Measurement planning

We plan a sequence of sessions for each participant in a group. One session lasts 15 minutes and comprises several physical and mental activities. All sessions are the same in activities, environment, and equipment. The main problem is the lack of a session quality criterion (the score of a session). We could assign it manually, or we could set it by testing procedures. The goal of this document is to start a discussion on how to measure the reproducibility and quality of the measurements.

Princinpes

1. We are developing a service that extends a participant's attention span.
2. This service runs a daily routine that takes 15 minutes each day (one time). Call it a session.
3. During this training, the service shows the relative (or absolute) score of a participant.
4. The training program (and a participant) expects that:
    a. The score of attention span grows (it could be measured in seconds) in the long training run
    b. A more experienced participant has a bigger score than a novice.
5. This version of the service does not provide dynamic feedback to the participant.

Environment

Since we have an EEG, the perception of a participant plays an important role.
Question: Shall a participant meditate in

1) dark,
2) quiet place,
3) without distractions (family, kids, animals),
4) in a comfortable sitting or lying position. Or any of these items could be violated?

Question: What is the state of the body before meditation: calm or energized? Shall we expect to observe declining HRV as we do now?

Testing the EEG data acquisition and model

Since there are no ground truth variables for the training score, it is useful to test the system (before we start massive measurements). Here, the ground truth comes from the stimulating program.

1. With event-related potentials: a series of questions where a participant replies by pressing buttons; two or four classes classification. Can we organize measurements to see some ERPs?
2. Without ERPs: a participant perceives information via one of four channels by hearing, seeing, and sensing; two or four classes classification.

The accuracy of the classification shall not vary too much for different sessions of a participant and different participants.

Testing the IMU data acquisition and model

The IMU module runs here on different devices, including phones. A sequence of repetitive movements shall work. Typical classification is two, four, or six classes (walking, jogging, up and down stairs, sitting, and lying positions). Since the IMU is placed at the chest, it is reasonable to suggest hand movements. The ground truth here comes from the button or from the command. As previously mentioned, the accuracy of classification shall not differ too much for different sessions and for different participants.

The EEG-IMU synchronization to start a session

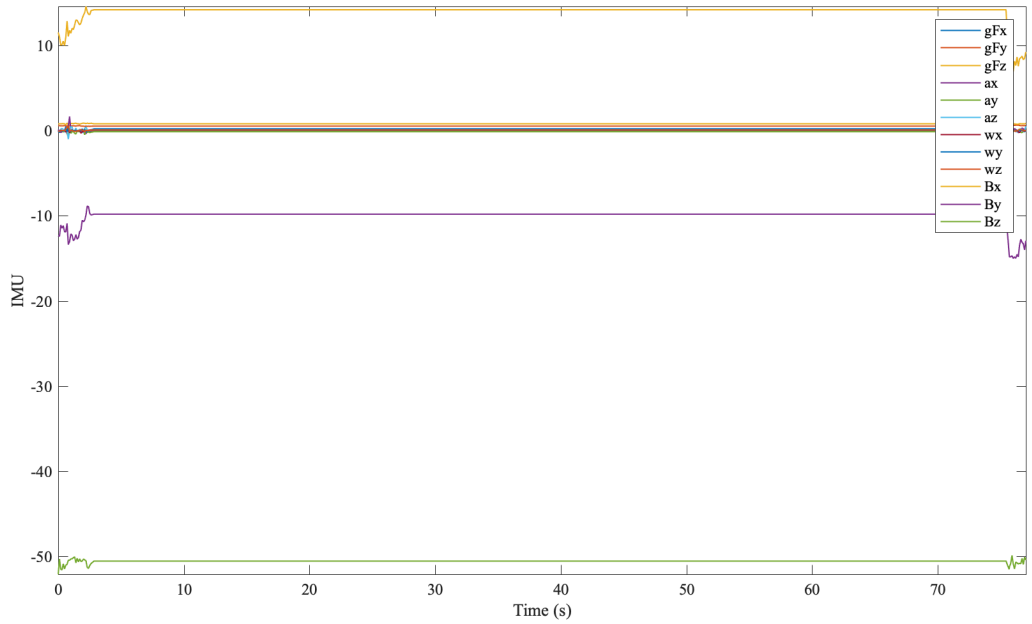
To start with, an audio command or a button works. The Labstreaminglayer library is great, too.

