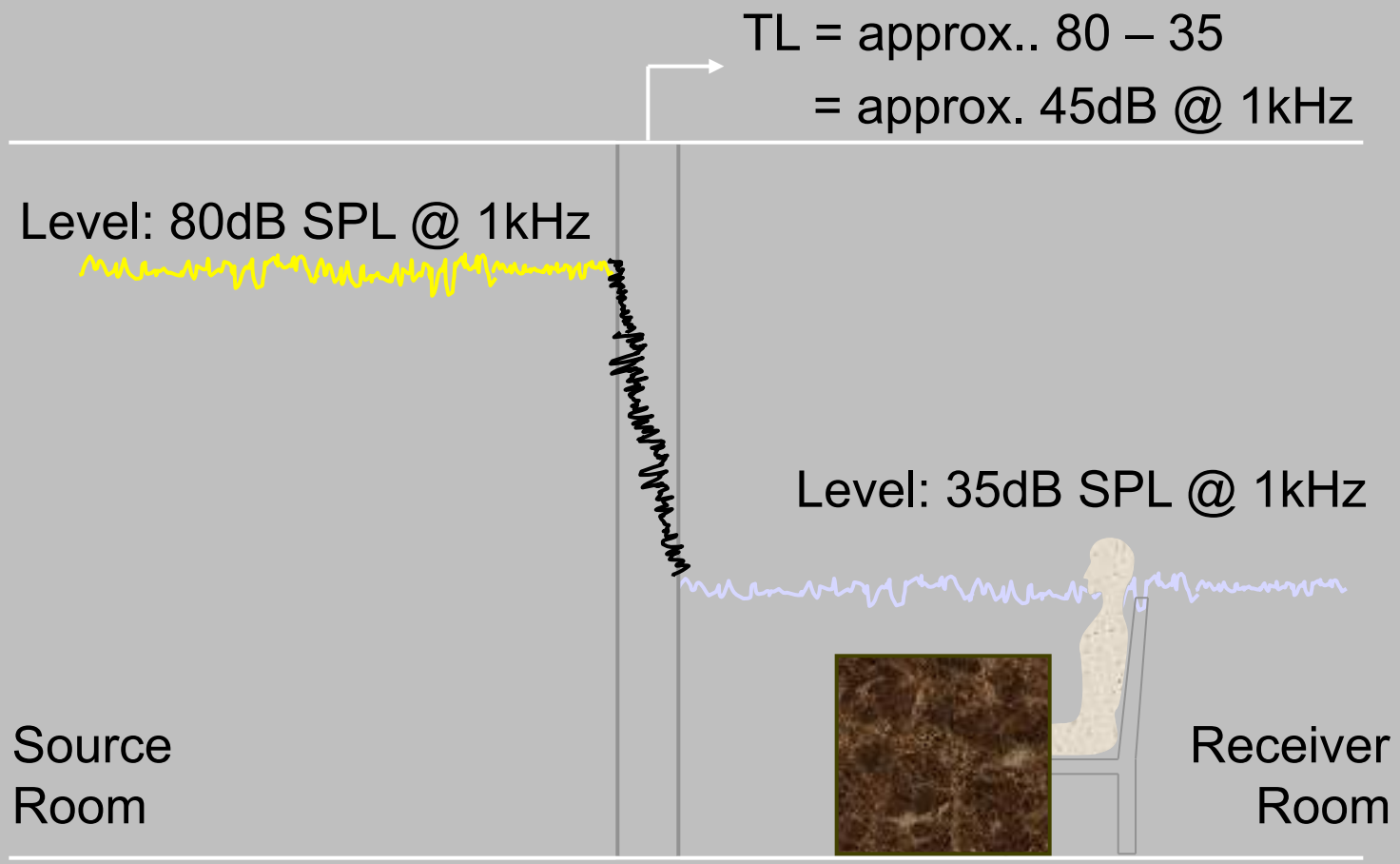


Typical NC Values

Conditions	NC level
Sleeping	25-35
Living	35-45
Office	30-45
Audio Studio	15-20
Restaurant	35-50
Home Theater	20-25
Conference Room	25-30

Transmission Loss (TL)

The most common way of determining airborne sound insulation is the two room method.



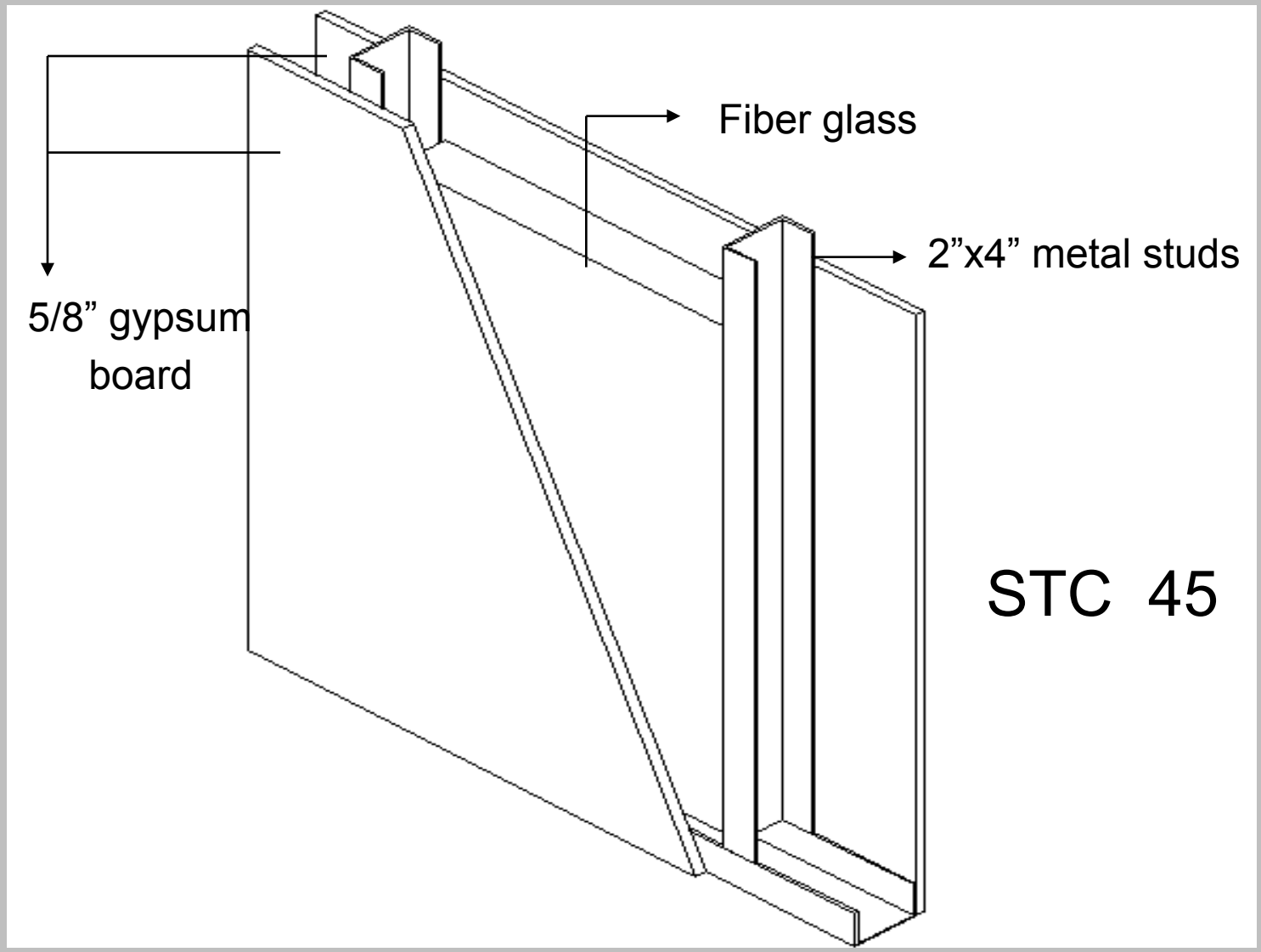
Room-within-Room Design

Two keywords for sound isolation design
Mass
Decoupling

A clever combination of both: physical mass and mechanical decoupling will result in good sound isolation.

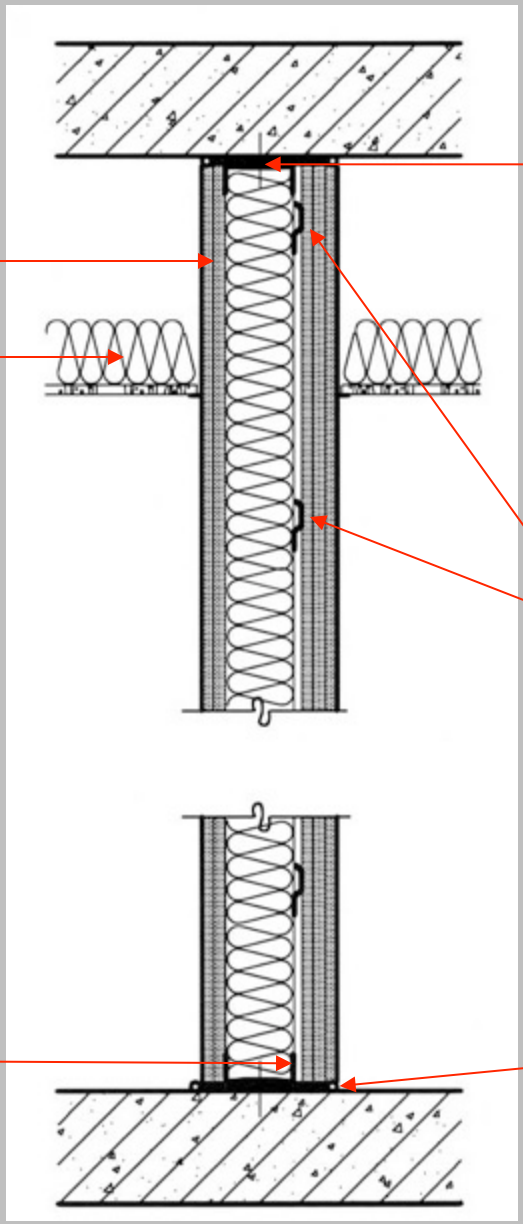
High performance acoustic isolation often results in
Room within Room Construction

Sound Transmission Class



Partitions

Metal Stud Systems



2 Layers of 5/8” Gypsum Board

Attenuation Blanket

Metal Studs

Open Cell Neoprene

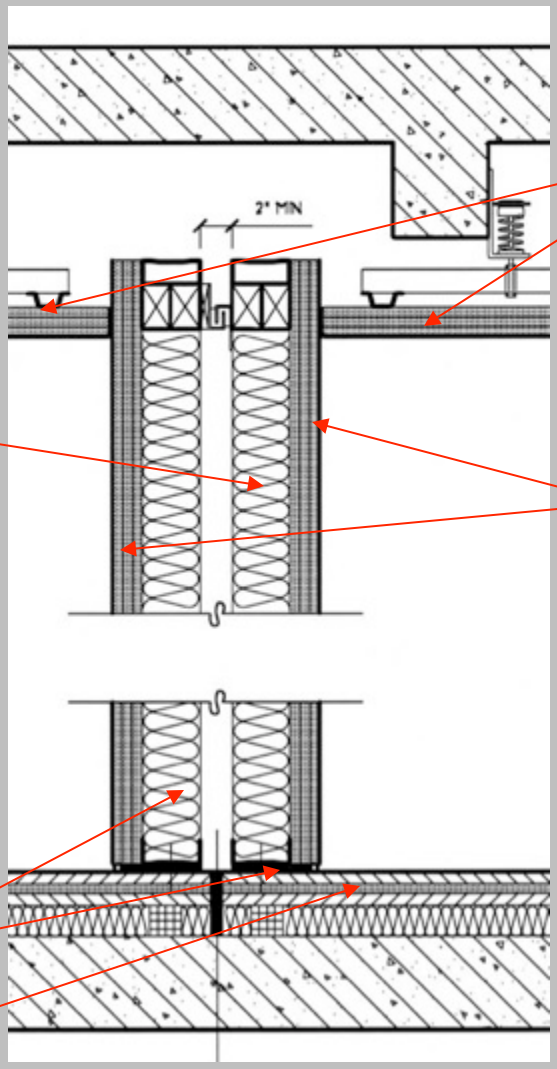
Resilient Channel

Acoustical Sealant

STC 52

Partitions

Metal Stud Systems



"de-coupled acoustic ceiling

Attenuation Blanket

multiple g.b. layers

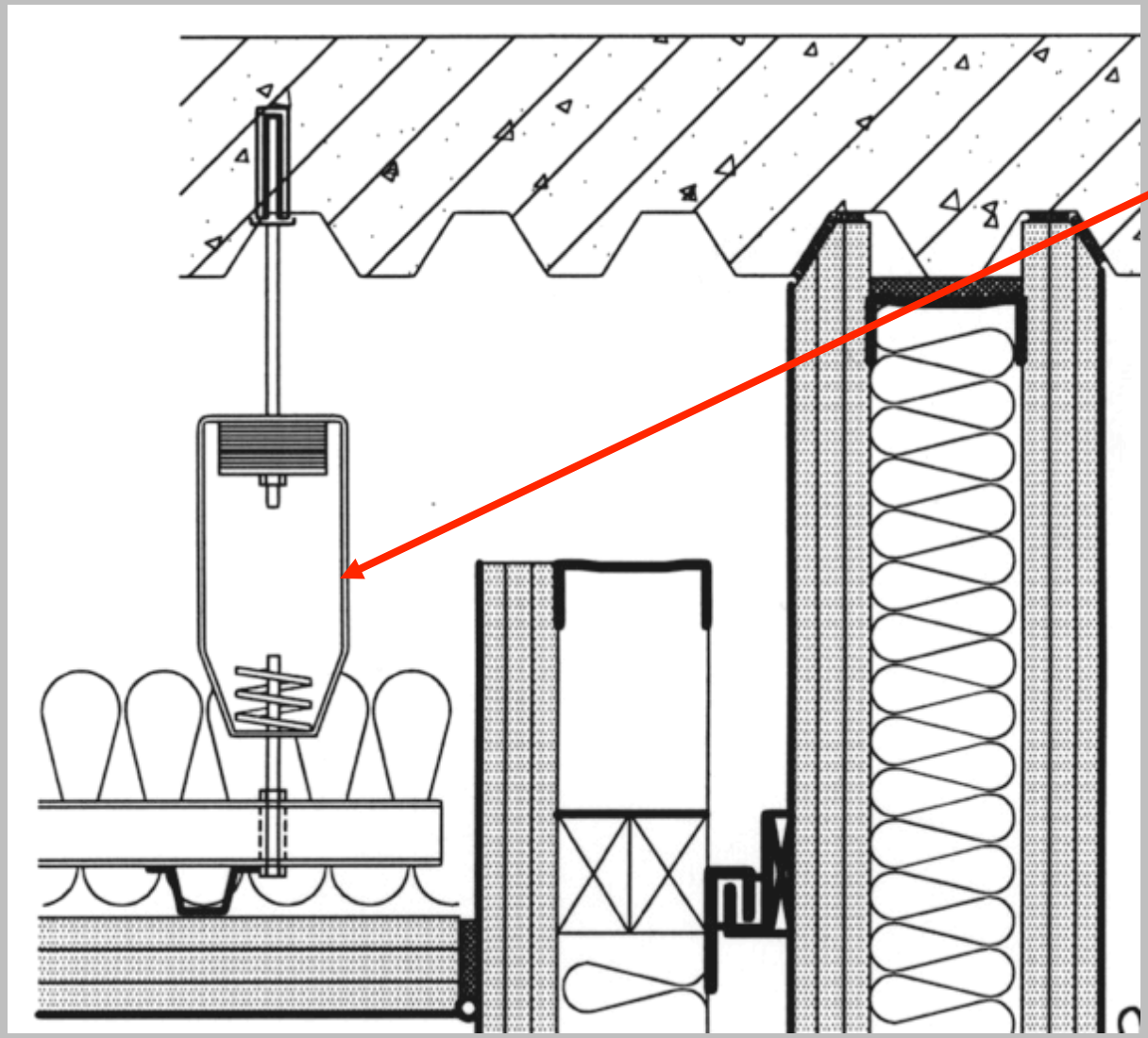
Metal Studs

"Floating Floor"

