



“It is assumed that the ideal to be aimed at in the design of a sound reproducing system is

realism

i.e. that

the listener should be able to imagine himself to be in the presence of the original source of sound.”

"The Development of High-Quality Monitoring Loudspeakers: A Review of Progress" (Expanded Version of I.EoE. Paper Read on **23 April 1958**). Report No. L-041 (1958/31), The British Broadcasting Corporation



High End
München2025

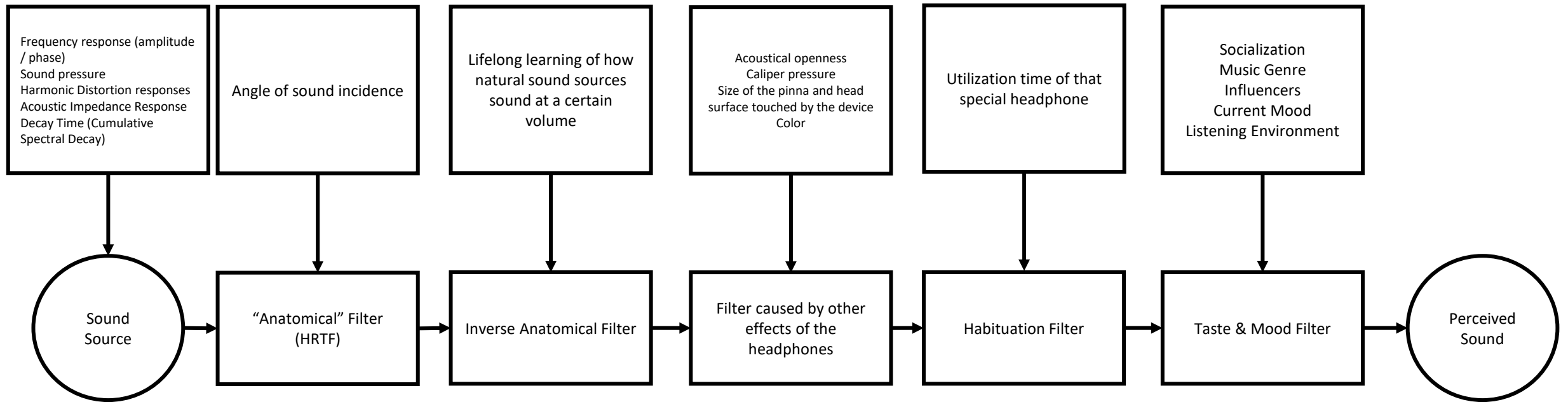
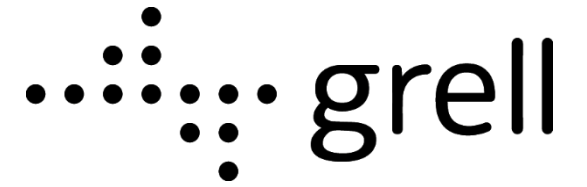


