



New Developments in Custom-made Hearing Protection

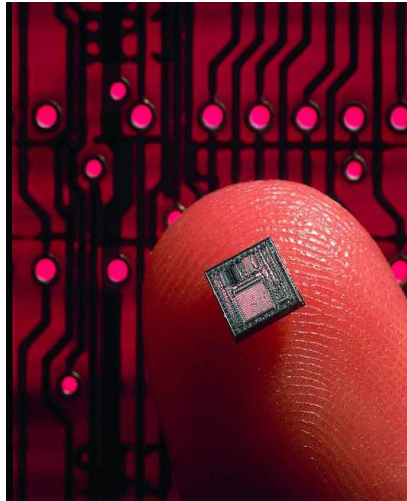
21st EAGOSH-Meeting

22.-23. November 2006

Frankfurt

Hans E. Hessel

Phonak Communications



Phonak Group

Phonak

- Founded 1947 in Zurich
- Since 1994 listed on the Swiss stock exchange
- One of the 3 market leaders for hearing solutions with 1+ million sold hearing aids
 - Before closure of pending acquisition of GN Resound
- 3'500 employees, 860 Million CHF revenue
- Technology leader with 200 employees in R&D
- World wide present, >50% of sales in North America

Hearing Aids

- Brands Phonak und Unitron
- Styles:
 - BTE (behind the ear), ITE (in the ear), CIC (completely in the channel)
- Remote controls for hearing aids as watches, key rings...
- Communication solutions for audiological appliances
 - FM audio transmission directly (in)to hearing instruments





Phonak Communications Systems

Security

- covered and hands free radio communication for use with professional mobile radios



Studio

- in-ear radio frequency receiver for prompting and monitoring
- ear mounted microphones

Sports

- team communication: UEFA, Alinghi...





Phonak Earcare Solutions

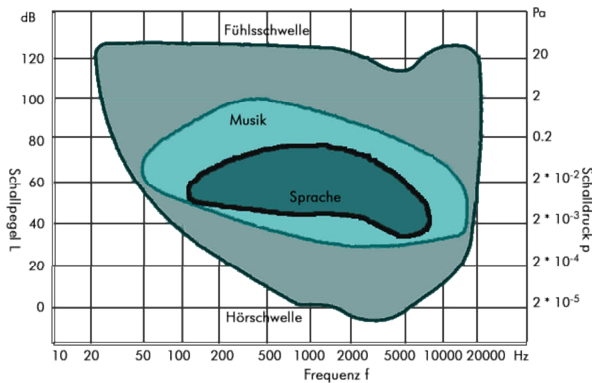
• Hearing protectors

- Custom-made earmolds precisely fitted to the individual anatomy of the user
- Multiple static attenuation filters for different noise exposures
- Dynamic systems with level dependent attenuation
- Integration of communication capabilities

• Full service solutions

- Consulting for hearing conservation and noise protection
- Ear impression taking
- Attenuation control

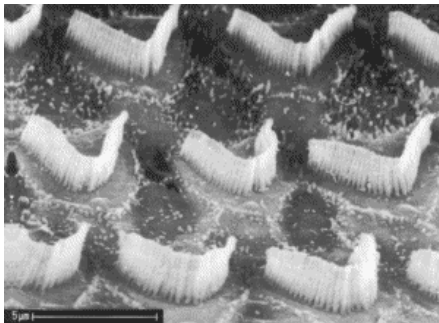


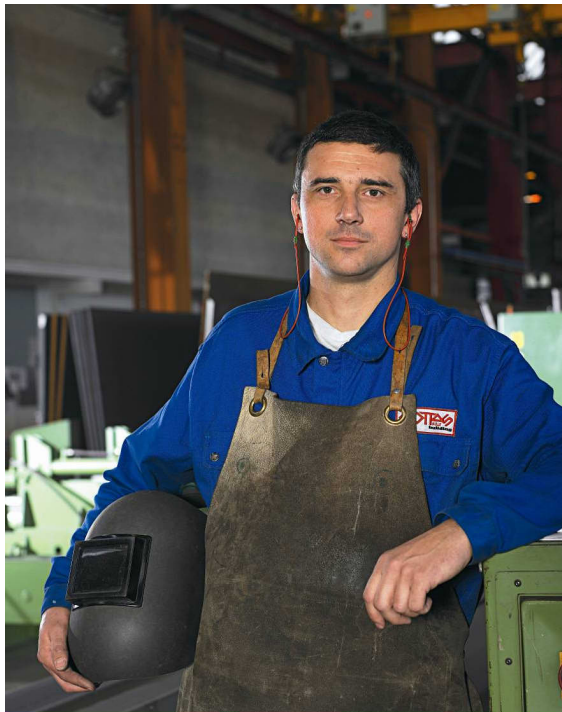


Hearing Loss

Hearing loss is irreversible

- Noise induced and aging induced hearing losses add
 - Effects become apparent, when it is too late for correction
- Hearing loss can be compensated only in part
- Similar stigmatization
 - Not using hearing protectors
 - Not using hearing aids





