Social implications of acoustic space and sociopolitical potential of spatialized sound Pt. I

Dr. Jamilla Balint & Anto Manhartsberger, BA MA

10.04.2025

Guest lecture at ETH Zürich

Audio example

Reverberation chamber
V = 241 m³
(5 x 8 x 6 m)

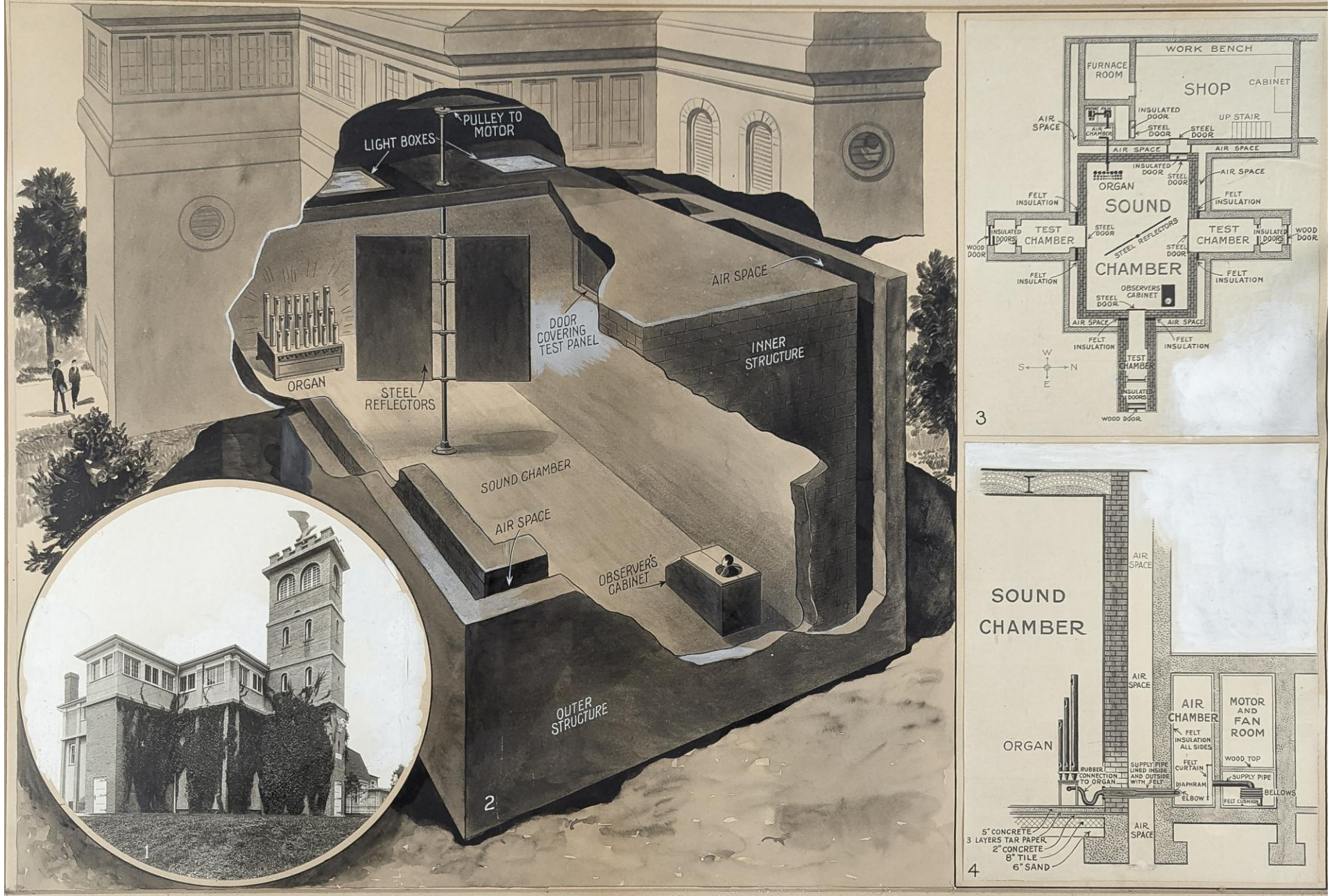
Reverberation chamber
V = 241 m³
(5 x 8 x 6 m)

11 m² glass wool

Because of the reverberation,
there’s always more to the sound than just the sound.
Listen to everything all the time
and remind yourself when you are not listening.

Pauline Oliveros, 2010

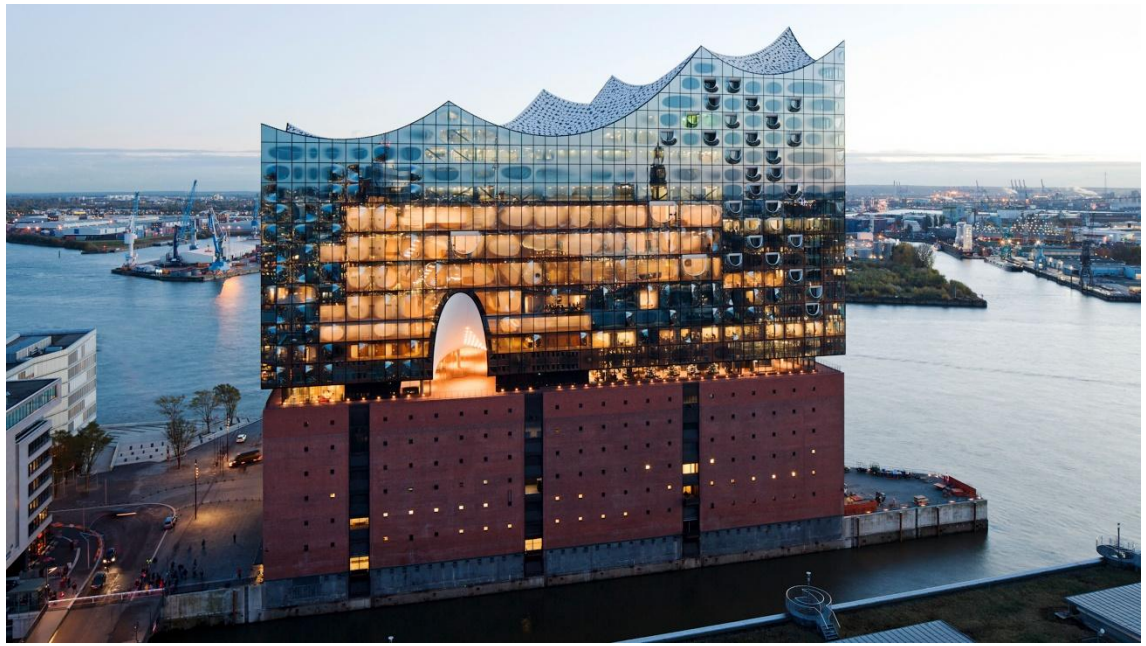

3



SCIENTIFIC AMERICAN

SEPTEMBER 1923

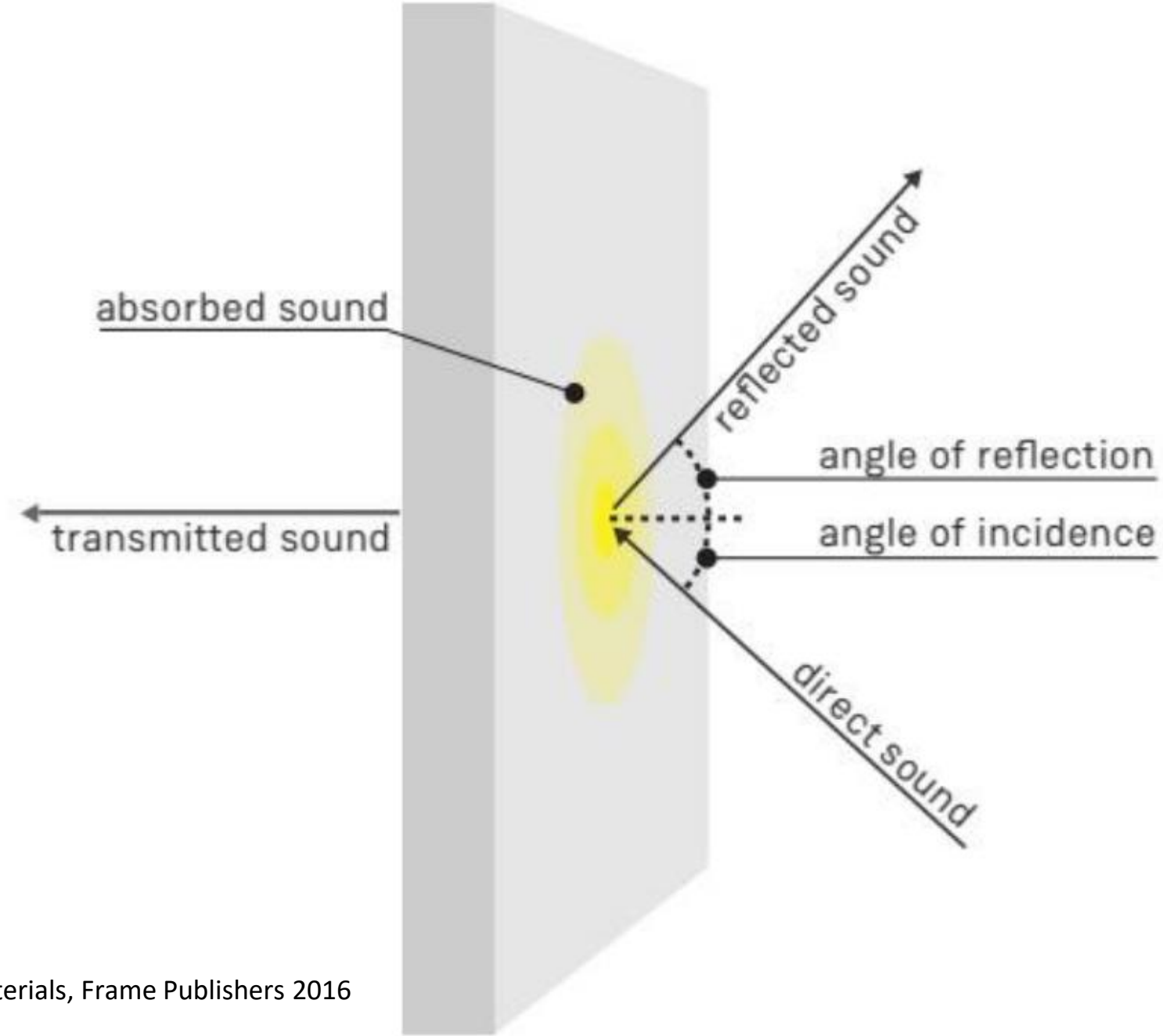
Historical development



Acoustic Environment

When sound collides with a surface, it interacts with and responds to the material and formal conditions of that surface. These interactions, however subtle they may be, are conveyed to the listener when sound reflects from the boundaries of our environment and arrives at our ears. All materials reflect or absorb sound in their own particular manner.

