GOAL OF THE STUDY

Determine auditory threshold for speech reverberation using a specific room model.

PROCEDURE

1. Model a room for auralization based on an actual room (choice of room is somewhat arbitrary!)

2. Manipulate two independent variables of the modeled room for speech processing:

- Bandwidth (octave-band Fc at .25, .5, 1.0 and 2.0 kHz)
- Reverberation time (volume & absorption): "room size"

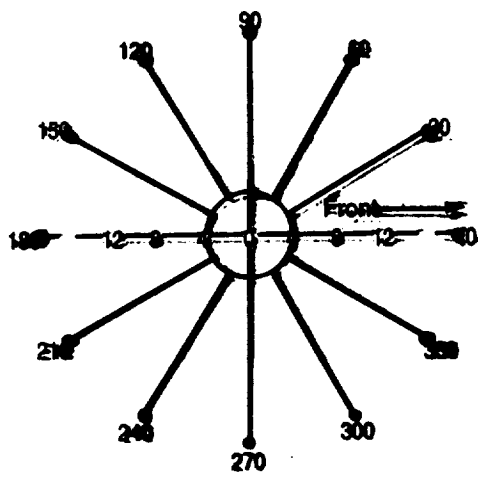## 3-D sound systems benefit from simulated reverberation

- Diffuse field simulation minimizes the problem of UNEXTERNALIZED STIMULI
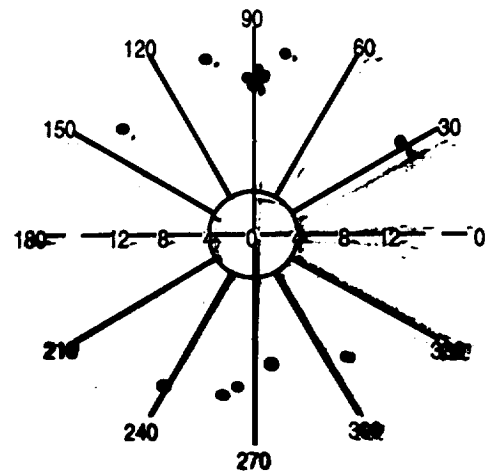
- Begault 92 AES study, speech: IHL reduced from 25% to 2%