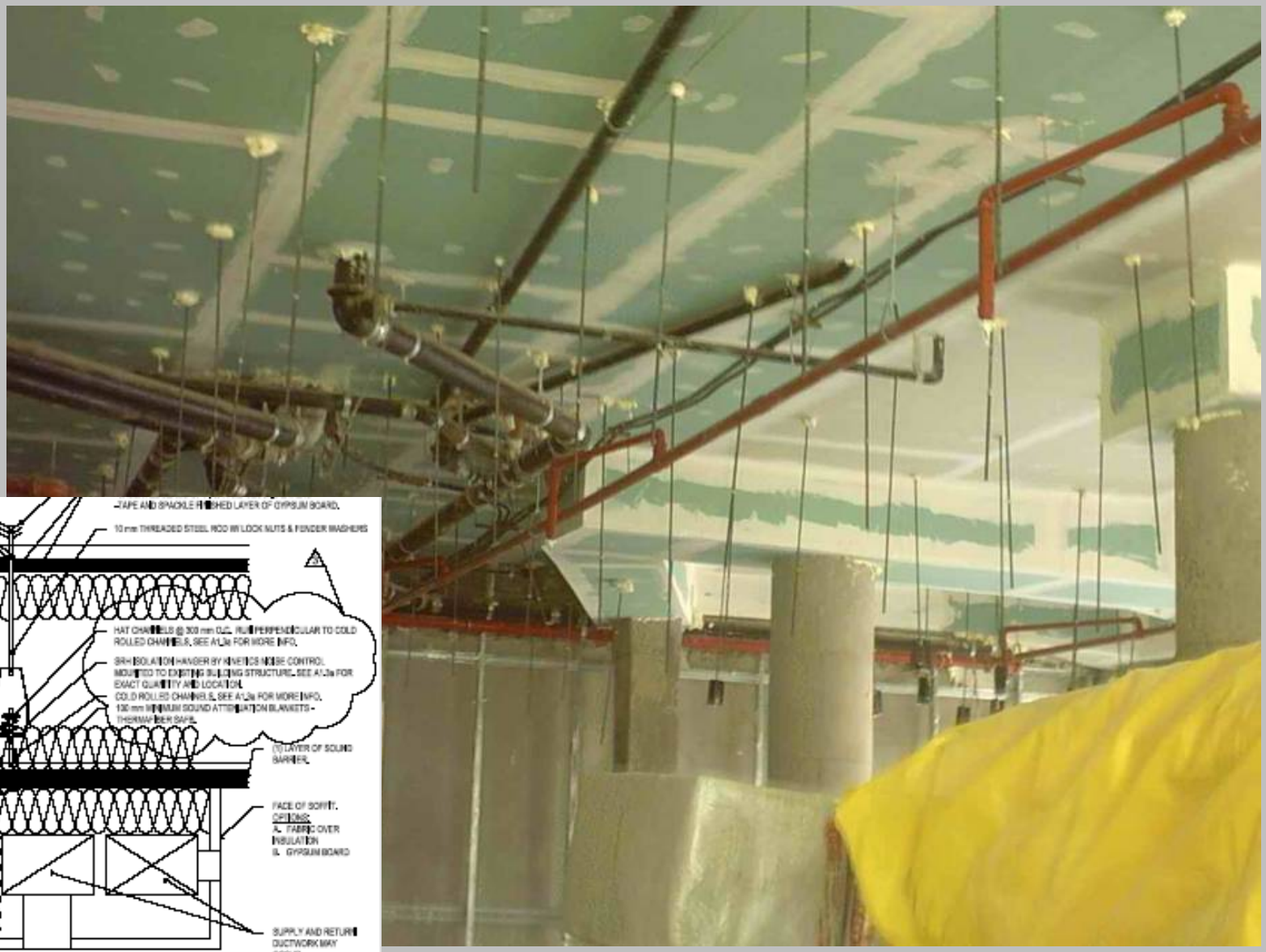
STC 62

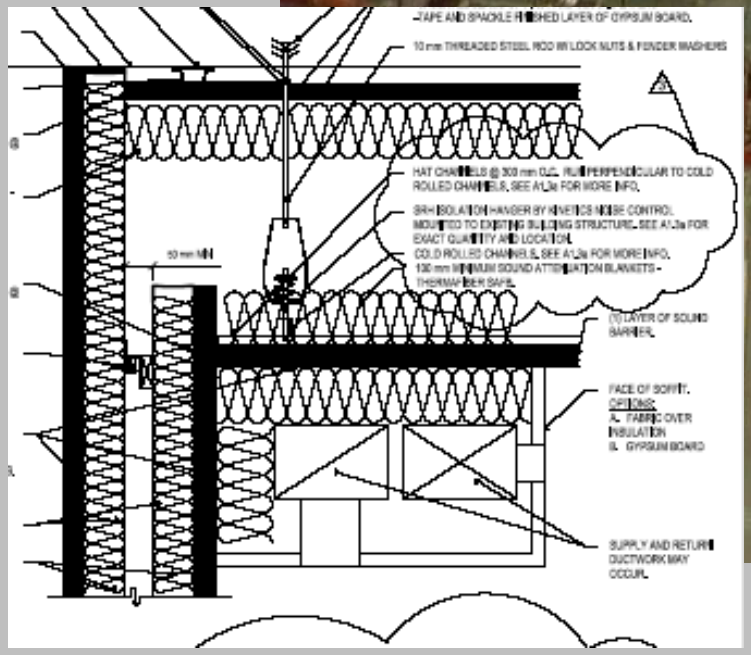
Shown here
with
De-Coupled Floor
and
Ceiling Systems

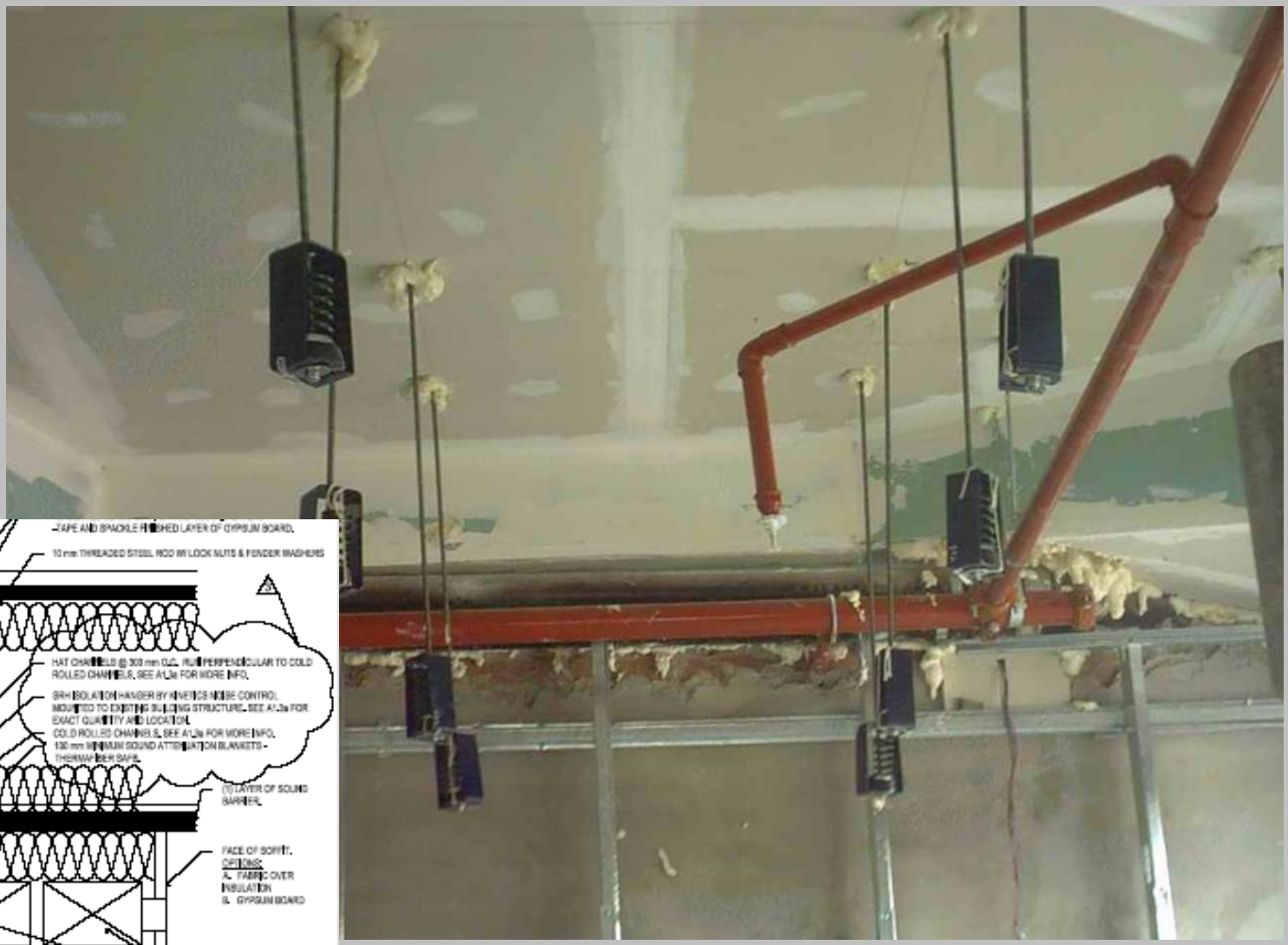
Room-within-Room Design

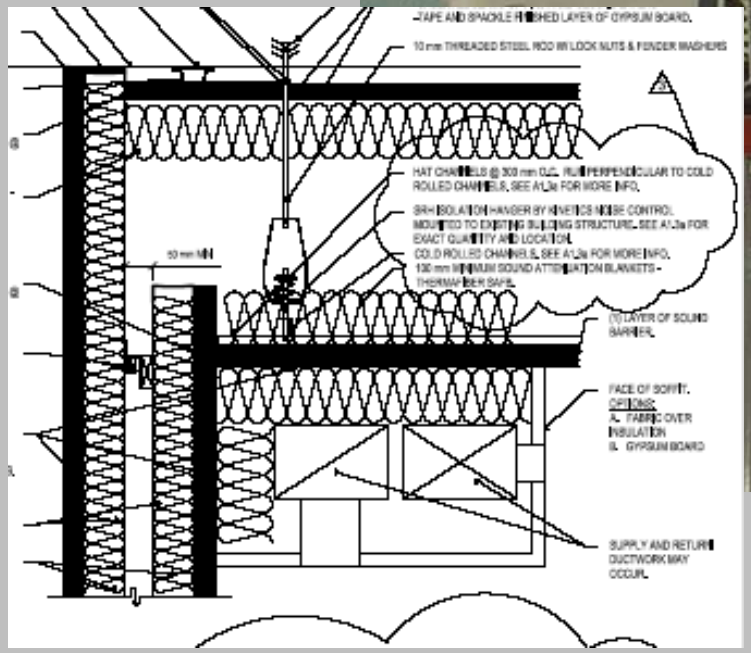


Detail of ceiling spring isolator system




TAPE AND SPACKLE FINISHED LAYER OF GYPSUM BOARD.
10 mm THREADED STEEL ROD W/ LOCK NUTS & FENDER WASHERS
HAT CHANNELS @ 300 mm O.C. RUN PERPENDICULAR TO COLD ROLLED CHANNELS, SEE A1.3a FOR MORE INFO.
RH ISOLATION HANGER BY KINETICS NOISE CONTROL MOUNTED TO EXISTING BUILDING STRUCTURE. SEE A1.3a FOR EXACT QUANTITY AND LOCATION.
COLD ROLLED CHANNELS, SEE A1.3a FOR MORE INFO.
100 mm MINIMUM SOUND ATTENUATION BLANKETS - THERMAFIBER SAFB.
1/2 LAYER OF SOUND BARRIER.
FACE OF SOFFIT.
OPTIONS:
A. FABRIC OVER INSULATION
B. GYPSUM BOARD
SUPPLY AND RETURN DUCTWORK MAY OCCUR.

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RESILIENT ISOLATION HANGER BY KINETICS NOISE CONTROL MOUNTED TO EXISTING BUILDING STRUCTURE. SEE A1.3a FOR EXACT QUANTITY AND LOCATION.
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100 mm MINIMUM SOUND ATTENUATION BLANKETS - THERMAFIBER SAFB.
50 mm MIN
(2) LAYER OF SOUND BARRIER.
FACE OF SOFFIT. OPTIONS:
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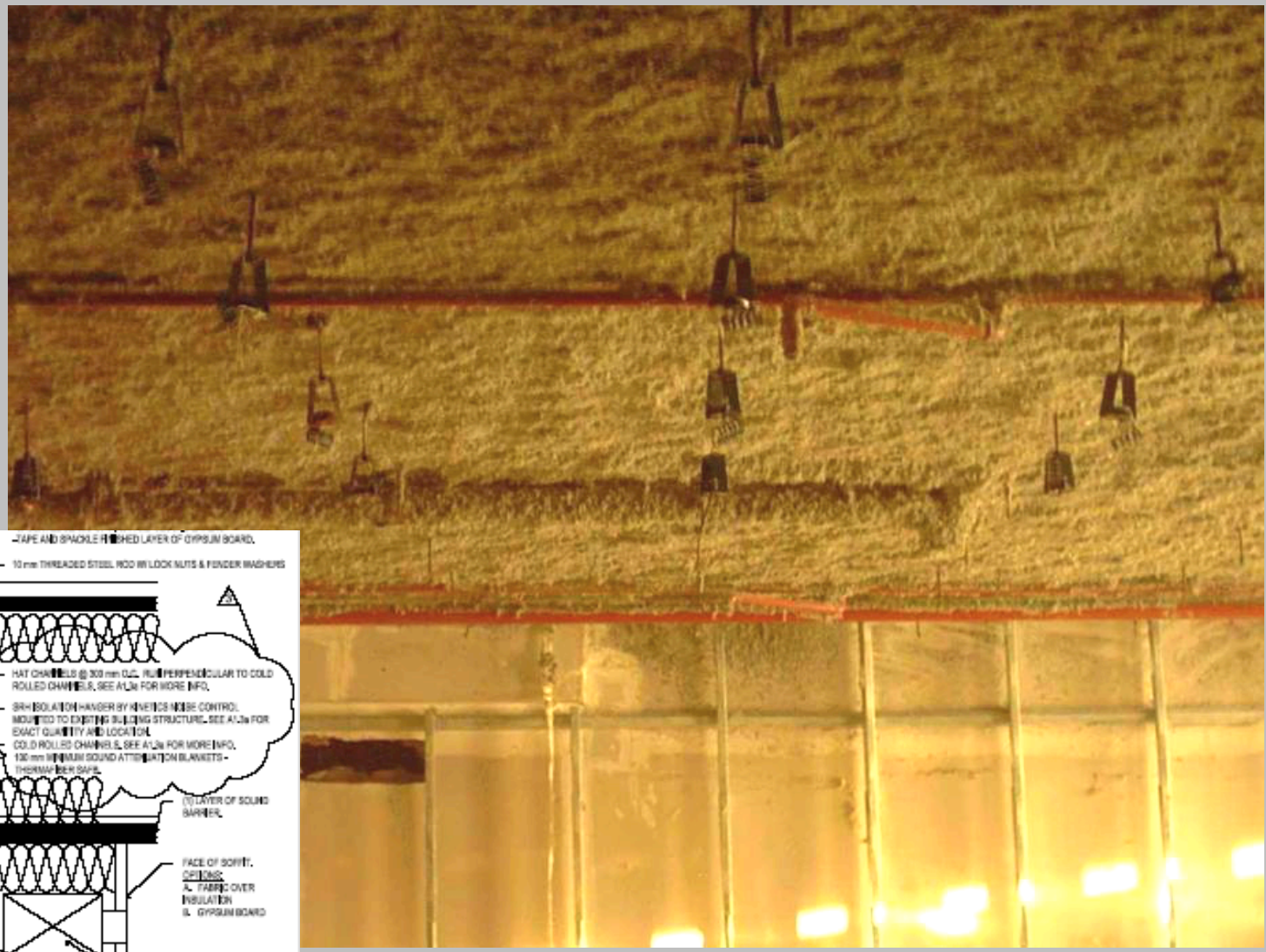

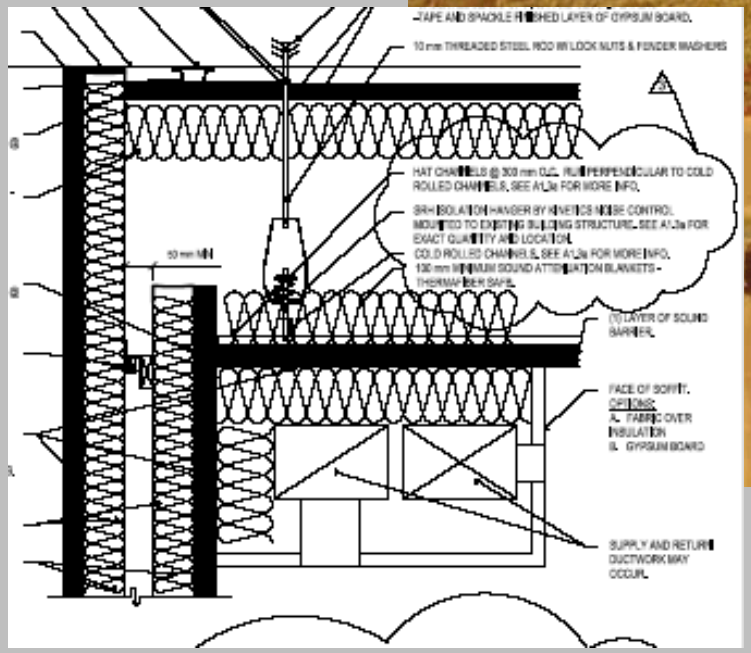
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FACE OF SOFFIT.
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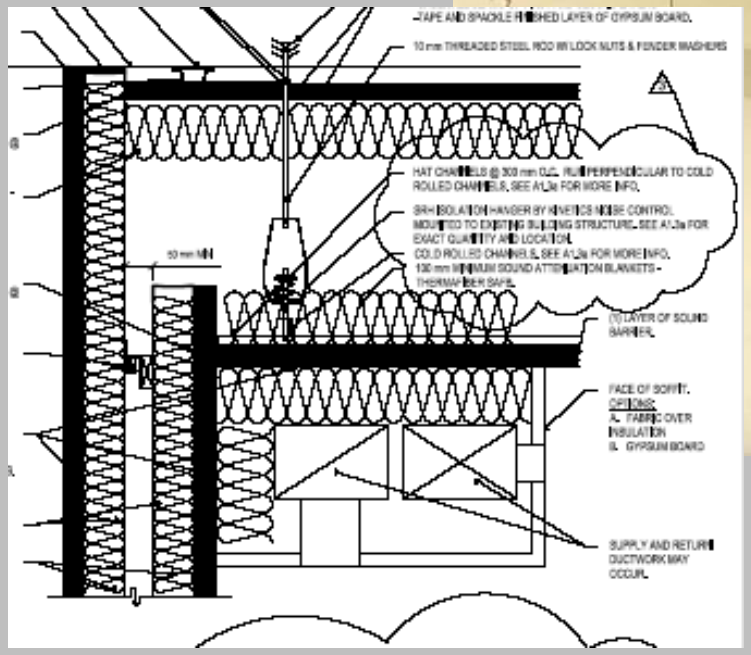
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SRH ISOLATION HANGER BY KINETICS NOISE CONTROL MOUNTED TO EXISTING BUILDING STRUCTURE. SEE A1.3a FOR EXACT QUANTITY AND LOCATION.
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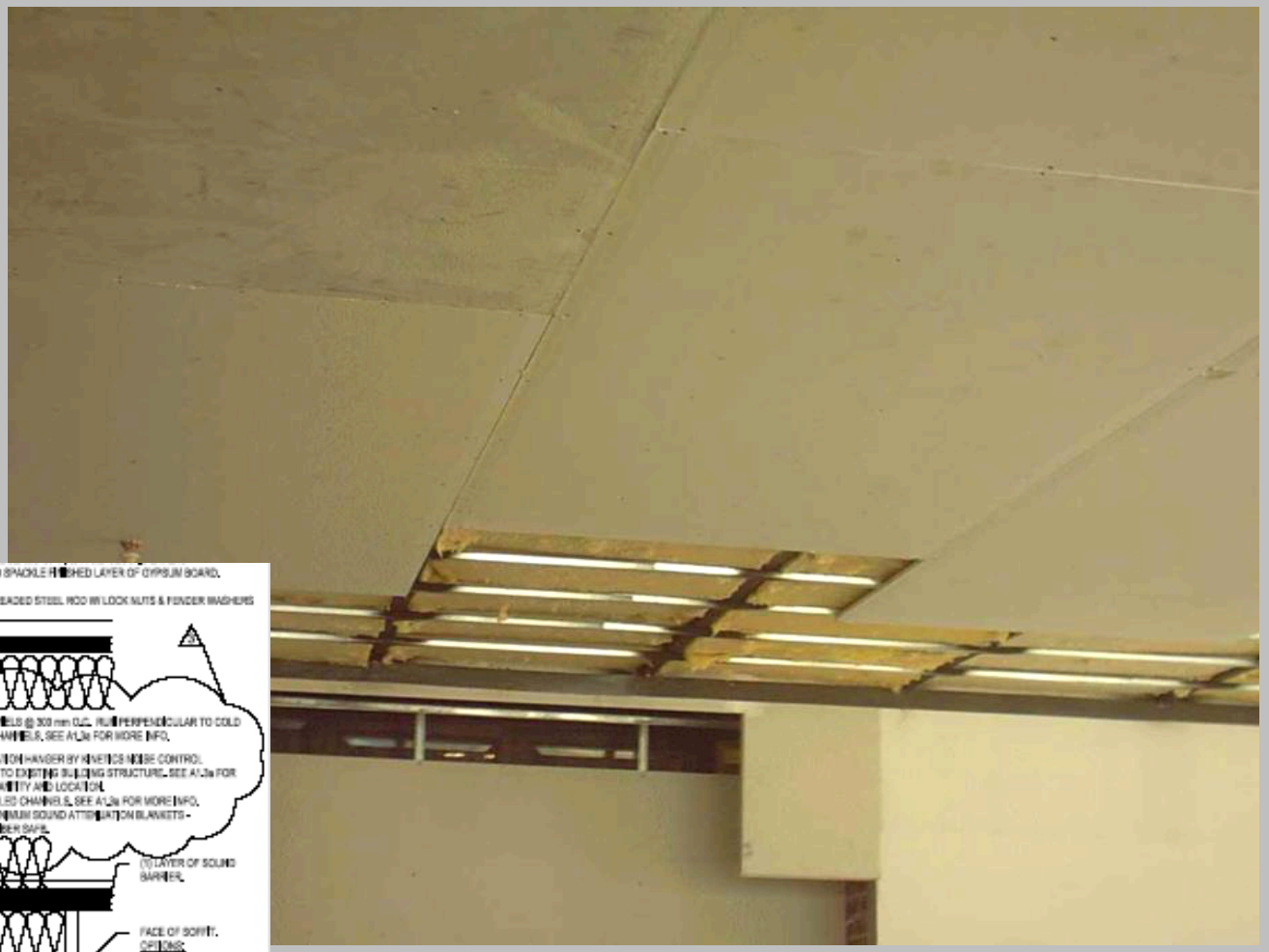