Headphone Target Curves

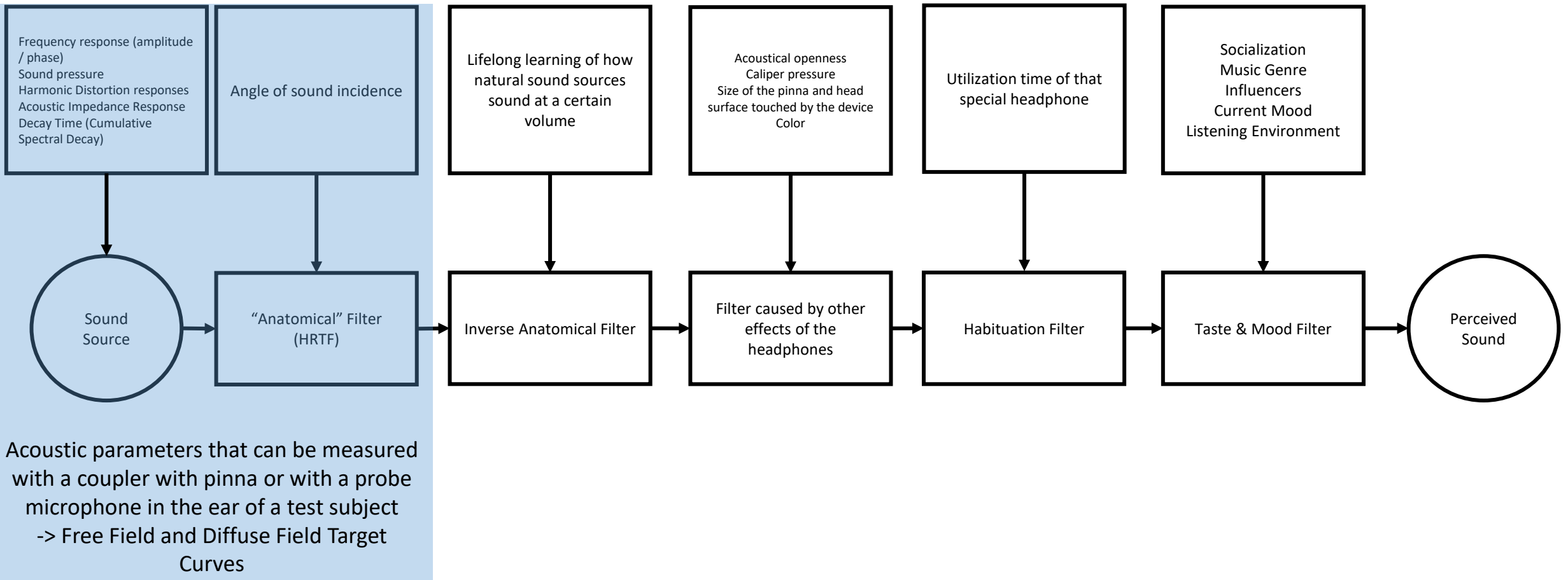
A new approach

Axel Grell

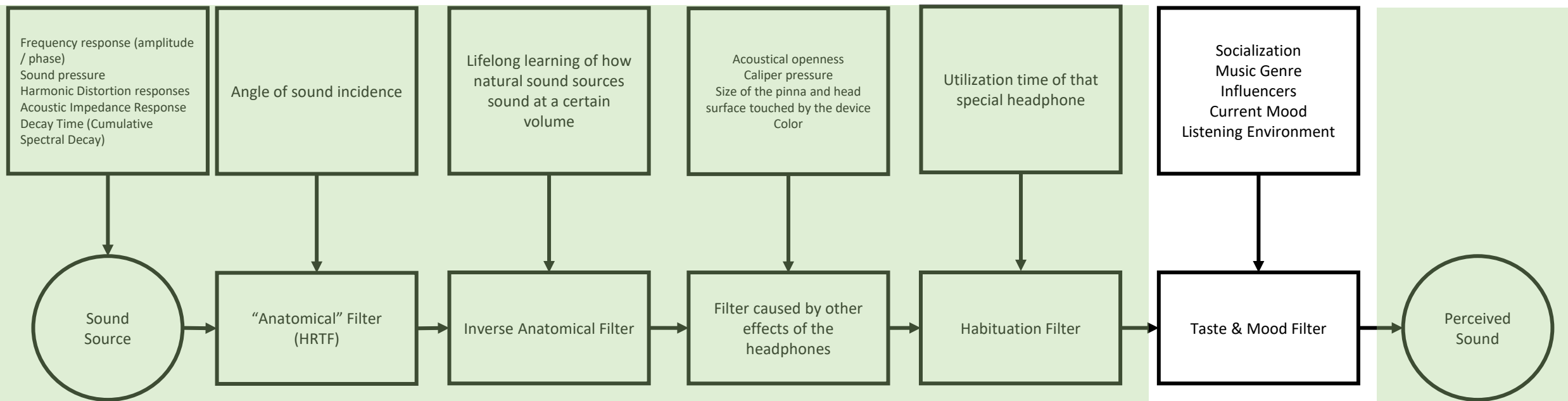
Factors that influence the perceived sound of headphones



Factors that influence the perceived sound of headphones



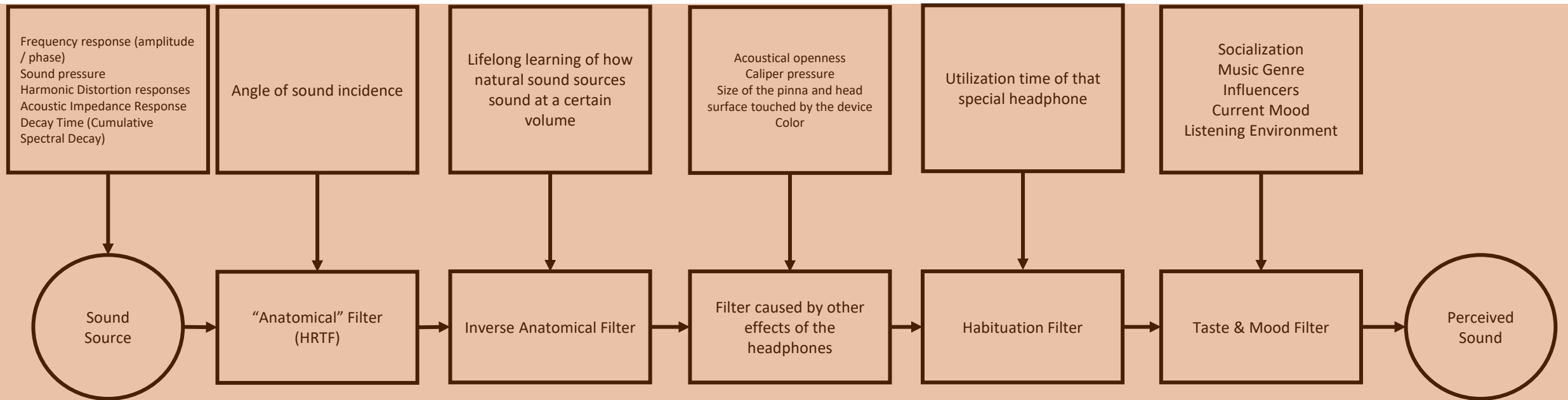
Factors that influence the perceived sound of headphones



