Diffusivity of Performance Spaces

– it’s significance to perceived sound quality from directional sources

Magne Skålevik,

www.akutek.info

Brekke Strand Akustikk,

Oslo, Norway

msk@bs-akustikk.no

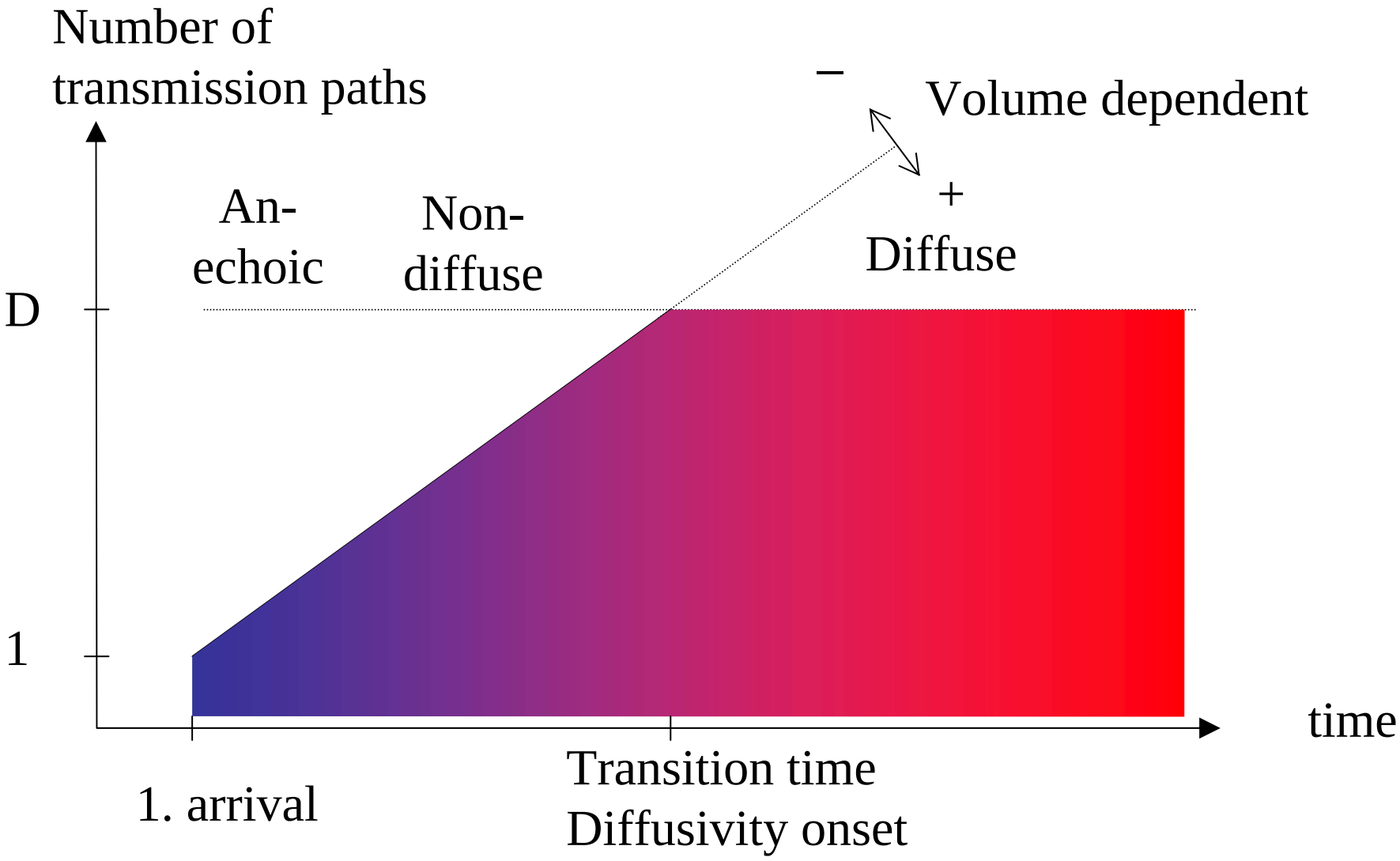
Diffusivity - optical analogy:

Domain	Diffuse	Non-diffuse
Room lighting	Indirect lighting, matt white surfaces, insensitive to source directivity	Direct lighting, mirrors, high contrast shiny surfaces, sensitive to light beam directions

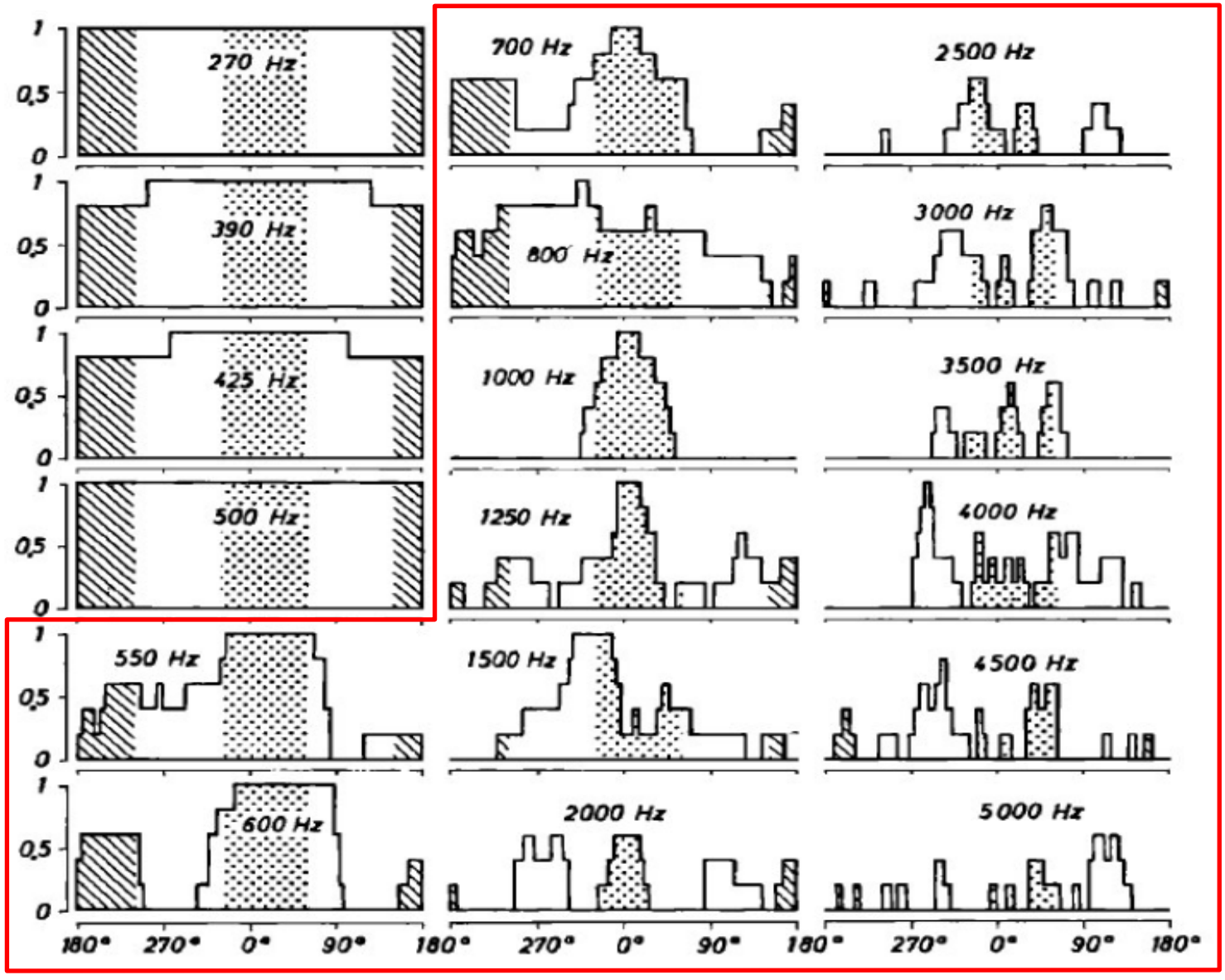
Diffuse and non-diffuse conditions

Domain	Diffuse	Non-diffuse
Time	Even energy density; Smooth exponential decay	Prominent reflections - short delays or echoes, time-energy gaps
Freq	Even frequency response	Peaks, dips, modes, comb-filters
Space	Even intensity distribution, no sound shadows; ***Multitude of transmission paths***	Hot spots, dead spots, beaming, acoustic glare, interference patterns; ***Few effective transmission paths***