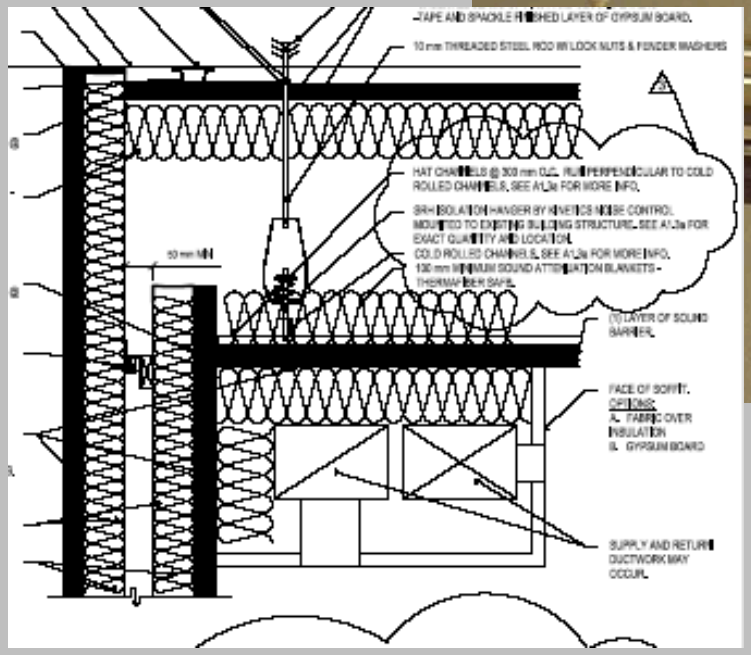
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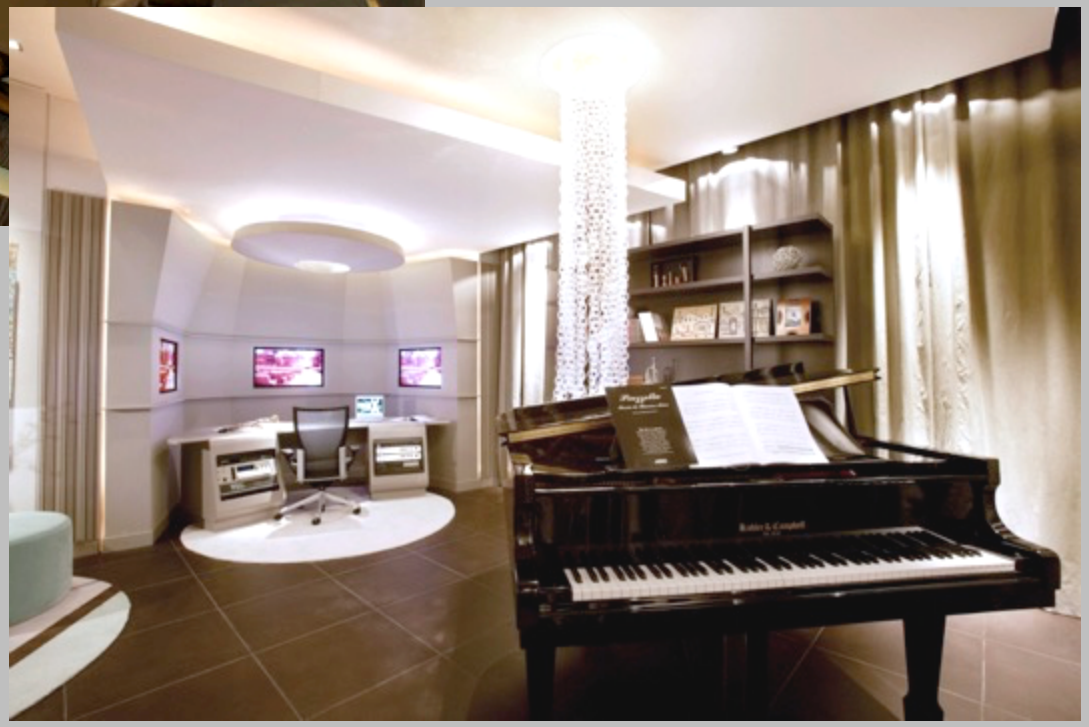
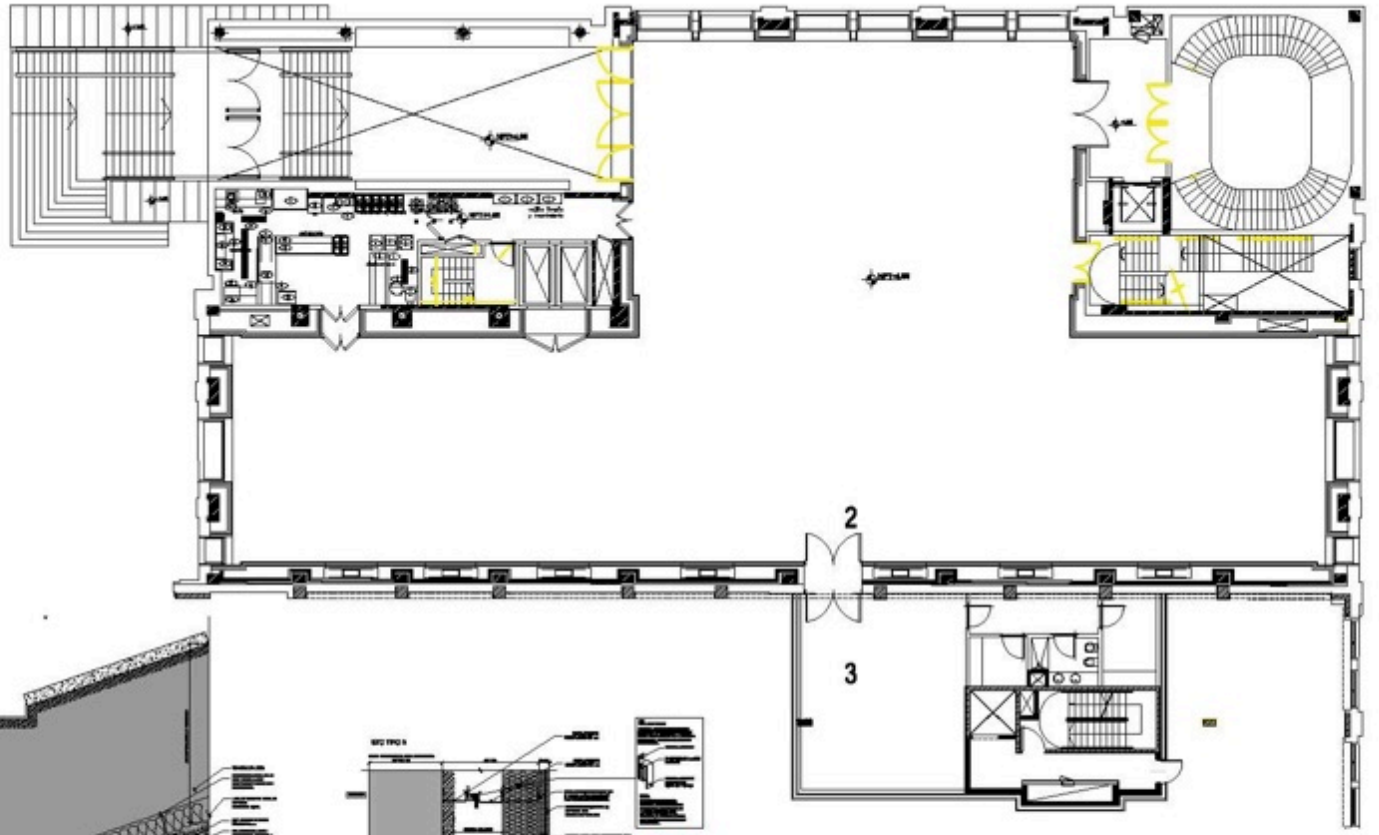
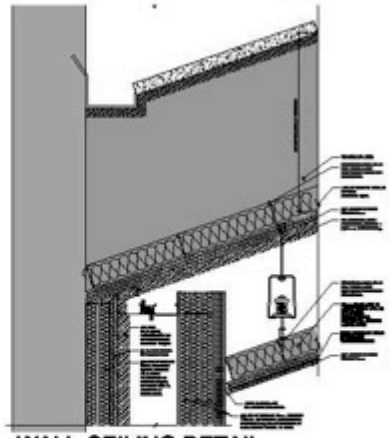


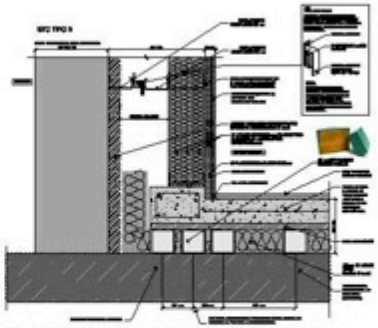

FAENA ART CENTER
ERNESTO
NETO
CURATOR
JESSICA MORGAN
ERNESTO
NETO
CURATOR
JESSICA MORGAN
1908.2011


FAENA
FAENA ARTS CENTER





WALL-CEILING DETAIL

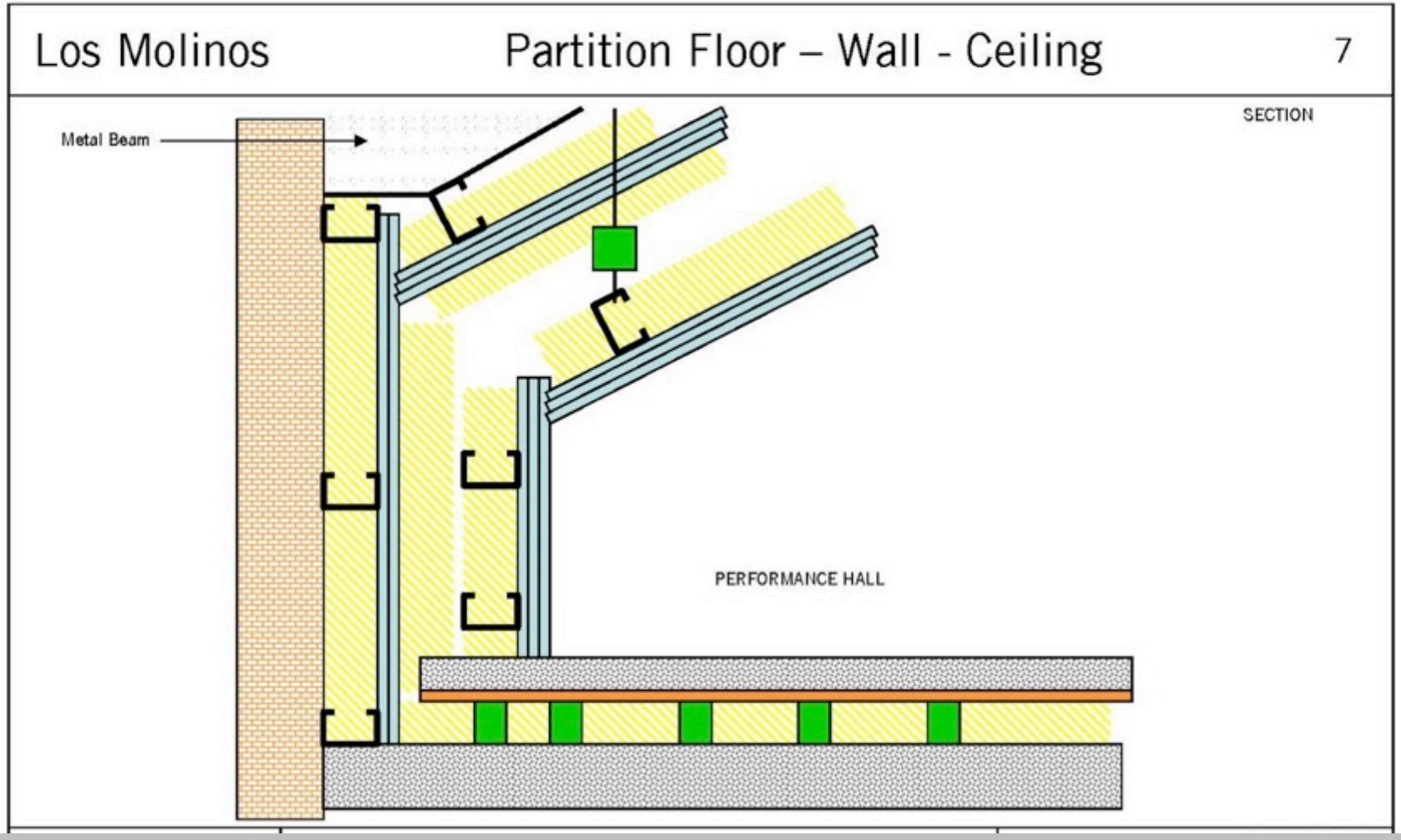


WALL-FLOATING SLAB DETAIL

2- LA CATEDRAL 3- BACK STAGE

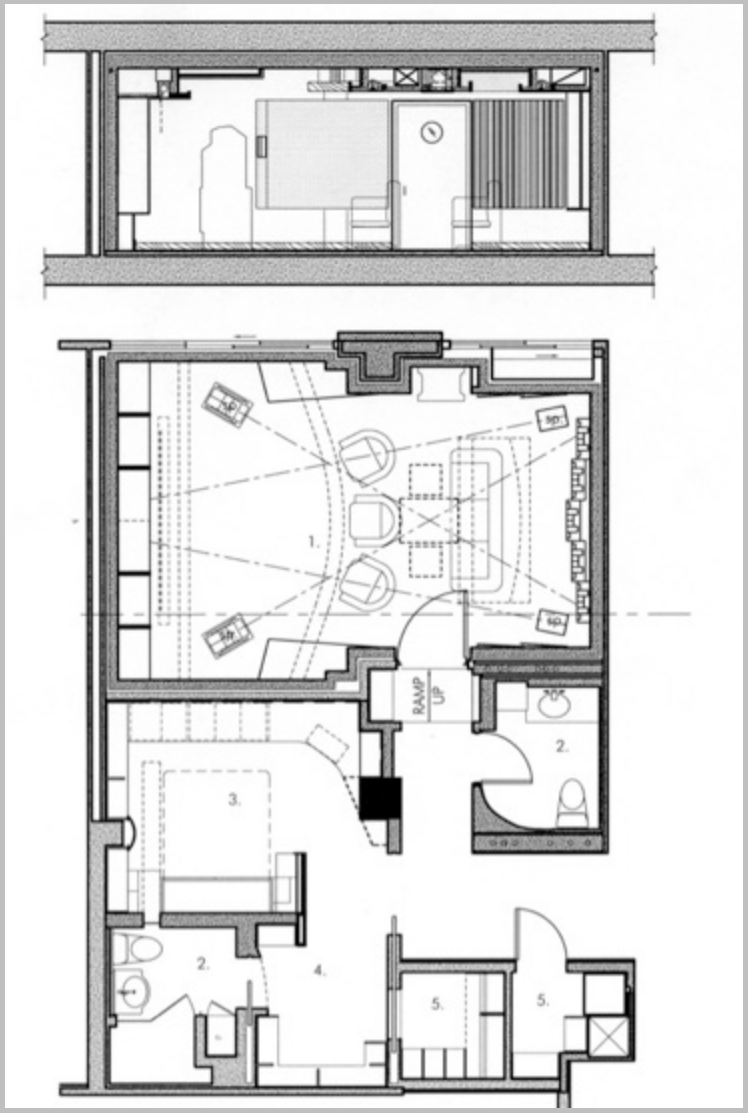
LOS MOLINOS
BUENOS AIRES, ARGENTINA

Walters-Storyk Design Group
GASCON 1364, Bs. As. ARGENTINA


Los Molinos
Partition Floor – Wall - Ceiling
7
SECTION
Metal Beam
PERFORMANCE HALL

early project reminders

- make an acoustic site survey
- develop a robust program statement with exact quietness requirements

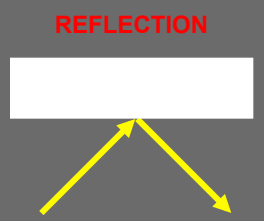

RAMP
UP
1.
2.
3.
4.
5.
5.

