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ROOM CONSTRUCTION

"Referencing Cedia White Paper CEB22 Home Theater Recommended Practice: Audio Design"

APPENDIX 3
WALL AND CEILING CONSTRUCTION

Home theater installation technicians can use multiple wall and ceiling construction applications to achieve sound isolation. Each method has its own inherent advantages and disadvantages. Key considerations, however, are that such constructions incorporate high mass, mechanical decoupling from the building's structure, and absorption.

Framing techniques

- **Room-within-a-room method**

In the framing process, the most effective method is the room-within-a-room method. This method however may not be acceptable due to the amount of floor space consumed, local fire-code objections and loss of floor to ceiling clearance. A true room-within-a-room style of construction dictates an isolated floor, isolated base/top plates, and an isolated ceiling framing. Prior to proceeding on such a path, one is advised to seek professional input from either an architect or structural engineer.

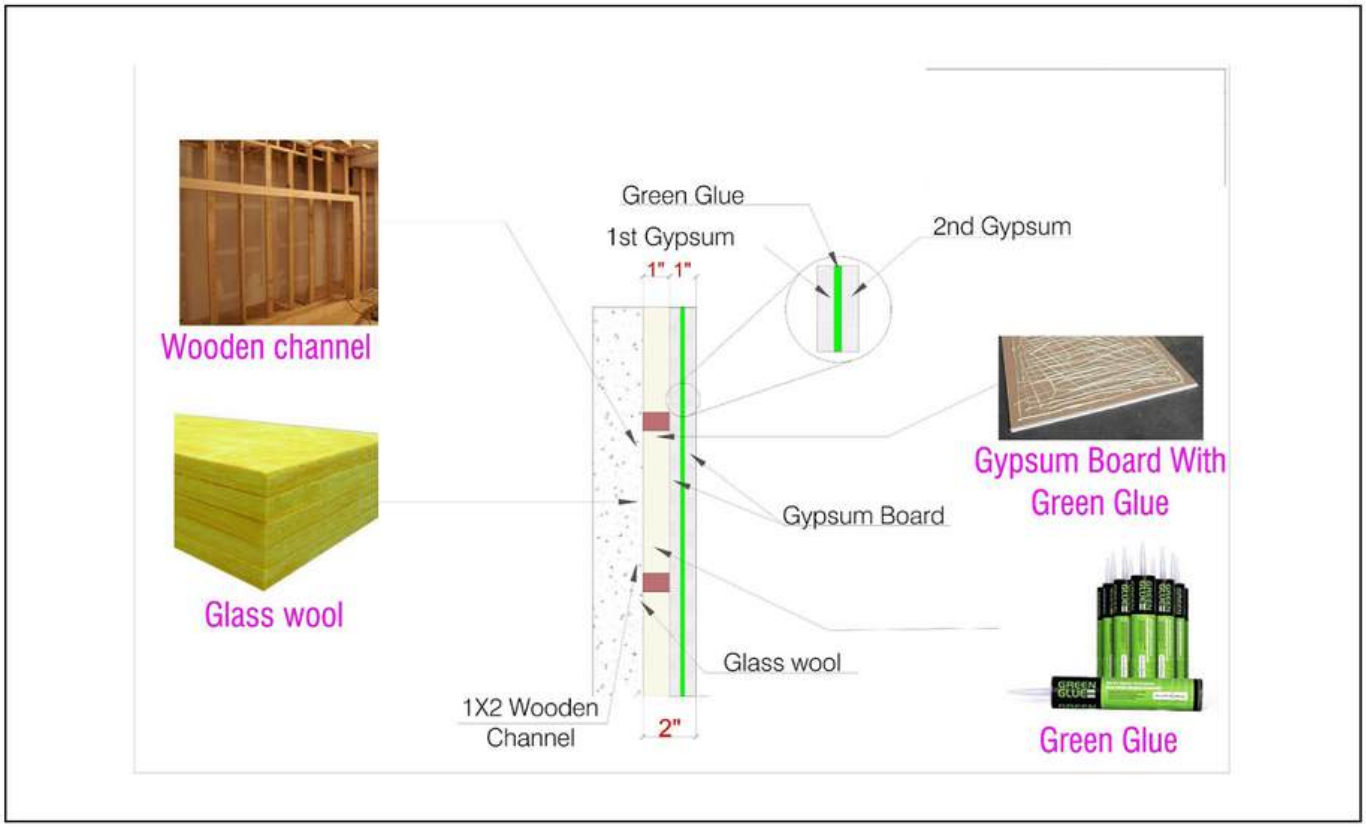
- **Stagger-stud method**

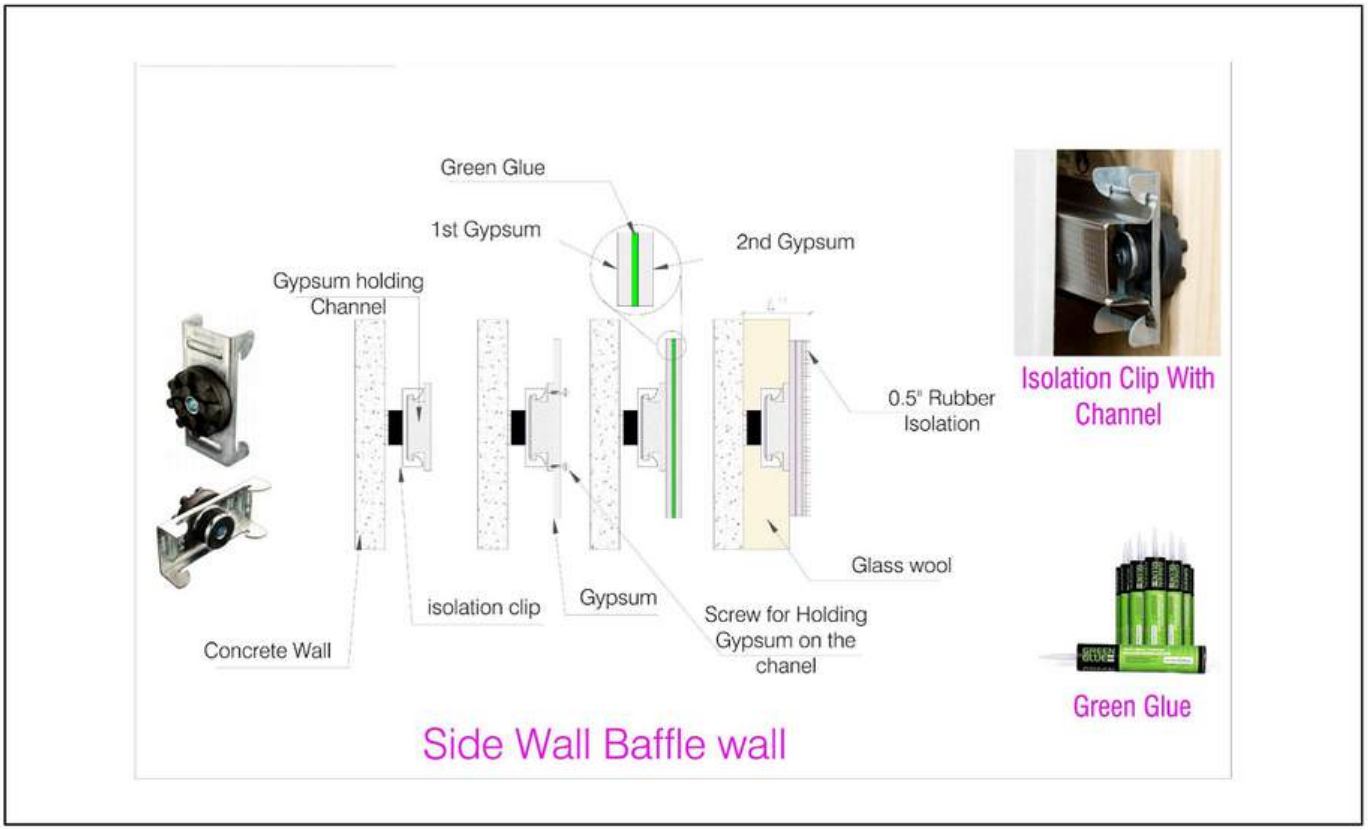
The least effective is the stagger-stud method of framing. While this method does provide mechanical isolation, neither the base nor top plates are isolated. More of an issue is implementing stagger joist to provide ceiling isolation. Usually stagger joist construction is not viable with existing mechanical and plumbing systems running through the joist space areas.

