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Introduction to the Nucleus Nexa Cochlear Implant System

Presenters: Ginger Grant, AuD, CCC-A, FAAA, Jay Patterson

Hi, my name is Ginger Grant and I'm an audiologist and professional education manager at cochlear. I'm excited to introduce you today to the Cochlear Nucleus Nexa system. The Nexa system is the future of hearing delivered today and introduces the world's first and only smart cochlear implant system for topics Today we'll introduce you to the Nucleus Nexa, the world's first and only smart cochlear implant system. We'll discuss patient benefits of upgradable firmware, dynamic power management and smart sync with maps saved on the implant. And then we'll end today's session with key changes to the programming defaults within custom Sound Pro fitting software for the Nucleus Nexa system.

After this course, participants will be able one explain the potential of a smart implant with upgradable firmware, two counsel patients on the benefits of maps on the implant and three get started programming a Nucleus Nexa device in the latest version of custom SoundPro fitting software.

Before we jump into the content, I want to take a moment to review Cochlear's mission as we are very much a mission driven company. At Cochlear, we help people hear and be heard. We empower people to connect with others and live a full life, we transform the way people understand and treat hearing loss and we innovate and bring to market a range of implantable hearing solutions that deliver a lifetime of hearing outcomes. This mission drives everything that we do at Cochlear and I think you'll see these key points resonate throughout this presentation.

We know that every patient has their own potential, but what if you could give them more? Our job as hearing professionals is to help each patient reach their individual full potential, not just today, but over their entire hearing journey.

This Nexa implant is that future ready implant. With its rewritable internal memory and onboard firmware, the Nexa implant can receive new features through its firmware even after it's been implanted. And so excitingly, the flexibility of the system combined with its modern electronics means it's ready to adapt to new scientific discoveries and innovation. The Nexa system features the Nucleus

Nexa implant, the Kanso 3 Nexa sound processor and the updated Nucleus 8 Nexa sound processor. And it is the future of hearing delivered today.

To understand how we got to where we currently are, we need to go back in time to share some of the research that got us here.

Nucleus implants are well established as effective solutions for those across indications, including adults, children, patients with single sided deafness, those in need of EAS stimulation. But because the device is implanted, There is a possibility of reaching a plateau in terms of what the implant can deliver. It may perform perfectly well. But what if technology could evolve over time With a given patient's hearing journey? We know that long term hearing outcomes in hearing performance Are related to the hardware that's implanted.

But hardwired electronics means fixed features and capabilities. An implant may perform its intended functions well, but can't necessarily adapt or improve beyond the original design. But what if we could bypass those limitations? The question is, could the technology in the implant itself Evolve over time With a patient's hearing journey?

What if we could do better? How could we improve the receiver stimulator to further improve the electroneural interface, to implement future scientific discoveries, to take advantage of rapidly improving technologies, and to meet evolving patient needs? Well, to meet these needs, we had to look inside the physical body of the device itself. To get to the nexos chipset in the nucleus nexa implant, A complex clinical trial was conducted out of our Denver office. For over 20 years, 50 patients were implanted With a device known as a percutaneous contour implant.

This implant, which you see on the left, Is comprised of an electrode array and a connector. There are no stimulation electronics in this implant. In fact, the implant electronics are housed in the processor itself with that larger cable coil connector. And the system was programmed using a perc plug benchtop system. So basically, these 50 patients came into the Denver lab and were essentially plugged into the benchtop testing.

And what that allowed us to do was to use novel stimulation strategies and test the system's capability without being limited by the chip itself, because the chip was external. Now, these 50 patients are heroes in our product development. They enrolled in this study Knowing that they were gonna have to be reimplanted About a year and a half after they started the study. So they unselfishly gave us a lot of information and an exorbitant amount of their own time so that we could get to where we are today. Just so you know, all of those patients were implanted about 18 months later with whatever the latest implant was at the time.

And what their efforts brought us is the nucleus nexus system, which we'll talk about now. Again, this is the world's first and only smart cochlear implant system. And what these efforts brought us is the nucleus nexa implant. The Nexa implant is powered by the cochlear Nexos chipset. And this is game changing technology now.

Plus improved access to to innovations in the future. The implant itself, the body of it, is built on the reliability of the Profile plus series. And the device is smart and secure. So hearing information is protected in the implant via the enhanced RF link and internal memory protections. Speaking of the Nexos chipset, you might be interested to know that Cochlear has innovated for the last 40 years.

And this CI1000 implant, or the Nexa implant, is this next step in innovation. And prior to today, the most recent chip was the CIC4 chip back from 2005. And what that means is that it's been 20 years since a new Cochlear implant chip was introduced. Think of all of the innovations that previous chipsets have helped to bring to this industry. Smart sound and scan, wireless streaming processor, miniaturization, remote care, MRI compatibility, the slim mediolar electrode, and so much more.