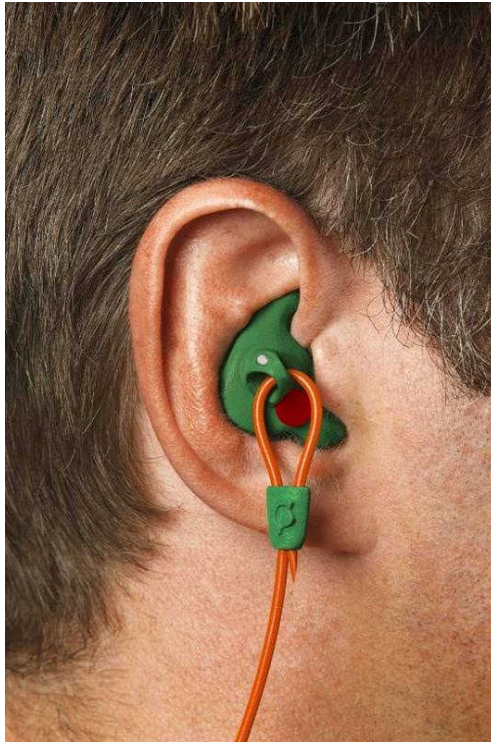
Custom made hearing protection

➤ Unmatched **acceptance** and **wearing comfort**

- User comfort most important for consistent wearing
 - feather light, no pressure to head or ear
 - flexible in combination with other personal protective equipment
- Secure attenuation
 - can only be correctly inserted
- Significant lower increase of average hearing loss for users of custom made hearing protectors compared to users of other hearing protection equipment
 - R. Weiß, Beurteilung der Wirksamkeit von Gehörschutz, SMBG-Präventionsbericht 25/2003

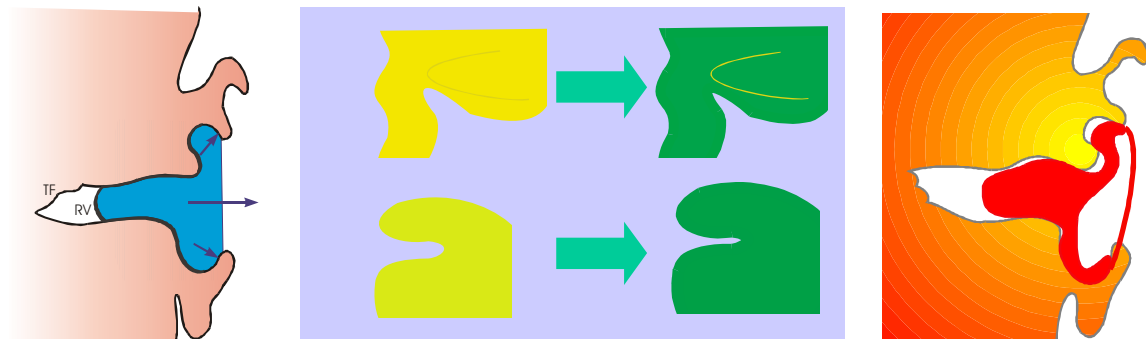
➤ Attenuation critically dependent on the **precise fit** of the ear mold

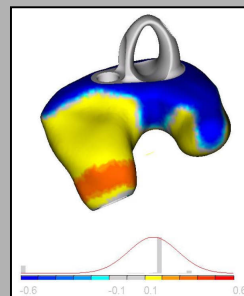
- Work safety insurances (BG, SUVA) recommend a functional test of the attenuation while wearing
 - BG-Information BGI 5024



Key Dependencies for a Perfect Fit

- Ear impressions
 - Reduced variance through strict control of the impression taking process
- Precise reproduction of the anatomic shape of the ear
 - Avoid any leveling effects in traditional molding techniques
 - Design sealing and retention areas

