

# Neuro-Compensator<sup>®</sup>

The World's First Neural-based  
Hearing Algorithm

VitaSound Audio, Inc.





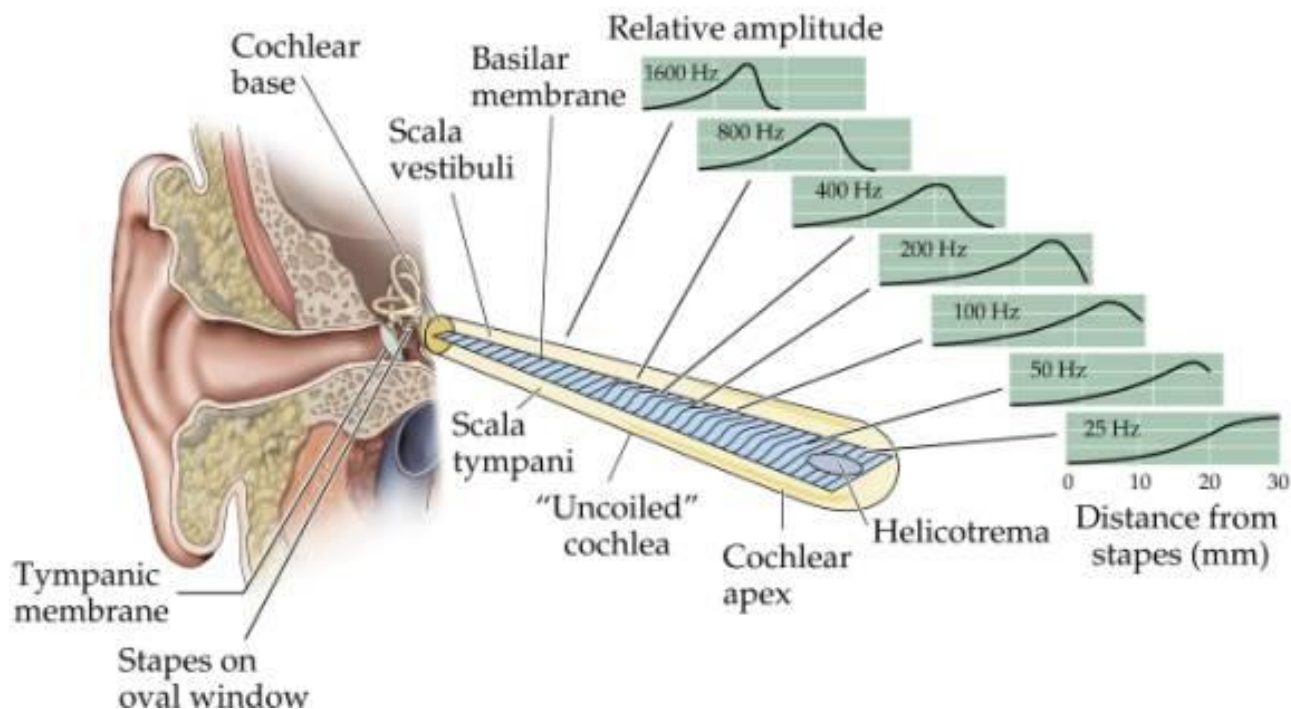
# Neuro-Compensator<sup>®</sup>

Fundamental Theory and Science

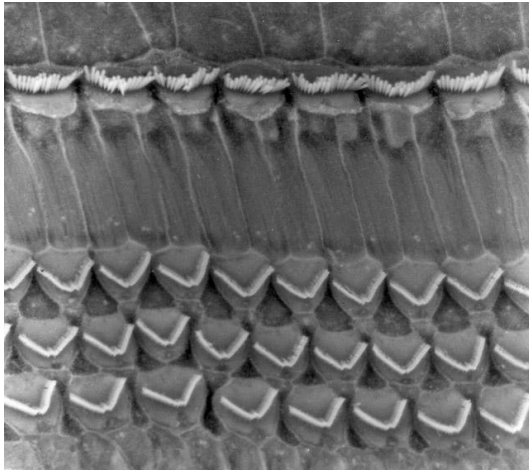
## Goals:

- Compensate for loss of outer and inner hair cells
- Learn optimal compensation parameters for a specific individual's pattern of hearing loss

