

# ***Impact and Audibility of Distortion in Automotive Audio Applications***

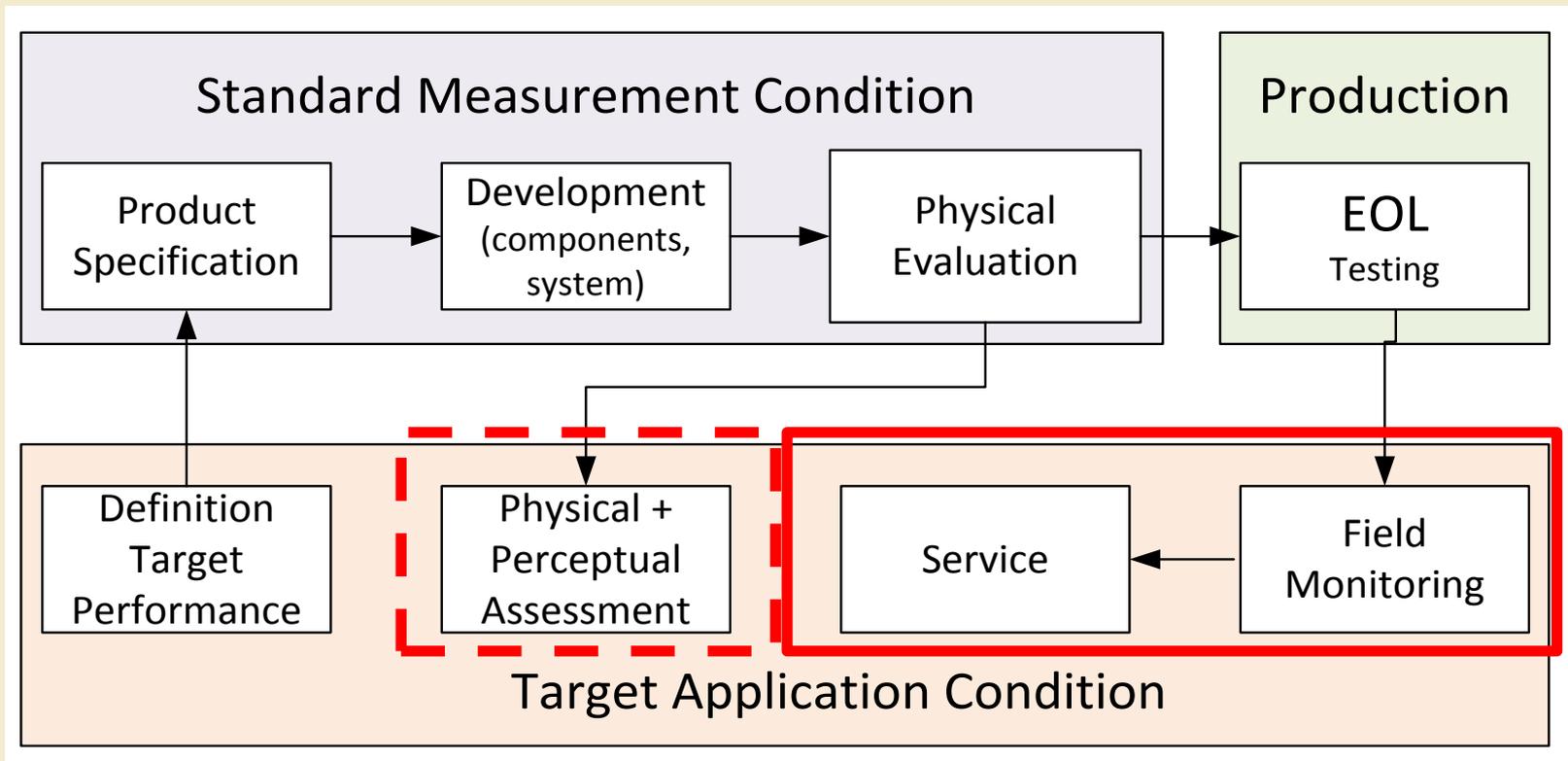