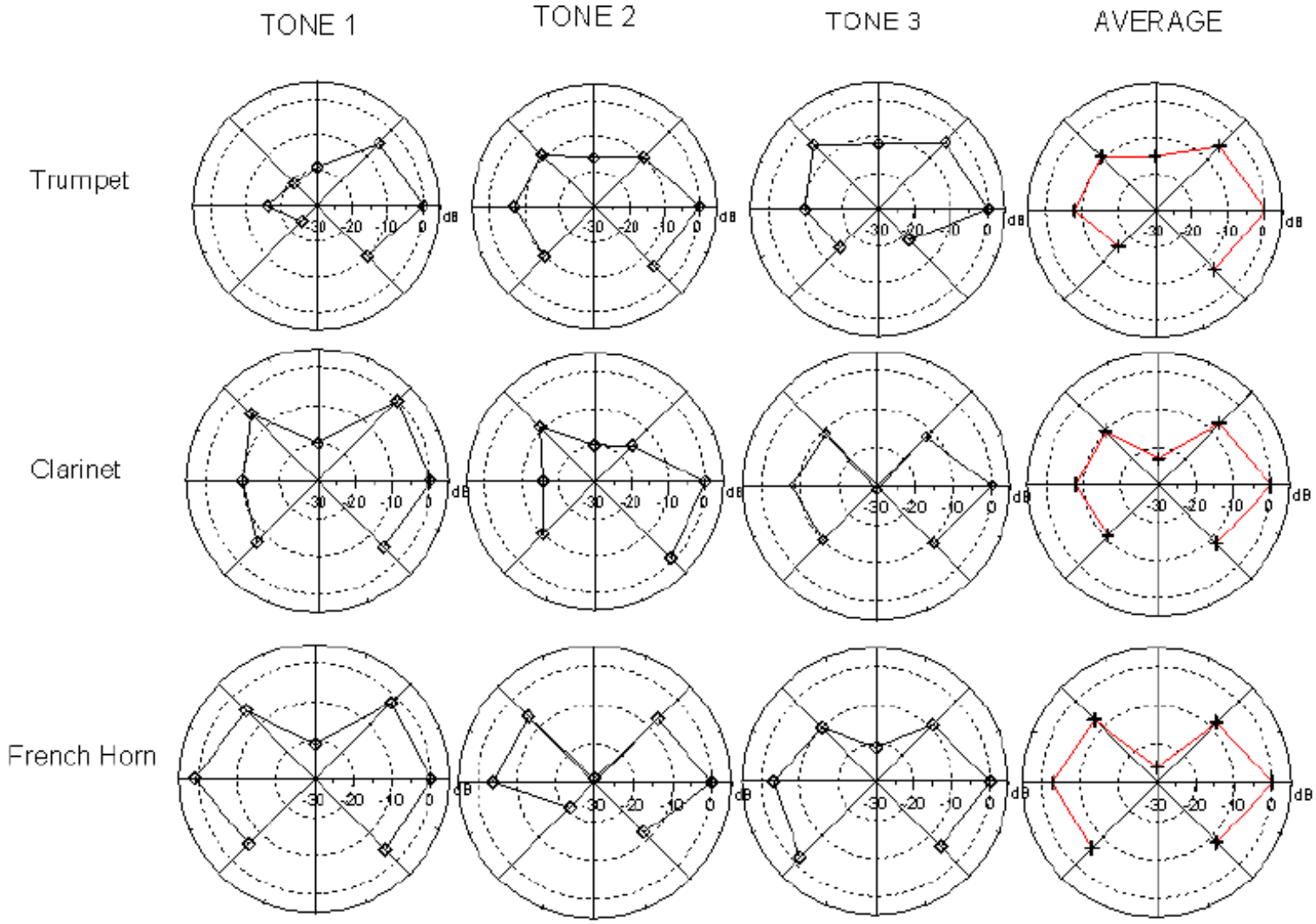
Dynamic Diffusivity



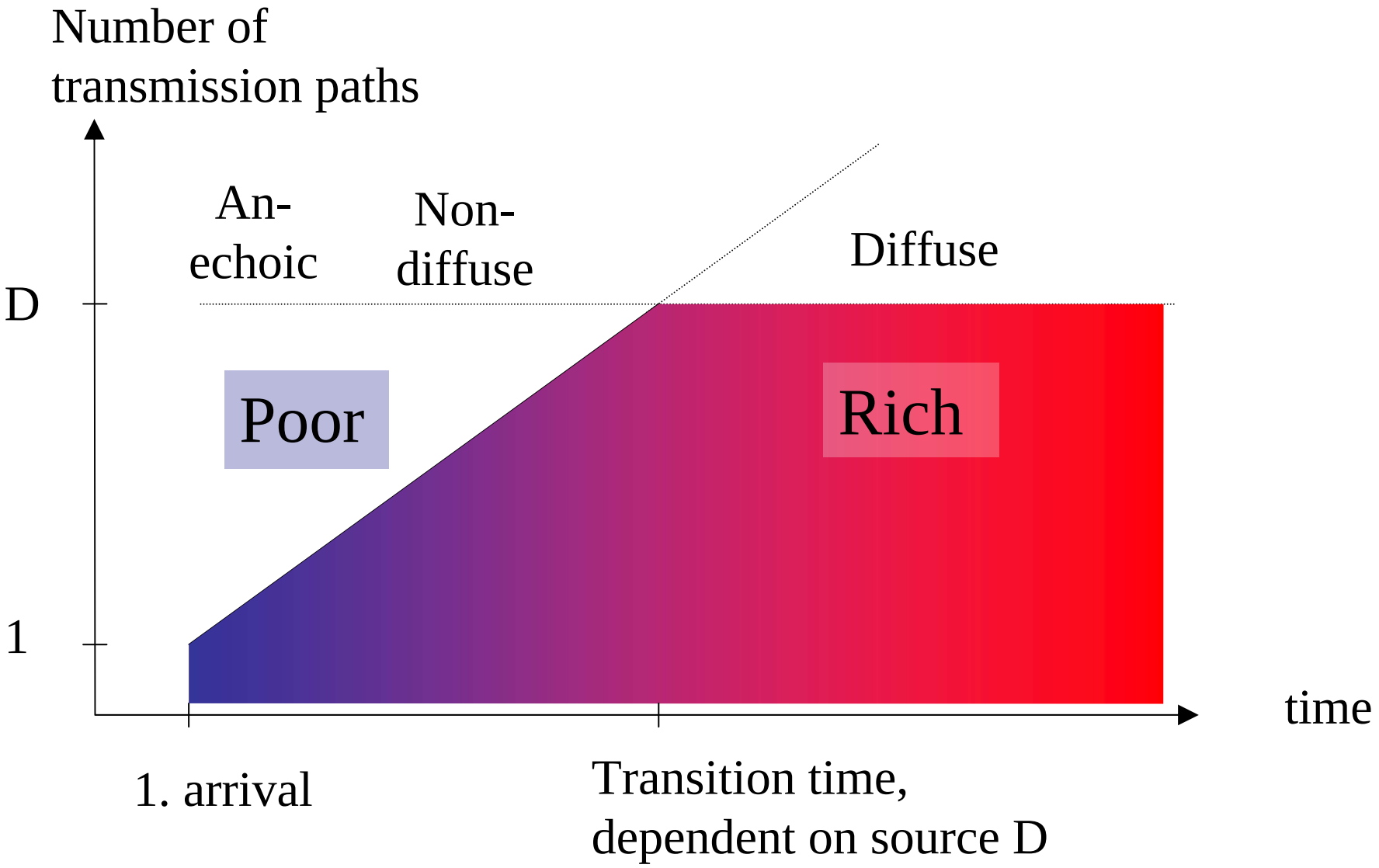
J.Meyer 1972: Violin radiation



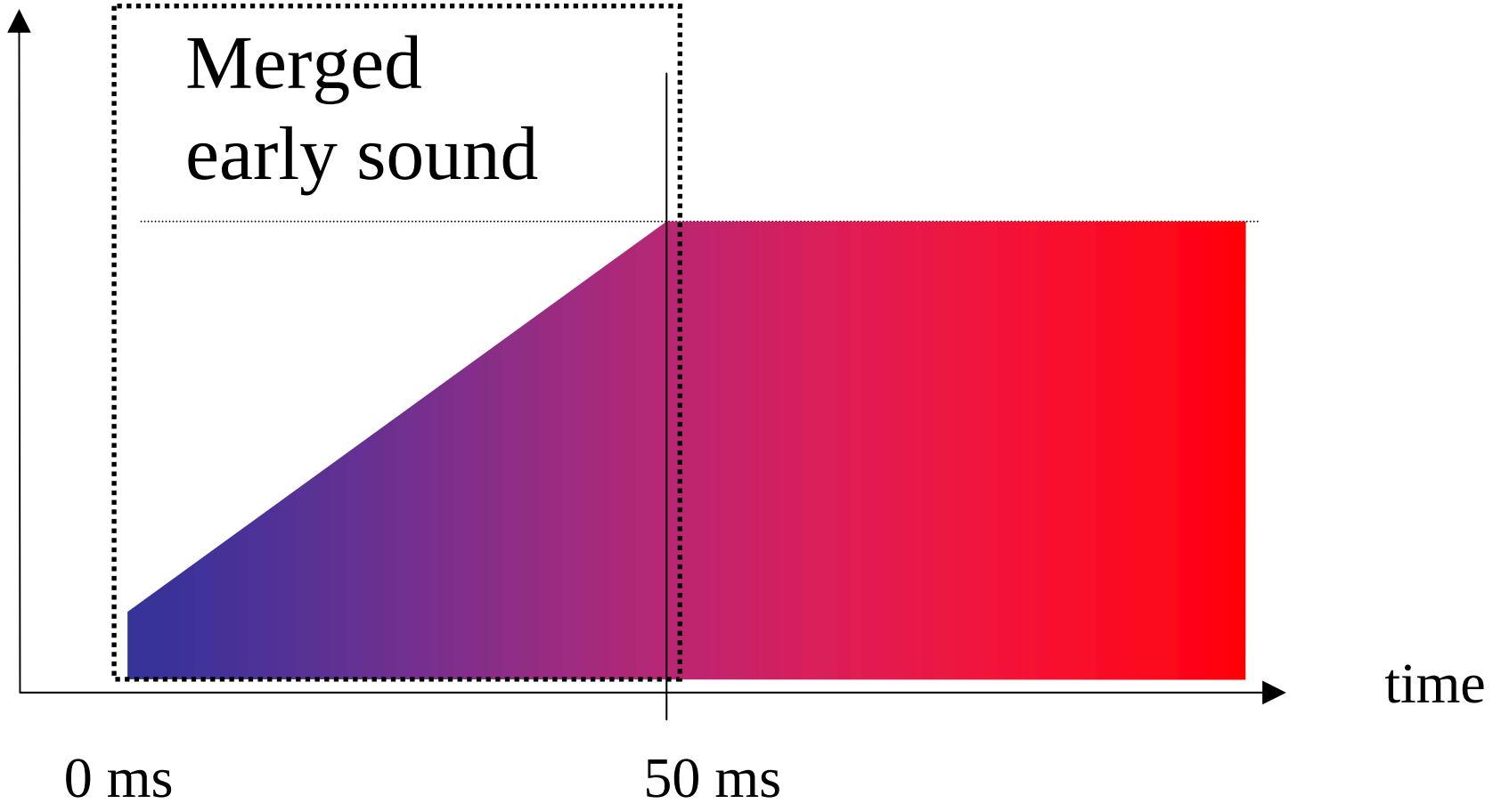
Otondo & Rindel 2002



