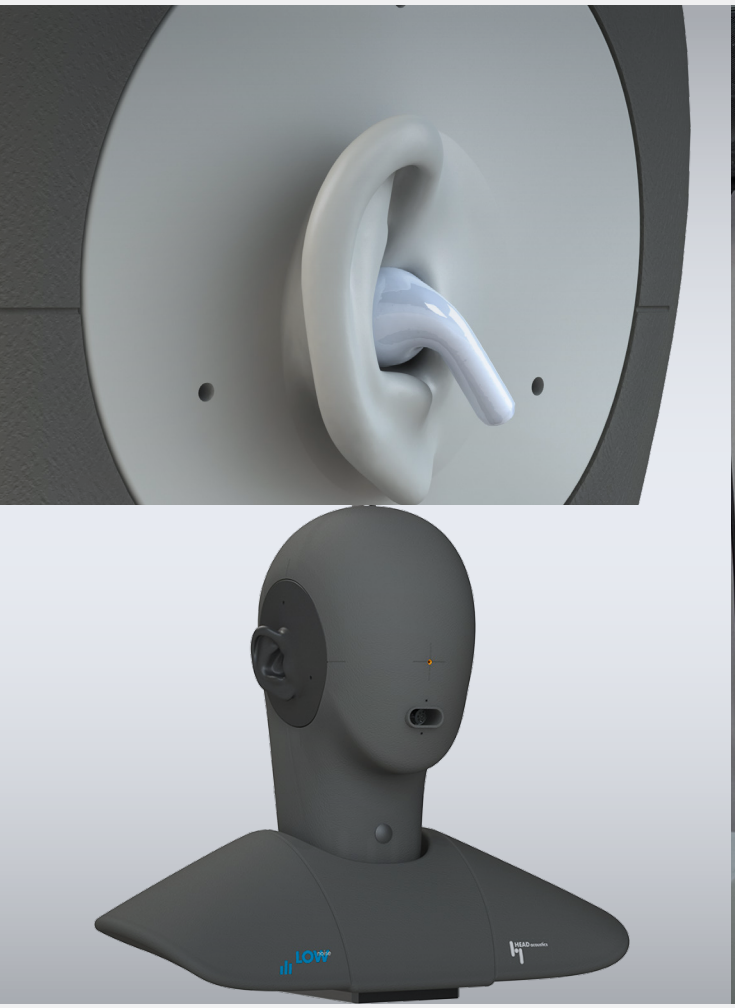
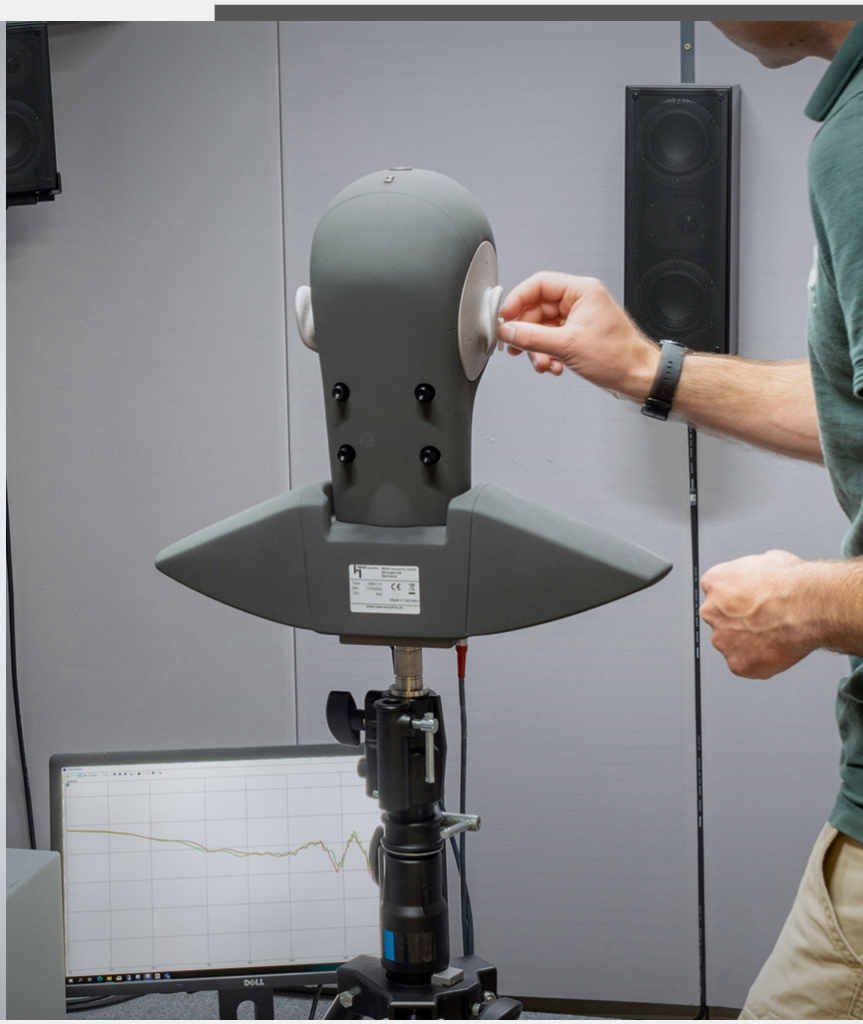
HEAD acoustics

APPLICATION GUIDE





In-ear headphones positioning at HMS II.3 LN HEC

Application Guide

In-ear headphones positioning at HMS II.3 LN HEC

Revision 1

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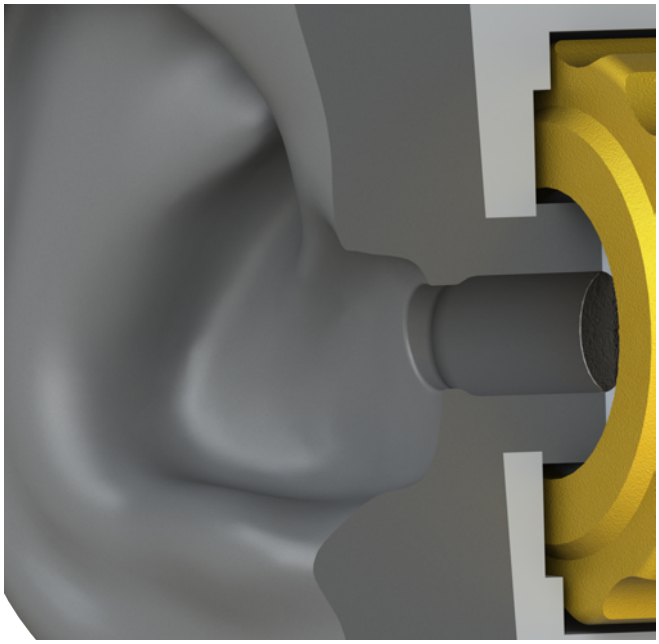
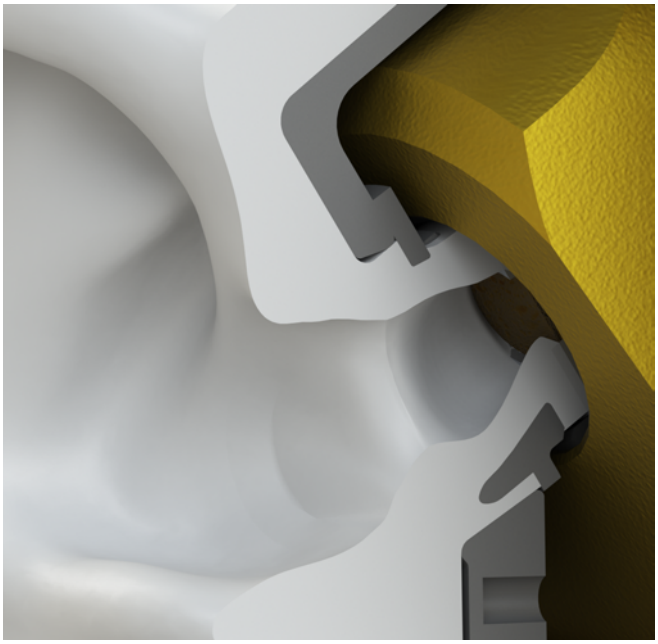
1 Introduction

The HEAD Measurement System HMS II.3 LN HEC is equipped with an ear simulator and type 4.4 pinnae including a human-like ear canal. It is ideally suited for close-to-reality measurements of in-ear headphones and other insert-type devices with or without active noise cancellation (ANC).

Because of the human-like geometry of pinna and outer ear canal, the ear simulators of HMS II.3 LN HEC require a different technique for inserting in-ear headphones as opposed to the regular type 3.3 pinna with its straight ear canal. It is important to apply the technique described in this document when working with HMS II.3 LN HEC to prevent damage from pinna and ear canal.



Straight ear canal, type 3.3 pinna



Human-like ear canal, type 4.4 pinna

Additionally, the document introduces a highly recommended technique to achieve proper fit of in-ear headphones / headsets and other insert-type devices in the pinnae of HMS II.3 LN HEC. The procedure ensures an equally proper seal of the ear canal for both, the left and right unit of in-ear headphones. Repeatability of measurements when inserting the same in-ear headphones again is significantly improved. The introduced technique only needs a reasonable one-time expenditure during initial hardware setup. It simplifies and accelerates each subsequent measurement procedure.

The document distinguishes procedures for in-ear headphones with and without ANC functionality. The procedures require different approaches and equipment. The first procedure only applies to in-ear headphones with ANC functionality. The other one applies to in-ear headphones with Bluetooth wireless technology or wired headphones connected to a smartphone.

Concluding, the techniques described in this document improve measurement reliability and repeatability, prevent accidental damage of sensitive equipment and streamline the setup process for more efficient work.