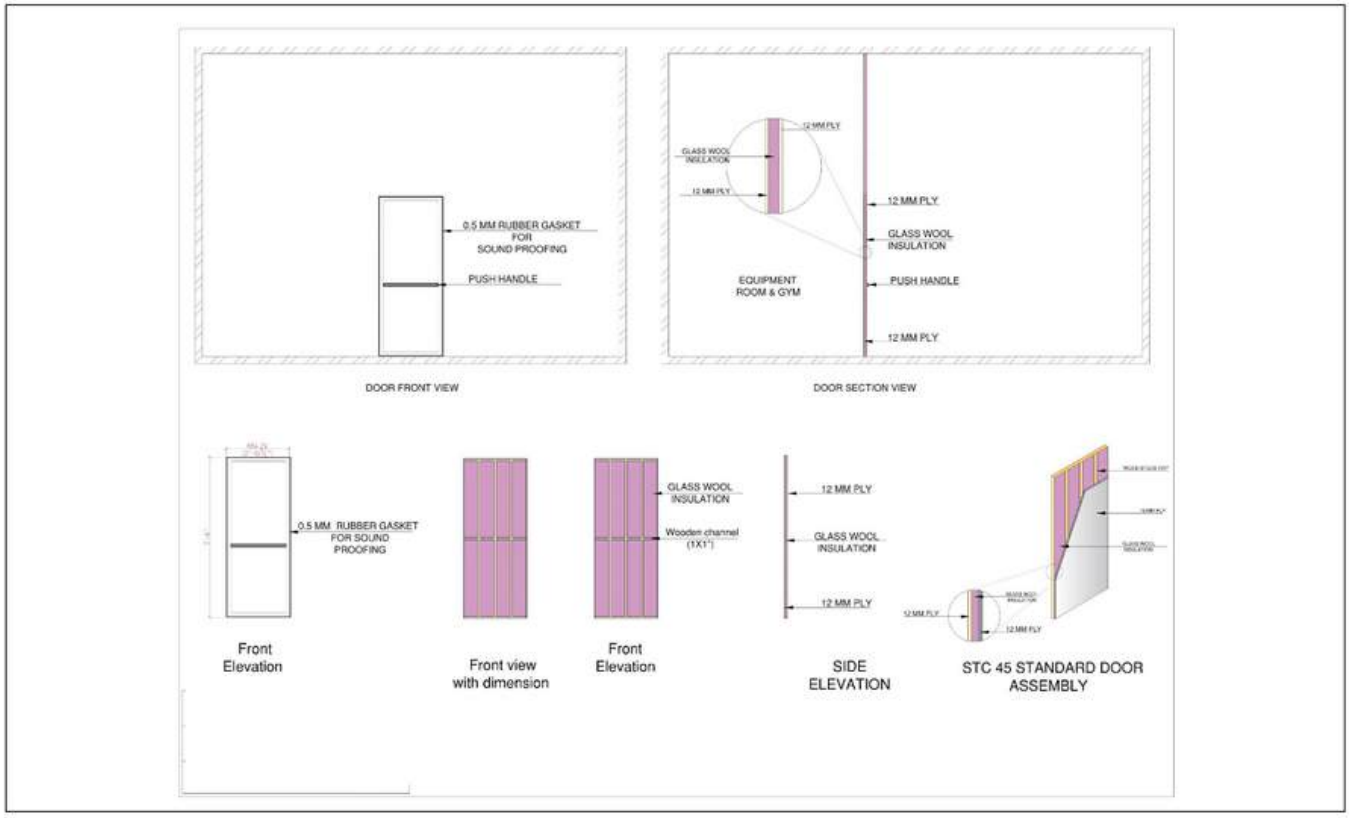
- **Isolation clips**

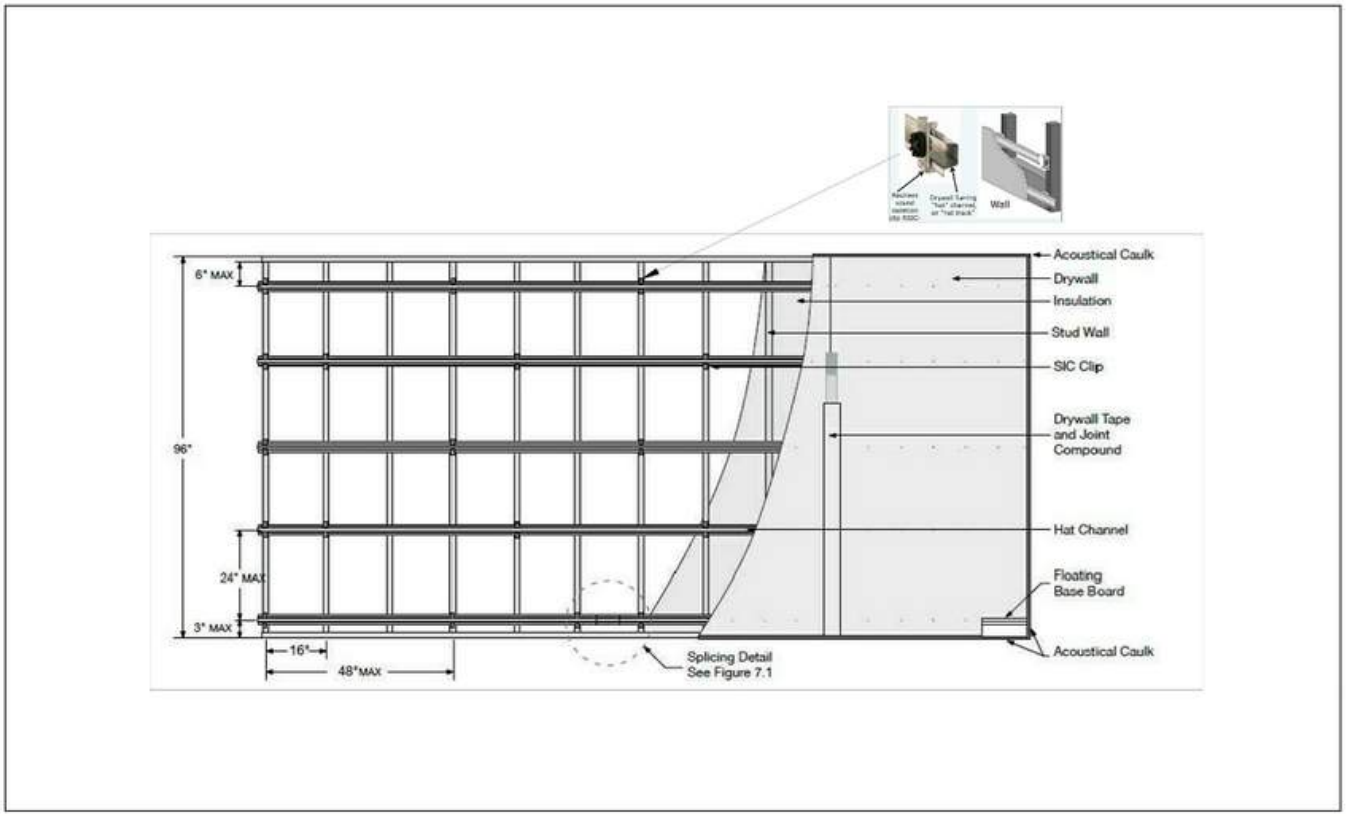
The third method utilizes isolation clips installed onto the framing members (wall and ceiling), a metal "HAT" or furring channel installed into the clips, and then the drywall is installed to the HAT channel. The isolation clips consist of a rubber, or flexible material, which isolates, or damps, the wall/ceiling from the structure. This method is can be very effective and is not cost or space prohibitive. Traditional "Z" channel or resilient channel is not an effective solution for music or cinema sound reproduction spaces.

All joist and framing cavities should have fiberglass batts, blown-in wet cellulose, or similar insulation material in the cavities. Closed cell foam insulation products are counterproductive. If open cell foam is to be used, the foam should not contact both sides of a wall or ceiling. This would re-couple the walls.









- **Drywall isolation techniques**

Drywall is installed directly onto the framing for double wall or stagger-stud construction or into the "HAT" channel when isolation clips are utilized. Two layers of drywall are highly recommended and provide a doubling of mass. Such high mass walls will reduce the resonance frequency of the wall assembly.

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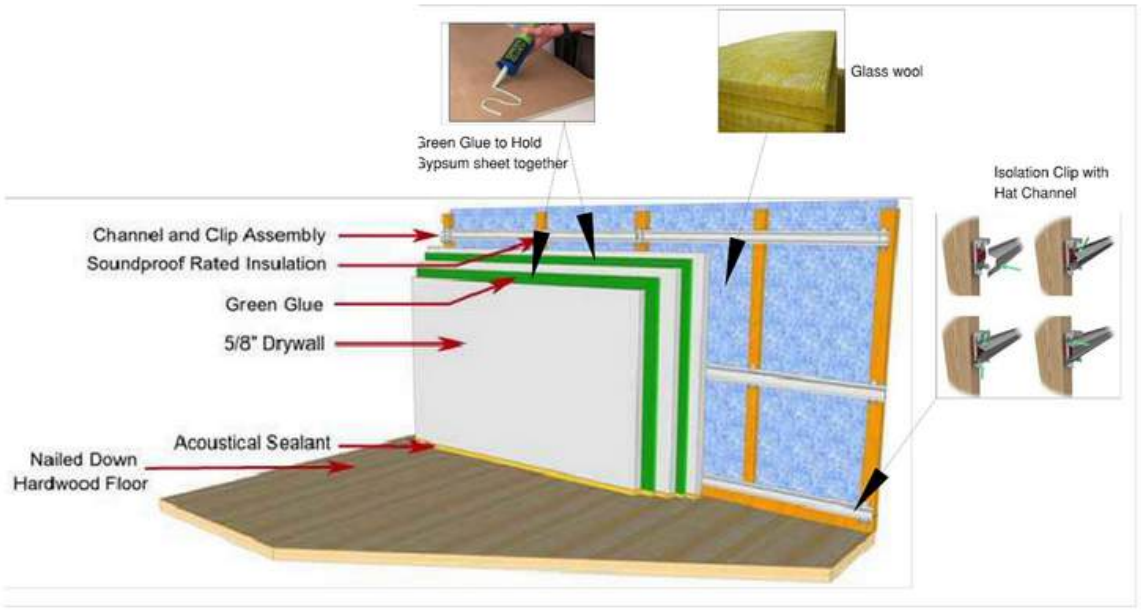
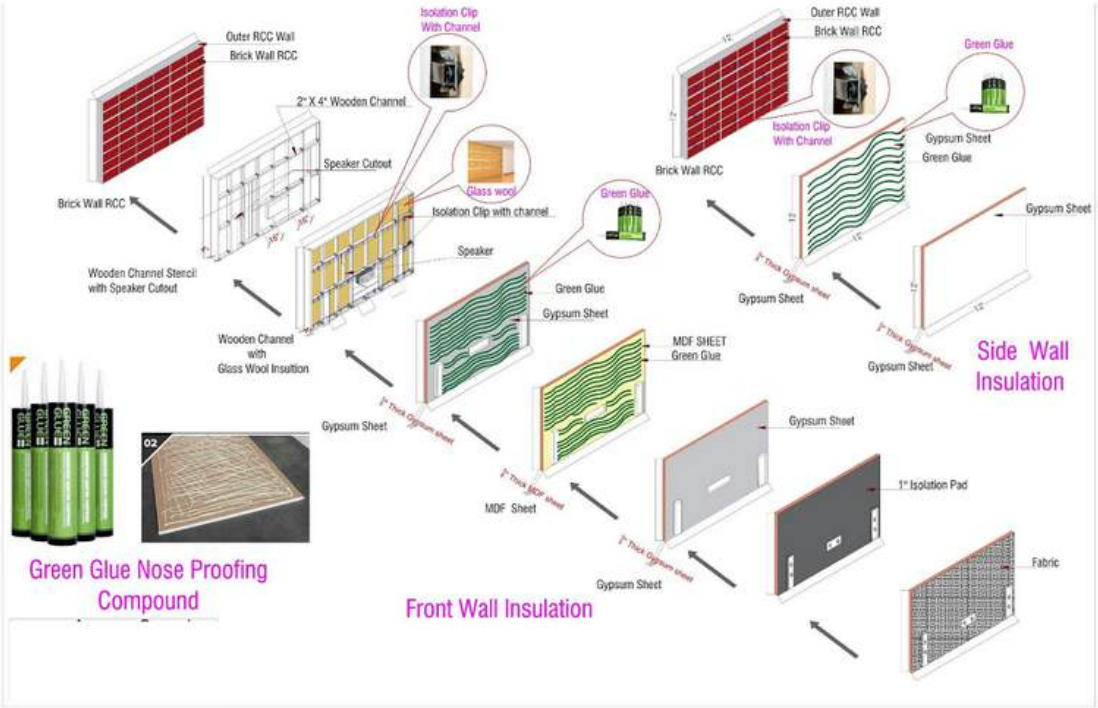
When multiple layers of drywall are used, each layer should be completely installed before any subsequent layer. In other words, ceiling then walls followed by ceiling and walls again. This results in a lap joint in the corners rather than a butt style joint which, if not well sealed, will provide a flanking path and defeat your sound isolation efforts. Layers of drywall should have a viscoelastic coating applied between each layer of drywall. Such coatings have been shown to be very effective in damping (absorbing) low frequency energy.

