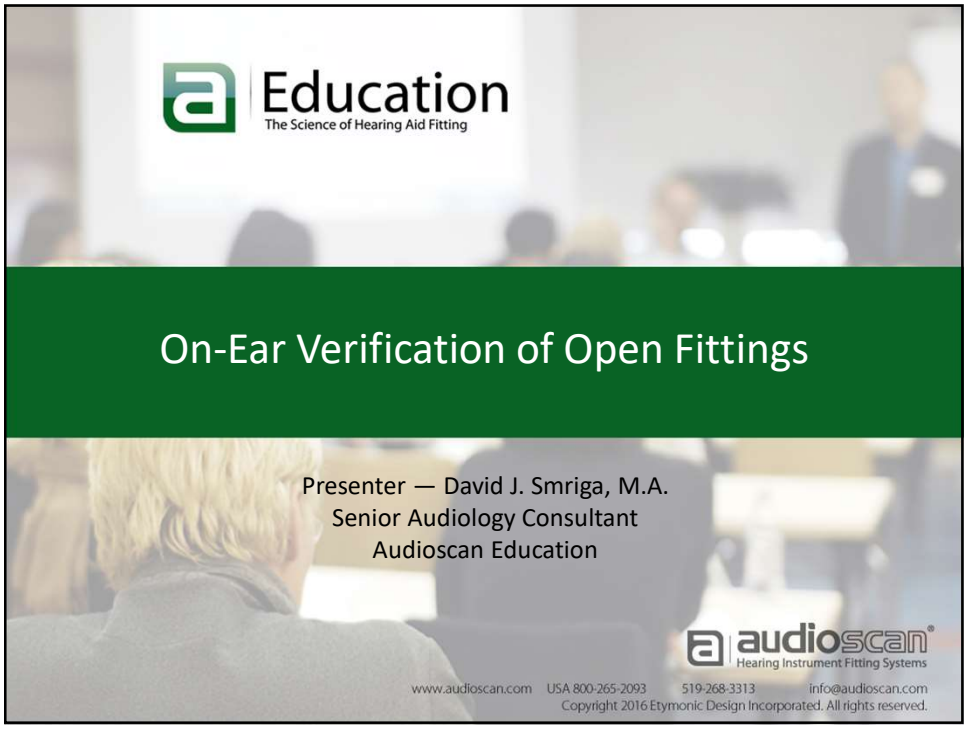

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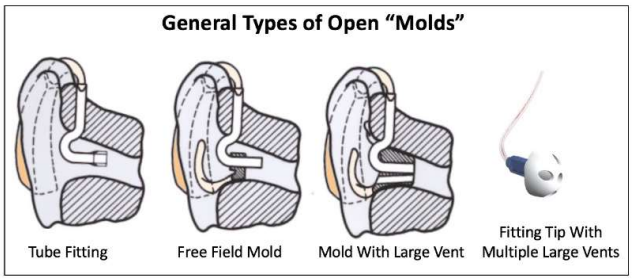
Learning Objectives

- Correctly identify and objectively verify an open fitting condition with any patient.
- Correctly identify open fit candidates using real ear measures.
- Correctly fit open fit candidates using real ear measures.

What Is An Open Fitting?

- *Any style of hearing instrument (and its associated "plumbing") that creates minimal occlusion of the ear canal when worn.*



Staab, W., Open Earmold Hearing Aid Fittings", HHTM January 2016
McCabe, E., Galster, J. "Reducing Occlusion In CIC's With Custom Venting" online pdf

Why An Open Fitting?

- Primary value:
  - Addresses occlusion and own voice complaints
    - Particularly for patients with little hearing loss in the lower frequencies
  - Provides a more natural sound quality
- Primary limitation:
  - Increased feedback potential will limit available gain
  - Best suited for high frequency loss

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Digital/Thin-Tube/RIC

- Contributions:
  - Digital feedback management technology has facilitated greater access to more useable gain in an open ear canal environment
  - Thin-tube and RIC styles have advanced the cosmetic acceptance of the BTE form
  - Comfortable, non-occluding ear tips make these products easier to fit, adjust to and wear

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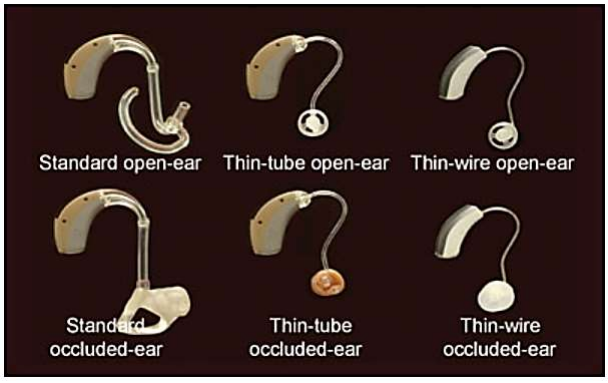
As A Result. . .

- In the first quarter of 2016:
  - RIC products accounted for 64.5% of sales
  - BTE products accounted for 80.7% of sales

HIA
Hearing Industries Association

Not All RIC/Thin-Tubes Are Open



The six possibilities of BTE couplings used in today's fittings

Kuk, F., Baekgaard, L., "Hearing Aid Selection and BTE's: Choosing Among Various Open Ear and Receiver-in-Canal Options", Hearing Review, March 2008

What Is An "Open" Instrument?

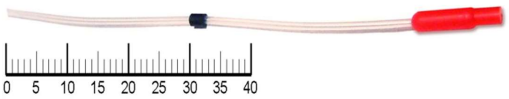
- "Open" should NOT be defined by hearing aid design
  - Thin Tube
  - RIC
- "Open" defined by hearing aid coupling to the ear:
  - If coupling does not occlude the ear canal, it is an "Open" fitting

METHODS *FOR CONFIRMING AN OPEN FITTING*

1) The Real Ear Unaided Response (REUR) vs. the Rear Ear Occluded Response (REOR)

Probe tube placement

- Begin with otoscopic inspection of ear canal
- Place probe tip within 5mm of the eardrum
- Placement methods include:
  - Visually-assisted positioning
    - Use anatomy of external ear to guide positioning



Average distance from intertragal notch to probe tip
Male: 30-31mm Female: 28mm Child: 20-25mm

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Interested in learning more?

Visit the education and article section of Audioscan's expo page on AudiologyOnline
www.audiologyonline.com/expo/audioscan
Video tab: "Probe tube Placement

Probe Tube Placement
September 18, 2015

Tips on proper probe tube placement for Speechmap and other real ear measures on Audioscan hearing instrument fitting systems.