2 Handling of in-ear headphones

2.1 Insertion of in-ear headphones

The type 4.4 pinna has a human-like ear canal. The ear canal in the pinna is not perpendicular to the pinna's surrounding surface.

The ear canal of the type 3.3 pinna as described in Recommendation ITU-T P.57 is straight and perpendicular to the surrounding surface, thus a straight insertion of in-ear headphones is recommended only for type 3.3 pinna.

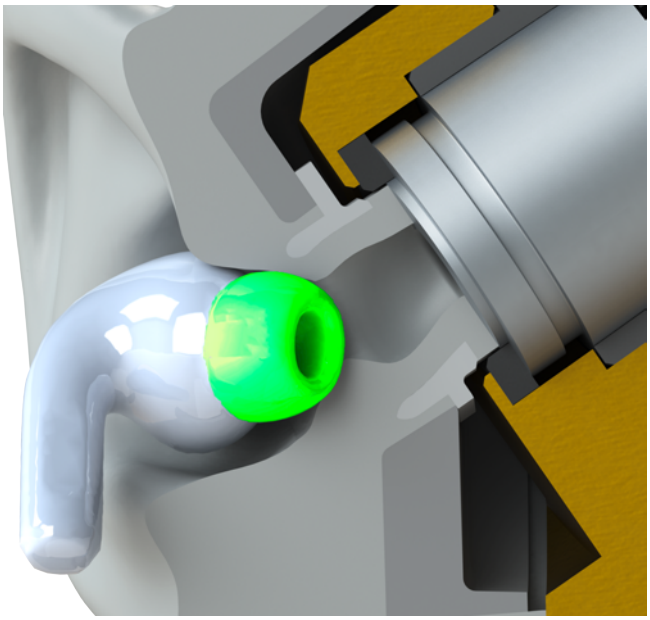
The ear canal of HMS II.3 LN HEC follows human anatomy, progressing towards the face and increasingly upwards when viewed from the outside. In-ear headphones and similar devices are designed to fit the human anatomy with optimum comfort and a good seal. Therefore, such devices must not be inserted directly perpendicular to the pinna's surrounding surface as it is standard practice with the perpendicular ear canal of other artificial ears.

Insert the in-ear headphone into the type 4.4 pinna in the same way it is inserted into a human ear: gently and carefully, angled from the back towards the face and with some gentle twisting of only a few degrees of angle.

For inserting in-ear headphones, always follow the instructions of the original equipment manufacturer (OEM).

Never press the in-ear headphone forcefully into the ear canal. Neither the in-ear headphones, nor the type 4.4 pinna are designed to withstand excessive force. Using excessive force damages the pinna.

Many in-ear headphones have a silicone eartip (green) that adjusts to the shape of the ear canal.



The eartip is designed to achieve a proper seal in a human ear while maintaining optimum comfort by avoiding unpleasant pressure onto any part of the ear. Hence, forcing the in-ear headphone into the ear has no benefits. Neither for a real human ear, nor for the type 4.4 pinna.

Verify a proper fit and the quality of the seal by following chapter 3.2 or chapter 4.2 in accordance with the functionality of the in-ear headphones.

2.2 Wear of pinna HEL / HER 4.4(-V1)

The pinna HEL/HER 4.4(-V1) is a wear part.

The periodic exchange of in-ear headphones wears out the ear canal of pinna HEL/HER 4.4(-V1). Misuse and forcefully insertion of in-ear headphones may lead to damage and / or rapid wear of the pinna.

Do not forcefully insert in-ear headphones into the pinna.

Insert in-ear headphones by following the instruction of the manufacturer (OEM).

The figures in this chapter illustrate the wear after an endurance test.

Replace the pinna when wear is clearly visible in the ear canal and / or the measurement results start deviating from former results with the same equipment and settings.

3 Fit of ANC in-ear headphones

3.1 Prerequisites

3.1.1 Software requirements

- ACQUA (Code 6810), Advanced Communication Quality Analysis Software
- ACOPT 19 (Code 6842), ACQUA option Online analysis
- Background noise simulation software
  - 3PASS *lab* (Code 6990), Background noise simulation software

  or
  - 3PASS *flex* (Code 6995), Background noise simulation software

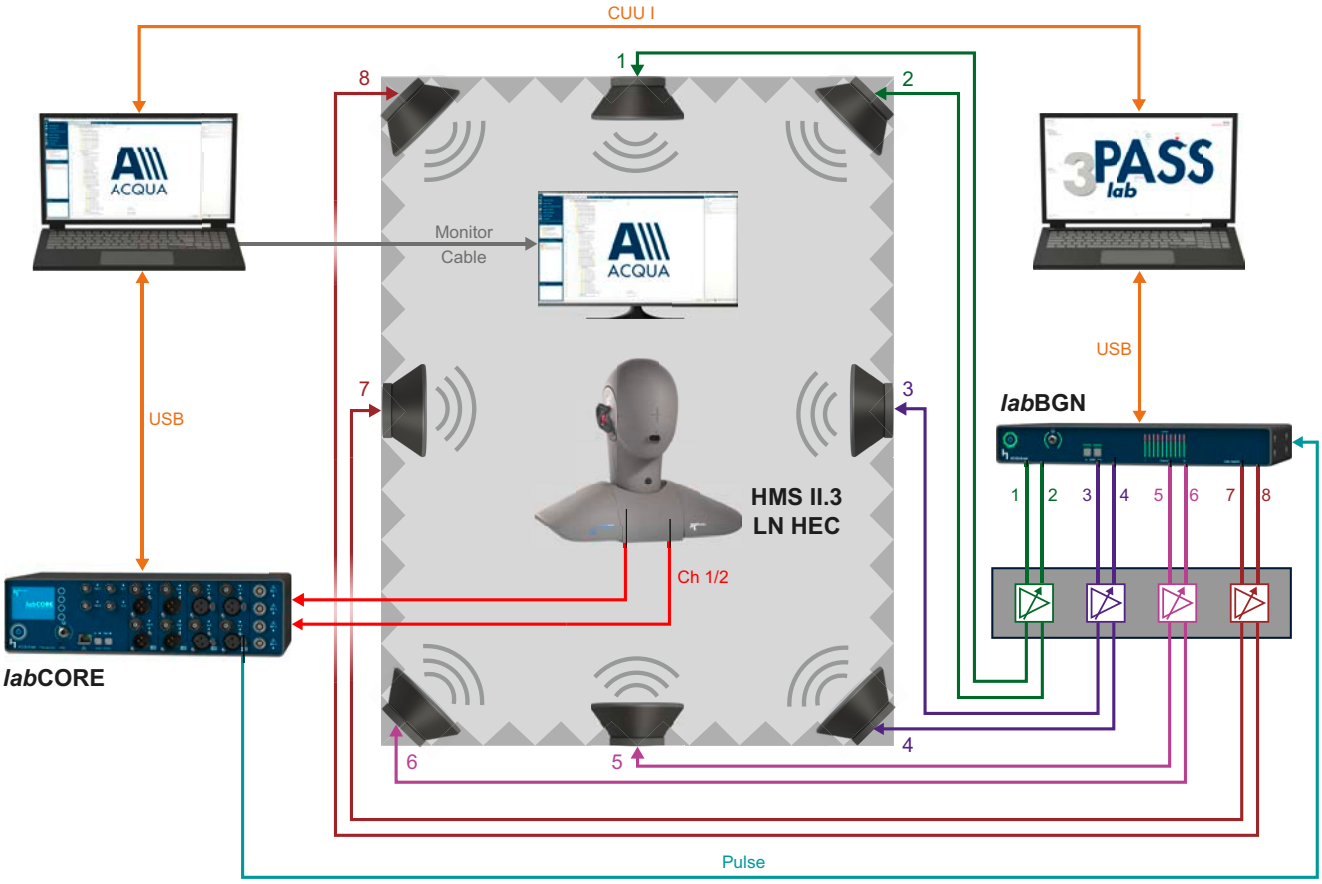
3.1.2 Hardware requirements

- *lab*CORE (Code 7700) including
  - *core*BUS (Code 7710), I/O bus mainboard
  - *core*IN-Mic4 (Code 7730), Microphone input board
  - *core*BEQ (Code 7740), Binaural equalization software extension
- HMS II.3 LN HEC (Code 1703.2), HEAD Measurement System, Low-Noise Version with Human-like Ear Canal Simulator Right & Artificial Mouth
- Hardware equipment for background noise playback via 3PASS *lab* / *flex*
- ACQUA PC with at least two video output ports
- PC for 3PASS *lab* / *flex*[1]
- 3 x computer screens
  - 2 x for ACQUA PC
  - 1 x for 3PASS PC[1]

1 ACQUA and 3PASS lab / flex may also run on one PC. PC shall meet appropriate system requirements.

3.1.3 Measurement configuration

This measurement configuration illustrates the interconnection of the hardware components. Position ACQUA PC, 3PASS PC, *lab*CORE and *lab*BGN outside of the measurement cabin. Place HATS, loudspeakers for background noise simulation and a second computer screen connected to the ACQUA PC inside of the measurement cabin. Position the screen accessible close to the HATS, but not obstructing a loudspeaker of the 3PASS system.

