Acoustics of timber buildings

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Education and vocational training

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wood PoP

REPUBLIC OF SLOVENIA
MINISTRY OF THE ECONOMY,
TOURISM AND SPORT

SUMMARY

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SPEAKER PRESENTATION

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Field of expertise: Acoustics

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WOOD IN ACOUSTICS

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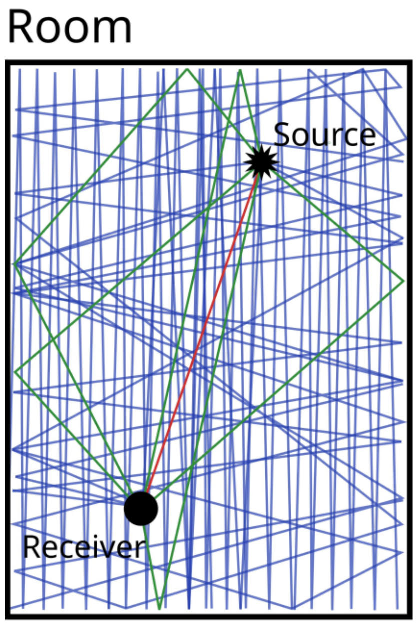
- Wood has **traditionally** been the material of choice in room acoustics.
- It is a **structural** material and the **finishing** layer at once with several **processing** options.
- It is easy to create **rich geometric shapes**, while in combination with other materials high **sound-absorbing** properties can be achieved.

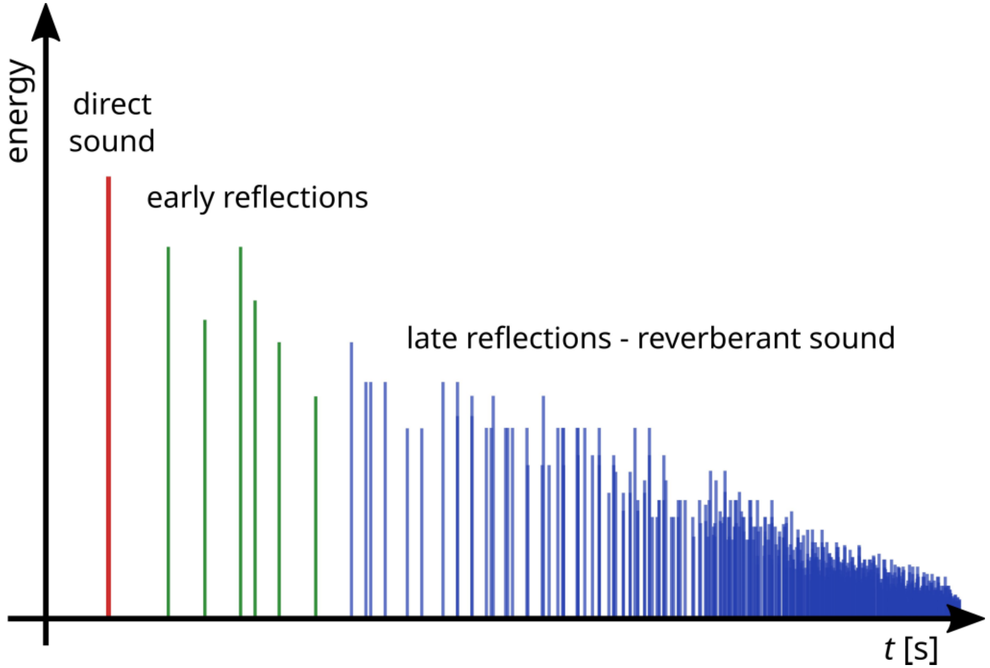
https://culturezvous.com/guide-pratique-opera-comique/

ROOM ACOUSTICS

SOUND IN ROOMS

- **Room acoustics** is a subfield of acoustics dealing with the behavior of sound in enclosed or partially-enclosed spaces [1].
- In addition to **direct sound**, there are also **reflections** at the boundaries of a room.
- We distinguish between **early** and late **reflections**.