[1] Tyler Adamy: Sound Materials, Frame Publishers 2016



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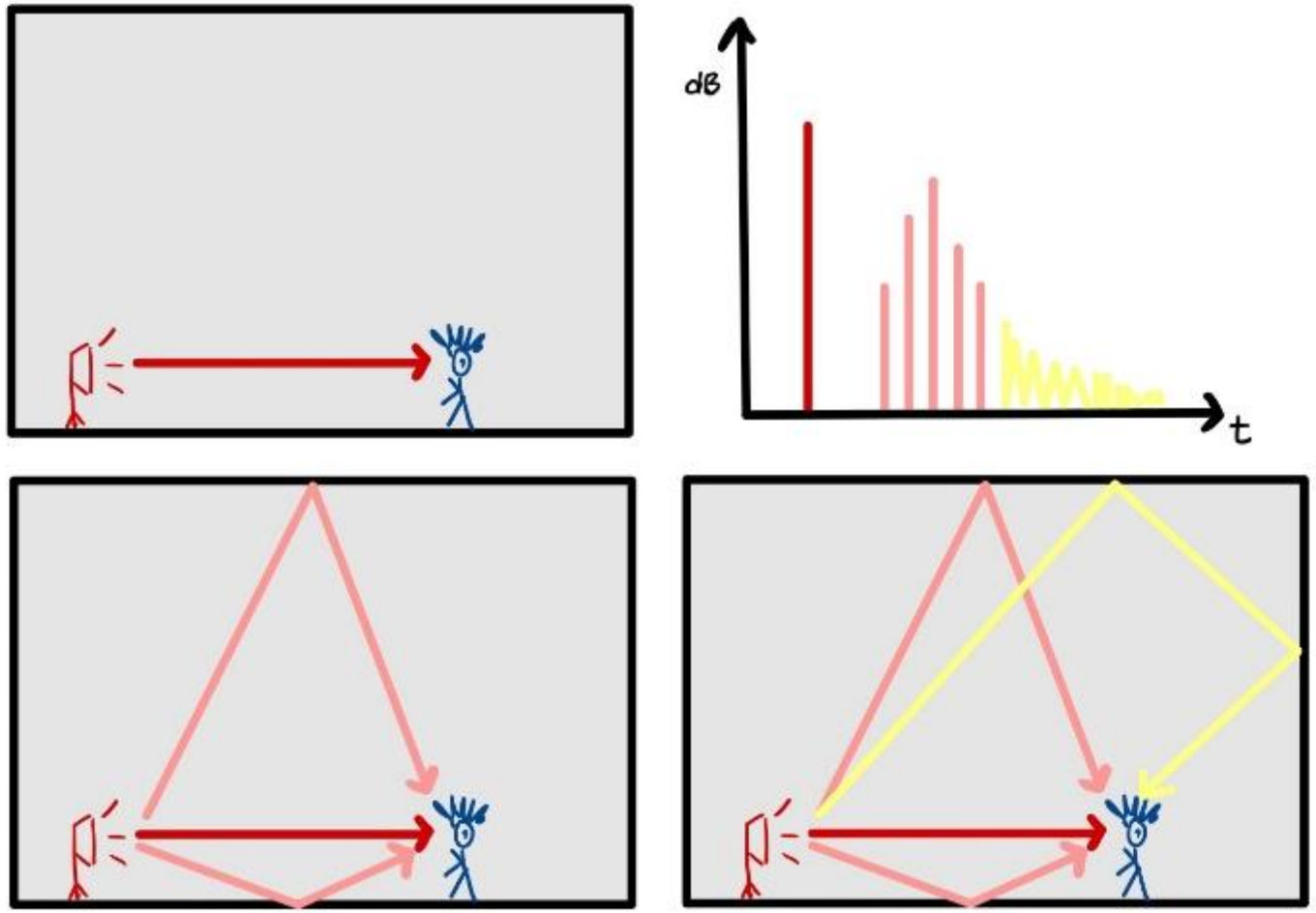
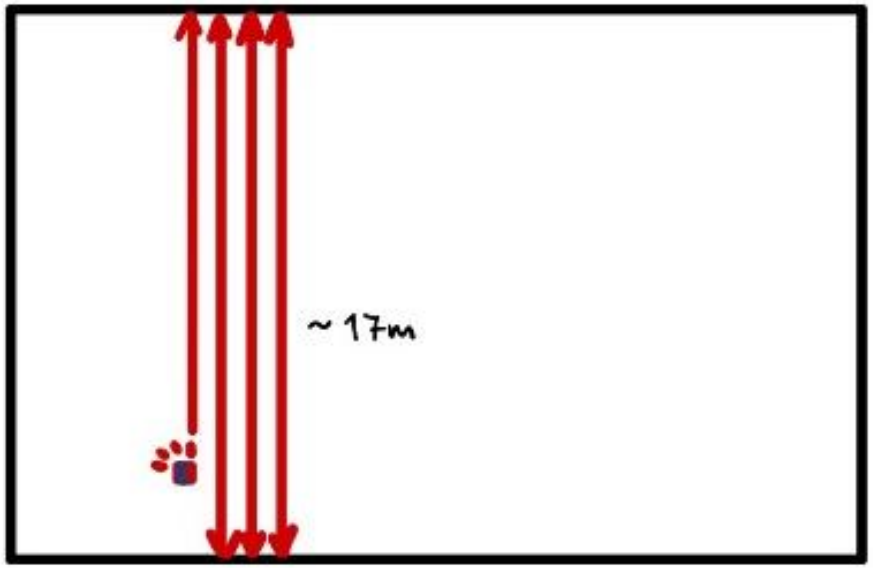
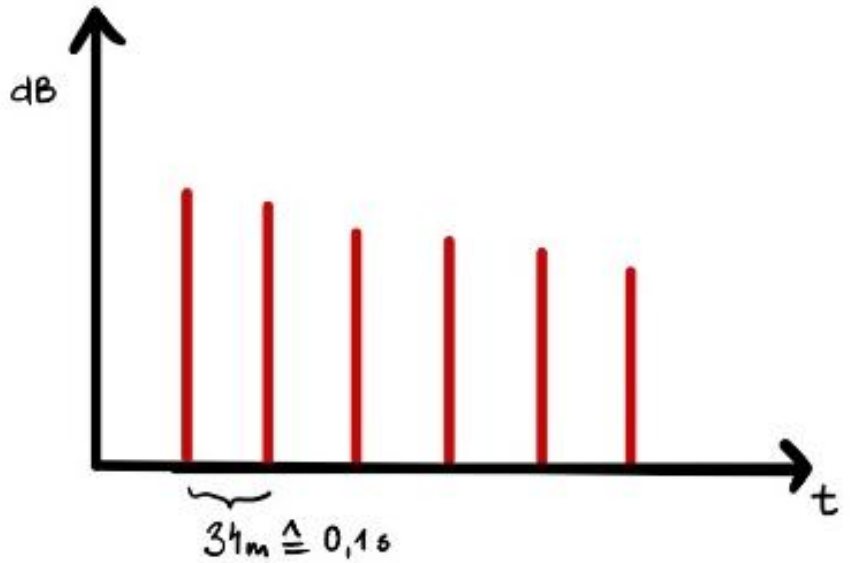
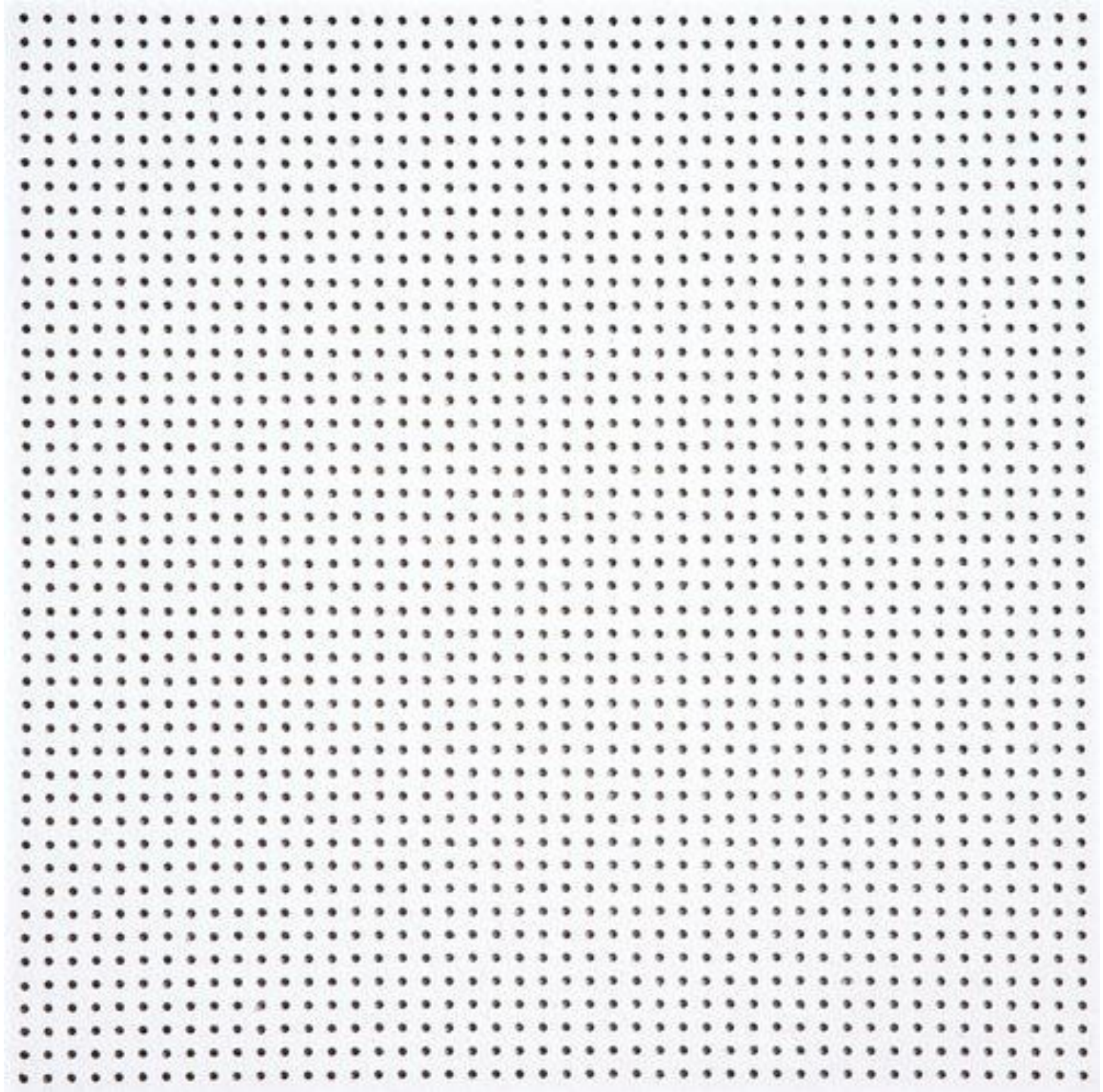