Workshop on 146th AES Dublin 2019

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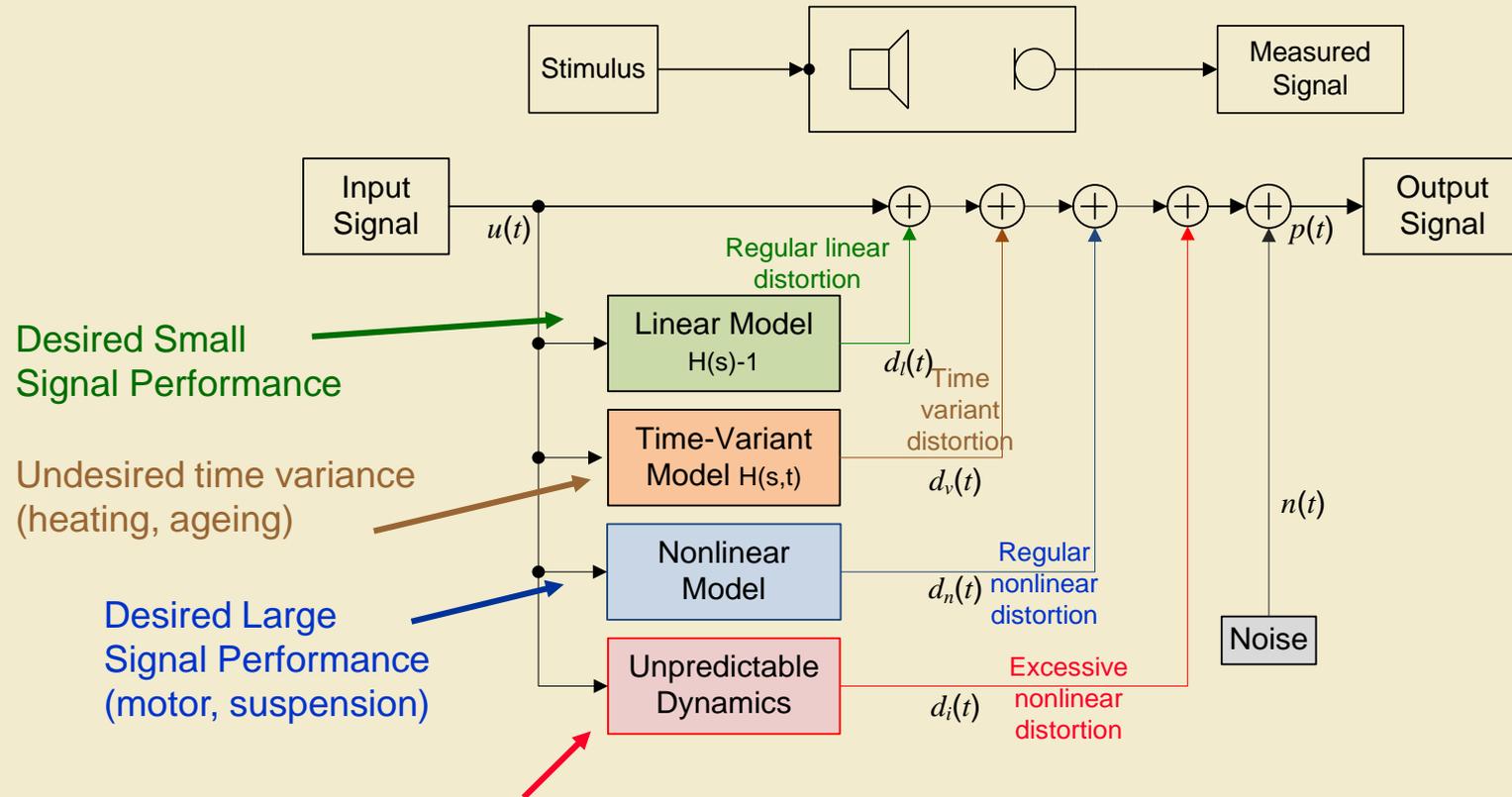