Acoustical and perceptual parameters that can be determined in total by subjective tests with **non-music signals** that are carried out with as many test subjects as possible, about whom as many of the parameters influencing perception as possible should be known.

-> Loudness Diffuse-Field Method

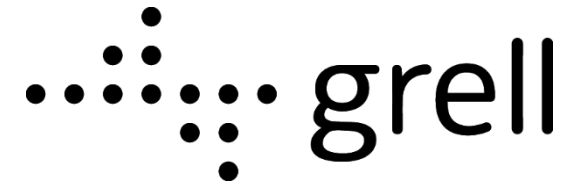
Factors that influence the perceived sound of headphones



Acoustical and Perceptual parameters that can be determined in total by subjective tests with **music** that are carried out with as many test subjects as possible, about whom as many of the parameters influencing perception as possible should be known.

-> Harman Target Curve

Some Target Curves for the Frequency Response



- Free Field Response Curve

(HATS / Probe Microphone Measurement)

- Diffuse Field Response Curve

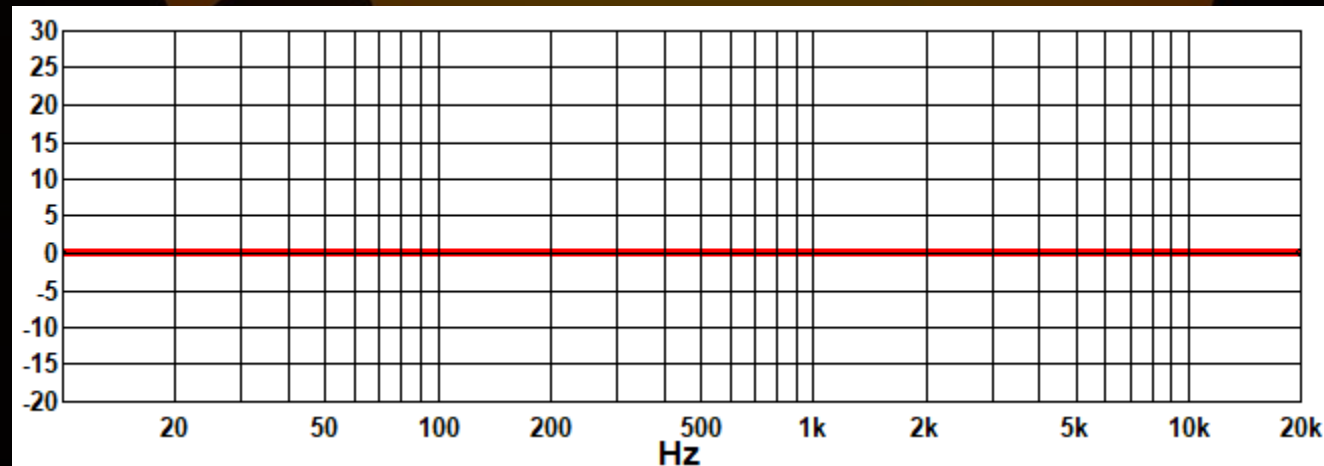
(HATS / Probe Microphone Measurement)

- Loudness Diffuse Field Response

(Subjective Comparison of a flat Diffuse Sound Field and Headphones using 1/3 Octave Noise.)