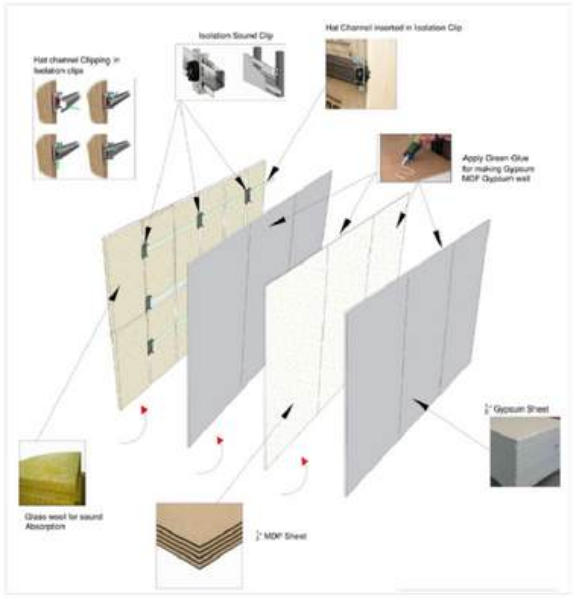
Drywall products are available which have been manufactured with a constrained layer damping material laminated into the drywall at the time of manufacture. Special caution should be taken when electing to utilize such manufactured products. First, two layers of the material may be required to achieve a wall with a mass equal to two layers of 1/2" or 5/8" drywall. Second, using such single layer products will require careful attention to sealing any gaps or flanking paths where the sheets of material butt together.

For less critical applications, or where the existing space is already dry walled, a second layer of drywall can be installed over the existing walls and ceiling using a viscoelastic material applied between the old and new drywall. Do not be tempted to install resilient channel or isolation clips over an existing wall surface and then install the new drywall. This form of construction will create a triple leaf and will result in more transmission of sound through the barrier rather than less.

In order to effectively seal the room, it is suggested the installation of drywall occur before the installation of any architectural acoustical treatment elements such as columns, soffits, stages, or raised seating platforms. Columns can be used to house speakers, electrical outlets, and lighting control dimmers without the adverse effects associated with putting holes in the sound isolation barrier around the room. Installing wall to wall seating and stage platforms inside the barrier will also allow these items to be used as bass traps.


Green Glue to Hold
Gypsum sheet together
Glass wool
Isolation Clip with
Hat Channel
Channel and Clip Assembly
Soundproof Rated Insulation
Green Glue
5/8" Drywall
Acoustical Sealant
Nailed Down
Hardwood Floor


Outer RCC Wall
Brick Wall RCC
Isolation Clip
With Channel
2" X 4" Wooden Channel
Speaker Cutout
Glass wool
Isolation Clip with channel
Speaker
Green Glue
Gypsum Sheet
MDF SHEET
Green Glue
MDF Sheet
Wooden Channel Stencil
with Speaker Cutout
Wooden Channel
with
Glass Wool Insultion
Side Wall
Insulation
1" Isolation Pad
Fabric
Green Glue Nose Proofing
Compound
Front Wall Insulation



Floor Isolation Techniques

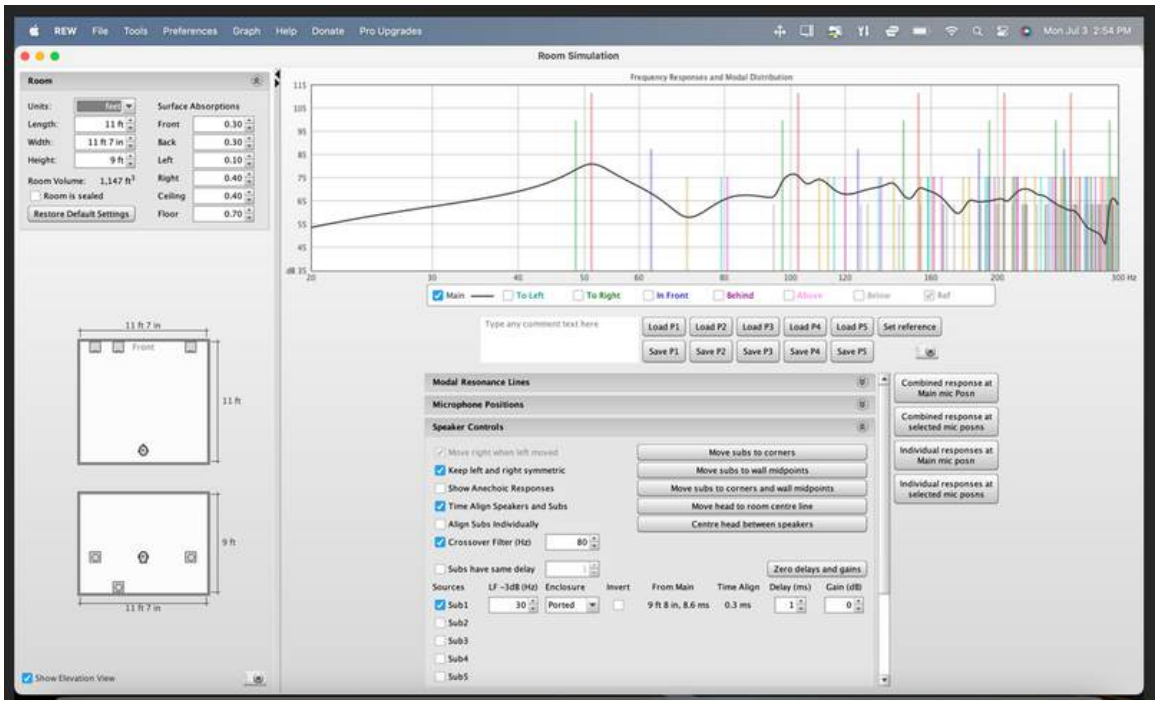
- Floors should be decoupled from the structure of the building. Failing to do so will create a significant and undesirable flanking path. Again, in a double wall construction method, floor faming can be isolated by use of commercially available isolation pucks, “U” anchors, floor suspension devices and similar materials. Such methods will generally consume more height than is desirable in most residential situations. Concrete is an excellent transmitter of kinetic sound energy and any temptation to avoid isolating concrete slab floors should be dismissed.
- An effective method of floor isolation (without large structural impacts on upper floor rooms) is to install a high mass 5/16- to 1/2-in. (7.5-12.5mm) rubber mat over the existing subfloor or slab. This mat should be installed after the drywall is installed; any gap between the bottom of the drywall and the subfloor should be thoroughly caulked. The mat should be installed 1/4” (5mm) short of the drywall and not contact the drywall at any point. Oriented strand board (OSB) or plywood is then installed over the mat, again not contacting the drywall, using an approved mastic. Seating platforms and stages are then installed over the new subfloor.