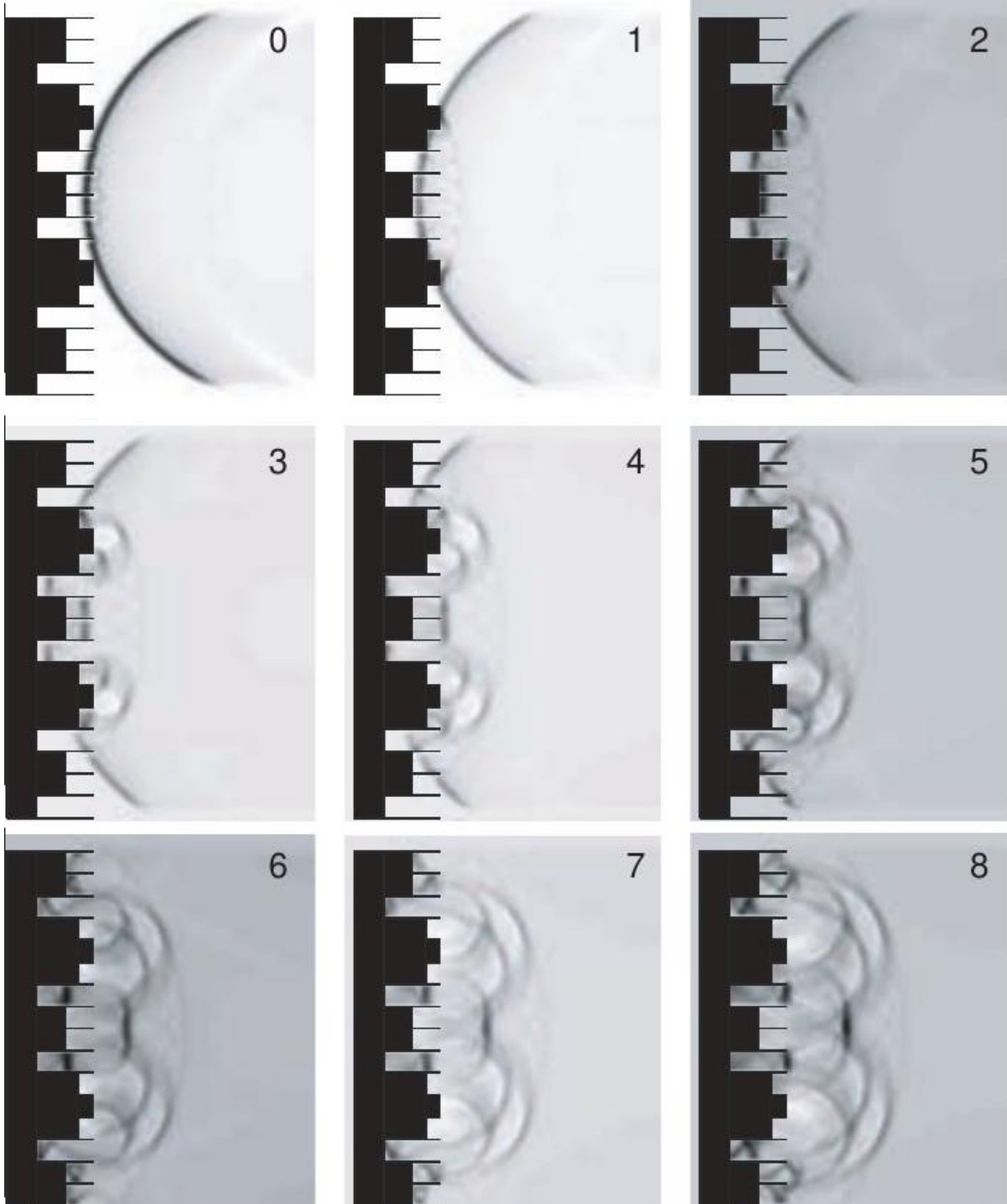


[1] https://en.wikipedia.org/wiki/Room_acoustics

SOUND REFLECTION

- On rigid flat surfaces waves specularly reflect.
- On surfaces of complex geometries, waves are scattered.
- When reflected, the energy of the sound wave is reduced (partially absorbed).