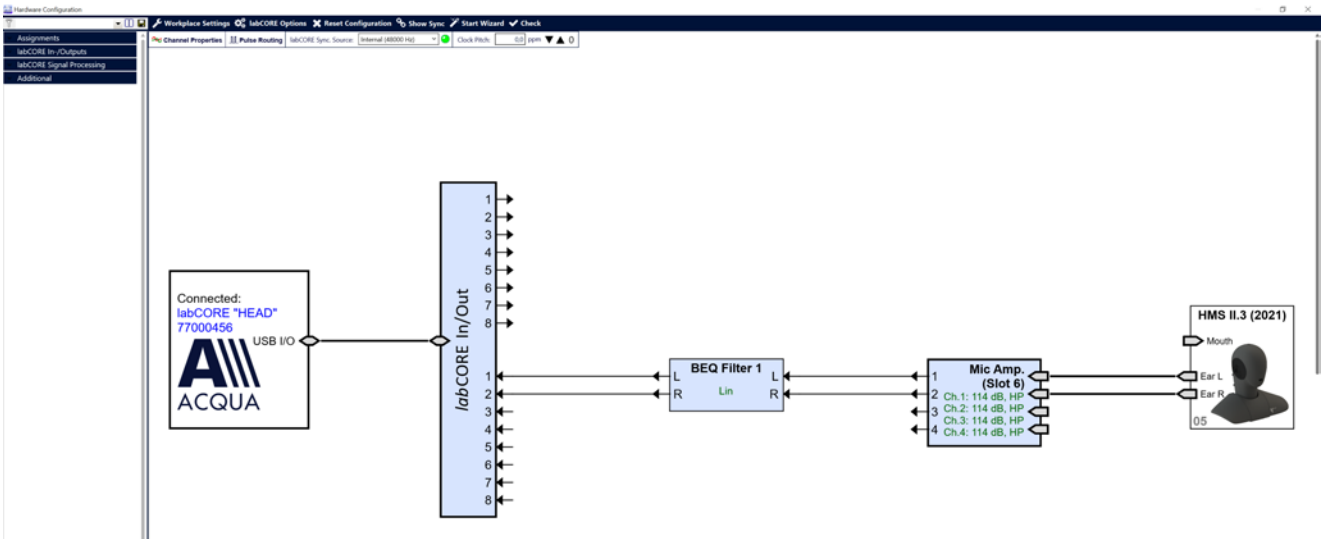


3.2 Verify the proper fit and seal of ANC in-ear headphones

- Set up the measurement configuration according to chapter 3.1.3 appropriately.
- Insert the in-ears into the left and right pinna of HMS II.3 LN HEC according to chapter 2.

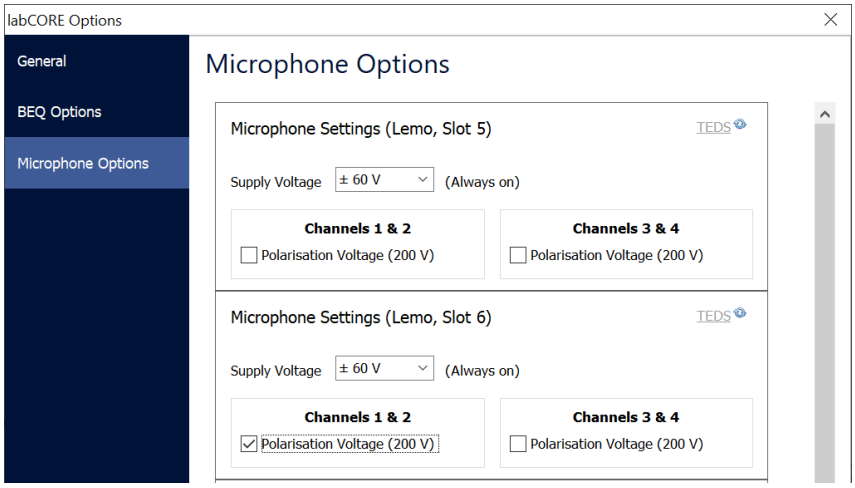
3.2.1 Hardware configuration in ACQUA

1. Start ACQUA.
2. Open Hardware Configuration.



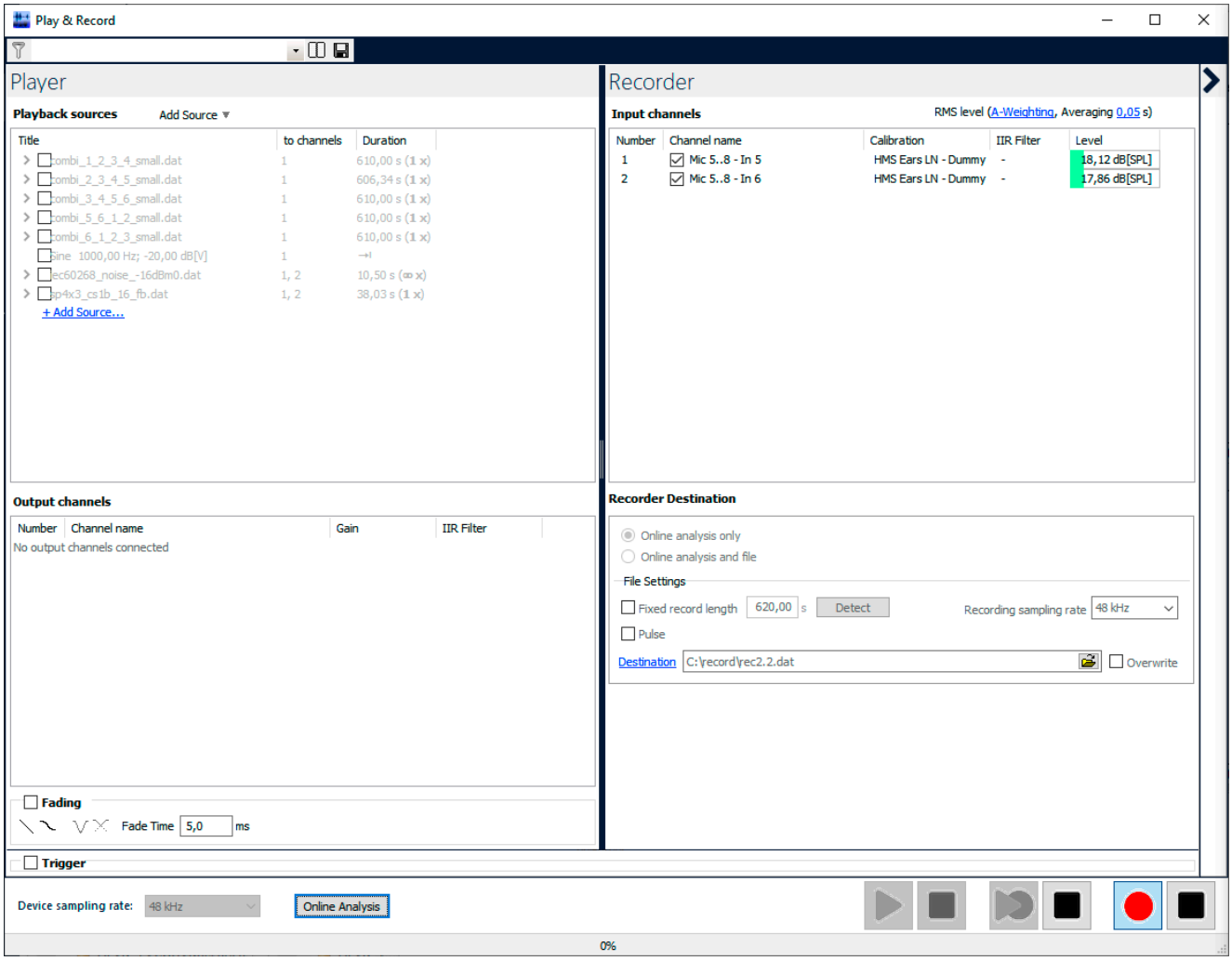
3. Drag and drop the blocks of the applied
   - HMS II.3 LN HEC → HATS
   - *core*IN-Mic4 → Mic Amp.
   - *core*BEQ → BEQ Filter

   to the configuration area.
4. Connect both ears of HATS to Mic Amp.
5. Connect two channels of Mic Amp. to BEQ Filter.
6. Connect two channels of BEQ Filter to labCORE In/Out.
7. Select labCORE Options.
8. Select Microphone Options.
9. Select Supply Voltage → ±60 V from the drop-down list.
10. Enable Polarization Voltage (200 V) for the applied channels.
11. Close labCORE Options.
12. Close Hardware Configuration.