dB
t


~ 17m

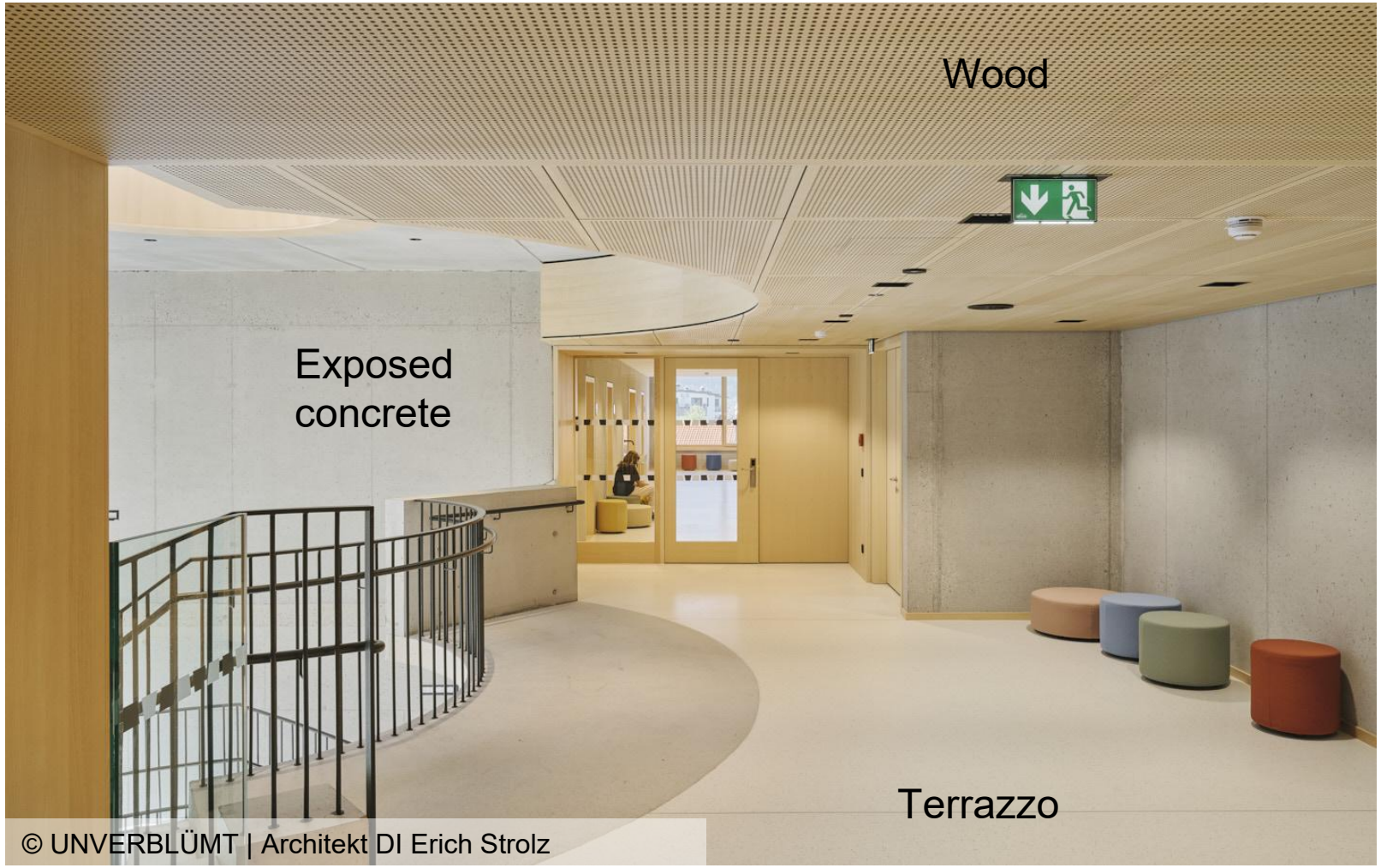

dB
t
34m ≙ 0,1s

Materials



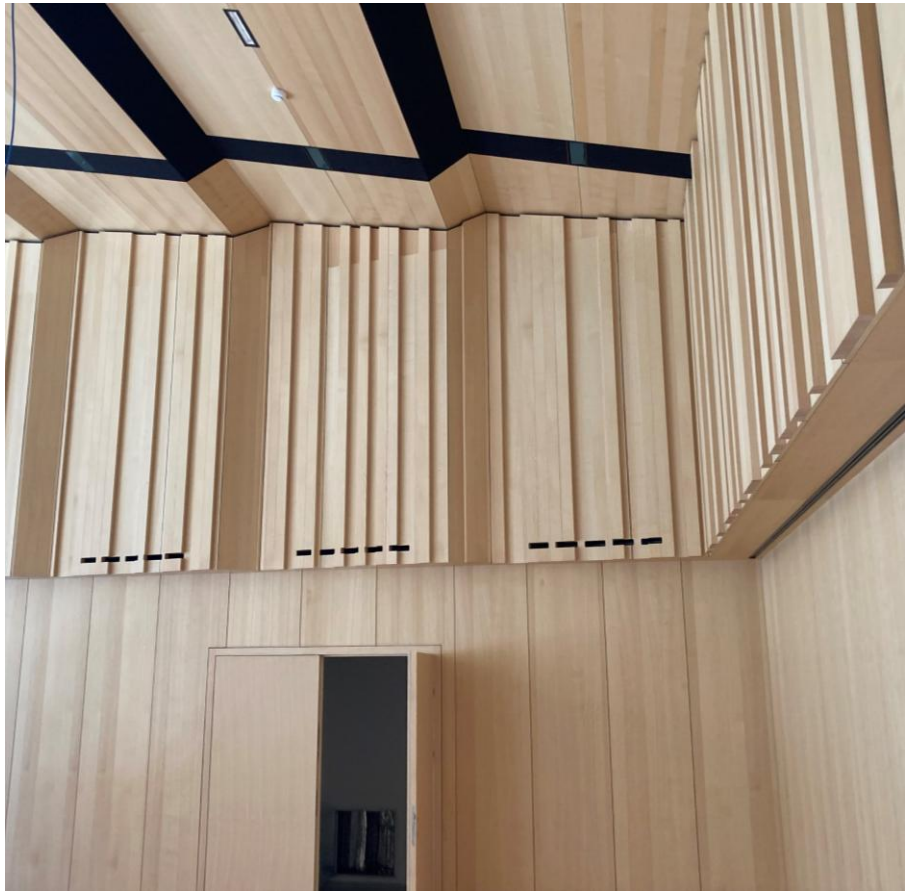
Music school Ebbs

Material concept



Spiral staircase

Applied materials

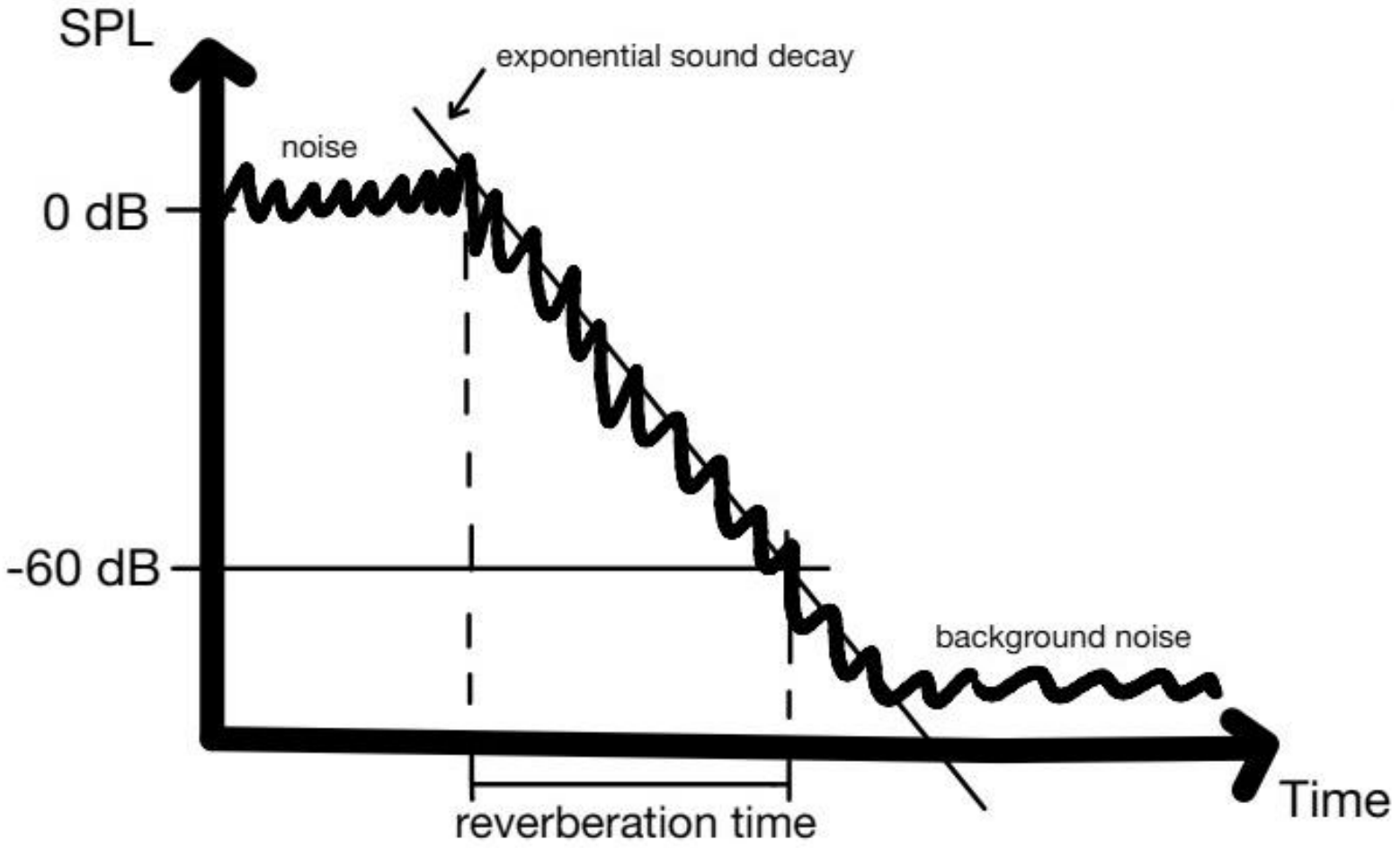


Adolf Loos – The mystery of acoustics

- And materials are very sensitive. You only have to let a military band blast away in the Bösendorfer Saal for a week and its celebrated acoustics will have gone to pot. Just as a hamfisted amateur would ruin a violin that had belonged to Paganini. As a matter of general principle brass music is bad for building materials. That is why one side of opera houses is always poorer acoustically. [… Halls] in which brass instruments [are] never play[ed] develop the best acoustics. The tones of Liszt and Messchaert live on in the mortar of the Bösendorfer Saal and vibrate with every note of a new pianist or singer. That is the mystery of the hall's acoustics.

