

Phonak nano

Great custom products get even smaller

In-the-ear hearing aids offer many benefits for end users. By sitting directly in the ear canal, they provide excellent sound, wind noise is effectively reduced and natural directional hearing is possible. A well-crafted, well-fitting in-the-ear hearing aid also offers high wearer comfort. Completely-in-the-canal (CIC) hearing instruments worn deep in the auditory canal are ideal in terms of appearance. Phonak, the global technological market leader in both the development of digital hearing aids and the computer-assisted production of in-the-ear hearing aids, is introducing a new premium product with the Phonak nano. The material used to produce the custom ear shells, the faceplate, the battery door and the positioning of the microphone and electronics have been redesigned. By optimizing these and other aspects, the Phonak nano can be made smaller than the previously smallest CIC hearing instruments.

Objectives of the Phonak nano product development

It has long been known that the perceived occlusion effect can be reduced when an in-the-ear hearing aid is placed deeper in the auditory canal (Killion et al, 1988; Mueller et al, 1996). This is one compelling reason to make the previously smallest CIC hearing instruments even smaller. But there are also a whole range of other benefits. The following goals and requirements were defined for the new nano custom device:

- Increased user acceptance through reduced occlusion effect and improved cosmetic appearance
- Improved fit and wearer comfort
- Expansion of the customer base for which completely-in-the-canal hearing instruments are suitable
- An alternative for those individuals for whom the use of a Phonak Lyric is contraindicated
- Greater overall customer satisfaction

To enable a size reduction of the current generation CIC instrument, virtually all mechanical parts, software and the audiological approach had to be reviewed.

This meant:

- Redesign of the faceplate and the battery compartment
- Innovative, space-saving internal placement of the electronic components
- Reduction of the shell thickness
- Extended AOV implementation

The challenge: miniaturization

The first design optimization was to change the external shape of the battery compartment such that as little space as possible is required on the faceplate (Figure 1).

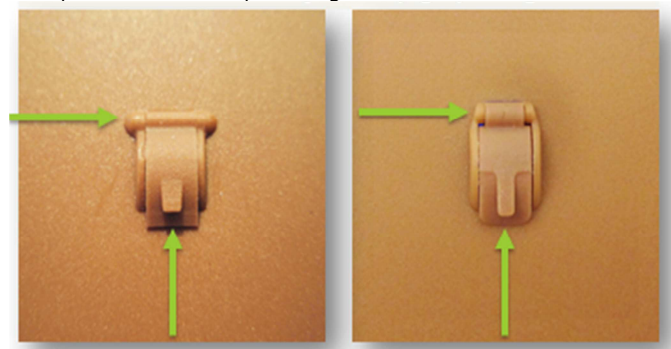


Figure 1: Battery compartment of a standard CIC (left) and the new Phonak nano (right)

Since the internal electronic components have a predetermined size, they have to be packed as closely together as possible within the custom shell. Changes to the positioning of both the microphone and the Spice+ electronics make better use of previously unused space. By individual 3D computer aided modeling of the device, the microphone is placed at a specific angle to the battery, better utilizing the available space.

An additional reduction of the shell size was achieved by decreasing the shell thickness. To reliably and safely make thinner shell walls with digital manufacturing technology,

Phonak has used a new material that was originally developed for the dental industry and adapted to the specific requirements of hearing instrument shell production. The innovative material mix (with addition of silica particles) allows reducing the shell thickness from 0.6/0.7 mm to 0.4 mm, which is almost 40% thinner (Figure 2). This creates additional space inside the shell, while the new shell material is sturdy and durable.

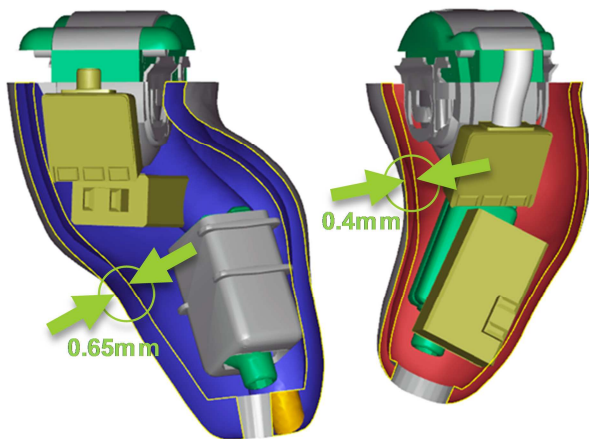


Figure 2: Shell thickness of a standard CIC (left) and with the new Phonak nano shell material (right)

Due to the deeper placement in the ear, a new programming cable and cable routing were developed. The cable hangs behind the ear and reduces strain on the programming connector. The new cable also allows the device to fit deeper inside the ear canal while being programmed.