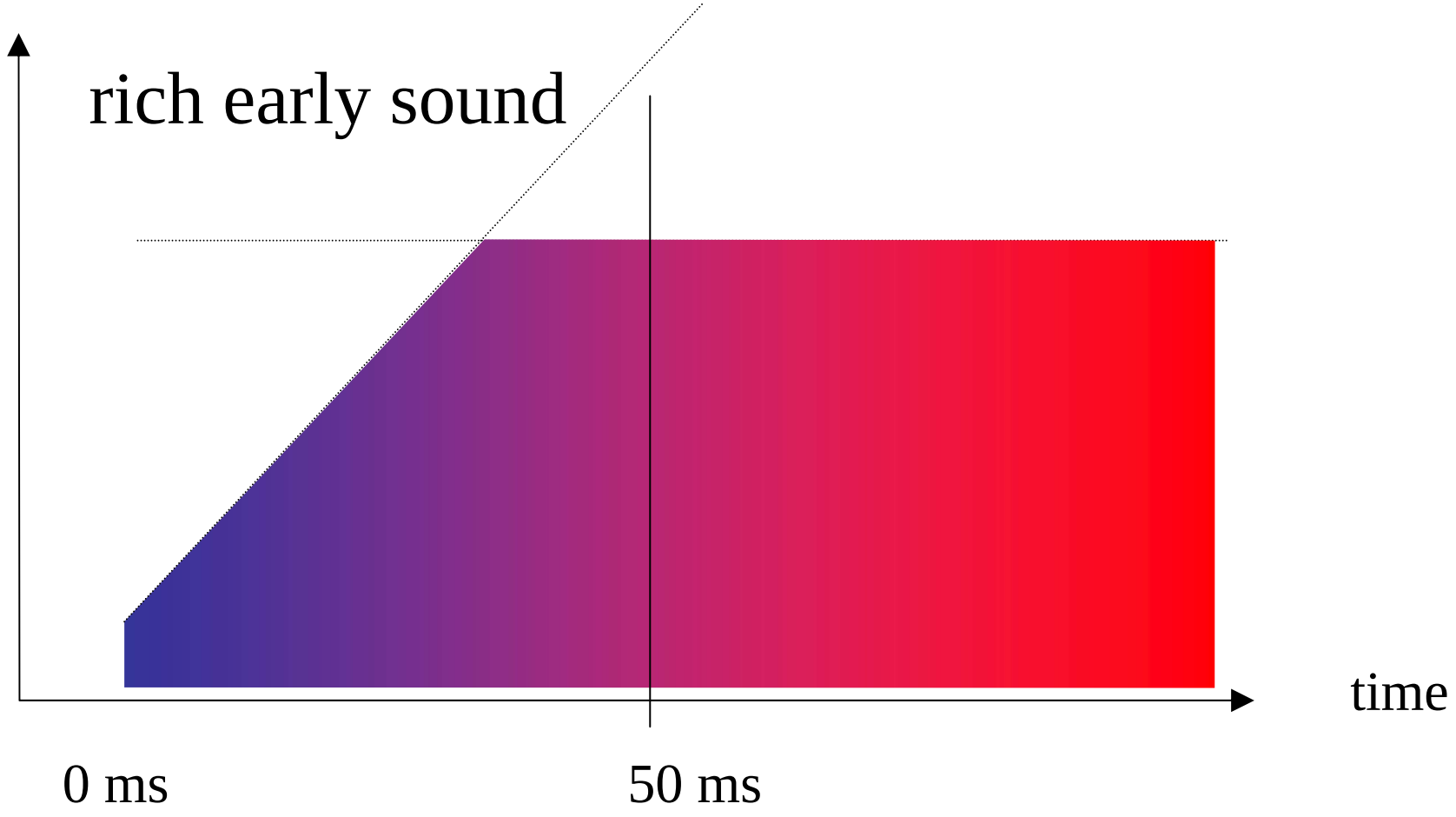
Transmission quality



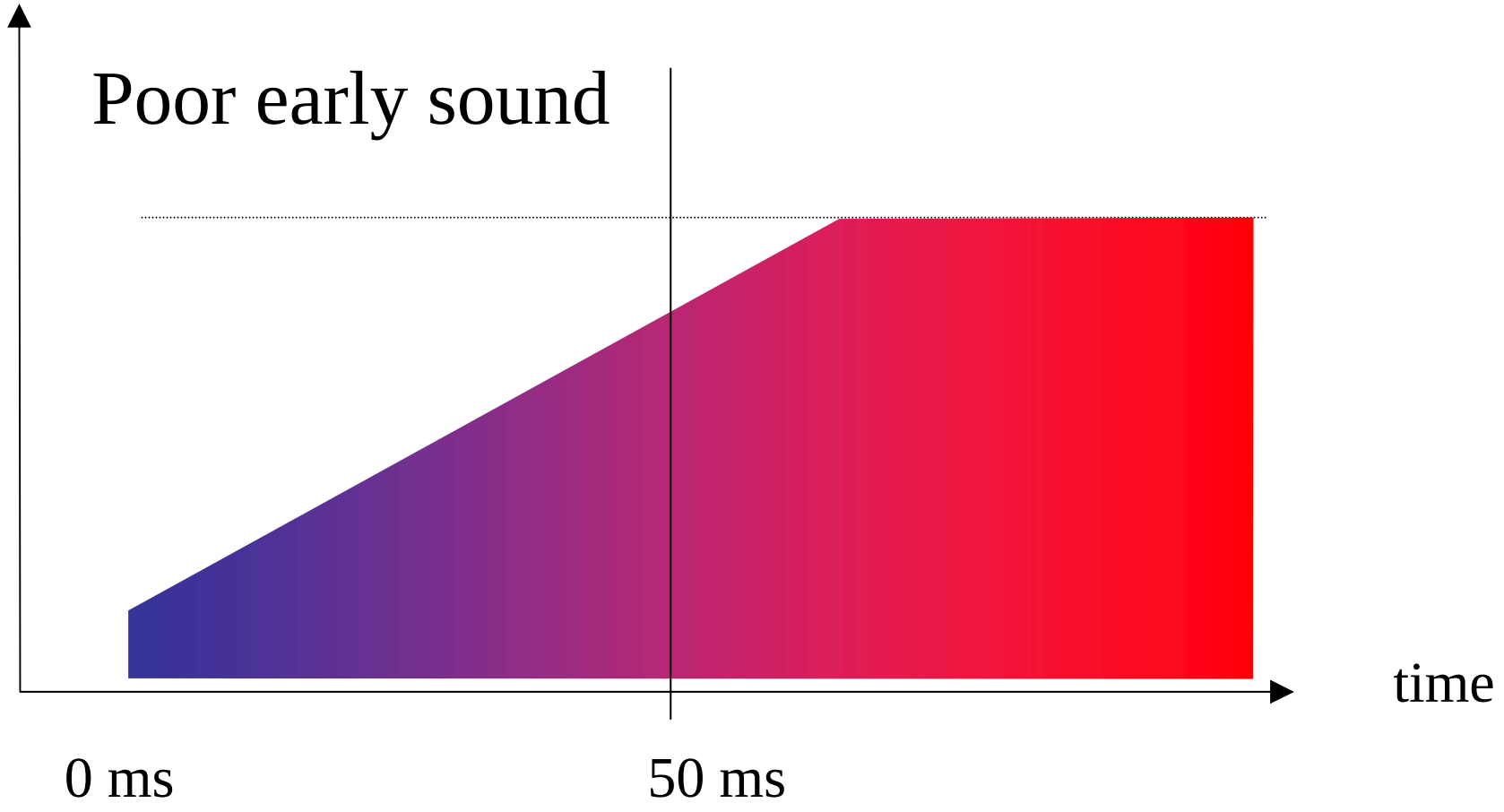
Perceived transmission quality



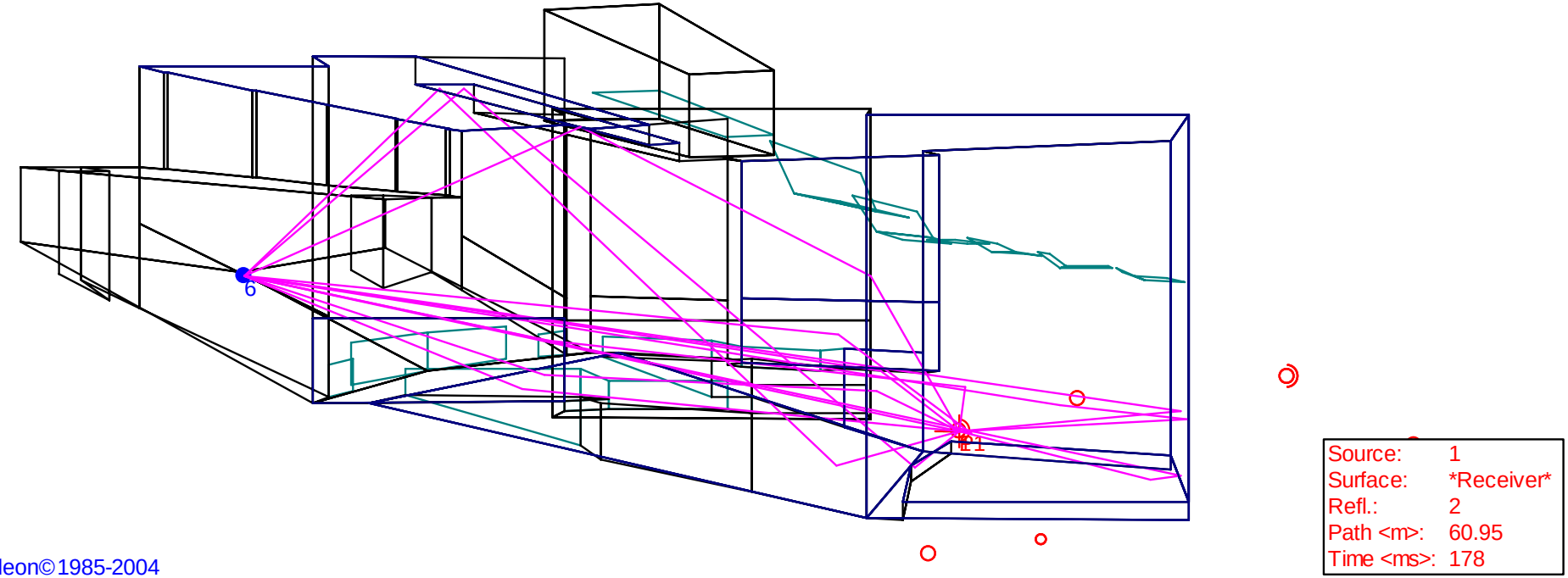
Sufficiently early transition