[2] T. J. Cox, P. D'Antonio, *Acoustic Absorbers and Diffusers: Theory, Design and Application* (2009)



SOUND ABORPTION

The energy loss at boundary reflection

The most common sound absorbing materials are **porous**.

Sound **propagates into the structure** of the material, where sound energy converting it into heat (viscous losses energy dissipation).

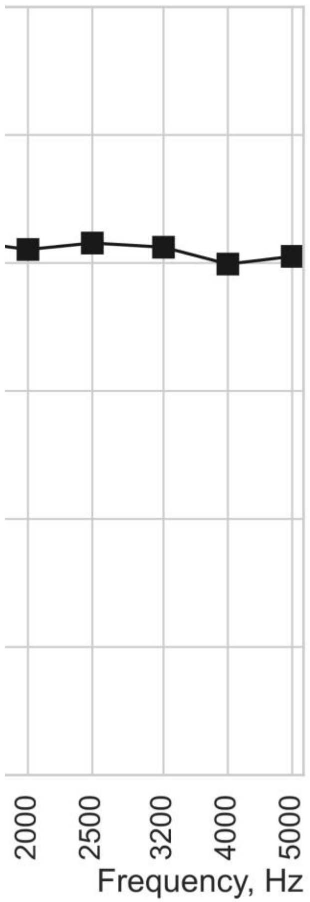
The sound absorbing properties of materials are characterized by their **sound absorption coefficient, α:**

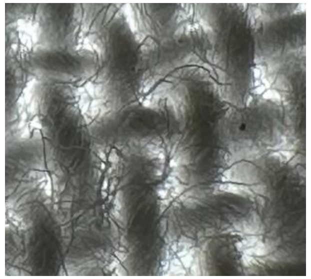
- *“The fraction of the incident acoustic power arriving at the boundary that is not reflected”* [3], i.e. is absorbed.
- Ranges from 0-1 (perfect reflector/absorber)
- Is a frequency-dependent parameter.