Acoustics and Audiology

The sound outlet, ventilation and the residual volume in the auditory canal have a significant effect on the output level and on frequency response. This has been systematically researched in recent times leading to the development of Acoustically Optimized Venting (AOV) by Phonak (Pötzl, 2008). Numerous studies have shown that the diameter of a vent alone is not sufficient to describe the acoustic properties of an earmold. The much more complex acoustic vent mass (AVM) is better suited for this and is taken into consideration when making shells with AOV. Now, all in-the-ear custom hearing aids and earpieces for BTE (including traditional BTE earmolds) manufactured by Phonak can be produced with this vent technology.

Thanks to optimized vent-mass calculation, AOV can ensure good acoustic results even if there is no room for a large traditional vent. Hence, a smaller vent in the Phonak nano has the same effect in terms of comfort and occlusion as a larger

vent in a traditional CIC hearing instrument or ITC device. Internal validation studies confirm that the Phonak nano has achieved the goal of reducing occlusion, providing high spontaneous user acceptance and very good own-voice sound quality assessment.

Additional parameters – the use of technology

The Phonak concept of acoustically optimized venting takes into account several parameters that have an influence on the acoustic properties for each individual case. When digitally modeling custom shells for the new nano product, additional acoustic parameters have been considered on the basis of their audiological influence and are implemented in the device accordingly. They include:

- the acoustic vent mass
- the appropriate shell shape for the hearing loss and ear anatomy
- the shell length for the required amplification, the least occlusion and the most comfortable fit
- the sound entrance surface area and canal sealing areas that give the best performance level

Since the introduction of digital shell production, Phonak has accumulated thousands of individual ear impression data, and these were analyzed for parameterization. Extensive computer simulations were performed and evaluated to apply the key parameters to optimize the pre-calculation algorithms that are used by Phonak Target fitting software with the nano device .

Production of Phonak nano

The modeling of a Phonak nano requires no special ear impression techniques . It is sufficient to have a high-quality standard CIC impression, in which the second bend is clearly visible.

The production of the Phonak nano uses computer-aided manufacturing (Rapid Shell Modeling, RSM). Comparing the Phonak nano with a conventional CIC the difference in size is clear to see (Figure 3). Internal trials have been carried out in Switzerland and the USA. These tests have clearly shown that a Phonak nano can normally be built much smaller than before, and much smaller than a standard CIC instrument (Figure 4.)

Preliminary validation trials of the nano devices have shown that the design is evaluated as very pleasant for wearing comfort. This is partly because the device is strongly tapered behind the second bend and therefore does not impinge on the sensitive area of the auditory canal wall.