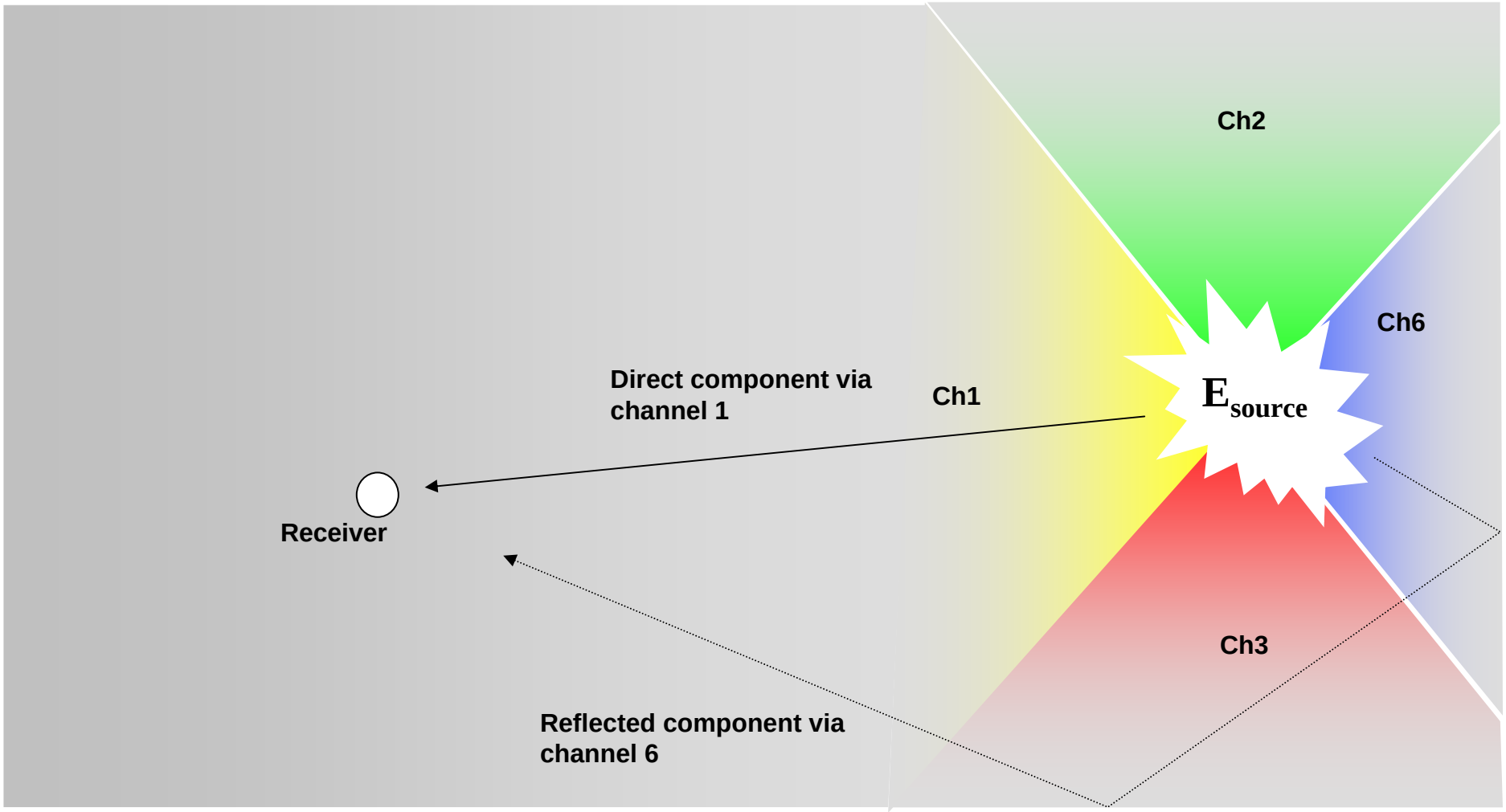
Too late transition



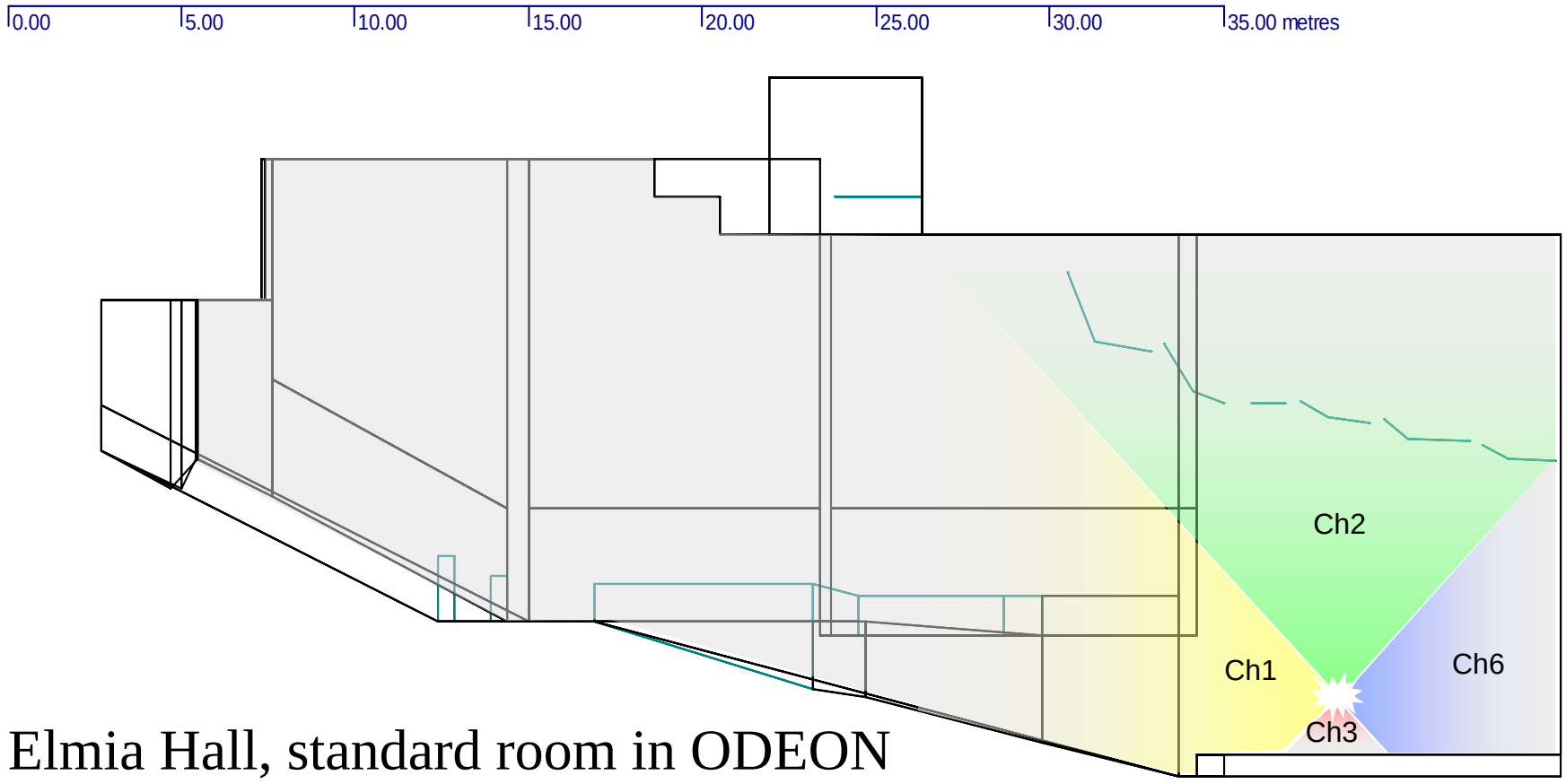
Multi-channel transmission



Multi-channel transmission



Multi-channel transmission