A.1 Table of absorption coefficients *(continued)*

Material	*Frequency (Hz)* 125	250	500	1000	2000	4000
Acoustics plaster, 40 mm thick[22]	0.31	0.55	0.84	0.78	0.71	0.54
Acoustics plaster, 68 mm thick[22]	0.47	0.74	0.76	0.65	0.62	0.49
Plasterboard						
Gypsum board, 1.27 cm nailed to studs with 4.1 m c-t-c[2]	0.29	0.1	0.05	0.04	0.07	0.09
Plasterboard on frame, 9.5 mm boards, 10 cm empty cavity[23,9]	0.11	0.13	0.05	0.03	0.02	0.03
Plasterboard on frame, 9.5 mm boards, 10 cm cavity filled with mineral wool[23,9]	0.28	0.14	0.09	0.06	0.05	0.05
Plasterboard on frame, 13 mm boards, 10 cm empty cavity[23,9]	0.08	0.11	0.05	0.03	0.02	0.03
Plasterboard on frame, 13 mm boards, 10 cm cavity filled with mineral wool[23,9]	0.30	0.12	0.08	0.06	0.06	0.05
2×13 mm plasterboard on steel frame, 5 cm mineral wool in cavity, surface painted[12,9]	0.15	0.10	0.06	0.04	0.04	0.05
Glazing						
Glass, ordinary window glass[2,10]	0.35	0.25	0.18	0.12	0.07	0.04
Single pane of glass, 3–4 mm[6]	0.2	0.15	0.1	0.07	0.05	0.05
Single pane of glass, >4 mm[6]	0.1	0.07	0.04	0.03	0.02	0.02
Single pane of glass, 3 mm[23,9]	0.08	0.04	0.03	0.03	0.02	0.02
Double glazing, 2–3 mm glass, 1 cm gap[8,9]	0.10	0.07	0.05	0.03	0.02	0.02
Double glazing, 2–3 mm glass, >3 cm gap[23,9]	0.15	0.05	0.03	0.03	0.02	0.02
Glass, large panes, heavy glass[2,5,13]	0.18	0.06	0.04	0.03	0.02	0.02
Wools and foam						
25 mm fibreglass, rigid backing[24]	0.08	0.25	0.45	0.75	0.75	0.65
2.54 cm fibreglass, 24 to 48 kg/m^3[2]	0.08	0.25	0.65	0.85	0.8	0.75
2.5 cm fibreglass, 2.5 cm airspace[2]	0.15	0.55	0.8	0.9	0.85	0.8
5 cm fibreglass, rigid backing[24]	0.21	0.50	0.75	0.90	0.85	0.80
7.5 cm fibreglass, rigid backing[24]	0.35	0.65	0.80	0.90	0.85	0.80
10 cm fibreglass, rigid backing[24]	0.45	0.90	0.95	1.00	0.95	0.85
5 cm mineral wool (40 kg/m^3), glued to wall, untreated surface[8,9]	0.15	0.70	0.60	0.60	0.85	0.90
5 cm mineral wool (40 kg/m^3), glued to wall, surface sprayed with thin plastic solution[8,9]	0.15	0.70	0.60	0.60	0.75	0.75
5 cm mineral wool (70 kg/m^3) 30 cm in front of wall[8,9]	0.70	0.45	0.65	0.60	0.75	0.65
5 cm wood-wool set in mortar[8,9]	0.08	0.17	0.35	0.45	0.65	0.65
5.1 cm fibreglass, panels with plastic sheet wrapping and perforated metal facing[2]	0.33	0.79	0.99	0.91	0.76	0.64
5.1 cm fibreglass, 24–48 kg/m^3[2]	0.17	0.55	0.8	0.9	0.85	0.8
Acoustic tile, 1.27 cm thick[5]	0.07	0.21	0.66	0.75	0.62	0.49
Acoustic tile, 1.9 cm thick[5]	0.09	0.28	0.78	0.84	0.73	0.64
Polyurethane foam, 2.5 cm thick	0.16	0.25	0.45	0.84	0.97	0.87
Thermafleece, sheep wool absorbent 100 mm thick[25]	0.47	0.86	1.00	0.94	0.96	1.02

(continued)