Now imagine what we could accomplish in the next 20 years. That is what makes this so special and exciting. The Nucleus Nexa implant comes with added reassurance. Not only is it built on Cochlear's proven record of reliability, it also features onboard diagnostics. Let's talk about each of these a little bit more now.

Reliability is a cornerstone for any device implanted in a human body. The Nucleus Nexa implant is built on the proven reliability record of the Profile and Profile plus series implants. It has the same implant body and electrical feedthrough, the same Magnet as the CI600 series, the same electrodes, and it's manufactured using the same equipment and manufacturing processes. Like every implant that Cochlear develops, the Nucleus Nexa implant underwent extensive mechanical and electrical testing. So such as, but not limited to impact resistance, vibrational resistance, hermeticity, coil fatigue, electrical functionality and endurance testing of internal memory.

The Nucleus Nexa has context awareness and is able to adapt or respond to input. That context awareness and responsiveness is inside the implant is what makes Nexa intelligent. An example of that is onboard diagnostics. With onboard diagnostics, the Nexa implant is constantly monitoring its own function. It has context of how it's functioning and if it's within specifications.

If a component of that function is outside of specifications, the implant can respond from a simple notification push to an implant reset.

And although the intelligence inside the implant with the Nexus chip is completely new, we are continuing to use Cochlear's trusted electrode portfolio. We continue to offer all electrode types to accommodate patient anatomy and surgical needs. The examples you see Here are the CI 1012 or contour advanced electrode. The CI1032 or slim mediolar electrode and the CI1022, the slim straight electrode.

Because the implant body is the same and the electrodes are the same as previous models, there's consistency in surgical technique. That is the Nucleus Nexa implant has the same body as the Profile Plus. So you can offer your patient's latest technology and the world's third thinnest cochlear implant with no change to the surgical technique or surgical instruments.

So you might be asking, what's new? Well, as we mentioned, the Nucleus Nexa implant has the Nexus chipset plus it also features an enhanced RF link with a gold coil and importantly internal memory which helps deliver the smarts of this unique system. It's all powered by the chipset, the first update to an implant chipset by any manufacturer in nearly 20 years. We all know how much technology has changed since then. We just created a brand new category of cochlear implants.

So in summary, the new implant builds on the trusted mechanical architecture of the C.I. 600 with additional technology to deliver improved power efficiency, onboard diagnostics and firmware that creates a smart implant that can be updated in in the future. And importantly, how do these capabilities deliver benefits to patients? Think about that a little bit and we'll continue to talk about some examples.

I mentioned before that the Nucleus Nexa system is comprised of the Nucleus nexa implant and two Nexa sound processors. The first of those is the Kanso 3 Nexa sound processor. So for those who want an off the ear sound processor, the Kanso 3 remains the small, smallest and lightest off the ear processor available. Because of the Nucleus Nexa implant's enhanced RF link, patients will get a full day of battery life on a single charge because of dynamic power management. The Kanso 3 also has what we call feature parity with the Nucleus 8 and that includes scan 2 and scan 2 forward focus.

It is also the world's first first off the ear cochlear implant sound processor that's designed for next generation Bluetooth LE audio. For patients who prefer a behind the ear sound processor, the Nucleus 8 Nexa sound processor is available. So this is the world's smallest and lightest. Behind the ear processor, dynamic power management provides all day battery life with an even smaller, smaller configuration in the power compact battery. And we're keeping patients hearing what is important with Scan2 and Scan2 forward focus.

Again, the signal processing algorithms with the Nucleus 8 Nexa are the same as those with the Kanso 3 Nexa sound processors. You just heard me Mention the term feature parity. And what that means is that a lot of the same features are in both sound processors, meaning patients don't necessarily have to choose which processor they use based on the signal processing. But let's go through some of the details to look at what's in each sound processor. So first of all, dynamic power management, something I'm going to talk about in more detail.

And it's related to the RF link in the Nexa system. And that is available if you're using either a Nucleus 8 Nexa or a Kanso 3 Nexa sound processor. Smart Sync or the ability to pull maps saved to the implant itself itself is also available with both processors. The Power Compact rechargeable battery is new to the Nucleus 8 Nexa alone. The Kanso 3 continues to have an inbuilt rechargeable battery.

Both processors offer SmartSound IQ2 with Scan2 and Scan2 Forward Focus or an automatic Scan2 algorithm. Both processors are ready for Bluetooth LE Audio and Oracast Broadcast Audio. Both are the world's smallest and lightest processors in their own class. Both are rated for IP68 for water resistance only. The Kanso 3 Nexa has an integrated rechargeable battery and the Kanso 3 Nexa has a buttonless tap control, while the Nucleus 8 Nexa continues to have a one button option for programming and for operating the sound processor.

Let's now jump into some of the meat of what makes Nexus special. I'm going to talk about three main features now. We'll start with upgradable firmware. We'll discuss dynamic power management and then end on Smart Sync. So upgradable firmware provides access to future innovations through upgradable firmware.

