

Breaking performance barriers

The Cochlear™ Nucleus® 5 Sound Processor and Remote Assistant

A COCHLEAR IMPLANT HEARING SOLUTION



- Outstanding single microphone technology
- Dual microphone technology gives breakthrough in hearing in noise
- MP3000™ – outstanding performance delivered more efficiently

Hear now. And always



Breaking ground with the Cochlear™ Nucleus® 5 Sound Processor (CP810)

Listening is a complicated process that relies on the brain being able to recognise and interpret constant fluctuations and minute differences in the sounds around us – differences in intensity, spectral shape and origin. The Cochlear™ Nucleus 5 Sound Processor (CP810) breaks new ground in hearing performance making use of all these different dimensions of sound to enhance the listener's hearing performance particularly in noise. The Nucleus 5 Sound Processor combines sophisticated signal processing algorithms, dual microphone technology and MP3000™, a new sound coding strategy, to deliver the best possible hearing experience.

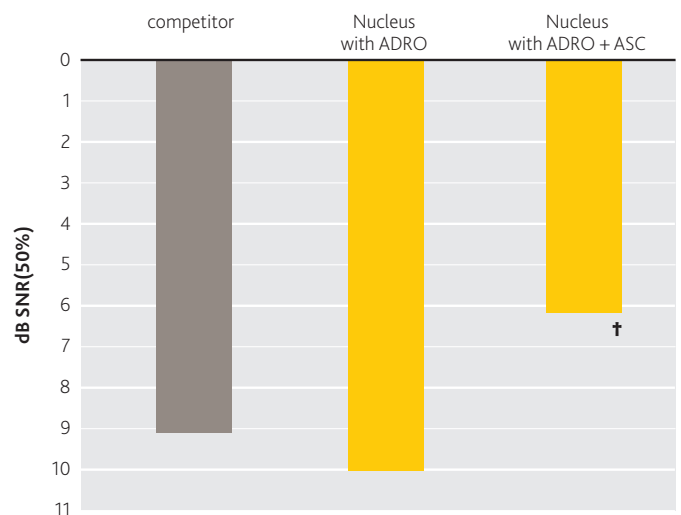
Outstanding single microphone technology is only the first step to breaking performance barriers

The Freedom™ and the Nucleus 5 Sound Processor operate two independent automatic single microphone processing algorithms: Automatic Sensitivity Control (ASC) preserves a positive signal to noise ratio, even in loud listening conditions and ADRO® optimises audibility and comfort in dynamic listening conditions across the whole frequency spectrum. Both processing strategies have long proven their effectiveness^{1, 2, 3}.

The combination of both processing strategies substantially improved hearing in noise over and above ADRO alone⁴ and outperformed an otherwise comparable group of users of a contemporary competitive cochlear implant system⁵.

However, in real life, sounds do not come from a single speaker alone but are spatially distributed. Sophisticated dual microphone technology takes advantage of this and further improves hearing performance in more real life conditions – beyond what is possible with single microphone processing alone.

Users of single microphone systems cannot reach their optimal hearing potential.



Mean BKB-SIN score at 75 dB SPL N_0S_0 (signal-to-noise ratio in dB for 50% correct scores) for a mixed group of unilateral and bilateral cochlear implant users. Nucleus users include Freedom and Nucleus 5 Cochlear Implant technology. Nucleus: N=14, competitor: N=13 † denotes significance ($p \leq 0,05$)

¹ Müller-Deile J. Zur Störsignalreduktion bei Cochlear Implant Sprachprozessoren [Noise reduction in cochlear implant processors]. HNO. Hals-, Nasen-, Ohrenärzte, 1995; 43(9): 545-551

² Dawson P, Decker J, et al. Optimizing dynamic range in children using the Nucleus cochlear implant. Ear and hearing, 2004; 25(3): 230