3-D sound & auralization systems benefit from head-tracked interfaces

- Head tracking minimizes the problem of REVERSALS, enhances IMMERSION
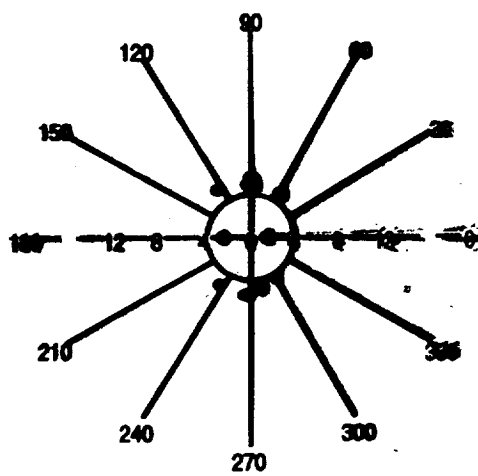
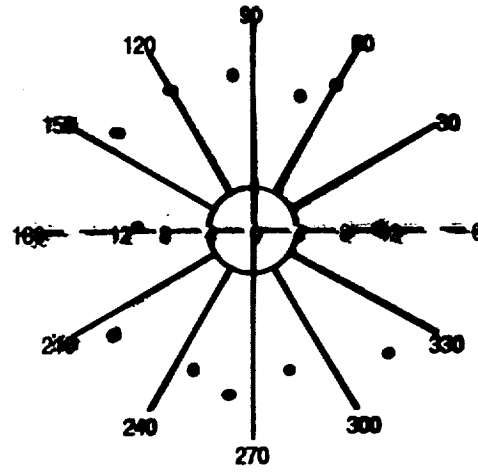- Wenzel 96 