

Motivation

Sound Quality

Hardware Improvements

Hearing Aid Design

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# Acceptance of hearing instruments

- According to Market research (USA) **59%** of the hearing impaired are satisfied with their hearing instruments!
- About **16,2%** of all hearing instruments end „in the drawer“ and are never worn
- What are the reasons for the bad acceptance?

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„Complaints were uncomfortable sound, sound of crickets, unnatural, distorted, slight hiss, tinny, picks up wind, chewing, and swallowing noise, poor fidelity, hollow sound, aversiveness of sound.....“<sup>1)</sup>

1) all information from MarkeTrak VI, S. Kochkin, Knowles Electronics

## Acceptance of hearing instruments

% of HI customers <u>not</u> satisfied	
Clearness of sound	42%
Natural sounding	42%
Sound of voice	42%
Quality of soft sounds	49%
Quality of loud sounds	56%
Feedback / whistling	56%

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⇒ Acoustic quality of hearing instruments is an essential issue, huge potential for improvements!

1) all information from MarkeTrak VI, S. Kochkin, Knowles Electronics

# Evaluation of sound quality

- Frequency response (shape, bandwidth)
- Linearity / distortions
  - feedback
- Dynamic behaviour
  - improved impulse response
  - acoustic dampening of the receiver
  - AGC and compression systems
- System noise
- Artefacts

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# Hardware improvements in Hörtech

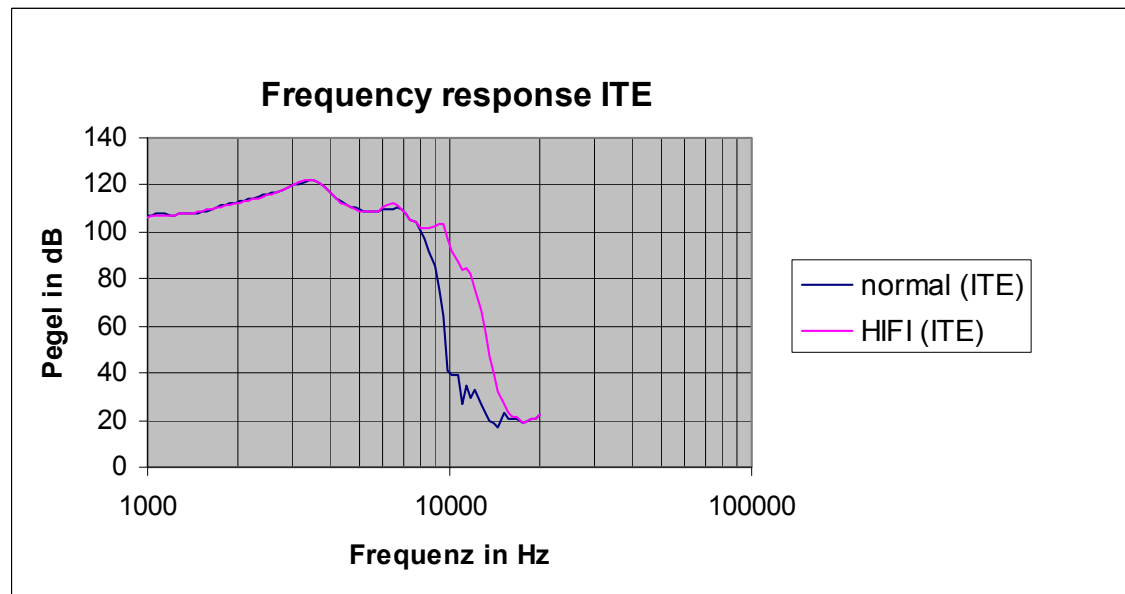
- Transducer technology
  - receiver optimized for bandwidth/distortions
- Electronic circuit
  - low noise circuitry
  - sufficient bandwidth
  - good dynamical range
- Acoustic duct
  - shaping of frequency response
  - avoid resonances
- Venting
  - decreased outside radiation
  - ventilation
- Ear mould fit
- Component arrangement / design

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- Wide band receiver, microphone
- Wide band electronic circuit (more dynamic range, less noise)
- After evaluations with headphones different arrangements were implemented (ITE, BTE)
- Evaluations with hearing impaired confirm audibility

Goal: Feedback prevention is necessary to keep the transfer function free of unwanted non-linearities!