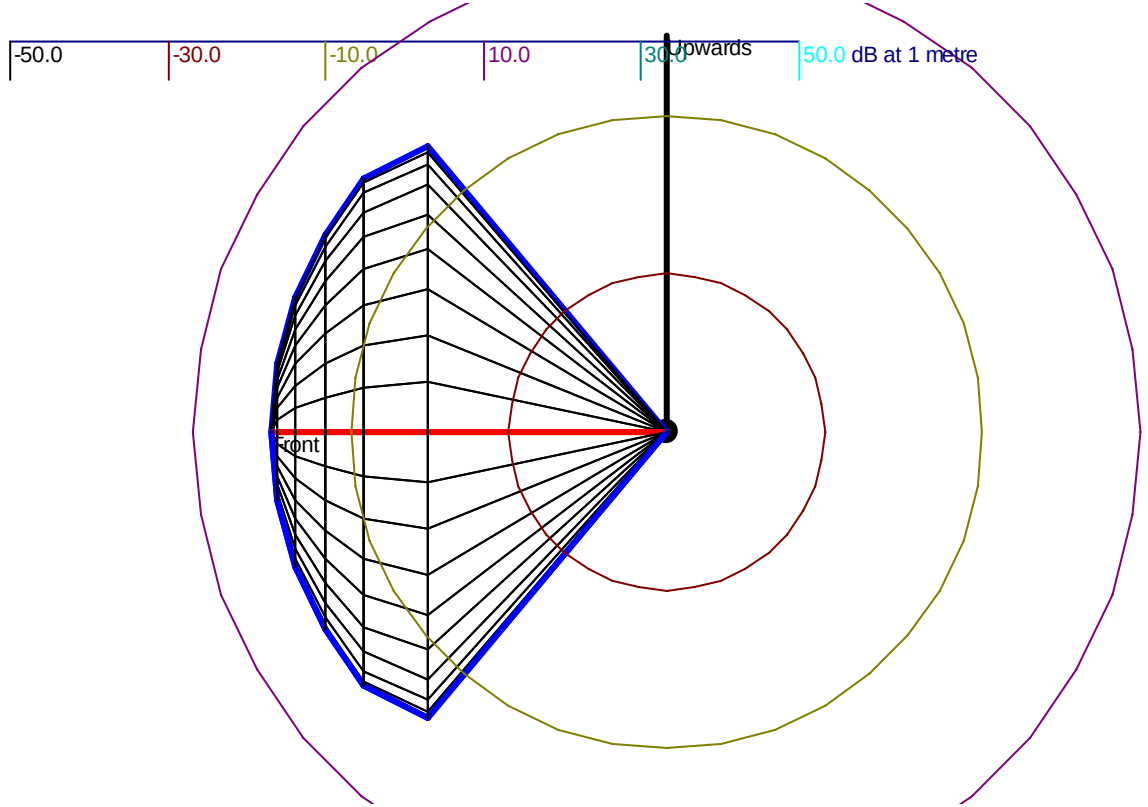


Elmia Hall, standard room in ODEON

Multi-channel transmission

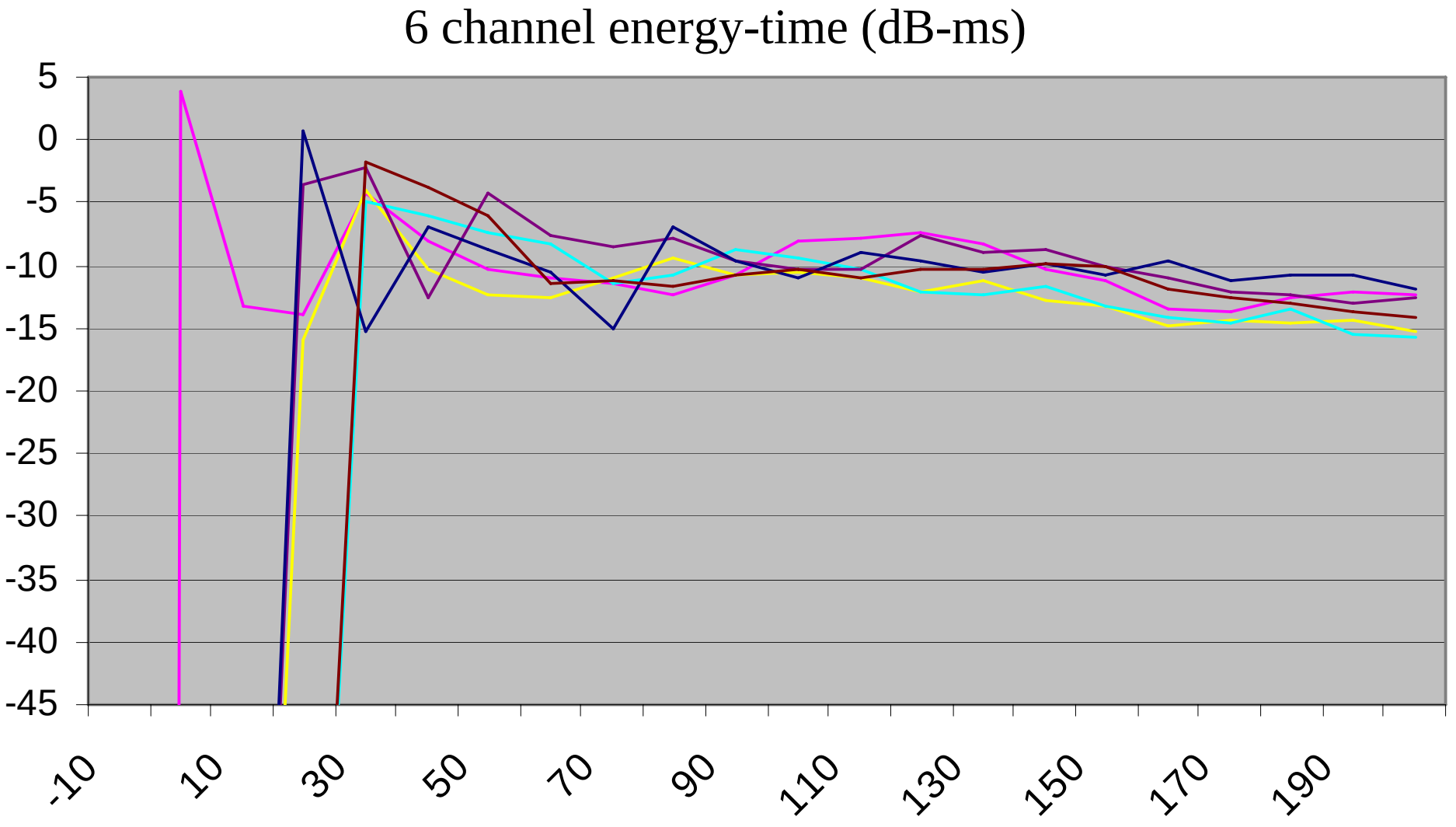
The 100dB channel separator created in ODEON 7.0