Because of the Cochlear Nexus chipset and the firmware, dynamic power management provides all day battery life with the world's smallest sound processors because of an enhanced RF link. And finally, with internal memory, patients are able to get back on air faster using a process called Smart Sync.

Let's start by talking about upgradable firmware. So I've talked about the intelligence of the Nucleus Nexa implant and the question is, what really does make it smart? Well, that intelligence comes from three essential components. One is the processing core, the second is upgradable firmware, and the third is internal memory. And for a smart cochlear implant to truly be smart, the critical difference is where all of this intelligence lives.

Historically, cochlear implant systems have intelligence only in the sound processor.

Only. The Nucleus Nexus system includes this intelligence inside the implant, and what that means is that for a cochlear implant system like the Nucleus Nexa to be called smart, or we know that the intelligence exists in both parts of the system. It's a smart sound processor that has that processing core, upgradable firmware, and internal memory, plus a smart implant, which also has a processing core, upgradable firmware, and internal memory. So what does that mean for patients? Well, we know that traditional implants have access to innovations through sound processor upgrades, right?

We're all used to that. Every few years, there's a new sound processor, and patients with existing implants are likely able to upgrade to that processor to take advantage of some of those new technologies. But with a smart implant, innovations can also be applied to the implant as well as the sound processor. And this chart is an illustration of what these innovation changes could be over a patient's lifetime.

Rewritable is key in this. We aren't talking about accessing unused space. We're talking about reconfiguring how the firmware on the chip operates. So the Nexa upgradable firmware is rewritable, allowing the implant to be updated or reconfigured to enhance features and performance without replacing the implant. Let's contrast that to traditional cochlear implants, which, which add features and improve performance exclusively through sound processor technology.

So hopefully you have a good understanding now of the importance of upgradable firmware and how the Cochlear Nexus chipset allows patients to access future innovations through upgradable firmware on both the implant and the sound processors. Let's talk more now about dynamic power management allowed for because of the enhanced RF link of the Nucleus Nexa system.

Dynamic power management is available because of the Nexa processing core and upgradable firmware. The Nexa implant assesses power requirements on an ongoing basis. It can then account for specific map and stimulation requirements. It calculates the exact amount of power needed moment to moment. And then the implant requests the power level from the sound processor to maximize the efficiency.

What this results in is increased power efficiency. Rather than providing one power level all the time, the system is adaptive to respond to the power needs on an ongoing basis.

So how is this possible? Well, it's possible because of an updated radio frequency or RF link. In previous generation implants, we used an RF link that sent power and data at the same time. Because they're being sent back and forth between the implant and the sound processor together, there's a need for a system to Balance the power transfer efficiency and the data integrity at any moment in time. What's unique to the Nucleus Nexus system is that CI1000 implants have a new RF link that transmits data and power separately.

This gives the system the ability to optimize the power efficiency by adapting to a recipient's power needs while transferring data appropriately.

What this gives us is improved power efficiency. And improved power efficiency allows us to use longer default pulse widths to keep more patients in compliance. And while we're doing that, more patients still get all day battery life with an even smaller battery. Think about that. A wider pulse width.

Patients are still in compliance, they're getting all day battery life, and they have a smaller battery because of dynamic power management. We now have four battery options available for the Nucleus 8 Nexa behind the ear option, and longer typical battery Life of about 21 hours for the integrated rechargeable battery in the Kanso 3 Nexa sound processor. So for the Nucleus 8 Nexa, you'll see over on the left, the compact battery module has a typical battery life of 10 hours. What we're able to bring new with the Nucleus Nexa system is the Power compact battery module, which provides typical battery life of 16 hours for all day. Wearing the power extend battery module for 21 hours typical life is also available, as is the disposable battery module, providing a typical battery life of approximately 37 hours.

So what does this new power compact battery mean? Well, we are recommending this as the default battery option because it can meet the needs of patients in terms of power, size and comfort.

So far today, we've discussed the details of the Nucleus Nexus chipset, allowing for upgradable firmware. We just talked about the Nexus system's enhanced RF link, which gives us dynamic power management. Let's spend a little bit of time now on the internal memory and what that means for patients with Smart Sync.

With the Nucleus Nexa, a patient's maps are stored on the implant, and therefore those maps are always with them wherever they are. Who here has had a recipient who needed a replacement sound processor when you were on vacation or when they were on vacation? What about on a Friday night before a holiday weekend? How about when they're in their first week of summer camp? What's that experience like for the patient?

They're potentially off air without sound. How has that disrupted their life, their family's lives? And what's that experience like for clinics? Where's the map request? What's an acceptable map age?