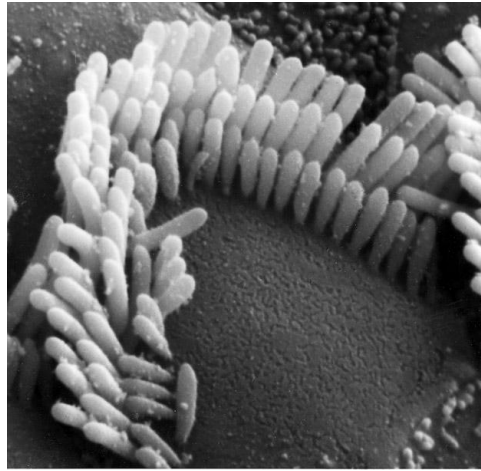
### Hearing loss usually affects cochlear functioning



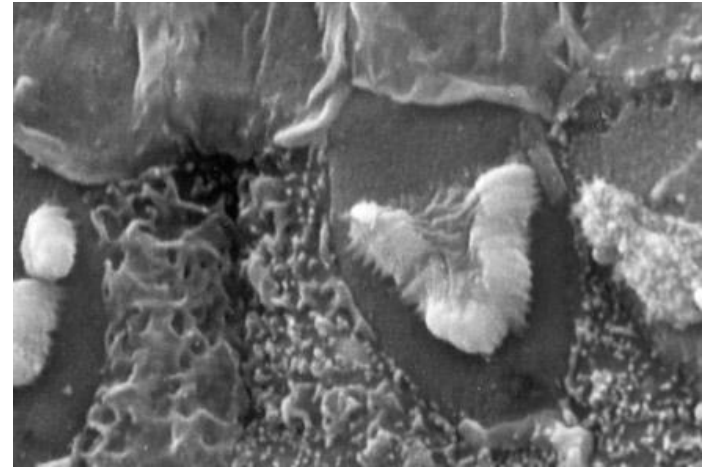
Ageing and noise-trauma cause loss of inner and outer hair cells



