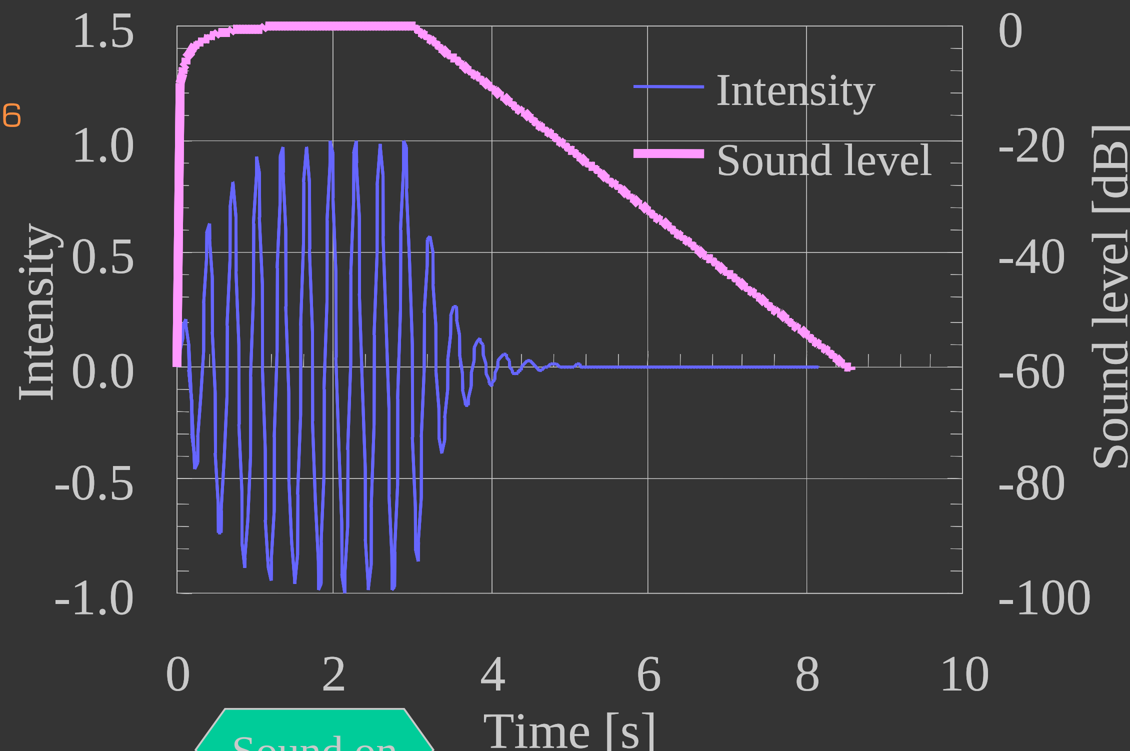
Room acoustics

Sound source in a room

- intensity increases quickly to equilibrium: $I_{equil} = 4\frac{P}{A}$ where $A = \sum_i (\alpha_{si} S_i)$
- switched off then gradual decay
- Reverberation time RT
  - intensity $\downarrow$ by factor 10^6
  - sound level $\downarrow$ by 60 dB



