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Era 100 Pro

Our first solution designed for professional installation

SONOS

Hall 2, 2F800

Low Frequencies Optimization

Using Acoustic Treatment and One (or More) Subwoofers

Donato Masci - www.studiosoundservice.com
Jorge Castro - www.artnovion.com

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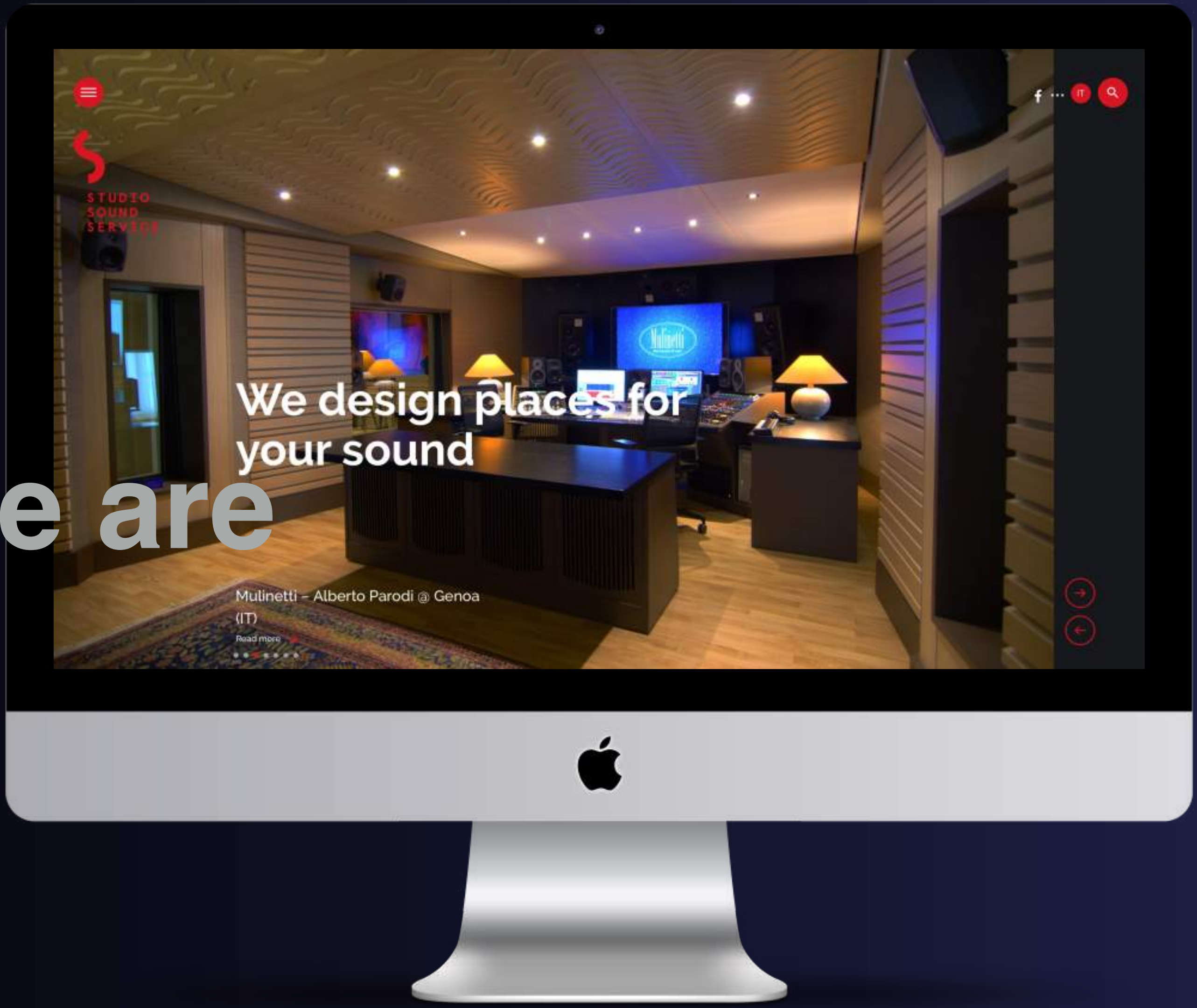
Who we are



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Donato Masci

Studio Sound Service – Team

Studio Sound Service is a well-established design and consultancy company that specialises in every aspect of acoustics and sound systems.

Founded in 1983
SSS has built an enviable reputation for the production of world class performance and recording spaces, from personal studios to large scale film, broadcast and corporate facilities.

By combining aesthetic and technical skills with decades for experience SSS strives to make every project successful, both sonically and visually.

ADR, Post & Broadcast. Cinema Mixing studios. Gaming Studios.

- Iyuno (ex SDI Media) Acoustic Designers (more than 15 countries)
- Cinecittà Studios (Postproduction Facility 2020 Renewal) @ Rome
- Dubbing Brothers (Italy, USA)
- 3Cycle postproduction Facility @ Rome
- FOX Dolby Atmos Studios @ Rome (IT), Münich (DE), London (UK)
- Netflix Facility @ Rome
- Disney Facility @ Warsaw (PO), Milan
- inHouse (Oscar winner Sorrentino) @ Roma

Music Studios (400+)

- Cicaleto Recording – Francesco Ponticelli @ Arezzo
- Aemme Recording Studio – Salvatore Addeo @ Lecco
- D:POT Recording Arts @ Prato – Fabrizio Simoncioni
- Mulinetti Studio @ Genova – Alberto Parodi
  Resolution Award 2015 Best Audio Facility
- The Garage @ Civitella v.d.C. (AR)
  Resolution Award 2014 Best Audio Facility
- House of Glass @ Viareggio (LU) – Gianni Bini
  Resolution Award 2013 Best Audio Facility
- SonicFab Studio @ Pioltello (MI)
- Waves Music @ Genova
- Marco Borsatti Studio @ Bologna
- Pop Fiction – Janie Price @ Firenze
- Sugarmusic @ Milano
- Experimental Studios @ Torino

Dolby Atmos Music Studios: 50+ rooms
Dolby Atmos Home Entertainment Studios: 80+ rooms
Dolby Atmos Theatrical Studios: 10+ Theatres

Personal Studios:

- Andrea Bocelli, Asaf Avidan, Biagio Antonacci, Daniele Silvestri, Damian Lazarus, Diego Calvetti, Enrico Cremonesi (Fiorello), Enrico Melozzi, Fabio Rovazzi, Federica Vincenti (Michele Placido), Gabry Ponte, Giorgia Angiuli, Irko (Kanye West sound engineer), Luca Agnelli, Marco Masini, Marco Messina (99 Posse), Merk & Kremont, Nari&Milani, Paolo Sandrini, Petra Magoni, Piero Pelù, Pino Iodice, Renato Zero, Vinai.

- Barys Arena (ice hockey) @ Astana, Kazakhstan
- Chorus Life (arena e cittadella) @ Bergamo
- Stadio Tardini @ Parma

- Hospitals: Nuovo Ruggi @ Salerno, Cesena

- George Lucas Home Theater, Italy
- Cinema Barberini @ Roma

- Chiesa Santa Maria Nuova (Arch. M. Botta) @ Terranuova B. (AR)
- Duomo di Siena new audio system

- Prada Auditorium and Conference Room via Orobia @ Milano
- Presentation room Ferrari HQ @ Maranello (MO)
- Siemens HQ @ Milano
- Heineken HQ @ Milano
- Leonardo Elicotteri @ Milano

- Four Seasons Hotel @ Firenze
- Portrait Milano – Ferragamo @ Milano
- Caffè dell'Oro – Ferragamo @ Firenze
- Hotel Veronesi (Calzedonia) @ Verona

- EVAC Dubai Metro
- EVAC Bahrain and Islamabad airport (THALES)
- EVAC Scuola di Magistratura Castelpulci @ Scandicci Firenze

- Teatro del Popolo @ Castelfiorentino (FI)
- Teatro del Popolo @ Colle di Val d'Elsa
- Teatro del Popolo @ Poggibonsi
- Teatro il Ferruccio @ Empoli
- Teatro Marconi @ Pistoia
- Teatro Nazionale @ Firenze

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Countries where we operate

Paesi in cui siamo attivi

Countries where we operate

Bahrain
Canada
China
Czech Republic
Denmark
Dubai
Finland
France
Germany
Hong Kong
Hungary
Italy
Kazakhstan
Mexico
Netherlands
Oman
Pakistan
Poland
Russia
Saudi Arabia
Spain
Switzerland
Thailand
Turkey
UK
USA

Studio Sound Service is the only Italian Dolby CSP.

We can provide design, commissioning and consultancy services worldwide with Dolby's certified quality standards.

Dolby
Certified service partner

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CEDIA associated

CEDIA®

MEMBER 2024 - 2024

Studio Sound Service Srl

Industry-Related Professional

CEDIA Members are smart home professionals providing comfort, control, connection, and entertainment for clients to experience the best moment in life in their homes.

The Association for Smart home Professionals™

CEDIA Member Code of Conduct

Each member of CEDIA shall agree to adhere to the following:

1. Provide to all persons truthful and accurate information with respect to the professional performance of duties.

2. Maintain the highest standards of personal conduct to bring credit to the custom electronic and design industry.

3. Promote and encourage the highest level of ethics within the profession.

4. Responsibly uphold all laws and regulations relating to CEDIA policies and activities.

5.Strive for excellence in all aspects of the industry.

6. Use only legal and ethical means in all ndustry activities.

7.Protect the public against fraud and unfair practices.

8.Use written contracts clearly stating all charges, services, products and other essential information.

9. Demonstrate respect for every professional within the industry by consistently performing at or above the standards acceptable to the industry.

10. Make a commitment to increase professional growth and knowledge by participating in technical and industry business training.

11. Contribute knowledge to professional meetings and journals to raise the professionalism of the industry.

12. Maintain the highest standards of safety

13. When providing services or products, maintain in full force adequate or appropriate insurance.

14. Cooperate with professional colleagues, suppliers and employees to provide the highest quality service.

15. Extend these same professional commitments to all persons supervised or employed.

16. Subscribe to CEDIA's Code of Ethics and abide by the CEDIA Bylaws.

Learning Objectives

Session Learning Objectives:

- **understand the importance of low-frequency acoustic treatment for a critical listening room**
- **know the pros and cons of placing more or less subwoofers in a room and understand the critical issues that can be encountered**
- **be able to suggest to the customer, depending on his budget, a correctly balanced acoustic and electroacoustic solution**
- **bridging professional and consumer applications**

Question to answer

Questions:

- what is the most suitable number of subwoofers for reproducing low frequencies in a room?

Problem with the answer!
it depends on…:

- it heavily depends on the intended use

  Studios: it's more important to optimize the single listening point, so it's better to work with a single source.

  Home cinemas: it's more useful to have a uniform distribution, even at the expense of other listening qualities.

Technical Acknowledgments

Technical-scientific supervision and Comsol® simulations were carried out in collaboration with:

Dr. Valentina Cardinali, PhD
Head of Research, B&C Speakers

B&C GROUP

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Professional background

Professional vs Consumer Audio: Core Differences

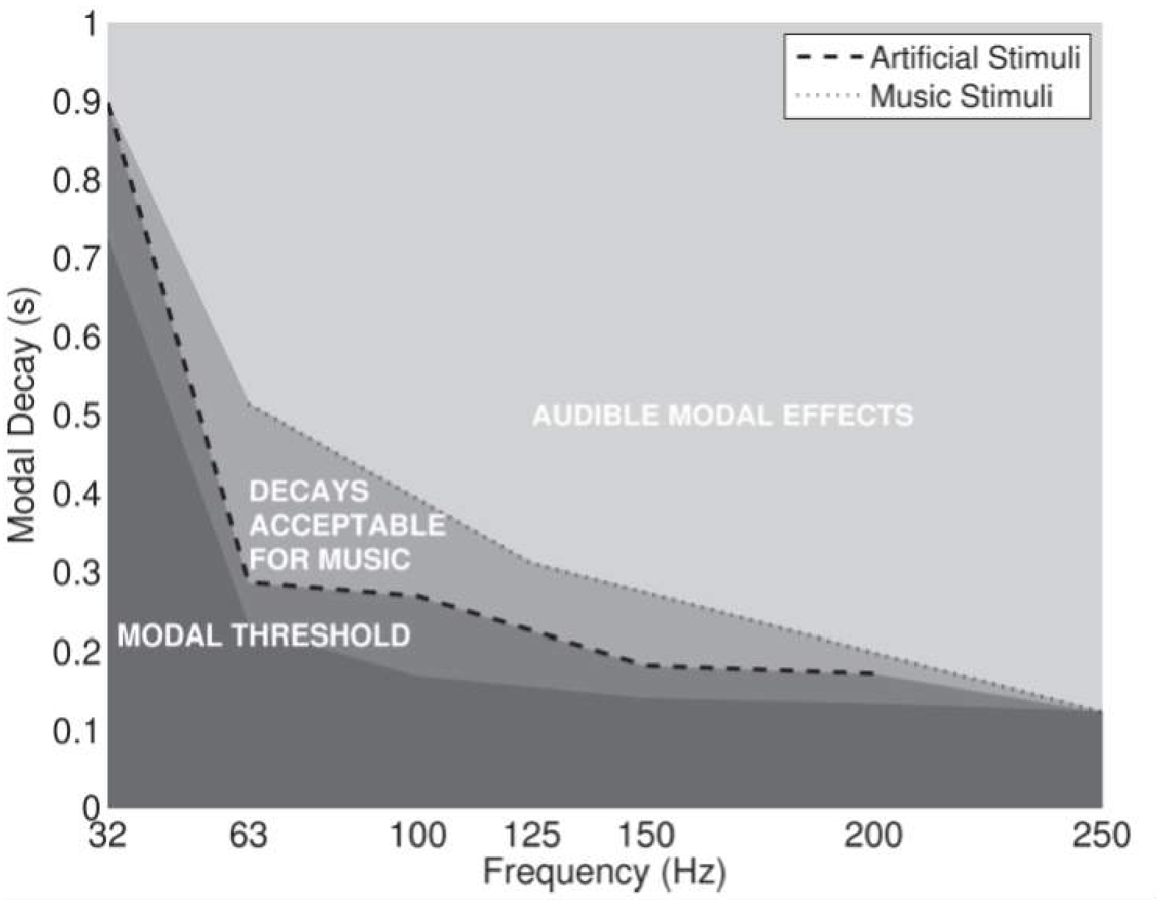
1. Professional Audio:

- Single-user optimization and precision at listening position
- Acoustic solutions over electronic correction

2. Consumer audio:

- More emphasis on room-wide uniformity
- Electroacoustic correction and active absorption are highly valued (try to reduce traditional acoustic treatment)

Perception limits of LF reverberation



Perception limits of low-frequency reverberation (by Bruno Fazenda)

- **The Chart shows the limits of perception of modal decay for various sound sources under controlled laboratory conditions. The absolute limits are in effect the point where further reduction in decay time by acoustic or other means would be futile.**
- **The critical frequency would seem to be 63Hz and resonant decay above that is noticeable if longer than 0.2s. Above 250Hz modes become reverberation which is more likely to be significant in terms of spatial awareness. Below 63Hz modal decay can increase exponentially to almost 1s at the limit of our hearing.**
- **It is logical that reverberation control should match as closely as possible the threshold for modes as basically they are the same thing but with different distribution.**

Optimal Reverberation times

They depends on the intended use:

Recording: Dubbing studios (ADR)

1. have a neutral tonal coloration
2. not to exceed the low frequency modal perception threshold

- LF reverberation time 0.30÷0.35s
- HF flat reverberation time 0.10÷0.15s

Dolby Atmos Home Entertainment
(Where broadcast and TV contents are mixed and post produced)

- LF reverberation time 0.35÷0.45s
- HF flat reverberation time 0.15÷0.30s

Dolby Atmos Cinema Mixing Room
(Where movies are mixed)

- LF reverberation time 0.40÷0.80s
- HF flat reverberation time 0.20÷0.40s

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Cinecittà Sala A

Roma

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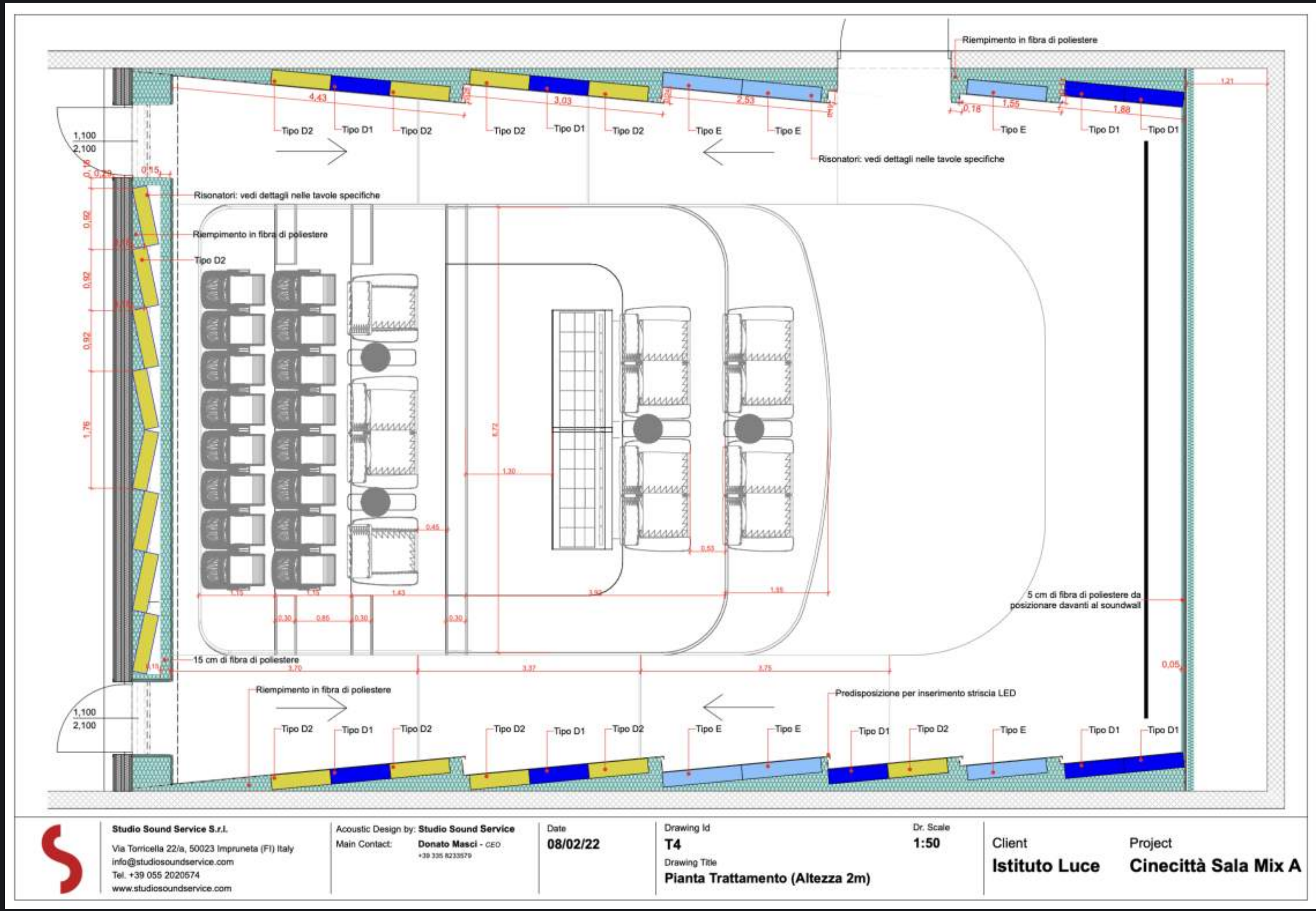
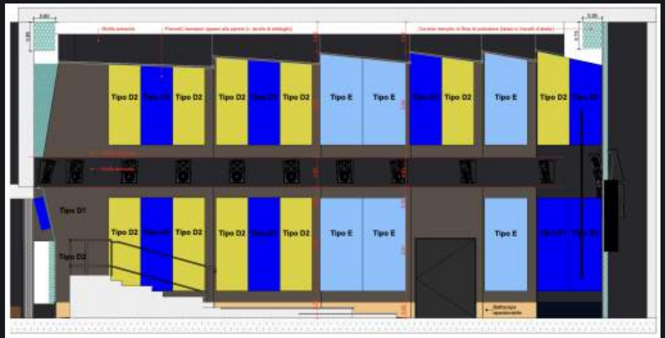
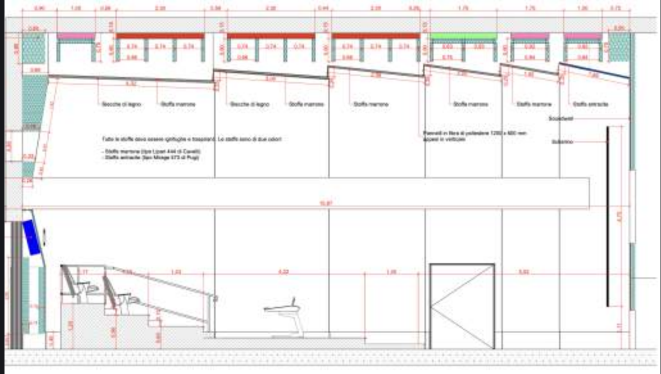
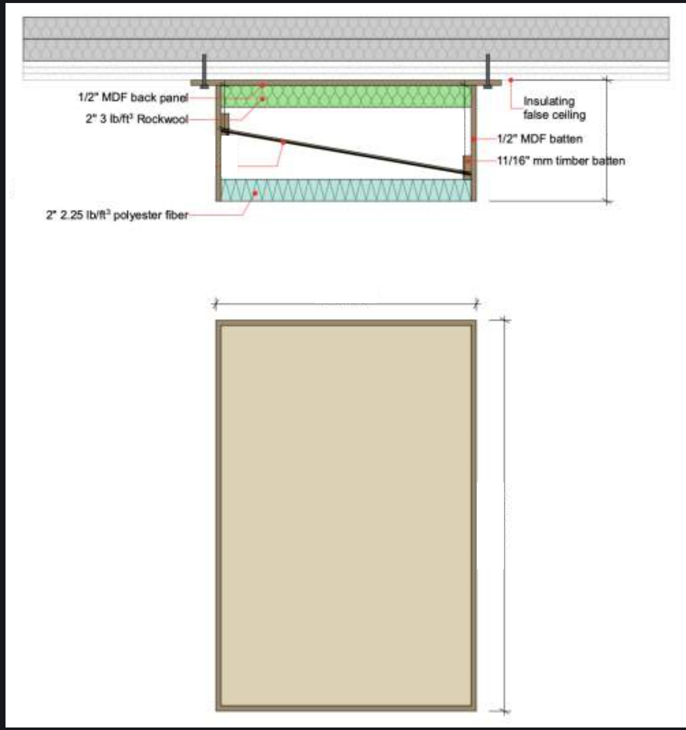
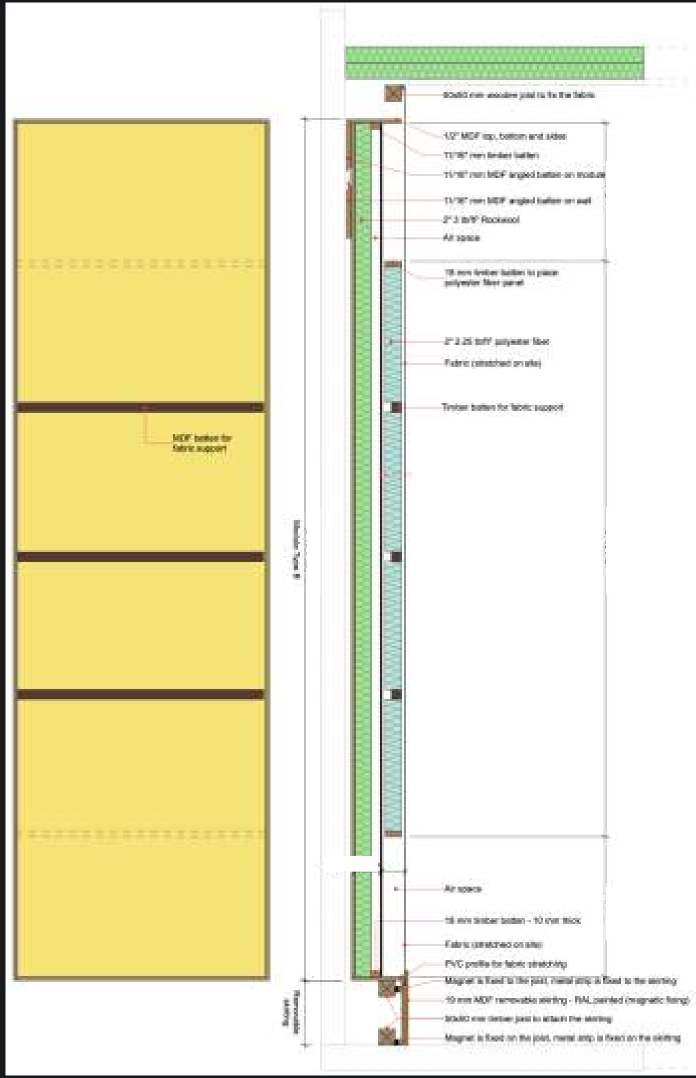


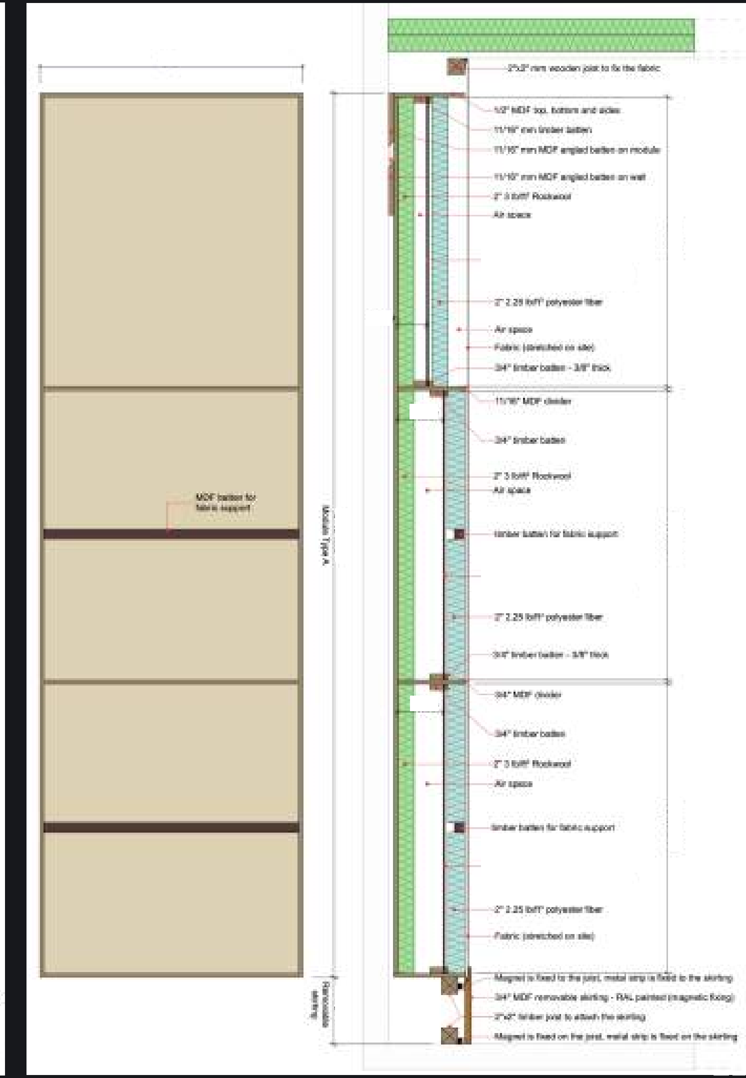




Low Frequency Absorption







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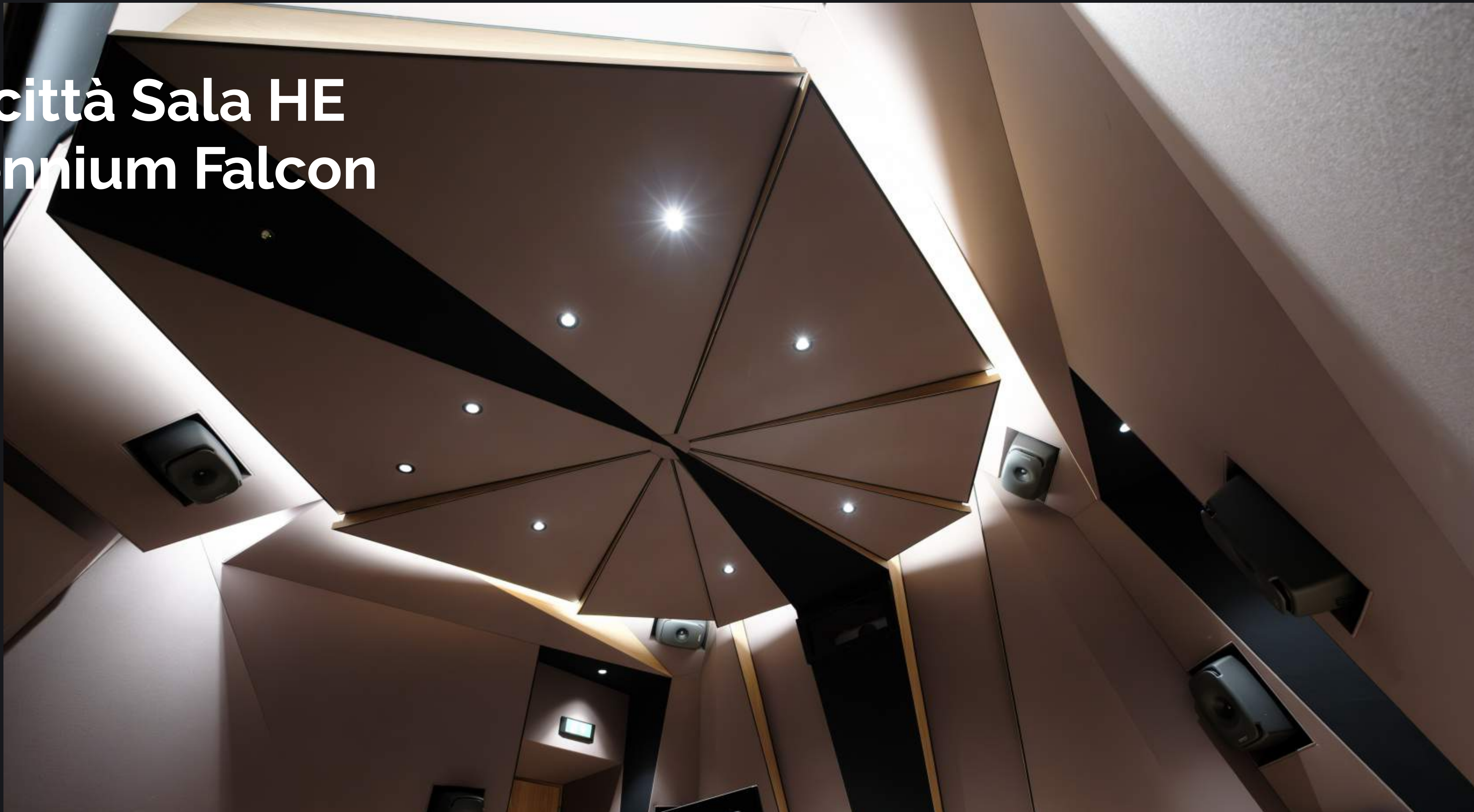
Cinecittà Sala HE
Millennium Falcon

Roma



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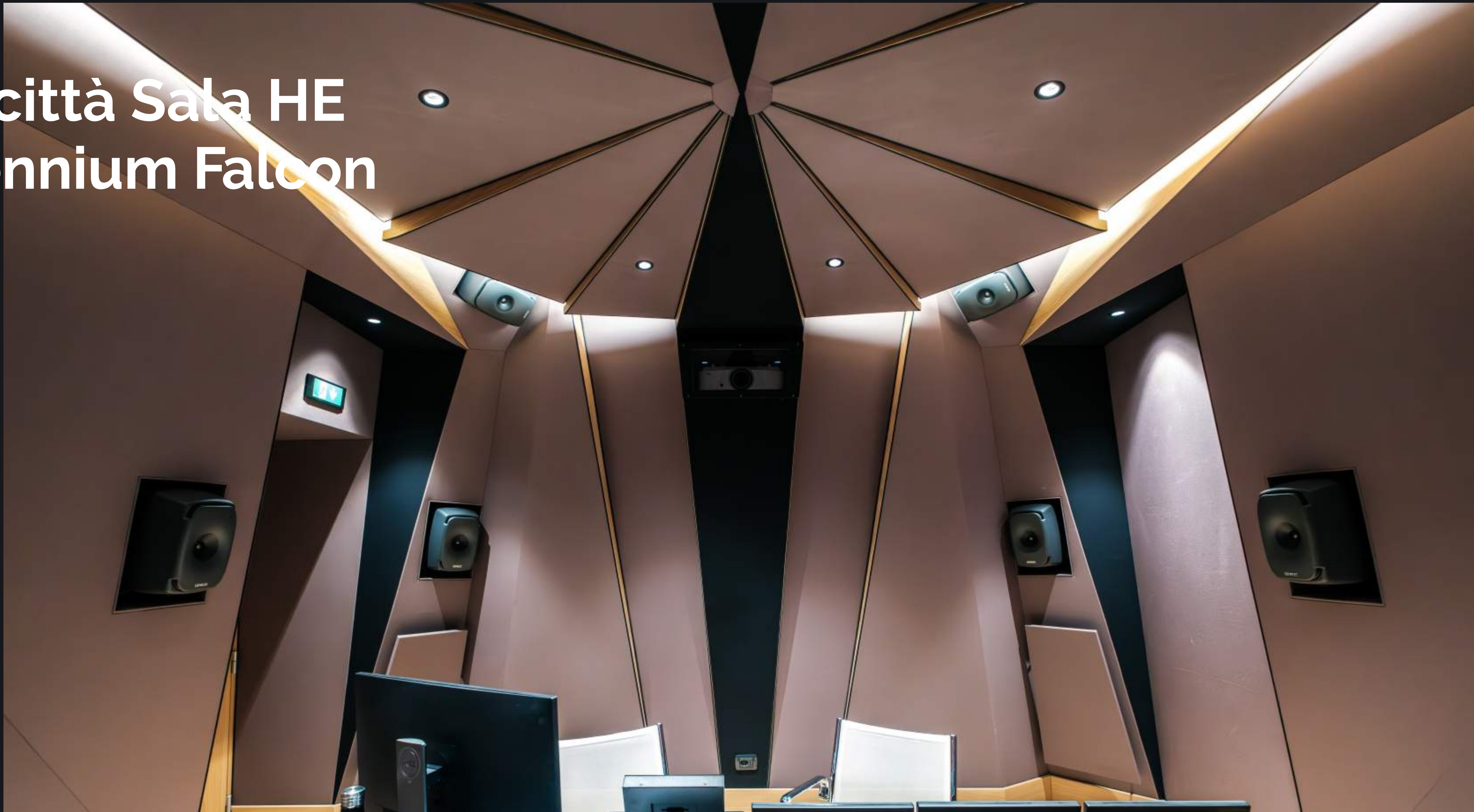
Cinecittà Sala HE
Millennium Falcon

Roma



Marco Borsatti Studio

Bologna

Marco Borsatti Studio

Bologna

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Acoustic Treatment with suspended panels