Healthy cochlea:  
1 row of inner hair  
cells and 3 rows  
of outer hair cells

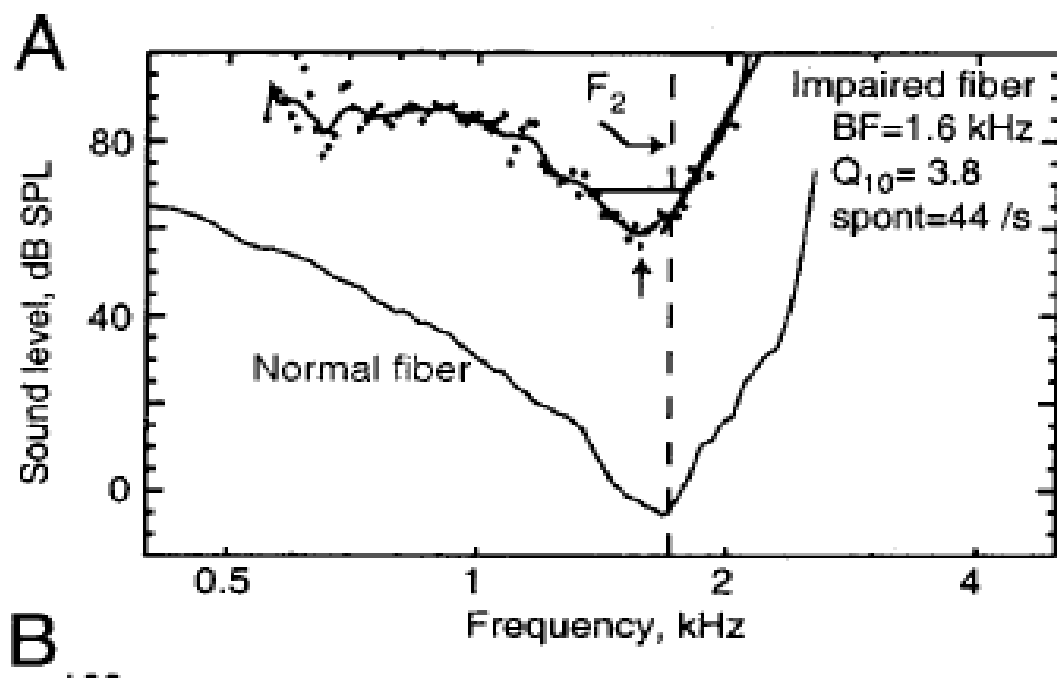


Mildly damaged  
outer hair cells



Severely  
damaged outer  
hair cells

# Auditory nerve fiber tuning curves after hearing loss



## Consequences of hearing loss

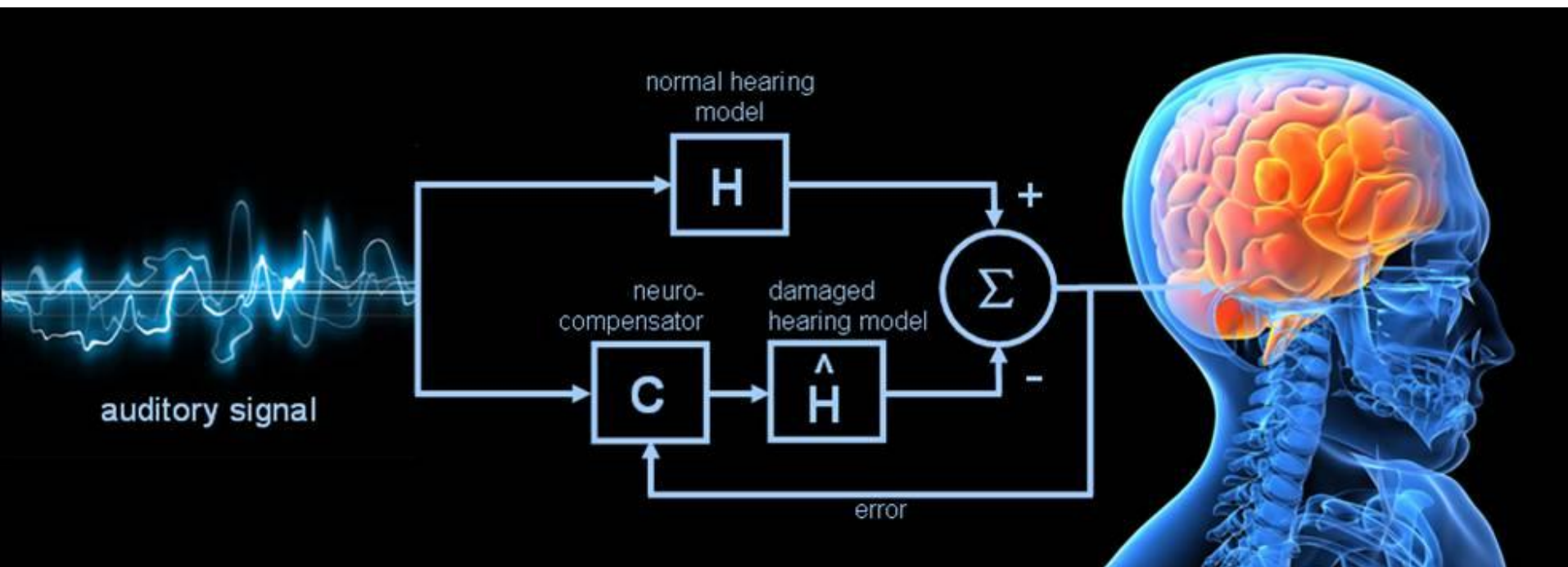
### Outer hair cell loss

- Loss of loudness compression
- Elevated thresholds
- Loss of nonlinear contrast enhancement → broader tuning curves, more interference

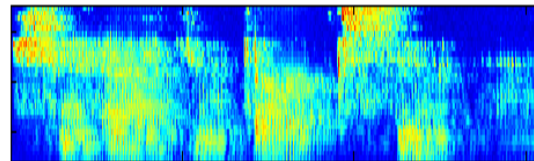
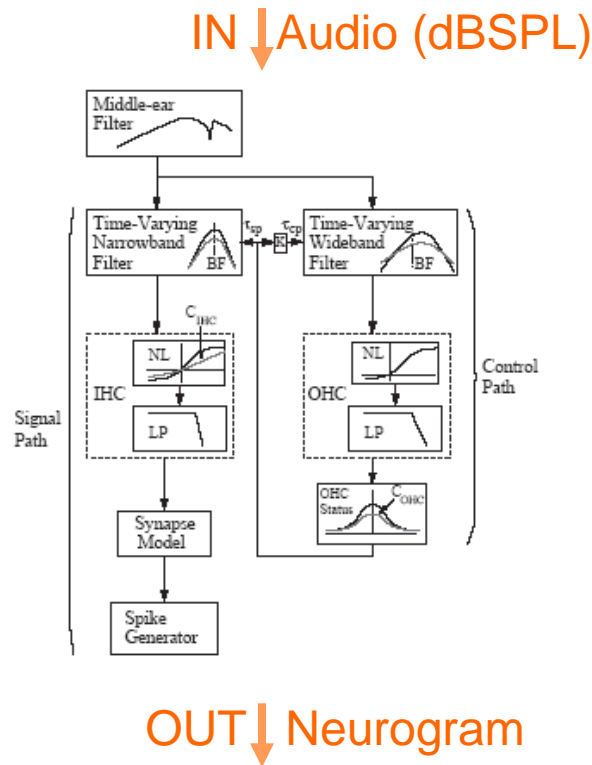
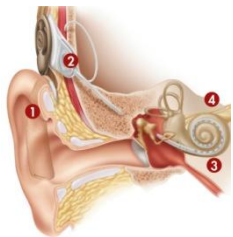
### Inner hair cell loss