- Harman Target Curves (Subjective Sound Preference Curves)

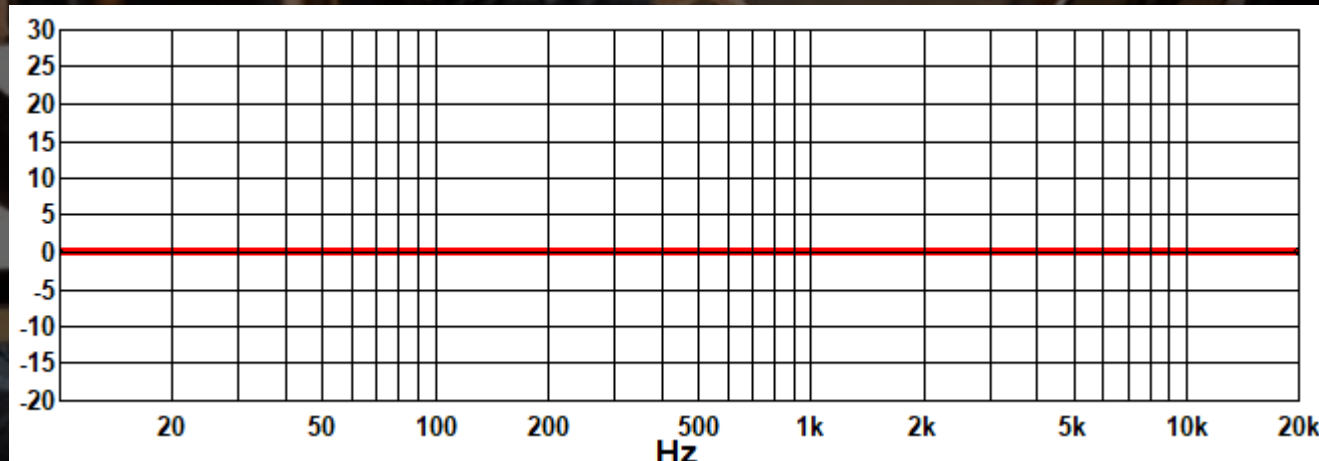
Free field sound transmission:
All frequencies are transferred from the source to the
sink with the same intensity



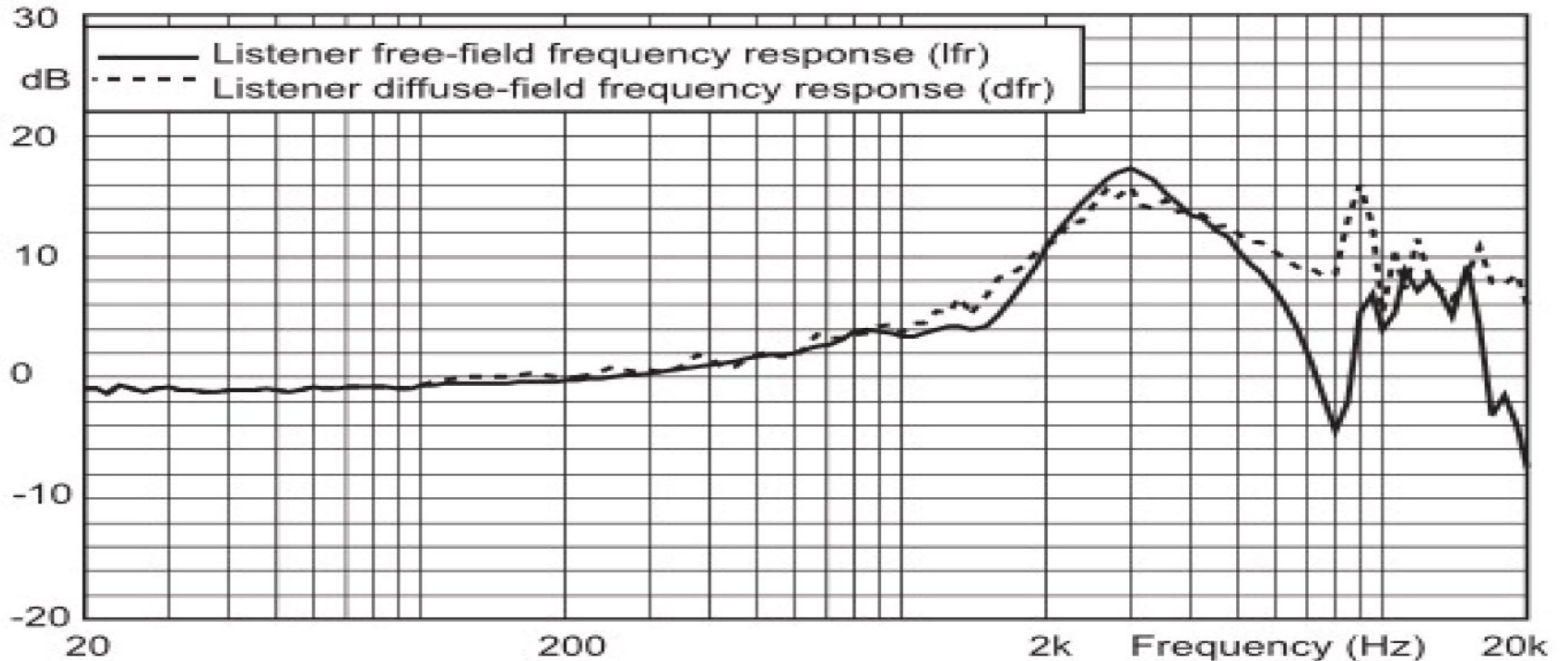
Diffuse sound field:

In a perfect room in which all frequencies are reflected equally by the walls, all frequencies are transmitted from one point to another with the same intensity.