N = 6 channels sufficient for analyzing up to D = 6



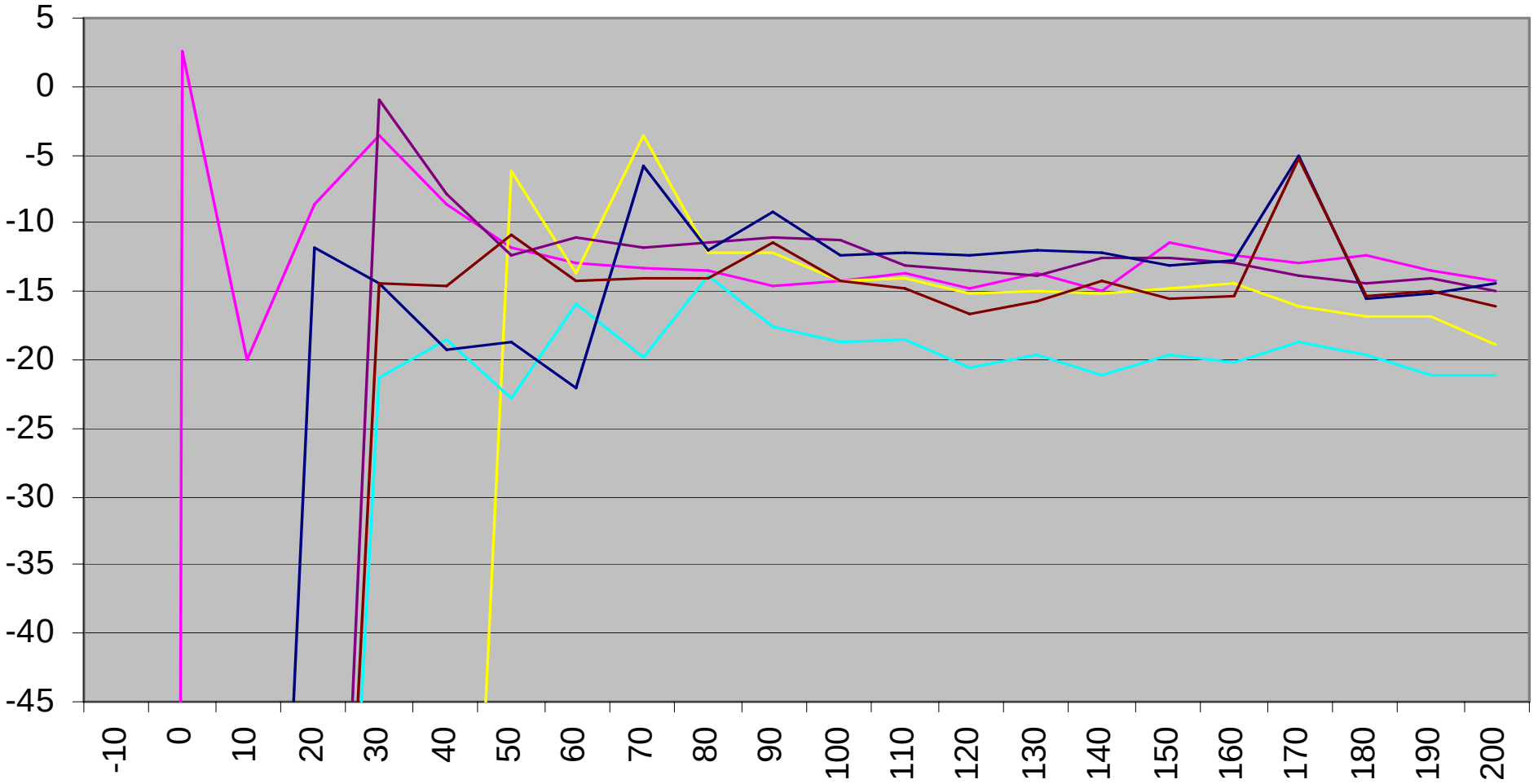
Polar diagram for 1 of 6 channels

Elmia 10.000m³



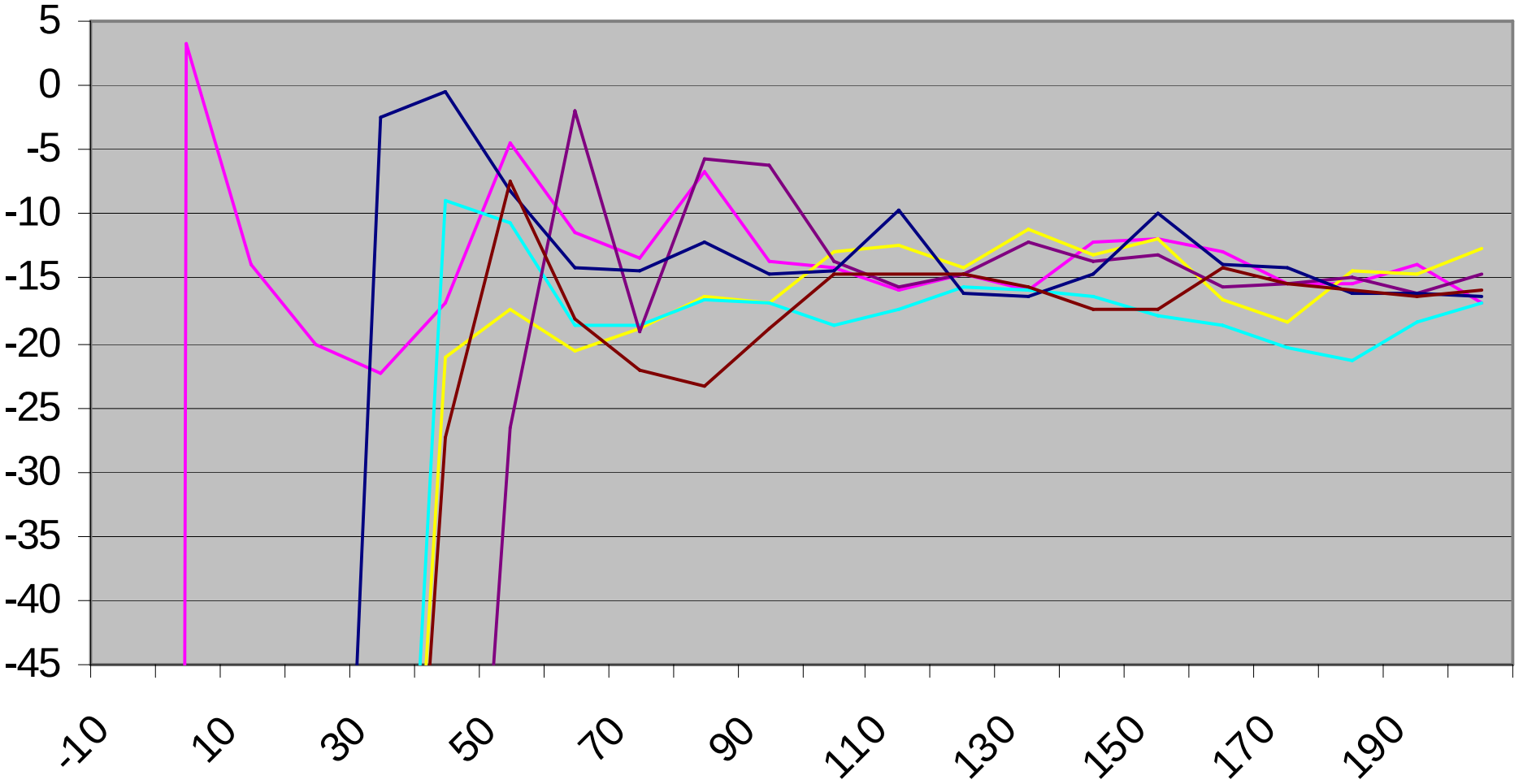
Vienna 15.000m³

6 channel energy-time (dB-ms)



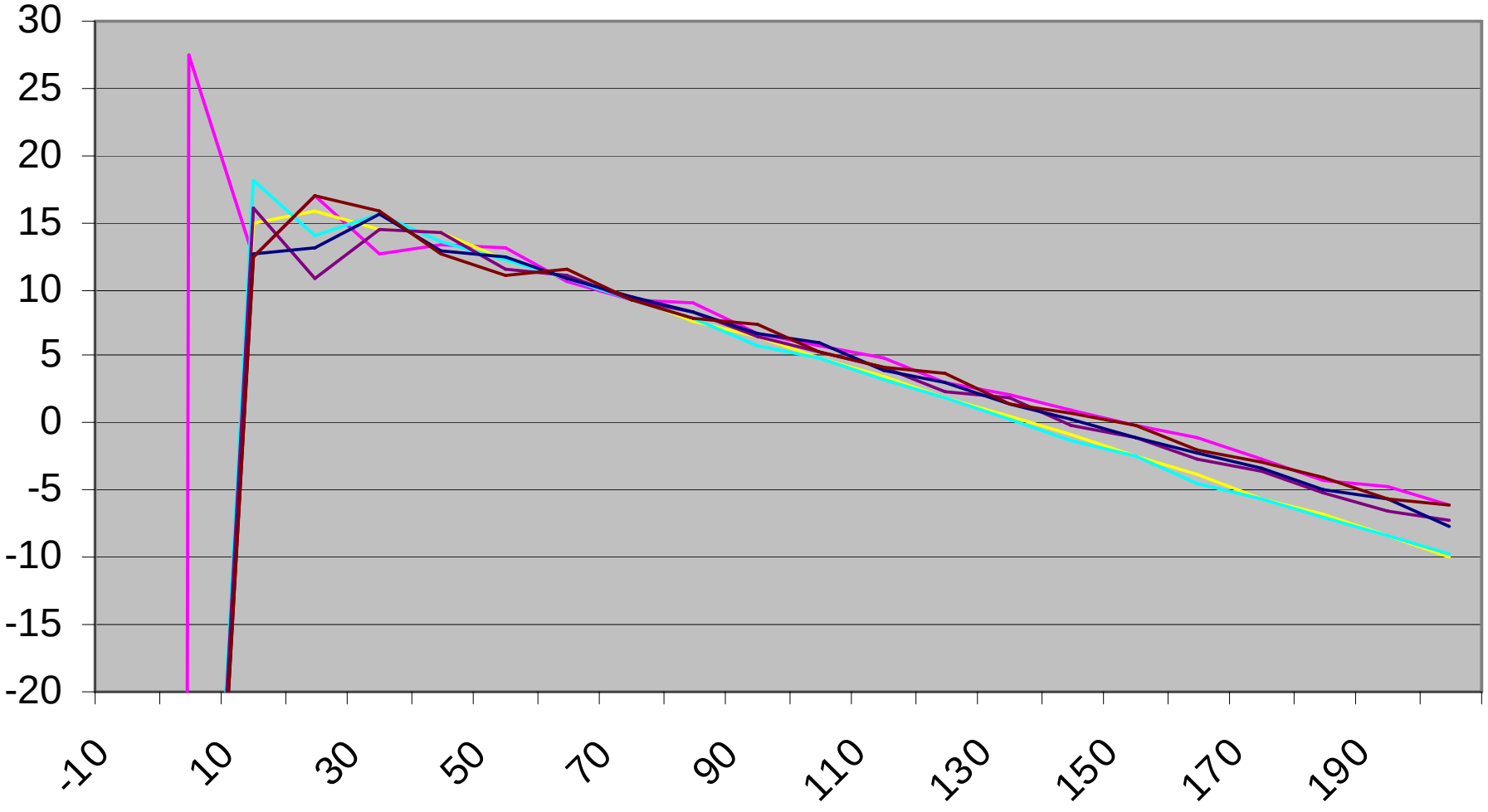
Oslo 19.000m³

6 channel energy-time (dB-ms)



