

A High-Fidelity Portable Platform for Development of Novel Algorithms for Assistive Listening Wearables*1

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***1 including hearables, OTC hearing aids, PSAPs and hearing aids**

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The Need

- New algorithms cannot be developed in a vacuum, but rather within a set of interdependent hearing aid routines (such as feedback cancellation). Thus the development platform needs to feature a complete basic set of hearing aid algorithms.
- Also, an organised set of rules has to exist to incorporate the new algorithms (“plugins”) within the desired hearing aid configuration.
- Finally, it is anticipated that academic researchers would be more efficient if these algorithms and the environment are at a relatively “high” software level as opposed to the Assembly programming common in the current industrial environments. This mainly means something from the broad families of:
 - C++
 - Matlab
 - Unix/Linux shell programming

The Need

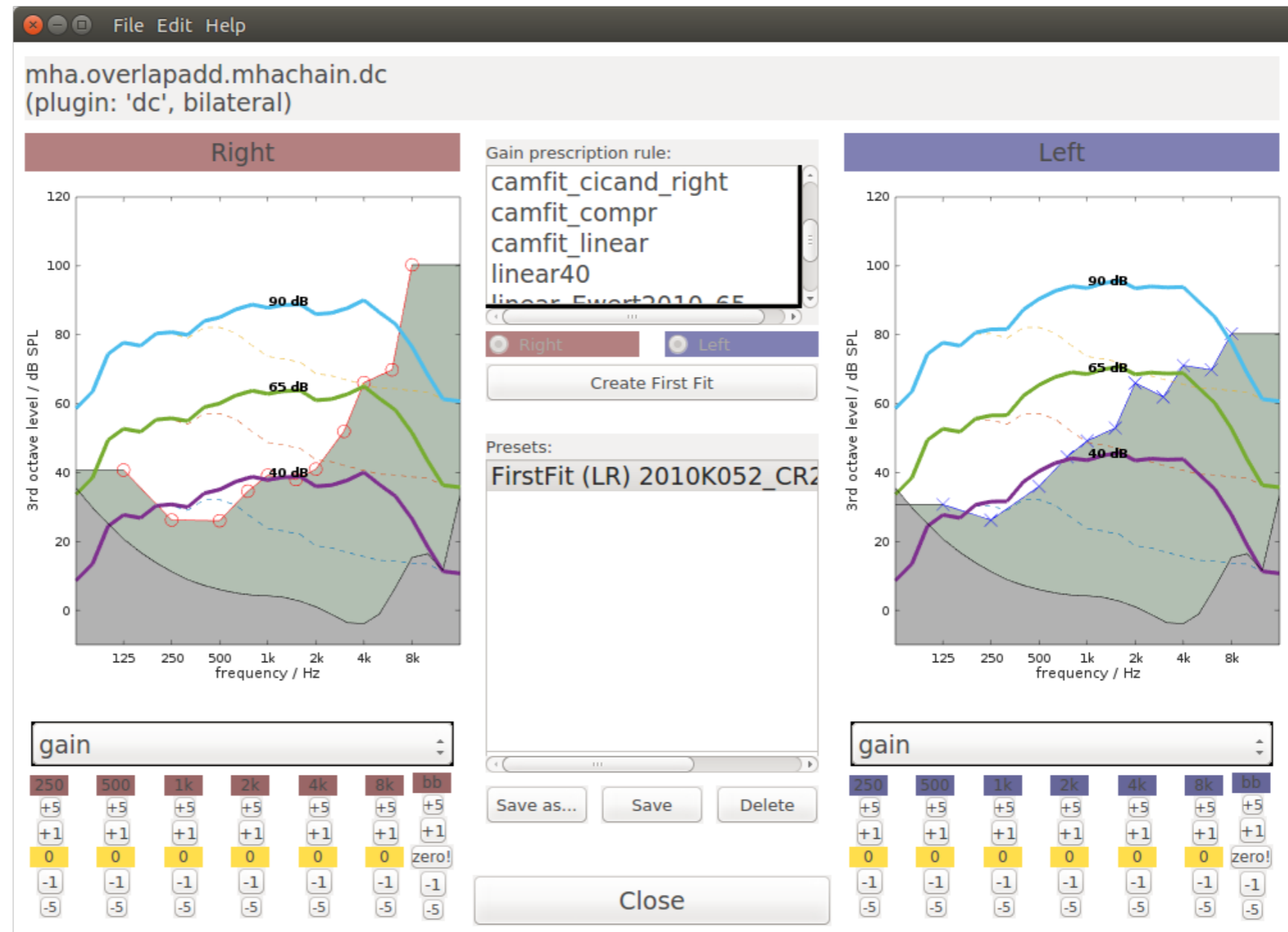
New algorithm development also requires:

- portability: the ability to test the innovation outside of the laboratory
- realistic transducers corresponding to various hearing aids and wearables (RIC, ITE, earbud, etc.)
- apps for testing new algorithms

SOFTWARE designed for different user groups

Clinicians who

- use “plug and play” software modules
- change processing parameters at high level



SOFTWARE

designed for different user groups

Audiological Researchers

- who access configuration interface as a text file

```
# Frequency bands
mha.overlapadd.mhachain.fftfilterbank.f = [250 1000 4000]

# Threshold of noise gate in dB SPL
mha.overlapadd.mhachain.dc_simple.expansion_threshold = [20 20 20 20 20 20]

# Slope of level mapping below noise gate
mha.overlapadd.mhachain.dc_simple.expansion_slope = [4 4 4 4 4 4]

# Gain at 50 dB SPL
mha.overlapadd.mhachain.dc_simple.g50 = [10 25 40 11 31 55]

# Gain at 80 dB SPL
mha.overlapadd.mhachain.dc_simple.g80 = [5 15 10 5 21 19]

# Limiter threshold, a.k.a maximum possible output level, in dB SPL
mha.overlapadd.mhachain.dc_simple.limiter_threshold = [120 120 120 120 120 120]

# attack time constant in s
mha.overlapadd.mhachain.dc_simple.tau_attack = [0.02]

# decay time constant in s
mha.overlapadd.mhachain.dc_simple.tau_decay = [0.1]

# Name of fftfilterbank plugin. Used to extract frequency information.
mha.overlapadd.mhachain.dc_simple.filterbank = fftfilterbank
mha.overlapadd.mhachain.combinechannels.outchannels = 2
```

SOFTWARE

designed for different user groups

Plugin developers

```
# include "mha_plugin.hh"  
# include "mha_tablelookup.h"  
# include "mha_filter.hh"  
  
namespace dc {  
using namespace MHAPlugin;  
class wideband°inhib°vars°t;
```