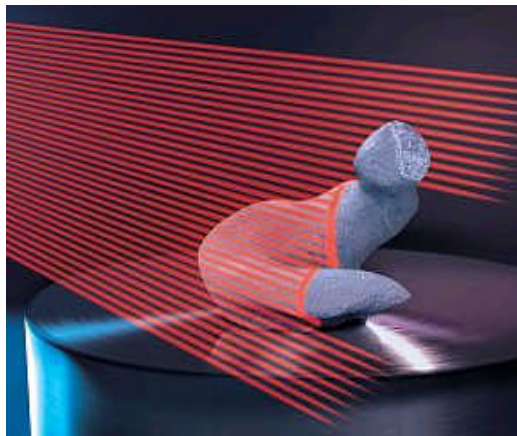




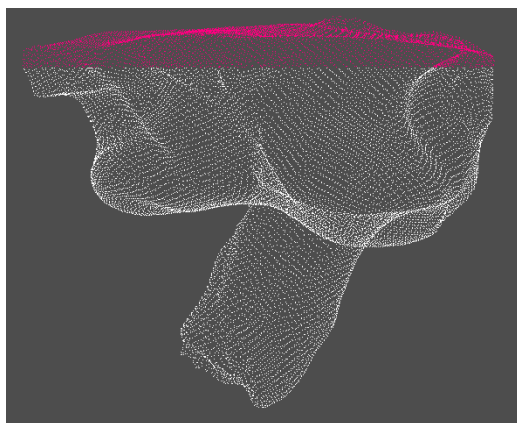
Digital Manufacturing

- Originally developed for ITE hearing aids
 - Used for many years on several Mio hearing aids and earmolds
- Key part: special 3D modeling SW for desing of individual parts
- Replace Art with Science
 - Reproducible process

Digitizing of earmolds



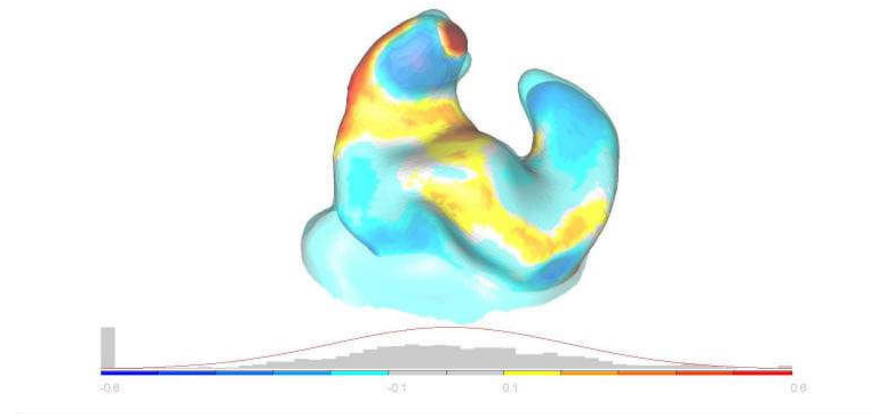
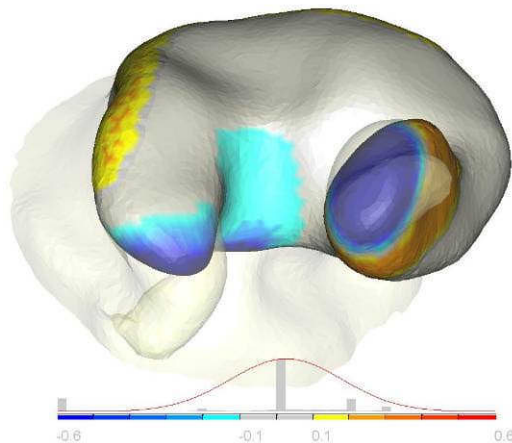
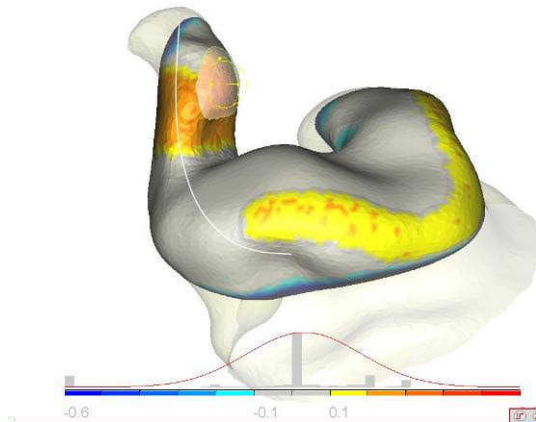
- Ear impressions are scanned with precision 3D scanners
 - 100 000 data points per impression with an accuracy of 50 µm
- All impressions are filled without loss of quality
 - Quick reproduction of lost ear molds