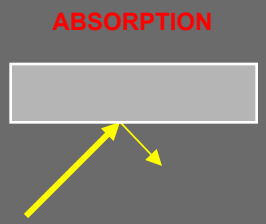
internal room acoustics

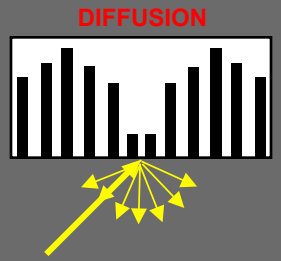
Acoustical Palette

Geometry links the real world to what we hear

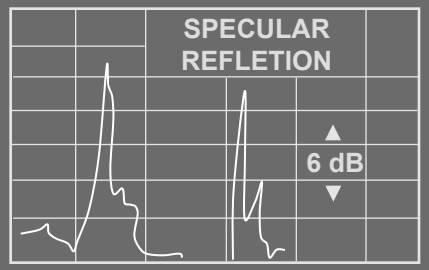
Acoustical Treatment

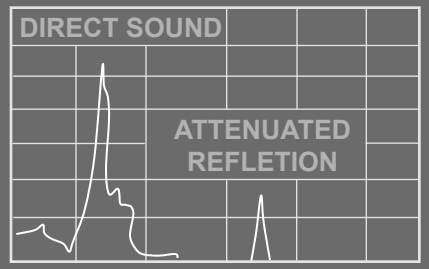


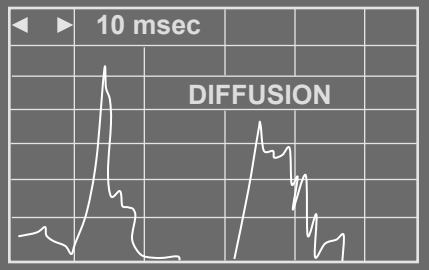




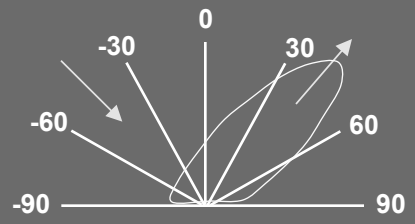
Temporal Response

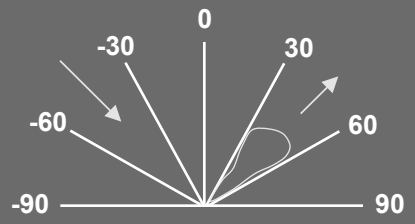


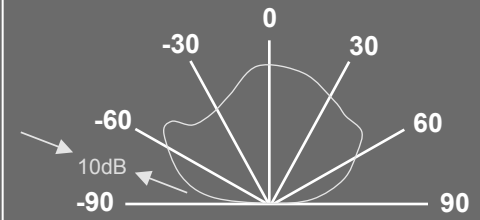




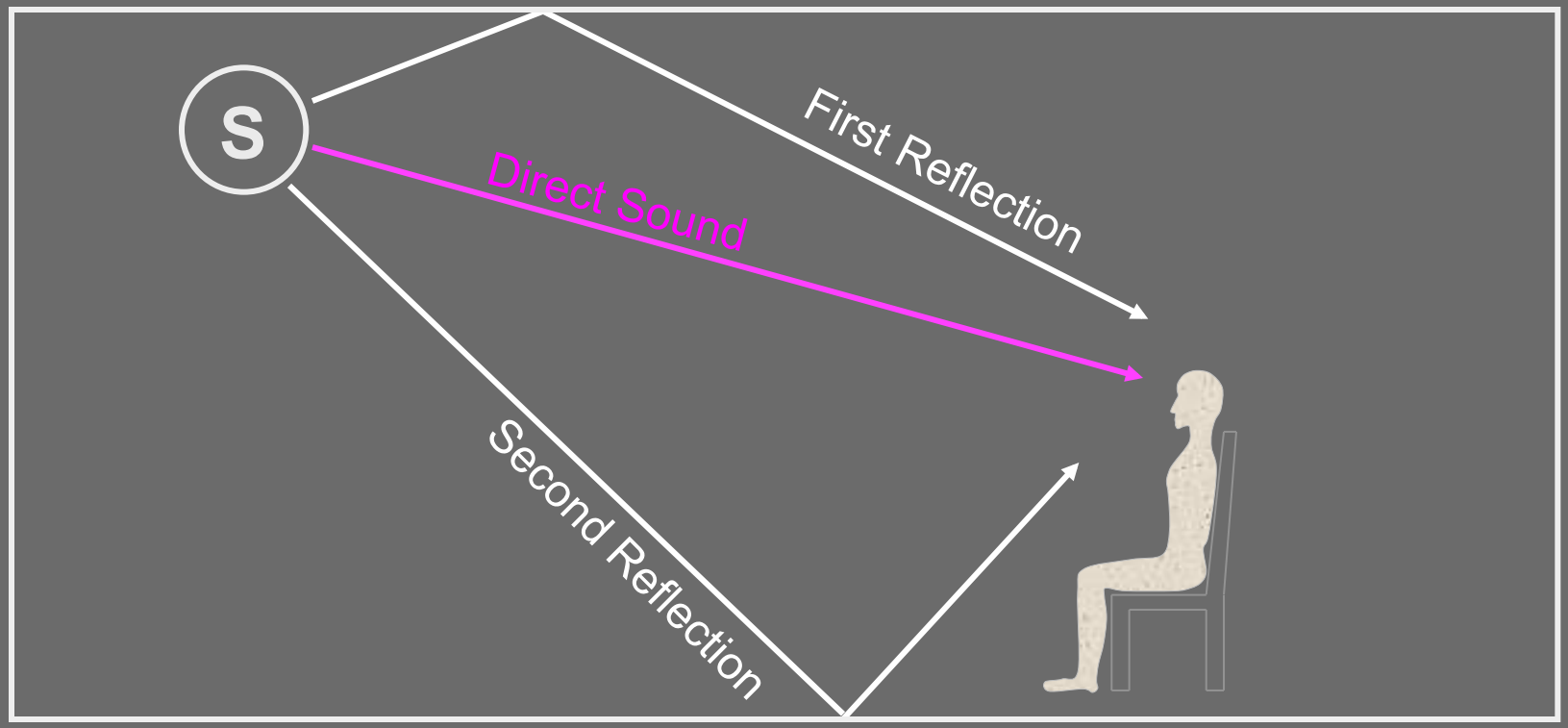
Spatial Response







Reflections



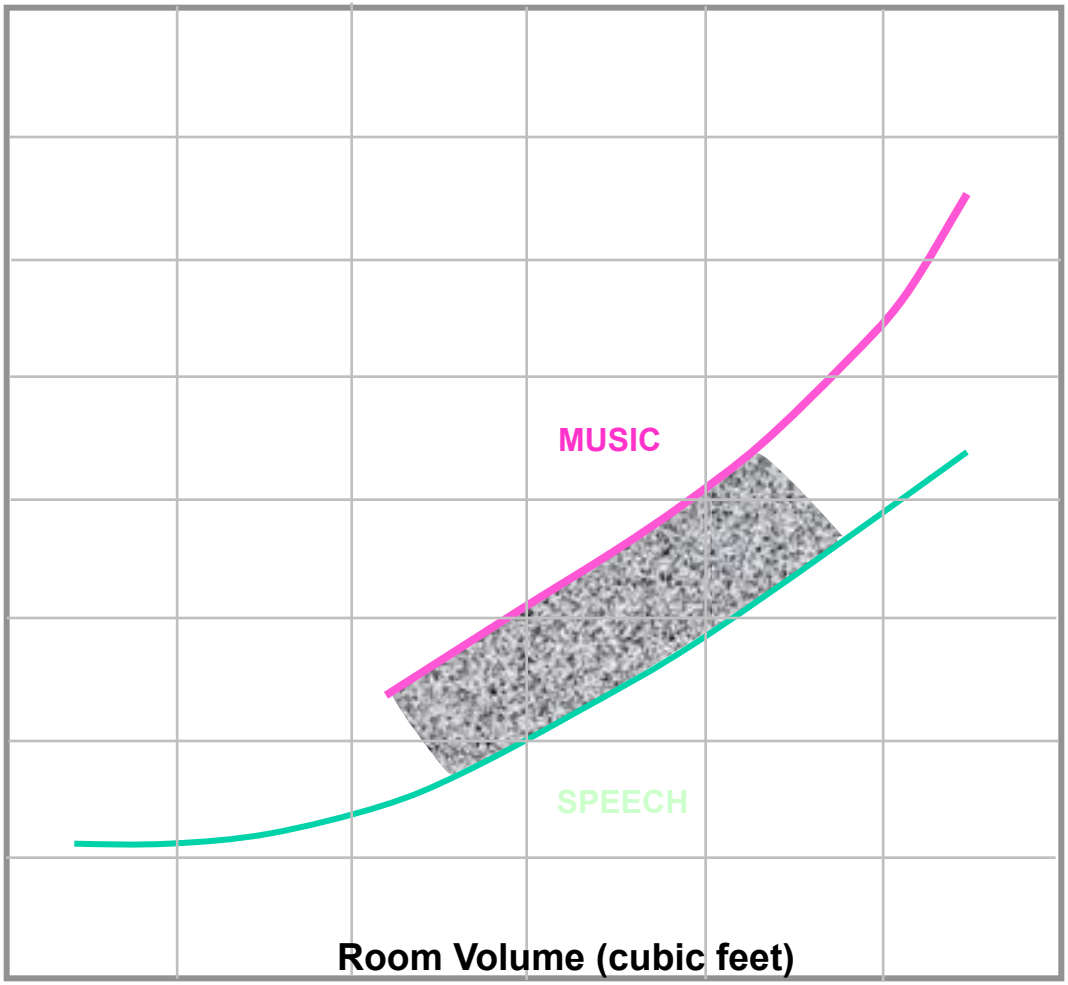
Reverberation

The RT_{60} Decay Time measures the (frequency dependent) time necessary for a 60 dB decay in sound pressure level (one-millionth of original Signal).

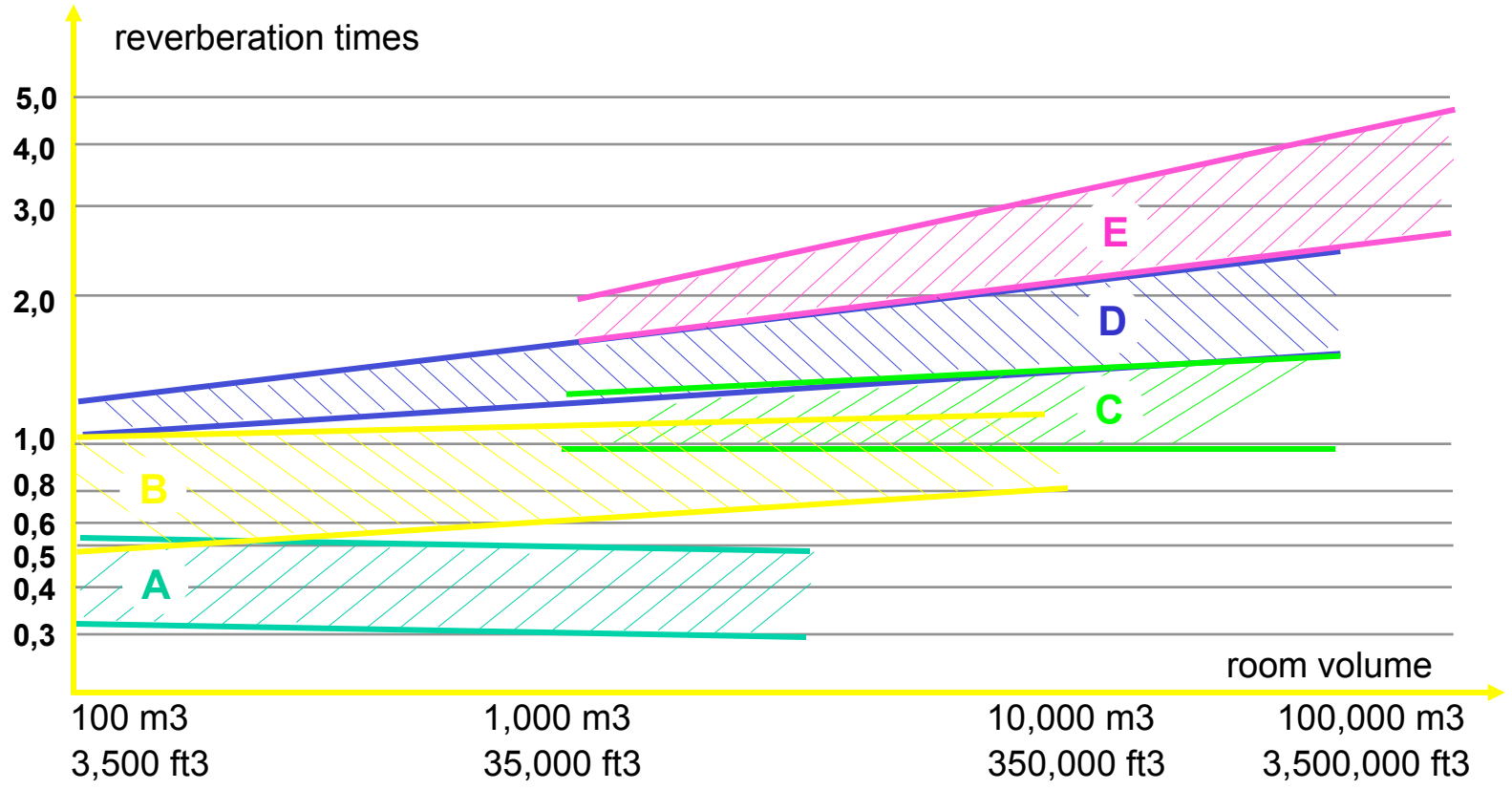
The steepness of the slope with which the reverb decays (which defines the RT60 Decay Time) is an important (but not the only parameter) in defining the acoustic signature of a room.

However, the distribution of the individual reverberation peaks is the other half of the story!

Target RT60 Values



Target Values

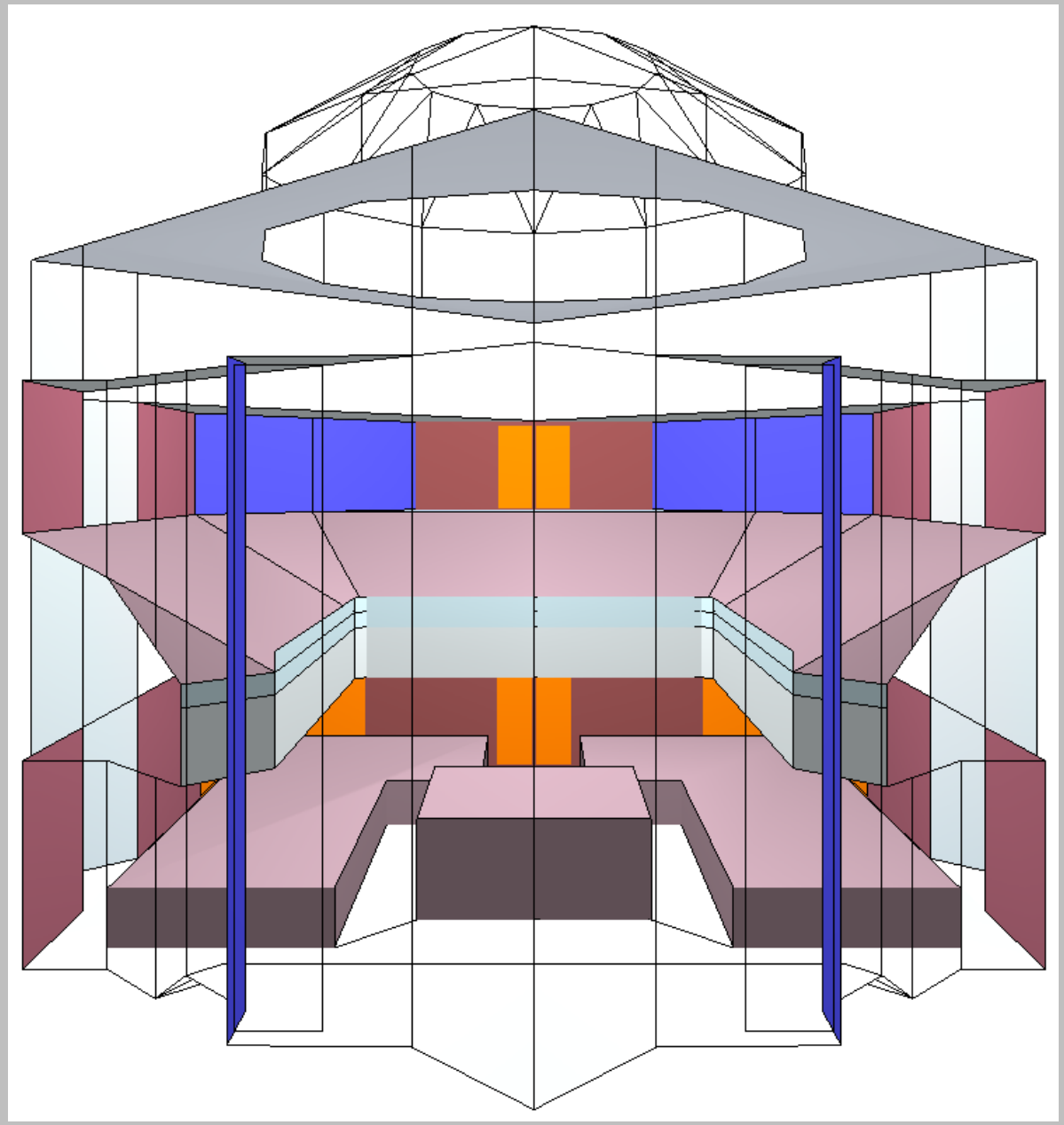


Favorable reverberation times for various room usages

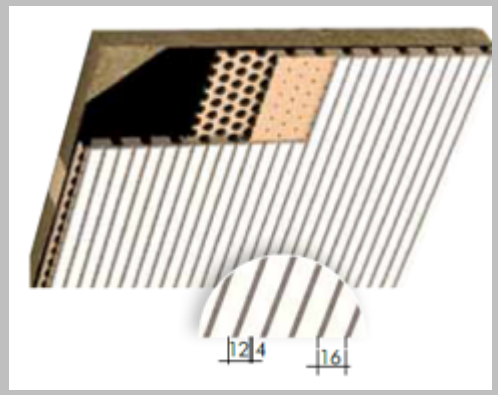
- A. Pop music studio
- B. Conference Room
- C. Opera house with audience
- D. Concert hall with audience
- E. Church empty (max.)