“End Reference Cedia White Paper CEB22 Home Theater Recommended Practice: Audio Design”

LOW FREQUENCY RESPONSE:

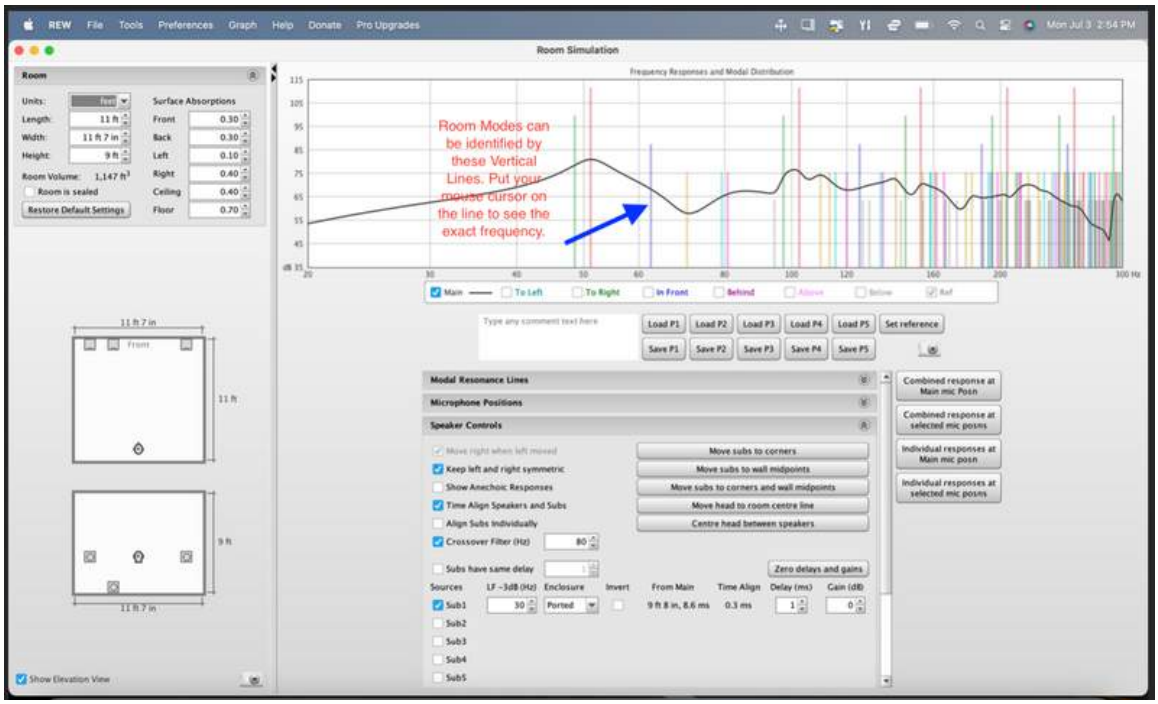
STEP 1

Create your room and place your speakers, subwoofers and seats using REW's Room Sim software.



STEP 2

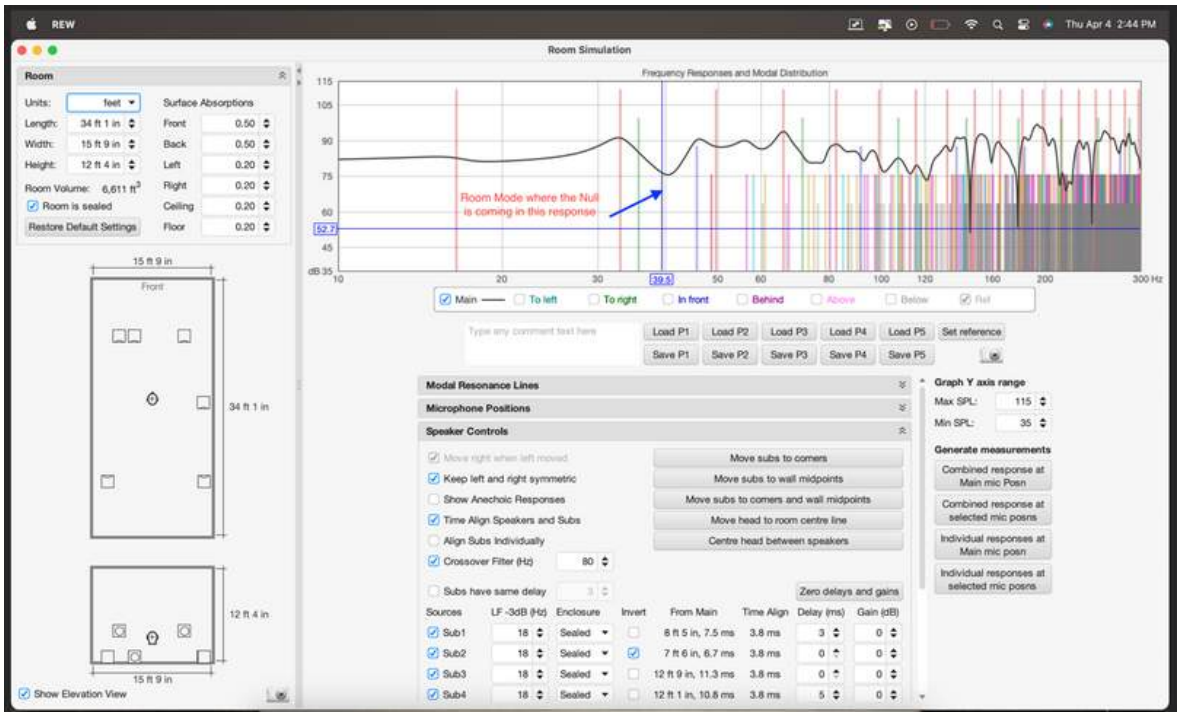
Identify the room modes and nulls in the response based on the predicted frequency response. Try and move the subwoofers or seating positions around if required to achieve the best possible response

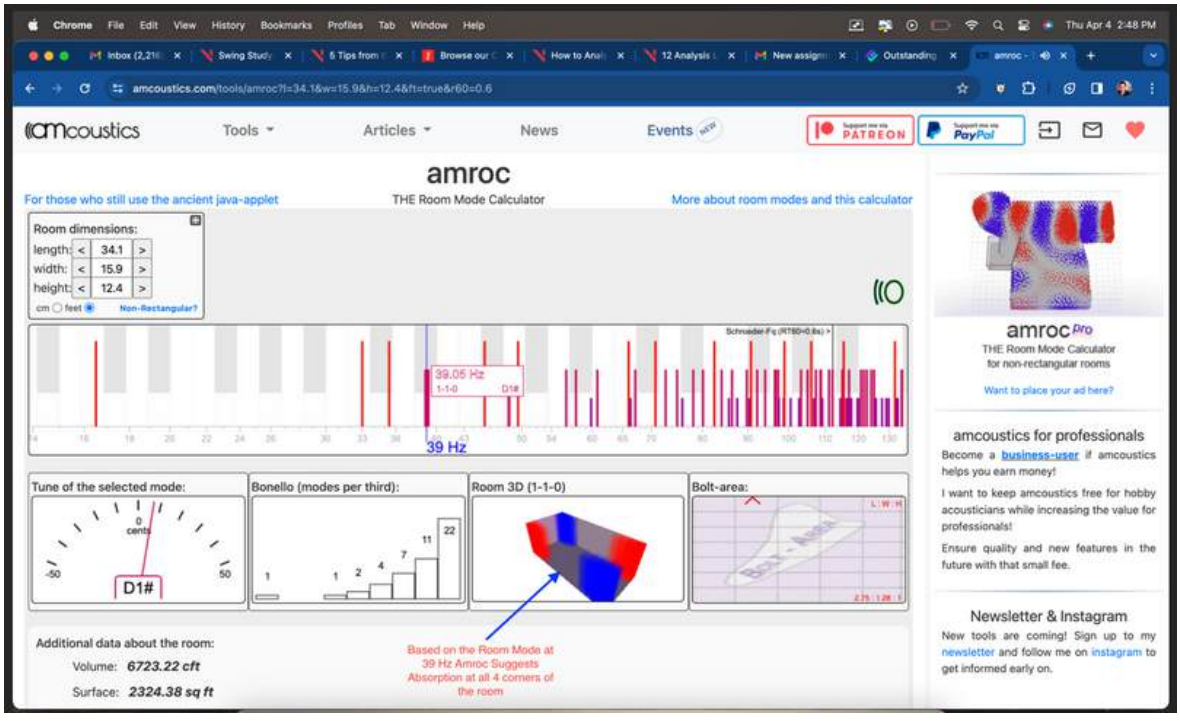


STEP 3

Based on the frequency response identify any of the major nulls in the response and identify any room modes associated with that null. Put your music cursor on the vertical line for the room mode as shown in the above screen shot and you will see the frequency response associated with that mode. Visit https://amcoustics.com/tools/amroc and choose New "Shoe-Box Shaped Room".

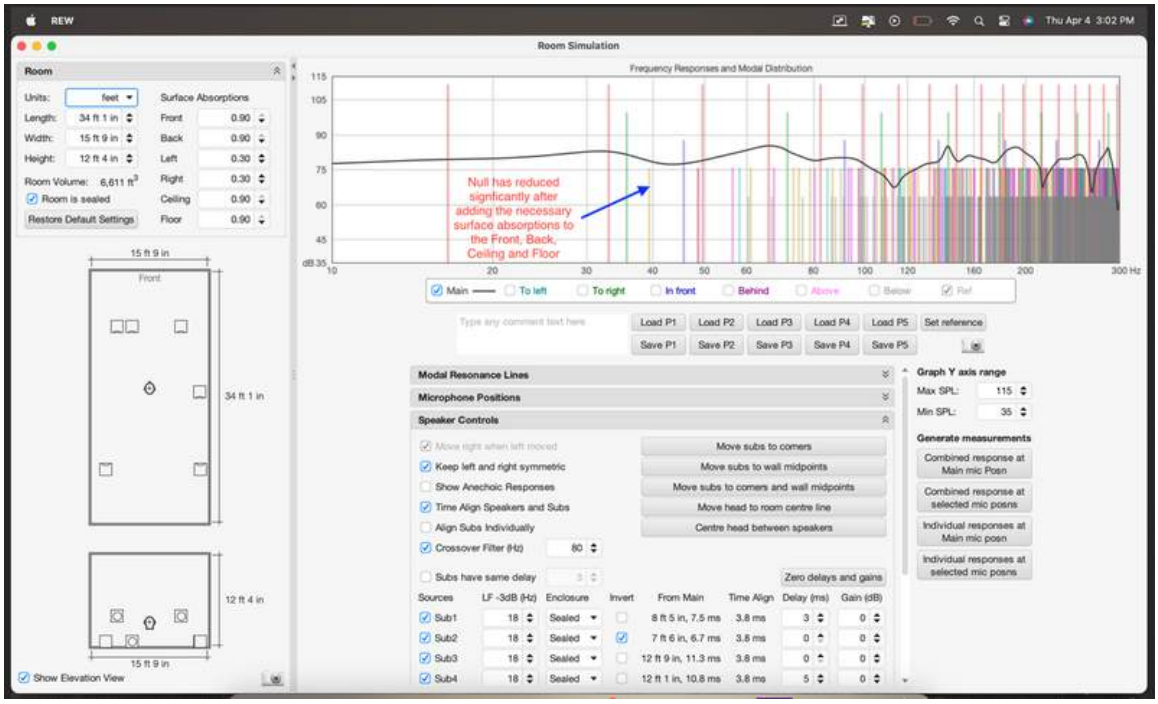
Insert the room dimensions for your room and be particular which metric you choose, centimeters or feet.