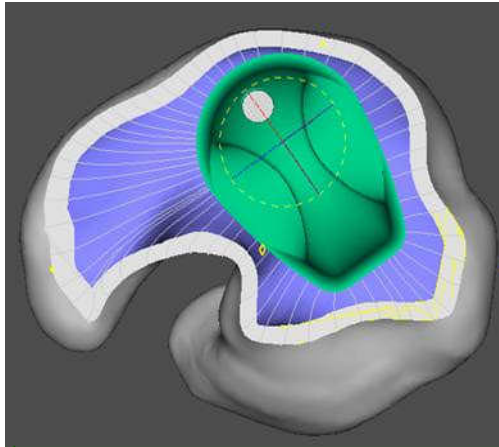


3D Modeling

• Design of the ear molds

- Precise definition of sealing and retention areas with controlled enlargement by 0.1 – 0.3 mm
- Material reduction in sensitive areas of the ear for high comfort and easy insertion
- Analysis of the fit through exact measurements, optical simulations and comparison with the ear molds, especially in case of remakes

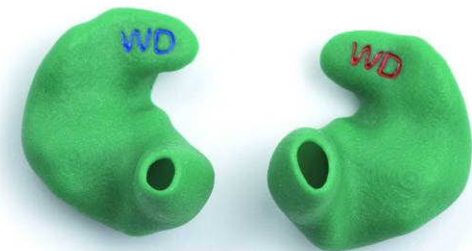
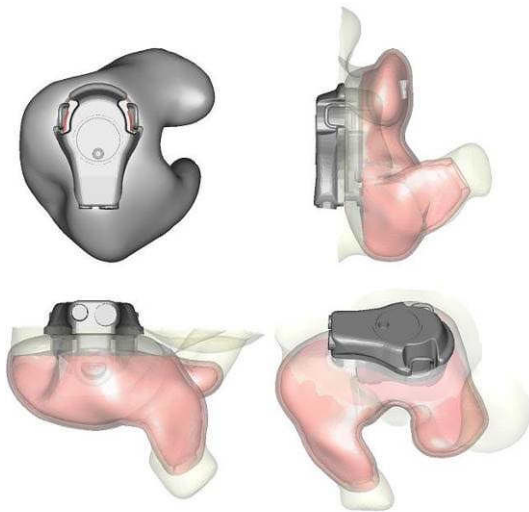




3D Modeling

Functional design of the final part

- Hollow shell design
 - Light weight
 - Good heat exchange with the inner ear
 - Improved acoustics, reduced occlusion
- Add initials for identification
- Add functional elements for holding and ports for the measurement microphones
- Standardized port
 - Click in earJack™-Adapters for different functionalities





Ear mold production with 3D printers

- **Selective Laser Sintering (SLS) for production of individual parts**
 - layer by layer fabrication in 0.1 mm layers
 - sintering of Nylon powder via CO₂-Laser
 - high precision via calibration and statistical process control: $\pm 3\sigma$ kleiner 50 μm
- **Post processing for a comfortable surface properties**
 - biocompatible, without itching