³ Müller-Deile J, Kiefer J, et al. Performance benefits for adults using a cochlear implant with adaptive dynamic range optimization (ADRO): a comparative study. Cochlear Implants International, 2008; 9(1): 8-26

⁴ Wolfe J, Schafer EC, John A, Hudson M. Comparison of speech recognition in quiet and noise for users of different cochlear implant systems, submitted

⁵ Wolfe J. Comparison of speech recognition for recipients with cochlear implant technology from different manufacturers. Cochlear, 2010; N34481F ISS1 JUN10

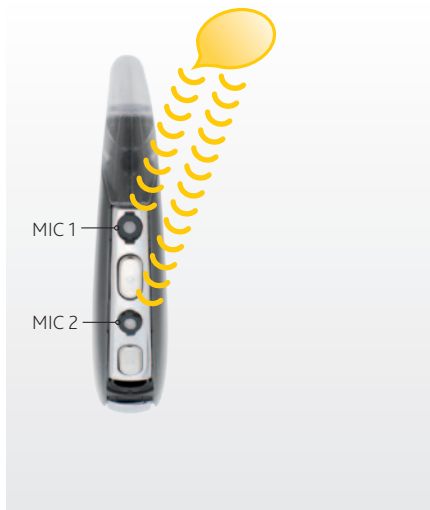
Dual microphone technology

Since the first generation sound processor, Cochlear has used standard fixed hardware directional microphones. The benefit to users of enhanced ability to hear in noisy environments has been repeatedly demonstrated by research throughout the hearing healthcare industry⁶. Nucleus Systems remain the only cochlear implant systems on the market that deliver more than one type of directional capability. Now, with the Nucleus 5 Sound Processor, a further technological advancement has been introduced.

Nucleus 5 dual microphone technology

The implementation of dual microphone technology in the Cochlear Nucleus 5 Sound Processor incorporates two omni-directional microphones. They are precisely calibrated to +/- 1 dB tolerance to ensure accuracy and consistency. In addition, the two microphones are phase matched.

These low noise microphones are combined into selected directional responses using digital signal processing. Dual microphone technology allows us to provide an enhanced suite of directionality for improved listening in noise, available only in the Nucleus 5 Sound Processor.



Sounds from in front arrive at MIC 1 first then at MIC 2 second.



Sounds from the side arrive at MIC 1 and 2 at the same time.

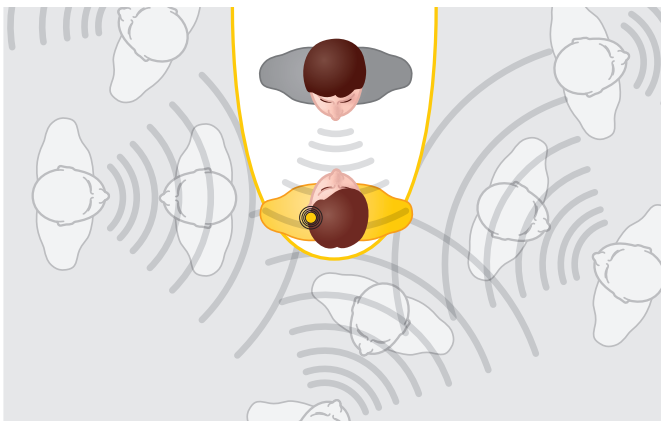


Sounds from behind arrive at MIC 2 first then at MIC 1 second.

SmartSound™ dual microphone technology

Only dual microphone technology with intelligent processing can also block out competing sounds and voices – similar to natural hearing.

On average it can improve understanding by 30%* in multi talker situations.



* Nucleus 5 Sound Processor validation, Cochlear internal data Aug 2009

⁶ Bentler, R. Effectiveness of directional microphones and noise reduction schemes in hearing aids: a systematic review of the evidence. *J Am Acad Audiol*, 2005; 16:473-483

Suite of directionality

The Cochlear Nucleus 5 Sound Processor uses exclusive dual microphone technology and digital signal processing to provide not just directionality, but a suite of directionality options, including: standard directional, zoom processing and Beam™.