# Audio System Evaluation over the product life cycle



# Desired and Undesired Components ?

## Generation of Signal Distortion in an Audio System



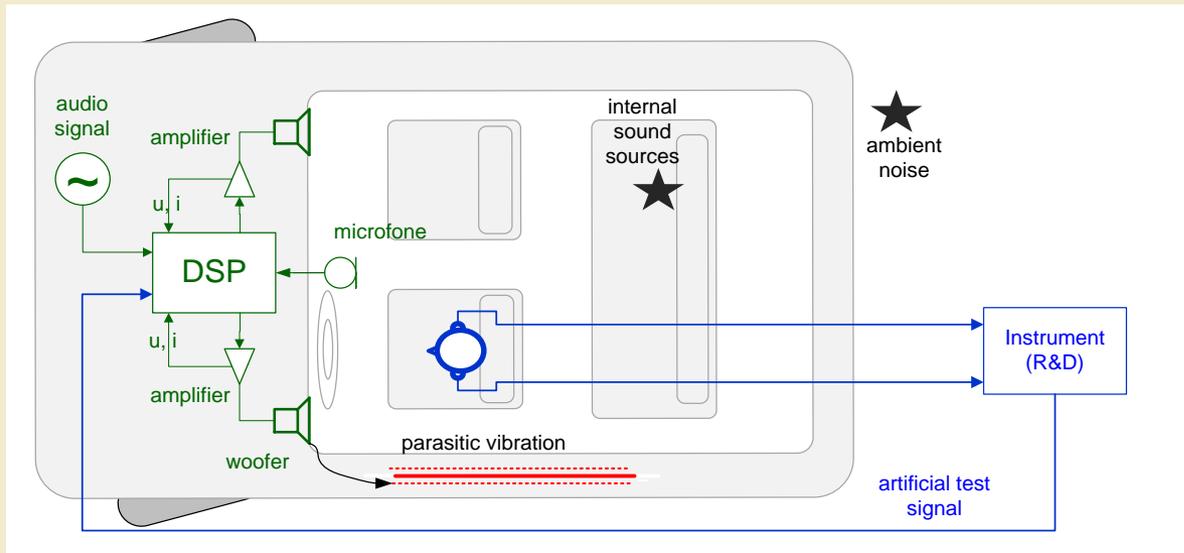
### Undesired Defects

- Rubbing coils, buzzing parts
- Wire beat, coil bottoming
- Loose particles, air leak noise
- Parasitic vibration of other components

# What is a critical defect?

- Related to customer complaints
- Observable in in-situ condition
  - Impulsive distortion (panel buzzing, loose particles, loose electrical connection)
  - Significant air noise caused by a leakage of the enclosure (Subwoofer)
  - Excessive nonlinear distortion caused by motor instability and severe asymmetries

# Evaluation in Final Application



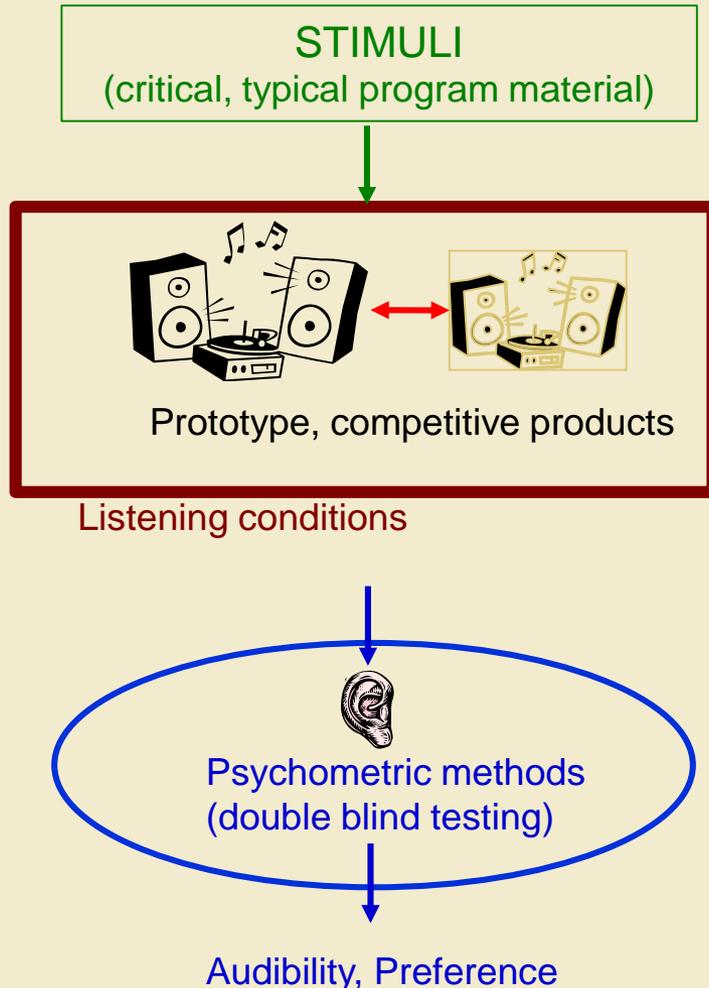
## Standard Measurements

- using R&D equipment (artificial head, analyzer, ...)
- limited to type approval test
- artificial test signal can be used
- operated by engineer

## In-situ Measurements

- applicable to all units
- ordinary audio signals used as stimulus
- external
- Using existing hardware
- operated by end-user

# Listening Tests



How to make listening test more effective ? (meaningful, valid, reliable data in a shorter time !!)