Watch Video

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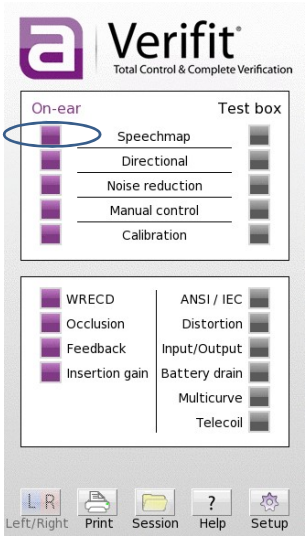
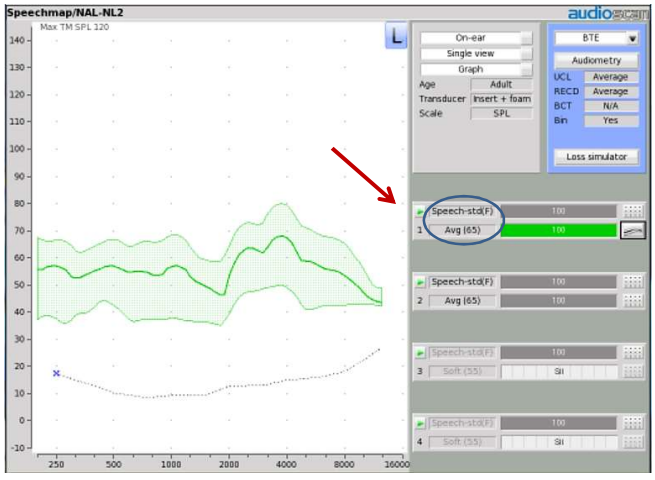
Method For Determining an "Open" Fit



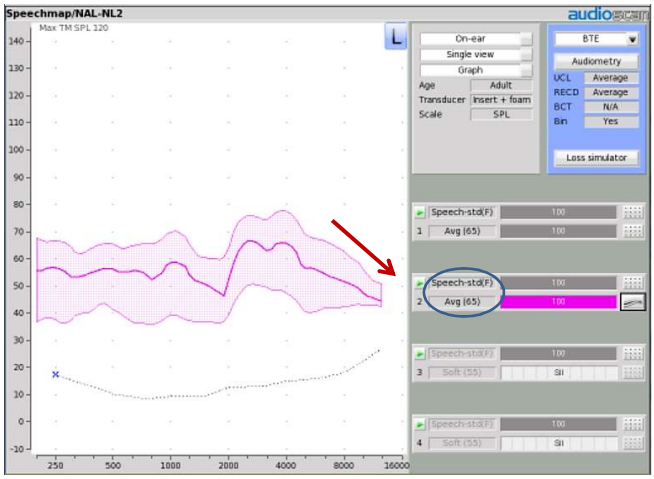
Once the probe tube has been properly inserted into the ear canal, select "Speechmap" in the On-ear column of the Verifit test selection menu.

REUR



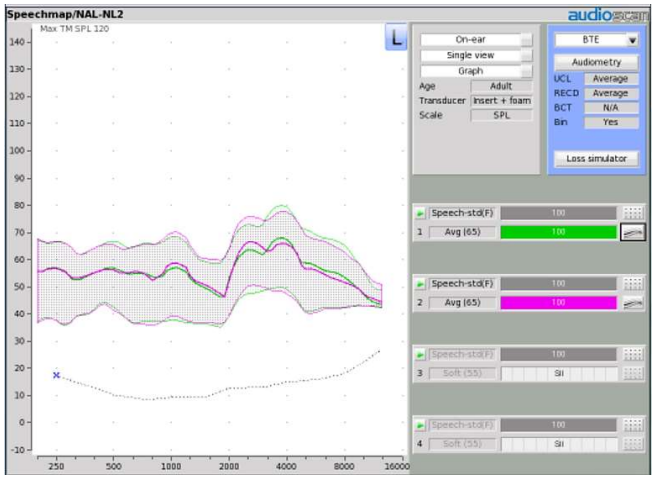
On-Ear result obtained when only the probe tube is in the ear canal

REOR (Open dome)



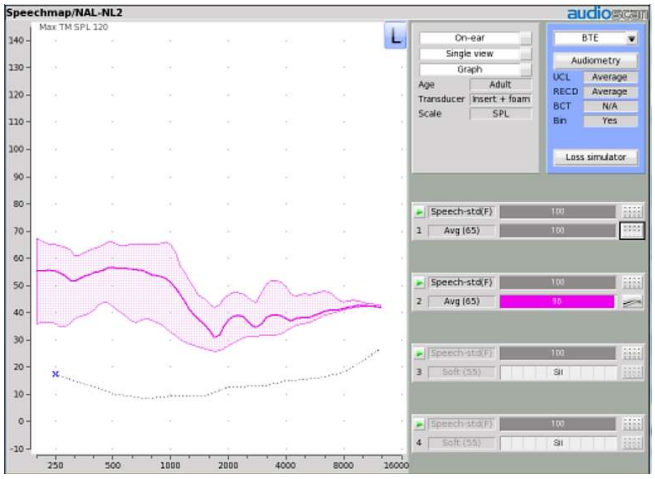
On-Ear result obtained when the probe tube and a **muted open-dome** RIC instrument is in the ear canal

REUR & REOR Superimposed



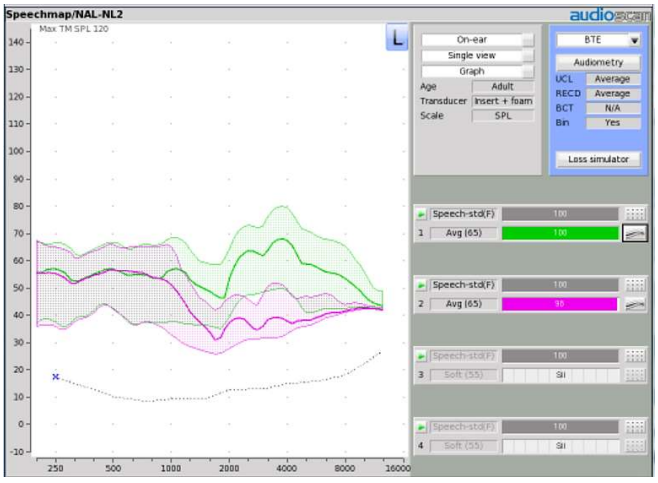
Note that the two measurements are virtually identical, indicating that the physical presence of the hearing instrument/plumbing does not change ear acoustics

REOR (Closed Dome)



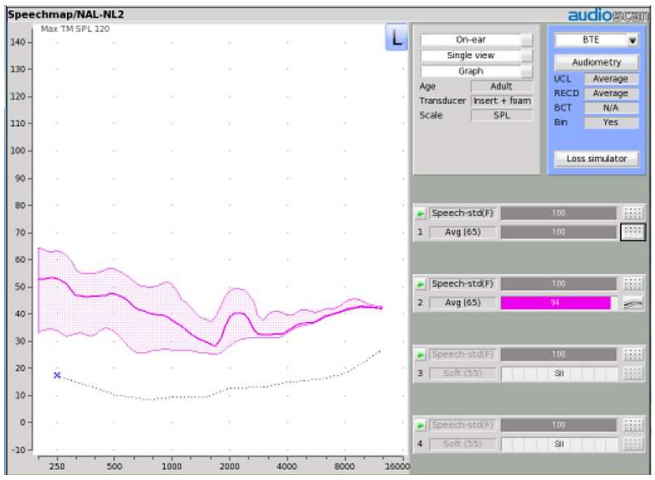
On-Ear result obtained when the probe tube and a muted **single-wall closed-dome** RIC instrument is in the ear canal

REUR & REOR Superimposed



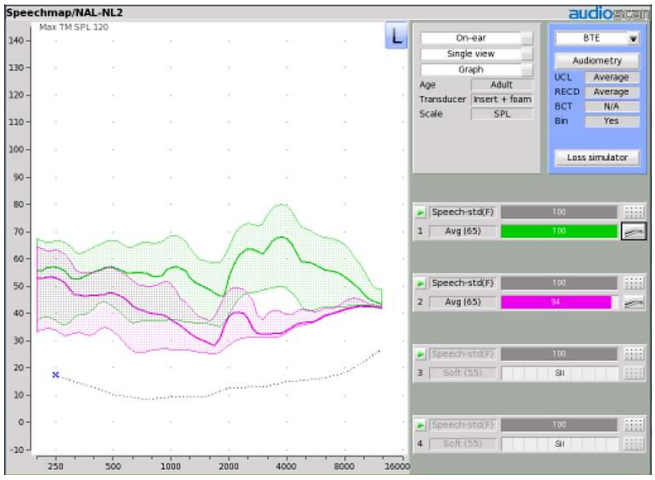
Now, the two measurements are not identical, indicating that the presence of the hearing instrument/plumbing is indeed changing ear acoustics