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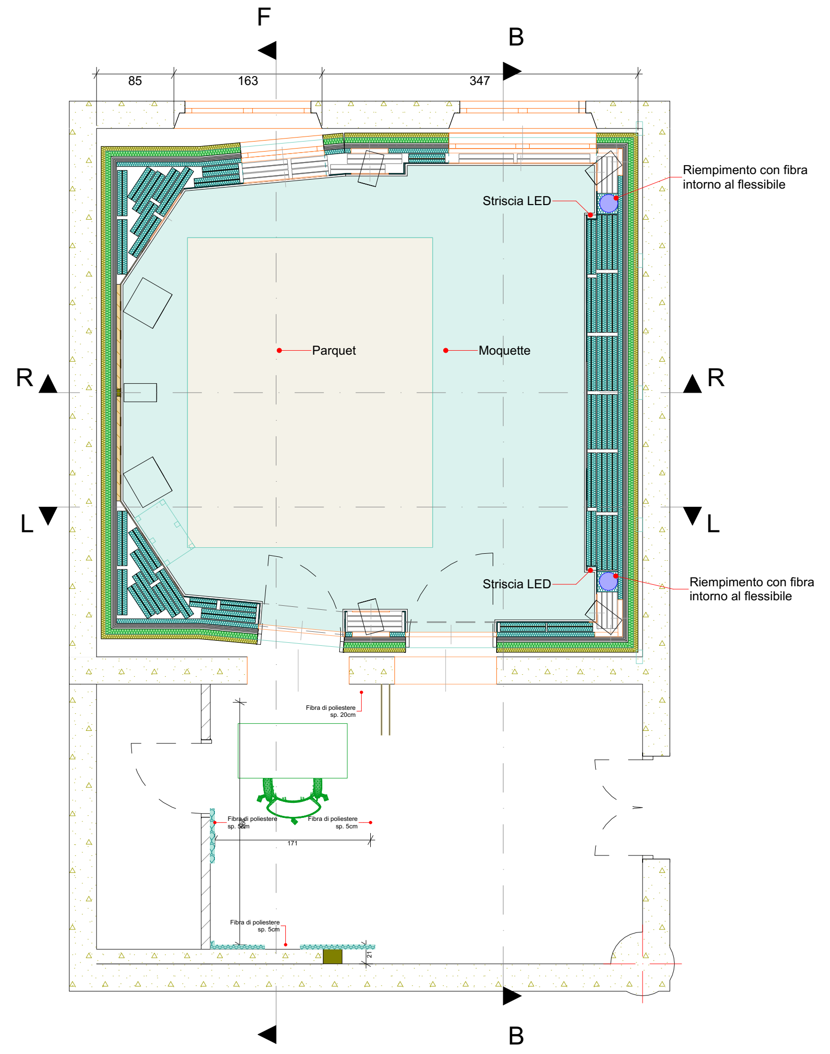
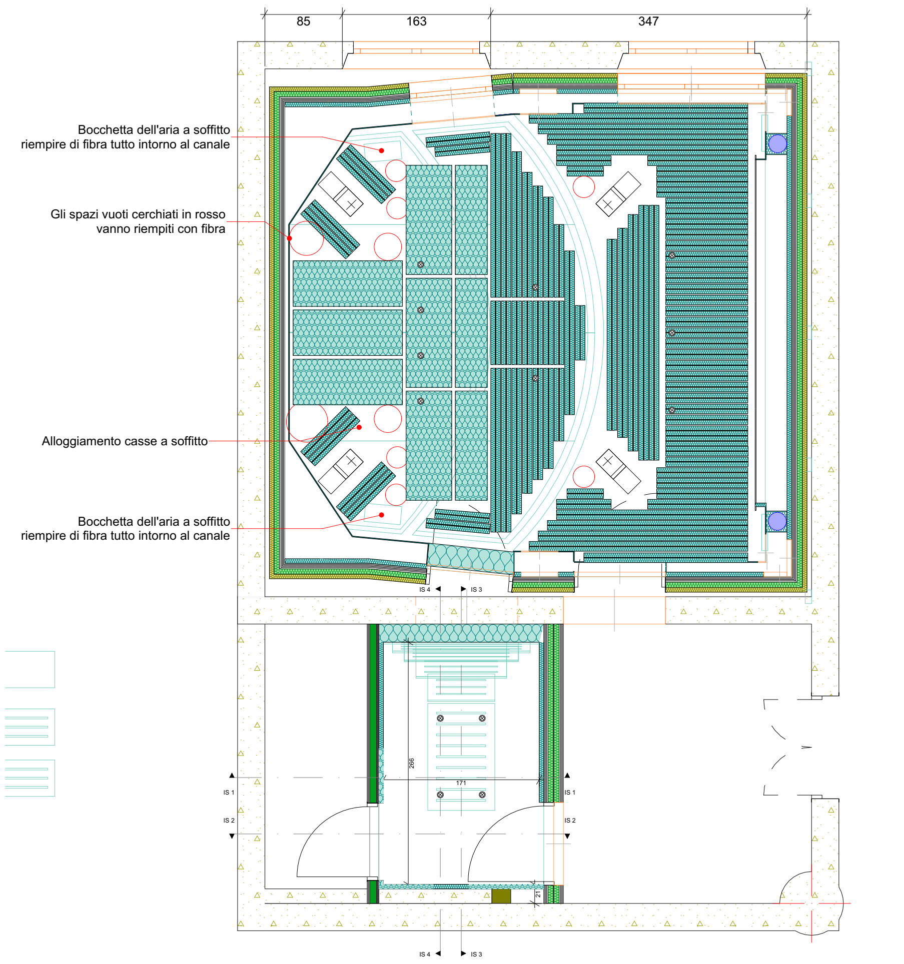


Treatment Layout 1:50



Treatment Ceiling 1:50

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Tel. +39 055 2020574
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Acoustic Design: **Studio Sound Service**

Date	Drawing Number	Title	Dr. Scale	Client	Project
08/06/2023	**9 /4**	**Treatment** Layout	**1:50**	**Marco Borsatti**	**Studio Borsatti**
Revision **Definitive**					

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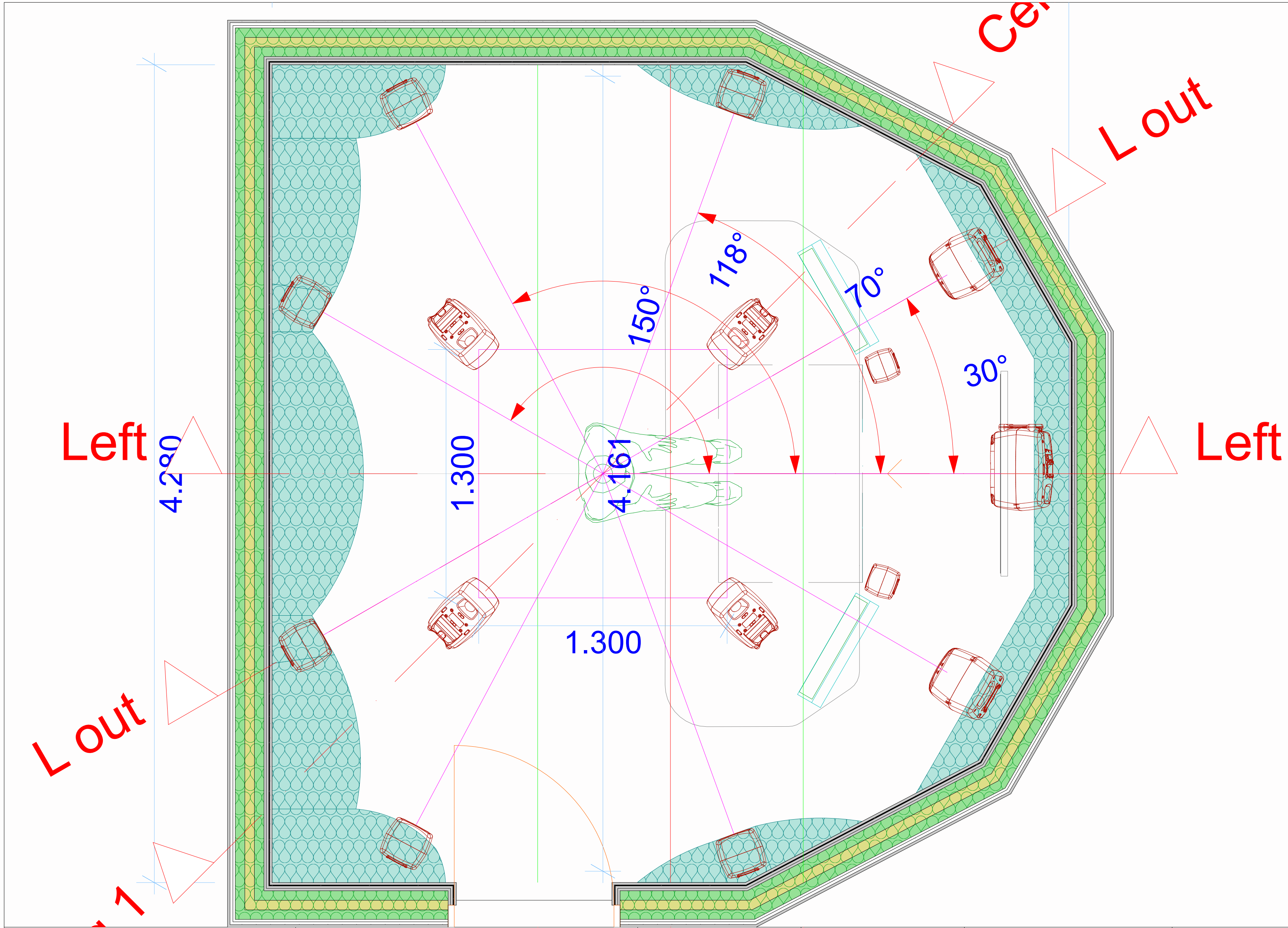
FOX Studio



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Thank you very much for understanding.

9.1.4

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2018
Fox Networks IT

9.1.4 Dolby Atmos
Home Entertainment

Fox Networks Group Italia

FOX international Channels
Via Salaria 1021, Roma - Italy

Acoustic Design by:

dott. Donato Masci
Via Torricella 22/a, Impruneta (FI) - 50023 Italy
+39 335 8233579, donatomasci@gmail.com
T.C.A.A. 447/95 n.184 (FI)

ing. Cecilia Torracchi
+39.333.8628738
c.torracchi@gmail.com

Drawing Name: Floor	Drawing Scale: 1:20
Drawing Status	Layout ID: Tav.00

- Polyester Fiber 40 kg/m³
- Mineral wool 50 kg/m³
- Mineral wool 90 kg/m³
- Wood
- Concrete

Proaudio Consulting Srl
Via IV Giugno 36 – 47899 Serravalle - RSM
Project Manager: Francesca Bianco
Tel. +378 0549 941536 +39 333 7020564
info@proaudioconsulting.it
www.proaudioconsulting.it

FOX Studio

FOX - NatGeo DE

München, DE

FOX - NatGeo UK

Hammersmith, London UK

Room Design: Treatment Strategy

...Perfect Absorber?

The perfect absorber doesn't exist, but fortunately it's not necessary to achieve perfect silence…

it would be sufficient to reach a value close to the perception threshold!

This is true for professionals, so why it couldn't be true for the consumer world?

Porous Absorber (velocity)

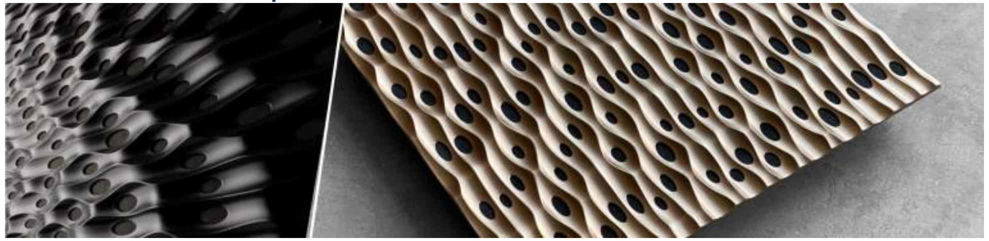
Wools, extruded materials etc.

Membrane Resonator (pressure)

Panel absorber

Helmholtz Resonator (pressure)

Perforated panel



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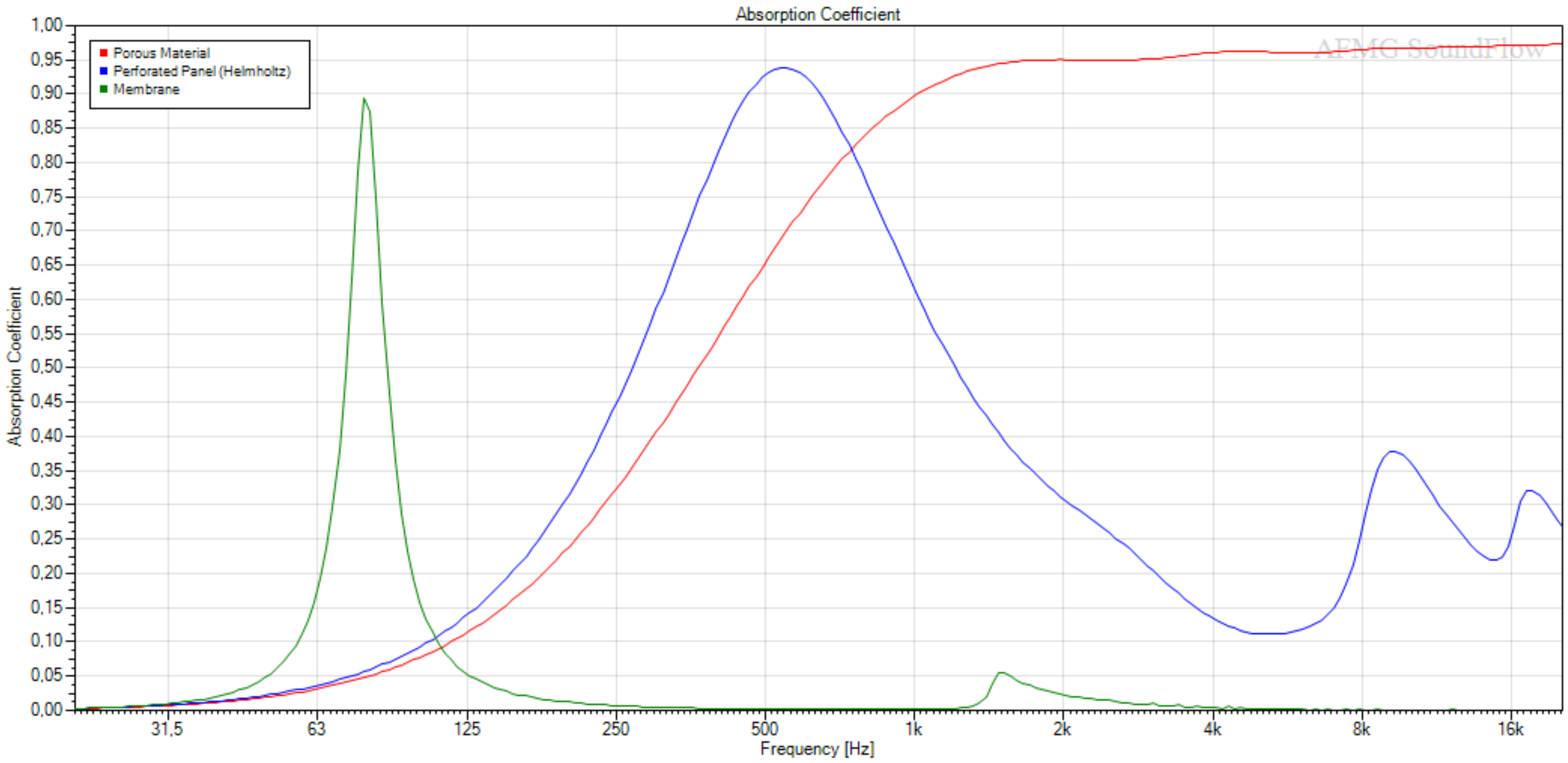
Acoustic Treatment Strategies



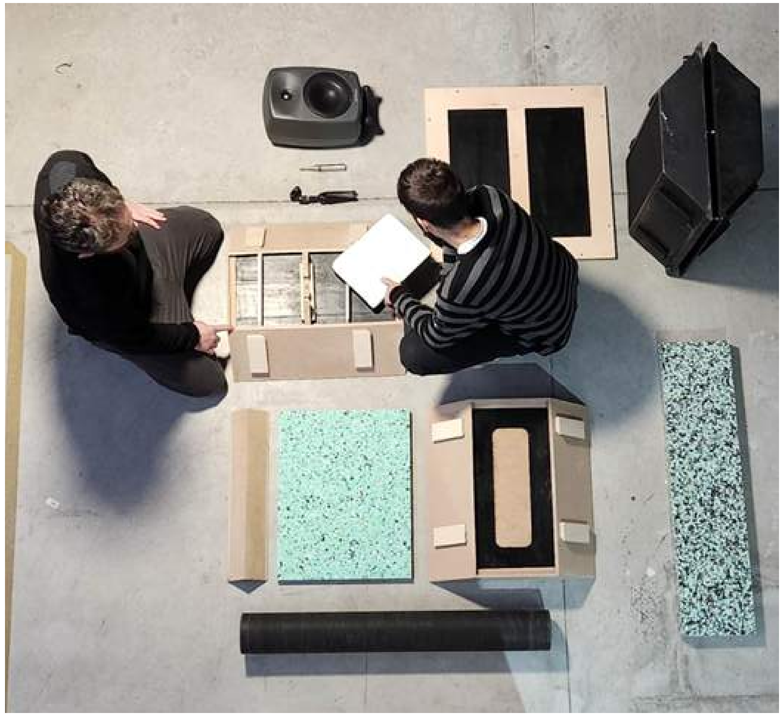
- **Below 100-120 Hz: Membrane absorbers**
- **100÷250 Hz: Helmholtz resonators**
- **Above 250 Hz: Porous materials**

Membrane Absorbers

The resonant frequency is determined by the following criteria:

- Enclosed volume characteristics;
- Membrane characteristics (area, mass, stiffness);

$$f = \frac{\sqrt{\dfrac{\dfrac{1.21 \times c^2}{V} \times A^2}{m}}}{2\pi}$$



Tunable Pistonic Diaphragmatic Absorber (TPDA)

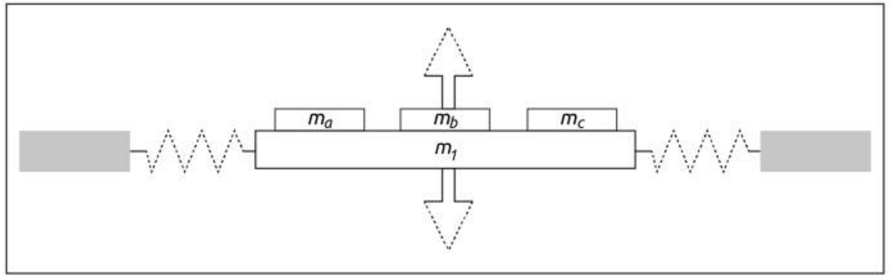
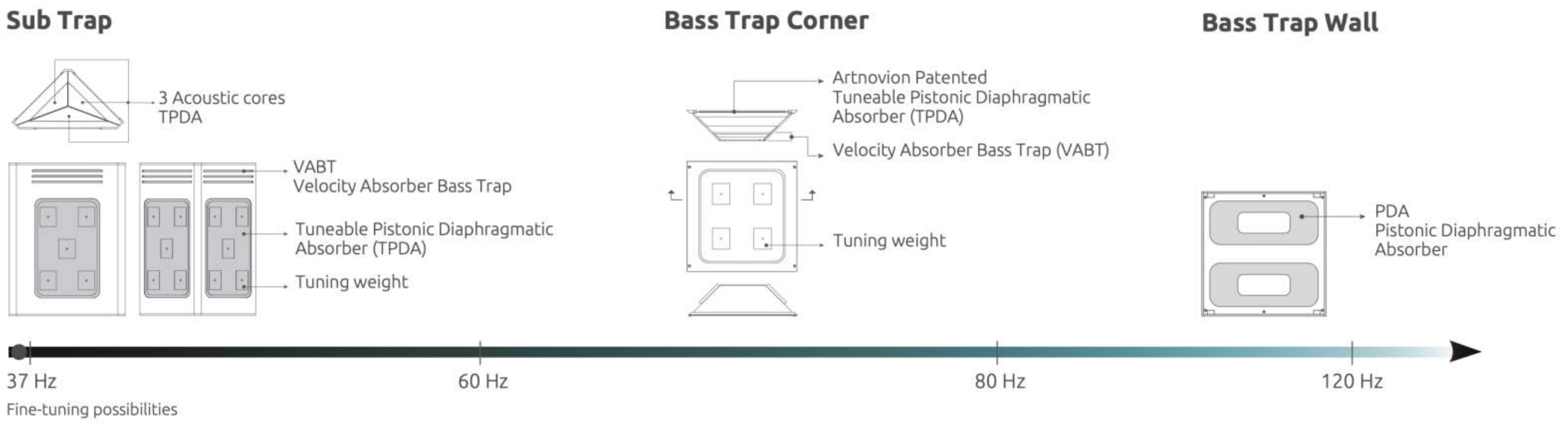


Figure I: The diaphragm schematics show Total mass = $m_1 + m_a + \ldots + m_i$

Artnovion Low-Frequency Absorbers



Diaphragm Movement

How to evaluate the diaphragm movement?

- Displacement
- Velocity
- Resonant Frequency
- Working Range

Laser Doppler Vibrometer

Measurement of mobility with the LDV, highlighting the tuning frequency of the absorber.

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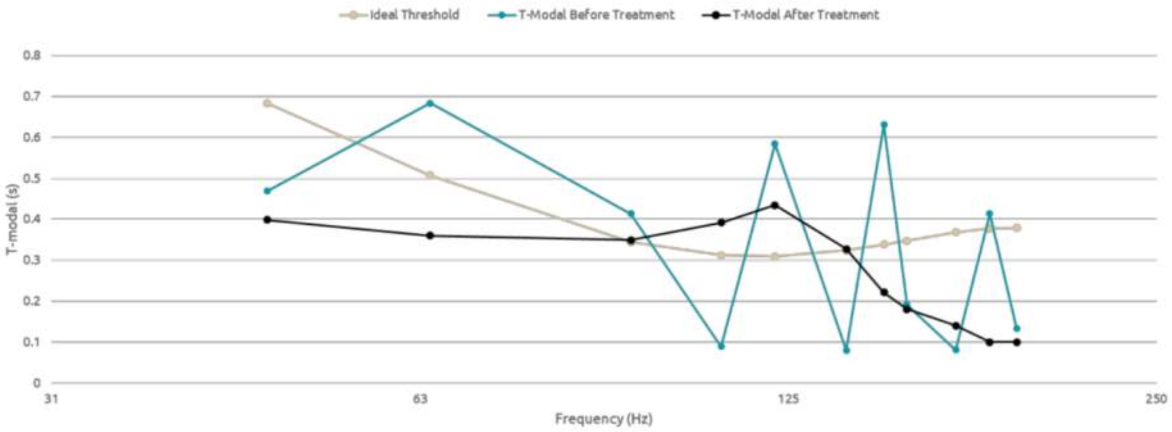
Case Study - Cedofeita Studio (Porto)

Main Goal: Achieve a balanced room acoustic environment that would facilitate music production, mastering and recordings.
Acoustic Analysis: Identified low-frequency control as the critical factor for improvement
Solution: Tunable Membrane Absorbers (Artnovion's TPDA range)*



Before Treatment

After Treatment

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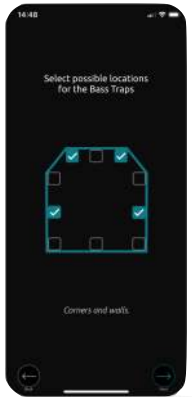
*Ideal Threshold from "Perceptual Threshold for the Effects of Room Modes as Function of Modal decay" (by Fazenda B., et al.)

Who can do this?

Everybody! We aim to democratize acoustics, making it accessible to everyone

Soon it will be available an update to the Impulso app that will help address your room's modal issues.



- **Measure the room response at key locations (pressure zones and possible BT placement areas).**
- **Use the new algorithm to identify the most problematic frequencies based on T-modal values and the Ideal Threshold*.**
- **Recommend the most suitable product (type, quantity, and tuning).**
- **Presented in a user-friendly interface, requiring no advance expertise**

*Ideal Threshold from "Perceptual Threshold for the Effects of Room Modes as Function of Modal decay" (by Fazenda B., et al.)

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Room Acoustics: Key Challenges and Solutions

1. Dual Nature of Problems:

- Room modes
- Loudspeaker boundary interactions
  —> Complex interweaving of both issues

2. Simulation Limitations:

- Difficulties in accurately modeling combined effects
  —> Need for practical, proven solutions

3. Absorption Strategy:

- Use of proven, specific absorption designs
  —> Preference for broadband vs single-frequency solutions
  (contradiction with common HiFi industry claims)

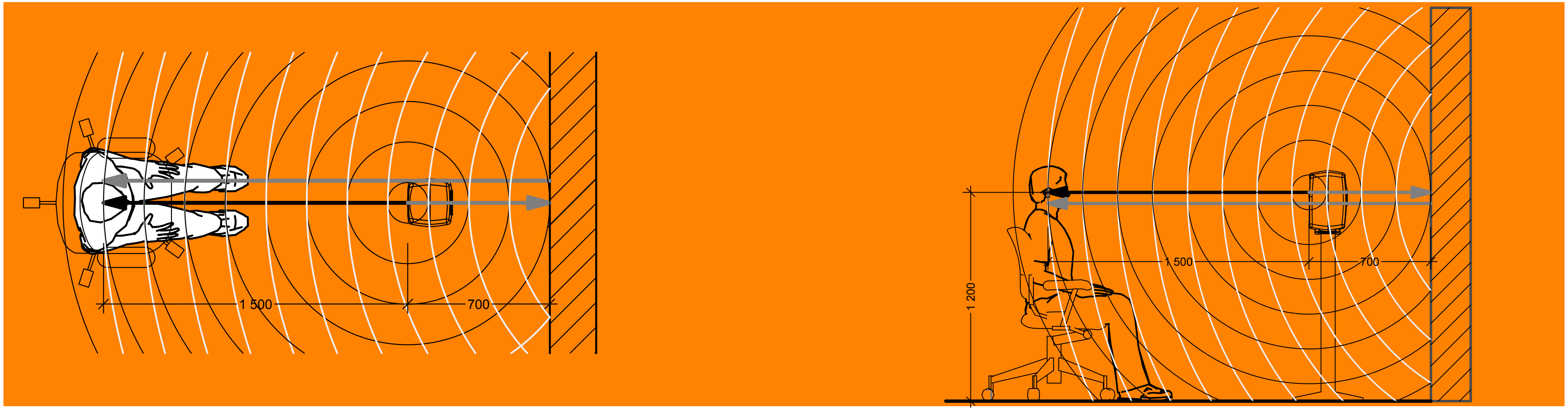
4. Loudspeaker Boundary Issues:

- Most problematic acoustic challenge
- More prominent in dry acoustic fields
  (critical impact of floor/wall interactions)

Room Modes vs. Loudspeaker/boundary effects

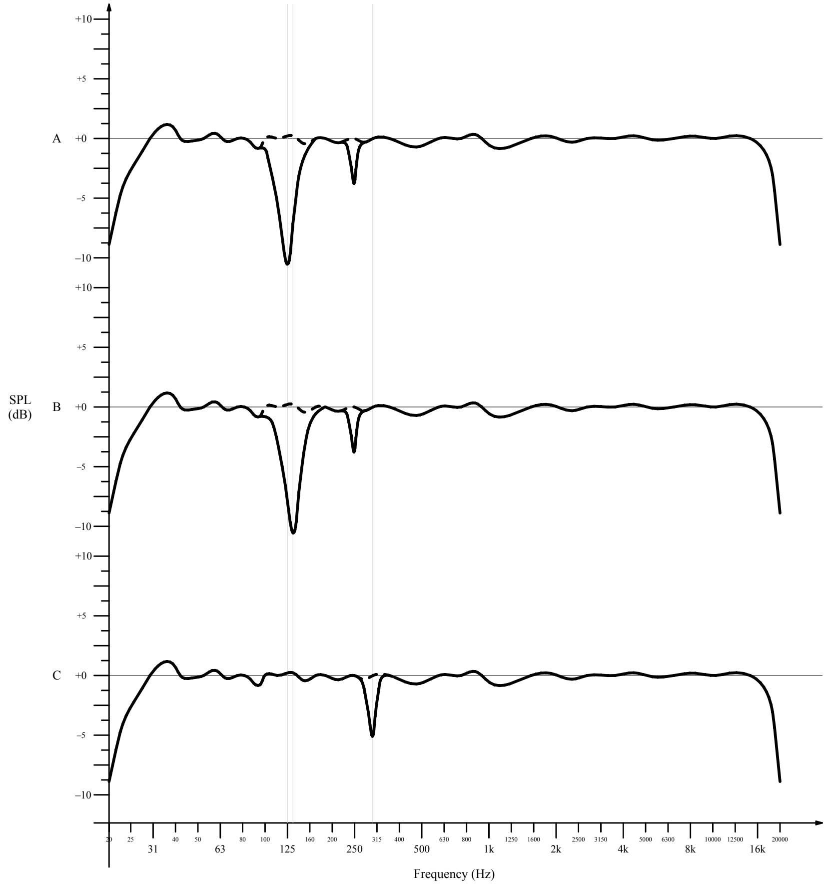
A dip in the frequency response can be caused by positioning in a resonance mode minimum or by a loudspeaker-boundary effect

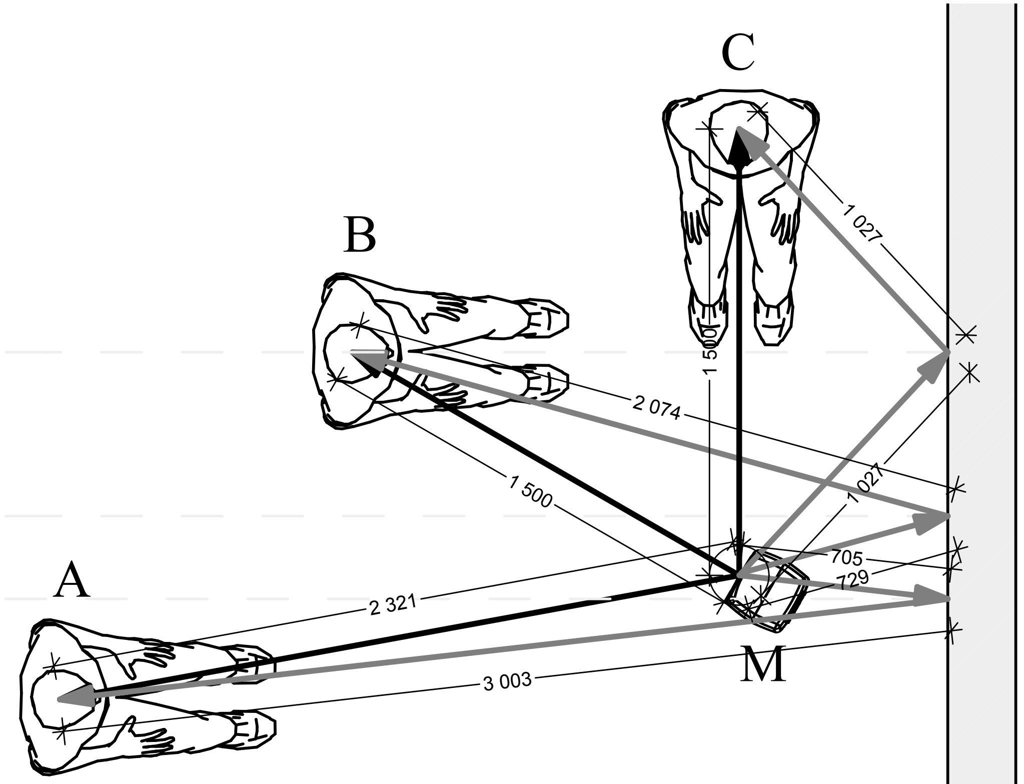
Room modes create maximum and minimum pressure zones, but loudspeaker-boundary interactions create very strong phase cancellations.



Non-minimum phase effect

Room Modes vs. Loudspeaker/boundary effects





Non-minimum phase effect

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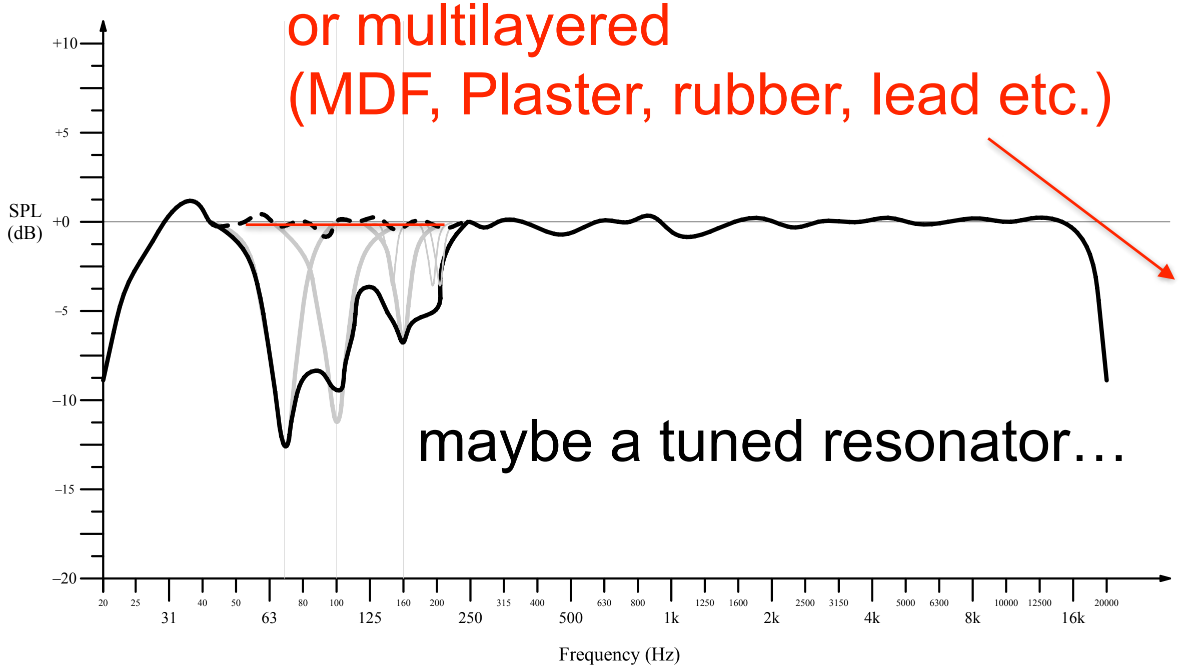
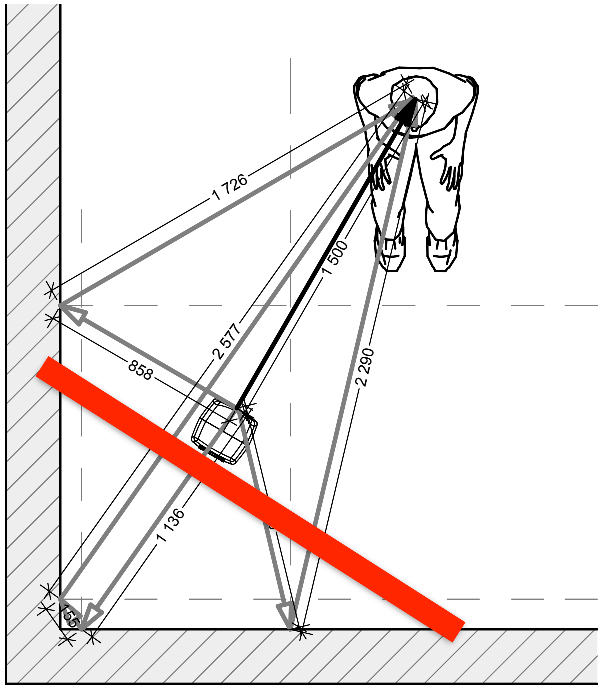
Non minimum phase effects

Solid (concrete, masonry)
or multilayered
(MDF, Plaster, rubber, lead etc.)



maybe a tuned resonator…



Non-minimum phase effect

Active Absorption: Insights and Limitations

1. **Basic Principles**
   - **Real-time** sound detection and cancellation
   - Highly effective at **very low frequencies**
   - Immediate room response changes
   - Source-independent operation

2. **Technical Limitations**
   - **System stability issues** *(feedback challenges)*
   - Frequency-dependent effectiveness:
     - Excellent up to 80Hz
     - Increasing complexity above (>120Hz)
     - Multiple mode challenges

3. **Implementation Challenges**
   - Multiple sensor requirements
   - Room mode considerations: *Axial/Tangential/Oblique*
   - Cost escalation

4. **Key Learnings**
   - **Similar behavior to passive systems**
   - Higher costs
   - Greater instability
   - Limited broadband effectiveness *(crossover with acoustic treatment???)*

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FEM Simulations VS Measurements

R&D Program

In this section, we will explain our R&D program aimed at optimizing the design and low-frequency treatment for small critical listening rooms
(applicable to both recording studios and home theaters).