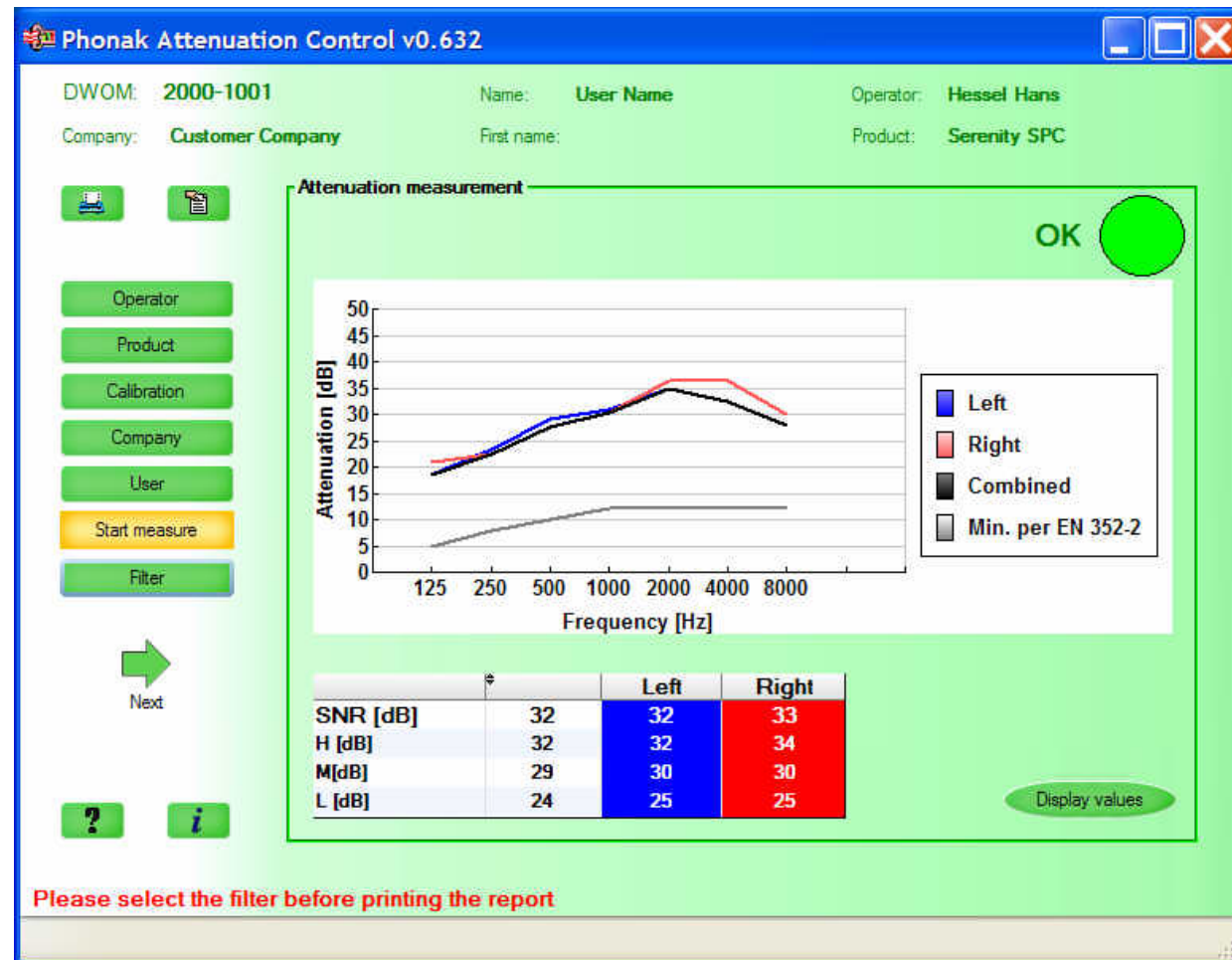
Functional control at delivery via **PAC**

- **Phonak Attenuation Control System**
- **Determine the attenuation in-situ for the user when wearing the ear plug**



Phonak Attenuation Control System

- SW based measurement of the frequency dependent attenuation

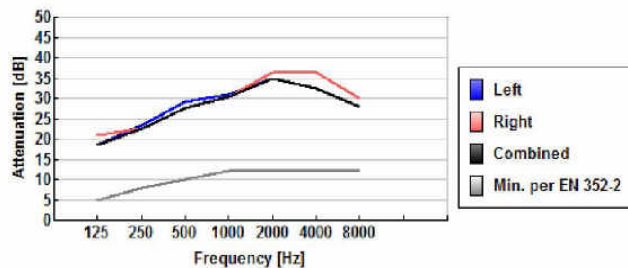


Phonak Attenuation Control System Measurement Certificate

Order: 2000-1001 Company: Customer Company
Product: Serenity SPC Date: 26.09.2006
User name: User Name First name:
Operator: Hessel Hans Version: PAC v0.632

The protection is OK

Attenuation values for filter 110WH



Filter	Selected	SNR	H	M	L	EN 352-2
110WH		31.6	31.8	29.3	24.3	OK
105OR		31.2	31.8	28.8	23.2	OK
100YE	X	28.6	31.9	25.8	17.7	OK

File: Customer Company\2000-1001_User Name_20060926_211555.pdf

Phonak earcare solutions info@phonak-earcare.com www.phonak-earcare.com

Phonak Attenuation Control System

- Determination of typical attenuation values
 - SNR, H, M, L values
- Extrapolation for different acoustical filters
 - Support appropriate selection for a given noise exposure
- Documentation of results
 - in data base to determine trends
 - as .pdf Document for filing



Key Advantages of Custom Earmolds

🔗 High wearing comfort

- 🔗 feather light without permanent pressure on head or ears
- 🔗 no sweating around ear, good heat exchange to inner ear
- 🔗 biocompatible and skin friendly

🔗 Secure protection with secure attenuation

- 🔗 independent on how it is inserted
- 🔗 also in combination with other protection equipments
- 🔗 improved fit via digital manufacturing processes

🔗 Granted protection by PAC System

- 🔗 eliminates leaky protectors, fulfills requirements of BGIA/SUVA
- 🔗 increases time of use, as long as attenuation is sufficient
- 🔗 documentation of results