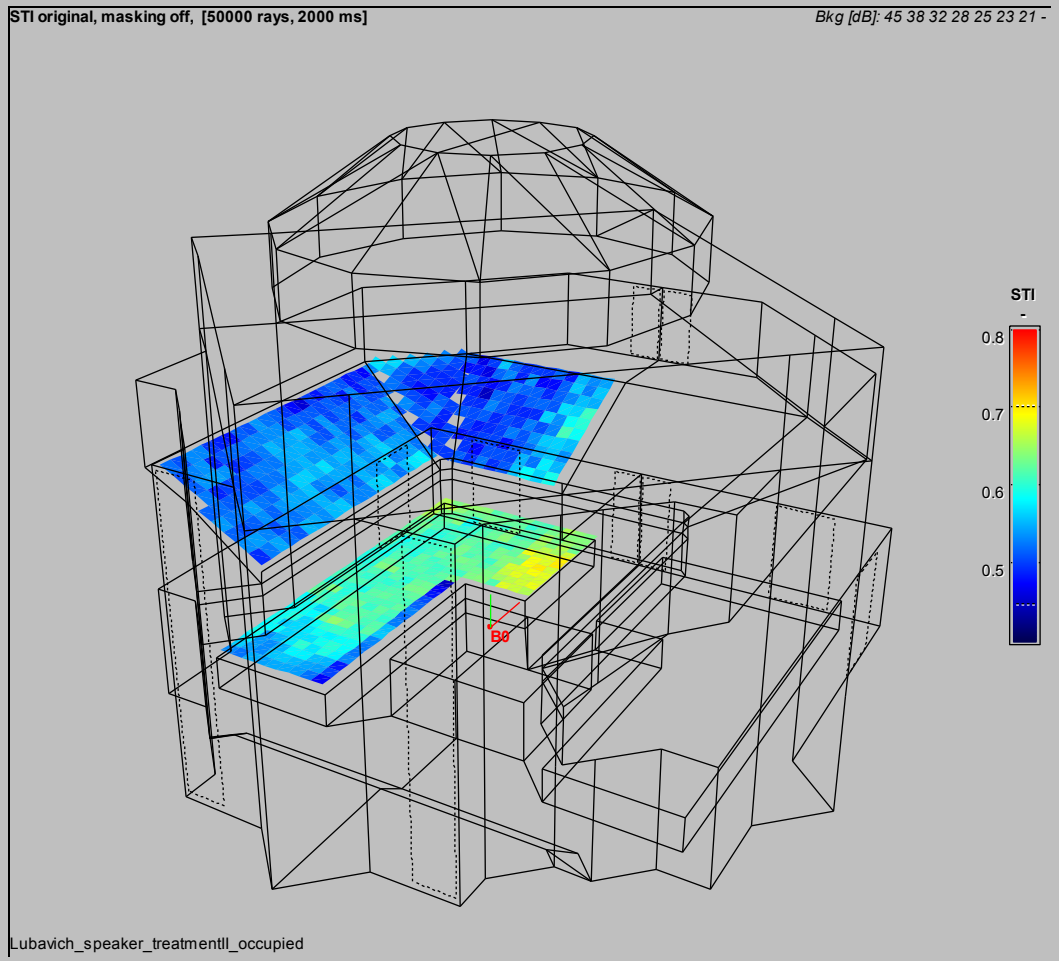
acoustic prediction – auralization

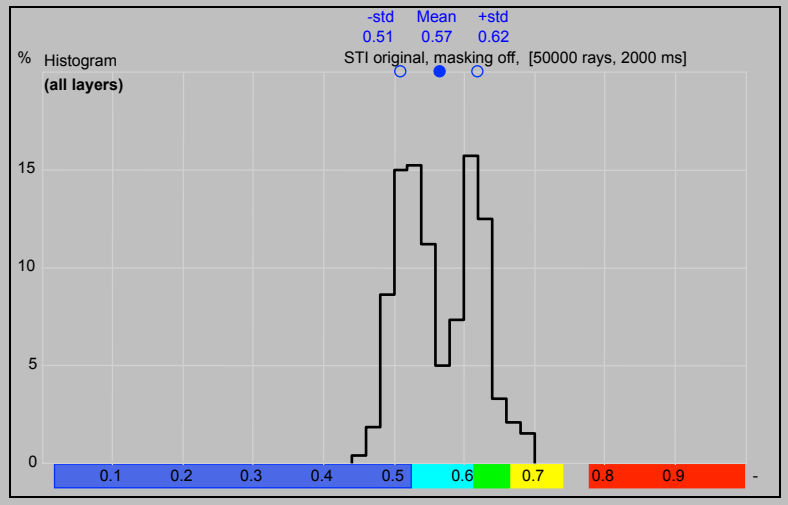
slightly into the future for all rooms

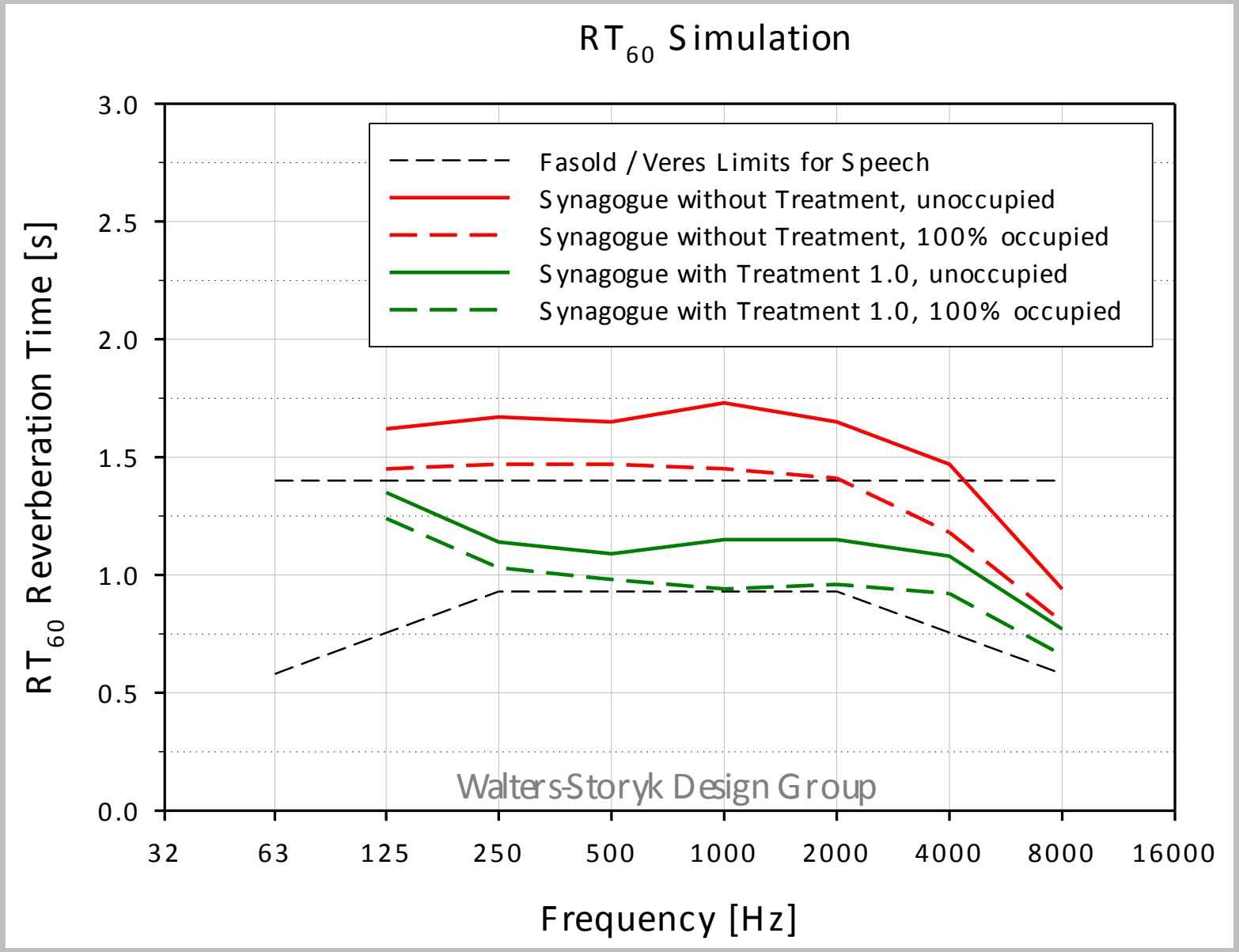


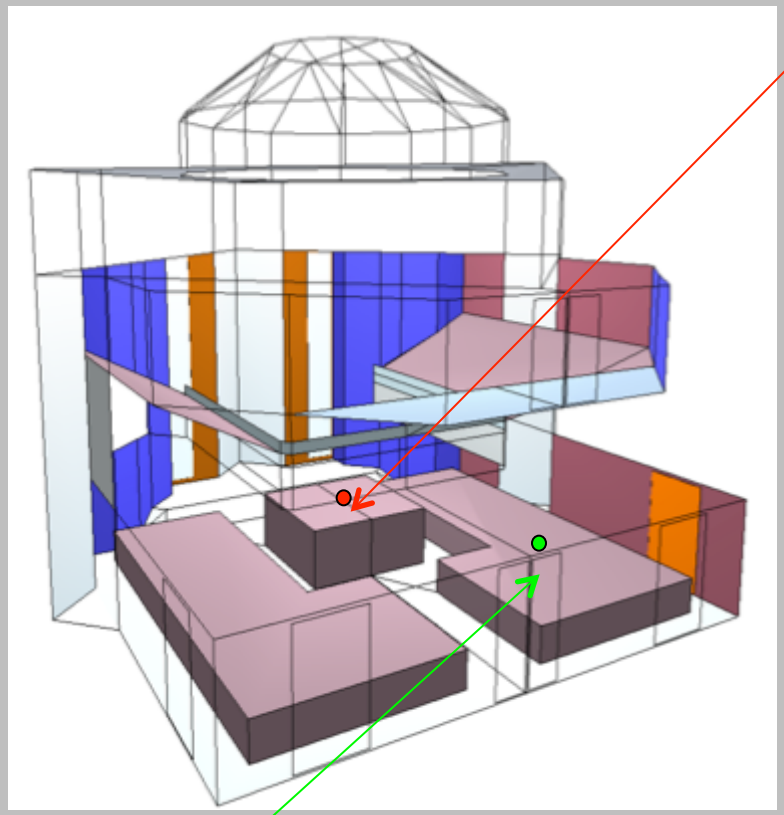

1"
1½"
2"
2½"


12
14
16


STI original, masking off, [50000 rays, 2000 ms]
Bkg [dB]: 45 38 32 28 25 23 21 -
STI
-
0.8
0.7
0.6
0.5
B0
Lubavich_speaker_treatmentII_occupied


-std Mean +std
0.51 0.57 0.62
% Histogram
(all layers)
STI original, masking off, [50000 rays, 2000 ms]
15
10
5
0
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9
-


RT60 Simulation
RT60 Reverberation Time [s]
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Fasold / Veres Limits for Speech
Synagogue without Treatment, unoccupied
Synagogue without Treatment, 100% occupied
Synagogue with Treatment 1.0, unoccupied
Synagogue with Treatment 1.0, 100% occupied
Walters-Storyk Design Group
32
63
125
250
500
1000
2000
4000
8000
16000
Frequency [Hz]



Speaker position 1 in center of Synagogue

1. Original Design - No acoustic treatment

2. Recommended Acoustic treatment

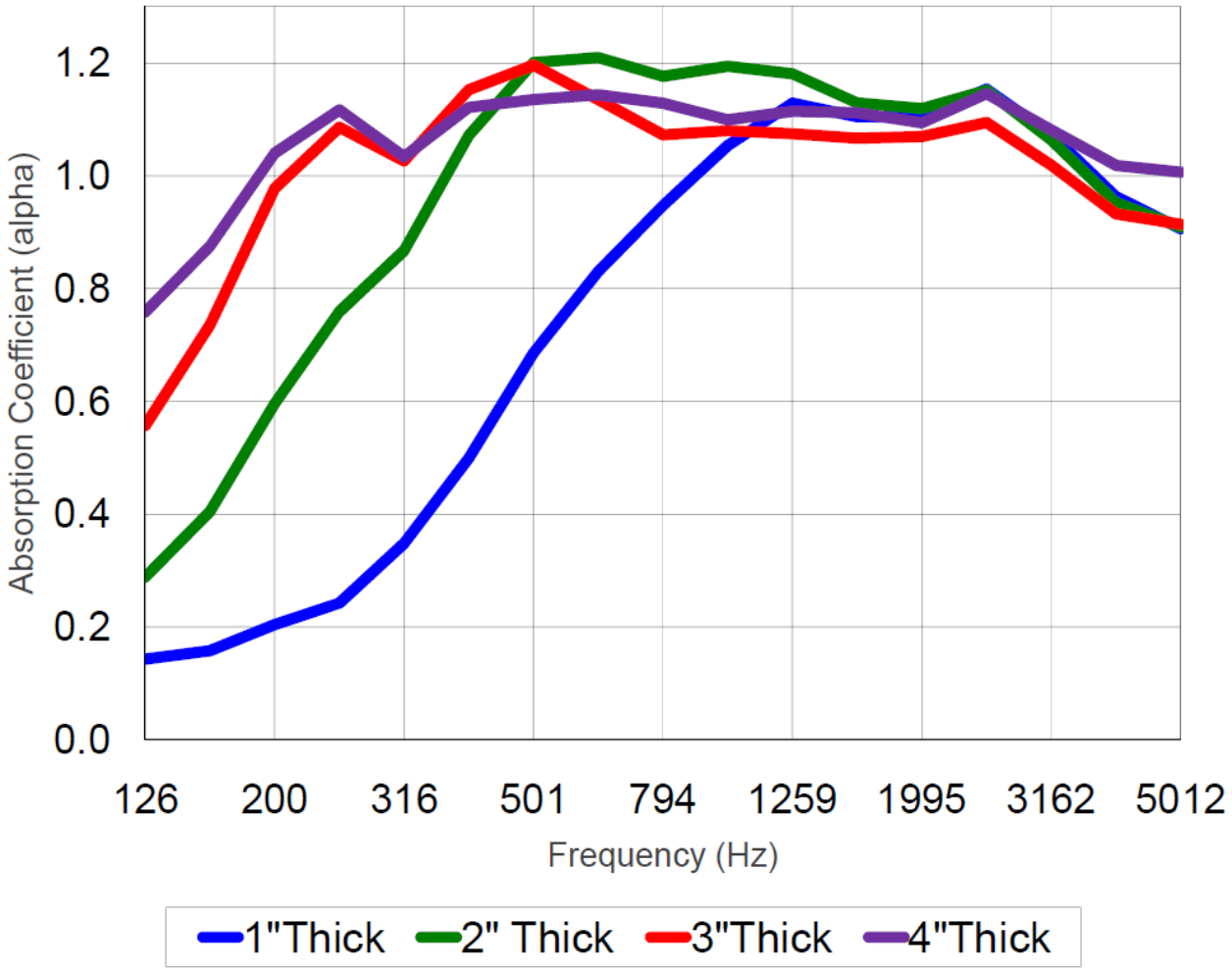
Receiver position 1 in Audience @ Ground Floor

