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Live demonstration of a portable, affordable and versatile AEP recording system mostly based on off-the-shelf electronics

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International Evoked Response Audiometry Study Group (IERASG)

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Long term objectives with AEPs

- **New methods:**
 - deconvolution, multi-response deconvolution
- **New experiments:**
 - more natural, conditioning the auditory system
- **New applications:**
 - hearing research, clinical applications
- **New audience:**
 - audiologists, ENT specialists, engineers, education (university, high school, primary), society

AEP recording out of the laboratory (problem 1)

- The noise
 - Low noise instrumentation amplifier
 - Number of stimuli to be averaged
 - Minimize external interference
 - Minimize myogenic activity
- EM interference from 50 (60) Hz power line
 - Shielded booth: laboratory or special room

AEP recording out of the laboratory (solution 1)

- Interference from power line is a common-mode noise
- We estimate both, the differential signal (contaminated with CM) and the CM signal
- We process both signals in order to estimate a clean differential signal (i.e. a clean EEG)
- This alleviates the need of shielded booth

AEP recording out of the laboratory (problem 2)

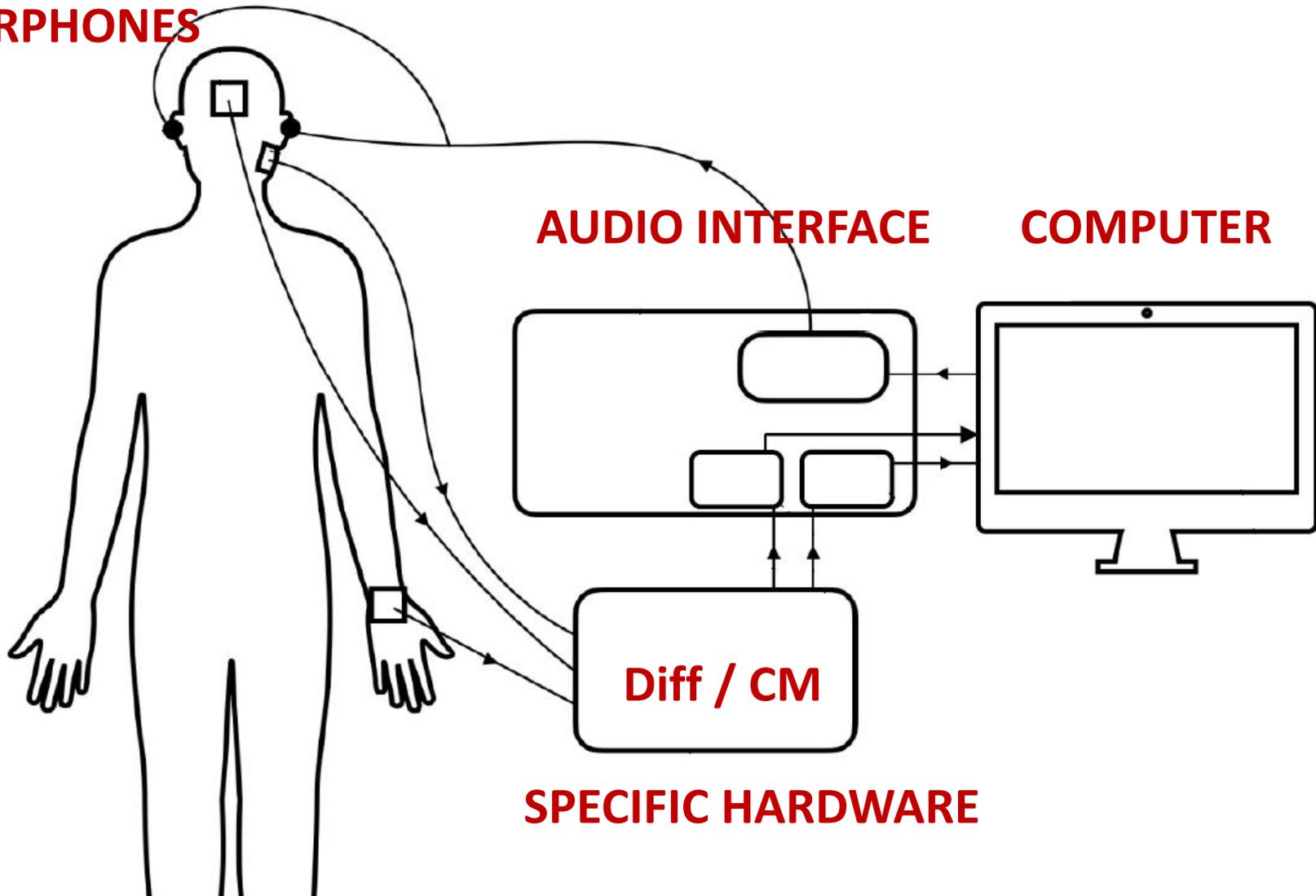
- AEP recording systems are usually expensive
- Open AEP recording systems are necessary for interesting experiments, but difficult to be used

AEP recording out of the laboratory (solution 2)

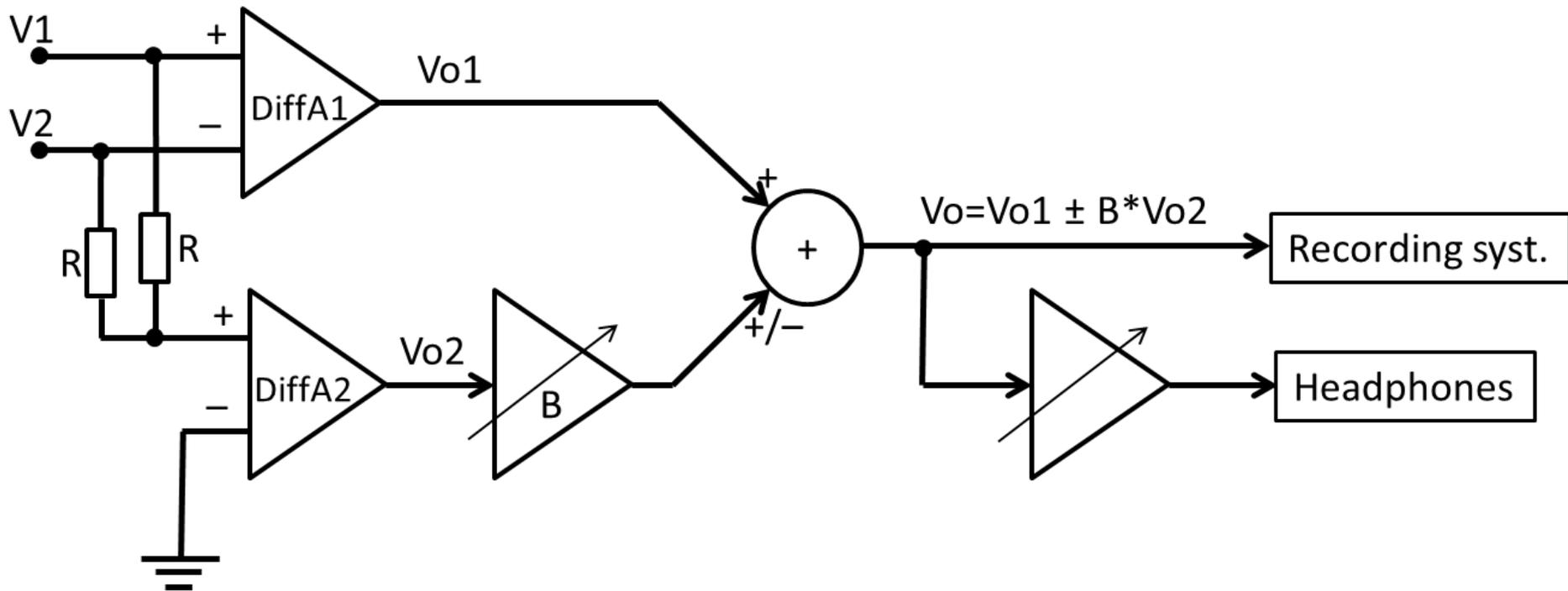
- Let's develop our own AEP recording system:
 - Minimum specific hardware
 - Rest of the hardware: consumer electronics
- Let's develop our own (open) code / methods
 - Functions for efficient deconvolutions
 - Scripts (for recording and analysis) for specific experiments