🔗 User friendly

- 🔗 easy to clean
- 🔗 mechanically and chemically very robust
- 🔗 fast and cheap reproduction when lost



Protection and Communication System

Based on earJackTM adapters

Changing Noise

Constant Noise

Serenity DP

- Dynamic protection
- with level dependent attenuation
- for impulse and changing noise

Serenity DPC

- Dynamic protection
- with connection to external communication systems
- with acoustic shock limiter

Serenity SP

- Static Protection
- three acoustic filters
- for constant noise conditions

Serenity SPC

- static protection
- three acoustic filters
- with connection to external communication systems

Communication near field

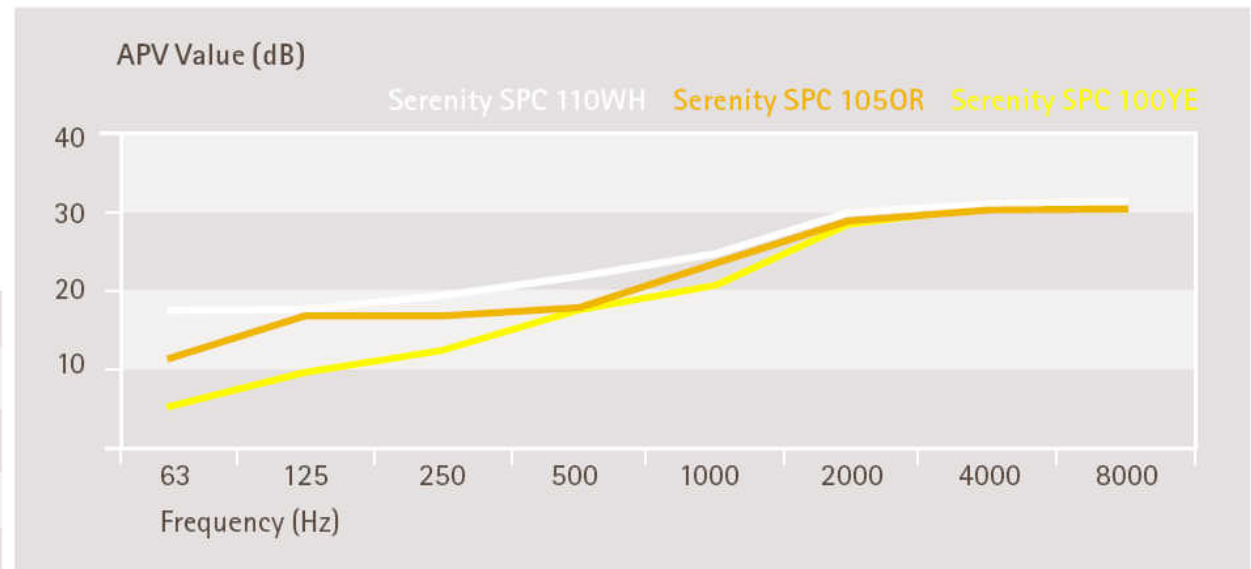
Communication near and far field



Serenity SP/SPC – Attenuation Filter Characteristics

- Attenuation filters suited for the noise environment
 - Avoid overprotection to preserve maximum ambient awareness
 - Hearing of warning signals
 - Germany (BG): protectors certified for hearing warning signals and/or for usage while driving
 - Communication with coworkers

Product	Attenuation values in dB			
Filter	SNR	L	M	H
Serenity SPC 110WH	28	21	25	30
Serenity SPC 105OR	26	19	22	28
Serenity SPC 100YE	25	16	21	28