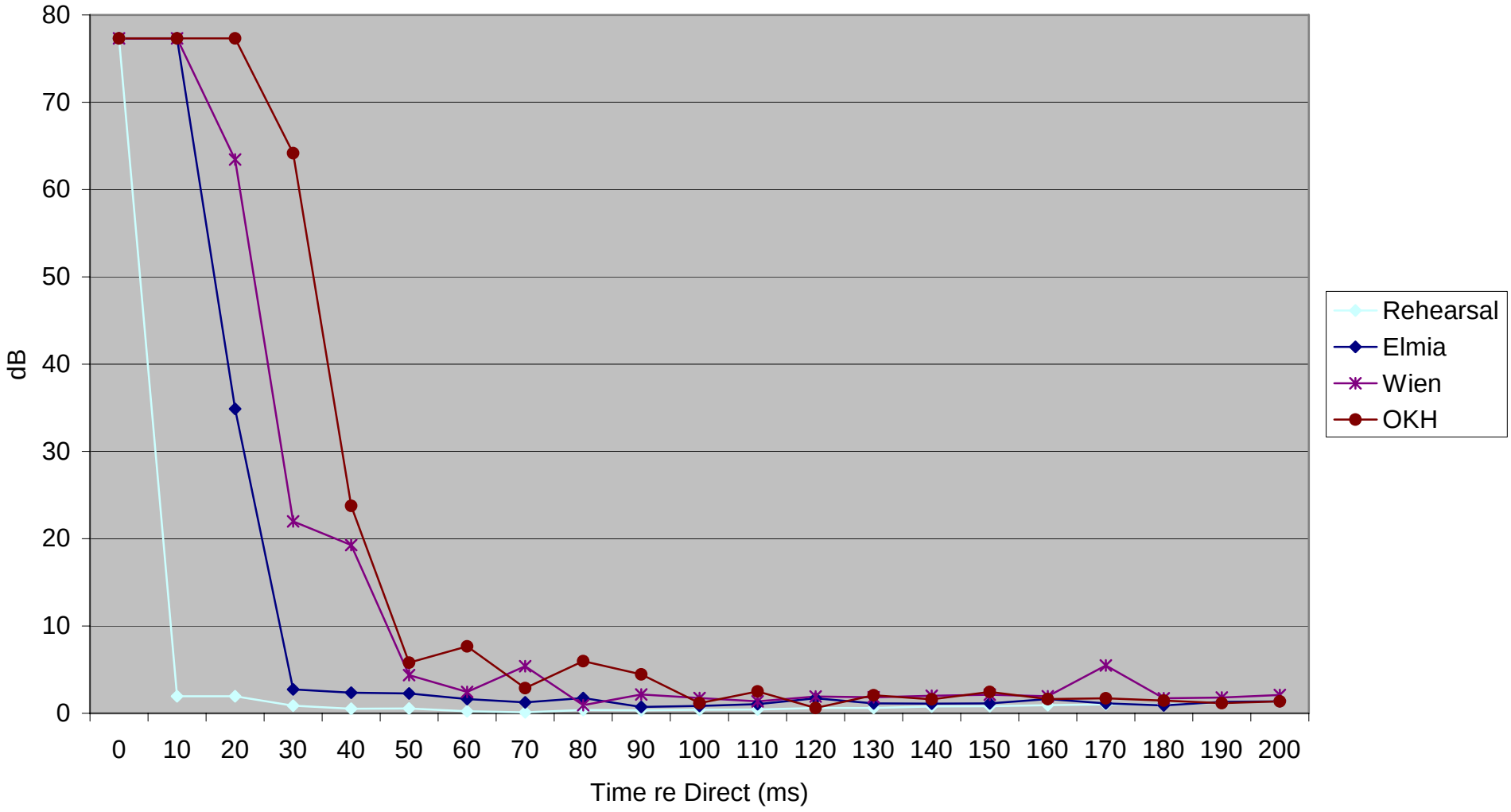
Rehearsal room 60m³

6 channel energy-time (dB-ms)



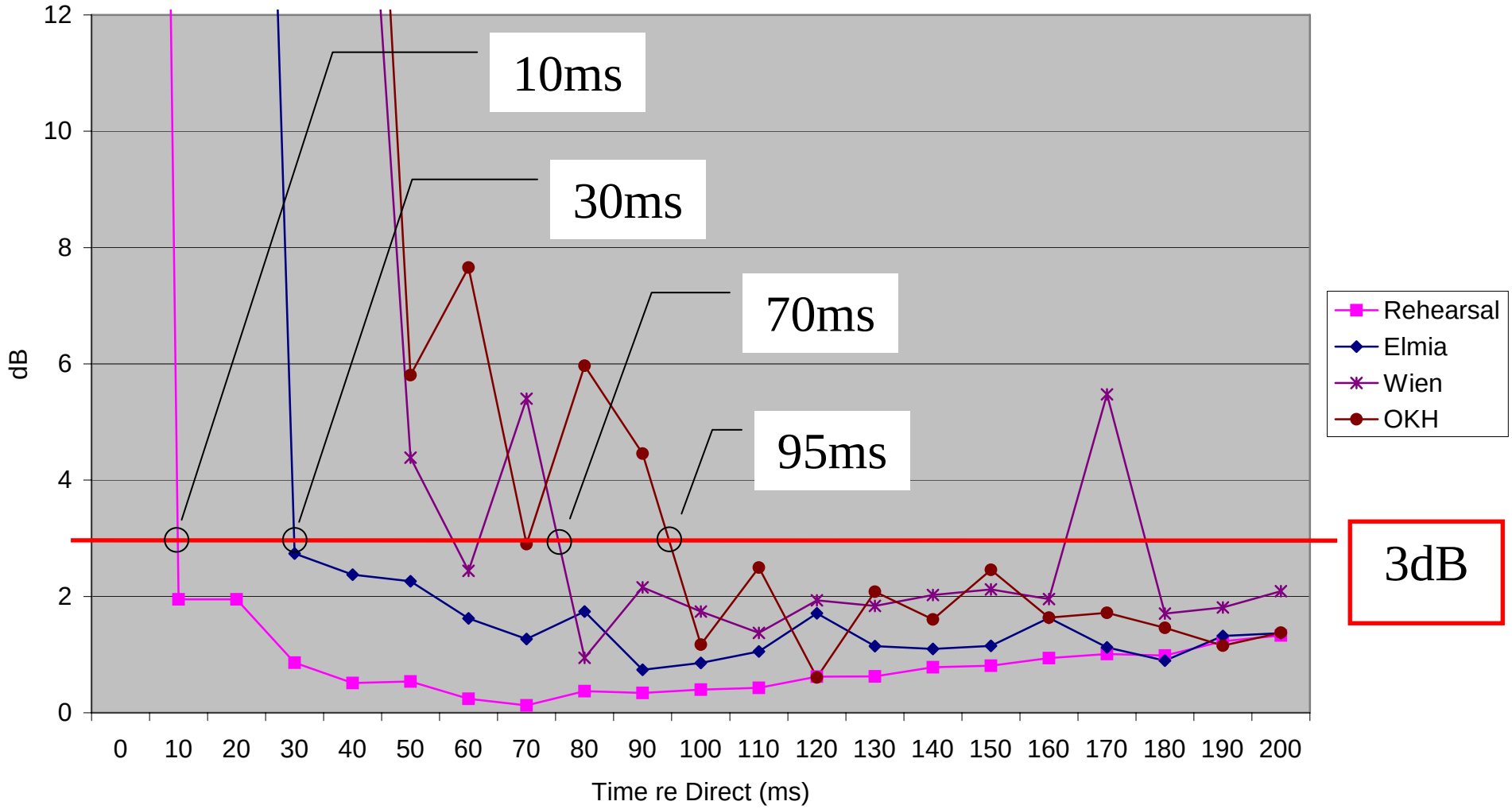
Channel separation

Average separation between 6 room acoustical channels, in 4 different performance spaces



Early-late channel separation

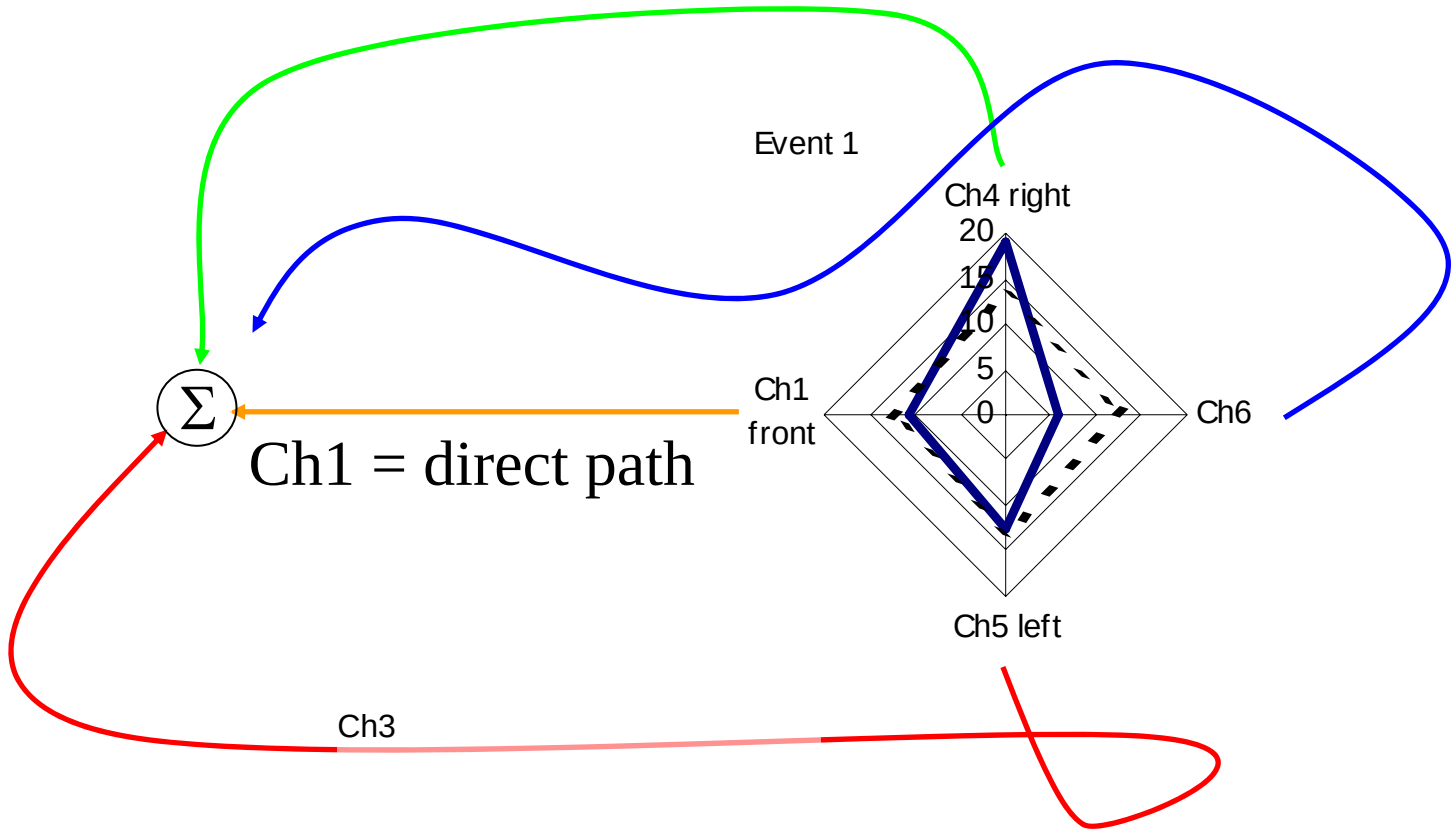
Average separation between 6 room acoustical channels, in 4 different performance spaces