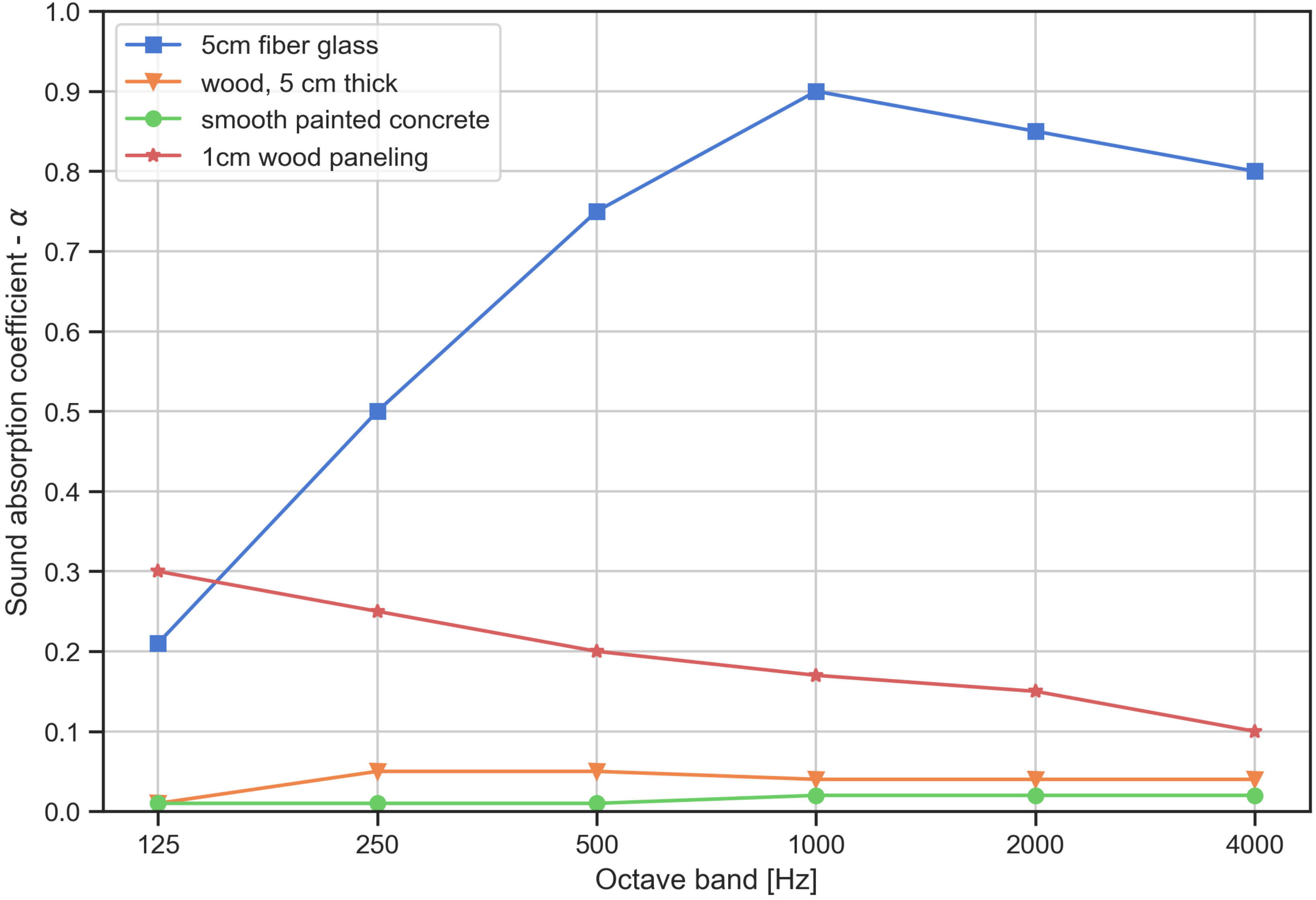




[3] C.L. Morfey, *Dictionary of Acoustics* (2000)

