WIDEX MOMENT™ – TRUACOUSTICS™ OPTIMISED

OLIVER TOWNEND, LEAD AUDIOLOGIST, WIDEX
LAURA WINTHER BALLING, PH.D. EVIDENCE AND RESEARCH SPECIALIST

1. INTRODUCTION

Widex stands by the belief that ensuring the sound levels are perfectly correct in every ear canal is the best way to deliver the sound quality that all listeners deserve. Widex also believes that this is an essential ingredient in fitting that takes us on a journey towards effortless hearing and listening in all environments. We achieve this ambition in **WIDEX MOMENT™** via **TruAcoustics™**.

TruAcoustics™ is not just a new way of fitting Widex, it is an intelligent algorithm by which the in-situ acoustics of the individual user's ear canal can be integrated in the parameter settings of the hearing aid, so that all processes and gain settings are optimised at first fit. TruAcoustics™ was launched with WIDEX MOMENT™ in order to deliver a better way of calculating gain when fitting Widex hearing aids. This was inspired, in part, by the dramatic increase in use of instant ear-tips over the past 10 years and the consequent need for a more detailed fitting model but primarily by the need to apply the Widex sound in two processing pathways.

TruAcoustics™ is the basis for both the classic processing and ZeroDelay™ pathways. It is important to remember that the Widex sound is based more on the input level than input frequency. The relationship between soft, normal and loud input sounds is one of the biggest contributing factors to the Widex sound. Accommodation of all input sounds, soft, normal and loud in the residual hearing range of the user is essential to get the Widex sound optimised for everyone. In order to accommodate these three input levels, it is essential that we maintain accuracy in fit, both in the way we set the TruAcoustics™ calculation up and also through the selections being made in GPS and good measurements taken during fitting.

Following a successful launch period, data-driven improvements continued, and our analysis of consented fitting data revealed where we could fine-tune TruAcoustics™ further to allow the Widex sound to shine. This article will describe and follow the development history of TruAcoustics™ to date.

2. TRUACOUSTICS™ - BUILT ON THE AMBITION TO DELIVER PERFECT SOUND AT THE EARDRUM

TruAcoustics™ is active for all initial fittings in WIDEX MOMENT™ – for both inexperienced and experienced users – and the target is natural, perfect sound. If you have less than optimal control of the in-situ acoustics you risk not delivering the optimum sound. TruAcoustics™ calculates fittings more accurately than ever before and builds the foundation for the natural sound of WIDEX MOMENT™. The application of TruAcoustics™ is done seamlessly during the fitting in the three simple steps Selection, Feedback Test and Sensogram.

Before TruAcoustics™, Widex has been using the AISA (Assessment of In-Situ Acoustics) model to estimate the acoustic effect of the ear mould and the true individual vent effect that affects the gain calculation for an individual hearing aid user.[1] When the feedback test was done, AISA used a database to predict the vent effect of the ear mould in the ear. This database was based on the precise data from custom moulds built with the CAMISHA printer in our ear-mould lab. It was easy to predict the vent status based on measurements (feedback test), and the AISA algorithm then looked up vent models in the vent model database to achieve the closest match for vent compensation (Kuk & Nordahn, 2006). AISA was an accurate model until the arrival of instant ear-tips and open fittings.

As part of the TruAcoustics™ development project, we looked at how gain was summed for all our current moulds and ear-tip solutions. While custom moulds and custom ear-tips are very consistent in their acoustic properties, instant ear-tips are very much the opposite, with large variation between individual users in the amount of direct sound entering the ear. Research showed us that in instant fittings the vent leakage is not just defined by the type of ear-tip. It is just as much defined by the combined leakage in and around the instant ear-tip itself [Caporali et al. 2019]. As instant ear-tips are used in most hearing aid fittings[Hearing Review 2019], it is particularly interesting to understand the acoustic robustness and performance of these ear-tips. We studied all available Widex instant ear-tips: open, tulip, round ear-tips and double domes. Based on this research, the classic AISA model evolved in the WIDEX MOMENT™ family into the more intricate TruAcoustics™ model.