Sound on

Room acoustics

- Sabine's empirical equation for RT

$$RT = 0.163\ V/A$$

with

$$A = \Sigma\,(\alpha_{si}\ S_i)$$

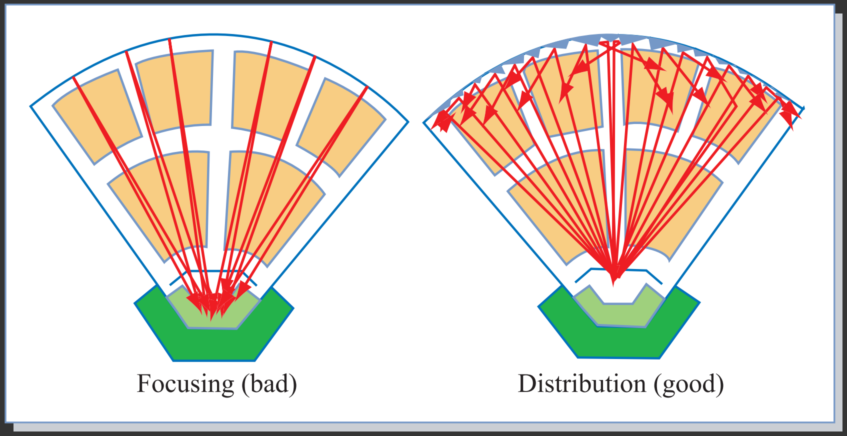
- depends on frequency

Room acoustics

- Good acoustics
  - low background noise, loud wanted sound
  - well diffused sound field
  - no echoes or acoustic distorsions
  - appropriate RT

Room acoustics

- Good acoustics
- Geometrical acoustics
  - avoid large planar surfaces facing each other (fluttering echo)
  - avoid concave surfaces (focusing)



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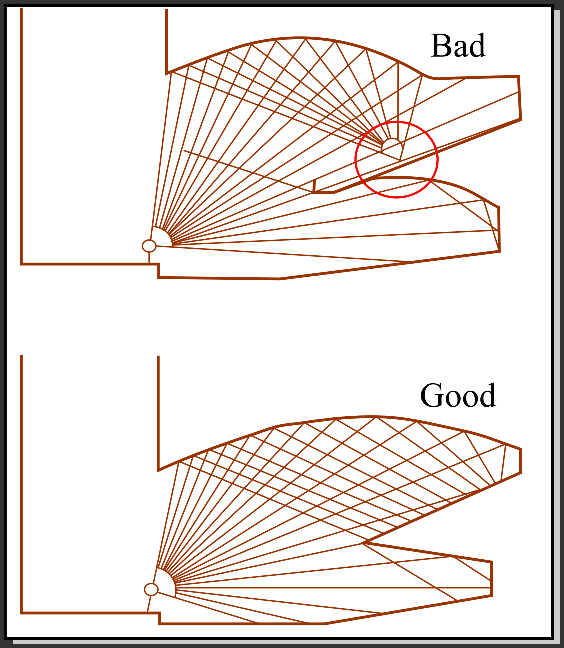

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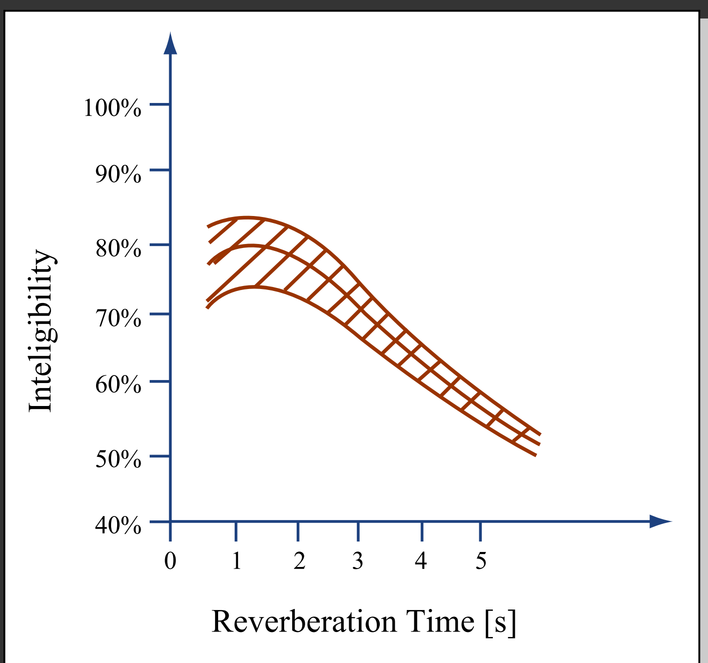
Room acoustics