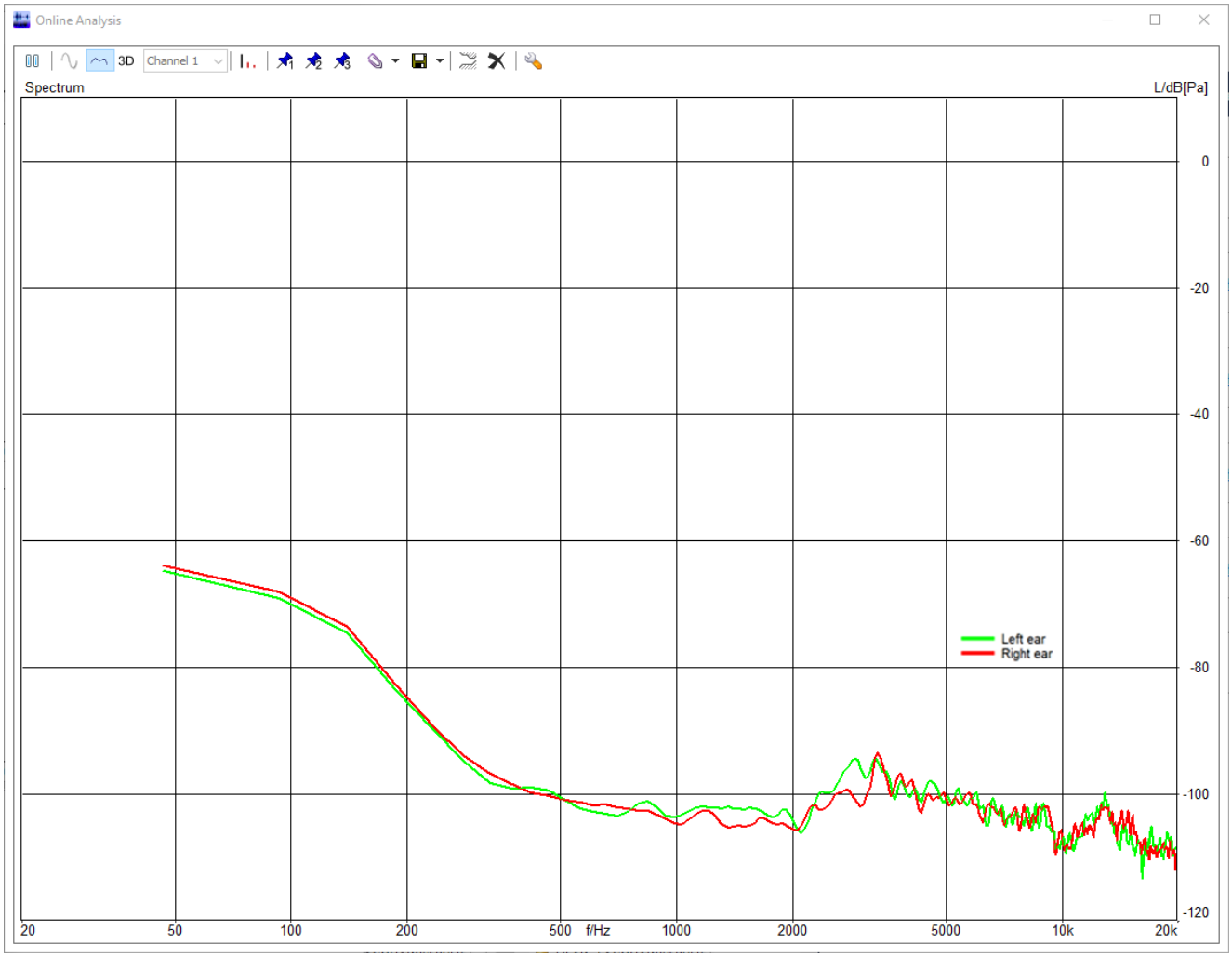
3.2.2 Play & Record settings

1. Open ACQUAlyzer.
2. Select to open Play & Record.



3. Enable both active channels in section Recorder → Input channels.
4. Enable Online Analysis only in Recorder Destination.
5. Select to start recording with the ear microphones of HMS II.3 LN HEC.
6. The indicated level shows the idle noise of the measurement cabin.

7. Select Online Analysis to start Online Analysis.

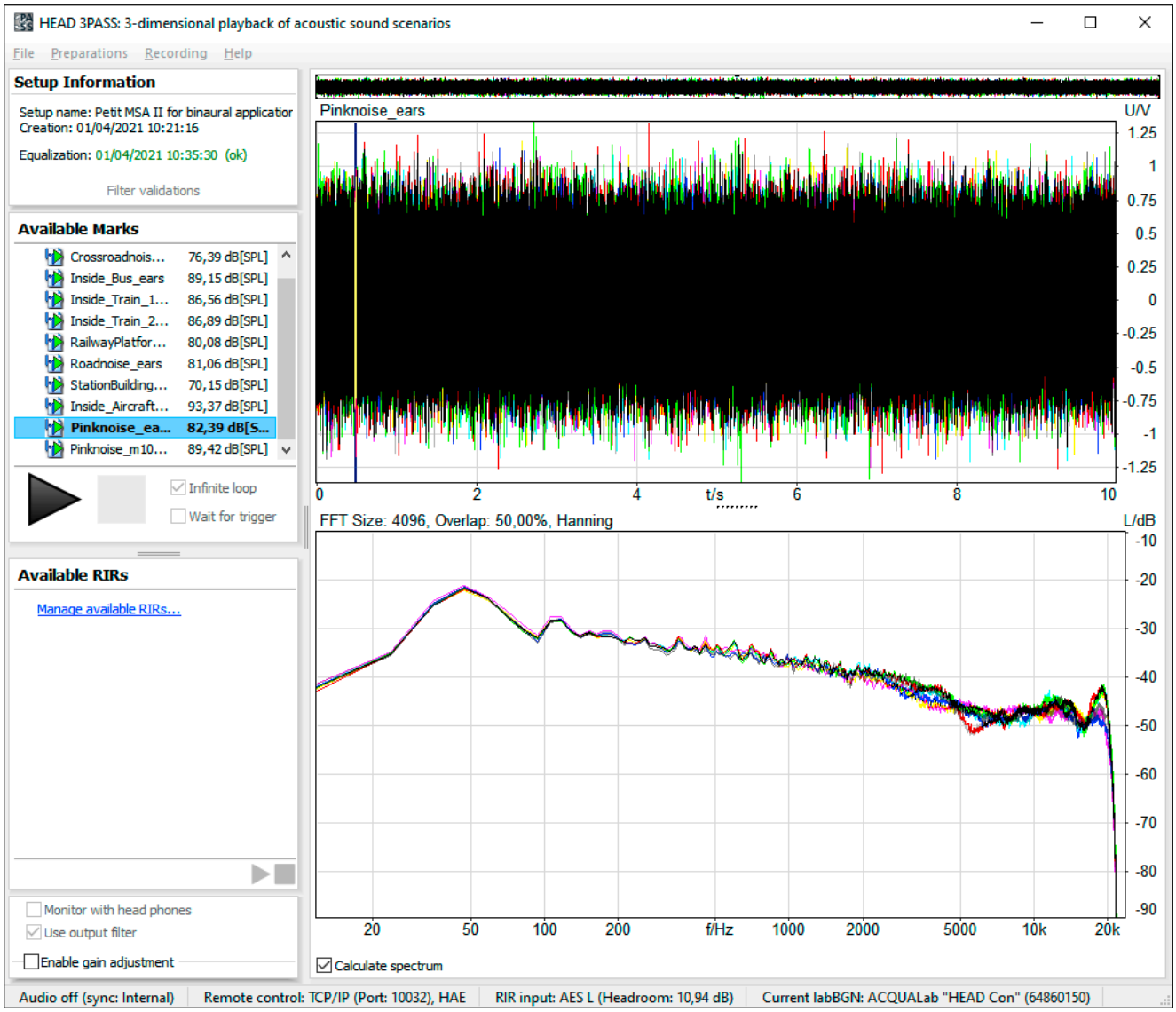


8. Online Analysis displays the current frequency response of both activated microphone channels.
9. Drag the Online Analysis window to the second screen of the ACQUA PC. The screen is positioned in the measurement cabin.
10. Maximize the Online Analysis window.

3.2.3 Playback via 3PASS

	Personnel shall wear hearing protection inside of the measurement cabin.

1. Start 3PASS lab / flex for playback of background noise.

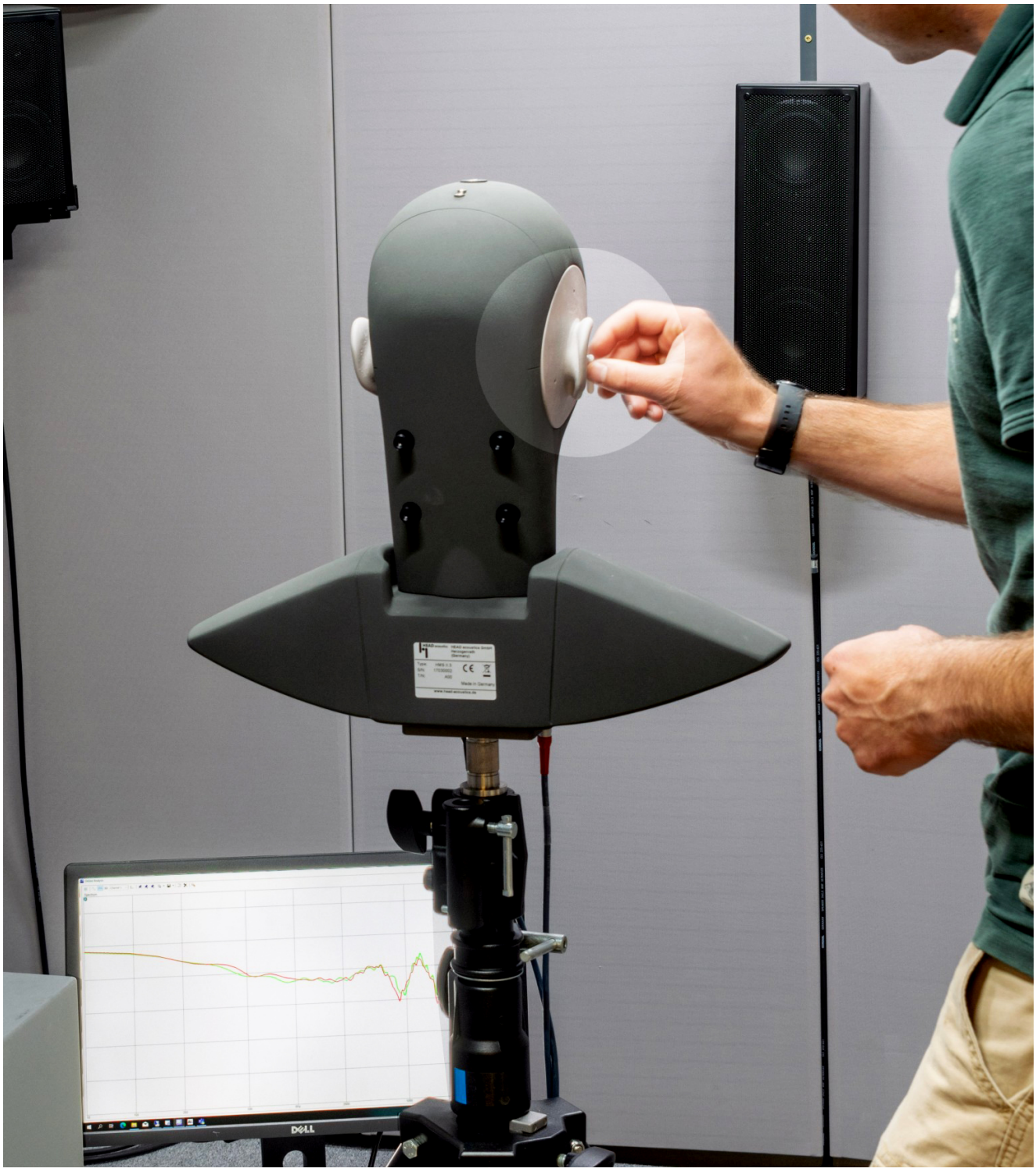


2. Select an appropriate setup including a valid equalization.
3. Select File → Add Sourcefiles...
4. Browse for file Pinknoise_ears.dat. The file is available for download on the HEAD acoustics website → Link.
5. Select Pinknoise_ears.dat in Available Marks.
6. Select ▶ to start playback of Pinknoise_ears.dat.