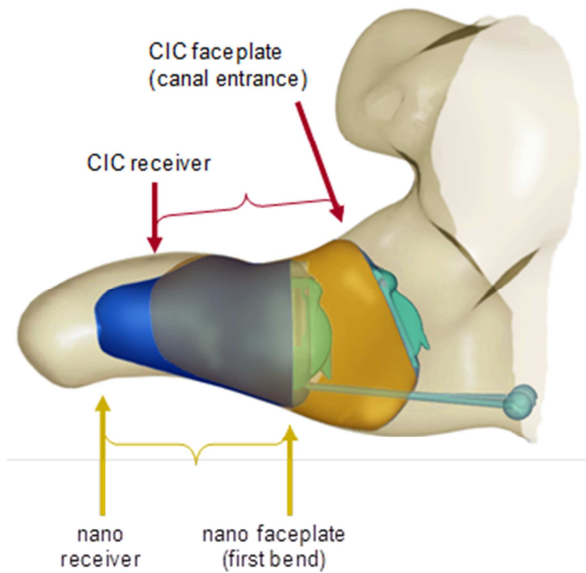


Figure 3: Placement of a standard CIC and Phonak nano in the ear

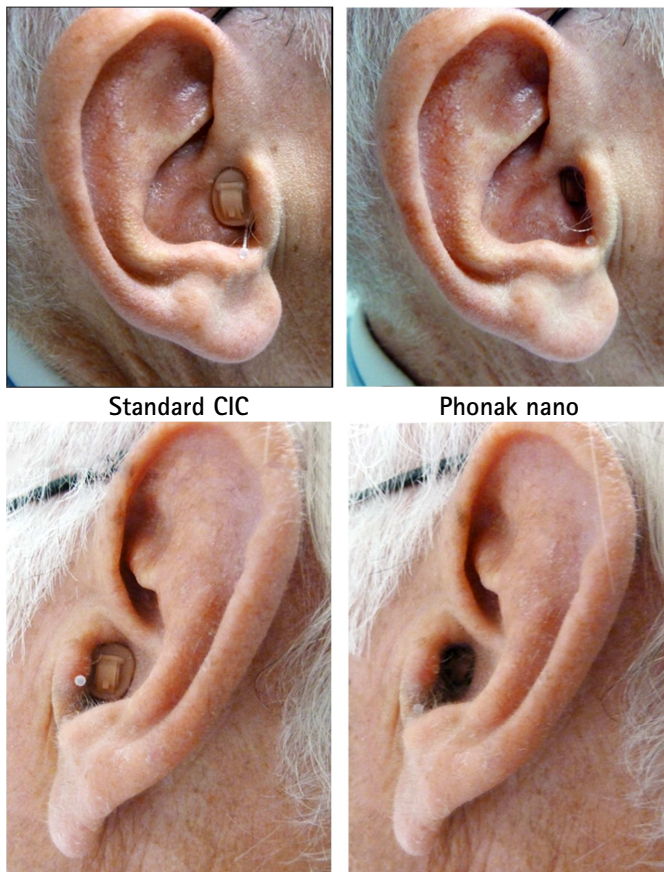


Figure 4: Fit of a standard CIC (left) and Phonak nano (right) in the ear

Due to the deep position of the nano devices in the ear canal, when viewing the device in the hand it can be difficult to judge for certain whether it is a left-ear or a right-ear unit. To make this immediately recognizable for the customer, the shells of the Phonak nano are produced in red for the right side and in blue for the left side as standard. The removal handle is always securely attached to the underside of the hearing device – it is also an important component for the safe and easy removal of the nano from the ear.

Improved wearing comfort

Hearing aids are often worn more than 10 hours a day (Kochkin et al., 2010). Therefore, wearing comfort is a very important point for the user. Wearing comfort is excellent for the Phonak nano than due to its small size and deep seating, tapered fit in the ear canal. After inserting the device, wearers comment that it fits securely, and will not work its way out the ear canal on its own. The deeper seating of the Phonak nano in the ear canal brings other distinct benefits. Disruptive wind noise is reduced and there is no hindrance to wearing helmets and goggles. When telephoning (fixed-line and cell phones), the phone can be held directly and comfortably to the ear as usual without interference.

Who is the Phonak nano suitable for?

The complete mechanical overhaul and the use of the smallest components and innovative materials have made the Phonak nano so small that it fits in almost any ear. Internal studies have shown that 60% of customers whose ear anatomy makes a standard CIC hearing instrument unfeasible can be fitted with a Phonak nano.

The Phonak nano is suitable for mild to moderate hearing loss. Due to the smaller residual volume between the sound outlet and the eardrum, Frye CIC coupler measurements show amplifications of more than 50 dB and output power of 120 dB could be achieved in practice.

Summary

With the nano, Phonak has succeeded in developing an even smaller, comfortable in-the-ear custom hearing aid. Due to the fact that it sits deep in the auditory canal, in most cases it is no longer visible and for the first time it is possible that almost all potential users – at least in terms of the fit – can be candidates for this device. The Phonak nano has been designed from scratch on all levels – mechanically, audiological and in terms of digital manufacturing. It complements the extensive range of custom hearing aids, and does not replace the current CICs which offer additional options and connectivity choices. The Phonak nano is an attractive alternative, for example, for people who were originally interested in being fitted with a Lyric, but for whom this was not possible due to contraindications. For customers, the advanced anatomically optimized venting technology from Phonak provides an excellent first fit sound quality and high spontaneous acceptance.

The Phonak nano is an excellent new custom hearing system which, in addition to its outstanding Spice+ acoustic performance, is also almost invisible, is comfortable and offers a secure fit in the auditory canal.

Reference

Killion, M.C., Wilbur, L. and Gudmundsen, G.I. (1988).
Zwislocki was right... A potential solution to the "hollow
voice" problem (the amplified occlusion effect) with
deeply-seated earmolds. *Hearing Instruments*, 39, 14-18.

Kochkin S, Beck D, Christensen L, Compton-Conley C, Fligor B,
Kricos P, McSpaden J, Mueller HG, Nilsson M,
Northern J, Powers T, Sweetow R, Taylor B, Turner R: MarkeTrak
VIII: The impact of the hearing healthcare professional on
hearing aid user success. *Hear Rev* 2010;17(4):12-34.

Mueller, H.G., Bright, K.E. and Northern, J.L. (1996).
Studies of the hearing aid occlusion effect. *Seminars in
Hearing*, 17, 21-32.

Pötzl T., Das Akustisch Optimierte Vent,
Audio Infos No. 89, 2008