- Intelligibility and sound level

  high sound level → low A → high RT → lower intelligibility

- Recommended RT



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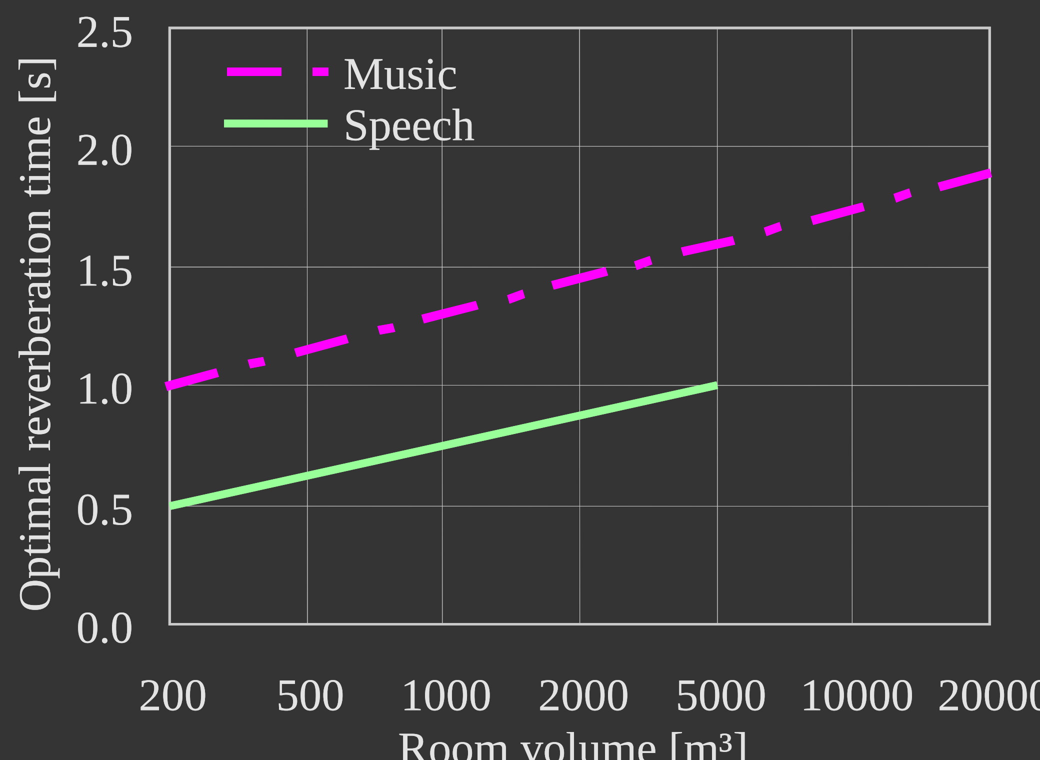

Room acoustics

- Intelligibility as a function of delay
  - direct sound → path l
  - reflected sound → path l'

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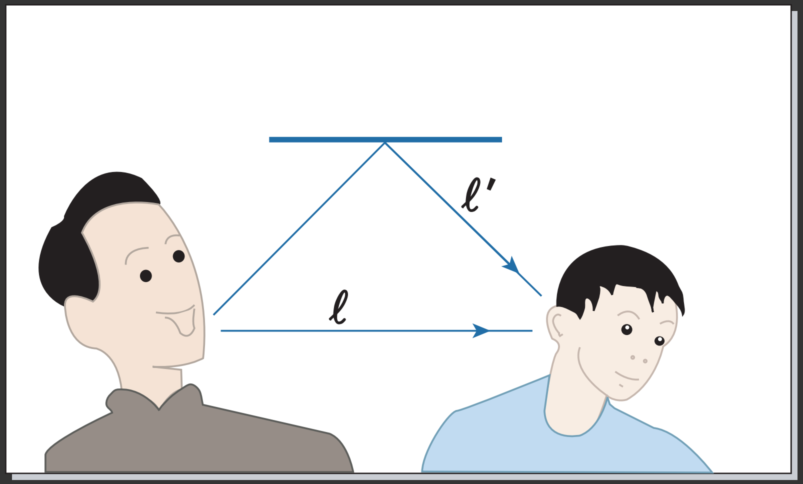