3.2.4 Manual adjustment of ANC in-ear headphones

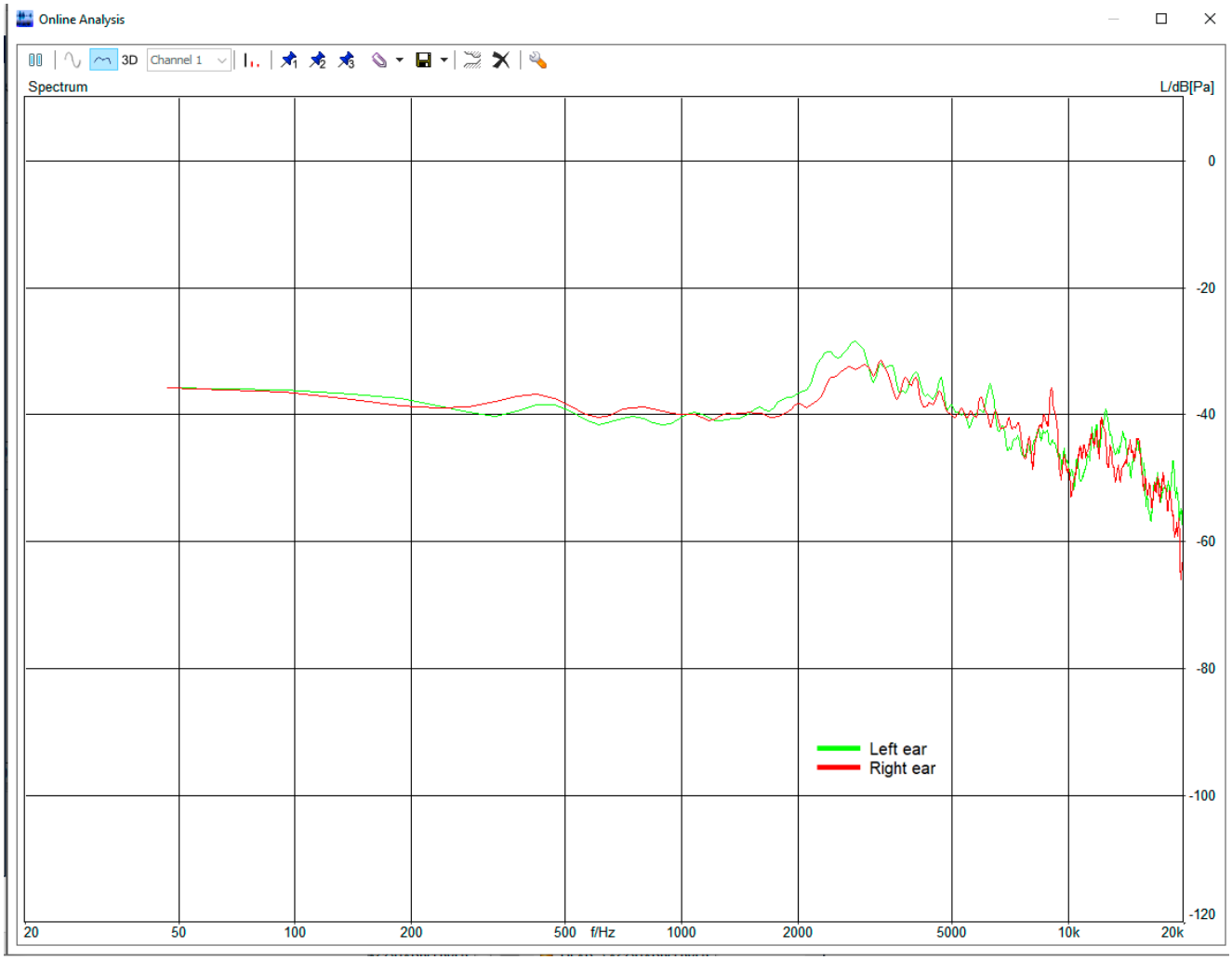
	Personnel shall wear hearing protection inside of the measurement cabin.

1. Enter the measurement cabin.



2. Switch on ANC functionality of the in-ear headphones.
3. Watch the online analysis spectra curves on the computer screen and carefully adjust the fit of the in-ear headphone within the right pinna.

4. A proper seal is indicated by the measured frequency response visible on the screen decreasing to a low SPL value. The low SPL indicates that the ANC is most effective, which is achieved only with a proper fit of the in-ear headphone in the ear canal. ANC usually is most effective at low frequencies, therefore the frequency response will most likely change the most towards the lower frequencies.



5. Repeat steps 3 and 4 for the in-ear headphone in the left pinna.
6. Match the spectra curves of left and right pinna as close as possible.

4 Fit of in-ear headphones

4.1 Prerequisites

4.1.1 Software requirements

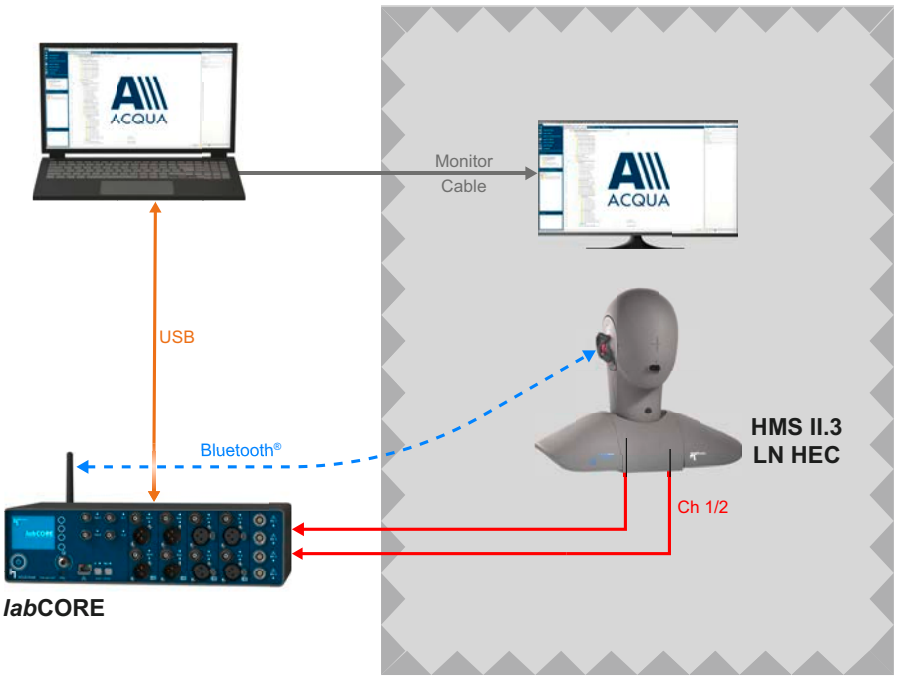
- ACQUA (Code 6810), Advanced Communication Quality Analysis Software
- ACOPT 19 (Code 6842), ACQUA option Online analysis

4.1.2 Hardware requirements

- *lab*CORE (Code 7700) including
  - *core*BUS (Code 7710), I/O bus mainboard
  - *core*IN-Mic4 (Code 7730), Microphone input board
  - *core*BEQ (Code 7740), Binaural equalization software extension
  - *core*IP (Code 7770), VoIP extension[2]
  - *core*BT2 (Code 7782), *lab*CORE Bluetooth extension[3]
    or
    coreBT (Code 7780), *lab*CORE Bluetooth extension[3]
- HMS II.3 LN HEC (Code 1703.2), HEAD Measurement System, Low-Noise Version with Human-like Ear Canal Simulator Right & Artificial Mouth
- ACQUA PC with two video output ports
- 2 x computer screens for ACQUA PC