study, noise bursts: reversals reduced from 28% to 7%
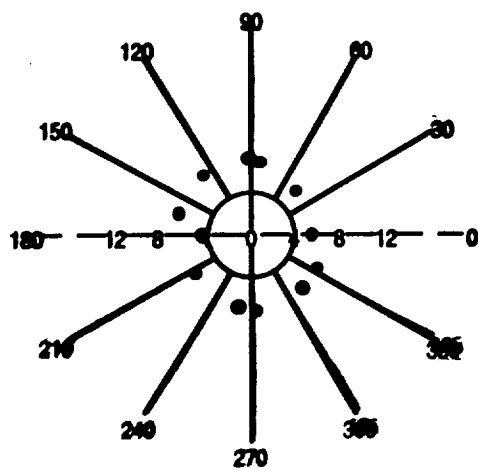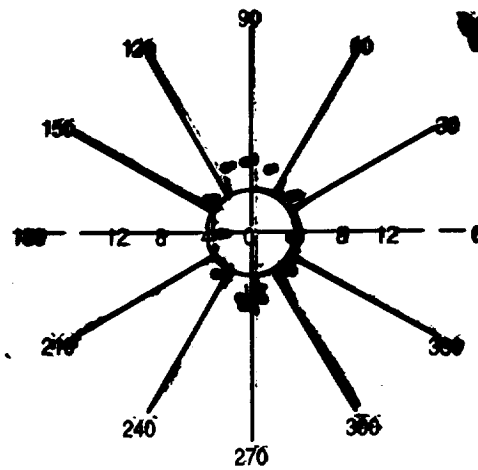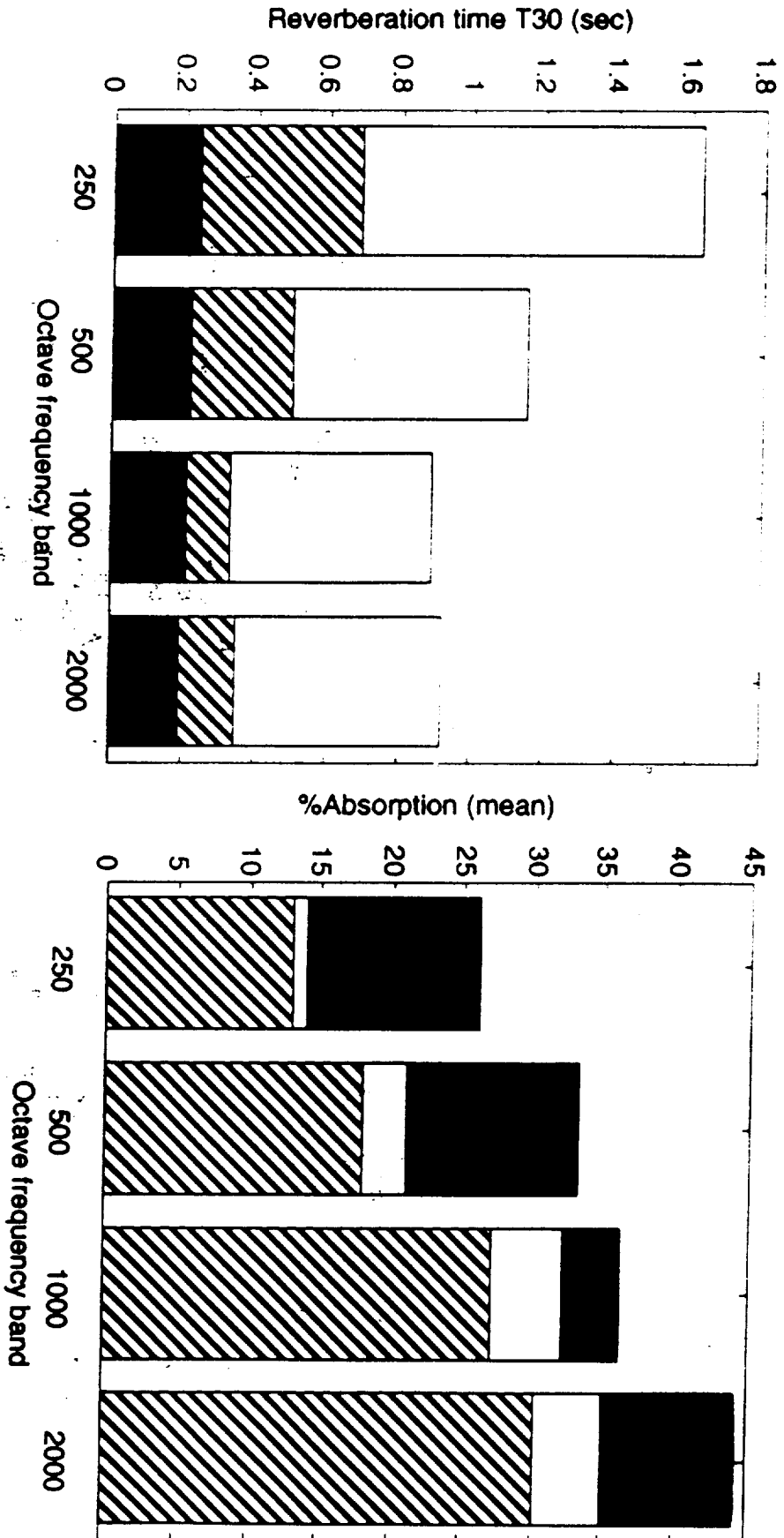
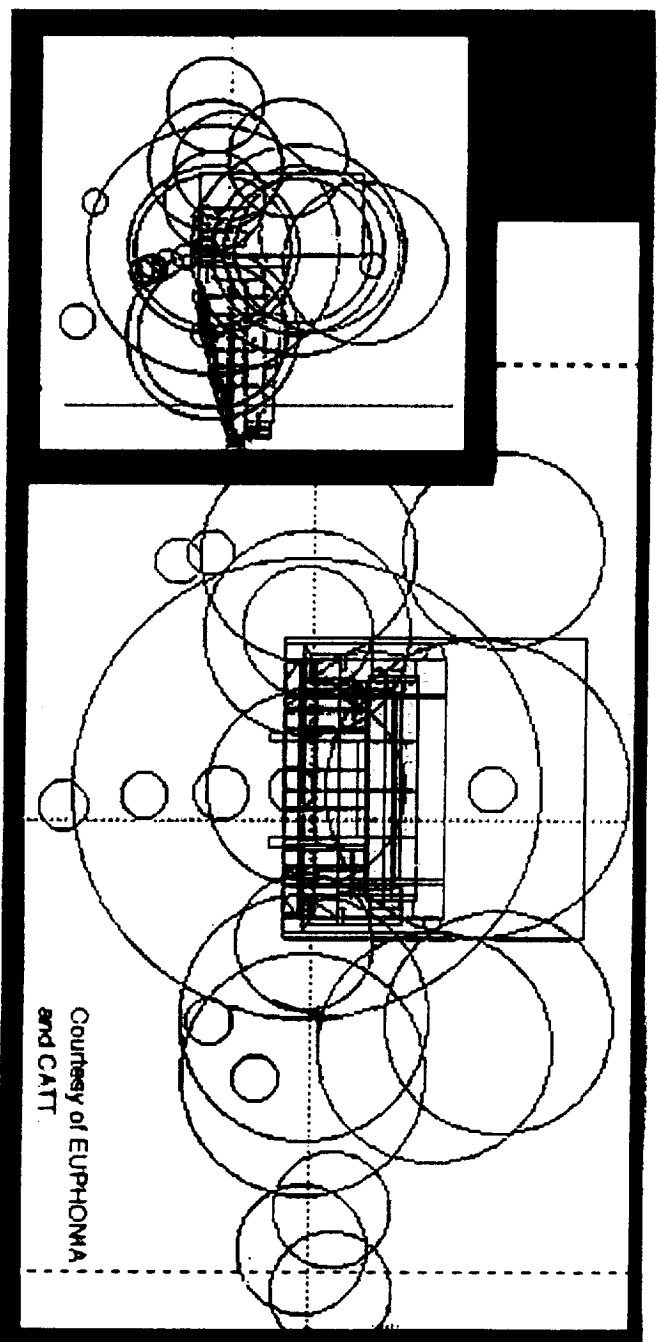"ideal responses"