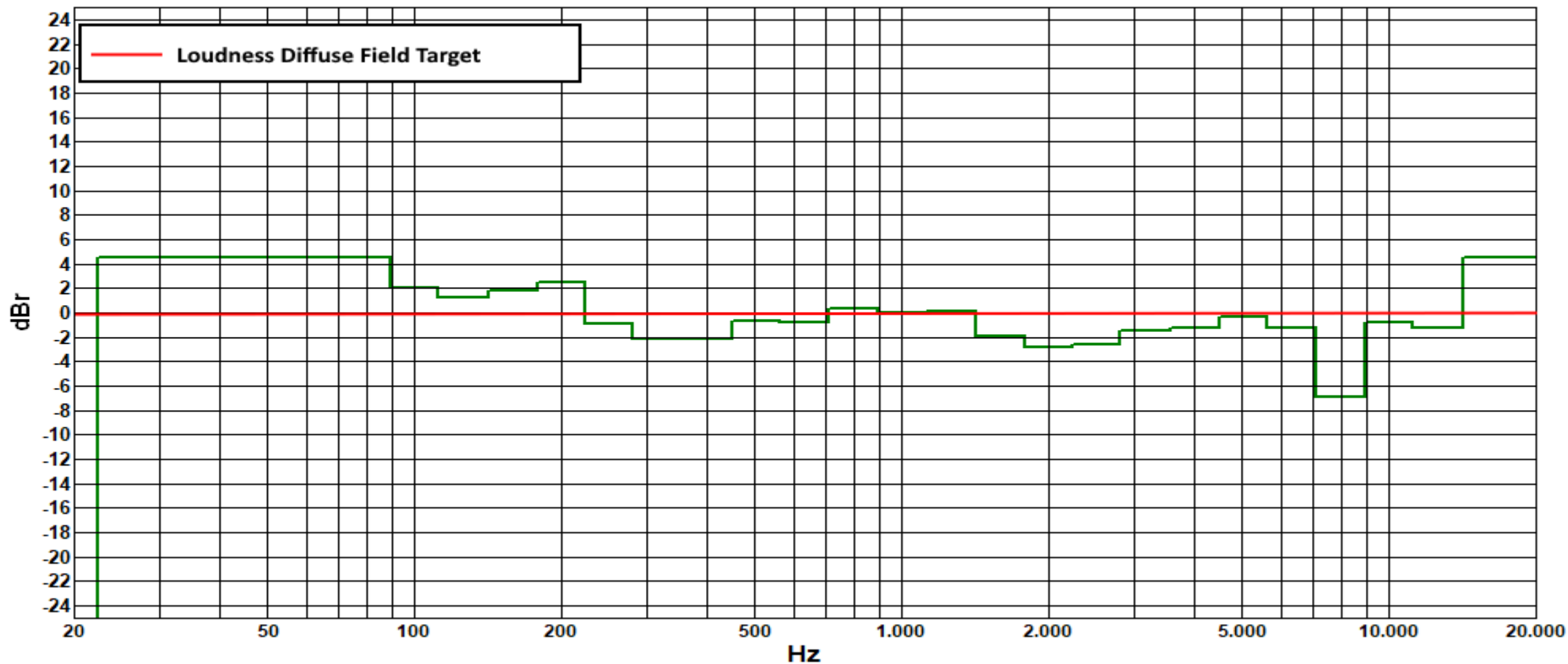
The sound field contains no directional information.