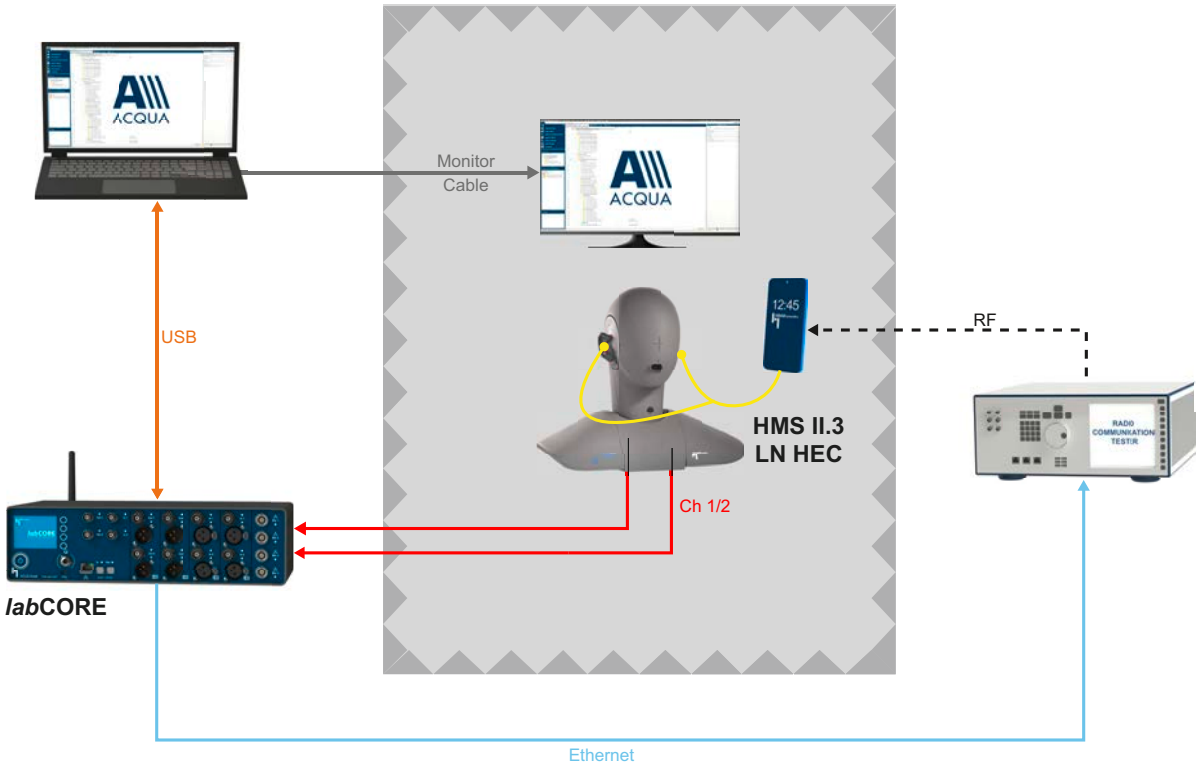
4.1.3 Measurement configurations (exemplary)

These measurement configuration illustrate the interconnection of the hardware components. Position ACQUA PC and *lab*CORE outside of the measurement cabin. The HATS is in the cabin. Additionally, a second computer screen is connected to the ACQUA PC and placed inside of the measurement cabin. Place the second screen accessibly for a person standing next to the HATS. Connect headphones according to their connection technology.



2 VoIP extension and a third party radio tester are required to send a signal via Smartphone to wired headphones.

3 Bluetooth extension is no requirement for wired in-ear headphones.

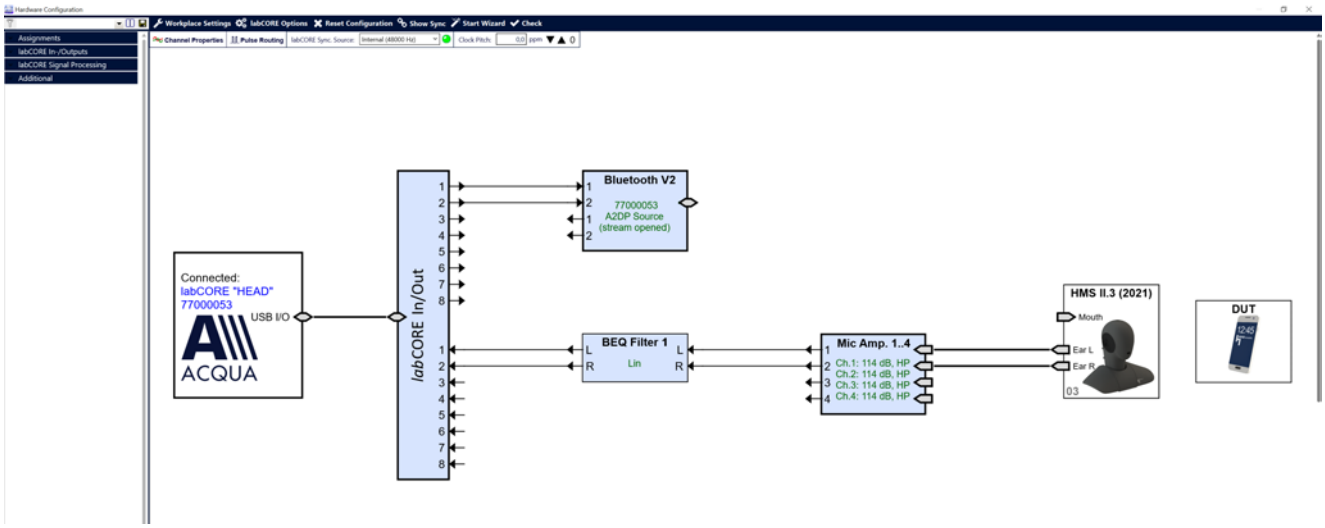


4.2 Verify the proper fit and seal of in-ear headphones

- Set up the measurement configuration from chapter 4.1.3 appropriately.
- Insert the in-ear headphones into the left and right pinna of HMS II.3 LN HEC according to chapter 2.

4.2.1 Hardware configuration for Bluetooth headphones

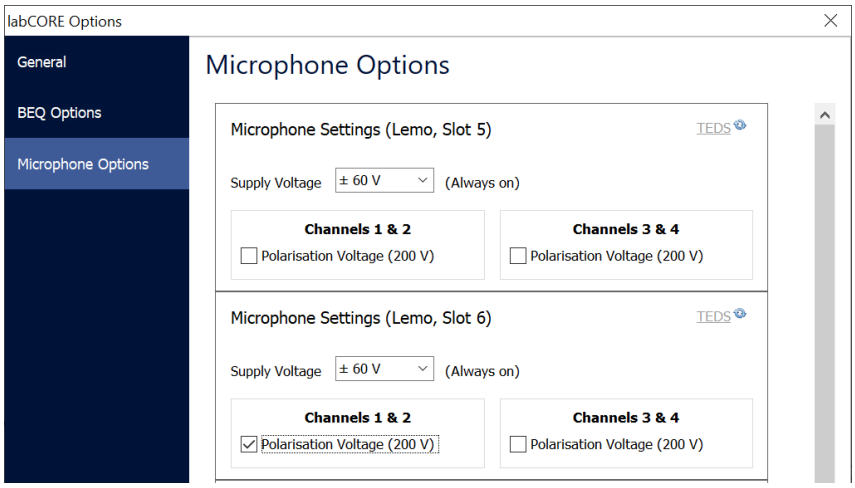
1. Start ACQUA.
2. Open Hardware Configuration.



3. Drag and drop the blocks of the applied
   - HMS II.3 LN HEC → HATS
   - *core*IN-Mic4 → Mic Amp.
   - *core*BEQ → BEQ Filter
   - *core*BT / *core*BT2 → Bluetooth Audio / Bluetooth V2

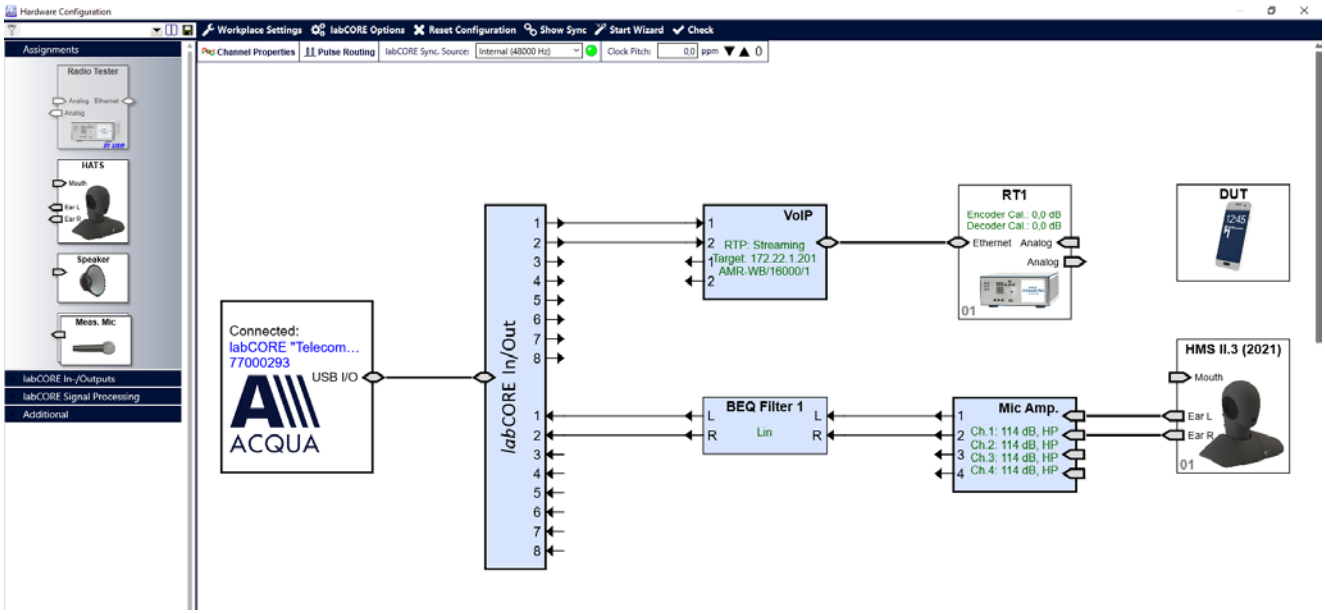
   to the configuration area.