- Total loss of hair cells for some frequencies causes “hole in hearing”
- Other hair cells become more broadly tuned → erroneous thresholds in audiogram

The concept behind the Neuro-Compensator®: Use an auditory model to derive the optimal hearing parameters



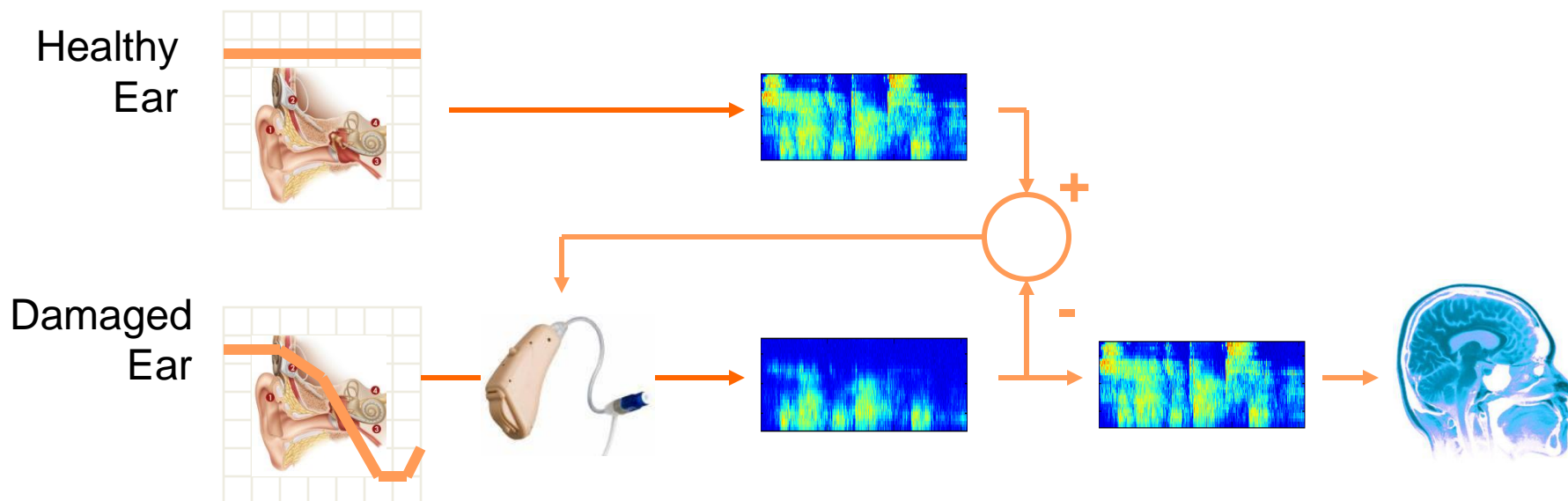
Use an auditory model to derive the optimal hearing parameters



- Patient's auditory model derived from audiogram
- Describes the functions of the auditory system from the middle ear to auditory nerve
- Captures a range of phenomena due to hair cell nonlinearities