The AEP recording system

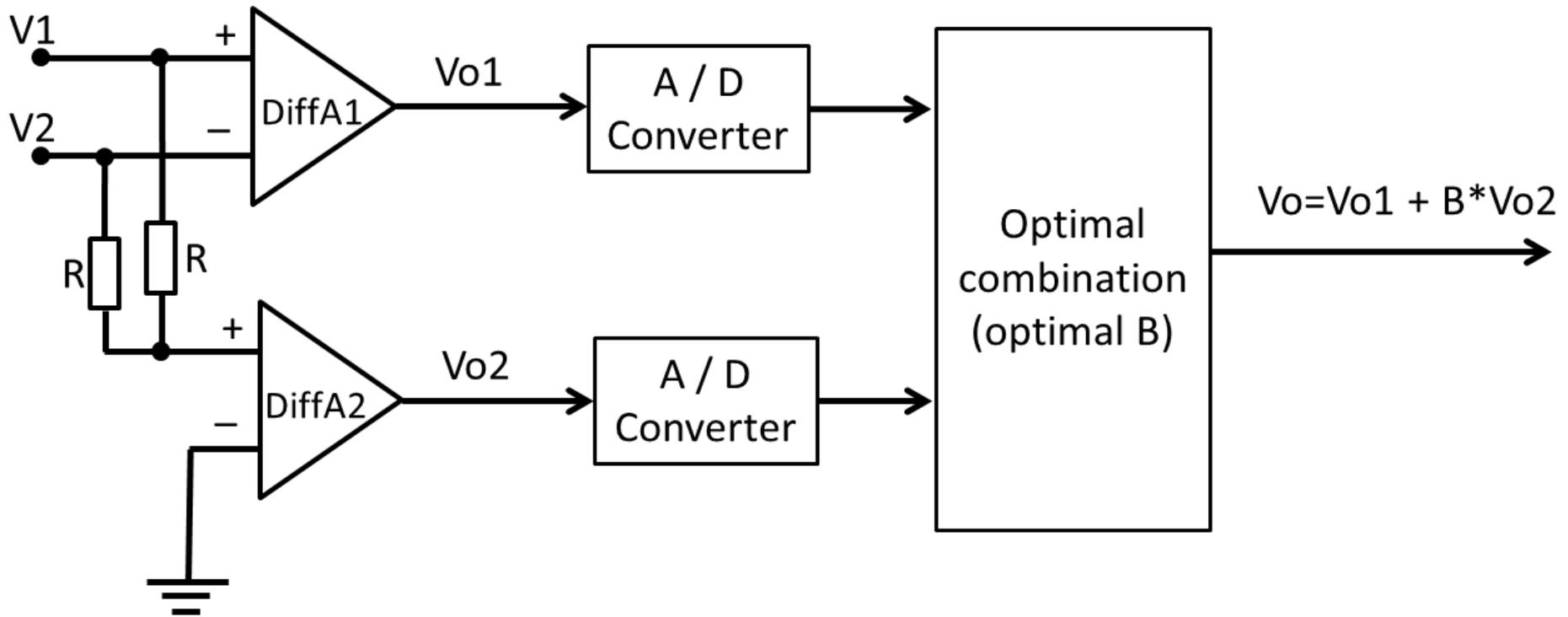
**ELECTRODES
AND
EARPHONES**



Reduction of CM component (manual)



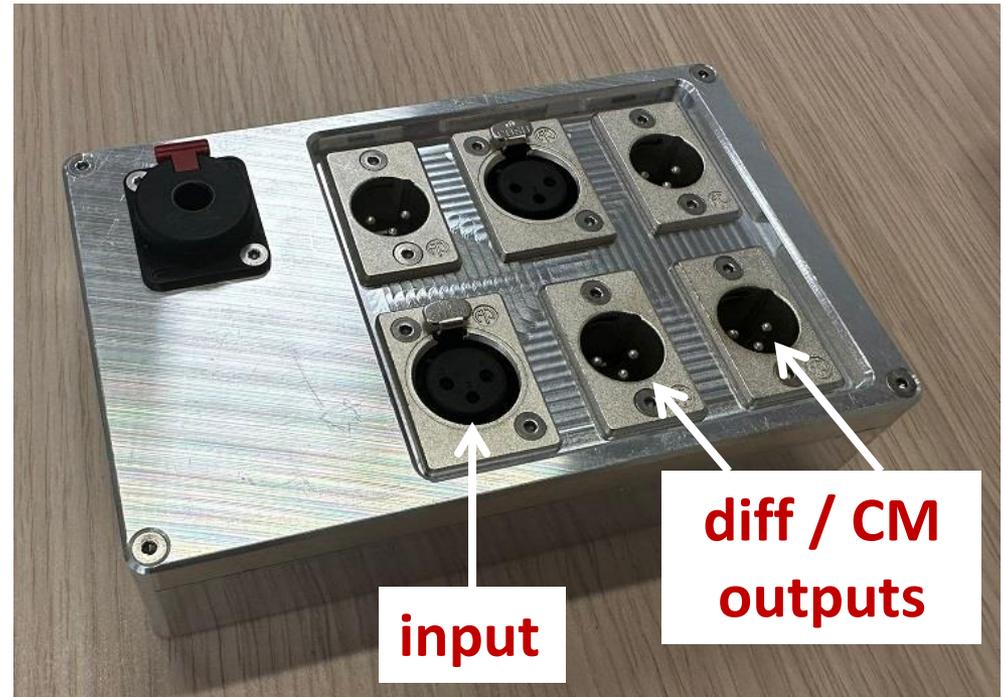
Reduction of CM component (numerical procedure based on statistics)



The specific hardware (passive interface)