What's the password for your colleague's computer. Now, if a patient needs a new or replacement sound processor with Nexa, there's no need to have that new sound processor programmed. Any unprogrammed device can be sent to the patient and through the Smart Sync process that utilizes the internal memory and the smarts of the Nexus chipset. When they place the sound processor on their head, the maps are automatically transferred and the patient is back on air in about 20 seconds. It doesn't depend on being online or using an app, or downloading maps from the cloud.

With the Nucleus Nexa implant, patients maps are stored on their implant, so they're ready to go whenever they need to replace or update their sound processor.

So how does this work? Well, during a fitting session, when the patient is with you in the clinic using Custom Sound Pro, maps are written to both the connected sound processor and now for the first time, to the implant. Once those maps are on the implant, they're always with the patient, regardless of what happens to the sound processor. If a patient requests a replacement, an upgrade, a backup, or a loaner device, they can receive a processor out of the box, place it on their implant, and Smart Sync will automatically copy and synchronize the stored maps onto the sound processor, personalizing it for a patient. Note that this is a one time transfer, so bilateral nucleus Nexa patients need to be conscious of which side they're placing the new or replacement sound processor.

What happens if they do it wrong, you might be asking. Well, that processor can simply be reset in the clinic, of course. But once a map is reset, it's considered unprogrammed and it can be used again for the Smart Sync process. After the maps are copied onto the sound processor from the implant, the patient is instantly back on air and can proceed with repairing to their mobile devices and wireless accessories. They don't need to relink their bilateral or bimodal pair, as that information was saved onto the implant from the file.

If you have a sound processor that's already been personalized for a specific patient and you wish to reuse it for another patient, again, that sound processor can always be reset through Custom Sound Pro.

Let me show you what this looks like in practice.

So you can see here you have a patient who's turned a processor on, and it can be either a nucleus 8 Nexa or a Kanso 3 Nexa. The patient places the processor on the head, the coil on the head, and then over the course of about 20 seconds, the maps are transferred from the implant to the processor. Once the Smart Sync is complete, the patient will Hear short beeps, and the light on the processor will turn green and they're ready to go. And it's that easy. If by chance, the processor were to come off during the sync, it's okay.

The transfer would simply stop. They could replace the processor on the head and restart the Smart Sync process.

You might be asking exactly what information is stored on the implant and therefore can be transferred using the Smart Sync process. Well, clinical data is stored on the implant, and that includes up to four maps, including hybrid clinical data logs, device and program settings, MVBT adjustments in remote assist, and bimodal or bilateral linking. What's not saved to the implant is wireless accessory pairing, mobile device pairing, Nucleus smart app, and CR310 pairing, MVBT adjustments made from the Nucleus Smart app, and setting changes made through the Nucleus Smart app. Now, if you look closely here, what you can see is on the left is all of the information that was created using custom SoundPro. On the right is information that was created using a mobile device, either a remote or possibly a phone.

So the information that's made from that mobile device is not saved to the implant. Information that was created in Custom Sound Pro, which is also called clinical data, is saved to the implant and therefore can be transferred using Smart Sync. I think one of the most exciting parts about Smart Sync is that maps created for any Nexa sound processor can be transferred from the Nexa implant to to any unprogrammed Nexa sound processor using Smart Sync. So let me say that in a different way. Let's say a Nexa patient is in the clinic and you create maps for their Nucleus 8 Nexa sound processor.

N8 Nexa maps are saved to the processor and to the implant. That patient then goes home. But they have a backup Kanso 3 Nexa sound processor. They can place that Kanso 3 next to sound Processor if it's unprogrammed, onto the head. And the original maps that were created for Nucleus 8 will transfer onto the Kanso 3 without the need to convert the maps.

I think that's a very exciting piece. Now, you might be wondering, how do you know what the map is? Well, next time they come into the clinic, when you connect the processor to Custom Sound Pro, it will create those new maps for the Kanso 3 processor. They'll have new map numbers in Custom Sound Pro, and you'll be able to see on that main map screen that those maps were created using Smart Sync. You might be wondering, what does this look like for you when you go to see patients in your clinic?

Let's Talk now about some of the updates that have been made to Custom Sound Pro fitting software in version 6.7.1 specifically for patients with Nucleus Nexa devices.

First of all, you'll see that there are still two separate versions of Custom Sound on your desktop. One is the primary programming software and one is Training Mode. As a reminder, Training Mode simulates a patient, an implant, and sound processors so that you can play with the parameters and try things out. A word of caution is to not use real patient information in Training Mode because that information will not be saved to the patient's file. But I really recommend Training Mode as it's a good way to kind of get used to the new parameters, see how things work together, and really be confident in your fitting flow before you're in front of a patient.

Why did we update custom sound pro 7.1, you might be asking. Well, it's for a few reasons. One is to improve the overall ease of fitting. As I mentioned before, there are some pulse width changes, and with the Nexus system, our goal is to always keep the pulse width as wide as possible, and because of this, you're less likely to encounter compliance issues. There are some additional changes to parameters such as jitter and loudness growth, which are almost never used, and so updates have been made to improve improve that ease of fitting.