Tools

Reverberation time



Reverberation time T

$$T \sim \frac{V}{A}$$

V…room volume

A…equivalent absorption area

$$A = \alpha * S$$

α…absorption coefficient, S…surface area

Sabine’s equation

$$T = 0.161 * \frac{V}{A}$$

Immersive lab: V = 500 m³

T = 0.4 s

A ~ 200 m²

Floor: 90 m² * 0.2 = 18 m²

Ceiling: 90 m² * 0.4 = 36 m²

Walls: (50 + 50 + 50 m²) * 0.9 = 135 m²

Window: 50 m² * 0.1 = 5 m²

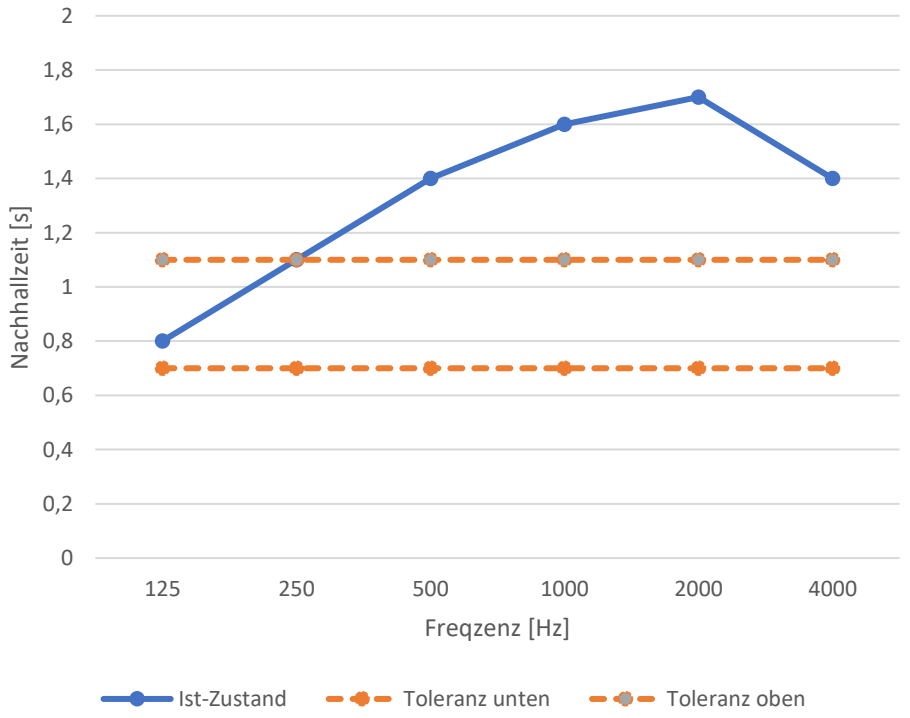
Projects

Folded space 2019

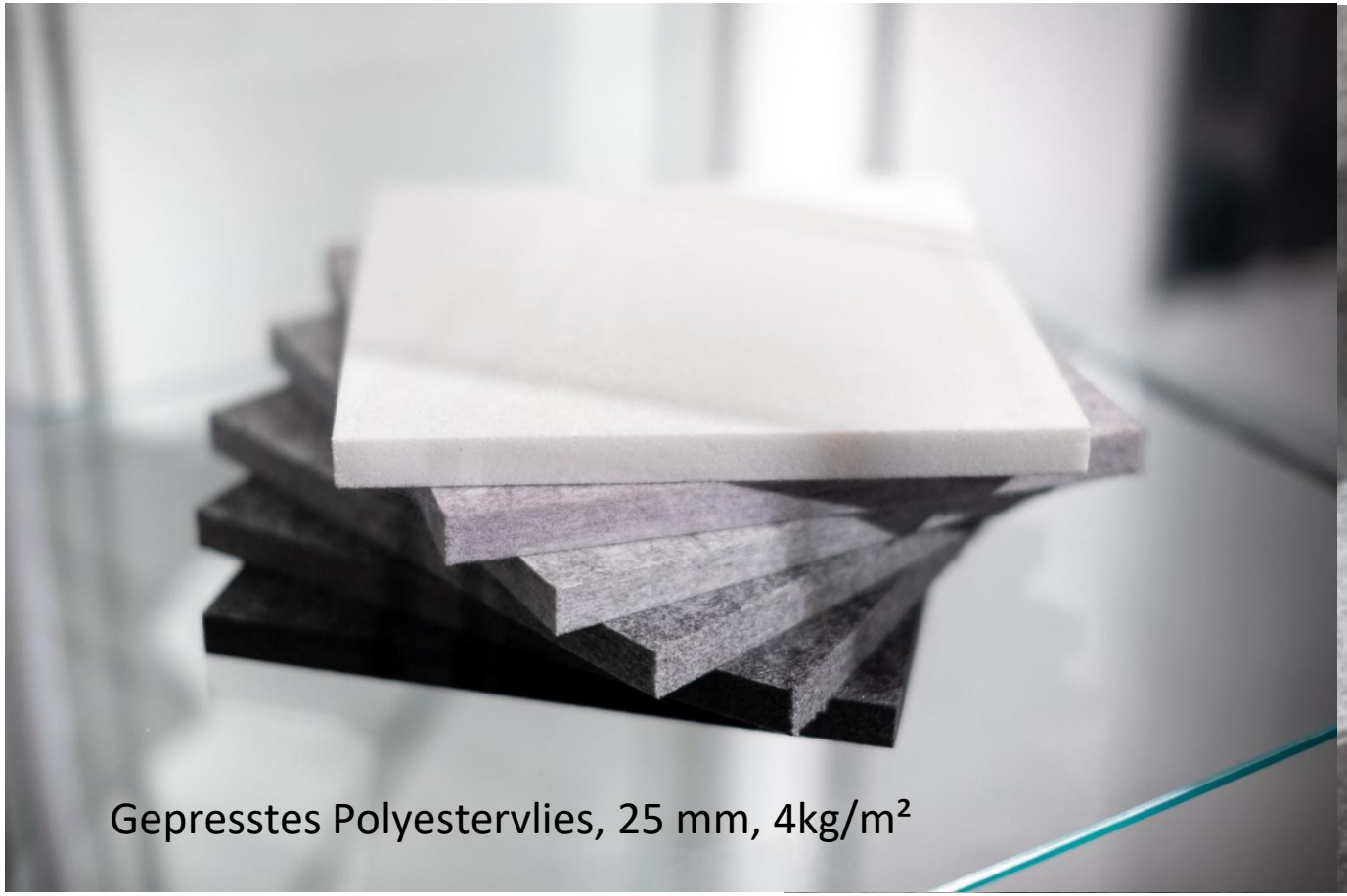

FOYER NORD
Steiermärkische SPARKASSE
Bankomat
smarter
WLAN

Poster presentations

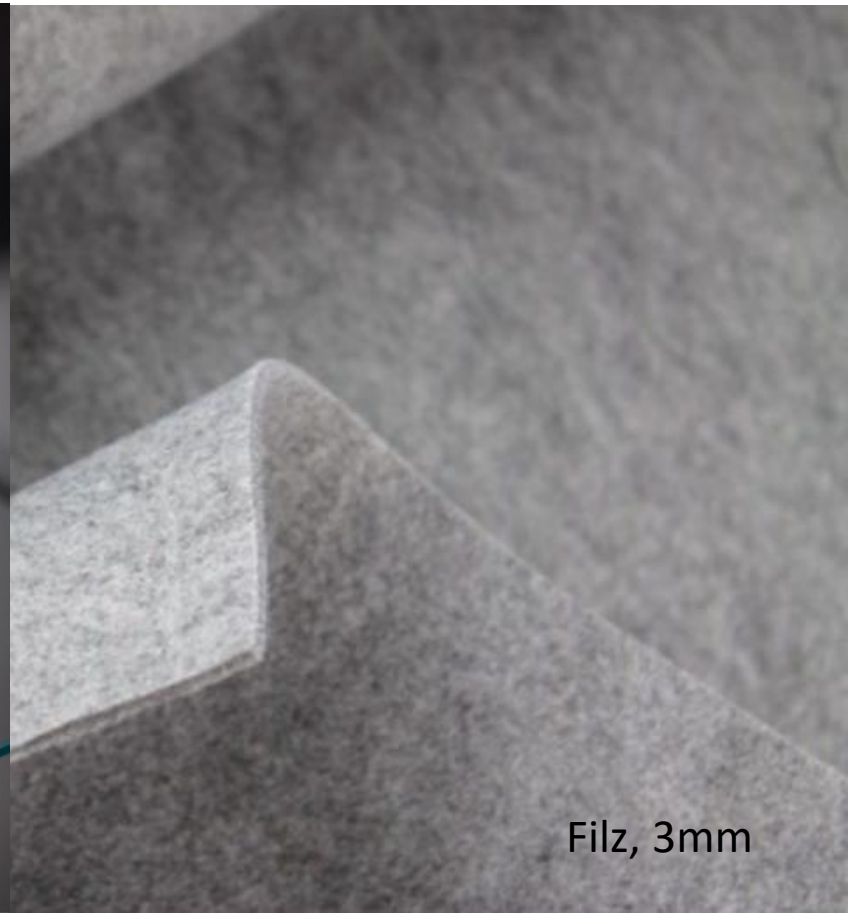
Poster room in Graz



Materials



Gepresstes Polyestervlies, 25 mm, 4kg/m²

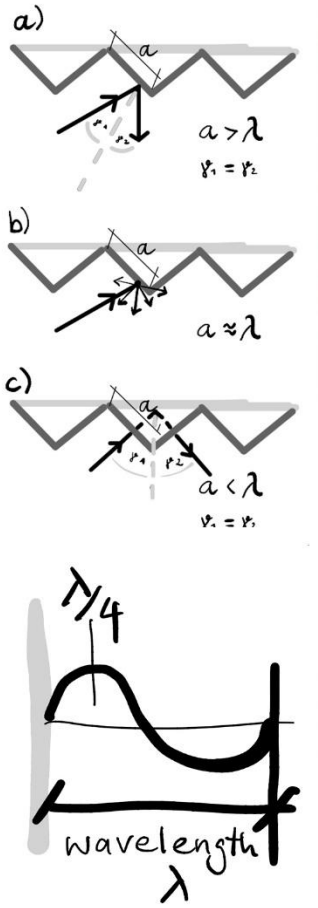


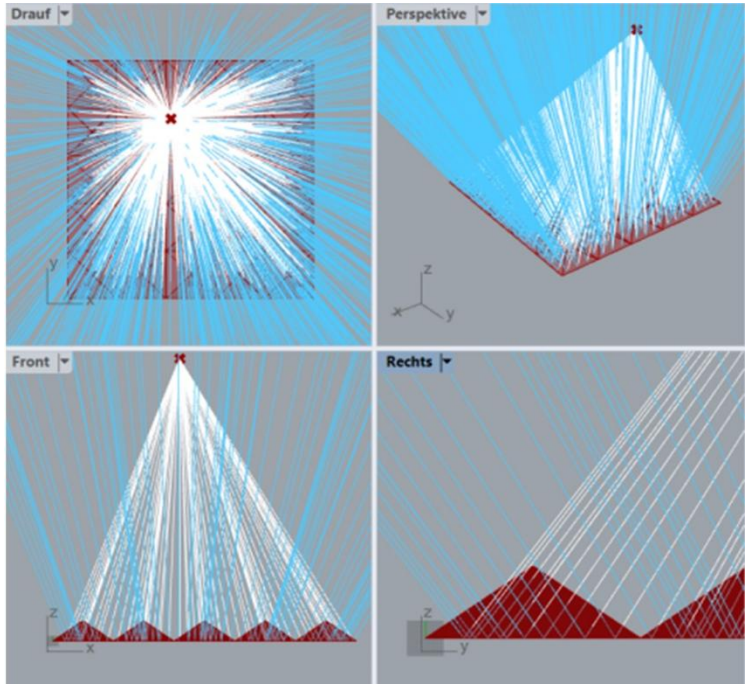
Filz, 3mm

Concept | *Folded space*

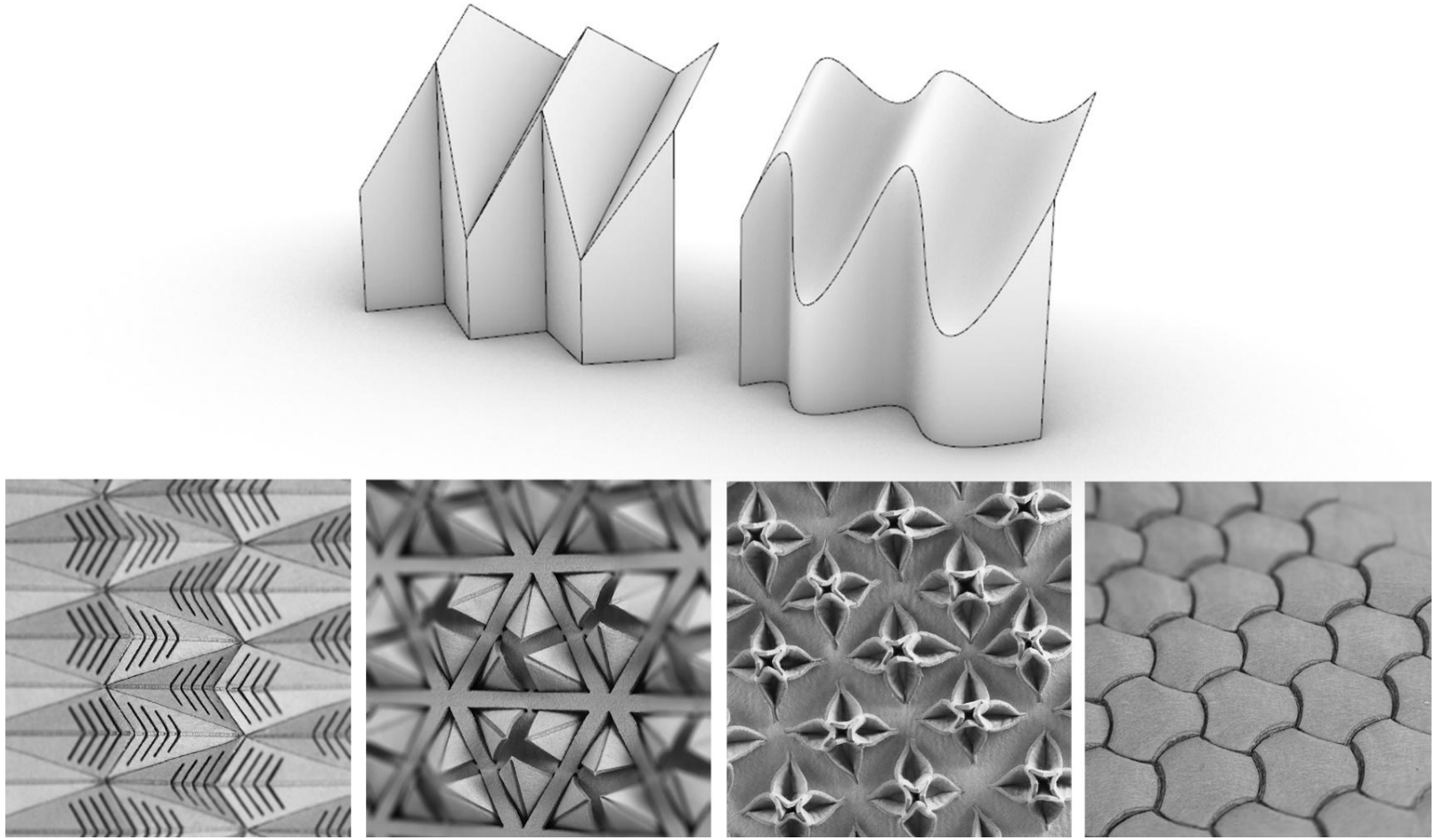
- Interdisciplinary work between architects and audio engineers
- Students worked together
- Fundamentals in acoustics presented for architects
- Research through Design