Once TruAcoustics™ was launched, we started gathering insights through the fitting data that users consent to share with us. Analyses of these data inspired us to implement further improvements to the TruAcoustics™ model. This data was used by the teams responsible for the continued optimisation of TruAcoustics™, and their work with the TruAcoustics™ model in late 2020 resulted in enhanced performance of Widex sound characteristics in a broader range of fittings.

3. TRUACOUSTICS™ - A NEW WAY OF CALCULATING WIDEX FITS

As mentioned before, during the development of WIDEX MOMENT™, we conducted a large-scale investigation into the behaviour of Widex instant ear-tips in terms of Insertion Loss (IL) and Vent Effect (VE). Figures 1 and 2 show how IL and VE are measured. The published research is based on 58 ears and hundreds of measurements. The measurements show very large variation between ear-tips in how much direct sound is transmitted through the ear-tip (IL) and how much sound escapes from the ear (VE).

The VE results are illustrated in Figure 3. The figure shows large variation between the different ear-tips, which goes in the expected direction, with the open ear-tips showing the largest VE, followed by tulip, round and double domes. This is clear from the top left panel which shows the mean VE per eartip. More importantly, however, there is also very large variation between different ears with the same ear-tip, indicated by the shaded areas in the remaining panels of the figure. This variation is seen for all ear-tips but is particularly pronounced for the double domes, which may behave as almost entirely open or entirely closed.

Based on these measurements and comparisons between all the instant ear-tips, the custom ear moulds, and the existing AISA model, we developed TruAcoustics™. As a result, the vent effect can now be estimated in a new and more precise way for the individual hearing aid user, leading to greater accuracy of fit, better sound and more precise recommendations throughout the fitting process. In other words, we have replaced the AISA Transmission Line Model with a new statistical model for all instant ear-tips, thereby removing the source of overcompensation in lower frequencies and reducing the risk of boominess of own voice. Through the research into the in-situ acoustics of all the ear-tips, we also obtained better precision in the recommendation of instant ear-tips during acoustic selection in COMPASS™ GPS, and we fine-tuned the precision for custom ear moulds. This precision in ear-tip recommendation ensures the best premise to deliver appropriate gain. Importantly, the whole process still relies on the feedback test being completed to supply COMPASS™ GPS with the in-situ fit characteristics.