REOR (Ventless Earmold)



On-Ear result obtained when the probe tube and a muted BTE with a **Double-walled power dome** is in the ear canal

REUR & REOR Superimposed



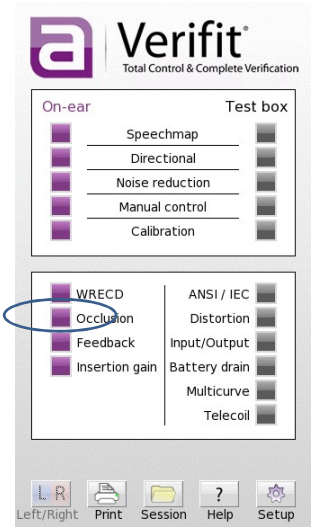
Note the significant difference between the two measures when this magnitude of occlusion is present

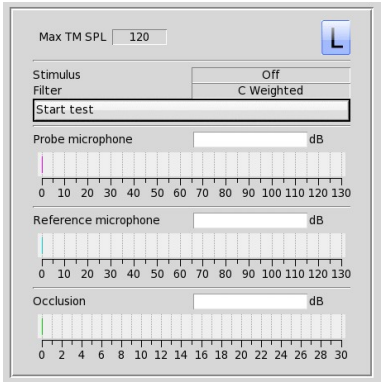
METHODS FOR DETERMINING AN OPEN FITTING

2) OCCLUSION EFFECT TEST

Education
The Science of Hearing Aid Fitting

Occlusion Effect Test





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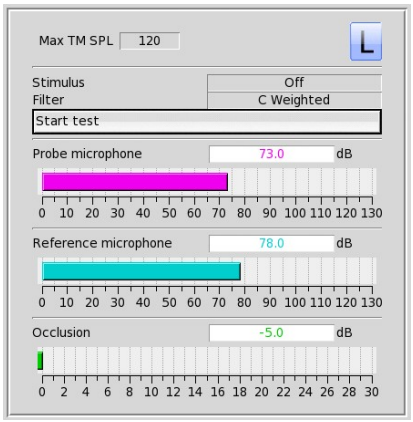
Occlusion Test Result: Open Dome



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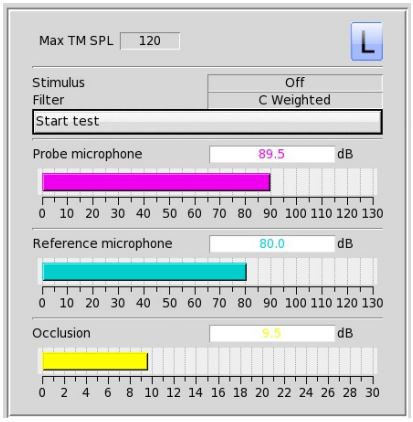
Occlusion Test Result: Closed Dome



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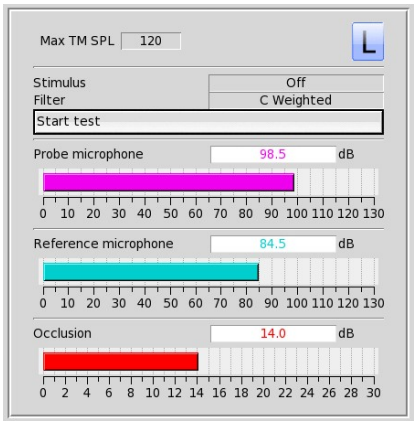
Occlusion Test: Power Dome



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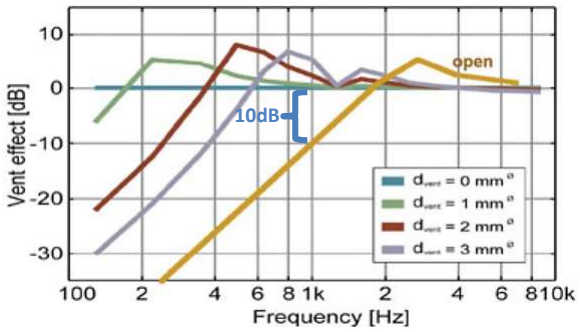
*OPEN FIT **ACOUSTIC** CONSIDERATIONS*

1) VENTING

Education
The Science of Hearing Aid Fitting

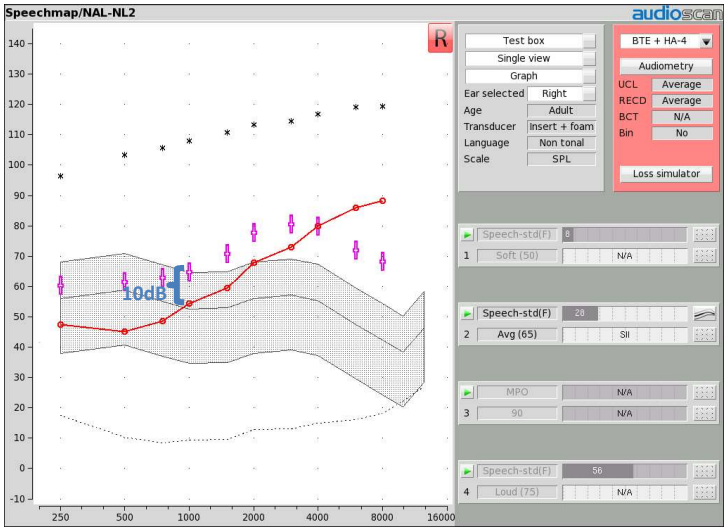
Comparative Vent Effects



Effect of vent diameter and open fitting on hearing aid output

Kuk, F., Baekgaard, L., "Hearing Aid Selection and BTE's: Choosing Among Various Open Ear and Receiver-in-Canal Options", Hearing Review, March 2008

NAL-NL2



*OPEN FIT **ACOUSTIC** CONSIDERATIONS*

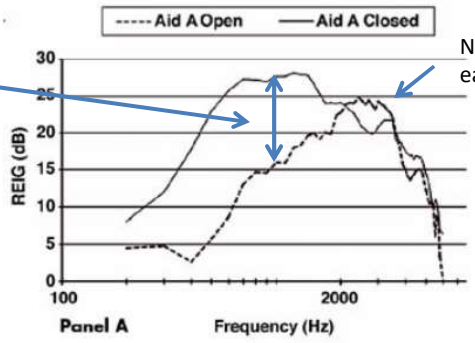
2)EAR CANAL RESONANCE

Education
The Science of Hearing Aid Fitting

Comparative Vent Effects

10dB loss of gain near 1KHz

No loss of ear canal resonance



Effect of open and closed fitting on REIG

Mueller, H.G., Ricketts, T.A., "Open-canal Fittings: Ten Take-home Tips: Hearing Journal, November, 2006

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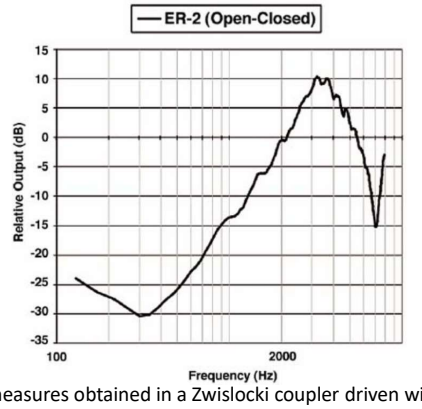
Ear Canal Resonance



Difference in probe measures obtained in a Zwislocki coupler driven with steady state noise between a response obtained with the probe sealed at the coupler opening (zero line) and a response obtained with the probe simply placed in the coupler (measured line).