Standard directional

The standard, fixed directional microphone setting is more sensitive to sounds from in front of the listener than to sounds from other directions. This means that sounds originating from the direction the listener is facing are amplified more than sounds from behind or in other directions.

This setting is good for quiet or windy environments and when there is no specific sound source to listen to.

Zoom processing – new in the Nucleus 5 Sound Processor

Zoom processing is a fixed super-directional microphone setting. The super directionality of zoom processing is made possible due to the precisely calibrated and phase-matched dual microphones and the use of Cochlear's proprietary advanced DSP algorithm to form a super-directional pattern. Zoom processing constantly blocks sound from behind and to the sides of the listener, allowing for easier understanding in noisy environments.

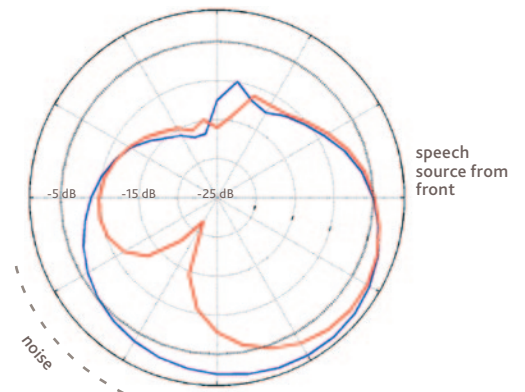
Zoom processing is a great choice for situations when the desired signal is relatively stationary and remains in front of the cochlear implant user and noise is behind the listener and is not moving. It is also an excellent choice for situations where the user can (re)position herself so that the noise is behind her and the speaker is in front.

Beam

The updated algorithm uses more precise calibration to provide maximum noise cancellation, about a 5 dB improvement compared to Beam in the Freedom Sound Processor. The adaptive directionality of Beam is achieved using Cochlear's digital signal processing. The Beam algorithm has maximum sensitivity at 0 degrees and maximum suppression between 90 and 270 degrees. Unlike zoom processing, the noise cancellation is adaptive; the null point will follow the noise source (or the loudest noise source, if there are several different noise sources in the area) making it an ideal choice for a situation in which the noise source, or cochlear implant users, are in motion.

For example, Beam works well when the implant user is listening to TV and children are playing behind him in the same room.

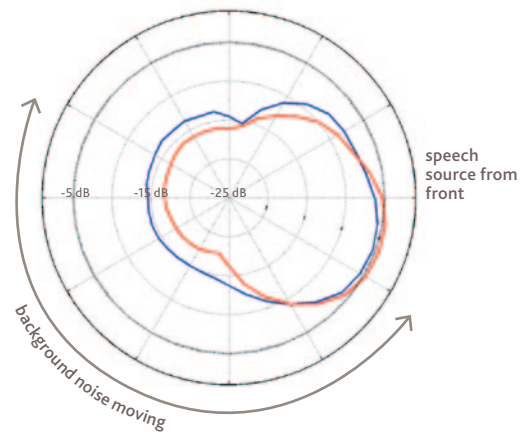
- Standard directional
- Zoom processing



Zoom processing*

The default setting for the Noise programme in Custom Sound™ Suite 3.1 and 3.2 is zoom processing+ASC+ADRO. Head effect is shown (processor is on the right side of the head).

- Freedom Beam
- CP810 Beam



Beam*

The Beam algorithm on the Nucleus 5 Sound Processor more reliably preserves sounds from in front of the device. Head effect is shown (processor is on the right side of the head).