1. **Method**
   - Acoustic impedance estimation using Magalotti-Cardinali's method
   - Variables (surface impedances)
   - Strategic measurement points selection
2. **Measurements in the SSStudio**
   - Source placement in corner to excite room modes
3. **Post-processing**
   - MT60 calculations using decay time estimation
4. **Modeling**
   - Comsol room model creation
   - Acoustic impedance implementation and validation
5. **Simulations**
   - Different Subwoofer configurations
   - Acoustic treatment configurations

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1. Method

Conference Paper | PDF Available

A simulation test bench for decay times in room acoustics

October 2018

Conference: COMSOL Conference 2018 · At: Lausanne (Switzerland)

Authors:

Roberto Magalotti
Bowers & Wilkins

Valentina Cardinali
B&C Speakers

We used the procedure from Roberto Magalotti and Valentina Cardinali's paper: [“A simulation test bench for decay times in room acoustic”]

to indirectly estimate the acoustic impedance of the walls with COMSOL®,

and we calculated it using a Mathematica® tool

1. Method - Notes

MT60 formula:
4 equations, 4 β

$$MT_{60,N} = \frac{6\ln(10)}{c}\frac{V}{\sum_j \epsilon_{N_j}\beta_j S_j}$$

Notes on situation complexity:

1. MT60 evaluation was complicated by the empty room being highly reflective, but not as much at low frequencies due to the <u>resonant behavior of drywall</u>

2. The room has small dimensions and similar width and height, creating <u>degenerate modes</u> that are difficult to isolate in the FR

Additional note: in the final result, this calibration was equally well approximated by an <u>average β</u> calculated from this calibration

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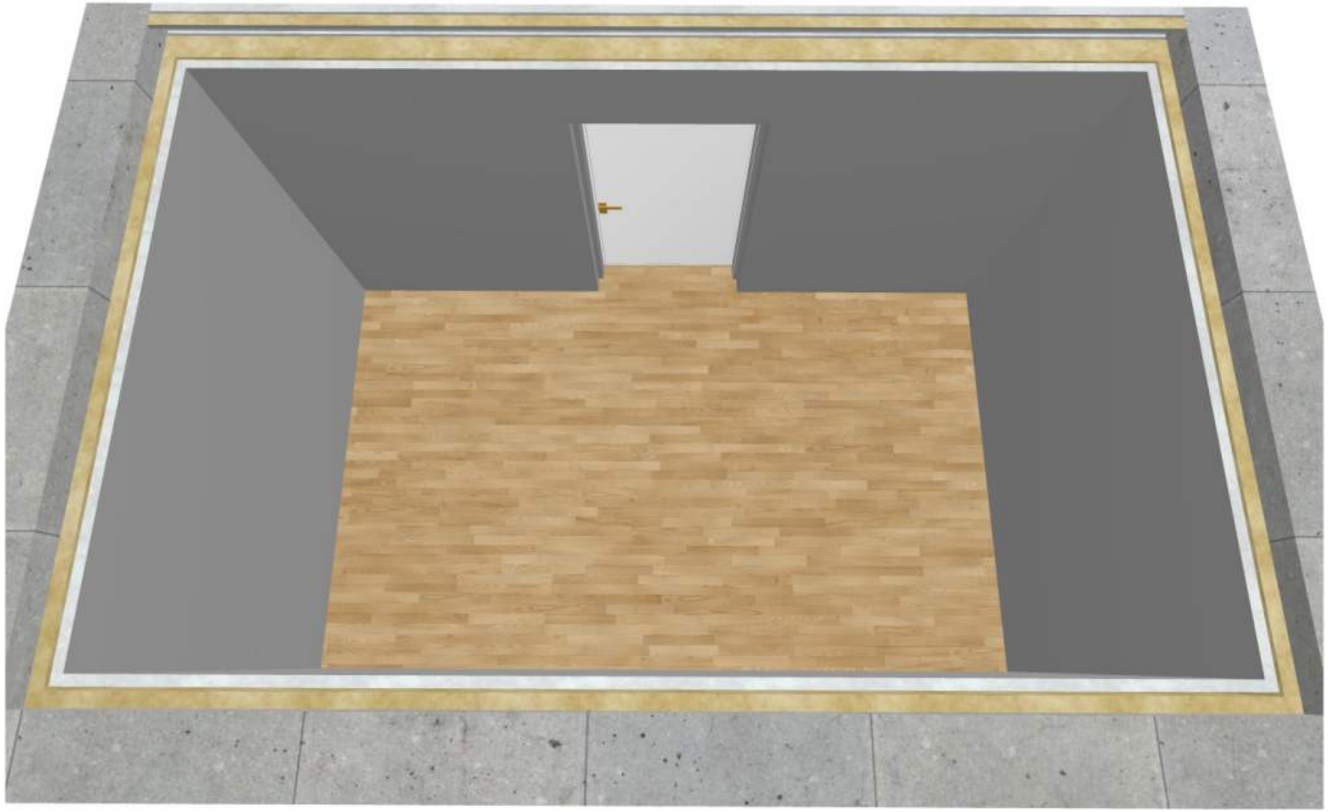
1. Method - Variables

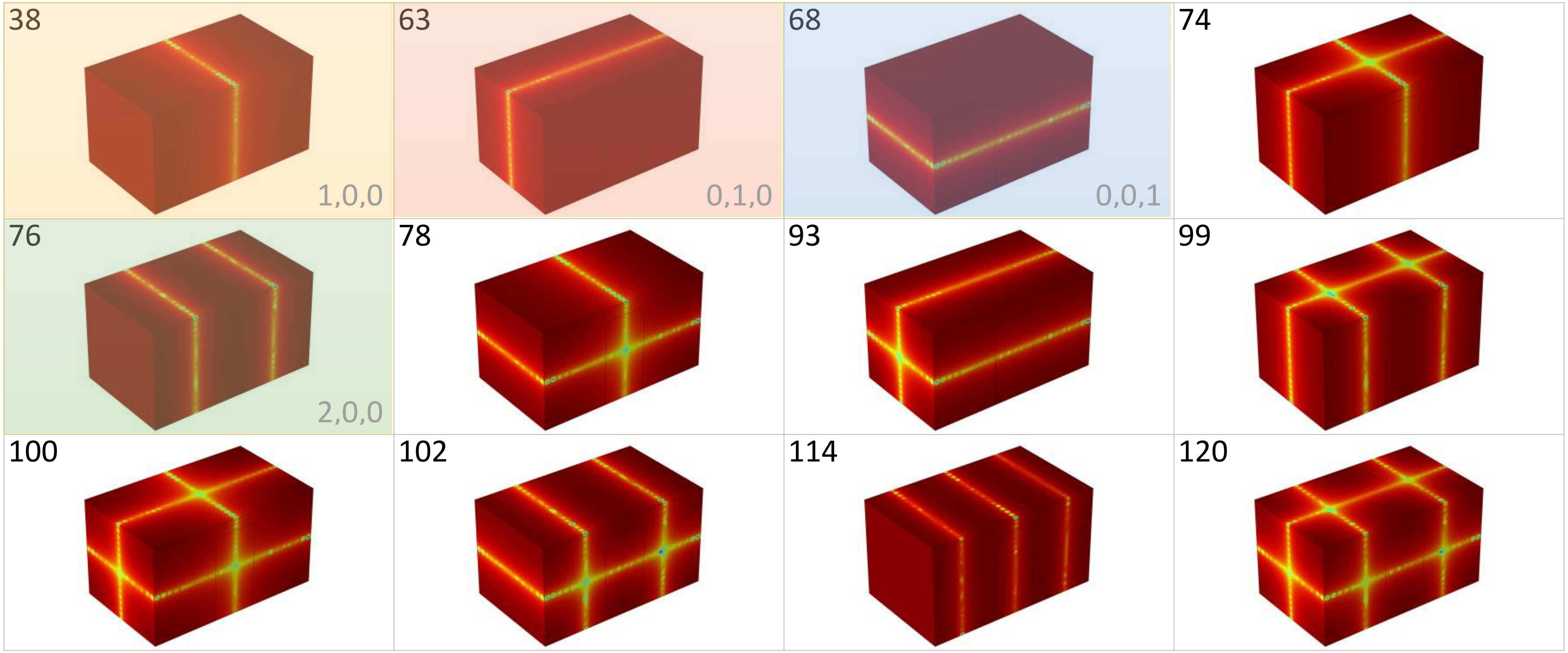


We determined the number of unknown variables in the room (different impedances):

- 3 false walls against concrete
- ceiling and floor
- 1 door
- 1 drywall partition

We need to choose 4 room mode in order to have
4 equations and
4 unknown variables

1. Method - Room modes



1. Method - Factor ε

$$\epsilon_{N_j} = \langle {\phi_N}^2 / \Lambda_N^0 \rangle_{S_j}$$

Eigenfrequency (Hz)	epsPAV_N	epsSOFF_N	epsRETRO_N	epsLATSX_N	epsLATDX_N	epsFRONTE_N	epsPORTA_N
4.0014E-6-4.0714E-7i	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
38.219	1.0000	1.0000	1.0000	2.0000	2.0000	1.2423	0.093896
63.722	1.0000	1.0000	2.0000	1.0000	1.0000	2.0000	2.0000
67.988	2.0000	2.0000	1.0000	1.0000	1.0000	1.0353	0.86818
74.304	1.0000	1.0000	2.0000	2.0000	2.0000	2.4847	0.18779
76.438	1.0000	1.0000	1.0000	2.0000	2.0000	0.82456	1.6559
77.994	2.0000	2.0000	1.0000	2.0000	2.0000	1.2456	0.081522
93.182	2.0001	2.0001	2.0001	1.0000	0.99999	2.0706	1.7364
99.516	1.0000	0.99999	2.0001	2.0001	2.0001	1.6492	3.3120
100.72	2.0001	2.0001	2.0001	2.0000	2.0000	2.4914	0.16305
102.30	2.0001	2.0001	0.99999	2.0001	2.0001	0.88295	1.4377
114.66	0.99999	0.99999	0.99999	2.0002	2.0002	1.0886	0.66858
120.53	2.0002	2.0002	2.0002	2.0002	2.0002	1.7660	2.8755
127.45	0.99996	0.99999	2.0003	0.99999	0.99997	2.0003	2.0003
131.18	0.99999	0.99997	2.0002	2.0004	2.0004	2.1775	1.3373
133.06	0.99996	0.99998	2.0004	2.0000	2.0001	2.4851	0.18783
133.30	2.0002	2.0002	0.99996	2.0004	2.0004	1.1122	0.58047
135.98	2.0004	2.0004	0.99998	0.99992	0.99996	1.0244	0.90876
141.25	2.0005	2.0005	0.99996	2.0000	2.0000	1.2446	0.085337
144.45	2.0002	2.0002	2.0005	0.99997	0.99997	2.0711	1.7368
147.76	2.0003	2.0003	2.0003	2.0006	2.0006	2.2247	1.1610
148.62	0.99995	0.99999	2.0006	2.0004	2.0003	1.6496	3.3129
149.42	2.0003	2.0002	2.0006	2.0000	2.0001	2.4921	0.16310
150.18	2.0006	2.0006	2.0002	0.99995	0.99991	2.0491	1.8178
152.89	0.99994	0.99996	0.99987	2.0005	2.0006	0.99133	1.0325
154.97	2.0007	2.0007	2.0002	1.9999	2.0001	2.4896	0.17070
156.00	2.0007	2.0007	0.99995	2.0003	2.0004	0.86493	1.5048
163.44	2.0003	2.0003	2.0009	2.0005	2.0004	1.7666	2.8765
165.64	0.99996	0.99990	2.0003	2.0009	2.0010	1.9828	2.0654
167.33	2.0004	2.0003	0.99979	2.0010	2.0009	1.0278	0.89662
168.52	2.0010	2.0010	2.0002	2.0004	2.0004	1.7302	3.0100
171.45	0.99994	0.99989	2.0009	2.0008	2.0009	2.1783	1.3378
177.89	2.0012	2.0011	0.99986	2.0009	2.0009	1.1049	0.60765
179.06	2.0004	2.0003	2.0004	2.0013	2.0013	2.0557	1.7931
184.45	2.0003	2.0004	2.0012	2.0010	2.0011	2.2258	1.1616
186.39	2.0013	2.0014	2.0012	1.0002	0.99953	2.0501	1.8185
188.97	2.0015	2.0014	2.0003	2.0012	2.0010	2.2102	1.2156

We built the model in COMSOL® and performed **eigenfrequency analysis** to determine the modal participation factor *ε* of each surface.
We did not rely on the uniform rectangular room model because we had a door, which represents an impedance non-uniformity.
Surfaces have a higher participation factor where the mode has maximum pressure points.

ε represents a form of modal intensity on the surface

- Modal participation factor of the surface
- ε is a two-index factor Nj that relates to a mode and a surface:
each surface of the room contributes to modifying the single mode with its own epsilon weight.
- Indeed, in a perfectly rectangular room these values follow simple patterns
- for example, the door that is halfway along the long side doesn't contribute at all to the main mode because at that point the pressure is zero, while it does contribute to other modes.

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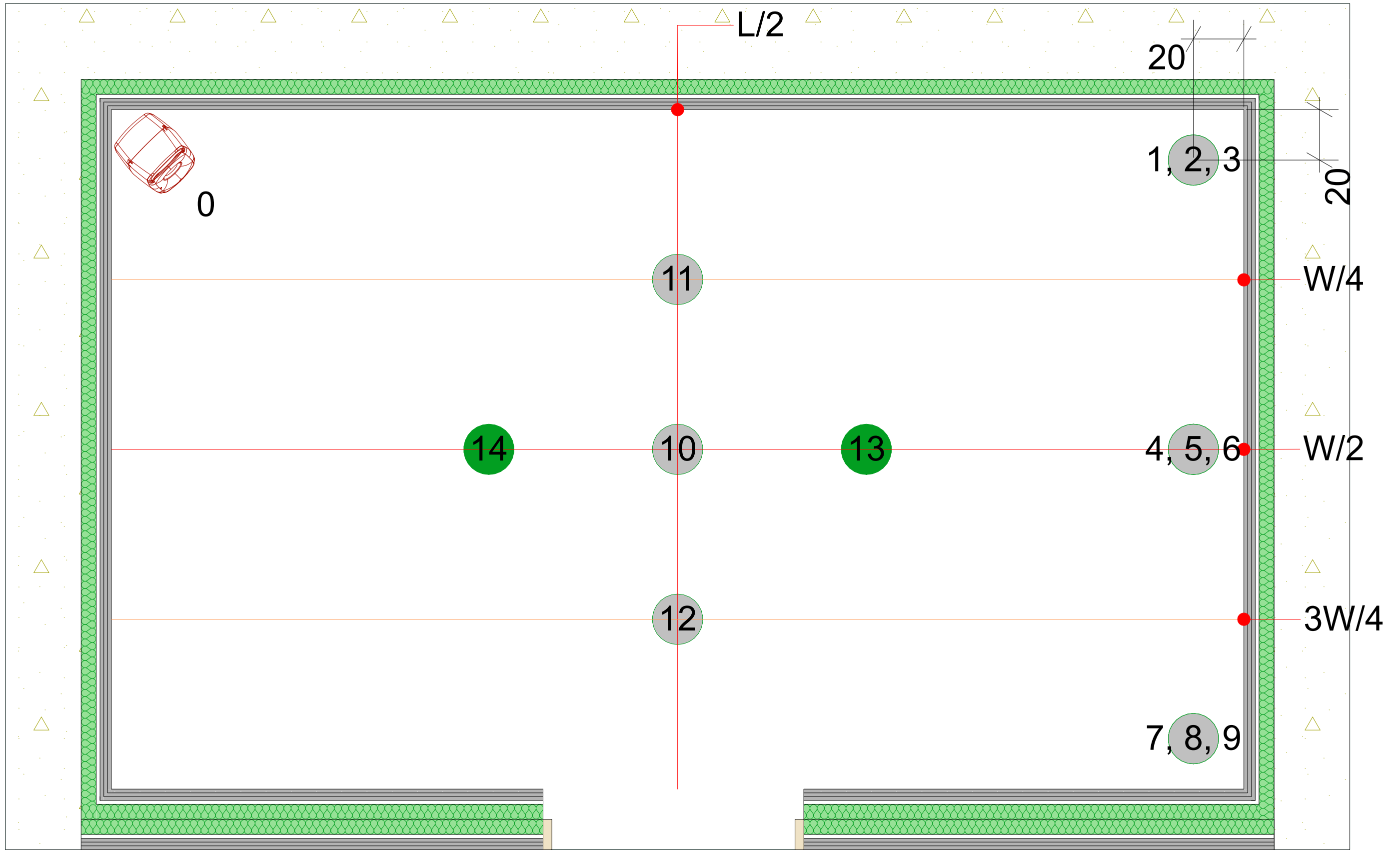
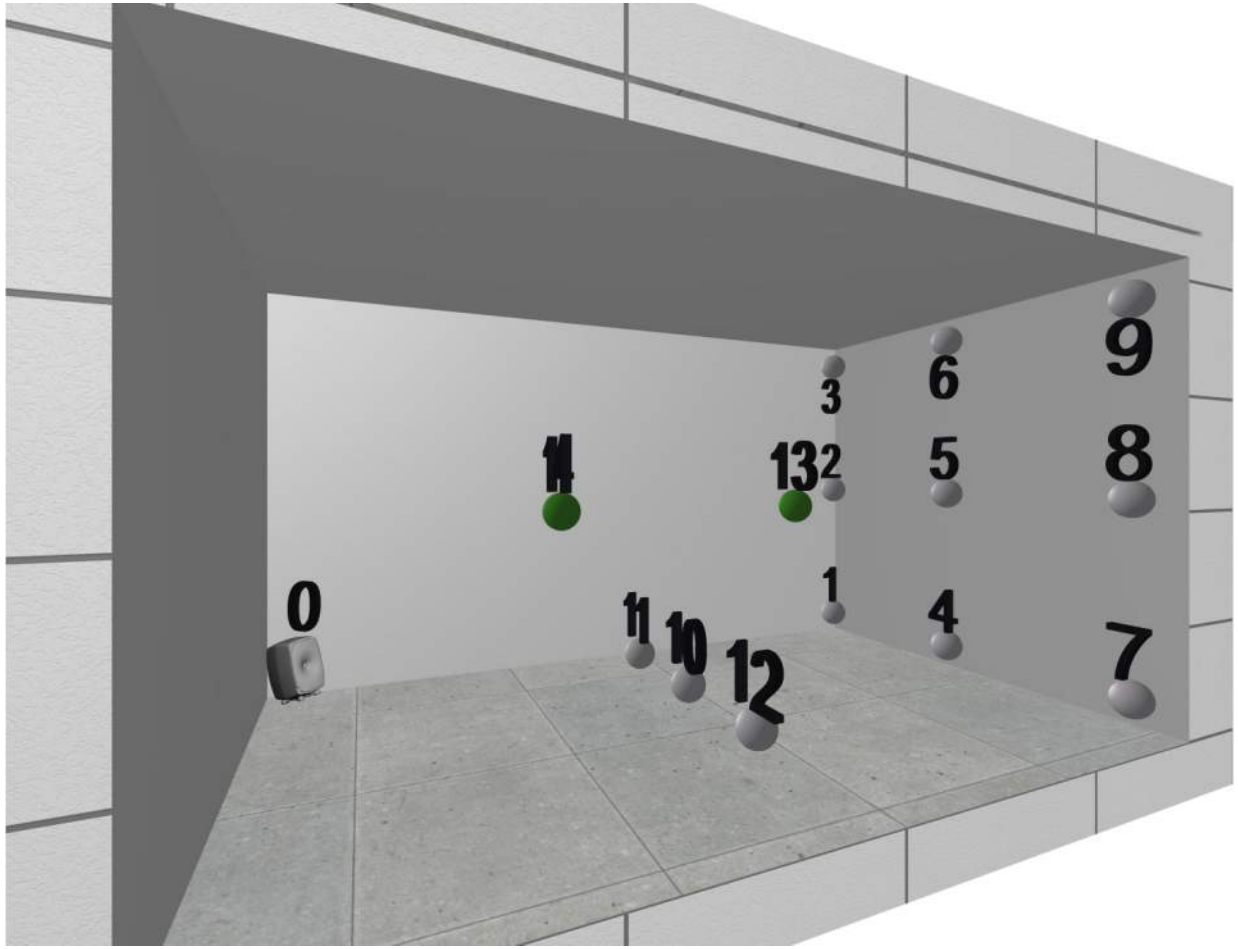
2. Measurements in the SSStudio



1. **We chose to place the source in a corner in order to excite all room modes**

2. **We decided to place the measurement points in strategic positions to get a complete representation of the first modes for room calibration.**

2. Measurements in the SSStudio



Points were selected

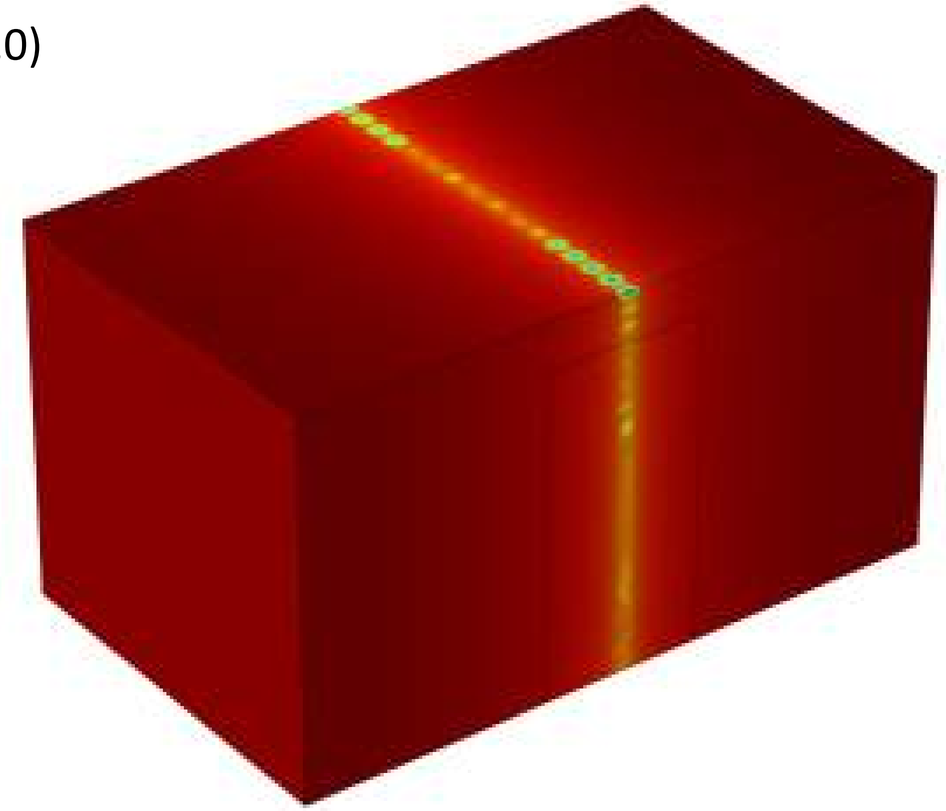
1. on the back wall (9 points)
   - 4 in the corner (1,3,9,7)
   - 1 in the middle (5)
   - 4 at the midpoints of the sides (2, 4, 6, 8)

2. at the middle of the room to distinguish the modal responses
   - 10
   - 11 and 12 at 1/4W

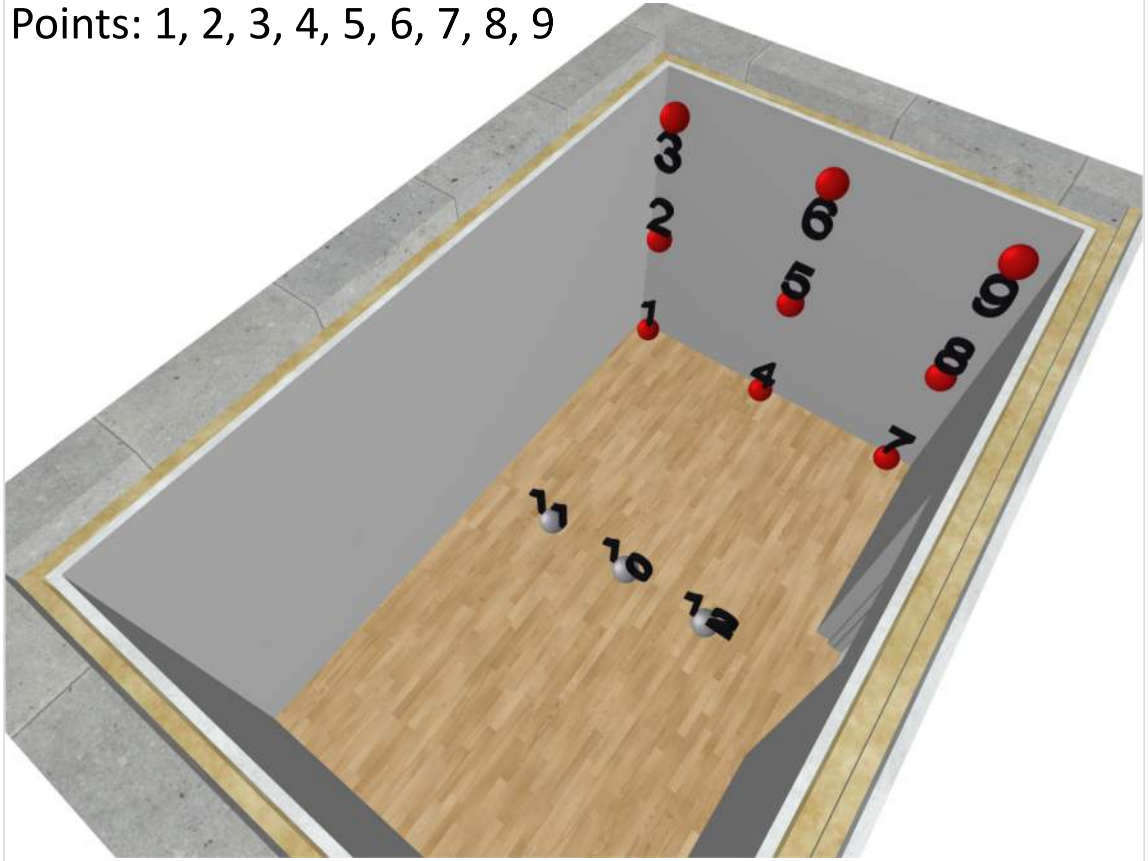
3. Points at 1/3 of the length as a control position (13, 14)

2. Measurements - Room modes

38
(1,0,0)

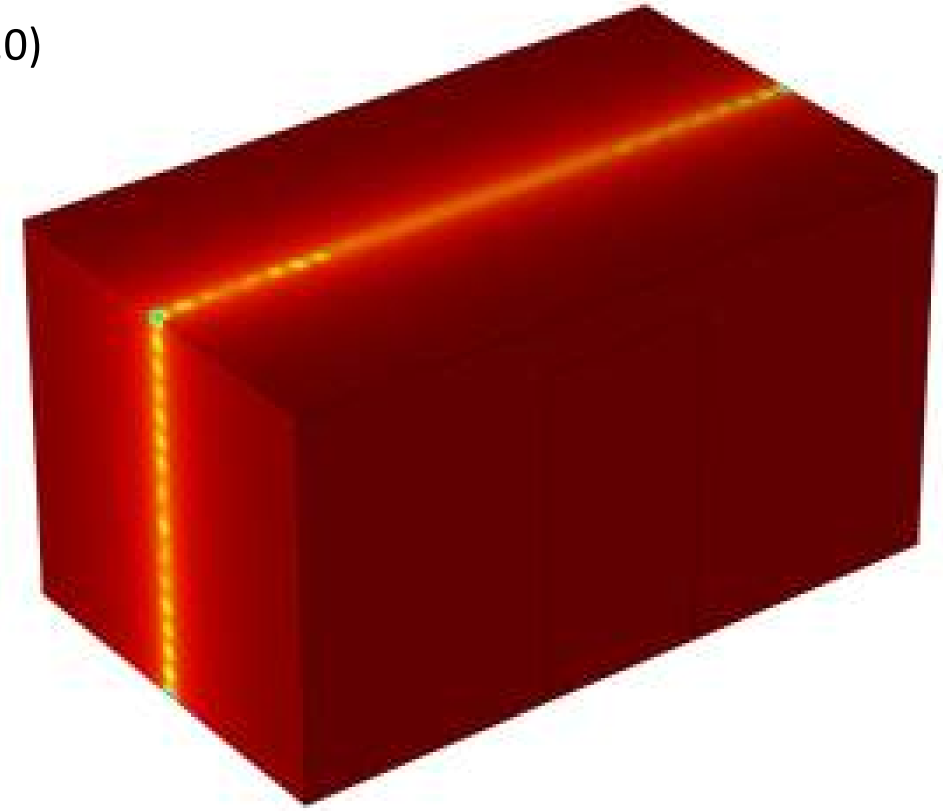


Points: 1, 2, 3, 4, 5, 6, 7, 8, 9

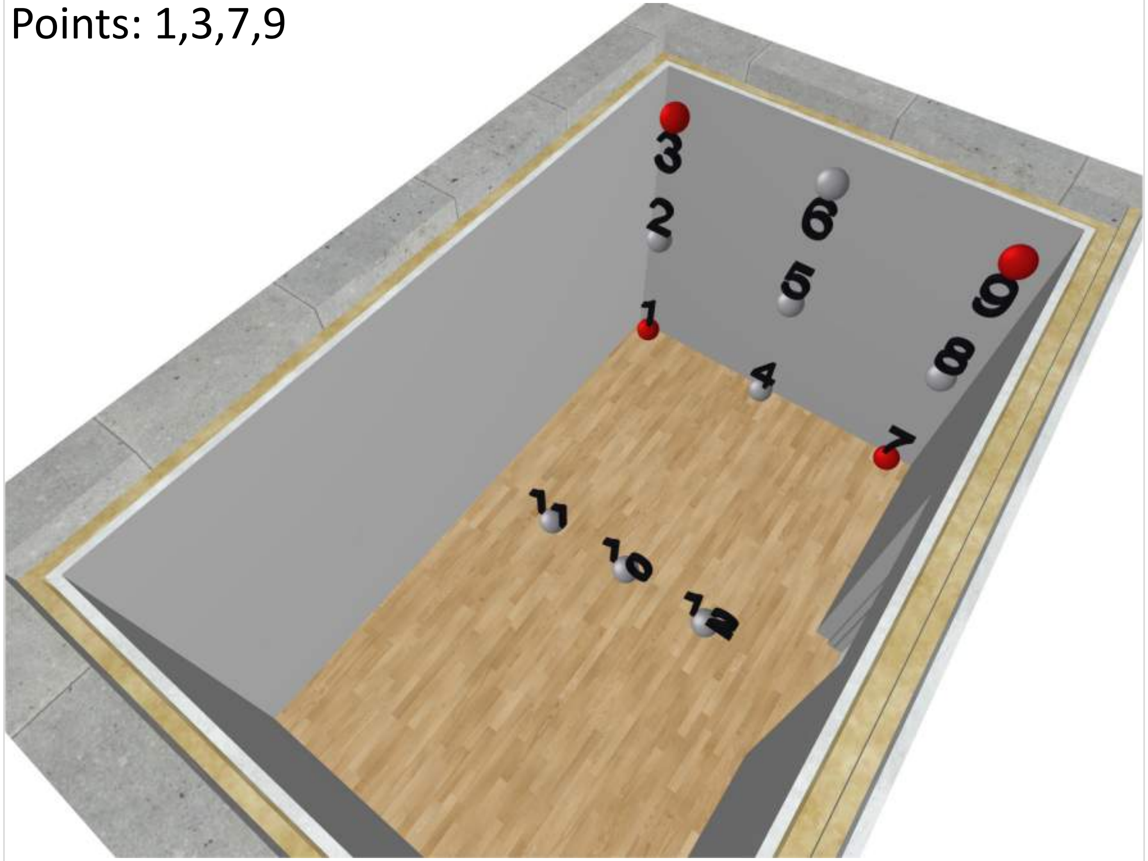


2. Measurements - Room modes

63
(0,1,0)

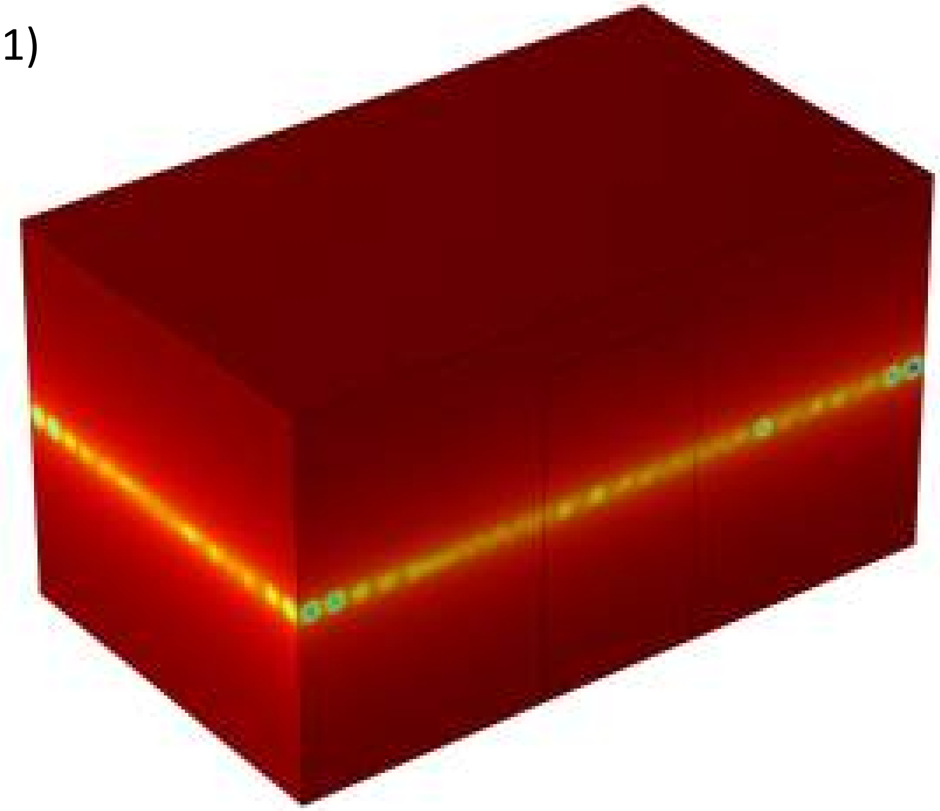


Points: 1,3,7,9

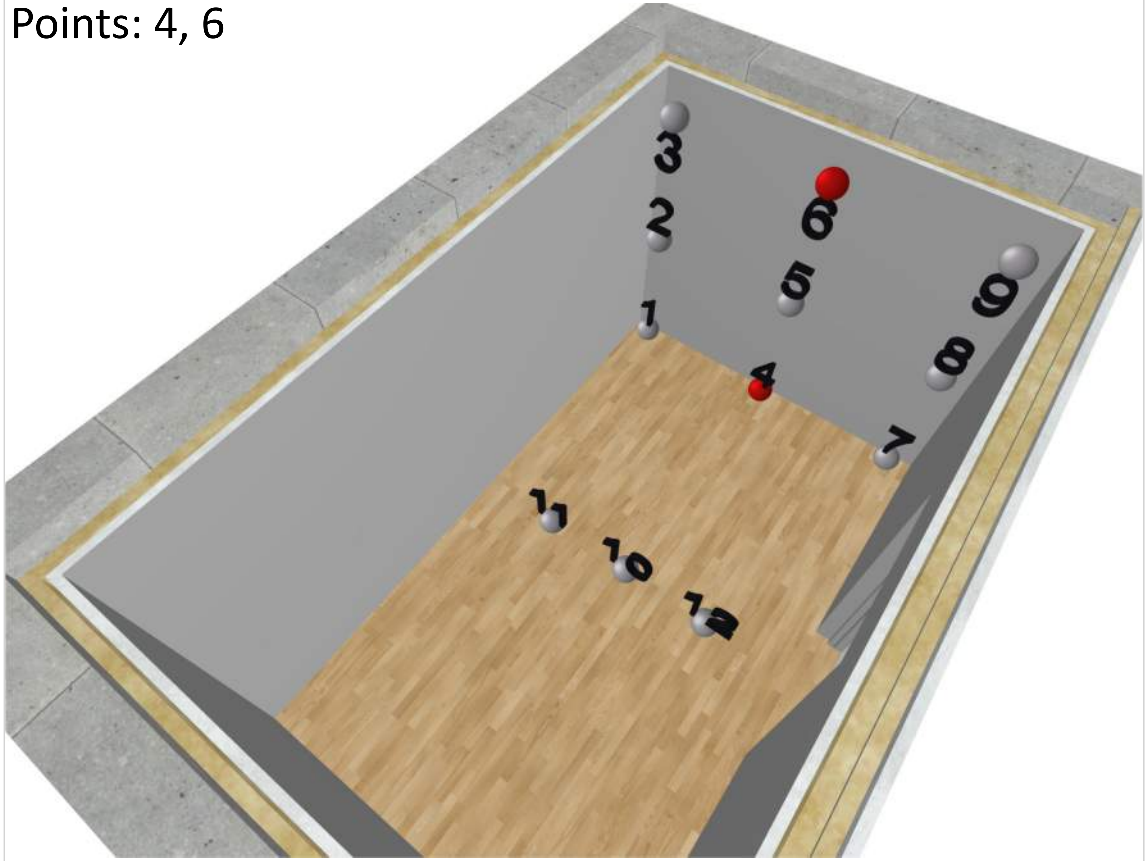


2. Measurements - Room modes

68
(0,0,1)