Mueller, H.G., Ricketts, T.A., "Open-canal Fittings: Ten Take-home Tips: Hearing Journal, November, 2006

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*OPEN FIT **ACOUSTIC** CONSIDERATIONS*

3) ACOUSTIC PATHWAYS

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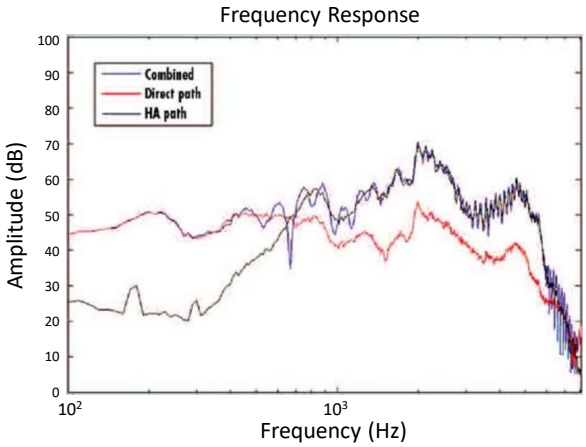
The Science of Hearing Aid Fitting

In an Open Fit, There Are Several Pathways to Get SPL to the Eardrum

- Direct pathway
  - Sounds that reach the eardrum unprocessed by the hearing aid
- Amplification (Indirect) pathway
  - Sounds that reach the eardrum via the output signal of the hearing aid

Acoustic Pathways



The Advantage of REAR Measurement

- An REAR displays the combined acoustic pathway result
  - It measures and displays the aided SPL at the probe tube tip regardless of how that SPL was delivered
- An REIG displays only the hearing aid pathway

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OPEN FIT ***VERIFICATION CONSIDERATIONS***

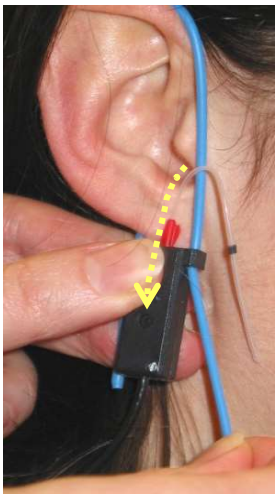
If an Open Fitting Is Present. . .

- Pre-fit (in the test box) is off the table
  - There is no such thing as an "Open" coupler
- All fitting measures need to be done on the ear
- "Concurrent" calibration (equalization) should not be used

Impact of sound calibration method

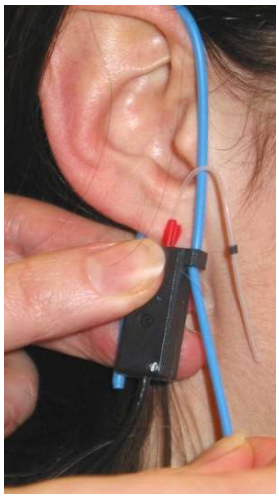
For open fitting:

- Outflow from ear canal received by reference mic.
  - Lowers speaker output
- Resulting measured output will be reduced



Open Fitting Recommendation

- Use 'stored' equalization instead of 'concurrent' equalization
  - Presents the calibration signal independent from the speech signal
  - Hearing aid is on the ear, but muted during the calibration signal event
  - Thus, outflow from ear canal can not affect speaker level and your measurement



Effect of equalization approach

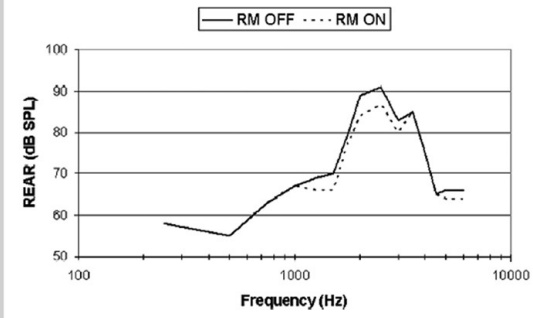


Figure 11. *REAR findings for an OC fitting using concurrent equalization (reference microphone on) versus stored equalization (reference mic off)*

Mueller, H.G., Ricketts, T.A., "Open Canal Fittings" Ten Take Home Tips", Hearing Journal, v9:11, Nov. 2006

OPEN FIT ***VERIFICATION PROCEDURE***

1) VERIFYING PATIENT CANDIDACY

Education
The Science of Hearing Aid Fitting

Patient Candidacy

- Select “Speechmap” from the On-Ear menu
- Enter audiogram into verification system
- Select a fitting target (i.e., NAL-NL2)
- Place the probe tube only in the patient’s ear(s)
- Run and record the REUR for 65dB speech
- Compare the displayed LTASS to the displayed target

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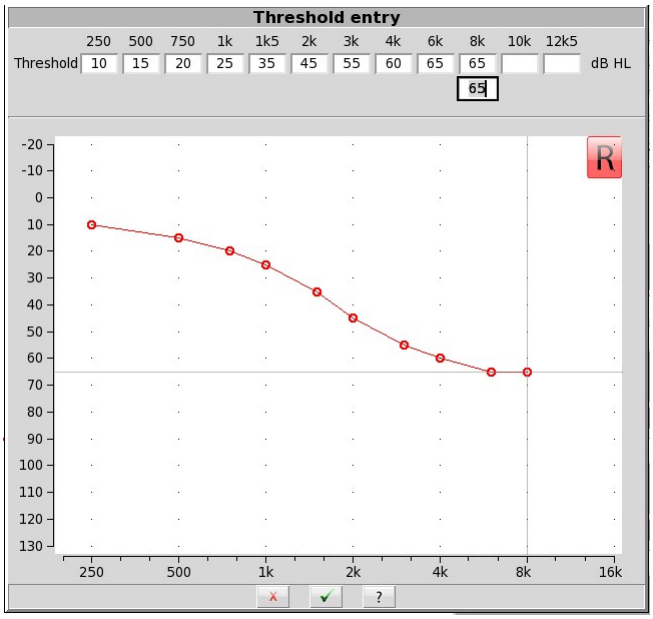

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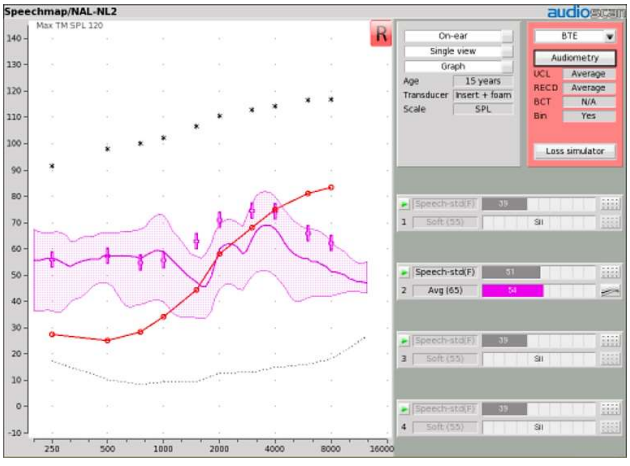
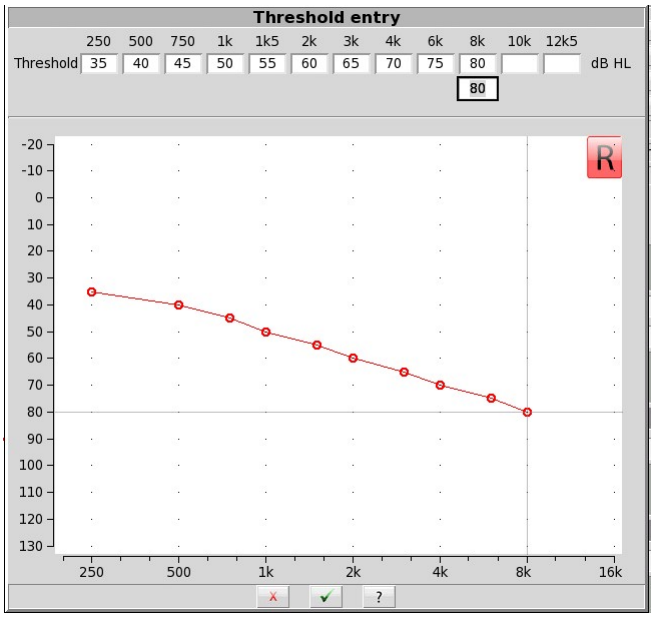