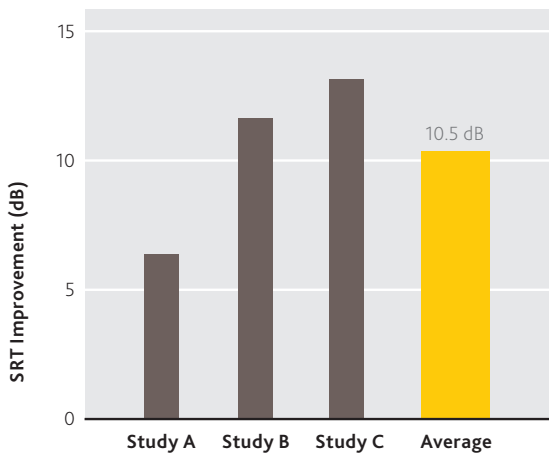
Zoom processing	Fixed directionality	Fixed null point	Use in more noisy environments or when the listener can position himself so that a stationary noise source is behind and the speaker is in front
Beam	Adaptive directionality	Adaptive null point	Use when one or a few noise sources are moving around and the listener can position himself so that the speaker is in front

* Each circle represents a 5 dB increase in attenuation

Breakthrough in hearing in noise

In three separate and independent clinical studies^{7,8,9} Nucleus 5 users were tested using either a single microphone¹⁰, or the Nucleus 5 unique dual microphones with speech and noise coming from different directions.

In every study Nucleus 5 users achieved significantly better results when using dual microphones. On average, dual microphones gave a 10.5 dB average improvement in the Speech Reception Threshold (SRT) in noise. This means that, compared with using a single microphone, Nucleus 5 users maintained their level of speech understanding with twice as much competing noise¹¹.



Each study evaluated the performance of the single and dual microphone capabilities of the Cochlear Nucleus 5 Sound Processor by comparing different listening programmes using an adaptive noise test.

Nucleus 5 is the only sound processor to feature dual microphones for superior hearing in noisy situations.

Across three separate and independent studies⁷⁻⁹, Nucleus 5 users achieved an average SRT improvement of 10.5 dB when using dual microphones.

Study A

A multicentre study⁷ with 34 adult Nucleus 5 Sound Processor users showed a **mean SRT improvement in noise of 6.3 dB** when comparing Everyday (ASC+ADRO) versus Noise (ASC+ADRO+**zoom processing**) using the BKB-SIN test with speech (75 dB SPL) from the front and noise at the CI side (significant at $p < 0.001$).

Study B

A study⁸ with 24 Nucleus 5 Sound Processor users showed a **mean SRT improvement in noise of 11.8 dB** comparing Nucleus 5 Sound Processor standard (ADRO) versus Focus (ASC+ADRO+**BEAM**) using the Oldenburg Sentence test in noise with speech from the front and noise (65 dB SPL) at the CI side (significant at $p < 0.0001$).

Study C

A study⁹ with 9 Nucleus 5 Sound Processor users showed a **mean SRT improvement in noise of 13.3 dB** comparing standard (no SmartSound) versus Focus (ASC+ADRO+**BEAM**) using the Oldenburg sentence test in noise with speech from the front and noise (65 dB SPL) at the CI side (significant at $p < 0.001$).

⁷ Study A: Wolfe J. 2010. Assessment of Performance of Cochlear Implant Recipients Upgrading to the Cochlear Nucleus 5 System. Presentation at the 11th International Conference on Cochlear Implants and other Implantable Auditory Technologies, Stockholm June/July 2010

⁸ Study B: Müller-Deile J, Brademann G, Hessel H, Hey M. 2010. Signal pre-processing Beam and Zoom can improve listening in noise with CP810 sound processor. Presentation at the 11th International Conference on Cochlear Implants and other Implantable Auditory Technologies, Stockholm June/July 2010

⁹ Study C: Dillier N, Lai WK. 2010. Speech intelligibility in various noise conditions with the Nucleus 5 system sound processor. Presentation at the 11th International Conference on Cochlear Implants and other Implantable Auditory Technologies, Stockholm June/July 2010

¹⁰ Nucleus 5 Sound Processor offers a "standard" microphone setting which combines the dual microphones to emulate a standard directional microphone response

¹¹ Average improvement in Speech Reception Threshold (SRT) was 10.5 dB. A 10 dB increase in SPL is perceived as a doubling in loudness/intensity (Bentley S, Murphy F, Dudley H. Perceived noise in surgical wards and an intensive care area: an objective analysis. British Medical Journal, December 1977; 1503-1506)

Optimal hearing in changing conditions is automatic

Hearing performance is of primary importance to cochlear implant users. It's about the ability to understand speech, particularly amidst the background noise of the real world.