Observations from the measurements

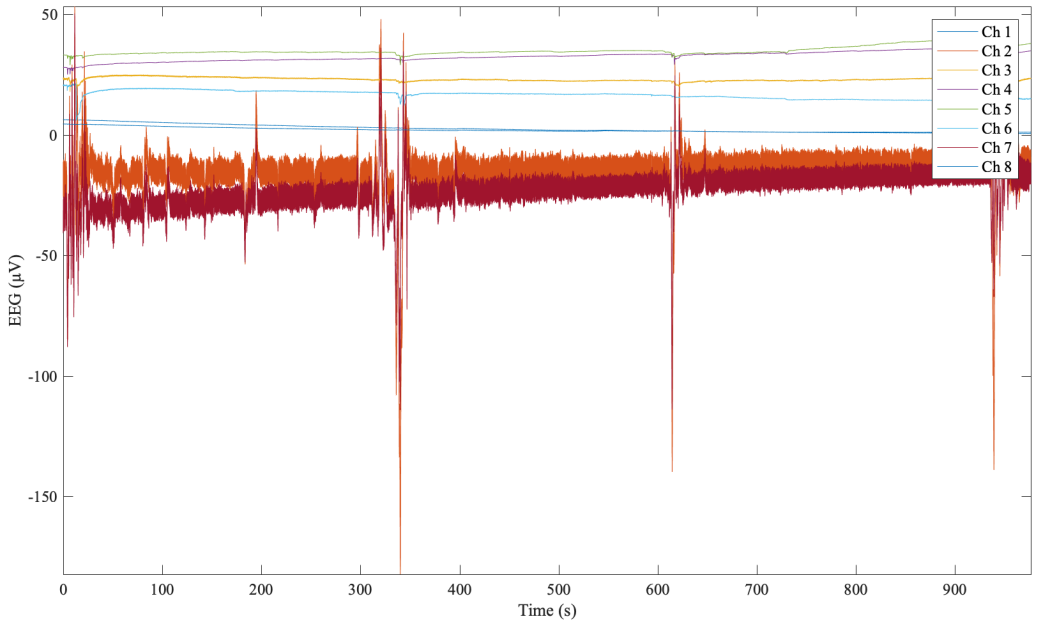
General considerations

1. IMU data was not recorded: 70 seconds, mainly constants
2. EEG data
    a. How do channels 2 and 7 differ from the others? They have different amplitudes of oscillation.
    b. The high-frequency oscillation has the same frequency. What process does it cause?
    c. Can we organize measurements to clearly see some ERPs in the data?
3. The HRV data looks adequate. Why don’t we run the service only on this data to see how the business works?