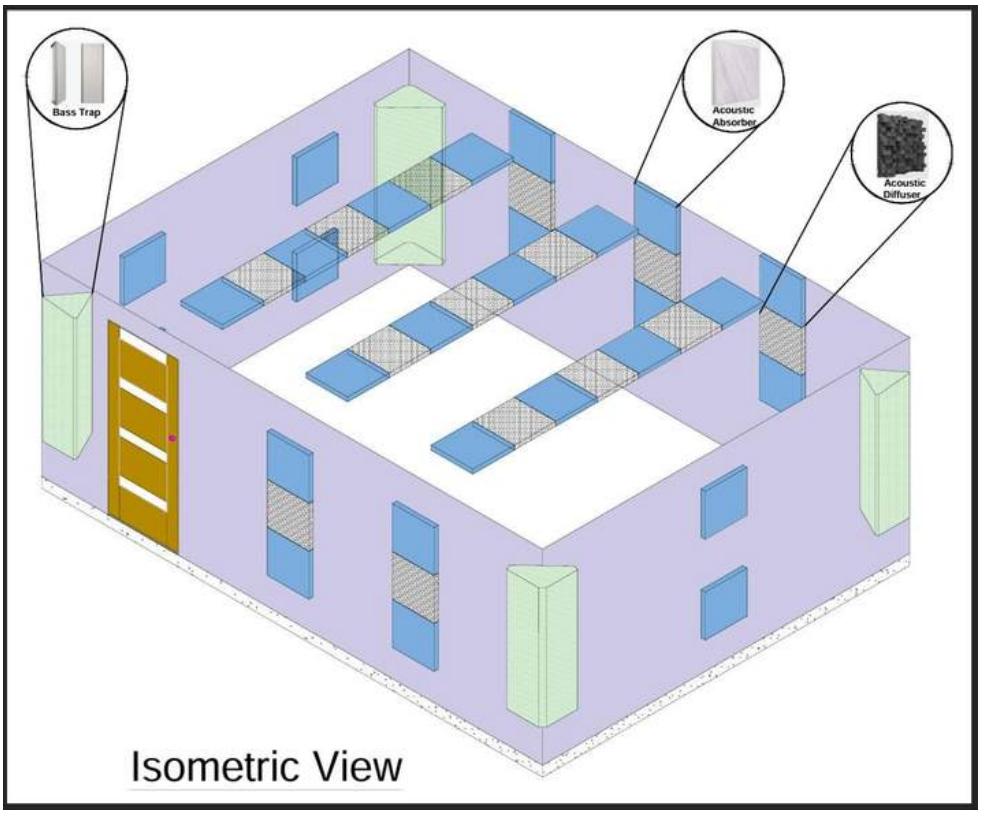
STEP 4

Accordingly adjust the surface absorptions in rew's room gain software on that particular wall based on amroc's suggestions. See how that affects the frequency response.



STEP 5

Once you have a response you are happy with note which surfaces require absorption and your NRC coefficient for each surface based on REW's Room Gain software and a low frequency absorption design can be created



MID TO HIGH FREQUENCY RESPONSE

STEP 1

We will require the off axis response measurments of all speakers being used except for the subwooders. If you already have this information open it, or else take measurements of the speakers you plan to use at 15 degrees, 45 degrees, 60 degrees and 90 degrees off axis.

STEP 2

Based on the off axis response we can determine where in the response we have nulls or large dips after the transition frequency for the room. We are looking at all responses higher then the transition frequency, because below the transition frequency is being considered in the low frequency treatment plan.

STEP 3

Once we identify the frequency or frequencies which have a significant null or dip, we can which type of treatment we want to use to treat those frequencies. For example, if we have a null at 1600 hz and it continues till 4200 hz. We want to use acoustic treatment which will treat frequencies between 1000hz and 5000hz

https://mehlau.net/audio/calculator/

1600hz frequency = 8.46 inches
4200hz frequency = 3.22 inches

STEP 4

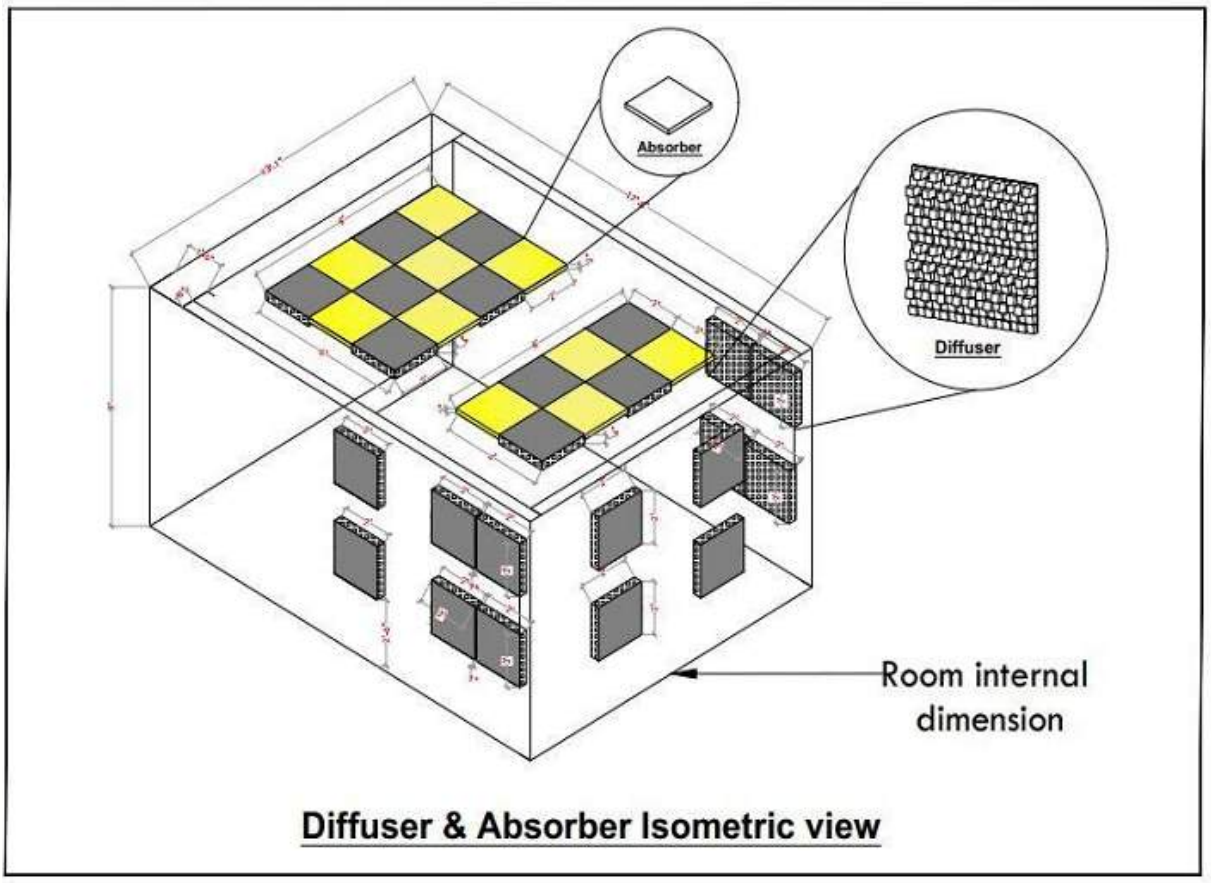
Considering these distances it becomes obvious the surfaces which will be affected by the frequencies where the null occurs, 1600hz to 4200hz is a within 9 inches of the speaker.

STEP 5

We accordingly need to plan acoustic treatment which has been built to treat frequencies between 1,600hz to 4,200hz and place it on the nearby surfaces covering 3 inches to 8.5 inches away from the position of the speaker in the room. In this example we can look at the Vicoustic Multifuser DC3. This does a great job of scattering the sound from 800hz to 5000hz which covers the trouble frequencies we are finding in our off-axis response.

https://drive.google.com/file/d/15AcgVUwA6PUxf8EyfzVw3EVEDKkVFgak/edit

We can plan to place the Multifuser DC3 around our speaker positions up to 9 inches away from the speaker to scatter sound coming at an off-axis response. So from the left and right and above and below the speaker a single DC3 panel can be placed around the speaker which will properly treat the frequencies which are of concern in the off axis response.