s13

s20

s10

s14

s25

Hardware & Software

- Stimuli preparation and playback

- CATT Acoustic (auralized room model)

- Crystal River Engineering Acoustetron

  (direct sound synthesis)

- LAKE CP-4 convolution engine, equalization

- Roland S-760 sampler

- Anechoic speech from EBU SQAM CD

  ("Sound Quality Assessment Material Recordings for Subjective Tests")

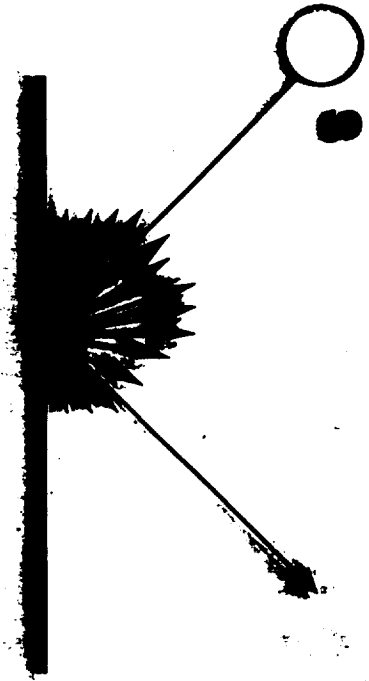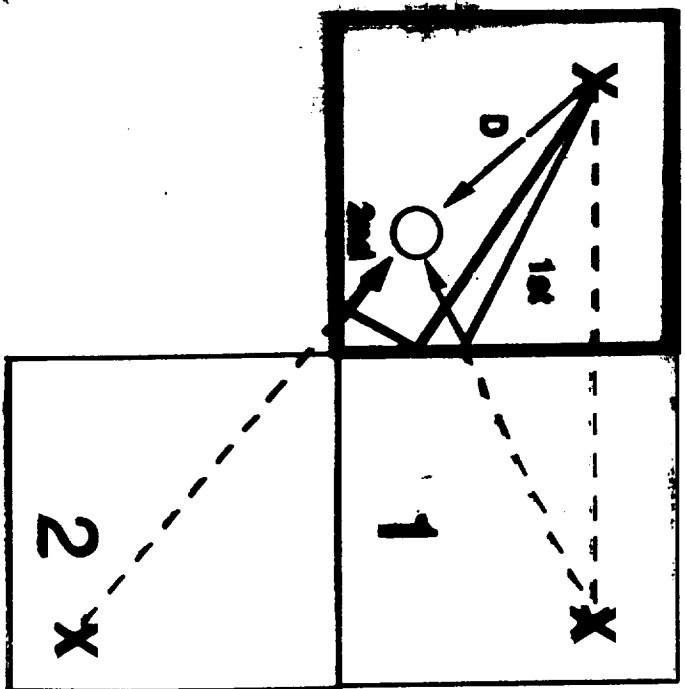# RT and absorption in the 3 modeled rooms (ray tracing)

Reverberation time T30 (sec)

Octave frequency band: 250, 500, 1000, 2000

%Absorption (mean)

Octave frequency band: 250, 500, 1000, 2000

Spatial calculation of the intensity of virtual early reflection images.
Left: side view; right: forward view.