The second reason is to maximize the sound processor battery life with dynamic power management. Now, there's no power penalty associated with wider pulse widths because of the advances in the RF link, where power and data are now sent separately. Custom Sound Pro 7.1 supports this by always keeping the pulse width for a Nexus system as wide as possible possible with any given rate and maxima combination. And finally, the system has the ability to provide additional diagnostics. I talked to you about some of the onboard diagnostics that are available with the Nucleus system, but with this is the introduction of the implant communication test, which gives you the tools needed to optimize the RF link for every patient.

First, I'll summarize some of the key fitting changes for Nucleus Nexa implant patients, and then we'll go into a little bit more detail on some of these. So, first of all, when creating a map, you'll notice for a

Nucleus Nexa patient that the default pulse width has been increased. In fact, the default for a Nexa implant is a pulse width of 45.6 microseconds, regardless of electrode type. The second is the rate. The maxima and the pulse width are closely linked in that for Nexa patients, if you change one of these Parameters at least one other will also change.

Again, the system has been designed to always keep the pulse width as wide as possible in order to make sure that patients remain in compliance. And because of dynamic power management, there's no power penalty for doing that, so it can only benefit patients. The third is automation of rarely used functions. The first example I'll give you is channel gains. So channel gains are not necessary to measure when those are automatically adjusted frame by frame using Addro.

There are others and we'll go into some more detail later. Finally, frequency allocation tables have been adjusted. How many of you have gone into that chart and not really been sure what to type in the upper or lower frequency boundaries? With nexa, what we've done is provided nine different low frequency options and three different high frequency options. And with those combinations, there are 27 different frequency allocation tables available that we think takes care of all clinical use cases.

When you go to adjust a map, there are also some changes. So first I think you'll notice that the starting global sea level is lower. When it used to be 120 to 130 current levels, it's now 80 to 90. Why is that? Well, it's because we're using a wider default pulse width.

In addition to having that sea level lower, the overall expected range is also lower. We're still looking for a range with population mean, for example, of 46 current levels between T and C levels. So the dynamic range itself hasn't changed, but where that range sits in the map area has changed. So instead of being up higher, it may be lower. You're still going to increase those T's and C's together in live voice and then finally updated stimulation parameters.

So again, we talked about the 45 point show you some other changes specific to Nexa.

But why, oh why are we changing things, you might be asking. Well, I'll tell you that the changes that we've made to custom sound programming for NEXA have been shaped by an analysis of over 39,000 maps, where we examine the number of maps that differed from the defaults, in addition to existing efforts that support robust clinical clinical practices. So basically what we're able to do by looking at 39,000 maps is see what you all are changing. What is providing the most quote unquote bang for your buck when it comes to optimizing patient maps. And then those are the parameters that we're focusing on.

In addition, we have the ability to take advantage of our new technology. So the NEXA brings some new opportunities in terms of what it can do ultimately to benefit patients. And so the programming will reflect those updates. What did we see in those 39,000 maps, you might be asking. Well, the data in this graph comes from a paper that was published by Maritha, Cara and Bennett in 2022.

And this is where they examined this very large data set to inform CI programming in Custom SoundProfit. Now, this data set included both adults and children age 12 and over. And we looked at children under 12 just to make sure that the data still applied. And it actually did. And what we know is that for most of the map parameters.

So for example, look at coding strategy and stimulation mode and power level, and you can work your way across from the left hand side. What we know is that the default setting was used. The bars on this graph reflect the percentage of recipients using defaults. So in other words, if the bar is up to 9,100, it means that most patients, if not all, are using defaults. And this is a parameter that audiologists are not typically changing.

However, what you do see if you look over on the right hand side, is that the changes that audiologists are making are primarily to pulse width, maxima and rate. And so that's what we're going to look at. Now, let's start with pulse width. So remember that with electrical stimulation, pulse width is the same as pulse duration. So it's not actually about how wide the current is spread, but rather how long the pulse is kept on.

Because leaving a pulse on longer increases the overall amount of charge and makes it sound louder to patients. So what you see here are two biphasic charge balanced pulses. And these pulses can be delivered in different ways. So on the left you see a pulse width of 25 with slightly higher current. On the right, you see a pulse width of 50 with slightly lower current.

Overall, the area under the curve or the area of each of these biphasic pulses. On the 25 microsecond pulse and the 50 microsecond pulse, the area is exactly the same. And so what that means is that these two pulses would sound equally loud to a patient. Right? So on the left there's higher current level and on the right there's wider pulse width or longer pulse duration, depending on how you want to say it.

So the pulses can be delivered in either way. But we know that wider widening the pulse width is a handy tool to have as a way to increase the total loudness for the patient without impacting compliance. And we'll talk about why next.