Better hearing in any environment

Our latest input processing innovation provides clinicians with an easy, environment based approach to programming.

- SmartSound offers four customised settings for different listening environments – designed to provide a superior hearing experience for your patients, by ensuring that complete and optimal sound is delivered to the hearing nerve.
- The fitting recommendations are simple and straightforward, leaving you with more time for counselling your patients.
- Patients can access SmartSound features via the sound processor buttons or the remote assistant.
- Only Cochlear's unique two-microphone SmartSound programmes, Noise and Focus, reduce both general noise and competing voices from behind and beside the listener. So your patients hear sounds they need to hear and can tune out those they don't.

Other systems

Many common situations include both constant background noises (eg. fan, computer hum, air conditioner etc.) and the noise of other people speaking. Some systems will help with the constant noise from the fan, as shown in the image, but not with competing voices.



Everyday (ASC + ADRO)*

SmartSound features the "hands-free" Everyday setting. Everyday automatically adjusts to a wide range of typical everyday situations such as at home or the workplace. It is intended as the main programme your patients use throughout the day. They simply turn the processor on and are ready to go – Everyday does the rest.



Noise (zoom processing + ASC + ADRO)*

Noise is designed to provide the best possible hearing in excessively noisy situations by using dual microphone technology which filters sound coming from the side and behind.



Focus (Beam + ASC + ADRO)

Focus makes it easy to understand a person standing in front even when there is a variable background noise. It uses dual microphone technology to reduce specifically the most significant noise source from the side or behind.



* When programmed with Custom Sound Suite 3.1 and 3.2

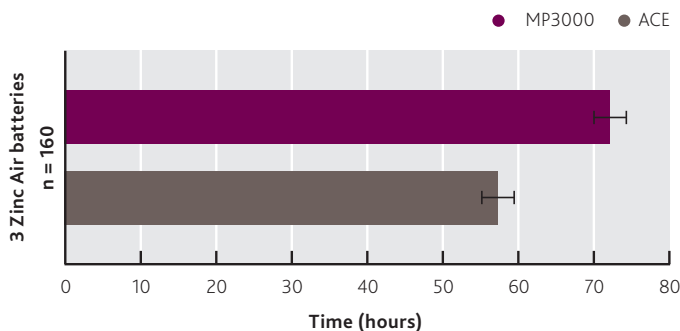
MP3000™ – outstanding performance delivered more efficiently

Cochlear's MP3000 is the world's only cochlear implant sound coding strategy to emulate the masking process found in natural hearing. In natural hearing, sounds are "filtered" through a process called simultaneous masking, meaning only a fraction of all the sounds received by the ear are perceived by the listener.

By incorporating masking techniques, MP3000 delivers the same outstanding hearing performance as our benchmark ACE™ sound coding strategy, but with greater efficiency*. Stimulation of the hearing nerve is greatly reduced, allowing users to benefit from a substantial increase in battery life, giving cost savings and improved convenience. The efficiencies delivered by MP3000 also mean more users can enjoy the smallest sound processor configurations.

Cochlear is already investigating the potential of this new technology in other fields. Trials currently underway in leading European clinics include comparisons of music perception between ACE and MP3000; perception of emotional prosody, informational masking in noise and hearing effort in children.