Secure External Communication in Noise Requirements

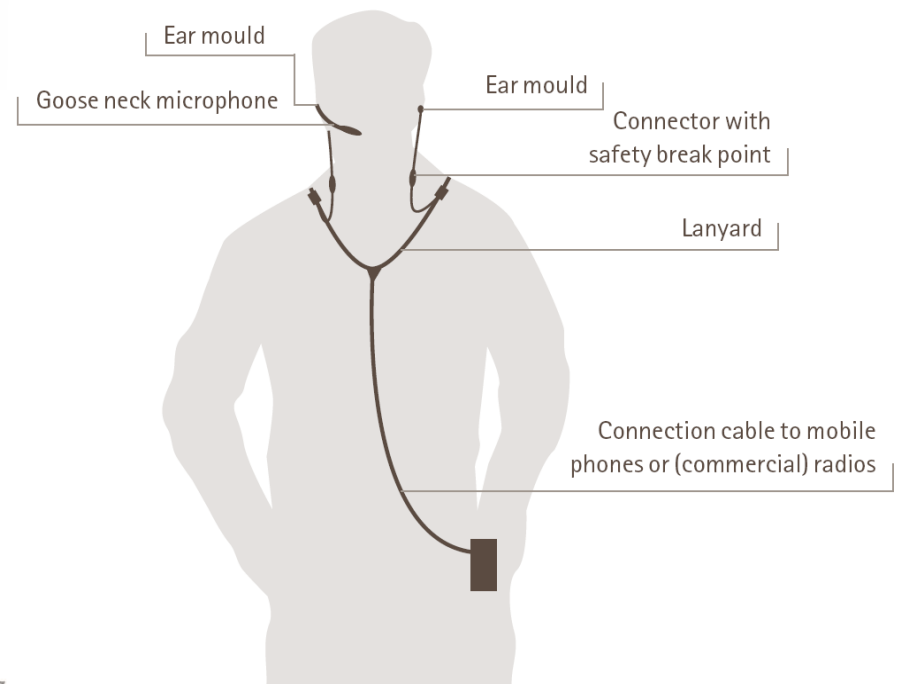
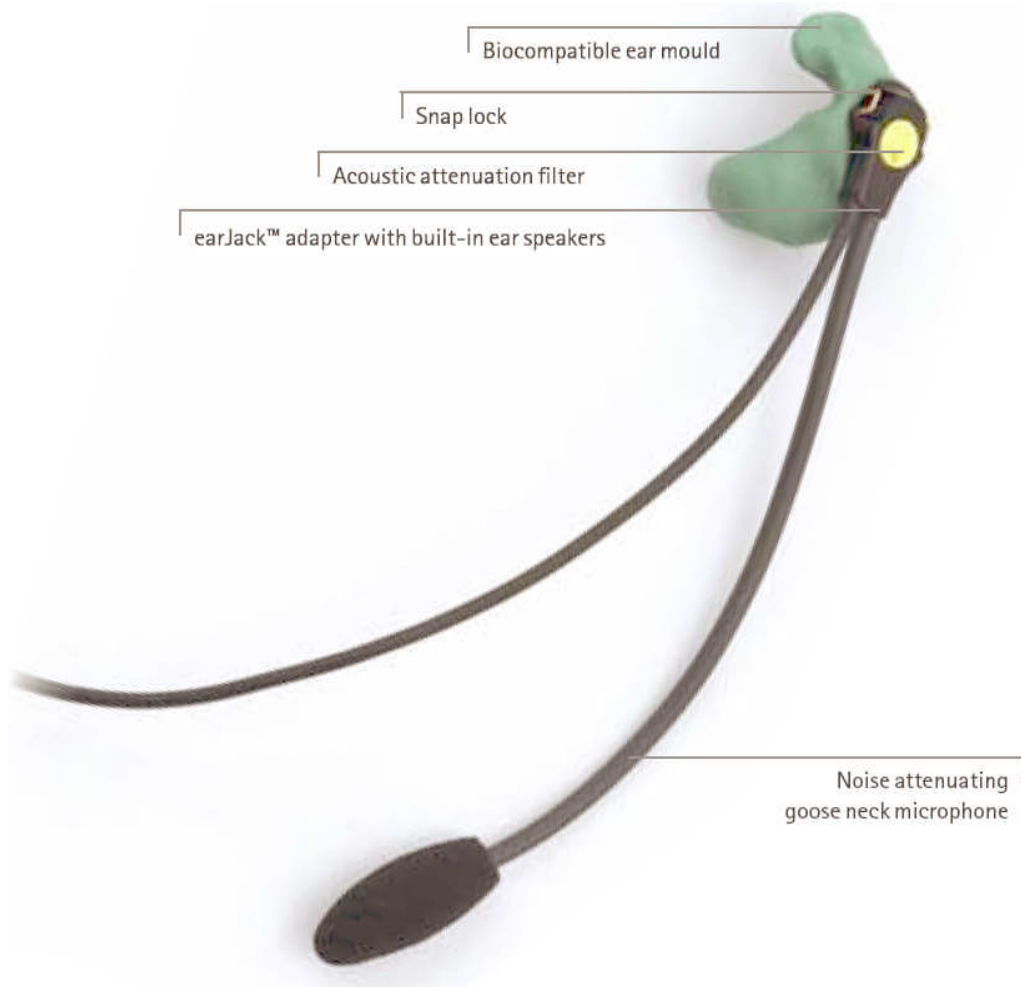
➤ Consistent noise protection