4. Connect both ears of HATS to Mic Amp.
5. Connect two channels of Mic Amp. to BEQ Filter.
6. Connect two channels BEQ Filter to labCORE In/Out.
7. Connect two channels of labCORE In/Out to Bluetooth Audio / Bluetooth V2.
8. Select labCORE Options.
9. Select Microphone Options.
10. Select Supply Voltage → ±60 V from the drop-down list.
11. Enable Polarization Voltage (200 V) for the applied channels.
12. Close labCORE Options.
13. Establish a Bluetooth connection between *lab*CORE and the in-ear headphones.
14. Close Hardware Configuration.



4.2.2 Hardware configuration for wired headphones

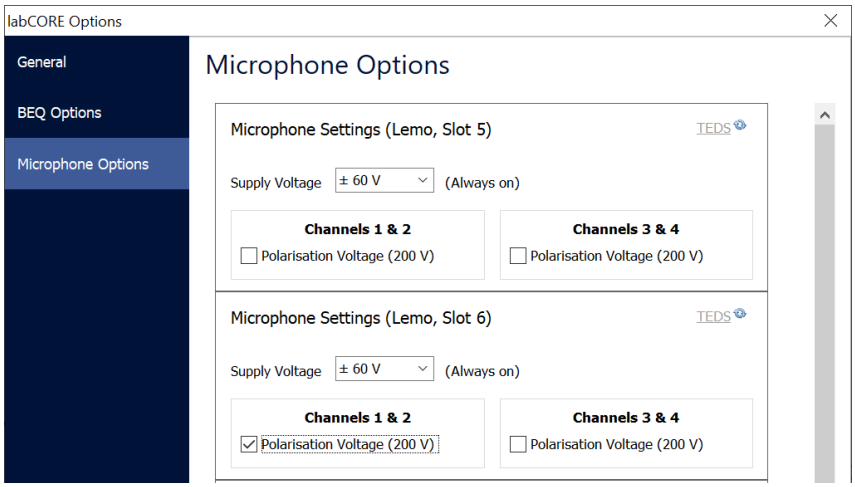
1. Start ACQUA.
2. Open Hardware Configuration.



3. Drag and drop the blocks of the applied
   - HMS II.3 LN HEC → HATS
   - *core*IN-Mic4 → Mic. Amp
   - *core*BEQ → BEQ Filter
   - *core*IP → VoIP
   - Radio Tester

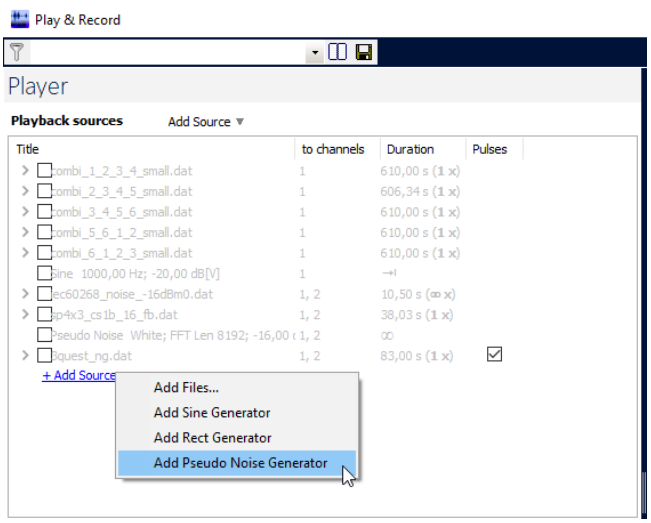
   to the configuration area.
4. Connect both ears of HATS to Mic Amp.
5. Connect two channels of Mic Amp. to BEQ Filter.
6. Connect two channels of BEQ Filter to labCORE In/Out.
7. Connect two channels of labCORE In/Out to VoIP.

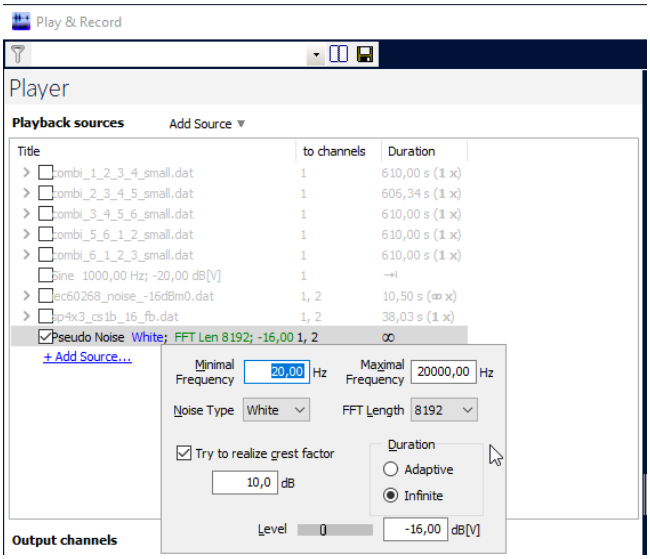
8. Select labCORE Options.
9. Select Microphone Options.
10. Select Supply Voltage → ±60 V from the drop-down list.
11. Enable Polarization Voltage (200 V) for the applied channels.
12. Close labCORE Options.
13. Set up connection between *lab*CORE and radio tester via VoIP.
14. Establish a VoLTE connection between smartphone, radio tester and *lab*CORE.
15. Close Hardware Configuration.



4.2.3 Play & Record settings

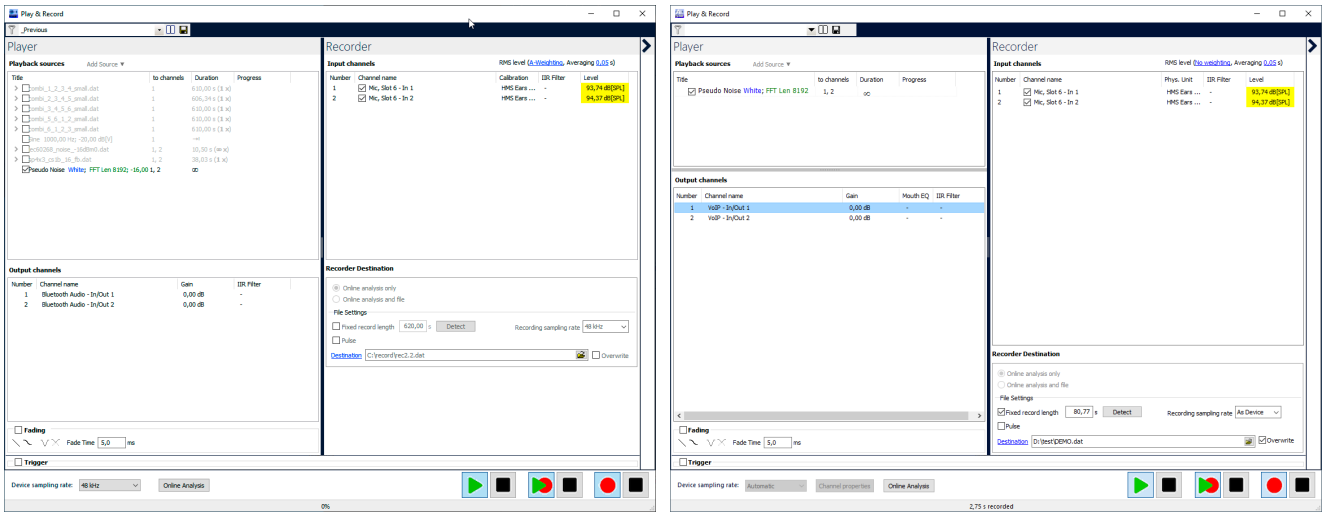
1. Open ACQUAlyzer.
2. Select to open Play & Record.
3. Select +Add Source... in the section Player → Playback sources.
4. Select Add Pseudo Noise Generator.



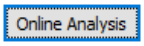


5. Generate an appropriate white / pink noise with an infinite length.

6. Enable both active channels in section Recorder → Input channels. The indicated level shows the idle noise of the measurement cabin.