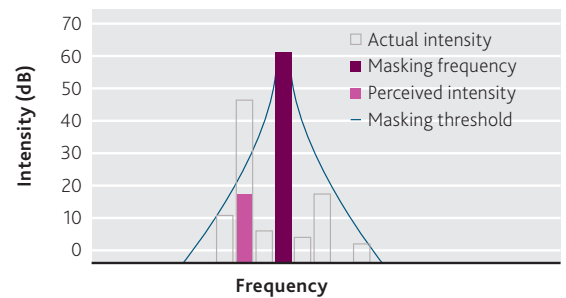
Greater efficiency



MP3000 battery life comparison

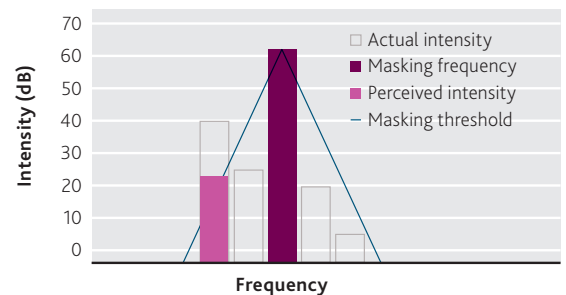
In the MP3000 optimisation trial, MP3000 users achieved a 24% average increase in battery life compared to Cochlear's benchmark ACE sound coding strategy*.

What is masking?



Natural masking

The louder frequencies "mask" the softer adjacent frequencies, substantially reducing their perceived intensity. Many frequencies are not perceived at all.



MP3000 masking

MP3000 takes the masking effects of the louder channels into account to determine the perceived – rather than actual – intensity of each channel.

* MP3000 optimisation trial, data held on file

Hear now. And always

As the global leader in hearing solutions, Cochlear is dedicated to bringing the gift of sound to people all over the world. With our hearing solutions, Cochlear has reconnected over 250,000 people to their families, friends and communities in more than 100 countries.

Along with the industry's largest investment in research and development, we continue to partner with leading international researchers and hearing professionals, ensuring that we are at the forefront in the science of hearing.

For the hearing impaired receiving any one of Cochlear's hearing solutions, our commitment is that for the rest of their life they will Hear now. And always



Cochlear Ltd (ABN 96 002 618 073) 14 Mars Road, Lane Cove NSW 2066, Australia Tel: 61 2 9428 6555 Fax: 61 2 9428 6352

Cochlear AG European Headquarters, Peter Merian-Weg 4, 4052 Basel, Switzerland Tel: 41 61 205 0404 Fax: 41 61 205 0405

EC REP Cochlear Deutschland GmbH & Co. KG Karl-Wiechert-Allee 76A, 30625 Hannover

Germany Tel: 49 511 542 770 Fax: 49 511 542 7770

Cochlear Europe Ltd 6 Dashwood Lang Road, Bourne Business Park, Addlestone, Surrey KT 15 2HJ, United Kingdom Tel: 44 1932 87 1500 Fax: 44 1932 87 1526

Cochlear Benelux NV Schaliënhoeverdreef 20j, 2800 Mechelen, Belgium Tel: 32 1579 5511 Fax: 32 1579 5500

Cochlear Italia S.r.l. Via Larga 33, 40138 Bologna, Italia Tel: 39 051 601 53 11 Fax: 39 051 39 20 62

Cochlear France S.A.S. Route de l'Orme aux Merisiers, Z.I. Les Algorithmes - Bât. Homère, 91190 Saint Aubin, France Tel: 33 811 111 993 Fax: 33 160 196 499

Cochlear Nordic AB Konstruktionsvägen 14, 435 33 Mölnlycke, Sweden Tel: 46 31 335 14 61 Fax: 46 31 335 14 60

Cochlear Tibbi Cihazlar ve Sağlık Hizmetleri Ltd. Sti. Cubuklu Mah. Bogazici Cad., Bogazici Plaza No: 6/1, Kavacik 34805 Beykoz-Istanbul, Turkey Tel: 90 216 538 5900 Fax: 90 216 538 5919

www.cochlear.com