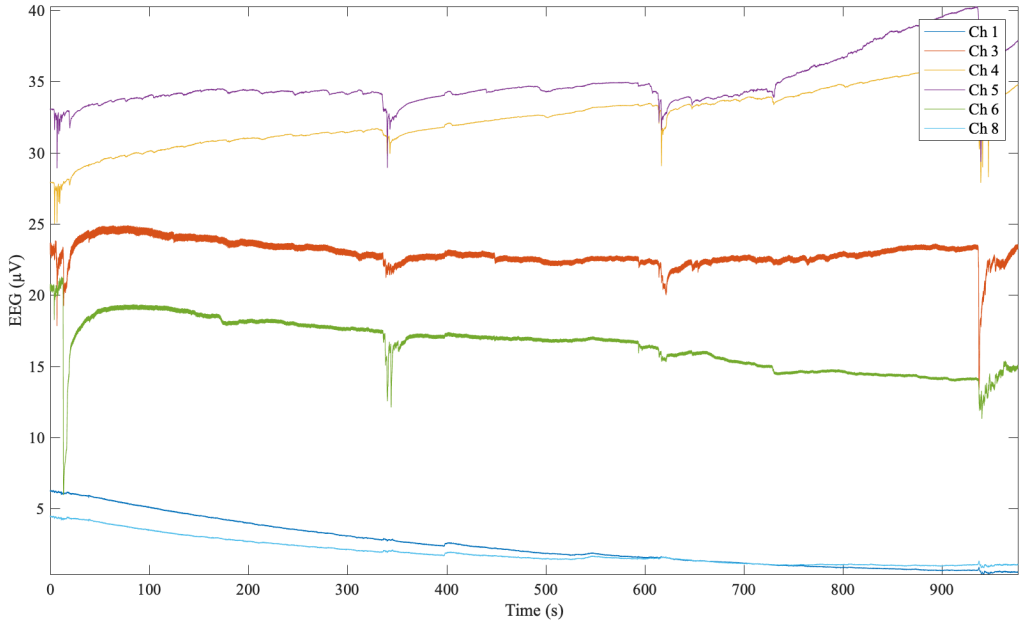
IMU data



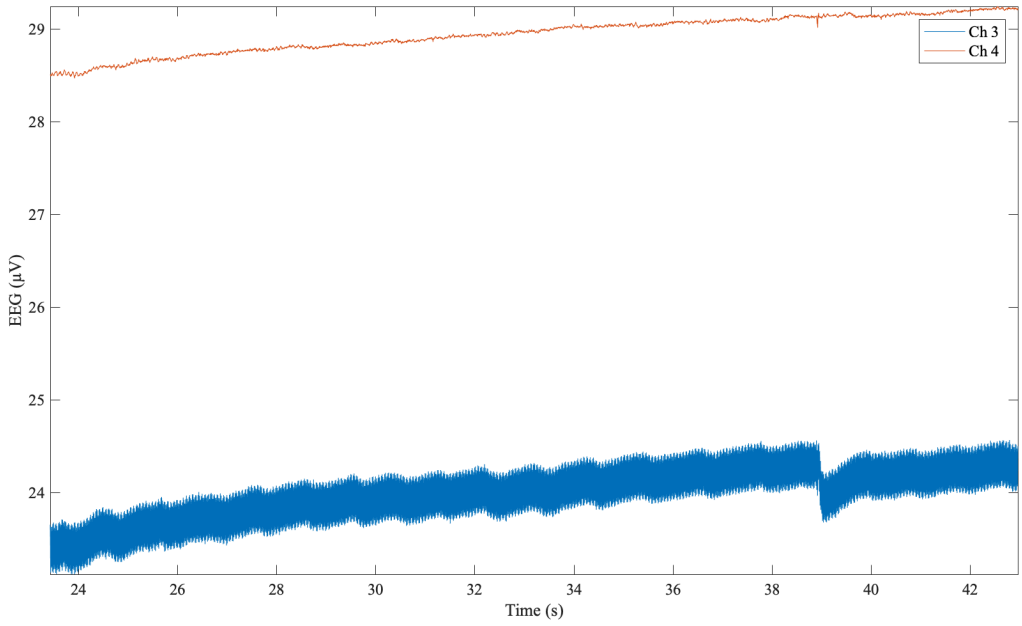
EEG data: 8 channels, 250 Hz



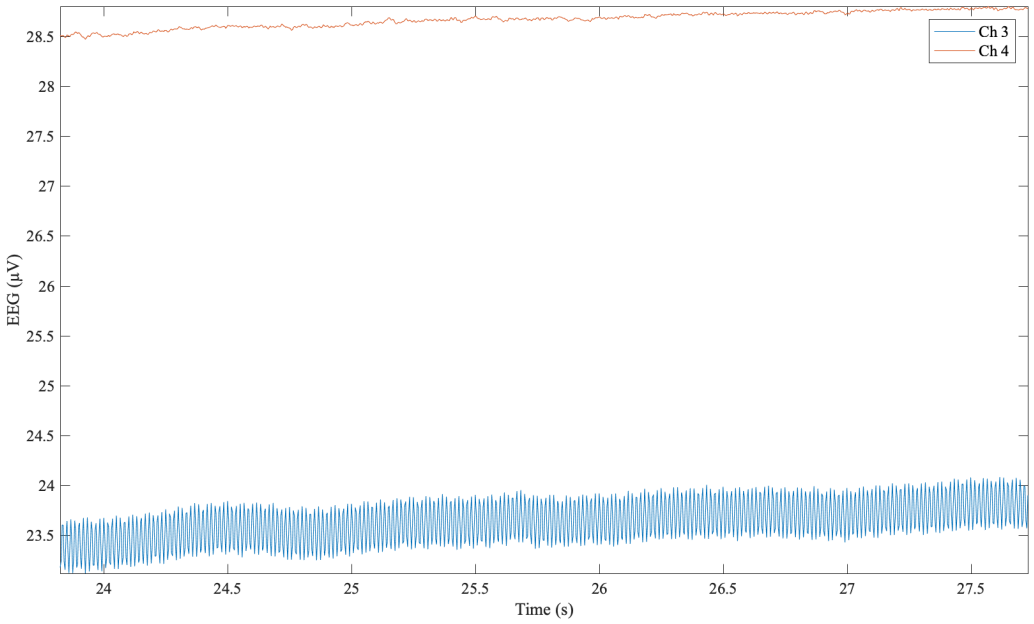
Eight channels, the full 16-minute history



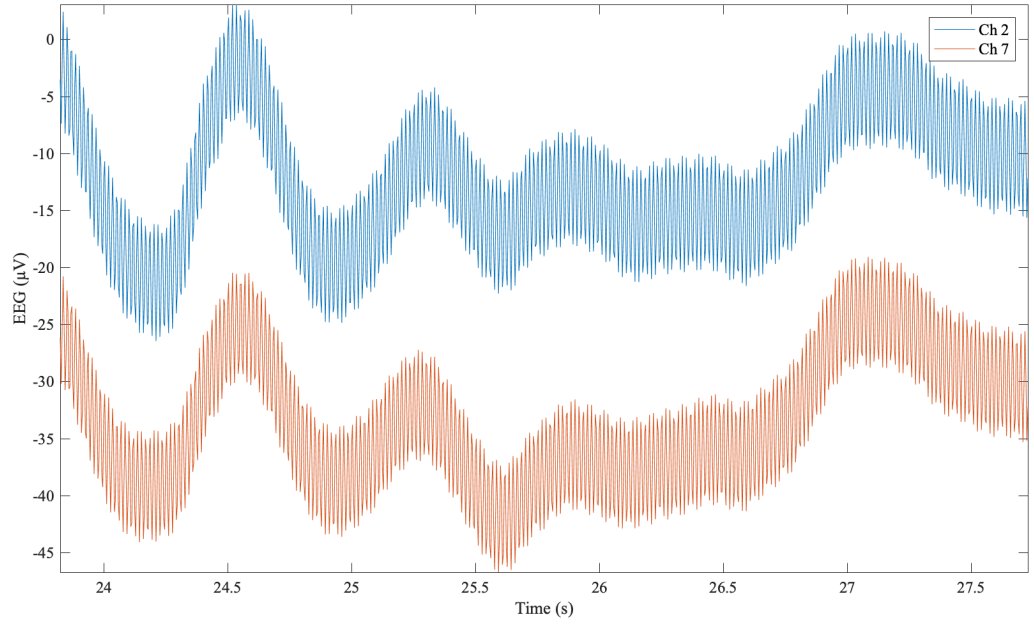
Six channels, without 2 and 7, the full 16-minute history