FIRST PROTOTYPE

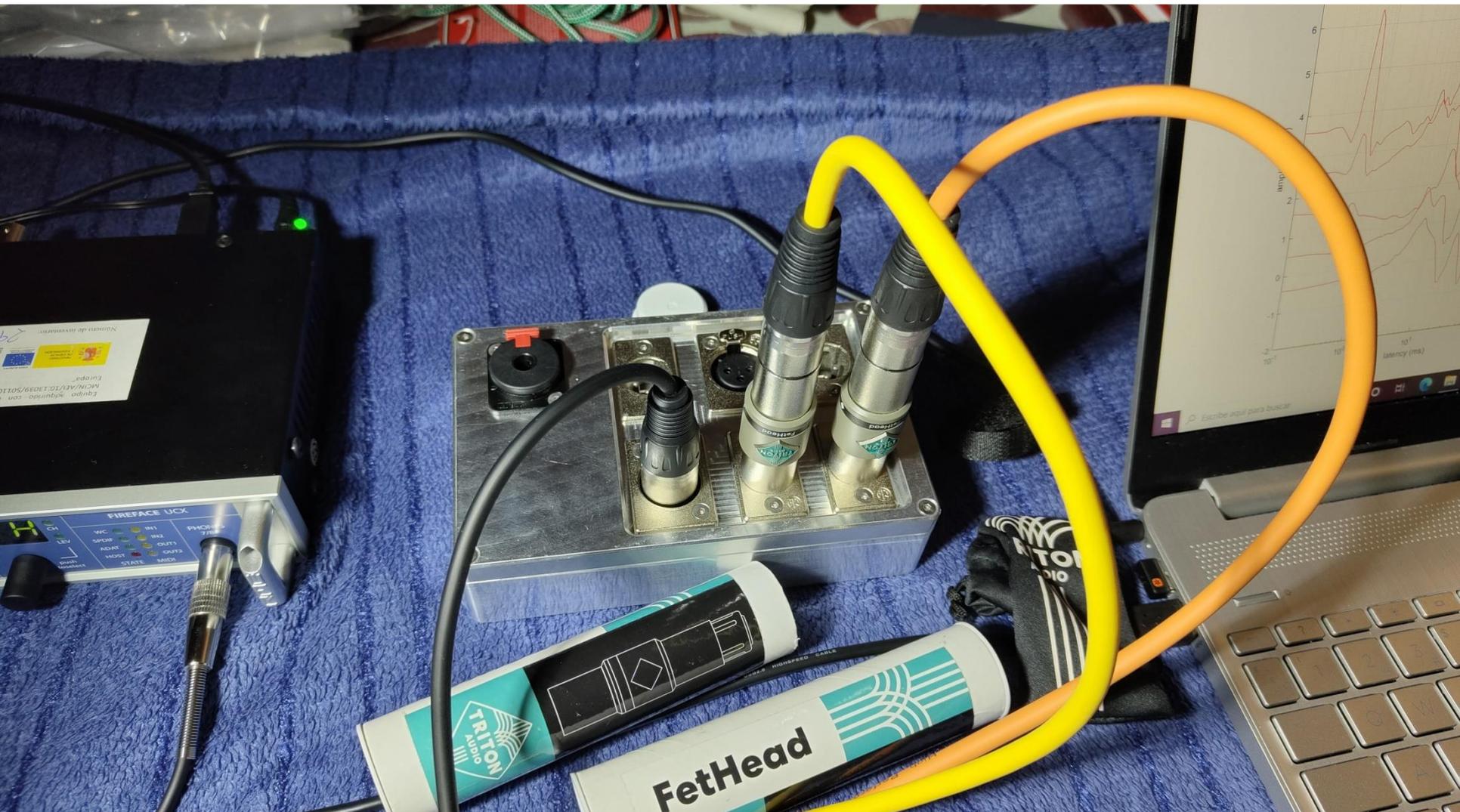


SECOND PROTOTYPE

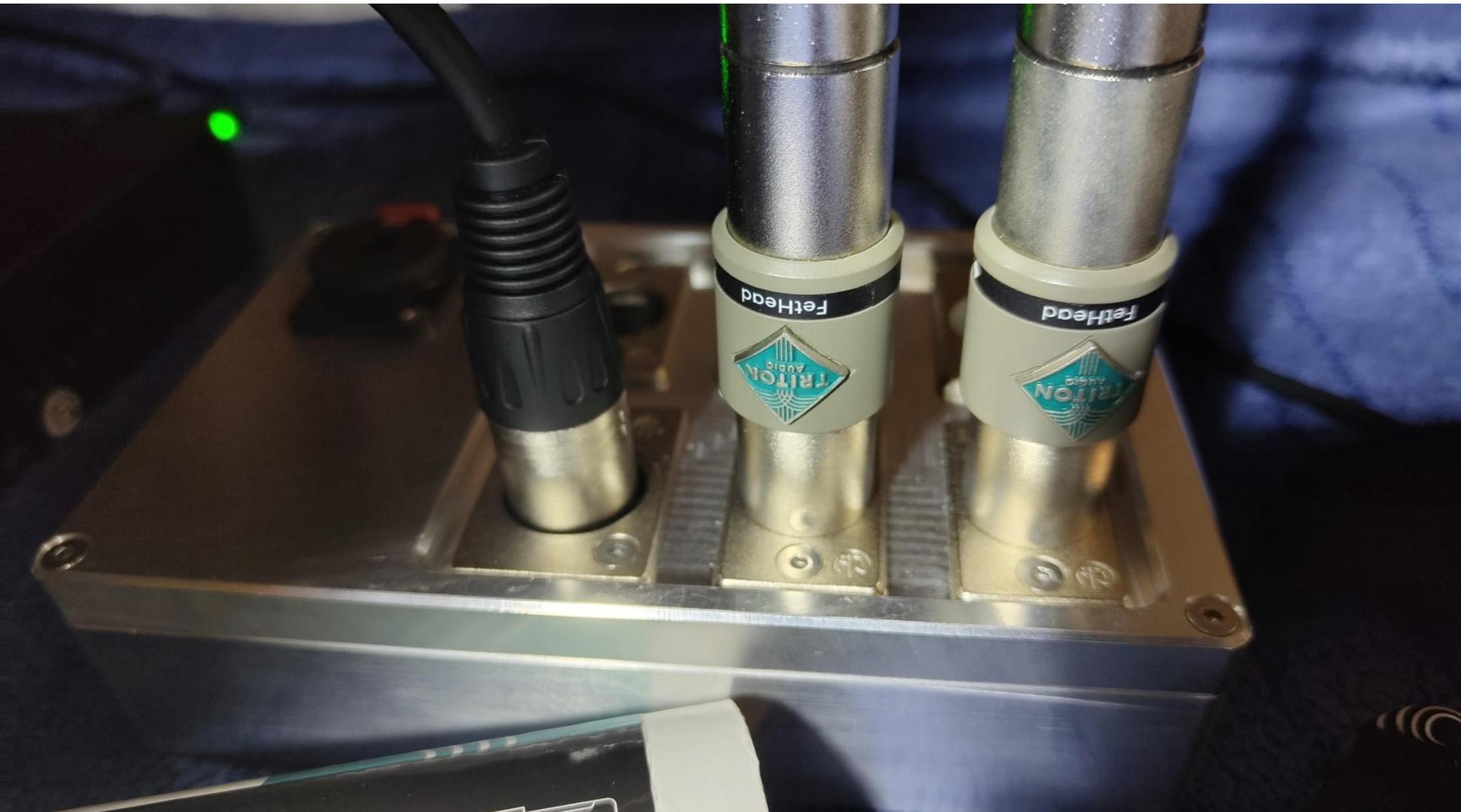
The AEP recording system (headphones and electrodes)



The AEP recording system (interface and preamplifiers)



The AEP recording system (interface and preamplifiers)



The AEP recording system (audio interface)



The AEP recording system (configuration of the audio interface)