Internal Room Acoustics
Product Review

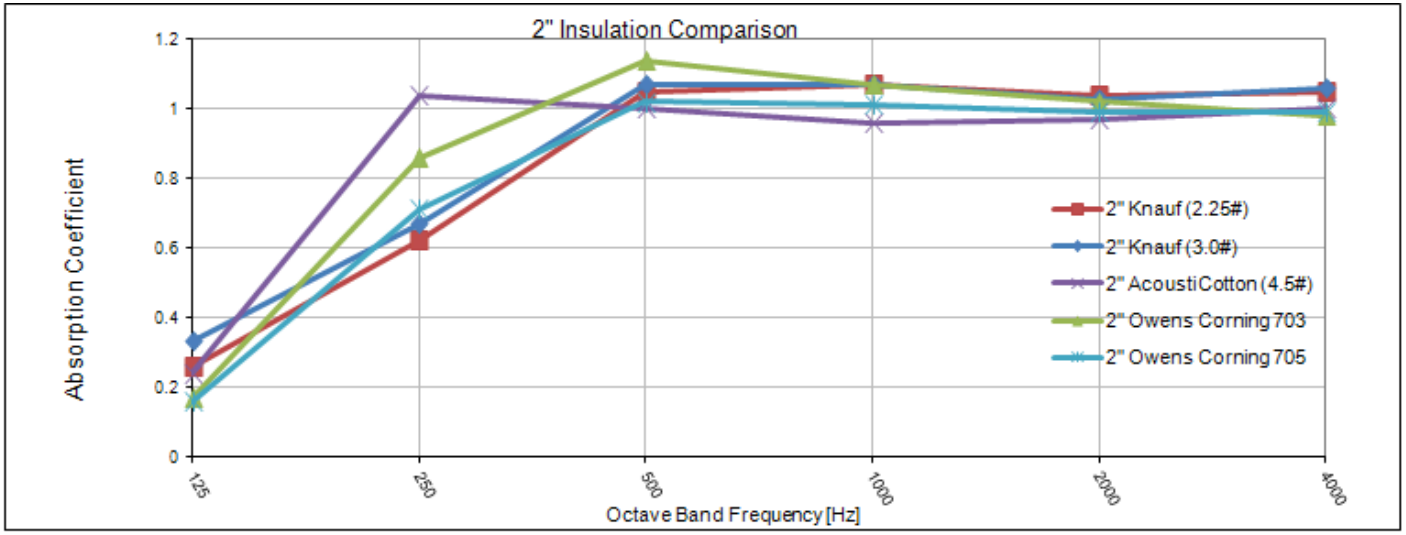
Mid/High Absorption

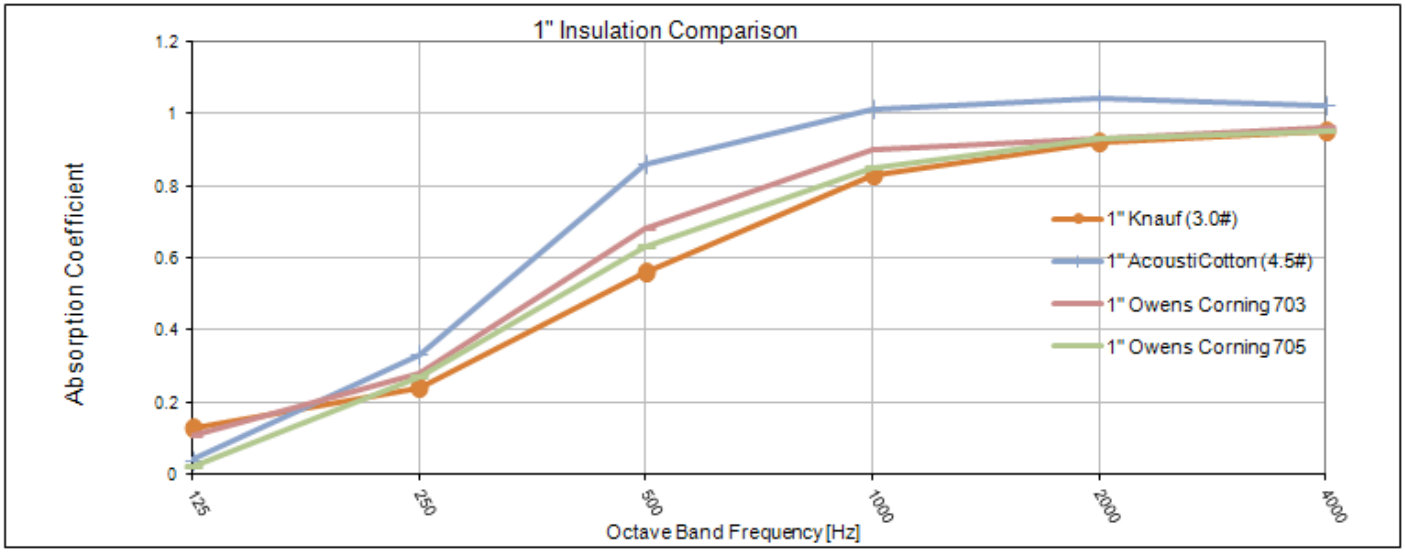
Fabric Wrapped Panels

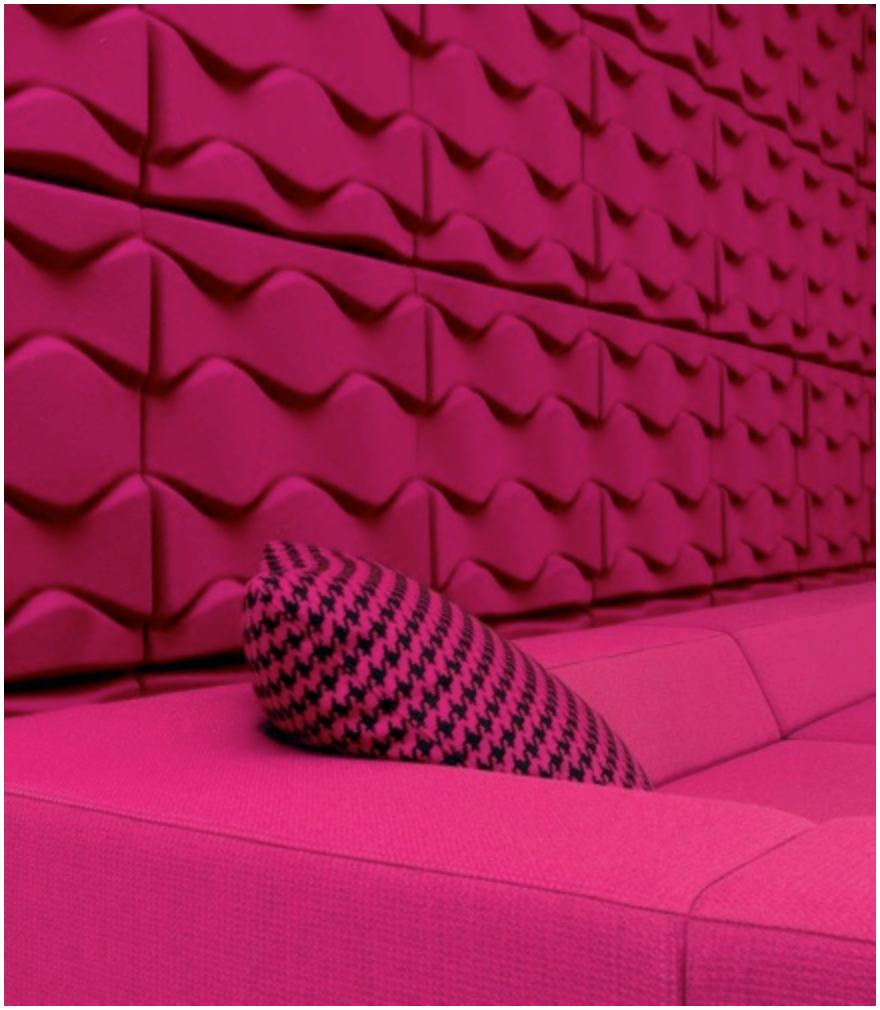
Fabric Wrapped Insulation

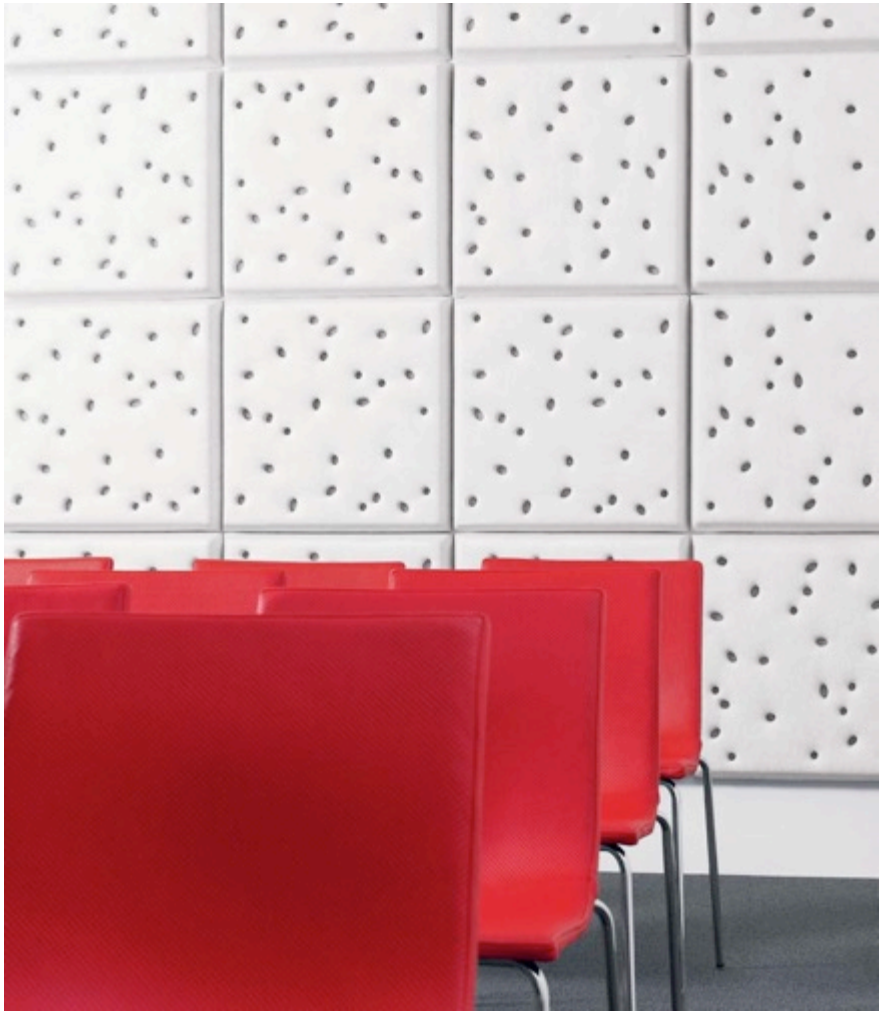


Insulation Comparison

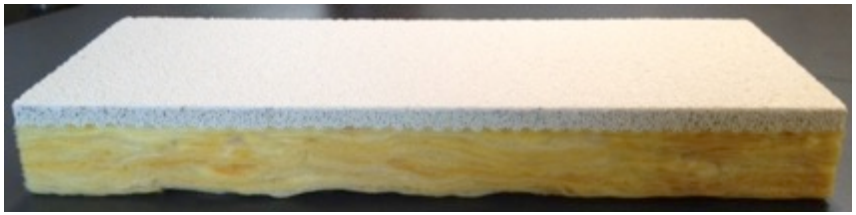




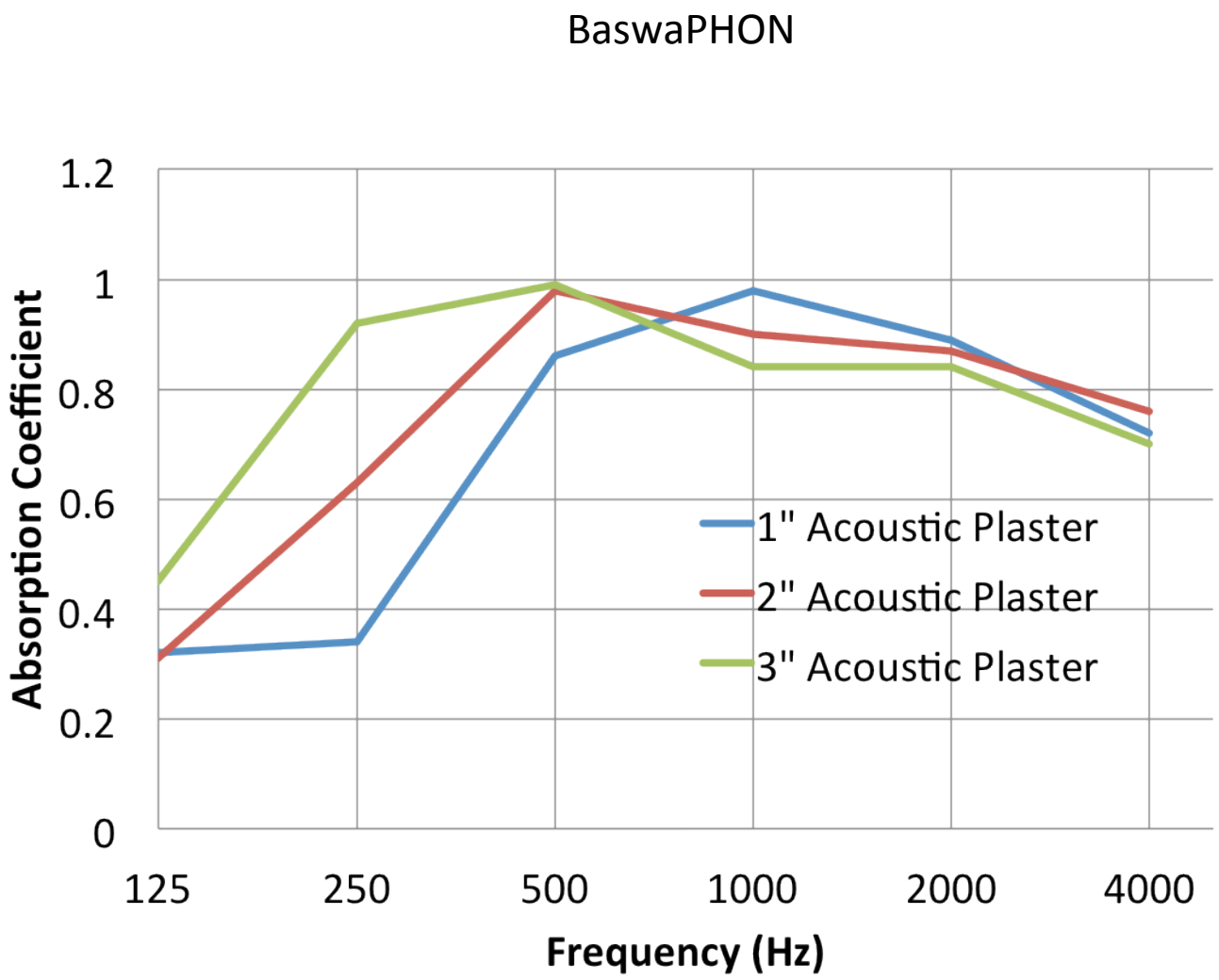




Acoustic Plaster

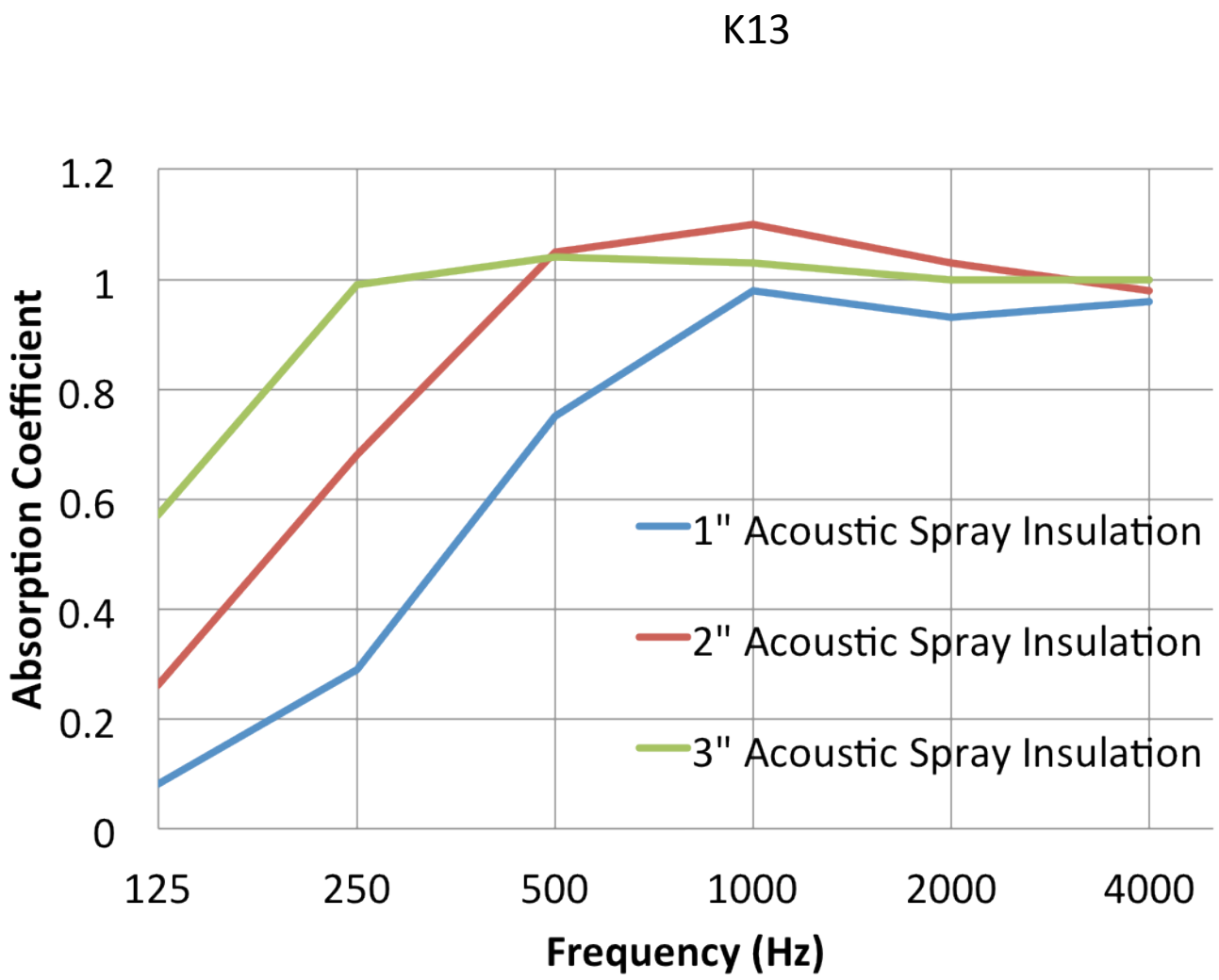


Acoustic Plaster



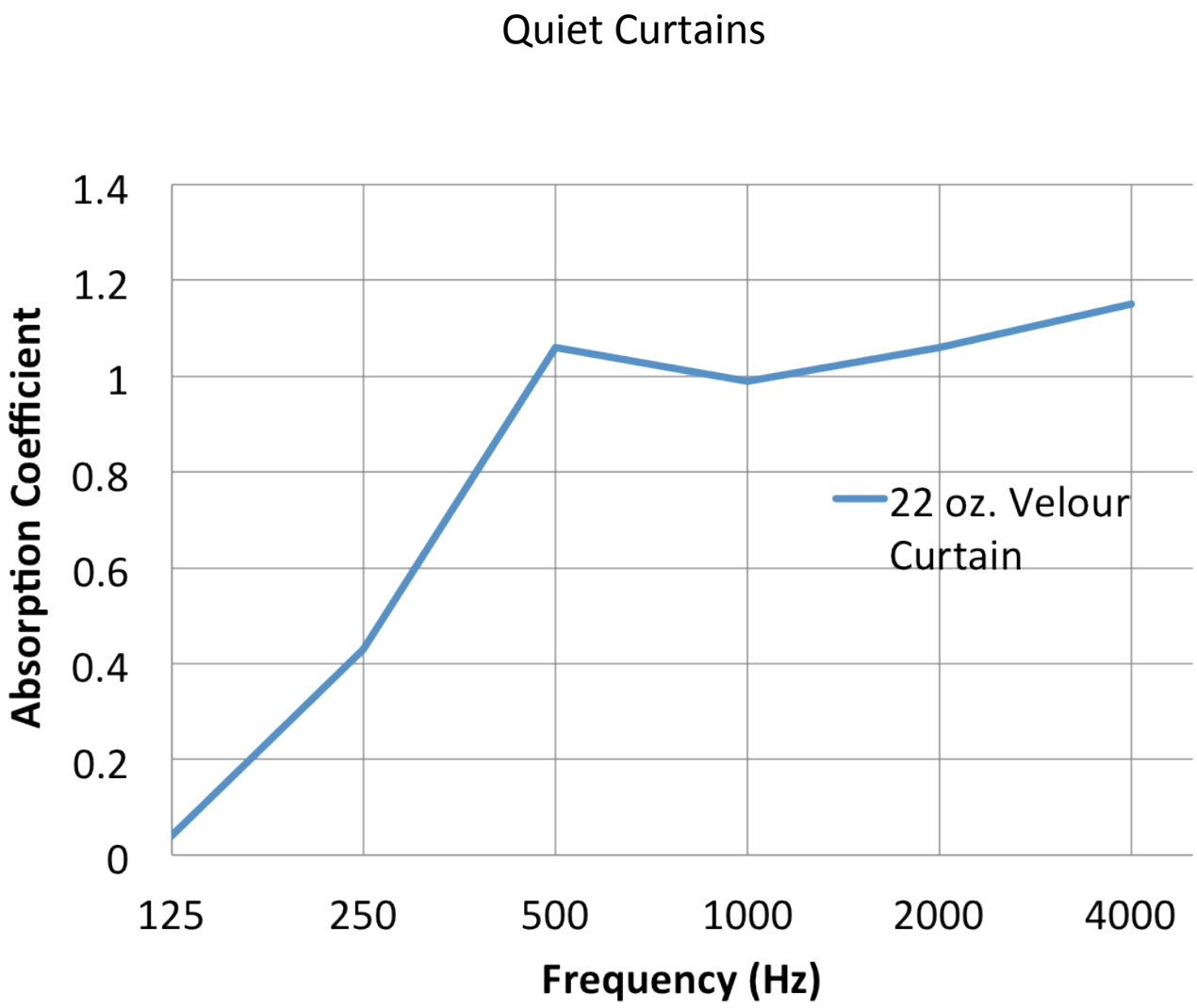
Acoustic Spray Insulation

Acoustic Spray Insulation

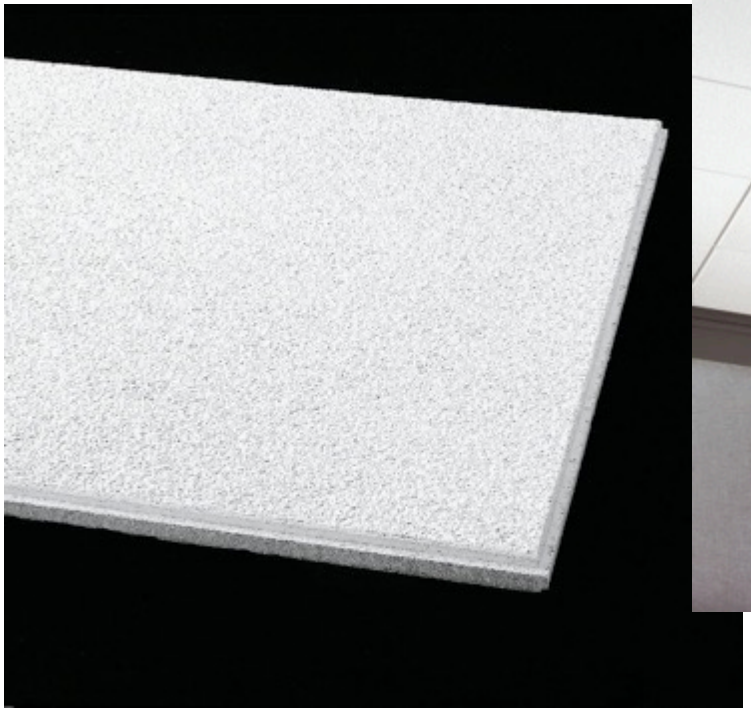