- Increased feedback tendency for wideband arrangement due to stronger acoustic and vibration coupling in the higher frequency range
- Typical feedback situation was measured on the ITE at 10 to 13kHz
- Limitation to the maximum gain
- As proven in simulations and experiments, the outward radiation of the vents is critical for higher frequencies

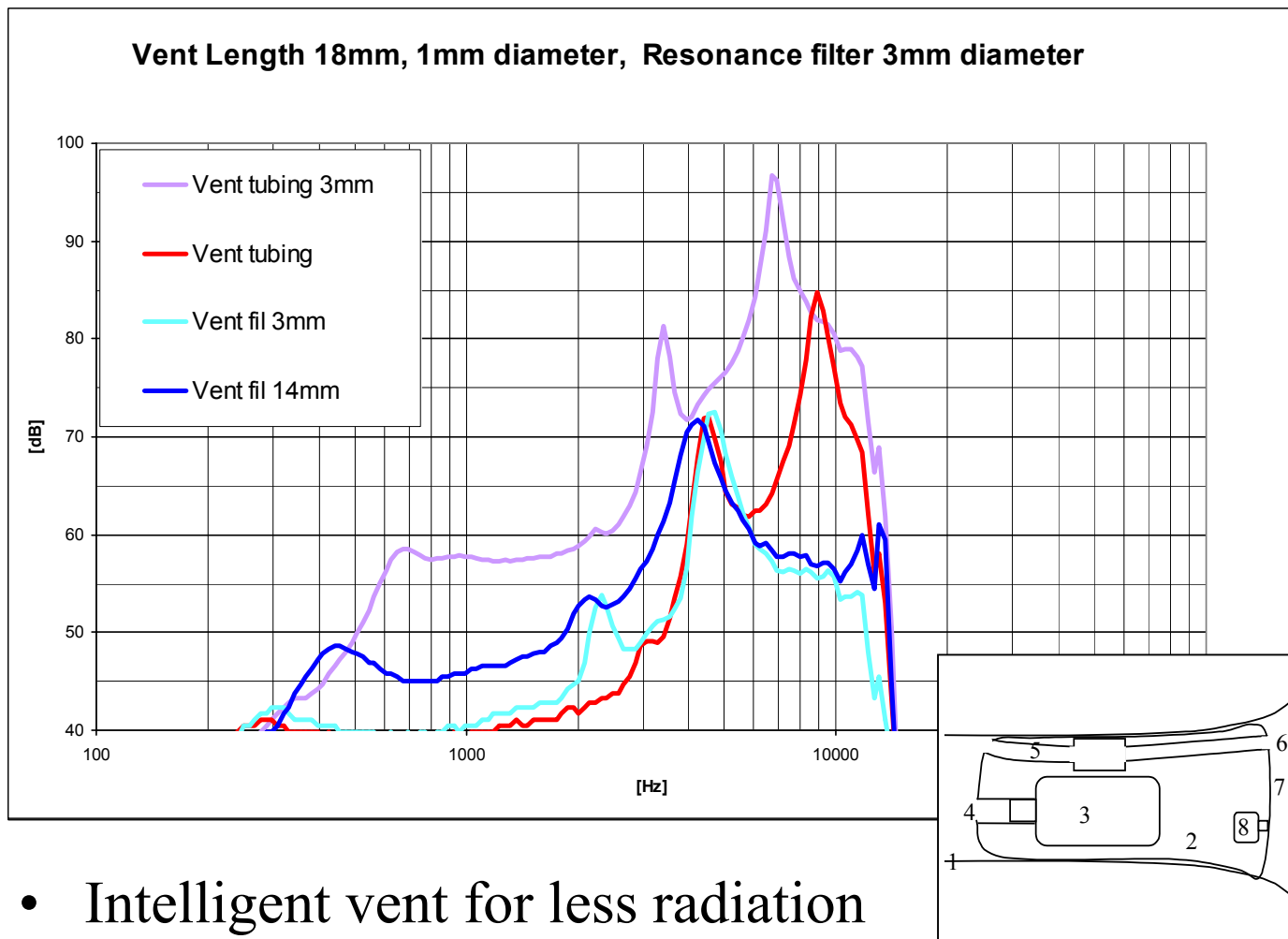
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# Vent radiation



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⇒ Bad fit of the ear mould causes feedback and bothers the HI user

Investigations led to guidelines for ear mould manufacturing to avoid typical handling errors:

1. Neglecting the shape/volume change after dip-coating (wax) of the ear impression
2. Neglecting the individual anatomy, consideration of “Cym-Za” (incision between Cymba-cavum and auditory canal) and “Con-Za” (incision between Concha-cavum and auditory canal)
3. Ignore the hold of the ear mould in the outer ear
4. Keeping non-necessary parts/planes

# New hearing instrument designs



„ITE“-Concept



„AdO“-Concept

- New designs provide better acoustic conditions
- New approaches to overcome the typical HI stigma

# Summary



- Poor acoustic quality is a major reason for HI refusal
- Several hardware improvements have been implemented, optimized venting improves feedback behaviour
- Guidelines for reliable ear mould manufacturing
- New design approaches with high cosmetic appeal and good acoustic conditions
- Evaluation and field tests still running

⇒ By combination of several hardware improvements the wearing and hearing comfort of hearing instruments can be improved