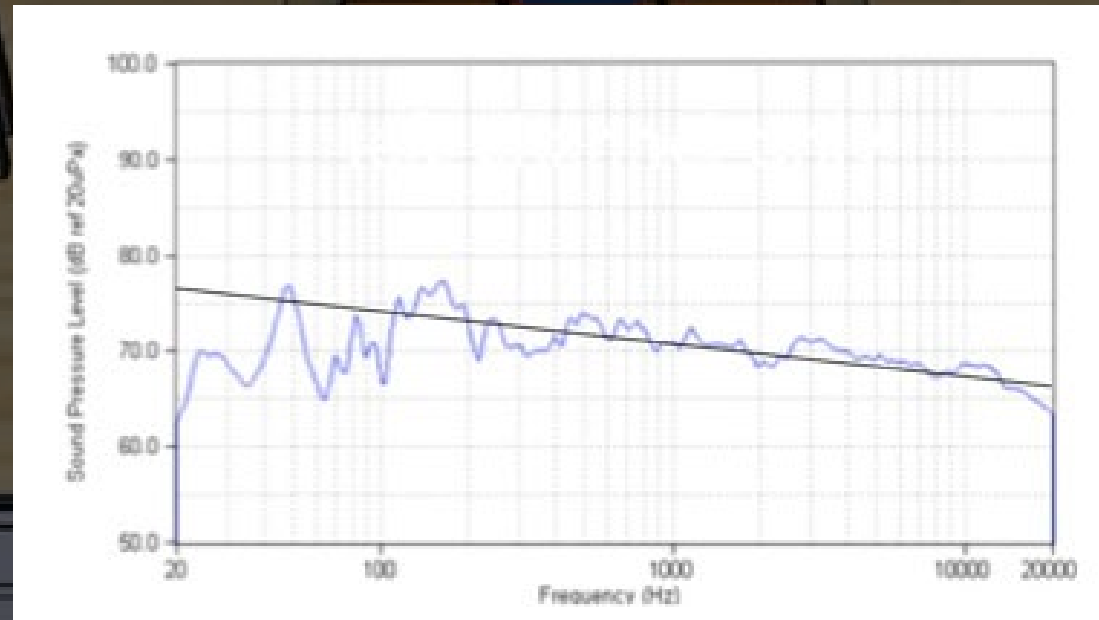
Free Field and Diffuse Field Target Curves for Headphones on a B&K 4128 HATS



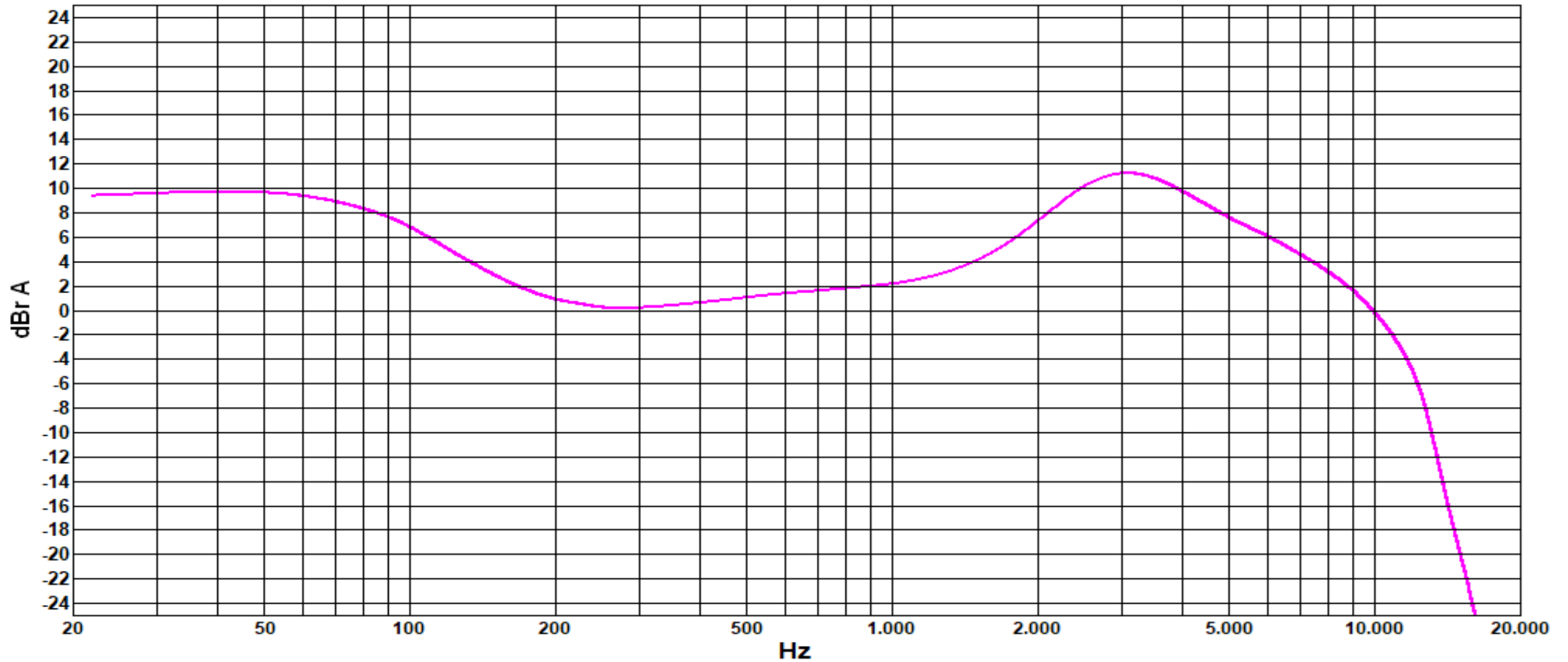
Loudness Diffuse Field Target Curves for Headphones



Harman Listening Room:
This room has a slight roll off to the high frequencies from the speakers to the listening place



Harman Target Curve OE 2017



A New Target Curve?