Audioscan® Education



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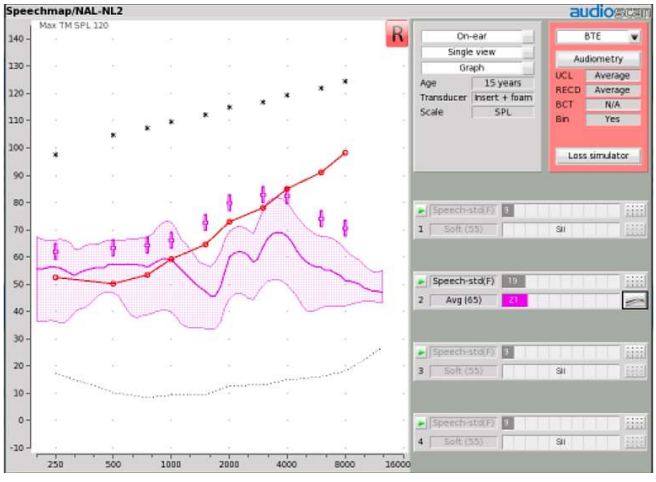

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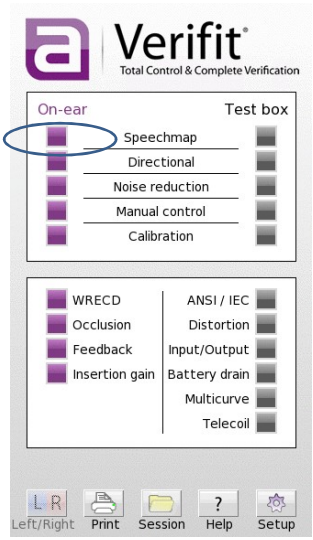
OPEN FIT ***VERIFICATION PROCEDURE***

2) VERIFYING AIDED PERFORMANCE (ON-EAR)

Education
The Science of Hearing Aid Fitting

Open-Fit On-Ear Verification Procedure



Select “Speechmap” in the On-ear column of the Verifit test selection menu.

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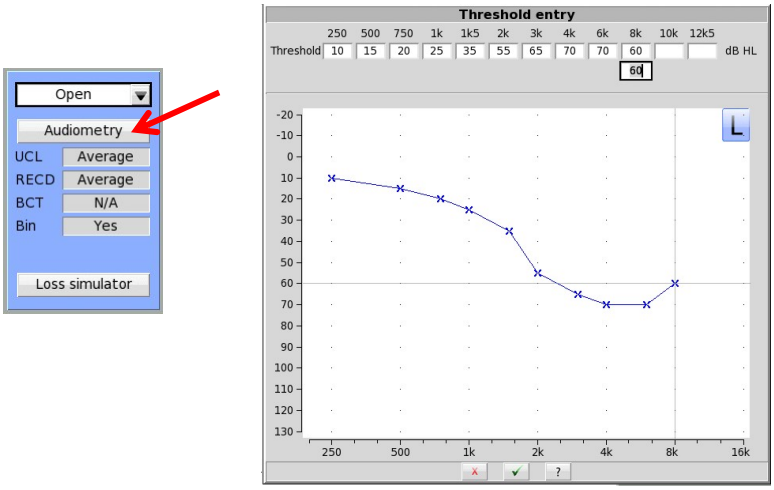
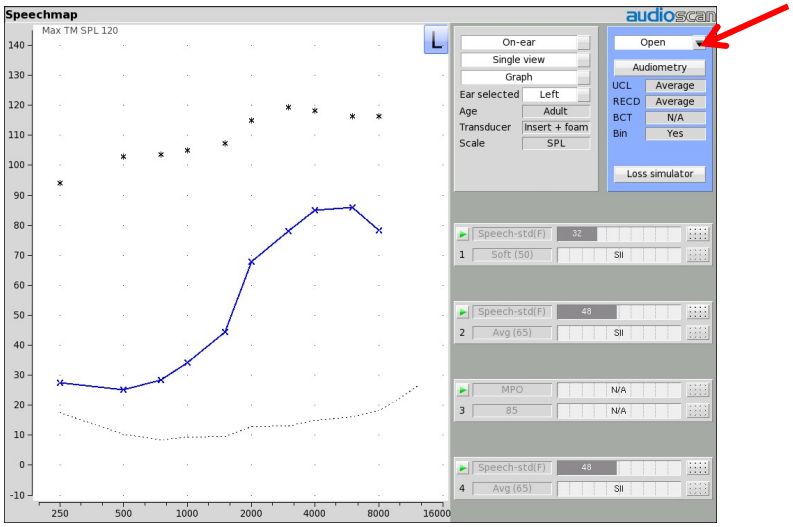
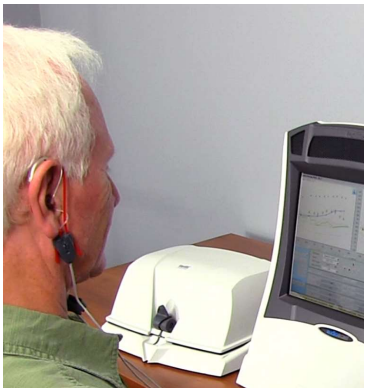
Audiogram Being Used In This Example



1) Select “Open” in Instrument menu

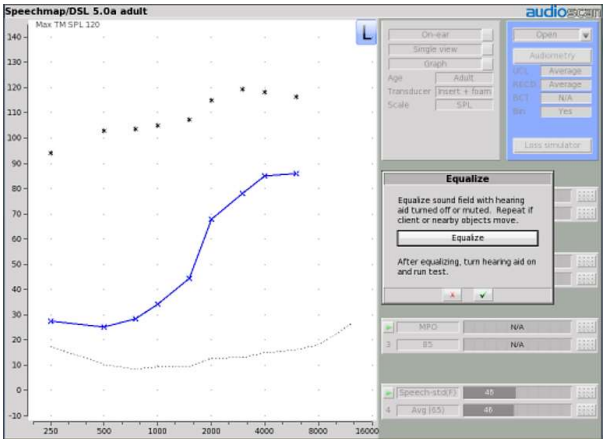


2) Place probe mic and HI on ear per usual



Turn OFF or Mute the Hearing Instrument

3) Select Play in Test 1 and store equalization when prompted

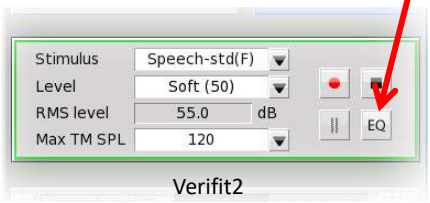


Once Equalization is completed, turn ON the hearing instrument

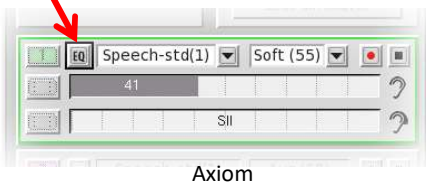
Re-equalizing sound field

If sound field changes at *any time* during testing, including if patient or clinician moves, the sound field eq must be repeated.