What does equal charge with different pulse widths look like in an actual map. So, first, we're going to show you an ACE 978 Hz map using the monopolar 1, 2 stimulation and a pulse duration of 22.4 microseconds, which is as close as we could get with the Nexus system to 25 microseconds, which you're familiar with. We then took this map and widened the pulse width to 45.6 microseconds, which is the new NEXA default. And this is what we got. Notice that the average sea level went from 181 down to 135.

And this is what an increase of pulse duration does. So why is this relevant? Well, it's relevant because you should be noticing the compliance markers with the 22.4 microsecond map on the left. We're very close to the compliance markers, which means that if that patient should have any kind of a health issue, that might change impedances, or maybe they don't wear the device for a day and that might change impedances, they're at risk for going out of compliance with the wider pulse width. We have all of this room between C levels and compliance markers, which means even if kind of typical changes might happen in impedances, it won't impact compliance.

Why does that matter, you might ask? Well, it matters because research tells us that having a map that's out of compliance can impact people patient outcomes. Our goal in programming is to elicit sufficient loudness percept, and widening the default pulse width is an effective way to do this when a narrower default wouldn't be sufficient. So this particular study was performed a few years ago by researchers from Mayo Clinic in the US Simulating the effect of an auto compliance map. They found that outcomes were significantly compromised when the patient received a clipped signal and when their upper loudness levels were set too low.

This was especially evident when tested in noise. This study shows us the importance of reaching appropriate loudness in cochlear implant systems. Having maps that are out of compliance or if Cs are set too low can significantly compromise outcomes.

So we Talked about the 45.6 microsecond pulse width for Nexa and the fact that we're using that in order to make sure that more patients are in compliance, knowing that we don't have to sacrifice battery life because of dynamic power management. But how about the rate? We're at 978Hz and you might be asking, why such precise numbers?

Our goal with the Nexus system is to keep the pulse width as wide as possible so as to keep most patients in compliance with traditional implants. We're at a 25 microsecond pulse width with a perimodiolar array and 37 microseconds with a lateral wall array. Because of dynamic power management and the more efficient RF link of the NEXUS system, we had the option to go wider while still getting all day battery life. So we went out to 45.6. And there's a mathematical reason for that.

So the question is, how do we get to the rest of these two numbers? Well, let's start with a biphasic pulse with a pulse width of 45.6. You have a negative and a positive phase, and there's also an interphase gap and an interstimulus gap. So at the beginning of any pulse or maxima is what's called processing time. And you can see on the slide that the processing time for this pulse is 101.4 microseconds with a pulse width of 45.6.

We see that in the negative phase of this biphasic pulse and also in the positive phase of the biphasic pulse, we have a 12 microsecond interphase gap and then a 12 microsecond interstimulus gap. So if I total up all of these numbers, what I get for the Pulse itself is 115.2 microseconds.

So what if I have eight maxima? Well, I'm going to have my processing time of 101.4 microseconds, and then I'm going to have eight pulses or maxima at that 115.2. So here's one maxima, here's one maxima, and so on and so forth. Now, if I add up the time it takes to deliver each of those pulses or maxima, all 115.2 plus the 101.4 processing time, I end up with 1023 microseconds. That's the total time that it's going to take to deliver these eight maxima.

So how do I get to the rate? Well, rate is simply one over time. And so one over 1023 is 978 hertz. And that's where the stimulation rate decreases. Default for Nucleus Nexus system comes from.

Now, I'm not going to talk in great detail about maxima, except to tell you that our default with Nexa is still 8 maxima. And the reason for that is that we don't have any literature to suggest that, on average we should be Always using a different number of maxima. What we know with Nucleus devices is it's generally not good to to go below six. So we're kind of suggesting you keep keep around a minimum of six to eight, and I would say eight as your default. I certainly do know clinics that choose to use different default maxima, and that's up to you and your clinical protocol.

But the default fault overall for NEXA to start with is 8 maxima. So we're going to switch to the next slide which is going to show you a very short video talking about how rate maxima and pulse width all work together.

A cochlear implant, or CI works by electrically stimulating auditory nerve fibres from within the cochlea using fitting software. The implant is programmed by adjusting electrical stimulation parameters to deliver audible and comfortable sound to the user. Pulse width, maxima and stimulation rate are three of these programming parameters which affect the intensity and frequency of electrical stimulation. Let's review how these parameters work, starting with pulse width. Cochlear implants convert acoustic sounds into electrical pulses to stimulate auditory nerve fibres.

Each stimulation pulse is rectangular in shape with both a negative and positive phase of equal charge, making it safe for electrical stimulation of neural tissue. The pulse width is the duration of each phase in microseconds, and between each phase is a short period of no stimulation called the interphase gap. Cochlear implants can encode signal intensity by adjusting both the amplitude and the duration of the stimulation pulses. These parameters are set by default for different implant types to optimise efficiency, but in some cases may need adjustment in the fitting software. For example, you can increase pulse widths to deliver loudness using less current when needing to keep comfort levels below compliance limits, or increase them to reduce rare instances of non auditory side effects like eye twitching.