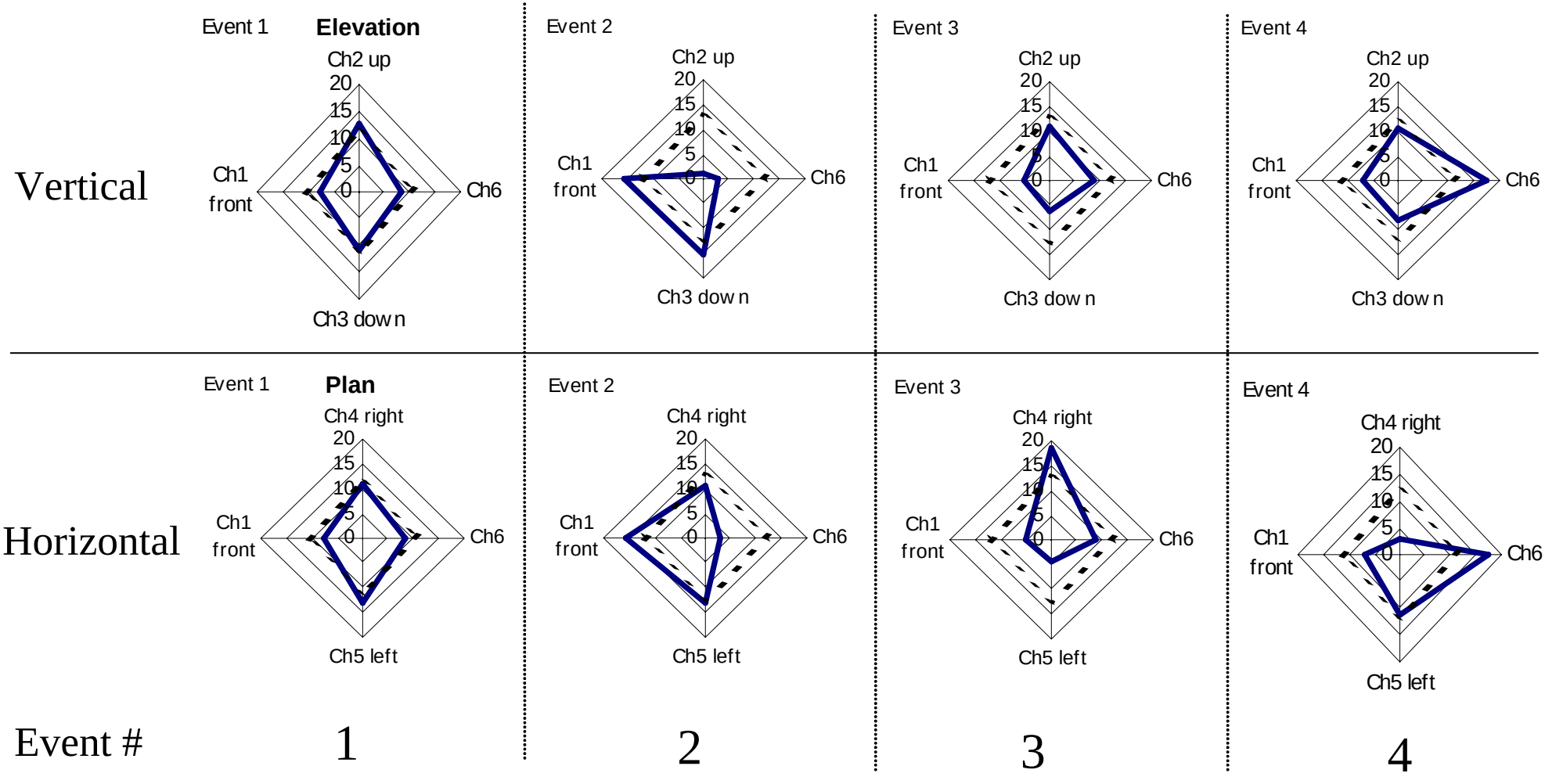
Early energy E50 study

- E50 = energy received 0-50ms
- E50’s predicted via 6 channels in ODEON 7.0
- Channel inputs from simulated directive source
- Varying directionality D < 6

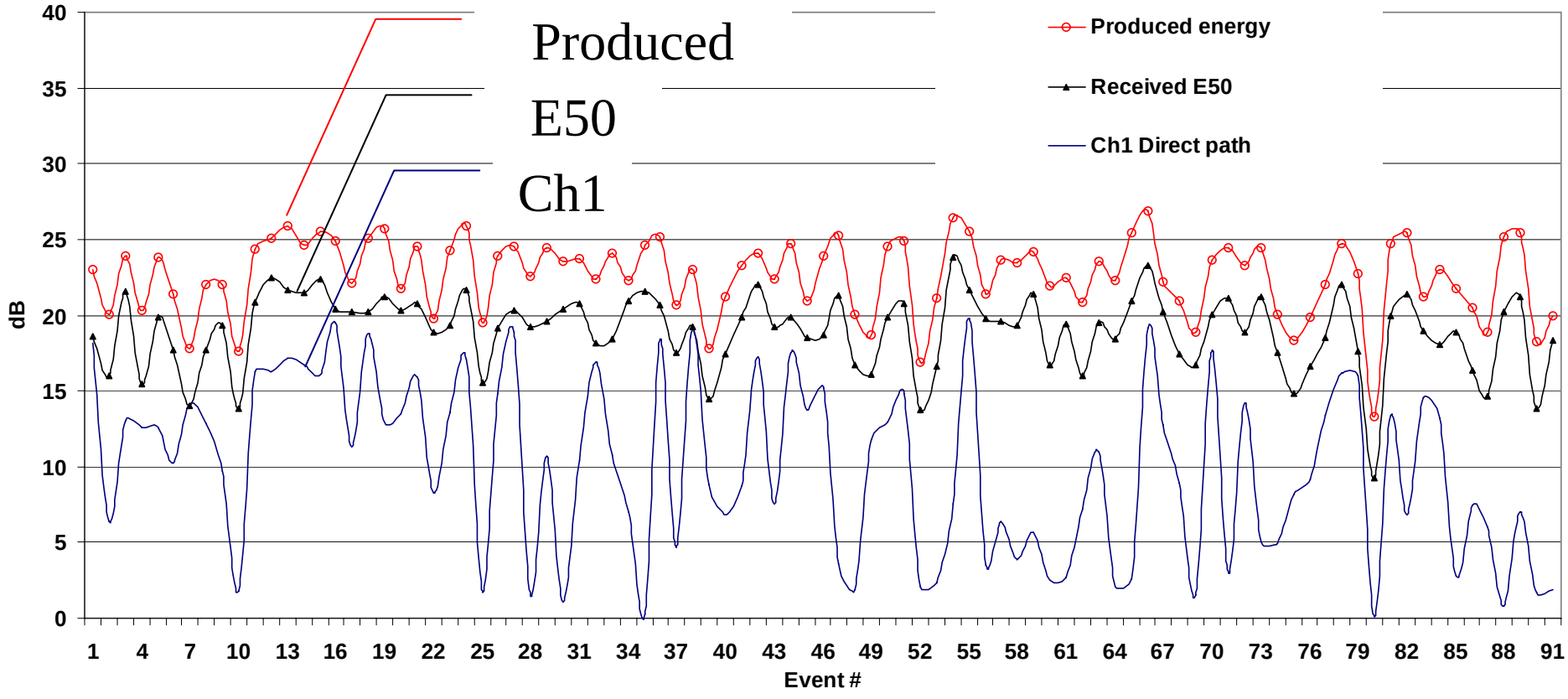
Sum of 6 channel transmission with input from directional source, Event 1:



4 events (e.g. musical notes): source outputs



91 random events: E50 correlates better with produced energy than does energy via direct path (Ch 1)



Room condition sensitivity

- Early sound quality responds positively to
  - Smaller volumes
  - Less absorption
- Early sound quality is insensitive to surface diffusion (scattering) for $D < 6$

Conclusions

- If its onset is sufficiently early, the DIFFUSIVITY of a performance space provides for transmission of an instrument's FULL SOUND to receivers, independent of angle or positions relative to the instrument, or any obstruction of sightline between source and receiver
- For instrument directivities up to D=6 (at least), diffusivity onset is determined by the size of the performance space

Further work

- The significance of surface diffusion will be investigated for $D > 6$
- This requires more than 6 channel analysis

Thank you for your time!

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