Click the "EQ" button to interrupt the running test to allow a new equalization to be stored.

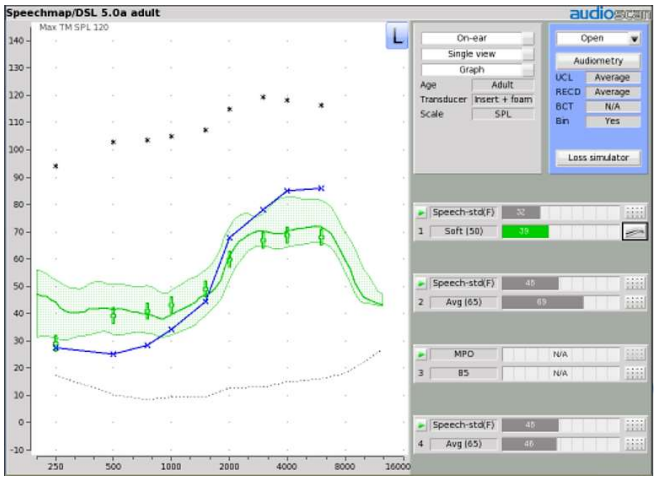


Verifit2



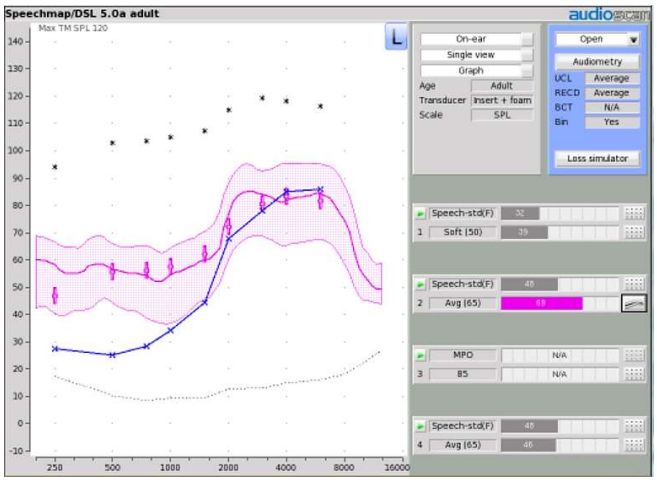
Axiom

4) Run Test 1: Calibrated Soft Speech

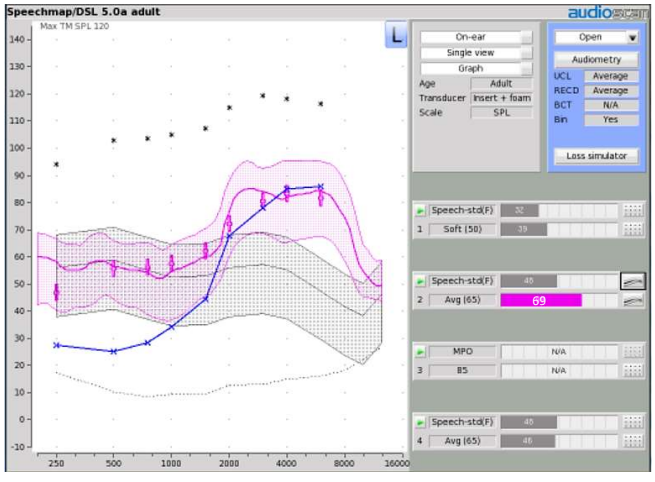


Adjust HI gain until best target match has been achieved

5) Run Test 2: Calibrated Average Speech

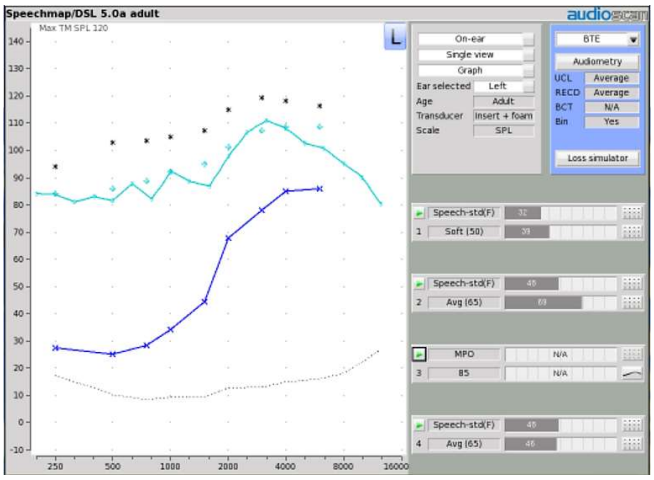


5) Run Test 2: Calibrated Average Speech



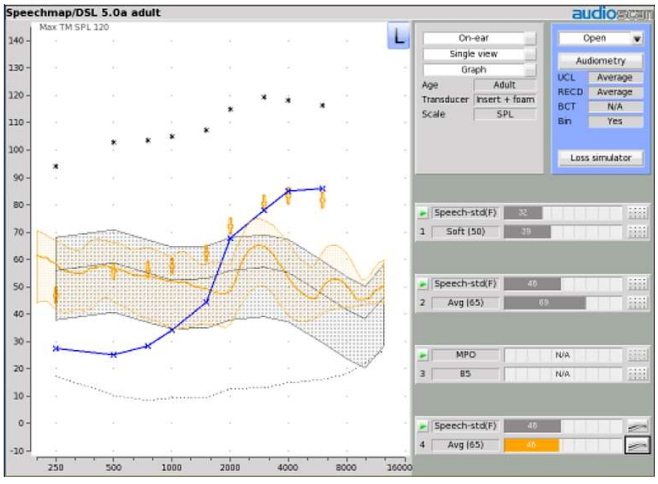
"Showing" unaided speech banana (grey) helps define HI difference

6) Run Test 3: MPO



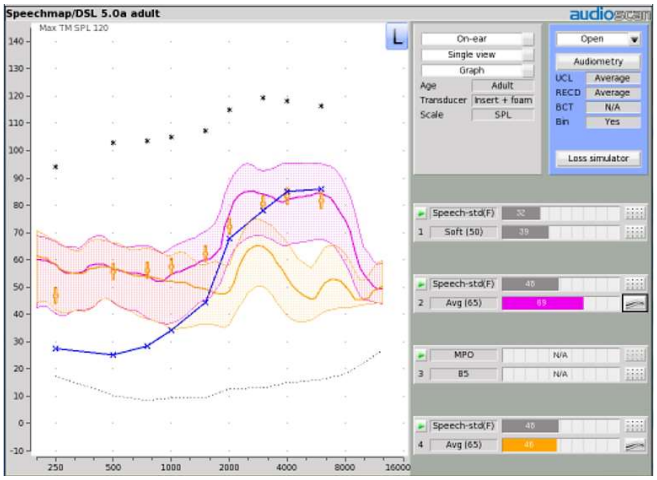
Adjust hearing aid output to approximate MPO target on Speechmap Screen

Optional: Run REUR in Test 4



Actual unaided speech in ear canal (gold) vs. predicted unaided speech (grey)

Optional: Run REUR In Test 4



Actual unaided (gold) and aided (pink) normal conversational speech in ear canal

Interested in learning more?