Acoustic Curtains

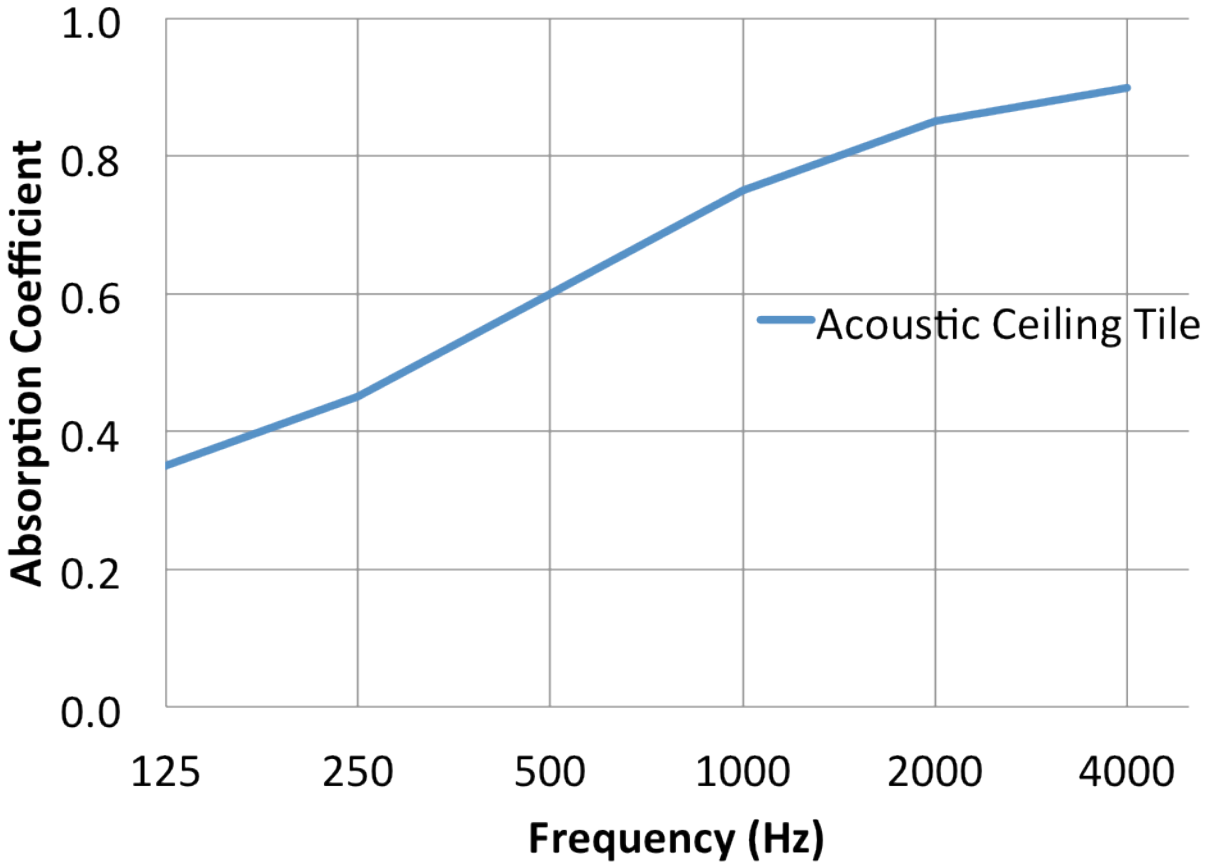
Acoustical Curtains



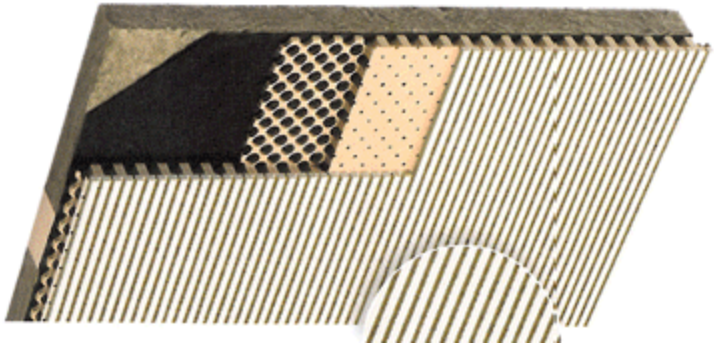
Acoustic Ceiling Tile

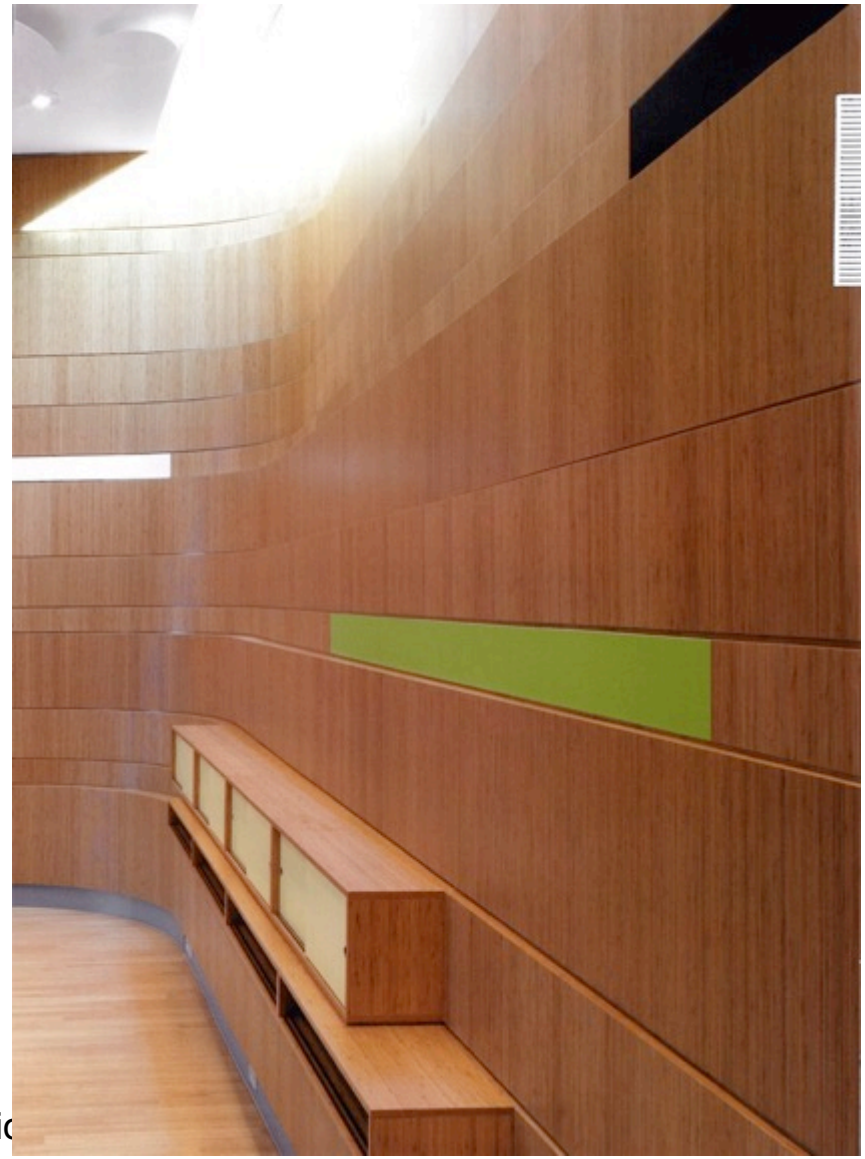


Acoustic Ceiling Tile

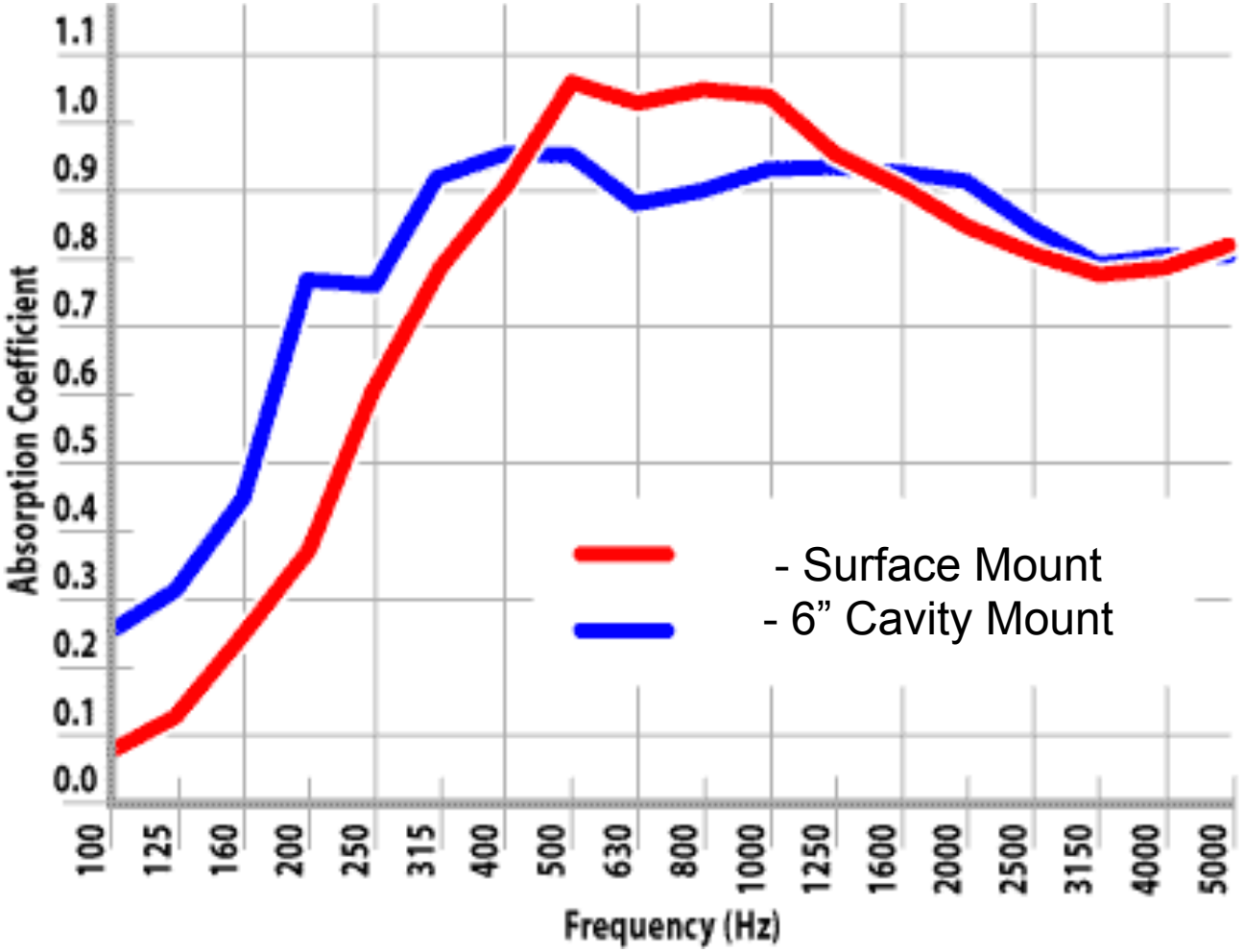


Perf / Slotted Wood

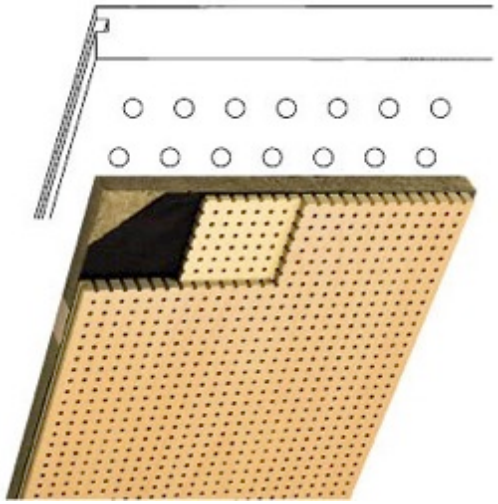


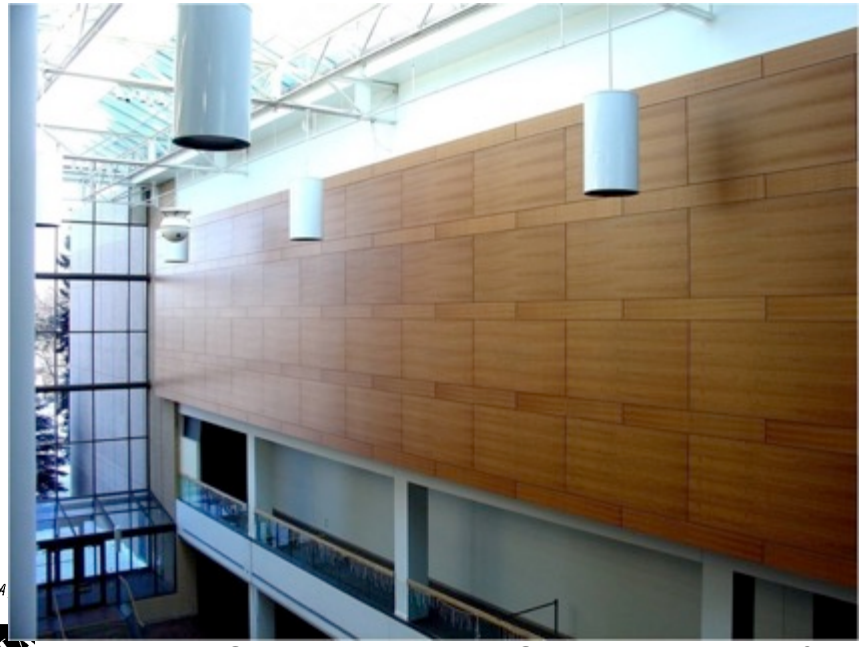


Topakustik


Absorption Coefficient
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
100
125
160
200
250
315
400
500
630
800
1000
1250
1600
2000
2500
3150
4000
5000
Frequency (Hz)
- Surface Mount
- 6” Cavity Mount