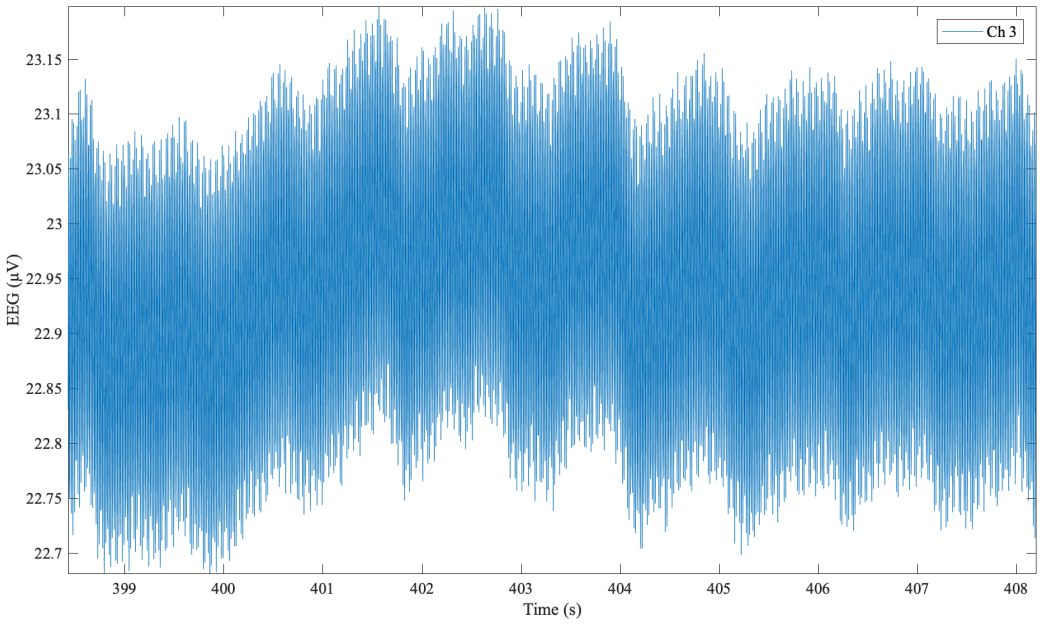
Channels 3 and 4, 20-second cut



Channels 3 and 4, 4-second cut



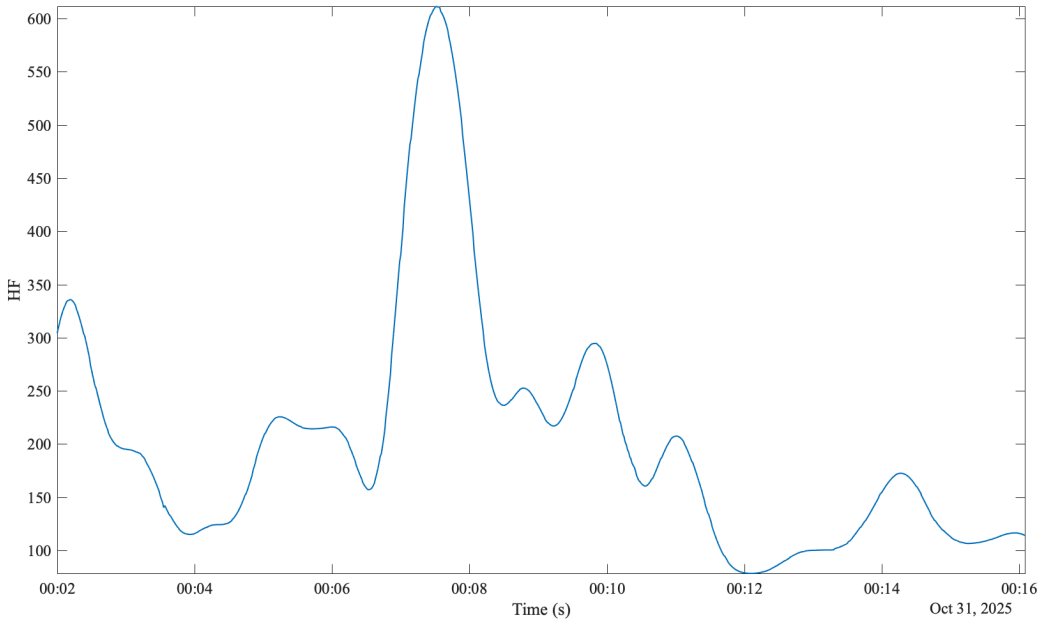
Channels 2 and 7, 4-second cut



Channel 3, 10-second cut

HRV Data

Below is the whole table, full 16-minute history. Correction: the x-axis shows time in minutes.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450
400
350
300