Fundamentals



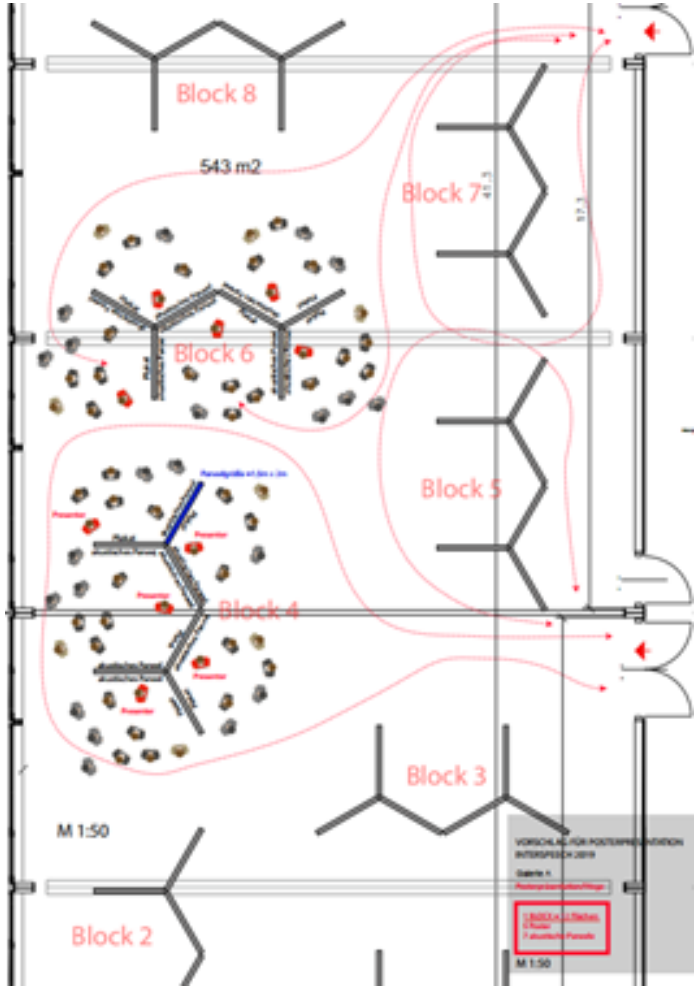


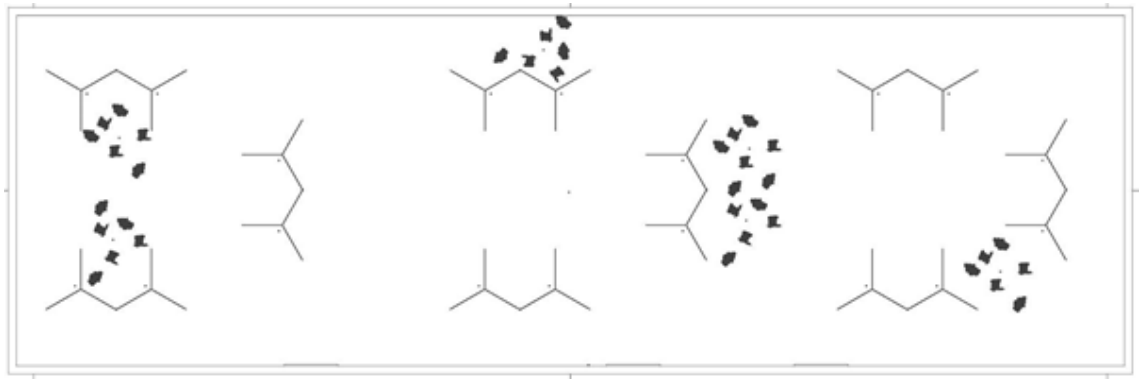
Parametric design

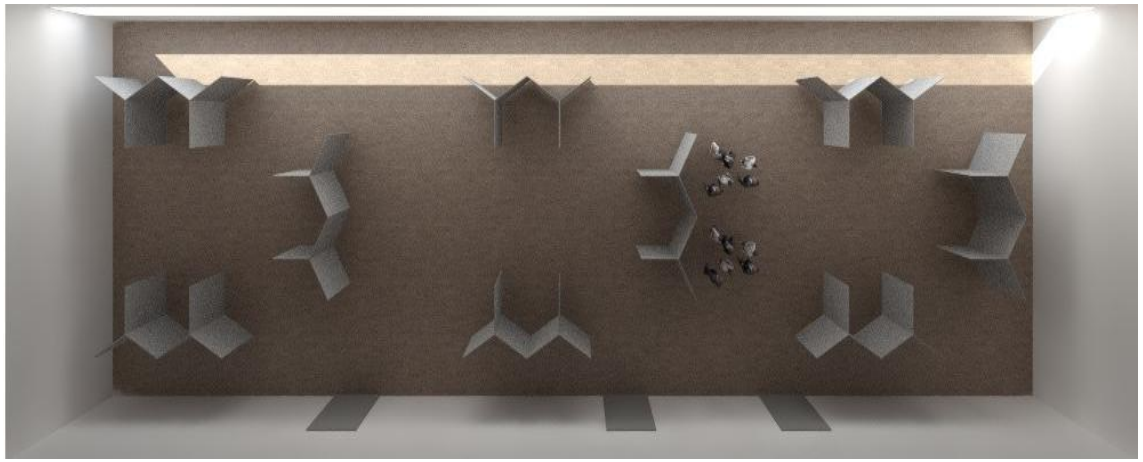


Absorption coefficient

Visualization

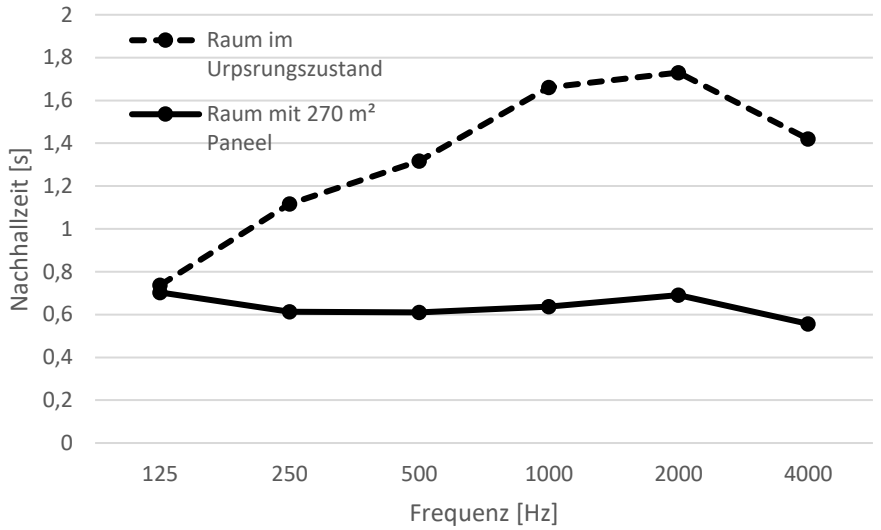




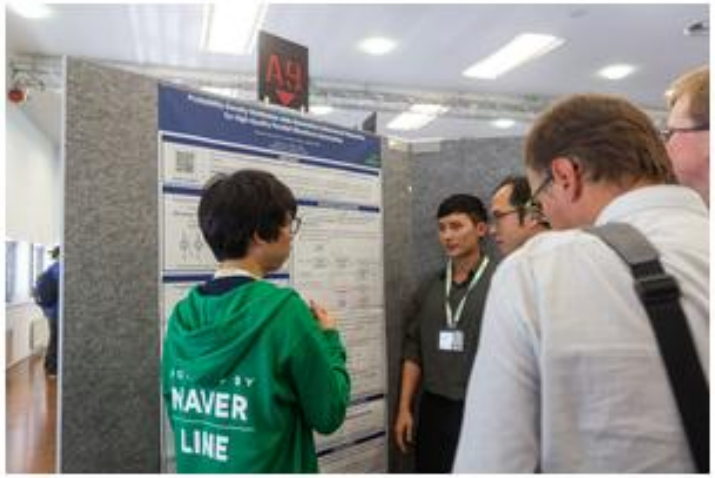


Visualizaton

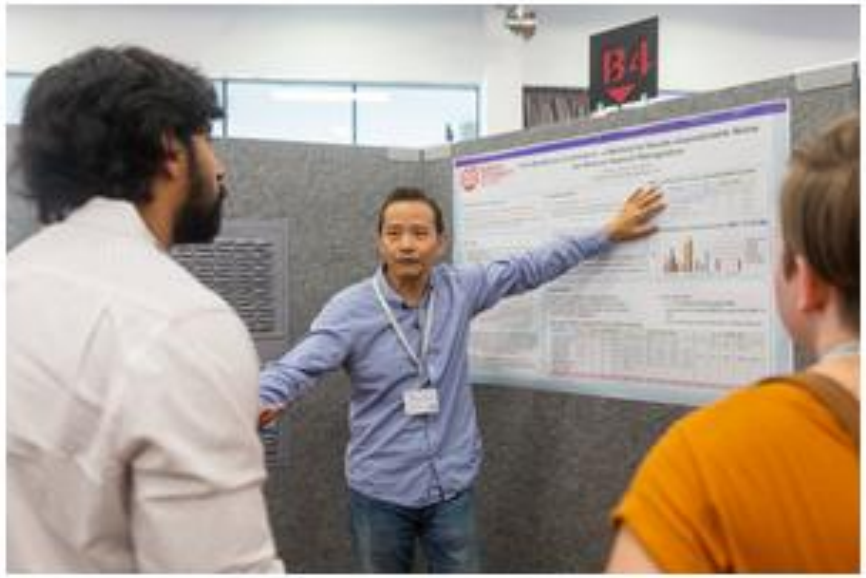
Implementation

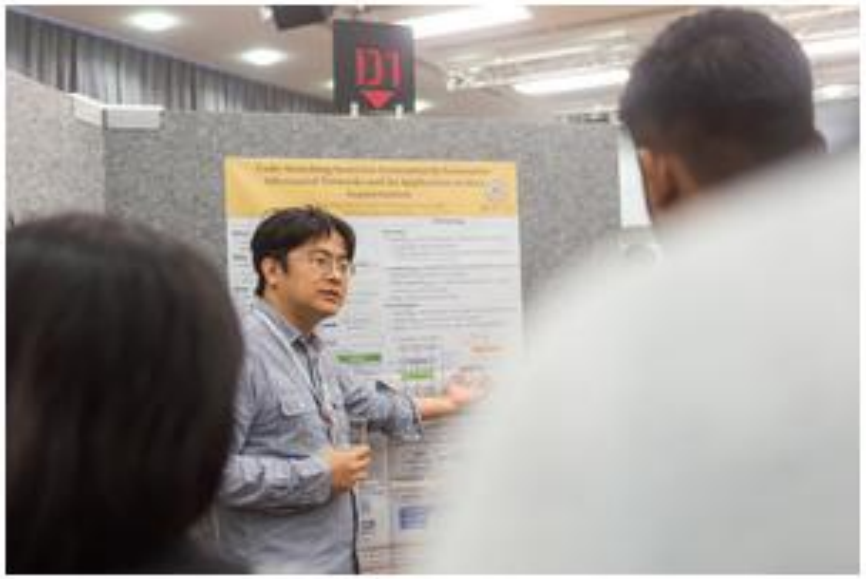


Impressions




Acoustic cues to topic and narrow focus in Egyptian Arabic


B4


D1

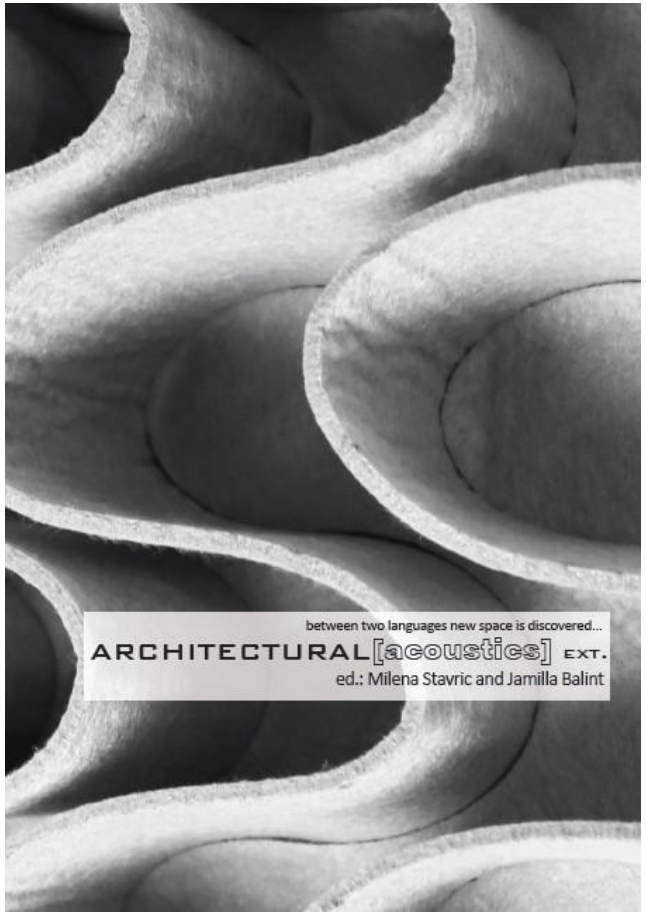
Feedback

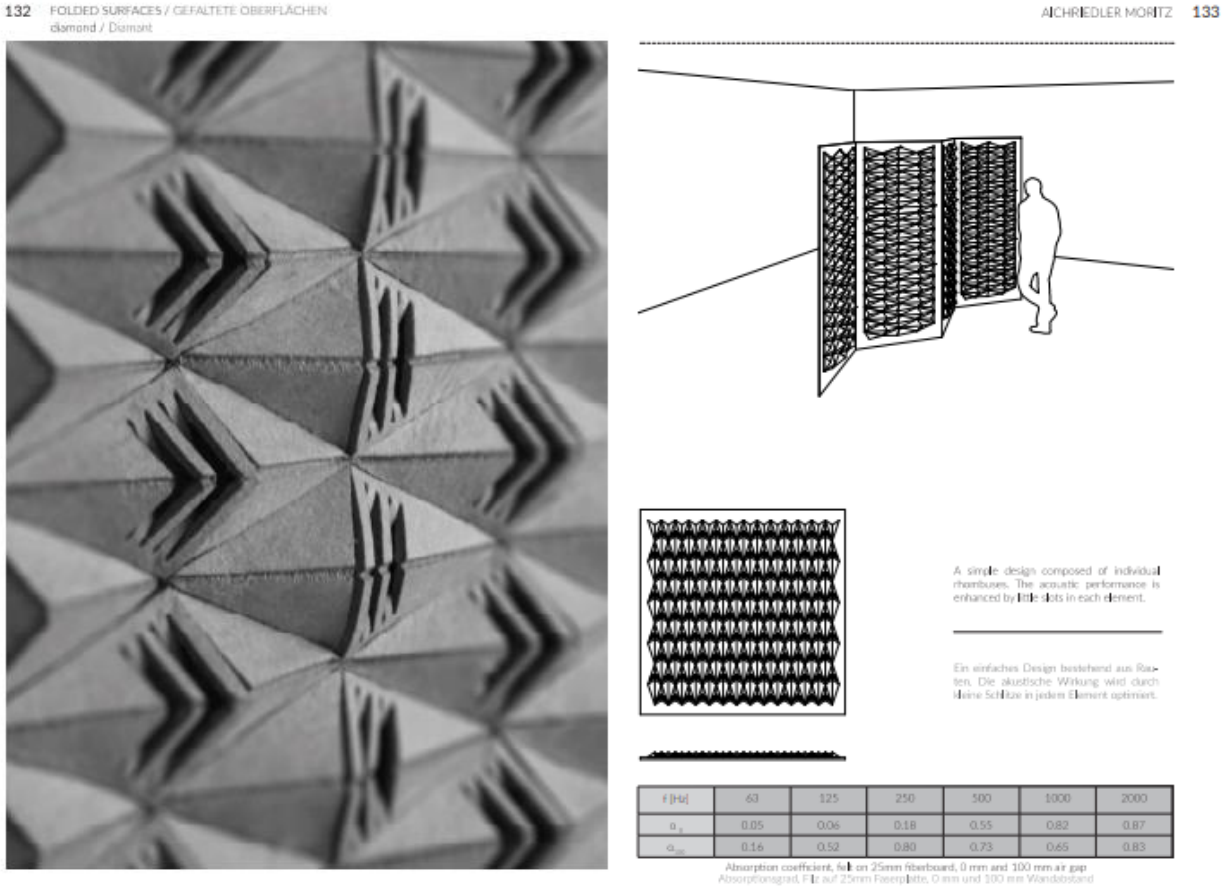
“Conference organizers, please note: these great acoustic panels gave the best poster experience I’ve had in 30+ years of attending such sessions. Thanks”.

“Background noise also interferes with speech production, not only with speech perception! The poster boards are so helpful in making conversations run smoothly!”

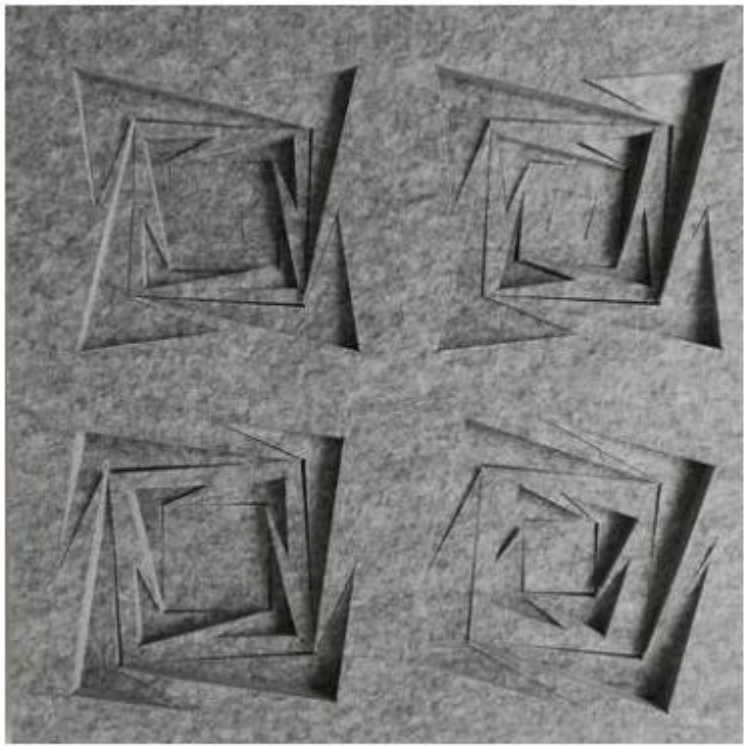
“Many have lauded the excellent poster designs @interspeech2019 led by Milena Stavric and Jamilla Balint, bringing together design and acoustics. Many thanks to them, their team and students, it‘s great!!”

Results

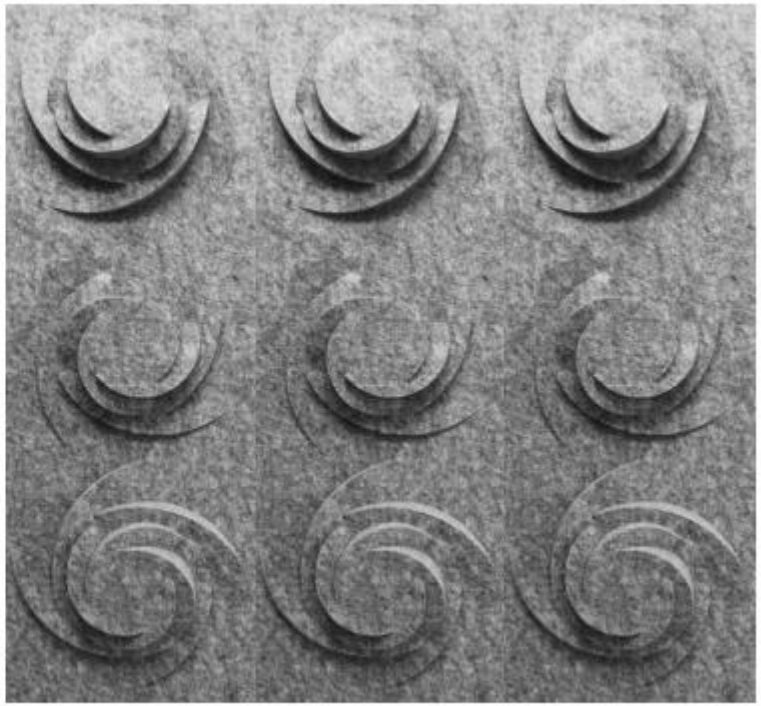

between two languages new space is discovered...
ARCHITECTURAL[acoustics] EXT.
ed.: Milena Stavric and Jamilla Balint


132 FOLDED SURFACES / GEFALTETE OBERFLÄCHEN
diamond / Diamant
ALCHRIEDLER MORITZ 133
A simple design composed of individual rhombuses. The acoustic performance is enhanced by little slots in each element.
Ein einfaches Design bestehend aus Rauten. Die akustische Wirkung wird durch kleine Schlitze in jedem Element optimiert.
f [Hz] 63 125 250 500 1000 2000
α_s 0.05 0.06 0.18 0.55 0.82 0.87
α_w 0.16 0.52 0.80 0.73 0.65 0.83
Absorption coefficient, felt on 25mm fiberboard, 0 mm and 100 mm air gap
Absorptionsgrad, Filz auf 25mm Faserplatte, 0 mm und 100 mm Wandabstand