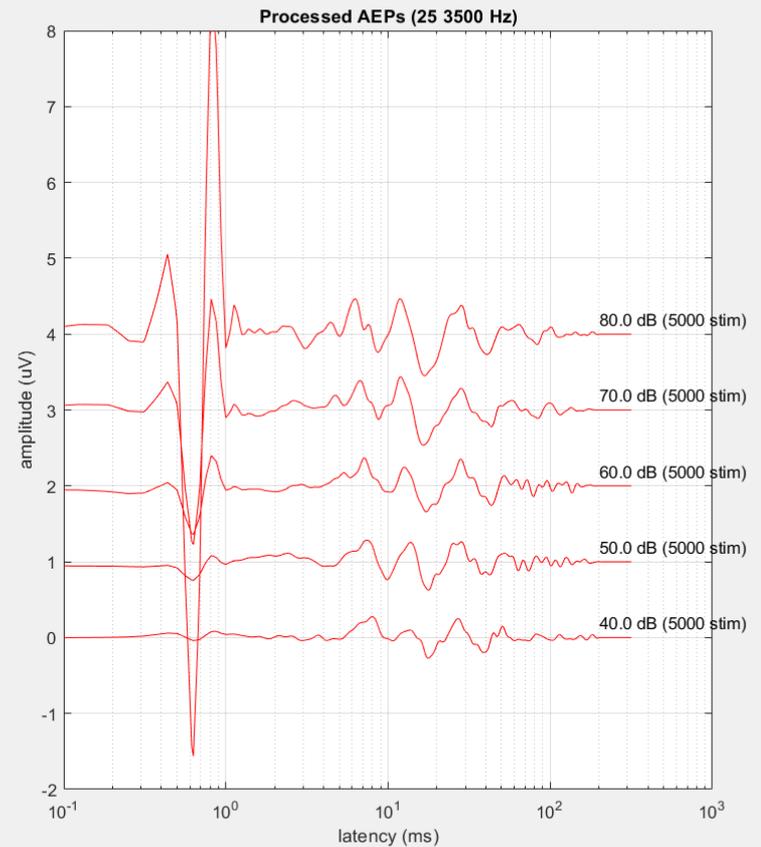
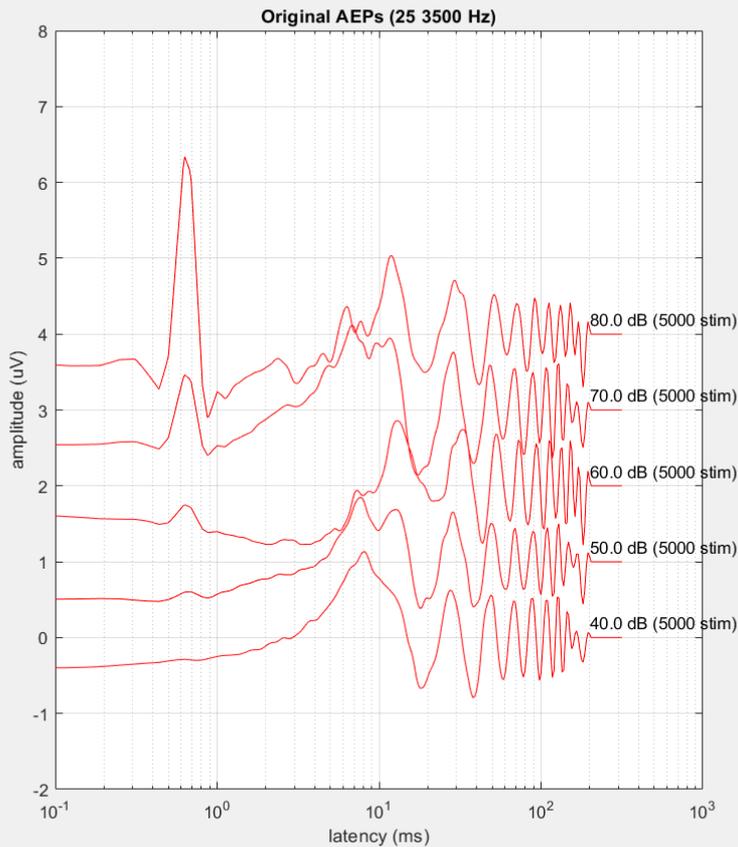
The screenshot displays the RME TotalMix FX software interface, titled "RME TotalMix FX: Fireface UCX (1) - 48.0k - ...efinitivo_Joaquin_Isaac\ConfiguracionDemoAEPs.tmx". The interface is organized into several sections:

- Hardware Inputs:** This section contains 12 channels, including two microphone inputs (Mic 1 and Mic 2) and ten line inputs (AN 1 through AN 7/8, SPDIF, AS 1/2, ADAT 3/4, ADAT 5/6, ADAT 7/8). Each channel features a gain knob, a stereo/mono selector, a phase switch, and an EQ section.
- Hardware Outputs:** This section contains 10 channels (AN 1 through AN 7/8, SPDIF, AS 1/2, ADAT 3/4, ADAT 5/6, ADAT 7/8). Each channel has a level knob and a phase switch.
- Software Playback:** This section contains 10 channels (AN 1 through AN 7/8, SPDIF, AS 1/2, ADAT 3/4, ADAT 5/6, ADAT 7/8). Each channel has a cue button, a level knob, and an EQ section.
- Control Room:** Located at the bottom right, this section includes a main level knob, a stereo/mono selector, a recall button, a speaker button, a phase switch, and a mute button.
- Right Panel:** This panel includes a "View Options" menu with buttons for "ROUTING MODE" (SUBMIX, FREE), "LEVEL METERS" (POST FX, RMS), "SHOW" (FX, TRIM), and "ZOOM" (ZOOM, NAMES). It also features a "Snapshots" list (Mix 1-8), a "Groups" list (1-4), and a "Layout Presets" list (Layout 1-6).

latency (ms)

The AEP recording system

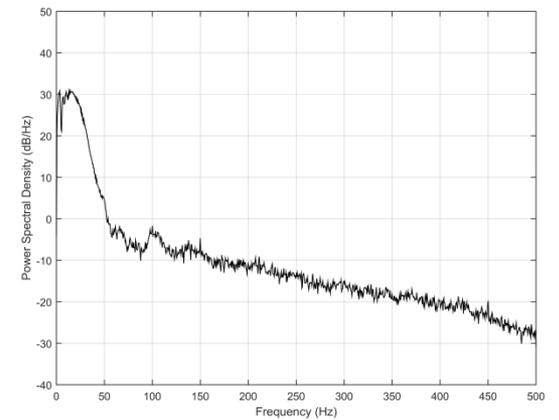
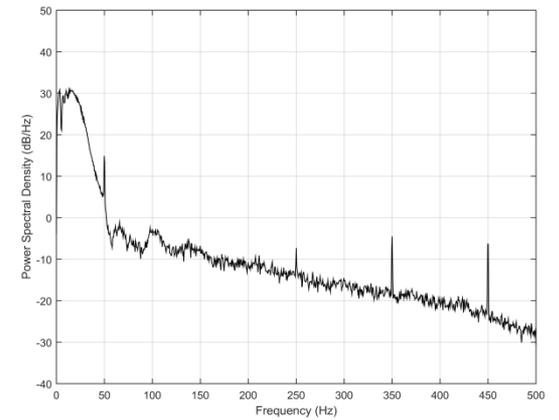
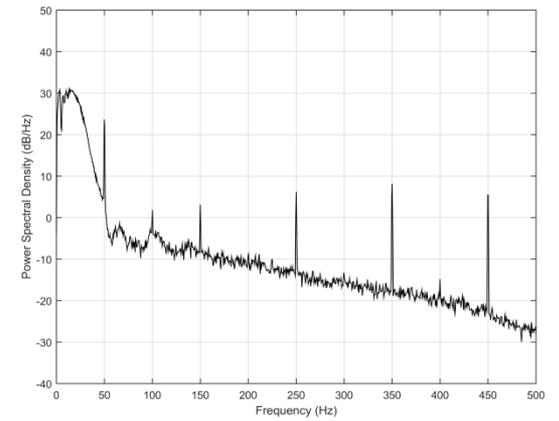
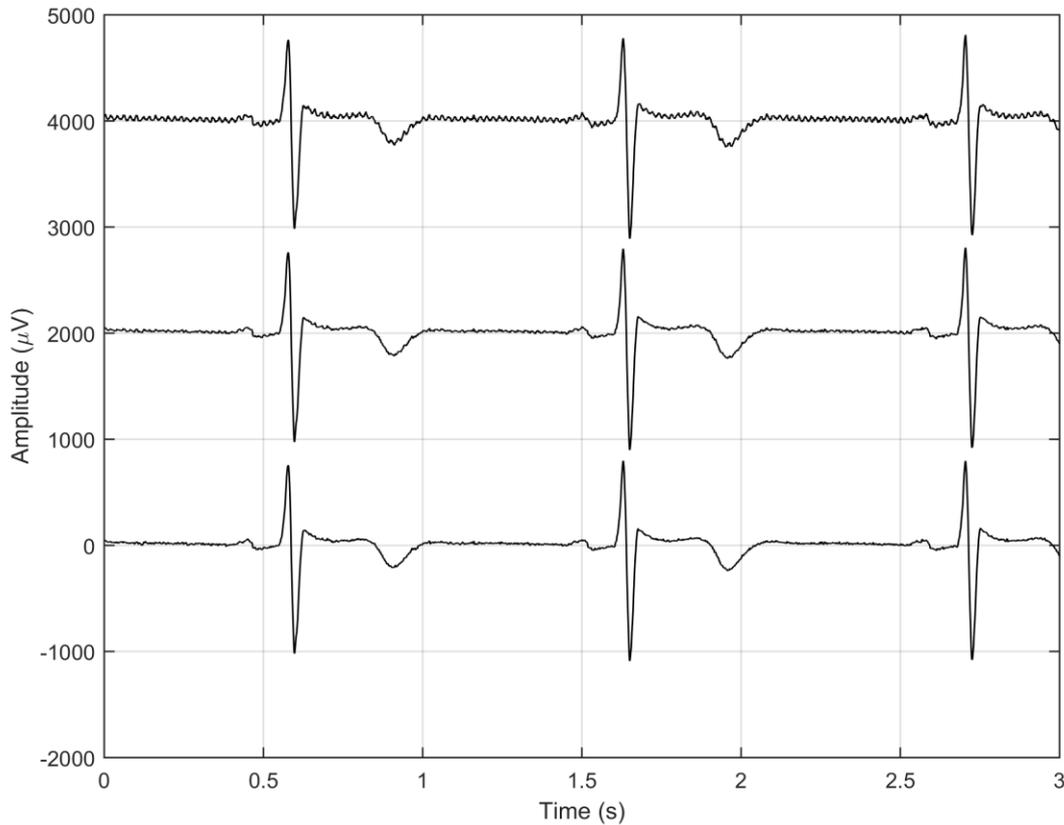
(MatLab application for AEP recording - demo)