How to cope with the influence of the listening conditions (stimuli, room, location) ?

How to understand relationship between physics, audibility of distortion and preference of the product ?

## → Auralization Techniques

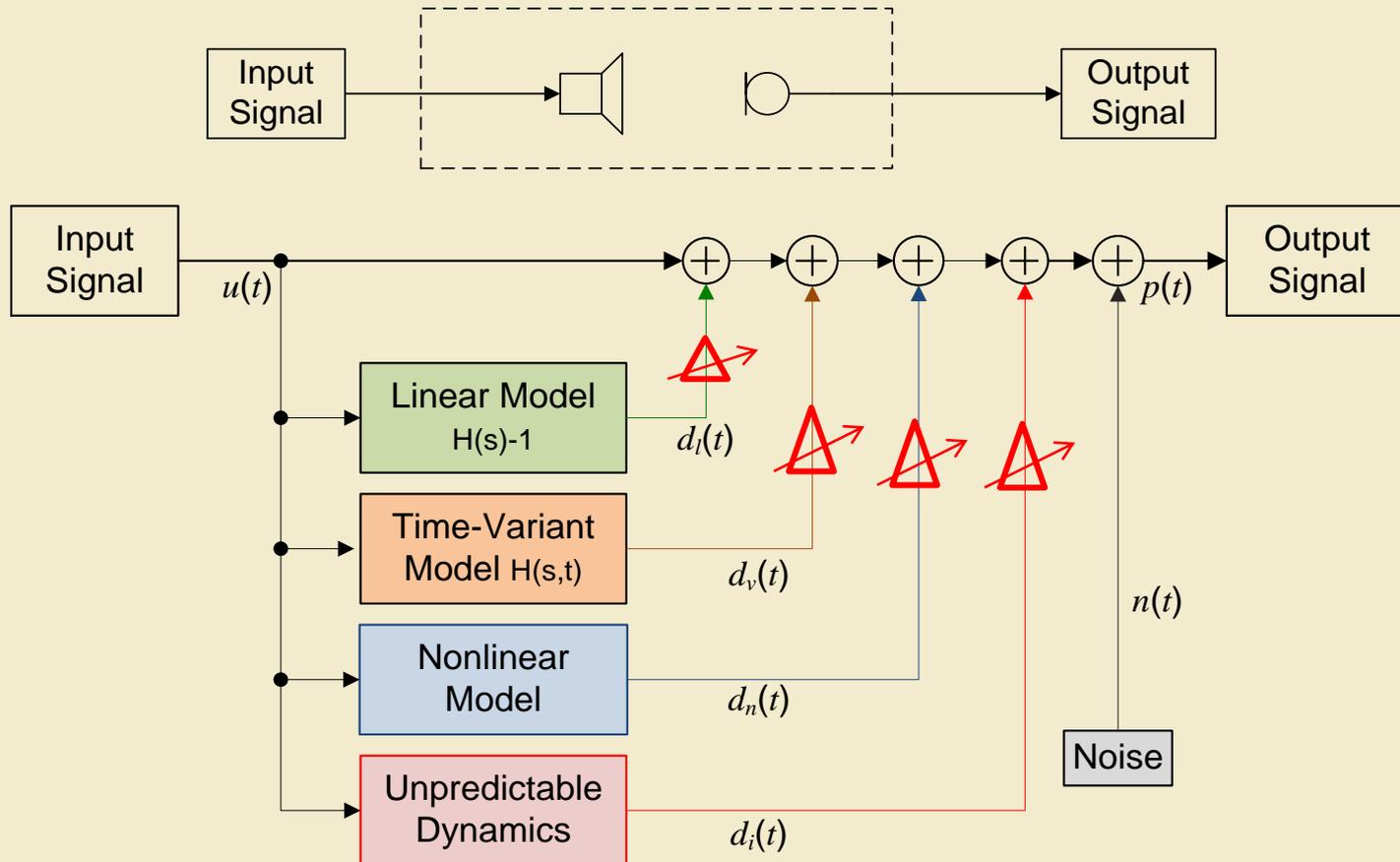
Reduce complexity of the testing