Designs



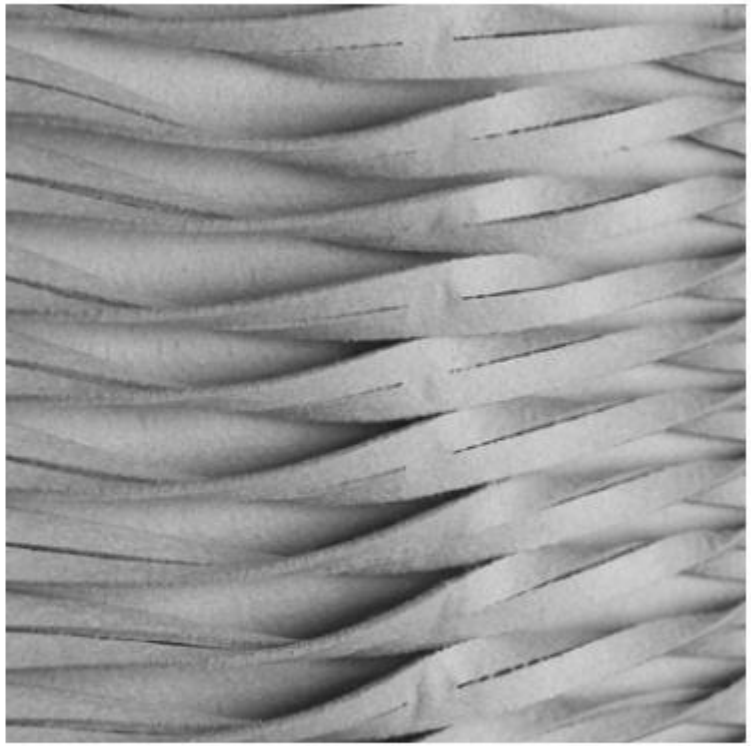
BOLDBAATAR UYANGA



BOLDBAATAR UYANGA

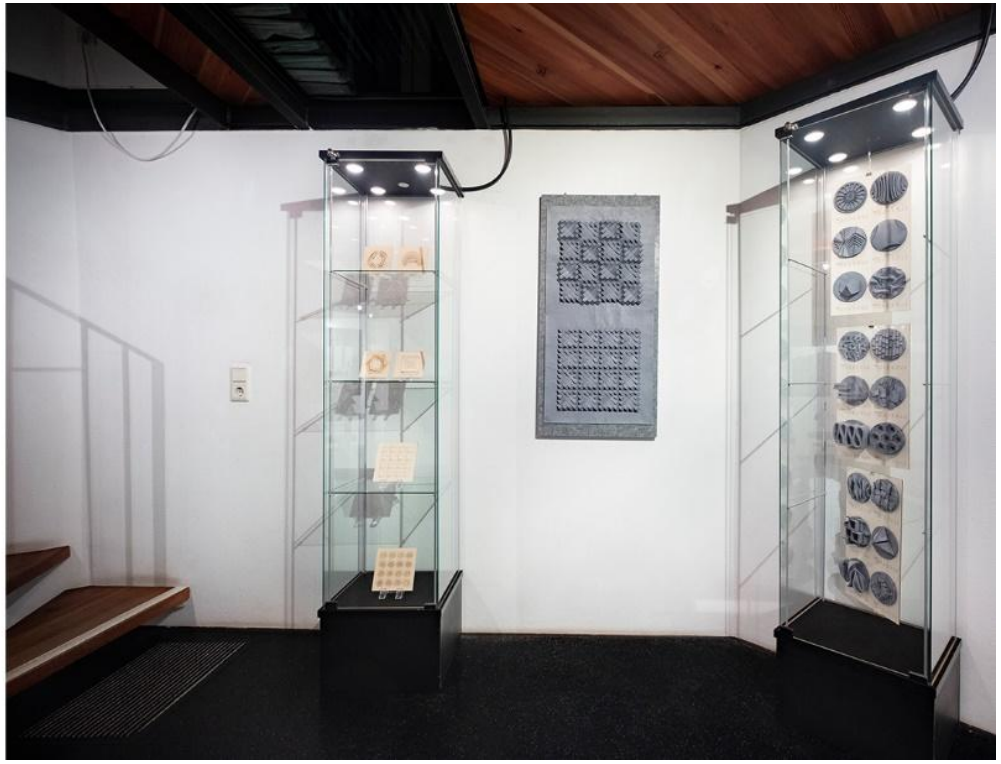
Designs

Perkovic Filip / Radl Julian Nikolas



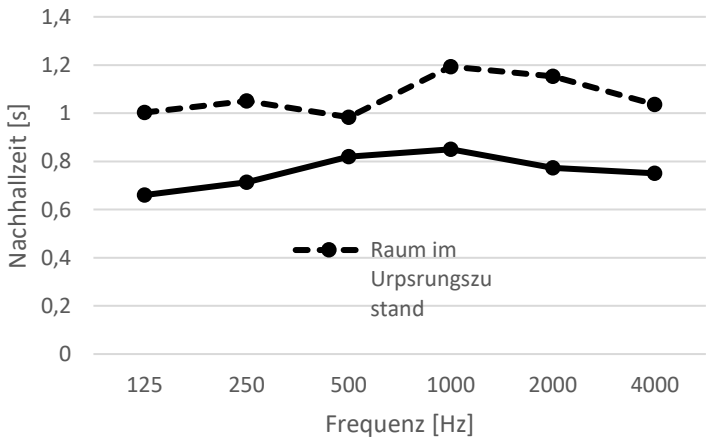
Perkovic Filip / Radl Julian Nikolas

Exhibition – Museum of Perception

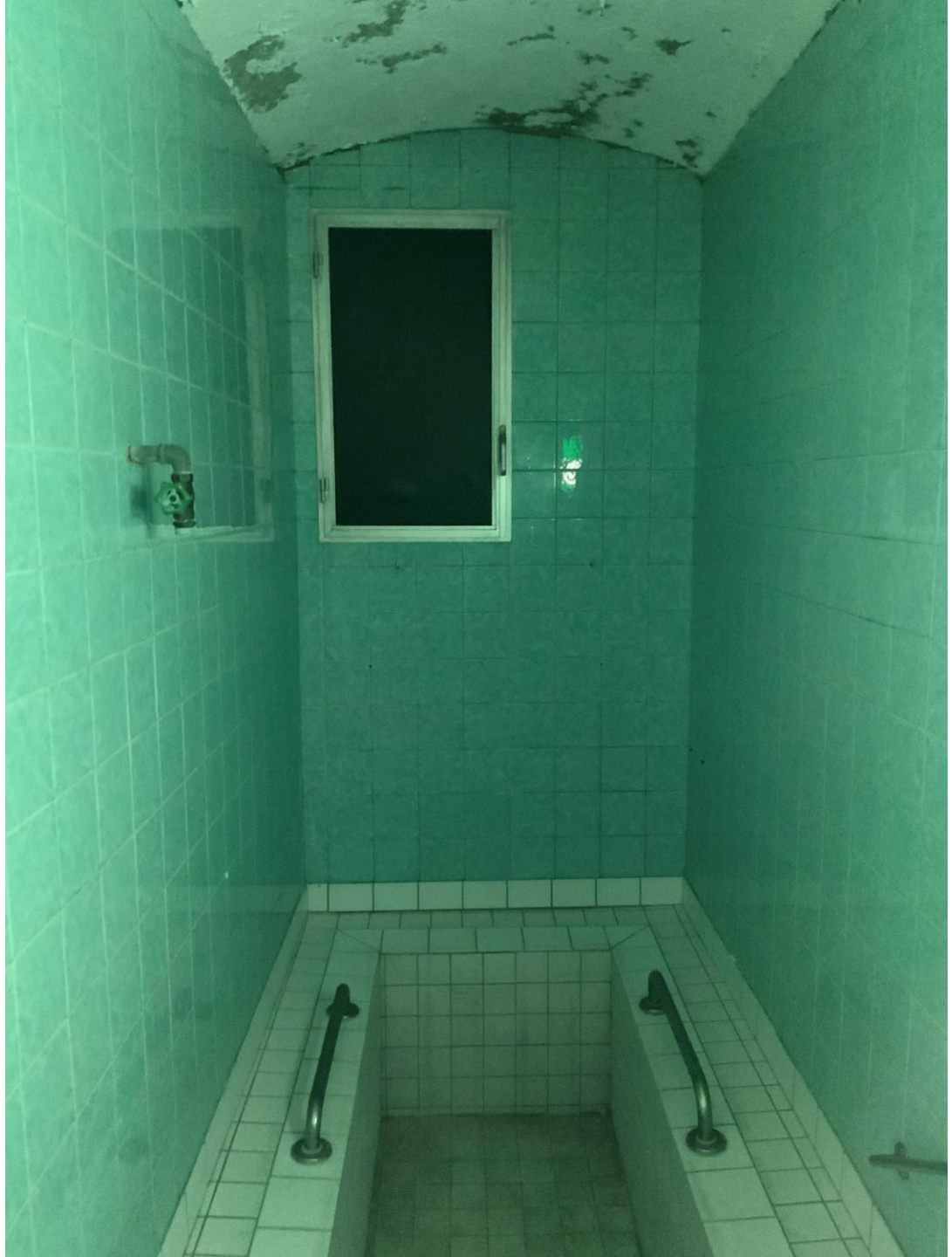


Materials as exhibits

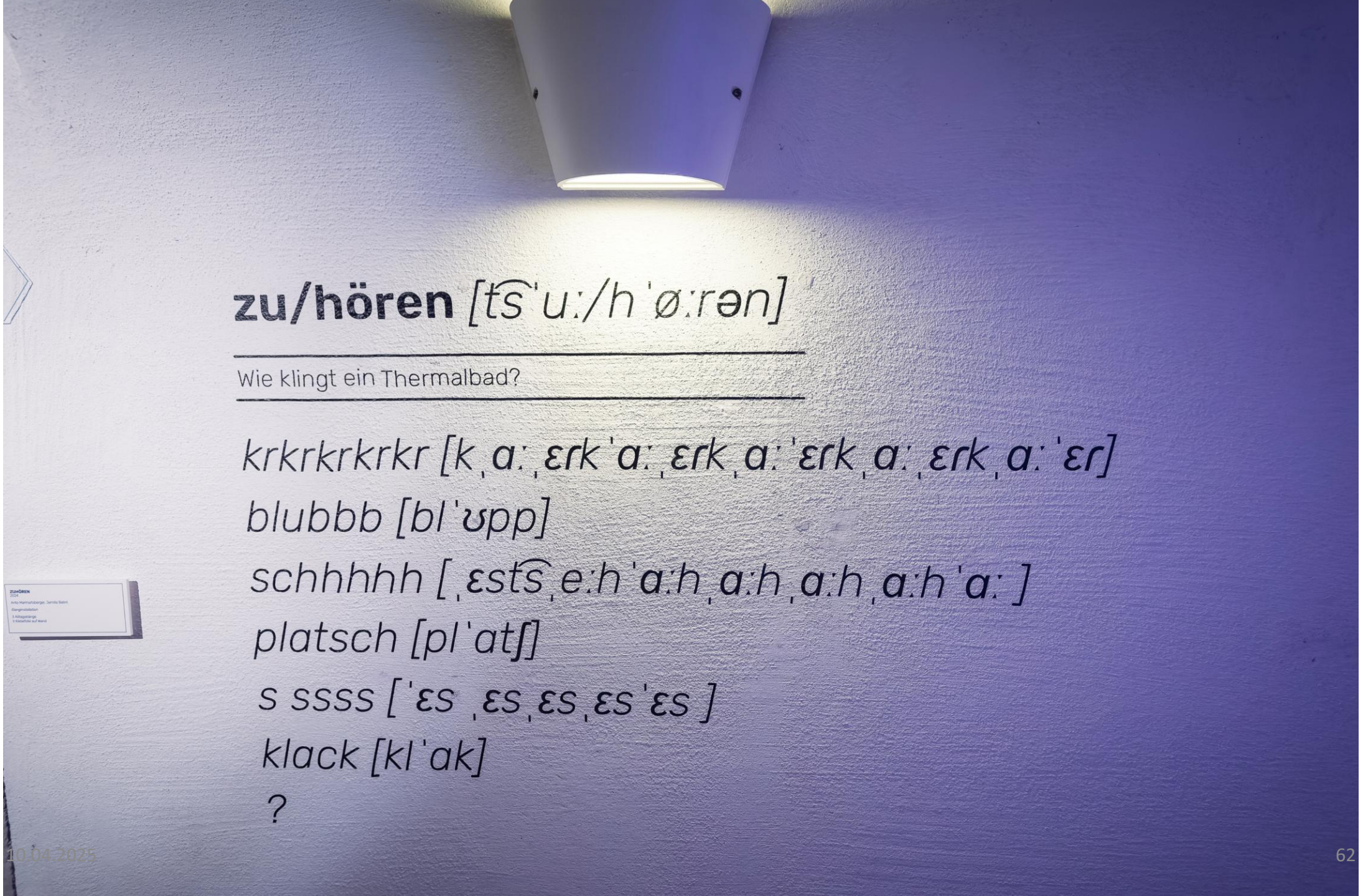
Further implementation

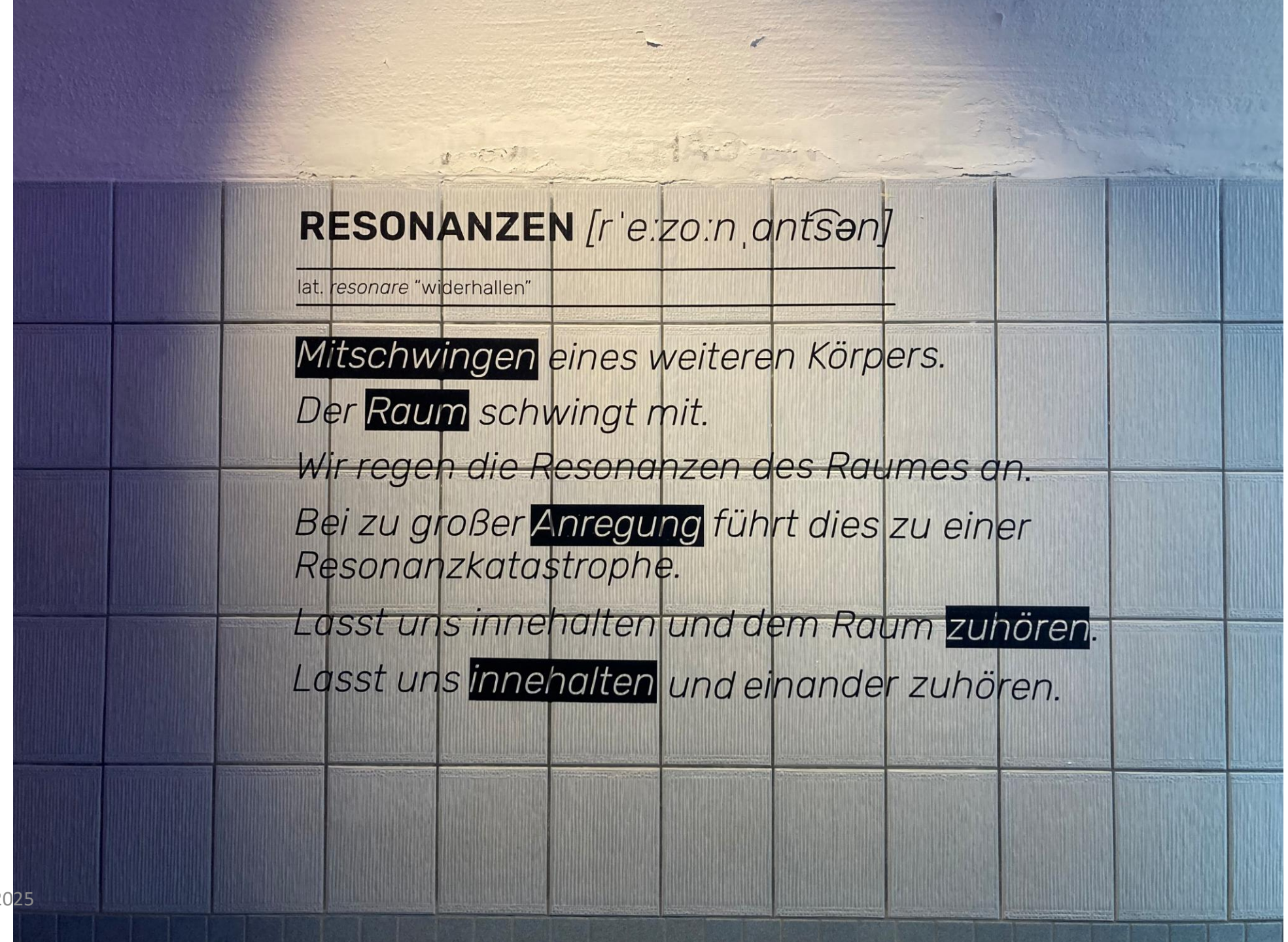


Bad zum Raben – Baden 2024




Constantly
evolving.
Never
finished.