SOUND ABORPTION

The energy loss at boundary reflection



BUILDING ACOUSTICS

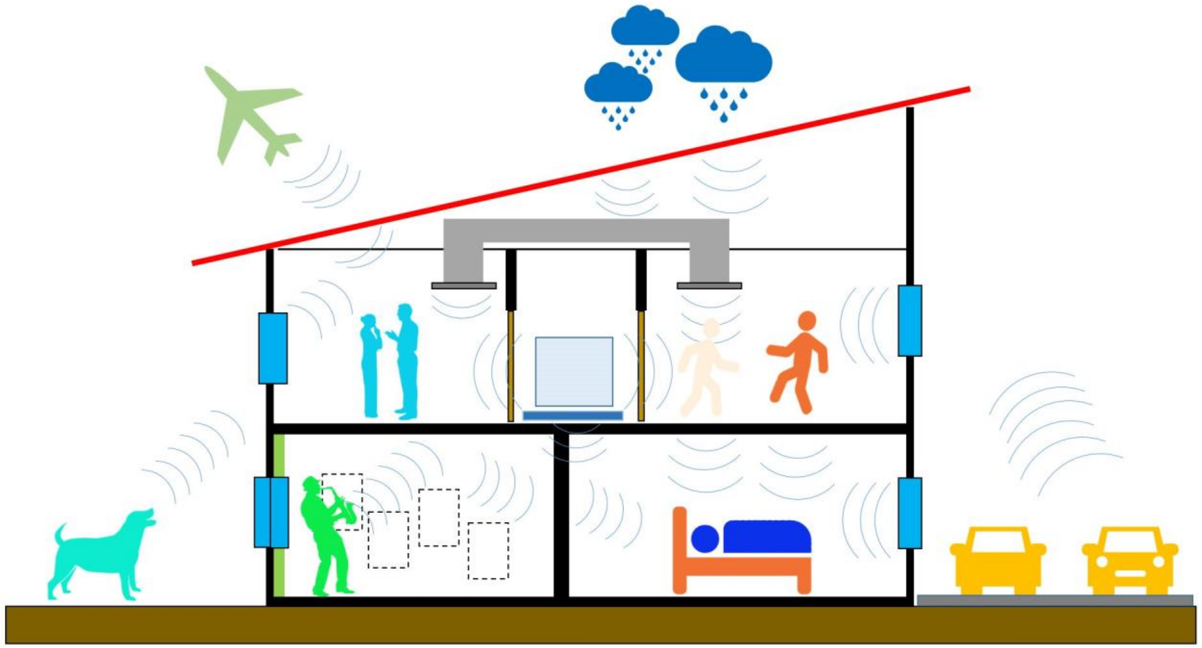
BUILDING ACOUSTICS

The science of controlling noise in buildings.

NOISE = UNWANTED SOUND

Main topics of building acoustics:

- Limit noise transmission from one space to another and from the external environment.
- Limit the noise from machinery and equipment.