The Harman Target Curve does not contain allocatable information about the contribution of other factors such as:

- Harmonic distortion responses
- Acoustic impedance response
- Angle of sound incidence
- Decay time (Cumulative Spectral Decay)

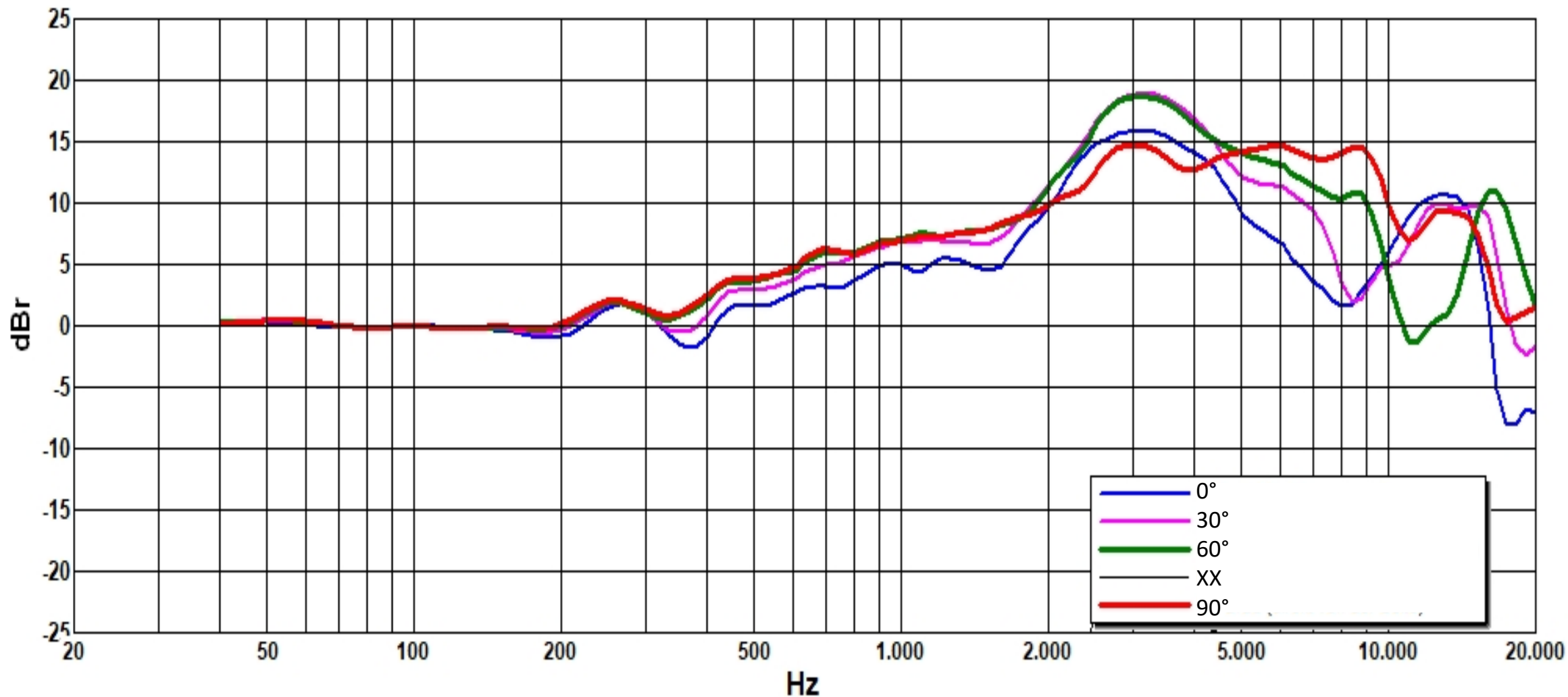
to the perceived sound of headphones.

A New Target Curve?