zu/hören [ʦˈuː/hˈøːrən]
Wie klingt ein Thermalbad?
krkrkrkrkr [kˌaːˌɛrkˈaːˌɛrkˌaːˈɛrkˌaːˌɛrkˌaːˈɛr]
blubbb [blˈʊpp]
schhhhh [ˌɛsʦˌeːhˈaːhˌaːhˌaːhˌaːhˈaː]
platsch [plˈatʃ]
s ssss [ˈɛs ˌɛsˌɛsˌɛsˈɛs]
klack [klˈak]
?


RESONANZEN [rˈeːzoːnˌantsən]
lat. resonare "widerhallen"
Mitschwingen eines weiteren Körpers.
Der Raum schwingt mit.
Wir regen die Resonanzen des Raumes an.
Bei zu großer Anregung führt dies zu einer Resonanzkatastrophe.
Lasst uns innehalten und dem Raum zuhören.
Lasst uns innehalten und einander zuhören.


PFLANZEN [pflˈantsən]
Betrachtungen
Schon das bloße Betrachten von Zimmerpflanzen entspannt uns.
Bei der Pflege von Pflanzen werden Glückshormone ausgeschüttet.
Zimmerpflanzen wie Bob können dir Trost spenden.
Bob verurteilt dich nicht, wenn du mit ihm über deine Gefühle sprichst.
LASS WALDBADEN
MUSTAFA
HANK
MARC
HANNELORE

RHYTHMS *[ɹˈɪðəmz]*

by PAULINE OLIVEROS (frei übersetzt)

Wie oft blinzelst du?

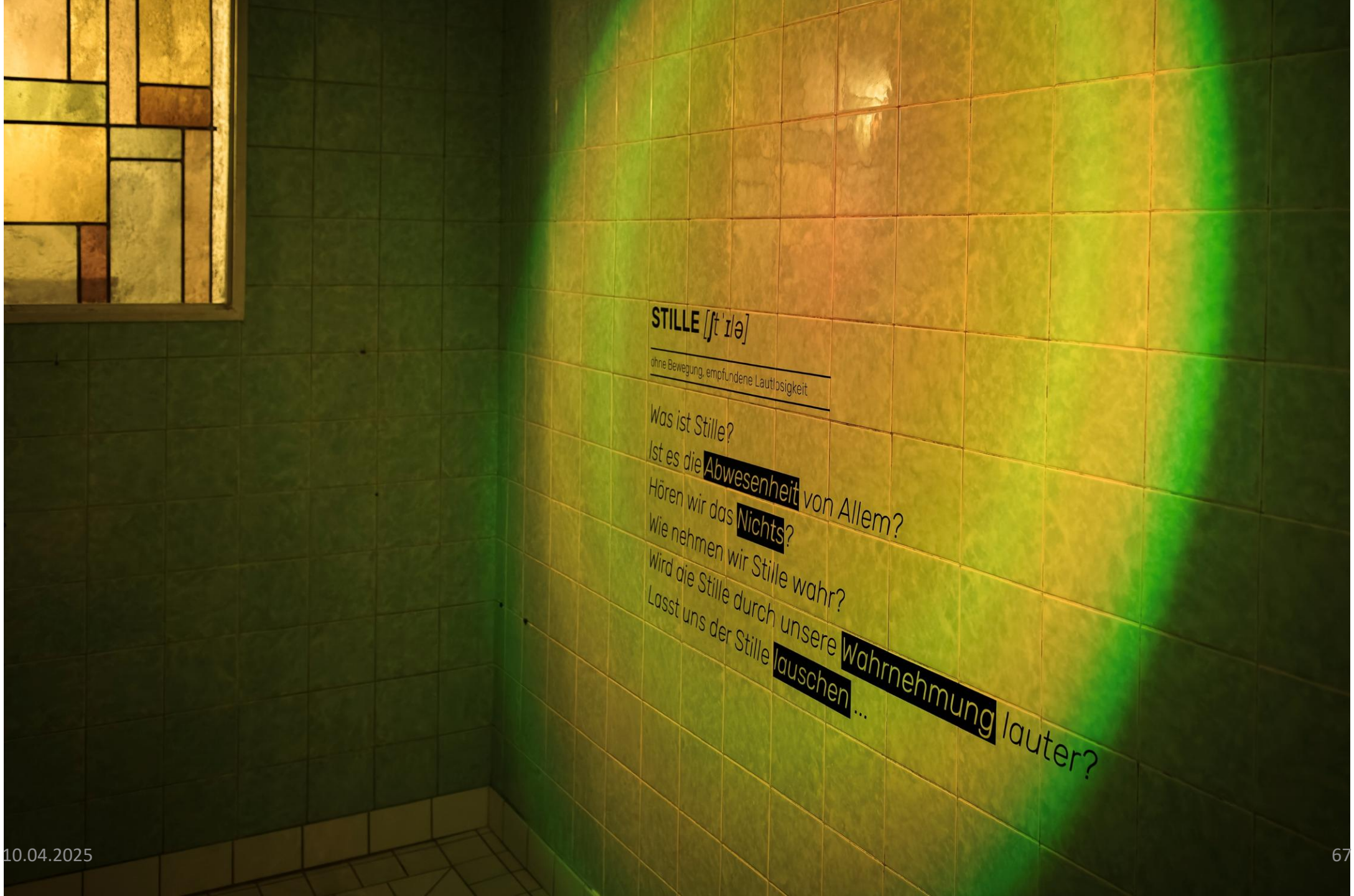
Welches Tempo hast du beim normalen Gehen?

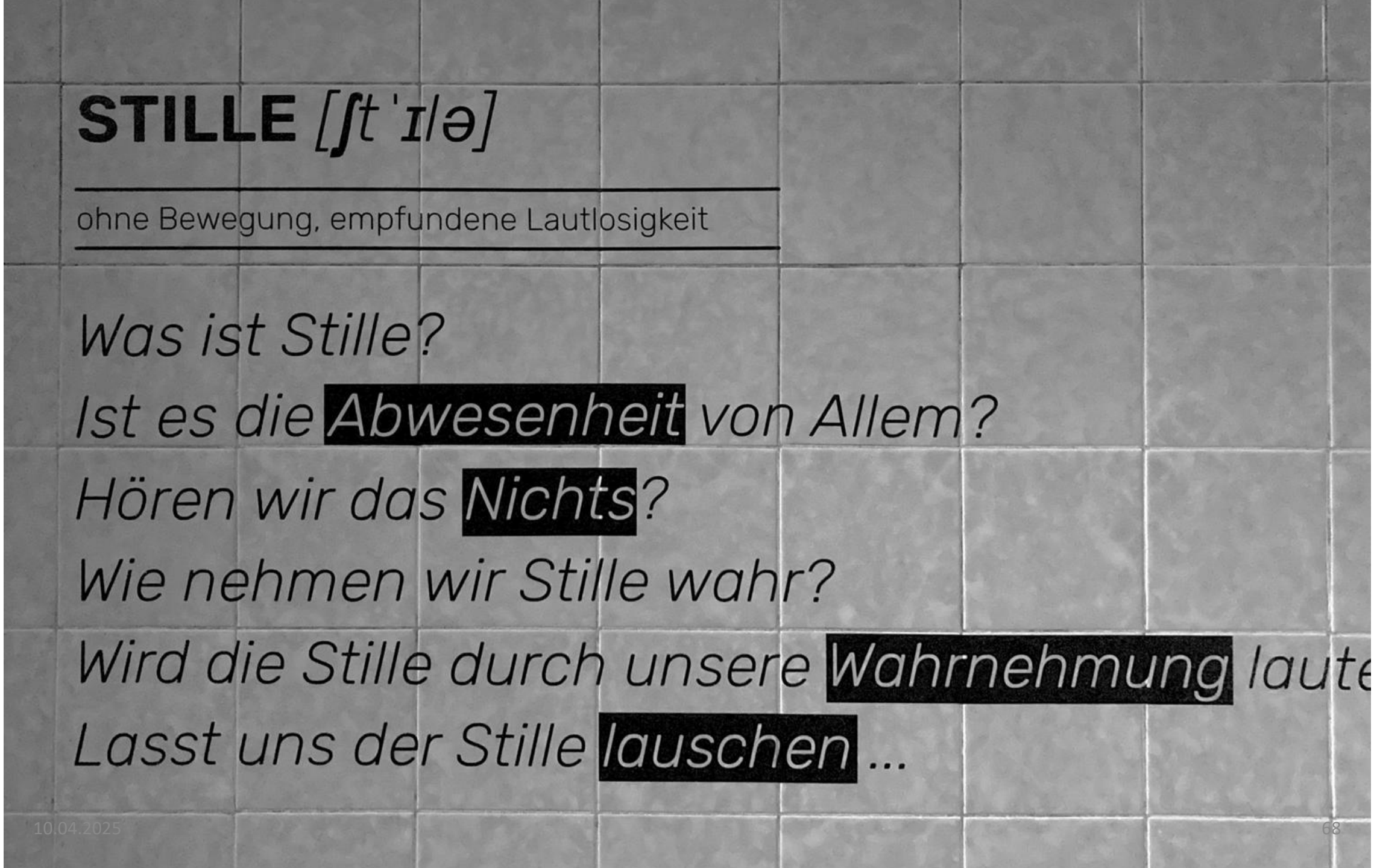
Wie langsam atmest du in diesem Moment?

Wie schnell schlägt dein Herz?

Welche anderen Rhythmen nimmst du wahr, wenn du zuhörst?

In welcher Beziehung stehst du zu all den Rhythmen, die du gleichzeitig wahrnehmen kannst?


STILLE [ʃtˈɪlə]
ohne Bewegung, empfundene Lautlosigkeit
Was ist Stille?
Ist es die Abwesenheit von Allem?
Hören wir das Nichts?
Wie nehmen wir Stille wahr?
Wird die Stille durch unsere Wahrnehmung lauter?
Lasst uns der Stille lauschen ...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Spatial Music

Strategies of Spatialization and Social Aspects of Sound in Space

Historical Overview

Post-WWII Musical Shift

- Avant-garde and experimental music post-1945 aimed to break traditions.
- Focus on democratic musical thinking and moral, intellectual and social change.
- Engagement with space became central to new compositions.