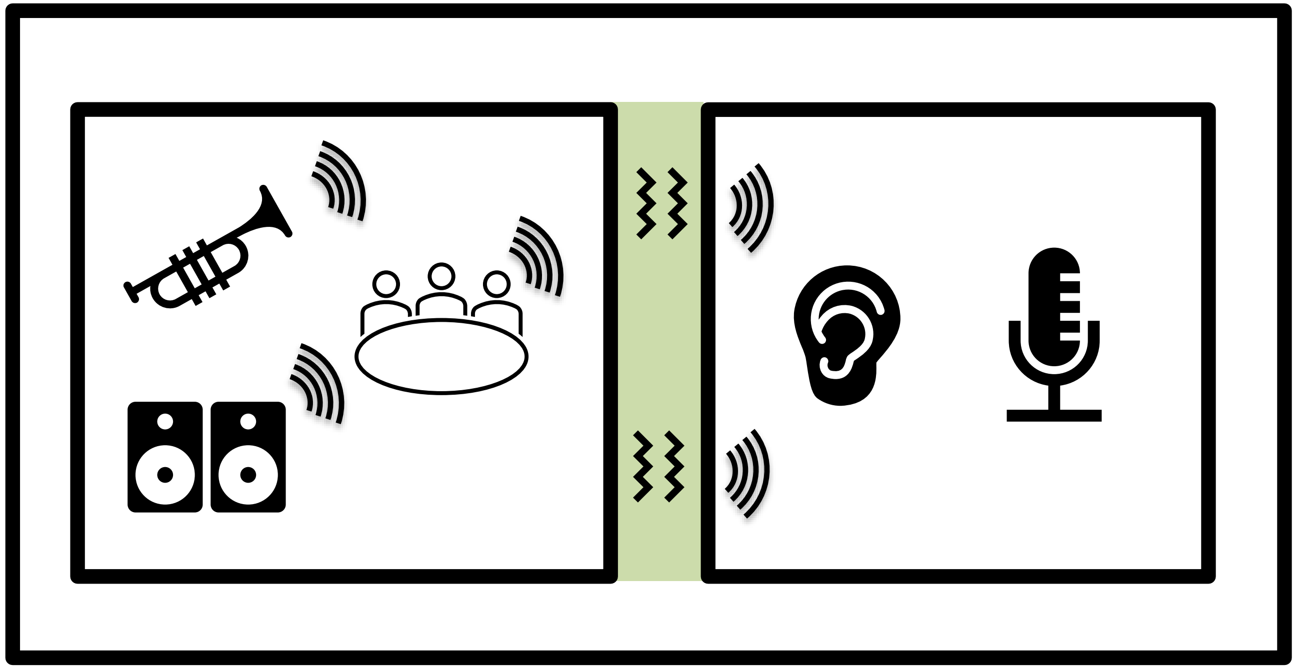


[4] https://commons.wikimedia.org/wiki/File:Building_Acoustics.jpg

SOUND INSULATION

Sound generation principles

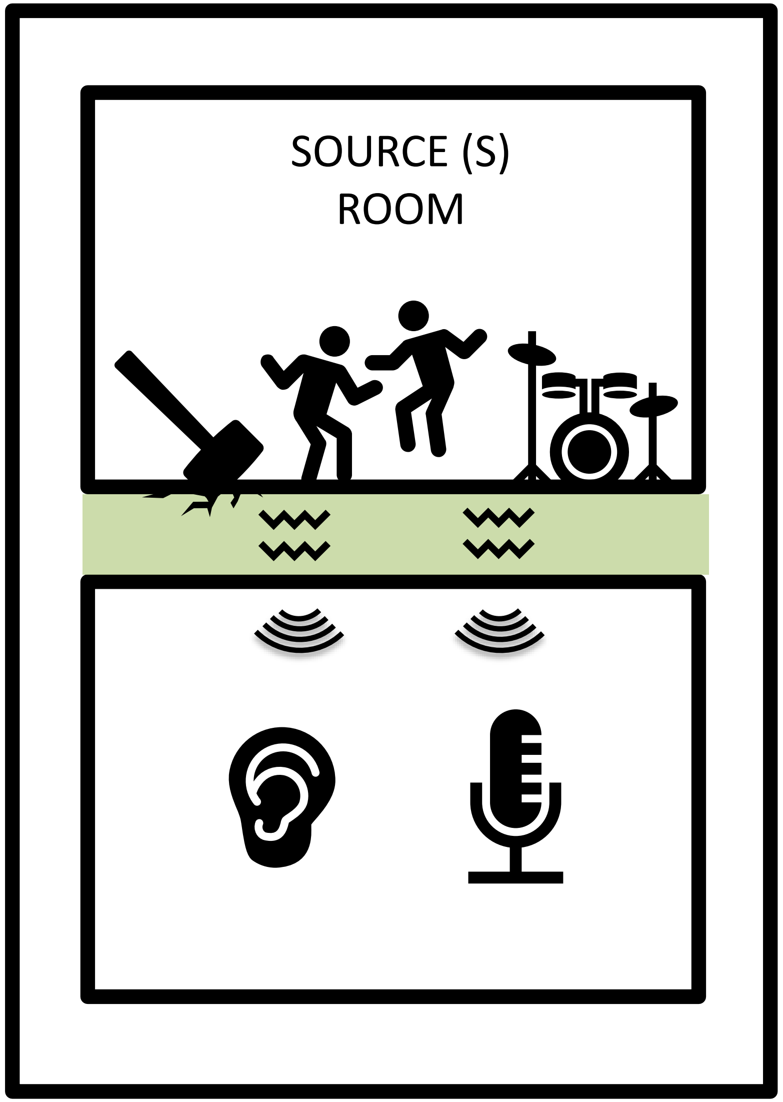