Basic Hearing Aid Algorithms

50% of the processing capacity

50% for new algorithms

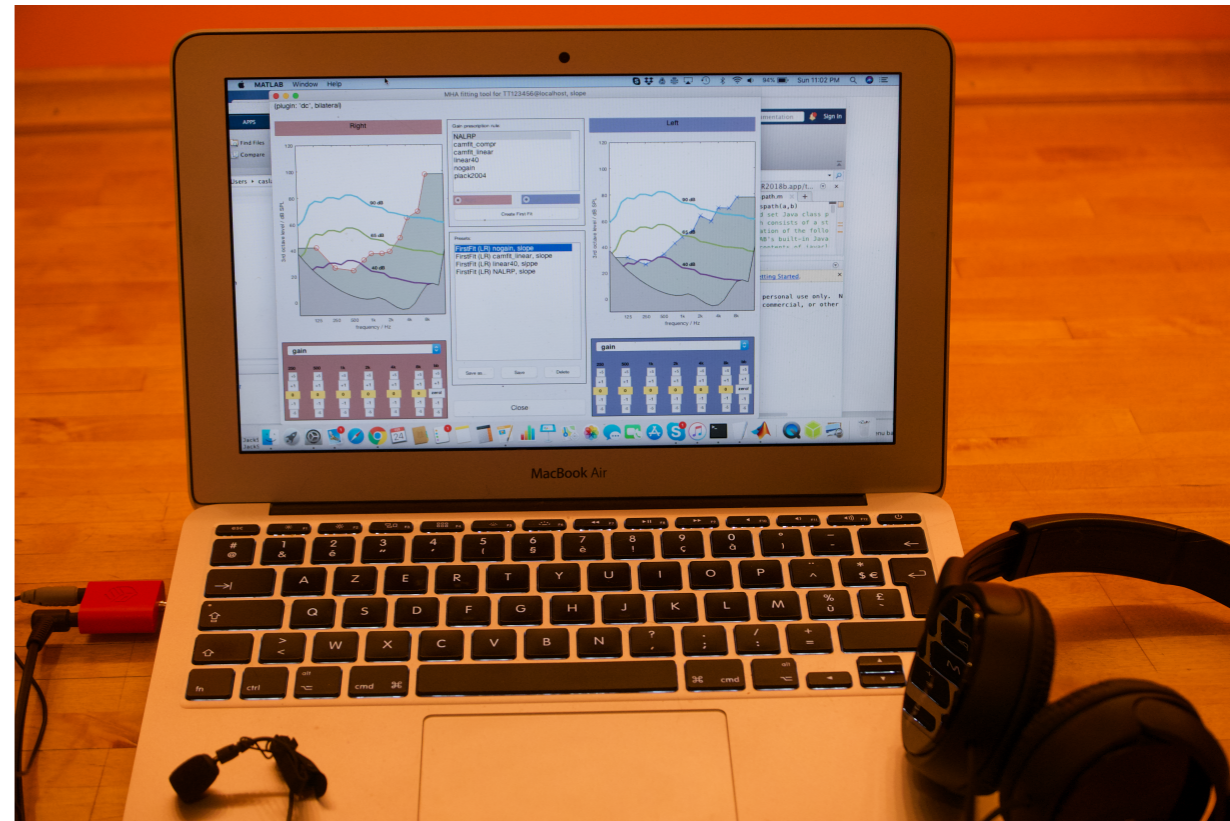
- calibration
- multi-band dynamic compressor
- adaptive feedback cancellation
- single-channel noise reduction
- adaptive differential microphone
- binaural coherence filter
- binaural beamforming algorithms
- sound source localization

Two Hardware platforms

1. Desktop setup - off the shelf

requires:

- Windows, Linux or MacOs
- Headphones that provide a good sound isolation
- A lapel microphone(s)