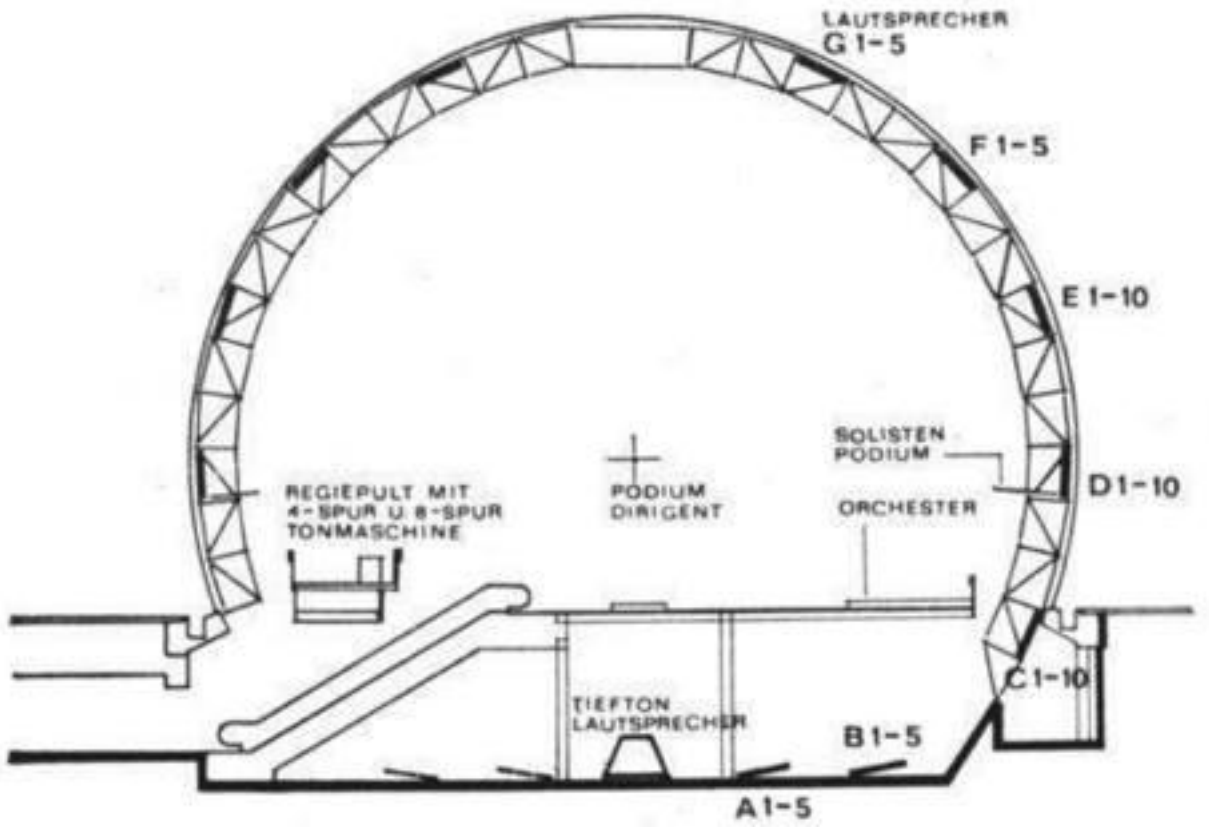
Experimental Music

- Key traits: eliminate intentionality, chance operations, open forms (e.g., John Cage).
- Audience becomes co-creator of the performance.
- Fusion of different art forms, off conventional art spaces, e.g. galleries, factories, public spaces…
- Dissolve dichotomy between life and art and create spaces of interaction to collectively shape new social reality

Musical Avant-Garde

- Built on compositional developments before WWII - twelve-tone technique - serial music - equal distribution of all musical parameters (pitch, volume, duration, timbre) - via electronic sound synthesis.
- Think of space as compositional parameter.
- Democratically organized and spatially arranged compositions as basis for a new social reality.
- Intervene in listening habits and incorporated social conditions and general passivity
- Ideal: create new music houses off traditional elitist concert halls, for more accessibility and equality

Kugelauditorium – Stockhausen/TU Berlin

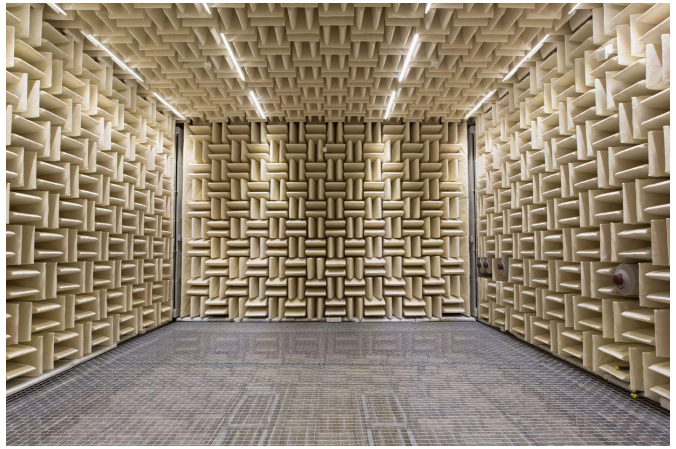


Berlin Philharmonie – Scharoun/Cremer

Approaches to Spatialization

Two Approaches

1. Ideal: acoustically neutral space, where a virtual space can be created using multichannel spatialization speaker technology (linked to avant-garde approach).



2. Include physical-acoustic space as an element into conception (linked to experimental approach).

Sociology of Space

The Spatial Turn - sociology of space

- Space as a social category since the 1990s.
- Publication: Martina Löw „Soziologie des Raums“
- space = relational arrangement of social goods and living beings in places.
- Key concepts: processual character - space is continuously produced by spacing and synthesis.
- institutionalization of arrangements and behaviours.

Phenomenological and Rhythmanalytical Approaches to Space

- Phenomenology of perception (Merleau-Ponty 1945):
  - Space is relative and tied to the body as a primary perceptual system
  - Our bodily serves as a reference matrix for perceiving spatial relations
- Rhythmanalysis (Henri Lefebvre 1992):
  - Space exists as a space-time continuum (time as an additional parameter in analysis of spaces)
  - Rhythms (linear, cyclical, situational) structure spaces
  - Our bodies reproduce surrounding rhythms and create rhythms
  - Marxist critique of rhythmical organization of urban spaces which follow merket driven interests.
  - primary reference is body and internal rhythmical organization

So what about the sociopolitical utopia of spacial audio?

- Avant-garde ideals:
  - Aimed to democratize listening and break hierarchical structures
  - Intended to create participatory, open sound environments

- Contradictions:
  - Spatial music today remains tied to elite or academic contexts
  - Requires complex technology and specialized spaces
  - Often inaccessible to general audience

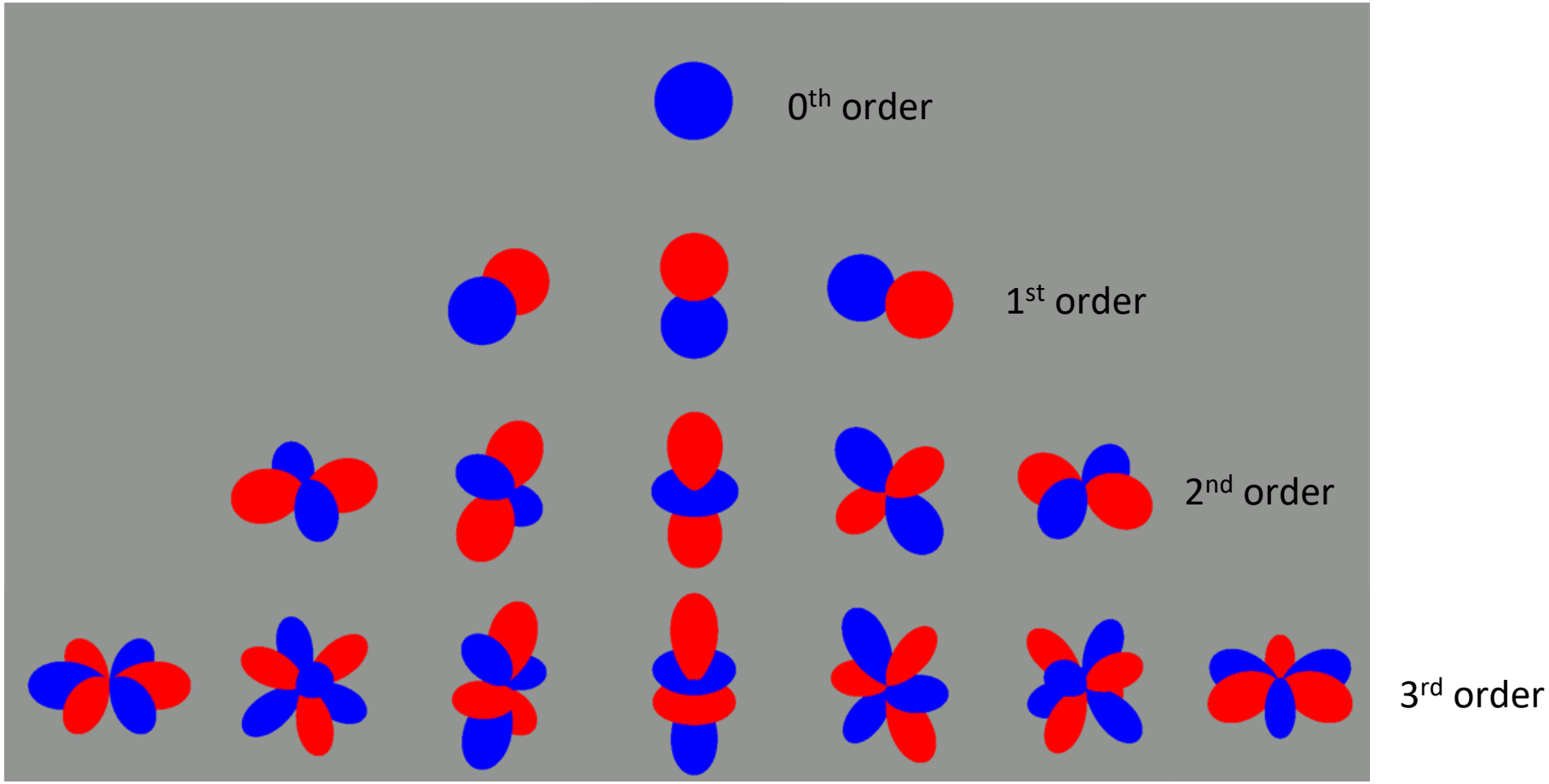
- Potentials:
  - Destabilize general perception of reality
  - Intervene reproduction of spaces (especially when we want to change social structures or atmosphere, e.g. increase accessibility)

Technical Implementation

Ambisonics

- 3D sound technique using flexible speaker arrangements like a sphere surrounding listeners.
- Spatial resolution depends on order. (1st order - 7th order)
- Applications: ambisonics domes (e.g. IEM Cube), IKO, VR.
- Pros: binaural playback, flexibility. Cons: sweet spot issues, technical effort.

Spherical harmonics in Ambisonics



iem cube (institute electronic music and acoustics), Graz

Source: https://www.kug.ac.at/en/university/campus-and-buildings/iem-institute-17-electronic-music-and-acoustics

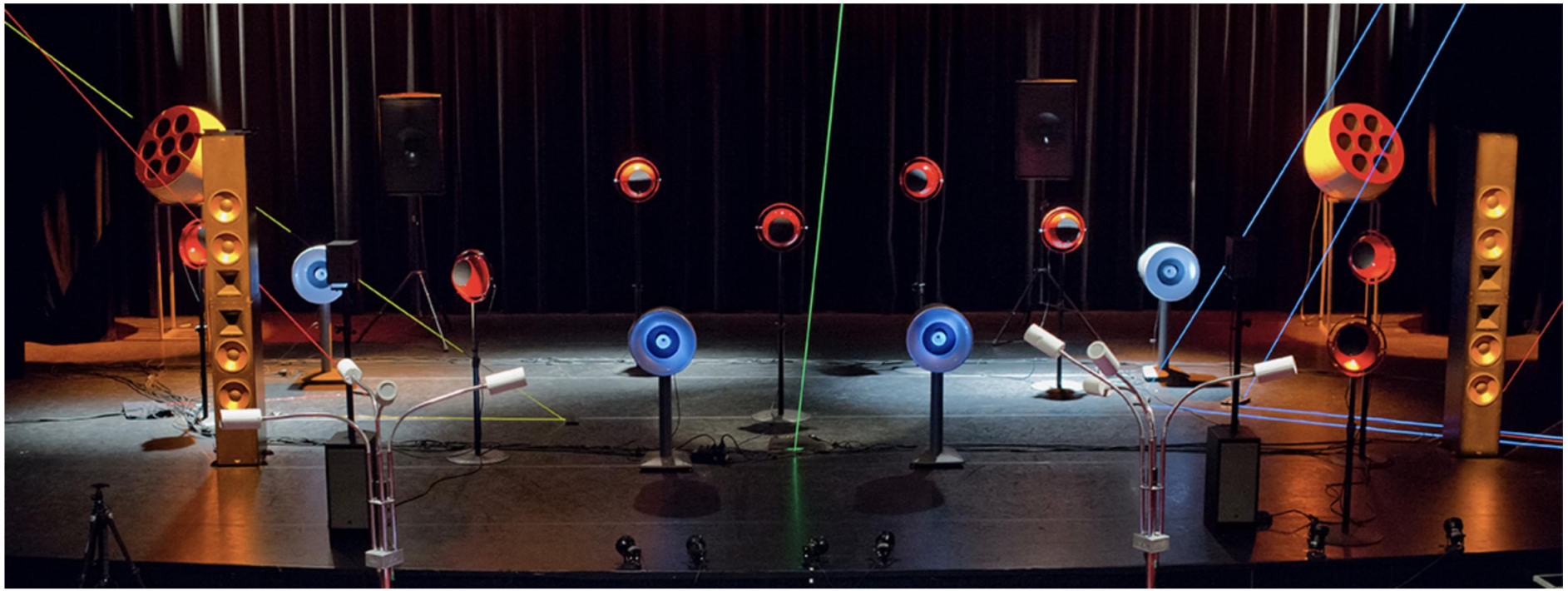
IKO - icosaedral loudspeaker

Source: https://iko.sonible.com/en.html

Acousmonium

- Treats speakers as instruments, integrating acoustic space and timbre of speakers.
- Can be realized in different architectonic environments off conventional concert halls.
- Live spatialization with stereo files via faders to control the distributing channels.
- Example: GRM Acousmonium.

GRM Acousmonium



Source: https://inagrm.com/en/showcase/news/202/the-acousmonium

Examples & Composition

Compositions

- mo.ve. (2017): Composed for IKO.
- reset.discover: VR/AR spatial audio.
- Die Schichtschläferin: Layered spatial composition.

Compositional Aspects

- Spectral properties shape spatial perception.
- Sound is often described using spatial attributes.
- essential to consider how sound interacts with the surrounding space—how reflections, absorptions, and the room’s acoustic characteristics shape and co-create the intended sonic image.
- Sine tones hard to localize; complex sounds evoke space.

mo.ve [modus vertiginis] (2016)

- Fixed media composition for IKO
- Projecting sound beams against reflective surfaces
- architectural properties of the space is incorporated in the composition - relationship between sound quality and acoustics
- Audience is invited to autonomously move within space and explore it.

Die Schichtschläferin (2020)

- Ambisonics Radioplay
- Collaboration with Antonia Biberger
- 3 different layers of narration
  - Distinguished via spatialization
- 3rd order ambisonics
- Elaborated at ICST (ZHdK, Zurich)
- Listeners are invited to walk through space and follow the narration
- Push boundaries of ambisonics dogma

reset.discover (2018)

- Collaboration with Constantinos Miltiadis
- VR/ambisonics piece
- Sonic and visual elements where categorized in ambient, objects/events, gestures.
- Arranged and edited in game engine Unity
- Can run in a loop, but has development
- Interactive elements
- Aims to question experience of everyday reality, destabilize general patterns of perception
- Simultaneously refers to different acoustic environments

reset.discover [for VR and ambisonics]
(2018) Anto Manhartsberger and Constantinos Miltiadis

Link