Visit the education and article section of Audioscan's expo page on AudiologyOnline

www.audiologyonline.com/expo/audioscan

Education tab: "Speechmapping As A Fitting and Counseling Tool"

Articles tab: "Speechmapping As A Fitting and Counseling Tool"

Directional Mic Test

OPEN FITTING CONSIDERATIONS

ON EAR AND TEST BOX MODES

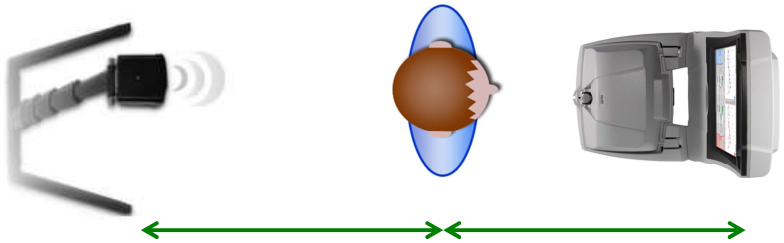
Education
The Science of Hearing Aid Fitting

Directionality Test (ON EAR)

Rear speaker

Aided ear with probe tube positioned

Verifit in On-ear directional mode



Equal distance

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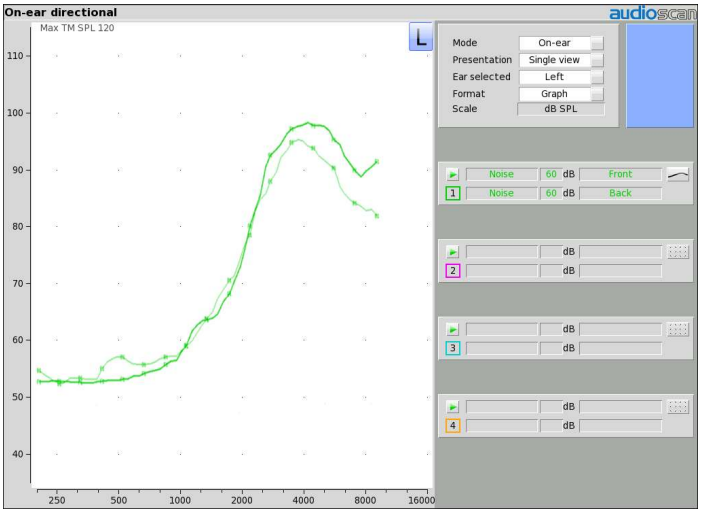
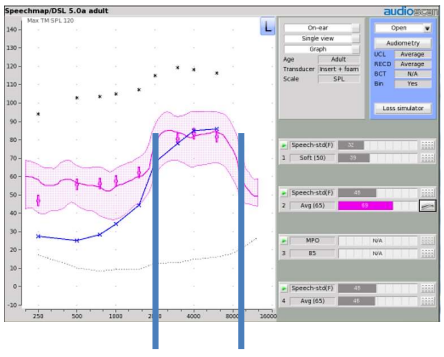
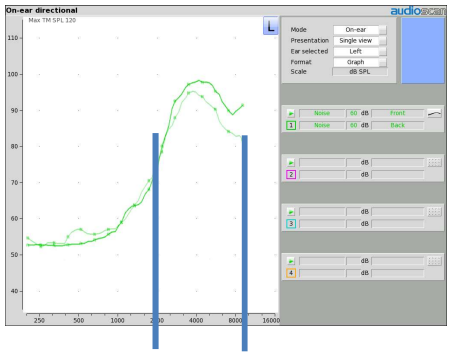
On Ear Directional Mic Test Result



Aided On Ear REAR for Speech Compared to On Ear Directional Mic Test



Frequency Range of Aided Region



Frequency Range of Aided Region

On Ear Directional Mic Measurement Considerations

- Open venting will likely mask directional mic functionality in the lower frequencies
- Directional mic port angle can effect the magnitude of curve separation
  - The closer to horizontal, the better the curve separation
- Head and pinna effects play a role in the directional mic result obtained.

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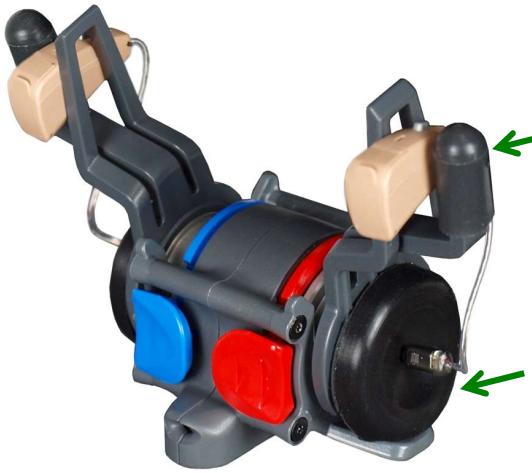
Directionality Test Test Box



Adjust HA Stabilizer until front and rear mic ports are parallel to test box floor

Putty-less TRIC adapter couples RIC and Thin Tube products to wideband .4cc coupler

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Directional in Test-box - RIC

Front speaker

Rear speaker

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Recommended Positioning – Verifit2

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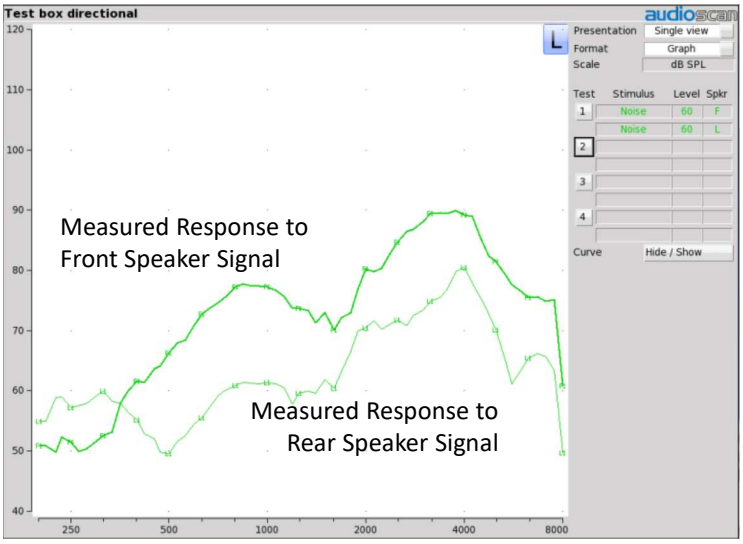
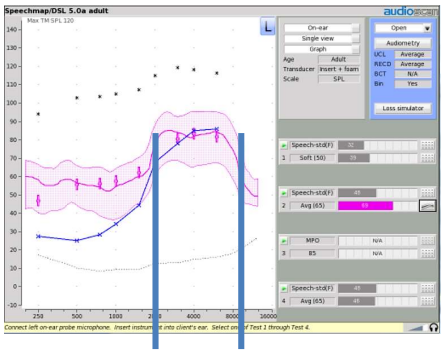
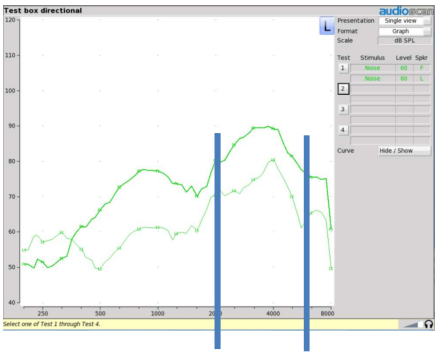
Directional Test Box Result



Aided On Ear REAR for Speech Compared to Test Box Directional Mic Test



Frequency Range of
Aided Region



Frequency Range of
Aided Region

Interested in learning more?