Size of circle = intensity of the reflection;
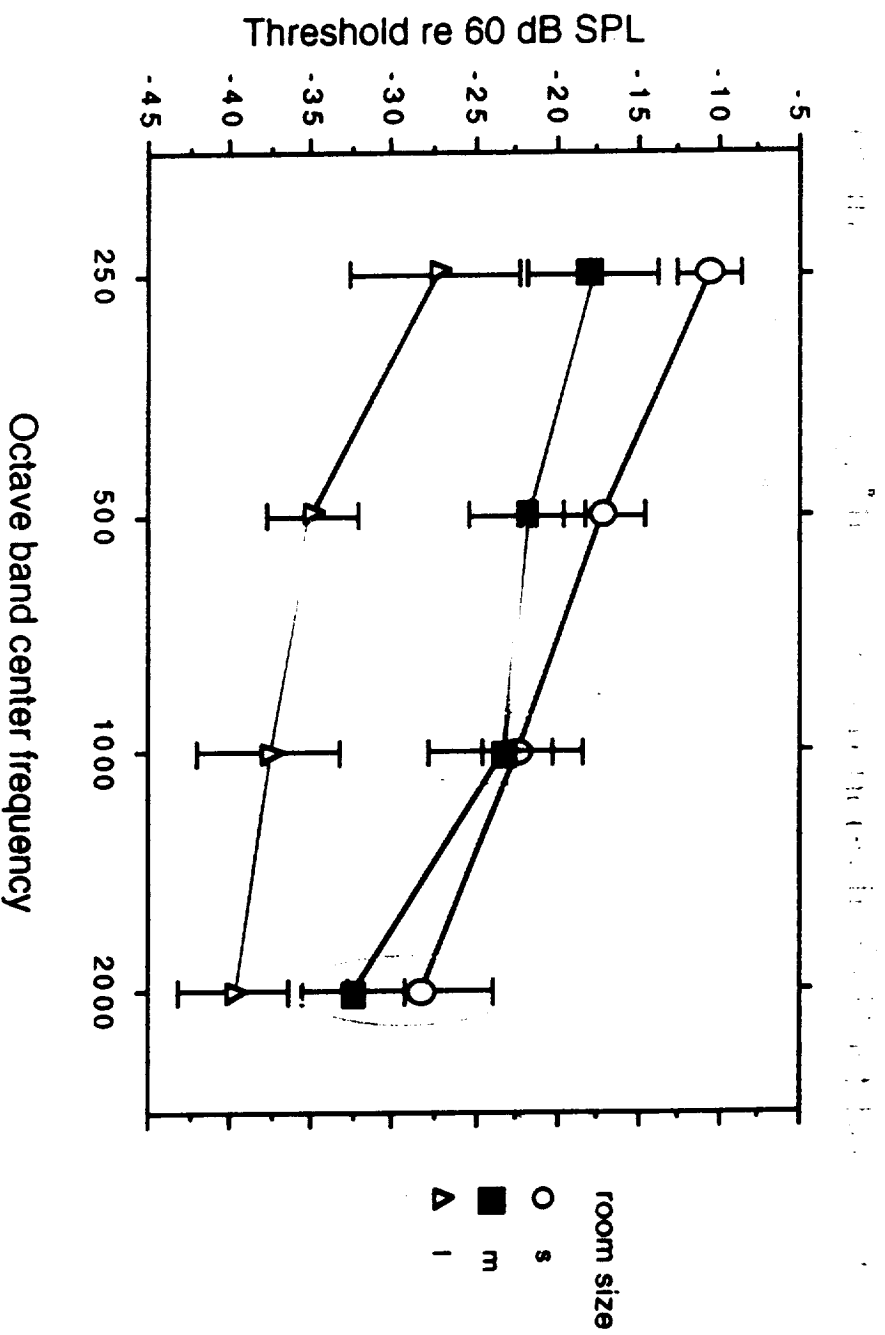Distance = time delay;
Location = incidence to a listener.

Courtesy of EUPHONIA and CATT.

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D

Threshold study

- 10 subjects (normal hearing, "non-expert")

- Within-subjects design (all Ss ran all conditions)

- Levitt staircase algorithm used to adjust level of reverberation to within 1 dB of threshold

- Three-alternative forced choice, using absolute threshold criteria (identify *any* change).