250
200
150
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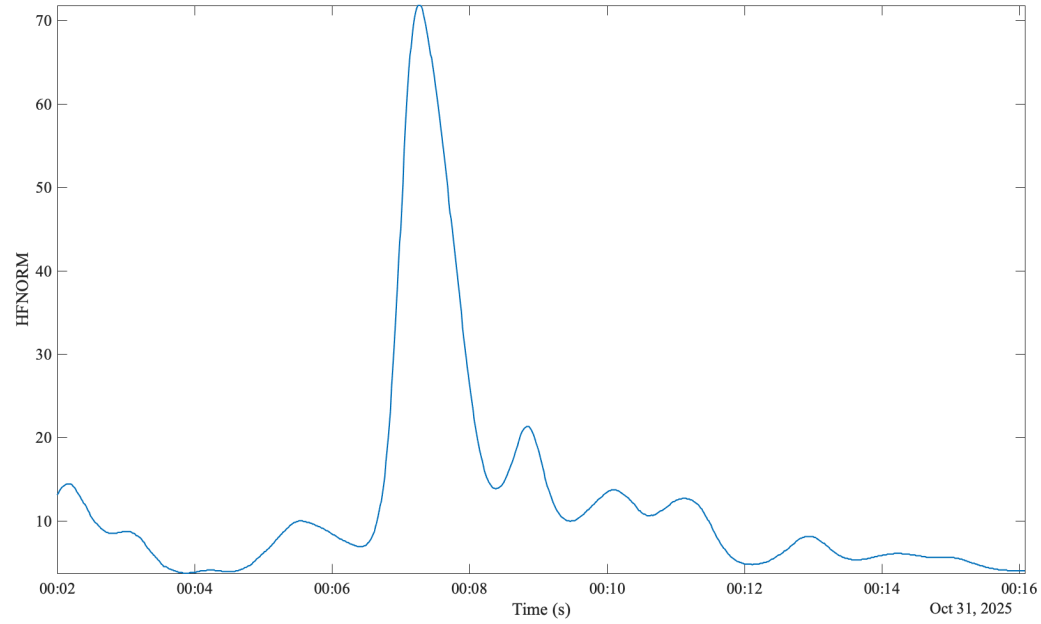
00:06
00:08
00:10
00:12
00:14
00:16
Time (s)
Oct 31, 2025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Time (s)
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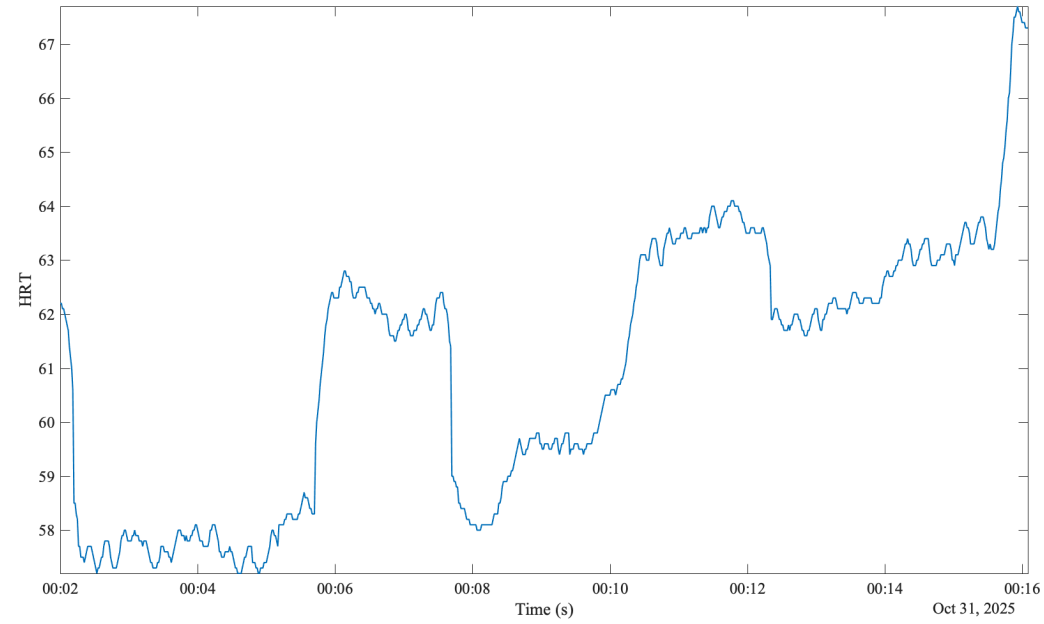
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Time (s)