The AEP recording system



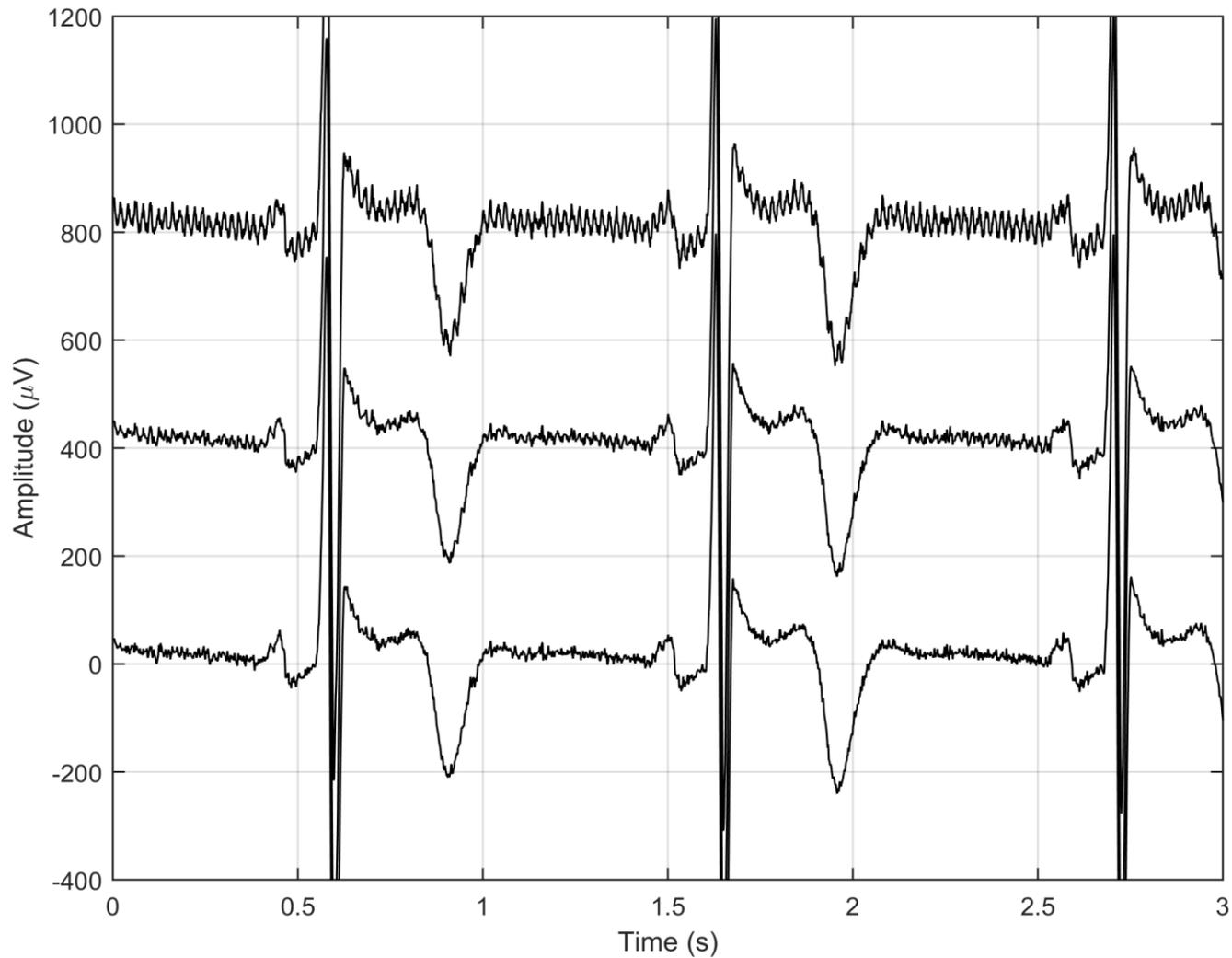
ECG recording (out of lab)



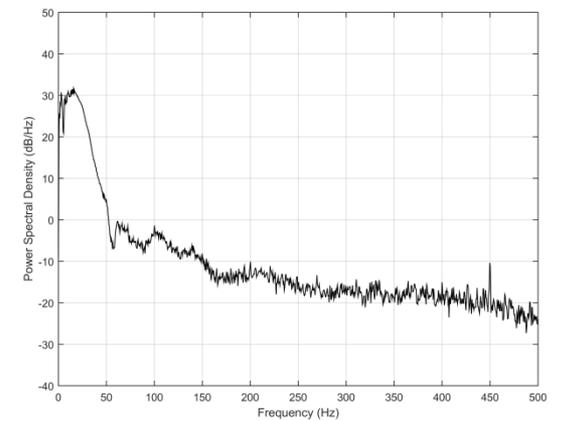
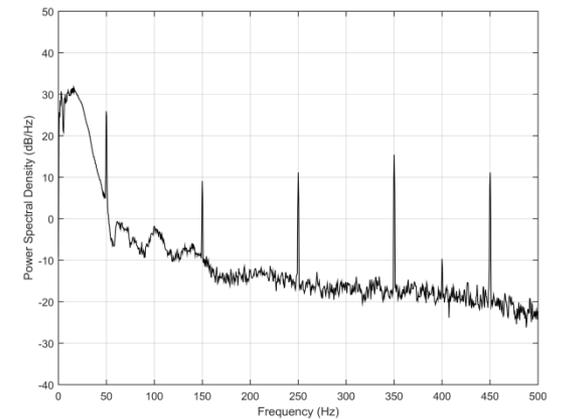
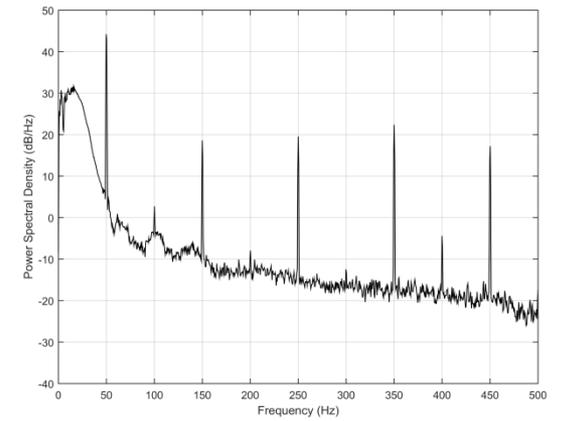
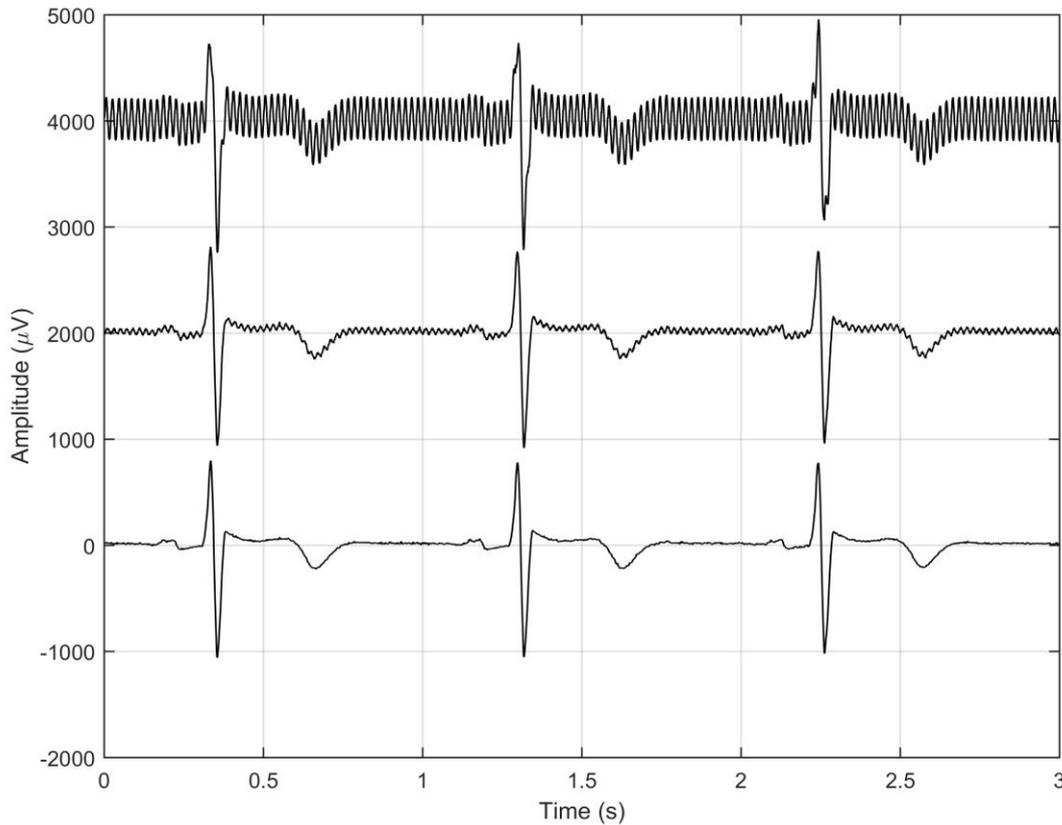
**Without
CM-removing**