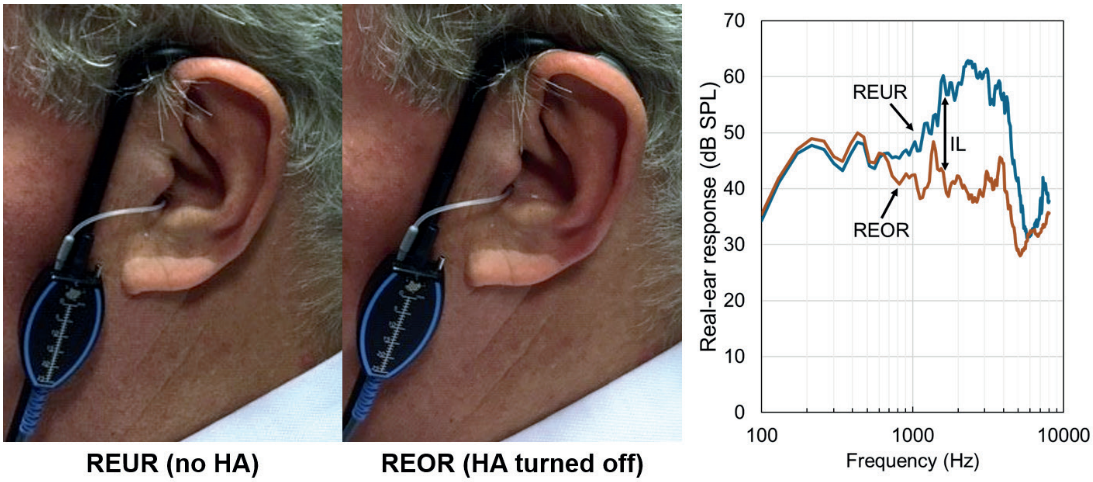

Figure 1 Real-ear measurement configurations used for insertion loss (IL) estimation, with pink noise presented from a loudspeaker in front of the participant. IL was calculated as the difference between REOR and REUR, as shown in the example on the right.

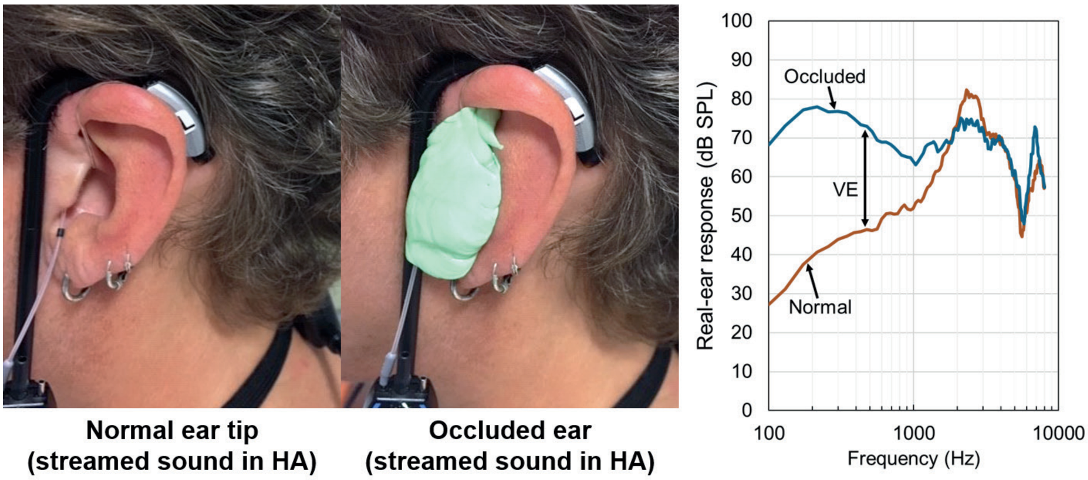

Figure 2 Real-ear measurement configurations used for VE estimation, with brown noise being streamed to the HA and presented via the receiver. VE was calculated as the difference between the 'normal' response and the 'occluded' response, as shown in the example on the right.