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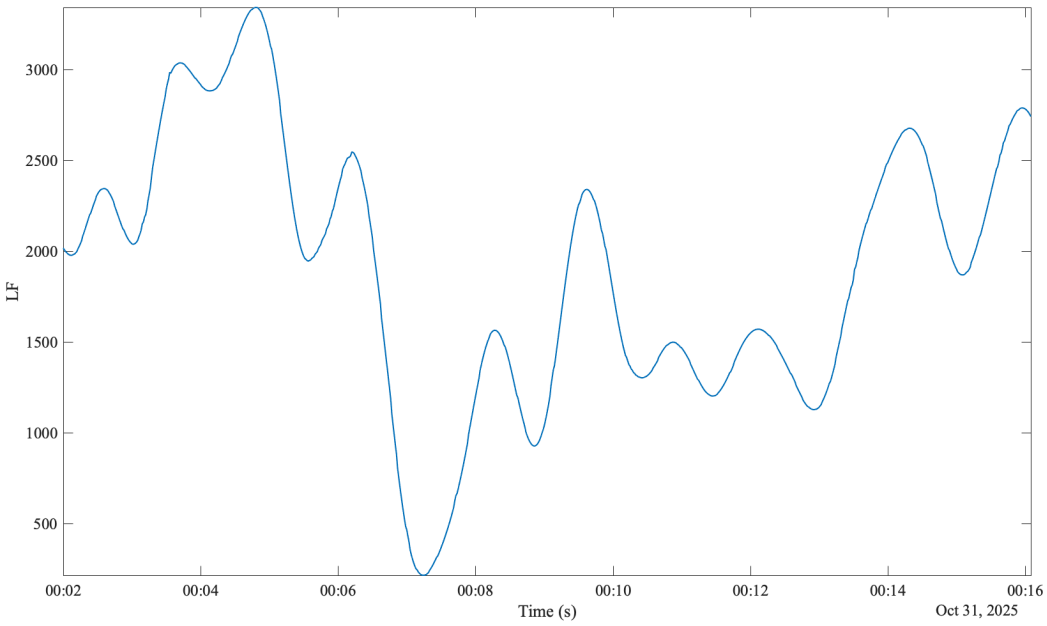
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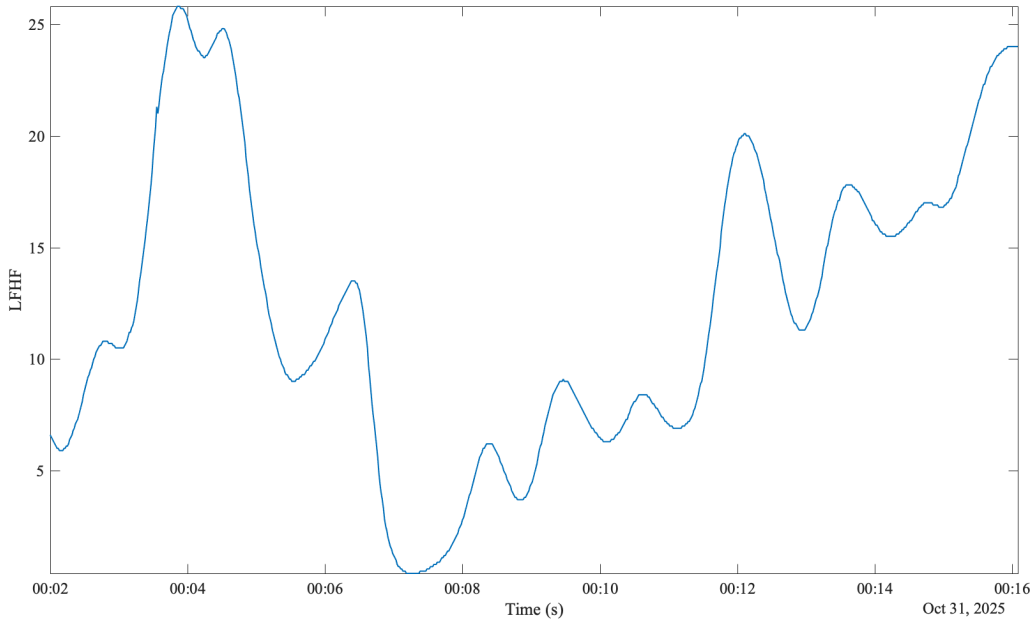
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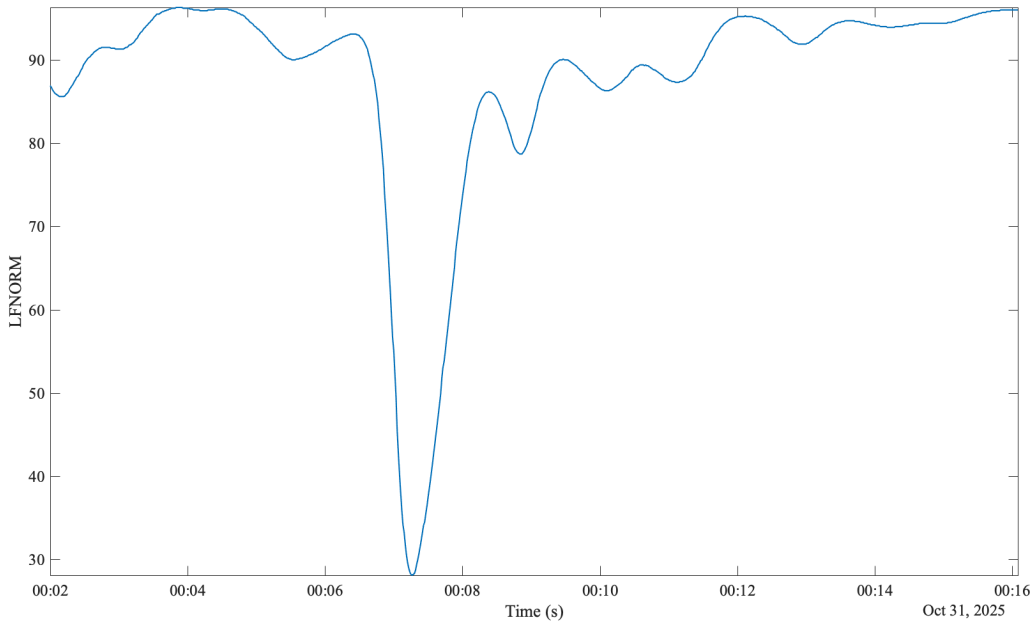
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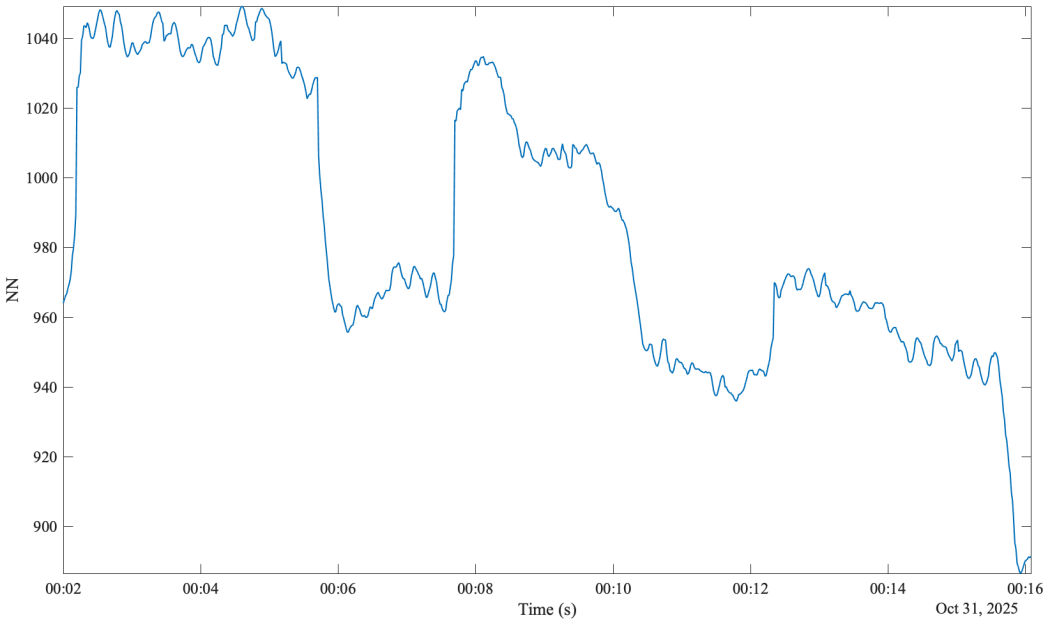