**CM-removing
basic**

**CM-removing
advanced**



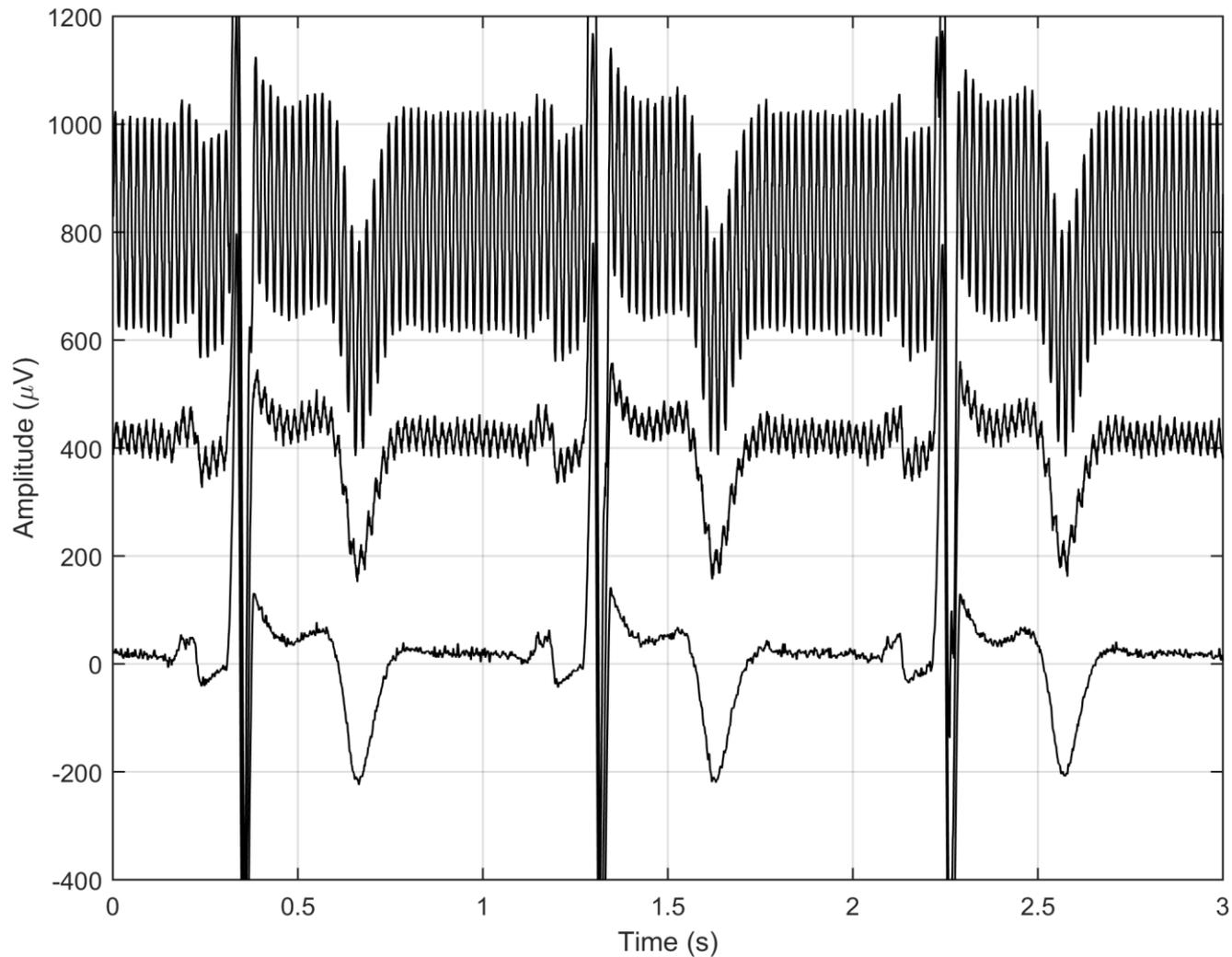
ECG recording (out of lab)