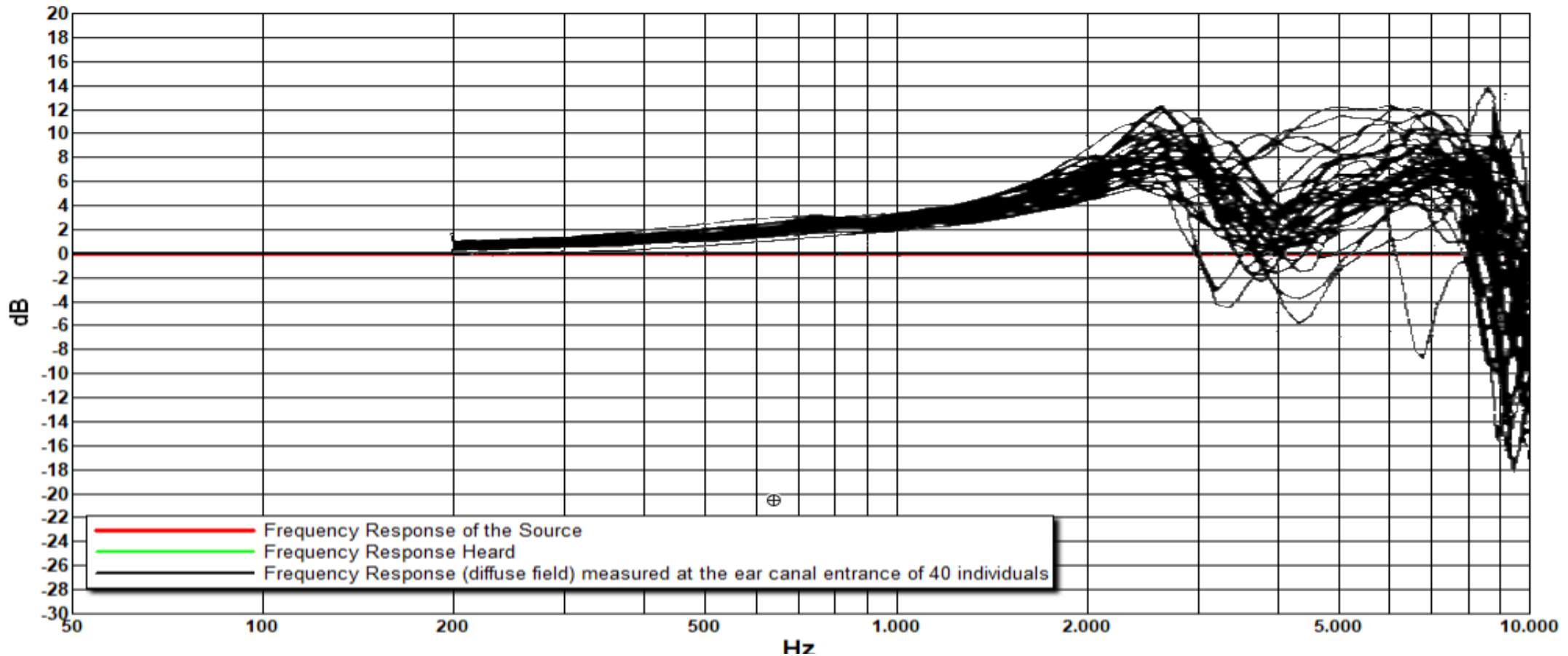


Therefore, the Harman Target Curve is strictly speaking only valid for the headphones, the test subjects and the measuring coupler with which it was determined.

Influence of the Angle of Incidence of the Sound in the Horizontal Plane

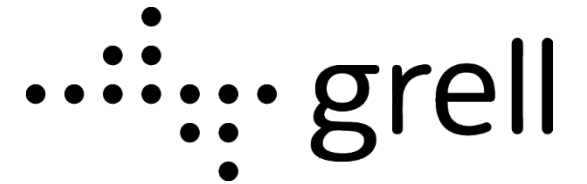


Individual Head related Transfer Functions



Measurement of the open Ear Canal Diffuse Field Response taken from:
Møller, H., Jensen, C. B., Hammershøi, D., & Sørensen, M. F. (1995).
Design criteria for headphones. *Journal of the Audio Engineering Society*, 43(4), 218-232

A new Way to specify the Sound of Headphones



Since the Harman target curve does not contain any assignable information about the contribution of other factors to the perceived sound of headphones, these factors must be specified and their influence on the sound perception quantified. Once this is done, they can be determined for the headphones used to define the Harman curve and subtracted from the Harman curve. Then the specific factors of one of the headphones to be specified can be added to create the specific target curve. The deviations from this target curve then show the sound character of this headphone.

Research on the factors is in progress or will be started soon.

- Harmonic distortion responses -> (not started yet)
- Acoustic impedance response -> Roman Schlieper et al (to be continued)
- Angle of sound incidence -> Roman Kilian et al (in progress) -> PIAF
- Decay time (Cumulative Spectral Decay) -> (not started yet)



A new Way to specify the Sound of Headphones

Pina Interaction Factor (PIAF)



With the PIAF, I would like to introduce a new measure for determining the quality of headphones. It indicates the extent to which the pinna (and the other ERTF factors) contributes to the influence of the sound pressure above the frequency at the eardrum. At a value of 100, the influence of the pinna is equivalent to that at the sweet spot of an LEDE studio. A PIAF of 0 means no match. This is the case with in-ear headphones due to their design.



Thank You!



Questions?



Good Bye Munich!