Points: 4, 6



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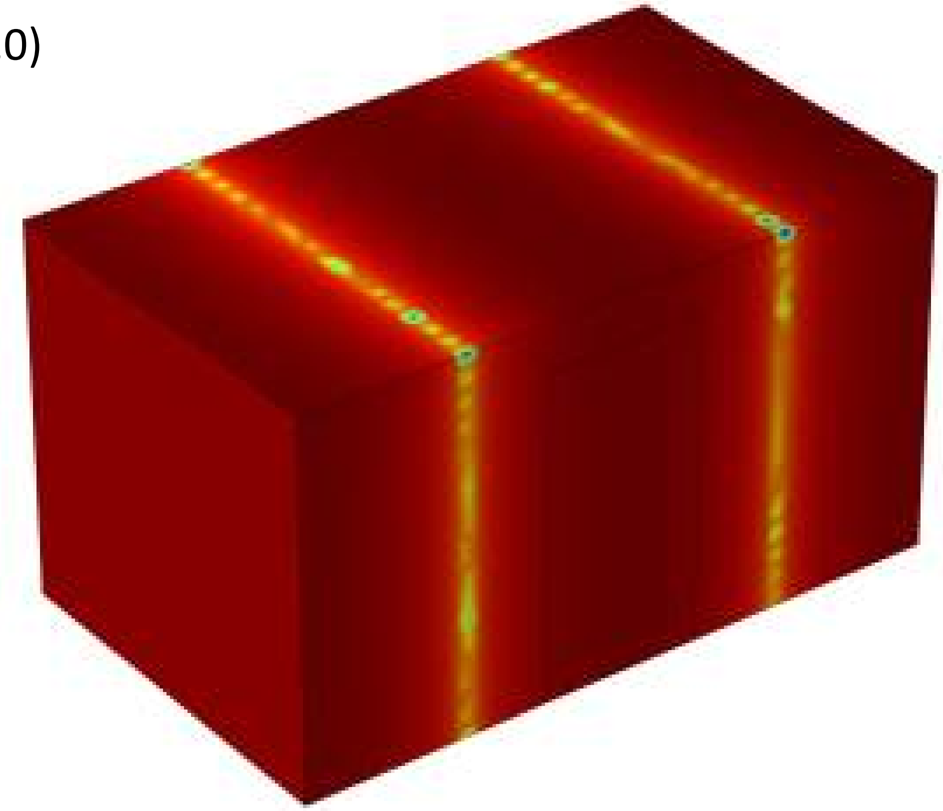
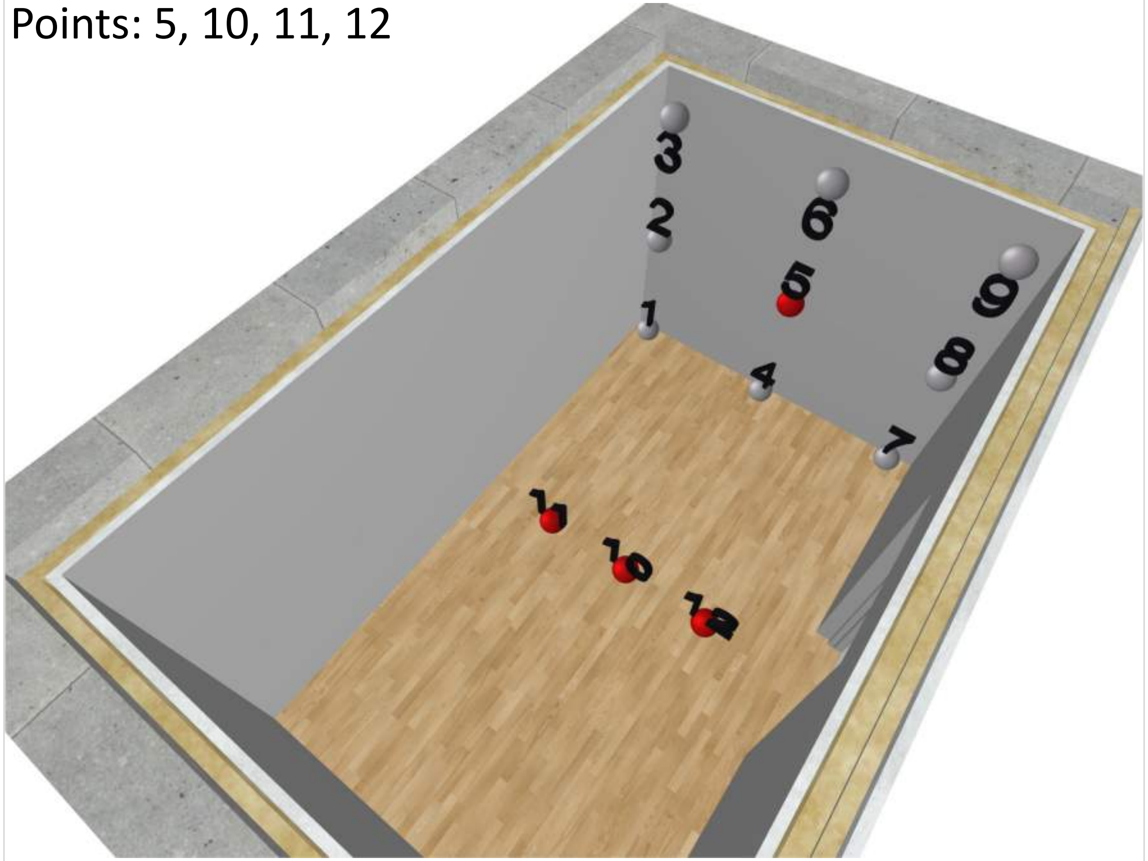
2. Measurements - Room modes

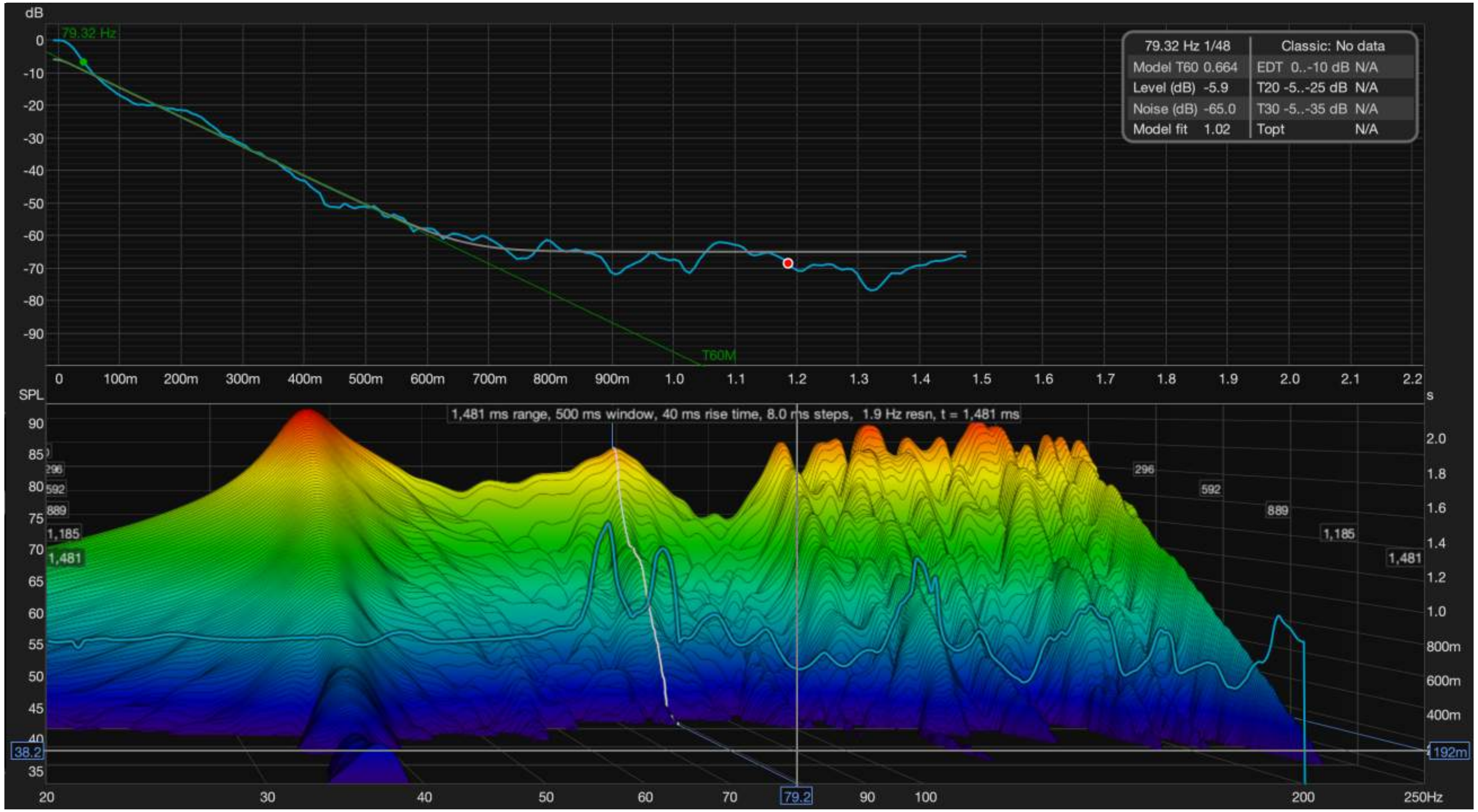
76
(2,0,0)



Points: 5, 10, 11, 12



3. Post-processing - MT60 estimation



We estimated the MT60 for specific modes using measurements in different positions to isolate the modal decay response as much as possible.

For this analysis, we used REW's decay estimation tools.

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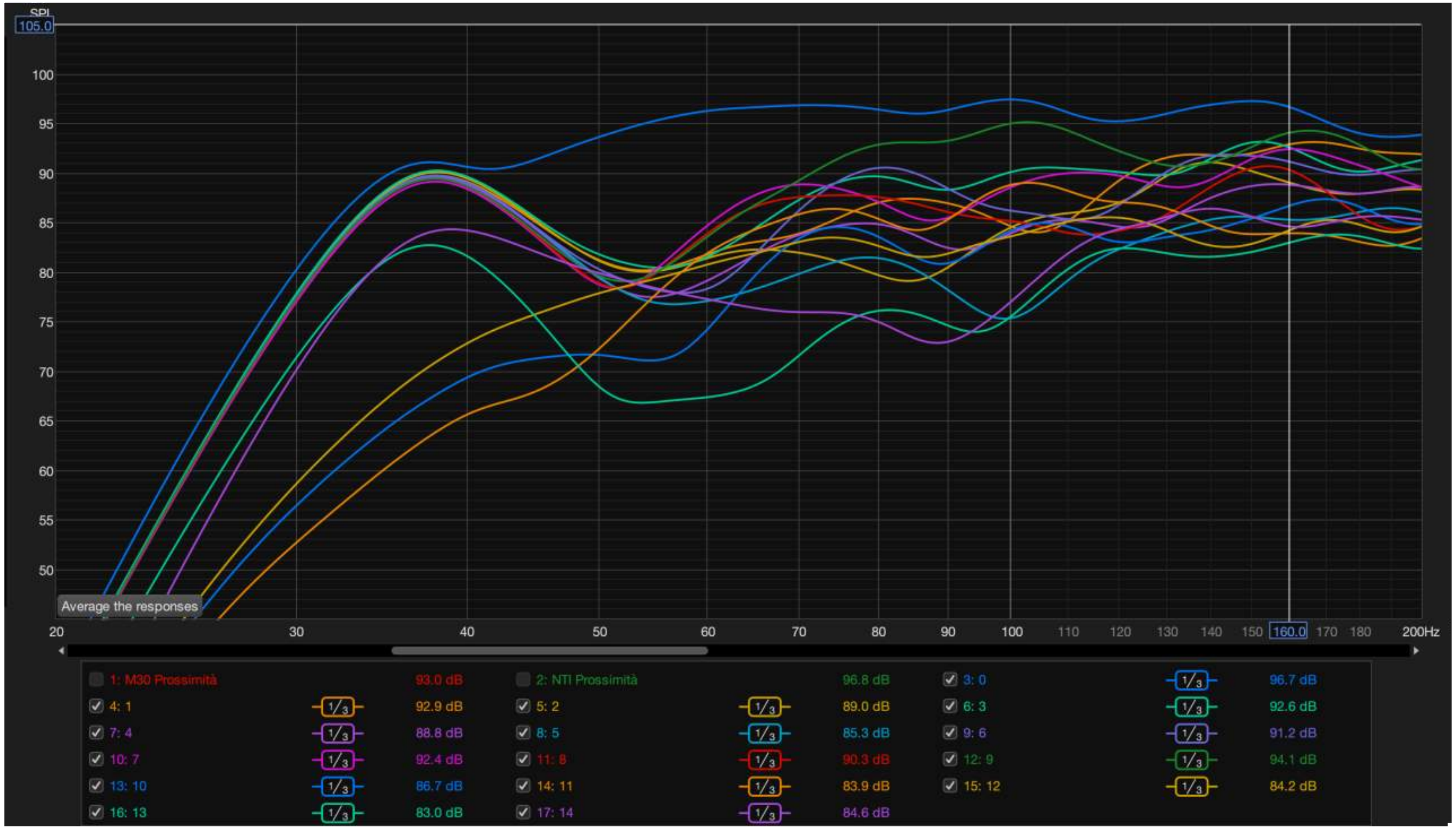
3. Post-processing - FR



All results shown are unsmoothed!

With 1/3 octave smoothing, they would appear as follows…

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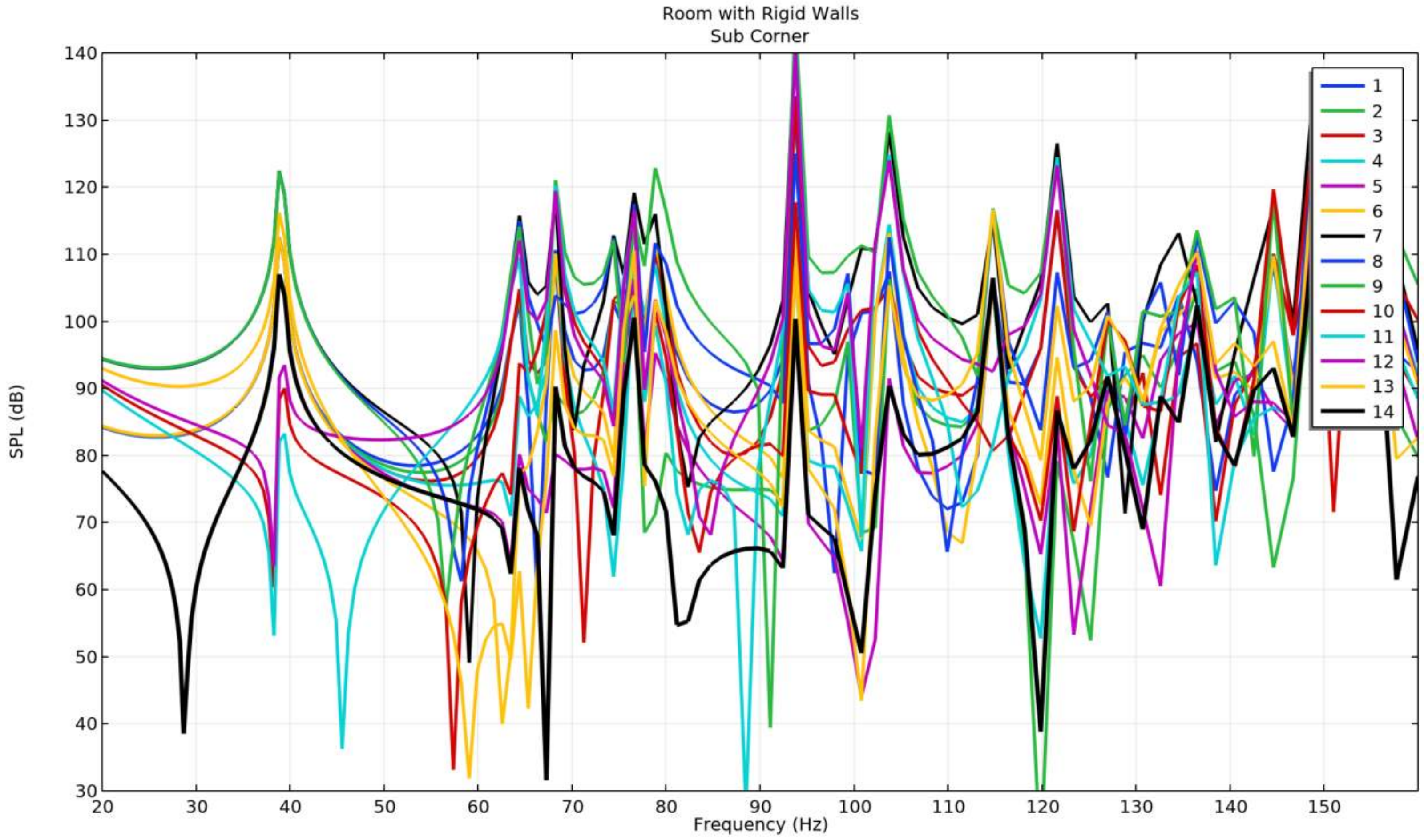
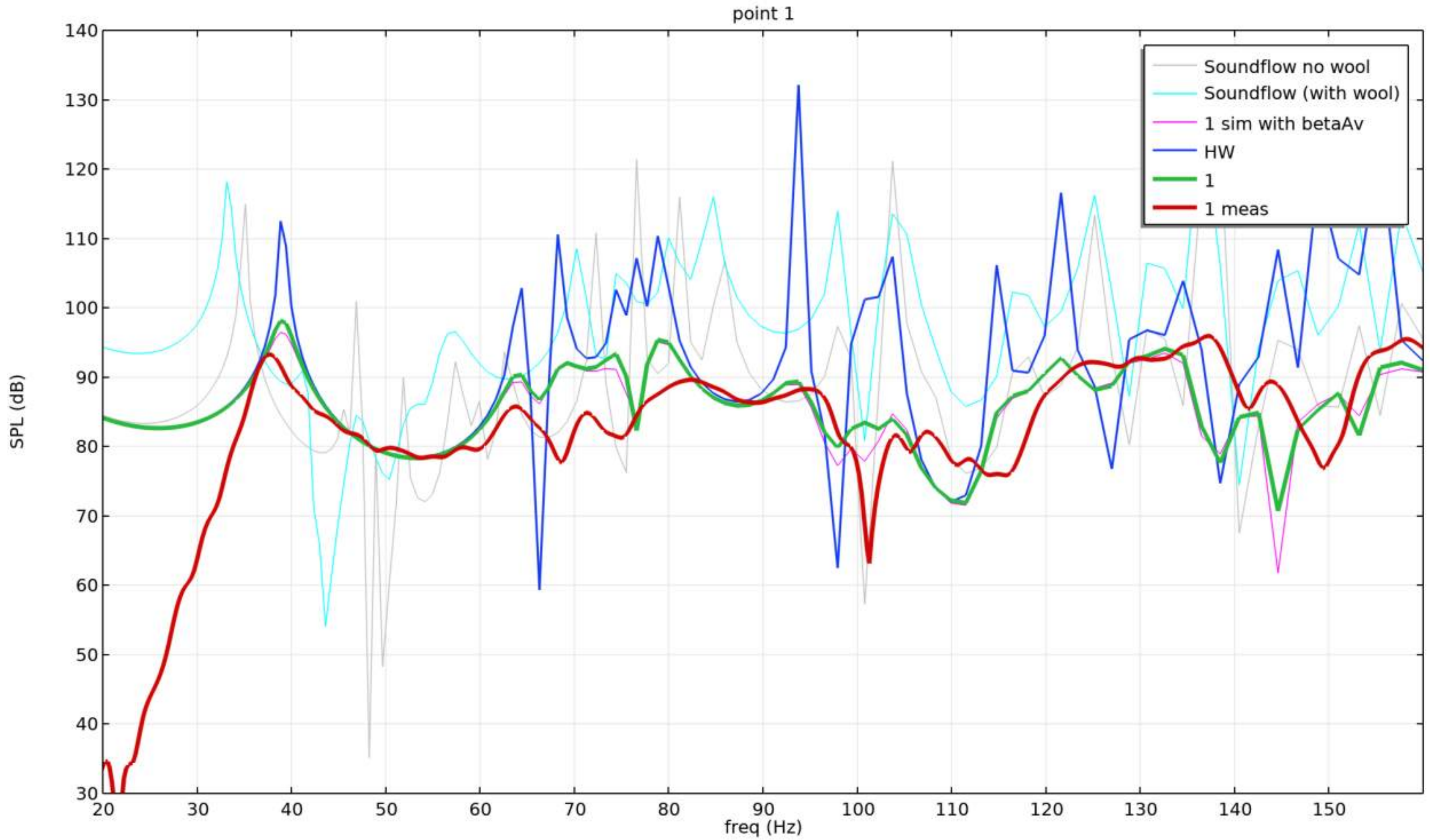
4. Modeling



We created the room model in COMSOL, included the measurement points and source location, and analyzed the room behavior (frequency response) with rigid walls

4. Modeling



We applied the calculated acoustic impedance to the model walls and compared the frequency response results between:

- **simulations using the calculated impedance**
- **rigid walls**
- **measurements**

4. Modeling

Blue: Hard wall   Green: Simulation   Red: Measurements

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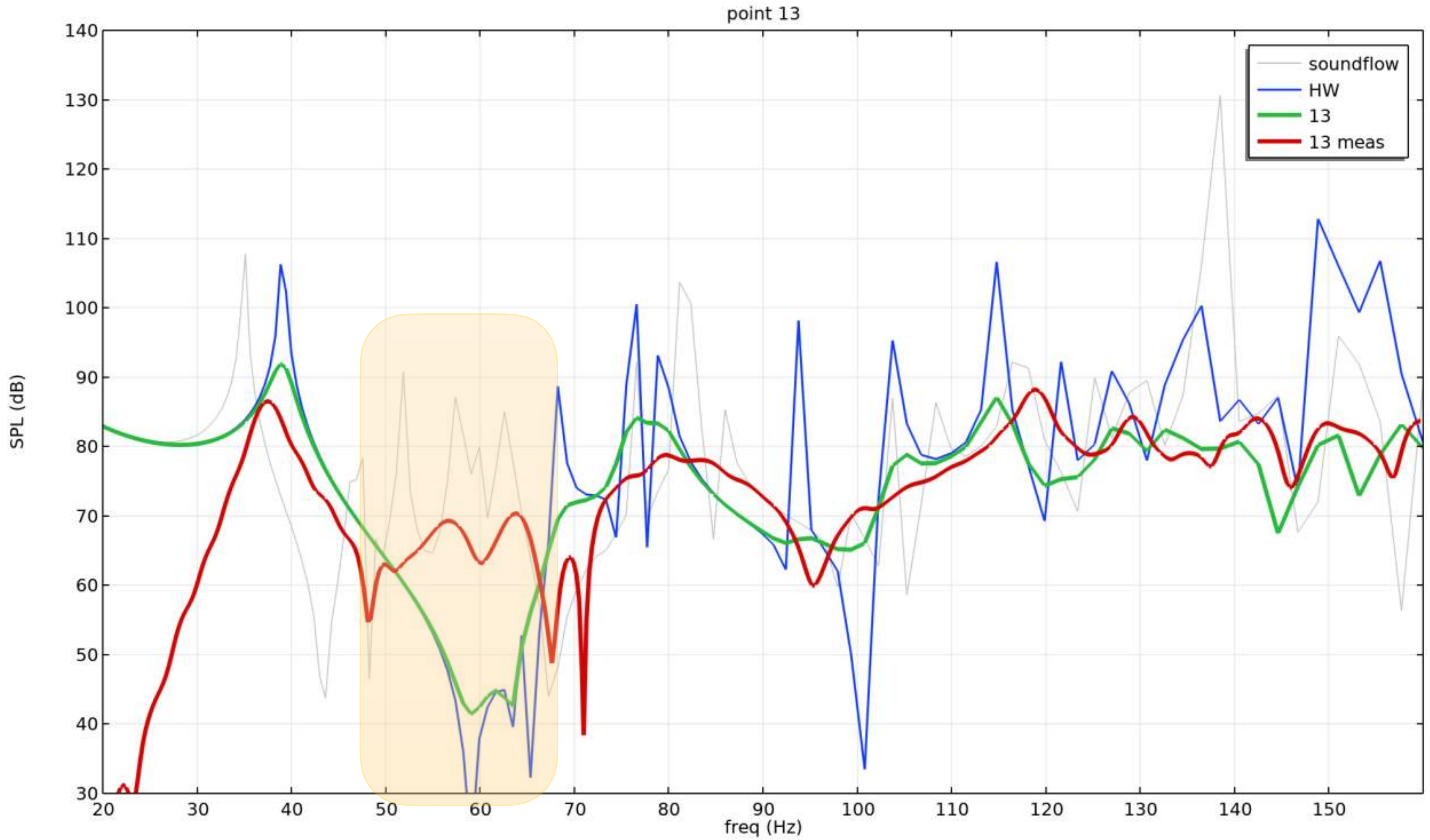
4. Modeling - Soundflow tentative



The agreement between simulations and measurements is good, however this is only an estimate with an impedance value in *rayls* and doesn't have a specific frequency behavior.

The part of the spectrum most affected by drywall resonance is certainly impacted by this. For this reason, we decided to evaluate the impedances through simulation using Soundflow.

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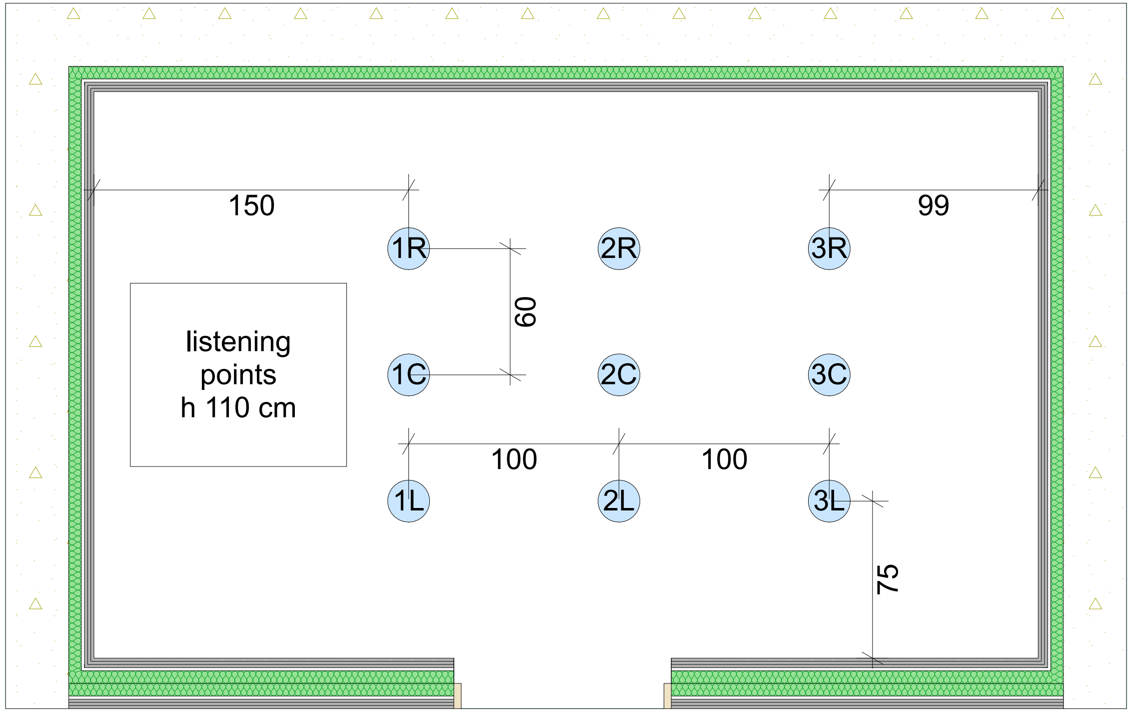
5. Simulations and Treatment

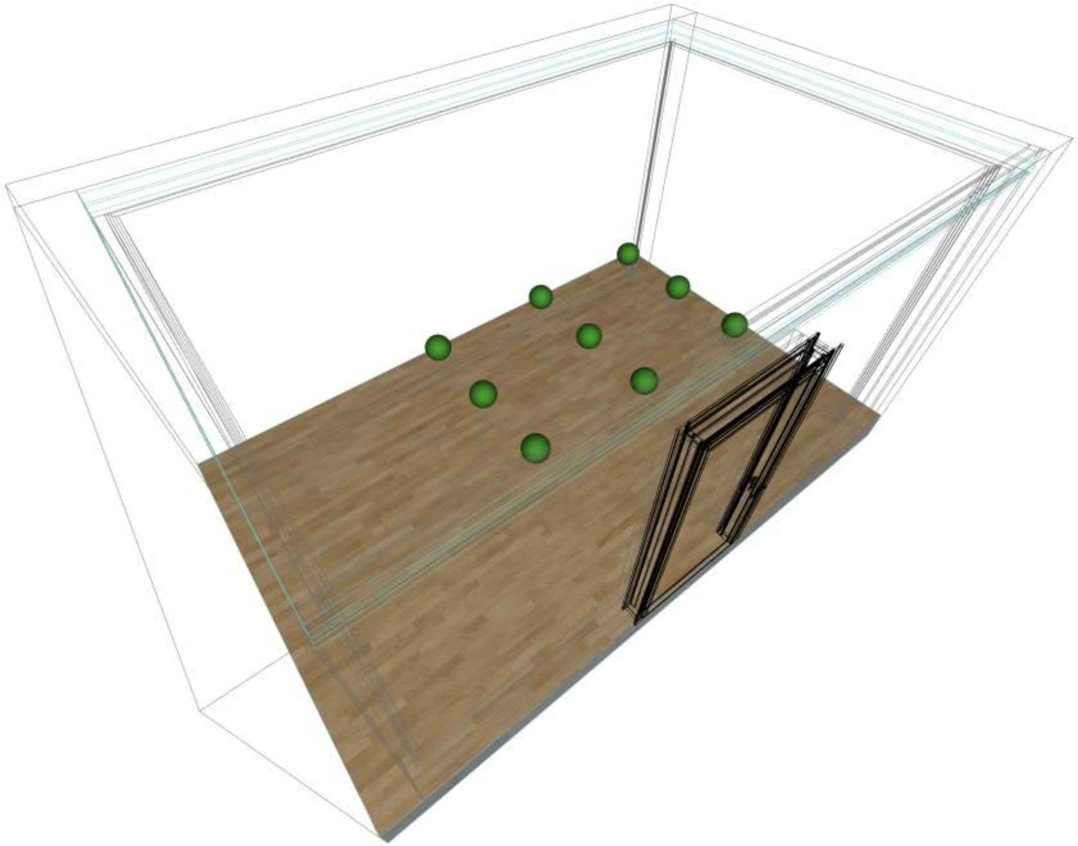
Once the model was tuned as best as possible, we were able to add more things to the room:

A. Subwoofer positions
- **1/3 W (Dolby)**
- **1/2 W**
- **a) Cedia**
- **b) and b_h) Cedia**
- **c) Cedia**
- **e) Cedia**
- **f) Cedia**
- **Array with 3 Sub on front**