- Avoid protection breaks due to communication needs

➤ Secure communication in noise

- Good understandability of transmitted voice
 - Speech pickup not disturbed by environment
- Receiving sound remains at secure levels
 - Transmitted sound adds to total noise exposure
 - Good noise isolation allows to listen at significant lower levels
 - Typically at the level of best understandability
 - Independent of noise, if changing
- Binaural sound delivery reduces the required minimum volume setting by 6 dB

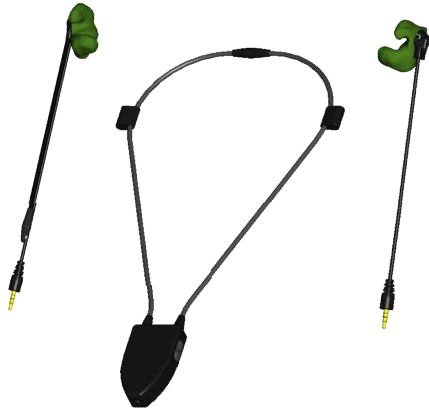
Serenity SPC – Product Details



Serenity SPC – Attachment to Communication Systems



- Mobile and cellular (DECT) phones
 - Direct attachment via 2.5 mm headset jack connector
 - Adapters for most phones on the market
- Mobile radio systems
 - Special lanyards (build to order) with connectors to most radio handsets
 - Push to Talk button integrated in the connection



Serenity DP – dynamic hearing protection

• Application areas

- Situations with unpredictable changing noise
- Impulse noise (shooting)

• Features

- Dynamic, level dependent hearing protection
 - In quiet: full transparency to ensure ambient awareness
 - In noise: safe limitation of sounds to 82 dBA
- Volume control
 - Slight amplification selectable
 - Output reducible if remaining noise is disturbing
- Powered by standard/rechargeable AAA battery
- Rugged system fulfilling IP 54 requirements

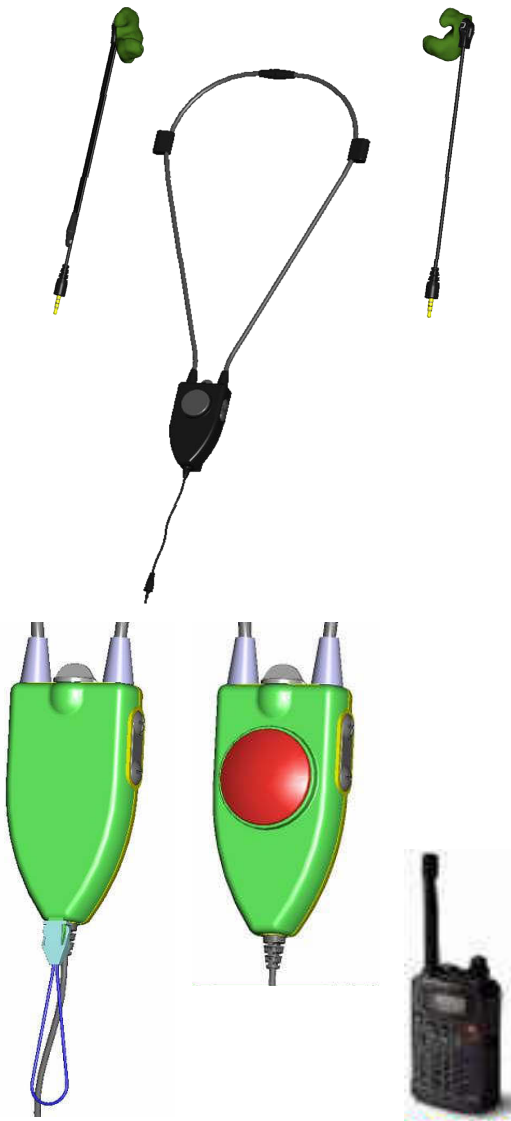
Serenity DPC – dynamic hearing protection with com.

Application Areas

- Users with communication needs in changing noise
- Security forces, SWAT teams

Features

- Dynamic, level dependent hearing protection
- Communication system with acoustic shock protection
- Connection to multiple communication systems
 - Cellular or GSM mobile phones
 - Radio handsets
 - PTT usable with gloves, IP54
 - Optional: receiver for wireless PTT
- Powered by radio system or standard AAA battery
 - Battery as backup, while radio powered





Serenity

Modular Protection and Communication System

- Custom ear molds detachable from attenuation and communication elements
- User exchangeable attenuation filters
- Upgradeability to dynamic protection and/or external communication
- Modular components remain usable for other users



**„Not seeing, separates man from things
not hearing separates man from man.“**
Immanuel Kant