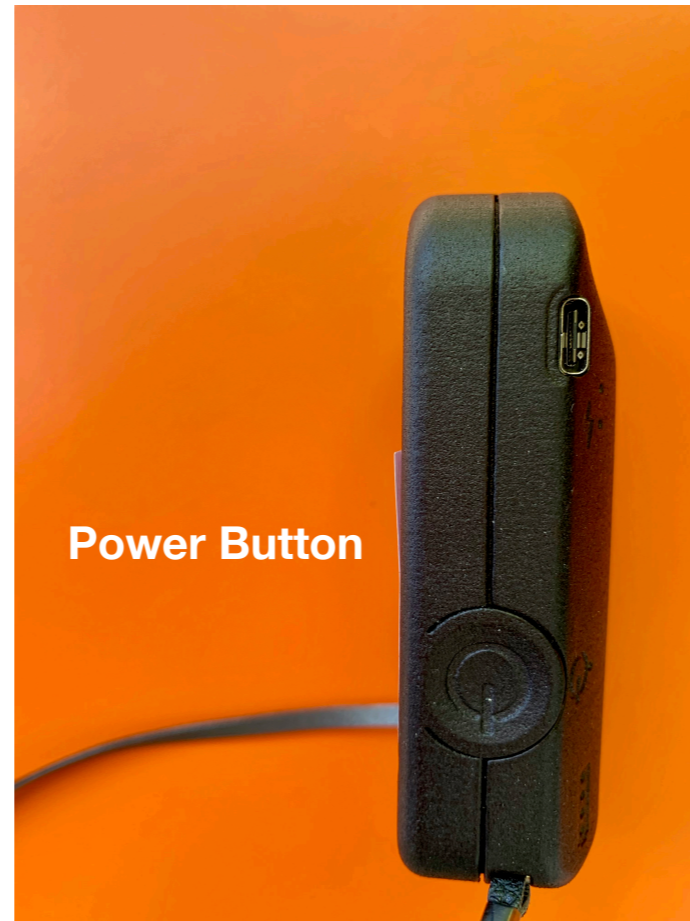


2. Portable platform (B&C Hub)

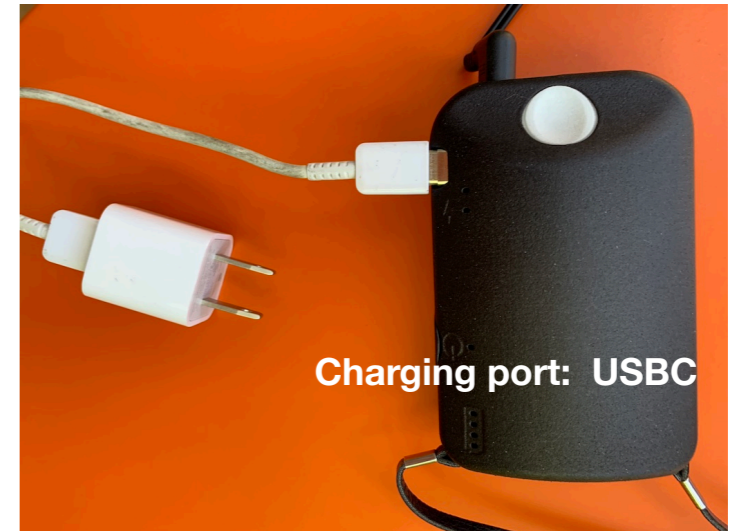
- Linux computer system
- ARM Cortex A8 processor core
- Clock: 1 GHz
- Flash Memory: 2 GB
- RAM: 512 MB
- 6 input and 6 output channels

2. Portable platform (B&C Hub)

Power Management



Power Button



Charging port: USB-C



Power ON/OFF LED



Charge Indicator LED

- Battery capacity 2600 mA
- 6 hour battery life with the full basic algorithm set
- 3 hours at 100 % processing load

2. Portable platform (B&C Hub)

Programming ports



2. Portable platform (B&C Hub)

Wireless interface ports for smart phones and other wearables

- WiFi
- BLE data

coming later:

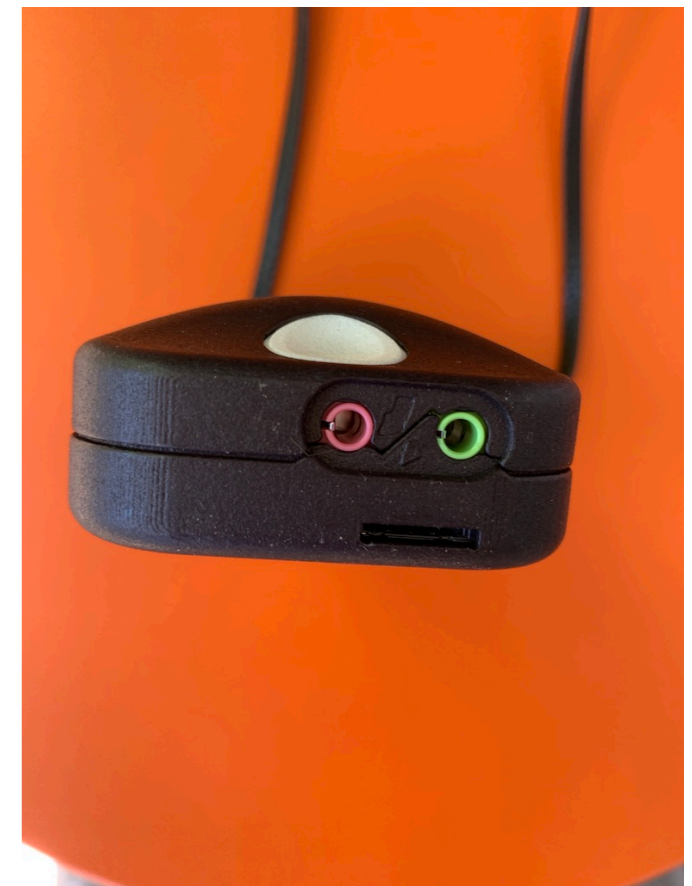
- BT Classic
- BLE voice

2. Portable platform (B&C Hub)

Audio Connectivity



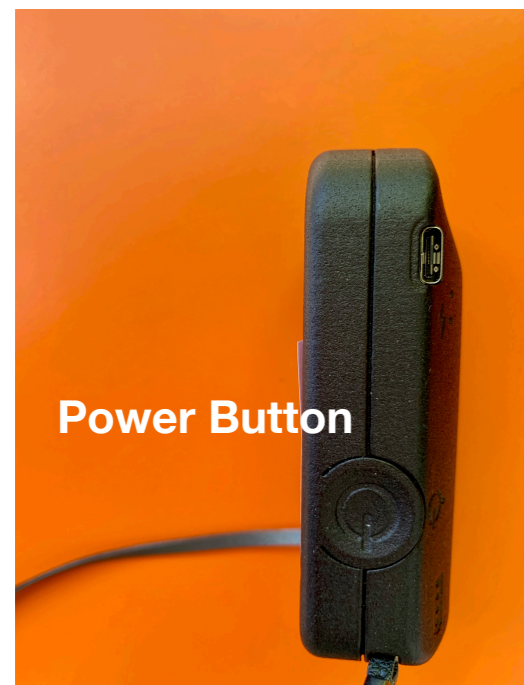
- The HDMI connector supports 6 microphones and 6 speakers
- The Line In and Out connectors support 2 microphones and two speakers



2. Portable platform (B&C Hub)

User Interface

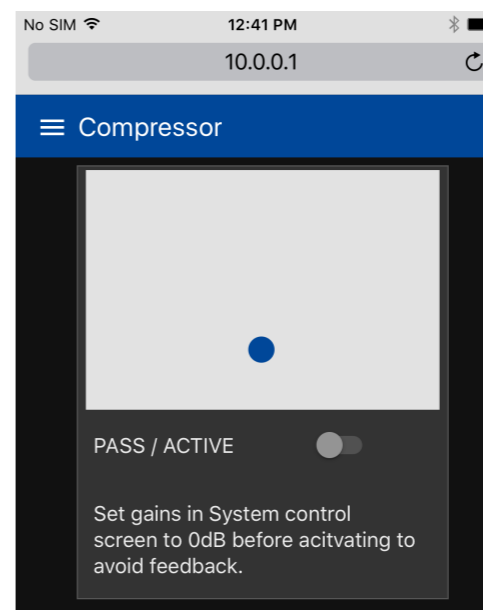
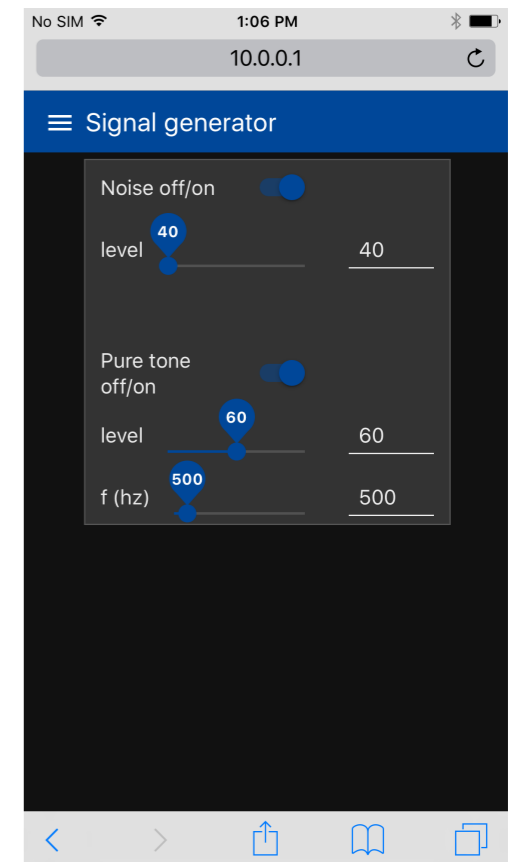
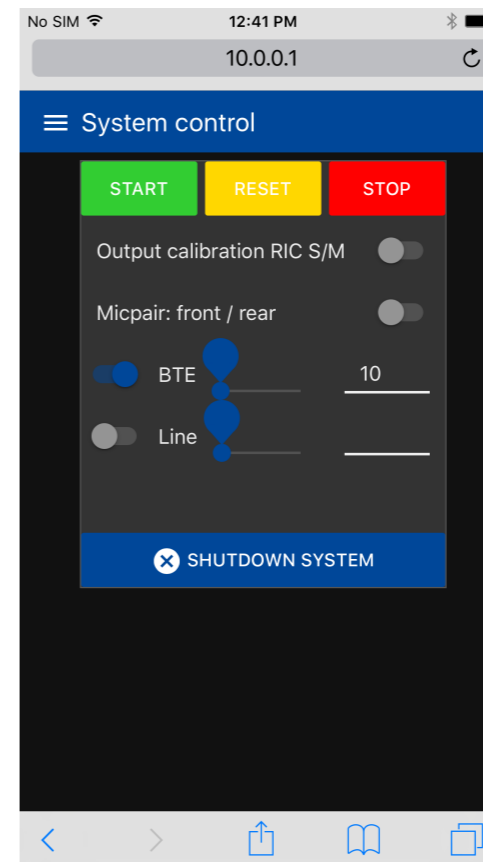
1. On the hub:



2. On the smart phone

tools for the researcher:

Earprint for self-fitting



System Solutions

Binaural BTEs



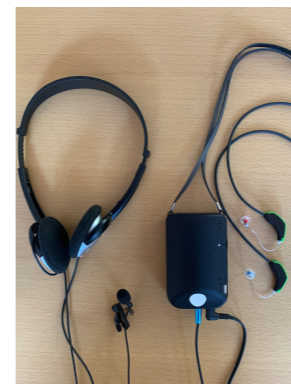
Binaural ITEs



Solutions for Wearables/Hearables



A Researcher Setup



BTE devices

Binaural BTEs

Dual microphones

Equivalent Input Noise 18-20 dB SPL

2 models:

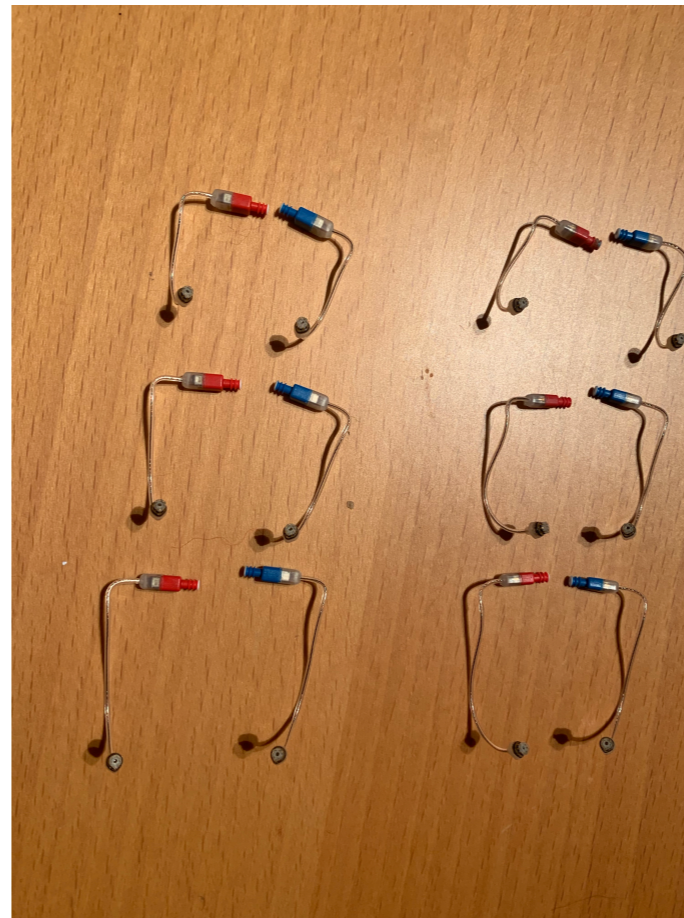
Subject model

Researcher model



BTE Accesories

- 2 different Sonion RICs cover mild to severe loss
- 3 different RIC connector lengths
- 4 different dome types for different occlusion
- Wax guards



ITE devices

- Developed by: Florian Denk & colleagues (University of Oldenburg) and InEar GmbH
- Adapted via Bat&Cat Y adapter to the B&C Box
- Two models: with and without the vent
- Three microphones at the outer surface (two supported with the current Y adapter wiring)
- One in-ear microphone.
- Two balanced armature speakers with separate drivers in each earpiece



Wearables

- Line In
- Line Out



Research Setup

Three listening modes for algorithm development:

- BTE mics to RICs
- BTE mics to comfortable headset speakers
- Headset mics to headset speakers