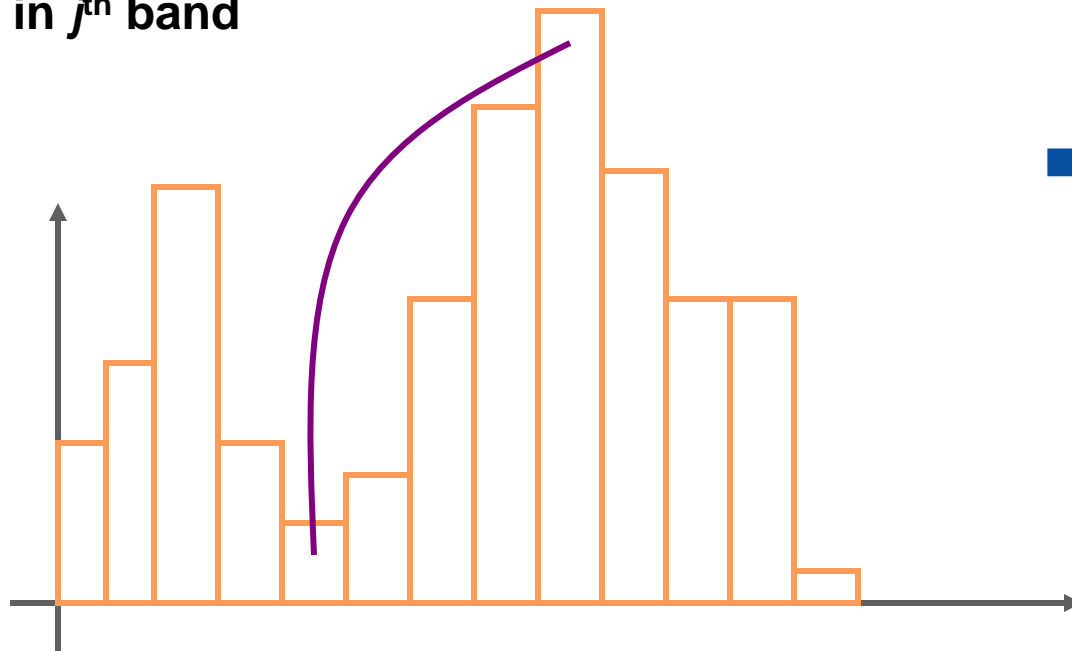
## How the Neuro-Compensator® works



The Neuro-Compensator® restores a near-optimal electrical signal from the auditory nerve to the brain

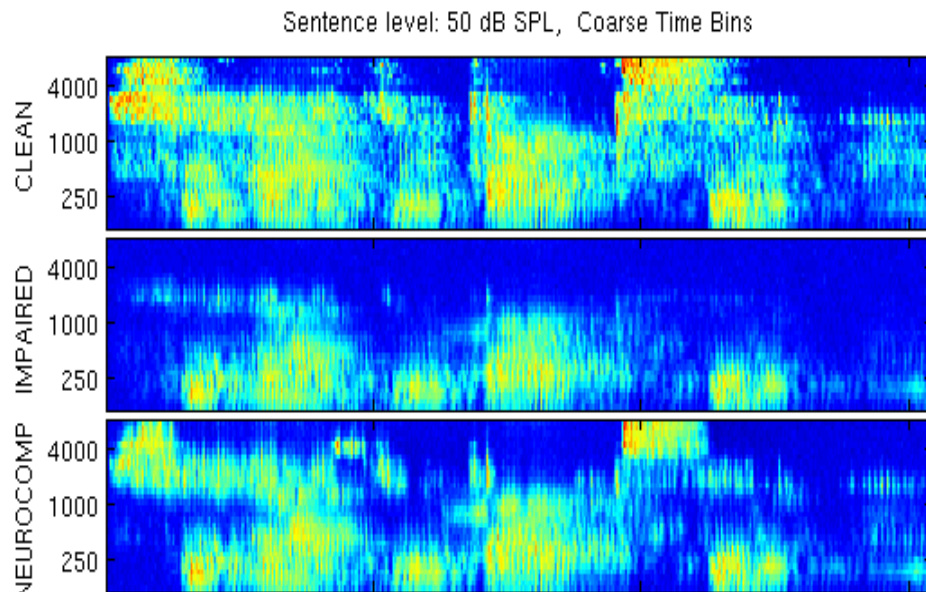
## Amplification algorithm

Level in  $i^{\text{th}}$  band affects  
gain in  $j^{\text{th}}$  band



- Algorithm minimizes error between healthy and damaged models
- Machine-learning algorithm computes Neuro-Compensator<sup>®</sup> parameters
- Takes into account cross-frequency and cross-temporal interactions

## Neuro-Compensator®



- Healthy ear
- Impaired (unaided)
- Impaired + Neuro-compensation



Neuro-Compensator®

Benefits

## Benefits

- Users have reported improvements in
  - Clarity of sound/intelligibility of speech
  - Fuller spectrum of TV sounds at lower levels
  - Perception of true pitch
  - Naturalness of speech, music, and own voice
  - Localization & 'spatial' quality



# Neuro-Compensator<sup>®</sup>

## Benefits

- *“increased my ability to hear in crowded situations – for example, a cocktail party, or out shopping with friends”*
- *“the room just came alive”*

- *“provides transparent sound well into the soprano range and I could hear better how the bass fitted into the harmonization”*
- *‘was pleased with the reproduction of natural sounds, particularly birds’ .....’no problem with occluded sound when I was singing’*