- Delay
  - $\Delta t = (l' - l) / 340$ [m/s]
  - Speech: $\Delta t \leq 35$ ms i.e. $l' - l \leq 12$ m (130 ms per syllable)
  - Music: $\Delta t \leq 44$ ms i.e. $l' - l \leq 15$ m
- If critical
  - change room geometry
  - add absorbing panels

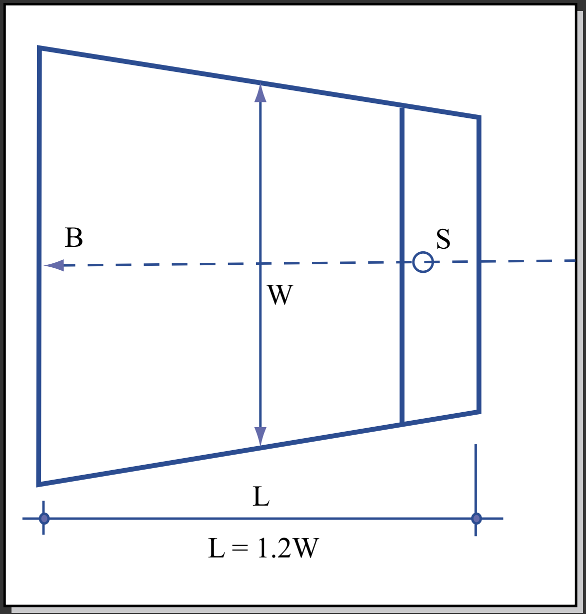
Room acoustics

Wave nature of sound

- standing wave if $L = n \frac{1}{2} \lambda$
- proper frequency $f_n = v/\lambda_n = n\, v/(2L)$

→ no rational relationship between lengths

→ non-rectangular plan



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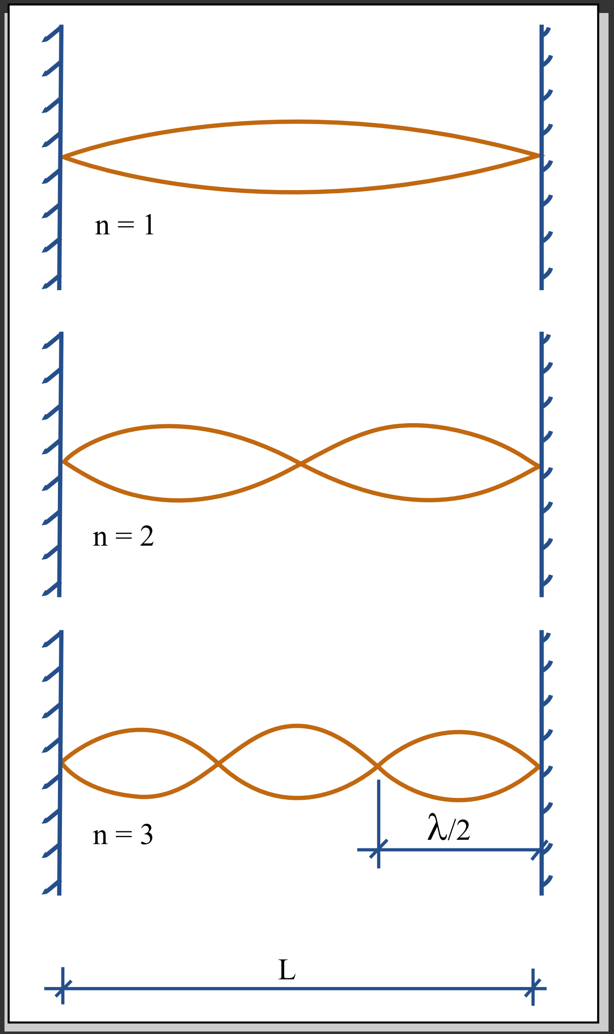

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Room Acoustics

- Reading assignment from Textbook:
  - “Introduction to Architectural Science” by Szokolay: § 3.4
- Additional readings relevant to lecture topics:
  - "How Buildings Work" by Allen: pp. 129-132 in Chap 14