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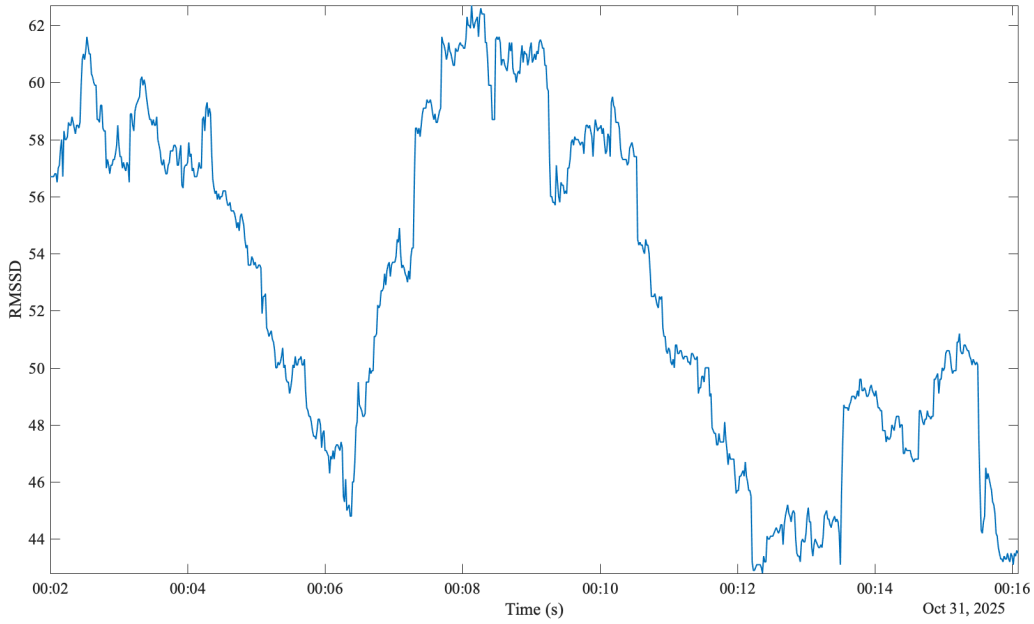
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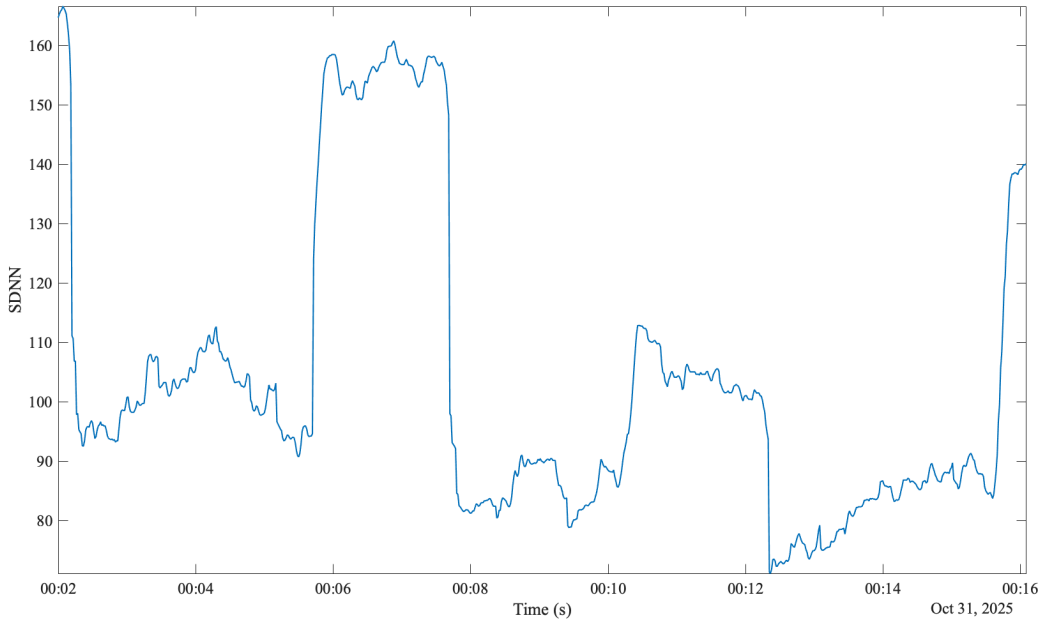
Time (s)
Oct 31, 2025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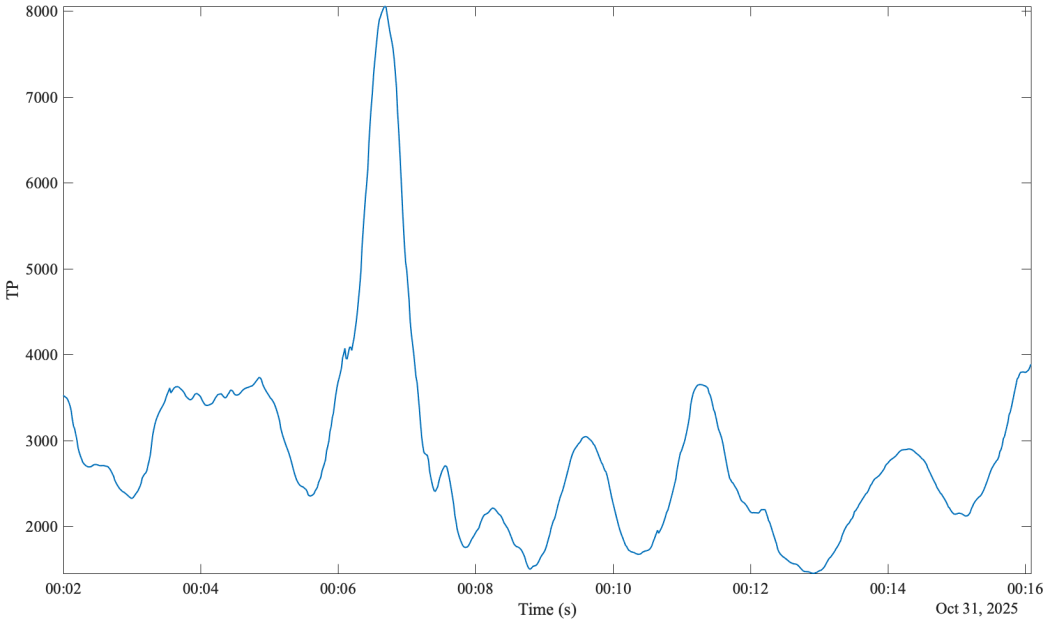
Time (s)
Oct 31, 2025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4000