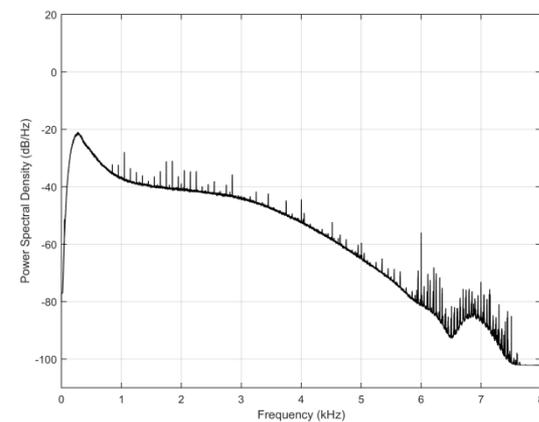
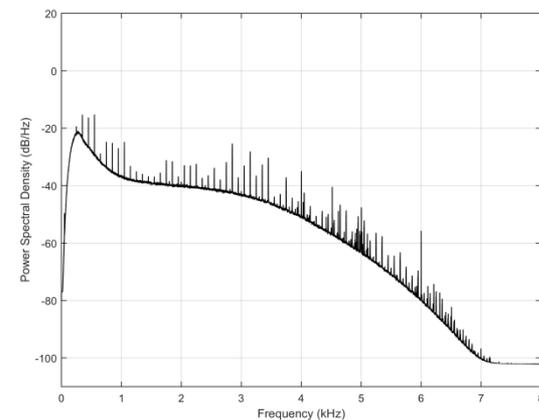
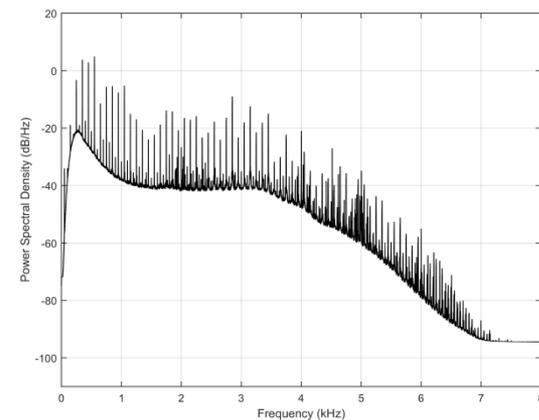
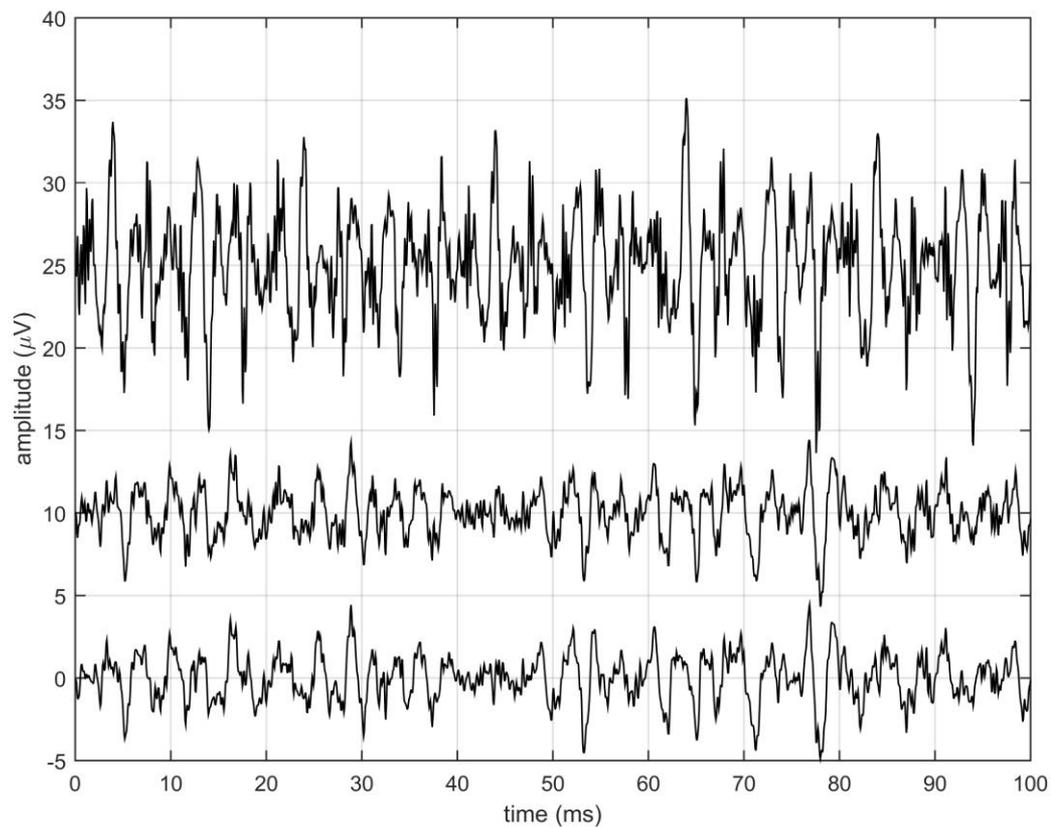
**Without
CM-removing**