Focus on critical questions, hypothesis

Systematic test using virtual loudspeaker modifications



# Auralization of Signal Distortion

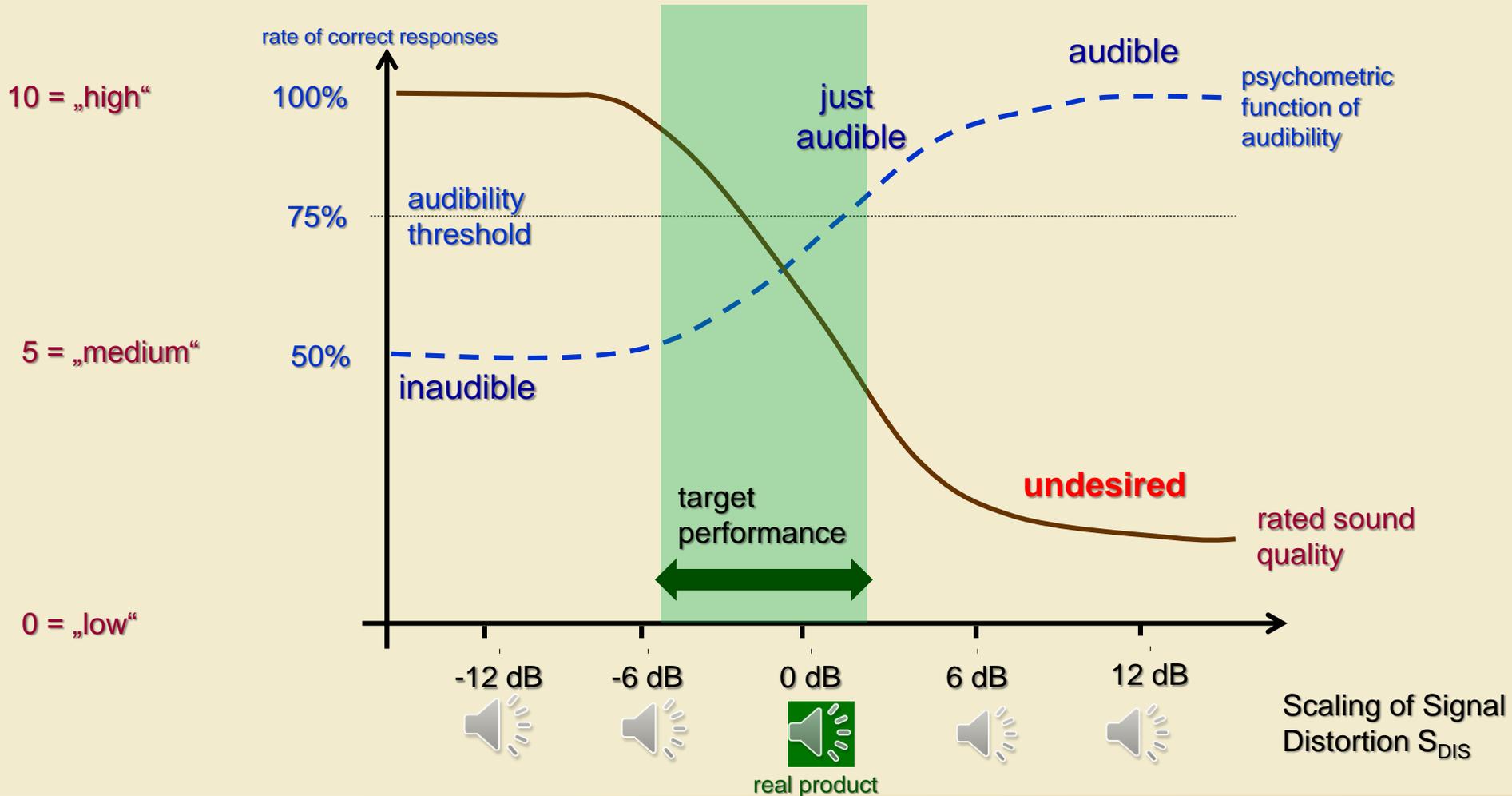


**OBJECTIVE:**

Virtual enhancement or attenuation of the distortion components

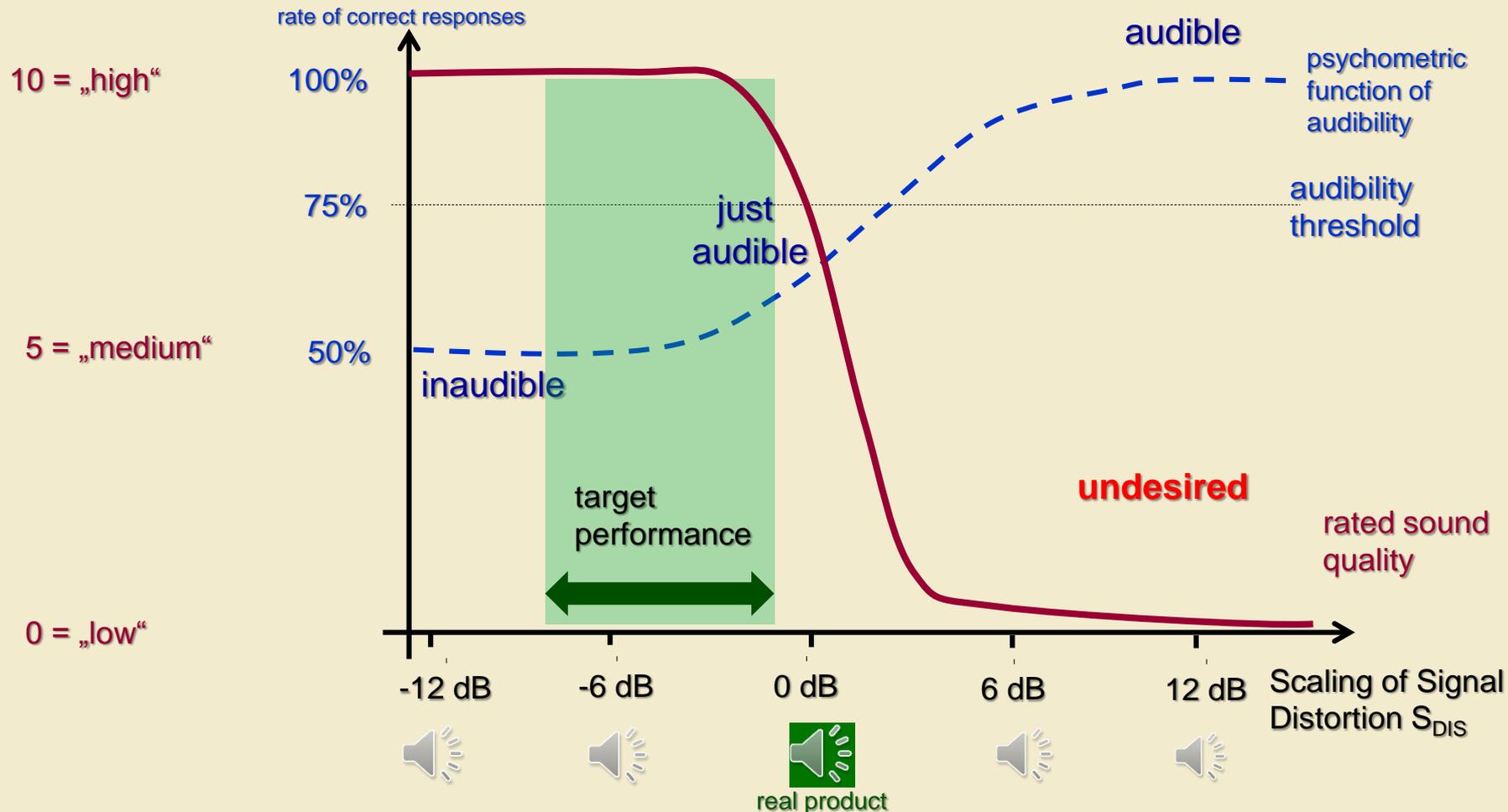
# Audibility and Preference

## Distortion generated Motor and Suspension



# Audibility and Preference

Impulsive distortion generated by rub&buzz and other loudspeaker defects



# Combining Physical and Perceptual Evaluation of the Audio Product Measured in Target Application