B. Acoustic Treatment
- **Resonator panels 1**
  (alpha constant)
- **Resonator panels 2**
  (alpha frequency dependent)

5. Simulations - Matrix of Positions





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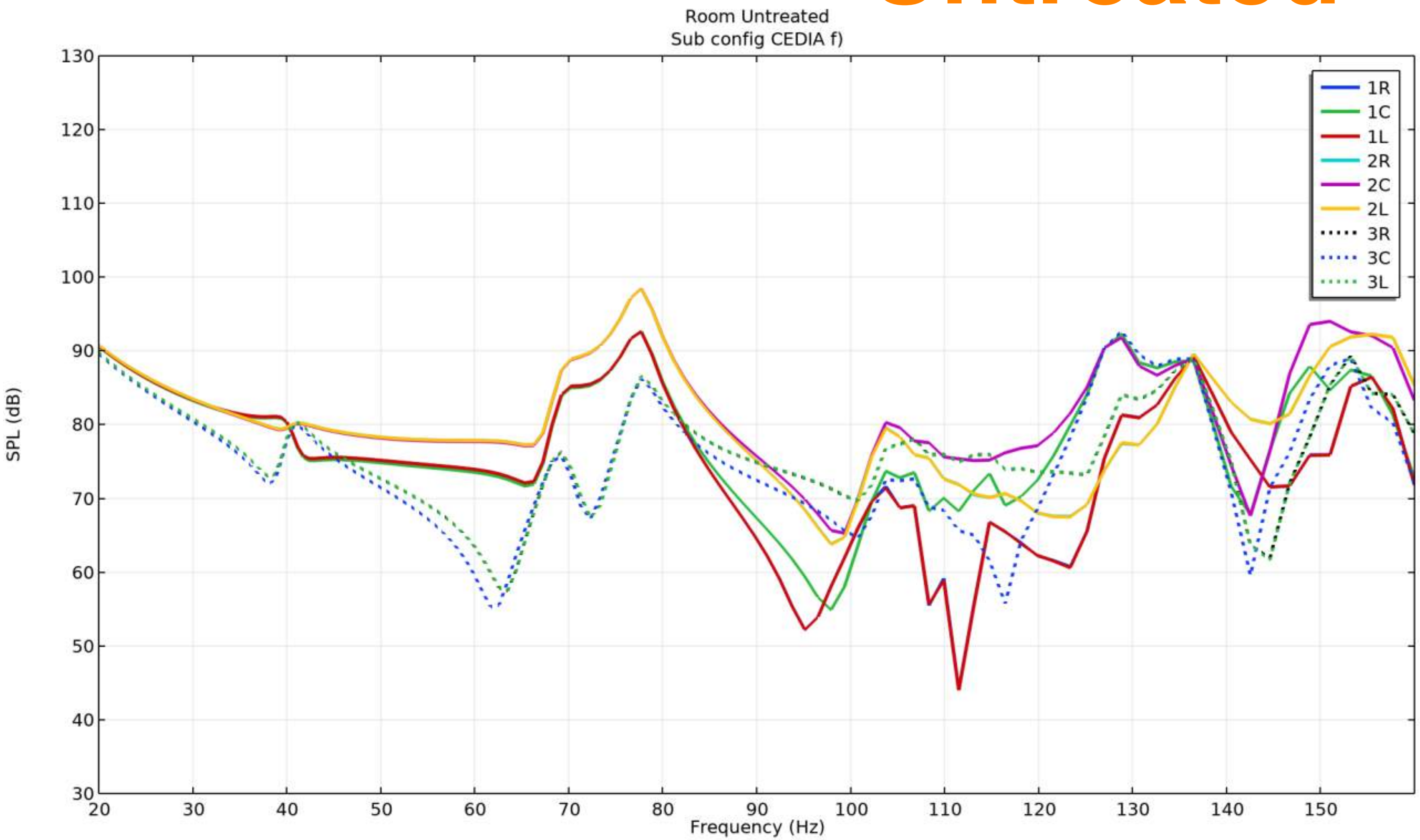
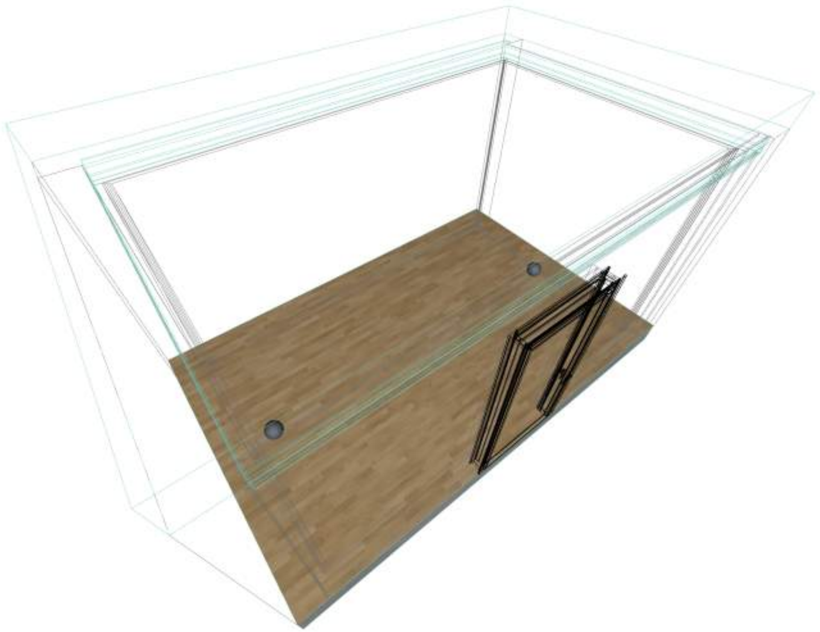
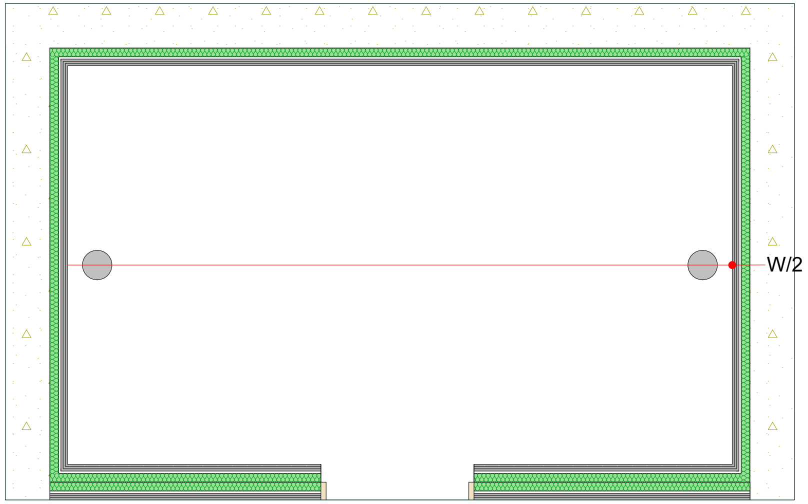
5. Simulations - Cedia f) Untreated







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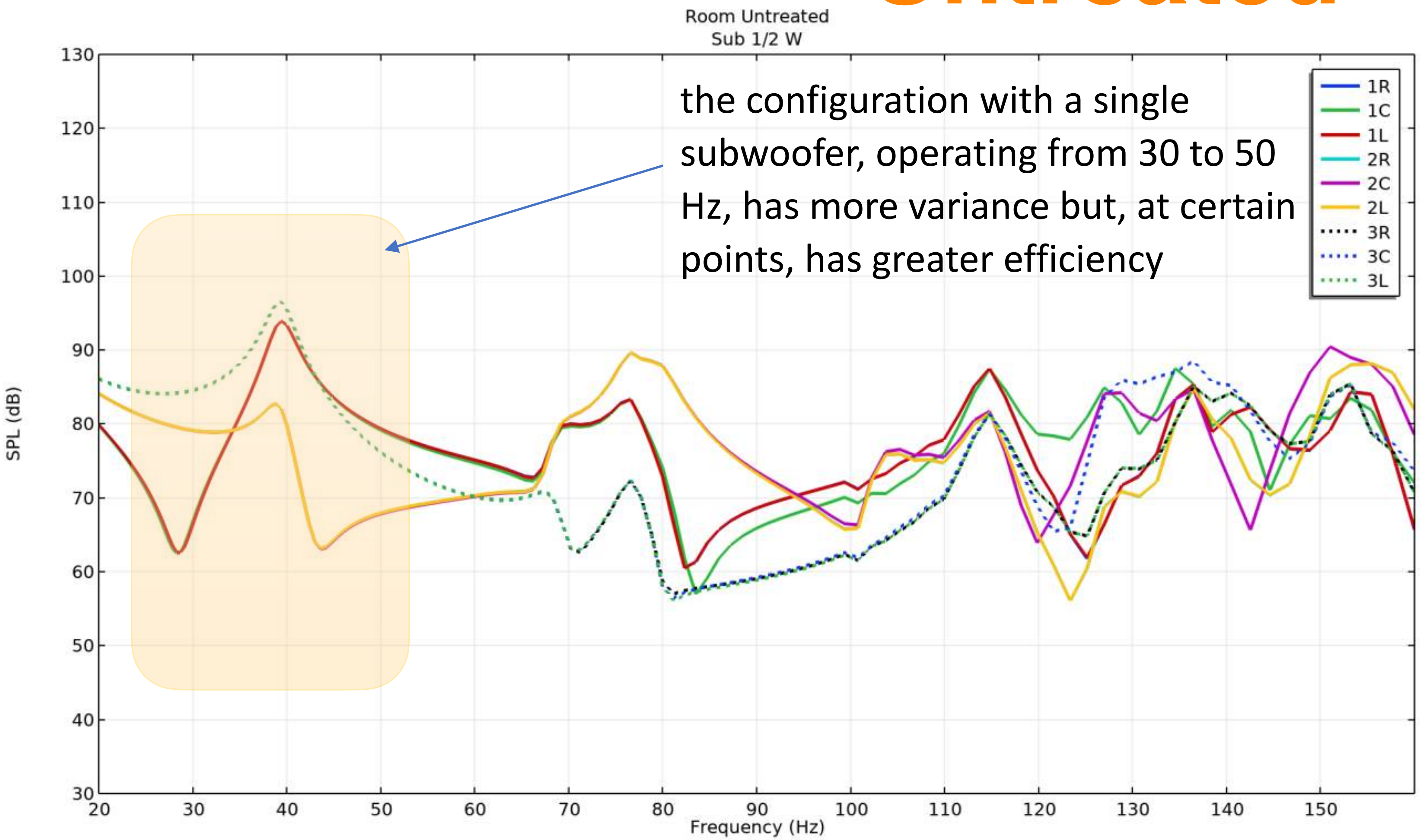
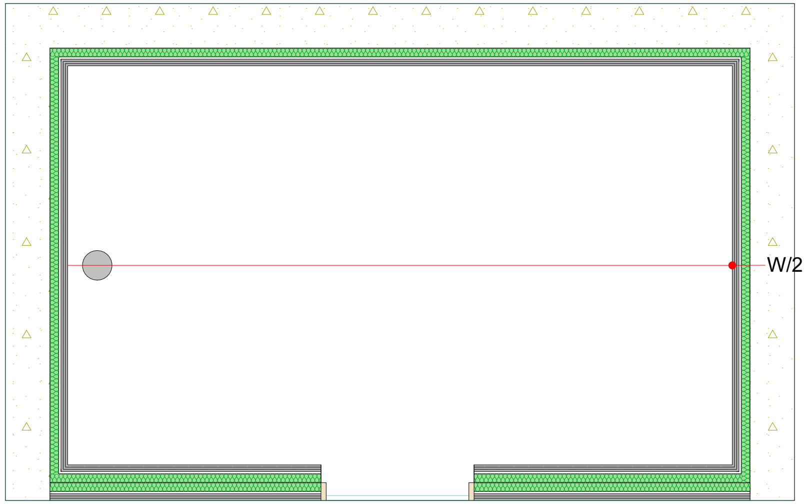
5. Simulations - 1/2

Untreated



the configuration with a single subwoofer, operating from 30 to 50 Hz, has more variance but, at certain points, has greater efficiency



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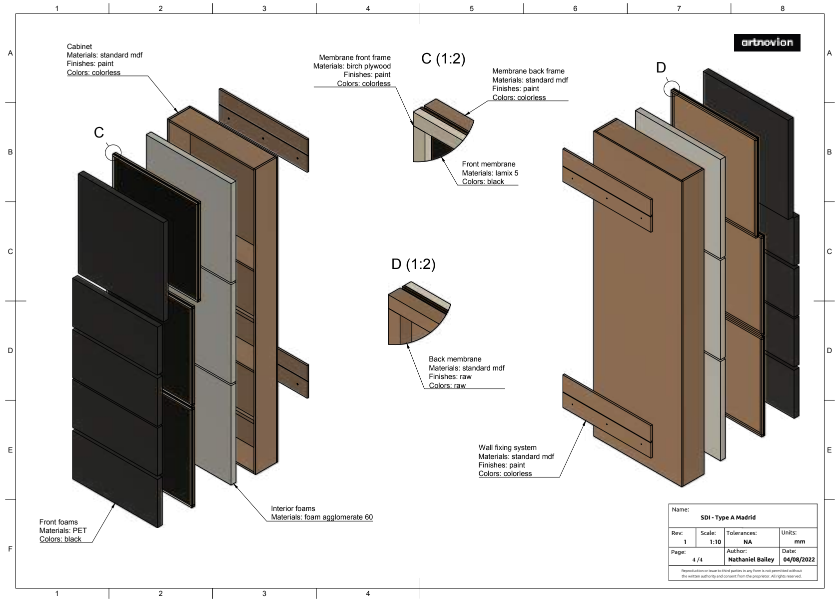
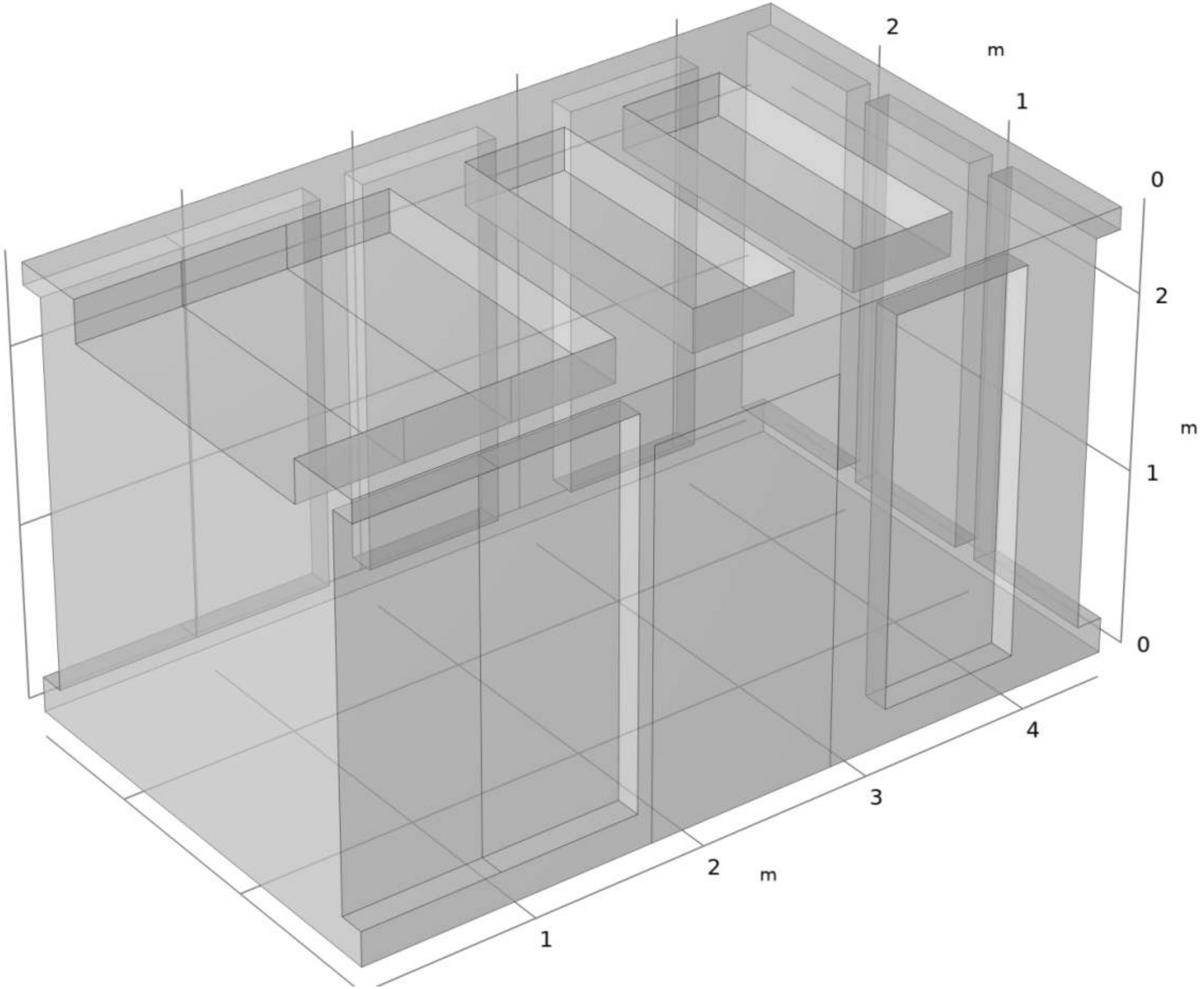
Treatment 1



approximated constant impedance and absorption coefficient



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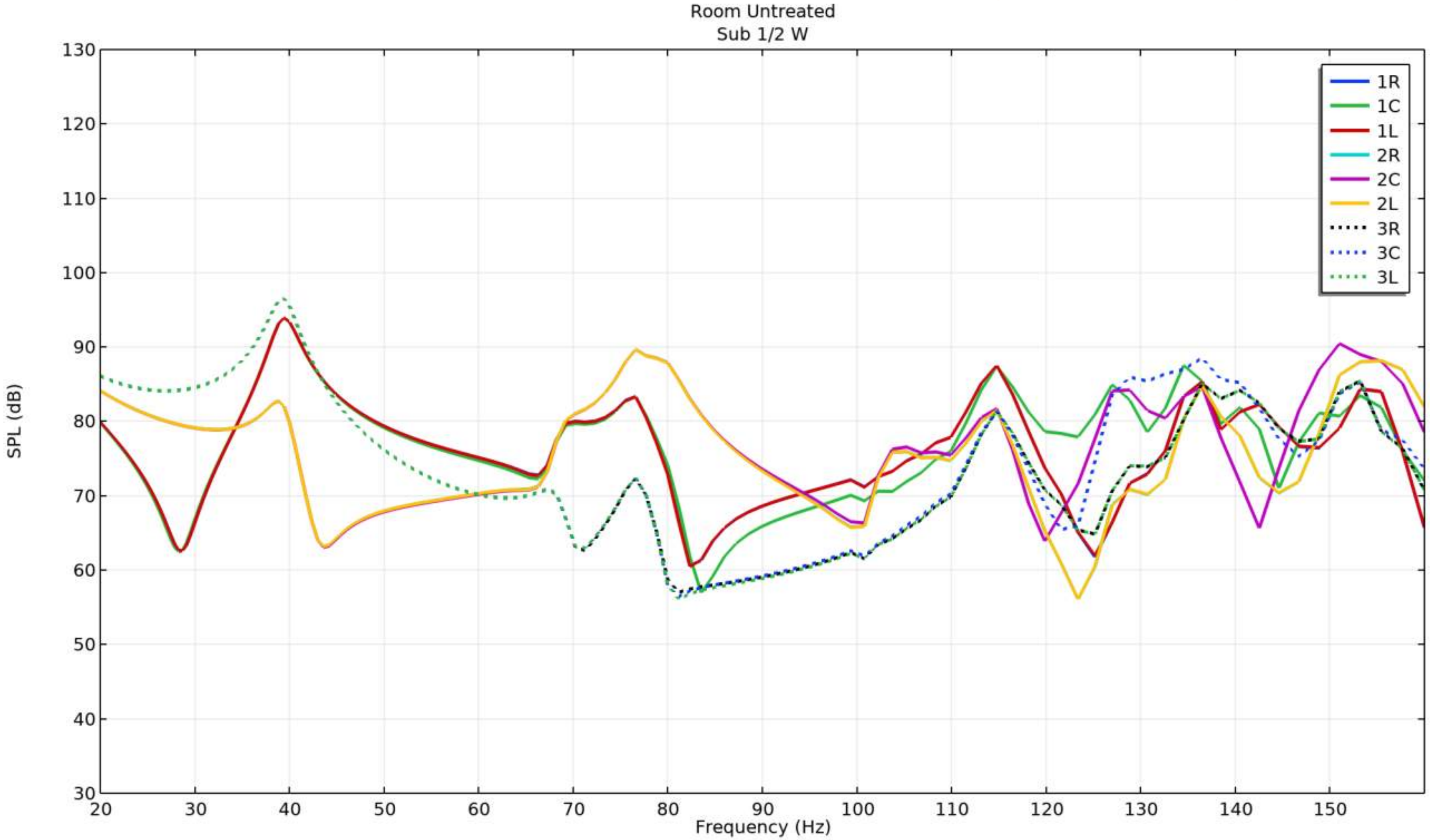
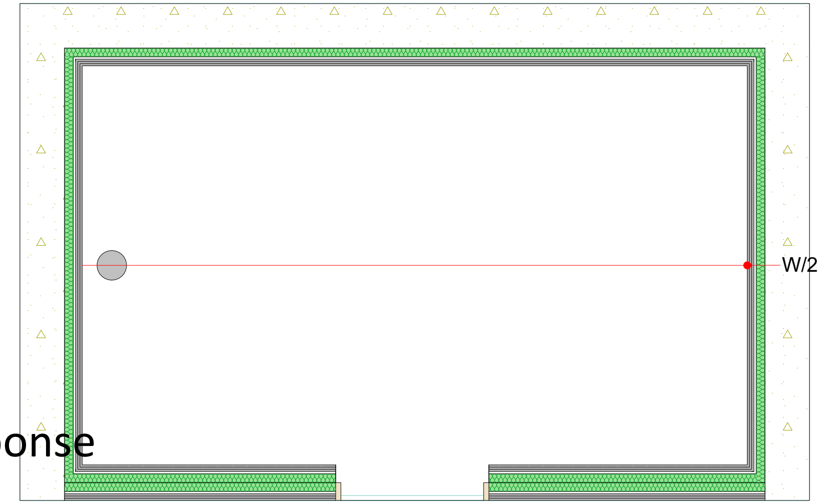
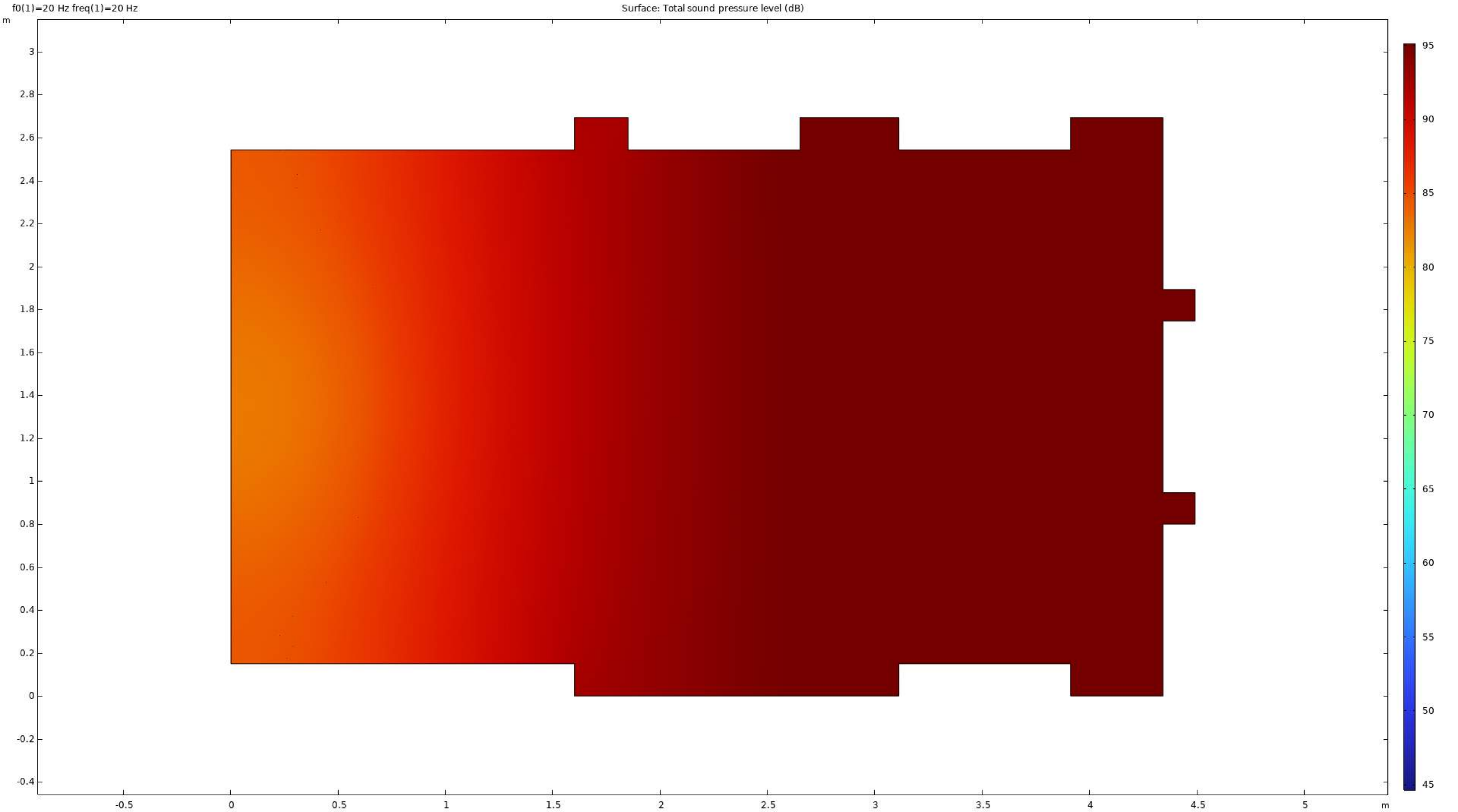
5. Simulations - 1/2

Treatment 1



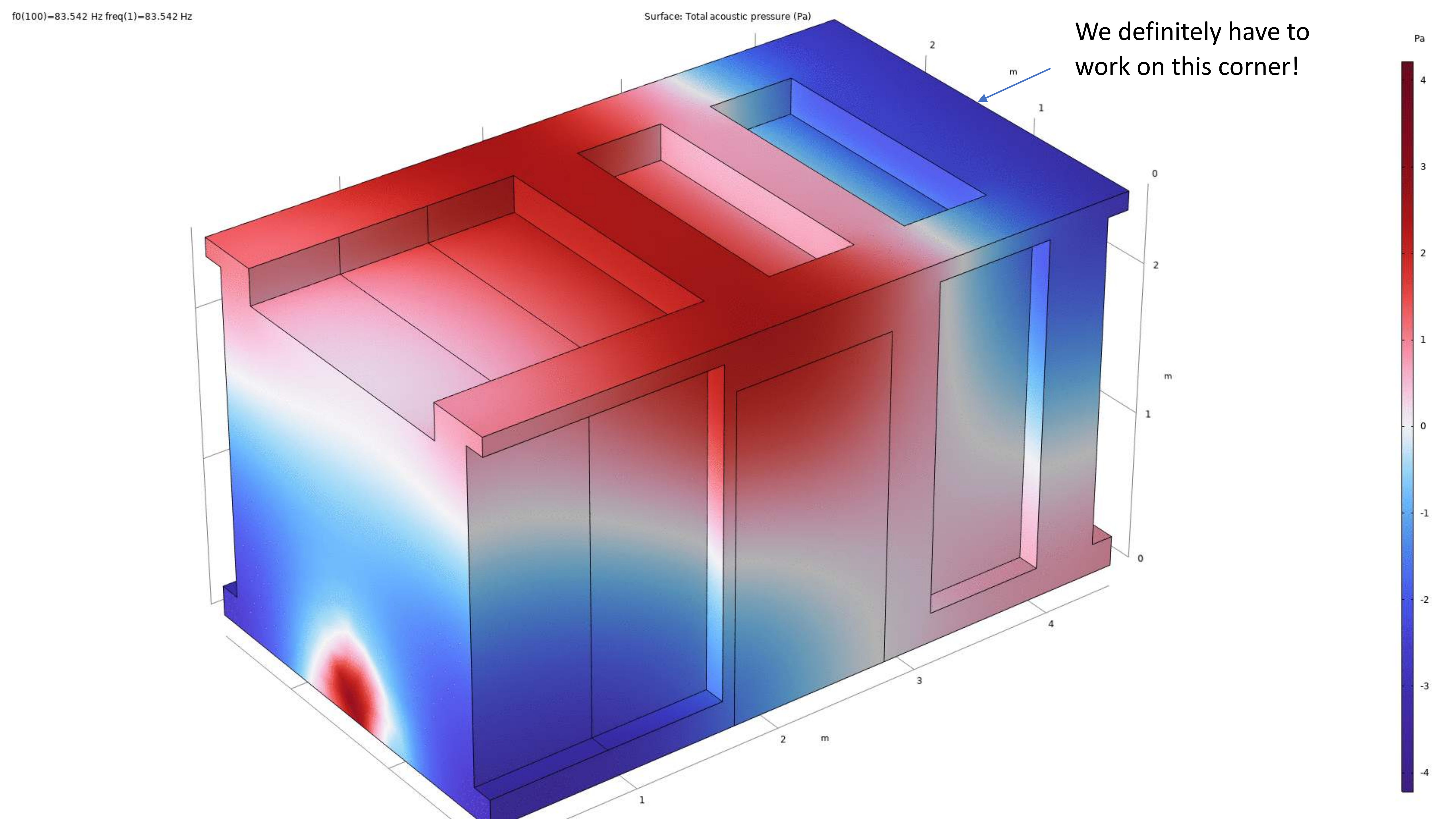


n
sponse



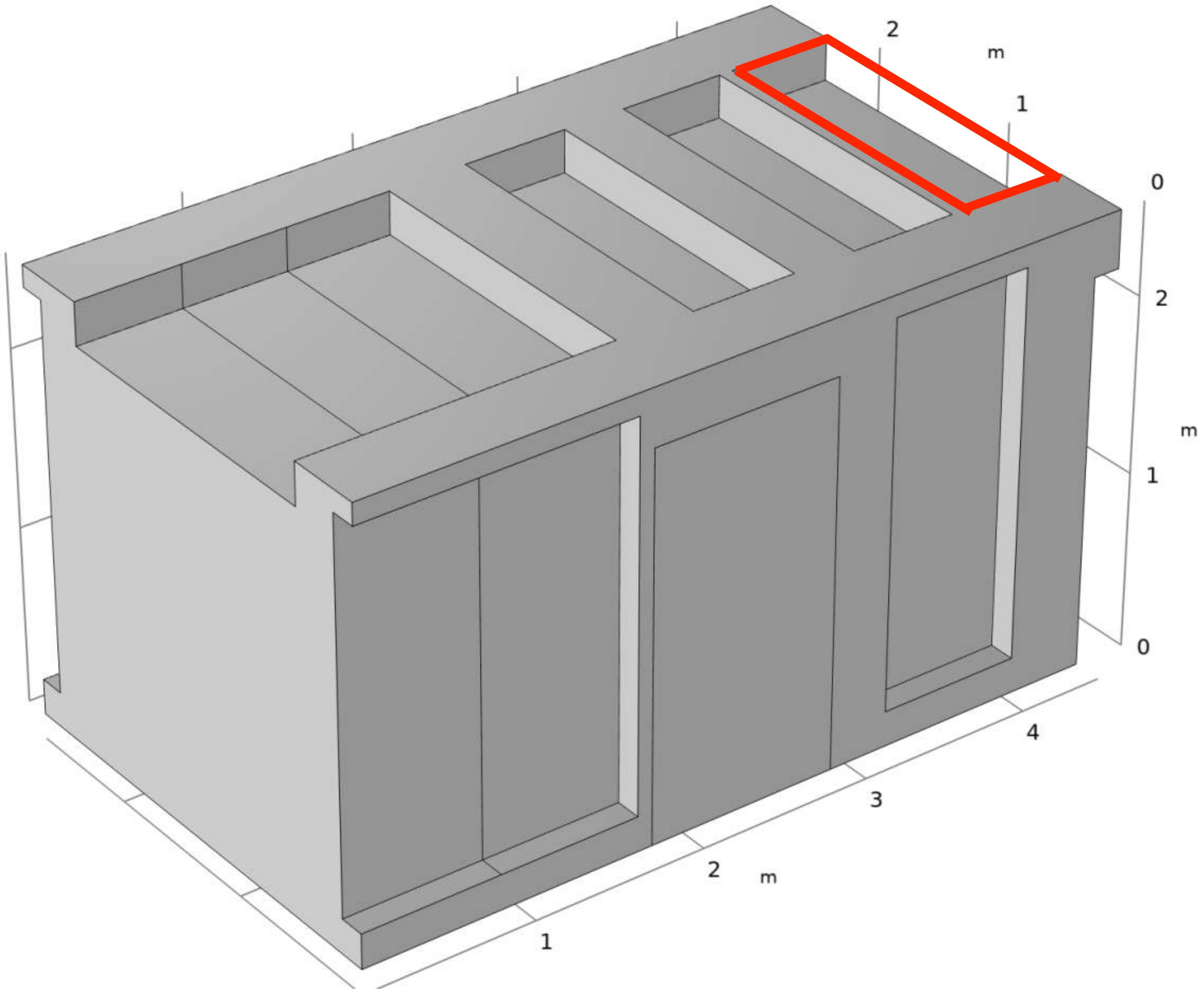
f0(1)=20 Hz freq(1)=20 Hz
Surface: Total sound pressure level (dB)
m
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
m
95
90
85
80
75
70
65
60
55
50
45

We definitely have to work on this corner!