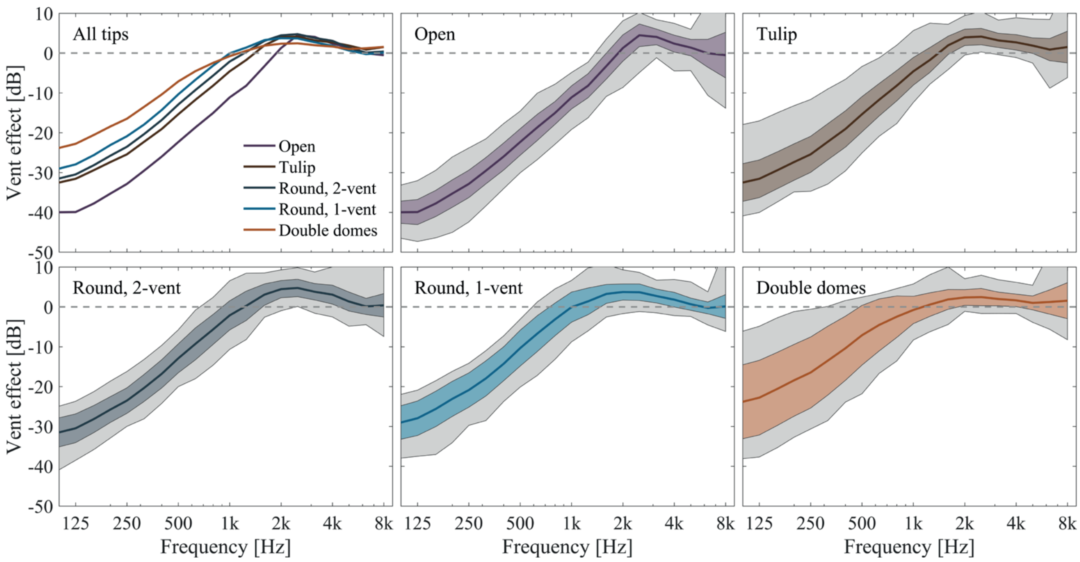

Figure 3 Average VE in 1/3 octave bands across 58 ears for the five ear tips (top left). The other panels show the average VE per tip (thick colored line) ±1 standard deviation (color-shaded area). The grey-shaded area represents the observed range of individual

4. ANALYSIS OF CONSENTED DATA FROM THOUSANDS OF FITTINGS

Since the launch of TruAcoustics™ with WIDEX MOMENT™ and thanks to HCPs and end users around the world consenting to share fitting data with us, we were able to analyse large numbers of real-life WIDEX MOMENT™ fittings from our secure cloud and gain valuable insights. A key measure of the success of MOMENT is of course the fit-to-target properties of each fitting within COMPASS™ GPS, which we analysed based on the consented data.

We analysed a sample of more than 8500 individual WIDEX MOMENT™ fittings, looking at the fit to target (in COMPASS™ GPS) in each of the 15 bands. In our sample, there were just under 7000 mild and moderate hearing losses (above 25 to 60 dB HL) and more than 1500 severe and severe-profound hearing losses above 60 to 90 dB HL).

Figure 4 shows the results of this analysis, for the mild and moderate hearing losses in the top row and for the severe and severe-profound in the bottom row, with normal gain on the left and soft gain on the right. For both soft and normal gain and for both types of hearing loss, the large majority of bands were on target (or turned up or down by the HCP), and among those that were below, these are in most cases within 5dB of target gain. Summarising these numbers across bands, we see for normal gain that more than 98% of bands are on target, and another 1% no more than 5dB below; the corresponding numbers for severe and severe-profound are 95% and 2,7%, for a total of more than 99% within 5dB for mild and moderate and more than 97% within 5 dB for severe and severe-profound. The picture of course looks a bit less positive for soft gain, but still 96% of bands for mild and moderate and 92% for severe and severe-profound are on target (or turned up or down) or within 5dB below. Our attention was drawn to the way TruAcoustics™ was calculating gain for soft inputs and around the high frequency inputs.

This data was used by the teams responsible for the continued optimisation of TruAcoustics™ and their work with the TruAcoustics™ model in late 2020 resulted in enhanced performance of Widex sound characteristics in a broader range of fittings. The fundamental changes were found in the way TruAcoustics™ now calculates the gain to accommodate IGSoft, IGNormal and IGLoud in the residual hearing range of the user and in turn allows for these classic Widex characteristic sounds to shine through even more.