Diffuser & Absorber Isometric view

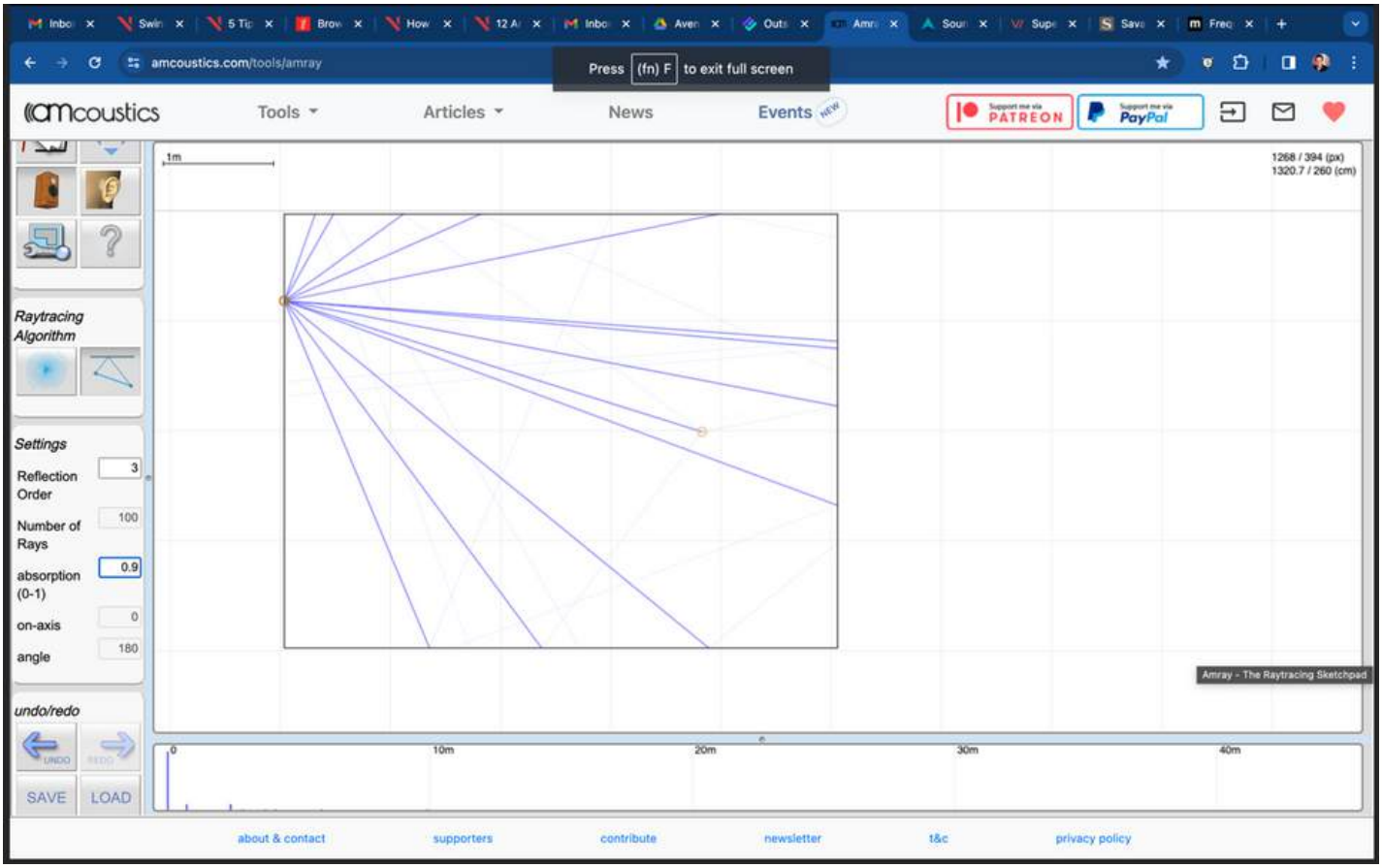
RAY TRACING

STEP 1

Visit https://amcoustics.com/tools/amray and draw the room based on your room dimensions in the ray tracing sketchpad. Set Reflection Order to 3, Number of Rays to 100, and Absoprtion Coeffecient to what value was calculated in the REW Room Sim.

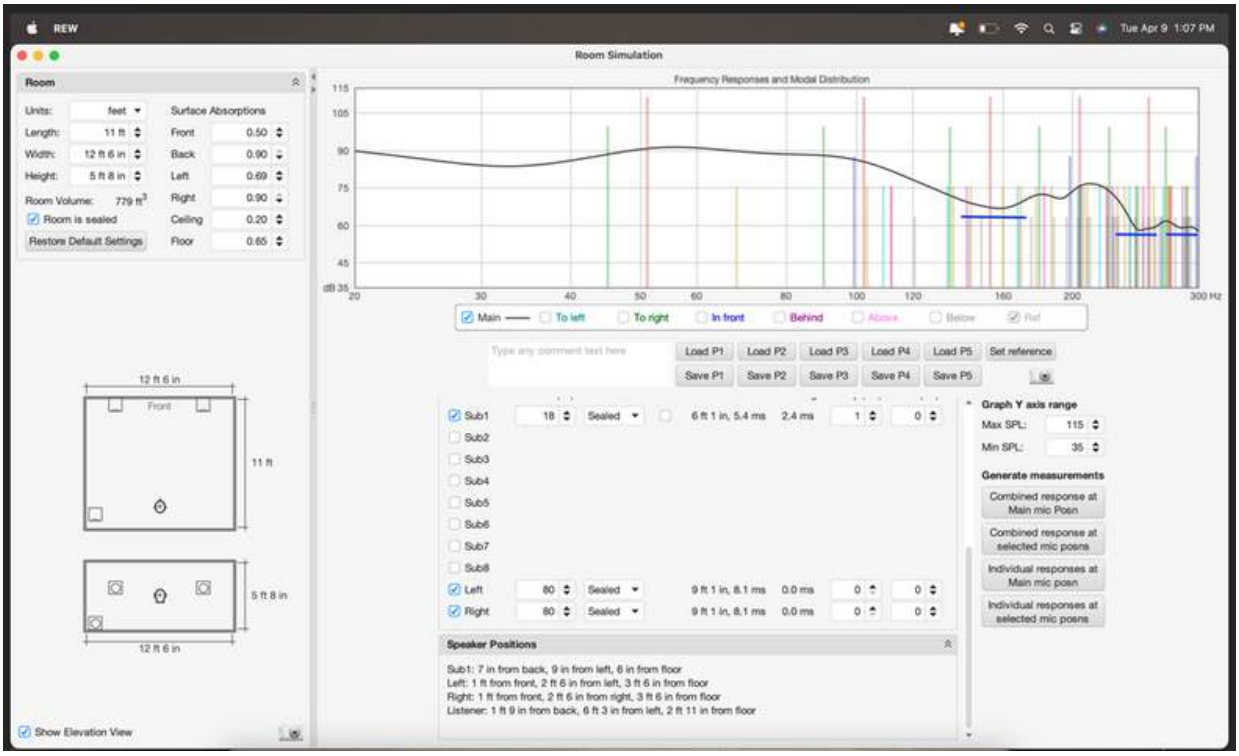
STEP 2

Place your speaker and listening positions in their respective positions in the room. Depending on your absorption coefficient you will see the reflections which are present in the room based on your speaker position and listening position. Take a screenshot of the page. Repeat this process for all the speakers positions.



STEP 3

Check your room sim design in REW to see where expected frequency nulls may occur. Please see the example below.



As we can see from the REW Room Sim image above, we have 3 large dips. The first at 158hz, the second at 247hz and the third at 284hz. If we use our frequency calculator