Treatment 2

- **added a new resonator to the rear ceiling section**
- **the absorption coefficient and impedance have been better analyzed across frequencies**



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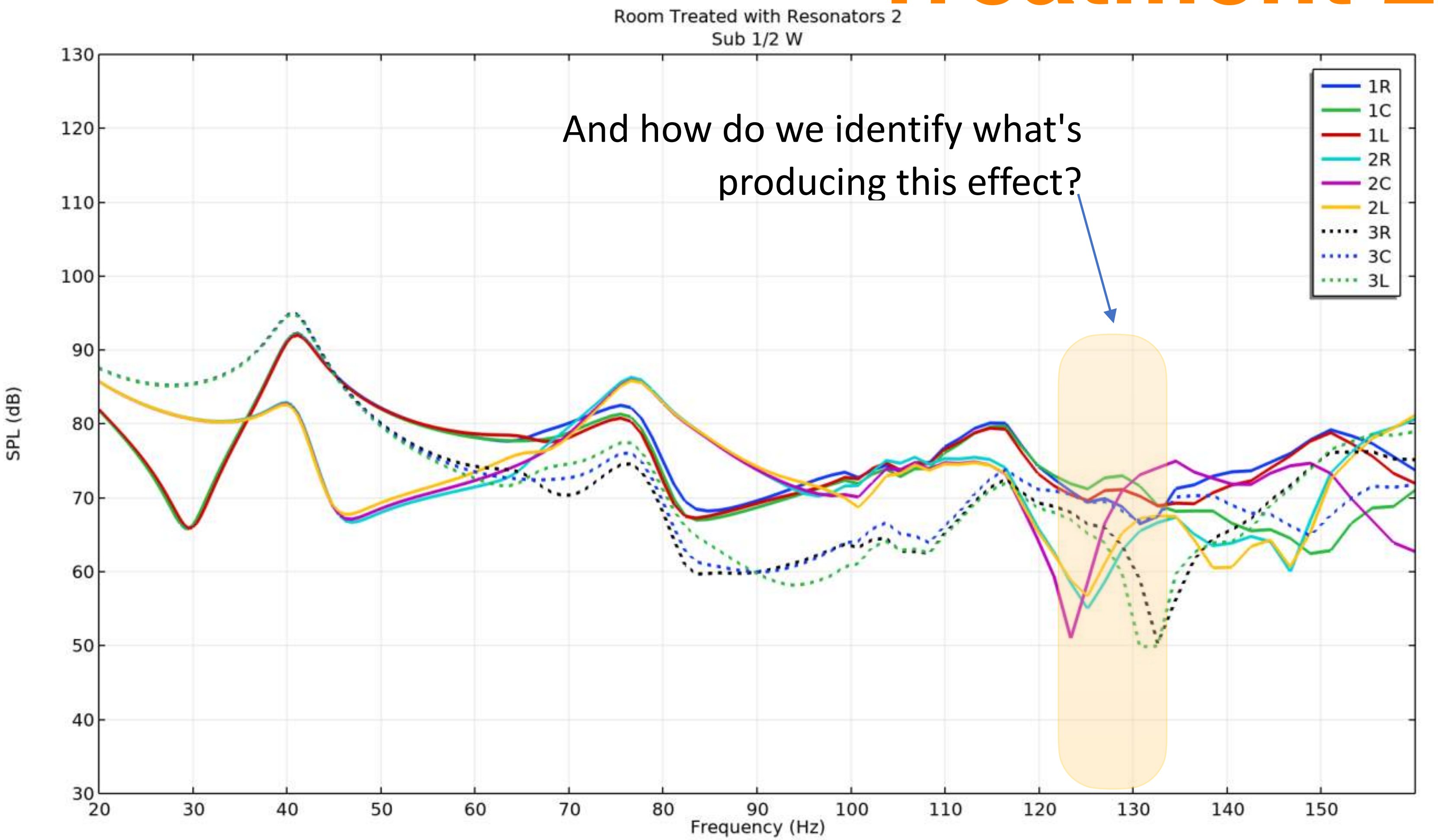
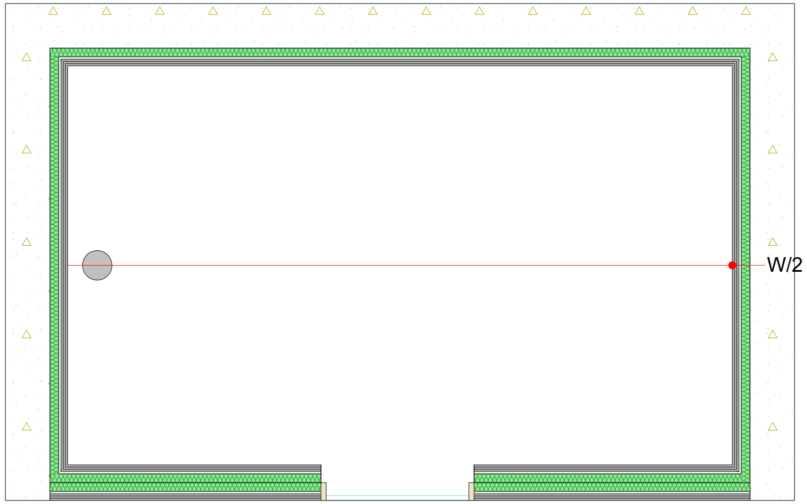
5. Simulations - 1/2

Treatment 2





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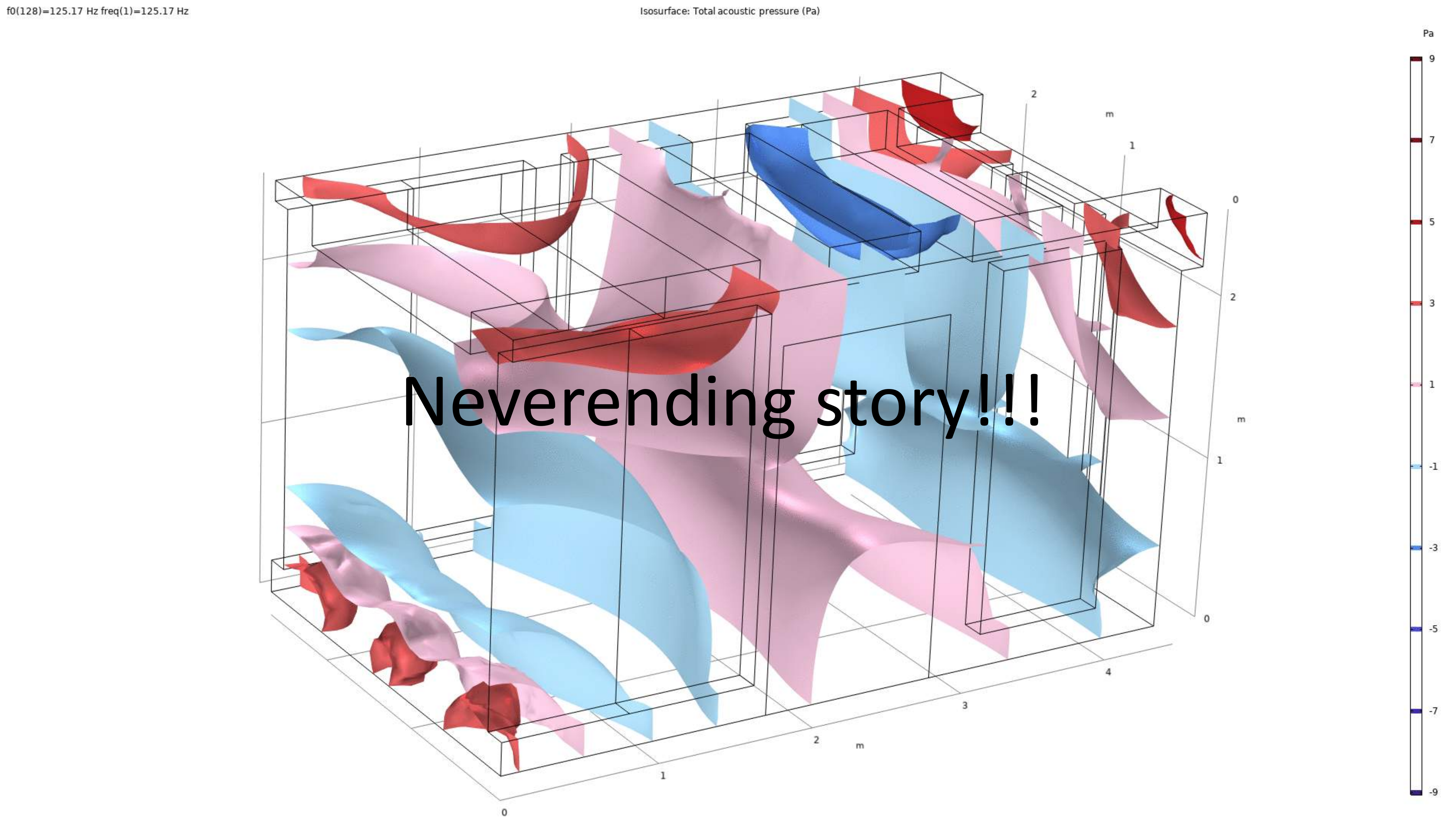
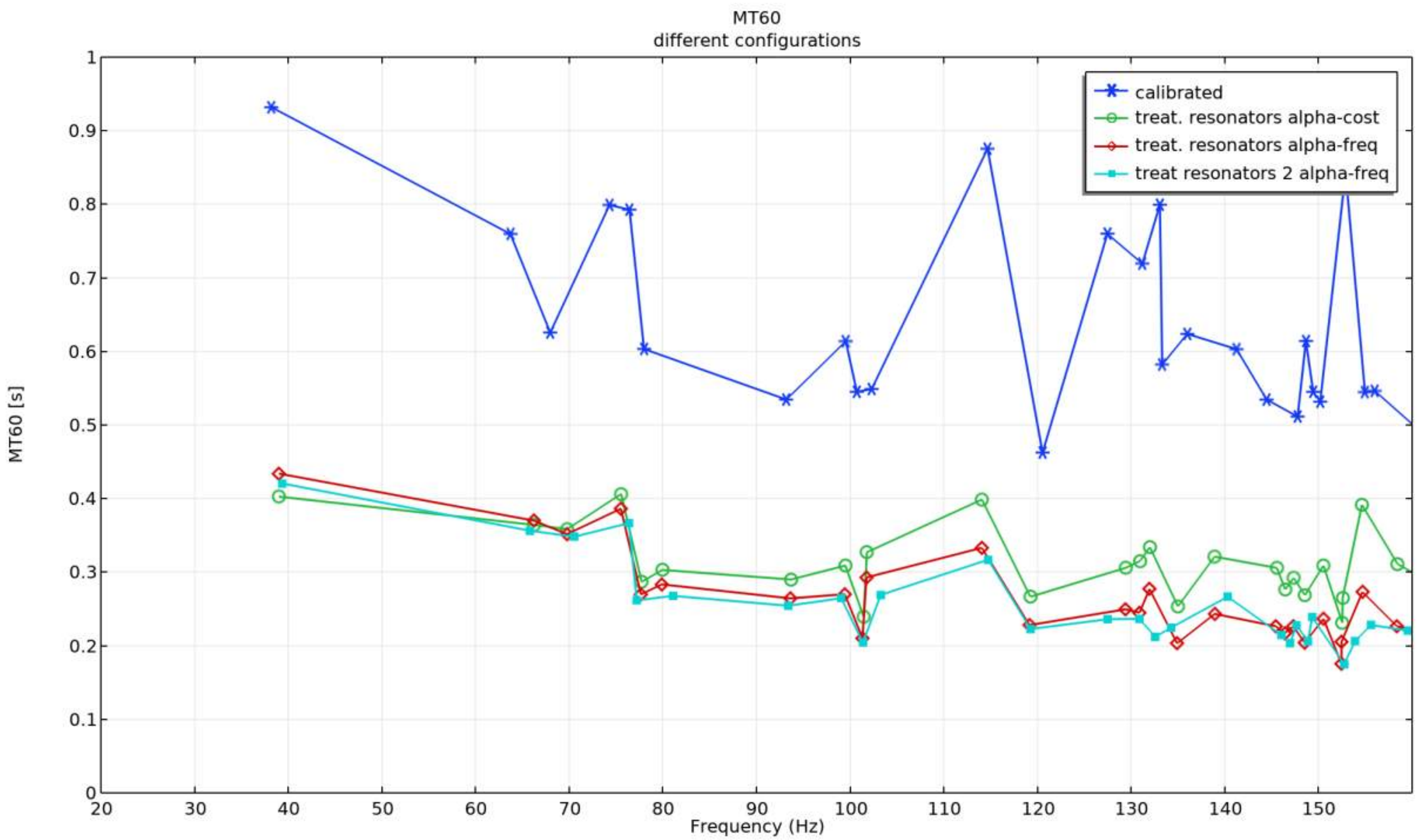
Neverending story!!!



5. Simulations and Treatment - MT60



We performed a slight fine-tuning to match the resimulated MT60s with the measured ones

(actually, to simplify, we ultimately used an average β value derived from the calibration)

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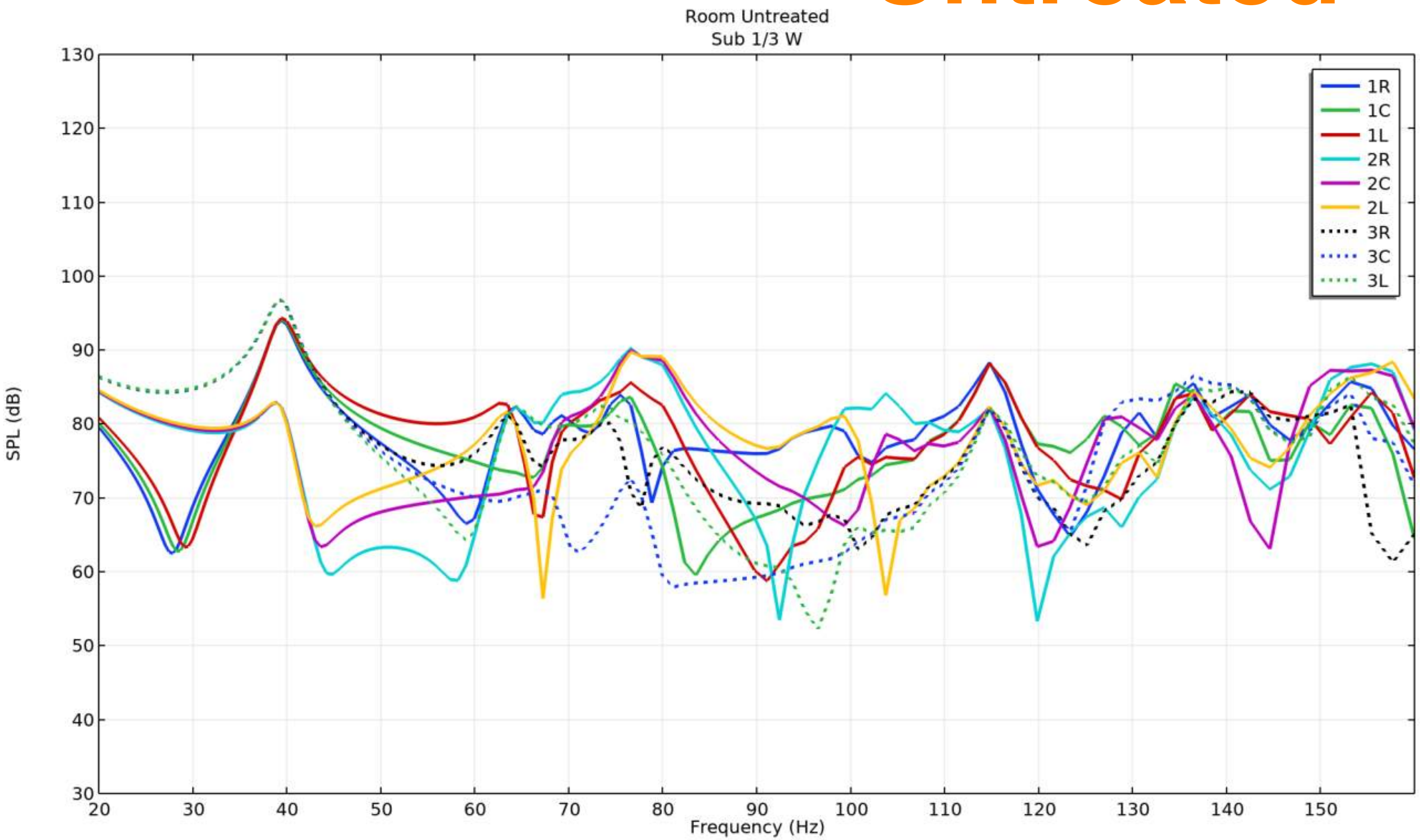
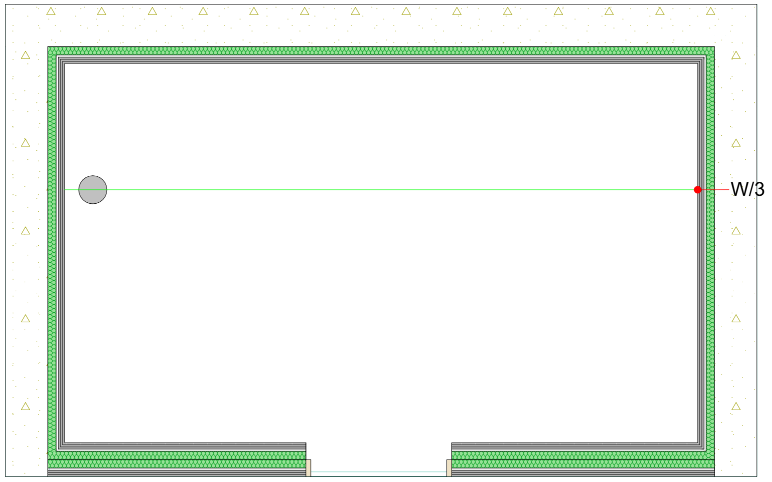
5. Simulations - Dolby 1/3 Untreated





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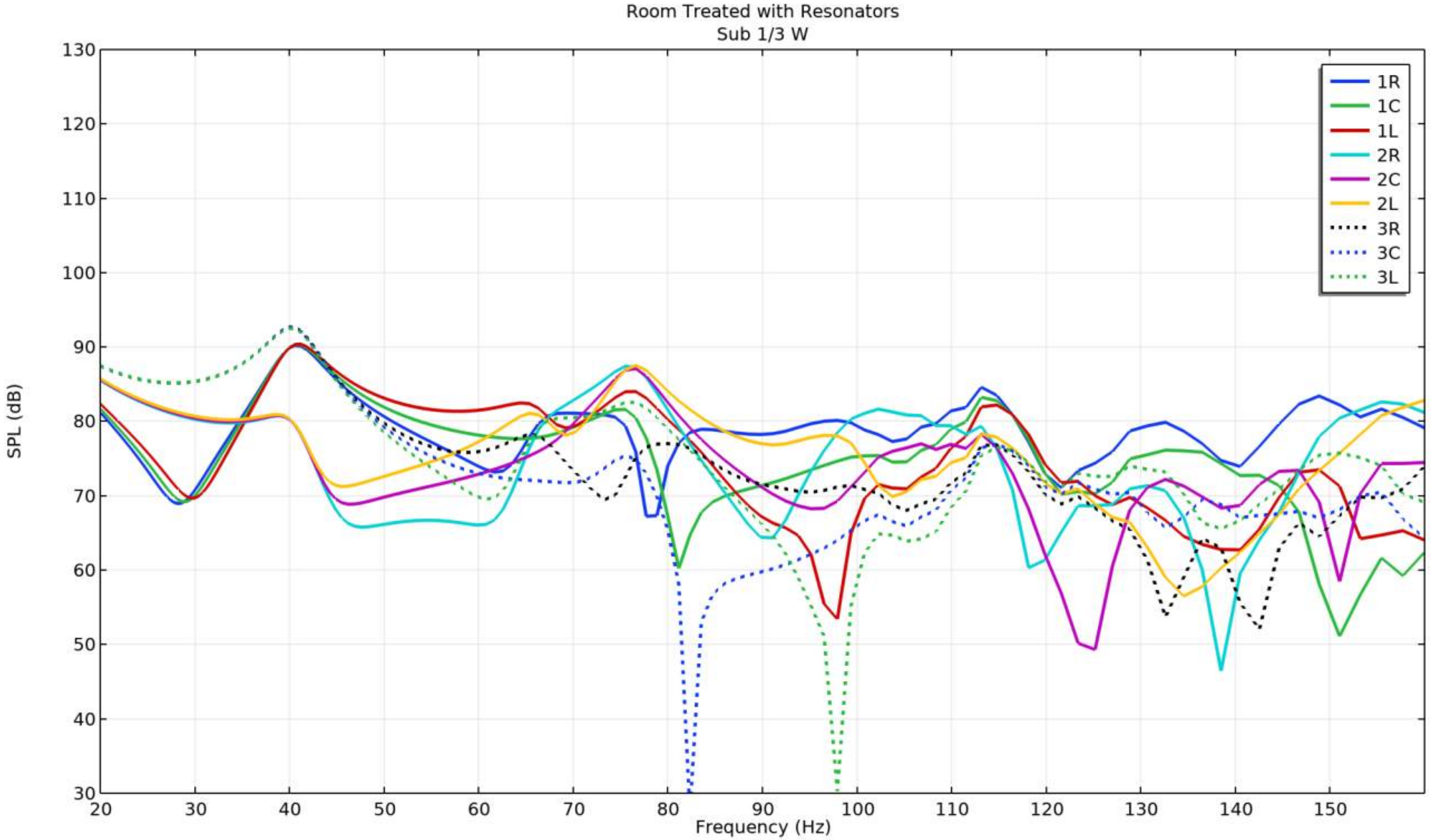
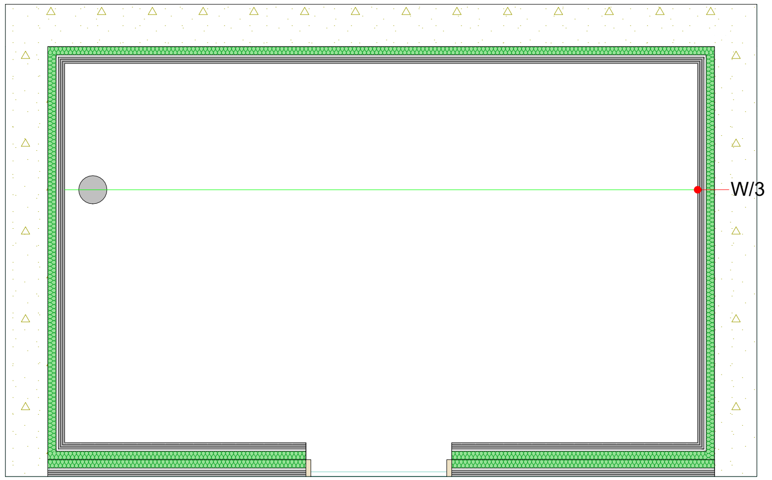
5. Simulations - Dolby 1/3 Treatment 1





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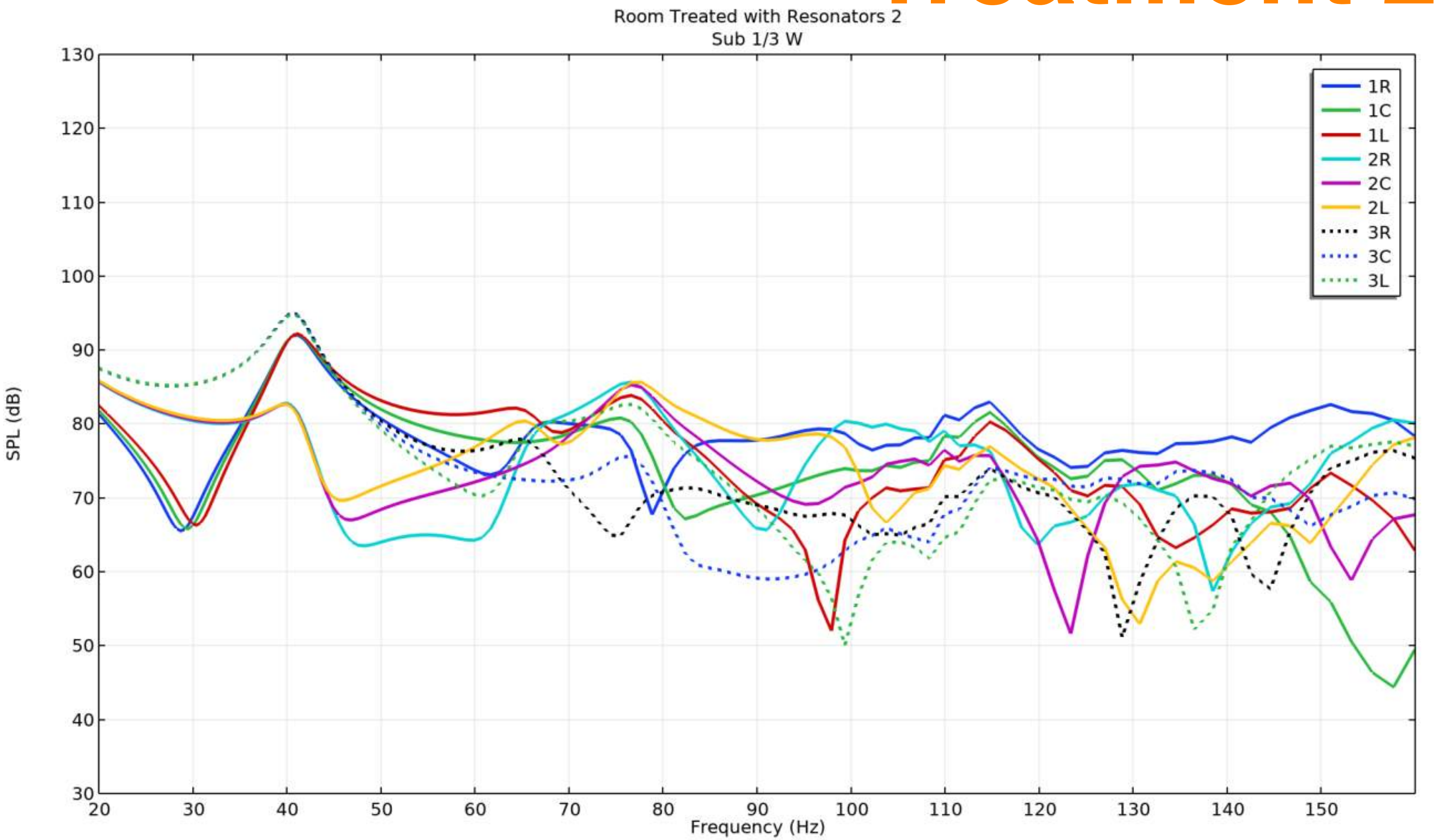
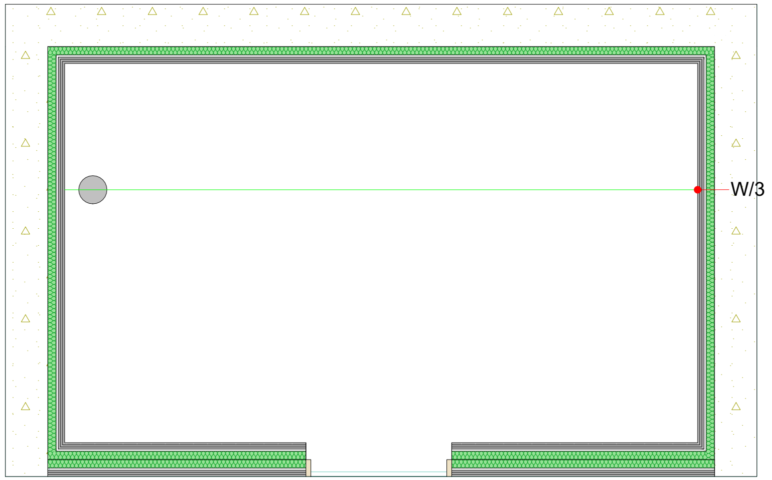
5. Simulations - Dolby 1/3 Treatment 2





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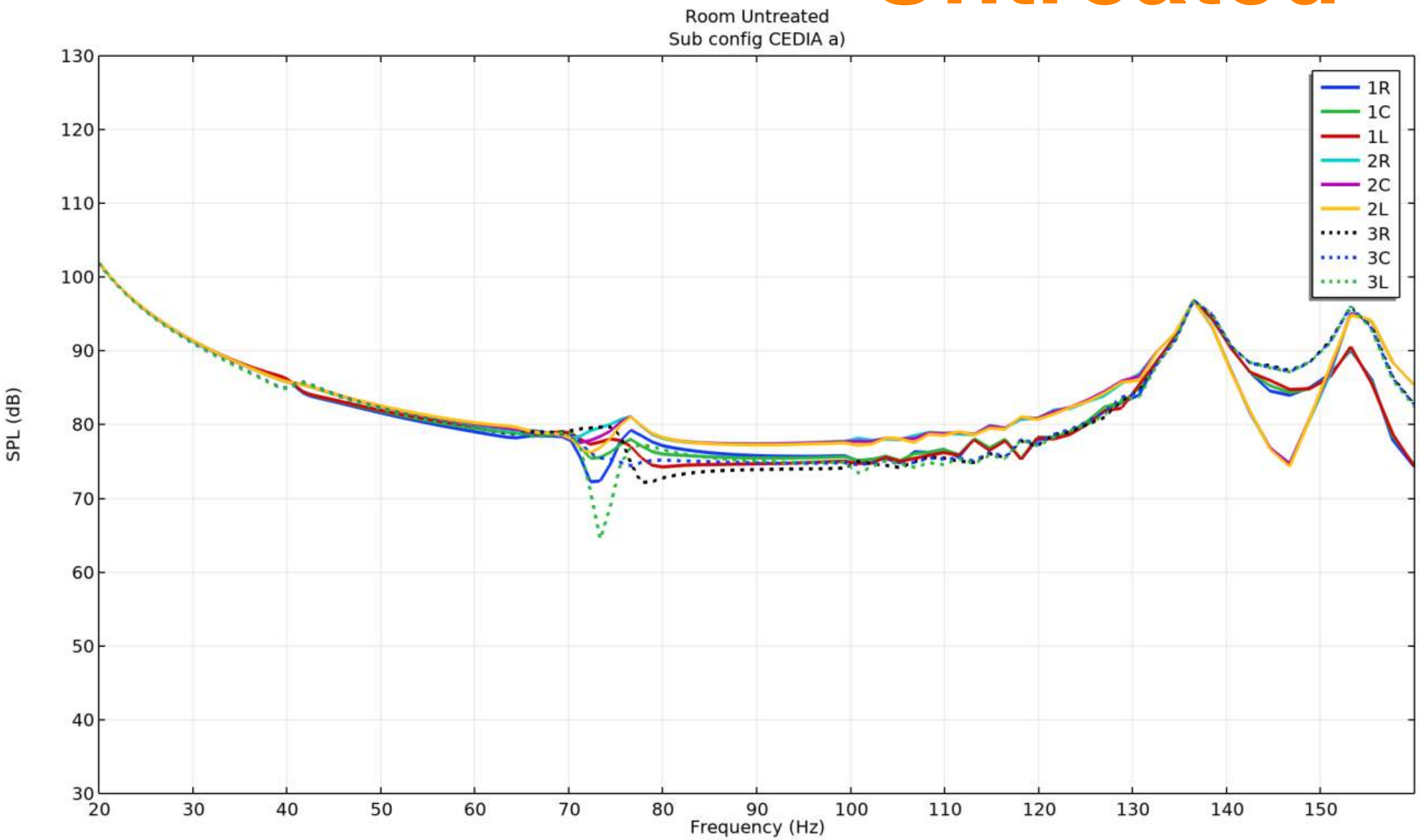
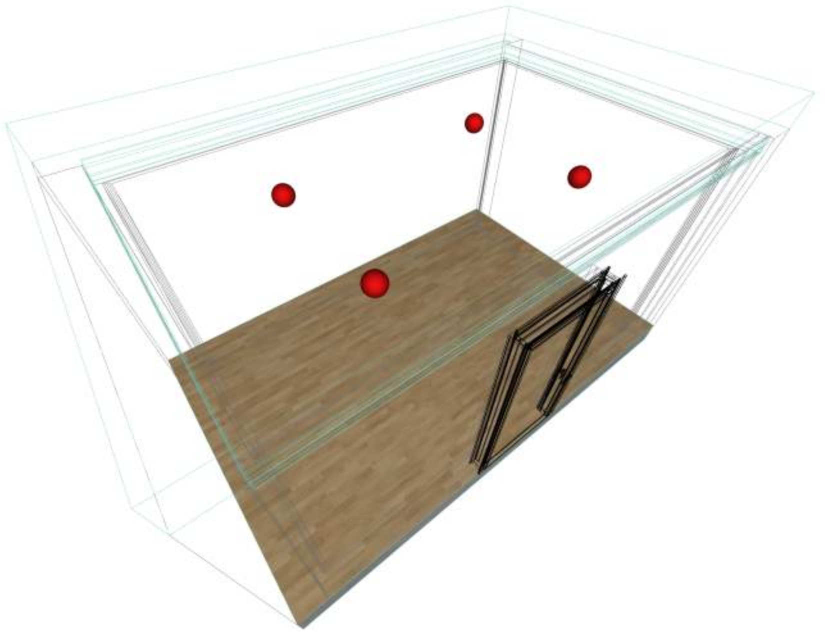
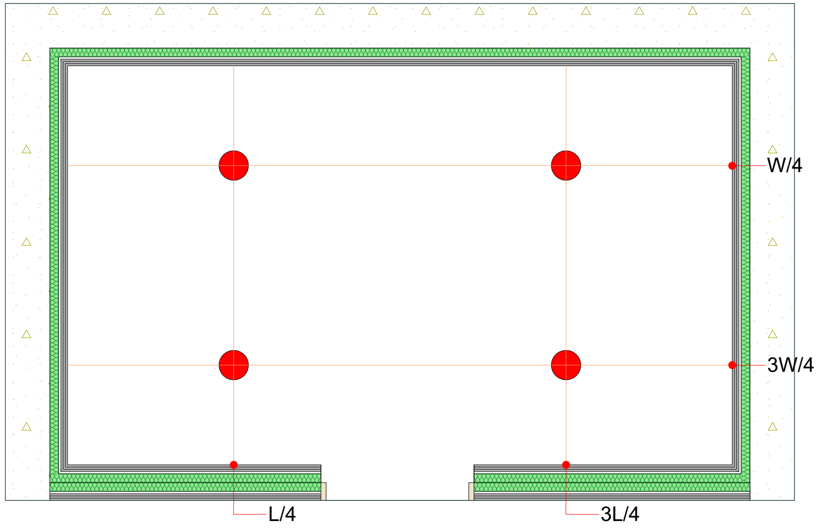
5. Simulations - Cedia a) Untreated







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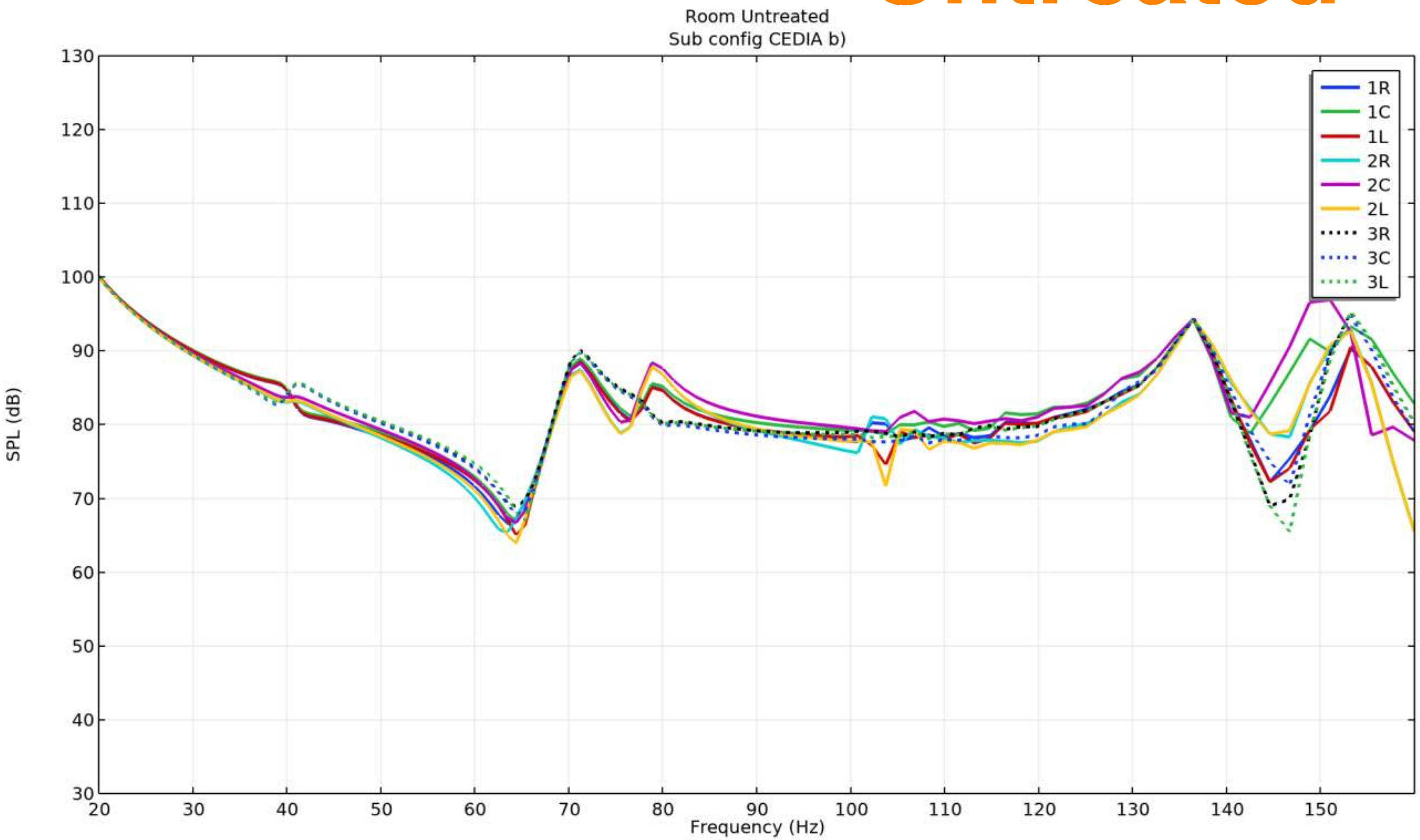
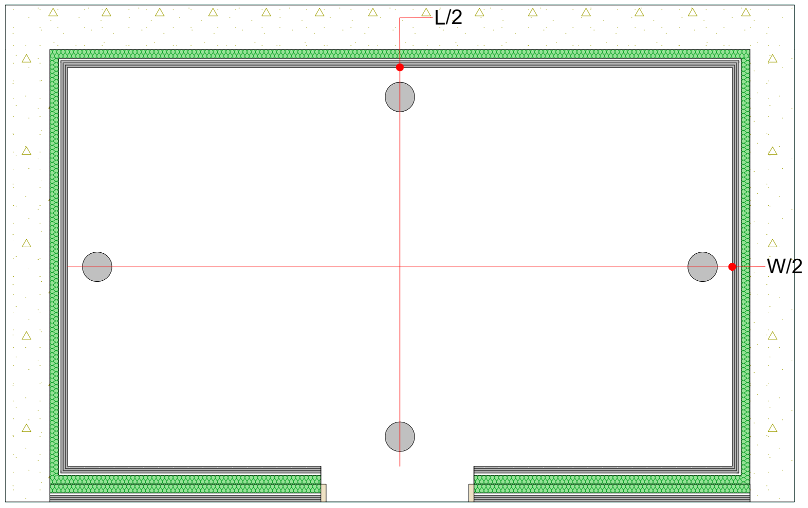
5. Simulations - Cedia b) Untreated