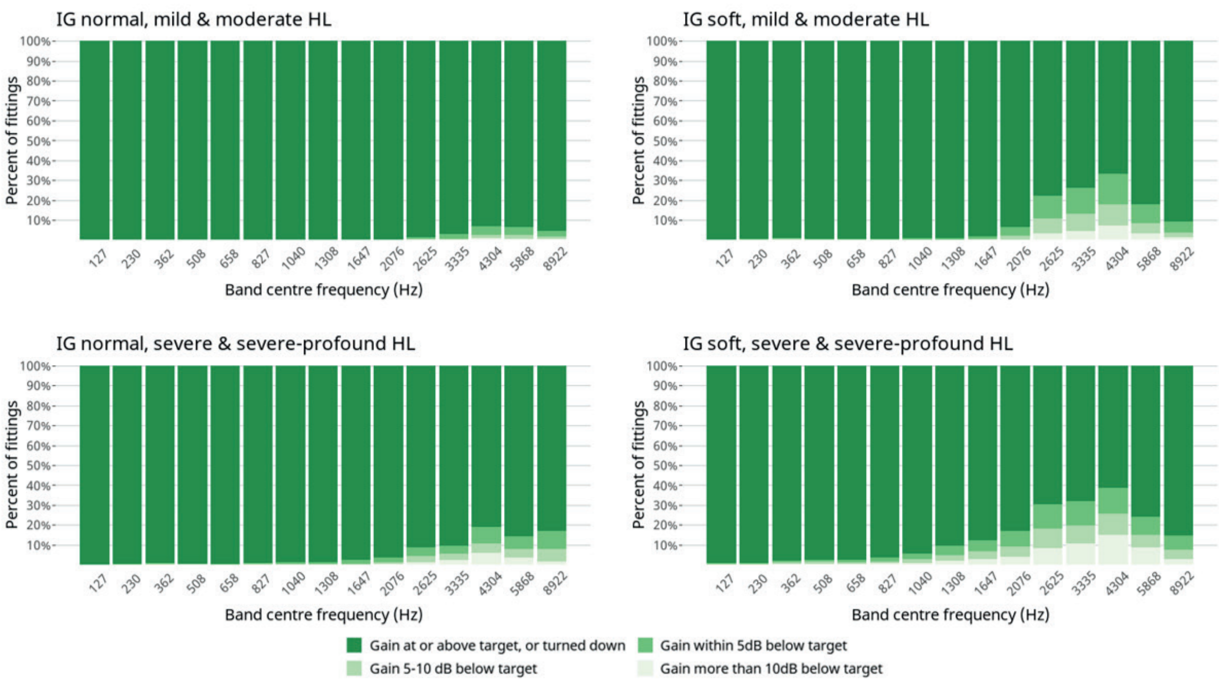

Figure 4 Fit to target per band for normal (left) and soft (right) gain, for hearing losses over 25 to 60 dB HL (top) and for hearing losses over 60 to 90dB HL (bottom).

5. TRUACOUSTICS™ OPTIMISED – HIGHLIGHTS OF THE CHANGES

The main aim of the optimisation of TruAcousitcs™ is to ensure the fitting allows for the Widex sound to shine for the widest range of fittings possible. These changes also has an impact in graphical changes in GPS too.

- Acoustic Selection - Fitting Range display is improved now to show both the receiver fitting range and the available fitting range for the entire system, hearing aid, receiver/tube, ear ware and vent. (fig. 5)
- Feedback Test - Our changes to the gain calculation affects the measured headroom in the hearing aid, releasing gain, and can be the difference between a good feedback test result and a great one. In GPS 4.2 we now see a recalculation of the gain and rebalancing of the gain limits when the feedback test is measured. (fig. 6)
- Fine Tuning - The changes made with GPS at the launch of WIDEX MOMENT™ were designed to make life easier for the HCP and to bring GPS into alignment with other fitting software on the market. Insertion gain vs Frequency is the default view now to align with competitors. We previously used Output vs Frequency. The main difference visually is that the soft gain is at the top of the graphic, where before we had soft output at the bottom. Insertion gain vs frequency shows a headroom for gain. That is the maximum gain the HA wants to apply for soft input and the threshold of feedback for gain. With optimisation of the gain calculation there is more headroom and we no longer impact the sounds. We allow more of the Widex sound to shine through. (fig. 7)

All of the visual changes represent the optimisation work on the way TruAcoustics™ calculates the gain and the impact on the final sound will be that more of the characteristics expected with a Widex hearing aid, access to soft sounds, for example, will be audible. We will still see in a small number of cases that the feedback test will limit to a small degree the amount of soft gain applied. This is due to the simple fact that the Widex Feedback management will prioritise sound quality first. We will ensure that we aim to meet target for normal inputs, to ensure good speech understanding and while access to soft sound is an important part of the Widex philosophy if this gain impacts on sound quality due to feedback then the system will always put sound quality first.