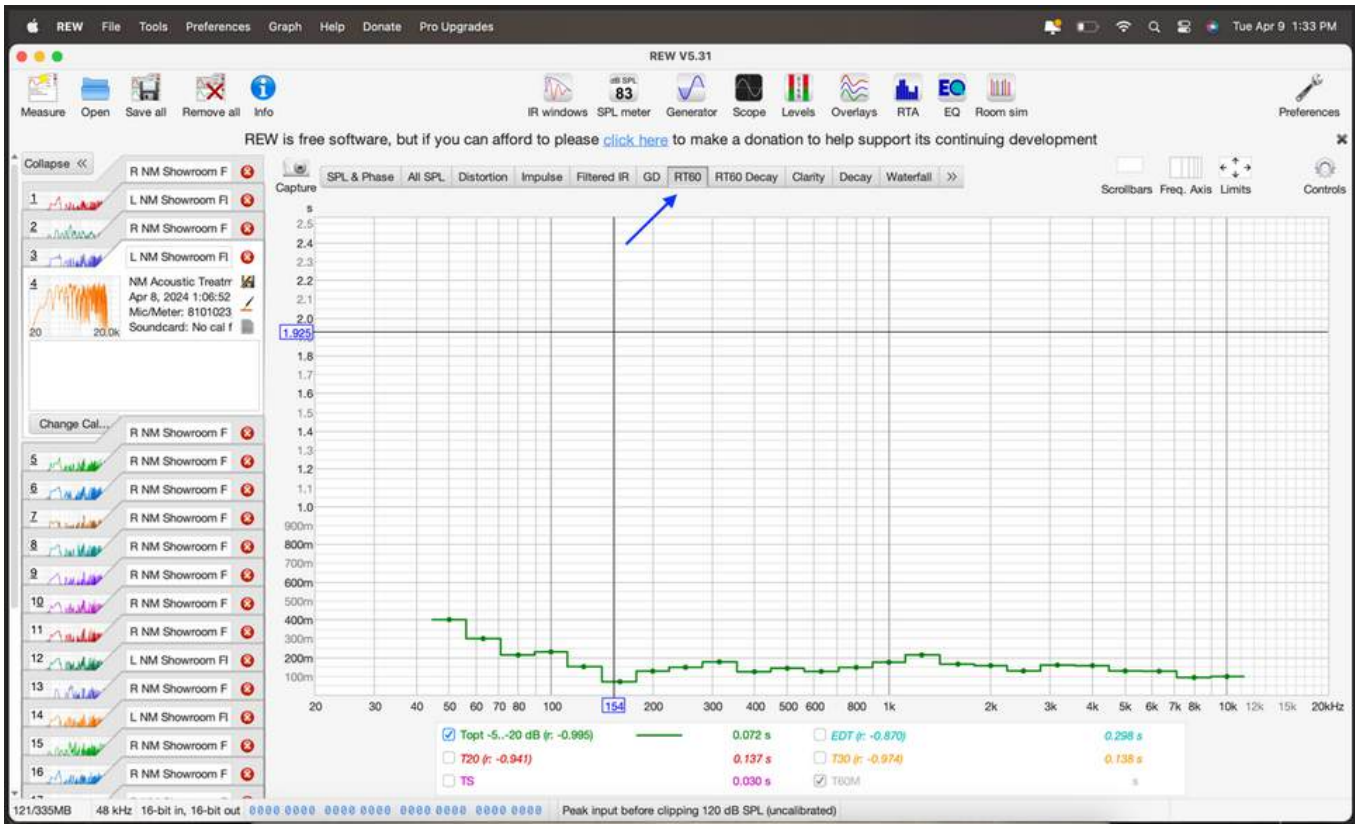
https://mehlau.net/audio/calculator/

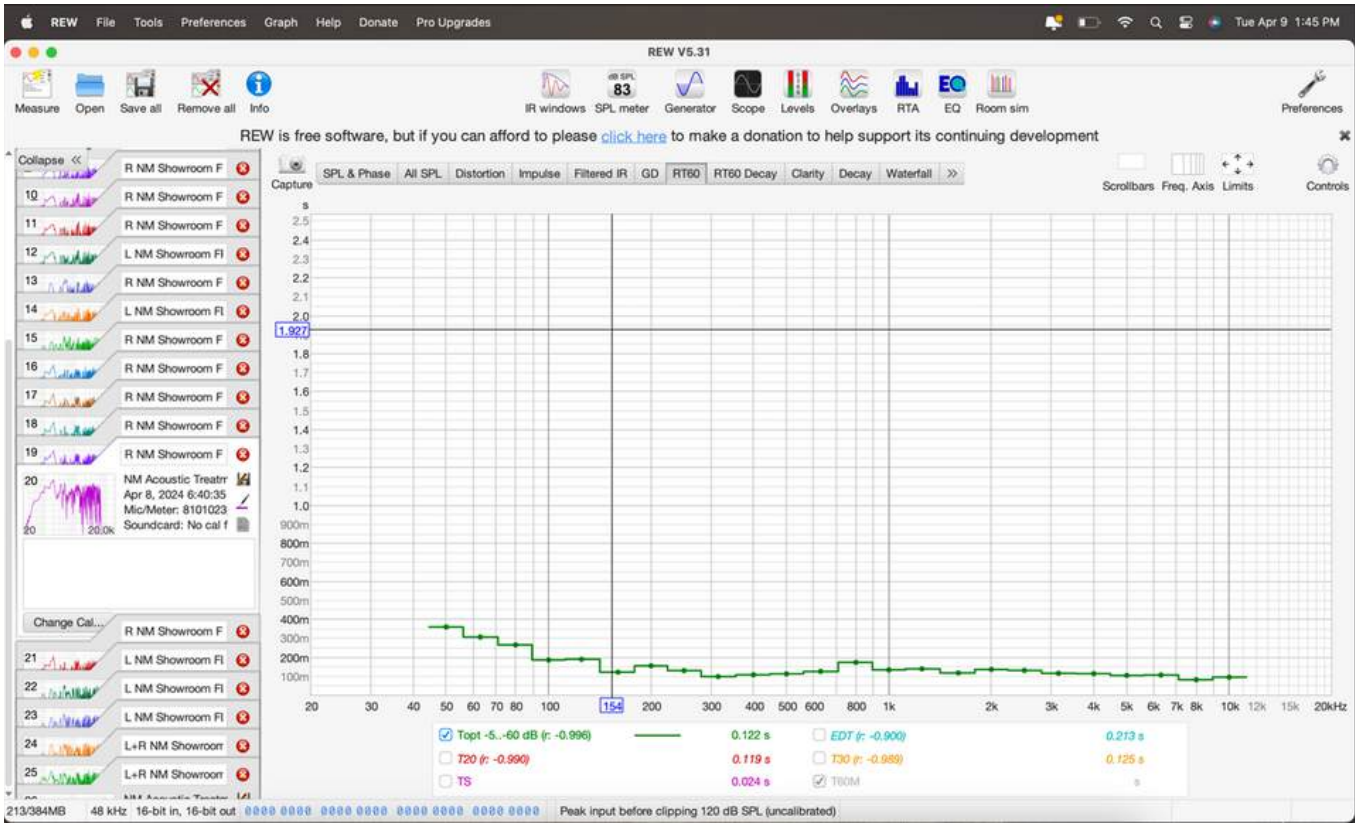
we know that 158hz is around 85 inches or just above 7 feet. Using the ray tracing diagram we can mark out a line 7 feet from our speaker to the nearest reflection point. This the location where we can add the necessary treatment to treat this frequency.

RT60:

Take a measurement of any single speaker in the room. Generally, we measure the LCR since they are furthest from the listening position. Take a full range measurement from 20hz to 20,000hz.

Select the measurement in the left side of the REW software. Choose the RT60 tab as shown in the screen shot below.



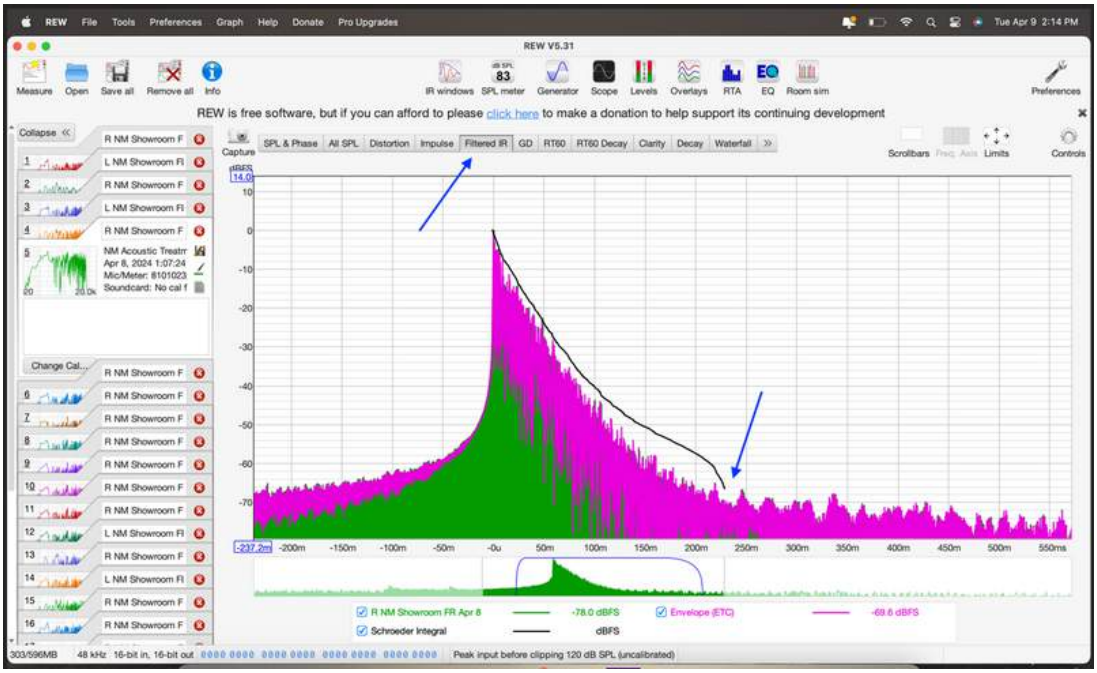


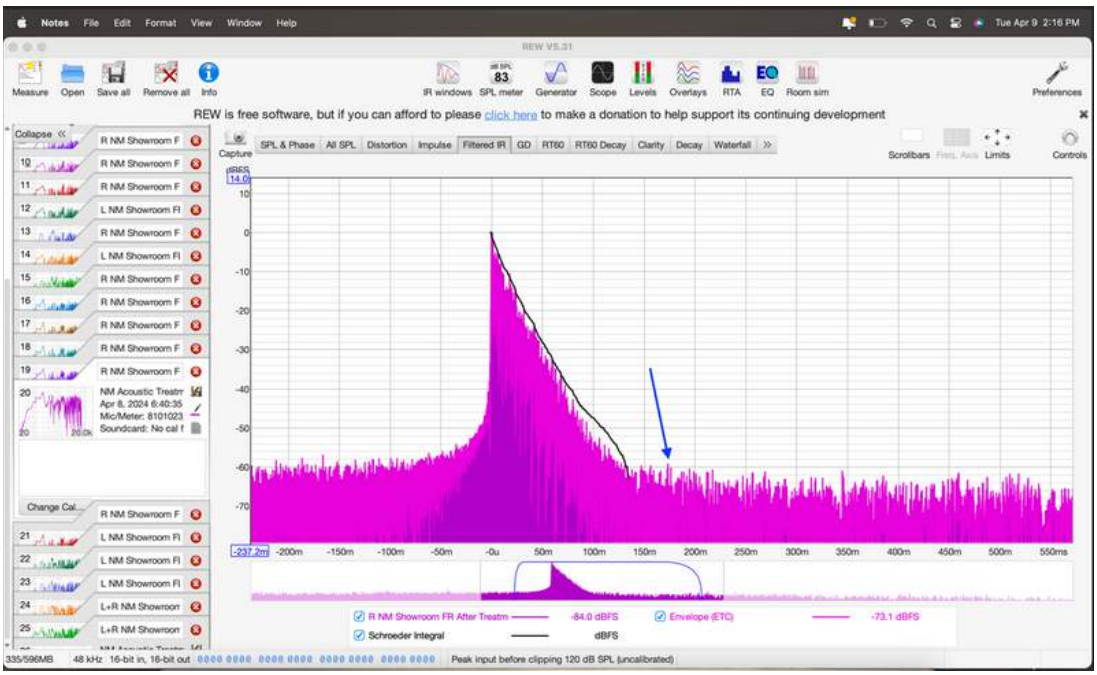
The first screen shot shows the RT60 for the Front Right speaker in this room without treatment. If we compare with screen shot 2 which measures the same speaker after applying acoustic treatment, it is quite evident how much more uniform the reverberation time for the room becomes beyond 154hz.

Energy Time Curve (ETC):

Using the same measurements of a single speaker in the room as above, click on the Filtered tab.

Select the measurement in the left side of the REW software. Choose the Filtered IR tab as shown in the screen shot below.