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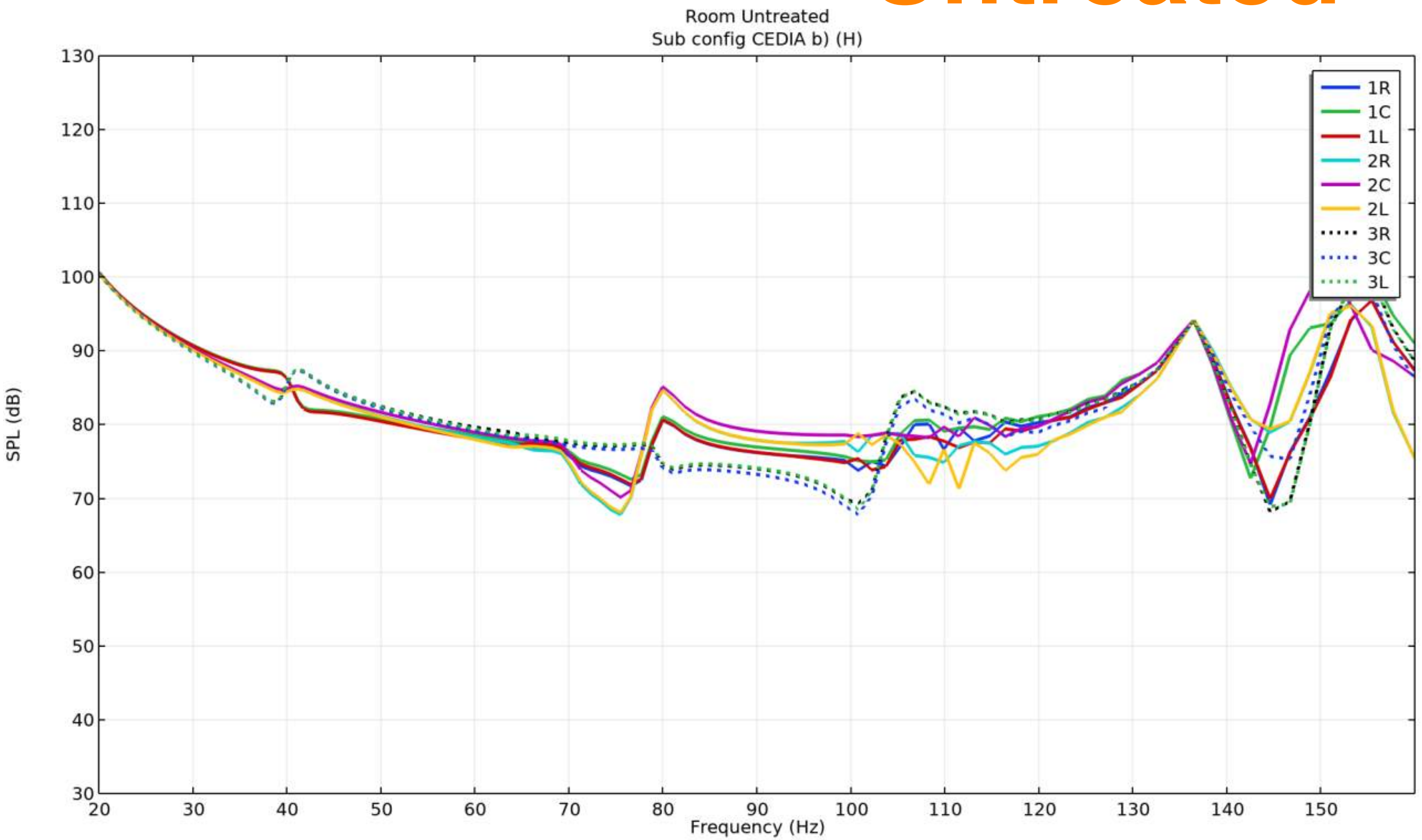
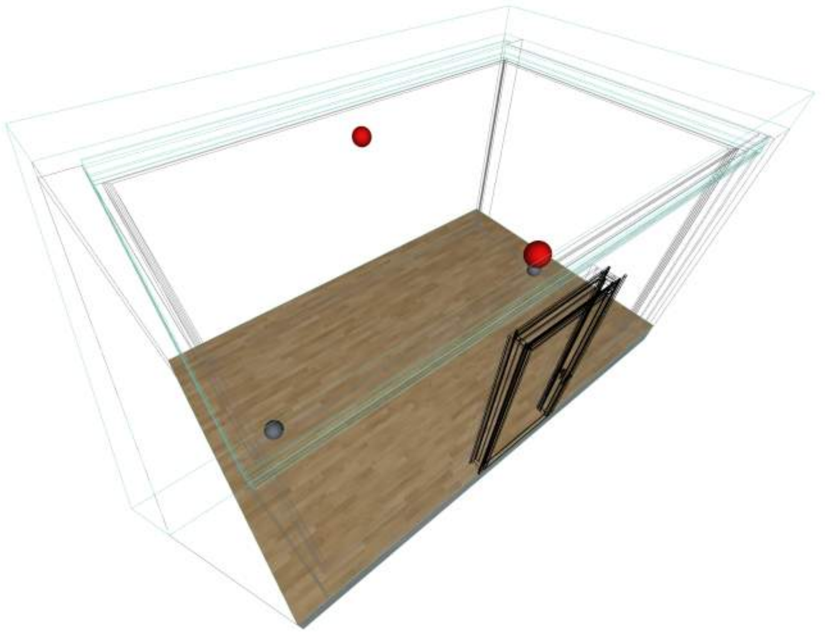
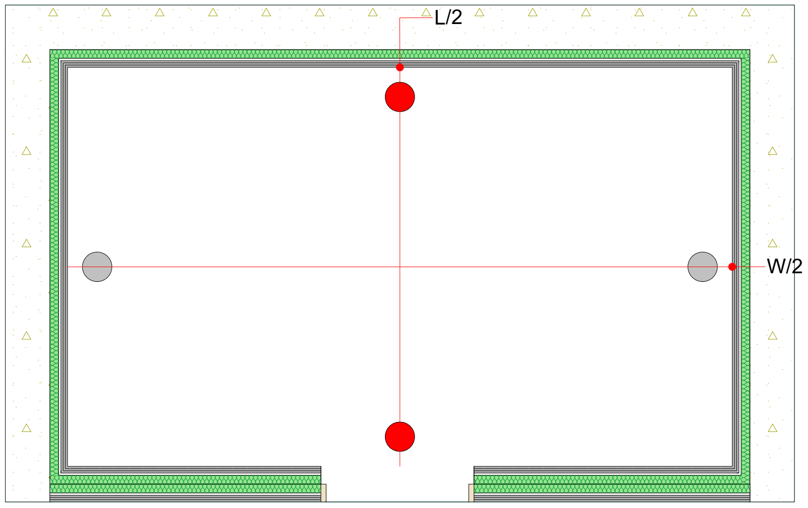
5. Simulations - Cedia b_h) Untreated







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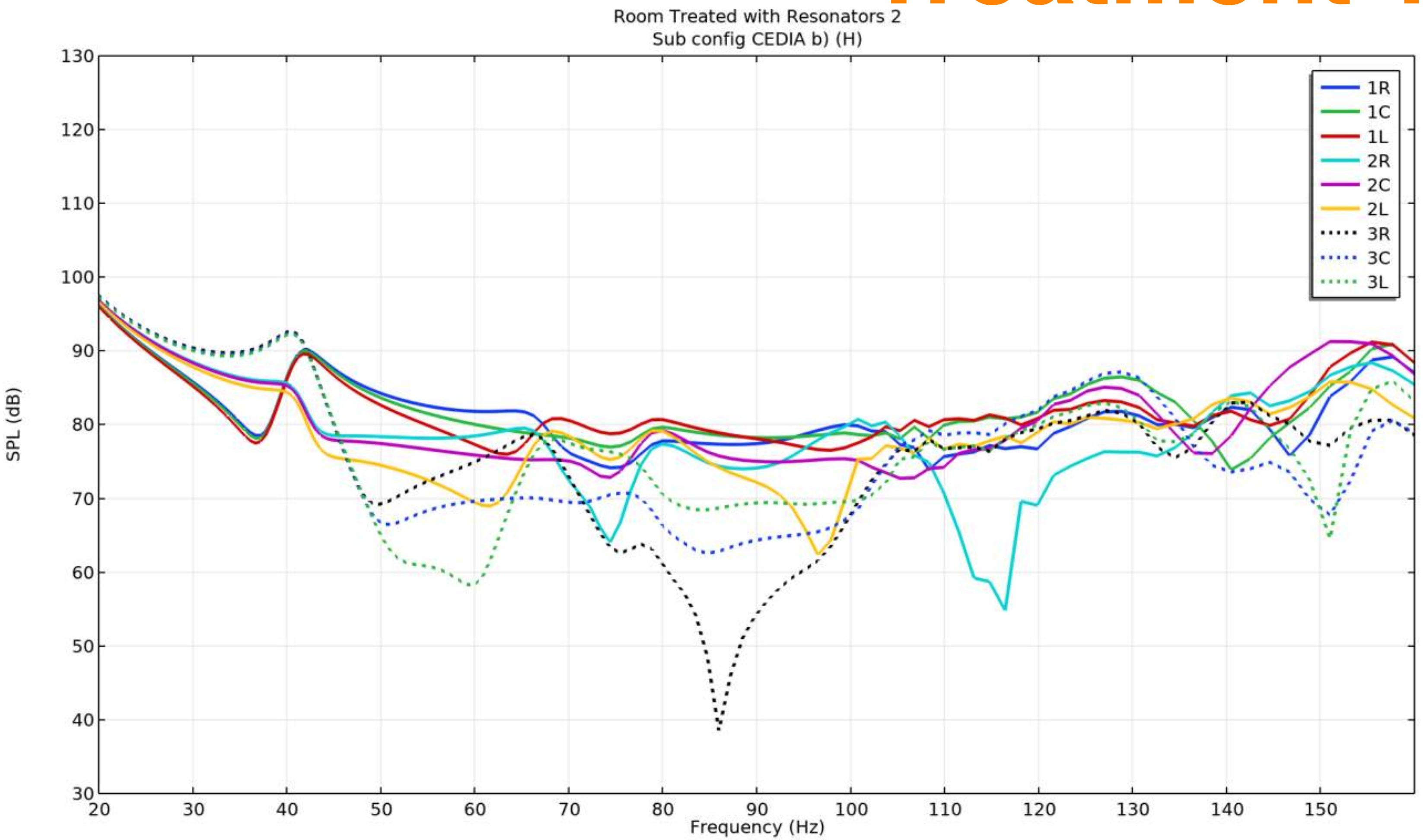
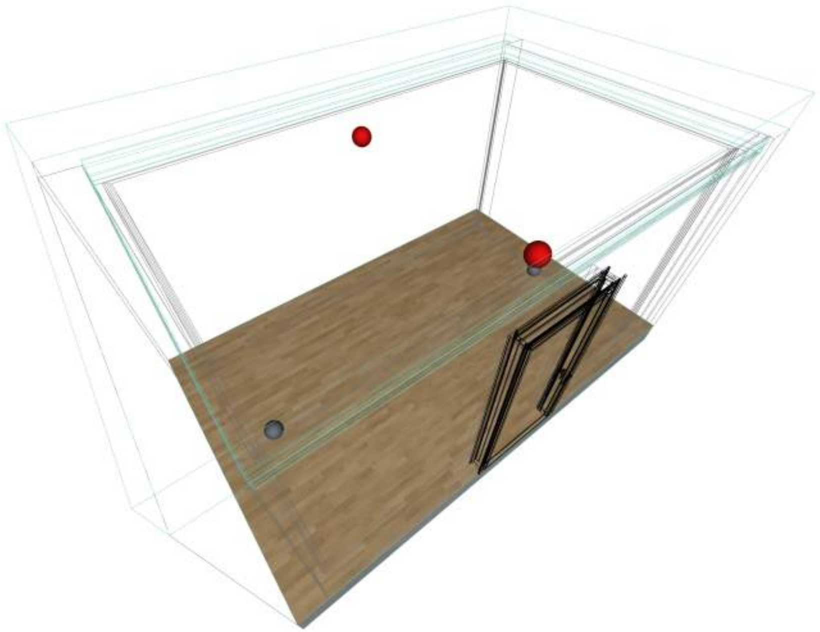
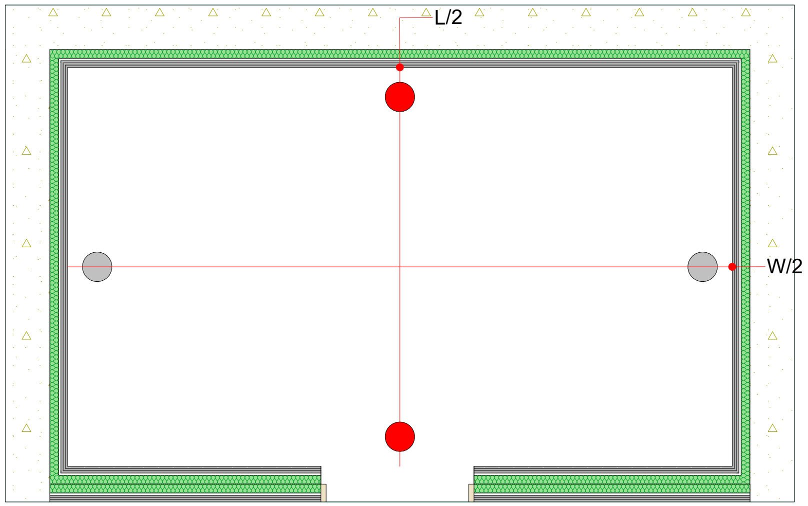
5. Simulations - Cedia b_h) Treatment 1







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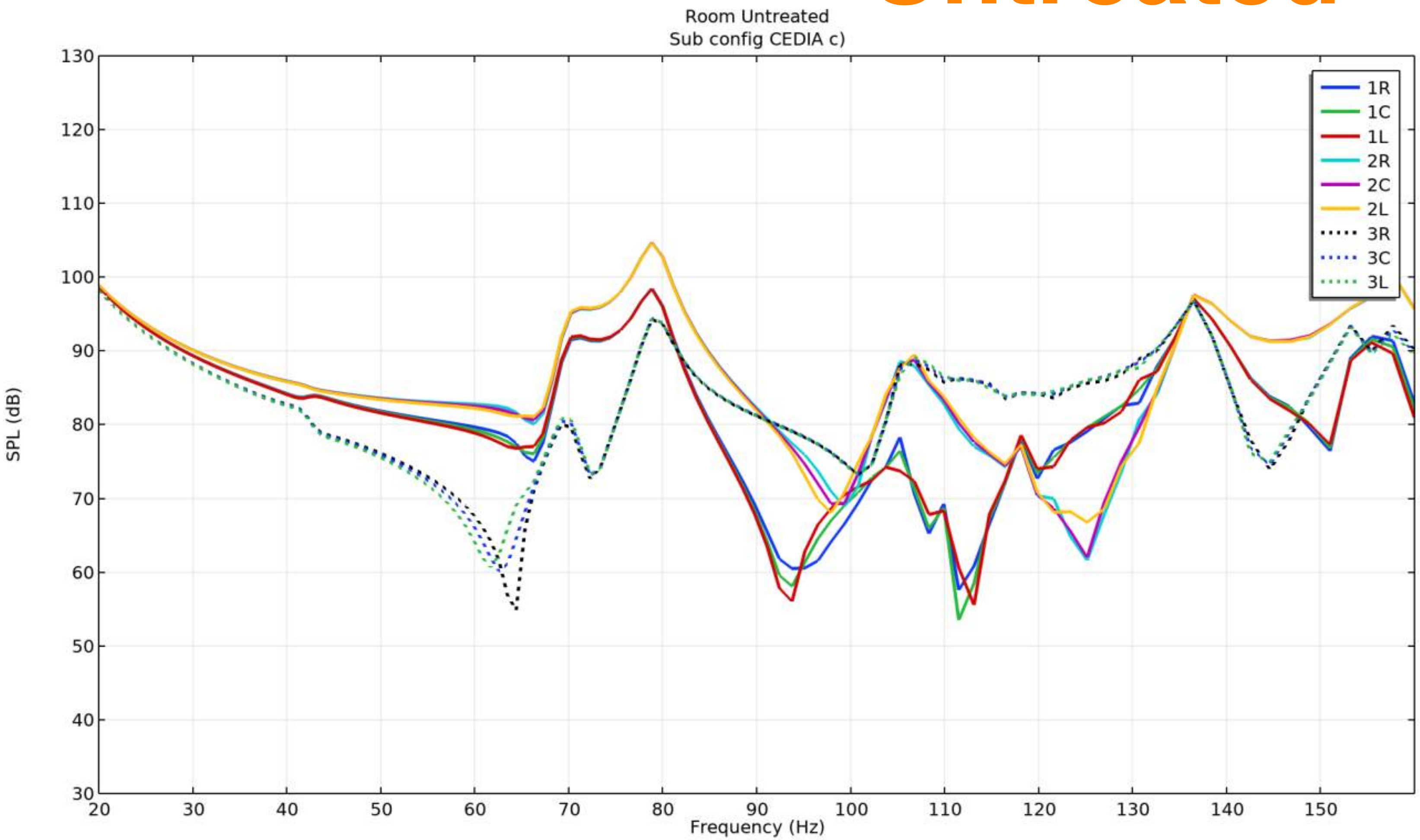

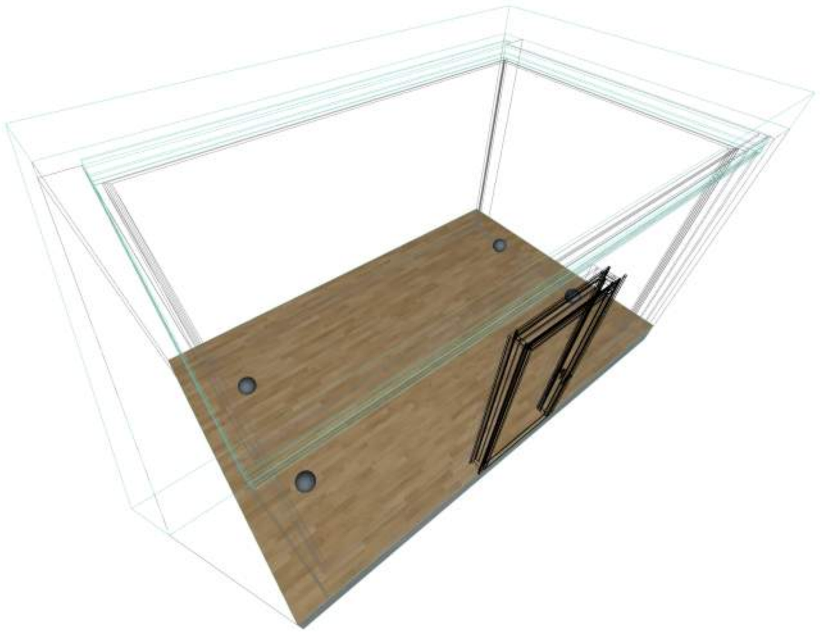

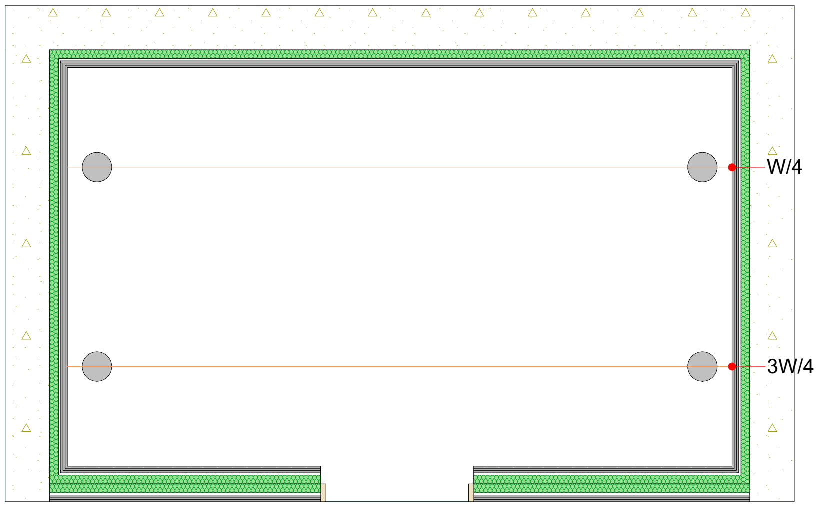

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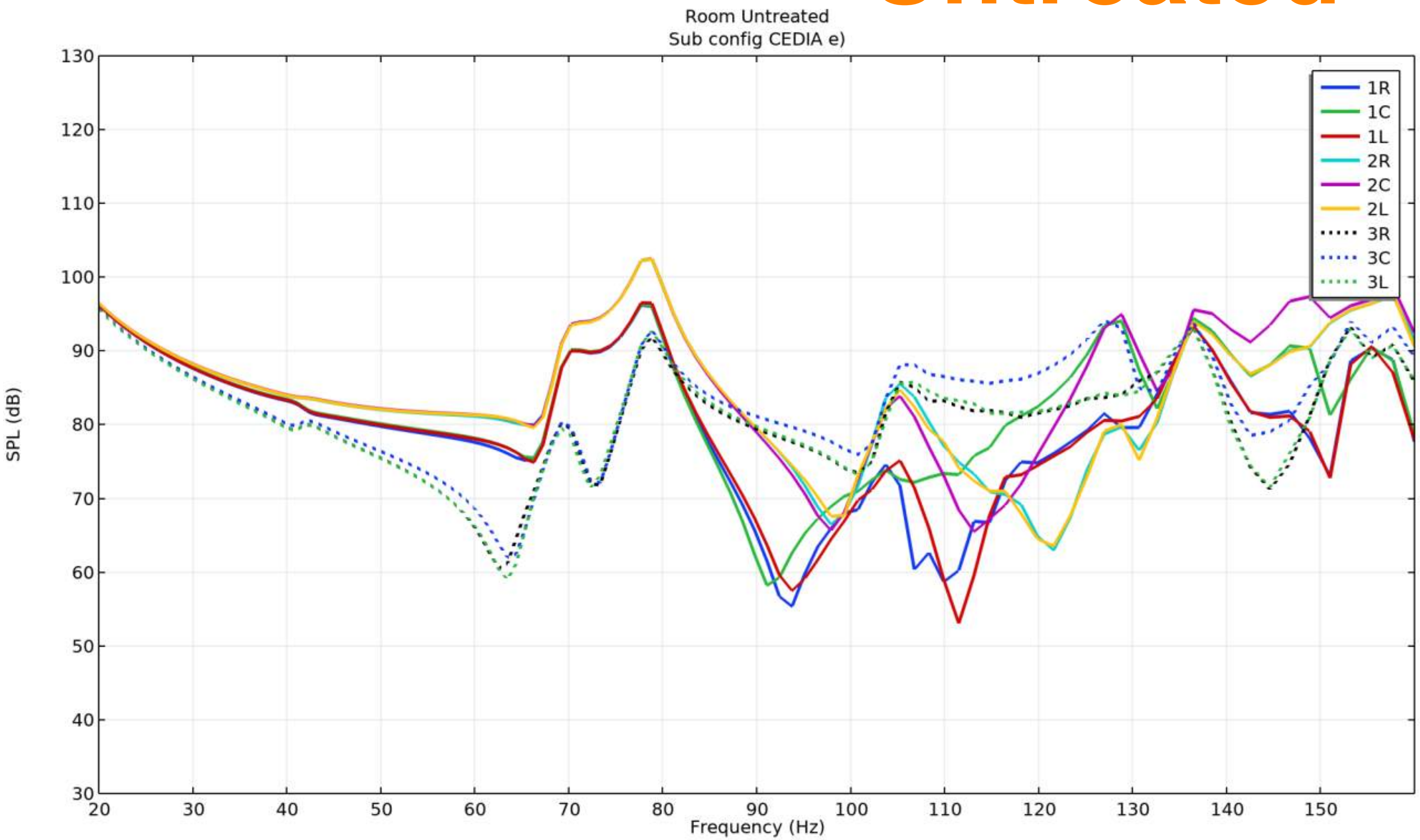
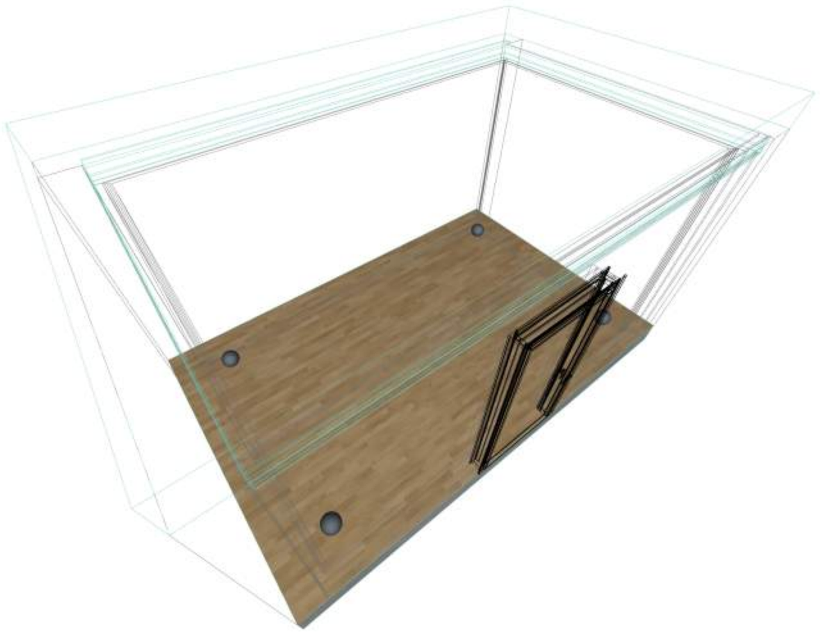
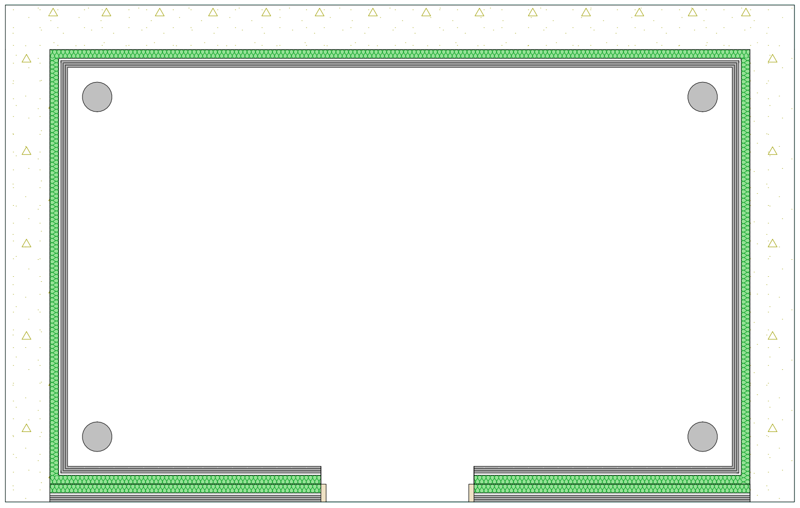
5. Simulations - Cedia e) Untreated







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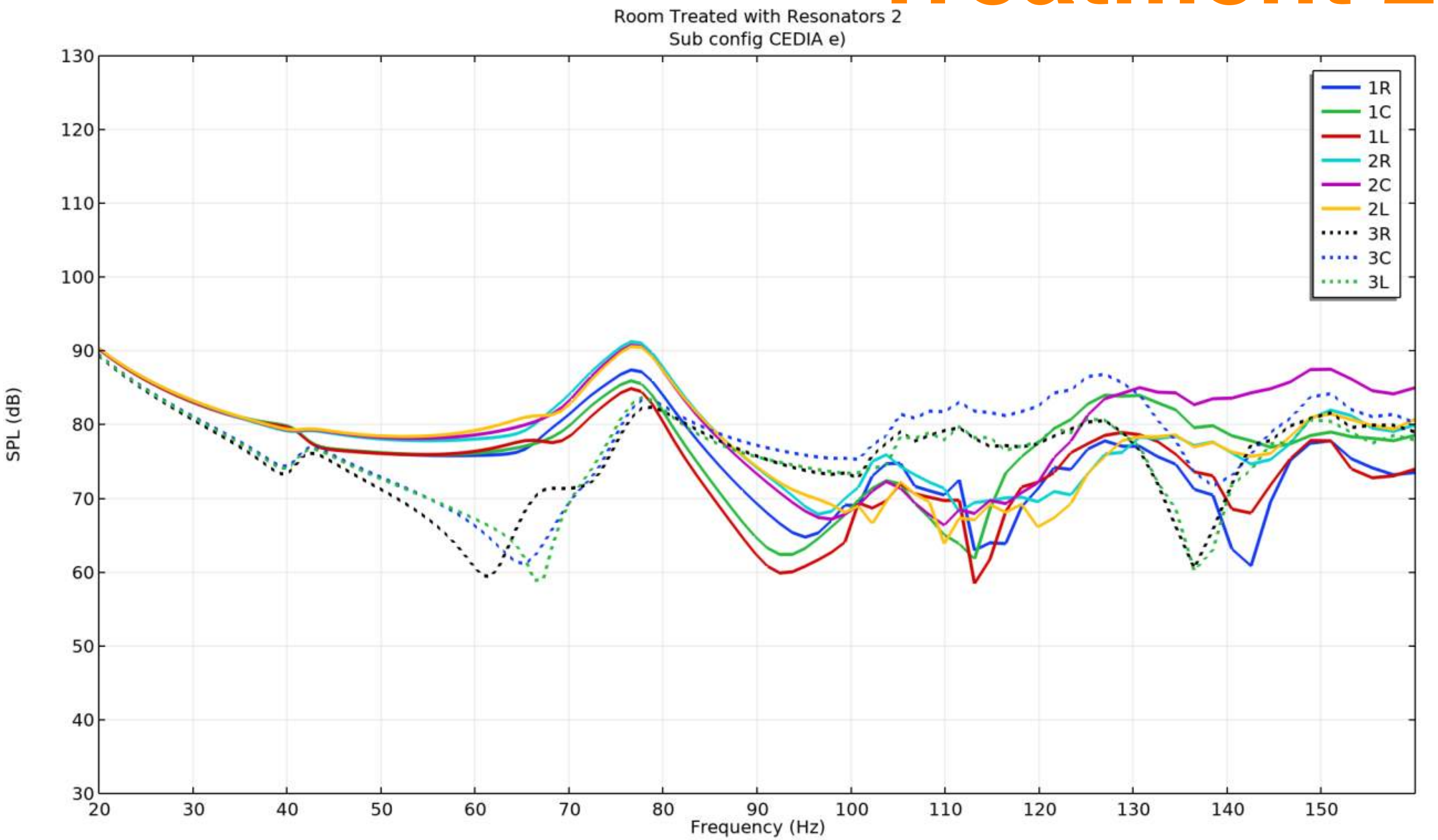
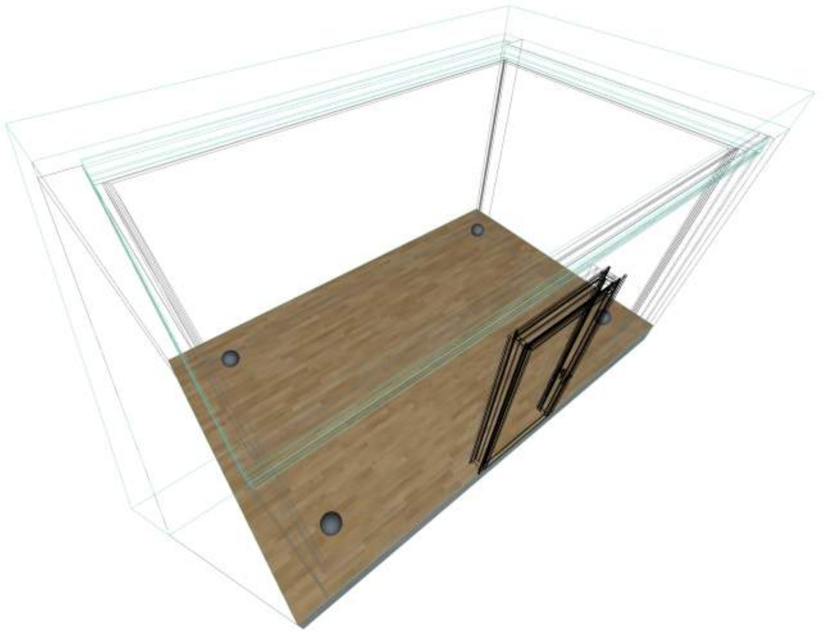
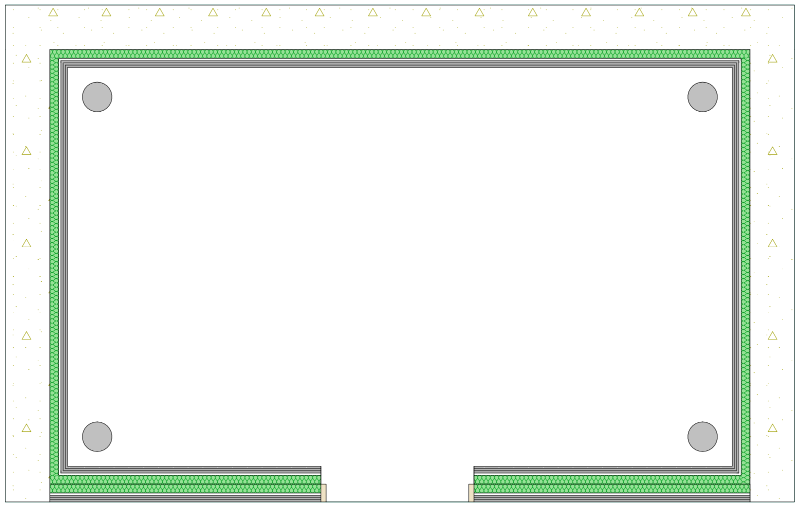
5. Simulations - Cedia e) Treatment 2