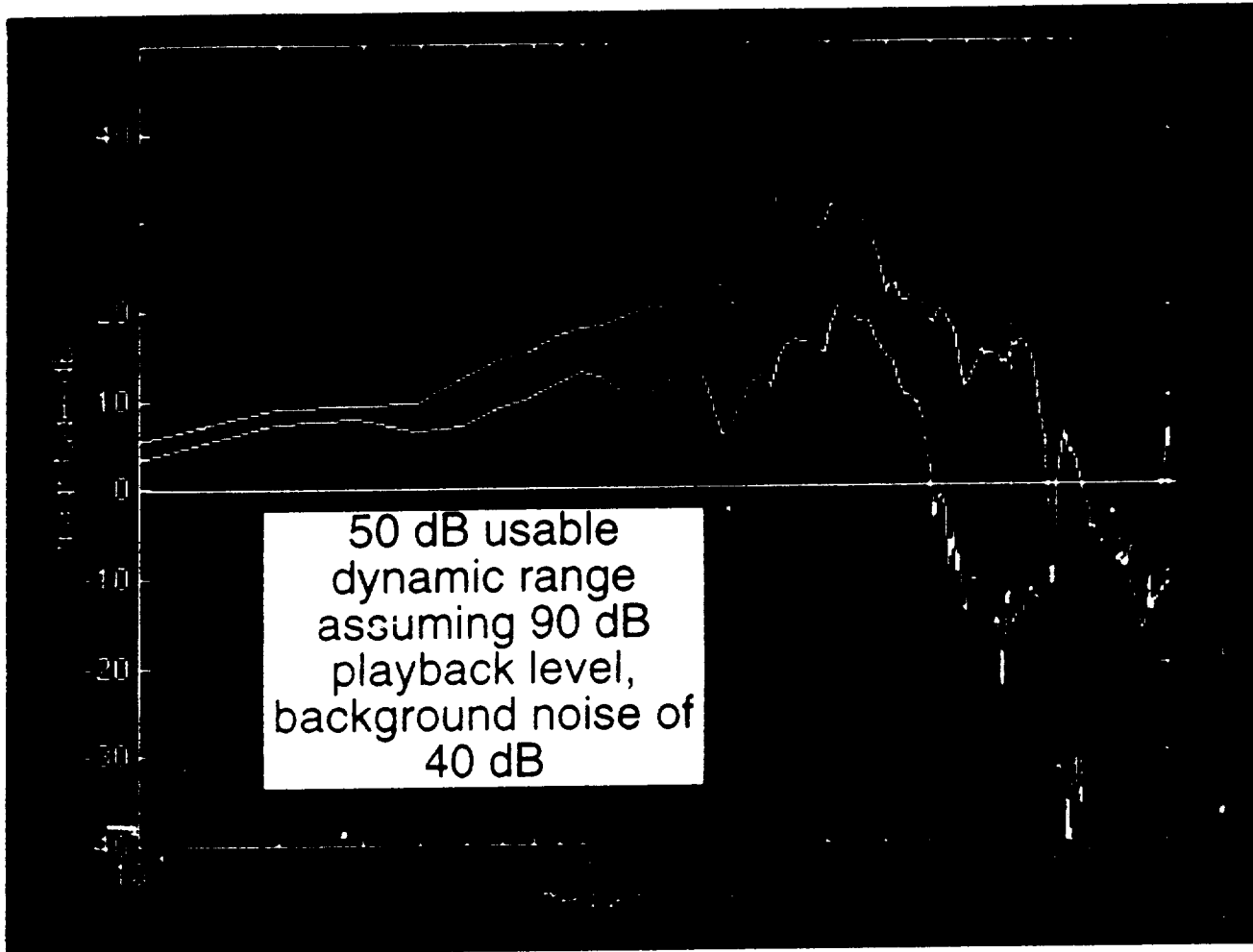Comparison of results to full-BW stimuli

The interaction between room size and filter band was also significant.

Threshold re 60 dB SPL

-45 -40 -35 -30 -25 -20 -15 -10 -5

Octave band center frequency

250 500 1000 2000

room size

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■ m
△ l

0 degree direct sound
60 degree reflection -12 dB

50 dB usable dynamic range assuming 90 dB playback level, background noise of 40 dB

Masking of spectral cues relevant to:
—playback from loudspeakers in typical rooms
—perception of reflection spectral cues in real rooms