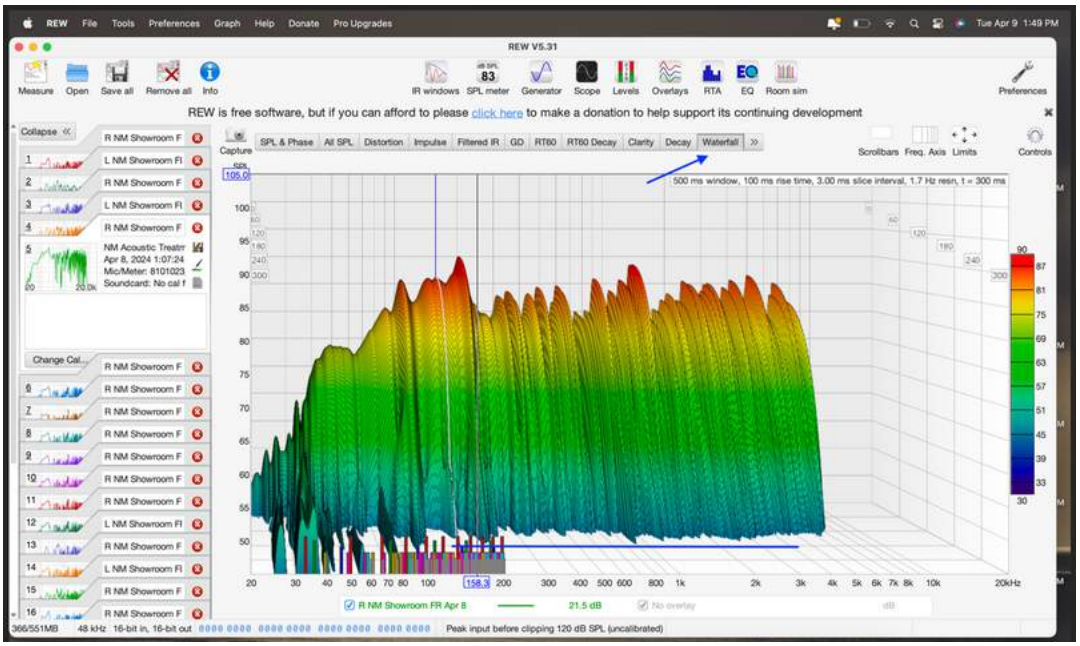


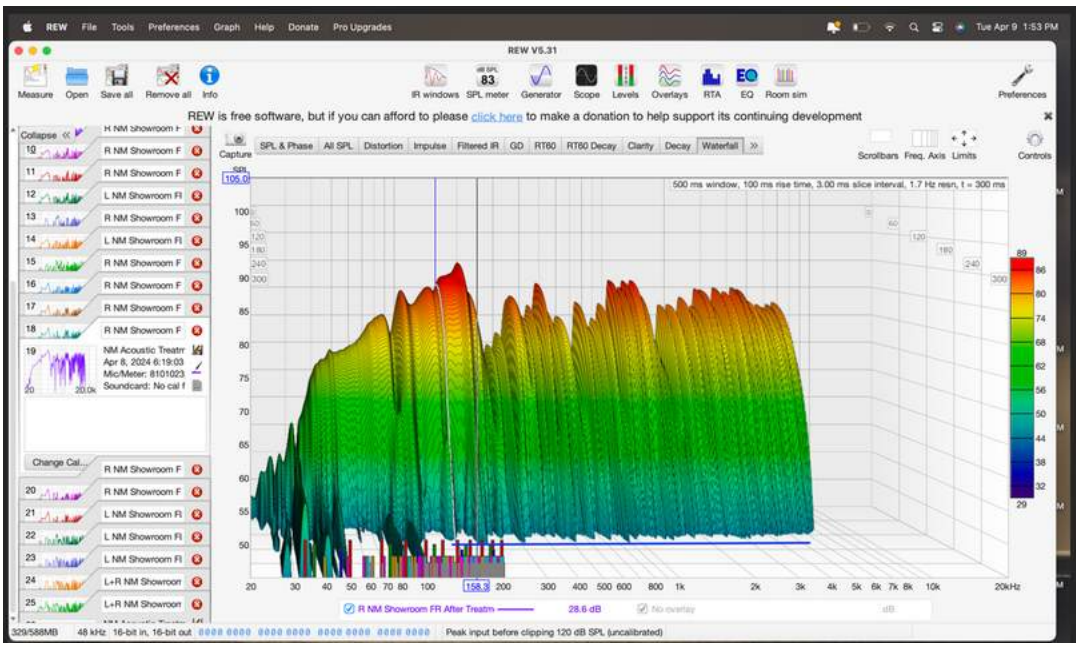
If we compare screen shot 1 above to screen shot 2 we see that in screen shot 1 before applying acoustic treatment our mid to high frequencies decay till atleast 240ms. In screen shot 2 after applying acoustic treatment our longest reverberation time decreases to around 200ms. This is a great way to ensure that you have not over absorbed your room. Ideal decay time of small cinema rooms should be between 200 to 350ms.

Waterfall:

Using the same measurements of a single speaker in the room as above, click on the Waterfall tab.

Select the measurement in the left side of the REW software. Choose the Waterfall tab as shown in the screen shot below.



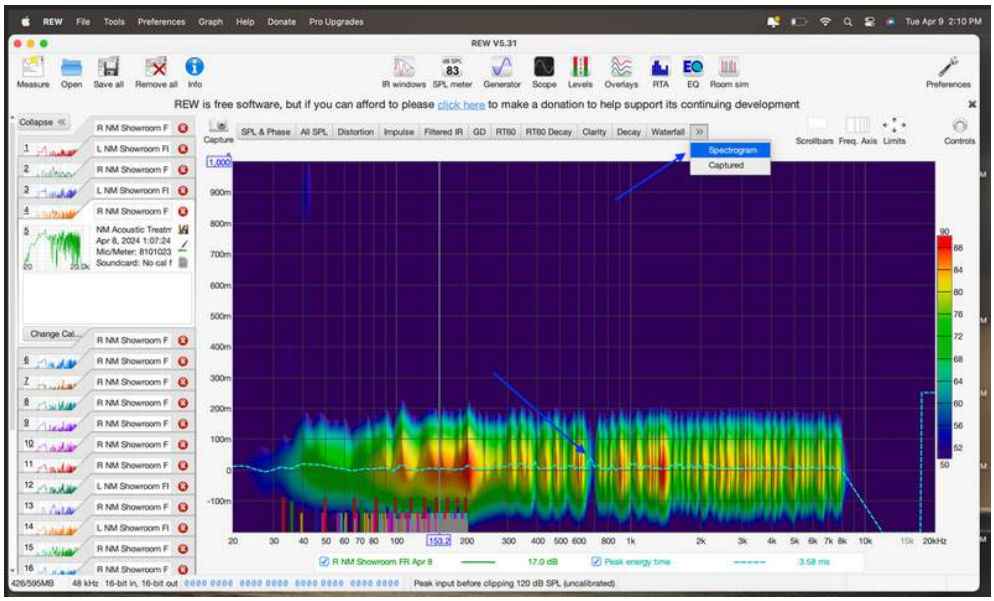


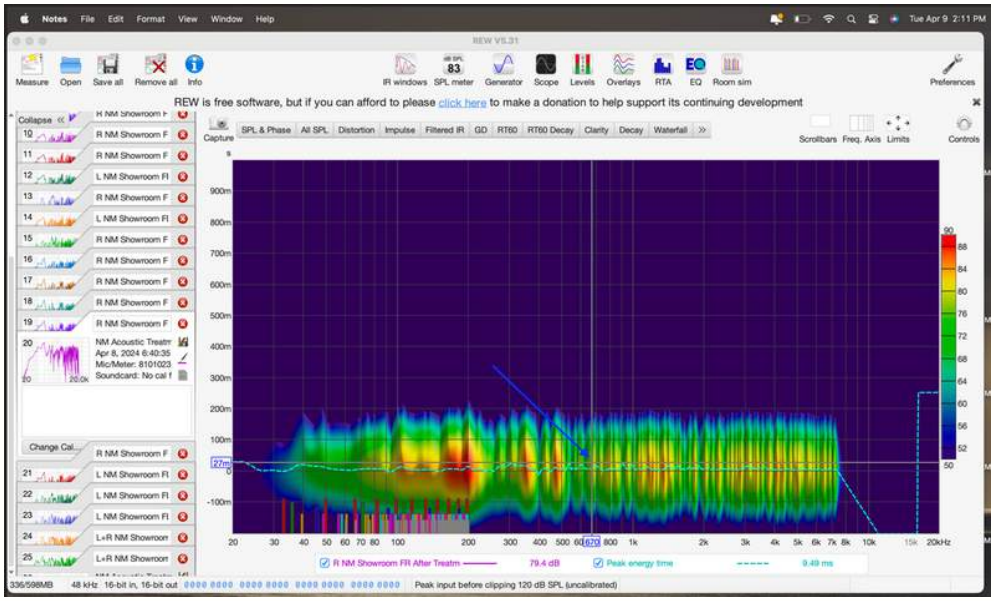
If we compare screen shot 1 above to screen shot 2 we see that in screen shot 1 before applying acoustic treatment our mid to high frequencies reverberate till atleast 240ms. In screen shot 2 after applying acoustic treatment our longest reverberation time decreases to around 210 ms and the reverberation time across the frequency spectrum above 150hz is much more uniform. This lets us know we have less ringing and late reflections in the room.

⏩ Spectogram:

Using the same measurements of a single speaker in the room as above, click on the Spectrogram tab. The Spectrogram is another way of viewing the same results which we find in the Waterfall graph.

Select the measurement in the left side of the REW software. Choose the Spectrogram tab as shown in the screen shot below.





Again if we compare Screenshot 1 with Screenshot 2, we see the peaks evident in Screen shot 1 which is the response without acoustic treatment, around the 670hz range. In screenshot 2 the peaks are reduced and we have a much smoother more even decay after applying acoustic treatment.

References Used:

Andreas Melcher, Software Developer, Amcoustics.com
Markus Mehlau, Multimedia Consultant and Developer, Mehlau.net
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