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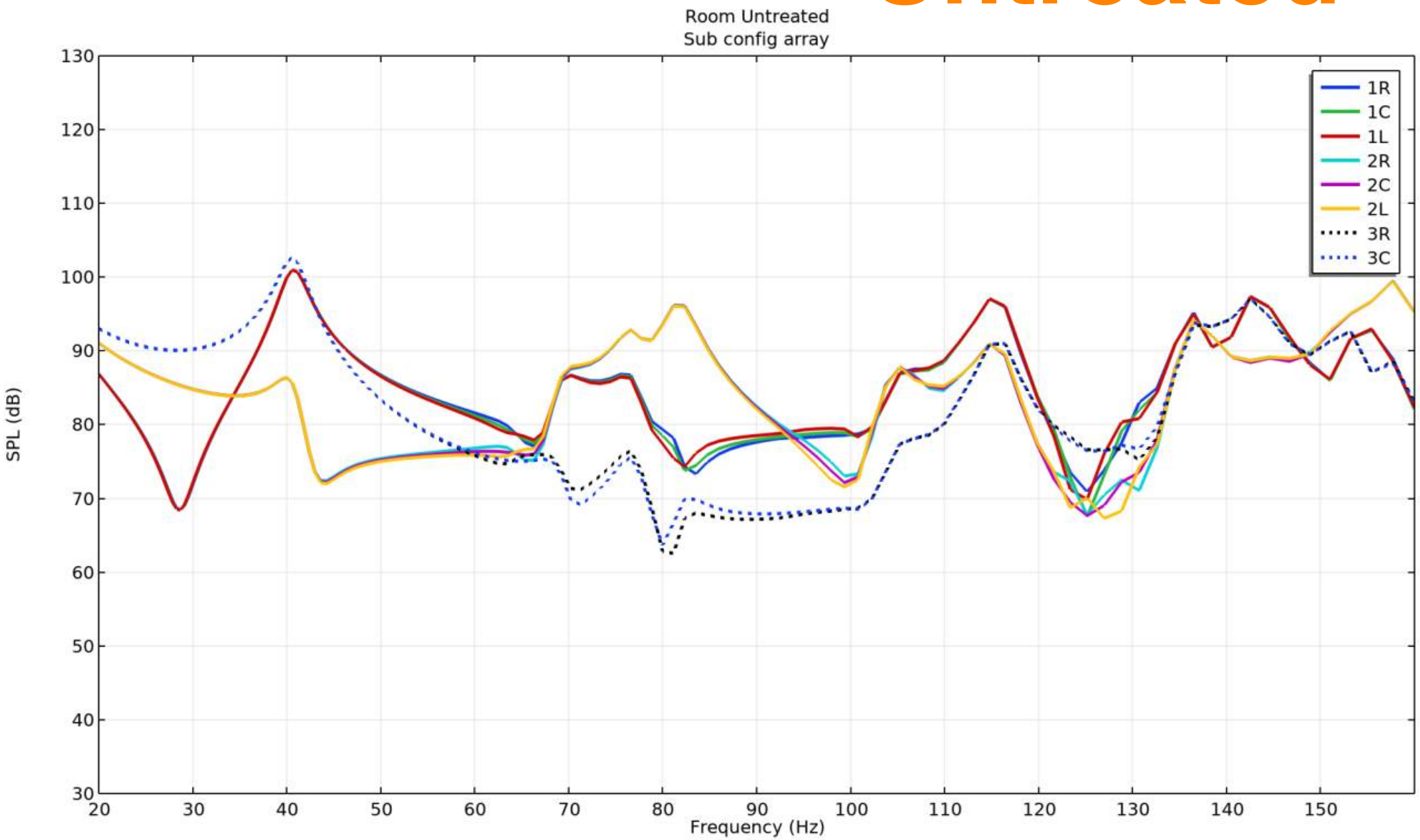
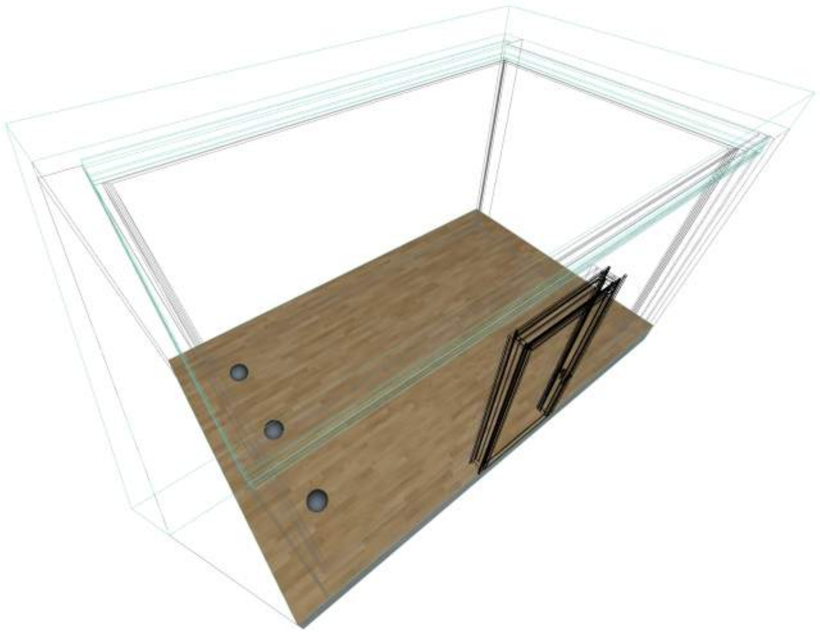
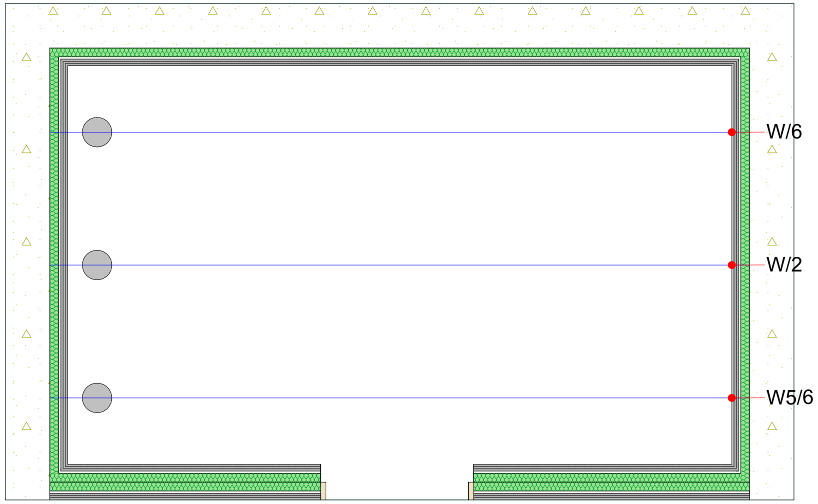
5. Simulations - Array Untreated







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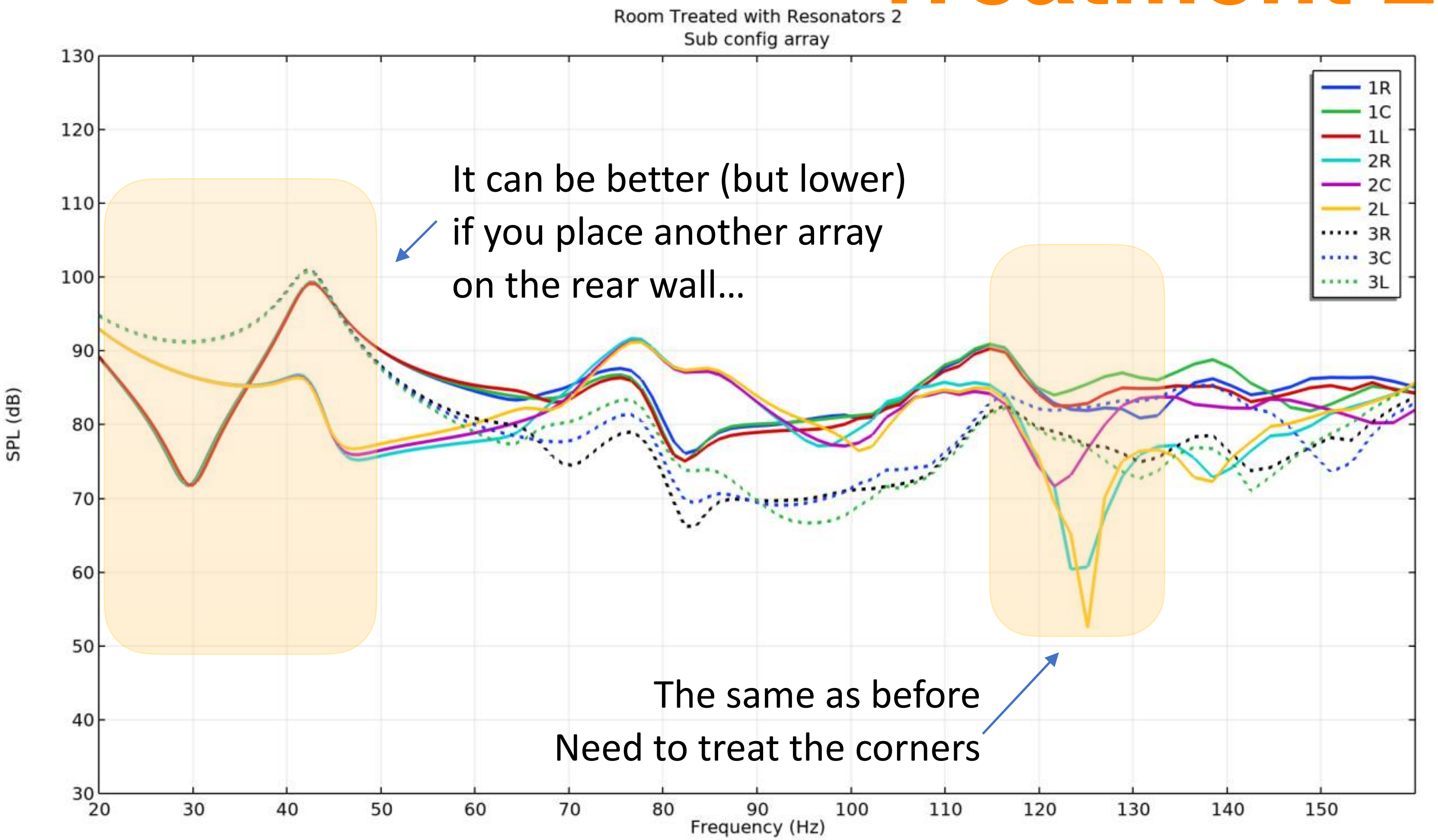
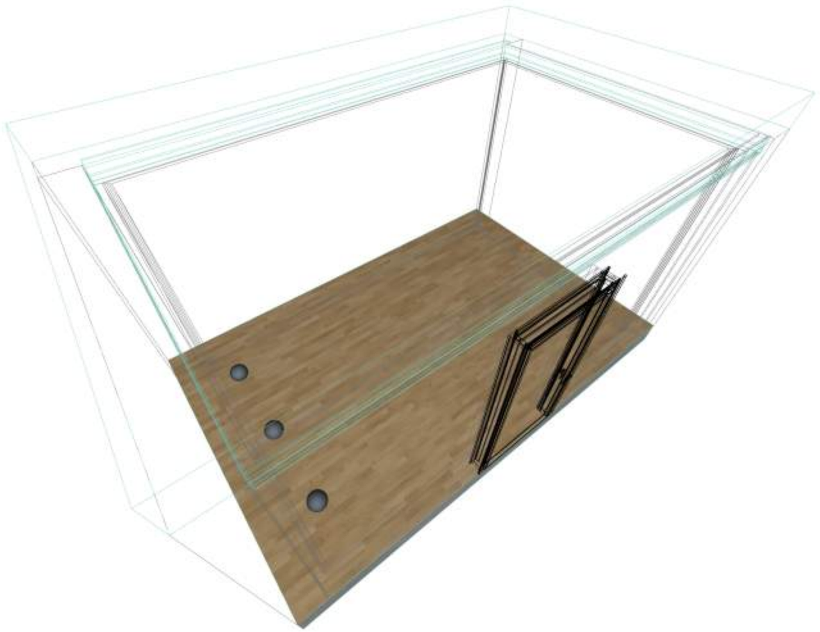
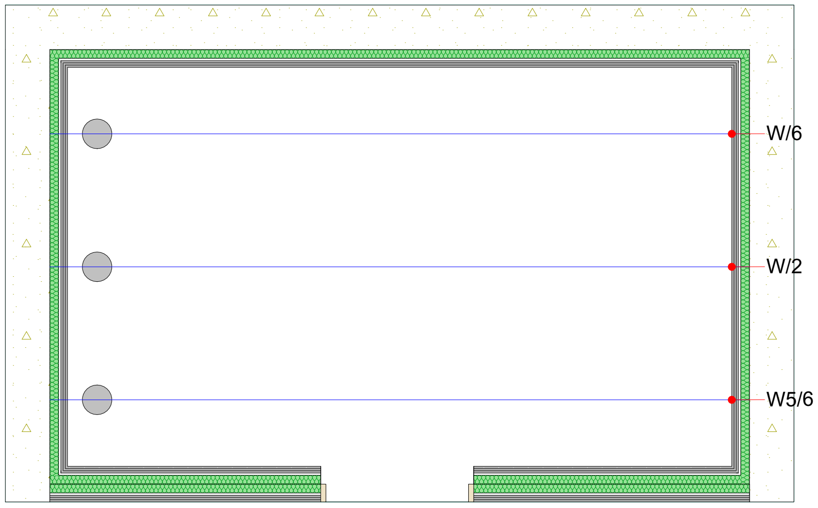
5. Simulations - Array Treatment 2



It can be better (but lower) if you place another array on the rear wall...

The same as before
Need to treat the corners





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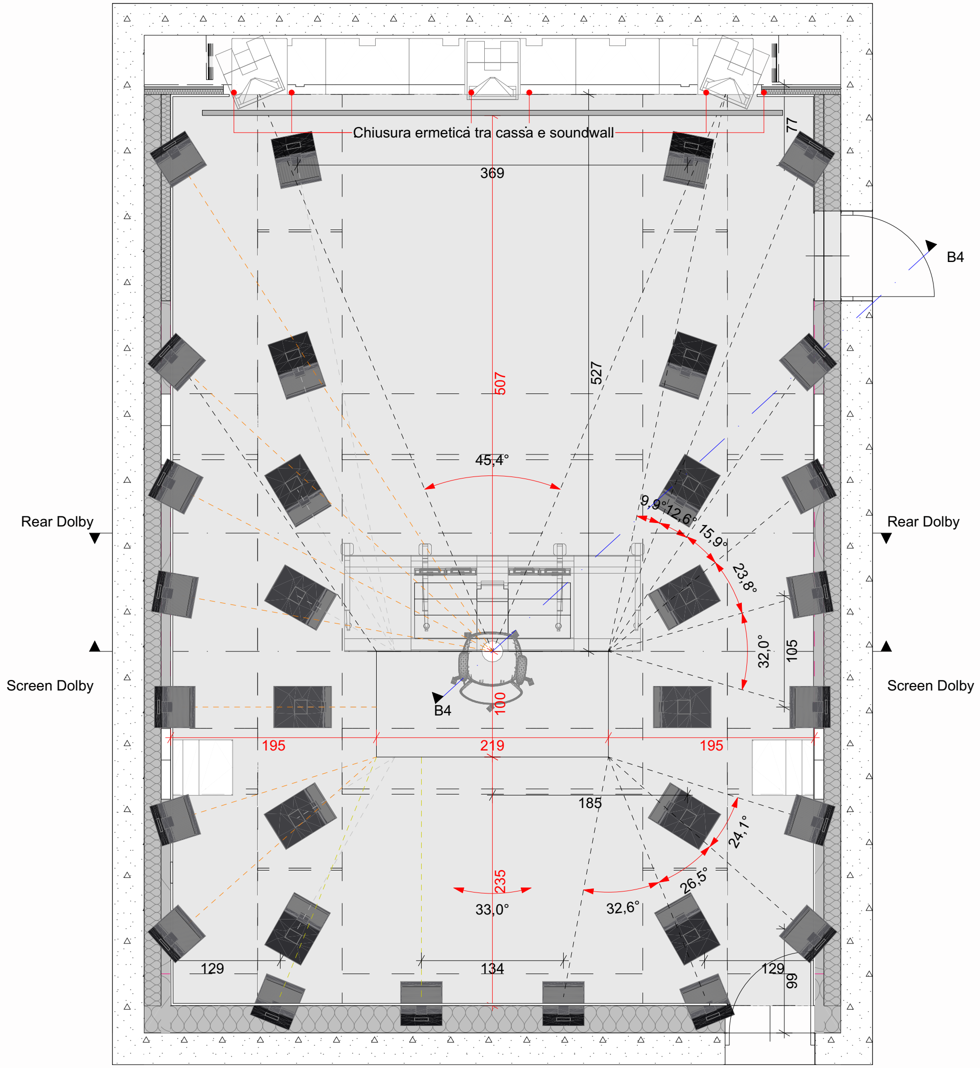
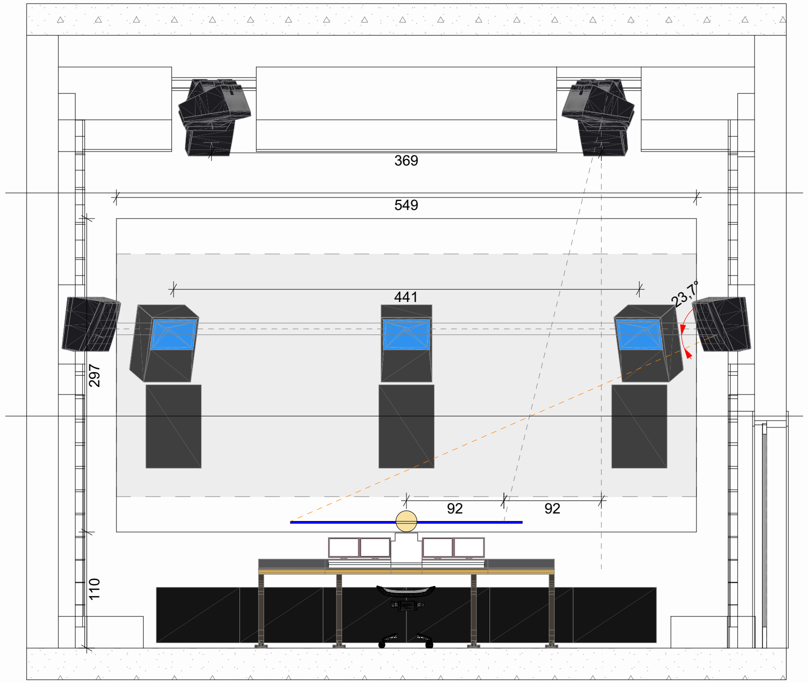


Layout 1:50



Screen elevation 1:50

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Tel. +39 055 2020574
www.studiosoundservice.com

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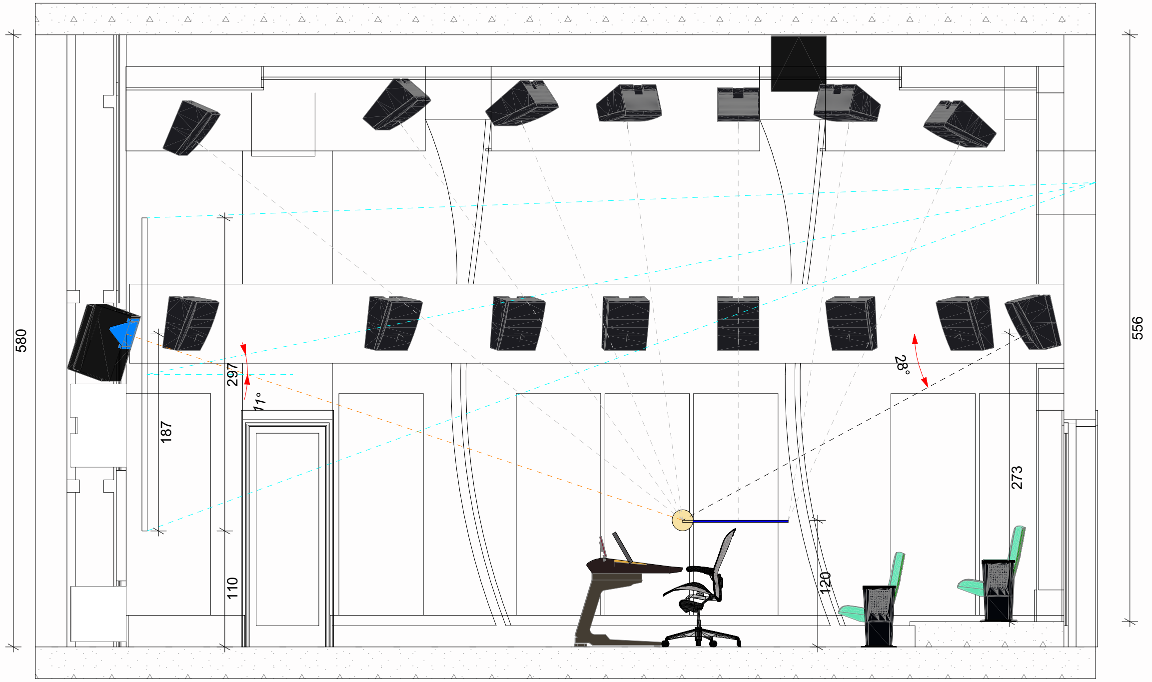
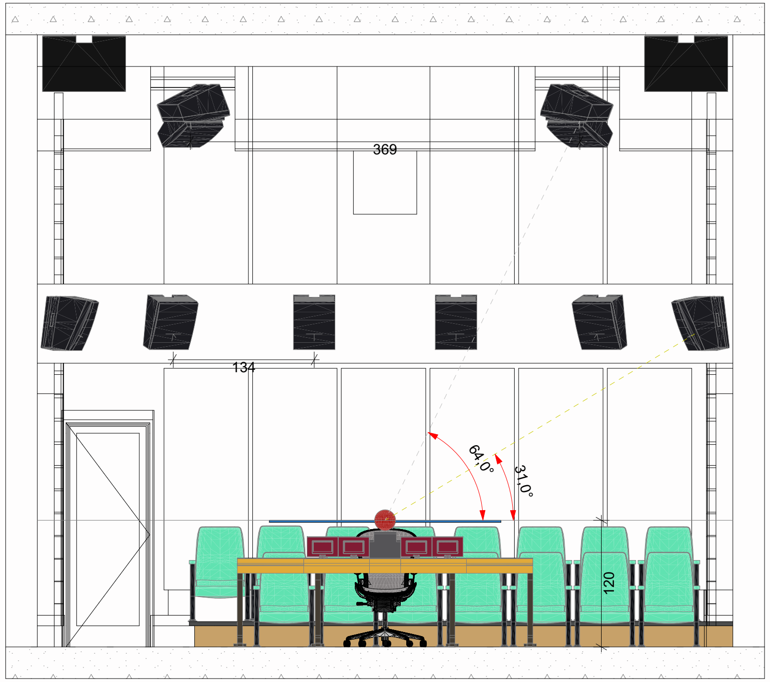
Acoustic Design: **Studio Sound Service**

Date	Drawing Number	Title	Dr. Scale	Client	Project
11/12/2023	**19 / 21**	**Dolby** Layout and sections	**1:50**	**Cinecittà**	**Sala E**
Revision **Definitive**					



Side elevation 1:50



Rear elevation 1:50

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Acoustic Design: **Studio Sound Service**

Date	Drawing Number	Title	Dr. Scale	Client	Project
11/12/2023	**20 / 21**	**Dolby** Sections	**1:50**	**Cinecittà**	**Sala E**
Revision **Definitive**					

DARDT Status

The tool does not ensure full approval of the selected equipment and displayed speaker positions. The design and equipment needs to be approved in conjunction with loudspeaker configuration plans by Dolby Atmos design approvers.

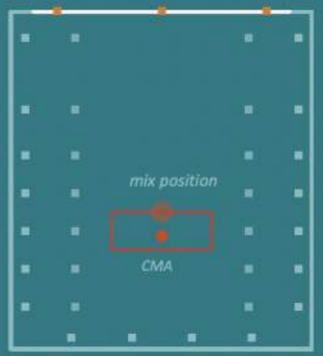
Room Data	(Metric)	Length (m)	Width (m)	Length of raked staging (m)	Room Height at Screen (m)	Room Height at Booth (m)
Show Label Guide		8,9	6,6	6,7	5,8	5,6

Application	Speakers per Side Wall (7 recommended)	Speakers Booth Wall (6 recommended)	Surround Subwoofers	3/5 Screen Speakers	Amping Screen Speakers
Dolby Atmos Feature Studio	7	4	2	3	bi-amped

Screen Width (m)	Screen Ratio	Screen Bottom to Floor (m)
5,6	Flat	1,1
Speaker-Screen-Spacing	**Linear Spacing Distance**	**ISS Rear (m)**
1,3	1,0	1,3

Auditorium Configuration Options

Amplifier Channels Side	7	Screen subwoofers, LFE clustered	☑
Amplifier Channels Top	7	Screen subwoofers, LFE floor mounted	☑
Top Speakers *Checkbox for equidistant spacing*	7 ☐	Surround subwoofers behind screen	☐
Rear Surround Pairing	☐	Surround subwoofers mounted in joint of floor/wall or wall/ceiling	☑



Full linear spacing selected

Location	Speaker Channel	Loudspeaker Throw Distance Coordinates referenced from Mix Position: X (m)	Y (m)	Z (m)	3D distance from mix pos (m)	Speaker (*Click here for screen speaker target SPL´s*): Speaker Model *Checkbox only for active loudspeakers*	Speaker Watts (Cont.)	dB SPL 1W@1m	Ω	Active Speaker: Maximum Peak SPL (dB)	Required Power Rating for Speaker selected: Watts required 102dB	Watts required for target SPL	Watts re-quired per speaker 115dB	Headroom above target SPL (dB)	Amplifier: Amplifier Model	stereo/ bridged	Ω	Watts available *Single Channel driven*	Amp headroom over target (dB)	Notes	Cables: Length (m)	ø (mm2)
Screen Left	L (LF)	2,3	5,3	1,8	6,2	Meyer Bluehorn System ☑				132,1				5,3					0		25,0	
	L (HF)																		0		25,0	
Screen Center	C (LF)		5,3	1,8	5,7	Meyer Bluehorn System				132,1				5,9					0		25,0	
	C (HF)																		0		25,0	
Screen Right	R (LF)	2,3	5,3	1,8	6,2	Meyer Bluehorn System				132,1				5,3					0		25,0	
	R (HF)																		0		25,0	
LFE	LFE		5,3	-0,9	5,3	Meyer X-400C ☑				123,0	6 unit			5,0					0		25,0	
Surr. Subw.	SUB 1	3,0	-1,1	4,6	5,6	Meyer X-400C ☑				128,6	1 unit			4,6				W	0		15,0	
	SUB 2	3,0	-1,1	4,6	5,6	Meyer X-400C				128,6	1 unit			4,6				W	0		15,0	
Side Surround	LSS 1	3,0	4,6	1,8	5,8	Meyer HMS-10 ☑				126,6				3,4					0		20,0	
	LSS 2	3,0	2,7	1,8	4,4	Meyer HMS-10 ☑				126,6				5,7					0		20,0	
	LSS 3	3,0	1,5	1,8	3,8	Meyer HMS-10 ☑				126,6				7,0					0		15,0	
	LSS 4	3,0	0,5	1,8	3,5	Meyer HMS-10 ☑				126,6				7,6					0		15,0	
	LSS 5	3,0	-0,5	1,8	3,5	Meyer HMS-10 ☑				126,6				7,6					0		15,0	
	LSS 6	3,0	-1,5	1,8	3,8	Meyer HMS-10 ☑				126,6				7,0					0		15,0	
	LSS 7	3,0	-2,5	1,8	4,3	Meyer HMS-10 ☑				126,6				5,9					0		15,0	
	LSS 8					☑													0			
	LSS 9					☑													0			
	LSS 10					☑													0			
	LSS 11					☑													0			
	LSS 12					☑													0			
	RSS 1	3,0	4,6	1,8	5,8	Meyer HMS-10 ☑				126,6				3,4					0		20,0	
	RSS 2	3,0	2,7	1,8	4,4	Meyer HMS-10 ☑				126,6				5,7					0		20,0	
	RSS 3	3,0	1,5	1,8	3,8	Meyer HMS-10 ☑				126,6				7,0					0		15,0	
	RSS 4	3,0	0,5	1,8	3,5	Meyer HMS-10 ☑				126,6				7,6					0		15,0	
	RSS 5	3,0	-0,5	1,8	3,5	Meyer HMS-10 ☑				126,6				7,6					0		15,0	
	RSS 6	3,0	-1,5	1,8	3,8	Meyer HMS-10 ☑				126,6				7,0					0		15,0	
	RSS 7	3,0	-2,5	1,8	4,3	Meyer HMS-10 ☑				126,6				5,9					0		15,0	
	RSS 8					☑													0			

Conclusions

- There are some subwoofer configurations that linearize the FR and make it more uniform in space, but they don't make the room resonate at all, therefore they are definitely less efficient

- If the BM crossover is low (<80Hz), the perception of source location doesn't change much – be careful because the LFE goes up to 120 Hz and its location is perceivable!
  Therefore, content plays a fundamental role in placement decisions

- Even if the FR is linear, it doesn't mean you have good listening conditions.
  The reverberation time and its frequency behavior make the difference

- There are additional aspects regarding the attack and release of low frequencies that play a fundamental role in both active and traditional acoustic treatment

- Debunking the single-frequency myth: There's never just one frequency to treat. When you address the most obvious one, others become apparent. It's always about broadband treatment

- To achieve excellent results, one must be knowledgeable about both the active part and traditional acoustics in a room

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Music Studios

Sudestudio

Guagnano – LE

Sugar Music

Milan

Aemme Recording Studio
Salvatore Addeo

Lecco

Waves Music

Genova

Officina Sonora del Bigallo

Bagno a Ripoli - FI

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Marzi Recording Studio

Riccione

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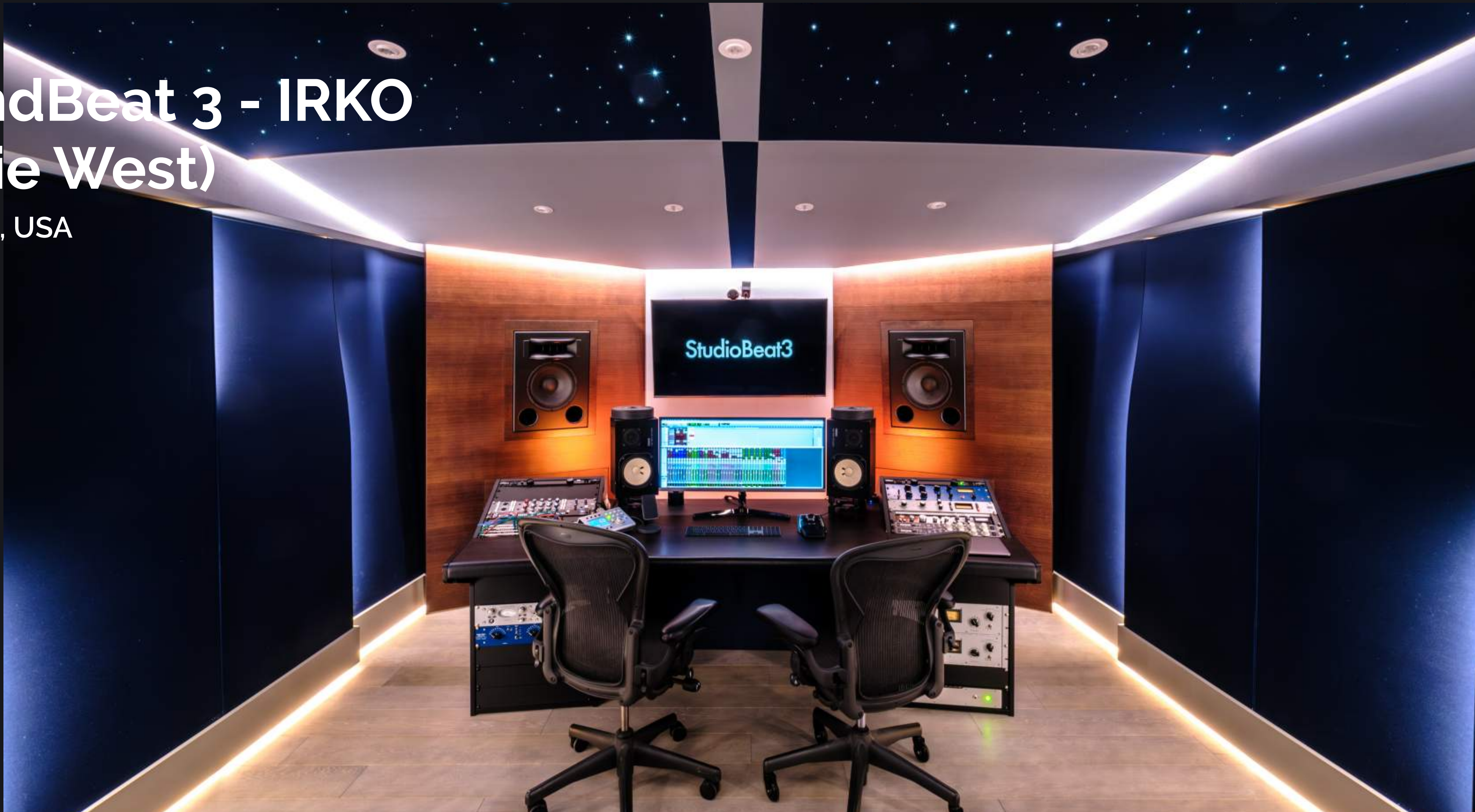
SoundBeat 3 - IRKO (Kanie West)

Pasadena, USA



Fabio Piazzalunga

Florence

Andamento Analogico

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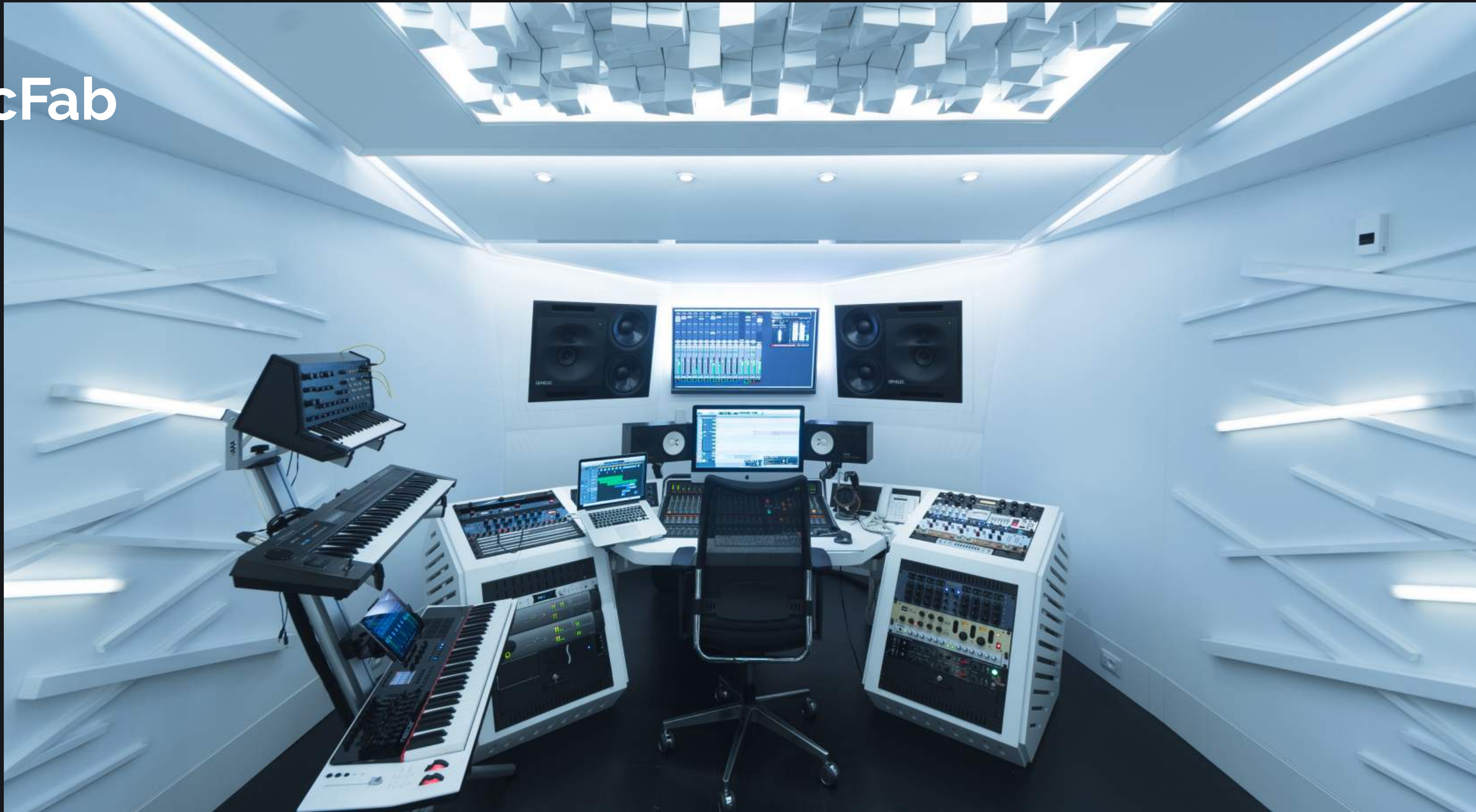
Dolby Atmos Music Studio + Rec Room

Experimental Studios

Turin

SonicFab

Pioltello



House of Glass
Gianni Bini

Viareggio

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Donato Masci
Casi studio

Recording Studio, post-production

Mulinetti Alberto Parodi

Genoa

PORFTOLIO
Post/Broadcast & Cinema studios

inHouse
Mirko Perri

Roma

Iyuno

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Cinema mixing Room, Dolby Atmos Theatrical

3Cycle

Rome

3Cycle

Rome

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Case Study

Cinema, Dolby Atmos

Cinema Barberini

Roma

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Case Study

Cinema, Dolby Atmos

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Cinema, Dolby Atmos

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Thank You!

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