Figure 5 Acoustic Selection showing in Light Red: Maximum fitting range that the selected receiver (or tube, for BTEs) can give, it is the same as fitting ranges in the datasheets. Dark Red: Available fitting range for the entire system, including hearing aid and acoustic coupling.

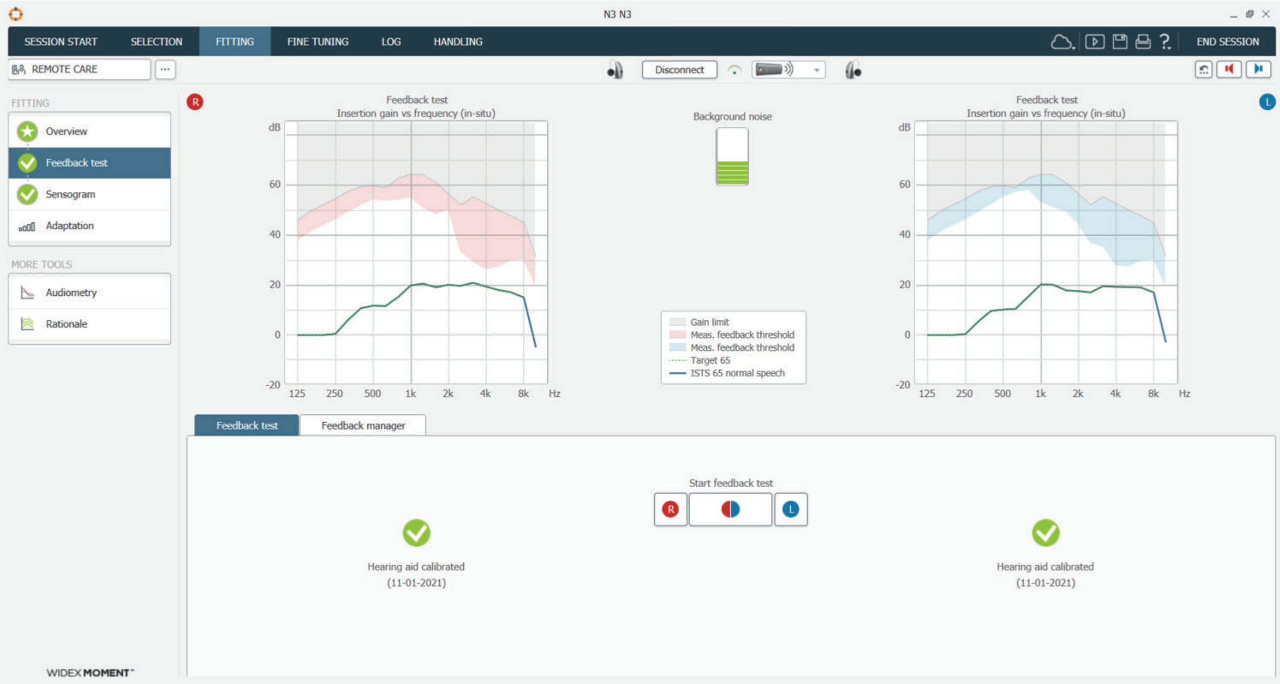

Figure 6 Feedback test: In GPS 4.2 we now see a recalculation of the gain and rebalancing of the gain limits when feedback tests is measured.