**CM-removing
basic**

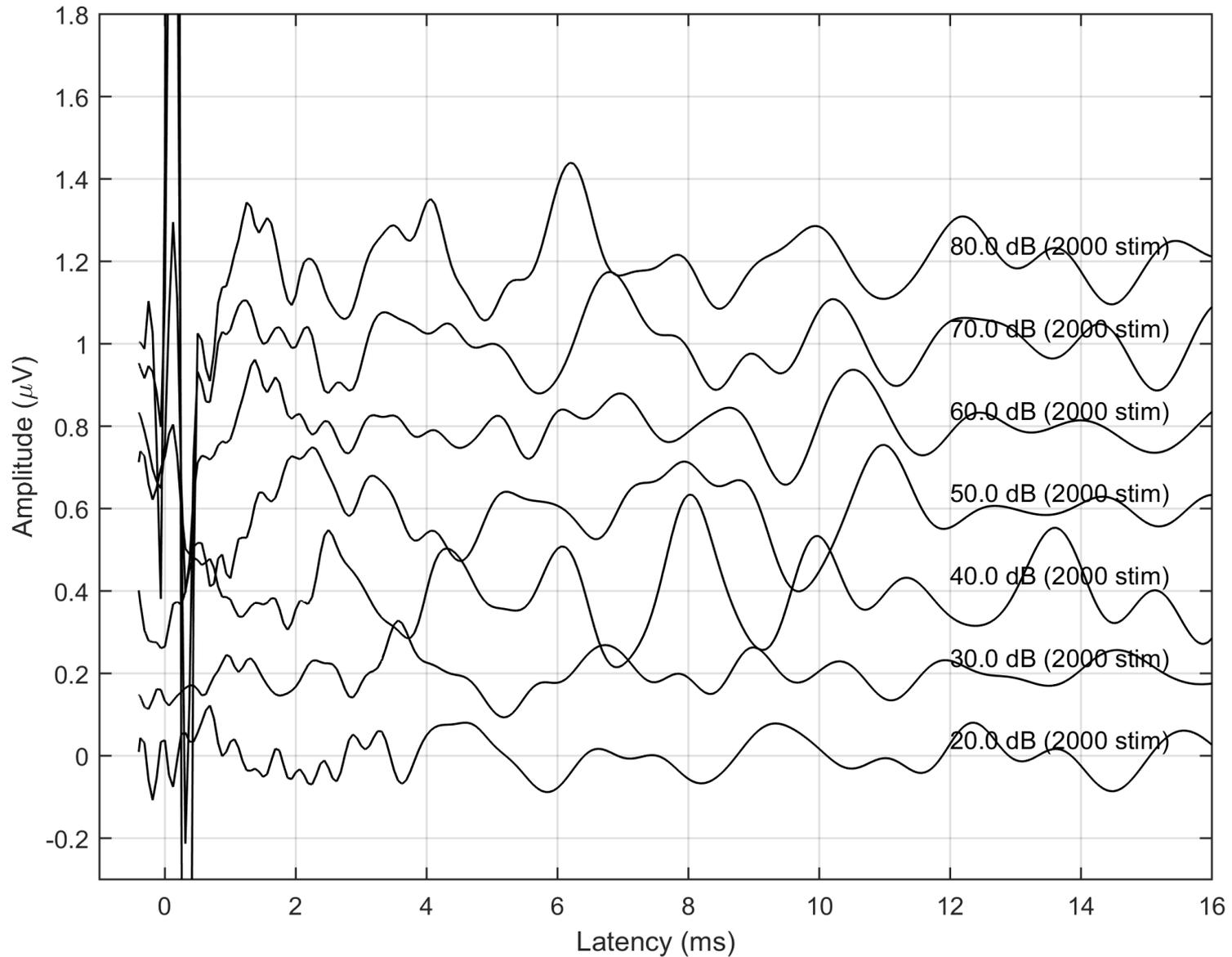
**CM-removing
advanced**



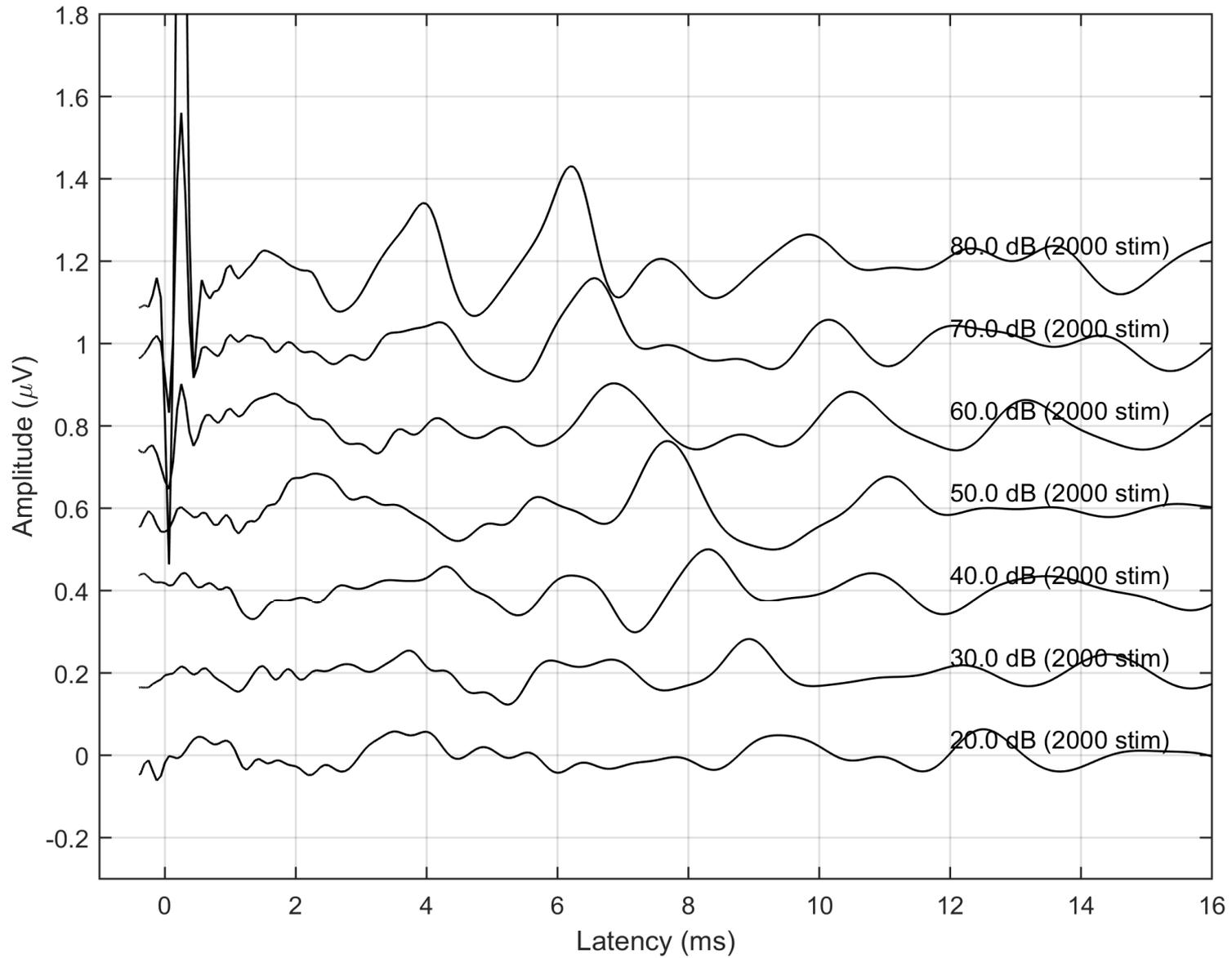
AEP recording (out of lab)



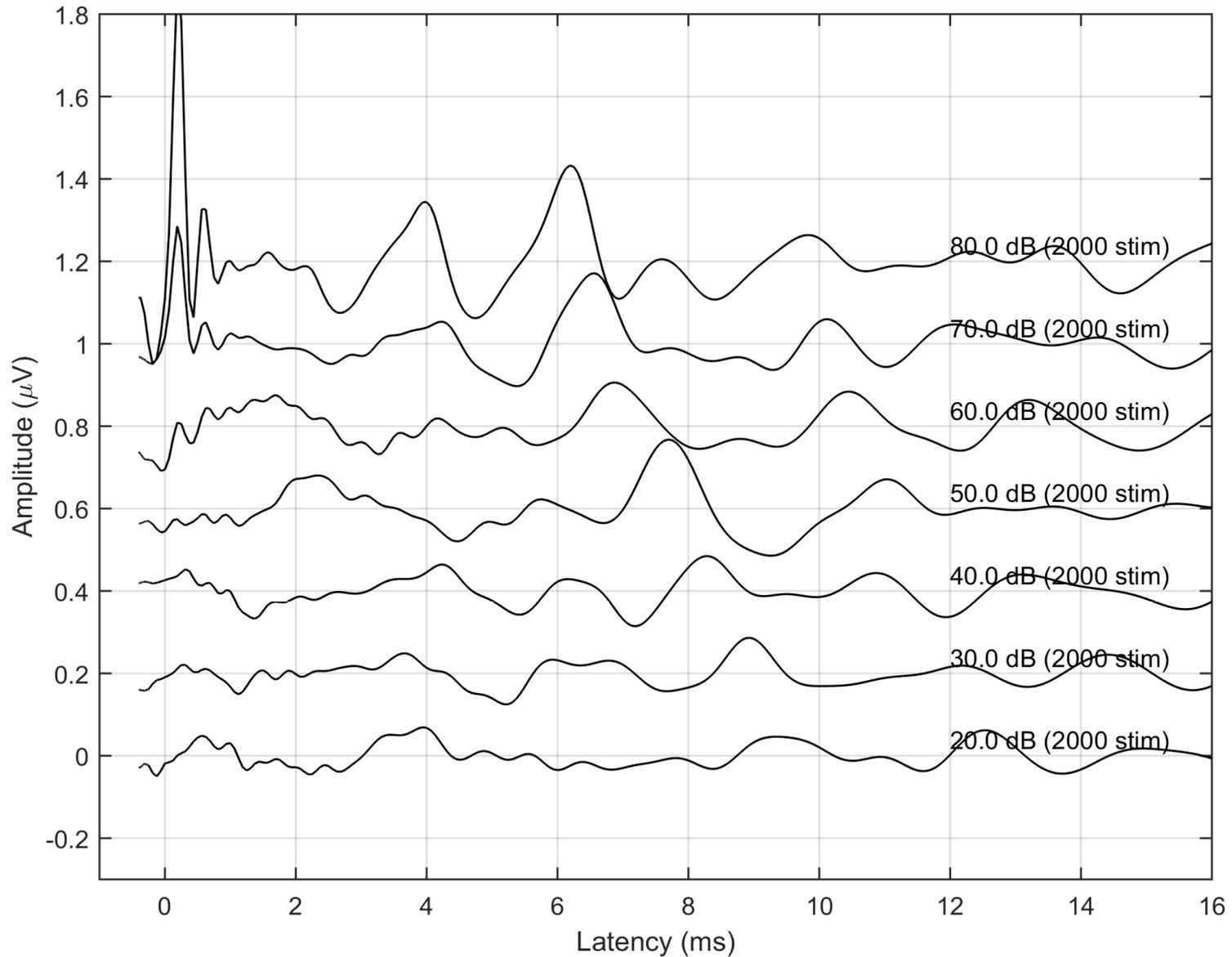
ABRs before CM removing procedure



ABRs CM-removed (basic procedure)



ABRs CM-removed (advanced procedure)



Signal Processing in Audiology



UNIVERSIDAD DE GRANADA

RELEVANT INFORMATION:

- Flexible AEP recording system is affordable
- Recording AEPs (other biopotentials) is possible outside the Lab
- Demo



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Dr. Joaquin T. Valderrama



Dr. Jose L. Vargas

Speech-AEPs / PID2020-119073GB-I00 / AEI / 10.13039/501100011033

BINAURAL-EVAL / B.TIC.382.UGR20



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María Zambrano Fellowship



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The screenshot shows the website for 'Signal Processing in Audiology'. The header includes navigation links: Home, Projects, Dissemination, Technology, Members, Contact. The main title is 'Signal Processing in Audiology' with a subtitle: 'Designing the next-generation methods for recording neurophysiological signals from the human auditory system'. A 'Meet the team' button is visible. Below the main content, there is a section about the research team, including the University of Granada and Hospital Universitario Clínico San Cecilio logos. The text describes the research focus on auditory evoked potentials and lists several objectives: opening new avenues in hearing research, empowering clinicians with diagnostic tools, providing industry with disruptive algorithms, and helping society gain awareness of noise overexposure. At the bottom, there are sections for 'Projects' (with an image of a desk and lightbulb) and 'Dissemination' (with an image of a lecture hall), along with a QR code.