AIRBORNE SOUND



SOURCE (S) ROOM

RECEIVING (R) ROOM

IMPACT SOUND



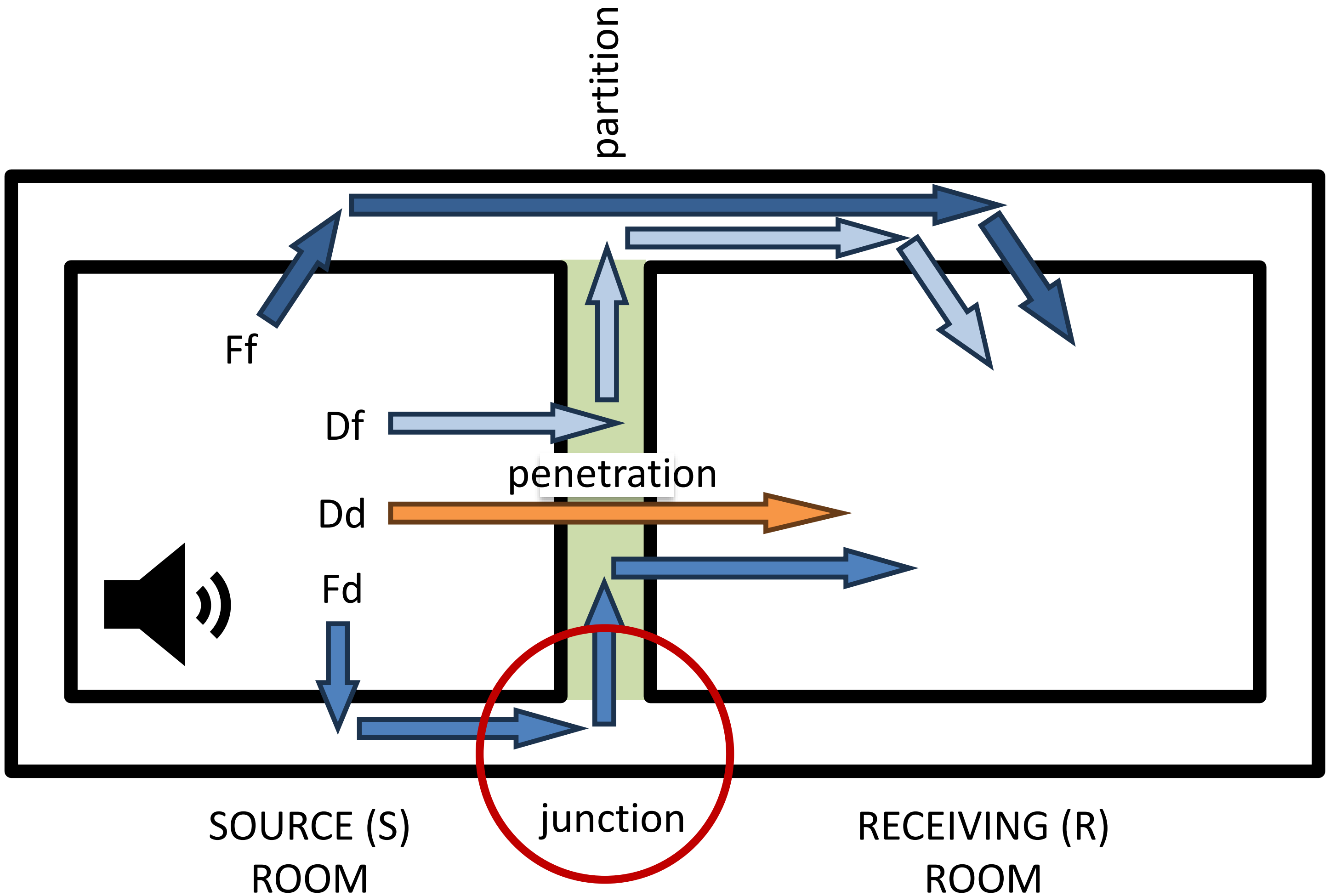
RECEIVING (R) ROOM

SOUND INSULATION

Sound transmission paths

- Direct

- Flanking



LIVE EXPERIMENT