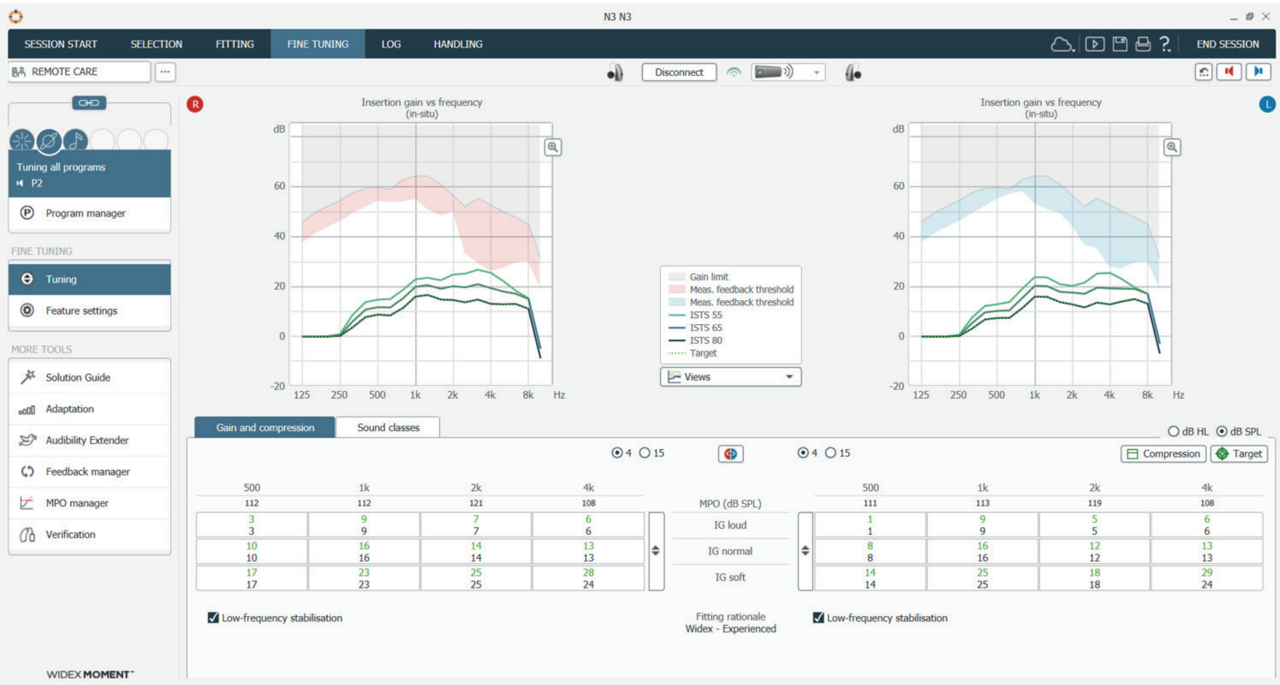

Figure 7 Fine Tuning: In GPS 4.2 we now see a recalculation of the gain and rebalancing of the gain limits when feedback test is measured. There is more headroom and we no longer impact the sounds. We allow more of the Widex sound to shine through.

5. TRUACOUSTICS™ SUMMARY

TruAcoustics™ is our best Widex fitting calculation and we have just made it even better to lead to our most natural sound for all Widex fits. Our new statistical model provides sound more accurately than before. TruAcoustics™ is an essential step in the personalisation and customisation of the perfect Widex sound, shaping the sound delivery to the exact properties of the individual acoustics in the ear canal and earware. Being the foundation of a precise fitting calculation means that TruAcoustics™ enables us to take another leap towards even more natural sound in PureSound™.

Our heritage is to secure audibility of speech at normal input levels, allow loud sounds to sound loud without being uncomfortable and lifting soft sounds to audible levels without being disturbing. Based on this, Widex once again leads the way in leveraging cloud data through careful analysis to find new ways to make TruAcoustics™ and WIDEX MOMENT™ even better, reflecting our dedication to sound.

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