But it's important to keep all the pulse widths the same in the map, even if only some of the electrodes require a change when changing pulse widths. Remember, this may affect the other two parameters, maxima and stimulation rate, to maintain optimal stimulation and sound quality. Next, let's investigate maxima and why they matter. When listening to complex sounds such as speech, some acoustic elements are more prominent and carry more information about a speaker's voice and emotion. Rather than stimulating every electrode cochlear's default coding strategy, ACE uses maxima selection to identify and stimulate channels with the greatest amplitude for speech and the best signal to noise ratio.

Research has shown that using the default of 8 maxima gives the spectral richness needed for good speech Understanding using six or less maxima is less optimal and should be avoided. It's important to note changing maxima can affect the pulse width and stimulation rate used in the map. The fitting software may at times reduce the maxima below 6. Typically when longer pulse widths are used at these times, it's recommended to reduce the stimulation rate instead to preserve sufficient maxima. So let's take a closer look at the final programming parameter in the trio.

Stimulation rate. Stimulation rate refers to the number of electrical pulses on a given electrode delivered every second to the auditory nerve. A 900 Hz rate is a commonly used stimulation rate across many implant types, although research has shown that rates as low as 250Hz are also sufficient for speech perception. While stimulation rates above 900 Hz may deliver information more rapidly, there is a limit to how fast the audio pathway can effectively process what is heard. In fact, clinical studies have shown that using lower rates such as 500 Hz gives comparable speech perception outcomes for most recipients, with the added benefit of power and battery life savings.

CI programming is an important part of delivering optimal outcomes for recipients. So remember the golden rule of the parameter. Increase pulse widths first, then when needed, lower the stimulation rate next, keeping Maxima above 6.

So hopefully that was a good summary for you in terms of how pulse width, rate and maxima work together. A couple of things that I want to point out, and one is that video is a little bit older, so you will have noticed that that we talked about a 900 Hz rate, for example a 500 Hz rate. But you notice that with Nexa, those are not the numbers we're using. We're using 978. So while the exact values don't necessarily apply to Nexa, the concepts absolutely do.

The piece that we've been able to remove with NEXA is the need to widen pulse width. So most of the time, most patients are going to be okay using that 45.6 microsecond pulse width. There certainly will be times that you need to widen the pulse width either because a patient, for example, doesn't get loudness with a 45.6. Maybe they have an ossified cochlea, for example, or maybe there's facial nerve stimulation and you need to widen the pulse width beyond what the default is. Certainly that's an option.

The point that the narrator made at the very end, in terms of adjusting one parameter may impact other parameters. With nexa, I think you'll find that that's actually will impact other parameters. So, so I just Want you to be aware of that. And I'm hoping that that video was able to tie all these concepts together for you. So to summarize these Nucleus Nexa programming changes.

So it's because of the Nexus chipset that's built into the Nexa implant and the enhanced RF link, partly because of the three turned gold coil. So it transmits power and data between the implant and the processor differently. In the Nexa system, the Nexa implant is more efficient with less constraints balancing power requirements and all day battery life. And what that all leads to is lower voltage requirements, lower power consumption and more patients in compliance, which based on the information you heard a little bit earlier, can positively impact patient performance.

What you're looking at here is a summary of all of the available NEXA or CI 1000 parameter sets. What you'll notice on the left, first of all is we're looking at a combination of rate maxima and pulse width, as well as total stimulation rate. So the default parameter set is 978 Hz channel rate, 8 maxima and 45.5, I'm sorry, 45.6 microsecond pulse width. Now you are always able to change that. So for example, let's say you want to go to a lower rate.

So I can go from my 978 and if you follow that up, I can go to 489. Okay. Which is pretty close to what we used to have with 500. Again, these are comparable. So at 489, my default maximum might be 16 if I want to have a 45.6 microsecond pulse width.

What if I don't want 16 maxima and I want 8 maxima? I can still do that at 489 Hz, but my pulse width is going to widen to 95.2. So I think what I found and what you might find if you're a programming audiologist is this is requiring a new way of thinking because many people who have programmed for many years see a wider pulse width and they think bad things. They think it's going to suck up the power, that it's going to sound different to patients, and that a pulse width is kind of a sign that something is wrong. Right.

You had to widen the pulse width to fix something. With Anexa, we have to kind of turn around that thinking and know that a wider pulse width is keeping patients in compliance and it's not affecting battery life. So we don't have that power penalty with the Nexus system. And so basically with this Nexus system, The architecture or the hardware design has huge amounts of flexibility still possible, and more flexibility in some areas than others. So we are looking at the way the sound processor and the implant operate together in order to determine what the best parameter sets are going across.