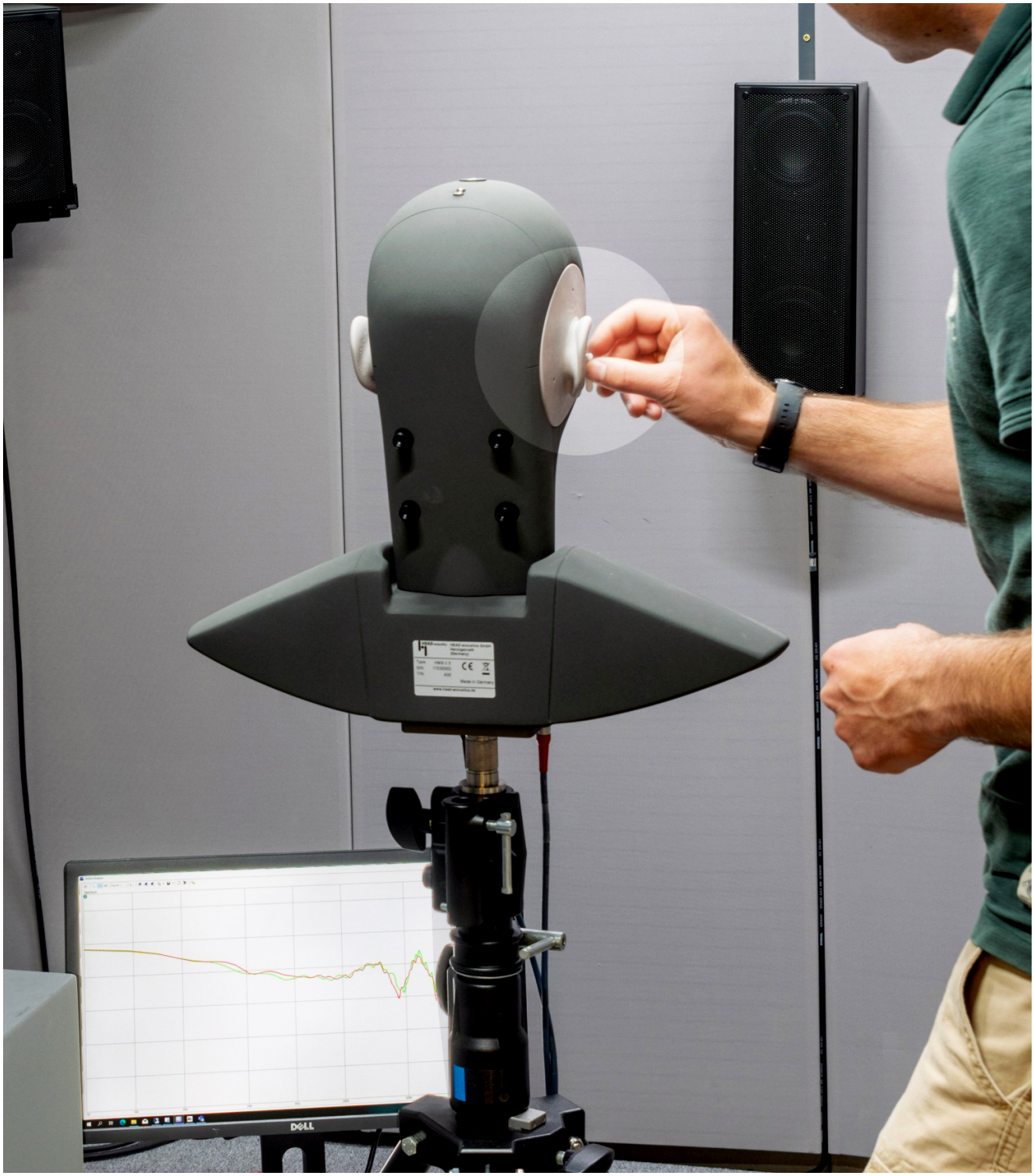


Left: Bluetooth headphones | Right: Wired headphones

7. Enable Online Analysis only in Recorder Destination.
8. Select  to start playback on the in-ear headphones and recording with the ear microphones of HMS II.3 LN HEC.
9. Select  to start Online Analysis.
10. The Online Analysis displays the current frequency response of both activated microphone channels.
11. Drag the Online Analysis window to the second screen of the ACQUA PC. The screen is positioned in the measurement cabin.
12. Maximize the Online Analysis window.

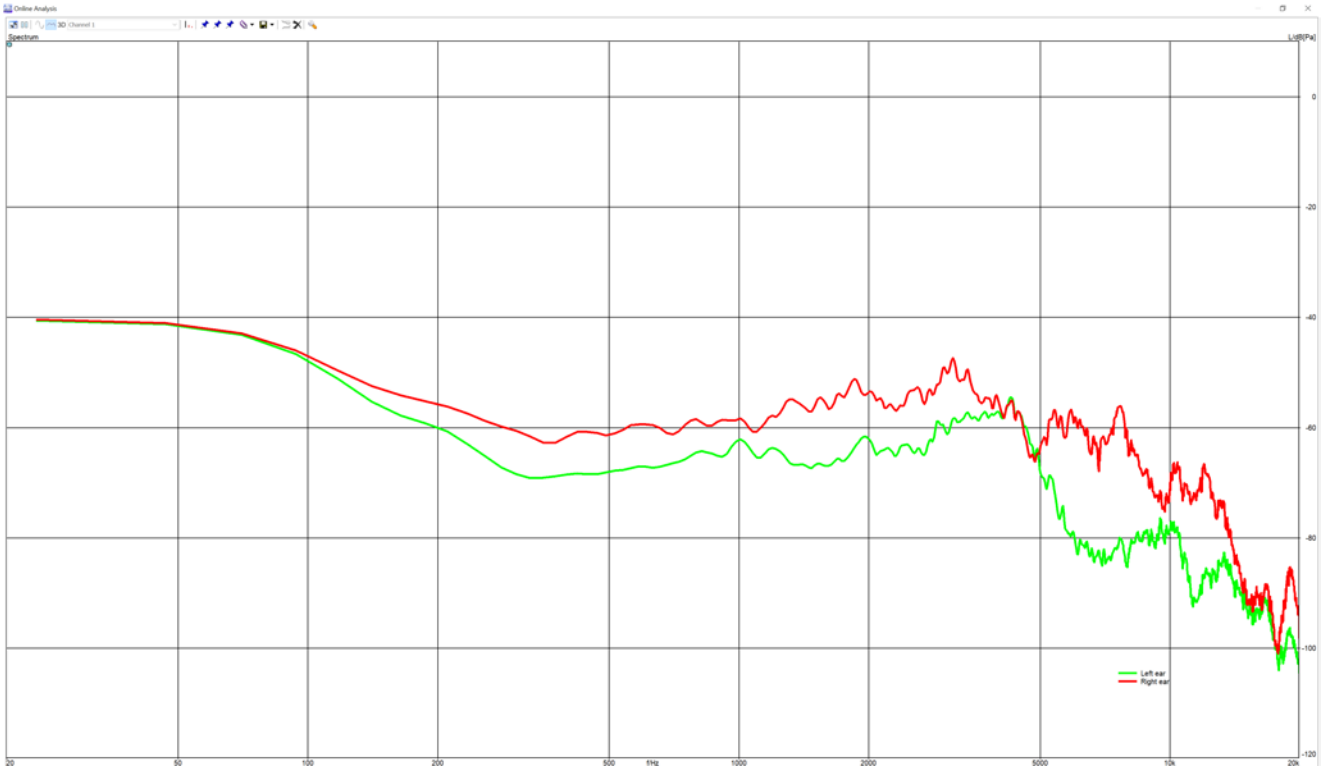
4.2.4 Manual adjustment of in-ear headphones

1. Enter the measurement cabin.

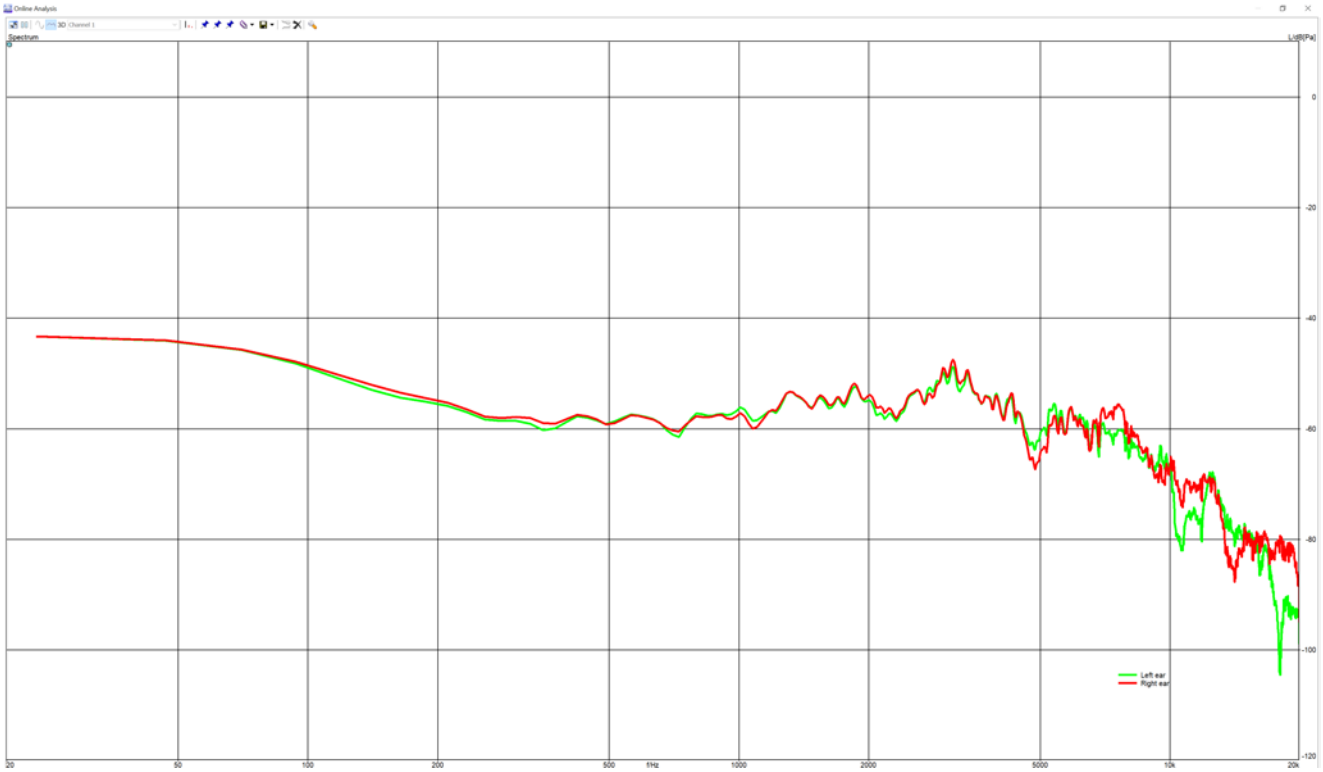


2. Watch the online analysis curves on the computer screen and carefully adjust the fit of the in-ear headphone within the right pinna.

3. A proper seal is indicated by the measured frequency response visible on the screen increasing to a high SPL value. A high SPL indicates a proper fit of the in-ear headphone in the ear canal.



4. Repeat steps 2 and 3 for the in-ear headphone in the left pinna.



5. Match the spectra curves of left and right pinna as close as possible.