Visit the education and article section of Audioscan's expo page on AudiologyOnline
www.audiologyonline.com/expo/audioscan
Education tab: "The Verifit Directional Mic Test: Evaluating Modern D Mic Technologies"
Articles tab: "The Verifit Directional Mic Test: Evaluating Modern D Mic Technologies"

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Noise Reduction Test

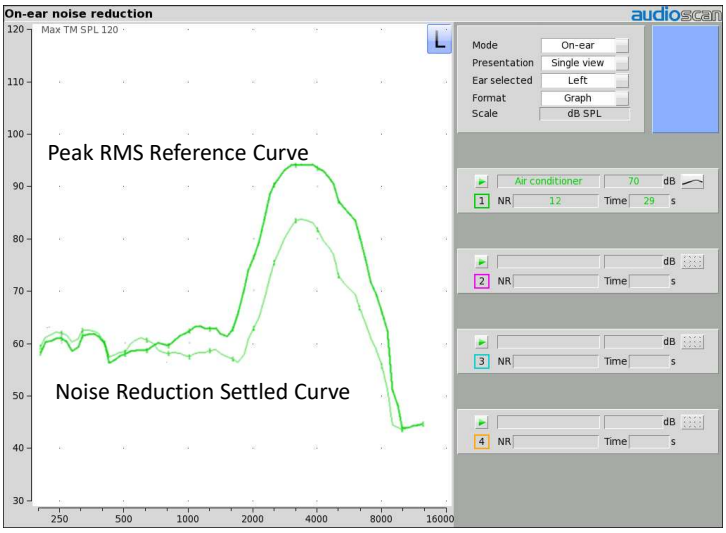
On Ear and Test box

Education
The Science of Hearing Aid Fitting

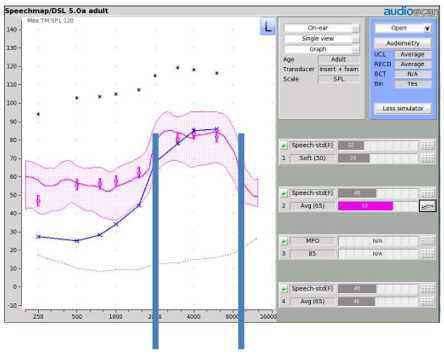
Digital Noise Reduction Properties

- Digital algorithm programmed to recognize "non-speech" elements of incoming stimulus
  - Operates independently in bands
  - Analyzes incoming signal modulation
- Can vary in terms of time constants
  - Typically, slow attack, fast release

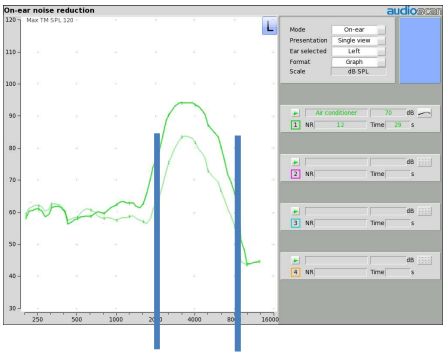
On Ear Noise Reduction Test Result



Aided On Ear REAR for Speech Compared to On Ear Noise Reduction Test

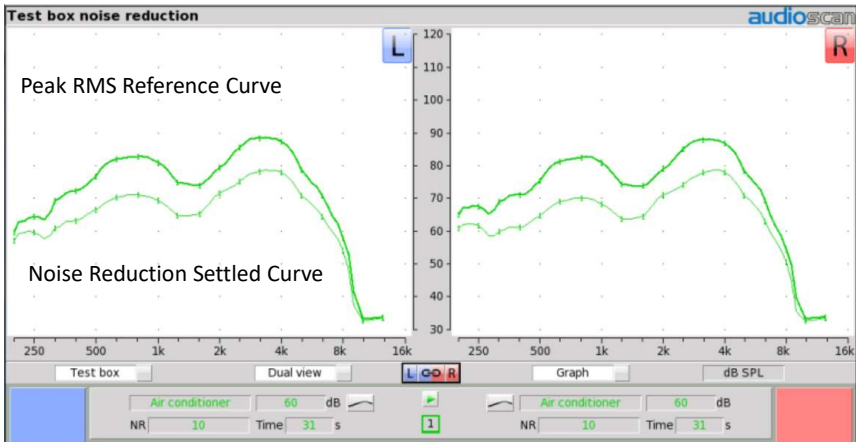


Frequency Range of Aided Region

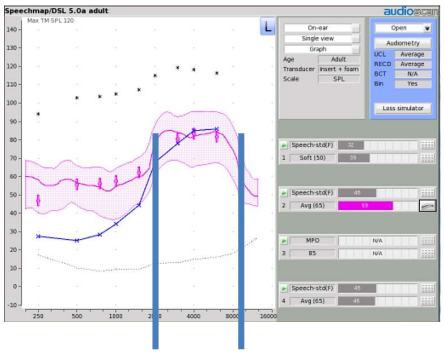


Frequency Range of Aided Region

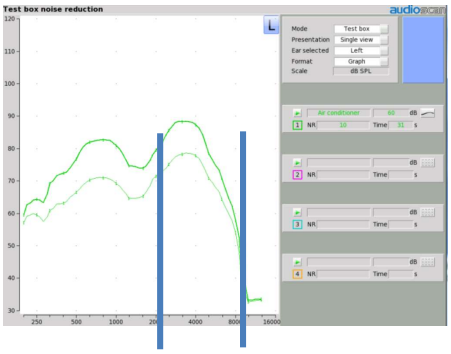
Test BoxNoise Reduction Test Result



Aided On Ear REAR for Speech Compared to Test Box Directional Mic Test



Frequency Range of Aided Region



Frequency Range of Aided Region

Key Open Fit Verification Considerations

- An open fitting exists when any hearing aid is coupled to the ear in a way that does not occlude the ear
  - Defined more by plumbing than HA style
  - An occlusion-free ear canal can be verified
    - REUR/REOR test
    - Occlusion effect test

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Key Open Fit Verification Considerations

- There are several important acoustic properties associated with open fittings
  - Vent effects
  - Ear canal resonance
  - Combined acoustic pathways

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Key Open Fit Verification Considerations

- Regarding open fit verification:
  - Pre-fitting (test-box Speechmap) is not an option
  - Concurrent microphone equalization (in REM) is replaced with stored microphone equalization
  - All fitting/fine-tuning steps will need to be completed On-Ear

Key Open Fit Verification Considerations

- Advantages associated with the REAR:
  - Can be used to "verify" open-fit candidacy
  - Displays an aided result that accounts for the combined acoustic signal conditions unique to an open fitting

Key Open Fit Verification Considerations

- Directional mic can be verified On-Ear with an auxiliary speaker
  - Demonstrates the effects of open venting on directional performance
  - Shows the value of D-Mic under these conditions
- Noise reduction can be verified On-Ear
  - Demonstrates the effects of open venting on this feature
  - Shows the value of noise reduction under these conditions.

Key Open Fit Verification Considerations

- The test box can still be a valuable tool in open fit verification
  - Test box directional mic test results can be compared to REAR results to identify directional mic advantage potential
  - Test box noise reduction test results can be compared to REAR results to identify noise reduction advantage potential


Education
The Science of Hearing Aid Fitting
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