On this slide, you can see in the middle, we're looking at frequency allocation. I did tell you earlier that we have nine options for low frequencies and three options for high frequency cutoffs. The default for ace is still 188 to 7938 as it's always been. But you have the ability to, for example, go to a lower low frequency cutoff. For example, if you have a patient who is a healthcare worker and wants to be able to hear body sounds using a stethoscope, or maybe you want to go to a higher low frequency cutoff, maybe 438 or 563, which we see is sometimes very beneficial, especially for patients with single sided deafness who are trying to get used to the sound of an implant in comparison to a normal ear.

At the same time, the high frequency cutoffs can be adjusted. The most common use case I see for that is for patients who really don't like those high quality frequencies often because it's been a very long time since they've been able to hear them. So we're always shooting to provide more information for all patients, but sometimes you have to kind of work your way up to the full frequency range. The coding strategy available with Nexa is ace. The loudness growth function or Q value is set automatically, although there are a couple of other options there.

You have all of the options for modes. So MP1.2 is the default as it's been for quite some time. But other options are available. Channel gains are auto. I mentioned that earlier because when we are using adro they're automatically adjusting anyway, so there's no need to spend your time measuring those.

And then TSPL and CSPL changes are available. The default is 25 for TSPL and 65 for, I'm sorry, 25 for TSPL and 65for CSPL. But you can see different options in five unit increments if you should need to change that. I've mentioned a couple of times additional parameters that have been modified and or automated with custom sound pro 7.1. We won't go into great detail on any of these, but I will tell you at a high level, first of all that these can all be accessed under Manufacturer settings.

If you go to map at the top menu within Custom Sound Pro and then Manufacturer Settings you can get to these. Many of them can only be adjusted if the patient is off air. And the system will indicate that if you're trying to change it. Jitter, as a quick reminder, is a bit of variability in the stimulation rate that's meant to provide a smoothness to the sound. And what the research tells us is that it's only necessary at low stimulation rates.

So with the Nexus system, jitter has automatically been applied at 244 hertz and it's not available because it's not needed at stimulation rates higher than that. We talked about the revised frequency allocation tables. We Talked about the 5 unit increments for TSPL and CSPL. We talked about the loudness growth function, and we talked about channel gains.

One final piece in programming that I want to make note of today for you to investigate further, if you need to, is a change in the unique identification. So you all might be familiar with Implant id. And Implant ID is used historically in Nucleus implants, making it so that a processor can only be used with a specific implant. With the advent of Smart Sync, we have shifted that implant ID to be even more secure with something called MAP uid. And this is a safety feature that's been built in to prevent any sound processor that has not been programmed for a specific implant from being able to stimulate.

So any changes in map parameters will result in the generation of a new MAP uid. And in order for a processor to be able to communicate with the implant, the MAP UID on the processor has to match the MAP UID on the implant. And so what we recommend is actually to use Smart Sync. The best thing to do is to just have a completely unprogrammed processor. And that processor can be unprogrammed by, through a reset each time a patient comes into the clinic.

If the processor is unprogrammed, that means there won't be anything on it to match with the implant. And it means that it will be able to be used with the Smart Sync process. So just remember that the maps on the implant have to match the maps on the processor in order for them to communicate with each other. And this is a safety feature that's built in to make sure that only the correct processor is being used for any given implant.

We've provided you with a lot of information on the Nucleus NEXUS system. And especially when we get to the details of programming and some of the hardware details, there's really a lot of information to take in. So what I want to encourage you all is to take a look at the cochlear Learning center if you want a little bit more detail beyond what today's webinar has been able to provide, then go to the cochlear Learning center and you can get to that from your My cochlear homepage under the Resources and Training tab and the cochlear Learning center, you don't have to log in. Once you're logged into mycochlear, it'll take you right there. You can enroll in courses.

Many are available on demand. We also occasionally offer live webinars through this platform, but there's really a lot of information in there to enhance your own learning. So please take a look when you get a chance to summarize. I want to thank you for joining this webinar today to learn more about the Nucleus NEXA system. The NEXA is in fact the world's first and only smart cochlear implant system, with intelligence both on the processor and on the implant.

And with the new Nexos chipset and the enhanced RF link, we have upgradable firmware, which means that patients are ready for the future. Upgrades can happen both on external components and internal components as advances come about in the future. Dynamic Power Management Remember, this is a really big deal because this is the ability of the implant to separate out the transfer of data and power information between the implant and the processor, meaning that the system can optimize each separately. And what that gives patients is the world's smallest sound processors with all day battery life, and we're able to use a wider default pulse width to keep patients in compliance without a power penalty. And finally, we're able to store maps on the implant, which means that patients always have their maps with them and they're able to get back air on quickly on air quickly using the Smart Sync process.

I want to thank you for joining today's webinar. Again, I'm Ginger Grant and if you need additional information or have any questions, please feel free to reach out to me or your local cochlear representative anytime. Thank you.