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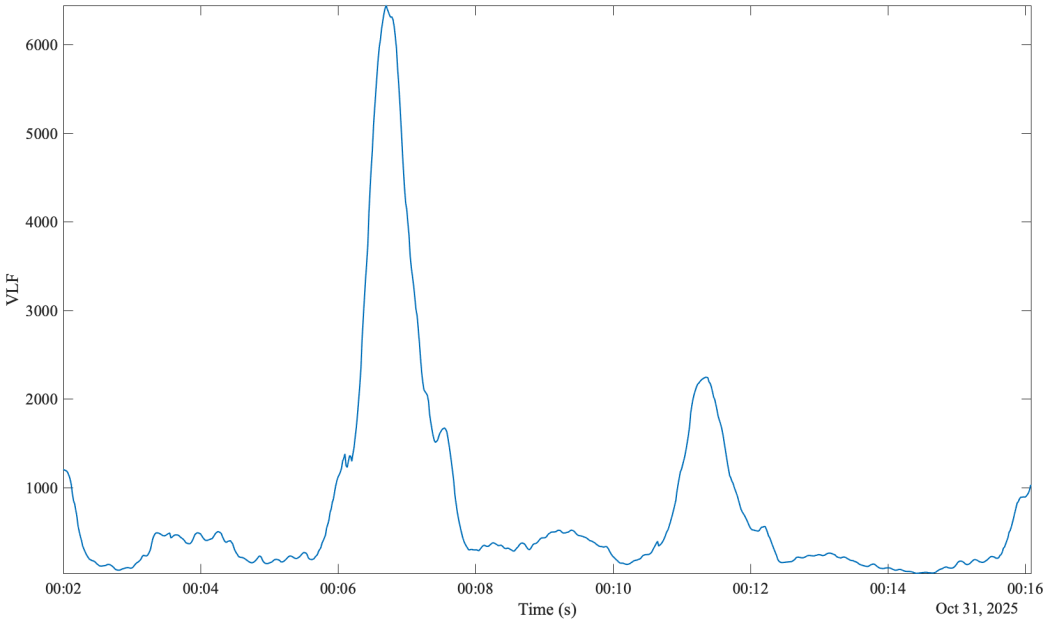
Time (s)
Oct 31, 2025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4000
3000
2000
1000
VLF
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00:04
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00:10
00:12
00:14
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Time (s)
Oct 31, 2025