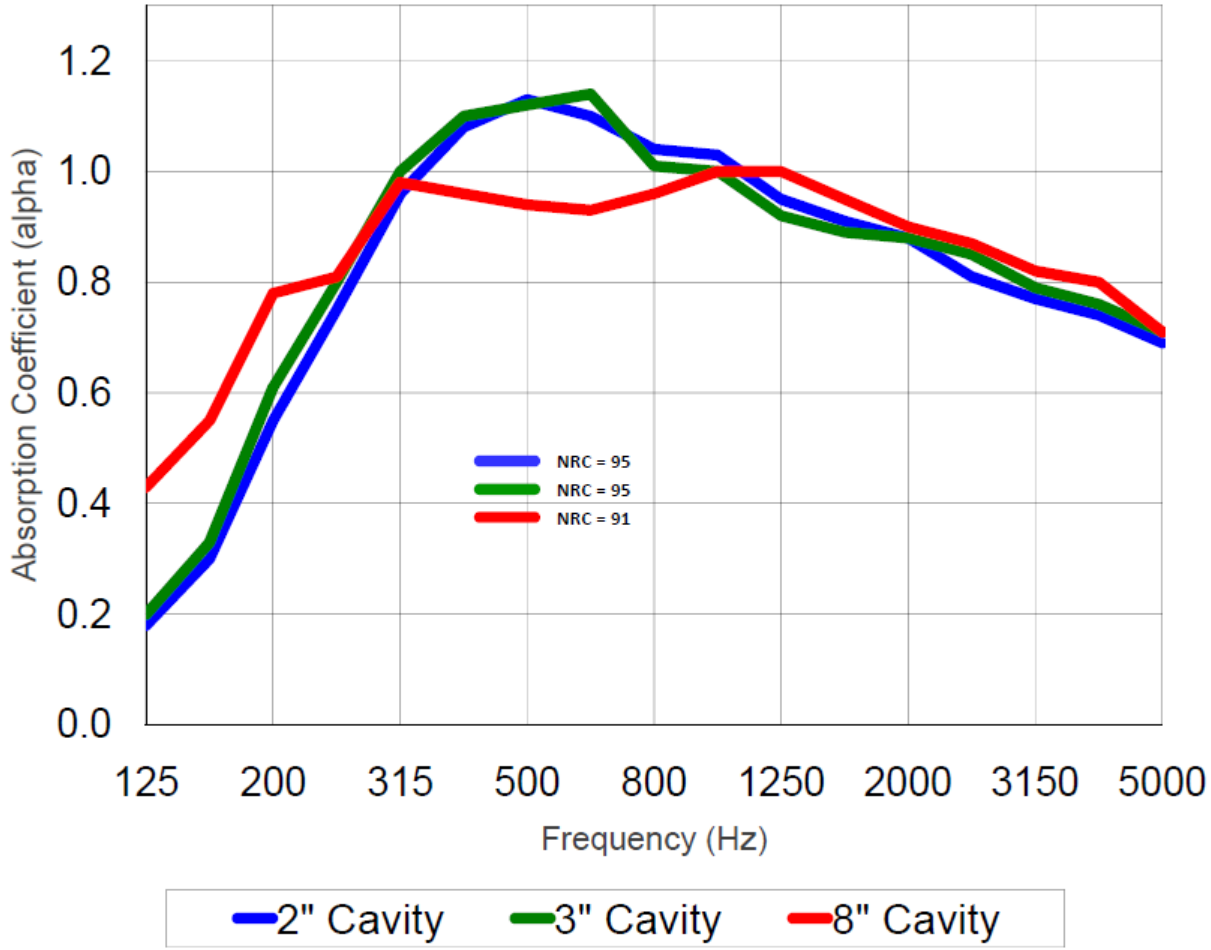
Topperfo



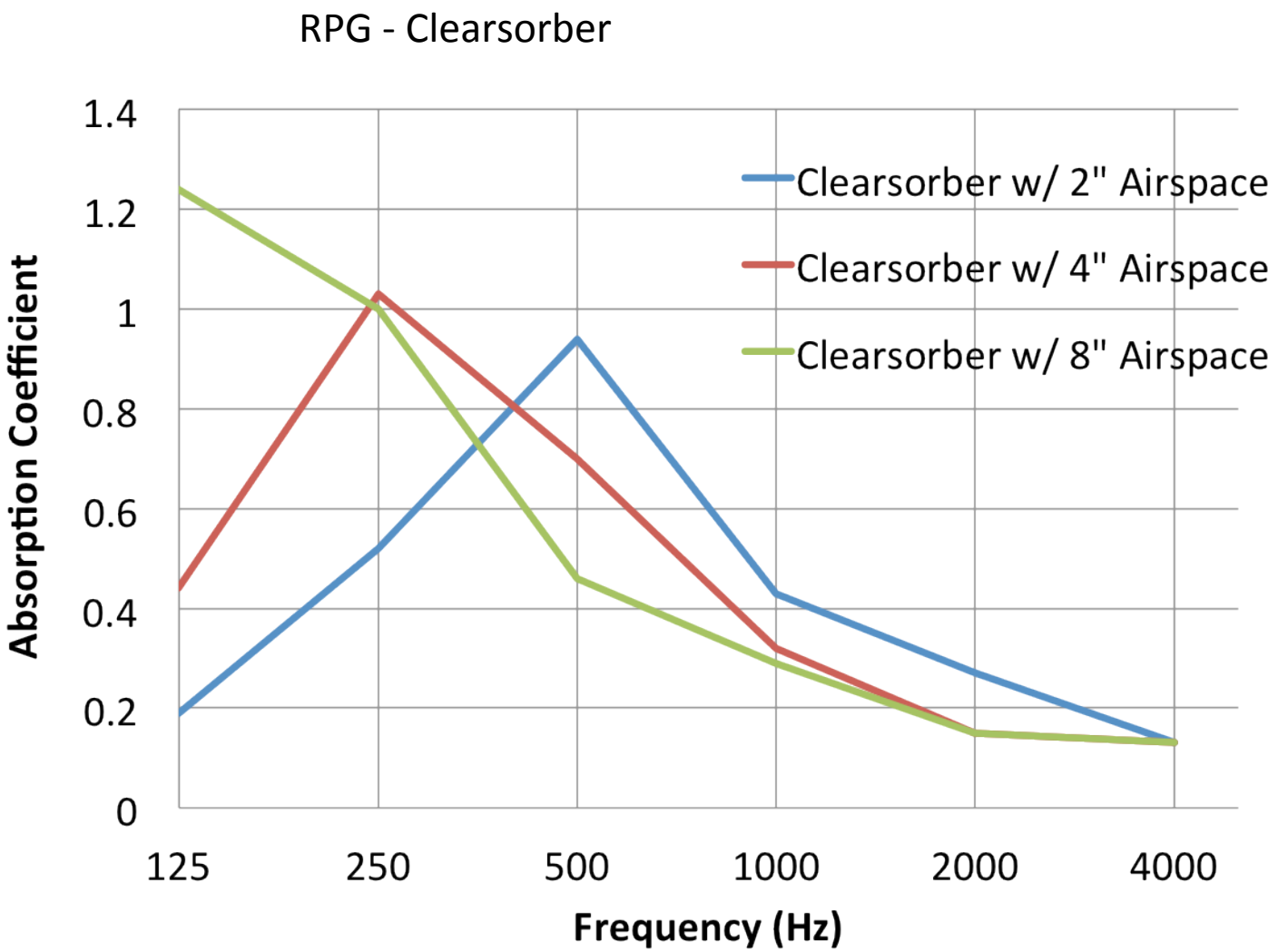


Microperforated Foil

Topperfo – Microperf

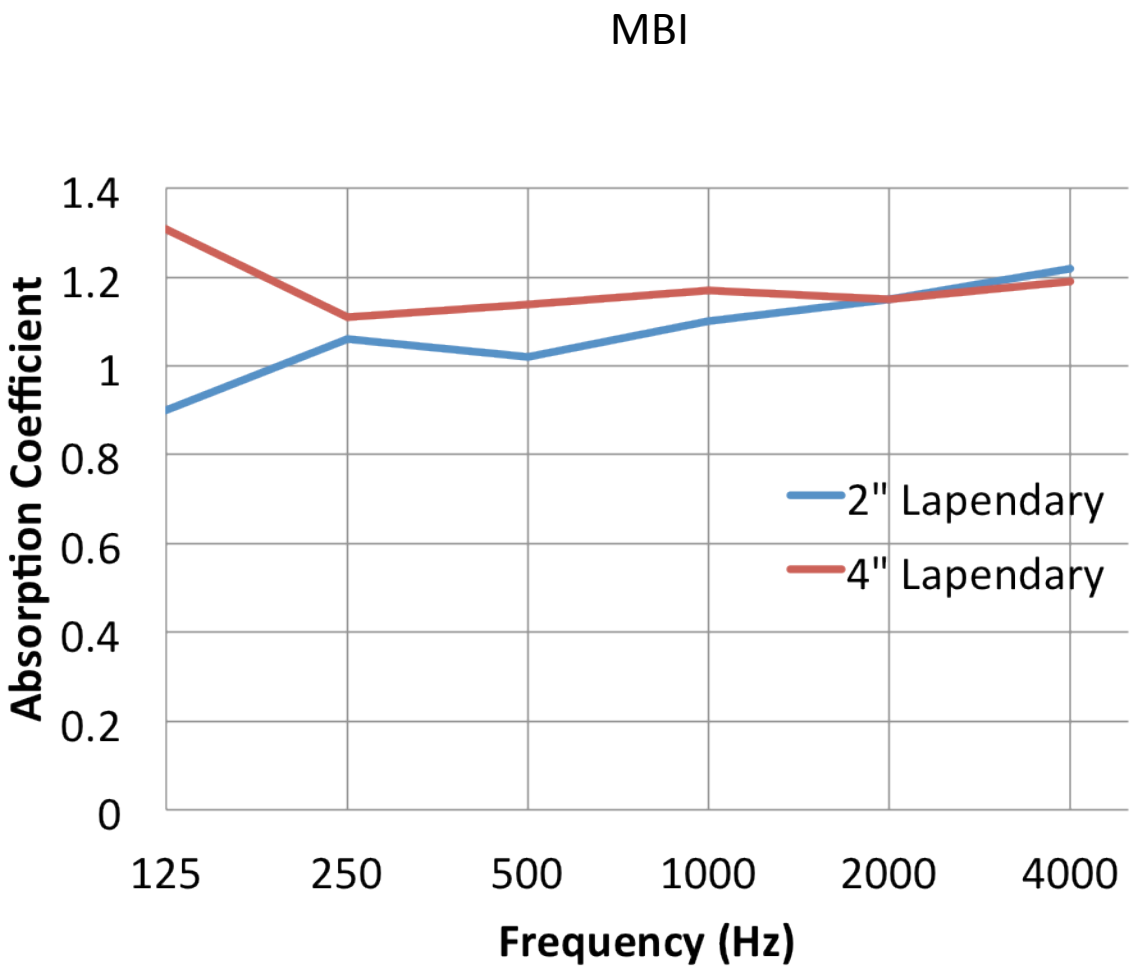


RPG - Clearsorber

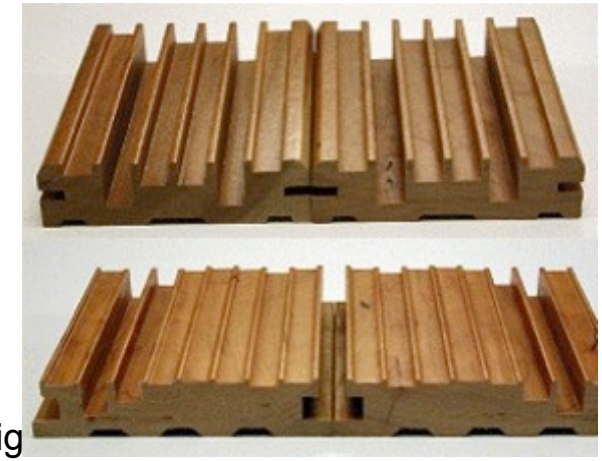

RPG - Clearsorber
Absorption Coefficient
1.4
1.2
1
0.8
0.6
0.4
0.2
0
125
250
500
1000
2000
4000
Frequency (Hz)
Clearsorber w/ 2" Airspace
Clearsorber w/ 4" Airspace
Clearsorber w/ 8" Airspace

Lapendary Panels

Lapendary Panels



Diffusors



Design

early in the design process

- programing
- room shaping
- a/v – control - display requirements
- audio – and specifically low frequency control
- quietness and isolation
- internal room qualities
- hvac
- wire management (future proof)

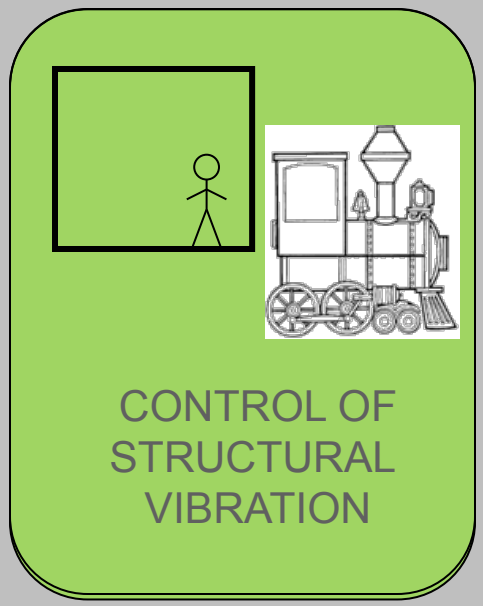
the “bare maximum”

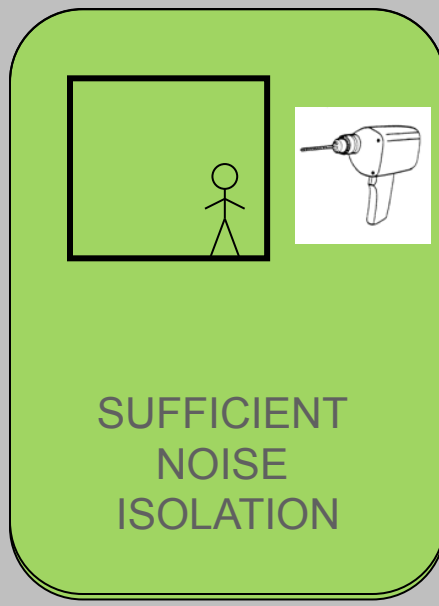
1. Quietness & Isolation
2. Internal Room Acoustic Values
3. Audio Video Requirements
4. Client Education & Programming

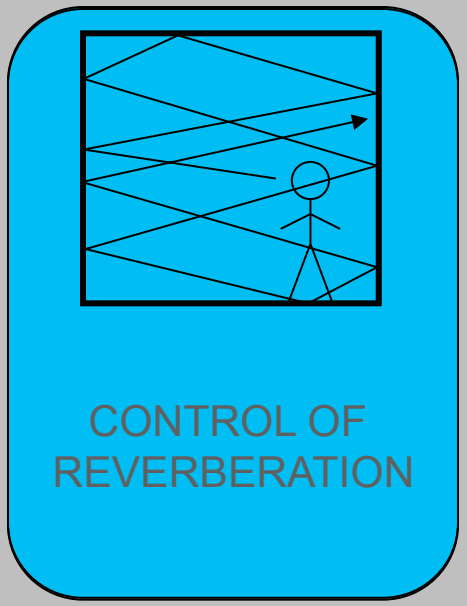
ACOUSTICS AND SYSTEMS INTEGRATION IMPLEMENTATION

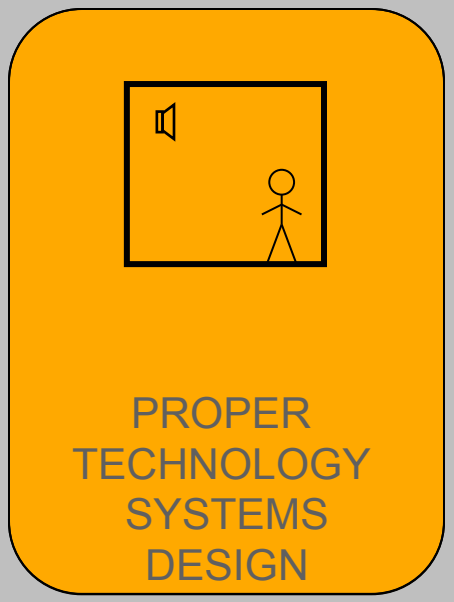
Acoustics do have a major impact on people ‘s comfort level (speech intelligibility, quietness, privacy) and safety (announcement systems).

The following aspects contribute to the acoustical and technology success of a project:









PLANNING AND CONSTRUCTION TIMELINE

STRUCTURAL ACOUSTICS | ROOM ACOUSTICS | TECHNOLOGY

Systems Integration Design

Audio Visual

- Electroacoustical Systems
- Systems Design & Integration
- Home Theater & Residential Systems Design

Technology Integration

- Media Distribution
- IT and Communication Systems
- Control Systems
- Theatrical Technology

Systems Integration Design

Audio Visual

- Electroacoustical Systems
- Systems Design & Integration
- Home Theater & Residential Systems Design

Source

Processing

Amplification

Output

Control

Systems Integration Design

Technology Integration

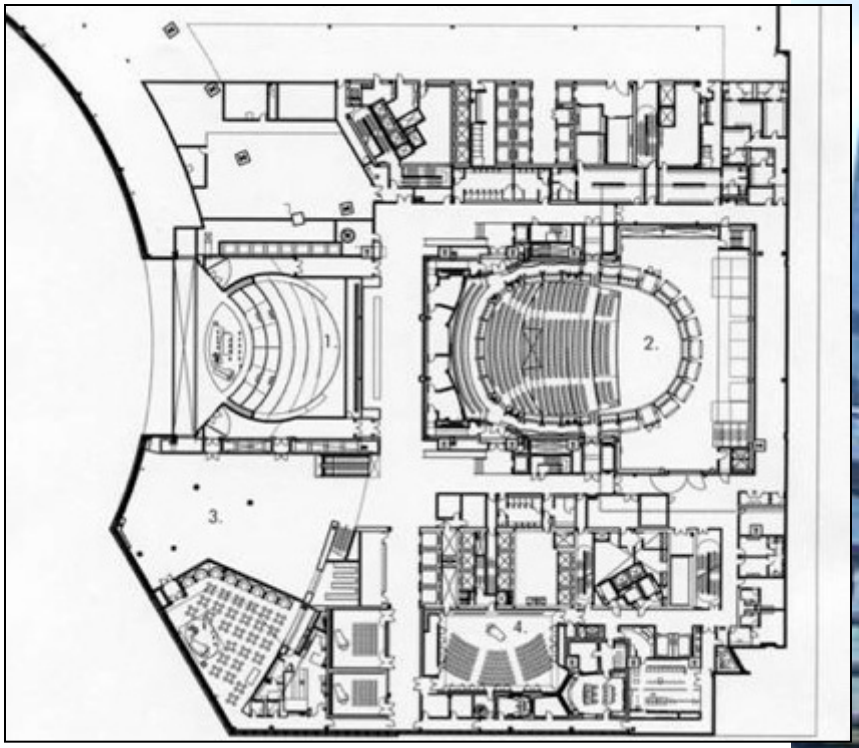
- Media Distribution
- IT and Communication Systems
- Control Systems
- Theatrical Technology

Systems Integration Design

1. Program Description
2. System Narrative
3. System Equipment Specification
4. Conduit Layout and Topography
5. System Diagram
6. Equipment Location and Distribution
7. Coordination with ID and MEP

advanced technology and improved acoustics will appear in almost all building types

no limits - all IDEAS are possible


1.
2.
3.
4.

Acoustic and Systems Considerations for Critical Listening & Interior Design

presented by
Sergio Molho
Principal
Walters-Storyk Design Group

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www.wsdg.com